2.7 C Culverts

1. General

Culverts are intended to safely pass flow under road crossings. Criteria are designed to protect, maintain, and enhance public health, safety, and the environment. Where culverts convey streams, additional standards are established to minimize impairment of stream functions and fish passage.

a) The minimum inside diameter of driveway and cross road culverts is 18 inches on MOA and State streets except that within the MOA ROW, smaller diameter culverts may be allowed if it can be demonstrated that glaciation will not be a problem, the pipe will handle peak flows, pipe cover is adequate, and ditch depths are sufficient. Actual culvert sizing shall be based on peak flows from recurrent events specified in Table 2-1 and glaciation potential.

b) The minimum cover over a culvert is 12 inches. Culvert cover depth shall be based on an evaluation of traffic loads, culvert gauge thickness, material used for culvert fabrication, and glaciation potential. The crossing design must demonstrate that it can support the expected traffic loads without compromising structural integrity.

c) Culvert ends shall be designed to minimize length and entrance and exit losses that lead to erosion at both the inlet and outlet ends with headwalls or flared end sections. Headwalls or flared end sections are required on all culvert ends.

d) The minimum pipe slope is 0.5 percent. The slope shall be selected such that the velocity of the design flow causes neither siltation nor erosion

e) Culverts over 100 feet in length shall meet requirements of Section 2.7 D, which specifies location and minimum spacing of manholes.

f) Culverts in series shall be spaced at least 20 feet between each other.

g) Non-stream culverts shall be designed without submerged inlets at the design flows except that culverts 18-inches in diameter (and smaller) and less than 20 feet long may have submerged inlets at the design flow but shall include energy dissipation and erosion control measures immediately downstream of the outlet.

h) Culvert inverts shall match the drainageway or ditchline, subject to 2.7.C.1.d, above.

i) Culvert slope shall be within 25% of the slope ratio (see Glossary).

2. Stream Crossing Culverts

a) All stream crossing projects shall consult with the appropriate state agency to determine fish presence. Alaska Statute Title 41 (Fishway Act and Anadromous Fish Act) requires maintenance of fish passage. If the stream reach is determined to harbor fish, refer to fish passage criteria in Section 2.7.K.

b) Stream crossing culverts shall use erosion control measures, such as terracing, vegetation, headwalls, and grading to adjacent vegetated areas to reduce erosion into the stream from surrounding fill.

c) Stream culverts shall be designed without submerged inlets at the design flow except in tidally influenced areas. Stream crossing culverts shall have a headwater depth to culvert height ratio of less than one.

d) Stream crossing culverts on 3rd order or higher streams shall be at least the diameter of the bankfull width of the channel (see Glossary).

e) Stream crossing culverts on 1st and 2nd order streams shall be designed to reduce glaciation potential. This can be achieved by maximizing cover and low flow stream depth, as described in the *Drainage Design*

Guidelines, but must satisfy fish passage requirements (Section 2.7K) if fish are determined to be present per Section 2.7.C.2.a.

f) A single culvert for a stream is required. Under special circumstances, other design considerations, such as multiple stream channel culverts, can be considered but in these circumstances a bridge is the preferred option.

g) Floodplain culverts, also known as relief culverts, shall be used as an alternative to obtain required design flow capacity while maintaining creek dimensions and reducing glaciation potential.

h) Stream culverts shall be designed to be aligned as closely as possible with the natural alignment of the stream channel in order to minimize backwater effects from flood events and potential blockages.

i) Peak flows used to size stream crossing culverts shall consider fully developed tributary area conditions, as discussed in Section 2.2.D.

j) The potential for erosion at culvert outlets shall be evaluated and appropriate treatment provided in the design. Such treatment measures shall not impede fish passage or trap debris during flood events.

2.7 D Manholes

1. A manhole shall be installed at major junctions, places where there are changes in vertical or horizontal alignment, and at locations where there are changes in pipe size or shape.

2. Maximum manhole spacing is 300 feet because of MOA Maintenance and Operations Department pipe cleaning equipment limitations.

3. Manholes within street ROWs are to be located in accordance with M.A.S.S. standard locations for new utilities. Manholes within storm drain easements are to be centered in the easement. Whenever possible, locate manholes outside of wheel paths. Depress manhole lids per M.A.S.S.

4. The minimum invert elevation difference across a manhole is 0.05 feet.

5. The absolute minimum inside manhole diameter is 4 feet. The designer shall refer to manhole standard details in the M.A.S.S. to determine minimum manhole size.

6. A minimum 18-inch trap shall be provided on all manholes.

2.7 E Subdrains

1. Subsurface flow volumes are estimated by using the water table elevation, the depth from the water table elevation to the subdrain invert, and the hydraulic conductivity of the soil.

2. The need for subdrains to collect and transport subsurface waters is determined by the engineer. Storm drain pipes may be perforated to collect subsurface drainage as a secondary function.

3. The diameter of subdrain pipe will be determined using Manning's equation and Table 2-5 or other generally accepted engineering practice.

4. Subdrains are to be constructed of perforated pipe surrounded by filter material. Filter fabric (geotextile) shall be placed around the filter material; however, wrapping filter fabric directly around the pipe is not acceptable.

5. Subdrains and basement sump pumps shall discharge into the storm drain or subdrain by buried pipe. Discharge over land into the ROW is prohibited because of glaciation concerns.

6. An upstream subdrain pipe terminus shall be a standard cleanout or manhole.

2. Insulation is required for pipe diameters less than 30 inches if the depth of cover is less than 4 feet.

3. When necessary, roadway culverts shall include provisions for thaw wire or heat trace. The use of steam thawing techniques requires the written approval of the MOA Maintenance and Operations Department.

4. Oversizing of the outlet pipe may be used as a means of freeze protection if information demonstrating its effectiveness is provided.

2.7 K Fish Passage Criteria

1. General

Determination of fish presence is required for all stream crossings. The designer shall refer to MOA Stream Reach Maps to determine if a waterway is listed as a stream, and contact the appropriate state agency determine whether fish are present. In addition, culvert design shall conform to the regulatory requirements of Alaska Statutes Title 41 Fishway Act and Anadromous Fish Act.

Within the Municipality of Anchorage, there are two main methods of designing for fish passage: the stream simulation method and the hydraulic method.

In general, the stream simulation method shall be the primary method applied to stream crossing culverts where fish passage is required except as noted in this Section.

a) All culverts less than 100 feet long in streams with less than 6% slope shall be designed using stream simulation method criteria. Stream simulation will be the preferred design alternative in streams up to 6% slope.

b) In cases where stream simulation is desired for lengths greater than 100 feet, the design must meet state requirements for a fish passage permit under Alaska Statutes Title 41. Site-specific evaluation is necessary because over 100 feet, the effects of culvert length on streambed stability and configuration are not yet sufficiently understood.

c) Stream channel slopes greater than 6% shall require additional stability analyses for stream simulation to be authorized. Culvert design methods such as hydraulic, zero-slope, or other design options shall be authorized when site-specific conditions preclude use of the stream simulation design.

2. Stream Simulation Method

Stream simulation methods of culvert design at road crossings emulate the natural functions and physical conditions within the stream channel of a stream, facilitating sediment transport, fish passage and reducing glaciation issues in some cases. The intent is to mimic the local stream features so that the crossing represents no more of a fish and debris passage challenge than the natural channel itself, while satisfying other road crossing design criteria. Information on this methodology is available at Alaska Department of Fish and Game Sport Fish Division (http://www.sf.adfg.state.ak.us/SARR/fishpassage/fishpass.cfm) and at the USDA Forest Service (http://www.stream.fs.fed.us/fishxing/).

All stream simulation designs and methodologies must comply with the following criteria.

a) Culvert slope shall approximate the stream slope through the reach in which it is being installed or appropriate reference reach (see Glossary). The slope ratio (see Glossary) shall not vary more than 25% to minimize adverse effects on channel conditions.

b) Stream crossing culverts on 3rd order or higher streams shall be at least as wide as the product of 1.2 times the bankfull channel width plus 2 feet, but may be subject to limitations due to cover requirements.

c) Stream crossing culverts on 1st and 2nd order streams shall be at least as wide as the bankfull channel width, rounded to the nearest foot.

d) Culverts shall be embedded over the entire length with streambed material of sufficient depth to withstand maximum scouring at the design flow or shall be embedded at least 40% of the culvert diameter for round culverts and 20% of the maximum height in pipe arch culverts.

e) Substrate material will be designed for at least two flow conditions:

   i. Streambed material shall be sized to be dynamically stable to at least the 50-year event and mimic the natural streambed material within this stability requirement.

   ii. Streambed material shall maintain the natural low flow and depth of the reach as surface flow unless the reach is documented to naturally go dry during low flow periods under normal hydrologic and climatic fluctuations.

f) The cross-section shall simulate an appropriate reference stream channel cross-section and shall be designed to be dynamically stable at the design flow. Channel sides can be continuous or rockbands utilized as necessary to maintain channel shape. Continuous channel sides are required to reduce glaciation potential. In other cases, rockbands can be utilized, providing they are spaced the lesser of either five times the width of channel or such that the maximum vertical difference between crests is less than 0.8 feet.

3. Hydraulic Method

The hydraulic method uses the swimming capability and migration timing of target design species and sizes of fish to create favorable hydraulic conditions throughout the culvert crossing. Information on this methodology is available at Alaska Fish and Game Sport Fish Division (http://www.sf.adfg.state.ak.us/SARR/fishpassage/fishpass.cfm), the Federal Highway Administration (http://www.fhwa.dot.gov), and the USDA Forest Service Stream Systems Technology Center (http://www.stream.fs.fed.us/fishxing/).

a) The design fish shall be a 55 mm (2.16 in) juvenile coho salmon for anadromous streams and a 55 mm (2.16 in) Dolly Varden char for nonanadromous streams. These criteria may change based on ongoing research by federal and state agencies.

b) Fish passage high flow design discharge will not exceed the 5% annual exceedance flow or 0.4 times the 2-year peak flow, whichever is lower and has the most supporting hydrologic data.

c) Fish passage low flow design discharge shall ensure a minimum 6-inch water depth or natural low flow and depth within the reach the crossing occurs. In cases where local conditions preclude natural low flow characteristics, backwatering or in-culvert structures shall be considered.

d) In cases where flared end sections with aprons are necessary and fish passage is required, water depths and velocities that satisfy fish passage criteria must be demonstrated across the apron in addition to within the culvert.

e) Fish passage criteria for all culvert design options must be satisfied 90 percent of the time during the migration season for the design species and age class pursuant to Alaska Statute 41.14.840. Tidally-influenced streams may sometimes be impassable due to insufficient depth at low flow and low tide. If the tidal area immediately downstream of a culvert is impassable for fish at low tide, the 5-percent exceedance criterion shall apply only to the time during which fish can swim to the culvert. Tidally-influenced fish passage structures shall satisfy Alaska Statute 41.14.840 for an average of at least

90% of the tidal cycles, excluding periods when the stream channel is not accessible to fish because of natural conditions at low tide.

2.7 L Maintenance Considerations

In the preparation of plans for construction of drainage facilities, engineers shall include life cycle maintenance and operation costs of these facilities as a primary design consideration. The following considerations shall be made in the design process:

1. All access ways shall be designated on the plans and cleared, graded, and constructed with the facility construction.

2. Major facility designs such as sedimentation basins and oil and grit separators shall consider access by maintenance vehicles and be approved by the MOA Maintenance and Operations Department. At least one all-weather access roadway capable of supporting a 70,000 pound load shall be provided.

3. The length of the access way shall be minimized.

4. Specific access easements or agreements that preclude planting of shrubs, construction of fences, and other structures within the access area shall be obtained. Standard drainage easements are not acceptable for access (unless they are modified to specifically allow it).

5. The sloping of access ways around facilities shall have a maximum cross slope of 5 percent and be designed in a manner to accommodate maintenance vehicles.

6. Drainage facilities shall be designed in order to minimize potential tampering impacts.

END OF SECTION 2.7

SECTION 2.8 DRAINAGE CRITERIA FOR STREETS

2.8 A Curbs and Gutters

In urban areas, curbs and gutters are usually required to pick up drainage from streets and adjacent properties. The longitudinal grade shall match the edge of the street grade. An exception is on street grades of less than 1 percent where the gutter may be depressed to direct drainage into a catch basin. Curb and gutter design guidelines and types are discussed in Chapter 1.

2.8 B Ditches

In rural areas, roadside ditches usually pick up drainage from streets and adjacent properties. Standards for ditches are provided in Section 2.9.

2.8 C Storm Drain Inlets

1. Inlet spacing shall be designed so that no more than 20 to 25 percent of the gutter flow reaching each inlet will pass on to the next inlet downstream and in accordance with Section 2.8.E. The spacing of inlets along curbs and gutters shall be supported by engineering calculations or a tabulation of inlet capacity compared to design flow and shall not exceed 1,100 feet.

2. Inlet spacing evaluation shall also include:

   a) The flow velocity on street grades over 5 percent; and

   b) Evaluation of the effects of 50 percent of the inlet opening being obstructed (such as by trash, debris, and leaves).

3. At intersections where storm drains are available, catch basins shall be used instead of valley gutters. In unpaved areas, the placement of an asphalt or concrete pad that slopes toward the inlet is required. The asphalt pad shall extend at least 2.5 feet from the outside edge of the inlet to the outside of the pad.

SECTION 2.14 EROSION AND SEDIMENT CONTROL

2.14 A Objectives

Road construction, land development, and re-development projects can substantially accelerate erosion and sedimentation resulting in adverse impacts on adjacent lands and waterways. Because of this, erosion and sediment control measures shall be provided both during and after construction on all work discussed in this manual. The *Stormwater Treatment Plan Review Guidance Manual* establishes standards to minimize the impact on land and water resources, and is available from PM&E.

END OF SECTION 2.14

SECTION 2.15 STREAM RESTORATION

Streams function as fish and wildlife habitat, flood attenuating drainageways, and natural greenbelts in developed areas. Construction in streams must consider these factors. This section provides additional design criteria for this work.

2.15 A Hydrology

1. Floodplain design discharges shall be selected in accordance with FEMA regulations, or the maximum recorded flood flow, whichever is greater.

2. The restored main channel design discharge shall be the 2-year recurrence interval flood, unless otherwise approved by the Municipal Engineer.

3. The shape of the restored main channel shall be consistent with the shape of undisturbed channel reaches immediately upstream and downstream of the constructed channel.

4. Average summer flows shall be identified for use in the evaluation of fish habitat.

5. The channel improvements shall not extend the 100-year floodplain limits.

2.15 B Stream Channel Alignment

1. Selection of the stream alignment shall incorporate the following considerations:

   a) Match the original alignment of the creek when possible.

   b) Match the original length when the original alignment is known but the restored channel is unable to follow it. The alignment of the stream channel shall be such that the length of the restored channel is approximately equal to the original length of the natural stream channel.

c) Match a natural gradient when the original alignment is unknown. Compute the length of channel using the slope of undisturbed reaches immediately upstream and downstream of the project site, and the elevation drop through the site.

d) Select an alignment and a gradient that alleviates defined problems such as glaciation, flooding, and enhances wildlife habitat.

2. The longitudinal profile of the restored stream bed shall be similar to the existing profiles upstream and downstream of the reach being designed.

3. Sharp bends shall be removed from the alignment whenever possible.

4. The alignment of a restored and/or reconstructed floodplain may be relatively straight but the restored main channel shall meander within the floodplain.

5. Locate the restored stream channel adjacent to undisturbed vegetated areas whenever possible. Construction equipment may be confined to the excavated channel or previously disturbed areas to avoid disturbing naturally vegetated areas.

2.15 C Erosion Control and Bank Protection

1. Erosion control and bank protection shall be provided whenever work is performed in or adjacent to a creek.

2. The design of stream alignment or grade change improvements shall include a hydraulic and hydrologic analysis to determine the need for erosion control and/or bank protection.

3. Where stream bank stability is critical, riprap in conjunction with bioengineered vegetative erosion control above the Ordinary High Water line is the recommended method for stream channel protection. In areas where bank stability is not critical, bioengineering methods such as fascines, coir logs, brush layering, and other methods incorporating vegetative materials shall be considered. The use of riprap without the incorporation of vegetative materials is discouraged.

4. The recommended floodplain protection method is the planting of grass and natural woody vegetation.

5. Access to the creek by MOA maintenance personnel shall also be considered.

2.15 D Stream Channels

The design of restored stream channels shall consider the undisturbed, pre-development conditions of the stream. In-stream structures that are constructed solely for the creation of habitat shall be designed so that changes in local stream hydraulics do not cause bed scour, bank erosion, or deposition in the vicinity of the habitat feature as the stream adjusts its configuration. Habitat features designed for use in areas with bed or bank protection shall be designed with caution since the desired natural readjustment in the cross-section may be inhibited by the presence of the protection structures. Stream channels shall be designed using the following guidelines.

1. Identify a reference reach or most likely pre-development condition of the stream channel. Identification is subject to approval by the Municipal Engineer.

2. Design channel to mimic the stream geomorphology of the approved reference reach or undisturbed, pre-development condition.

2.15 E Riparian Habitat Enhancement and Floodplain Construction

1. The purpose of providing riparian habitat enhancement and a floodplain along a restored reach of stream is to create habitat diversity for fish and wildlife, and provide natural flooding characteristics in the stream

valley. Riparian vegetation provides shade, cover, and insect food sources for fish, and food, resting, and nesting sources for wildlife.

2. A floodplain bench shall be constructed at an elevation corresponding to the level of the two-year recurrence interval flood. The bench shall be revegetated as described in Section 2.15.F to provide the desired riparian habitat.

3. Restored and/or reconstructed floodplain side slopes above the two-year recurrence interval flood level shall be no steeper than two horizontal to one vertical (2:1) and shall be roughened prior to revegetation as described in Section 2.11.F.

4. Restored and/or reconstructed floodplains shall be designed to accommodate, at a minimum, the 100-year recurrence interval flood. Intermediate floodplain benches that are designed to accommodate the 25-year flood may be incorporated as appropriate.

2.15 F Revegetation

1. The purpose of revegetation in stream restoration projects is to provide a filter for surface flow to the creek, provide stream bank stability, and to provide fish and wildlife habitat. Revegetation in the riparian zone (frequently flooded zone adjacent to the stream channel) and inactive floodplain (infrequently flooded zone adjacent to the riparian zone) shall be accomplished in a way that:

   a) Reduces erosion and stabilizes stream banks and side slopes;

   b) Provides protective cover for fish;

   c) Traps sediment and other pollutants;

   d) Provides nutrients to streams;

   e) Supports growth of aquatic insects that are eaten by fish;

   f) Aids in water recharge of streams during low flow periods;

   g) Provides wildlife habitat; and

   h) Supports recreation such as fishing, bird watching, nature study, and photography.

2. Revegetation plans shall be developed concurrently with design.

3. Side slopes shall be contoured to slopes no steeper than two horizontal to one vertical (2:1). Benches included on the side slopes shall:

   a) Intercept surface flow on side slopes;

   b) Provide a stable surface for revegetation; and

   c) Distribute flow over a wider area to reduce scour potential.

4. Side slopes and benches shall be roughened prior to revegetation to create small pockets, which provide a more favorable growing environment for plants.

5. Ground cover and/or seedlings shall be planted on side slopes to reduce erosion. No seedlings shall be planted below the elevation of the two-year recurrence interval flood in the channel.

6. Large, woody plants shall be planted on benches to establish a root mass that will stabilize the stream bank (see Chapters 2 and 3 for plant selection details).

7. Maintenance includes frequently checking the revegetated side slopes and benches until the vegetation becomes established and to identify and stop any localized erosion that may develop. Fertilizer may be used provided water quality impacts are addressed.

END OF SECTION 2.15