

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

FISH RACEWAY OR TANK

(m, ft and m³/s, ft³/s)

CODE 398

DEFINITION

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

PURPOSE

- To provide a facility containing flowing water of suitable temperature and quality for dependable production of fish.
- To manipulate the chemical, physical, and biological factors to enhance fish production and maintain water quality.

CONDITIONS WHERE PRACTICE APPLIES

Where water and land resources are suitable for constructing a raceway or tank that can be used to produce a commercial fish crop.

CRITERIA

General Criteria Applicable To All Purposes

The cooperators' objective as well as the limitations and potentials of available aquaculture resources will dictate the level of development and management to be planned.

An aquaculture resource assessment must be made to determine the feasibility of the raceway or tank culture system.

The facility must be designed to provide protection from flooding, sedimentation and contamination by pollutants from outside sources.

All Federal, State and local regulations will be followed and necessary permits obtained prior to stocking, etc.

In Massachusetts, the regulatory authorities pertaining to aquaculture include:

- Inland Fisheries and Game and Other Natural Resources, MGL chapter 131. Regulations in [321 CMR section 4.09](#). (Division of Fisheries and Wildlife (MDFW)).
- Marine Fisheries Law, MGL chapter 130 section 57 and 69 (MDFW Division of Marine Fisheries).
- Administration of Waterways Licenses, Chapter 91 at 310 CMR 9.00 et seq..
- Massachusetts Wetlands Protection Act, MGL 131:40. (Conservation Commissions).
- Massachusetts Environmental Policy Act (MEPA), MGL chapter 30:61-62H; regulations in 301 CMR section 11.00.
- Federal and State Clean Water Acts: Surface and Ground Water Discharge Permit Program; regulation 314 CMR 3.00 (Massachusetts Department of Environmental Protection (MDEP)); and National Pollutant Discharge Elimination System (NPDES) permits (U.S. Environmental Protection Agency (USEPA)).
- Water Management Act, regulations in 310 CMR 36.17: Water Withdrawal permits (MDEP).
- 401 Water Quality Certificates (MDEP) for altering bordering vegetated wetland, land under water, isolated wetland or Outstanding Resource Water.
- Federal Clean Water Act (33 U.S.C. 1344) section 404; and section 10 of the Rivers and Harbors Act of 1899: Programmatic General Permits (Army Corps of Engineers).

Water quantity. A water supply of sufficient volume must be available either by gravity or by pumping. For linear raceways, there shall be a continuous incoming water supply to provide a minimum velocity of 0.015 m/s (0.05 ft/s) flowing at a minimum average depth of 0.6 m (2 ft). This is approximately two complete water exchanges per hour for a raceway length of 25 to 30 m (80 to 100 ft). The water volume shall be measured during periods of low flow.

Predators. Fences, screens, nets, wires, or other materials shall be provided as needed to prevent the loss of fish to predators. Traps or other devices that are potentially harmful for humans, livestock, or pets shall be placed only in secure locations not normally accessible except through special effort.

Waste treatment. Plans for treatment or use of waste that are generated or caused by the operation of fish raceways or tanks shall be developed and made a part of the design and installation of the practice. The treatments will include the construction of waste storage ponds, storage structures, treatment lagoons, settling basins, or other facilities. Waste utilization by the spreading of waste on land through irrigation or hauling is permissible if soils and land resources are available. Discharges into streams must meet state standards for the stream, based on size operation, and comply with National Pollutant Discharge Elimination System (NPDES) regulations.

Protection. A protection cover of vegetation shall be established on all exposed surfaces that have been disturbed. If soil or climatic conditions preclude the use of vegetation, other methods may be used for protection. Adequate provisions must be made to protect earth surfaces from wave erosion. Fences shall be installed as necessary. Road surfaces along raceways and the outer perimeter of tanks shall be treated as needed to provide access and reduce erosion. Dikes and levees should be crowned to provide drainage.

Additional Criteria For Facilities Containing Flowing Water For Fish Production.

Fish raceways are generally constructed as 1) linear channels where water flows in at one end

and exits at the other end or 2) as circular, rectangular, or oval tanks where water enters through nozzles or jets in a manner that creates a rotary circulation within the tank and discharge typically is through the tank center by means of a standpipe or bottom drain. The raceway dimensions shall be designed based upon the available water and planned production level.

Linear Channel Raceways

Channel raceways are generally of two types: a) concrete or concrete block construction and b) earthen channels constructed with a trapezoidal or parabolic cross section.

- a) Concrete or concrete block raceways shall be designed and constructed according to established principles and techniques outlined in the National Engineering Manual (NEM), ACI Code Masonry Handbook, or other approved guides as appropriate. Where concrete or concrete block raceways are installed, the bulkheads or checkdams must be of the same construction.
- b) Earthen channel raceways shall be constructed with a trapezoidal or parabolic cross section. Bottom widths depend on the volume of water available but shall be no less than 1.2 m (4 ft). Side slopes shall be 1:1 or flatter depending on a saturated soil slope stability analysis. Side slopes and bottoms of raceways must be smooth and uniform to minimize dead water areas.

Grade. Wherever possible, raceways shall be constructed with a minimum bottom grade of 0.15 m per 30 m (0.5 per 100 ft). The raceway outlet will control the water surface grade.

Length. The maximum length of each raceway section is determined by site topography and need for re-aeration of the water but should not exceed 30 m (100 ft). Depending on water volume and quality, raceway sections may be constructed in series by installing a bulkhead or checkdam at the lower end of each section.

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 0.15 m (0.5 ft).

Dikes and levees. The minimum top width of an earthen dike or levee shall be 1.8 m, (6 ft). Side slopes of earthen dikes and levees above the designed water surface shall be 2:1 or flatter. When the top of the dike or levee is to be used for a road, the minimum top width shall be 4.3 m (14 ft).

Bulkheads. Structural or earthen barriers called bulkheads are to be placed across raceway channels to create shorter sections, to establish and maintain the desired water levels, and to provide aeration of the water. In addition to serving as a barrier, they shall have an opening or throat section that allows complete drainage to the bottom of the raceway channel unless other drainage facilities are provided. Bulkheads may be constructed of earth, concrete, concrete block, rock masonry, steel or other durable metal, treated timber, or combinations of these. Earthen bulkheads are to have a minimum top width of 1.2 m (4 ft) and side slopes of 2:1 or flatter. Structural bulkheads used in earthen raceways must extend at least 61.0 cm (24 in) into the sides and bottom of the channel. Concrete bulkheads shall have a minimum top width of 15 cm (6 in) and a minimum bottom width of 20 cm (8 in). Openings and cores in concrete blocks shall be filled with either concrete or mortar mix. The opening or throat section of bulkheads may be constructed of concrete, concrete block, wood, or metal. It shall have slots or grooves along the vertical face that allow flashboards and screens to be installed.

Drains. A pipe drain with minimum diameter of 15 cm (6 in) shall be provided at the bottom of the bulkhead unless flashboards used to establish the desired water level can be removed to provide complete drainage. Where possible, each unit in a series should be constructed so that it can be drained independently of the other units.

Screens. Screens shall be provided at the inlet of the system if necessary to exclude wild fish. Screens shall also be placed at each bulkhead between sections and at the exit end to prevent loss of fish. They shall be placed at least 15 to 20 cm (6 to 8 in) upstream from the flashboards and shall extend at least 15 to 20 cm (6 to 8 in)

above the expected water level to prevent fish from escaping by jumping.

Aeration. Each bulkhead shall be fitted with a weir overfall. Flashboards in the opening or throat section of the bulkhead may be used for this purpose. The width of the weir or weirs should be equal to the bottom width of the raceway but shall not be less than 1.2 m (4 ft) where flashboards are used to establish the desired water level. Two or more weirs separated by rigid center sections shall be installed when the width of the raceway exceeds 2.4 (8 ft). To increase aeration, a splash board or series of boards arranged to create successive splashes shall be considered in design. The minimum distance from the weir crest to the water level below should be no less than 0.31 m (1 ft).

Tank Raceways

Tank raceways are circular, rectangular, or oval and are constructed of concrete, metal, fiberglass, or other suitable material. Fiberglass and a variety of similar materials commonly referred to as “plastic” tanks are generally suitable if construction and support are sufficient to provide strength and durability. Noncircular tanks must have an interior dividing wall to obtain proper circulation. Tank raceways shall be constructed at locations accessible to water supplies, management personnel, and feed and harvest equipment.

Water supply. Water inlets to the tank may be through jets or nozzles or similar devices that provide a tangential force to the water in the tank. These nozzles should be located above the water surface to provide aeration. They may be submerged but should not be near the bottom because of the problem of uplift of waste particles. The nozzles shall be positioned so that flow in the tank is counterclockwise to take advantage of the natural tendency for water in North America to rotate in this direction.

Waste removal. Provisions for waste removal shall be incorporated in the design. Bottom troughs, screens, or center-positioned drain pipe shall be provided as part of the tank construction.

Additional Criteria For Manipulating The Chemical, Physical, And Biological Factors To Enhance Fish Production and Water Quality.

The plan and specifications shall include the minimum biological requirements of each aquaculture species that is to be grown under these types of culture systems. The limits of essential water quality parameters shall be defined for each cultured species.

Water must be free of harmful gases, minerals, silt, pesticides, and other pollutants. A water analysis shall be made before design and construction unless previous use or experience indicates the quality is satisfactory. Water quality requirements for trout and catfish are shown in table 1.

Table 1. - Water quality requirements

Quality parameter		Species	
		Trout	Catfish
Dissolved oxygen	Desirable	8 ppm or >	5 ppm or >
Temperature	Minimum	5 ppm	3 ppm
	Desirable	12.8 - 17.8 °C (55 - 64 °F) 7.2/21.1 °C (45/70 °F)	23.9 - 28.9 °C (75 - 84 °F) 15.5/32.2 °C (60/90 °F)
pH	Desirable	6.5 - 9.0 6.0/9.5	6.5 - 9.0 6.0/9.5
	Minimum/ maximum		
Carbon dioxide	Desirable	2 ppm or <	5 ppm or <
	Minimum*/ maximum	0/3 ppm	0/10 ppm

*Toxicity varies with dissolved oxygen concentration and temperature

CONSIDERATIONS

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

Effects on downstream flows and aquifers that would affect other water uses.

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

Effects on the visual quality of downstream water resource.

Short-term and construction-related effects on the quality of the onsite and downstream water.

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

Effects on wetlands and water-related wildlife habitats.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing raceways and tanks and their appurtenances shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

A plan shall be prepared that provides for inspection, operation, and maintenance of vegetation, pipes, valves, raceways, tanks, dikes, levees, bulkheads, and other parts of the system.

REFERENCES

Massachusetts Aquaculture White Paper, September 1995. Massachusetts Department of Food and Agriculture.

Summary of Aquaculture Regulations, January 1995. Massachusetts Division of Fisheries and Wildlife.