1.0 PROJECT DESCRIPTION

WATERBODY NAME AND LOCATION

The location of the proposed works lies within the City of Winnipeg along a gentle outside bend of the south bank of the Assiniboine River approximately 500 m downstream of the Osborne St Bridge. The riverbank at the location of the proposed works predominantly consists of alluvial origin clay deposits which have been progressively deteriorating, eroding, failing, and resulting in loss of riverbank property and vegetation including the loss of mature trees and native grasses along the river bank. Mature trees and native grasses are located along the bank and extend from the top of bank area down to the shoreline. River bottom substrate consists of a mixture of silt and clay. An existing 2.4 metre diameter outfall is centrally located in the project area. Existing riprap shoreline erosion protection exists upstream of the proposed works.

PROPOSED WORKS

In order to protect against further erosion along the lower bank area and reduce the potential for future bank movements at the site, the following riverbank stabilization works are proposed:

- Construction of a 4 m effective width rockfill trench shear key along the lower bank at the winter ice level;
- A 0.6 m thick rockfill riprap erosion protection blanket along approximately 50 metres of riverbank at the upstream limit of Fort Rouge Park and at 1 River Avenue to protect against the ongoing loss of trees and the effective natural bank stability reinforcement they provide;
- Replacement of the downstream 36 metres of the 2.4 meter diameter outfall pipe and the installation of a manhole weir structure at the pipe tie in point.
- Infilling of existing tension cracks and re-grading the mid bank of to promote positive overland drainage at the limits of the work;
- Planting of new trees and native grasses over the re-graded areas to enhance habitat and allow the maturing tree roots to provide natural bank reinforcement in a stabilized environment.

The limits of the works are shown on the attached Drawings. A brief description of the main work items along with estimated material quantities is outlined below.

The 0.6 m thick riprap blanket is to be constructed across the entire length of 1 River Avenue and the upstream 20 metres of Fort Rouge Park extending from Elev. 226.0 m± down to the channel thawleg (Elev. 220.0 m±). The estimated quantity of rockfill riprap to be deposited is 1,000 m^3±. The width of riprap to be placed in the channel below the Summer River Level (SRL Elev. 223.7 m±) is approximately 20 m. The portion of riprap above the Winter River Level (WRL Elev. 222.0 m±) will be recessed or subcut into the existing bank. The estimated quantity of rockfill riprap to be recessed or subcut is 500 m^3±. The rockfill for the riprap blanket will consist of clean crushed rock (free from silt and clay) ranging in size from 50 to 450 mm in diameter.

Project Description

The 4 m effective width rockfill trench shear key at is to be constructed along the lower bank area (Elev. 222.0 to 223.5 m±) along a 500 m± length of bank. The in-situ clay soils within the limits of the trench shear key will be excavated to the underlying till and removed off-site and replaced with clean, crushed limestone backfill ranging in size from 50 mm to 450 mm. The top of the shear key will be topped with a 0.6 m clay cap to prevent a hydraulic interconnection between the river and potential groundwater in the till. Approximately 1,500 m^3± of excavation and rockfill backfill will be performed for the shear key.

The replacement of the outfall pipe will involve constructing a shored excavation approximately 6 metres in width with a depth of excavation varying from 1 to 6 metres. Backfill will consist of sand and gravel to 0.6 m above the top of pipe and excavated clay material to the original ground level. The area will be restored with topsoil and native grasses.

The bank regrading at the limits of the works will involve the excavation of native soils within the limits of the eroded and over-steepened areas of the bank. Select excavated materials will be utilized to fill tension cracks and fill local depressions. Regraded areas will be restored with native grass vegetation and native tree plantings as part of the project. Approximately 100 m^3± of excavation will be performed for bank regrading.

New trees and grass vegetation will be installed in those areas affected by the construction works. The trees to be installed will be indigenous riverbank species such as but not limited to Green Ash, Manitoba Maple and Cotton Wood. Approximately 600 m^2± of native grass vegetation suitable for river bottom areas will be installed and twenty (20) new native trees planted.

A temporary silt fence will be installed and will remain in place until completion of the works, and until new vegetation is established.

Copies of the Tender Package complete with construction drawings are included with this submission.

ALTERNATE RIVERBANK REMEDIATION WORKS CONSIDERED

A number of alternative measures to limit bank erosion and improve overall bank stability were examined. Factors which determine the overall suitability of these measures include:

- Maintenance of existing or enhancement of productive capacity for fish or other biota
- Maintaining or improving in-stream habitat diversity
- Minimizing short and long term potential impacts to biota and productive fish capacity during construction and operation
- Minimizing or eliminating potential impacts to adjacent properties (upstream, downstream or opposite, etc.)
- Limiting erosion from the toe of the embankment to above normal summer water level
- Providing natural looking and aesthetically pleasing bank treatment in keeping with the surrounding riverbank
- Cost effective to install and maintain
- Contributing to environmental sustainability

Project Description

On the basis of existing cross-sections, aerial photographs and site observations, this section of riverbank is unstable with evidence of both historical and recent deep seated overall and mid bank movements along with ongoing active shoreline erosion. Further bank movements along with ongoing shoreline erosion will result in further loss of vegetation, namely that of mature trees and native grasses along the top river edge of bank. These ongoing losses of riverbank property and riverbank movements have resulted in the failure of the outfall pipe, an essential part of the city infrastructure.

Alternatives that were assessed as potential riverbank remediation measures included the traditional armoring methods as well as "green" methods. The intent of this project is to utilize a combination of some traditional armoring methods plus "green" methods such as natural tree root reinforcement of the bank. The *"do nothing"* option was considered but it is not possible due to the extent of repairs required to the outfall.

Traditional or "Hard" Erosion Control Methods

As is discussed in KGS (1992), erosion control in a medium to large river such as the Assiniboine Red or Red River includes:

- Bank structures such as wing deflectors, groins, jetties and wing dams
- Armoring and revetment structures such as sheet pile, gabions, timber cribs, rockfill riprap and concrete erosion control mats.

Green Erosion Control Methods

- Vegetation and stream plantings such as willow plantings and grasses
- Physical reinforcement of the shoreline using native deciduous trees

The above mentioned ongoing shoreline erosion occurs along the riverbank shoreline from Elev. 222.0 m±. to Elev. 225.0 m±. Along the shoreline, the natural bank consists of exposed native soils predominantly consisting of alluvial origin silty clays with little to no vegetation. This section of the bank is naturally exposed due to fluctuating Assiniboine River levels occurring for extended portions of the summer growing season submerging potential vegetation. At the same time, the soft erodable bank sediments are also subjected to the effects of naturally occurring river currents and wave action.

On the basis of the acceptance criteria and aspects defined above, only rockfill riprap blankets can provide:

- Long term toe to Ordinary High water Mark (O.H.W.M.) erosion protection
- The ability to minimize effects on fish habitat
- Improved bank stability and erosion protection
- Limited construction impact
- Cost effective short and long term protection

If the riprap is placed directly on the existing natural bank consisting of exposed native soils predominantly consisting of alluvial origin silty clays with little to no vegetation, there will be a relatively small decrease in the stream channel cross section. When placed, the rock will displace into the bank deposits and reduce the theoretical volume, reducing adverse effects on the present productive capacity. The riprap at this site will be subcut or recessed into the bank above the existing winter river level (Elev. 223.5 m±) to minimize the disturbance to the productive capacity of the channel. At the same time, the riprap blanket provides additional mass at the toe of unstable riverbanks and is a cost effective method of immediately increasing overall bank stability by 5% to 10% depending on the thickness of the riprap blanket.

At the same time, it has been KGS Group's experience historically that riprap blankets along the lower Assiniboine River silt in and frequently silt over with alluvium in this reach where the Red River hydraulically controls the Assiniboine River.

On the basis of the review and assessment of the various potential erosion control measures suitable for an average sized river at this site, the most suitable measure to provide both erosion protection is rockfill riprap laid on the substrate during the winter low flow period.

It, however, is proposed to couple the "hard" riprap armouring with "green" vegetation plantings consisting of trees and native grasses along the riverbank. This project relies upon the natural reinforcement such that the trees must be secured in an erosion resistant environment.

2.0 EXISTING SITE CONDITIONS

Riverbank Geometry

The existing riverbank geometry at the location of the proposed works is shown on Sections A, B and C on the Drawings. From the top of bank area located at Elev. 230.5 m±, the bank slopes at approximately 6.5H:1V down to a relatively flat mid bank area located at Elev. 227.0 m±. The relatively flat mid bank area varies from 20 to 30 m± wide and gently slopes down to the crest of the lower bank located at Elev. 226.0 m±. From here, the riverbank drops at approximately 2H:1V to the Summer River Level (SRL) at Elev. 223.7 m±. Below the SRL, the river channel slopes at approximately 5.5H:1V down to the channel thawleg located at Elev. 220.0 m±.

Representative photographs of existing riverbank conditions and geometry are included in Appendix A.

Substrate

The substrate of the Assiniboine River varies within the City of Winnipeg. Downstream of the Osborne Street Bridge the substrate is similar to those sampled along the Red River. In general, the substrate of the Red River within the City of Winnipeg is composed of about 86% silt/clay, 12% sand, and 2.0% gravel when the banks are formed of glacio-lacustrine Lake Agassiz clays. Of the 256 locations at which substrates were characterized downstream of the Osborne Street Bridge to the Red River during 2001, 37% were classified as moderate or hard compacted silt/clay or sand with gravel and/or cobble. Other substrates present were soft silt/clay (35%), hard sand or gravel with cobbles, silt/clay and/or sand (23%), and hard boulder or cobble (5%). Submerged riprap as part of the Assiniboine River Walkway corresponded with most of the sampling points classified as hard boulder or cobble.

Bank Stratigraphy

Based on the KGS Group test hole drilling, the stratigraphy at the Fort Rouge Park at the lower bank (TH07-02) has been interpreted to consist of alluvial clay overlying lacustrine clay underlain by silty sand till. The upper bank (TH07-01) was interpreted to consist of lacustrine high plasticity clay over silty sand till. KGS Group's interpretation of the stratigraphy at the site is summarized on KGS Drawing 07-107-08 03. Detailed summary soil logs are included as Appendix B.

Upper Bank Stratigraphy (TH07-01)
The stratigraphy of the upper bank is based on TH07-01.

Existing Site Conditions

Lacustrine Silty Clay (CH)– Silty clay of lacustrine origin was encountered in the upper bank, extending from ground surface (Elev. 227.06 m±) to Elev. 219.1 m±. The silty clay was brown in colour and became grey at Elev. 223.6 m±, layered, firm in consistency, of high plasticity, and contained trace amounts of fine sand, rootlets oxidation, gravel and silt lenses. Estimated undrained shear strength as determined by the Field Torvane ranged from 30 to 52 kPa with an average of 42 kPa. Moisture contents ranged from 25.5 to 48%.

Atterberg limit testing of the soil indicated a liquid limit (w_L) ranging from 57% to 88% and plastic limit (w_P) ranging from 15% to 23% and plasticity index (I_P) ranging from 40% to 65% classifying the soil a CH.

Silty Sand Till – A layer of silty sand till was encountered beneath the clay. This silty sand till was light brown, soft to firm, wet, with some clay and some gravel. Power auger refusal was encountered

at Elev. 217.24 m± in TH07-01.

Lower Bank Stratigraphy (TH07-02)

The stratigraphy of the lower bank is based upon TH07-02.

Alluvial Silty Clay (CI) – Silty clay of alluvial origin was encountered in the lower bank, in the active zone, extending from ground surface (Elev. 225.30 m±) to Elev. 221.8 m±. The silty clay was layered, soft to firm in consistency, of intermediate plasticity, brown in colour, with some brown and grey mottling, and contained trace amounts of fine gravel, silt, rootlets, and oxidation throughout.

The average estimated undrained shear strength determined by the Field Torvane was 31 kPa. Moisture contents ranged from 28 to 39.5%. Atterberg limit testing on a soil sample from Elev. 223.78 m± within TH07-02 indicated a liquid limit (w_L) of 51%, a plastic limit (w_P) of 17% and a plasticity index (I_P) of 34% classifying the soil as CH.

Lacustrine Silty Clay (CH) – Below the alluvial clay there was high placticity clay, extending down to Elev. 217.7 m±. The silty clay was grey in colour, moist, soft to firm in consistency, of high plasticity, contained silt pockets, with varving of silt and clay. Estimated undrained shear strength as determined by the Field Torvane ranged from 20 to 32 kPa with an average of 26 kPa. Moisture

contents ranged from 32.1 to 57.9% with an average of 45%. Atterberg limits testing from TH07-02 indicated a liquid limit (w_L) ranging from 63% to 78% and a plastic limit (w_P) ranging from 17% to 18% and a plasticity index (I_P) ranging from 47% to 60%, classifying the soil as CH.

A thin layer or pocket of till was encountered within the lacustrine clay at Elev. 222.5 m±. The till was grey to creamy in colour, wet, soft to firm in consistency, and of low plasticity. Moisture content of the till was 57%.

Silty Sand Till - Silty sand till was encountered below Elev. 217.7m. The silty sand till was light brown, soft to firm, wet, and with some clay and some gravel (up to 19 mm in diameter). Power auger refusal was encountered at Elev. 216.8 m± in the TH07-02.

GROUNDWATER

Monitoring of the piezometers was performed twice during the summer of 2007. The measured ground water levels in the upper bank clay (PN -1) were 222.48 m on June 24, 2007 and 221.06 m on July 26, 2007. The measured till ground water level in the upper bank (SP -1) decreased from 222.51 m to 221.09 m over the same monitoring period. The ground water levels measured in the lower bank clay (PN -2) were 224.95 m and 223.49 m on June 24, 2007 and July 26, 2007 respectively. The lower bank measured till groundwater levels (SP - 2) were 224.74 m and 223.28 m on June 24 and July 26 respectively. The decrease in the measured groundwater levels is interpreted to be due to the recession of the summer flood waters between the two monitoring dates.

Stereo Aerial Photography Review

The recent history and performance of the bank has been reviewed based on available aerial photography. The air photo stereo coverage used in the review included:

Photo Series	Year	Scale
AS88013	1988	1:5000
FF98096	1998	1:5000

Background reports reviewed as part of this assessment included:

- "Riverbank Stability Study at 7 Roslyn Rd.," KGS Group January 2006.

Aerial Photography Interpretation

1988 – A pre-existing head scarp was visible along the lower bank area extending across the entire Fort Rouge Park and extending approximately 50 m upstream and 100 m downstream of the site. There was also evidence of historic mid to upper bank instability, but there was no evidence of recent lower bank movements in the 1988 photos. The pipe outlet was visible, appeared in good condition with some rock immediately around pipe outlet. There was no riprap protection installed along the Fort Rouge Park shoreline. Riprap was suspected along the shoreline of 7 Roslyn Road and was clearly visible along the shoreline of the two properties upstream of 7 Roslyn Road. The Assiniboine Walkway had yet to be constructed along the opposite shoreline.

1998 – The shoreline area is obscured and less visible in the 1998 photos as compared to the 1988 photos due to the oblique angle at which the photos were taken. However, the same head scarp remained visible along the lower bank area. Tree growth is more mature. There was no direct evidence of recent lower bank movement or of movements between 1988 and 1998.

TERRESTRIAL VEGETATION

The vegetation along the riverbank of the proposed project area consists of mature trees and native grasses located along the bank and extends from the top of bank area down to the top river edge of bank. Mature trees located in the mid bank area were observed to be leaning in the predominant direction of an existing failure scarp consistent with ongoing bank movements. Further bank movements along the failure scarp may result in the loss of presently leaning mature trees detrimentally impacting the overall bank stability due to the inherent loss of functional mature tree root systems which are used to both lower the in-situ ground water table and increase the overall strength of in-situ bank materials. Also, due to ongoing shoreline erosion, mature trees along the river edge of bank were noted to have either fallen into the river channel or to have their root systems exposed. This will likely result in the future loss of these trees. Photographs of typical bank vegetation are enclosed in Appendix A.

BIOTIC COMMUNITY

The Assiniboine River and its tributaries in Manitoba are known to contain at least 45 species of fish. In a recent study seven (7) large fish species were captured at twelve (12) sites downstream of Portage la Prairie. These species included sauger, shorthead redhorse, goldeye, quillback, mooneye, silver redhorse, and silver chub. During the summer and early fall of 1999 fish sampling within the project area found channel catfish, sauger, goldeye, mooneye, quillback, silver redhorse, white sucker, walleye, carp, shorthead redhorse and fathead minnow. No fish were captured in the project area during February gillnetting.

There are no endangered species of fish known to occur in the Assiniboine River within the City of Winnipeg. Bigmouth buffalo, chestnut lamprey, and silver chub have been designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as species of special concern (a species with characteristics that make it particularly sensitive to human activities or natural events)(COSEWIC 2001). The Manitoba Conservation Data Centre (MCDC) lists silver chub, bigmouth shiner and river shiner as species of concern, and bigmouth buffalo, channel catfish, flathead chub, golden redhorse and spotfin shiner on their watch list. Lake Sturgeon has been stocked by the Manitoba Fisheries Branch into the Assiniboine River near Brandon. Reports since 1996 have indicated that the sturgeon have remained in the Brandon area.

The majority of fish species in the Assiniboine River spawn in the spring during high flows and rising temperatures. Several species such as channel catfish, freshwater drum, carp, and goldeye spawn in late spring or early summer. Burbot spawn under the ice during late winter. Specific spawning and rearing locations within the Assiniboine River main channel are not well known.

Manitoba Fisheries Branch consumption advisory guidelines indicate that most species in the Assiniboine River are safe to eat. The exceptions are large walleye and channel catfish, which may contain elevated mercury levels. The two advisories issued by the Manitoba Fisheries Branch in regard to elevated mercury levels pertain to walleye over 58 cm at Lake of the Prairies and channel catfish over 79 cm at Brandon.

Although the section of the river adjacent to work area is used by a number of fish species, the degree to which the area is used for spawning or nursery habitat is unknown. The habitat probably provides foraging opportunities for most fish species occurring within the City of Winnipeg. Peak fish migration through the area would occur in the spring, as fish move between over-wintering and spawning areas, and in the fall, as fish move from summer habitat to over-wintering areas. The value of this reach as overwintering habitat is unknown.

Sandy bottom substrates that dominate the Assiniboine River downstream of Portage la Prairie provide a favourable habitat for freshwater mussels. Eighteen (18) species of Unionic mussels and two (2) genera of Sphaeriid clams (fingernail clams) may inhabit these areas. The three ridge clam (*Amblema plicata*) have some economic importance but are not commercially harvested in the Assiniboine River. The three ridge and wabash pigtoe (*Fusconaia flava*) have been designated species of special concern by the Manitoba Conservation Data Centre.

However based on previous studies, the substrates found in the Assiniboine River downstream of the Osborne Street Bridge are similar to those substrates found in the Red River. The only invertebrates found within the reach of the Assiniboine River from the Osborne Street Bridge downstream to the Forks were oligochaets.

3.0 CONSTRUCTION DETAILS

Proposed Bank Improvement Measures and Construction Activities

CONSTRUCTION SCHEDULE

It is anticipated that construction of the proposed works will commence in January, 2008 (pending review and/or approvals), with in-water improvement measures completed before March 31, 2008. Site restoration / revegetation will be completed before June 30, 2008.

A detailed description of the construction methods is outlined below.

Site Access

Minor regrading of the riverbank area will be required for equipment access, it shall be performed by excavation only. Under no circumstances will any fill be allowed on the riverbank for equipment access. In general, all excavation shall proceed from the top of bank area down to the bottom so as not to jeopardize riverbank stability. All material excavated shall be disposed of off-site immediately upon excavation. Stockpiling of excavated material at the site will not be allowed.

Upon completion of the works, the access ramp along the riverbank shall be restored to the pre-construction condition and geometry.

Rockfill Riprap Blanket

The proposed rockfill riprap blanket will extend from Elev. 226.0 m± down into the channel approximately 12 m beyond Winter River Level (Elev. 222.0 m). The rockfill material for use as riprap will consist of clean free draining material, free from organics, roots, silts, sand, clay or any other material that would detract from the strength and drainage characteristics of clean rockfill. The riprap will range in size from 50 to 450 mm in diameter, with at least 50% being larger than 300 mm and less than 5 % finer than 5 mm to minimize small particles in the river. The riprap will be durable, white crystalline limestone. Softer buff to yellow dolomite or dolostone will not be accepted. No rockfill will be permitted without providing the source and supplier.

Outfall Pipe Replacement

The replacement pipe will consist of a 36 metre length, 2.4 metre diameter corrugated metal pipe constructed in a shored excavation. A reinforced concrete chamber and weir will be constructed at the upstream end. The pipe invert will vary from approximately 222.8 m at the shoreline to 222.9 m at the upstream end. The pipe will be bedded in clean granular material extending 0.6 meters above the top of pipe. The remaining backfill will consist of select excavated clay.

The rockfill will be subcut into the bank above the WRL (Elev. 223.7 m) so as to maintain existing channel geometry and then be pushed or rolled into place in such a manner that the larger rocks are uniformly distributed and the smaller rocks serve to fill the places between the larger rocks, and that the excessive segregation of the various particle sizes does not occur. It is anticipated that the contractor will use large excavators and work off of the newly placed riprap so as to minimize shoreline erosion during the riprap placement activities. Sufficient leveling will be done to procure a neat and uniform surface, conforming to the shape and dimensions shown on the Drawings.

Rockfill Trench Shear Key

The 4 m effective width rockfill trench shear key at will be constructed along the lower bank area (Elev. 223.7 m±) along the length of bank. The rockfill material for use as rockfill backfill will consist of clean free draining material, free from organics, roots, silts, sand, clay or any other material that would detract from the strength and drainage characteristics of clean rockfill. The rockfill will range in size from 50 to 450 mm in diameter, with at least 50% being larger than 300 mm and less than 5 % finer than 5 mm. The rockfill will be durable, white crystalline limestone. Softer buff to yellow dolomite or dolostone will not be accepted. No rockfill will be permitted without providing the source and supplier.

The shear key excavation shall be excavated to the depths and widths, and in the locations shown on the Dwg. 06-1411-01 32 and 33. An adequate volume of rockfill for backfilling shall be on-site prior to excavation of each incremental length of the trench shear key. The excavation shall proceed in a timely manner and rockfill must be placed as soon as excavation takes place. Stockpiling of excavated material on the riverbank will not be permitted. The maximum open length of the shear key at any time shall be 2 metres along the bottom of the excavation.

Clay Cap

The clay backfill for the fill placement shall consist of a high plasticity material with a liquid limit in excess of 50%. The clay shall be free of deleterious material such as roots, organics, ice, snow or other unsuitable materials, and may be salvaged from the trenched shear. Placement of frozen material will not be acceptable.

Clay fill shall be placed along the bank to the lines, grades, and elevations shown on the Drawings. The clay shall be spread and placed in layers not exceeding 150 mm thick and compacted to 95% Standard Proctor Maximum Dry Density (SPMDD).

Riverbank Regrading

The materials to excavated for the regarding work consist of the in-situ overburden soils and may include but not necessarily limited to organic topsoil, clay, silt, sand, gravel, fill, rubble, trees, tree roots, shrubs, etc., all of which may be excavated with standard hydraulic excavation equipment.

All material encountered within the limits of the works shall be excavated to the lines and grades shown on the Drawings to provide for positive downslope drainage. All materials shall be removed off Site immediately upon excavation.

Revegetation Plan

New trees and grass vegetation will be installed in those areas affected by the construction works. The trees to be installed will be indigenous riverbank species such as but not limited to Green Ash, Manitoba Maple and Cotton Wood. Both native grasses and topsoil and sod will be installed at the locations shown on The Drawings. All sediment and erosion control measures will remain in place until vegetation is re-established.

Construction Equipment Required

Site Access: Excavators, loaders, tandem trucks

Rockfill Riprap Blanket: Excavators, loaders, dozers, tandem trucks

Rockfill Trench Shear Key: Excavators, loaders, dozers, tandem trucks

Riverbank Regrading: Excavators, loaders, tandem trucks

Fill Placement: Excavators, loaders, tandem trucks

Revegetation Plan: Excavators, loaders, tandem trucks

SEDIMENT AND EROSION CONTROL PLAN DURING CONSTRUCTION

Any excavation or other construction activities on the site that may cause sediment laden runoff to enter the Assiniboine River will be prevented by the use of silt fences. These improvement measures will be maintained until re-vegetation has been re-established.

In addition to the above, all work will be performed in accordance with an Environmental Protection Plan approved by the Contract Administrator.

4.0 POTENTIAL ENVIRONMENTAL EFFECTS

Potential environmental effects of the works include the following:

A. Potential alteration or loss of fish habitat – project scheduling of the bank remediation improvement measures may disrupt fish spawning and in-water improvement measures may alter the physical characteristics of the aquatic environment.

B. Introduction of Sediments - Construction activities have the potential to introduce sediments to the river thereby increasing total suspended solids levels and resulting in sedimentation downstream of the project area.

C. Accidents and/or spills of hazardous substances – spills/accidents could occur during the use of construction equipment and/or product storage in the project area and could adversely impact the aquatic environment at and downstream of the project site.

D. Alteration of the river hydraulics - velocity of the Red River may be influenced by the placement of riprap.

E. Cumulative environmental effects – cumulative effects may result from the current project in combination with other existing and proposed projects involving riprap placement in the Red River.

Selected potential environmental effects are discussed in more detail below.

Potential Alteration or Loss of Fish Habitat

Substrate

A total of approximately 1100 m^2 of substrate will be covered with 50 to 450 mm diameter rockfill riprap below the Summer River Level (Elev. 223.7 m±). Based upon direct observation by KGS Group since 1988, interstitial spaces in the riprap do fill with sediments quickly and are frequently (usually) silted over between the St-James Bridge and the Forks because this lower portion of the Assiniboine River is frequently hydraulically backed up by controlling higher Red River flows. It is expected that sedimentation will occur throughout the summer, while some level of scouring (sediment and removal) may occur during spring. KGS Group has completed post construction monitoring of installed riprap blankets for DFO at the CAR*RAC Hugo Street Dock site (located 3 km downstream of the project area) and the Waterfront Drive project on the Red River. In addition, other ongoing observations at Balmoral Hall School, 29 Balmoral Street, 333 Wellington Crescent, and 7 Roslyn Road are of older intact riprap blankets that have completely silted over. Results of the monitoring indicate that significant infilling of the recently installed riprap has occurred below the Summer River Level at all of the above sites. Monitoring was also completed along Kingston Row/Crescent after the annual fall drawdown in 2003 by KGS Group. Results of the monitoring once again indicated that significant infilling of the installed rockfill riprap had occurred below the Summer River Level

The primary value of the existing substrate to fish in the Assiniboine River is probably the production of benthic invertebrates for foraging. The stability and structural complexity that riprap provides has also been shown to benefit macroinvertebrate populations (Wesche 1985). Where riprap provides unique habitat within a river, it can support higher densities of macroinvertebrates than along natural bank habitats (Beckett et al. 1983; Henderson 1986). Zrum and Davies (in prep) found that artificial substrate samples composed of uniformly-sized rocks set in the Red River yielded the same number of invertebrate taxa as ponar grabs from softer substrates. Nelson and Franzin (2000) found that larger particle size substrates (i.e. boulder, cobble, gravel) in the Assiniboine River, whether they occurred in bank or channel habitats, were always over utilized compared to other substrates. Therefore, it is expected that the addition of riprap as part of the riverbank remediation works will have no negative long-term effect on foraging habitat. There will be some short-term reduction in the benthic community after the riprap has been placed on the river bottom. However, it is expected that re-colonization will occur quickly and that invertebrate production will be equal to or greater than pre-project levels within the first openwater season.

Interstitial spaces within the riprap would be expected to provide cover for juvenile fish and increase the value of the substrate as nursery habitat. Riprap placement is expected to create potential spawning opportunities for walleye and sauger. Negative effects to spawning opportunities for other species are not expected.

Water volume and velocity

The volume of the channel cross-section within the vicinity of the project will decrease nominally as a result of riprap placement below the winter river level. However, when compared to the overall cross sectional area of the river the backwater effects of the riprap are considered to be insignificant. The maximum depth and wetted perimeter are not expected to change. Consequently, no significant effects to overwintering and foraging habitat are expected.

Because of the small reduction in cross-sectional area, increases in water velocity are expected to be relatively insignificant.

Project scheduling may disrupt fish spawning

Instream works will be scheduled to avoid spawning activity in the Assiniboine River. No disruptions to spawning or spawning migrations are expected as a result of the instream work.

Placement of rock will cause a physical disturbance within the water column and has the potential to directly harm aquatic biota (i.e. change in habitat). However, since construction will occur after winter drawdown, when fish abundance in the Assiniboine River within the City of Winnipeg is lowest, direct effects to fish are expected to be minimal.

Introduction of Sediments

The Assiniboine River is characterized by high levels of turbidity and total suspended solids (TSS). Turbidity and TSS levels are derived from soil erosion and scouring of the riverbed during periods of high flow and are generally highest during April and lowest during the winter (Gurney 1991). Between 1980 and 1989, total suspended solid levels in the Assiniboine River exceeded Manitoba Water Quality Objectives 80 per cent of the time with the highest frequency of exceedences occurring in the summer months.

Because of the naturally high TSS levels, relatively small introductions of sediments as a result of the project would not be expected to have measurable effects on Assiniboine River fish or fish habitat. Disturbed sediments probably would settle within the first 1000 to 2000 m downstream. Scouring during the following spring would transport the sediments further downstream. Monitoring of downstream TSS loads during maintenance of the Red River Floodway Inlet Control Structure suggested that most of the introduced solids were deposited within one to two km downstream (C. Bezte, North/South Consultants Inc., Winnipeg, pers. comm.). Monitoring of sediment inputs from granular coffer dams used to repair the St. Andrews Lock and Dam during winter 1994/95 and winter 1995/1996, showed no detectable increase in TSS levels 1000 m downstream of the dams (MacDonell 1995, 1996).

5.0 PROPOSED MITIGATION MEASURES

An environmental protection plan will be completed and implemented for the proposed riverbank remediation works, which includes measures to mitigate the potential environmental effects identified plus follow up and reporting requirements. The plan will be enforced under the requirements of the construction contract.

Potential Alteration or Loss of Fish Habitat

- No in-water improvement measures will be conducted between April 1 and June 30, 2007 to avoid spring migration, spawning, and egg incubation.
- The proposed riprap placement (in-water improvement measures) will provide beneficial habitat diversity and stability, and is not expected to result in a loss of productive capacity of fish habitat.

Loss of Vegetation and Erosion and Sedimentation

- Instream improvement measures are designed to not disturb riparian vegetation
- Disturbed areas along the lower, mid and upper bank, and access areas, will be re-vegetated as soon as possible after construction with perennial grass, trees and shrubs to protect against erosion.
- The sediment and erosion control plan outlined above will be implemented and adhered to.

Accidents and/or Spills of Hazardous Substances

Fuel Use and Storage

- No equipment re-fueling will be conducted within 15 metres of the high water mark of the Assiniboine River.
- No fuel storage will be within 100 meters of the Assiniboine River, and in accordance with Manitoba Regulation MR 97/88R.
- Contractors will be required to have spill clean-up materials on site with a minimum of 25kg of suitable commercial sorbent, 30 m^2 of 6 mil polyethylene, a shovel, and an empty barrel for spill collection and disposal (CPWCC1999).
- Contractors will be required to report any spills of petroleum products in excess of 100 litres (22 imperial gallons) to Manitoba Conservation in accordance with Manitoba Regulation MR 439/87.
- Secondary containment and drip trays will be present for all fuels stored on-site

Servicing and Maintenance of Construction Equipment

- Construction equipment will be required to be maintained to prevent leaks and spills of fuels, lubricants, hydraulic fluids, or coolants.
- No on-site maintenance of equipment will be permitted.

Waste Management

- Collection and disposal of waste hazardous materials, including oil and lubricating products from construction equipment will be in accordance with Manitoba regulations.
- Collection and disposal of all construction wastes from the development will be in a licensed waste disposal ground.

ON-SITE SUPERVISION DURING CONSTRUCTION

KGS Group will have personnel on-site to visually inspect all phases of the project to ensure that all mitigation measures proposed during construction are being implemented, adhered to and are effective. Activities monitored during construction include, but are not limited to:

- Protection of riparian vegetation during construction
- Implementation of an erosion control plan to manage sedimentation

6.0 POST CONSTRUCTION SITE RESTORATION TECHNIQUES

Implementation of all measures proposed to mitigate potential effects associated with the riverbank stability improvement measures will ensure no net loss of the productive capacity of the Assiniboine River Fishery. It is anticipated that the proposed mitigation measures will enhance existing habitat. Site restoration will include:

- Re-vegetation of bank with indigenous riverbank tree and grass species.
- Revegetation of all areas impacted by construction.

References

7.0 REFERENCES

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