Appendix II

BMP Handbook

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BMP • Handbook

MANAGEMENT PRACTICES FOR PROTECTING WATER QUALITY

SAN JOAQUIN VALLEY

SPONSORS

Funding for this project has been provided in full or in part through an Agreement with the State Water Resources Control Board (SWRCB) pursuant to the Costa-Machado Water Act of 2000 (Proposition 13) and any amendments thereto. The contents of this document do not necessarily reflect the views and policies of the SWRCB, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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BMP Handbook

MANAGEMENT PRACTICES FOR PROTECTING WATER QUALITY

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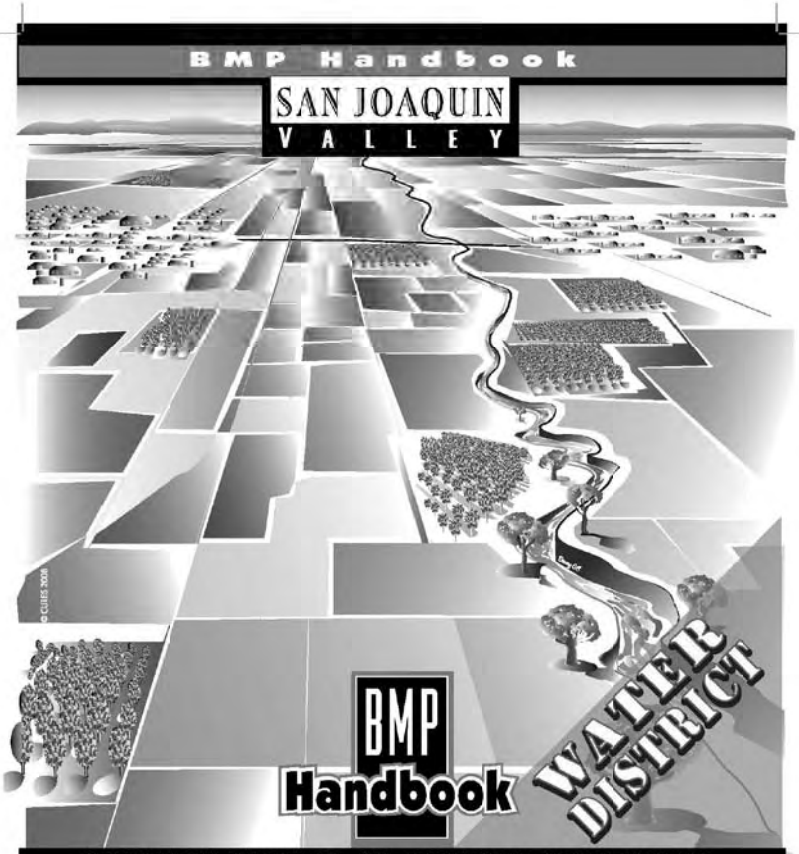
SAN JOAQUIN VALLEY



BMP Handbook WATER DISTRICT

MANAGEMENT PRACTICES FOR PROTECTING WATER QUALITY

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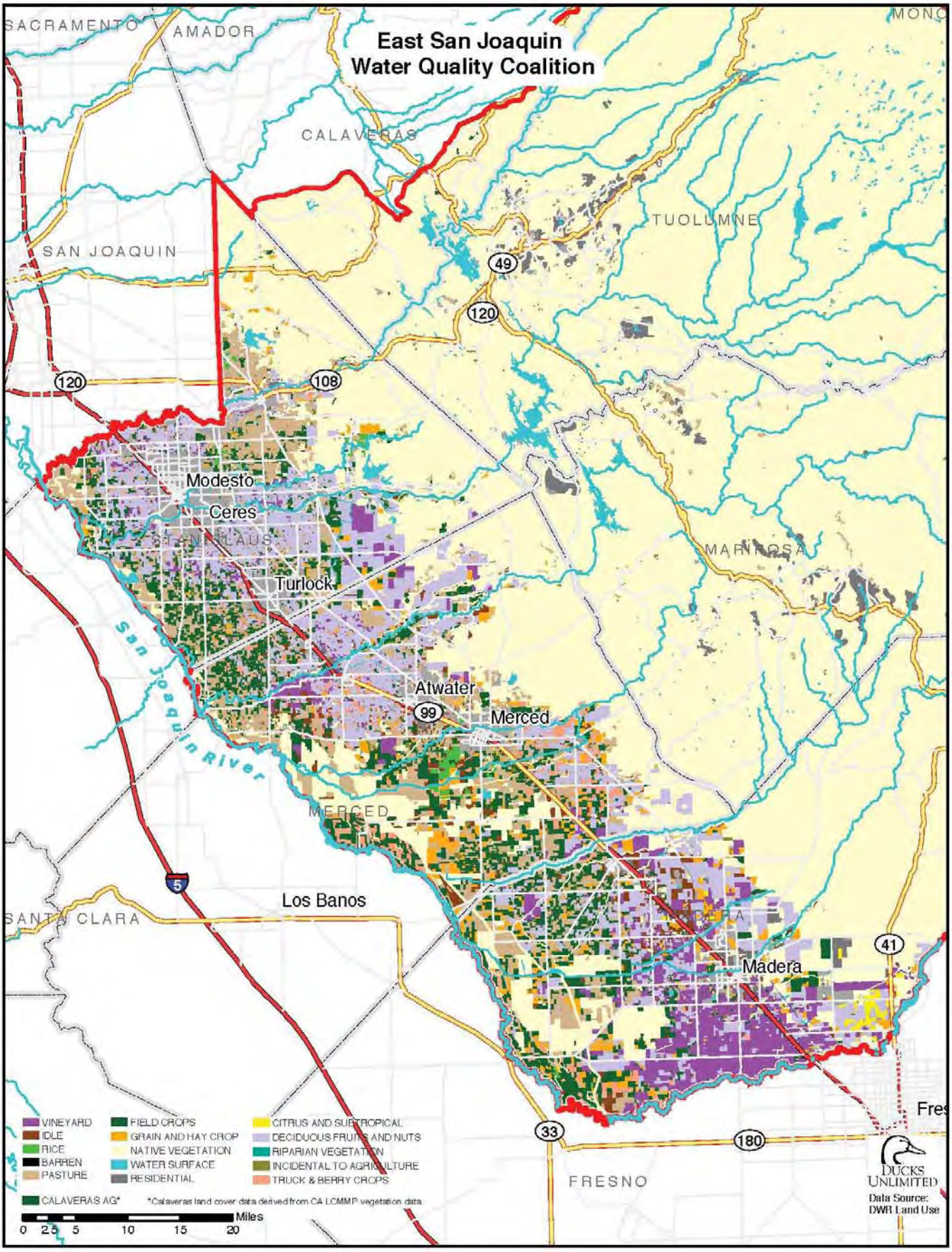
SAN JOAQUIN VALLEY

EAST SAN JOAQUIN WATER QUALITY COALITION MAP

BMP Handbook

MANAGEMENT PRACTICES FOR PROTECTING WATER QUALITY


East San Joaquin
Water Quality Coalition
SACRAMENTO
AMADOR
CALAVERAS
TUOLUMNE
SAN JOAQUIN
MONO
MARIPOSA
STANISLAUS
MERCED
SANTA CLARA
FRESNO
Modesto
Ceres
Turlock
Atwater
Merced
Los Banos
Madera
San Joaquin River
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120
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99
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180
VINEYARD
IDLE
RICE
BARREN
PASTURE
FIELD CROPS
GRAIN AND HAY CROP
NATIVE VEGETATION
WATER SURFACE
RESIDENTIAL
CITRUS AND SUBTROPICAL
DECIDUOUS FRUITS AND NUTS
RIPARIAN VEGETATION
INCIDENTAL TO AGRICULTURE
TRUCK & BERRY CROPS
CALAVERAS AG*
*Calaveras land cover data derived from CA LCMMP vegetation data
Miles
0 2.5 5 10 15 20
DUCKS UNLIMITED
Data Source:
DWR Land Use

SAN JOAQUIN VALLEY

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Resource Guide: San Joaquin Valley

BMP Handbook

INTRODUCTION

The San Joaquin Valley BMP Handbook was developed with funding by a grant from the State Water Resources Control Board. Much of the information in the handbook is the outcome of a project to evaluate Best Management Practices (BMPs) for irrigated agriculture and provide updated information on installation and maintenance of these practices.

Information in this BMP handbook is intended to encourage and increase BMP implementation to reduce or eliminate pesticide, nutrient and other contaminant loads carried by irrigation return flows and storm water into the San Joaquin River watershed.

Contained in this BMP Handbook is information on farming practices such as sediment basins, PAM, tailwater return systems, vegetative ditches, irrigation scheduling and others. These documents are summaries of technical reports developed for this project by the California Water Institute, Ducks Unlimited, California Department of Pesticide Regulation and others. Also included in this binder are booklets developed by CURES covering BMPs for commonly used pesticides. The complete reports and booklets are available on request by contacting CURES by mail or at **www.curesworks.org**

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Special thanks to the West Stanislaus Resource Conservation District and Westside San Joaquin River Watershed Coalition without whose support this project would not have been possible.

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BMP Handbook

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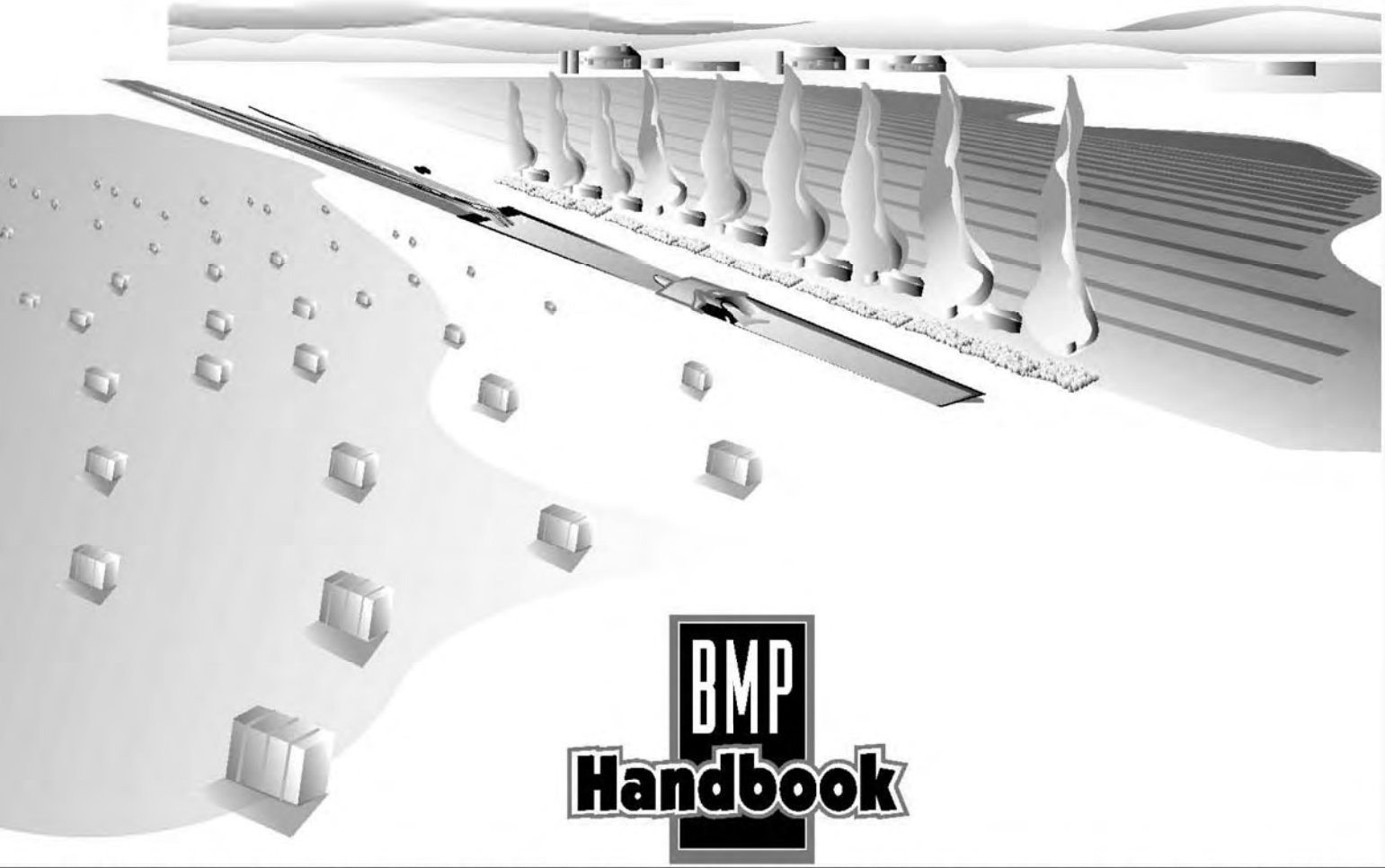
Guidelines for Selecting BMPs - Alfalfa

This publication is designed to guide growers through a selection process for deciding which single or combination of water quality BMPs are most appropriate for a farming operation in the Central Valley. BMP (Best Management Practice) is a broad term describing a wide range of agricultural practices for mitigating the environmental impact of modern farming. BMPs for protecting surface water can include improvements in pesticide application methods, drip or low volume irrigation systems or use of amendments to prevent soil erosion. A BMP can also be engineered structures such as vegetated ditches, sediment catch basins and constructed wetlands.

The following illustration is designed to lead growers through a selection process to identify BMPs that are best suited for improving water quality draining from a field or multiple fields. The final BMP(s) selected can range from individual field practices or a combination of practices to construction of regional water recycling and water quality control structures.

The Pest Control table includes a list of both conventional and "Reduced Risk" pest control options for common pests in the Central Valley. Reduced Risk products, as defined by US-EPA, have a low potential for groundwater and surface water contamination, lower use rates than conventional products, low pest resistance potential, low-impact on human health, low toxicity to non-target organisms (birds, fish, and plants) and compatibility with Integrated Pest Management. The table also briefly describes cultural controls, biological controls and organic practices that target common pests.



BMP Handbook

MANAGEMENT PRACTICES FOR PROTECTING WATER QUALITY

GUIDELINES FOR SELECTING BMPS

ALFALFA PEST MANAGEMENT OPTIONS

Pest	Conventional Control	Reduced Risk*	Biological Control	Cultural Control	Organic Method
Aphids (Blue Alfalfa, Pea and Spotted Alfalfa Aphids)	LORSBAN[I, II] (Chlorpyrifos) DIMETHOATE[II] 2.67EC MALATHION[II] PROAXIS[I, II] (Gamma-cyhalothrin)		Plant aphid-resistant alfalfa varieties; seven spotted and convergent lady beetles, green lacewings, bigeyed bugs (*Geocoris* sp.), damsel bugs, syrphid fly larvae, parasitic wasps (*Aphidius* sp.), and other parasites (*Aphidius* ervi for blue alfalfa and pea aphids, *Trioxys complanatus* for spotted alfalfa aphid)	Border-strip harvesting helps preserve parasite populations	Biological and cultural controls; azadirachtin (Neemix), neem oil (Trilogy), and pyrethrin (PyGanic). *In CA studies indicate these insecticides do not control aphids.*
Armyworms (Beet and Western Yellowstriped Armyworms)	LANNATE[I, II] 90SP (Methomyl) PROAXIS[I, II] (Gamma-cyhalothrin)	STEWARD* 1.25 SC (Indoxacarb) INTREPID* 2F (Methoxyfenozide)	Bigeyed bugs, spiders, parasitic wasps (*Hyposoter exiguae*), minute pirate bugs (feed on eggs), damsel bugs, lacewings, and viral diseases	Border-strip harvesting to preserve parasite populations; early harvest if infestation late in cutting cycle	Biological and cultural controls; XENTARI[III] *or* AGREE[III] (*Bacillus thuringiensis* sp. Aizawai)
Weevils (Alfalfa and Egyptian Alfalfa Weevils)	MUSTANG MAX[I, II] (Zeta-cypermethrin) IMIDAN 70W (Phosmet) WARRIOR[I, II] (Lambda-cyhalothrin) BAYTHROID[I] 2E *or* RENOUNCE[I] 20WP (Cyfluthrin) FURADAN[I, II] 4F (Carbofuran) LORSBAN[I, II] 4EC (Chlorpyrifos) MALTHION[II] 8E	STEWARD*,II EC (Indoxacarb)	Parasitic wasps (*Bathyplectes curculionis* and *Bathyplectes anurus*), soil-dwelling fungus (*Zoophthora phytonomi*)	Cut as soon as most plants are in bud stage	Early cutting
Caterpillars (Alfalfa Caterpillar and others)	MUSTANG MAX[I, II] (Zeta-cypermethrin)	STEWARD* (Indoxacarb) INTREPID* 2F (Methoxyfenozide)	Parasitic wasps (*Cotesia/Apanteles medicaginis*), *Trichogramma* sp. wasps consume the caterpillar eggs, assassin bugs (*Zelus* sp. and *Sinea* sp.), spiders, damsel bugs	Border-strip harvesting helps preserve parasite populations; early harvesting of infested fields	Biological and cultural controls; KERSTAKI[III] (*Bacillus thuringiensis* sp.)
Cutworms (Variegated and others)	POUNCE[I] 25WP, 3.2EC, WSB *or* AMBUSH[I] 25WP (Permethrin) BAYTHROID[I] 2E *or* RENOUNCE[I] 20WP (Cyfluthrin) WARRIOR[I, II] (Lambda-cyhalothrin)	STEWARD* 1.25SC (Indoxacarb)		Tillage, flood irrigation (daytime), and weed control	Cultural controls
Sharpshooters (Green, Red-Headed, Glassy-Winged and Blue-Green Sharpshooters)	Insecticide treatments for sharpshooters are not recommended in alfalfa		Egg parasitic wasps (family: Mymaridae genus: *Gonatocerus*) for the glassy-winged sharpshooter	Remove grass weeds from field and surroundings to control green and red-headed sharpshooters	Biological and cultural controls

Source: Crop Protection Industry contacts; UC IPM Pest Management Guidelines- Alfalfa, http://www.ipm.ucdavis.edu/PMG/selectnewpest.alfalfa-hay.html
Trademarked names in capital letters.

I Permit required from county agricultural commissioner for purchase or use.

II Do not apply when bees are present.

III Acceptable for use on organic crop.

* EPA criteria for reduced risk (RR) designation: low-impact on human health, low toxicity to non-target organisms (birds, fish, and plants), low potential for groundwater contamination, lower use rates, low pest resistance potential, and compatibility with Integrated Pest Management.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the State Water Resources Control Board or CURES.

Checklist

Site Evaluation

Before Spraying...

- ☐ Evaluate each field to pinpoint areas that are erodible where sediment might move offsite to waterways.
- ☐ Identify points where surface water runs off onto waterways or other sensitive areas. Get help with identifying these sites through local Natural Resource Conservation Service (NRCS) offices.
- ☐ Flag or stake no treatment buffer zones. Develop a field layout map and note location of: wells, sinkholes, highly erodible land, drainage ditches, streams and rivers.
- ☐ Provide the sketch to all sprayer operators, commercial applicators, Pest Control Advisors or anyone involved with pest management decisions.

Mixing & Loading Practices

- ☐ Do not mix and load within 50 feet of any stream, river, or edge of a lake or reservoir.
- ☐ Do not leave a sprayer unattended while filling.
- ☐ Partially fill tank (1/4 full of water) prior to the addition of chemicals.
- ☐ Do not overfill tank: spills can wash away to vulnerable sites. Use an air gap to prevent tank overfilling.
- ☐ Use backflow valve on the fill tube.
- ☐ Open paper chemical packages with scissors or knife, rather than tearing.
- ☐ Immediately triple rinse containers. Pour rinseate into tank prior to filling.
- ☐ Apply rinse water back to the treated field. Never just drain out.
- ☐ Never leave pesticides in a spray rig overnight.
- ☐ Check with county for proper disposal methods for empty plastic containers.

SAN JOAQUIN VALLEY

Managing Alfalfa Runoff

BMP Selection Guidelines

This graphic portrays various Best Management Practice (BMP) scenarios to consider should storm or irrigation drainage leave your farm.

These guidelines focus on two areas:

- Managing the drainage water on-farm (or correcting a problem before it happens);
- Directing drainage from multiple farms to a single constructed wetland area.

Under each BMP are comments on effectiveness and potential drawbacks. Read more about the BMP practices and studies used to determine those rankings at:
www.curesworks.org/bmp/bmpGeneral.asp

See back page for a list of pest management options available for specific crops.

Note: Each field or farm has multiple characteristics to consider when making a decision on which BMP is best suited to manage runoff. Information provided here is intended to assist in making that selection but should be considered with all factors specific to the field or farms.

Does runoff leave field?

NO

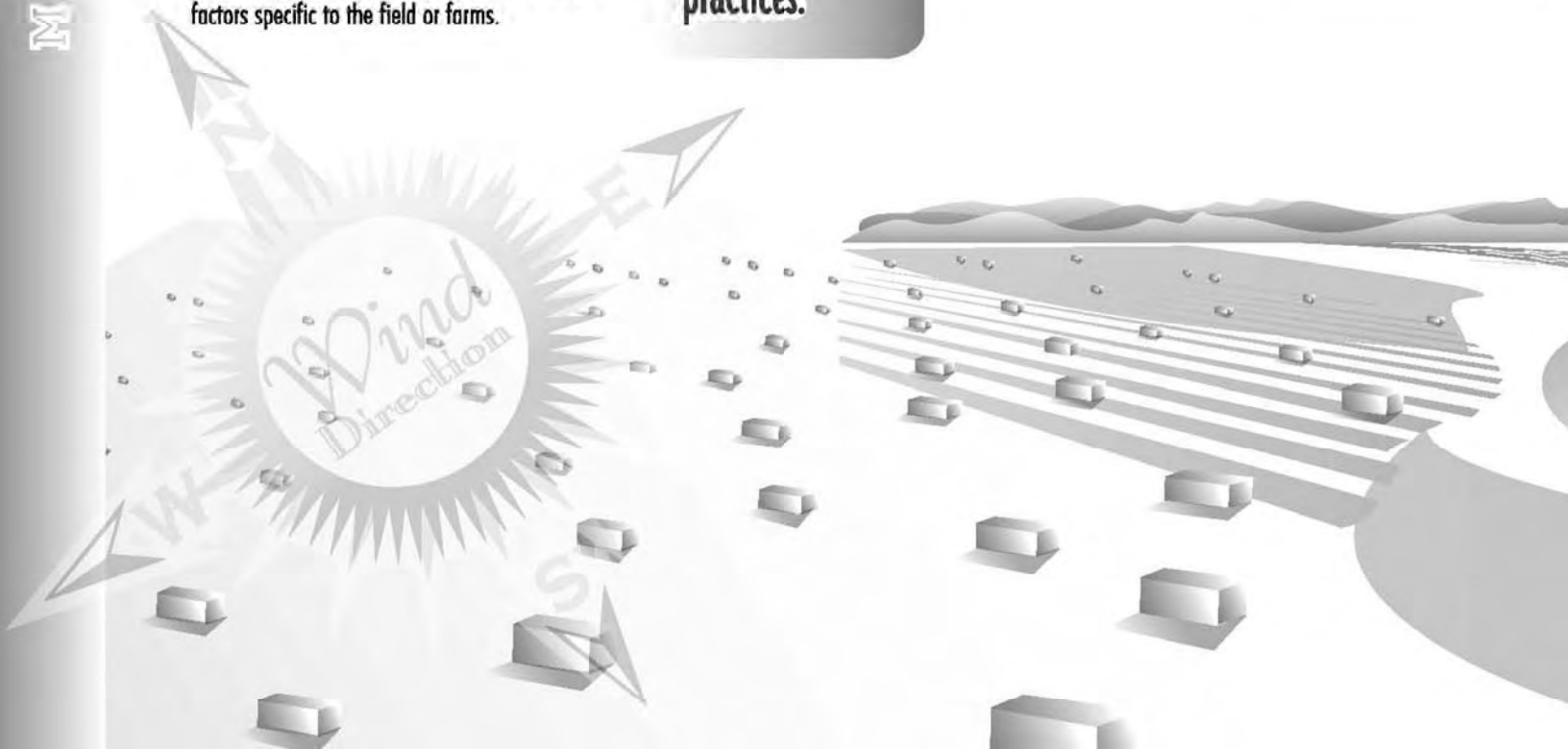
Consider ground water protection practices.

One or more following in

YE

Minimize impact with BMPs such as:

- Use reduced risk pesticides when feasible
- Manage spray drift near waterways
- Follow nutrient management plan
- Review site evaluation checklist



SAN JOAQUIN VALLEY

e of the runoff?

Insecticides

Fall/Winter applied
Herbicides

New plantings
Sediment

ES

ON-FARM

PAM
(Polyacrylamide)

Good effectiveness for removing:
- Sediment

Minimal effectiveness for removing:
- Water soluble pesticides
- Phosphate fertilizers
- Nitrogen fertilizers

Other benefits:
- Removes some microorganisms (potential pathogens)

Potential drawback:
- Cationic and neutral forms can be toxic to aquatic organisms

Note: Limited studies on effectiveness of PAM and pyrethroid pesticides; some data show positive results.

Vegetated Ditch/Waterway

Moderate effectiveness for removing:
- Sediment
- Hydrophobic pesticides (i.e. pyrethroids)
- Water soluble pesticides

Minimal effectiveness for removing:
- Phosphate fertilizers
- Nitrogen fertilizers (good effectiveness for NO3, but moderate for NH3)

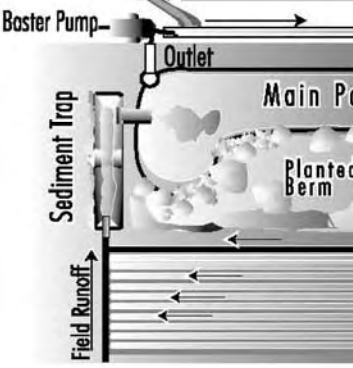
Other benefits:
- Wildlife habitat
- Use existing structures

Potential drawback:
- Effectiveness reduced in significant storm runoff events

Recircul Syste

Excellent effec for removing:
- Farm inputs & (keeps on site

Drawbacks
- Initial cost ca
- Potential salt



SAN JOAQUIN VALLEY

BMP Installation Location

SINGLE OR MULTIPLE FARMS

Sediment Basin/Pond

Good effectiveness for removing:

- Sediment
- Hydrophobic pesticides (i.e. pyrethroids)

Moderate effectiveness for removing:

- Phosphate fertilizers

Minimal effectiveness for removing:

- Water soluble pesticides
- Nitrogen fertilizers

Other benefits:

- Wildlife habitat

Potential drawbacks:

- Occupy large land area
- Initial cost may be high
- At least annual dredging/disposal of dredged material
- Groundwater contamination

Combining Pond + PAM:

- Greater effectiveness for removing sediment and hydrophobic pesticides

Note: PAM may result in slick sides of the pond, creating a possible drowning hazard for wildlife.

MULTIPLE FARMS

Constructed Wetland

Good effectiveness for removing:

- Sediment
- Hydrophobic pesticides (i.e. pyrethroids)
- Water soluble pesticides (i.e. organophosphates)

Moderate to good effectiveness for removing:

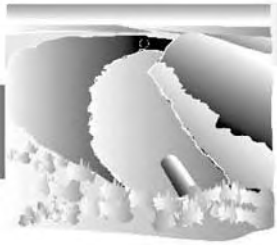
- Phosphate fertilizers
- Nitrogen fertilizers

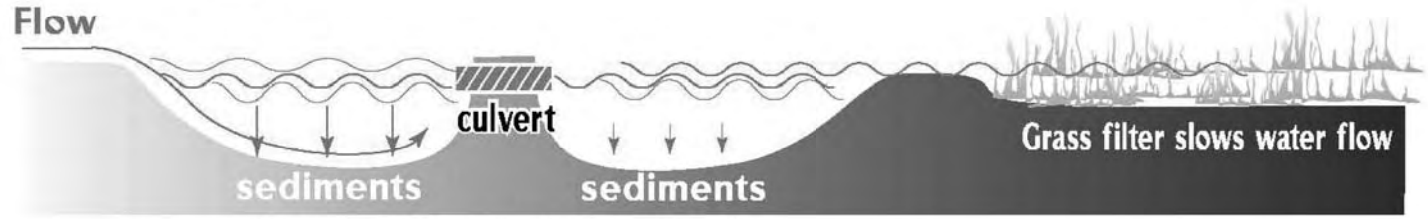
Other benefits:

- Wildlife habitat
- Flood control

Potential drawbacks:

- Occupy large land area
- Initial cost may be high





Holding Ponds (side view)

SAN JOAQUIN VALLEY

Guidelines for Selecting BMPs - Orchard

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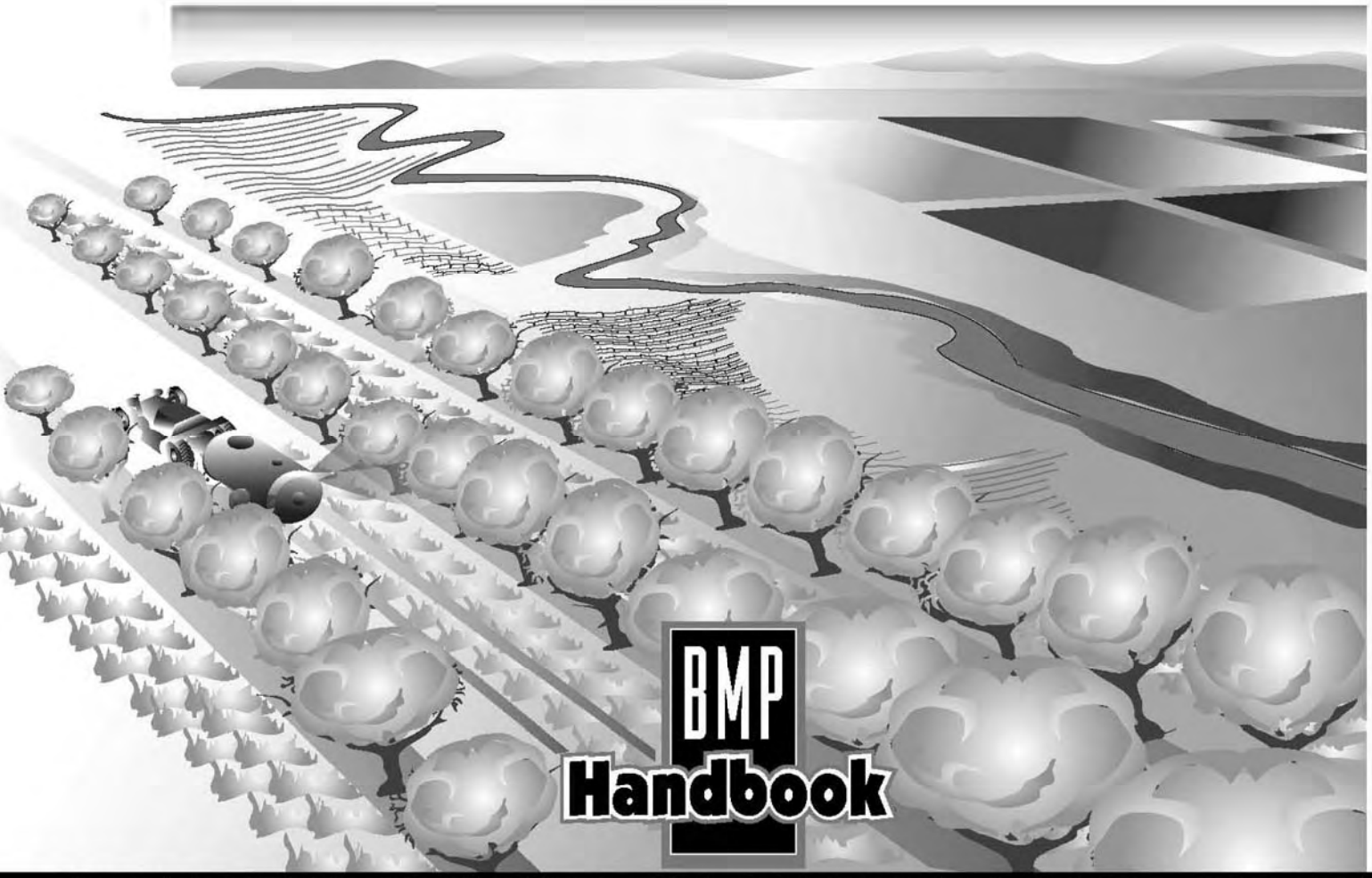

ALMOND ORCHARD PEST MANAGEMENT OPTIONS

Pest	Conventional Insecticides	Reduced Risk*Insecticides	Management/ Cultural Control	Biological Control	Organic Method
Peach Twig Borer (PTB)	***DORMANT*** SUPERIOR or SUPREME (Narrow Range Oil) *with* DIAZINON[I] 50WP *or* SUPRACIDE[I] 25W (Methidathion) *or* LORSBAN[I] 4E (Chlorpyrifos) IMIDAN 70 WP (Phosmet) ASANA[I] XL, (Esfenvalerate) ***DELAYED DORMANT*** SUPERIOR *or* SUPREME (Narrow Range Oil) *with* DIMILIN[I,IV] 2L (Diflubenzuron) ***SPRING*** LORSBAN[I] 4E (Chlorpyrifos) GUTHION 50 WP (Azinphosmethyl) CONFIRM* 2F (Tebufenozide) ***IN-SEASON*** CONFIRM* 2F (Tebufenozide)	***DORMANT*** SUCCESS*[III] *or* ENTRUST*[III] (Spinosad) DELEGATE*[II] WG (Spinetoram) INTREPID* 2F (Methoxyfenozide) ***BLOOM*** KURSTAKI[III] (*Bacillus thuringiensis)* INTREPID* 2F (Methoxyfenozide) SUCCESS*[III] *or* ENTRUST*[III] (Spinosad) ***SPRING*** SUCCESS*[III] *or* ENTRUST*[III] (Spinosad) INTREPID* 2F (Methoxyfenozide) DELEGATE*[II] WG (Spinetoram) DIPEL (*Bacillus thuringiensis*) PHERMONE MATING DISRUPTION	Preferred treatment timing at bloom; treat during the dormant season with SUCCESS *or* ENTRUST (Spinosad) *or* DIMILIN 2L (Diflubenzuron) (do not apply after petal fall) Organophosphates applied during dormant season threaten water quality when they run off during winter rainfall.	Peach twig borer has many natural enemies including chalcid wasps, *Paralitomastix varicornis* and *Hyperteles lividus*; these natural enemies destroy a significant portion of larvae, but they may not reduce twig borer populations below economically damaging levels. Ants, *Formica sp.*, also can be found preying on peach twig borer larvae.	Use *Bacillus thuringiensis* or SUCCESS[III] *or* ENTRUST[III] (Spinosad) Delayed dormant oil treatment for the control of scale and mite eggs followed by spray at bloom
San Jose Scale	***DORMANT*** Horticultural oil *with* DIAZINON[I] 50WP *or* SUPRACIDE[I] 25W (Methidathion) *or* LORSBAN[I] 4E (Chlorpyrifos) *or* SEVIN[I] 80S SEVIN[I] XLR PLUS (Carbaryl)	***DORMANT*** OMNI[III] *or* SUPREME[III] (Narrow Range Oil) *with* SEIZE 35WP *or* ESTEEM 0.86 EC (Pyriproxyfen) ***IN-SEASON*** OMNI[III] *or* SUPREME[III] (Narrow Range Oil) *with* SEIZE* 35WP *or* ESTEEM* 0.86 EC (Pyriproxyfen) *or* CENTAUR* *or* APPLAUD* 70 WP (Buprofezin)	Application of broad-spectrum insecticides may disrupt natural enemies; manage low-moderate populations with dormant season oil sprays; insecticides used during the growing season for other pests may disrupt biological controls	Natural enemies: twice stabbed lady beetle, *Chilocorus orbus*, *Cybocephalus californicus*; *Aphytis* sp. and *Encarsia* (*Prospaltella*) sp. Mild winter temperatures permit a buildup of scale populations	Biological control and properly applied oil spray during the delayed dormant period Oil alone can be effective in controlling low-to-moderate populations OMNI[III] *or* SUPREME[III] (Narrow Range Oil)
Webspinning Spider Mites Pacific spider mite, Twospotted spider mite, Strawberry spider mite	***SPRING*** OMITE 6EC, OMITE 30WP (Propargite) VENDEX[I] 50 WP (Fenbutatin-oxide) AGRI-MEK[I] 0.15 EC (Abamectin) APOLLO[I,*] (Clofentezine) ONAGER EC (Hexythiazox) PYRAMITE (Pridaben)	***SPRING*** ACRAMITE* 50WS (Bifenazate) OMNI[III] *or* SUPREME[III] (Narrow Range Oil) HEXACIDE[III] (Rosemary oil)	Maintain groundcover; water roadways to reduce dusty conditions; water stress makes trees more susceptible to damage; avoid in-season pyrethroid, organophosphate, or carbamate applications which often result in spider mite outbreaks	Western predatory mite, six spotted thrips, and spider mite destroyer prey on Web spinning spider mites *Galendromus occidentalis* (predatory mites)	Biological controls, including predator releases, cultural controls and various types of oil sprays HEXACIDE[III] (Rosemary oil) OMNI[III] *or* SUPREME[III] (Narrow Range Oil)

Source: Crop Protection Industry contacts; UC IPM Pest Management Guidelines, Almonds - http://www.ipm.ucdavis.edu/PMG/selectnewpest.almonds.html
Trademarked names in capital letters.

I Permit required from county agricultural commissioner for purchase or use.

II Do not apply when bees are present.

III Acceptable for use on an organically grown crop

IV Do not apply after petal fall

* Reduced risk is defined by EPA as a product with low-impact on human health, low toxicity to non-target organisms (birds, fish, and plants), low potential for groundwater contamination, lower use rates, low pest resistance potential, and compatibility with Integrated Pest Management.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the State Water Resources Control Board or CURES.

WALNUT ORCHARD PEST MANAGEMENT OPTIONS

Pest	Conventional Control	Reduced Risk*	Biological Control	Cultural Control	Organic Method
Navel Orangeworm	IMIDAN 70 WP (Phosmet) GUTHION SOLUPAK[I] (Azinphosmethyl) SUPRACIDE[I] (Methidathion) ASANA[I] XL (Esfenvalerate) SEVIN[I] (Carbaryl)	INTREPID* 2F (Methoxyfenozide)	Parasitic wasps for navel orangeworm: *Copidosoma (Pentalitomastix) plethorica* and *Goniozus legneri*; winter ground cover aids in decomposing trash nuts	Orchard sanitation: remove nuts from trees; flail mow or burn crop waste before mid-March; minimize damaged nuts by controlling walnut blight and codling moth; early harvest; dry and fumigate nuts immediately	Biological and cultural controls
San Jose Scale	SUPRACIDE[I] 25 WP (Methidathion) CHLORPYRIFOS[I] (Lorsban) 4EC	***DORMANT*** SEIZE* 35 WP (Pyriproxyfen) ***IN-SEASON*** Oils	Walnut aphid parasite, *Trioxys pallidus* (oil is toxic to this parasite)	Maintain natural enemies	Biological controls NARROW RANGE OIL[II]
European Red Mite	OMITE[I] 30W (Propargite) VENDEX 50 WP (Fenbutatin-Oxide AGRI-MEK[I] (with oil) (Abamectin) APOLLO* SC (Clofentezine)	NARROW RANGE OIL[II] ACRAMITE* 50WS (Bifenazate)	The western predatory mite, Sixspotted thrips, spider mite destroyer and minute pirate bugs	Avoid treating low-to-moderate levels of European red mites	Biological control; narrow range oils; dilute, delayed-dormant oil treatment may aid control of European red mite
European Fruit Lecanium (and Frosted Scale)	SUPRACIDE[I] 25WP (Methidathion) LORSBAN[I] 4EC (Chlorpyrifos)	NARROW RANGE OIL[II]	Coccophagus, Encyrtus, and Metaphycus	Parasites	Biological control NARROW RANGE OIL[II]
Webspinning Spider Mites (Twospotted Spider Mite, Pacific Red Spider Mite)	ENVIDOR 2SC VENDEX 50 WP (Fenbutatin-Oxide OMITE 30W (Propargite) KELTHANE MF (Dicofol)	ZEAL* (Etoxazole) ACRAMITE* 50WS (Bifenazate) ECOTROL[II] (Rosemary Oil/ Peppermint Oil)	Western predatory mites; Sixspotted thrips; spider mite destroyer; minute pirate bugs	Minimize dust; well-irrigated, vigorous trees are less troubled by mite infestations	Biological control NARROW RANGE OIL[II] (under certain conditions) ROSEMARY OIL/PEPPERMINT OIL[II]

Source: Crop Protection Industry contacts; UC IPM Pest Management Guidelines-Walnuts, http://www.ipm.ucdavis.edu/PMG/selectnewpest.walnuts.html
Trademarked names in capital letters.
I Permit required from county agricultural commissioner for purchase or use.

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* EPA criteria for reduced risk (RR) designation: low-impact on human health, low toxicity to non-target organisms (birds, fish, and plants), low potential for groundwater contamination, lower use rates, low pest resistance potential, and compatibility with Integrated Pest Management.

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SAN JOAQUIN VALLEY

Managing Orchard Runoff

BMP Selection Guidelines

This graphic portrays various Best Management Practice (BMP) scenarios to consider should storm or irrigation drainage leave your farm.

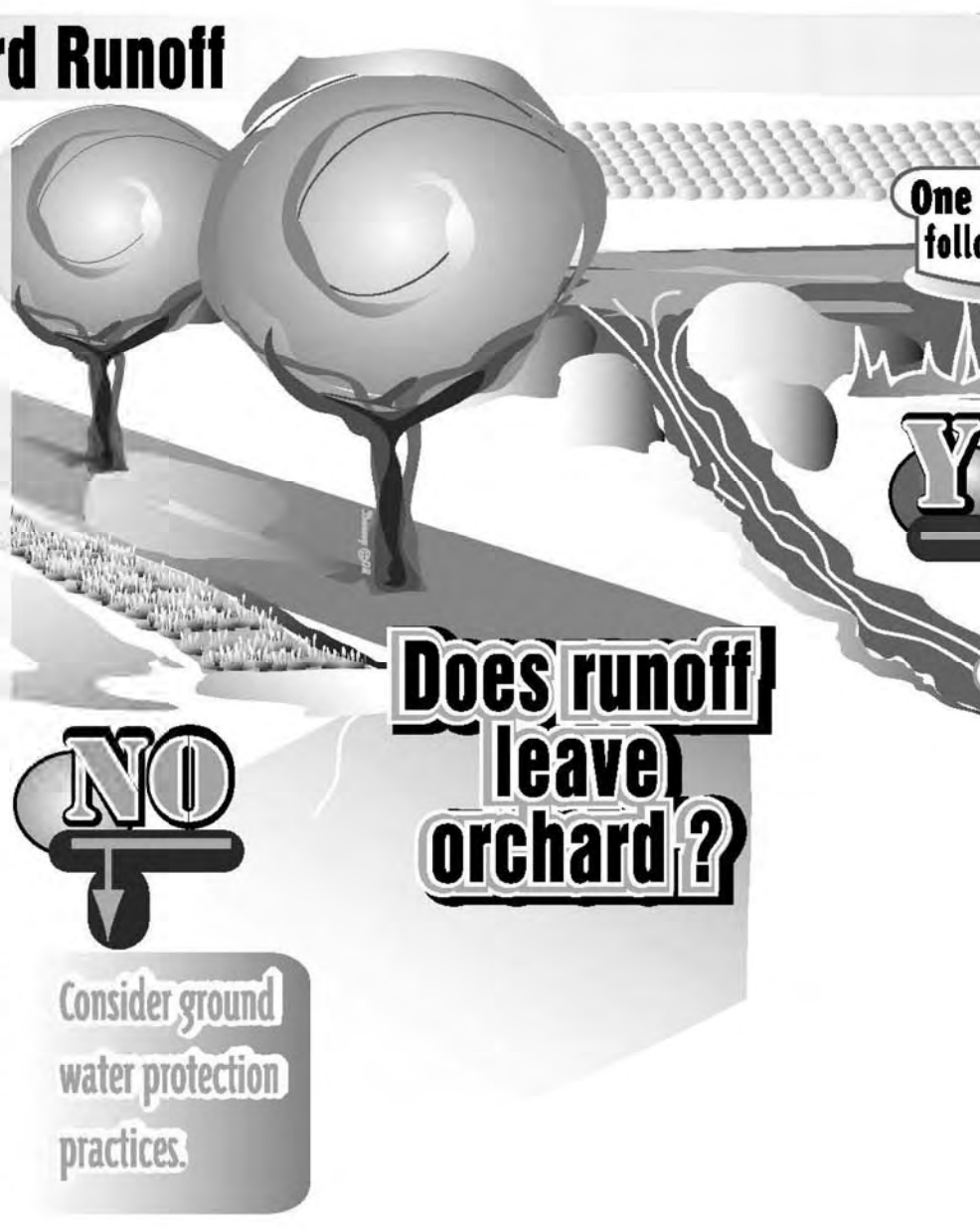
These guidelines focus on two areas:

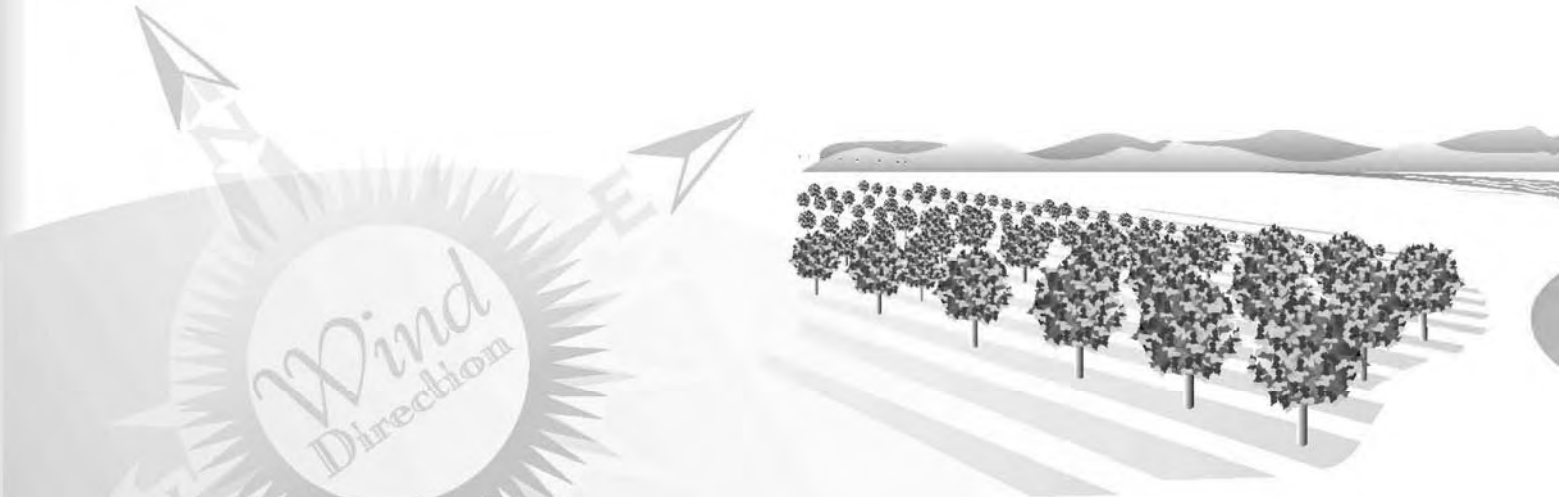
- Managing the drainage water on-farm (or correcting a problem before it happens);
- Directing drainage from multiple farms to a single constructed wetland area.

Under each BMP are comments on effectiveness and potential drawbacks. Read more about the BMP practices and studies used to determine those rankings at:
www.curesworks.org/bmp/bmpGeneral.asp

See back page for a list of pest management options available for specific crops.

Note: Each field or farm has multiple characteristics to consider when making a decision on which BMP is best suited to manage runoff. Information provided here is intended to assist in making that selection but should be considered with all factors specific to the field or farms.





MANAGING ORCHARD RUNOFF

SAN JOAQUIN VALLEY

or more of the
owing in runoff?

·Pesticides ·Nutrients ·Sediment

ES

ON-FARM

Minimize impact with BMPs such as:

- Use reduced risk pesticides when feasible
- Manage spray drift near waterways
- Follow nutrient management plan
- Review site evaluation checklist

Vegetated Ditch/Waterway

Moderate effectiveness for removing:

- Sediment
- Hydrophobic pesticides (i.e. pyrethroids)
- Water soluble pesticides

Minimal effectiveness for removing:

- Phosphate fertilizers
- Nitrogen fertilizers (good effectiveness for NO_3, but moderate for NH_3)

Other benefits:

- Wildlife habitat
- Use existing structures

Potential drawback:

- Effectiveness reduced in significant storm runoff events

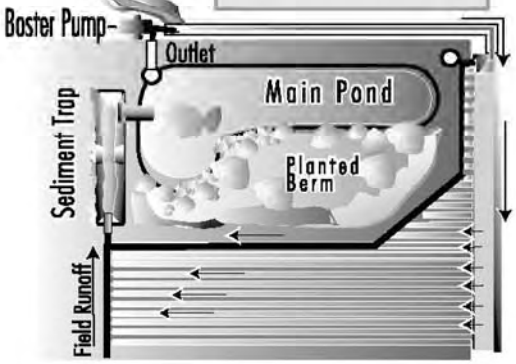
Recirculation System

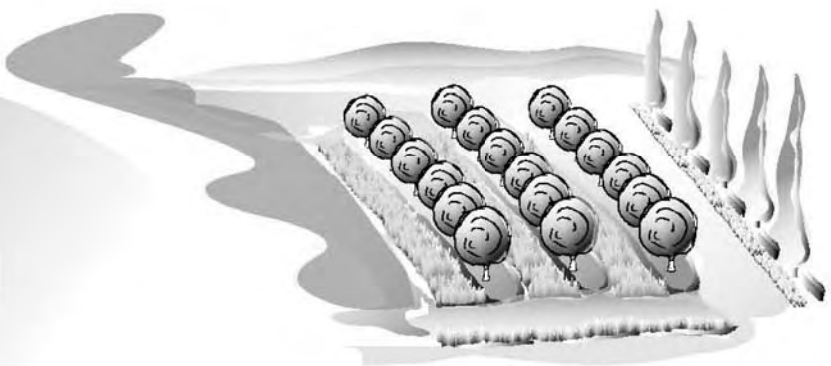
Excellent effectiveness for removing:

- Farm inputs & sediment (keeps on site)

Drawbacks

- Initial cost can be high
- Potential salt build up





Vegetated

SAN JOAQUIN VALLEY

BMP Installation Location

SINGLE OR MULTIPLE FARMS

Sediment Basin/Pond

Good effectiveness for removing:

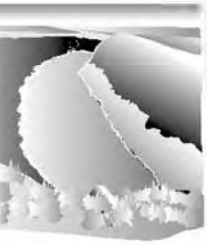
- Sediment
- Hydrophobic pesticides (i.e. pyrethroids)

Moderate effectiveness for removing:

- Phosphate fertilizers

Minimal effectiveness for removing:

- Water soluble pesticides
- Nitrogen fertilizers



Other benefits:

- Wildlife habitat

Possible drawbacks:

- Occupy large land area
- Initial cost may be high
- At least annual dredging/disposal of dredged material
- Groundwater contamination

MULTIPLE FARMS

Constructed Wetland

Good effectiveness for removing:

- Sediment
- Hydrophobic pesticides (i.e. pyrethroids)
- Water soluble pesticides (i.e. organophosphates)

Moderate to good effectiveness for removing:

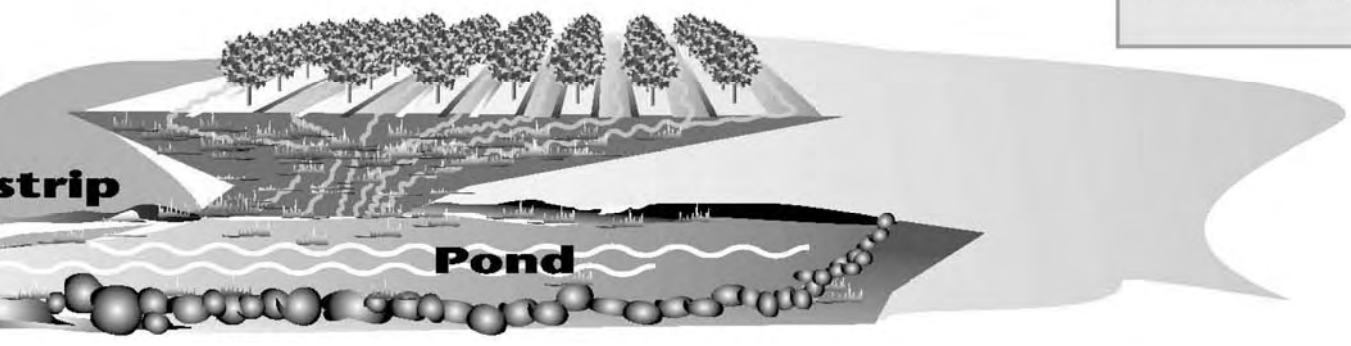
- Phosphate fertilizers
- Nitrogen fertilizers

Other benefits:

- Wildlife habitat
- Flood control

Potential drawbacks:

- Occupy large land area
- Initial cost may be high



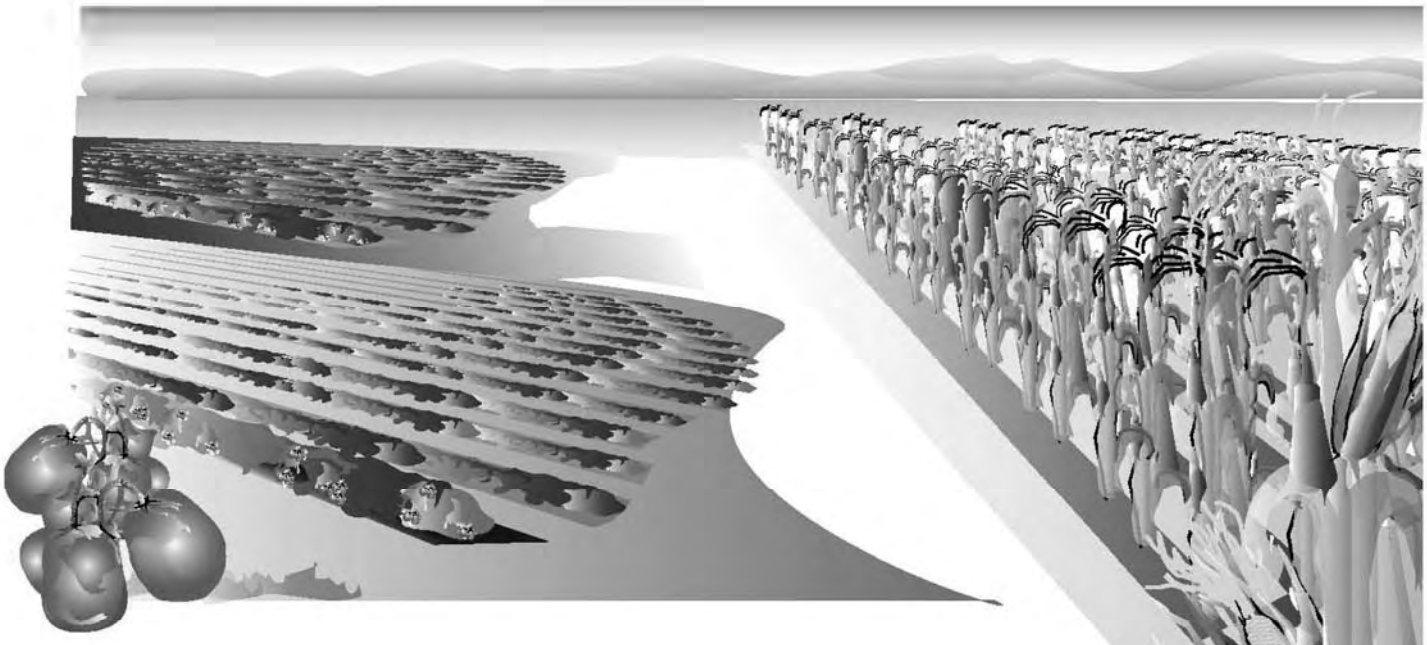
SAN JOAQUIN VALLEY

Guidelines for Selecting BMPs - Row Crops

This publication is designed to guide growers through a selection process for deciding which single or combination of water quality BMPs are most appropriate for a farming operation in the Central Valley. BMP (Best Management Practice) is a broad term describing a wide range of agricultural practices for mitigating the environmental impact of modern farming. BMPs for protecting surface water can include improvements in pesticide application methods, drip or low volume irrigation systems or use of amendments to prevent soil erosion. A BMP can also be engineered structures such as vegetated ditches, sediment catch basins and constructed wetlands.

The following illustration is designed to lead growers through a selection process to identify BMPs that are best suited for improving water quality draining from a field or multiple fields. The final BMP(s) selected can range from individual field practices or a combination of practices to construction of regional water recycling and water quality control structures.

The Pest Control table includes a list of both conventional and "Reduced Risk" pest control options for common pests in the Central Valley. Reduced Risk products, as defined by US-EPA, have a low potential for groundwater and surface water contamination, lower use rates than conventional products, low pest resistance potential, low-impact on human health, low toxicity to non-target organisms (birds, fish, and plants) and compatibility with Integrated Pest Management. The table also briefly describes cultural controls, biological controls and organic practices that target common pests.



BMP Handbook

CORN PEST MANAGEMENT OPTIONS

Pest	Conventional Control	Reduced Risk*	Biological Control	Cultural Control	Organic Method
Aphids (Corn Leaf Aphid, Greenbug, Green peach Aphid)	ASANA[I] XL (Esfenvalerate) THIONEX[I] 3EC (Endosulfan) DIMETHOATE 400 (For field corn only) LORSBAN[I] 4E (Chlorpyrifos)		*Lysiphlebus testaceipes (aphid parasite)*, lady beetles and their larvae, lacewing larvae, and syrphid fly larvae	Some corn varieties more susceptible to aphids	Biological control and oil/soap sprays
Armyworms (Armyworm, Beet armyworm, Western Yellowstriped armyworm)	LANNATE[I] SP (Methomyl) ASANA[I] XL (Esfenvalerate)	AVAUNT* (Indoxacarb) (sweet corn) INTREPID* 2F (Methoxyfenozide)	Tachinid flies parasitize armyworm larvae and are an effective biocontrol agent [III]	Armyworms attracted to barnyardgrass, Echinochloa crus-galli) then migrate to corn; weed control important	Control weeds, especially barnyardgrass; use of *Bacillus thuringiensis* or *Spinosad*
Corn Earworms	LANNATE[I] SP (Methomyl) ASANA[I] XL (Esfenvalerate) LORSBAN[I] 4E (Chlorpyrifos)	ENTRUST*,[II] or SUCCESS*,[II] (Spinosad)	Species of *Trichogramma* attack corn earworm eggs, lacewings, minute pirate bugs, and damsel bugs	Early plantings of sweet corn require fewer treatments than late-season plantings; varieties with long tight husks help impede entrance^	Biological/ cultural controls; use of *Bacillus thuringiensis* and Spinosad (see reduced risk)
Corn Leafhopper	Seed treatments with systemic insecticides have been shown to reduce corn leafhopper populations, but incidence of corn stunt disease has only been negligibly reduced		Minute pirate bugs, green lacewings, and assassin bugs are associated with corn leafhoppers but appear to have little effect on populations	Plant early as possible; reflective plastic mulch shown to repel adult leafhoppers in sweet corn; control volunteer corn and alfalfa which are winter hosts	Plant with reflective mulch for management in sweet corn; remove volunteer corn and alfalfa plants
Cutworms (Black cutworm, Variegated cutworm)	AMBUSH[I] 25W (Permethrin) LORSBAN[I] 4E (Chlorpyrifos) SEVIN 5% Bait (Carbaryl)			If cutworm population reduces plant stand, treat during the seedling stage	Remove weeds 2 weeks pre plant in and adjacent to field; avoid planting on newly broken sod
Flea Beetles (Desert corn flea beetle, Three-spotted flea beetle, Potato flea beetle, Palestriped flea beetle)	SEVIN[I] XLR Plus, 4F (Carbaryl)			Crop rotation works fairly well; use varieties resistant or tolerant to Stewart's wilt (transmitted by flea beetles); numbers are greatly reduced by cold winters with little snow cover^	Keep fields weed-free, particularly field bindweed and mustard, preferred flea beetle hosts
Seed Corn Maggot	DIAZINON[I] 50W ***BEFORE PLANTING*** CRUISER 5FS (Thiamethoxam) PONCHO (Clothianidin)			Preventive treatment (seed or broadcast) best control method; try to create conditions for rapid germination (use ridges and wait until soil has warmed)^	Incorporate crop residues and destroy weed growth; plant under ideal conditions to best manage pest
Spider Mites (Two-spotted spider mite, Banks grass mite, Strawberry spider mite, Pacific spider mite)	COMITE EC (Propargite) OBERON* 2SC (Spiromesifen)		Use predatory insects and mites, particularly early season: thrips, minute pirate bugs, and bigeyed bugs; minimize early season insecticide applications	Keep fields, field margins, and irrigation ditches weed free. Minimizing dust can reduce spider mite populations	Biological/ cultural controls; poor water management or water stress can predispose crop to spider mites
Wireworms	LORSBAN 15G (Chlorpyrifos) CRUISER 5FS (Thiamethoxam)		Rotate crops and cultivate infested soil late summer or autumn to kill or expose various insect stages to predators	Damage most likely to occur to corn planted in former pasture or weedy alfalfa field	Biological controls and cultural controls

Source: Crop Protection Industry contacts; UC IPM Pest Management Guidelines, Corn: http://www.ipm.ucdavis.edu/PMG/selectnewpest.corn.html
Trademarked names in capital letters.

* Reduced risk is defined by EPA as a product with low-impact on human health, low toxicity to non-target organisms (birds, fish, and plants), low potential for groundwater contamination, lower use rates, low pest resistance potential, and compatibility with Integrated Pest Management.

I Permit required from county agricultural commissioner for purchase or use.

II Acceptable for use on an organically grown crop.

III Oregon State University Extension Service, 2006, http://extension.oregonstate.edu/catalog/html/em/em8919/index.html#p3

^ Resource Guide for Organic Insect and Disease Management: http://www.nysaes.cornell.edu/pp/resourceguide/cmp/corn.php

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TOMATO PEST MANAGEMENT OPTIONS

Pest	Conventional Control	Reduced Risk*	Biological Control	Cultural Control	Organic Method
Aphids (Potato Aphid, Green Peach Aphid and other early-season Aphids)	ACTARA (Thiamethoxam) LANNATE[I, II] 90SP (Methomyl) DIMETHOATE E267, 400 PYGANIC[III] 1.4EC (Pyrethrin) WARRIOR with Zeon[I] (Lambda-cyhalothrin) MOVENTO (Spirotetramat)	ASSAIL* 70WP (Acetamiprid)	Lady beetles and their larvae, lacewing larvae, and syrphid fly larvae	Winged aphids are repelled by silver or aluminum colored mulches	Use varieties tolerant of potato aphid; insecticidal soap; thyme oil or pyrethrin
Armyworms (Beet Armyworm and Western Yellowstriped Armyworm)	ASANA XL[I, II] 0.66EC (Esfenvalerate) DANITOL[I] 2.4EC (Fenpropathrin) LANNATE[I, II] 90WSP (Methomyl) CORAGEN (Rynaxypyr) PROCLAIM (Emamectin benzoate)	INTREPID* 2F (Methoxyfenozide) ENTRUST*[III] or SUCCESS*[III] (Spinosad) AVAUNT* (Indoxacarb)	*Hyposoter exiguae, a small wasp*, nuclear polyhedrosis viruses (NPVs), bigeyed bugs and minute pirate bugs feed on eggs	Proximity to weed hosts or alfalfa may predispose crop to injury; physical barriers such as trenches can be deterrents	ENTRUST*[III] (Spinosad) and *Bacillus thuringiensis* ssp. *aizawai*
Cutworms	LANNATE[I, II] 90SP (Methomyl) SEVIN[I, II] Bait 5% (Carbaryl)		Beneficial nematodes, trichogramma parasitize cutworm eggs, diatomaceous earth applied to soil surface	Tillage at least 2 weeks before planting will help destroy plant residue that could harbor larvae	Cultural control
Flea Beetles	ASANA XL[I, II] 0.66EC (Esfenvalerate) WARRIOR with Zeon[I] (Lambda-cyhalothrin) SEVIN[I, II] 80S (Carbaryl) PYGANIC[III] EC (Pyrethrin)	VENOM* 20SG (Dinotefuran)	Trap cropping with Chinese Southern Giant Mustard (Brassica juncea var. crispifolia) every 55 yards between rows +	Rotate tomatoes with a non-host crop (wheat or sunflowers), till weeds and crop residues in fall	Crop rotation with a non-host crop and sprays of pyrethrin
Hornworms	SEVIN[I, II] 80S (Carbaryl) ASANA XL[I, II] 0.66EC (Esfenvalerate)	KURSTAKI[III] (various products) *Bacillus thuringiensis* INTREPID* 2F (Methoxyfenozide) AVAUNT* (Indoxacarb)	Hornworm eggs are attacked by *Trichogramma* parasites and the larvae by *Hyposoter exiguae*.	Discing after harvest destroys pupae in soil; rotate with non-host crops to reduce population levels	Biological and cultural controls; use of *Bacillus thuringiensis*
Tomato Fruitworm	ASANA XL[I, II] 0.66EC (Esfenvalerate) DANITOL[I] 2.4 EC (Fenpropathrin) CORAGEN (Rynaxypyr)	PROCLAIM (Emamectin benzoate) AVAUNT* (Indoxacarb)	*Trichogramma* spp. egg parasites, *Hyposoter exiguae*, and predators such as bigeyed bug and minute pirate bug	Monitor for eggs and small larvae in July	Biological control, *Bacillus thuringiensis;* ENTRUST*[III] (Spinosad)
Tomato Pinworm	LANNATE[I, II] 90SP, LV (Methomyl) CORAGEN (Rynaxypyr)	NO MATE TPW SPIRALS[III] or CHECKMATE TPW[III] AVAUNT* (Indoxacarb) ENTRUST[III] or SUCCESS[III] (Spinosad)	*Apanteles* sp., *Sympiesis stigmatipennis*, and *Parahormius pallidipes*	Destroy residues by burning or plowing; avoid growing both an early and late-season crop	Biological and cultural control; mating disruptants
Whiteflies (Silverleaf whitefly, Greenhouse whitefly, Bandedwinged whitefly)	***AT PLANTING*** VENOM Soil application (Dinotefuran) ADMIRE PRO (Imidacloprid) ***GROWING SEASON*** VYDATE[I] L (Oxyamyl) ACTARA (Thiamethoxam)	***GROWING SEASON*** ASSAIL* 70WP (Acetamiprid) OBERON* 2SC (Spiromesifen), apply early to reduce virus transmission	*Encarsia* and *Eretmocerus* genera, bigeyed bugs, lacewing larvae, and lady beetle larvae	Maximize distance and time interval between host crops (melons, cole crops, and cotton); silver- or aluminum-colored mulches	Cultural and biological control; insecticidal soaps and oil plus azadirachtin (neem products)

Source: Crop Protection Industry contacts; UC IPM Pest Management Guidelines for tomatoes; http://www.ipm.ucdavis.edu/PMG/selectnewpest.tomatoes.html
Trademarked names in capitol letters.

I Permit required from county agricultural commissioner for purchase or use.

II Do not apply when bees are present.

III Acceptable for use on an organically grown crop

* Reduced risk is defined by EPA as a product with low-impact on human health, low toxicity to non-target organisms (birds, fish, and plants), low potential for groundwater contamination, lower use rates, low pest resistance potential, and compatibility with Integrated Pest Management.

+ National Sustainable Agriculture Information Service, http://attra.ncat.org/attra-pub/fleabeetle.html

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SAN JOAQUIN VALLEY

Managing Row Crop Runoff

BMP Selection Guidelines

This graphic portrays various Best Management Practice (BMP) scenarios to consider should storm or irrigation drainage leave your farm.

These guidelines focus on two areas:

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Under each BMP are comments on effectiveness and potential drawbacks. Read more about the BMP practices and studies used to determine those rankings at:
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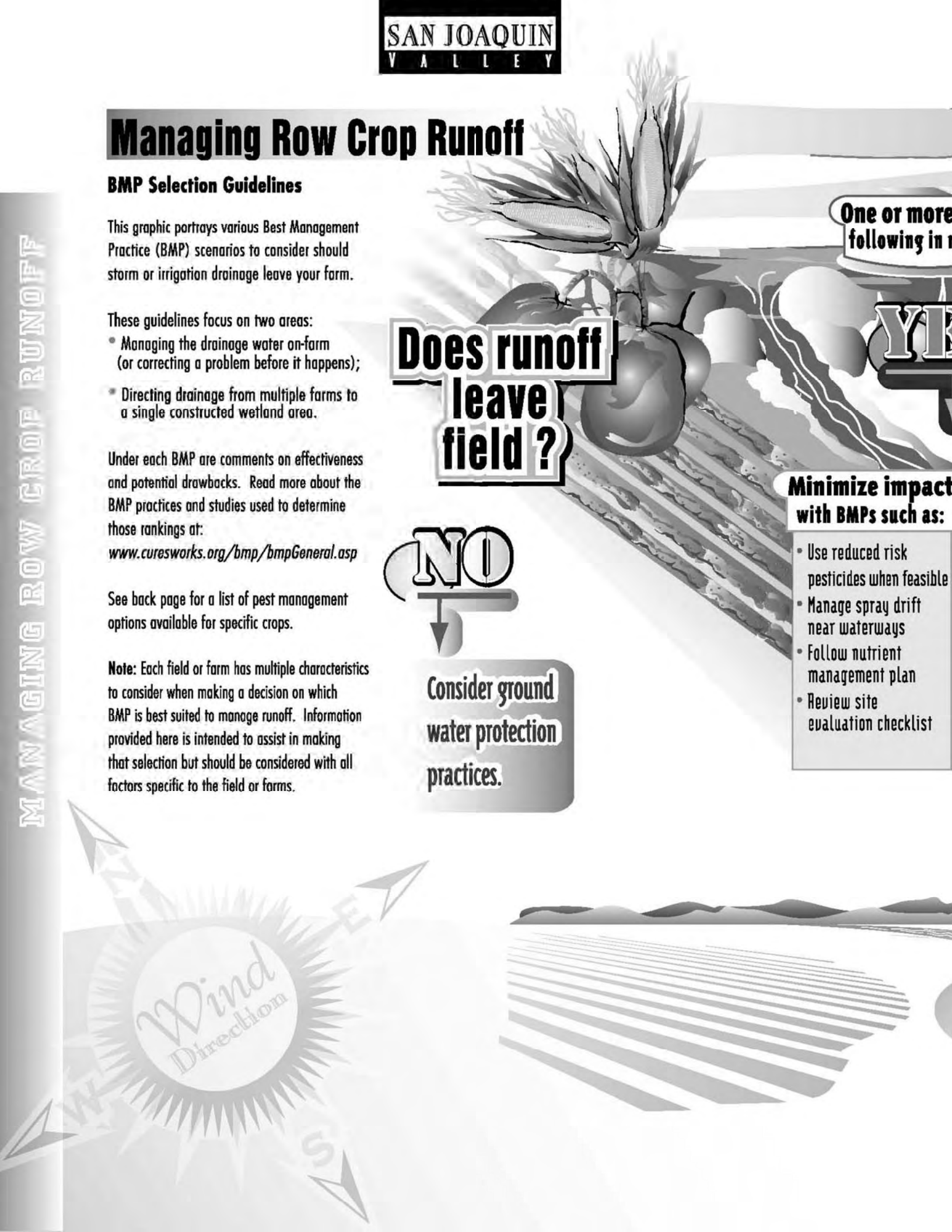


MANAGING ROW CROP RUNOFF

SAN JOAQUIN VALLEY

of the runoff?

Pesticides | Nutrients | Sediment

ES

ON-FARM

PAM (Polyacrylamide)

Good effectiveness for removing:

- Sediment

Note: Limited studies on effectiveness of PAM and pyrethroid pesticides; some data show positive results.

Minimal effectiveness for removing:

- Water soluble pesticides
- Phosphate fertilizers
- Nitrogen fertilizers

Other benefits:

- Removes some microorganisms (potential pathogens)

Potential drawback:

- Cationic and neutral forms can be toxic to aquatic organisms

Vegetated Ditch/Waterway

Moderate effectiveness for removing:

- Sediment
- Hydrophobic pesticides (i.e. pyrethroids)
- Water soluble pesticides

Minimal effectiveness for removing:

- Phosphorous nutrients
- Nitrogen fertilizers (good effectiveness for NO3, but moderate for NH3)

Other benefits:

- Wildlife habitat
- Use existing structures

Potential drawback:

- Effectiveness reduced in significant storm runoff events

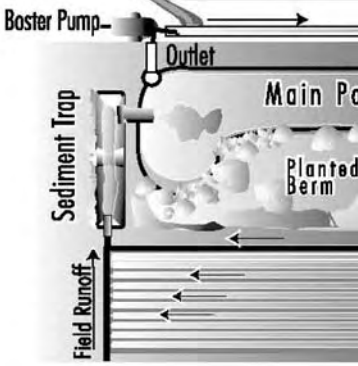
Recircul Syste

Excellent effec for removing:

- Farm inputs & (keeps on site)

Drawbacks

- Initial cost ca
- Potential salt



SAN JOAQUIN VALLEY

BMP Installation Location

SINGLE OR MULTIPLE FARMS

Sediment Basin/Pond

Good effectiveness for removing:

- Sediment
- Hydrophobic pesticides (i.e. pyrethroids)

Moderate effectiveness for removing:

- Phosphate fertilizers

Minimal effectiveness for removing:

- Water soluble pesticides
- Nitrogen fertilizers

Other benefits:

- Wildlife habitat

Potential drawbacks:

- Occupy large land area
- Initial cost may be high
- At least annual dredging/disposal of dredged material
- Groundwater contamination

Combining Pond + PAM:

- Greater effectiveness for removing sediment and hydrophobic pesticides

Note: PAM may result in slick sides of the pond, creating a possible drowning hazard for wildlife.

MULTIPLE FARMS

Constructed Wetland

Good effectiveness for removing:

- Sediment
- Hydrophobic pesticides (i.e. pyrethroids)
- Water soluble pesticides (i.e. organophosphates)

Moderate to good effectiveness for removing:

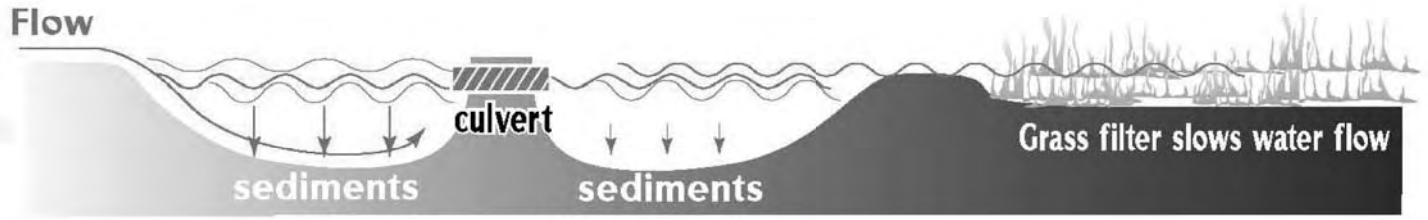
- Phosphate fertilizers
- Nitrogen fertilizers

Other benefits:

- Wildlife habitat
- Flood control

Potential drawbacks:

- Occupy large land area
- Initial cost may be high



Holding Ponds (side view)

SAN JOAQUIN VALLEY

Irrigator BMP Tips

Irrigation runoff from farms is under new, stricter regulations in California. Drain water leaving a farm can contain silt, pesticides or fertilizers which can pose a threat to the environment. Everyone working with crop irrigation needs to understand the importance of protecting water quality, especially the irrigator. Here are steps you can take to do your part.

Water Ditches and Dams

- Be aware of where water drains from fields.
- Use plastic sheeting to cover dams, spills and furrow cuts to prevent erosion/washing away of soil.
- Build "dams" every 100-200 feet down drain ditch to slow flow and settle silt from water.

Irrigation Tips

- Use shortest row lengths possible to reduce water and sediment runoff.
- When water running fertilizer, turn off fertilizer just as water reaches the row end to minimize run off.
- Use correct siphon pipe size to match row length: too large can cause furrow erosion.

PAM in Irrigation Water

- Use PAM when drain water is high in sediments.
- PAM can be applied in the furrow at the end of siphon tubes or where gated pipe flows.
- PAM is best applied following field cultivations when soil is lose.

Sediment Basins/Ponds

- Before irrigation season begins, be sure to clean all ponds.
- If sediment pond fills during the season, notify supervisor to clean basin. A full pond will not operate as designed.

IRRIGATOR BMP TIPS

SAN JOAQUIN VALLEY

Sugerencias para Mejores Prácticas de Manejo (BMP, por sus siglas en inglés) para las personas que riegan

IRRIGATOR BMP TIPS

El agua de escurrimiento de riego que viene de establecimientos agrícolas está sujeto a reglamentaciones nuevas y más estrictas en California. El agua que drena de un establecimiento agrícola puede contener limo, pesticidas o fertilizantes que representan una amenaza para el medio ambiente. Todas las personas que trabajen en riego de cultivos, en especial las personas que se encarguen del riego, deben entender la importancia de la protección de la calidad del agua. A continuación presentamos algunos pasos que usted podrá seguir para colaborar.

Acequias y "embalses" de riego

- Preste atención hacia dónde drena el agua de los campos.
- Utilice tela plástica para cubrir embalses, derrames y cortes en los surcos, a fin de prevenir la erosión / arrastre de suelo.
- Construya "embalses"cada 100-200 pies en la acequia de desagüe para disminuir el flujo de agua y hacer que los sedimentos se decanten.

Sugerencias para el riego

- Haga hileras de la menor longitud posible, a fin de reducir el escurrimiento de agua y de sedimentos.
- Cuando aplique fertilizante en el agua de riego, interrumpa la aplicación del fertilizante no bien el agua llegue al extremo de la hilera, para minimizar así el escurrimiento.
- Use sifones del tamaño correcto que correspondan a la longitud de la hilera: los sifones demasiado grandes pueden provocar erosión en el surco.

PAM en el agua de riego

- Utilice PAM cuando el agua de drenaje tenga un alto contenido de sedimentos.
- El PAM puede aplicarse en el surco en el extremo de los sifones o donde descargan las tuberías de compuertas.
- Es mejor aplicar PAM después de las labores de cultivo, cuando el suelo está más suelto.

Estanques de sedimentación

- Antes de que comience la temporada de riego, asegúrese de limpiar todos los estanques.
- Si los estanques de sedimentación se llenan durante la temporada, notifique al supervisor para limpiar la cuenca. Un estanque lleno de sedimentos no funcionará de acuerdo a su diseño.

Sediment Basins

On site practices for protecting surface water can include modifying small areas of a field so drainage water from irrigations or storms passes through specially designed structures. These structures can assist in removal of sediment and farm inputs.

Sediment Basin Description

The most commonly used drainage management structure in the Central Valley is the sediment pond or silt basin. Sediment basins are typically simple in design and maintenance. Sediment basins used in agriculture reduce erosion and improve water quality by trapping water, sediment and potential pollutants. They can be effective to manage runoff from both winter storms and irrigation.

Sediment basins are located at the end of tail water ditches and collect drainage water, allowing time for sediment in the runoff to settle out. The runoff flows through the basin at a low velocity so sediment drops to the bottom of the pond. Water releases slowly through soil infiltration or a pipe outlet, improving the quality of the water leaving the basin.

Sediment basins are most effective when used in conjunction with other field-level erosion control practices, such as irrigation scheduling, use of polyacrylamide (PAM), vegetated filter strips or vegetated ditches/swales. Use of these practices can also reduce the costs of maintaining the sediment basin.

Sediment basins can be very cost-effective because they can be easily constructed with farm machinery and are efficient for most soil types. Sediment basins can also be used in conjunction with tailwater recovery systems.

Advantages

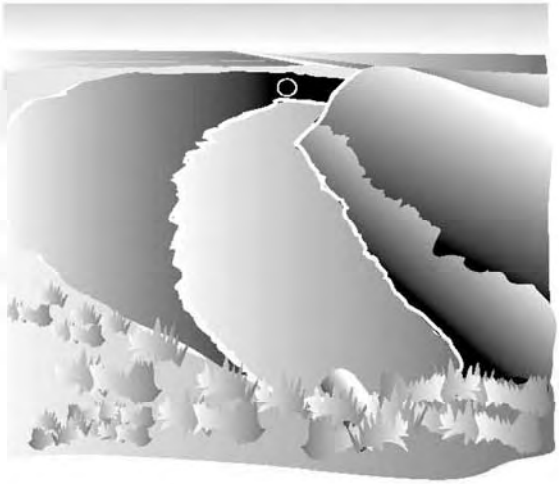
- Reduces sediment leaving property
- Enhances downstream water quality
- Possible pollution reduction
- Can provide near complete off-farm sediment control

Disadvantages

- Requires frequent clean out
- Sediment mounds must be spread on fields
- Loss of farmable acres
- To handle large quantities of off-farm sediment, basins can be expensive to install and maintain

*Design and Construction**

Sediment basins should be long and narrow so that sediment carried in the water has sufficient time to settle out before the tail water passes through. The length-to-width ratio can vary, but optimum settling can be achieved when the length is about three to four times greater than the width. Generally, the embankment should have a minimum top width of 4 feet and side slopes of 2:1 or flatter. The embankment top and edge can be planted with vegetation (annual, non-native perennial or native perennial grasses) to help prevent sloughing and erosion. The outlet should be lower than the inlet structure/inflow level of the basin. Outlet structures can be flashboard riser type to allow for ponding and outflow control.



SEDIMENT BASINS Central Valley Installation and Maintenance Costs

Sediment basins should be designed to store at least one year's accumulation of sediment. Natural Resource Conservation Service (NRCS) technicians can assist in computing sediment yield. A drying area is needed so sediment can dry after it is removed. Dredged sediment can be used to increase the bank height and therefore the capacity of the basin, or can be spread on adjacent farmland.

*The USDA Natural Resource Conservation Service National Practice Standard 350 addresses the general design and installation of sediment basins. Local NRCS technical advisors can provide site-specific specifications.

Maintenance

Maintenance costs are directly proportional to the field size and sediment yield. Reducing sediment yield before it enters the pond will reduce the cost significantly. It is recommended that other sediment management practices be installed in conjunction with a sediment basin. The construction cost is a one-time cost: maintenance is a continuous cost to keep the sediment basin operating properly.

For best operation, sediment basins and structural components should be inspected regularly and restored as needed. Maintenance activities include removal of collected sediment, repair of rodent holes, vehicular traffic, seepage, erosion, or woody vegetation. Drainage outlets should be periodically checked for clogging and/or pipe damage.

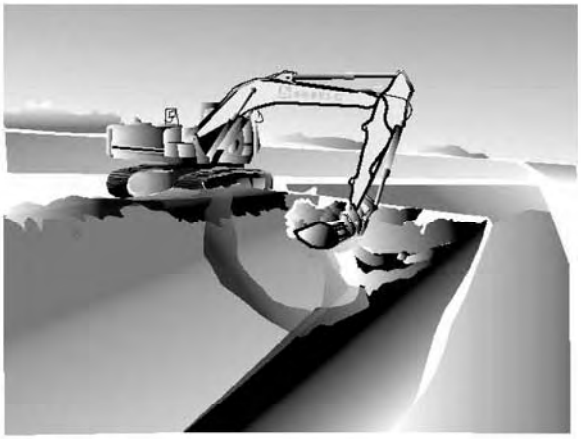
Below are cost estimates for hiring a subcontractor to install and maintain sediment basins in 2005:

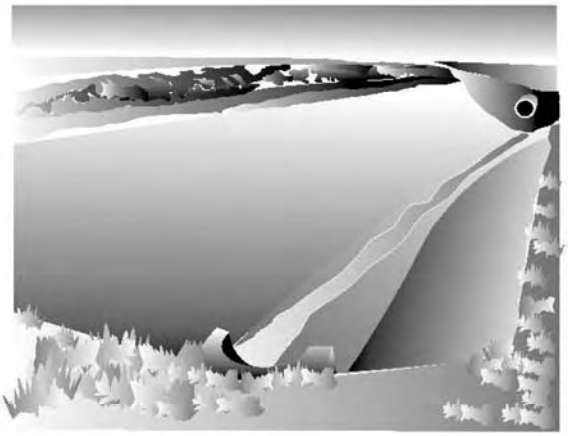
Central Valley Construction/Maintenance Costs

Costs for Contractor-Installed Sediment Basin; 2005 estimate

Item	Costs* 30' x 200'	30' x 400'
Installation	$2,675	$3,175
Annual maintenance (silt removal)	$ 925	$1,375

*Including $175 equipment transport





SEDIMENT BASINS Central Valley Installation and Maintenance Costs

Example Construction/Maintenance Costs (Based on Central Coast study)

Sediment Basins Non-Engineered Water/Sediment Control Basin (237 Cubic Yards) – Partial Budget – Central Coast – 2003

COSTS PER UNIT*	ESTIMATED COSTS		
Installation (Year 1)	LOW	REP**	HIGH
Layout & Mark Site	$41	$41	$41
Clear Site	$9	$9	$9
Excavate & Compact Basins	$220	$440	$880
Install Pipes, Couplers, Riser	$1,065	$1,431	$2,055
Channel/Check Water-Sandbags	$0	$57	$154
Plant Cover at Installation	$0	$45	$77
(1a) Installation – Subtotal	*$1,335*	*$2,023*	*$3,216*
Annual Operation & Maint. (Years 2-5):			
Remove & Redistribute Sediment	$330	$1,320	$2,310
Mow Basin Perimeter	$0	$12	$54
Spot Spray-Herbicide	$9	$13	$31
Plant Annual Cover	$0	$45	$77
Channel/Check Water-Sandbags	$0	$57	$154
(1b) Ann. Oper. & Maint. Costs – Subtotal	**$339**	**$1,447**	**$2,626**
Interest on Operating Capital @ 7.4%	$9	$21	$35
(1c) Costs – Subtotal	*$1,683*	*$3,491*	*$5,877*

POTENTIAL BENEFITS			
ADDITIONAL RETURNS PER UNIT	LOW	REP	HIGH
None	$0	$0	$0
(5) Additional Returns – Subtotal	*$0*	*$0*	*$0*

REDUCED RETURNS PER UNIT	LOW	REP	HIGH
Strawberry Acreage Removed (.1 Ac)	$15	$570	$1,125
(2) Reduced Returns – Subtotal	*$15*	*$570*	*$1,125*

REDUCED COSTS PER UNIT	LOW	REP	HIGH
Labor & Equip. Use for Prevention & Repairs	$0	$650	$1,950
(6) Reduced Costs – Subtotal	$0	$650	$1,950

COSTS & REDUCED RETURNS	LOW	REP	HIGH
(3) Totals Per Unit Year 1 (1c+2)	*$1,698*	*$4,061*	*$7,002*
(4) Totals Per Unit Per Year – Years 2-5 (1b+2)	*$354*	*$2,017*	*$3,751*

ADD. RETURNS & REDUCED COSTS	LOW	REP	HIGH
(7) Totals Per Unit Year 1 (5+6)	*$0*	*$650*	*$1,950*
(8) Totals Per Unit Per Year – Years 2-5 (5+6)	*$0*	*$650*	*$1,950*

NET CHANGE IN INCOME PER UNIT (Basin = 237 cubic yards) YEAR 1 (7-3)	-$1,698	-$3,411	-$5,052
NET CHANGE IN INCOME PER UNIT (Basin = 237 cubic yards) PER YEAR – YEARS 2-5 (8-4)	-$354	-$1,367	-$1,801
NET CHANGE IN INCOME PER CUBIC YARD YEAR 1	-$7	-$14	-$21
NET CHANGE IN INCOME PER CUBIC YARD YEARS 2-5	-$1	-$6	-$8

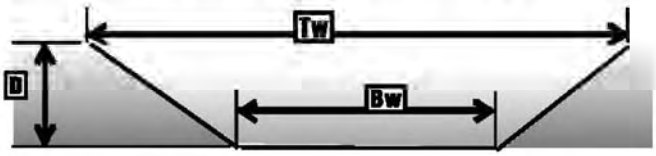
*Unit = Basin = 237 cubic yards; 1,600 square foot area with a 4 foot depth.
**Rep = Representative Cost.

Excel Spreadsheet for Tailwater Pond Design

Notes	Please Fill In the Information Below:		
1	Total size of the fields that will drain into the pond	205	(acres)
2	Typical annual applied water	4	(af/acre)
3	Typical turnout delivery	7	(cubic feet per second)
4	Typical number of irrigations per season	10	
*5	Tailwater Fraction	25%	(% of Applied Water)
*6	Pond Hold Time	12	(hours)
*7	Operating Depth (D)	5	(feet)
*8	Length / Width	1	(1 will provide a square pond)

* Assumptions (Typical values: adjust to fit specific field conditions)

Use the Excel spreadsheet in the CD below to calculate the size of tailwater pond to fit your field. The example below shows the information needed and the design parameters it will produce.



Calculation accounts for drained acreage, applied water rate and amount of suspended solids

Pond Dimensions	
Top Width (Tw)	131 (feet)
Bottom Width (Bw)	116 (feet)
Length (L)	131 (feet)
Depth (D)	5 (feet)
Total Volume	1.8 (acre feet)
Expected Annual Sediment Volume	155 (cubic yards)

SAN JOAQUIN VALLEY

Orchard Floor Vegetation and Filter Strips

Encouraging vegetation to grow in orchards during the winter dormant season has shown to provide multiple benefits to growers and the environment. Whether resident vegetation or planted cover crops, orchard vegetation can:

- Reduce or eliminate sediment movement from the orchard site.
- Reduce or eliminate dissolved pesticides and nutrients in runoff water.

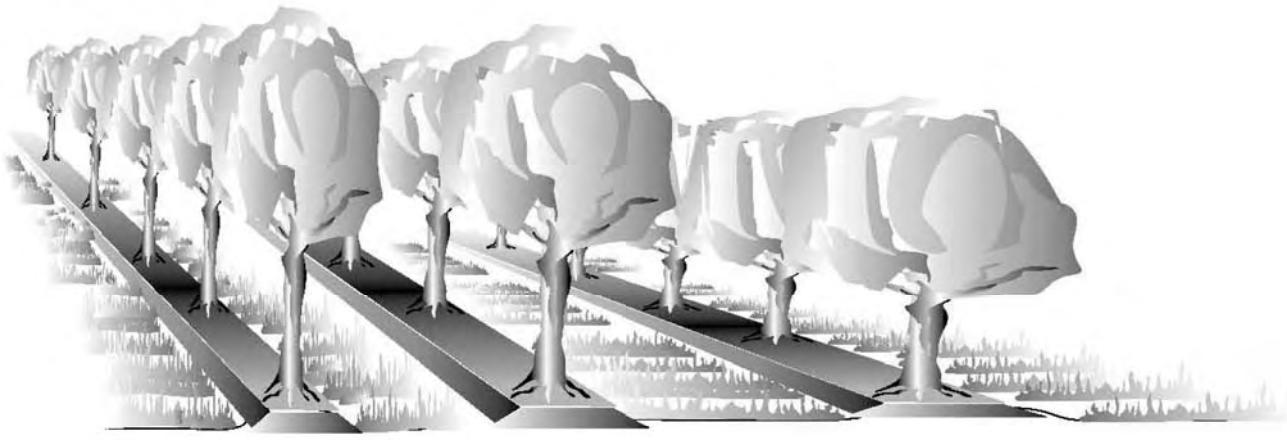
Orchard growers in many regions already allow growth of resident vegetation during the winter, which is commonly defined as existing, unplanted mixture of annual or perennial weeds, crop species and/or native grasses and forbs which have adapted to management methods used in the orchard. Many orchard growers prefer native vegetation over seeded vegetation because it can be easily encouraged to grow in the fall or early winter with a single post harvest irrigation or moisture from early rains. Resident vegetation also requires little to no management to establish.

Seeded vegetation is generally planted cover crops with mixes of cultivated species including legumes (bell beans, peas, clover, medics and vetches) and grasses such as cereal grains, turf grasses or sudan grass.

Typically, both seeded and resident vegetation on orchard floors is mowed and/or sprayed with herbicides prior to bloom.

Orchard floor vegetation can reduce dormant spray pesticide runoff to surface waters through several processes:

- Reduction in runoff volume through increased water infiltration.
- Reduction in sheet erosion caused by rainfall impact on bare ground.
- Decrease in pesticide mass carried by sediment.
- Shorter pesticide persistence (faster breakdown) on vegetation than soil.
- Adsorption of pesticides to plant surfaces.
- Anchors soil during winter rains preventing soil, nutrient and pesticide runoff.
- Accelerates the biodegradation of pesticides in soil.



BMP Handbook

ORCHARD FLOOR VEGETATION AND FILTER STRIPS

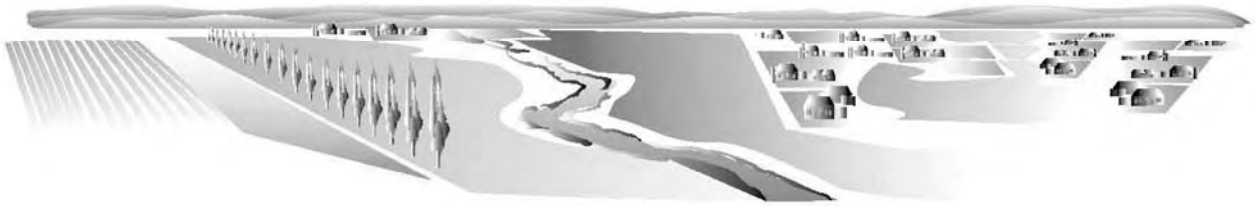
Benefits of vegetation for orchard crops:

- Legume cover crops fix atmospheric nitrogen and release it to the orchard crop during the growing season.
- Improves water infiltration, soil aeration and soil texture.
- Reduces soil compaction caused by the impact of raindrops.
- Improves soil fertility.
- Assists in weed control (seeded covers).
- Improves orchard access during wet weather.
- Cover crops can provide nectar sources, pollen and prey for beneficial predators.

Drawbacks of orchard vegetation

Orchard vegetation is not without its drawbacks. While most or all can be overcome through adjustments in cultural practices, growers should be aware of the following considerations:

- Increased cover and feed for gophers, ground squirrels and mice (also higher populations from increased habitat and reduced predation).
- Difficulty managing noxious weeds if they are present.
- Increased danger of frost damage. A tall, dense cover crop can reduce orchard temperatures by to 2 to 6 degrees, increasing the potential for frost damage. However, orchards with closely mowed cover crops and moist soil may be only about 1 degree colder than bare soil. Alternate row cover cropping can reduce the difference even more. Mowing before frost reduces the risk of frost damage.
- Trash (plant residue, particularly grasses) at harvest can hinder almond pick-up. However, growing an annual legume cover crop mix that can be mowed and allowed to decompose over summer causes fewer harvest problems.
- Increased humidity can potentially create conditions for fungal diseases.
- Potentially increased nematode populations with summer-grown cover crop.
- Higher water use with perennial cover crops.
- Sprinklers can be blocked by climbing vetches.
- Blooming cover crops can compete with tree crops for pollinator insects if not mowed.
- In almonds, perennials may interfere with harvest. Perennials are most suited for stone fruit orchards.



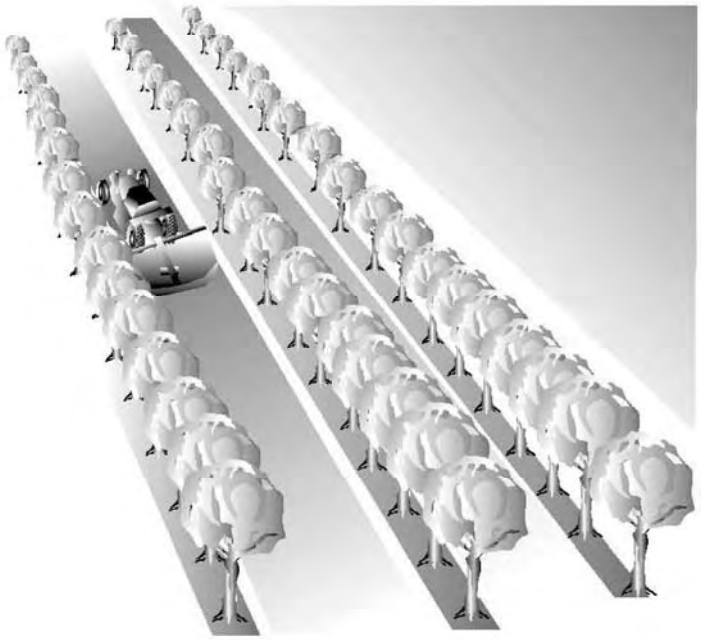
Cover Crop Management

Cover and Green Manure Crop

Plants are disked to incorporate organic material and improve soil fertility and tilth. Disking (or mowing) is generally done when plants are in full-bloom to post-bloom stage, depending on frost potential and soil moisture conditions.

Mowed Cover Crop

Manage by mowing to maintain at least 60% ground cover where erosion is possible. Mowing to 3-4 inches prior to frost can reduce cold temperature damage potential. Mowing intervals can often allow adequate seed production for following season re-growth. Mowed cover crops reduce dust during harvest operations and improve water infiltration rates.



Vegetative Filter Strips

Vegetative filter strips are areas or strips of land surrounding an orchard that are maintained in permanent vegetation. They are used to reduce sediment, organics, nutrients, pesticides and other contaminants in runoff to maintain or improve water quality. To effectively trap pesticides, filter strips must slow water runoff and increase infiltration so that pesticides can be trapped and degraded in buffer vegetation and soil. Depending on the site, a full border around an orchard may not be necessary for mitigating impacts to surface water. Filter strips can be planted at low ends of fields or in other critical zones. For best success, they should be used in conjunction with other mitigation practices.

Benefits of Vegetative Filter Strips

- Slows runoff allowing sediment to drop out of suspension.
- Traps sediment with adsorbed pesticide residues.
- Increases water infiltration into the soil profile.
- Catches some pesticide drift, preventing it from reaching erodible soil.
- Effective in trapping eroded sediment, reducing runoff of pesticides that are adsorbed to soil particles. Note: some pesticides (e.g. organophosphates) are highly water soluble and don't adsorb to soil particles as readily as others (e.g. pyrethroids).

Drawbacks of Vegetative Filter Strips

- California-based research is limited on the potential for orchard filter strips and grassed waterways to reduce OP pesticide loading, although the practices have been shown to be effective in other regions of the U.S.
- Uncertainties of filter strips include: appropriate dimensions for volume of water flow; appropriate plant species and plant density for the soil types and rainfall zones; and other considerations for various locations.
- Can necessitate setting aside productive acreage.
- If water runoff is channeled, a grass strip may not effectively trap the adsorbed pesticides.

ORCHARD FLOOR VEGETATION AND FILTER STRIPS

Grassed Waterways

Natural or constructed channels planted in permanent vegetation and located in an area where runoff concentrates. Constructed waterways can be graded to carry surface water at a non-erosive velocity to a stable outlet. Waterways are most effective in trapping sediment and dissolved chemicals when designed to spread concentrated water flow evenly cross a vegetative filter adjacent to waterways.

Benefits of grassed waterways

- Helps slow the flow of water to a non-erosive level.
- Provides a means of trapping sediment, nutrients, and pesticides while preventing gully erosion.
- Provides habitat for wildlife.

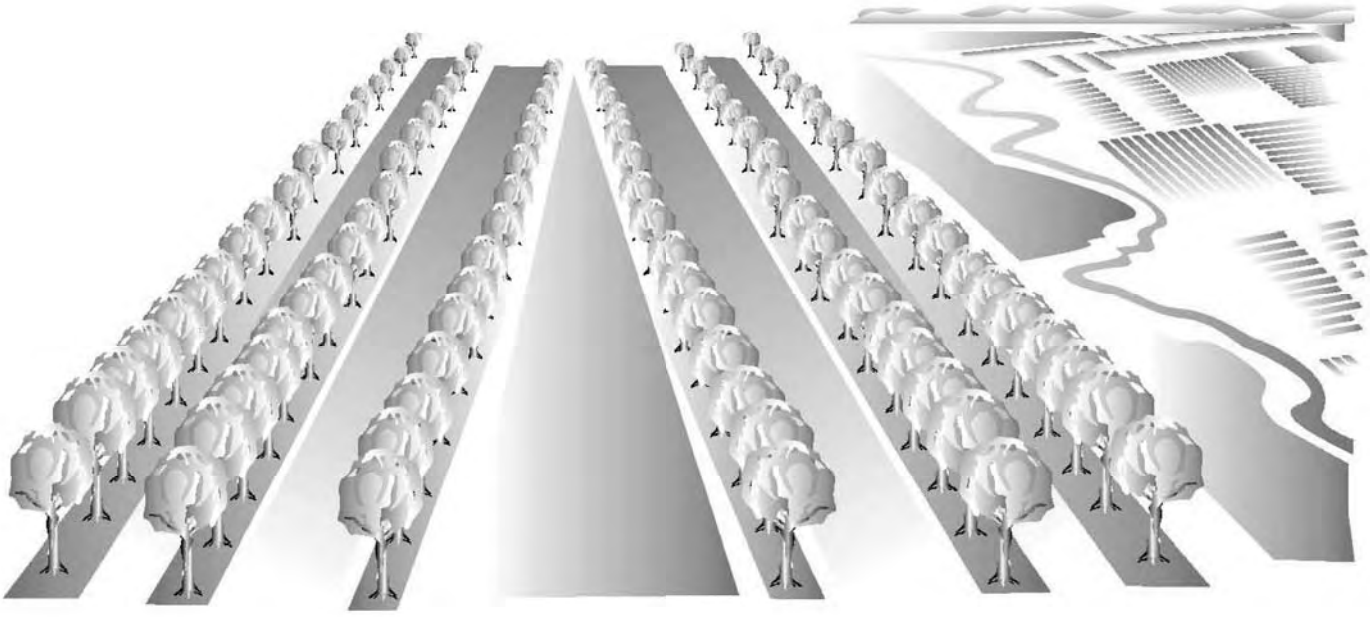
Drawbacks of grassed waterways

- Storm flows can be restricted by overgrown channels causing waterway breaching and flooding.
- Due to the concentrated flow that normally occurs in waterways, sediment trapping and water infiltration can be minimal with large runoff events, but substantial with smaller events.

For more information on vegetation for orchards, go to

http://www.sd.nrcs.usda.gov/

Search FILTER STRIP (ac.) CODE 393



Vegetated Ditch/Grassed Waterway

On site practices for protecting surface water can include modifying small areas of a field so drainage water from irrigations or storms passes through specially designed structures. These structures can include vegetated ditches (also called grassed waterways or vegetated swales). While commonly used to buffer field runoff from rolling farm land in the Midwest, grassed waterways are only recently being tested and installed on Central Valley farms.

Vegetated Ditch Description

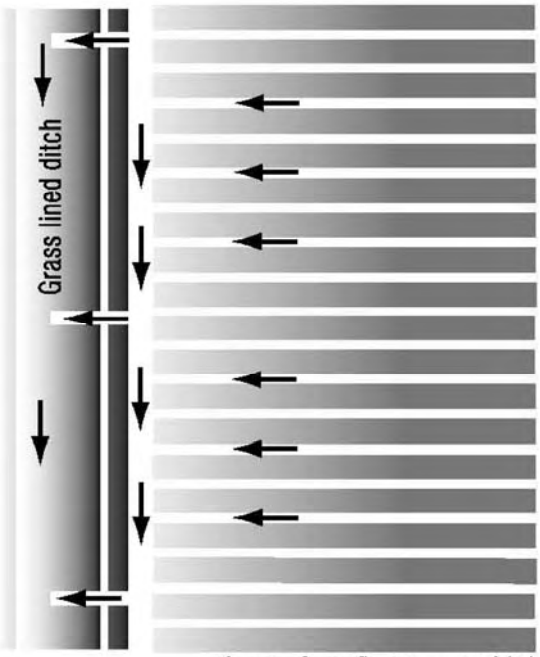
Vegetated ditches are wide, often shallow, low velocity channels used to transport irrigation or storm water drainage from fields to sumps or downstream waterways. A vegetated ditch (versus an earthen drainage ditch) has less ditch bank erosion and slows flow to enable sediment settling, thus reducing sediment transport potential. A vegetated ditch would be located at the lower end of a field where irrigation water drains. Vegetation would need to be established before the ditch is effective. When irrigation water is high in sediment, a settling pond may be needed to remove some portion of the suspended silt before flowing through the ditch. Excessive sediment in irrigation water can cause premature silting of the waterway.

Advantages

- Slows water movement and reduces sediment carried in surface flows
- Reduces ditch erosion
- Protection from overland flows
- May reduce farm input residues in drainage water (through filtration and biological action) when vegetation is properly maintained

Disadvantages

- Requires annual maintenance
- Acreage out of production
- Can potentially harbor pests
- Grass seed can be spread to other fields if tailwater is recirculated



Plan veiw of water flow into vegetated ditch

Design and Construction

Designs vary based on size of field and amount of drain water but a typical large grassed waterway has a 10-foot wide bottom with 4:1 side slopes. A smaller vegetated ditch can have a 6-foot wide bottom with 4:1 side slopes. Vegetated ditches typically require more land area than a standard drain ditch.

Ideal planting time is early fall so grass is well established before irrigation begins the following spring/summer. For optimum growth, fertilize and mow periodically. Irrigate after planting for best seedling establishment (unless rainfall occurs soon after planting). In the second year after planting, vegetated ditches can provide storm runoff benefits. Circulating storm runoff immediately after planting can wash out seedlings or reduce stand vigor. Experts in native grasses say that perennials need 18 to 24 months before they are adequately matured and most effective.

VEGETATED DITCH/GRASSED WATERWAY Central Valley Installation and Maintenance Costs

Construction/Maintenance Costs

A vegetated ditch can be constructed with common farm implements. Banks are formed with border disks, an angled scraper blade or motor grader. Disc or harrow the waterway bottom to form a seedbed. Seed can be planted either broadcast or drilled, using a vineyard or orchard cover crop drill. Roll the seeded area after planting. Vegetated ditches can be semi permanent installations (5 years or more) or removed and replanted every 3 to 5 years. Effective useful life depends on the amount of accumulated silt and vigor of the vegetation. Vegetated ditches are most effective when used in conjunction with other field-level erosion control practices such as irrigation scheduling, use of polyacrylamide (PAM) or sediment basins. Frequency of sediment removal (maintenance) would be dependent on level of sediment in irrigation tail water.

Grassed waterways are currently being evaluated on Westside San Joaquin Valley farms for their effectiveness in removing pesticides and sediment from irrigation runoff. The ½ mile waterways built for the evaluation will be monitored over several irrigation seasons for their effectiveness under local conditions.

The following charts summarize construction costs for the Stanislaus County grassed waterways. Cost for labor, equipment, and materials (seed) costs, derived from information provided by the owner/managers and with price quotes from a local seed supplier. Maintenance for the sites has not been calculated: anticipated costs are weed control, mowing and cleaning waterways to be performed as needed by the grower.

Costs for Grower Installed Vegetated Ditch

Item	*Costs*
Equipment and Labor	
Farm equipment (8 hours @ $50/hr)	$400
Farm labor (8 hours @ $20/hr)	$160
Total labor and equipment	**$560**
Materials	
Native grass seed	$590
Non-native grass seed	$75
Total cost (with native grass seed)	**$1,150**
Total cost (with non-native grass seed)	**$635**

Costs for Contractor Installed Vegetated Ditch

Equipment and Labor	
Farm equipment rental*	$1500
Farm equipment transport	$525
Labor	$770
Total labor and equipment	**$2,795**
Materials	
Native grass seed	$590
Non-native grass seed	$75
Total cost (with native grass seed)	**$3,385**
Total cost (with non-native grass seed)	**$2,870**

*Cost for grader, disk, and roller

VEGETATED DITCH/GRASSED WATERWAY Central Valley Installation and Maintenance Costs

In 2003, U.C. Cooperative Extension estimated costs for grassed waterways on the Central Coast. Grassed waterways are similar in function and cross-section to vegetated ditches, and therefore their costs are provided below. Sizing allowances were made to assist cost comparison with other vegetated ditches.

UC Cooperative Extension Costs for Grassed Waterways

Item	Costs		
	Low	Mid	High
Installation*	$0	$1560	$3,638
Annual maintenance**	$71	$869	$2,025

* To clean waterways and smooth banks and plant erosion control mix
** To mow vegetation and clean waterway

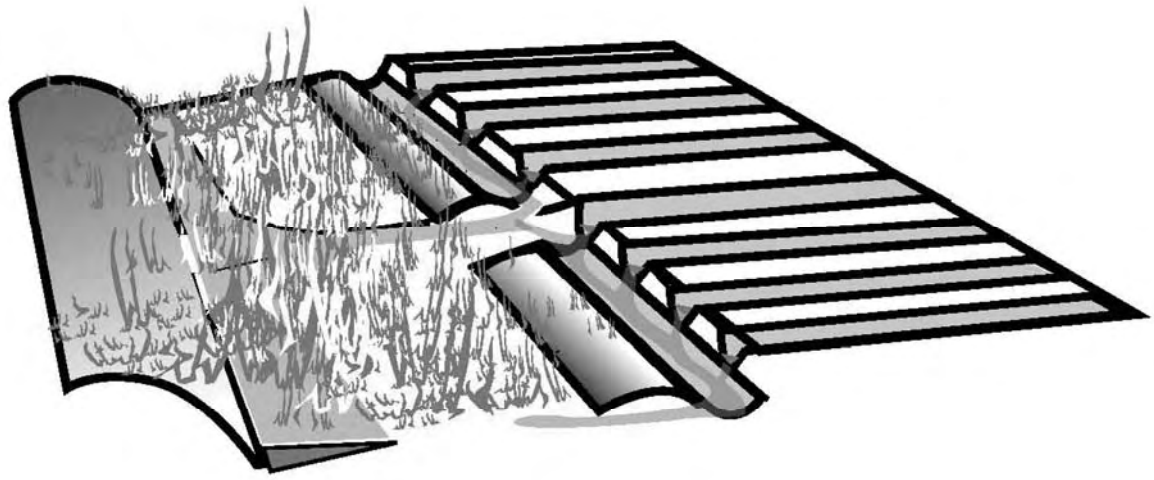
Seed Mix for Native Grass Planting

Seed/Plant	Lbs PLS*/acre	Cost
Leymus triticoides Creeping wildrye 'Luna'	6	$64.00[2] price/PLS/lbs**
Elymus glaucus Blue wildrye	10	$9.00 price/PLS/lbs
Hordeum brachyantherum Meadow barley	8	$14.50 price/PLS/lbs
Total Cost/Acre		**$590**

* PLS = pure live seed
** Price quotes from Pacific Coast Seed, Livermore

Seed Mix for Non-Native Grass Planting

Seed/Plant	Lbs PLS*/acre	Cost
Dactylis glomerata Orchard grass 'Berber'	12	$2.95 Price/PLS/lbs
Agropyron trichophorum Pubescent wheatgrass 'Luna'	16	$2.50 Price/PLS/lbs
Total Cost/Acre		**$75.00**



VEGETATED DITCH/GRASSED WATERWAY Central Valley Installation and Maintenance Costs

Detail of Representative Installation, Operation & Maintenance Costs†

Non-Engineered Grassed Waterways (1,000 Linear Feet) – Central Coast 2003

	Non-Match Labor		Machine Labor		Custom Work				
Operation	Hrs/ 1,000 LF	Cost/ 1,000 LF	Hrs/ 1,000 LF	Cost/ 1,000 LF	Hrs/ 1,000 LF	Cost/ 1,000 LF	Material Cost ($/1,000 LF)‡	Total Cost ($/1,000 LF)¶	Your Cost ($/1,000 LF)
Installation (Year 1):									
Clean Waterway					10	550		550	
Plant Erosion Control Mix	1.50	20	.25	5			17§	41	
Set Up Sprinklers & Irrigate	.6	8	.25	5			40	54	
Subtotal		28		10		550	57	645	
Annual Operation & Maint. (Years 2-5):									
Mow Vegetation (Hand)	4.0	54						54	
Clean Waterway					5	275		275	
Subtotal		54					275 0	329	
Interest on Operating Capital @ 7.4%								6	
Total Costs Per Unit – Year 1							57	980	
Total Costs Per Unit Per Year – Yrs 2-5							0	329	
Total Costs Per Linear Foot – Year 1							**	1	
Total Costs Per Linear Foot – Yrs 2-5							0	**	

From U.C. Cooperative Extension, Central Coast Conservation Practices, Estimated Costs and Potential Benefits for Non-Engineered Grassed Waterways 2003

† Costs are per 1,000 linear feet.

‡ Detail of material costs located in Table 3. Representative Material Costs.

¶ May not sum due to rounding.

§ Includes fuel, lube and repairs.

** Cost is negligible when represented on a linear foot basis.

Managing Manure Applications

Animal manure is a valuable agronomic resource for growing crops. However, it is important to follow proper handling and application Best Management Practices (BMPs) so your crop receives the nutrient benefits while protecting the environment and human health.

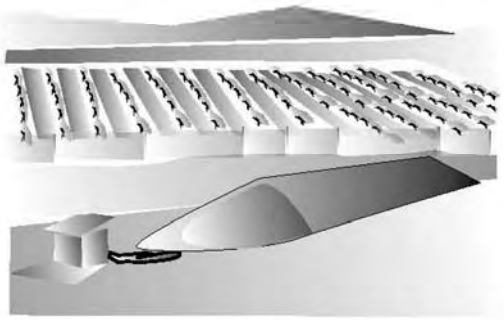
Surface water sampling in the Central Valley has found exceedances of State surface water quality standards for E. coli bacteria. Potential sources of bacterial contamination are leaky sewer lines or septic systems, runoff from livestock operations, irrigated pasture, domestic animals (dogs, cats), wildlife, manure applied to farmland and washed off in rain or irrigation, or allowing livestock uncontrolled access to creeks.

Since animal manure used on cropland can potentially be a source of E. coli bacteria, landowners and operators should consider the following practices when storing or applying livestock manure. The information below is condensed from several sources, including "Good Agricultural Practices" developed by the Almond Board of California.

When applying manure as a nutrient to soils, check with a nutrient specialist such as a Certified Crop Adviser (CCA). Under new Central Valley Regional Water Board regulations, California dairymen must use a CCA-approved nutrient management plan for their cropland when applying manure. They must also submit sampling results of manure sources, irrigation water and soil. For a complete description of NRCS cost sharing manure management programs, please consult the publication: ftp://ftp-fc.sc.egov.usda.gov/CA/technical/cnmp/590_AFO_Manure_Nutrient_Mgt_2008.pdf.

Animal Manure: A Potential Pathogen Source

- Non-composted or incompletely composted manure may carry harmful pathogens.
- Pathogens include bacteria that may potentially cause human illnesses.
- Pathogens can survive in the field for 9 to 12 months or longer after a manure application.
- There is lower pathogen risk from manure or compost that has undergone a composting process with appropriate time and temperature controls.
- Fresh manure has the highest pathogen risk followed by aged/stacked manure. Correctly composted manure has the lowest pathogen risk.
- Manure and compost applications should be closely managed.



MANAGING MANURE APPLICATIONS

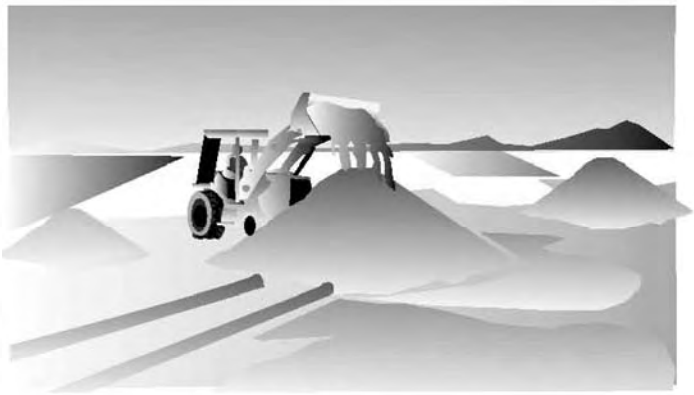
Manure Application Practices

Orchards, vineyards, other permanent crops

- Incorporate manure into soil as soon as practical after application to prevent wind drift and runoff in storm water or irrigation drainage water.
- If incorporation isn't possible, using adequately composted materials will minimize pathogen risk.
- Use proper land application practices to prevent rainfall runoff from transporting manure and nutrients into waterways. When possible, incorporate or inject manure when applying prior to the rainy season.
- Follow practices that reduce erosion and runoff from irrigated fields treated with manure (i.e. tailwater recirculation systems, sedimentation basins, vegetative filter strips, cover crops, residue management, special tillage practices).
- Do not apply manure near waterways unless protected with berms; use appropriate setbacks.
- Do not apply manure to saturated fields or when storms with runoff potential are forecast.
- Avoid applying manure to steep fields when runoff carrying manure can be expected to reach a water course.
- Where possible, divert rainfall runoff from upslope areas around cropland that receives manure.
- If tail water is generated during irrigation with liquid manure, a return system should be installed to recycle drainage water.
- Do not top dress with fresh or slurry manure (unless properly incorporated).
- Use biosolids or municipal waste only if allowed by local regulations.
- Document compost/manure applications.
- Date, rate and location

Leafy Greens*

- Raw manure and biosolids should not be used in the production of fresh leafy greens.
- The Leafy Green Marketing Order mandates a minimum 12-month waiting period for the application of raw manure or biosolids before planting fresh leafy greens. Some produce buyers will disqualify fields where animal manure or biosolids have been applied.
- Uncomposted manure should never be applied to fields just before planting to "ready-to-eat" crops.
- Only composted manure that satisfy established standards should be used.



MANAGING MANURE APPLICATIONS

Storing Manure and Compost

- Develop physical barriers to help prevent storm water contamination by runoff from stacked piles to waterways.
- Plan field storage and application so rainfall does not cause runoff from stacked piles.
- Locate piles away from sensitive areas, cover or provide other barriers to minimize wind-driven particle drift onto unintended products, crops or waterways, as needed.

Animal Husbandry Management Practices

- Control animal and equipment access to streams, stream banks and sensitive areas.
- Construct all animal facilities (barns, arenas, etc.) and manure composting/storage a sufficient distance from streams, drains and domestic wells to provide protection from runoff.
- Construct an adequate storm water collection system or earthen berm in cases where water quality can be impacted by facility drainage.
- Adopt pasture management practices appropriate for field conditions (i.e. slope, vegetation density, proximity to waterway, etc.)
- Use wetlands to capture tailwater and reduce runoff rates from pastures.
- Maintain berms, vegetated buffers or other conservation measures between streams and animal facilities and manure composting/storage areas.

Buying/Using Compost

- Manure that has been simply stacked and aged does not qualify as compost.
- If you buy compost, ask the compost producer for documentation that they have followed proper pathogen reduction procedures.

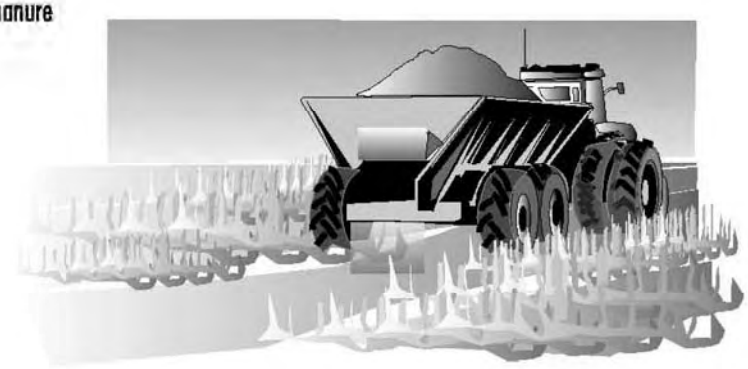
Minimum composting standards*:
For windrow compost:

- Active compost must maintain aerobic conditions for a minimum of 131 F for 15 days, with a minimum of 5 turnings.

For aerated static pile compost:

- Active compost must be covered with at least 12 inches of insulating materials and maintain a minimum of 131 F for 3 days.

*Source: Commodity Specific Food Safety Guidelines for the Production and Harvest of Leafy Greens



Managing Manure Applications

Information sources for animal manure management.

California Poultry Federation Website
http://www.cpif.org/Environment/nutrient.htm

California Certified Crop Advisers
http://www.cacca.org/

California Dairy Quality Assurance Program
www.cdqa.org

National Organic Program
http://www.ams.usda.gov/nop/indexIE.htm

Organic Trade Association Fact Sheet on Manure
http://www.ota.com/organic/foodsafety/manure.html

Organic Fertilizer Association of California
www.organicfertilizerassociation.org

Tulare County Manure Application Fact Sheet
http://cetulare.ucdavis.edu/pubgrape/ng797.htm.

UCD Poultry Manure Fact Sheet
http://animalscience.ucdavis.edu/avian/pfs10.pdf

Western United Dairymen
www.westernuniteddairymen.com

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