DESIGN BULLETIN #16/2003 (Revised July 2007)

Drainage Guidelines for Highways Under Provincial Jurisdiction in Urban Areas.

July 2007 Update to Design Bulletin #16/2003:
Added under Design Criteria – "Culverts of 600mm diameter are commonly used to drain medians on divided highways."

Summary

On behalf of the department, a report was recently finalized (July 2003) which addresses a number of issues related to stormwater management for highways within urban areas. The department recognizes that stormwater management and drainage guidelines vary amongst the various Alberta municipalities and this has the potential to create a non-standard highway system throughout the province. Representatives from municipal, provincial and federal governments, as well as the private development industry were consulted as part of this study. A number of recommendations were offered for the department to consider which would affect design criteria and policies related to highway drainage in urban areas.

This Design Bulletin identifies relevant design criteria and considerations for highway drainage and stormwater management in urban areas that have now been approved by the department for immediate implementation. Both discharge rate control and water quality improvement aspects are addressed, as well as related policy matters for review of proposed drainage works by others which affect the department's highway system.

Scope

The scope of this document includes stormwater management practices for roadways under Provincial jurisdiction in urban environments in Alberta. Urban environment refers to the location within an urban municipality (city, town or village) and it may include a highly developed area within a rural municipality. This should not be confused with the presence of an urban (curb and gutter) cross section. Alberta Infrastructure and Transportation generally prefers to use a rural design cross section with open ditches for highways in both rural and urban environments where this is feasible.

The guidelines contained herein are intended for the use of the department or its consultants in undertaking design of highway drainage systems or reviewing proposed drainage works by others which may affect a particular section of highway. It is intended to provide guidance for the department where drainage works outside the highway right-of-way by urban municipalities or private landowners may affect the highway drainage system.

Design Criteria

Generally highway drainage systems, including detention storage facilities and outfalls, shall be designed in accordance with Alberta Environment's guidelines (January, 1999) or the local municipal guidelines, whichever governs. The highway drainage system is to accommodate the runoff from a 1:100 year event

storm with minimal to no interruption in vehicle access. Flow depths and ponding of water are not to create a public hazard or cause erosion/flooding damages to private or public property.

A major-minor drainage system approach is generally used in which the minor system comprises the underground storm sewer system (catchbasins, manholes, storm sewers, underground storage) and the major drainage system comprises the surface drainage system (ditches, swales, curb-gutters, detention storage). The department encourages the use of rural (ditch) drainage wherever possible, wherein a minor system is not used. Urban (curb/gutter) drainage systems are discouraged as much as possible, but when they are used then the minor system associated with this type of system shall be designed to accommodate the runoff from a 1:5 year event storm with no surcharging.

Where curb-gutter drainage systems are used, flow or ponding depths are to be limited to the following:

- Posted traffic speeds > 80 km/hr - The 1:5 year event water resulting from ponding at low areas or the normal flow along the curb/gutter is not to encroach into the highway through lanes. For the 1:100 year event, the water shall not flow across the high point of the road cross-section and at least one lane of traffic shall remain open in each direction: or 2 lanes for 8-10 lane facilities.

- Posted traffic speeds ≤ 80 km/hr - The depth of water on the road surface shall not exceed 0.15m for the 1:5 year event with at least 1 lane of traffic free of inundation in each direction. At least 2 lanes shall be free of inundation for a 6-8 lane facility and 3 lanes free for a 10 lane facility. For the 1:100 year event, ponding/flow depths at the gutter should not exceed 0.3m and at least one lane of traffic shall remain open in each direction: or 2 lanes for 8-10 lane facilities.

- The 1:100 year event depth of water ponding on the roadway shall not exceed 0.5m

Where the minor system is oversized above the 1:5 year event to meet that the above ponding/flow depth limitations, surcharging be allowed provided the hydraulic gradeline (HGL) does not rise to ground surface. Underground storage or nearby surface storage should be considered as an alternative where economically feasible.

The highway drainage systems should be designed based on rainfall-runoff analysis in accordance with Alberta Environment's guidelines or the local municipal guidelines. Either a synthetic design storm or historic storm shall be used in accordance with the local municipal guidelines. As a minimum and where the local guidelines do not specify otherwise, a 1:100 year event design storm of the Chicago distribution shall be used with a storm duration of 4 hours for conveyance systems and 24 hours for detention storage facilities. A time interval of five (5) minutes shall be used with the rainfall distribution. Longer intervals, such as 15 minutes, may be used for the longer 24-hours duration storm. The ratio of time to storm peak versus storm duration, "r", shall be 0.3. Where IDF (Intensity-Duration Frequency) data or design storm parameters are not specified by the local municipal guidelines, the 1:100 year event storm shall yield a total rainfall amount of 60mm for the 4-hours duration and 110mm for the 24-hours duration.

Storm sewer systems may be designed using the Rational method in accordance with the urban municipality's design guidelines. For areas larger than that suggested by the local guidelines or for storm ponds, major drainage systems and overall watershed drainage planning, computer modeling is to be used for all hydrologic analyses.

Overland escape routes are to be provided to accommodate all runoff in excess of the 1:100 year event. If an overland escape route from a detention storage facility is not available then additional freeboard should be considered.

Where used, underground storm sewer material, sizes, manholes, catchbasins, etc. shall be specified in accordance with the local municipal specifications.

Highway ditches should maintain a minimum slope of 0.5% to prevent standing water and minimize velocities to avoid excessive erosion.

For highways with rural type (ditch) cross-sections, culverts should be sized while accounting for ditch storage at the inlet of culverts (i.e. hydrologic routing), using the ratio

$$\frac{HW}{D} \leq 2.5$$

where HW is headwater measured to the culvert invert and D is culvert diameter. Further, headwater should be no higher than the lowest part of the shoulder of the road. Minimum culvert sizes are 600mm for approach crossings and 800mm for centerline crossings. Culverts of 600mm diameter are commonly used to drain medians on divided highways. Roadside design factors (highway safety) are to be considered when designing ditch storage such that hazards are mitigated or located a safe distance from traffic.

Best Management Practices

Best management practices (BMPs) are to be incorporated in the highway drainage system to provide both quantity control and quality improvement objectives. Discharges to natural receiving watercourses shall be limited to pre-development rates except where otherwise specified by Alberta Environment. Discharges to a municipal storm drainage system shall be limited to the specified rate of discharge for that system. Appropriate measures are to be incorporated in the highway drainage system to provide a minimum 85% removal of sediments 75 μm and larger prior to discharges occurring to a natural drainage course (Alberta Environment, April 2001).

Alberta Environment's guidelines (January 1999) describe a number of possible BMP methods that can be implemented and further reference may be made to the guidelines for further details and design guidelines. The following BMP methods are commonly used and considered to be practical for application with highway drainage systems:

a) Detention Storage Facilities - These facilities temporarily detain the runoff from a catchment while their outlet controls the discharges to the receiving watercourse or municipal storm sewer system. They can be very effective for improving the quality of the stormwater, primarily by facilitating removal of sediments. These facilities may be designed as one or a combination of three main types:

- Dry Ponds – These detention facilities drain completely dry and are often incorporated as multi-use recreational areas. Typically, the maximum allowable

fluctuation depth for the 1:100 year event is 1.5m and the bottom slope is 1.5% to 2.0% to ensure that prolonged wet/soft areas do not develop. Dry ponds are often designed to pass low flows without inundation occurring, and for this reason they are not as effective as other types of facilities in providing sediment removal.

- Wet Ponds – These facilities incorporate a permanent pool of water all year round, usually 2.0 to 3.0m deep. All of the stormwater from a catchment passes through a wet pond, so they are effective for sediment removal. The permanent pool should not be too large so as to become stagnant. A common rule of thumb is the permanent volume should be turned over twice each year from the annual runoff. The allowable fluctuation depth above the permanent pool is 2.0, so less overall pond area is required compared to a dry pond.

- Wetlands – Storm ponds constructed as wetlands are becoming popular due to their environmental benefits and educational/recreational characteristics. A much smaller and shallower permanent pool is used (than a wet pond) which supports emergent and submergent vegetation. This vegetation is useful at removing other types of pollutants but it is sensitive to sediment loadings in the stormwater. An important design consideration is a separate sediment forebay to facilitate removal of the majority of sediments. Also, the storage fluctuation depths are typically lower than a wet pond. The area requirement for a wetland can be larger than either a wet pond or dry pond.

  Existing wetlands are often used as detention storage facilities due to their convenience and environmental significance. Changes to the wetland characteristics should be expected due to the increase in annual runoff from a developed catchment area. These changes are not necessarily good or bad; they need to be properly identified and assessed for the benefit of the regulatory authorities. The affect of sediment loading on existing habitat is also a concern, so separate cells/forebays are required to facilitate removal of the sediments.

(ii) Grassed/Vegetated Ditches – Ditches are the standard design practice by the department for its highway systems and when adequately vegetated they are economical and practical stormwater BMPs. The amount of rainfall that infiltrates into the subsoil is higher than that which would occur with curb and gutter systems. Ditches can reduce flow velocities and provide some detention of the runoff from frequent rainstorm events. The vegetation in the ditches can improve the quality of the stormwater runoff by filtering some of the sediments.

(iii) Underground Oil-Grit Separators – These are commonly associated with underground storm sewer systems and they are becoming popular for providing water quality improvement for private developments and arterial/freeway roadways in urban areas where detention storage cannot be easily incorporated. They tend to be more costly to install than utilizing a regional storm pond, but removal of sediments and scum is more easily done. Their design targets the low flows which result from frequent rainfall events while bypassing higher flows from intense (less frequent) storm events which may re-suspend material

previously retained. Underground oil-grit separators are currently available from several manufacturers.

(iv) Infiltration Conveyance and Ponding – Water is allowed to pond in conveyance ditches and detention areas to promote soil infiltration. This method may not be suitable where the subsoil material has poor permeability (i.e. clay, silt) but is practical and effective where the soil comprises a deep layer of sand or gravel. This method should not be used without the support of a geotechnical engineer.

Many urban municipalities incorporate detailed criteria and design guidelines for these facilities, particularly detention storage facilities. Reference to the local guidelines is to be made when designing these types of facilities.

Highway ditches should be maintained at least once per year to mow grass (minimum height of 75 mm), remove of debris at culvert inlets/outlets and repair erosion.

Policy Issues

The department, by agreement, may participate in sharing of drainage facilities with the local municipality or adjacent developer where the facility accommodates drainage from the highway and the location is suitable relative to topography, land availability and discharge to an existing drainage course. In these cases the urban municipality is to undertake all maintenance of the shared facility. The department will share in the capital construction and annual maintenance costs based on apportionment of the flow for conveyance systems or storage volume requirement for detention storage facilities.

The department may consider developer based proposals for drainage facilities within the highway right-of-way where there is a benefit to Alberta Infrastructure and Transportation and there is no alternative solution which is reasonably economical or practical. The developer shall be responsible for all costs, approvals and agreements, unless otherwise determined by the department. The municipal authority must be willing, by agreement, to be responsible for future operation and maintenance of the developer proposed facility.

Notwithstanding the requirement for the highway drainage system to accommodate existing upstream drainage noted previously, drainage from adjacent developments to the highway shall not be allowed unless the municipality agrees to undertake all necessary improvements to the highway drainage system and downstream drainage course as well as secure the appropriate regulatory approvals.

The department is responsible for managing the stormwater from the highway, within the municipal boundaries, to the receiving drainage course or municipal drainage system. The department may enter into an agreement with the local municipality to cover maintenance of the highway drainage system, whereby the municipality would be compensated for all associated costs excluding any premium costs imposed on the municipal drainage system on a proportional basis for handling additional flows from the highway. Where the highway drainage system is not maintained by the municipality but it outlets to the municipal drainage system, the department will enter into an agreement with the municipality to compensate for the storm drainage costs on a proportional basis. The department shall also be responsible for hazardous spills from the highway right-of-way.

Environmental Considerations

Applications for regulatory approvals are to be undertaken as follows:

(i) In the cities of Calgary and Edmonton, applications to Alberta Environment shall be submitted by the respective city. Alberta Infrastructure and Transportation's consultant will prepare the applications (on behalf of the department but for submission by the city) where the department is sponsoring the project. Submissions to DFO shall be made by the department (or its consultant) following consultation with all stakeholders including the city, Alberta Environment, fishermen's associations, etc.

(ii) In all other areas of the province (urban or rural), the department (or its consultant) shall be responsible for making submissions to Alberta Environment and DFO as required. Detailed plans showing proposed drainage facilities and associated works shall be circulated to all stakeholders for their input prior to submission to the appropriate environmental agency.

(iii) In all cases the department (or its consultant) shall take all reasonable care to ensure that outfalls located upstream of potable water supplies or intakes are suitably protected from highway stormwater and other highway spillages.

(iv) All other current environmental regulations shall also be followed.

Existing drainage patterns are to be maintained as much as possible and existing drainage from upstream lands is to be accommodated by the highway drainage system. Natural low areas shall be maintained or replaced where practically possible.

Protection/replacement of wetland habitat is encouraged. A biophysical impact assessment is to be undertaken where wetlands are impacted either directly by the highway drainage system or the addition/reduction of contributing runoff. Reasonable design measures are to be incorporated to minimize the risk of hazardous spills from entering a natural wetland or drainage course.

DFO staff are to be consulted where in-stream works or in-stream cross drainage structures are proposed so that they may determine if there is a potential impact to fish or fish habitat.

References

The following references are considered by the department to be relevant sources of design information and regulatory requirements. Other references not mentioned include the local municipal guidelines. The City of Edmonton and City of Calgary guidelines are referenced because they are excellent sources of technical information that may be used in the absence of local information.

Design Guidelines for Bridge Size Culverts; Alberta Transportation; (Original Document: December, 1995), November 2004

Design and Construction Standards, Chapter 3 – Drainage Standards; City of Edmonton; July, 1999

Environmental Protection and Enhancement Act; Statute of Alberta

Design Guidelines for Erosion and Sediment Control for Highways; Alberta Transportation; March 2003.

Fisheries Act; Statute of Canada

Municipal Policies and Procedures Manual; Alberta Environment; April, 2001

Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems; Alberta Environmental Protection; December, 1997

Stormwater Management & Design Manual; City of Calgary; December 2000

Stormwater Management Guidelines for the Province of Alberta; Alberta Environmental Protection; January, 1999

Water Act; Statute of Alberta

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