APPENDIX G

DRAINAGE CRITERIA

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I. POLICY

A. GENERAL - This Appendix to the Manual is intended to set forth uniform procedures and criteria for storm runoff determination and facility design. For floodplain regulations, see the Land Use Regulations. For federal requirements concerning channels or wetlands, contact the local office of the Army Corps of Engineers.

B. HYDROLOGY - The minimum criteria for sizing of drainage facilities in Teller County shall be:

1. The 100 year storm for all facilities which will carry 500 cubic feet per second or more as calculated on the 100 year storm, and the 5 year storm for all other facilities.

2. The 6-hour frequency storm or the 24-hour frequency storm shall be used depending on which one yields the greater runoff. The greater runoff shall be used.

3. The Rational Method shall be used for drainage areas of 20 acres or less and the Soil Conservation Service Method, current issue, shall be used for areas between 20 acres and 25 square miles. For drainage areas in excess of 25 square miles, the Soil Conservation National Handbook, Section 4, "Hydrology" shall be used. These flows shall be considered before and after the anticipated development and shall be used in determining the provision that must be made to adequately control peak flow.

C. STREET FLOWS - The primary use of streets is for the movement of traffic. However, streets shall have limited use as a waterway for storm runoff with flow capacities in quantities as approved by the County Engineer.

D. Drainage Facilities - Detention basins or other devices shall be used to maintain historical runoff amounts and rates. Maintenance of these facilities must be addressed by the developer and approved by the County to avoid public nuisances and health hazards. Care must be taken to design and construct all such facilities in accordance with applicable federal, state, and local regulations. Where these detention facilities are not possible, or if flows from development adjacent to the highway drainage system and/or in areas contributing to flows into the highway drainage system are to such extent that damage thereto or to downstream areas and/or facilities; the design engineer and/or methods to control such flows not to exceed historical runoff amounts or to such flow amounts as the County deems acceptable. Outside designated growth areas, drainage facilities shall have "soft" sides and bottoms, unless otherwise approved by the County Engineer. (Soft indicates use of materials such as earth, timber, rip-rap, and vegetation rather that "hard" material such as concrete.)

II. PROCEDURES

A. RATIONAL METHODS - The rational method must be used to analyze peak flows from drainage basins containing 20 acres or less. Detailed criteria to be used in the computations for runoff in these small basins shall be per Soil Conservation Service Methodology for small drainage areas.

B. SOIL CONSERVATION SERVICE METHODOLOGY - The procedures used shall be those discussed in the Soil Conservation Service publication, "Procedures for determining Peak Flows in Colorado", which incorporates and supplements, "Technical Release No. 55 (current issue)." All drainage reports shall include a determination of the soil types, as outlined by the PPACG study, "Environmental Resource Study-Soil Resource Analysis (current edition)."

III CULVERT AND CHANNEL DESIGN

C. CULVERTS - A culvert may be defined as a covered channel of comparatively short length installed to drain water through roadway embankments. The general criteria for design shall be:

1. The culvert shall be properly designed to take care of the water at all flows.

2. Inlets shall be designed to entrance and friction losses.

3. Outlets shall be designed to avoid sedimentation and erosion of the downstream channel. Outlet control devices may be required where excessively high discharge velocities occur.

4. The minimum size culvert shall be 15 inches in diameter or the hydraulic equivalent. The use of culverts less than 15" in diameter for driveways has to have the approval of the County Engineer or if within Teller County ROW, the Road & Bridge Director or authorized representative.

5. All culverts shall be designed for H-20 loading with the appropriate embankment considerations.

6. Culverts for Q5 value will be designed for flowing full with no head and culverts for Q100 value will be designed for full headwater conditions.

7. High density polyethylene pipe (HDPE) may be used in place of corrugated metal pipe (CMP). HDPE pipe shall be limited to non-pressure corrugated exterior, smooth interior pipe in sizes 12-inch through 36-inch diameter. HDPE pipe shall meet •AASHTO M294 - Type S - corrugated polyethylene pipe 12" to 36" diameter •AASHTO Section 18 - Soil thermoplastic pipe interaction systems •ASTM F667 - Large diameter corrugated polyethylene tubing and fittings.

8. If an adjacent roadside ditch is to be crossed, it shall be provided with a corrugated metal pipe (CMP) or plastic (HDPE) pipe with a minimum diameter of fifteen(15) inches, and a minimum length of twenty (20) feet to be installed no later than at time of commencement of site work on lot; culverts must have suitable head walls or rip rapped inlet and outlet ends which are not to exceed the elevation of the road grade; and installation of above are subject to county approval.

9. The hydraulic design of any culvert may be affected by its cross-sectional area, shape, entrance geometry, length, slope, construction material, and the depth of ponding at the inlet (headwater) either inlet or outlet control. Inlet control means that the discharge capacity of a culvert is controlled at the culvert entrance by the depth of headwater and the entrance geometry, including the barrel shape and cross-sectional area, and the type of inlet edge. In inlet control the roughness and length of the culvert barrel and outlet conditions, including depth of tailwater, are not factors in determining culvert capacity. Outlet control means that the discharge capacity of a culvert is controlled at the culvert exit. This usually results from a downstream flow constriction causing the tailwater to back up into the barrel, thus reducing the flow.

IV PROCEDURE FOR SELECTION OF CULVERT SIZE

Procedures to be used in selecting culvert sizes of varying configuration and materials, either with inlet control or outlet control, and the installation of culverts will be per manufacturers specifications.

V. CHANNEL DESIGN

A. The ideal channel is the stable natural channel evolving over many years. Modifications to such channels should be held to a minimum. If a channel improvement is necessary, follow the natural water course if possible. Man-made channels, including roadway ditches, improperly designed, can be a source of excessive maintenance. Good channel design consists of the proper selection of:
   1. Capacity, including freeboard.
   2. Alignment
   3. Erosion resistance
   4. Esthetics

VI. CHANNEL HYDRAULICS

There are two types of open channel flow, subcritical or supercritical. Natural channels are usually subcritical and man-made channels are usually supercritical due to smooth linings and steeper slopes. To determine if the slow is supercritical or subcritical the Froude number must be calculated. The Froude number is:

$$F = \frac{V}{(gA/T)^{1/2}}$$

Where:

V = Velocity determined from Manning's equation.
A = Cross-sectional area of water in sq. ft.
g = Acceleration due to gravity 32 ft./sec.^{2}
T = Width of water surface in feet.

If F > 1 the flow is supercritical, if F < 1 the flow is subcritical. This analysis is used in determining the freeboard.

Freeboard is the distance above the anticipated water surface to the top of the ditch or dike.

Subcritical Flow

(Minor Channels < 500 cfs)

Freeboard (in ft.) = 1.0' min. or 25% of depth, which ever is greater

Supercritical Flow

(Major Channels 500 cbs)

Freeboard (in ft.) = 2.0' + 0.025 V (d)$^{1/3}$

V = Velocity determined by Manning's equation.
d = A/T = Depth of flow in feet.

The stability of an unlined channel is of primary importance. See Table DC3-1 for maximum allowable velocities to insure the stability. Energy dissipators may be used to ensure the allowable velocities. When erosive forces of moving water are too great for an unlined earth channel and energy dissipators are not desirable, a protective lining such as rip-rap will be required.

TABLE DC3-1
ENTRANCE LOSS COEFFICIENTS

Coefficient k_e to apply to velocity head $V^2/2g$ for determination of head loss at entrance to a structure, such as a culvert or conduit, operating full or partly full with control at the outlet.

Entrance head loss $H_e = k_e$

Type of structure and design of entrance	Coefficient k_e
Pipe, concrete	
Projecting from fill, socket end (groove end)	0.2
Projecting from fill, sq. out end	0.5

Headwall or headwall and wingwalls
- Socket end of pipe (groove end) 0.2
- Square edge 0.5
- Rounded (radius = 1/12D) 0.2

Mitered to conform to fill slope 0.7
End section conforming to fill slope 0.5

Pipe, or arch pipe, Corrugated metal

Projecting from fill (no headwall) 0.9
Headwall or headwall and wings, square edge 0.5
Mitered to conform to fill slope 0.7
End section conforming to fill slope..... 0.5

Box, reinforced concrete

Headwall parallel to embankment (no wingwall).....
- Square edge on three edges 0.5
- Rounded on three edges to radius of 1/12 barrel dimension 0.2

Wingwalls at 30° to 75° to barrel
- Square edge at crown 0.4
- Crown edge rounded to radius of 1/12 barrel dimension 0.2

Wingwalls at 10° to 25° to barrel
- Square edge at crown 0.5

Wingwalls parallel (extension of sides)
- Square edge at crown 0.7

VII. LANDSCAPING AND EROSION CONTROL

A. GENERAL

Effective erosion control, revegetation, and reclamation is of great importance to Teller County's environment. Appropriate steps must be taken for landscape development and erosion control of roadside areas. Cut and fill slopes should be flat as practical. Rounding of slope intercepts will enhance overall appearance.

B. SLOPE

All slopes should be warped and rounded and provided with effective ground cover, except for rock cuts. Drainage swales and roadside ditches should be seeded, sodded, blanketed, or rip-rap grouted to minimize erosion. Consideration should be given to type of maintenance required and to make roadside improvements such that it will allow the operation of power mowing equipment.

C. PLANTS

Plants may be planted in the rights-of-way on written approval by the County. However plants not properly maintained thus creating traffic hazards may be trimmed or removed by the County.

D. TOP SOIL

If the natural soil is not a good medium and it is necessary to place top soils, such top soil may have to be supplied. If the area of construction has salvable fertile soils, such soil shall be salvaged and placed on the roadway side slopes to such depth as may be reasonable. If vegetation is more sparse than growth in the development area, then the roadway side slope will be seeded to achieve like or better growth as is native to the area.

E. SILT FENCE

Silt fence shall be used to protect all streams, rivers, lakes and other water resources from contamination by silt, sediment, and construction debris.

F. TEMPORARY CONSTRUCTION

Erosion control blankets and/or bales and/or silt fence shall be required during any construction to minimize impact to any existing pubic or private roadway or property.