NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

BEDDING

(Ac.)
CODE 310

DEFINITION

Plowing, blading, or otherwise elevating the surface of flat land into a series of broad, low ridges separated by shallow, parallel channels with positive drainage.

PURPOSE

To improve the drainage of surface water.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to areas with flat to nearly flat topography and with poorly drained soils.

CRITERIA

All planned work shall comply with all federal, State and local laws and regulations.

Bedding shall run in the direction of the available land slope.

The velocity of water in the channels shall be slow enough to prevent erosion during storm events. Beds shall be shaped and cross-row ditches provided where required to provide free movement of water from the crown to the dead furrow.

Crowns shall provide a cross slope of not less than 0.3 percent.

Soils must be of sufficient depth to provide a satisfactory root zone after bedding.

Crown height, width, and maximum length of beds shall be determined on the basis of site conditions and crop requirements.

Parallel channels shall be graded toward an outlet.

An outlet, natural or constructed, must have sufficient capacity and depth to provide for removal of water from the parallel channels.

CONSIDERATIONS

Parallel channels may be shallow and side slopes steep or flat, based on the soil, crops grown, and local construction and maintenance methods.

Areas where the rooting depth may limit plant growth after construction of the beds should be identified on the plan map.

Consider practices that will mitigate off-site water quality impacts (i.e., wetland treatment areas, filter strips, buffer strips, etc.)

If the bedding will exceed the depth of prior disturbance, this activity could affect significant cultural resources.

Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
2. Potential for a change in rates of plant growth and transpiration because changes in the volume of soil water.
3. Effects on downstream flows or aquifers that would affect other water uses or users.
4. Effects on the relation of the soil surface to the water table to ensure that a suitable rooting depth for crops.

Water Quality

1. Effects on erosion and the movement of sediment and soluble and sediment-attached substances carried by runoff.
2. Effects on the use and management of nutrients and pesticides and their effect on surface and ground water quality.
3. Effects on the movement of dissolved substances below the root zone and to ground water.
4. Effects of water levels on soil processes such as nutrient use by the plant.
5. Effects on wetlands or water-related wildlife habitats.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

6. Effects on the visual quality of downstream water.

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

PLANS AND SPECIFICATIONS

Plans and specifications for bedding shall identify the area where the practice will be applied, the direction of the channel drainage, the crown height, side slope, width, and length of the bed cross section, and location of the outlet.

OPERATION AND MAINTAINENCE

The beds shall be maintained to the planned height. Remove sediment from the channels as necessary to facilitate drainage and to prevent ponding.

Maintain the outlet in a stable condition.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

ANIMAL MORTALITY FACILITY

(No.)
CODE 316

DEFINITION

An on-farm facility for the treatment or disposal of livestock and poultry carcasses.

PURPOSE

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- Decrease non-point source pollution of surface and groundwater resources
- Reduce the impact of odors that result from improperly handled animal mortality
- Decrease the likelihood of the spread of disease or other pathogens that result from the interaction of animal mortality and predators
- To provide contingencies for normal and catastrophic mortality events

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where animal carcass treatment or disposal must be considered as a component of a waste management system for livestock or poultry operations. It applies where on-farm carcass treatment and disposal are permitted by federal, State, and local laws, rules, and regulations. It also applies where a waste management system plan as described in the National Engineering Handbook (NEH), Part 651, Agricultural Waste Management Field Handbook (AWMFH) has been developed that accounts for the end use of the product from the mortality facility. This practice includes disposal of both normal and catastrophic animal mortality; however, it does not apply to catastrophic mortality resulting from disease.

CRITERIA

General Criteria Applicable to All Purposes

The facility shall be designed to handle normal mortality and/or catastrophic mortality.

The planning and design of animal mortality facilities or processes must conform to all federal, state and local laws, rules and regulations. This includes provisions for closing and/or removing the facility where required.

All structural components integral to animal mortality management shall meet the structural loads and design criteria as described in NRCS conservation practice standard 313, Waste Storage Facility, unless otherwise designated.

Where an animal mortality facility can be damaged by surface runoff, the runoff shall be diverted away from the facility.

Location. The location shall minimize the impact of the facility on odor and other air quality issues affecting neighboring residences, as well as minimizing the impact of the facility on surface and ground water resources. In addition, the facility, where practical, shall be generally down gradient from a spring or well.

The animal mortality facility shall be located outside the 100 year floodplain; however if site restrictions require location within a floodplain, they shall be protected from inundation or damage. Measures used to provide this protection shall meet applicable NRCS Practice Standards.

The location of the animal mortality facility shall be consistent with the overall site plan for the livestock or poultry operation.

Seepage Control. Where seepage from mortality facilities will create a potential water quality problem and it is deemed necessary to reduce seepage, use AWMFH, Appendix 10D, for clay liner design criteria, or other acceptable liner technology.

Criteria Applicable to All Purposes – Normal Mortality

The facility shall be located as close to the source of mortality as practical, considering bio-security issues and the need to keep the facility out of sight of the general public.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Composters.

General. Composting mammalian animals is currently illegal in California, but composting is legal for poultry mortality. Design of facilities for composting animal mortality shall conform to conservation practice standard 317, Composting Facility, or the guidance in National Engineering Handbook Part 637, Chapter 2 – Composting (NEH 637.0211, Dead Animal Composting).

Freezers.

General. Freezer units shall be of the chest type with a construction compatible with the mechanism to be used to empty the freezer. Provisions for protecting the freezer unit from precipitation and direct sun shall be made as deemed appropriate.

The freezer unit design, construction, power source, and unit installation shall be in accordance with manufacturer's recommendations. Freezers shall be constructed of durable material with a life expectancy compatible with other aspects of the waste management system. The freezer container shall be leakproof to minimize odor and leachate pollution.

Where needed, the freezer will be placed on a pad of suitable strength to withstand loads imposed with vehicular traffic consistent with equipment used to load or remove the box or tray.

Temperature. The freezers shall be self-contained units designed to freeze animal carcasses before decomposition occurs. For best results, the temperature of the carcasses shall be maintained between 22^0 and 26^0 F.

Capacity. Freezer units shall be sized to accommodate the normal maximum volume of mortality to be expected in the interval between emptying. Volume calculations shall include the expected mortality rate of the animal, the period of time between emptying where mortality is given on a per day basis, the average weight of the animal between emptying, and a conversion factor for weight to volume. For broiler operations use a weight to volume conversion of a minimum of 45 pounds per cubic foot. Capacity calculations shall be supported by a removal schedule supplied by an integrator or approved vendor.

Power Source. An alternative source of power, where available, shall be used to maintain the integrity of the freezing process during power outages. Where an alternative power source will not be available, the operation and maintenance plan shall contain contingencies for disposal of the poultry mortality.

Disposal Pit.

General. Disposal pits shall not be located on sites with:

1) highly permeable soils or over fractured or cavernous bedrock within two feet of the bottom of the pit unless an approved liner is used, or

2) soils with a seasonal high water table less than two feet from the bottom of the pit.

Size and Capacity. Pits shall be sized to accommodate the normal mortality in accordance with criteria acceptable to state and local regulatory agencies. The disposal pit shall be a minimum of 4 feet wide and 4 feet long. No minimum depth is required, but the selected depth shall accommodate 2 feet of cover over the mortality. Multiple pits shall be separated by a minimum of three feet of undisturbed or compacted soil.

Structural Loading and Design. Vehicular traffic shall not be allowed within four feet of the pit structure. Fences or other barriers shall be used to exclude vehicles where necessary.

The disposal pit shall be cased with masonry blocks, treated timber, or a pre-cast concrete septic tank conforming to American Society of Testing Materials (ASTM) C1227-00b Standard Specification for Pre-cast Septic Tanks. In all cases, the bottom of the pit shall remain exposed to the soil. If the pre-cast septic tank is used, it shall be fabricated with three 6-inch openings in each end, and five six inch openings in each side. When masonry block are used, every fourth block in each course shall be laid sideways (openings toward the outside) except the top and bottom courses. The bottom course shall be on a reinforced concrete footing of at least one foot wide and six inches thick. When treated timbers are used for walls, a one-inch spacing shall be left between timbers.

For pits that are four to five feet deep, a step or bench 18 inches wide and one-foot deep shall be dug around the perimeter of the main pit so the remaining vertical wall shall not exceed four feet. For pits greater than five feet deep, the earthen wall shall be sloped back at 1 1/2 horizontal and 1 vertical or flatter.

The top of a disposal pit shall be covered with a slab constructed of reinforced concrete or treated timber having an appropriately sized hole for a drop chute. A pit over eight feet long shall have drop chutes every five feet and a minimum of two drop chutes. The drop chutes shall be appropriately covered and made of drainage tile, or concrete, clay, or polyvinyl chloride (PVC) pipe. A ten-inch opening is recommended for chickens, and a twelve-inch opening for turkeys and suckling pigs.

Incinerators.

General. Incinerators shall be dual burning Type 4 (human and animal remains) approved for use within the state.

Capacity. Minimum incinerator capacity shall be based on the average daily weight of animal mortality and the length of time the incinerator will be operated each day.

Location. The incinerator shall be located a minimum of 20 feet from any structure. The incinerator shall be placed on a concrete pad with the fuel source as distant as practical. If the incinerator is covered with a roof, at least six inches are required between the incinerator chimney and any combustible roof parts.

Criteria Applicable to All Purposes – Catastrophic Mortality

General. Processes addressed by this standard shall be limited to burial and composting. Catastrophic mortality shall be collected as soon as practical and moved away from the production facility.

Location. The facility shall be located as far away from neighboring dwellings and the poultry or livestock operation as site conditions permit. Locate on sites with restricted percolation and a minimum of two feet between the bottom of the facility and the seasonal high water table unless special design features are incorporated that address seepage rates and non-encroachment of contaminants into the water table. Use AWMFH Appendix 10D for selection of sites where seepage will be restricted with normal construction techniques.

Burial Pit

General. Catastrophic mortality resulting from natural conditions such as temperature extremes shall be buried on-site or as otherwise directed by state and local regulatory agencies. Burial of catastrophic mortality shall be timed to minimize the effects of mortality expansion during early stages of the decay process. Where possible and permitted by state law, mortality shall remain uncovered or lightly covered until bloating has occurred, or methods employed to reduce or eliminate bloating. Topsoil shall be retained to re-grade the disposal site after the ground has settled as the decay process is completed. Stockpiled soil shall be no closer than 20 feet from the edge of the burial pit.

Size and Capacity. Pits shall be sized to accommodate catastrophic mortality using appropriate weight to volume conversions. Capacity shall be in accordance with criteria acceptable to state and local regulatory agencies. The burial pit shall be a minimum of 4 feet wide with length necessary to accommodate mortality. Depth shall accommodate a minimum of 2 feet of cover over the mortality. Pit bottoms shall be relatively level. Lengths may be limited by soil suitability and slope. If more than one pit is required, they shall be separated by a minimum of three feet of undisturbed or compacted soil. The burial site shall be of sufficient volume to contain the mortality with a minimum of two feet of soil cover. The burial site shall be finish graded to slightly above natural ground elevation to accommodate settling.

Structural Loading and Design. Vehicular traffic shall not be allowed within four feet of the pit edge.

For pits that are four to five feet deep, a step or bench 18 inches wide and one foot deep will be dug around the perimeter of the main pit so the remaining vertical wall will not exceed four feet. For pits greater than five feet deep, the earthen wall shall be sloped back at 1 1/2 horizontal and 1 vertical or flatter.

Composting

General. Catastrophic mortality composting shall be in either passive piles or windrows as described in National Engineering Handbook Part 637, Chapter 2 – Composting (NEH 637.0210 and NEH 637.0211).

Composting mortality shall be protected from precipitation as necessary, or provisions made for collecting contaminated runoff. Static piles or windrows covered with sawdust, finished compost, or other benign material will not need further protection.

CONSIDERATIONS

Major considerations in planning animal mortality management are:

- Available equipment at the operation,
- The management capabilities of the operator,
- The degree of pollution control required by state and local agencies,
- The economics of the available alternatives, and
- Effect on neighbors.

Consideration should be given to prevailing wind direction and neighbors when siting animal mortality disposal facilities. A minimum of 900 feet should separate the facility from the nearest neighboring residence, and the facility should be 200 feet from a well, spring, or water course.

Runoff from the livestock or poultry facility, or from outside areas should be diverted away from the animal mortality disposal facility.

Composting of poultry mortality will be hindered if the bird carcasses are allowed to freeze. Birds should be kept in a dry, non-freezing environment until added to the compost mix.

Facility sizes for composting large animal carcasses should reflect the longer compost periods required.

The following table lists factors that could be used in determining minimum daily weight of animal mortality when sizing incinerators:

TYPE OF ANIMAL	DAILY LOSS FACTOR (pounds/day/animal)
Chicken:	
Broilers	0.0024
Laying hens	0.0014
Breeding hens	0.0019
Breeder, male	0.0082
Turkeys:	
Hen	0.0081
Tom, light	0.0193
Tom, feather production	0.0286
Swine:	
Suckling pigs (per sow)	0.0400

Poultry operations often experience higher rates of mortality as the birds reach maturity. The capacity of incinerators should be sized to insure the mortality of the large birds can be handled within the time frame allowed for incineration.

An alternative to prevent bloating of catastrophic mortality die off could include opening animal thoracic and abdominal cavities and viscera prior to placing required cover.

Incineration produces varying quantities of ash that will need to be properly handled.

Vegetative screens and topography can be used to shield the animal disposal facility from public view, and to minimize visual impact.

State requirements for record keeping vary. Items such as burial site location, type and quantity of mortality, burial date, and other pertinent details should be noted at the time of burial.

Operators should maintain a list of current phone numbers for state and local officials to aid in notification if disease-related catastrophic mortality occurs.

Safety devices such as fencing, warning signs, and freezer locks may be necessary at certain sites.

Bio-security concerns should be addressed in all aspects of planning, installation, and operation and maintenance of an Animal Mortality Facility.

Ground disturbing activities such as excavation and site preparation for disposal facilities have the potential to affect significant cultural resources.

Cultural Resources Considerations

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GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's

objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

OPERATION AND MAINTENANCE

An operation and maintenance plan applicable to this practice that includes, but is not limited to, the items listed below will be developed with the operator, and will become a part of the overall waste management system plan. The requirements in the individual operation and maintenance plan shall be consistent with the practice purposes, intended life, and design criteria. Safety considerations shall be prominently displayed in the plan.

Normal Mortality

Animal mortality facilities will normally be operated or used on a daily basis. At each operation or use, the facility shall be inspected to note any maintenance needs or indicators of operation problems.

Catastrophic Mortality

Possible locations for catastrophic animal mortality facilities shall be located during the planning process to be operated as needed.

Burial of catastrophic mortality shall be timed to minimize the effects of mortality expansion during early stages of the decay process. Where possible and permitted by state law, mortality shall remain uncovered or lightly covered until bloating has occurred. Some topsoil shall be retained to re-grade the disposal site after the ground has settled as the decay process is largely completed.

Where composting is used for catastrophic mortality disposal, the operation and maintenance plan shall identify the most likely compost medium, possible compost recipes, operational information, and equipment that will need to be readily available.

PLANS AND SPECIFICATIONS

Plans and specifications for animal mortality facilities shall be in keeping with this standard and shall describe the requirements for applying this practice to achieve its intended purpose.

REFERENCES

Natural Resources Conservation Service Animal Waste Management web site, http://www.wcc.nrcs.usda.gov/awm/

Agricultural Waste Management Field Handbook (AWMFH), http://www.ftw.nrcs.usda.gov/awmfh.html

National Engineering Handbook, Part 637, Chapter 2, Composting, http://www.info.usda.gov/CED/ftp/CED/neh637-ch02.pdf

NRCS GM 420 Part 401 – Cultural Resources

NRCS National Handbook of Conservation Practices

ASTM C1227-00b Standard Specification for Pre-cast Septic Tanks

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NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION CANAL OR LATERAL

(feet.)
CODE 320

DEFINITION

A permanent channel constructed to convey irrigation water from the source of supply to one or more irrigated areas.

PURPOSE

To convey irrigation water to one or more irrigated areas.

CONDITIONS WHERE PRACTICE APPLIES

A canal or lateral and related structures are needed as an integral part of an irrigation water conveyance system.

Water supplies and irrigation deliveries for the area served are sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

CRITERIA

All planned work shall comply with all federal, State, and local laws and regulations.

Capacity requirements. The capacity of canals or laterals shall be:

- capable of conveying surface runoff that is allowed to enter the channel, and
- sufficient to meet delivery demands of all the irrigation systems served and the amount of water needed to cover the estimated conveyance losses in the canal or lateral, or
- sized to convey the available water supply in water-short areas, where water is not normally available to meet the irrigation demands.

Velocities. Canals and laterals shall be designed at velocities that are nonerosive for the material(s) through which the channel passes. Local information on the velocity limits for specific soils shall be used if available. If such information is not available, the maximum design velocities shall not exceed those shown in Figure 6-2, Chapter 6, TR-25 "Design of Open Channels" or other equivalent method. For unlined canals and laterals constructed with earthen materials, a Manning's "n" no greater than 0.025 shall be used to check that velocities do not exceed permissible values.

Canals and laterals shall be designed to safely convey the required flows with the maximum probable retardance conditions. For capacity design, the value of "n" shall be selected according to the material in which the canal or lateral is constructed, the alignment, the hydraulic radius, the expected vegetative growth and planned operation and maintenance.

Side slopes. Canals and laterals shall be designed to have stable side slopes. Local information on side slope limits for specific soils and/or geologic materials shall be used if available. If such information is not available, the design side slopes for the banks of canals or laterals shall not be steeper than the following:

Material	Section	Slope
Solid Rock	Cut	1/4:1
Loose Rock	Cut	3/4:1
Cemented Gravel	Cut	3/4:1
Heavy Clay 1/	Cut	1:1
Heavy Clay 1/	Fill	2:1
Sand or Silt w/Clay Binder	Fill/Cut	1-1/2:1
Sand or Silt, no Clay	Fill/cut	3:1
Loam	Fill/cut	2:1
Peat, muck, and sand 2/	Fill/cut	1:1

1/ Heavy clays in CH soils often experience sliding problems caused by the structure of the clays. The recommended side slope for these soils is no steeper than 4:1.

2/ Silts and sands that have a high water table in the side slopes will slough due to hydrostatic pressure gradient. The recommended side slope for these saturated conditions is no steeper than 3.5:1.

Freeboard. The required freeboard above the maximum design water level shall be at least one-

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third of the design flow depth (0.33d) and shall not be less than 0.5 feet.

Water surface elevations. Water surface elevations shall be designed to provide enough hydraulic head for successful operation of all ditches or other water conveyance structures diverting from the canal or lateral.

Canal or lateral banks. The top width of the canal or lateral banks shall be designed to ensure stability, prevent excessive seepage, and facilitate maintenance. The bank top width shall not be less than 2 feet and shall equal or exceed the flow depth.

Protection from surface waters. Runoff from adjacent areas shall be conveyed over or under the canal wherever practical. If runoff is permitted to enter the canal or lateral, the side slopes shall be protected from erosion, and provisions shall be made for its disposal. Where sediment-laden water is allowed to enter the canal or lateral, the design shall include provisions to transport the sediment through the canal or lateral or measures shall be installed to trap and remove the sediment.

Related structures. Designs for canals or laterals shall provide for adequate turnouts, checks, crossings, and other related structures needed for successful operation of the facility. All structures shall be designed in accordance with the applicable NRCS practice standard. Structures needed for the prevention or control of erosion shall be installed before the canal or lateral is put into operation.

Linings. On sites where soils with moderately rapid to very rapid permeability must be crossed or where erosive water velocities will occur, the canals and laterals shall be lined or piped according to the appropriate NRCS Practice Standard(s) for ditch and canal linings or pipelines.

Maintenance access. Provisions shall be provided, as required, for maintenance operations. If the top of the bank or berm is to be used for a roadway, the width shall be wide enough to allow safe equipment travel and operation.

CONSIDERATIONS

When planning this practice incorporate safety elements.

Consider using buffers or filters to remove sediment from runoff water.

Cultural Resources Considerations

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Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
2. Potential for a change in plant growth and transpiration because of changes in the volume or level or soil water.
3. Effects on downstream flows or aquifers that would affect other water uses or users.
4. Effect on the water table of the field in providing suitable rooting depth for anticipated land uses.

Water Quality

1. Effects on erosion of banks and beds and the movement of sediment, and the soluble and sediment-attached substances carried by runoff.
2. Effects on the movement of dissolved substances to ground water.
3. Short-term and construction-related effects on the quality of downstream water courses.
4. Potential for uncovering or redistributing toxic material.
5. Effects on wetlands or water-related wildlife habitats.
6. Effects on the visual quality of soil, water and plant resources.
7. Effects of water levels on salinity of soils, soil water downstream waters.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing irrigation canals or laterals shall describe the requirements for applying the practice to achieve its intended purposes. Site specifics typically include cross-section details, embankment/bank requirements, channel grades and appurtenant structural details.

OPERATION AND MAINTENANCE

A site-specific operation and maintenance plan shall be provided to, and reviewed with, the landowner(s) before the practice is installed. The plan shall adequately guide the landowner(s) in the routine maintenance and operational needs of the irrigation canal or lateral. The plan shall also include guidance on periodic inspections and post-storm inspections to detect and minimize damage to the canal or lateral.

The plan shall as a minimum include requirements for the removal of accumulated sediment and debris from the channel, the repair of banks and berms and control of undesired vegetation.

REFERENCES

Natural Resources Conservation Service, Engineering Field Handbook, NEH Part 650.14, Chapter 14, Water Management (Drainage), April 2001, http://www.info.usda.gov/CED/ftp/CED/EFH-Ch14.pdf

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NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION FIELD DITCH

(feet.)
CODE 388

DEFINITION

A permanent irrigation ditch constructed in or with earth materials, to convey water from the source of supply to a field or fields in an irrigation system.

PURPOSE

This practice may be applied as part of an irrigation water management system to efficiently convey and distribute irrigation waters.

CONDITIONS WHERE PRACTICE APPLIES

This standard is limited to open channels and elevated ditches of 25 cubic feet per second or less in capacity and constructed of earth materials.

This standard applies where field ditches are needed as an integral part of an irrigation water distribution system design to facilitate the conservation use of soil and water resources.

CRITERIA

All planned work shall comply with all federal, state and local laws and regulations.

Water supplies and irrigation deliveries for the area served shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Field ditches shall be constructed in earth material that contains enough fines to prevent excessive seepage losses and where shrinkage cracks will not endanger the ditch, or cause down gradient water quality problems. The sealing effect of sediment carried in the irrigation water may be considered.

Capacity requirements. Field ditches shall have adequate capacity to deliver:

1. The design peak consumptive use of the crop(s) to be grown in the field, with proper provisions for the expected field irrigation efficiency.
2. The largest irrigation stream required for the irrigation method(s) planned for the field.

The design capacity shall include additional flow required to compensate for the ditch seepage loss and to safely carry surface runoff from adjacent lands that must be transported to waterways or overflow points.

For capacity design, the value of Manning’s "n" shall be selected according to the materials in which the ditch is constructed, the alignment and hydraulic radius, and the additional retardance due to vegetation.

Erosion Control, Velocities. Field ditches shall be designed for flows that are non-erosive for the soil materials in which they are constructed. Local information on the velocity limit for specific soils shall be used if available. If such information is not available, the maximum design velocity shall not exceed those shown in Figure 6-2, Chapter 6 of Technical Release 25 “Design of Open Channels” unless protective measures are implemented.

For checking designs to see that velocities do not exceed permissible values, a Manning's "n" no greater than 0.025 shall be used, and applicable criteria in NRCS conservation practice standard for Open Channels (582) shall be followed.

Erosion Control, Additional Treatments. If velocity control alone cannot control erosion to acceptable levels the ditch system design shall provide for the installation of such erosion-control structures as drops, chutes, buried pipelines, or erosion-resistant ditch linings. Polyacrylamide may be utilized for erosion control according to NRCS conservation practice standard for Anionic Polyacrylamide (PAM)-Erosion Control (450) in lieu of or in combination with structural measures.

Cross section. Freeboard in field ditches shall be not less than one-third of the maximum design depth of water, to a maximum freeboard of 0.5 feet. Side slopes shall be stable. The top width of banks as measured at the elevation providing the required freeboard shall be not less than 12 inches and shall

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equal or exceed one-half the flow depth.

If a field ditch is to be constructed on a fill section, side slopes of the fill shall not be steeper than the values shown in Table 1.

Table 1

Height of fill to water surface on centerline of fill **(feet)**	Steepest allowable side-slope of fill **(horizontal to vertical)**
< 3	1½:1
3 – 6	2:1
> 6	2½:1

Water surface elevations. All field ditches shall be designed so that the water surface elevations at field takeout points are high enough to provide the required flow onto the field surface. If ditch checks or other control structures are to be used to provide the necessary head, the backwater effect must be considered in computing freeboard requirements.

The required water surface elevation above the field surface will vary with the type of takeout structure or device used and the amount of water to be delivered through each. A minimum head of 4 inches shall be provided.

Related structures. Erosion control or water control structures, culverts, diversions, or other related structures needed to supplement the field ditch shall be designed and installed to meet NRCS standards for the particular structure and type of construction.

CONSIDERATIONS

When planning this practice, the following items should be considered, where applicable:

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, and deep percolation.

2. Potential for a change in plant growth and transpiration because of changes in the volume or level of soil water.

3. Effects on downstream flows or aquifers that would affect other water uses or users.

4. Effect on the water table of the field in providing suitable rooting depth for anticipated land uses.

Water Quality

1. Effects on erosion and the movement of sediment, and the soluble and sediment attached substances carried by runoff.
2. Effects on the movement of dissolved substances to ground water.
3. Short-term and construction-related effects on the quality of downstream water courses.
4. Potential for uncovering or redistributing toxic material.
5. Effects on wetlands or water-related wildlife habitats.
6. Effects on the visual quality of water resources.
7. Effects of water level control on salinity of soils, soil water or downstream water.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing irrigation field ditches shall describe the requirements for applying the practice to achieve its intended purposes.

OPERATION AND MAINTENANCE

An Operation and Maintenance plan shall be prepared for use by the landowner or operator. The plan shall provide specific instructions for operating and maintaining the irrigation field ditches to insure it functions properly. The plan shall include the following provisions:

1. Perform prompt repair or replacement of damaged components.
2. Remove debris and foreign material that hinder system operation from field ditches and other components.
3. Maintain recommended vegetative cover on all slopes and watercourses.

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NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

AQUACULTURE PONDS

(Ac.)
CODE 397

DEFINITION

A water impoundment constructed and managed for commercial aquaculture production.

PURPOSE

Provide a favorable aquatic environment for producing, growing, harvesting, and marketing commercial aquaculture crops.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to:

- All impoundments that store water and are managed for commercial aquaculture purposes.
- Embankment impoundments that do not exceed the requirements for Class (a) dams having a product of storage times effective height of dam less than 3,000 acre-ft^2 and effective height of dam less than 35 feet, as defined in conservation practice standard 378, Pond.

CRITERIA

General Criteria

A thorough aquaculture resource assessment shall be made to determine the feasibility of the project prior to design.

Aquaculture ponds may be: (1) embankment ponds that intercept and store surface runoff water, or (2) off-channel impoundments or excavated ponds that are filled by pumping ground water, or diverting spring or stream flows.

The site must be protected from flooding, sedimentation, and non-sediment contamination.

The soils within the pond area, as well as those in the contributing drainage area, must be checked for residues of pesticides and other harmful chemicals if there is any possibility of contamination.

Acid soils shall be limed to achieve a neutral condition or the desired pH level for best production.

When multiple ponds are installed, each pond shall be arranged so that it can be managed independently of the others to facilitate harvesting and the control of parasites and disease.

All ponds shall be designed with measures to assure containment of exotic species.

A protective cover of vegetation shall be established on all exposed soil surfaces that have been disturbed. If soil or climatic conditions preclude the use of vegetation, other protection methods shall be used.

Water supply. Any available water source may be used if the quality and quantity are adequate. If water is pumped from rivers and streams or other sources where undesirable fish, pesticide residue, fish disease, and parasites may be introduced, filters must be installed in the pumping system.

Evaporation rates, fish-stocking densities, and species requirements shall be used in establishing specific incoming flow rates.

Pond area, The topography and geology of the site shall permit storage of water at a depth and volume that will ensure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable.

Water Quality. Water entering the pond shall be aerated to increase dissolved oxygen and dissipate harmful gases if needed. The minimum dissolved oxygen level in ponds is 3 to 5 parts per million.

Water temperature and water chemistry shall be suitable for use for fish-stocking density and species requirements in the planned aquaculture production.

Incoming water shall be added as far away from outlet drain as possible to prevent the rapid removal of fresh water from the pond.

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Provisions shall be made for any needed treatment of water released downstream from the aquaculture impoundment structure.

All federal, state and local regulations will be followed and necessary permits will be obtained prior to construction and stocking.

Design Criteria – Embankment Ponds. Earthfill dams and embankments around excavated ponds shall meet or exceed the requirements for embankments specified for Pond (378).

The minimum top width of the embankment shall be 14 ft and 20 ft, respectively, where it is to be used as a one-lane or two-lane road for management purposes and is nonpublic.

Design Criteria – Excavated Ponds. Ponds established by excavating and constructing an embankment around their outer perimeter that excludes outside runoff shall have either an auxiliary spillway or a principal spillway pipe installed with sufficient capacity to remove a 10-year/24-hour direct rainfall amount in 48 hours. A minimum 8-inch diameter pipe shall be used.

Levee construction shall add the required embankment settlement to the minimum freeboard requirements. A minimum berm width of 10 feet shall be provided between the outside toe of levee and top of bank of outlet drainage ditch.

Orientation

Rectangular ponds shall be positioned as nearly as possible as follows:

> 10 acres or less-long axis in the direction of prevailing wind. More than 10 acres long axis perpendicular to the direction of prevailing wind.

Pipes and conduits. Pump discharge through levees shall be installed above expected high water level, and provisions shall be made to prevent pump and motor vibrations from being transmitted to discharge conduits.

Interior embankments constructed for division of water or to direct water flow for circulation shall have adequate cross section to ensure stability and function for its intended purpose.

Adequate provisions must be made to protect earth surfaces from turbulent water at pipe inlets and outlets.

Pond size and depth. The pond shall be constructed to the recommended size and depth for the species to be grown.

Drains. All ponds shall have facilities for complete as well as partial drawdown. Turn-down pipes, quick-release valves, bottom-water release sleeves, or other devices for water level control and pond management are to be included in the construction of the drawdown facility as appropriate. Conduit design and seepage control shall meet or exceed the requirements specified for Pond (378).

Pond bottom. Where fish are harvested by seining, the pond bottom shall be smooth and free of all stumps, trees, roots, and other debris. Existing channels and depressions in the pond area shall be filled and smoothed. The edges of the pond should be deepened to provide at least 3 feet of water.

Where crawfish are harvested by trapping, complete clearing and removal of trees, stumps, and other vegetation is not required.

The pond bottom shall be sloped to the outlet at a gradient of at least 0.2 foot per 100 feet.

Access and safety. Provisions shall be made for access to the site as well as access for operation and maintenance. The access ramps, if provided, shall have a grade for equipment access of 4 horizontal to 1 vertical or flatter.

Appropriate safety features shall be made available nearby to aid people who may fall into the pond and devices installed to prevent such accidents.

Fences shall be installed as necessary to exclude livestock and unwanted traffic.

CONSIDERATIONS

The owner/operator's objectives will dictate the level of development and management to be planned. The plan must be based on the limitations and potentials of available natural resources. A thorough aquaculture resource assessment must be made to determine the feasibility of the project. The planning is complete when all practice components essential to reaching the cooperator's management objectives have been identified.

The State fishery agency or appropriate State University or research institution should be contacted for recommendation on pond size, water depths, and adapted commercial aquatic species.

Consider any adverse impact to cultural resources when planning for aquaculture ponds.

Other planning considerations include the following:

- The visual design of ponds should be carefully considered in areas of high public visibility and those associated with recreational fishing.
- Consider the effects on the volume of downstream flow or aquifers that might cause undesirable environmental, social, or economic effects and contribute to water table decline from heavy pumping.
- Measures to avoid depredation by birds or other animals should be included in the design.
- Measures to assure containment of exotic species shall be included in the design.

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

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Endangered Species Considerations

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<u>Catfish Ponds</u>

a. Site Selection

1) Level topography is desirable, preferably with a slope of less than 5 percent.

2) Pond site should be located out of a hazardous flood zone.

3) Suitable soils are those that are fairly impervious, on which water can be impounded.

4) The pond area should be accessible to trucks and tractors for management and harvesting activities.

b. Water Supply

1) A dependable water supply that is free of disease or parasitic organisms, and pollutants is essential. As a general rule, a flow of at least 25 gallons per minute per surface acre is necessary.

2) Water from wells and springs should provide a flow sufficient to fill the pond, replace evaporation loss, and to provide an emergency flow for use in case of oxygen deficiency.

3) Water from streams, canals, or sloughs should be filtered to remove undesirable fish, fish eggs, and debris.

c. Water Quality

1) pH range of 6.5 to 8.5 is desirable.

2) Total hardness between 20 and 200 ppm is desirable.

3) Salinity - Catfish can tolerate brackfish water in production ponds - up to 9000 ppm, however, the water source for ponds should probably not exceed 5000 ppm (spawning ponds require fresh water - less than 2000 ppm for good results).

d. Water Temperature

Catfish require warm water for good growth (85°F is optimum). For commercial production, the water temperature in the ponds should remain above 70°F for at least 120 days during the year.

e. Pond Construction

1) Depth - Ponds should be 3 to 5 feet deep.

2) Size - 1 to 40 acres or more.

3) Bottom - The entire bottom should be graded and sloped (0.2 feet per 100 feet) toward harvest basin or outlet to keep fish from becoming stranded in pools when the pond is being drained. In large ponds slope from the center to the edges.

4) Harvest Basin (optional) - This is a sump at the low end of the pond into which the fish are concentrated for harvesting by draining the pond. It should be 18 inches deeper than the pond bottom, with smooth sloping sides and bottom. The area required will vary with pond size from 1/4 acre to 1 acre depending on the size of the pond.

5) Levees

a) Slope - Water Side (Small Ponds) 3:1, Large Ponds (More than 2 Acres), 4:1.

b) Freeboard - 1 foot on ponds with fetch length less than 660 ft; and 2 feet on ponds with fetch length greater than 660 ft.

c) Erosion Control - Seeded or planted to adapted grasses.

7) Water Control Structures - These should be located in the harvest basin or low end of the pond. They should be:

a) Capable of draining the pond in 48 hours or less.

b) Designed so that the water level can be readily adjusted (flashboards, etc.).

c) Provide for bottom water overflow.

d) Equipped with a removable screen.

8) Dams - Where dams are used to create catfish ponds a bottom water discharge feature should be included in the outlet structure and the bottom should be smoothly graded and shaped as in item e.(3) above.

Trout Ponds

Trout can be reared commercially in ponds or reservoirs in the cooler parts of California, i.e. the north coast and at elevations above 5000 feet. However, most commercially produced trout in California are reared in raceways or modified raceway ponds where large volumes of cold water can be used to keep the oxygen levels high and the temperature low.

a. Site Selection - Important characteristics are:

1) Have a suitable source of water.

2) Level topography.

3) Be out of the high flood hazard zone.

4) Soil suitable for the impoundment of water.

5) Suitable access for vehicles.

b. Water Quality

1) Temperature - water between 50°F and 65°F is ideal; 70oF is about maximum. Trout growth is slow below 50°F.

2) Dissolved oxygen content - trout water should have a minimum of 5 ppm; 7 ppm or higher is preferable.

3) Trout water should have pH value within the range of 6.5 and 9.0 for good production.

4) Hardness - for trout production it is desirable for water of at least 50 ppm in hardness.

5) The water supply shall be free of pollutants. Also, it must not contain lethal amounts of gases such as carbon dioxide, hydrogen sulphide or nitrogen and heavy metals such as copper and zinc.

6) Salinity - trout will tolerate brackish water along the coast.

c. Water Quantity

There should be a large enough inflow to fill the ponds and replace daily evaporation and percolation loss. An inflow of at least 25 gallons per minute per surface acre of water is desirable to maintain good water quality.

d. Pond Construction

1) Depth - Trout ponds should be 3 to 5 feet deep. Where ice cover persists for long periods, a depth of 15 feet or more may be necessary.

2) Size of trout ponds is usually 1/4 acre to 5 acres.

3) The bottom should be graded and sloped toward the outlet or harvest basin. It should be smooth and free of stumps, roots, and rocks that would snag fish seines.

4) A harvest basin can be installed in front of the outlet where the fish can be collected when the pond is drained (see previous section on catfish), or it can be installed below the outlet. In the latter case it usually consists of a concrete wire with plots for flashboards and a screen.

5) Water control structures for trout ponds should be designed to allow for bottom water discharge and be equipped with removable screens.

Minnow Ponds

a. Site Selection

1) Have a suitable source of water.

2) Level topography is desirable - less than 5 percent slope.

3) Ponds should be out of a flood zone.

4) Soil should be suitable for impoundment of water.

5) There should be good access for vehicles.

b. Water Supply

A dependable water supply is needed that is free of pollutants such as insecticides or silt. The pH of the water should be within the range of 6.5 and 8.5, not excessively hard, and free of excessive amounts of carbon dioxide, hydrogen sulphide, etc. Water temperature is not as critical as it is with catfish or trout, however, the growth rate is slow in cooler water (below 65°F).

The water supply should be sufficient to maintain the ponds at a stable level -- equal to evaporation and percolation.

c. Pond Construction

2) Depth - 3 to 5 feet

3) Size - 1/4 to 1 acre, but can be larger.

4) Pond bottom should be graded and sloped toward outlet (0.2 feet per 100 feet) and smoothed so that the pond can be seined readily.

5) A catch (harvest) basin should be installed at the outlet. Place either in front of the outlet or outside of the pond below the outlet (for details see page 19, U.S. Department of the Interior, Fish and Wildlife Service Circular 35).

6) A suitable water control device is necessary - i.e., a turn down standpipe, shear-gate valve, or regular gate valve-for each pond.

Water Quantity

This practice may change the amount of water available to other uses when water for filling the ponds is taken from a surface water source or pumped from wells. In humid areas this practice may have a negligible effect on the quantity of

water. In water short areas the impoundment of water may cause a shortage for other uses.

1. Effects on the water budget, with emphasis on effects on volumes and rates of runoff, infiltration, evaporation, tran-spiration, deep percolation and ground water recharge.

2. Effects on the volume of downstream flow or aquifers that might cause undesirable environmental, social, or economic effects.

Water Quality

Commercial fishponds disrupt the natural drainage system of the area on which they are constructed. They are a confined feeding area in which the fish are concentrated and the waste feed and fish feces are deposited. During the production cycle, the pond is managed to control water conditions by the addition or removal of water. Waste water is high in BOD, nutrients, organics, and other material. Waste water may have a temperature higher than ambient temperature and may be a potential pollutant of the surface water outside of the ponds. (Refer to Practice Specification 312, Waste Management System.)

Because the ponds are a concentrated feeding operation, pollutants are concentrated. Any seepage will carry dissolved pollutants into the ground water. Improperly managed runoff from around the ponds, from the feed storage, and from fish processing plant, may increase the opportunities for organics, BOD, pesticides, pathogens, and other chemicals to enter surface and ground water.

In locations where the ponds replace cropland, a new set of hydrologic conditions will be established. The effects of these conditions on water quality must be evaluated for each individual site. If the site was previously cropland determine if pesticide or other toxic residues may be a problem.

In locations where the impoundment of water reduces the flow further downstream, this practice may reduce the pollutant assimilative capacity of the stream.

When ponds are constructed above the water table, a ground-water mound of polluted water may be created beneath the pond.

Oxygen deficiency may become a problem at times. This is especially true early in the morning after hot days with little air movement. A system of aeration should be planned for in areas where this problem is common.

1. Effects on erosion and the movement of sediment, organics, and soluble and sediment-attached substances.

2. Effects on the visual quality of water resources.

3. Short-term and construction-related effects on the water resources.

4. Effects on the temperature of water discharged.

5. Effects on the movement of dissolved substances below the root zone and toward ground water.

6. Potential for redistributing toxic materials during earth moving.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing aquaculture ponds shall be in keeping with this standard and shall describe the site-specific requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

A plan for operation and maintenance shall be prepared for use by those responsible for the system. This plan shall provide for inspection, operation, and maintenance of vegetation, pipes, valves, spillways, roads, and other parts of the system.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE

DITCH AND CANAL LINING, PLAIN CONCRETE

(feet)

CODE 428A

DEFINITION

A fixed lining of impervious material installed in an existing or newly constructed irrigation field ditch or irrigation canal or lateral.

PURPOSE

- Improve management of irrigation water
- Prevent waterlogging of land
- Maintain water quality
- Prevent erosion
- Reduce water loss

CONDITIONS WHERE PRACTICE APPLIES

Ditches and canals to be lined shall serve as integral parts of an irrigation water distribution or conveyance system designed to facilitate the conservation use of soil and water resources on a farm or group of farms.

Water supplies and irrigation deliveries for the area served shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Lined ditches and canals shall be located where they are not susceptible to damage from side drainage flooding, or they shall be protected from such damage.

Plain concrete linings shall be installed only in well-drained soils or on sites where subgrade drainage facilities are installed with or before the lining. These linings shall not be installed on sites susceptible to severe frost heave or on sites where experience has indicated that the sulfate salt concentration in the soil causes rapid deterioration of concrete.

CRITERIA

General. Plain concrete linings installed under the practice standard shall be limited to ditches or canals with:

- a bottom width not greater than 6 feet,
- flow capacity equal to or less than 100 cubic feet per second, and
- design velocity equal to or less than 15 feet per second.

Materials. On sites where sulfate concentrations exist, concrete linings may be used only if they are made using special sulfate-resistant cement in accordance with those shown in Table 1.

Fly ash can be used to replace up to 15 percent of the cement, by weight when other pozzolans are not used.

Air-entrainment admixture is recommended to improve workability and reduce damage due to freeze-thaw cycles. In-place, air content shall not exceed 6 percent of the volume of concrete.

Consider the addition of fiber reinforcement to increase durability and reduce the potential for minor cracking.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Table 1. Cement Requirements for Concrete Exposed to Sulfates

Water-soluble sulfate (SO_4) percent by weight	Sulfate (as SO_4) in water parts per million	Cement type ASTM C150 or C595
$SO_4 \geq 0$	$SO_4 \geq 0$	Any
$SO_4 \geq 0.10$	$SO_4 \geq 150$	II, IP(MS), IS(MS), P(MS), I(PM)(MS), I(SM)(MS)
$SO_4 \geq 0.2$	$SO_4 \geq 1500$	V
$SO_4 > 2.00$	$SO_4 \geq 10000$	V plus pozzolan*

* Pozzolan known or shown to improve sulfate resistance in concrete with Type V cement

Capacity. A lined ditch or canal shall have enough capacity to meet its requirement as part of the planned irrigation water distribution or conveyance system without damage or overtopping. Design capacity shall be based on the following, whichever is greater:

1. The capacity shall be enough to deliver water needed for irrigation to meet design peak consumptive use of crops.
2. The capacity shall be enough to provide an adequate irrigation system for all methods of irrigation planned.

For design purposes, the capacity shall be considered to be equal to the capacity as computed by Manning's Formula, using a coefficient of roughness, "*n*", of not less than 0.015.

Velocity. To avoid unstable surge flows, restrict design velocities in excess of 1.7 times the critical velocity to straight reaches that discharge into ditch sections or structures designed to reduce the velocity to less than critical velocity. Maximum velocity in these straight reaches shall be 15 ft/s.

The velocity in ditch reaches from which water is to be delivered onto the field through gates, turnouts, siphon tubes or by similar means shall be less than supercritical and sufficiently low to permit operation of the planned takeout structure or device.

Freeboard. The required freeboard varies according to the ditch or canal, velocity of water, horizontal and vertical alignment, the amount of storm or wastewater that may be intercepted, and the change in water surface elevation that may occur when any control structure is operating. The minimum freeboard for any lined ditch or canal shall be 3 inches (in.) of lining above the design water surface.

Minimum freeboard requirement is based on assumption that the finished channel bottom elevation will vary no more than 0.1 ft from design elevations. If a construction deviation greater than 0.1 ft is permitted, the minimum freeboard shall be increased.

Additional freeboard shall be provided if required by velocity, depth of flow, alignment, obstruction, curves, and other site conditions.

Water surface elevations. All lined ditches and canals shall be designed so that water surface elevations at field takeout points are high enough to provide the required flow onto the field surface. If ditch checks or other control structures are to be used to provide necessary head, backwater effect must be considered in computing freeboard requirements.

The required elevation of the water surface above the field surface varies with the type of takeout structure or device used and the amounts of water to be delivered. A minimum head of 4 in. shall be provided. Where head is greater than 6 in. and on erosive soils, exit velocity from gates, turnouts or siphon tubes may need devices to reduce energy.

Lining thickness. Thickness of canal linings must be established on the basis of engineering consideration on each job. Location, canal size, velocity, subgrade conditions, method of construction, operation, and climate shall be evaluated in establishing thickness to be used. Minimum thickness for plain concrete linings in rectangular sections shall be 3½ in. For trapezoidal or parabolic sections, minimum thickness shall be in accordance with Table 2.

Table 2. — Minimum required thickness for plain concrete ditch and canal linings

Design velocity[1/] (ft/s)	Minimum thickness by climatic area[2/] (in.)	
	Warm	Cold
Less than 9.0	1.5	2.0
9.0–12.0	2.5	2.5
12.0–15.0	2.5	3.0

[1/] Velocities in short chute sections shall not be considered design velocity.

[2/] Climatic area:

Warm – Average January temperature is 40 °F and above

Cold – Average January temperature is less than 40 °F.

Ditch or canal side slopes. Plain concrete linings are generally used in ditches and canals that have either a trapezoidal or parabolic cross section.

They may be used in rectangular sections if the sidewall height is not greater than 1½ ft. Side slopes for usual construction methods shall not be steeper than shown below:

Hand-placed, formed concrete:

Height of lining less than 1½ ft ……...Vertical

Hand-placed, screeded concrete:

Height of lining less than 2½ ft ....3/4H to 1V*
Height of lining more than 2½ ft …..1H to 1V

Slip form concrete:

Height of lining less than 3 ft ...……...1H to 1V
Height of lining more than 3 ft ….1¼H to 1V

*H – Horizontal, V – Vertical

Ditch or canal banks. Ditch and canal banks shall be constructed with earth to at least the top edge of the lining. In cut sections, other than in rock, a berm shall be constructed not less than 2 in. above the top of the lining. Banks and berms shall be wide enough to ensure stability of fills and to prevent excessive deposition in cut sections.

When using siphon tubes, minimum berm or bank width of 12 in. shall be provided at the top of the lining on both sides of the finished ditch. All other canals and laterals shall have a minimum berm or bank width of 18 in. at top of lining.

If the bank or berm is to be used as a roadway, the minimum top width shall be adequate for the purpose. Minimum recommended roadway width for straight sections is 12 ft.

Outside bank slopes and slopes above the berm elevation in cut sections must be flat enough to insure stability. A minimum slope is 2H to 1V is recommended. Where vegetation will be maintained by mowing, the minimum slope shall be 3H to 1V.

Related structures. Plans for ditch or canal lining installations shall provide for adequate inlets, outlets, turnouts, checks, crossings, and other related structures needed for successful conservation irrigation.

Structures shall be constructed or installed in such a way that the capacity or the freeboard of the ditch is not reduced and the effectiveness of the lining is not impaired.

All structures shall meet applicable NRCS Conservation Practice Standard requirements for the type of structure used.

CONSIDERATIONS

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

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habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, evaporation, deep percolation and ground water recharge.
2. Effects on downstream flow or aquifers that would affect other water uses or users.
3. Potential use for irrigation water management.
4. Potential changes in growth and transpiration for vegetation located next to the conveyance because of the elimination of leakage from the system.

Water Quality

1. Effects of installing the lining on the erosion of the earth conveyance and the movement of sediment and soluble and sediment-attached substances carried by water.
2. Effects on the movement of dissolved substances to ground water.
3. Effects on wetlands or water-related wildlife habitats.
4. Effects on visual quality of water resources.

PLANS AND SPECIFICATIONS

Plans and specifications for installing plain concrete irrigation ditch and canal linings shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be developed for plain concrete irrigation ditch and canal linings. The plan should document needed actions to ensure that practices perform adequately throughout their expected lives.

O&M requirements shall be determined as part of the design. Any requirements should be documented as brief statements in the plans, the specifications, or the conservation plan narrative, or as a separate O&M plan. Typical O&M may include sediment/debris removal, patching of cracked concrete, and replacement of deteriorated linings.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE
DITCH AND CANAL LINING, GALVANIZED STEEL

(feet)
CODE 428C

DEFINITION

A fixed lining of impervious material installed in an existing or newly constructed irrigation field ditch or irrigation canal or lateral.

PURPOSES

- Improve control and management of irrigation water
- Prevent waterlogging of land
- Maintain water quality
- Prevent erosion
- Reduce seepage losses.

CONDITIONS WHERE PRACTICE APPLIES

Ditches and canals to be lined shall serve as integral parts of an irrigation water distribution or conveyance system designed to facilitate the conservation use of soil and water resources on a farm or group of farms.

Water supplies and irrigation deliveries for the area served shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Lined ditches and canals shall be located where they are not susceptible to damage from side drainage flooding or they shall be protected from such flooding.

Steel linings shall be installed in well-drained soils or on sites where suitable subgrade drainage facilities are installed before or with the lining, unless the lining is designed to resist the applicable uplift pressures.

CRITERIA

Capacity. A lined ditch or canal shall have enough capacity to meet its requirement as part of the planned irrigation water distribution or conveyance system without danger of overtopping. Design capacity shall be based upon the following, whichever is greater:

1. The capacity shall be adequate to deliver the volume of water required to meet the peak consumptive use of the crops.
2. The capacity shall be large enough to provide an adequate irrigation stream for all methods of irrigation planned.

For design purposes, the carrying capacity of steel-lined ditches and canals shall be computed by Manning's Formula, using a coefficient of roughness, "*n*", of not less than 0.013.

Velocity. A design velocity in excess of 1.7 times the critical velocity shall be restricted to straight reaches that discharge into a section or structure designed to reduce the velocity to less than the critical velocity. The maximum velocity in these straight reaches shall be 15 feet per second (ft/s).

Freeboard. The required freeboard varies with the size of the ditch or canal, the velocity of the water, the horizontal and vertical alignment, the amount of storm or waste water that may be intercepted, and the change in the water surface elevation that may occur when any control structure is operating.

The minimum freeboard for any lined ditch or canal shall be 3 inches. If the velocity is within ± 30 percent of critical, the freeboard shall be at least 6 inches. Additional freeboard shall be provided as required by slope, velocity, depth of flow, alignment, obstructions, curves and other site conditions.

Water surface elevations. All lined ditches and canals shall be designed so that the water surface elevations at field takeout points are high enough to provide the required flow onto the field surface. If ditch checks or other control structures are to provide the necessary head, the backwater effect must be considered in computing freeboard requirements. The required elevation of the water surface above the field surface varies according to the type of takeout or device used and the amount of water to be delivered. A minimum head of 4 inches shall be provided.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Ditch or canal pad or foundation. Ditch and canal banks shall be built up with earth to a height sufficient to support the full height of the lining and to provide an anchorage for the top edge of the lining. In cut sections, other than in rock, a berm shall be constructed not less than 2 inches above the top of the lining.

Berms and ditch banks shall be wide enough to prevent excessive deposition in cut sections and to insure support of the lining in fill sections. The minimum width shall be 1 foot. If the bank or berm is to be used as a roadway, the minimum top width shall be adequate for the purpose.

Outside bank slopes and slopes above the berm elevation in cut sections must be flat enough to insure stability.

Related structures. Plans for ditch or canal lining installations shall provide for adequate inlets, outlets, turnouts, checks, crossings, and other related structures needed for successful conservation irrigation.

Structures shall be constructed or installed in such a way that the capacity or the freeboard of the ditch is not reduced and the effectiveness of the lining is not impaired.

All structures shall meet applicable NRCS conservation practice standard requirements for the type of structure used.

Bulkheads, formed to fit the lining and of sufficient size to extend at least 12 inches into the earthen ditch pad for the entire width of the ditch lining, shall be installed at the beginning and end of the lining section and at intervening points, as needed, to provide adequate anchorage.

Joints. Joints in steel ditch and canal linings shall be flexible and watertight and provide for contraction-expansion of liner material for the expected temperature variations at the site.

Materials. Steel linings installed in soils with high salt or other chemical concentrations injurious to galvanized steel shall be protected with coatings or cathodic protection specifically designed to protect the liner from these chemicals.

Galvanized lining material shall equal or exceed the requirements of ASTM A 525 “General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process.” The minimum thickness of the lining material shall be 24 gauge for individual sheets 84 inches or less in width and 22 gauge for wider sheets. The minimum thickness of steel sheets used in bulkheads and related structures shall be 20 gauge.

The edges of the lining sheets shall be rolled or pressed into a shape that will provide added strength at the corners and a firm anchorage into the ditch bank berm at the top of the lining.

Fasteners in the assembly of liners shall be zinc or cadmium plated. Joints shall be filled with sealant material capable of withstanding the temperature variations expected at the site.

CONSIDERATIONS

Consider the effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, and deep percolation and ground water recharge.

Consider the effects on downstream flows or aquifers that would affect other water uses or users.

Consider the potential for improving irrigation water management.

Consider the potential changes in growth and transpiration of vegetation located next to the conveyance because of the elimination of leakage from the system.

Consider the effects of installing the lining on the erosion of the earth conveyance and the movement of sediment and soluble and sediment-attached substances carried by water.

Consider the effects on the movement of dissolved substances to ground water.

Consider effects on wetlands or water-related wildlife habitats.

Consider the effects on the visual quality of water resources.

Cultural Resources Considerations

NRCS’s objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

PLANS AND SPECIFICATIONS

Plans and specifications for installing galvanized steel irrigation ditches and canal linings shall describe the requirements for applying the practice to achieve its intended purposes and will include applicable lining cross-sectional shape, grades, material thickness, joints and pertinent structures.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan will be developed for galvanized steel and ditch linings. The plan should document needed actions to ensure that the practice performs adequately throughout its expected life.

O&M requirements shall be determined as part of the design. Any requirements should be documented as brief statements in the plans, the specifications, or conservation plan narrative, or as a separate O&M plan. Typical O&M may include sediment/debris removal, replacement of joint sealant, replacement of deteriorated linings, reshaping berms and weed control as needed.

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NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION SYSTEM, SURFACE AND SUBSURFACE

(No. and Ac.)
CODE 443

DEFINITION

A system in which all necessary water-control structures have been installed for the efficient distribution of water by surface means, such as furrows, borders, contour levees, or contour ditches, or by subsurface means.

PURPOSE

This practice is applied as part of a conservation management system to achieve one or more of the following:

- Efficiently convey and distribute irrigation water to the surface point of application without causing excessive water loss, erosion, or water quality impairment.
- Efficiently convey and distribute irrigation water to the subsurface point of application without causing excessive water loss or water quality impairment.
- Apply chemicals and/or nutrients as part of an irrigation system.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to the planning and design of an irrigation water distribution system or a chemical and/or nutrient application system.

Areas must be suitable for irrigation with water of suitable quality for the purpose intended. Water supplies must be sufficient in quantity and quality to make irrigation practical for the crops to be grown and the application methods to be used.

This standard does not apply to detailed design criteria and construction specifications for individual structures or components of the system.

This standard does not apply to NRCS conservation practice standard, Irrigation System, Microirrigation (441).

CRITERIA

General Criteria Applicable to All Purposes

This practice shall conform to all federal, state, and local laws and regulations. Laws and regulations of particular concern include those involving water rights, land use, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

The criteria for the design of components not addressed in NRCS practice standards shall be consistent with sound engineering principles.

Conservation irrigation methods. All irrigation systems must be designed as an integral part of an overall plan of conservation land use and treatment for the farm that is based on the capabilities of the land and the needs of the irrigated area.

All farm irrigation system designs shall be based on the use of sound irrigation water application methods that are suited to site conditions (combination of soil and slope) and crops to be grown. Adapted methods are those methods that will provide efficient use of water without destructive soil erosion or degradation of water quality. Detailed design criteria from local irrigation guides shall be followed where available.

Capacity. The irrigation system shall have adequate capacity to meet the intended purpose(s).

If more than one irrigation method will be used on the same field, the system capacity shall be adequate for the method requiring the highest rate of water delivery.

All structures and water delivery components shall be designed for maximum flow conditions expected and shall have adequate capacity and/or freeboard. All structures and water delivery components shall be designed according to appropriate NRCS conservation practice standards.

Design application rate. The design rate of application shall be within a range established by the minimum practical application rate for local

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climatic conditions and the maximum rate consistent with the intake rate of the soil and conservation practices used on the land.

Water control. Farm irrigation systems shall include structures needed for water control such as measuring devices, division boxes, checks, turnouts, pipelines, lined ditches, valves, and gates to control and regulate water for efficient application.

Irrigation water management. An irrigation water management meeting the requirements of Conservation Practice Standards 449 – Irrigation Water Management shall be developed for this practice.

Additional Criteria Applicable to Surface Irrigation Systems

Capacity. The system shall have either (1) a design capacity adequate to meet water demands of all crops to be irrigated in the design area or (2) enough capacity to meet the requirements of water application during critical crop growth periods when less than full irrigation is planned. In computing capacity requirements, allowance must be made for reasonable water losses during application and any leaching requirements.

Water surface elevation. All systems for irrigation by surface methods shall be designed so that the water surface elevation at field takeout points is sufficient to provide the required flow onto the field surface. A head of at least 4 inches shall be provided.

Location of head ditches or pipelines. Head ditches or pipelines used for surface irrigation shall be located so that irrigation water can be applied uniformly over the entire field without causing erosion. Ditch or pipeline spacing shall be such that irrigation run lengths are not longer than the maximums specified in the local irrigation guide or those determined by field evaluation. If more than one crop is to be grown or more than one method of irrigation used, the ditch or pipeline spacing shall not exceed the allowable run length determined for the limiting crop or method.

Erosion control. The design of farm irrigation systems shall provide for conveying and distributing irrigation water without causing damaging soil erosion. All unlined ditches shall have nonerosive gradients. If water is conveyed on slopes steep enough to cause excessive flow velocities, the irrigation system design shall provide for the installation of such erosion-control structures as drops, chutes, buried pipelines, or erosion-resistant ditch linings. Polyacrylamide may be utilized for erosion control according to NRCS conservation practice standard for Anionic Polyacrylamide (PAM)-Erosion Control (450) in lieu of or in combination with structural measures.

Seepage control. For surface irrigation systems, ditches shall not traverse highly permeable soils without adequate measures for seepage control. If site conditions require conveyance of water across excessively permeable areas, the irrigation system design shall provide for pipelines, flumes, or lined ditches as needed to prevent excessive seepage losses.

Tailwater and Excess Runoff Removal. Irrigation system designs shall include facilities of adequate capacity as needed for the safe removal of irrigation tailwater and storm water runoff from the field surface. Collection facilities (ditches) constructed for this purpose shall be on nonerosive gradients or be stabilized by lining or structural measures if erosion is a hazard. If field elevations do not permit the safe disposal of excess water by gravity flow, the design shall provide for installation of pumping plants and other needed appurtenant structures. Ditches shall be protected from bank erosion. If excess water will be reused for irrigation, the irrigation system design shall provide for collection facilities so that water does not flow directly from furrows or borders into irrigation head ditches. Tailwater systems shall be installed according to NRCS conservation practice standard, Irrigation System, Tailwater Recovery (447).

Additional Criteria Applicable to Subsurface Irrigation Systems

Subsurface irrigation systems shall be designed to maintain the water table at or between predetermined elevations below the ground surface at all points in the design area.

Feeder ditches or conduits for subsurface irrigation shall be spaced so that the variation in depth from the land surface to the water table is not greater than is permissible for adequate irrigation of the most limiting crop to be grown.

Additional Criteria Applicable to Chemical and/or Nutrient Application

The installation and operation of an irrigation system for the purpose of chemical and/or nutrient

application shall comply with all federal, state and local laws, rules and regulations. This includes backflow and anti-siphon prevention measures. Additionally, surface waters shall be protected from direct application and runoff.

Nutrient and pest management. Chemicals, fertilizers, waste water, and liquid manure shall be applied in accordance with appropriate NRCS conservation practice standards for Nutrient Management (590), Pest Management (595), and/or Waste Utilization (633).

CONSIDERATIONS

When planning this practice the following items should be considered, where applicable:

Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, and deep percolation, and ground water recharge.

2. Potential for changes in plant growth and transpiration because of changes in the volume of soil water.

3. Effects on downstream flows or aquifers that would affect other water uses or users.

4. Effects on the volume of downstream flow that could have undesirable environmental, social, or economic effects.

5. Effect on the water table of the field in providing a suitable rooting depth for anticipated land uses.

6. Potential use for irrigation water management.

Water Quality

1. Effects on erosion and the movement of sediment and soluble and sediment-attached substances that would be carried by runoff.

2. Effects of nutrients and pesticides on surface and ground water quality.

3. Effects on the movement of dissolved substances below the root zone or to ground water.

4. Effects of water level control on the salinity of soils, soil water or downstream water quality.

5. Effects of salt leaching on system management and capacity requirements.

6. Effects of water levels on such nutrient processes as plant nitrogen use or dentrification.

7. Effects on the temperatures of downstream water that could cause undesirable effects on aquatic and wildlife communities.

8. Effects on wetlands or water-related wildlife habitats.

9. Effects on the visual quality of water resources

PLANS AND SPECIFICATIONS

Plans and specifications for surface and subsurface irrigation systems shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan specific to the facilities installed shall be prepared for use by the landowner or operator responsible for operation and maintenance. The plan should provide specific instructions for operating and maintaining facilities to ensure they function properly. The plan shall include provisions to address the following, as a minimum:

- Periodic cleaning and regrading of collection facilities to maintain proper flow lines and functionality.
- Periodic checks and removal of debris as necessary from trash racks and structures to assure proper operation.
- Periodic removal and planned placement of sediment from traps and/or storage facilities to maintain design capacity and efficiency.
- Inspection or testing of all pipeline and pumping plant components and appurtenances, as applicable.
- Routine maintenance of all mechanical components in accordance with manufacturer's recommendations.
- Periodic land leveling or grading of surface irrigated fields is required to maintain uniform field grades for application uniformity.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

MOLE DRAIN

(feet)
CODE 482

DEFINITION

An underground conduit constructed by pulling a bullet-shaped cylinder through the soil.

PURPOSE

To establish a system of subsurface earthen channels for removal of trapped surface and subsurface water.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where the use of buried drains is physically or economically impractical to complete the drainage required. Mole drains may be used in fields with highly cohesive or fibrous soils that are free of stones, gravel, or sand lenses if the area served is small and if an outlet is available or can be constructed to provide continuously free outfall from the drains. They may also be used as a supplement to other drains.

CRITERIA

Planned work shall comply with all federal, state and local laws and regulations.

Size. The minimum diameter of a mole drain shall be 4 inches. A 6-inch mole will usually create a hole approximately 4½ inches in diameter.

Location, grade, and length. The location, grade, length of line, depth, spacing and size of drains, and the outlet protection for such drains shall meet requirements of NRCS National Engineering Handbook, Section 16, Drainage, or as modified by approved local drainage guide.

Outlet. Outlets must have sufficient depth and capacity to provide continuous free outfall.

CONSIDERATIONS

When planning this practice, consider the following:

Cultural Resources Considerations

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Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

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Endangered Species Considerations

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical

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habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

Water Quantity

1. Effects on runoff, infiltration, deep percolation, and potential ground water recharge.
2. Effects of increased drainage waters on downstream base flow.
3. Effects on existing wetland hydrology.

Water Quality

1. Effects of increase in dissolved substances that may be discharged to streams.
2. Effects on aquifer recharge water quality.
3. Reduction in the yields of sediment or sediment-attached substances, and effects on downstream water quality and water use.
4. Downstream water quality, water use, and water temperature.
5. Effects on the visual quality of downstream waters.

PLANS AND SPECIFICATIONS

Plans and specifications for installing mole drains shall be in keeping with this standard and shall describe the requirements for proper installation of the practice to achieve its intended purpose.

Mole drains shall be installed according to an approved plan, or as modified by an authorized technician at the site.

OPERATION AND MAINTENANCE

Operation and maintenance shall consist of periodic checks to determine that the outlet is open and free flowing.

The mole drains shall be reworked as needed to maintain adequate drainage.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

SURFACE DRAINAGE, FIELD DITCH

(Feet)
CODE 607

DEFINITION

A graded ditch for collecting excess water in a field.

PURPOSE

Collect or intercept:

- excess surface water, such as sheet flow from natural and graded land surfaces or channel flow from furrows, and carry it to an outlet;
- excess subsurface water and carry it to an outlet.

CONDITIONS WHERE PRACTICE APPLIES

Applicable sites are flat or nearly flat and:

1. Have soils that are slowly permeable (low permeability) or that are shallow over barriers such as rock or clay, which hold or prevent ready percolation of water to a deep stratum.
2. Have surface depressions or barriers that trap rainfall.
3. Have insufficient land slope for ready movement of runoff across the surface.
4. Receive excess runoff or seepage from uplands.
5. Require the removal of excess irrigation water.
6. Require control of the water table.
7. Have adequate outlets available for disposal of drainage water by gravity flow or pumping.

CRITERIA

General Criteria Applicable to All Purposes

Drainage field ditches shall be planned as integral parts of a drainage system for the field served and shall collect and intercept water and carry it to an outlet with continuity and without ponding. Compliance with federal, state, and local laws and regulations is required.

Investigations. An adequate investigation shall be made of all sites.

Location. Ditches shall be established, insofar as topography and property boundaries permit, in straight or nearly straight courses. Random alignment may be used to follow depressions and isolated wet areas of irregular or undulating topography. Excessive cuts and the creation of small irregular fields shall be avoided.

On extensive areas of uniform topography, collection or interception ditches shall be installed as required for effective drainage.

Design. The size, depth, side slopes, and cross section area shall:

1. Be adequate to provide the required drainage for the site.
2. Permit free entry of water from adjacent land surfaces without causing excessive erosion.
3. Provide effective disposal or reuse of excess irrigation water (if applicable).
4. Conduct flow without causing excessive erosion.
5. Provide stable side slopes based on soil characteristics.
6. Permit crossing by field equipment if feasible.
7. Permit construction and maintenance with available equipment.

CONSIDERATIONS

When planning this practice, the following items should be considered where applicable:

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Cultural Resources Considerations

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

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Endangered Species Considerations

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Water Quantity

1 Effects on water budget components, especially relationships between runoff and infiltration.

2. The effect of changes in the water table on the rooting depth for anticipated land uses.

Water Quality

1. Potential impacts on downstream flows or aquifers that would affect other water uses or users.
2. Potential water quality impacts for soluble pollutants, sediments and sediment-attached pollutants.
3. Potential for uncovering or redistributing toxic materials.
4. Effects on wetlands or water-related wildlife habitats.
5. Effects of water lever control on soil water, downstream water temperature or salinity of soils.
6. The need for riparian buffers, filter strips and fencing.
7. Effects on the visual quality of downstream water courses.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing drainage field ditches shall be in keeping with this standard and shall describe the requirements for properly installing the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

A site-specific operation and maintenance plan shall be provided to and reviewed with the landowner(s) before the practice is installed.

The plan shall adequately guide the landowner(s) in the routine maintenance and operational needs of the ditch(es). The plan shall also include guidance on periodic inspections and post-storm inspections to detect and minimize damage to the ditch(es).