Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

# FISH RACEWAY OR TANK

CODE 398

(no)

## DEFINITION

A channel or tank with a continuous flow of water used for high-density production of fish or other aquatic organisms.

## PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Design an aquaculture facility to supply flowing or recirculating water of suitable temperature, quantity, and quality to meet the basic needs of farmed fish and other aquatic organisms.
- Manipulate chemical, physical, and biological factors to treat effluents (reduce nutrients and pathogens) before release into receiving waterbodies.
- Assess and plan for increased system efficiency to conserve energy use.

## CONDITIONS WHERE PRACTICE APPLIES

This standard applies to aquaculture raceways or tanks that convey flowing or recirculating water to produce fish or other aquatic organisms. This includes earthen channels as well as channels and tanks constructed of concrete, concrete block, timber, rock, fiberglass, or other materials.

## CRITERIA

### General Criteria Applicable to All Purposes

Design a facility to provide protection from flooding, sedimentation, and contamination by pollutants from outside sources.

Design raceway or tank dimensions based upon the legally available water and planned production level. Meet all applicable Federal, State, territorial, Tribal, and local laws and regulations.

**Water quantity entering facility**
Maintain a water supply of sufficient volume and appropriate temperature, either by gravity flow or by pumping, to produce the desired species. Generally, this amount would equate to two complete water exchanges per hour for a raceway length of 80 to 100 feet (ft) but some systems may require less water. Measure the water volume during periods of low flow.

**Water quality entering facility**
Supply water free of (or at acceptable levels for species-specific biological needs) harmful gases, sediments, minerals, silt, nutrients, pathogens, pesticides, and other contaminants. Conduct a water analysis before design and construction unless previous use or experience indicates water quality is satisfactory for the desired species. Consult Land Grant University recommendations for species-specific water quality requirements.

**Vegetation**
During construction, stockpile topsoil for placement on disturbed areas to facilitate revegetation. Consider selecting and placing vegetation to improve fish and wildlife habitat, and species diversity.

**Waste (effluent) Management in Flow Through Systems**
Develop plans for the treatment of wastewater generated or caused by the operation of aquaculture raceways or tanks before effluent release into receiving waterbodies.

The essential components of a flow through system are the effluent water from the aquaculture facility, solids removal, and a treatment lagoon or wetland cell:

1. Effluent water – aquaculture waste includes feces, uneaten feed, dead organisms, dissolved metabolites, and soluble nutrients in the culture water. These wastes should be removed from the waste stream before they enter a solid removal facility.
2. Solids removal – This operation is dependent on the waste stream concentration and the water loading rate of a rearing-system. Solid separation can be accomplished by settling basins/ponds. Sludge and solid fraction from this operation must be disposed of appropriately. They may be diluted with water to spread on field or combined with other waste product (vegetable matter) to form compost.
3. Treatment lagoon or wetland cell – Treatment lagoons may be constructed as an anaerobic, natural aerobic, or mechanically aerated lagoon. Construct wetland systems with a minimum of two rows of functionally parallel cells and contain hydrophytic vegetation for biological treatment of the wastewater.

Such plans may include the construction of NRCS Conservation Practice Standard (CPS) Waste Treatment Lagoons (Code 359), Constructed Wetland (Code 656), or other facilities.

Solid waste handling - Apply and spread of solid waste in accordance with CPS Nutrient Management (Code 590). Export of excess waste according to CPS Waste Recycling (Code 633).

Final discharges into waterbodies must meet State and Federal standards for the stream or other surface waters, based on size of the operation, and comply with National Pollutant Discharge Elimination System (NPDES) regulations. For urban facilities, direct discharge into municipal sewer system must meet the local municipal wastewater quality requirements.

**Criteria Applicable to Linear Channel Raceways**
Raceways generally consist of linear channels where water flows in at one end and exits at the other end. Linear channel raceways generally consist of two types:

- Concrete or concrete block construction—
  - Design and construct raceways in accordance with NRCS National Engineering Manual, Part 536, “Structural Design.” When designing concrete or concrete block raceways, use the same design material for the bulkheads or check dams.
- Earthen channels construction with a trapezoidal or parabolic cross section—
  - Design raceways with a trapezoidal or parabolic cross section. Design bottom widths based on the volume of water available, but not less than 4 ft. Design side slopes 1:1 or flatter, depending on a slope stability analysis. Design and construct side slopes and bottoms of raceways with smooth and uniform surfaces to minimize dead water areas.

**Grade**
Wherever possible, design and construct raceways with a minimum bottom grade of 0.5 ft per 100 ft. The raceway outlet will control the water surface grade.

**Length**
Determine the maximum length of each raceway section by site topography and need for reaeration of the water, but no more than 100 ft. For the design of raceway sections in series, install a bulkhead or check dam at the lower end of each section.

**Width**
Select the width of individual raceways considering the available water supply, harvesting equipment, and operation and maintenance needs of the system.

**Freeboard**
The minimum difference in elevation between the water surface in the raceway and the top of the bulkhead, dike, or levee alongside the raceway is 0.5 ft.

**Dikes and levees**
Design a 6-ft minimum top width for earthen dikes or levees. Use 2:1 or flatter side slopes for portions of earthen dikes and levees above the water surface. Use a 14-ft minimum top width and 3:1 or flatter side slopes when using the top of the dike or levee as a road.

**Bulkheads**
Place structural or earthen barriers, called bulkheads, across raceway channels to create shorter sections, establish and maintain the desired water levels, and provide aeration of the water. In addition to serving as a barrier, they must have an opening or throat section that allows complete drainage to the bottom of the raceway channel unless other drainage facilities are provided.

Design bulkheads using earth, concrete, concrete block, rock masonry, steel or other durable metal, treated timber, or a combination of these as follows:

- Provide a minimum top width of 4 ft and side slopes of 2:1 or flatter for earthen bulkheads.
- Provide a minimum top width of 6 in and a minimum bottom width of 8 in for reinforced concrete bulkheads.
- Extend concrete, concrete block, rock masonry, or steel bulkheads used in earthen raceways at least 2 ft into the sides and bottom of the channel.
- Design the opening or throat section of bulkheads using concrete, concrete block, wood, or metal.
- Provide slots or grooves along the vertical face that allows installation of flashboards and screens.
- Fill openings and cores in concrete blocks with either concrete or a mortar mix.

**Drains**
Provide a pipe drain with a minimum diameter of 6 in at the bottom of the bulkhead or provide for flashboard removal to allow complete drainage. Where possible, design each unit in a series to allow drainage independent of the other units.

**Screens**
Provide screens at the inlet of the system, if necessary, to prevent wild fish (including wild, native species) from entering the production facility/operation and farmed fish from escaping into natural waterbodies. Screening design must meet state requirements and, where applicable, Federal requirements. Provide screens at each bulkhead between sections and at the exit end to prevent loss of fish. Place screens at least 6 to 8 in upstream from the flashboards and extend screens at least 6 to 8 in above the expected water level to prevent fish escape from jumping. Design screen openings based on the size range of fish requiring separation. Maintain water velocity through screens slow enough to prevent fish impingement on screens.

**Aeration**
Fit each bulkhead with a weir overfall such as flashboards in the opening or throat section of the bulkhead. Design the width of the weir or weirs equal to the bottom width of the raceway, but not less than 4 ft where flashboards are used to establish the desired water level. Design two or more weirs separated by rigid

center sections when the width of the raceway exceeds 8 ft. To increase aeration as part of the design, arrange a splash board or series of boards to create successive splashes or place nozzles in the tank above the water surface. Set the weir crest at least 1 ft above the downstream water surface elevation.

### Criteria Applicable to Tanks

Tanks generally have a circular, rectangular, or oval shape. Water enters a tank through nozzles or jets in a manner that creates a rotary circulation within the tank and typically discharges through the tank center by means of a standpipe or bottom drain.

Construct tanks using concrete, metal, fiberglass, or other suitable material capable of providing the strength and durability for the anticipated use. Noncircular tanks must have an interior dividing wall to obtain proper circulation. Construct tank raceways at locations accessible to water supplies, management personnel, and feed and harvest equipment.

#### Water supply

Install jets, nozzles, or similar devices that provide a tangential force to the water in the tank. Locate submerged nozzles above the tank bottom to minimize the uplift of waste particles. In the Northern Hemisphere, position nozzles to direct flow counterclockwise.

#### Waste removal

Incorporate provisions for waste removal in the design. Provide bottom troughs, screens, or center-positioned drainpipe as part of the tank construction.

## CONSIDERATIONS

### General Considerations

#### Waste (Effluent) Management using Recirculating Aquaculture Systems (RAS)

Consider a RAS approach, which includes among its purposes minimizing water use and allowing for secondary use of wastewater (e.g., re-use of water for fish, aquaponic, crop, algae, or invertebrate production).

The RAS also can improve system efficiency, which reduces surface and/or groundwater water withdrawal. For example, for situations where water scarcity is an issue (e.g., arid environments) or effluent water quality standards are limiting (urban agriculture or small-scale operations), consider developing a plan for the collection, treatment, and recirculation of effluent water generated by the aquaculture raceway or tank operation.

Essential components of a RAS include: effluent from the fish-rearing raceways or tanks; solids removal; biofilter or hydroponic component; and sump and/or return transfer to fish-rearing component.

For additional planning and design of an RAS system, refer to AWM Handbook, Chapter 14 – Recirculating Aquaculture Systems. Components may include the construction of NRCS Conservation Practice Standard (CPS) Waste Storage Structures (Code 313), CPS Waste Treatment Lagoons (Code 359), settling basins, or other facilities. Spread waste in accordance with CPS Nutrient Management (Code 590).

#### Fish and wildlife

Consider the impacts of cultivated nonnative fish on endemic fish populations, as well as potential interactions with wildlife and birds that can be attracted to these facilities.

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#### Water quantity

Consider effects upon components of the water budget, such as—

- Volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
- Variability of effects caused by seasonal or climatic changes.
- The effects of water withdrawal on native aquatic organisms. This is especially critical during seasonal low stream flow.
- Downstream flows and impacts to environment such as wetlands, aquifers, and social and economic impacts to downstream uses or users.

**Water quality**
Consider the effects of—

- Erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that runoff carries.
- Short-term and construction-related effects of this practice on the quality of downstream watercourses.
- Water-level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.
- Water level on wetlands and water-related wildlife habitats.
- Water levels on soil nutrient processes such as plant nitrogen use or denitrification.
- Soil water level control on the salinity of soils, soil water, or downstream water.
- Potential for earth moving to uncover or redistribute toxic materials.
- Movement of dissolved organic and inorganic chemicals downstream and towards groundwater recharge areas.

## PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice according to this standard. As a minimum, include—

- A plan view of the layout of the facility and appurtenant features.
- Typical profiles and cross sections of the facility and appurtenant features as needed.
- Structural drawings adequate to describe the construction requirements.
- Requirements for vegetative establishment and mulching, as needed.
- Safety features.
- Site-specific construction and material requirements.

## OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the facility.

As a minimum, include the following items in the operation and maintenance plan:

- Periodic inspections of all structures, earthen embankments, and other appurtenances.
- Prompt repair or replacement of damaged components.
- Prompt removal of sediment when it reaches predetermined storage elevations.
- Periodic removal of trees, brush, and undesirable species.
- Periodic inspection of safety components and immediate repair if necessary.
- Maintenance of vegetative protection and immediate seeding of bare areas as needed.

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