Best Management Practices for Agricultural Erosion and Sediment Control

SONOMA COUNTY AGRICULTURAL COMMISSIONER'S OFFICE

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INTRODUCTION

On December 9, 2008, the Sonoma County Board of Supervisors adopted Ordinance No. 5819, amending the Sonoma County Code and the previously adopted 2007 California Building Code with respect to the regulation of grading, drainage, and vineyard and orchard site development. One of the requirements of this ordinance is compliance with best management practice guidelines. The minimum requirements discussed in this handbook are specific to agricultural practices in Sonoma County for Sonoma County soul types and weather conditions.

The purpose of the Sonoma County Best Management Practices handbook is to provide the minimum requirements to control water quality impacts from accelerated erosion due to agricultural activities in Sonoma County. The intent of this handbook is to show what basic practices are effective in reducing erosion and sedimentation and to show how to install these practices.

It is not the intent of this handbook to provide design criteria for engineered structures. Steeper slopes and projects with grading and drainage components may need structures designed by a licensed engineer.

The process of soil erosion by water involves the detachment of particles from the soil mass, the transportation of the particles by runoff, and the eventual deposition of particles in the form of sediment. Most of the energy responsible for erosion is provided by the impact force of falling raindrops or by the force of surface storm water runoff. Disturbance of soil from farming practices can add to the problem by loosening and pulverizing soil particles, thereby making them more easily moved by rainfall and runoff and by removing the vegetative cover that protects and holds together soil and slows runoff velocity thereby decreasing its capability of transporting soil particles downslope.

Raindrops strike the ground with a velocity of approximately 20 mph. The force of the raindrops breaks apart soil particles, and surface runoff transports the particles downslope. If the soil is not protected from the force of raindrops it will be lost from the agricultural operation and eventually it will be deposited as silt in a creek or waterway where it can have water quality impacts and harm fish habitat.

Drainage features such as pipe with inlets, water bars, swales, and perforated pipe can discharge sufficient water to create a gully, sediment plume, or both, that can extend to a stream channel. These structures are very effective in some situations, provided they have a sediment collection component.

Technical support was provided by Munselle Civil Engineering and Enterra Associates.
Front cover photographs are (clockwise starting from upper left): Rock lined channel designed by Atterbury & Associates, Inc., olive orchard at Kunde Winery, sediment basin designed by Atterbury & Associates, Inc., and erosion control featuring cover crop, straw mulch, and straw wattles designed by Edwards Engineering.

REGULATORY REQUIREMENTS

Development of agricultural land for new crop planting or replanting may require permits from various regulatory agencies. The following are some guidelines to help determine if permits would be required and the agencies to contact.

Planting New Vineyard/Orchard or Replanting Existing Vineyard/Orchard

If your project is to plant new vineyard/orchard or replant existing vineyard/orchard, you will need to contact and obtain a permit from the Agricultural Commissioner's Office (707-565-2371).

Removing Trees

Oak trees are protected in certain areas of the county. Check with the Agricultural Commissioner's Office or Permit and Resource Management Department (707-565-1900) to see if a permit is needed. Redwood, fir, and pine trees may not be removed without first contacting the California Department of Forestry (707-963-3601).

Grading and Drainage

If your project involves moving more than 50 cubic yards of soil or stockpiling more than 50 cubic yards of material, you may need a grading permit from the Agricultural Commissioner's Office (707-565-2371). Also, if you are placing fill in the Laguna de Santa Rosa or within the Flood Prone Urban Area (see maps at PRMD) you may need a grading permit. In order to obtain a grading permit you may need to submit engineered plans.

If you are altering surface flow runoff by adding or changing existing drainage swales or installing drainpipe with inlets, you may need drainage review from the Agricultural Commissioner's Office. This review may require you to submit an engineered drainage plan. Re-directing subsurface flow with perforated pipe or french drains may not require drainage review. You must not discharge the pipe directly into a creek or onto a creek bank. Make sure the discharge end of the pipe is protected with rock rip-rap.

Altering a Creek or Stream Bed

A creek or stream is defined by the Department of Fish and Game (CDFG) as any drainage way having a defined bed and bank. These features may be under the jurisdiction of the CDFG. You may not substantially alter or obstruct a creek or stream or its bank subject to state jurisdiction without first obtaining a Streambed Alteration Agreement from the CDFG (707-944-5500). Activities which may require this prior approval include the diversion of a stream or creek, construction of a discharge pipe within a creek or stream, depositing or disposing of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into a creek or stream, the placement of a culvert into a creek or stream or construction of a stream or creek crossing.

Wetlands and Vernal Pools

Areas that are seasonally or perennially saturated with water can represent unique aquatic plant habitat such as wetland and vernal pools. Many of these areas are habitat for endangered species of both plants and animals. A common misconception is that these areas are springs and can be drained with the addition of subsurface drainage. Wet areas may be jurisdictional waters of the United States and may be regulated by the State of California. Their development for an agricultural crop may require a permit from the United States Army Corp of Engineers (415-977-8439) and/or

the State of California. The best advice if you have a wet area is to have it assessed by a biologist before proceeding with site development for your agricultural project.

Endangered Species

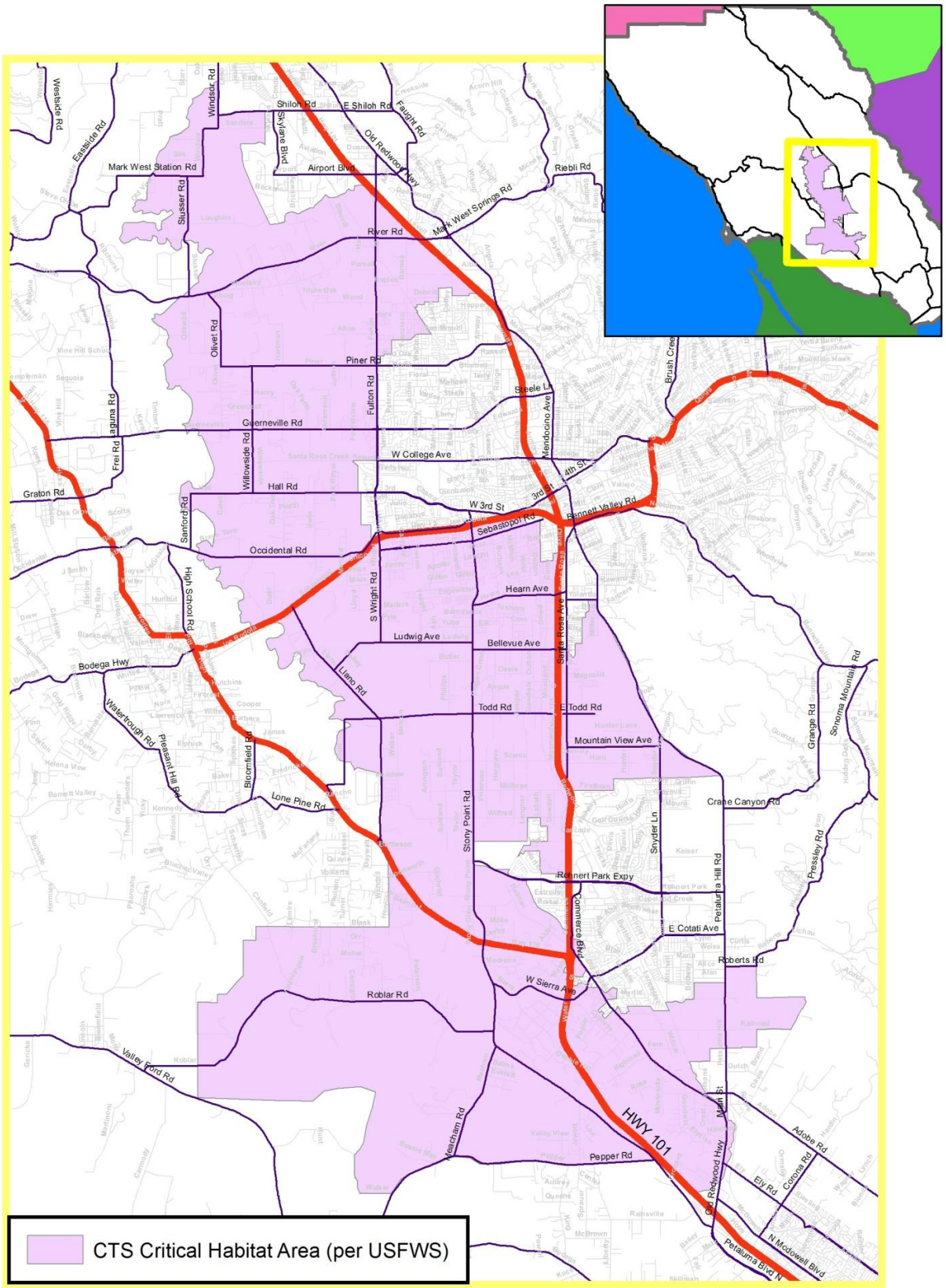
Both Federal Endangered Species Act (FESA) and the California Endangered Species Act (CESA) prohibit the "take" of a protected wildlife species. Under ESA, "take" includes activities that kill or injure a listed species, or activities that result in habitat impacts that cause actual death or injury. Under CESA, "take" means to "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill" a listed species.

California Tiger Salamander: On July 22, 2002, the United States Fish and Wildlife Service listed the Sonoma population of the California tiger salamander (CTS) as endangered under the FESA. On July 20, 2010, the State of California listed the CTS as "threatened" under the CESA. CTS require vernal pools and other temporary bodies of water for breeding and upland habitat (including ground squirrel holes) for growth and survival. CTS migrate between upland and aquatic areas during the fall months. CTS are known to exist in distinct areas of Sonoma County. If you are uncertain whether CTS may exist on your property we encourage you to consult with a qualified biologist.

Other Protected Species: Certain other plant and animal species present in Sonoma County are listed species under the FESA and CESA. If you are uncertain whether any protected species may exist on your property, we encourage you to consult with a qualified biologist.

If your proposed project involves activities that might "take" any listed species under California or federal law, you will need to consult an expert as to your obligations under the FESA and CESA or contact the United States Fish and Wildlife Service (USFWS) (916-414-6600) and/or the California Department of Fish and Game (707-944-5500) directly to discuss your project and its potential impacts. If your proposed project involves activities that might "take" any listed species and also requires a federal permit, such as a permit from the United States Army Corp of Engineers as described above or relies on federal funding, consultation with USFWS will be required

California Tiger Salamander (CTS) Critical Habitiat Area



Sonoma County Agricultural Commissioner's Office
133 Aviation Blvd, Santa Rosa, CA

Print Date: 12/11/2013

0 0.75 1.5 3 4.5 Miles

Official USFWS mapping portal: http://criticalhabitat.fws.gov/crithab/

CHAPTER ONE-Layout/Site Development

The layout of a vineyard/orchard can substantially affect the quantity of runoff delivered to a stream. Vineyards/orchards should be planned to take advantage of natural drainage features and maximize infiltration. Steps should be taken to minimize impacts on stream flow. Select varieties of grapes that are appropriate for the soil type, water source and frost conditions.

Environmental Concerns

Steep slopes are more vulnerable to erosion compared to gentle slopes. When fine sediments are eroded from adjacent hillsides, they can settle within the stream channel, fill in pools necessary for rearing, and smother gravels needed for spawning. Riparian areas provide stability to the natural drainage features of the land and are an important habitat component of streams. Trees provide shade that keeps water cool. Increased peak flows in a stream increase the likelihood that juvenile salmonids will be flushed downstream away from their rearing habitats. Reduced aquifer recharge reduces summer low flows and may result in a dewatering of streams and salmonid death

Site Evaluation

Examine the property for any signs of instability. Identify soil types, slopes, and types of vegetation, water source, frost prone areas, ponds, wetlands, designated and undesignated streams and riparian zones. Inventory existing roads and drainage improvements. To inform the landowner of site specific biotic resources, have a qualified expert conduct an assessment or studies for potential impacts to any listed species under California or federal law.

Best Management Practices

1.1. In accordance with the County's Grading, Drainage, Vineyard/Orchard Site Development ordinance, for new vineyards/orchards or replanted vineyards/orchards on steep slopes or highly erodible soils, follow plans prepared by a qualified civil engineer.

1.2. Avoid disturbing any areas with landslides, gullies and slips.

1.3. Reduce the length of slopes draining to riparian areas using numerous drop inlets with sediment traps, vegetated filter strips, or rolling dips.

1.4. Incorporate structural erosion control systems to intercept and diffuse water flow and encourage infiltration into vineyard design: Use drop inlets with sediment traps; daylight underground outlets to vegetated swales; energy dissipaters; infiltration galleries; or sediment basins to prevent excess sediment from entering streams.

1.5. Plan vineyard/orchard blocks and developed areas supporting the vineyard/orchard to drain to a grassy filter area or a detention/sedimentation pond to remove pollutants.

1.6. Riparian areas should be avoided if still intact, and if altered, they should be re-vegetated and restored (see Chapter 5 for more details).

1.7. Consolidate all-weather surfaced access roads, staging areas, and parking away from the riparian zone.

1.8. Consider the most efficient use of the water for irrigation and frost protection. Avoid planting in frost prone areas (e.g. near trees or buildings) that would require a water source for frost protection. Consider planting in frost prone areas if the area can be protected by wind machines.

1.9. Avoid planting early budding varieties in frost prone areas that would require sprinkler frost protection (e.g., areas where cold air is trapped by natural topography or vegetation).

1.10. When planning a new vineyard or a replant, consider dry farming once vines mature and groundwater conditions within the root zone are favorable.

1.11. Ensure that you have a legal right to your water source.

1.12. Base layout and site development on a qualified expert's recommendations with respect to any listed species protected under California or federal law. Avoid any action that constitutes take under the Federal Endangered Species Act or California Endangered Species Act, unless accompanied by an Incidental Take Statement or Incidental Take Permit issued by the appropriate agency.

Figure 1.1 Example Vineyard Layout

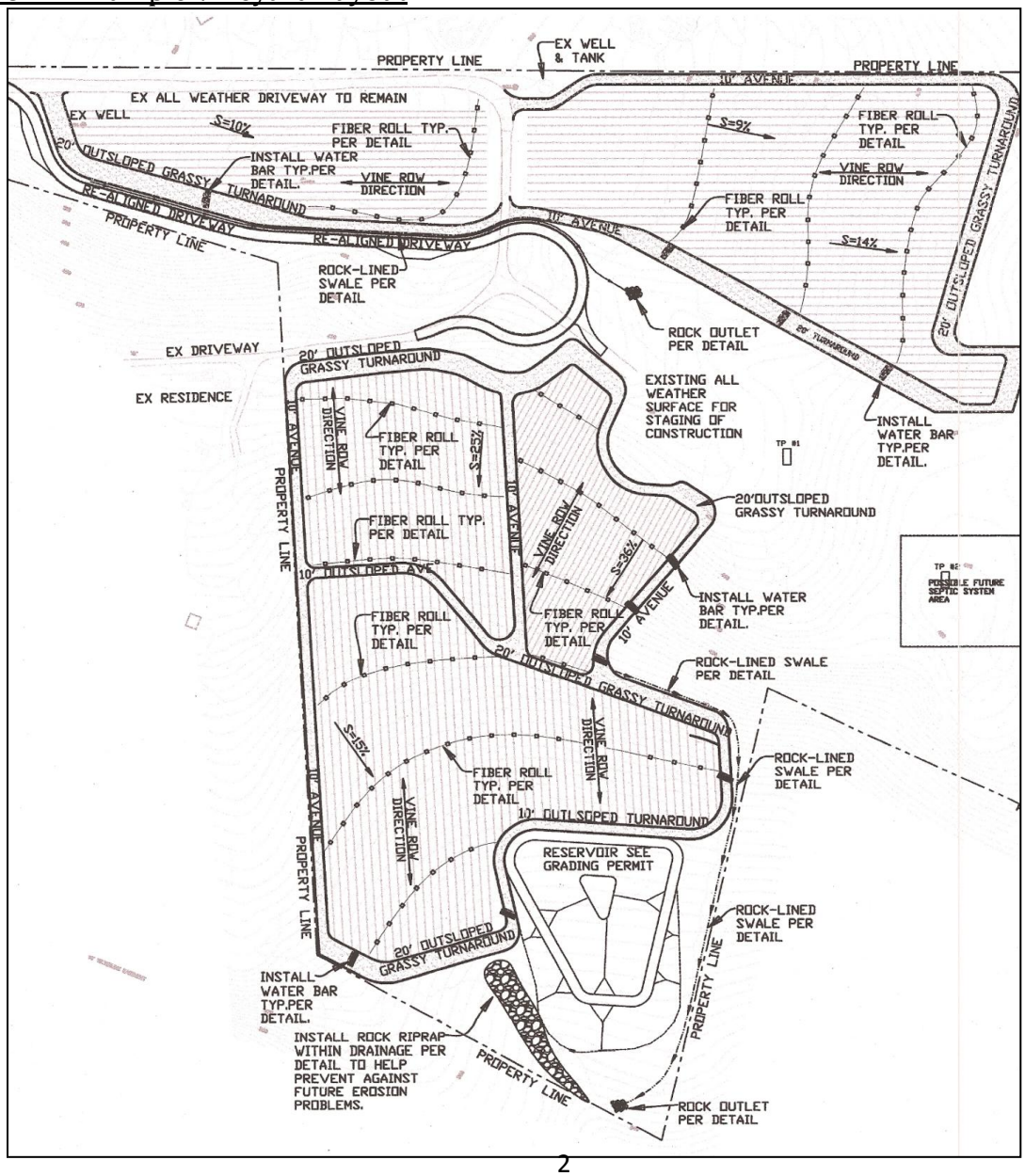
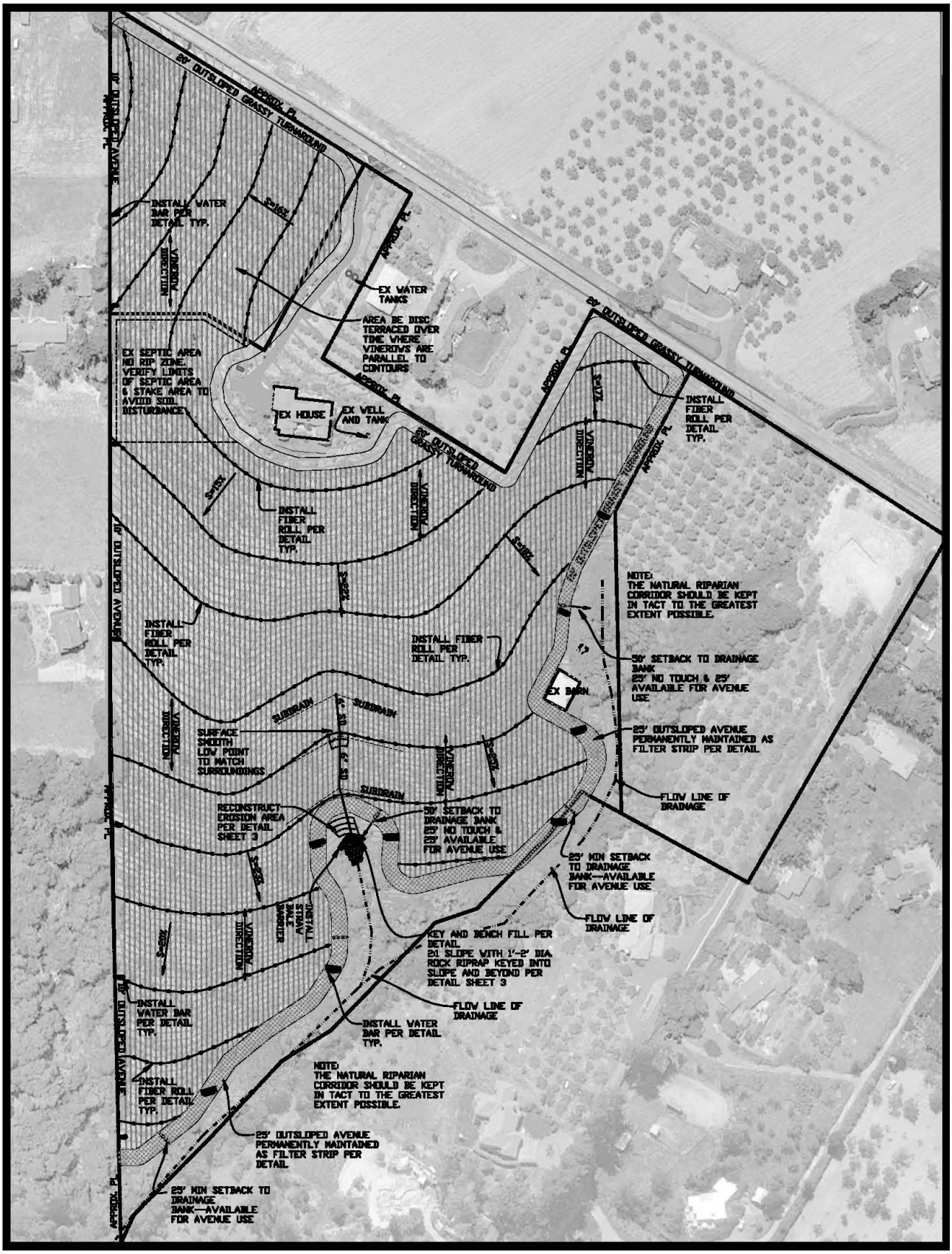


Figure 1.2 Example Vineyard Layout Near Stream



CHAPTER TWO-Roads

Fine sediments eroding from roads are a major source of sediment to streams in Sonoma County and throughout Northern California. Whether it is surface runoff or concentrated storm runoff, sediment and other pollutants are reaching streams and harming our natural resources.

Good planning, proper location and the use of progressive construction practices result in low maintenance, low impact roads.

Removing existing access roads from within the riparian zone will reduce fine sediment inputs, greatly improving spawning and rearing habitats for salmonids and eliminate the influence of the road on the stream system.

Environmental Concerns

Fine sediment delivered from roads to streams reduces the flow of oxygenated water to embryos, limits invertebrate prey, fills in pools used for rearing, and cements spawning gravels, reducing the area available for adult salmonids to successfully spawn.

If roads are built too close to a stream, the result is often that streams are armored and straightened to protect the adjacent road. Simplified channels provide less cover and rearing habitat for salmonids. Furthermore, roads interrupt the functions of riparian zones in providing bank stability, filtering sediment and pollutants, and providing shade, large woody debris, and invertebrates to streams. Improperly sized or designed culverts are a common barrier to fish passage in Northern California stream systems.

Site Evaluation

Use a map or aerial photo to view the location of the road system, including abandoned and unused roads and identify all potential sources of sediment to the stream. Identify stream crossings and the type and size of culverts. Examine the downstream side of stream crossings to see if there is erosion from concentrating flows or by directing flows into the streambank.

Best Management Practices for Agricultural Roads

2.1. Decommission or relocate existing roads away from the riparian zone whenever possible.

2.2. Weatherproof or harden daily traffic roads. Pave or chip seal before the rainy season to allow toxic compounds in the oils to solidify, degrade or volatilize from the road surface and not be delivered to waterways.

2.3. Establish a thick cover crop on temporary or seasonal ranch roads by October 15. Depending on traffic, this may require active seeding annually.

2.4. Use straw mulch during the rainy season in places where cover crops are sparse. Monitor and augment straw treatments as necessary.

2.5. Blade existing roads in dry weather when possible, but while moisture is still present in soil and aggregate to minimize dust and maximize compaction to prevent road fines from being discharged from the road surface.

2.6. Do not sidecast the bladed material to areas where the material can enter the stream directly or indirectly as sediment. Sidecast material can indirectly enter the stream when placed in a position where rain or road runoff can later deliver it to a channel that connects with the stream.

2.7. Out-slope roads wherever possible to prevent the concentration of flow within the ditch, to promote even draining of the road surface and to minimize disruption of the natural sheet flow pattern off the hill slope to the stream.

2.8. If unable to eliminate in-board ditches, crowning the road can remove half the road surface drainage from the ditch.

2.9. Use water bars and rolling dips to break-up slope length, diverting water to well-vegetated areas.

2.10. Maintain in-board ditches and line them, if needed, with geotextile fabric or rock.

2.11. Remove stream crossings wherever possible.

2.12. Replace culverts, fords, or Humboldt crossings with single span bridges where possible

2.13. Ensure that all stream crossings meet National Marine Fisheries Service and California Department of Fish & Game guidelines for fish passage.

2.14. Design culverts to pass 100-year flow.

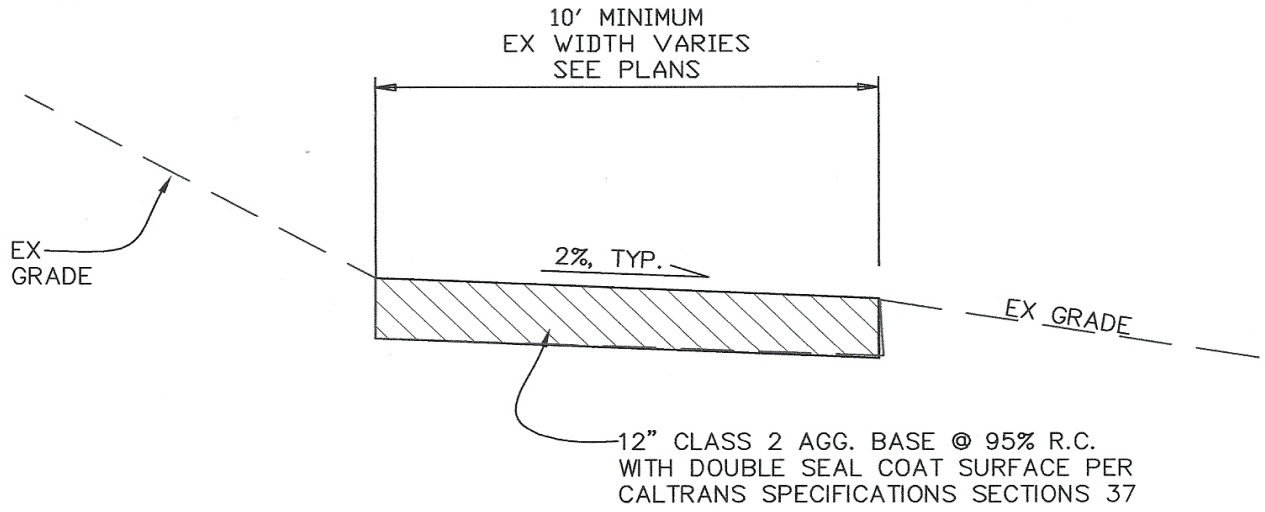
2.15. Check culverts periodically during the rainy season to ensure that they are not plugged with debris.

2.16. Minimize erosion downstream of culverts by using energy dissipaters.

2.17. Monitor energy dissipaters to make sure that they do not wash away or shift.

2.18. Maintain culverts at the level and gradient of the stream bed. In non-fish bearing streams, with "shotgun" culverts, use pipe extenders (e.g., elephant trunks) to bring the discharge down to the level and gradient of the stream.

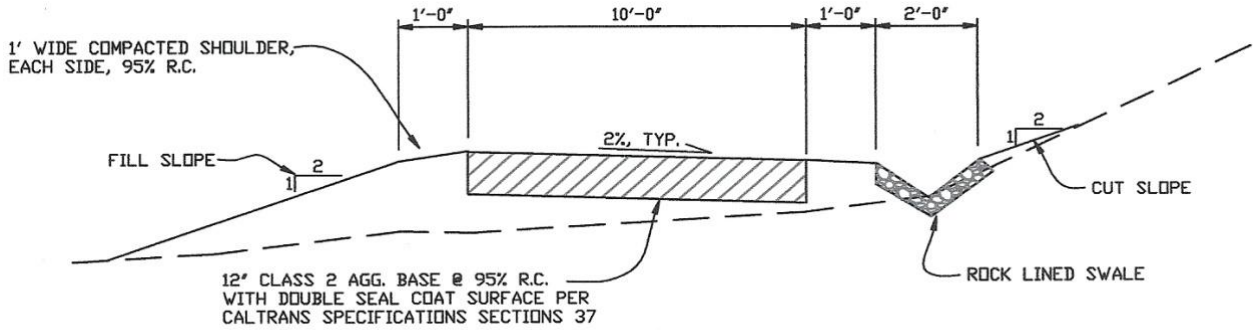
Figure 2.1 Example Outsloped Road



OUTSLOPED ROAD SECTION

N.T.S.

Figure 2.1 Example Insloped Road



NOTES:

1. REMOVE ALL WEAK SOILS AS DETERMINED BY THE GEOTECHNICAL ENGINEER IN THE FIELD DURING CONSTRUCTION.
2. THE SURFACE EXPOSED BY REMOVAL OF WEAK SOILS SHALL BE SCARIFIED TO A DEPTH OF 8", UNIFORMLY MOISTURE-CONDITIONED TO WITHIN 2% OPTIMUM MOISTURE CONTENT, AND COMPACTED TO AT LEAST 95% R.C.
3. FOR FILL SECTIONS APPROVED, SELECT FILL SHALL THEN BE SPREAD IN LOOSE, 8-INCH THICK LIFTS, UNIFORMLY MOISTURE CONDITIONED TO WITHIN 2% OF OPTIMUM MOISTURE CONTENT, AND COMPACTED TO AT LEAST 90% R.C..
4. ALL EXPOSED SOIL SHALL BE PROTECTED FROM EROSION PER EROSION CONTROL NOTES

INSLOPED ROAD SECTION TYP.

NO SCALE

CHAPTER THREE-Cover Crops/Tillage Practices

Planting cover crops is the most cost effective method to reduce the introduction of sediment, nutrients, and pesticides to the stream channel through overland flow.

In addition to their ability to prevent sheet erosion, cover crops can serve many agronomic purposes such as improving tilth, fixing nitrogen in the soil, and providing habitat for beneficial insects.

Protecting bare soil surfaces is one of the best ways to prevent soil loss. Grasses, depending on the type, provide short-term soil stabilization for disturbed areas during construction of your project and can serve as long-term permanent soil stabilization for disturbed areas. There are many different seed mixtures you can choose from. Here are some key things to consider when choosing and planting a cover crop:

- F Most important, be sure that your seed mixture provides overstory (tall fast growing plants like rye, grass, or barley) and understory (low growing broadleaf plants like clover) protection. For example, a mixture of oats and barley will only provide overstory protection and will only be slightly more effective than if you did nothing. The raindrops can still fall down between the tall plant stalks and dislodge soil particles. If you mix in some clover and brando brome, you will get understory protection and the soil will have better protection.

- F The amount of seed you will need depends on the mix you choose. It can range from 30 lbs per acre for a more permanent type of cover crop to 90 lbs per acre for a quick erosion control soil builder mix. Your seed company will be able to help you determine what mix is best for your project and give you the recommended seed rate.

- F Broadcast your seed in the fall. In order to have adequate protection by the start of the rainy season (October 15), the seed should be planted by mid-September. Initial irrigation will be required for most grasses with follow-up irrigation and fertilization. The cover crop should look like a lawn by October 15 (for new plantings and November 15 for replants) in order to provide adequate protection for the soil during the first heavy rains. If you cannot plant by mid-September and irrigate the seed, then you may plant your seed in October and cover it with straw mulch applied at the rate of two tons per acre.

Environmental Concerns

Surface runoff can carry sediment, nutrients, and pesticides directly to a stream, where they affect salmonids and their habitat.

Site Evaluation

Inventory all areas that have rilling and eroded channels. Also, note areas that have sparse natural vegetation or areas where the cover crop has not taken. These areas may need some soil amendments or may need to be reseeded with a different seed mix

Best Management Practices

3.1. Establish thick cover crops by October 15 and maintain them throughout the rainy season (until April 1st).

3.2. Use straw mulch (2 tons/acre) in areas where cover crops are planted late in the fall or if rain is likely after the cover crop has been tilled and there is no perimeter erosion control.

3.3. Whenever possible, avoid tilling early in the spring or late in the fall. Leave filter strip areas or other perimeter erosion control in place if the vineyard rows are tilled early.

3.4. Minimize tillage practices, especially if slopes are greater than nominal (>5-10%) or if soils are highly erodible.

3.5. Filter strip areas or other perimeter erosion control should be left in place if the vineyard/orchard rows are tilled early.

3.6. Do not till turn-around areas except for the infrequent need to reduce compaction. In this case, promptly cover the soil with straw and replant with a cover crop before the rainy season.

3.7. If you till regularly, use sedimentation basins or vegetated filter strips to filter sediment before it reaches the stream.

3.8. Avoid bringing equipment into the vineyard/orchard during the wet season. Close seasonal roads to traffic and maintain permanent roads to prevent erosion.

3.9. Keep on site extra erosion control materials such as straw bales or wattles, gravel or geo-textile fabric and train vineyard crews in their proper installation.

3.10. Check the site after each rainfall event

Example 3.1 Cover Crop Seed Mixes

Hillside- Shallow Soils "Erosion Control"

"Zorro" annual fescue	40%
"Blando" brome	27%
"Hykon" rose clover	23%

(seeding rate: 25lbs. per acre)

Hillside Quick Erosion Control "Soil Builder"

Red Oats	65%
Crimson clover	13%
Austrian winter pea	22%

(seeding rate: 90 lbs. per acre)

Hillside Soils -Frequent Mowing-

"Zorro" annual fescue	40%
Subterranean clover	35%
"Hykon" rose clover	25%

(seeding rate: 30 lbs. per acre)

Vineyard Terrace "Slope Stabilizer"

Blando" brome	45%
"Molate" red fescue	55%

(seeding rate: 25 lbs. per acre)

Quick Erosion Conrol -Cold Soils-

Cereal rye	83%
Crimson clover	17%

(seeding rate: 90 lbs. per acre)

Native, No-till Blend (Mature vineyards)

California meadow barley	36%
"Molate" red fescue	38%
California brome	26%

(seeding rate: 39 lbs. per acre)

Straw Mulch

The most effective erosion control practice (both in terms of protection and cost) is the use of cover crop and straw mulch. Straw provides a cushion between the disturbed soil and the velocity of the raindrop. It's the best insurance for protection from the early rains if you cannot plant your cover crop in mid-September and irrigate it.

- In order for straw to be effective, you must apply it at the rate of two tons per acre (about 42 bales per acre). You should not be able to see any soil once the straw is applied.

- Rice straw is the cleanest straw available (in terms of other weed seeds) but it is a coarse straw and therefore takes longer to degrade. Any straw or grass hay will work provided it's applied at the rate of two tons per acre.

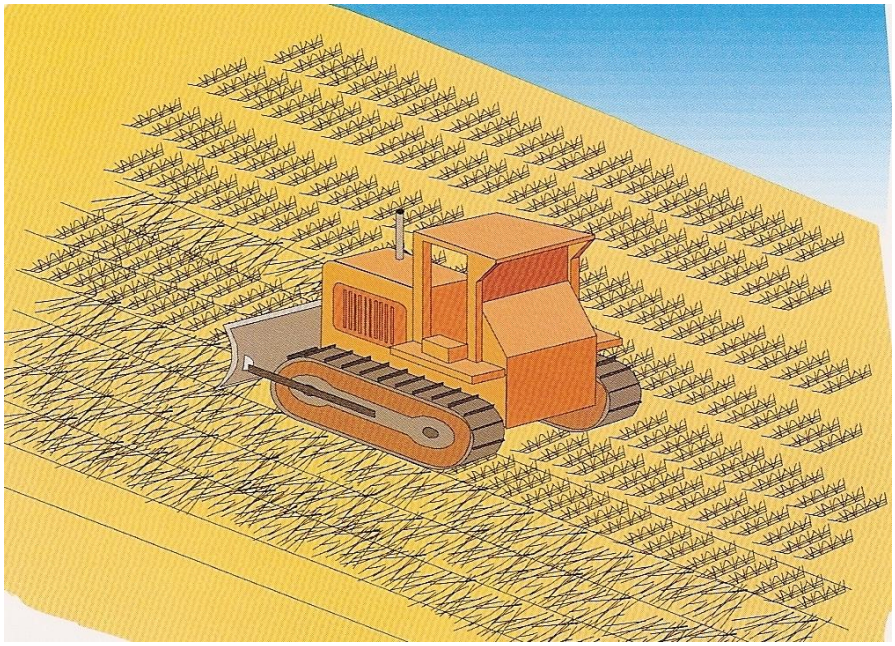
- If you are in an area that has high winds in the fall you must anchor your straw into the ground. You can do this by tracking it in (see example) or by crimping it. Otherwise, be prepared to replace the straw that gets blown away.

- Keep extra straw bales stored for emergency erosion control repairs. If you have an area that starts to gully you can stuff the gully with straw. You can also build emergency dikes to control drainage (see sediment barrier example)**.**

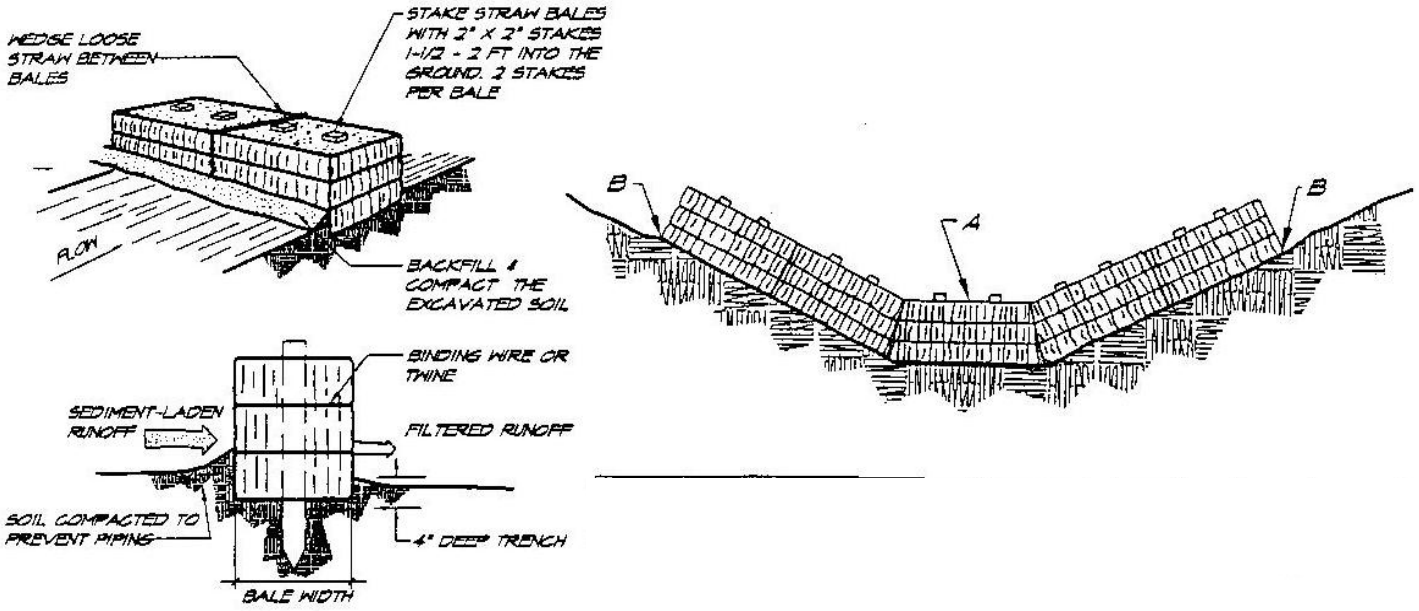
Example 3.2 Tracking Straw Mulch

Notes:

1. Roughen slope with bulldozer.
2. Broadcast seed and fertilizer.
3. Spread straw mulch 3” thick (2 tons/acre).
4. Punch straw mulch into slope by running bulldozer up and down the slope.
5. Tracking with machinery on sandy soil provides roughening without undue compaction.



Example3.3 Straw Bale Sediment Barriers

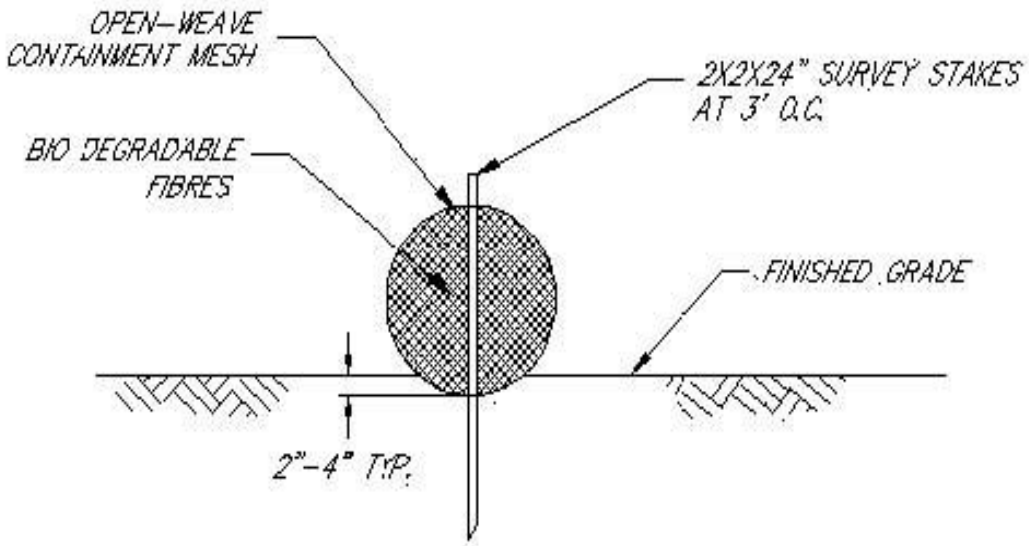


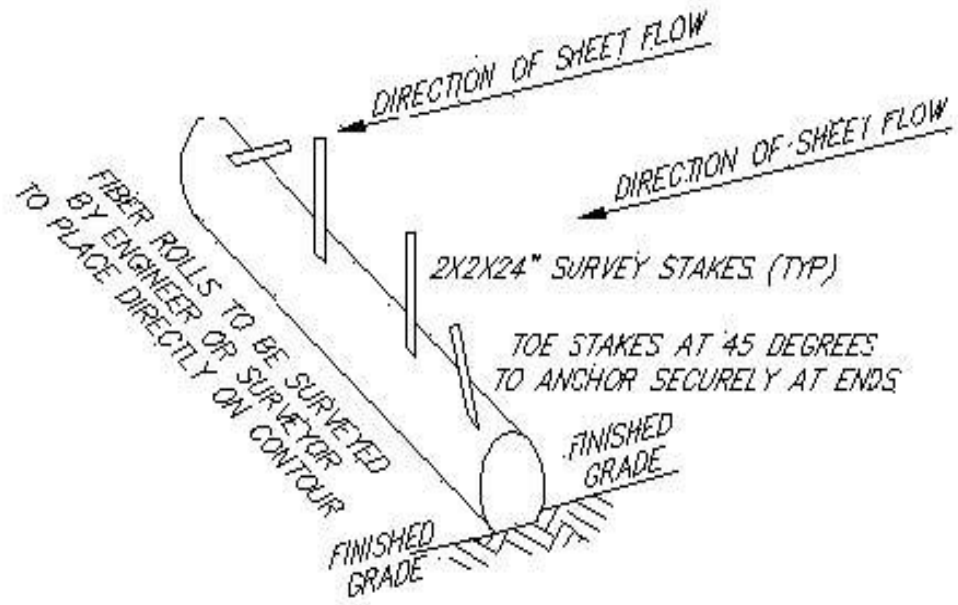
Straw Wattles

Straw wattles or fiber rolls are designed to slow down runoff, filter and trap sediment before the runoff gets into watercourses. Straw wattles are porous and allow water to filter through fibers and trap sediment. They also slow down runoff thereby reducing sheet and rill erosion.

- Straw wattles are effective on slopes to shorten the slope length. They are designed for short slopes or slopes flatter than 3:1 and low surface flows not to exceed 1 c.f.s. for small areas.
- Straw wattles can also be used along stream banks for extra protection.
- They come in several sizes ranging from 8 to 20 inches in diameter.
- It's very important that straw wattles are installed properly. If they're not installed properly, they will not work. Straw wattles must be installed on contour. You may need to have a surveyor help you to be sure you find the contours of your area.
- A good rule of thumb for vertical spacing is: 3:1 slopes = 30 feet apart, 4:1 slopes = 40 feet apart, or as the project engineer dictates.
- Cover Crop should be seeded prior to installation. You will then need to dig a concave key trench 2 to 4 inches deep along the contour. Place the roll in the trench and stake (see example). You must backfill the trench on the uphill or flow side of the roll to prevent water from undercutting the roll. When more than one fiber roll is placed in a row, the roll should be abutted securely to one another with stakes to provide a tight joint. **Do not overlap the joint**.
- After your fiber rolls are in place, the straw mulch can be applied at the rate of 2 tons per acre. Do not drive over the straw wattles.

Example 3.4 Straw Wattle Installation





FIBER ROLL INSTALLATION

CHAPTER FOUR-Drainage

Drainage systems should be designed and maintained to maximize infiltration and minimize sediment delivery to stream by dissipating flow energy, spreading flow, and encouraging infiltration. Drainage systems need to be periodically monitored and maintained to address erosion issues before they cause severe erosion or require costly repairs. It is better to have numerous discharge points in order to avoid the scouring effects of concentrated flow. Drainage systems can, and in some cases should, be designed to discharge into an off-channel water supply reservoir rather than directly to streams.

Drainage systems in new vineyards/orchards or replants in Sonoma County are required by county ordinance to be designed for at least a 25-year storm. They can require design or design approval by an approved civil engineer and should incorporate natural features of the landscape (such as swales) into the drainage system.

Environmental Concerns

Excess fine sediment suffocates developing salmonid embryos, reduces the availability of invertebrate prey to juvenile salmonids, reduces the depth of pools used for rearing, and embeds spawning gravels. Drainage systems should be designed to allow for infiltration and filtration of fine sediment to maintain quality instream habitat conditions for salmon and steelhead.

Drainage systems that rapidly transport rainfall to a stream increase peak flows and decrease groundwater recharge. Changing the natural hydrograph can act as a barrier for fish migrating upstream as adults or downstream as smolts.

Site Evaluation

Inventory all streams, natural drainage swales, wetlands and ponds, existing drainage structures such as culverts under roads, drainage ditches, inlets, outfalls, and sediment ponds.

Evaluate any existing erosion problems and unstable areas.

Best Management Practices

4.1 In accordance with the Sonoma County Grading Drainage and Vineyard and Orchard Site Development Ordinance, design drainage system to handle a 25-year storm; obtain designs or design approval from a civil engineer as required.

4.2 Incorporate natural drainage features into the vineyard/orchard plan to maintain natural sheet flow whenever possible. Consider using vegetated swales as an option to drain pipe whenever possible.

4.3 Monitor vegetated swales for signs of instability, especially in vineyards/orchards with more than minimal slopes and where water has been concentrated into the swale. Consider reinforcing swales with geotextile fabric or grade control structures for additional stability.

4.4 Spread and slow flows by incorporating the following BMP options into the drainage system:

- 4.4.1 Vegetated filter strips
- 4.4.2 Rocked energy dissipaters
- 4.4.3 Vegetated check dams or straw bale sediment barriers along ditches or swales
- 4.4.4 Daylight underground outlets to rocked ditches or vegetated swales
- 4.4.5 Sediment or infiltration basins
- 4.4.6 Straw wattles

4.5 Increase rainfall infiltration to recharge aquifers using the following BMP options:

- 4.5.1 Cover crops
- 4.5.2 Straw mulching
- 4.5.3 Detention ponds
- 4.5.4 Infiltration galleries.

4.6 Use equipment or specialty tires that minimize soil compaction.

4.7 Provide sediment collection features on all drop inlets.

4.8 Provide energy dissipaters for all pipe outfall areas.

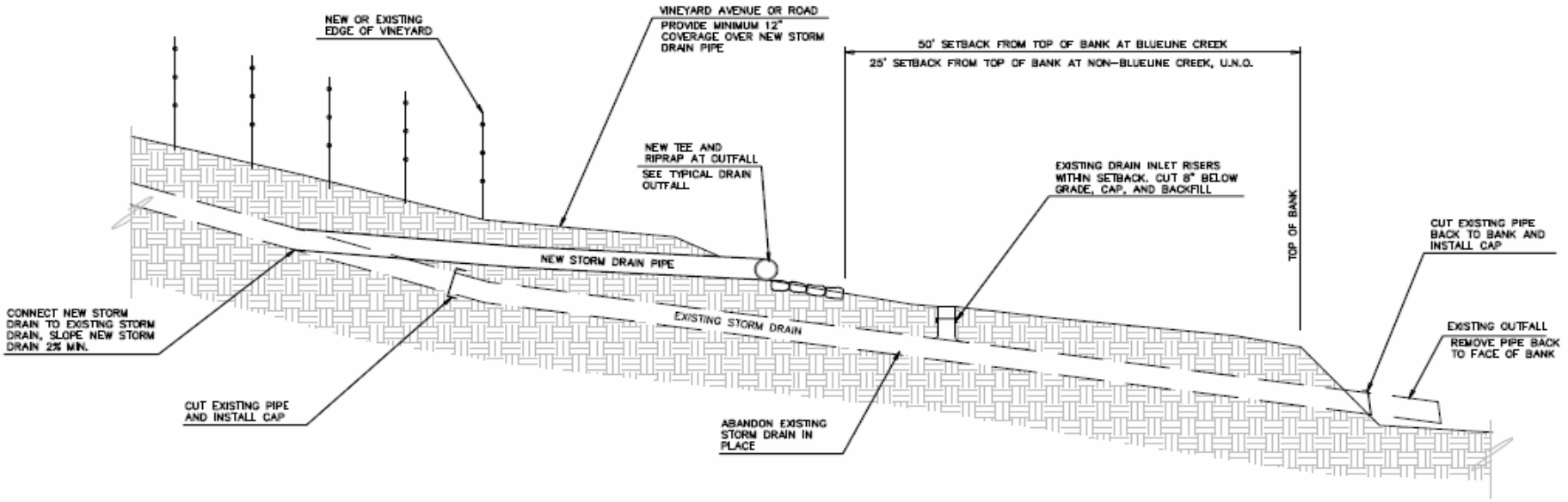
4.9 Discharge drainage pipes upslope of riparian areas and stream banks.

4.10 Use trash racks or caps on drop inlets to prevent debris such as branches from entering the system. Maintain capacity of sediment basins by removing sediments when dry and placing sediment in an area where it will not enter a stream. Design the release of water from sediment basins to mimic natural flow patterns while retaining the sediment in the pond. Perform culvert and drop inlet cleaning on a regular basis, before the wet season begins (October 15) as well as during and after any large storm.

4.11 Check temporary erosion control measures and repair as needed during and after storms: Remove sediment as needed from silt fences, sandbags, straw wattles, and sediment traps. Permanent measures, such as seeding, planting, and rocking, are preferred once the source of any runoff problem is corrected.

Example4.1-Storm Drain Outfall Modification

Drain pipes that outfall in stream channels or on top of stream banks can result in concentrated flow erosion in the channel itself or on the bank. The following photos and drawing is an example of how to modify the pipe outfall so the water will sheet flow through the stream setback area.

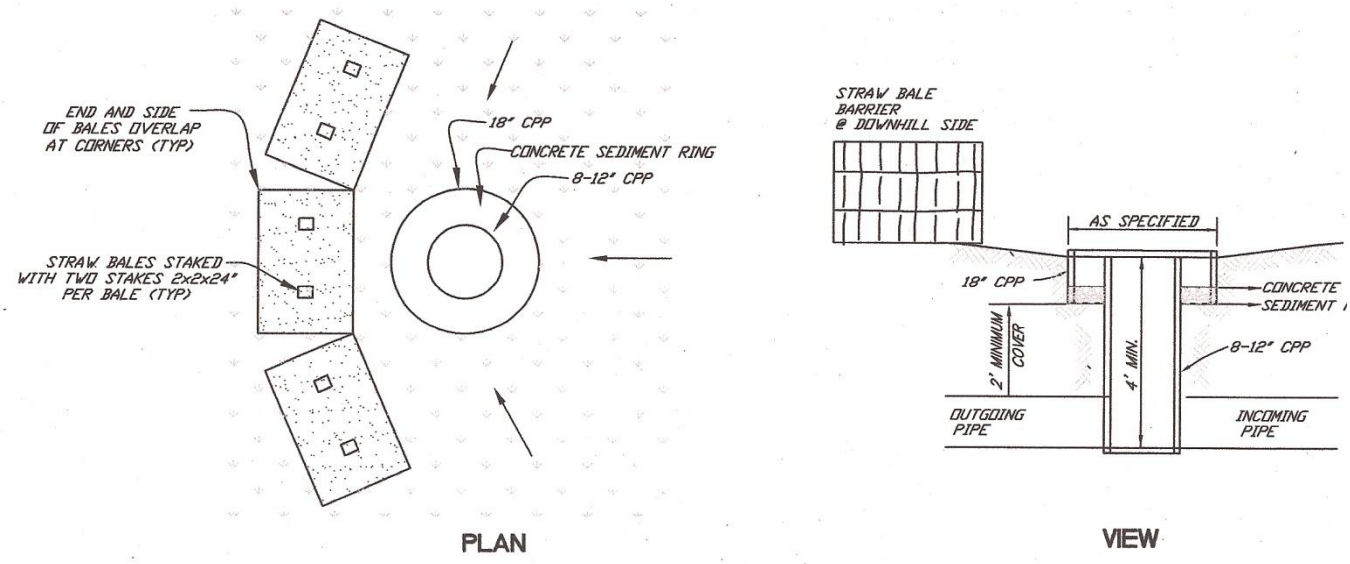


Example 4.2 STORM DRAIN MODIFICATION AT TOP OF CREEK BANK SETBACKS

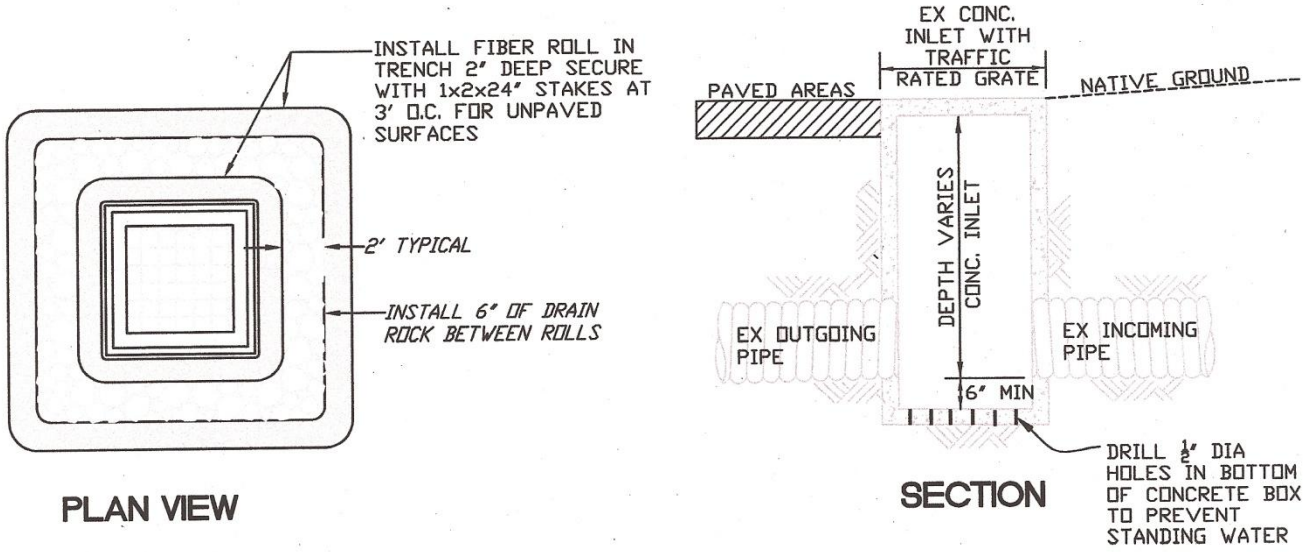
NTS

Example 4.3- Vineyard Inlet With Sediment Trap

All drop inlets should have a sediment collection component. Surface water should be filtered in some way to allow the fines to settle out before the water enters the pipe. Existing drop inlets that do not have a sediment collection component can be easily modified by adding a corrugated plastic pipe collar around the existing pipe. The collection area (sump) must be a minimum of 6 inches deep.

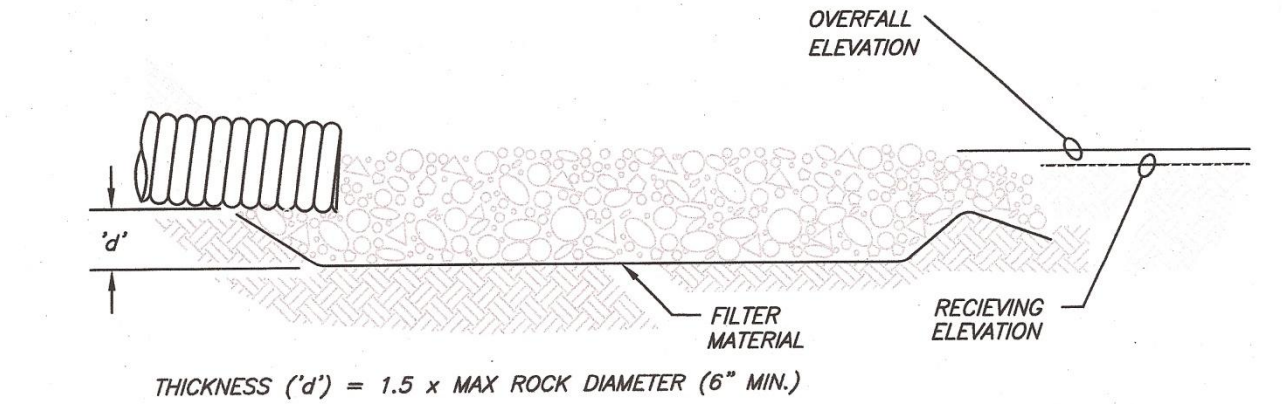


Example 4.4- Concrete Inlet With Sediment Trap

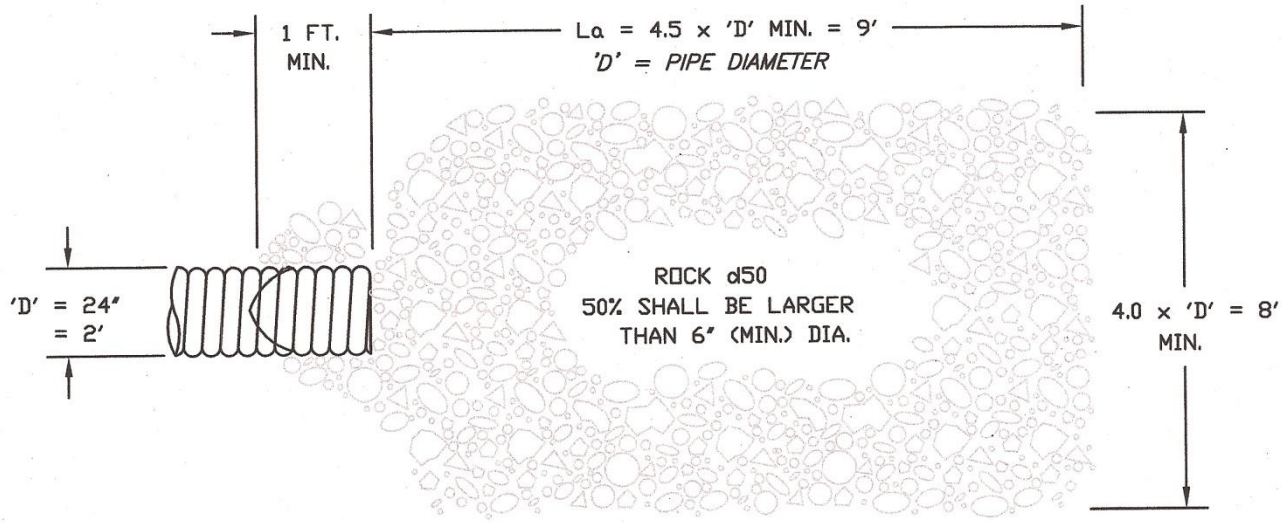


Example 4.5 - Rock Outlet for Storm Drains

All pipe outfalls should have scour protection to minimize sediment delivery downstream. The size of the dissipater is dependent on the size of the pipe. Rock protection can be easily added to existing pipe outfalls. Do not outfall the pipe directly into a creek.



SECTION



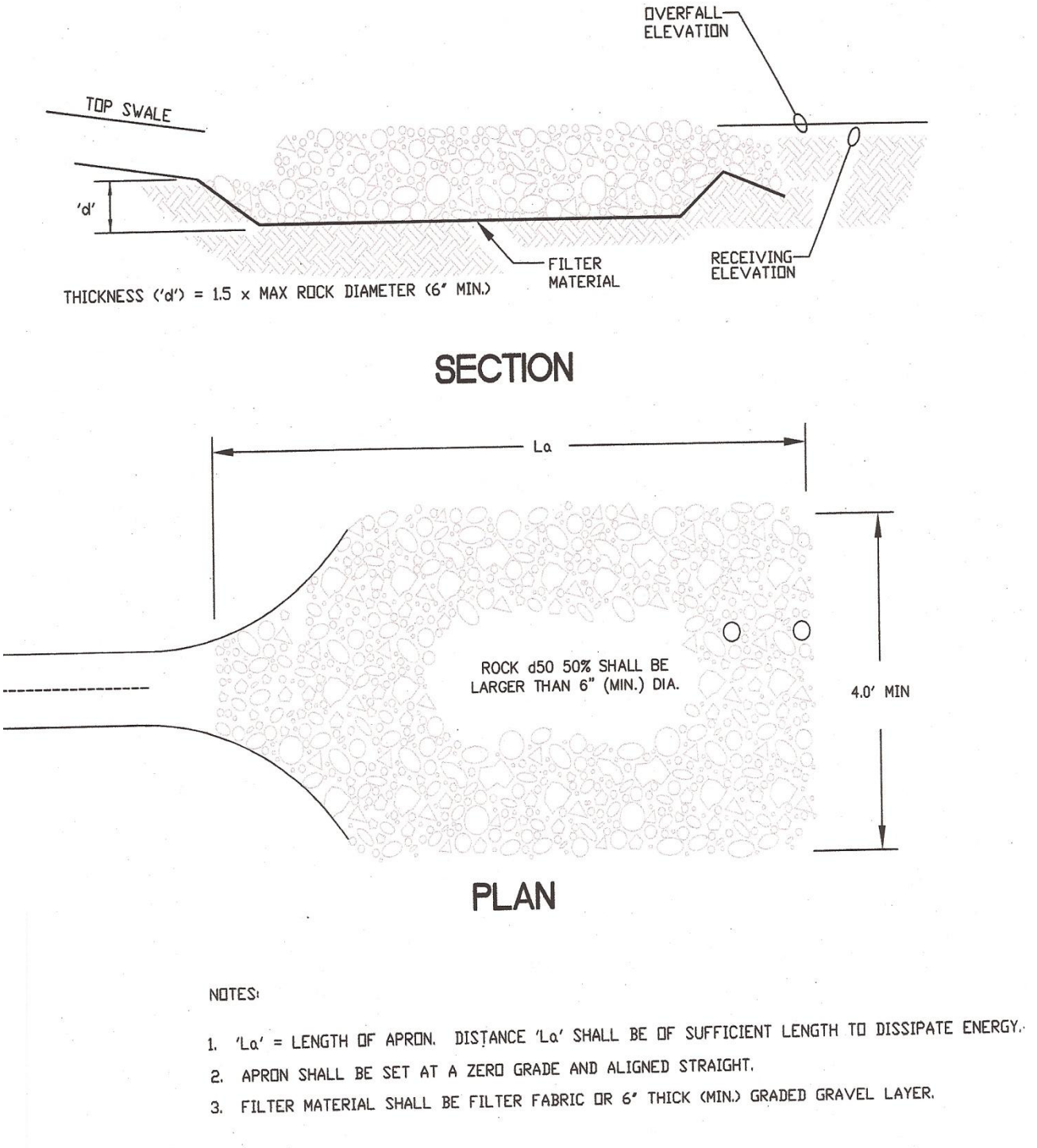
PLAN

NOTES:

1. 'La' = LENGTH OF APRON. DISTANCE 'La' SHALL BE OF SUFFICIENT LENGTH TO DISSIPATE ENERGY.
2. APRON SHALL BE SET AT A ZERO GRADE AND ALIGNED STRAIGHT.
3. FILTER MATERIAL SHALL BE FILTER FABRIC OR 6" THICK (MIN.) GRADED GRAVEL LAYER.

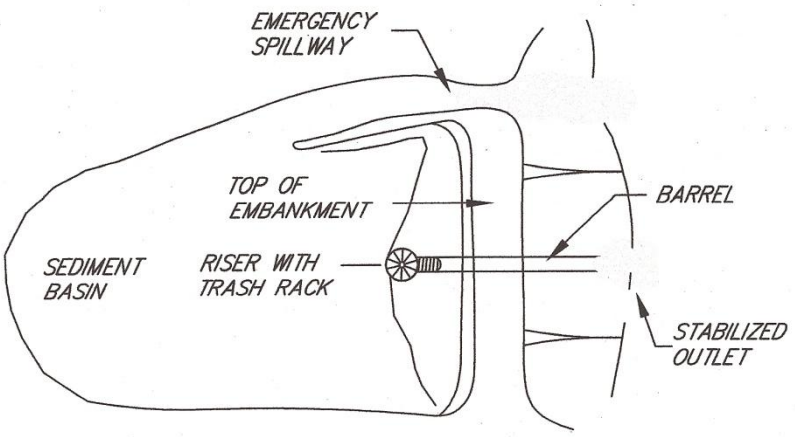
Example 4.6- Rock Outlet for Swales

All swale outfalls should have scour protection to minimize sediment delivery downstream. Rock protection can be easily added to existing swales.

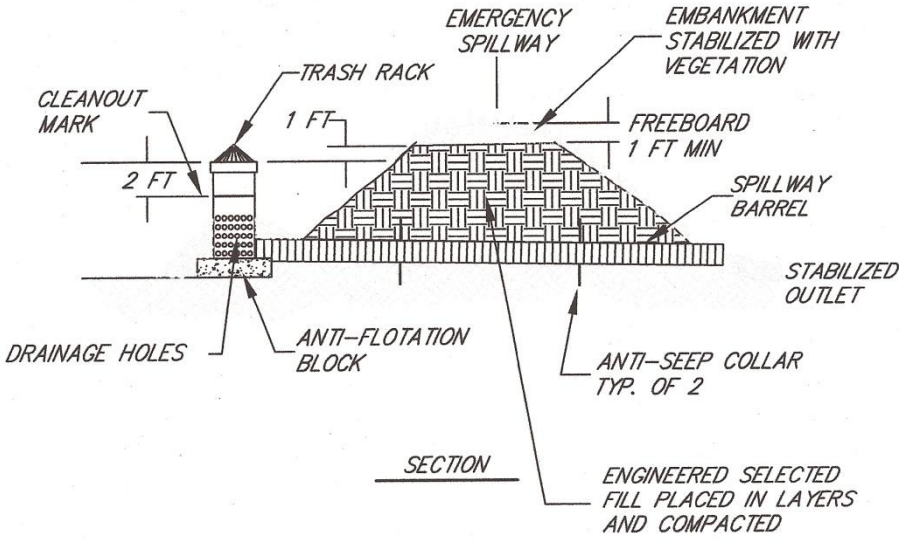


Example 4.7- Sediment Basin

Basins should be designed to drain within 72 hours following storms. The length of the basin should be more than twice the width of the basin determined by measuring the distance between the inlet and the outlet. All slopes should be protected with erosion control blankets.



PLAN



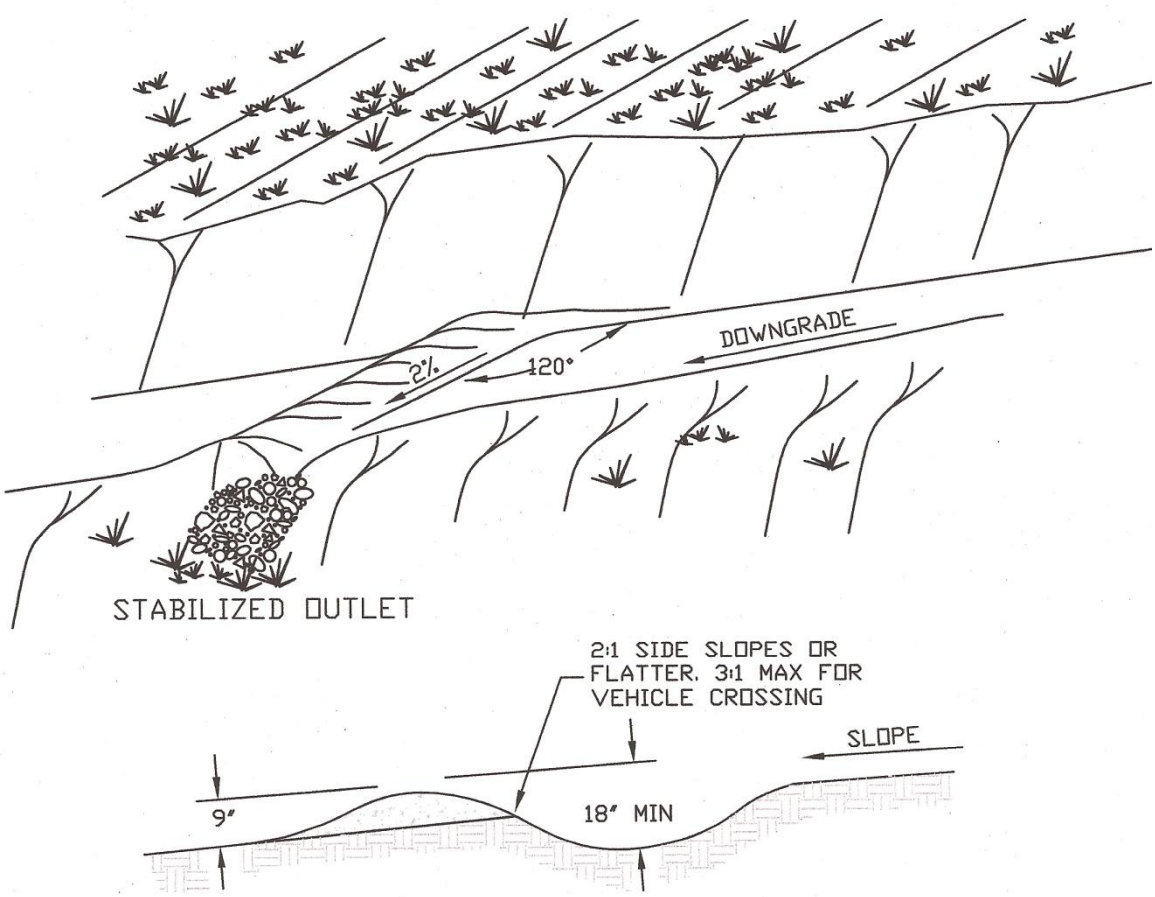
SECTION

NOTES:

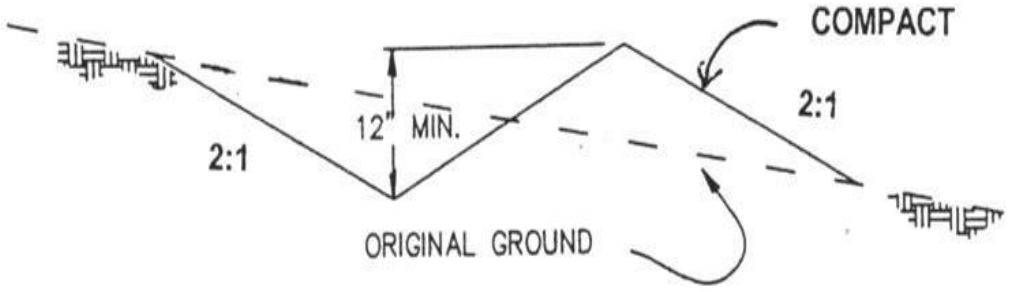
1. THE TEMPORARY SEDIMENT BASIN, DESIGNED BY A QUALIFIED PROFESSIONAL, IS REQUIRED FOR DISTURBED AREAS GREATER THAN 5 ACRES WITHIN A DRAINAGE AREA LESS THAN 100 ACRES.
2. THE SEDIMENT BASIN WILL BE REMOVED WITH- IN 3 YEARS.

Example 4.8- Ag Road Water Bar

Water bars should be installed when the slope of the road or avenue exceeds 15%. Construct water bars not more than 100 feet apart or 50 feet apart for steeper slopes.



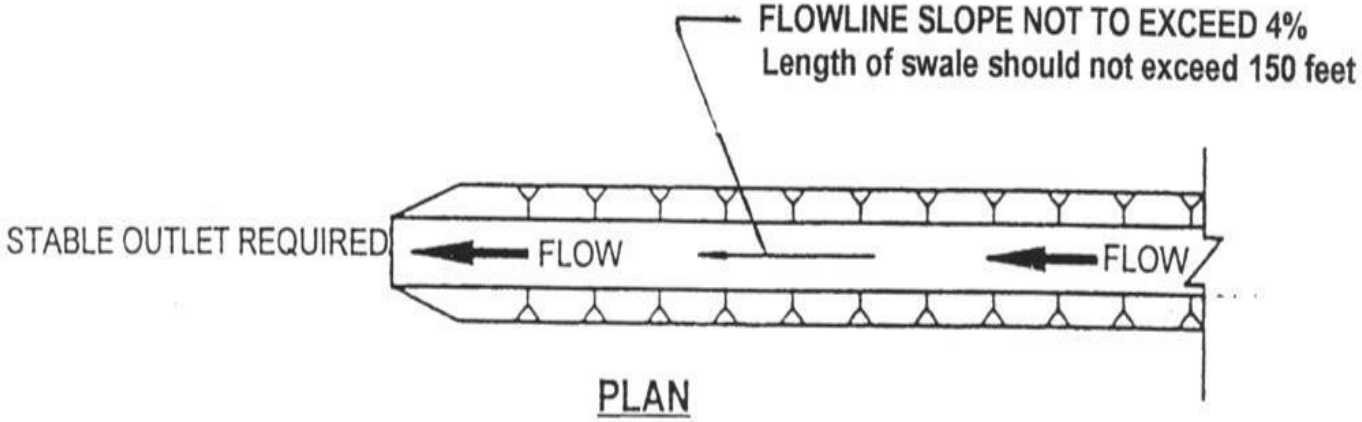
Example 4.9-Temporary Drainage Swale



NOTES

1. Construct drainage swale on contour
2. Flowline slope should not exceed 4%.
3. Swale should not be longer than 150 feet.

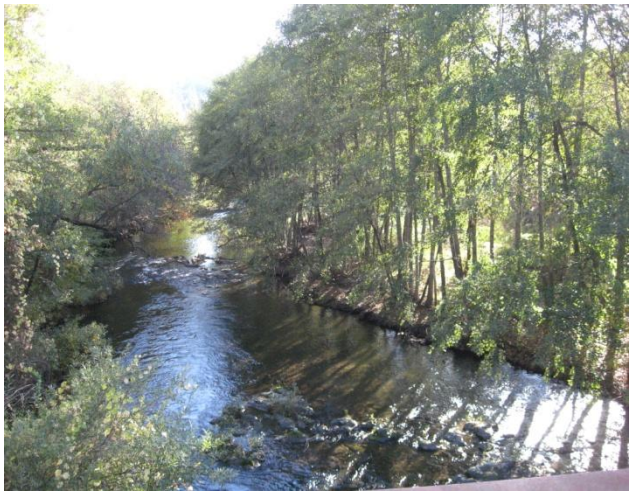
CROSS SECTION



PLAN

CHAPTER FIVE- Riparian Zones

Riparian zones provide and maintain many of the essential habitat features necessary to complete the salmonid life cycle such as erosion control, shade and temperature regulation, macroinvertebrate food supply, large woody debris supply, and filtration of sediments, nutrients, and pollutants.



Riparian vegetation also increases the water storage capacity of the soil, allowing for increased flow volumes within the streams during the warmer months.

Environmental Concerns

Bare stream banks are significantly more likely to erode than forested stream banks. Excessive bank erosion degrades salmonid habitat by filling pools, burying spawning gravels, and decreasing macroinvertebrate production. Removal of riparian vegetation causes elevated stream temperatures which can create thermal migration barriers for migrating salmon, generate stressful rearing conditions, decrease oxygen solubility and encourage disease. Loss of large woody debris alters natural geomorphic functions. Loss of litterfall alters the food source for many aquatic macroinvertebrates which in turn are important salmonid food source.

Site Evaluation

Evaluate your riparian areas. Measure the smallest and largest portions of the existing riparian zone, as well as vegetation composition, the extent of stream shading, and the distance from the edge of the riparian corridor to the first row of vines/orchard. Note any previous land use practices, infrastructure, roads, or structure within the riparian zone.

Best Management Practices

5.1. Abide by the required stream, pond, and wetland setbacks as defined in the County's Grading, Drainage, Vineyard/Orchard Site Development Ordinance.

5.2. Maintain the existing riparian zone. A healthy riparian zone consists of trees, shrubs of different ages growing closest to the channel and a grassy zone closest to the vineyard/orchard operation.

5.3. Maintain existing riparian vegetation to provide at least 65% shading of streams less than 50 feet in wetted width.

5.4. Plant native species in riparian zones that are not presently forested. Irrigate for the first two or three years and protect from browsing. Once established, leave riparian zone in a natural state.

5.5. Replace existing all-weather access roads that are within the county required setback no touch areas with grassy avenues. If the road must be used as an all-weather access road, then move the road out of the setback area and replant the old roadbed with riparian vegetation and/or a filter strip.

5.6. Leave downed trees in the riparian corridor for recruitment as large woody debris, as long as it does not pose an immediate threat to infrastructure or property downstream.

5.7. Maintain grass buffers along natural streams and drainage channels with a defined bed and bank.

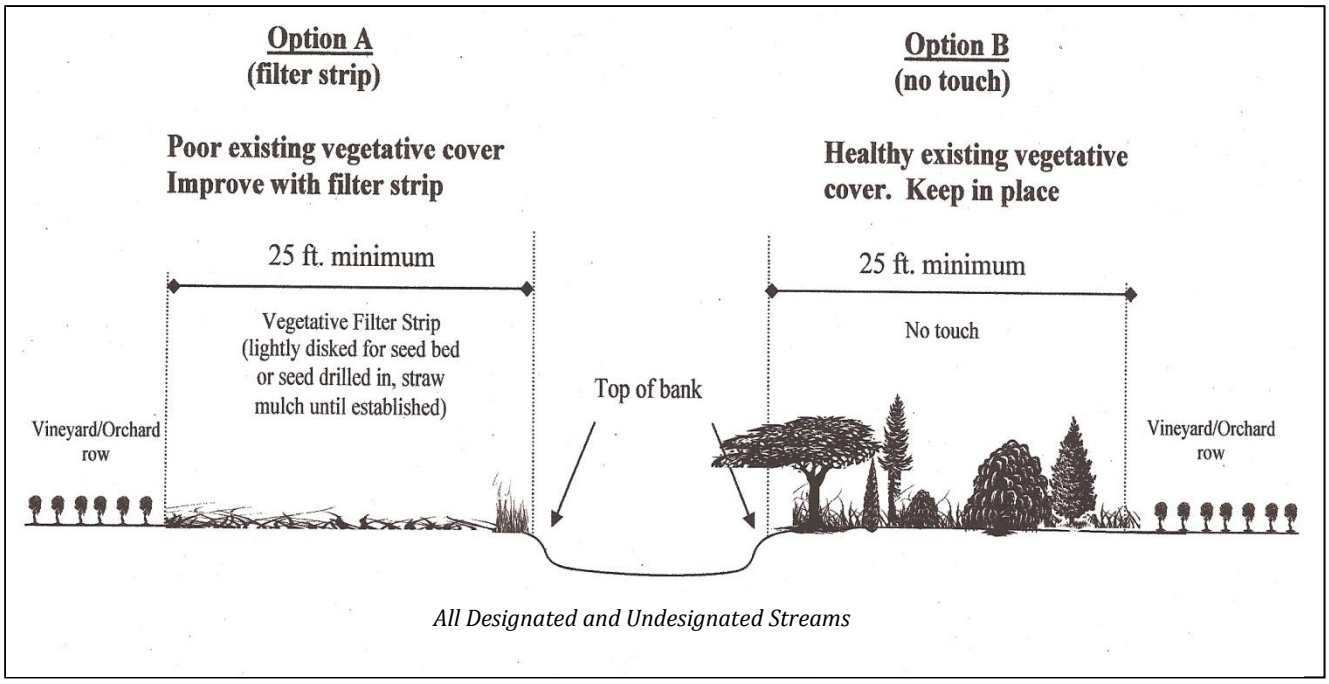
5.8. Cooperate in watershed-wide restoration projects that will help to improve riparian habitat.

Stream Setbacks

Existing riparian corridors should be maintained. The roots of the vegetation provide bank stability. Shade from trees and bushes keep water temperatures cool, which is important for sustaining aquatic species. Native grasses help filter sediment from surface runoff. However, if the existing vegetative cover is in poor condition the setback area may be improved with a vegetative filter strip for use as an agricultural avenue. The strip must be planted with a filter strip seed mix and maintained for the intended use.

Example 5.1 - Required Stream Setbacks for Level I Projects and All Replants

Setbacks apply to all new vineyards/orchards with a slope of 10% or less on highly erodible soils or 15% or less on non-highly erodible soils and all replant projects, unless stricter requirements are established in the general plan, local coastal program, and/or zoning code*

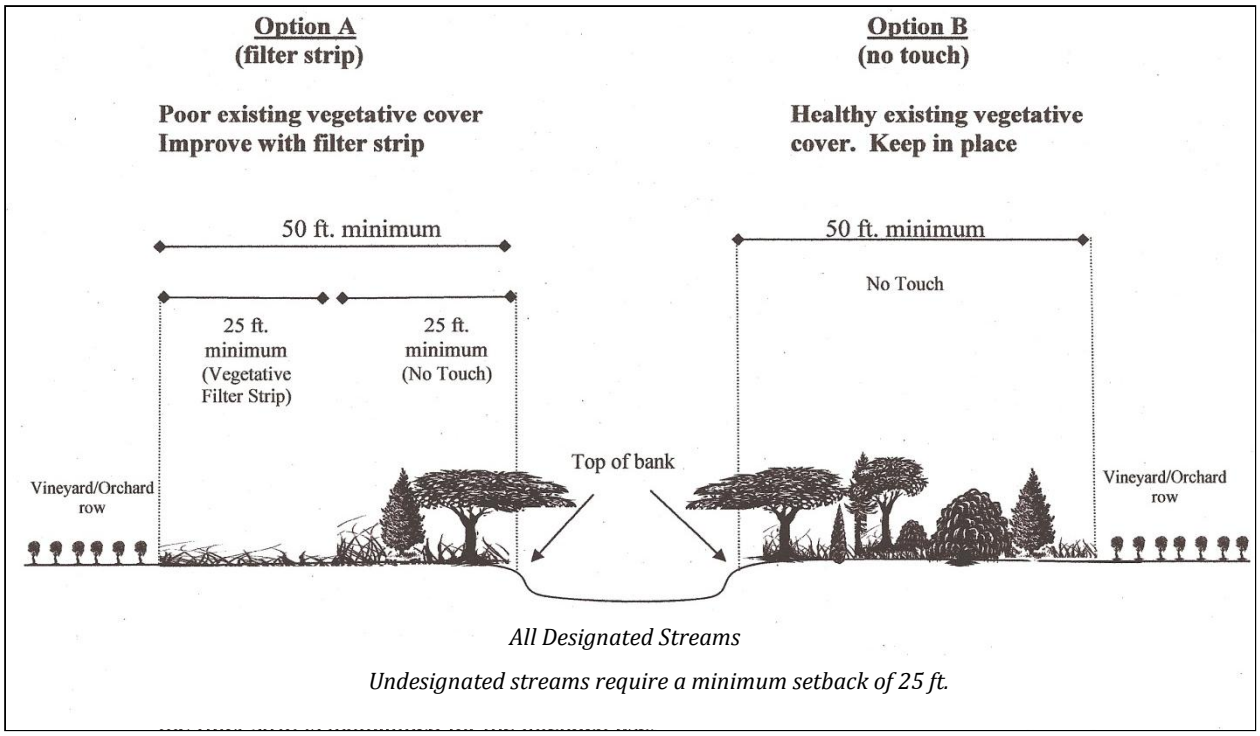


NOTE: Vegetative filter strips may be used as turnarounds or grassy avenues provided the filter strip is maintained for the intended use.

**Excerpted from the Sonoma County Grading, Drainage, Vineyard/Orchard Site Development Ordinance*

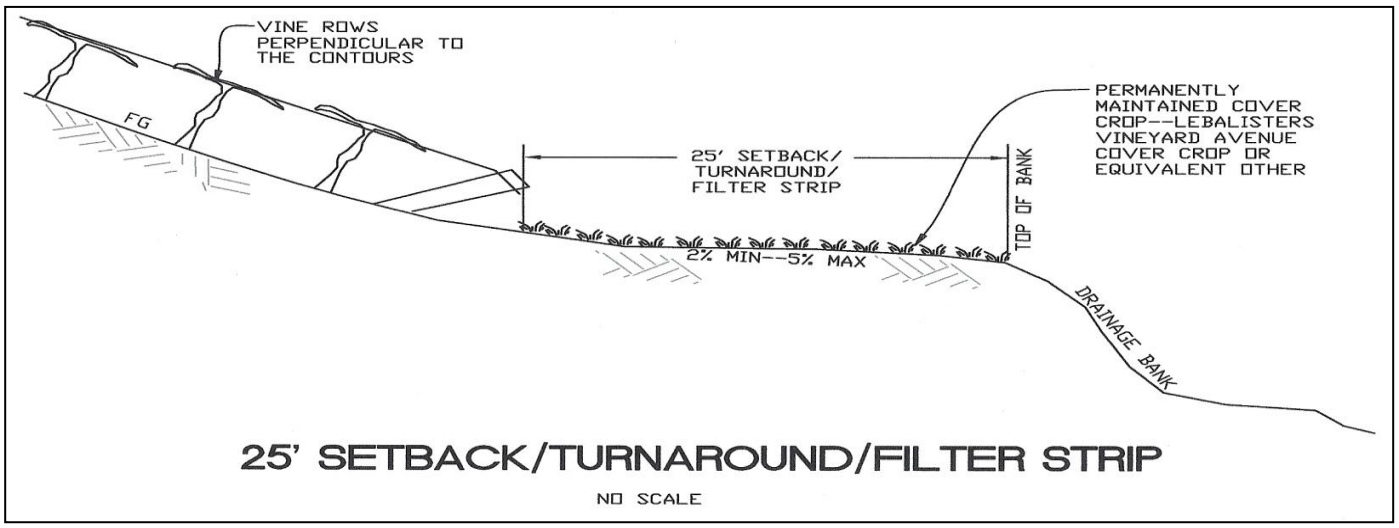
Example 5.2 - Required Stream Setbacks for Level II Projects

Setbacks apply to all new vineyards/orchards with a slope greater than 10% on highly erodible soils and greater than 15% on non-highly erodible soils, unless stricter requirements are established in the general plan, local coastal plan, and/or zoning code



NOTE: Vegetative filter strips may be used as turnarounds or grassy avenues provided the filter strip is maintained for the intended use.

Example 5.3 -Vineyard Setback/Filter Strip

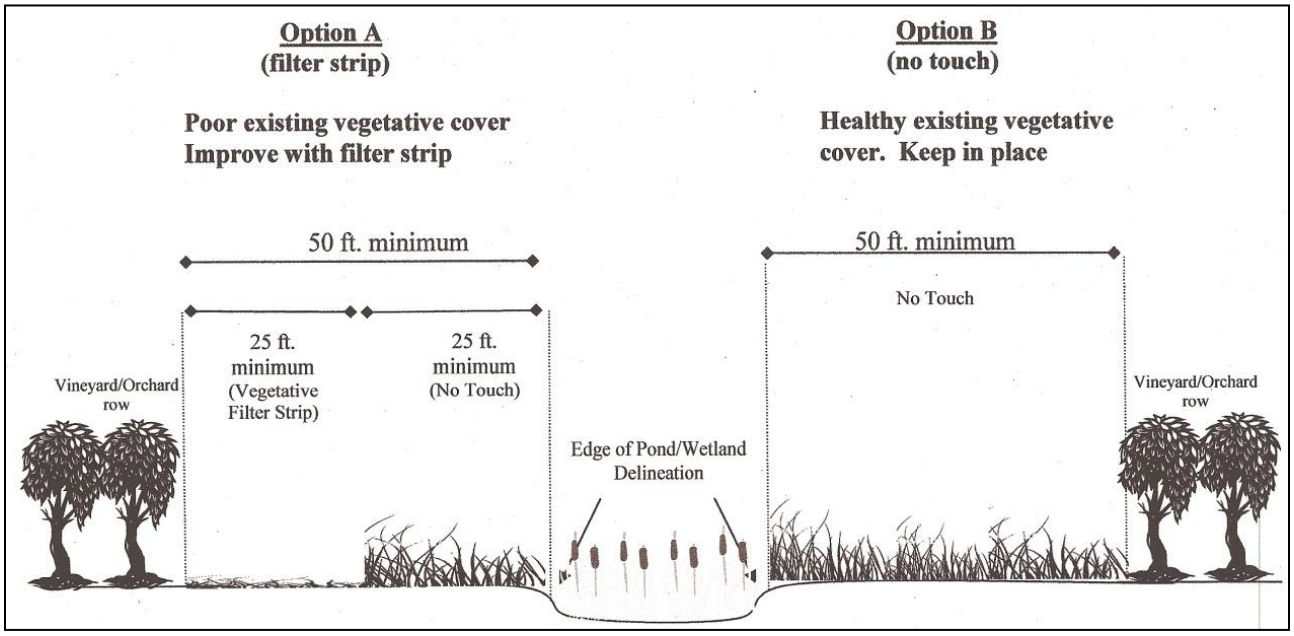


**Excerpted from the Sonoma County Grading, Drainage, Vineyard/Orchard Site Development Ordinance*

Wetland and Pond Setbacks

Existing wetland and pond vegetation should be maintained. The roots of the vegetation provide bank stability. Shade from trees and bushes keep water temperatures cool, which is important for sustaining aquatic species. Native grasses help filter sediment from surface runoff. However, if the existing vegetative cover is in poor condition, the setback area may be improved with a vegetative filter strip for use as an agricultural road. The strip must be planted with a filter strip seed mix and maintained for the intended use.

Example 5.4 - Required Wetland and Pond Setbacks



NOTE: Vegetative filter strips may be used as turnarounds or grassy avenues provided the filter strip is maintained for the intended use.

Setbacks apply to all new vineyards/orchards, unless stricter requirements are established in the general plan, local coastal plan, and/or zoning plan*

**Excerpted from the Sonoma County Grading, Drainage, Vineyard/Orchard Site Development Ordinance*

CHAPTER SIX-Tree Removal and Erosion Control

Through the combination of canopy and roots, trees help protect and stabilize the land. Their removal requires proper planning and adherence to land-based best management practices designed to reduce the velocity of run-off, safeguard surface waters from excessive runoff, and maintain the soil's integrity and its potential to absorb water.

The BMPs in this chapter shall only apply to vineyard and orchard planting projects proposing the removal of more than one-half acre of tree canopy (tree removal).

Removal of trees for vineyard and orchard planting projects shall be prohibited on natural slopes (with identified cohesionless soils) which are steeper than 40 percent.

Removal of trees for vineyard and orchard planting projects shall also be prohibited on identified areas of instability unless the area is repaired in compliance with Chapter 11 of the Sonoma County Code and details of the repair are shown on the project plans.

Environmental Concerns

Tree removal can:

- Encourage erosion due to an increase in precipitation runoff and/or soil disturbance. Erosion and sedimentation have the potential to impact aquatic habitat and related resources by affecting turbidity, and altering channel structure.
- Alter drainage patterns and may affect sheet flow dispersal and drainage to streams.
- Lead to a loss of stabilization of slopes, affecting slope integrity and contributing to substantial increases in erosion and sedimentation in surface waters.

Site Evaluation

For blocks in which tree or other vegetation removal has occurred since November 2008, the aerial photos available at www.sonoma-county.org/prmd/activemap (or more recent aerial photo as approved by the Agricultural Commissioner) will be used to determine pre-development cover/canopy levels.

If more than one-half acre of tree canopy has been removed since November 2008, or is proposed for removal, the project shall be subject to the tree removal standards.

A site assessment by an engineering geologist shall be required for all Level II projects proposing tree removal. The engineering geologist shall review each site for areas of instability.

In addition, for sites with natural slopes steeper than 25 percent in mapped areas of potentially cohesionless soils, the engineering geologist shall review the site for cohesionless soils. The preferred approach is to divide the development into blocks with similar landforms and slopes, generally no more than 20 acres in size. This allows for the use of existing drainages, major slope breaks, and topographic divides as natural boundaries.

As part of the engineered plan, the civil engineer shall calculate a soil loss or sediment delivery factor to evaluate pre-development and post-development conditions for each block.

Best Management Practices

For Level II projects proposing tree removal:

- With natural slopes no steeper than 25 percent, applicants should use the Universal Soil Loss Equation (USLE) to demonstrate no net increase in erosion from pre-development conditions.
- With natural slopes steeper than 25 percent, , applicants should use the Revised Universal Soil Loss Equation (RUSLE2) to demonstrate no net increase in erosion from pre-development conditions.
- When using USLE, use tabulated USLE slope length/gradient (LS), cover management (C), and conservation practice factors (P), listed in the BMP Handbook Appendix to evaluate the pre- versus post-development soil loss.
- Applicants can propose to use another published or peer-reviewed soil loss predictive model consistent with the standard of care to show no net increase in erosion from pre-development conditions.
- As an alternative to using a soil loss predictive model, and applicant can prepare a sediment delivery analysis using a published or peer-reviewed method consistent with the standard of care that demonstrates that the project will result in no net increase in sediment delivery to streams, lakes, or wetlands.

Slope Stability

6.1. For all projects proposing tree removal, adhere to the setbacks from identified areas of instability (landslides etc.) called for in Chapter 11 of the Sonoma County Code: 50 feet below or laterally and 100 feet above these landforms, or as recommended by an engineering geologist.

6.2. For all Level II projects proposing tree removal, a report by an engineering geologist shall be submitted identifying and characterizing areas of instability.

6.3. For Level II projects proposing tree removal with natural slopes steeper than 25 percent in mapped areas of potentially cohesionless soils, a report by an engineering geologist shall be submitted identifying any areas of cohesionless soils. Areas of mapped potentially cohesionless soils are determined from the map titled "Areas of Potentially Cohesionless Soils", which is available at the following web address: http://www.sonoma-county.org/agcomm/vesco.htm

6.4. For Level II projects proposing tree removal with natural slopes between 25 percent and 40 percent having cohesionless soils identified by a geologic report, a slope stability analysis shall be conducted. Tree removal shall be prohibited when the factor of safety will be less than 1.5 under saturated conditions after tree removal.

Ridgetops

6.5. For all projects proposing tree removal, adhere to 50 foot setbacks for defined ridgetops. Setbacks for ridgetops may consist of a 25 foot grassy turnaround and 25 foot "no touch" zone, or 50 foot "no touch" zone.

Operations

6.6. Individual trees and stands of trees to be retained within the limits of clearing shall be marked at a height visible to equipment operators and steps taken to protect the drip line of retained trees.

6.7. Identify and maintain the existing riparian zone. A healthy riparian zone consists of trees, shrubs of different ages growing closest to the channel and a grassy zone closest to the vineyard/orchard operation.

6.8. All native trees and associated woody vegetation should be retained within the active channel of all stream corridors.

6.9. Establish and maintain cover crops both between rows and around the perimeter of a vineyard/orchard to minimize the exposure of bare soil.

6.10. Minimize impact from roads, culvert installation and activity centers on stream channels.

6.11. Preserve existing ground cover and natural mulch around native trees to be retained in order to prevent erosion, protect roots and hold water.

6.12. Leave downed trees in the riparian corridor for recruitment as large woody debris, as long as it does not pose an immediate threat to infrastructure or property downstream.

6.13. Avoid placing other debris from tree removal operations in locations where it could potentially be discharged into streams.

6.14. All tree removal activity will be carried out from April 1st to October 15th.

6.15. At all times, erosion control measures must be utilized and in place prior to the end of the day if the US Weather Service forecast is a "chance" (30 percent or more) of rain before the next day, and prior to a weekend or other shutdown periods.

Monitoring and Reporting

6.16. During the first year after site development is completed, the project owner shall inspect the site for significant erosion or instability prior to the storm season and then monthly from October to May.

6.17. Annual monitoring reports shall be prepared and submitted to the Agricultural Commissioner on June 30th of each monitoring year. Year one will be considered the first full calendar year after final inspection.

6.18. The first year's report shall summarize the baseline information as well as the first year's monitoring results. Thereafter, annual reports shall include a summary of the year's monitoring results and a discussion of trends noted or problems observed, as well as a description of any repairs that were made. The report should include a description of the monitoring methods, including data collection and analysis.

6.19. Identical color photographic scenes shall be taken and submitted to the Agricultural Commissioner before development and each January from specific locations as identified in the project permit for a minimum of three years following completion of the project.

6.20. County staff shall perform at least one on site inspection at the end of the three year monitoring period, and other inspections as necessary.

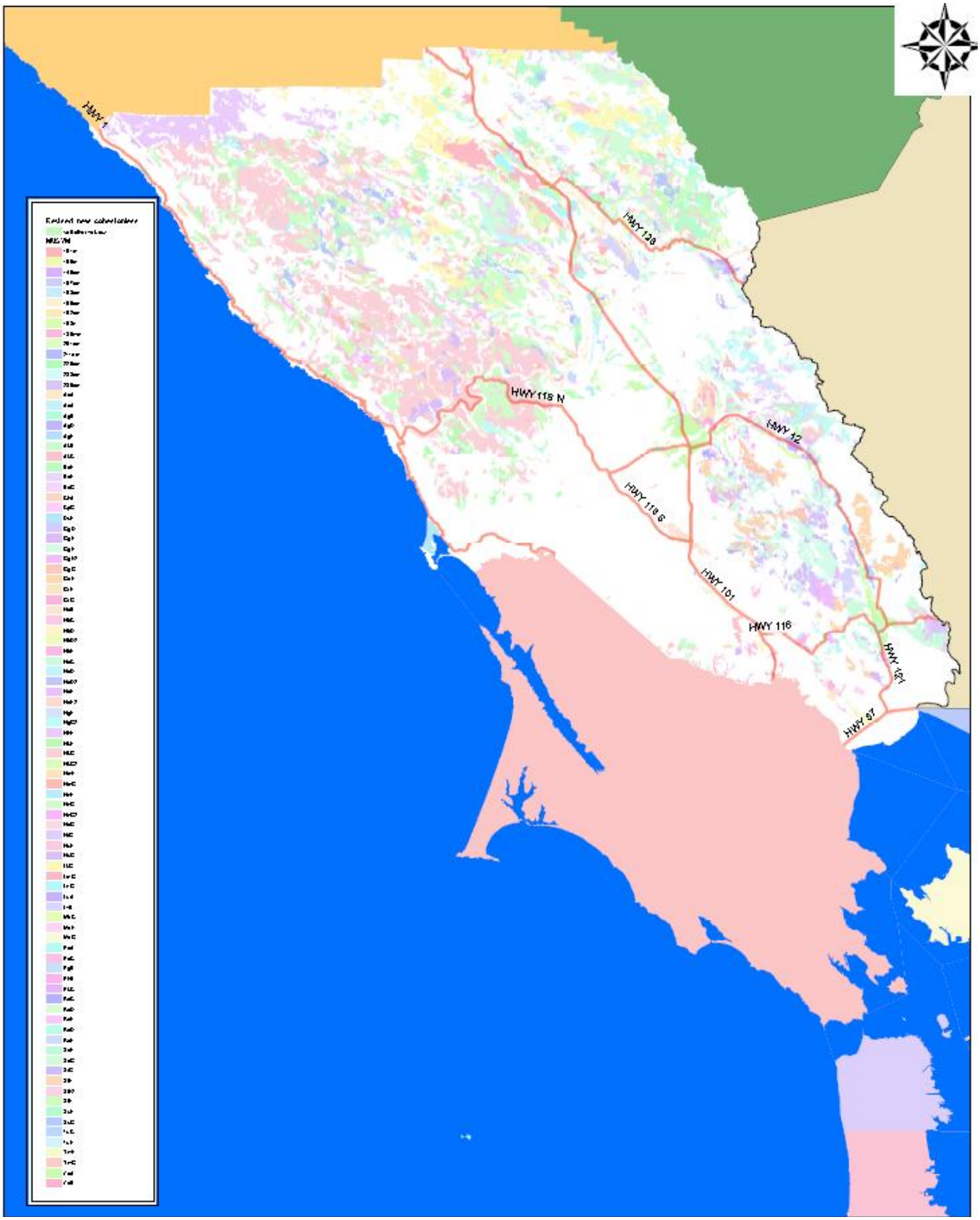
Compliance

6.21. The Agricultural Commissioner shall have all submitted engineered plans reviewed by a civil engineer, and all geologic reports reviewed by an engineering geologist. The purpose of the review shall be to verify compliance with Chapter 11 of the Sonoma County Code and these BMPs.

6.22. Projects that already have an approved CEQA document that contains measures that reduce geologic hazards and water quality impacts to a level of insignificance shall be considered to be in compliance with the applicable requirements of Chapter 11 and these BMPs.

APPENDIX

1) POTENTIALLY COHESIONLESS SOILS MAP



2) POTENTIALLY COHESIONLESS SOILS MAP UNITS

USCS Classification: GC, GC-GM, SP, SP-SW, GP-GC, GP-GM, GW-GC, GW-GM, GW, GP, SW, GM

101m	AgD	HgG2	SrG
105em	AgE	HhF	StE
109m	AkB	HkF	StE2
110em	AkC	HkG	StF
114n	BoE	HhF	SuF
116em	BoF	HkF	SuG
134I	BoG	HkG	TuC
135I	CgC	HkG2	TuE
135wm	CgD	HlF	YwF
137wm	CgE	HlG	YwG
148I	ChA	HmF	ZaA
149em	CmE	HmG	ZaB
152em	CmF	HnE	
157em	CmG	HnG	
158em	CpG	HnG2	
160em	CrA	HoG	
162em	CsA	HrG	
168n	DuE	HsF	
169I	FaD	HsG	
169wm	FaE	LkG	
170I	FaF	LmG	
171wm	FaG	LnG	
178m	GgD	LuA	
179m	GgE	LvB	
180em	GgF	MbC	
184m	GgF2	McF	
185wm	GgG	MlG	
186I	GlD	MoE	
191wm	GlE	MoG	
200I	GlF	PbB	
201em	GlF2	PeA	
202em	GlG	PeC	
205wm	GoF	PgB	
211em	GrE	PhB	
224I	GrG	PkC	
225em	HaB	PlC	
226I	HbC	PlD	
229I	HbD	PsC	
231wm	HbD2	PsD	
233em	HbE	RaC	
235em	HbC	RaD	
235wm	HcC	RaE	
237wm	HcD	RcD	
254I	HcD2	ReE	
AdA	HcE	RnA	
AeA	HcE2	SoF	
AgB	HgE	SoG	

3) SOIL LOSS RATIO (PERMANENT AND TEMPORARY BMPS)

The ratio between pre-and post-development predicted soil loss is called the soil loss ratio. Projects not using a sediment delivery analysis require a soil loss ratio of 1 or less. Pre-and post-development soil loss shall be calculated using the Universal Soil Loss Equation (USLE) for projects with slopes up to 25 percent and the computer based Revised Universal Soil Loss Equation (RUSLE2), or another published or peer reviewed soil loss model shall be used for projects with slopes greater than 25 up to 50 percent. The latest version of RUSLE2 can be downloaded for free at http://www.ars.usda.gov/Research/docs.htm?docid=6038

Alternatively, the applicant may use another published or peer reviewed soil loss predictive model to show no net increase in erosion from pre-development conditions or may prepare a sediment delivery analysis using a published or peer-reviewed method consistent with the standard of care that demonstrates that the project will result in no net increase in sediment delivery to streams, lakes or wetlands.

Soil Loss Equations The USLE and RUSLE2 soil loss equations are based on the

following formula: $A = R \times K \times LS \times C \times P$

Where

A = computed soil loss per acre for a given storm period of time interval;
R = rainfall factors
K = soil erodibility value
L = slope length factor
S = steepness factor
C = vegetation factor
P = erosion control practice factor

For the purposes of calculating the soil loss ratio, the factors of R and K are removed from the equation given the assumption that rainfall and soil type will be unchanged by site development.

Site Evaluation Divide the development area into blocks with similar landforms and slopes, generally no more than 20 acres in size for purposes of calculating the soil loss ratio or performing a sediment delivery analysis. For example, use existing drainages, major slope breaks, and topographic divides as natural boundaries between blocks. Then calculate a soil loss factor for pre-development conditions and post-development (temporary and permanent BMPs) for each block using the topographic (LS), vegetation (C) factors, and erosion control practice (P) factors as described below or using the RUSLE2 computer model.

Pre-development Soil Loss Factor The SOIL LOSS FACTOR sets the target for the post-development (temporary and permanent) erosion control requirements.

1. Topographic Factors for Slopes (LS_i)
    a. Determine the slope length of the block and the gradient of the slope using the methods outlined by the USLE.
    b. For projects with slopes less than or equal to 25 percent find the LS_i factor in the table in Appendix A.
    c. For projects with slopes greater than 25 percent, determine LS using RUSLE2.
2. Vegetation Factor (C_i)
    a. Determine the type/height of raised canopy and percent canopy/ground cover using methods outlined below.
    b. For projects with slopes less than or equal to 25 percent find the C_i factor in the table in Appendix B.
    c. For projects with slopes greater than 25 percent, determine C_i using RUSLE2.
3. Existing Erosion Control Practice Factor (P_i)
    a. If the site is being converted from an existing development use, determine the P_i factor using the table below.
    b. If the site is undeveloped, use a value of 1.
4. Pre-development soil loss factor
    a. Calculate using the following formula:

SOIL LOSS FACTOR = $LS_i \times C_i \times P_i$

4) Length of Slope (LS) Values (1 of 2)

	Length of Slope (in feet)							
Percent Slope	**25'**	**50'**	**75'**	**100'**	**125'**	**150'**	**200'**	**250'**
0.5%	0.07	0.08	0.09	0.10	0.10	0.10	0.11	0.11
1.0%	0.09	0.10	0.12	0.13	0.14	0.15	0.16	0.17
2.0%	0.13	0.16	0.18	0.20	0.21	0.23	0.25	0.26
3.0%	0.19	0.23	0.26	0.29	0.31	0.32	0.35	0.38
4.0%	0.23	0.30	0.36	0.40	0.44	0.47	0.53	0.58
5.0%	0.27	0.38	0.46	0.53	0.60	0.65	0.76	0.85
6.0%	0.34	0.47	0.58	0.67	0.75	0.82	0.95	1.06
7.0%	0.41	0.58	0.71	0.82	0.92	1.01	1.16	1.30
8.0%	0.49	0.70	0.86	0.99	1.11	1.21	1.40	1.56
9.0%	0.59	0.83	1.01	1.17	1.31	1.43	1.66	1.85
10.0%	0.68	0.96	1.17	1.35	1.51	1.66	1.92	2.14
12.0%	0.87	1.23	1.51	1.74	1.95	2.13	2.46	2.75
14.0%	1.08	1.52	1.86	2.15	2.4	2.63	3.04	3.40
16.0%	1.29	1.82	2.23	2.58	2.88	3.16	3.65	4.08
18.0%	1.51	2.14	2.62	3.02	3.38	3.70	4.27	4.78
20.0%	*1.74	2.46	3.01	3.48	3.89	4.26	4.92	5.50
22.0%	1.97	2.79	3.42	3.94	4.41	4.83	5.58	6.24
24.0%	2.21	3.12	3.83	4.42	4.94	5.41	6.25	6.99
26.0%	2.45	3.46	4.24	4.90	5.48	6.00	6.93	7.74
28.0%	2.69	3.81	4.66	5.38	6.02	6.59	7.61	8.51
30.0%	2.93	4.15	5.08	5.87	6.56	7.19	8.30	9.28
32.0%	3.18	4.49	5.50	6.35	7.10	7.78	8.99	10.0
34.0%	3.42	4.48	5.92	6.84	7.65	8.38	9.67	10.8
36.0%	3.66	5.18	6.34	7.32	8.18	8.97	10.4	11.6
38.0%	3.90	5.52	6.75	7.80	8.72	9.55	11.0	12.3
40.0%	4.14	5.85	7.16	8.27	9.25	10.1	11.7	13.1
45.0%	4.71	6.67	8.17	9.43	10.5	11.5	13.3	14.9
50.0%	5.27	7.45	9.12	10.5	11.8	12.9	14.9	16.7

4) Length of Slope (LS) Values (2 of 2)

	Length of Slope (in feet)										
Percent Slope	**300'**	**350'**	**400'**	**450'**	**500'**	**550'**	**600'**	**700'**	**800'**	**1000'**	**1200'**
0.5%	0.12	0.12	0.13	0.13	0.13	0.13	0.14	0.14	0.14	0.15	0.16
1.0%	0.18	0.19	0.20	0.20	0.21	0.22	0.22	0.23	0.24	0.26	0.27
2.0%	0.28	0.29	0.30	0.32	0.33	0.33	0.34	0.36	0.37	0.40	0.42
3.0%	0.40	0.42	0.43	0.45	0.46	0.48	0.49	0.51	0.54	0.57	0.60
4.0%	0.62	0.66	0.70	0.73	0.76	0.79	0.82	0.87	0.92	1.00	1.08
5.0%	0.93	1.00	1.07	1.13	1.20	1.25	1.31	1.41	1.51	1.69	1.85
6.0%	1.16	1.26	1.34	1.42	1.50	1.57	1.65	1.78	1.90	2.12	2.33
7.0%	1.43	1.54	1.65	1.75	1.84	1.93	2.02	2.18	2.33	2.60	2.85
8.0%	1.71	1.85	1.98	2.10	2.21	2.62	2.42	2.62	2.80	3.13	3.43
9.0%	2.03	2.19	2.34	2.48	2.62	2.75	2.87	3.10	3.31	3.70	4.06
10.0%	2.35	2.53	2.71	2.87	3.03	3.18	3.32	3.58	3.83	4.28	4.39
12.0%	3.02	3.26	3.48	3.69	3.89	4.08	4.27	4.61	4.93	5.51	6.03
14.0%	3.73	4.02	4.30	4.56	4.81	5.04	5.27	5.69	6.08	6.80	7.45
16.0%	4.47	4.82	5.16	5.47	5.77	6.05	6.32	6.82	7.29	8.15	8.93
18.0%	5.23	5.65	6.04	6.41	6.76	7.09	7.40	7.99	8.55	9.56	10.5
20.0%	6.02	6.51	6.96	7.38	7.78	8.16	8.52	9.20	9.84	11.0	12.0
22.0%	6.83	7.38	7.89	8.37	8.82	9.25	9.66	10.4	11.2	12.5	13.7
24.0%	7.65	8.26	8.84	9.37	9.88	10.4	10.8	11.7	12.5	14.0	15.3
26.0%	8.48	9.16	9.80	10.4	11.0	11.5	12.0	13.0	13.9	15.5	17.0
28.0%	9.32	10.1	10.8	11.4	12.0	12.6	13.2	14.2	15.2	17.0	18.6
30.0%	10.2	11.0	11.7	12.4	13.1	13.8	14.4	15.5	16.6	18.6	20.3
32.0%	11.0	11.9	12.7	13.5	14.2	14.9	15.6	16.8	18.0	20.1	22.0
34.0%	11.8	12.8	13.7	14.5	15.3	16.0	16.8	18.1	19.3	21.6	23.7
36.0%	12.7	13.7	14.6	15.5	16.4	17.2	179.0	19.4	20.7	23.2	25.4
38.0%	13.5	14.6	15.6	16.5	17.4	18.3	19.1	20.6	22.1	24.7	27.0
40.0%	14.3	15.5	16.5	17.5	18.5	19.4	20.3	21.9	23.4	26.2	28.7
45.0%	16.3	17.6	18.9	20.0	21.1	22.1	23.1	24.9	26.7	29.8	32.7
50.0%	18.2	19.7	21.1	22.3	23.6	24.7	25.8	27.9	29.8	33.3	36.5

5) Vegetation Factor

Vegetation Factor (C) Values for Pasture, Rangeland, and Idle Land	Type and Height of Canopy	Canopy Cover (%)	Canopy Type	Percent Ground Cover					
				0%	20%	40%	60%	80%	95 - 100%
	No significant canopy	0	G	0.45	0.20	0.10	0.042	0.013	0.003
			W	0.45	0.24	0.15	0.090	0.043	0.011
	Canopy of tall weeds or short brush (average drop height[2] of ≥20 inches or 0.5 m fall height)	25	G	0.36	0.17	0.09	0.038	0.012	0.003
			W	0.36	0.20	0.13	0.082	0.041	0.011
		50	G	0.26	0.13	0.07	0.035	0.012	0.003
			W	0.26	0.16	0.11	0.075	0.039	0.011
		75	G	0.17	0.10	0.06	0.031	0.011	0.003
			W	0.17	0.12	0.09	0.067	0.038	0.011
	Appreciable brush or bushes (2 m fall height)	25	G	0.40	0.18	0.09	0.040	0.013	0.003
			W	0.40	0.22	0.14	0.085	0.042	0.011
		50	G	0.34	0.16	0.09	0.038	0.012	0.003
			W	0.34	0.19	0.13	0.081	0.041	0.011
		75	G	0.28	0.14	0.08	0.036	0.012	0.003
			W	0.28	0.17	0.12	0.077	0.040	0.011
	Trees but no appreciable low brush (4 m fall height)	25	G	0.42	0.19	0.10	0.041	0.013	0.003
			W	0.42	0.23	0.14	0.087	0.042	0.011
		50	G	0.39	0.18	0.09	0.040	0.013	0.003
			W	0.39	0.21	0.14	0.085	0.042	0.011
		75	G	0.36	0.17	0.09	0.039	0.012	0.003
			W	0.36	0.20	0.13	0.083	0.014	0.011
	Mechanically prepared sites, with no live vegetation and no topsoil, and no litter mixed in.	0	N	0.94	0.44	0.30	0.200	0.100	Not given

Vineyard Cover Factor (Cf)					
Vine Row Tilled Ground Cover (%) Winter Months (Oct. 15th - April 15th)					
0	20	40	60	80	95
0.85	0.39	0.20	0.088	0.028	0.007
Vine Row Non-Tilled **Vine Row Non-Tilled Ground Cover (%) Winter Months (Oct. 15th - April 15th)**					
0	20	40	60	80	95
0.68	0.31	0.16	0.070	0.022	0.006

Temporary BMP C values

Type of Mulch	Mulch Rate	Land Slope (%)	Mulching C Factor	Length Limit (ft)[1]
Straw or hay, tied down by anchoring and tacking equipment[2]	1.0	5-10	0.20	200
	1.0	6-10	0.20	100
	1.5	1-5	0.12	300
	1.5	6-10	0.12	150
	2.0	1-5	0.06	400
	2.0	6-10	0.06	200
	2.0	11-15	0.07	150
	2.0	16-20	0.11	100
	2.0	21-25	0.14	75
	2.0	26-33	0.17	50
	2.0	34-50	0.20	35
Crushed stone, $^1/_4$ - $1^1/_2$ inch	135	<16	0.05	200
	135	16-20	0.05	150
	135	21-33	0.05	100
	135	34-50	0.05	75
	240	<21	0.02	300
	240	21-33	0.02	200
	240	34-50	0.02	150
Wood Chips	7	<16	0.08	75
	7	16-20	0.08	50
	12	<1 6	0.05	150
	12	16-20	0.05	100
	25	21-33	0.05	75
	25	<16	0.02	200
	25	16-20	0.02	150
	25	21-33	0.02	100
	25	34-50	0.02	75

Source: From USDA Soil Conservation Service (1978).

[1] Maximum slope length for which the specified mulch rate is considered effective. When this limit is exceeded, either a higher application rate or mechanical shortening of the effective slope length is required.

[2] When the straw or hay mulch is not anchored to the soil, C values on moderate or steep slopes of soils having K values greater than 0.30 should be taken at double the values given in this table.

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