APPENDIX B – Principles and design considerations for river crossings

Within the Calgary Region, there are many crossings of river, creek and ravine systems by transportation infrastructure, including freight railways, major *roadway* corridors, *Light Rail Transit* lines and pedestrian bridges. This infrastructure provides essential mobility and connectivity between communities and external destinations, and it supports economic development by ensuring the efficient movement of people and goods at a city-wide and regional level.

All transportation crossings of rivers and creeks require the construction of culverts, piers and bridges, and have the potential to affect riparian areas and river and creek habitats. For these reasons, the need for river and creek crossings must be balanced with impacts to the environment and be treated with the utmost environmental sensitivity.

During the next 30 years, components of Calgary's *roadway*, transit and pathway systems will require new crossings of river or creek systems, or widening or modification of existing bridge structures. *Watercourse* crossings may also be needed for electrical transmission, telecommunications, water or wastewater lines. In such projects, it is essential to balance the need for expanded infrastructure with the significance of the environmental areas and communities that may have to be crossed. When a crossing is deemed necessary, these facilities should be designed and constructed to protect the rivers, creeks and other natural *ecosystems* that will be affected.

The following discussion describes seven key principles that should be considered whenever a new or expanded river or stream crossing is contemplated.

Principle 1: Demonstrated need for the crossing.

A balanced triple bottom line framework should be used to assess the social, economic and environmental implications of the crossing and the corridor it serves and all alternatives, including the option of doing nothing.

Principle 2: Advanced planning for appropriate siting based on all relevant factors.

Several factors play a role when considering, planning, designing and constructing these crossings. These factors include:

- City-wide *street*, transit and utility connectivity to promote compact growth and public transit while reducing vehicle dependence;
- Use of river and stream corridors by people, fish, migratory birds and other wildlife and the sensitive integration of human development within *watercourse ecosystems*;
- Waterway constraints, such as *hydrology* (e.g., volume of water from droughts to floods), hydraulics (e.g., erosion power of moving water and ice) and channel morphology (e.g., meandering, braiding, entrenchment, etc.);
- Location and design of stream channel crossings; and
- Bridge design principles (e.g., structural, aesthetic).

River crossing sites should only be chosen after careful determination of the least damaging crossing location – before the crossing and the associated infrastructure leading to it are designed.

Principle 3: Adherence to the recommendations of a comprehensive biophysical and social impact assessment.

The biophysical impact assessment should consider:

- plants and animals;
- seasonal and climate-related hydrological changes (droughts, floods, ice conditions etc);
- conditions and functionalities before and after construction;
- hydraulic conditions and functions (e.g., erosion, scouring and deposition;
- connectivity of viable wildlife habitats;
- fish passage; and
- long term impacts from operations.

The social impact assessment should build on the needs assessment (see Principle 1) and cover all relevant issues related to how the crossing, corridor or related infrastructure will affect people, their quality of life, their behaviour and the communities in which they live.

Principle 4: Successful minimization of impacts from construction, rehabilitation and ongoing operation and maintenance through engineering design and rehabilitation requirements.

Every effort should be made to avoid potential adverse impacts, and such efforts should be demonstrated prior to accepting mitigation as an option.

To minimize the impacts of river crossings, the following standards should be implemented:

- Engineering design should follow best management practices, including the following:
  - Provide the minimum *roadway* width necessary to service intended needs and adjacent land uses. An effect of a highly connected *street* system is an increase in *impervious surfaces*. Therefore, it is beneficial to narrow *streets*, which can decrease the amount of impervious paving.
  - Wide *streets* and slope embankments can result in the need to disturb a significant length of the *watercourse*. By narrowing *street* and shoulder widths at *watercourse* crossings and by considering steeper embankments or clear span bridges, the total length of disturbed channel may be reduced.
  - Use more habitat-friendly forms of river training such as bio-engineering to mimic natural armouring, instead of riprap and concrete. Replicate historical natural bank stabilization, rather than hard surfaces.
  - A clear span bridge is usually the preferred type of crossing because it typically causes less impact to *watercourse* and flood plain functions.

- When combining utility crossings with bridges, any corrosion problems due to leaks or electric currents should be anticipated and prevented.
- Bridge spans that either eliminate or minimize the disturbance of the *watercourse* bed and shore are preferable.
- Recreation access to the *watercourse* and approach ramps should be included, as appropriate.
- Where significant conflicts are expected, priority should be given to the protection of wildlife habitat and corridors (ecologically sensitive areas) over all other uses.

• Adverse biophysical impacts should be avoided if possible, or minimized if unavoidable.
  - Vegetation impacts should be minimized by crossing the stream corridor at a right angle and keeping the *right-of-way* as narrow as possible.
  - Designing for acoustic, visual and safety factors is important.
    - o Sound barriers block the view and turn crossings into visual canyons; however, they may be needed to reduce salt spray and/or disruptions to wildlife habitat and corridors.
    - o Concrete is very noisy but physical buffers and rubberized surfaces help.
    - o Wet surfaces increase traffic noise, especially with low clouds that reflect sound back to the ground.

• Water from bridge and approach runoff needs primary and secondary treatment. Best management practices such as stormwater ponds, storm receptors, and constructed *wetlands* should be used in the vicinity of the crossing to treat *street* drainage and runoff from bridge decks to meet federal, provincial and municipal requirements as well as the objectives and criteria in water and *watershed* management plans.

• Shadowing from crossings can alter the seasonal and daily sunlight patterns on water and land and change biological functions, structure and viability. These impacts may be addressed by narrowing the *right-of-way*, using grated bridge decking where appropriate, or dividing the *roadway* into two with an open segment in between.

• The natural hydraulics of the *watercourse* must be respected and accommodated.
  - Bridge crossings should be sized to accommodate the maximum flood flow.
  - Adequate clearance must be provided between the high-water flood level and the lowest part of the bridge structure, to allow unobstructed passage of debris.
  - The placement of and hydraulic impacts due to bridge abutments should consider existing impediments and recreation river traffic because of the dangers to boaters during different water levels.
  - Bridge abutments, piers and footings should be located outside the bank-full channel. An arched construction that spans the channel may be preferable. For bridge elements located in the flood plain, the orientation and surfaces of the structures should be hydraulically smooth and designed in a manner to allow a gradual contraction of flow from the natural channel and flood plain through the crossing, and expansion of the flow downstream of the crossing.
  - Bridge length should be established to allow proper conveyance of the probable maximum flood flow. The length of the bridge should be increased to eliminate the potential for scour of

the abutments and piers, to provide access under the crossing for pedestrian paths, and to preserve wildlife migration corridors and riparian vegetation.

- The footprint of crossings and their associated facilities should be minimized to reduce impacts or interruptions to natural groundwater flows within the alluvial aquifer.

Principle 5: Co-operation between multiple jurisdictions based on long term planning and mutual agreement on objectives and uses.

- Integrate proposed *watercourse* crossings with relevant plans and policies such as local *watershed* management plans (e.g., Bow River, Elbow River, Nose Creek), the Provincial Water for Life Strategy and Land Use Framework, the *Calgary Metropolitan Plan*, and the City's Wetland Conservation Plan.
- Aim to exceed the current minimum requirements established by regulatory agencies, in anticipation of more stringent regulations as our increasing population puts more pressure on shared resources and natural capital.
- Contact agencies responsible for fisheries, terrestrial species, hydraulics, alluvial aquifers, flood plain management, *wetlands* etc. to ensure that all requirements and initiatives will be co-ordinated.
- Pre-screening of locations should include long term goals of multiple jurisdictions (municipal, regional, provincial, federal) to optimize each individual crossing and minimize the number of crossings.

Principle 6: Effective policies, regulations, guidelines and enforcement.

Proper planning and design of *watercourse* crossings must be governed and supported by environmentally responsible legislation. Some relevant examples of local regulations, guidelines, policies etc. are listed below:

- The Department of Fisheries and Oceans Canada (DFO) typically requires a site-specific analysis for major *watercourse* crossings, which would, at a minimum, include the following details: fish habitat, hydraulics, timing of the project (for spawning and mitigation), construction activities and sequencing.
- The City of Calgary biophysical components include flora, fauna, terrestrial, avian, amphibians, insects and *hydrology*.
- Alberta's Wetland Policy and Calgary's *Wetland* Conservation Plan include a 'no net loss' principle, with a prioritized approach: avoid, mitigate, compensate.
- The City of Calgary's Wetland Conservation Plan includes a minimum 3:1 replacement ratio on the basis of affected wildlife habitat and other functionalities.

Principle 7: Public consultation.

The City should consult the public, impacted communities and businesses on the planning, design and construction of any new river crossings. The consultation process should address the environmental, social, fiscal, safety and mobility impacts of the proposed crossing.