7.0 EFFECTS ASSESSMENT, MITIGATION AND MONITORING

7.1 PHYSICAL ENVIRONMENT

7.1.1 AIR QUALITY

7.1.1.1 EFFECTS AND MITIGATION

Potential effects of the Project on air quality include dust emissions from construction activities and exhaust emissions from construction equipment and vehicular traffic.

Construction

Dust will be generated by construction activities such as site preparation, excavation, earthworks, and road construction. Dust emissions will be short-term, limited to the duration of the specific construction phase (i.e., days to weeks), and the spatial extent will be localized to the project site. Specific activities/locations where dust control may be required include the demolition and construction of the abutments for the new river bridge. Dust will be controlled with the use of water sprayed on the haul/access roads.

The exhaust emissions from construction equipment will be short-term (limited to the construction phase), the spatial extent will be localized to the project site, and the incremental contribution to vehicular exhaust emissions on the project site will be negligible in comparison to the emissions from the daily vehicle traffic through the project site.

Operation

Operational activities with the potential to generate emissions to air include routine maintenance of the road surfaces (e.g., street cleaning, surface repairs) and structures (periodic repairs of the structures as necessary due to damage by vehicles and maintenance equipment.

The bridge is designed to replace an existing structure, hence, traffic volumes and their related air emissions are not anticipated to change as a result of the Project.

7.1.1.2 RESIDUAL EFFECTS

Construction

Effects of the Project on air quality during the construction phase will be limited to that phase.

Operation

There are no anticipated residual effects of the Project on air quality during the operation phase.

7.1.2 NOISE AND VIBRATION

7.1.2.1 EFFECTS AND MITIGATION

Construction

Noise and vibration resulting from construction will be limited to daytime hours and the spatial extent will be localized to the Project site. Noise and vibration during the construction phase of the Project will result from operation of equipment and vehicles on site and activities such as pile driving.

PCL will take video/photographic records to assess the condition of adjacent properties prior to construction activities that have the potential to cause damage through vibrations.

PRW will comply with the City Noise Control By-Law No. 2480/79. Part of this bylaw states:

"CONSTRUCTION ACTIVITIES
3.2.3 No person shall operate or permit the operation of any tools or equipment used in construction, drilling, or demolition work on Sundays at any time or on weekdays between the hours of 10:00 o'clock p.m. and 7:00 o'clock a.m. the following day or on Saturdays and statutory holidays before 9:00 o'clock a.m. and after 9:00 o'clock p.m."

Normal operating hours for construction will be weekdays from 7:00 am to 6:00 pm. Construction activities will only occur outside these hours on an "as required" basis. For example some activities such as tying the new bridge structures to the roadways will necessitate after-hours work to avoid peak-time delays for commuters on the bridges and the roads. Any "after-hours" construction activities will comply with By-Law No. 2480/79.

Project construction will cause increased noise levels on the Project site but within the limits of City Noise Control By-Law No. 2480/79. Given that noise will remain within

regulated limits and hours of the day this is considered a minor change with respect to both magnitude and the short-term duration.

Operation

The Project will not cause a change in traffic noise levels from the current background condition nor will it bring traffic closer to any potential noise receptors. There will be no operation-related effects on noise. Landscape features such as trees have been included in the project design to further reduce noise. No new sources of vibration will be introduced by the Project although the planned roadway replacement that is part of the project may remove existing pavements humps that are cause of local vibration.

7.1.2.2 RESIDUAL EFFECTS

Construction

No anticipated noise or vibration related effects from construction will extend beyond the construction phase of the Project.

Operation

The Project is not expected to have an effect on operational levels of noise or vibration and therefore will not have any residual effects.

7.1.3 SOIL CHEMISTRY AND QUALITY

7.1.3.1 EFFECTS AND MITIGATION

Construction

Contaminated soils occur on the west side of the Red River adjacent to Disraeli Street and Rover Avenue and are likely to be encountered during construction in this area (Figure 5.1). A Remedial Action Plan (RAP) for management of contaminated soil encountered in this portion of the Project will be in accordance with the RAP that has been submitted to Manitoba Conservation (Appendix E). The purpose of the RAP is specifically to address contaminated soil that may be excavated during the Project works. The RAP does not apply to or consider remediation of any contaminated soil beyond the excavation limits.

Soil excavation will be required at five substructure locations for pile placement and footing construction adjacent to Disraeli Street and Rover Avenue. Any contaminated soil encountered during the Project works will be contained, assessed, and disposed. Management measures include:

- Removal of contaminated soils with concentrations exceeding the applicable Canadian Council of Ministers of the Environment (CCME) guidelines for offsite disposal at an approved facility.
- Backfilling around the substructures with compacted, clean excavated material and/or imported clean backfill.

During excavation at each of the five locations, soil will be assessed in the field based on visual observations, headspace vapour concentrations measured with GasTECH™ combustible gas indicator, noticeable odours, and available analytical results from previous investigations. Soil assessed in the field to be "clean" (i.e., no visual evidence of impact and no noticeable odour) will be stockpiled on the site for later use as backfill material, pending confirmatory analytical results. The "clean" soil will be stockpiled on polyethylene sheeting adjacent to the excavation from which the soil was removed.

Excavated soil assessed in the field to be contaminated (i.e., visual evidence of impact and/or noticeable odours) will be loaded directly onto trucks or into roll-off bins for offsite disposal. In the event that trucks or bins are not immediately available, the soil will be temporarily stockpiled on polyethylene sheeting adjacent to the excavation from which it was removed. The stockpile will also be covered with polyethylene sheeting until it is removed for offsite disposal. Any stockpile will be located within a fenced area accessible only to authorized personnel.

Excavated material assessed in the field to be coal tar or coal tar-saturated (i.e. visual evidence of coal tar) will be loaded directly onto roll-off bins for temporary storage on the site. The bins will be located within a fenced area accessible only to authorized personnel. The bins will remain on the site until a sufficient quantity of the coal tar or coal tar-saturated soil has been collected for offsite disposal.

The reader is referred to Appendix E for a complete discussion of the land-based RAP. Site-specific procedures for dealing with excavations in hydrocarbon-contaminated areas will be included in PCL's Health, Safety and Environment Plan (HSEP). The land-based RAP has been developed to ensure the Disraeli Bridges Project will not have an adverse effect on soil chemistry and quality during the construction phase.

Operation

The Project will continue to affect soil quality immediately adjacent to the roadways in the same manner that it does now, through the use of salt and grit for management of ice on road surfaces and through the local deposition of any particulate contaminants emitted in vehicle exhausts. The Project will not cause an increase in these effects and so will not have any effect over the existing baseline condition.

7.1.3.2 RESIDUAL EFFECTS

Construction

The only residual effect of Project construction will be a net reduction in soil contamination resulting from the excavation and proper disposal of contaminated soils and replacement with clean backfill. This effect is local in spatial extent, long term (permanent), and beneficial.

Operation

The Project is not expected to have incremental residual effects on soil chemistry and quality during the operation phase beyond the baseline condition.

7.1.4 HYDROGEOLOGY

7.1.4.1 EFFECTS AND MITIGATION

Construction

There is potential for downward migration of contaminated groundwater during installation of the abutments, land piers and river piers. The following specific controls have been incorporated into the project design and construction procedures to prevent this exchange from occurring.

River Piers

There is the potential for water transfer from the Red River into the bedrock aquifer (Upper Carbonate Aquifer) and/or from the aquifer into the Red River during the installation of river piers through zones of contaminated groundwater. River piers SU6 and SU7 will each be supported on five caissons that will extend into the underlying bedrock. Each caisson will be constructed within primary and secondary steel containment sleeves as detailed in Section 5.3.2.4 to isolate the working area from the river and to ensure that any contaminated river sediments or groundwater are contained and isolated from the river. Drilling of each caisson will proceed through the bottom of the secondary containment sleeve. The primary containment sleeve will be advanced with the drilling. A bentonite cement mixture with be placed on the bottom of each caisson using the tremie method upon completion of excavation of the potentially contaminated sediments from within the secondary sleeve. The bentonite cement will seal the bottom of the caisson and prevent the exchange of water and any associated contaminants between the aquifer and the river.

Groundwater is expected to rise in the caisson during installation but will be contained within the secondary containment. Based on the geotechnical investigations at site, the groundwater level inside the secondary containment sleeve is not expected to rise above the river water level.

The water contained within the containment sleeves will be tested for contaminant concentrations prior to removal of the sleeves. In the event that any parameters exceed the greater of the applicable MWQSOG for protection of aquatic life of the background concentration in the river, the water will be removed for proper and treatment and disposal prior to removal of the containment sleeves.

The design and construction method are expected to effectively prevent the exchange of water and any associated contaminants between the river and the underlying carbonate aquifer.

Abutments

The west abutment of the new river bridge will consist of a reinforced concrete bearing seat that is supported on precast concrete piles driven to refusal in the underlying dense glacial till (see section 5.3.2.1). The abutment location will be pre-bored prior to driving the concrete piles.

The east abutment will be a box style constructed of reinforced concrete due to the large fill and proximity to Midwinter Avenue. Steel H-piles will be driven to refusal to provide the necessary support.

There is potential for downward migration of contaminated groundwater adjacent to the driven piles. Lateral ground pressures will prevent the contaminants from being pushed downward with the piles while immediate reconsolidation of the soil following pile driving will prevent the creation of a pathway for contaminant migration.

Land Piers

The land piers will be bents style and constructed from reinforced concrete (see section 5.3.2.1 and 5.3.2.2). The foundations will be comprised of steel H-piles driven to refusal in the underlying bedrock. There is potential for downward migration of contaminated groundwater adjacent to the driven piles. Immediate reconsolidation of the soil following pile driving is expected to mitigate this potential effect. Circular pile caps will be installed to minimize the amount of excavation and disturbance in the upland contamination zones.

The proposed pier SU5 location lies between the normal summer water level (NSWL) and the winter ice surface level. Sheet piling will be temporarily installed to isolate the pier footprint. Five steel H-piles will be driven to refusal at the underlying bedrock in an offset pattern to form the pier foundations. There is potential for downward migration of contaminated groundwater adjacent to the driven H-piles and sheet piling. Lateral ground pressures will prevent the contaminants from being pushed downward with the piles while immediate reconsolidation of the soil following pile driving will prevent the creation of a pathway for contaminant migration. A steel reinforced concrete pier will then be formed on top of the piles.

Operation

The design and construction of the piers and abutments will prevent the downward movement of contaminants into the underlying carbonate aquifer and the upward movement of contaminants from the aquifer. The Project will not affect groundwater quality during operation.

7.1.4.2 RESIDUAL EFFECTS

Construction

There are no anticipated residual effects of the Project on groundwater during the construction phase.

Operation

The Project is not expected to have an effect on groundwater during the operation phase and therefore will not have any residual effects.

7.2 TERRESTRIAL ENVIRONMENT

7.2.1 VEGETATION

7.2.1.1 EFFECTS AND MITIGATION

Construction

Preparation of the site for construction will involve vegetation removal as detailed on Figure 7.1 and Table 7.1. Project construction will require the clearing of 900 m^2 of river bottom forest. Approximately one third of this area (300 m^2) is located under the deck of new river bridge and will be permanently removed from vegetative production. The remainder of this area will be cleared to provide access for construction and will be reclaimed and revegetated on completion of construction. The reclaimed portion will be planted in a manner that will assist its return to a state similar to the surrounding forest but this recovery will take considerable time for succession and maturation.

The river bottom forest that will be lost has been evaluated by the City Naturalist as Class C and C/D. Class C indicates a low sensitivity to disturbance and Class D indicates a minimum sensitivity to disturbance. Overall these classifications indicate the habitat is of generally low quality.

Other vegetation community losses or alterations include: the clearing of 900 m^2 of grassland and the removal of 4800 m^2 of greenspace to accommodate construction of the new bridge (Figure 7.1 and Table 7.1). The clearing of grassland is considered a temporary loss, with the exception of the 65 m^2 that will be permanently lost beneath the

new river bridge pier SU4. The clearing of 3985 m^2 of greenspace will be reclaimed after the construction phase of the project and there will be a gain of 600 m^2 greenspace; hence there will be a total net loss of 215 m^2 greenspace from the Project.

The largest areas of vegetation disturbance will be the temporary use of Barber Buffer Park (5500 m^2) and of greenspace at the corner of Talbot Avenue and Midwinter Street (3000 m^2) for laydown areas. These disturbances will be for the duration of the construction phase, and the areas will be returned to a condition that is at least as good as the baseline condition on completion of construction.

The location of the new river bridge and access ramp to the work bridge on the east riverbank of the Disraeli Bridge will not result in a loss of riverbank vegetation. This riverbank is a recently disturbed area overlain by rock armouring.

PRW will minimize the clearing of vegetation, in particular riparian vegetation along the Red River, by ensuring construction vehicles use existing roads and/or specific access routes are established and used during construction.

All areas planned for a temporary loss in vegetation will be revegetated after the construction phase of the project. PRW plans to improve quality of greenspaces at the Elmwood landing and the Point Douglas landing (Figure 7.2) by adding more trees and plantings.

Native plants along the pathways and edges of native riverbank restoration areas will enhance the environment of the bridge. Although it will take time for the plantings to reach maturity, the plant selection, which requires minimal maintenance, will immediately increase bio-diversity, carbon sequestration, and native habitat. Tree planting will meet all requirements outlined in *Tree Planting Details and Specifications - Downtown Area and Regional Streets* (2009) which will greatly contribute to the sustainability of these plantings. Proposed planting options include:

- Raised native drought and salt tolerant plant buffers (where guard rails and fences are not necessary) to direct pedestrian and cyclist traffic along sidewalks and cycling routes.
- Native turf grass (low growing drought and salt tolerant native grasses) placed in areas where sod would traditionally be used to reduce maintenance requirements and increase bio diversity and carbon sequestering capabilities.
- Feature and street tree plantings will consist of tree species that are resistant to salt and drought including, but not limited to: Japanese Elm, American Elm, Mancana Ash, Prairie Spire, Green Ash and Black Ash (where there is excessive moisture). These will be subject to review and approval of the City of Winnipeg Urban Forestry Department.

- Educational signs providing information on the environmental benefits of sustainable plantings (e.g. water conservation, etc.) and permanent guides to native and man-made habitat.

Operation

The Project will continue to affect vegetation quality immediately adjacent to the roadways in the same manner that it does now, through the use of salt and grit for management of ice on road surfaces and through the local deposition of any particulate contaminants emitted in vehicle exhausts. The Project will not cause an increase in these effects and so will not have any effect over the existing baseline condition. All plantings will be considered for salt tolerance prior to use in landscaping.

7.2.1.2 RESIDUAL EFFECTS

Construction

The Project will result in the loss of 900 m^2 of riverbottom forest on the west bank of the Red River. Two-thirds of this (600 m^2) will be reclaimed and revegetated on completion of construction. The reclaimed portion will be planted in a manner that will assist its return to a state similar to the surrounding forest but this recovery will take considerable time for succession and maturation. The project will also result in a net loss of 815 m^2 of greenspace.

Operation

The Project is not expected to have incremental residual effects on vegetation during the operation phase beyond the baseline condition.

LEGEND

TYPE OF VEGETATION:

- GREEN SPACE
- PARK
- RIVERBOTTOM FOREST
- GRASSLAND

CHANGE IN VEGETATION:

- TEMPORARY LOSS
- PERMANENT LOSS
- PERMANENT GAIN

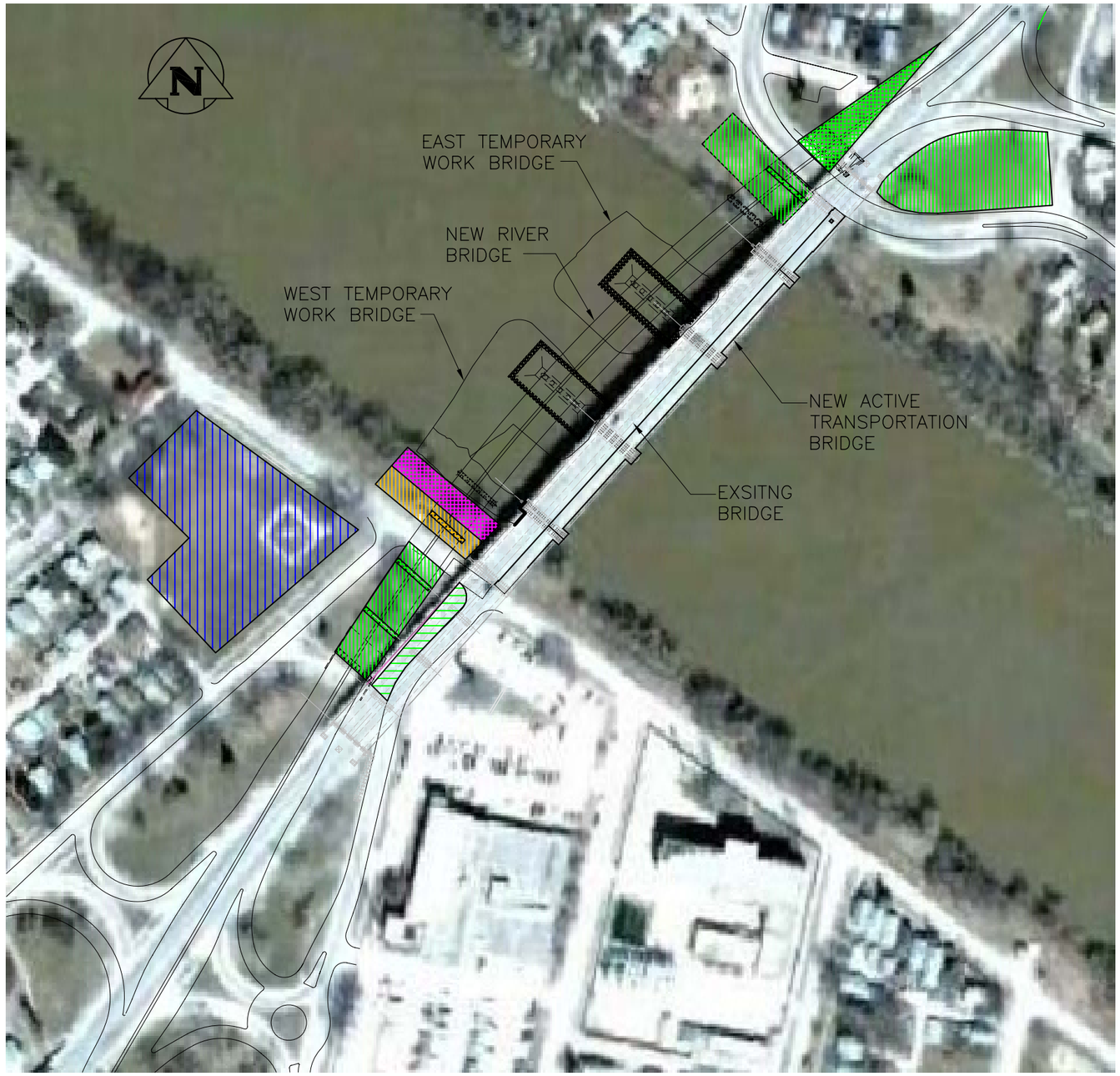
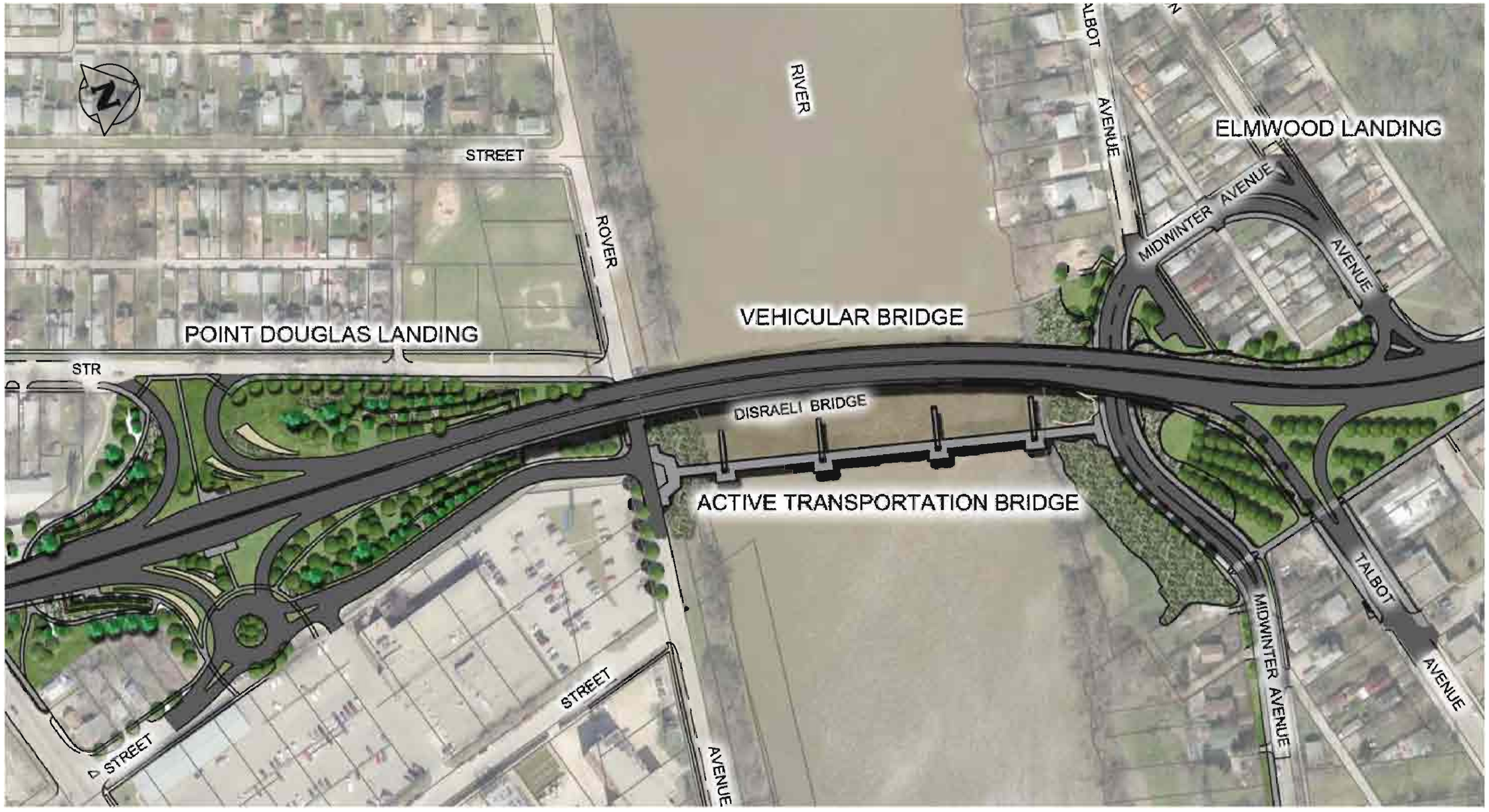


FIGURE 7.1
DISRAELI BRIDGES PROJECT
EFFECT OF PROJECT ON VEGETATION

Table 7.1 Summary of changes to vegetation within the local study area at the Disraeli Bridges Project

Feature	Temporary Loss (m^2)			Permanent Loss (m^2)			Permanent Gain (m^2)
	Grassland	Park	Greenspace	Riverbottom Forest	Grassland	Greenspace	Greenspace
West bank of river, beneath new bridge	235			300	65		
West bank of river, access ramp for work bridge	300			300			
West bank of river, between new bridge and AT bridge	300			300			
West side of river, new bridge alignment between Disraeli Street and Gladstone Street						600	600
East side of river, beneath new bridge			285			65	
East side of river, access ramp for work bridge			350				
East side of river, between new bridge and AT bridge			350				
East side of river, new bridge alignment						150	
Laydown area, Barber Buffer Park		5500					
Laydown area, between Midwinter Avenue and Talbot Avenue			3000				
Total (m^2)	**835**	**5500**	**3985**	**900**	**65**	**815**	**600**
Net Change (m^2)				**-900**	**-65**	**-815**	**600**

Note: 600 m^2 of riverbottom forest will be revegetated, but the recovery will take considerable time and it is categorized as a permanent loss in this effects assessment



WARDROP
A STANTEC COMPANY

PEOPLE, PASSION, PERFORMANCE.
TRUSTED GLOBALLY

FIGURE 7.2
DISRAELI BRIDGES PROJECT
LANDSCAPING

1000070301–SKT–V0087–A

7.2.2 WILDLIFE AND HABITAT

7.2.2.1 EFFECTS AND MITIGATION

Construction

Wildlife and habitat are expected to be affected by the Project during the construction phase. Riparian and upland vegetation will be cleared along the new river bridge right-of-way and at the access points to the Red River for the construction of the temporary work bridges. On the east side of the river, effects will be limited to greenspace areas of grass and occasional trees. The riverbank vegetation has already been disturbed by ongoing stabilization activities to address bank failure and erosion. On the west side of the river the Project works will result in the loss of river bottom forest and grassland on the riverbank and greenspace in the upland areas. All disturbed areas will be replanted following the works, however, the river bottom forest will take decades to re-grow.

Construction activities will temporarily disturb birds temporarily using habitat in the Project area. The work areas will be cleared beginning in the winter months before birds are seeking nesting areas therefore nesting birds will not be disturbed. Birds roosting and nesting under the bridge spans will be displaced when the existing structures are demolished.

Noise, vibration, and human presence are expected to cause bird and mammal species to avoid or migrate away from the Project area. More sensitive species will likely migrate farther than species acclimated to human activities. Resident species will likely migrate to other suitable habitat along the riverbank once works on-site begin. Effects will be temporary, lasting only as long as the construction activities.

Operation

Birds and mammals are expected to colonize the Project area following the completion of the construction activities therefore there are no adverse effects anticipated during the operation phase of the Project.

7.2.2.2 RESIDUAL EFFECTS

Construction

There will be a permanent loss of 300 m^2 of river bottom forest habitat under the new river bridge; 600 m^2 of cleared forest that will be re-planted, but will take decades to mature. Birds and mammals are expected to colonize and make use of the re-planted areas while the forest matures.

Operation

There are no anticipated adverse residual effects from the Project on wildlife during the operation phase.

7.3 AQUATIC ENVIRONMENT

7.3.1 SURFACE RUNOFF MANAGEMENT

7.3.1.1 EFFECTS AND MITIGATION

Construction

Site drainage is currently handled through the existing land drainage system consisting of storm relief and combined sewers. Alterations to the existing site drainage patterns will be minimal (see section 5.2.7). All the new river bridge deck drainage will be captured and directed into the existing stormwater management system. There will be minor alterations to the land drainage system east of the Red River to accommodate the new road plan. The two existing outfalls to the Red River on the east bank will be replaced by a single new outfall. The outfall will be located within the area of east bank armouring and will be installed in the winter months during the armouring works. The connecting pipe will be installed by pushing the pipe from the upland origin to the outfall thereby avoiding bank disturbance through trenching. None of the existing drainage facilities on the Disraeli Freeway west of the Red River and on Henderson Highway will be altered.

Short-term (limited to the construction phase of the Project) modifications to existing drainage patterns have potential to in increased erosion and result in sediments entering the Red River. Sediment and erosion control measures will be installed prior to the start of works and maintained until a vegetative cover can be re-established.

Operation

The Disraeli Bridges Project has been designed to minimize alterations to drainage patterns and there are no anticipated effects of the Project on surface water drainage patterns during the operation phase.

7.3.1.2 RESIDUAL EFFECTS

Construction

There are no anticipated residual effects of the Project on surface water drainage patterns during the construction phase.

Operation

The Project is not expected to have an effect on surface water drainage during the operation phase and therefore will not have any residual effects.

7.3.2 SHORELINE AND RIVERBANK STABILITY

7.3.2.1 EFFECTS AND MITIGATION

The east bank of the Red River in the vicinity of the existing Disraeli Bridge has a history of instability dating back to the 1970s. No stabilization measures are known to have been implemented to address the identified instability. Ongoing riverbank movements have been observed recently on the east bank in the area of the existing and proposed bridge locations. To address the riverbank instability issues, riverbank stabilization works will be conducted during the new river bridge construction. Less invasive measures can be utilized by incorporating these works into the Disraeli Bridges Project, such as drilling rather than trenching along the riverbank.

Construction

The east riverbank stability improvement works will include rockfill columns, upper riverbank offloading and slope regarding, and slope armouring. Rock columns will be installed along the crest of the east bank in three phases. Phase I has been completed. Phase II includes the installation of 48 rock columns from December 2010 to January 2011, and phase III includes the installation of 55 columns from December 2012 to January 2013. Slope flattening upslope of the rock columns is intended to improve the overall river bank stability. Rock armouring will be placed on the slope to provide erosion protection and improve toe stability.

Operation

There are no anticipated effects of the Project on shoreline and riverbank stability during the construction phase. The east bank stabilization works will result in improved river bank stability during the operation phase of the Project.

7.3.2.2 RESIDUAL EFFECTS

Construction

There are no anticipated residual effects of the Project on shoreline and riverbank stability during the construction phase.

Operation

The long term residual effects of the Project will be improved riverbank stability and erosion protection.

7.3.3 SURFACE HYDROLOGY

7.3.3.1 EFFECTS AND MITIGATION

Construction

The in-water works, including the installation of temporary work bridges during construction and the placement of the new river bridge river piers SU5, SU6 in the river channel have the potential to affect the Red River hydrology. The temporary work bridges will confine the Red River flow to a narrower, central channel. These work bridges will be installed and recovered during the lowest annual flow period (October to March; Table 6.8). The potential effects on river hydraulics during construction are scouring and sediment transport.

The Environmental Fluid Dynamic Code (EFDC) was used to estimate the stability of bed sediment in the Red River in the Disraeli Bridges Project study area under various flow conditions (Appendix G). Table 7.2 summarizes the flow conditions and corresponding bed stresses which for all scenarios that may occur in the study area. During the winter construction, when the river flow will be constrained between work bridges, the maximum bed stress reaches 16.5 N/m^2 for a winter high flow of 154 m^3/s. The modified Shield's diagram was used to determine that 30 mm or larger bed surface material would be stable under the highest stress conditions (< 20 N/m^2). Under normal seasonal flows, the scouring and sediment transport will not occur during bridge construction works. During construction, river flows will be monitored daily and flows exceed 154 m^3/s clean 30 mm gravel will be placed in the river channel between the work bridges. The rock that will be used in the construction of the temporary work bridges, pier armouring, and east bank stabilization works will be a minimum of 150 mm therefore these sites are expected to remain stable under all flow conditions during construction and operation.

Table 7.2 Flow conditions and maximum bed stresses in the Red River simulated under various flow rates for current, construction, and operation scenarios at the Disraeli Bridges Project

Flow Rate m^3/s	Current Conditions Maximum Stress N/m^2	Winter Construction Maximum Stress N/m^2	Future Conditions Maximum Stress N/m^2
75		5.74	
154		16.5	
200	0.82		0.89
1005	8.80		9.30
2240	16.2		17.0

Operation

The completed new river bridge will have a broader profile in the river channel than the existing river bridge. During bridge operation with discharges of 200 m^3/s, 1005 m^3/s, and 2240 m^3/s, the maximum bed stresses for future conditions increased by less than six percent over the existing conditions (Appendix G). The new river bridge is therefore not expected to have an effect on the scour and transport of sediment.

Rock placed on the riverbanks or on the riverbed will be graded into the existing substrate profile so as to mitigate the formation of vortices and scouring. These areas include the east bank armouring, the west temporary work bridge pad, and the work area around the pier SU5. The rock placed above the winter ice level on the east bank will be notched into and level with the existing bank profile.

7.3.3.2 RESIDUAL EFFECTS

Construction

Effects of the Project on surface hydrology during the construction phase will be limited to that phase.

Operation

There are no anticipated residual effects of the Project on surface hydrology during the operation phase.

7.3.4 SURFACE WATER QUALITY

7.3.4.1 EFFECTS AND MITIGATION

Construction

There is potential for water quality to be affected during the construction of the temporary work bridges through the disturbance of hydrocarbon contaminated sediment during in-water works, the excavation of contaminate soil, and sedimentation from disturbed riverbanks.

An estimated 1000 m^3 of potentially contaminated porewater is will be released from the riverbed from the consolidation of contaminated sediments during the construction of the west temporary work bridge. The porewater release will occur over the five days of work bridge construction at a rate of 200 m^3/d and will be rapidly diluted by the Red River flow. A conservative model was derived assuming that the daily release of the porewater would be instantaneous as the work bridge is constructed. Additionally, the area of the temporary work bridge (3330 m^2) spans approximately one third of the width of the Red River at the project site and as such, any dilution of the porewater released is assumed to occur only within the limited (one third) area above the work bridge site.

The porewater dilution by the Red River was estimated as follows:

$DF = V_{RR} / V_{PW} * AF$

where,

DF = dilution factor;

V_{RR} = average, instantaneous daily flow volume (9,072,000 m^3/day) of the Red River for October and November (data from a hydrological station nearest to the project site;

V_{PW} = estimated volume (200 m^3) of porewater released per day; and,

AF = limited dilution area factor (equal to one third).

Porewater quality sampled at four stations within the west temporary work bridge zone was used to provide the undiluted porewater PAH concentrations (ENSR 2007). The calculated dilution factor (15,120) was applied to the measured porewater PAH concentrations and added to the existing mean river PAH concentrations. These values were compared to MWQSOG to estimate the potential for adverse effects on aquatic organisms of the porewater release into the Red River (Table 7.3). Estimated river water concentrations after the estimated porewater release do not exceed the surface water MWQSOG for the protection of aquatic life.

During installation of the work bridges and the east bank rock armour (below the ice level), there will likely be some sediment re-suspension resulting in elevated total suspended solids (TSS) concentrations. The extent of this effect is expected to be one week and limited to the local study area. Any water generated during the installation of the river piers will be contained, assessed, and treated, if necessary, as per the caisson RAP therefore there are no anticipated effects from groundwater. Similarly, potential contaminated soils from the upland works will be contained as per the upland RAP. Sediment and erosion control measures will be installed around all in-channel work areas prior to the start of works and maintained until vegetation is re-established.

Operation

There are no effects of the Project on surface water quality during the operation phase.

7.3.4.2 RESIDUAL EFFECTS

Construction

Effects of the Project on surface water quality during the construction phase will be limited to that phase.

Operation

The Project is not expected to have an effect on surface water quality during the operation phase and therefore will not have any residual effects.

Table 7.3 **Mean polycyclic aromatic hydrocarbons (PAH) concentrations in: (i) porewater from sediments collected within the temporary work bridge area of the Red River at the Disraeli Bridge (ENSR 2007); (ii) mean river water calculated from UMA (2007) and CH2MHill (1995); and (iii) estimated concentrations of river water upon mixing with pore water. Shaded values exceed the *Manitoba Water Quality Standard, Objectives, and Guidelines* for the protection of aquatic life (MWQSOG; Williamson 2002). Units are µg/L. DL- detection limit.**

PAH	Porewater PAH (ENSR 2007)				[a]Mean River Water	Estimated Riverwater PAH (after dilution)				MWQSOG
	Station					Station				
	MH02	MH14	MH16	MH19	<DL	MH02	MH14	MH16	MH19	
Naphthalene	<DL	3020	1290	2720	<DL	--	0.200	0.085	0.180	1.1
2-Methyl Naphthalene	<DL	511	452	486	<DL	--	0.034	0.030	0.032	
1-Methyl Naphthalene	<DL	343	352	331	<DL	--	0.023	0.023	0.022	
Acenaphthylene	<DL	406	384	366	<DL	--	0.027	0.025	0.024	
Acenaphthene	0.017	64.2	57.3	64.7	<DL	<0.0001	0.0042	0.0038	0.0043	5.8
Fluorene	0.023	4.44	5.28	4.21	<DL	<0.0001	0.0003	0.0003	0.0003	3.0
Phenanthrene	0.085	72.6	101	71.2	<DL	<0.0001	0.0048	0.0067	0.0047	0.4
Anthracene	0.017	11.4	16.2	11	<DL	<0.0001	0.0008	0.0011	0.0007	0.012
Fluoranthene	0.091	6.19	15.3	5.94	0.0058	0.0058	0.0062	0.0068	0.0062	0.04
Pyrene	0.049	4.36	12.3	4.21	0.0036	0.0037	0.0039	0.0044	0.0039	0.025
Benzo(a)anthracene	0.012	0.139	0.735	0.12	0.0027	0.0028	0.0028	0.0028	0.0028	0.018
Chrysene	0.008	0.09	0.488	0.09	<DL	<0.0001	<0.0001	<0.0001	<0.0001	
Benzo(b+k)fluoranthene	<DL	<DL	0.153	<DL	NA	--	--	<0.0001	--	0.015
Benzo(e)pyrene	<DL	<DL	0.088	<DL	NA	--	--	<0.0001	--	
Benzo(a)pyrene	<DL	<DL	0.149	<DL	0.0006	--	--	0.0007	--	0.015
Perylene	<DL	<DL	0.031	<DL	NA	--	--	<0.0001	--	
Indeno(1,2,3-cd)pyrene	<DL	<DL	0.014	<DL	<DL	--	--	<0.0001	--	
Dibenzo(a,h)anthracene	<DL	<DL	<DL	<DL	<DL	--	--	--	--	
Benzo(g,h,i)perylene	<DL	<DL	0.022	<DL	<DL	--	--	<0.0001	--	
Total PAH34	0.421	4630	2850	4280	NA	<0.0001	0.3062	0.1885	0.2831	

[a]Mean river water calculated from 28 UMA (2007) samples and 8 CH2M Hill (1995) samples.

7.3.5 SEDIMENT QUALITY

7.3.5.1 EFFECTS AND MITIGATION

Construction

The Project will have a local effect on the physical composition of the river bottom sediment as a result of the placement of limestone rock (mixed boulder and cobble size) over the existing silt substrate for construction of the temporary west work bridge. The change is permanent and limited to the area of the west work bridge (the east bridge rock will be removed following caisson construction). It is a neutral or potentially beneficial effect and no mitigation is required.

A change in substrate composition (grain size) will result from the placement of limestone rock (mixed boulder and cobble size) over the existing silt substrate prior to the temporary west work bridge construction. The area affected would be localized to the west work bridge for pier SU6. Rather than removing all of the rock and geotextile following construction (note geotextile is not planned for the east work bridge), and potentially disturbing the underlying hydrocarbon-contaminated sediment, 0.6 m of the new substrate overtop of the geotextile (primarily cobble size) will remain in place for the lifetime of the new bridge. The remaining cobble substrate is expected to have a positive impact on benthic invertebrate and fish by increasing the quality of habitat and is not expected to introduce any adverse changes to sediment quality chemistry in the area. Conversely there will not be a change in substrate composition at the east work bridge as the remaining rock will be dredged from the river following construction of the caissons.

Operation

There are no anticipated effects of the Project on sediment quality during the operation phase.

7.3.5.2 RESIDUAL EFFECTS

Construction

The construction phase will result in a permanent change to the physical composition of the river bottom sediment as a result of the placement of limestone rock over the existing substrate. This effect will be neutral or potentially beneficial and limited to the area of the west work bridge

Operation

The Project is not expected to have an effect on sediment quality during the operation phase and therefore will not have any residual effects.

7.3.6 BENTHIC INVERTEBRATES

7.3.6.1 EFFECTS AND MITIGATION

Construction

There will be four areas of in-water works at the Disraeli Bridges Projects: pier SU5, pier SU6, pier SU7, and the east bank stabilization that could affect the benthic invertebrate community (Figure 7.3). The potential effects include temporary alterations, permanent alterations, permanent losses, and permanent additions to benthic habitat.

Several project works will be conducted in areas of habitat that The installation of pier SU5 will occur within the littoral area between the NSWL and winter ice level. This area is degraded as a result of ongoing water management activities (i.e. seasonal operations of the St. Andrews Lock and Dam). The littoral area above the 2 m isobath is exposed to air and is frozen over winter when the curtains at the St. Andrews Lock and Dam are raised each October, the Red River at the project site is drawn down by approximately 2 m. The placement of rock in this area will therefore have a temporary and negligible affect on the benthic invertebrate community.

All Project-related disturbances of the riverbed, whether through the placement of rock or through the recovery of temporary rock, are expected to have a negligible effect on benthic productivity. Works conducted at or below the NSWL during the winter months will be take place when benthic productivity is at an annual low. Because the Red River is a highly productive waterbody and produces abundant drift, work areas will be re-colonized the following spring (Williams and Hynes 1976). Bivalve density in the project area is low (35 individuals per m^2) and comprised entirely of small clam species (Sphaeriidae) while no mussel species (Unionidae) or species-at-risk are known to inhabit the area.

Operation

There will be no in-water works during the operations phase of the Project. Bridge Maintenance works will be conducted from the bridge superstructure and include the use of containment structures such as a catchment deck to catch any materials and debris produced as a result of maintenance activities. Captured materials and debris will be removed from site.

Rock placed on the riverbanks, riverbed, and around the river piers will remain stable and not require periodic maintenance therefore there will be no adverse operational effects on the benthic invertebrate community.

7.3.6.2 RESIDUAL EFFECTS

Construction

There will be a net increase in area and diversity of benthic habitat as a result of the Project-related works. There are no anticipated adverse residual effects to benthic invertebrate productivity. The increase in available habitat will increase benthic productivity in the project area. For example, cobble-size substrate is preferred over silt/clay substrate by most filter-feeding freshwater mussel species (Clarke 1981). The increase in habitat diversity will have commensurate effects on benthic community diversity.

The rock placed over the contaminated sediments is not expected to produce any adversely affect the behavior of the contaminants within the sediment therefore there will be no change in the exposure of the benthic invertebrate community to the sediment contaminants.

Operation

There will be no residual effects of the Project on benthic invertebrates during the operation phase.

7.3.7 FISH AND FISH HABITAT

The upland works, which include the construction of the new river bridge abutments and land piers SU2, SU3, and SU9, are outside and isolated from the river channel therefore these activities will not affect fish and fish habitat. The in-channel works, including construction of the new river bridge land piers SU4 and SU8 and river piers SU5, SU6, and SU7 have the potential to affect fish and fish habitat. Potential effects could be produced through the removal of riparian vegetation, the disturbance of the river banks, temporary disturbance of the river substrate, and the alteration and loss of river substrate.

7.3.7.1 EFFECTS AND MITIGATION

Construction

Riparian Vegetation and Bank Disturbances

Riparian vegetation will be cleared from the work areas including the east bank stabilization, land piers SU4 and SU8, and to develop access to the river to conduct the in-water works. The potential effects are erosion and sedimentation. Only the minimum area of vegetation necessary to conduct the works will be cleared. Sediment and erosion control measures will be installed along the river banks prior to the start of works to contain the sites and prevent the entry of sediment into the watercourse. The mitigation measures will be inspected regularly during the course of construction.

Following construction, access road material will be recovered, disturbed areas will be contoured and planted, and sediment and erosion control measures will be maintained until the vegetation cover has been established.

Substrate

There will be three areas of in-water works at the Disraeli Bridges Projects: pier SU5, pier SU6, and pier SU7 (Figure 7.3). The potential effects include temporary alterations, permanent alterations, permanent losses, and permanent additions to the Red River substrate. The total footprint of the works will be 5,799 m^2 and upon completion of the works there will be a net increase in substrate of 145 m^2 (Table 7.4). The net increase in area will result from the placement of rock around the river piers. There is no critical habitat, as defined by DFO (1998), identified in the project footprint or the study area and there will be no net loss of fish habitat following the construction phase. The specific changes at each work location are described below.

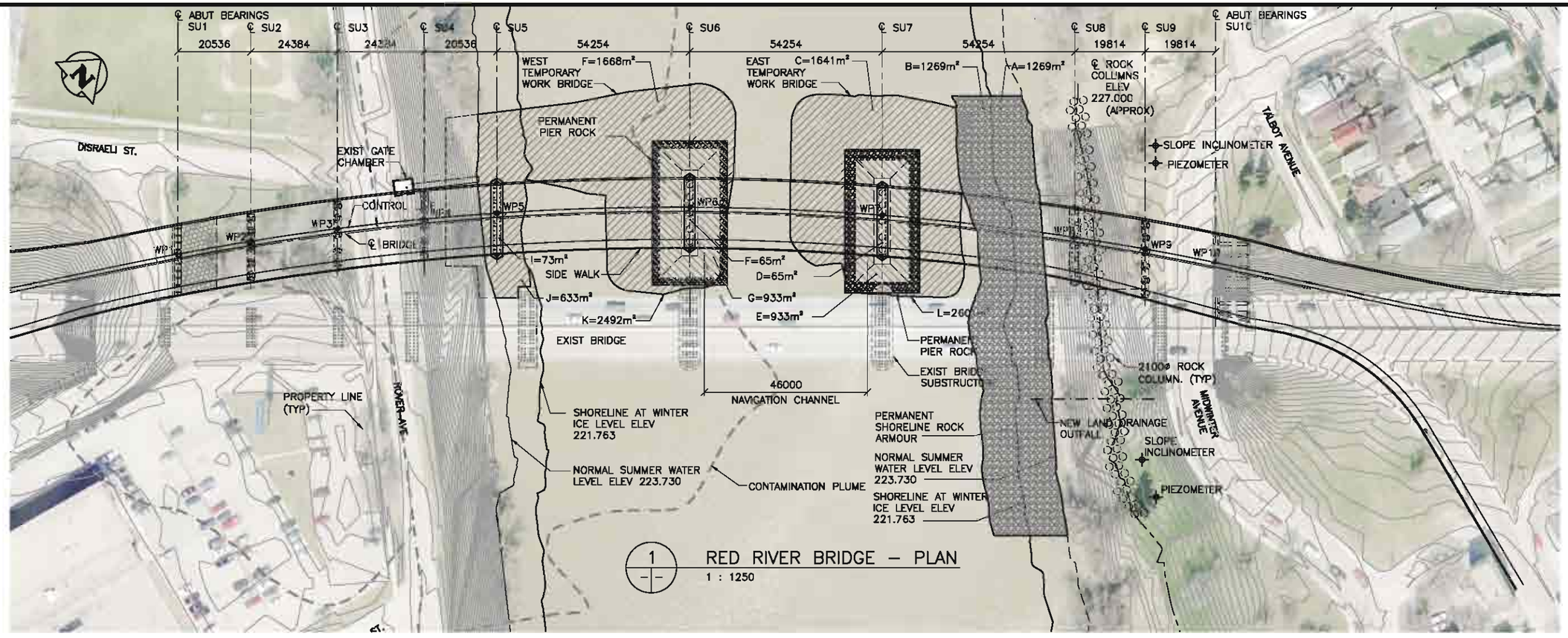
Table 7.4 Summary of river substrate alterations within the local study

Feature	Area of Works (m^2)	Temporary Disruption (m^2)	Permanent Alteration (m^2)	Permanent Loss (m^2)	Permanent Gain (m^2)	Net Change (m^2)
Pier SU5	706		633	-73		-73
Pier SU6	2,492		2,616	-65	189	124
Pier SU7	2,601	1,762	933	-65	159	94
Total	**5,799**	**1,762**	**4,182**	**-203**	**348**	**145**
Gain/Loss Ratio						**1.7:1**

Pier SU5 is located on the west bank between the normal summer water level (NSWL) and the winter ice level (Figure 7.3). The soil and sediment in the work area is contaminated. In order to mitigate the risk of disturbing the contaminants, a 706 m^2 permanent layer of clean, cobble-size limestone will be placed on the riverbank and around the work area to provide access to the pier and to create a work platform while minimizing disturbance to the underlying contaminated soil and sediments. Recovery of all of the limestone following pier installation is not possible without disturbing the underlying contaminated soil and sediments therefore the bottom layer of rock will be left in place following the completion of the works. The edges of this bottom layer will be sloped into the surrounding riverbed grade to remove sharp edges which could create vortices and result in sediment scouring. Sediment and erosion control measures will be installed around the work area to contain the site and prevent the entry of sediment into the watercourse. The mitigation measures will be inspected regularly during the course of construction. Pier SU5 will result in the permanent loss of 73 m^2 of substrate while the rock layer will permanently alter 633 m^2 of silt/clay substrate into cobble substrate. The net change in available substrate at pier SU5 will therefore be -73 m^2.

The construction site for pier SU6 will be accessed by installing a temporary work bridge from the west bank (Figure 7.3). The work bridge will be 2,492 m^2 and constructed of clean limestone. It will not be possible to recover the entire work bridge following construction without risking the disturbance of the underlying contaminated sediment therefore the mitigation measure is to leave the bottom layer (0.45 to 0.65 m) of cobble-size (150 mm) limestone in place on the riverbed. The edges of this bottom layer will be sloped into the surrounding riverbed grade to remove sharp edges which could create vortices and result in sediment scouring. The bottom rock layer will permanently alter 1,668 m^2 of silt/clay substrate into cobble-size rock substrate. Pier armouring placed around SU6 will occupy a footprint of 824 m^2 of deep water silt/clay substrate but will provide 948 m^2 of cobble substrate of varying depth for a gain of 189 m^2 of substrate. Pier SU6 will result in the permanent loss of 65 m^2 of substrate within the footprint of the pier but with the additional substrate area from the pier armour the net change will be a gain of 124 m^2.

The construction site for pier SU7 will be accessed by installing a temporary work bridge from the east bank (Figure 7.3). The work bridge will be 2,601 m^2 and constructed of clean limestone. The east side of the Red River is not contaminated therefore the work bridge will be entirely recovered down to the original substrate and resulting in a temporary disruption of 1,762 m^2 of river substrate. Pier armouring placed around SU7 will occupy a footprint of 839 m^2 of silt/clay substrate but, will provide 933 m^2 of cobble-size substrate for a gain of 159 m^2 of substrate. Pier SU7 will result in the permanent loss of 65 m^2 of substrate within the footprint of the pier but with the additional substrate area from the pier armour will result in a net gain of 94 m^2.



1 RED RIVER BRIDGE – PLAN
1 : 1250

WARDROP
A TETRA TECH COMPANY

PEOPLE, PASSION, PERFORMANCE.
TRUSTED GLOBALLY

FIGURE 7.3
DISRAELI BRIDGES PROJECT
IN-WATER WORK AREAS

1000070301–SKT–V0088–A

The installation of pier SU5 will occur within the littoral area between the NSWL and winter ice level. Area of habitat is degraded as a result of ongoing water management activities (i.e. seasonal operations of the St. Andrews Lock and Dam). When the curtains at the dam are raised each October, the Red River at the project site is drawn down by approximately 2 m over a period of 10 to 14 days. The littoral area above the 2 m isobath is then exposed to air and is frozen over winter. The placement of rock in this work area will therefore not affect the habitat.

Operation

There will be no in-water works during the operation phase of the Project. Bridge maintenance works will comply with the Fisheries and Oceans Canada *Bridge Maintenance* operational statement. Works will be conducted from the bridge superstructure and include the use of containment structures such as a catchment deck to catch any materials and debris produced as a result of maintenance activities. Captured materials and debris will be removed from site.

Rock placed on the riverbanks, riverbed, and around the river piers will remain stable and not require periodic maintenance. The minimum diameter of the rock will be 150 mm. This rock-size will remain stable in flows of up to 10,000 m^3/s, which exceeds any historic flood levels (Appendix G). With the capacity of Winnipeg Floodway recently expanded to 4,000 m^3/s (1:700 yr flood event) it is unlikely any future flood event would exceed 2,331 m^3/s at the Project site (Appendix G).

7.3.7.2 RESIDUAL EFFECTS

Construction

The combined footprint of piers SU5, SU6, and SU7 will result in a substrate loss of 203 m^2 in the project area. However, because the rock armouring around piers SU6 and SU7 provide a greater area than the footprints occupied, there will be a combined substrate gain of 348 m^2 resulting in a net substrate gain for the project of 145 m^2 and a commensurate gain in habitat productivity (Table 7.4).

As described above, the combined historic effects of the St. Andrews Lock and Dam and the Winnipeg Floodway have resulted in the impoundment and continuing accumulation of sediment in the Red River reach that includes Winnipeg. Historical habitat features have been buried by accumulations of silt and clay and resulted in a relatively uniform channel of which almost 92% is a silt/clay dominated substrate (Table 7.5). The in-channel works will convert silt/clay substrate into cobble-size substrate, providing an increase in overall substrate diversity within the local study area, and in effect reversing some of the historic impacts of the downstream water control structures (Table 7.5).

Table 7.5 Summary of river substrate in the local study area before and after the bridge works

Substrate Type	Before Works		After Works		Net Change (m^2)
	Area (m^2)	%	Area (m^2)	%	
Soft silt/clay	1,289	1.14	1,135	1.00	-154
Soft silt/clay w/sand/gravel	200	0.18	200	0.18	0
Soft silt/clay w/cobble	466	0.41	427	0.38	-39
Medium silt/clay	101,915	90.21	97,057	85.80	-4,858
Medium sand/gravel w/silt/clay	6,381	5.65	6,381	5.64	0
Hard Cobble	2,729	2.42	7,925	7.01	5,196
Total	**112,980**	**100**	**113,125**	**100**	**145**

The project works will also provide beneficial influences to fish and fish habitat that extend beyond the project area. Aside from the piers of the existing river bridge, there is no significant submerged structure in the local study area. The rock armouring around the piers will provide significant submerged structure in an area of very low structural diversity. The pier armouring will also create current shadows providing cover and current breaks extending downstream from the piers.

The in-channel works when completed will have no adverse effects on fish and fish habitat. Overall, the works will result in positive affects through an increase in the area and diversity of fish habitat. The bridge works will provide a greater area of productive benthic habitat as well as an increase the diversity of substrates available for the lifecycle requirements of the various species in the study area. The new river piers will provide structure in a section of the Red River channel characterized by little available structure.

Operation

There will be no residual effects of the Project on fish and fish habitat during the operation phase.

7.4 HUMAN ENVIRONMENT

7.4.1 HUMAN HEALTH AND SAFETY

Safety is of the utmost importance to the City of Winnipeg with respect to the Disraeli Bridges Project. Safe working conditions will be maintained for all Project personnel and the Project has been designed and will be constructed and maintained in a manner that secures the safety of the public (commuters and adjacent property owners).

7.4.1.1 EFFECTS AND MITIGATION

Construction

Occupational Health and Safety

The City and PRW are dedicated to providing and maintaining a safe and healthy work environment for all personnel throughout the construction and maintenance period of the Project. Occupational health and safety measures include:

- Effective implementation and utilization of the PCL Health, Safety and Environment Plan (HSEP).
- Effective implementation and utilization of the PCL Internal Responsibility System.
- Effective communication systems including site orientations/training, hazard assessments/control, safe work procedures meetings, tailgate meetings, safety committee meetings and incident reporting.
- Strict adherence to the Manual of Temporary Traffic Control in Work Areas on City Streets (newest edition).
- PCL currently maintains a valid Certificate of Recognition ("COR") recognized in Manitoba confirming that PCL is compliant with Manitoba legislated safety requirements. Both PCL and Plenary Group will, where practical, utilize subcontractors that have received COR certification through the Manitoba. Construction Safety Association or Manitoba Heavy Construction Association.
- All construction activities will comply with Manitoba's Workplace Safety and Health Act.
- Appropriate signage regarding construction and lane closures will be supplied and installed by qualified personnel to allow construction to proceed safely.

Public Health and Safety

Public health and safety measures during the construction phase of the Project include:

- Traffic barriers (temporary and permanent), if required, will be in accordance to standard City practices using concrete F-shape barriers. Aluminum traffic rails will be used on all the outside traffic barriers.
- Site security measures, including:
  - Site fencing, constructed of 1.8 m high chain link fencing and installed by qualified installers, will enclose all areas of construction for the new river bridge.
  - During construction hours, security will be provided by PCL or a subcontractor's workforce.
  - Schedule and secure smaller, manageable, and specific areas of construction.

- Closed-circuit TV and/or drive by security for after hours and unattended site protection.
- Fall protection (i.e. preventing injury from falls off the structures) physical barriers that exist for worker protection will be maintained after hours.
- All temporary road access will be secured with temporary construction fencing or signage when not in use.
- Temporary snow fencing will be installed on the frozen river ice to secure work areas.
- When not in use, heavy equipment will be secured and parked in a common location, as per normal industry practice.

- Traffic will be protected from falling debris from the existing bridge demolition and new construction by the presence of protective covers over the roadways. If these covers reduce the posted clearance, PRW will advise the City's Transportation Services department (1 month in advance), post appropriate signage, post notices in the local newspapers (1 week in advance) and notify local radio stations which provide traffic information (1 day in advance).

Pedestrian and Cyclist Health and Safety

Risk to pedestrian health and safety is not anticipated to increase during the construction phase. Pedestrian access across the bridge will not be permitted for a period of approximately one year due to sidewalk works.

Cyclists will be permitted to continue to use the bridge during construction. Risk to cyclist health and safety is not anticipated to increase during the construction phase.

Operation

Occupational Health and Safety

All maintenance work conducted during the operation phase will utilize the same health and safety policies as during the construction phase of the Project and will comply with Manitoba's *Workplace Safety and Health Act*.

Public Health and Safety

Public health and safety measures for the operation phase of the project include:

- Safety audits will be performed at various stages of the Project to determine, from the perspective of the road user, the potential for the geometry and operation features to contribute to collisions.
- On the new river bridge vehicle traffic lanes will be wider than existing lanes to improve safety for vehicles.

Pedestrian and Cyclist Health and Safety

The Project is being designed as per the Canadian Highway Bridge Design Code (CHBDC; 2006) and Crime Prevention Through Environmental Design (CPTED) strategies. Public safety features incorporated into the project design include:

- Under-bridge crossings pedestrian lighting and ramp pedestrian lighting.
- Under-bridge crossings moved closer to roadways to increase pedestrian safety through closer vehicle sightlines.
- A sidewalk separated from traffic by a concrete barrier and bike sharrows indicating shared lanes of travel for bicycles and vehicles on the new river bridge.

7.4.1.2 RESIDUAL EFFECTS

Construction

There are no anticipated residual effects of the Project on human health and safety during the construction phase.

Operation

There are no anticipated residual effects of the Project on human health and safety during the operation phase.

7.4.2 EXISTING OR PLANNED LAND USE

7.4.2.1 EFFECTS AND MITIGATION

Construction

There are numerous utilities and services along or in close proximity to the Project site. PRW has initiated proper and ongoing coordination and communication with all affected parties during Project planning to mitigate the potential for a disruption of utility services, including:

- Manitoba Hydro:
  - natural gas
  - power distribution
- MTS (telephone)
- Shaw (cable TV)
- The City of Winnipeg:
  - Waste and Water Department

- Waterways Branch
- Transit
- Traffic signals

Any Project related effects to utilities will be mitigated by:

- Obtaining underground service plans of existing services for potentially affected areas from utilities/service providers or relevant public registries.
- Obtaining information, design, and construction requirements from utility and service providers.
- Confirming alignments as required.
- Identifying crossing locations and potential impacts to both the Project and the utility/service (if any).
- Developing options to avoid, manage, and mitigate potential conflicts.
- Evaluating options with affected utilities and service providers, selecting and finalizing the preferred approaches (e.g. protection, relocation, avoidance), and incorporating feedback from the applicable utilities and service providers.
- Preparing and submitting plans to responsible utility or service authority for final review and signoff.

There are no anticipated losses of utility services to customers as a result of this project.

Operation

The Project components will be on property owned by the City and compatible with all permitted land use and zoning restrictions in the study area. There are no anticipated effects of the Project on existing or planned land use during the operation phase.

7.4.2.2 RESIDUAL EFFECTS

Construction

There are no anticipated residual effects of the Project on existing or planned land use during the construction phase.

Operation

The Project is not expected to have an effect on existing or planned land use during the operation phase and therefore will not have any residual effects.

7.4.3 Economic Development and Local Business

7.4.3.1 Effects and Mitigation

Construction

The City will work with affected stakeholders to accommodate traffic movement. As there will be no lane closures on the bridges during business hours (Monday to Friday, 6 am to 6 pm), the City believes the effect of construction on local businesses will be minimal. Access to private parcels and business will be maintained at all times and coordinated with the owners, either through current or alternate routings.

The Disraeli Bridges Project will have a positive effect on economic development during the construction phase; it will generate approximately 80 construction related jobs for a period of two and a half years.

Operation

There are no anticipated effects of the Project on economic development and local business during the operation phase.

7.4.3.2 Residual Effects

Construction

There are no anticipated residual effects of the Project on economic development and local business during the construction phase.

Operation

The Project is not expected to have an effect on economic development and local business during the operation phase and therefore will not have any residual effects.

7.4.4 Vehicle Use and Traffic Flow

7.4.4.1 Effects and Mitigation

Construction

Of the options considered for bridge reconstruction, the proposed Project will have the least impact on traffic flow, including pedestrians and cyclists. The Project has been designed and scheduled to reduce any disruption to normal traffic flow and avoid rerouting. The effects on traffic flow will be mitigated by employing an effective Traffic Management Plan, the presence of signs and flagpersons, and restricting lane closures to off-peak travel times throughout the construction period.

A Traffic Management Plan will be developed prior to the initiation of any works. The goal of the Traffic Management Plan will be to identify the best possible traffic diversion routes, optimize the safety and efficiency for traffic along the routes, and minimize the impact that construction activities may have on travelers, residents, businesses, emergency services and the environment.

A minimum of four lanes of traffic will remain open on the Disraeli Bridges Project at peak travel times (Monday to Friday 6 A.M to 6 P.M) throughout construction. Lane closures will be limited to off peak hour periods on a limited basis and will allow work to safely proceed for demolition, erection, and construction of overhead work, as well as for the transition and tie-in of the road works to the new bridge. Additionally, traffic flows within the ground level road network of the Point Douglas region are not expected to be affected for long durations.

Additional impacts to traffic and mitigation methods include:

- Several transportation network elements will be revised to ensure safe and efficient passage to the travelling public during the construction period. Revisions include lane-width reductions, speed reductions, temporary access restrictions, on-street parking restrictions and construction traffic restrictions.
- Construction access to the Project will be strategically located in less busy areas, as much as possible; PRW will review these access points with the City prior to installation of the chainlink fencing and gates.
- Gates will be located in areas where access can be gained from existing roads, which minimizes the requirement for temporary access roads.
- The City will ensure that PRW coordinates and schedules oversize delivery loads with the relevant transport companies during off peak traffic hours; certified flagpersons will be used to allow the load to safely enter the Project site and if necessary traffic control plans will be prepared by a qualified engineer to accommodate the oversized loads.
- The City (through PRW) will correspond with Winnipeg Transit on a weekly basis to keep them apprised of current and future roadway construction activities. This communication process will allow the Transit Authority to analyze the effect of the roadway construction activities on their operation and advise their patrons (if necessary) of any delays to their transit times.

PRW will encourage workers, when possible, to utilize the public transit system to access the Project site. In cases where this is not possible, PRW will encourage workers to park in areas that will not significantly impact the local area residents and businesses. Limited parking provisions will be made for site visitors (e.g. the City representatives) to the Project office.

Pedestrian and Cyclists Traffic

Pedestrian access across the bridge will not be permitted for most of the construction period due to sidewalk works. Impact to pedestrian traffic flow was minimized to the extent possible by designing the Project in phases, thus decreasing the closure period from 18 months to one year. It is anticipated that during this time pedestrians will use alternate routes not affected by the Project, such as the Louise Bridge. Cyclists will be permitted to continue accessing the bridge since vehicle lanes will not be restricted. Cyclists and pedestrians will be able to use the new river bridge during construction of the AT bridge.

Operation

The new river bridge has been designed to replace existing structures, and are not expected to have a significant effect on traffic volumes.

Access underneath the Disraeli Freeway at Gladstone Street will be closed. Access at Rover Avenue will be maintained. Sidewalks will connect the community to transit stops located in pull-outs from the travel lanes on both sides of the freeway. A more direct on-ramp will be constructed from Talbot Avenue and a sidewalk will be built where the existing road is located.

The reconstruction of the active transportation (AT) bridge will have a positive effect on pedestrian and cycling traffic. It will improve connectivity to the City's existing AT network and facilitate a safe connection between North Winnipeg Parkway and the Northeast Pioneers Greenway. Pedestrians and cyclists will also be able to use the new vehicular bridge.

The City of Winnipeg Active Transportation Study (Marr Consulting 2005) states that the benefits of accommodating and encouraging demand for modes of AT include reduced traffic congestion at peak periods, reduced need for additional roads, cleaner air through decreased vehicle emissions, more efficient land use, increased ability to attract new residents and tourists, improved health of citizens, improved safety and cleaner air in school zones due to less traffic congestion, reduced noise pollution, and reduced demand for parking. Almost 40% of respondents from a 2004 Public Works telephone survey indicated that additional infrastructure built by the City would encourage them to participate more in active modes of transportation (Marr Consulting 2005).

7.4.4.2 RESIDUAL EFFECTS

Construction

The net effect of the Project construction will be neutral to vehicle use and traffic flow.

Operation

There are no anticipated residual effects of the Project on vehicle use and traffic flow during the operation phase.

7.4.5 EMERGENCY SERVICES AND TRANSIT

7.4.5.1 EFFECTS AND MITIGATION

Construction

Transit Services

The Project design requires the rerouting of Gladstone Street straight to Rover Avenue rather than looping under the Disraeli Freeway to Disraeli Street. This street change will result in a temporary bus rerouting condition during construction and a permanent re-routed condition at completion of construction for the Point Douglas, Main, Fife (97) and Talbot (45) routes.

Transit services will be affected by the closure of Gladstone Street under the Disraeli River Bridge during the construction phase. This will be mitigated by the re-routing of buses from Disraeli Street to Rover Avenue then onto Annabella Street and finally onto Sutherland Avenue

Emergency Services

All emergency services will be contacted at the start of the Project and a detailed procedure and map will be developed indicating the location for each structure and road network. All emergency services within the vicinity will have a drawing of the site evacuation plan, as well as first aid stations and office locations.

Operation

There are no anticipated effects of the Project on emergency and transit services during the operation phase.

7.4.5.2 RESIDUAL EFFECTS

Construction

There will be permanent re-routing of the Fife (97) and Talbot (45) as a result of the Project; the re-routing will have a neutral effect on Transit Services.

Operation

The Project is not expected to have an effect on emergency and transit services during the operation phase and therefore will not have any residual effects.

7.4.6 AESTHETICS

7.4.6.1 EFFECTS AND MITIGATION

The Disraeli Bridges Project has been designed to improve overall aesthetics, including improved lighting, landscape features and other aesthetic elements such as an under-bridge art gallery and gateway features to create a more attractive and residential feel.

Construction

Aesthetics will be negatively impacted during the construction phase of the Project; impacts will include the presence of heavy equipment, construction signage, bridge demolition, etc. These impacts will be short-term (limited to the construction phase) and the geographic extent will be localized (limited to the Project site).

Operation

There are no anticipated effects of the Project on aesthetics during the operation phase.

7.4.6.2 RESIDUAL EFFECTS

Construction

Residual effects of the Project on aesthetics are positive. New aesthetic elements/improvements of the Disraeli Bridges Project are designed to complement the City's vision of Winnipeg as a vibrant and healthy city. Aesthetic improvements include:

- Gateways and public art features will enhance the Project and entryways to adjacent communities.
- Lighting and attractive banners will run the length of the vehicular bridge.
- While separate structures, the vehicular and AT bridges will be architecturally and aesthetically harmonious.
- Attractive landscaping at the Elmwood and Point Douglas landings. Landscaping treatments will:
  - Create a more residential feel for adjoining neighbourhoods and a convenient park-like haven for residents, pedestrians and cyclists.
  - Enhance the safety of those using these areas by providing well lit and open spaces.
  - Buffer the sight and sound of the Freeway.

- Improve the aesthetic appeal of the green spaces with trees, shrubs, grass, attractive benches and other furnishings.
- Ensure more plantings and green space will be visible for those crossing the river bridge by car, bicycle or on foot.

Operation

The operation phase of the Project is not expected to have an effect on aesthetics and therefore will not have any residual effects.

7.4.7 RECREATION AND RIVER USE

7.4.7.1 EFFECTS AND MITIGATION

Navigation will be maintained during construction, reconstruction, and operation of the bridges. In-water works will be conducted during the winter months, outside of the navigation season. Some overhead works such as deck installation, finishing, and existing bridge superstructure demolition will occur during the navigation season.

Construction

Navigation will be maintained down the centre of the river during construction, except when construction activities occur in this region. When this occurs, the river traffic will then be routed through a safe region.

Temporary navigation lights and markers will be installed to mark the navigation channel and checked on a daily basis for a period of approximately 12 months during the construction schedule (two navigation seasons). PRW will provide the applicable directional and safety signage/buoys to advise water traffic of applicable hazards and safe travel routes through the areas of the Red River affected by the Project.

Operation

There are no anticipated effects of the operation phase of the Project on recreation and river use. The new river bridge will exceed the vertical navigation channel clearances of the existing bridges immediately upstream and downstream of the Project site (Louise Bridge and Redwood Bridge, respectively; Table 5.1). The vertical clearance from the bottom of the bridge deck at mid-span to the NSWL of 223.73 m will be 10.23 m and 4.76 m at the high water elevation of 229.20 m (1997 flood level). The two central river piers will be in-line with the existing bridge piers, therefore there will be no reduction in the existing navigation channel width. Permanent navigation lights will be installed under the bridge deck to mark the navigation channel during operation.

7.4.7.2 RESIDUAL EFFECTS

Construction

There are no anticipated effects of the Project on recreation and river use during the construction phase.

Operation

The operation phase of the Project is not expected to have an effect on recreation and river use and therefore will not have any residual effects.

7.5 ACCIDENTAL RELEASE OF HAZARDOUS MATERIALS

7.5.1.1 EFFECTS AND MITIGATION

The principal source of risk for the accidental release of hazardous materials is the collision of traffic travelling on the bridge or boat collision with the piers. In the case of an accidental spill on land, any materials that could not be contained and cleaned up on surface would collect in the stormwater management system which eventually drains into the Red River. The probability of a spill is low as the bridge has been designed to safely accommodate current vehicular and boat traffic volumes and appropriate signage and lighting will be in place during construction and operation.

Construction

Impacts that may occur during the construction phase are minimized by the requirement of all contractors to adhere to PCL's Health, Safety and Environment Plan (HSEP) for the project. The HSEP includes procedures to prevent accidental releases to the environment (e.g., equipment refuelling procedures) as well as response plans to address accidental release (e.g., puncture of diesel tank of truck).

Operation

Overall, there are expected to be fewer collisions associated with the Disraeli Freeway as a result of new construction, therefore the potential for accidental spills is expected to decrease. During the operation of the Project, the City will continue to ensure that staff has training in spill prevention, containment, clean up and reporting procedures.

7.5.1.2 RESIDUAL EFFECTS

Construction

Although there are no anticipated accidental releases of hazardous materials, in the event that a release did occur, it would have the potential to have a lasting effect. The

probability of a release is low and there are no anticipated residual effects due to an accidental release of hazardous materials during the construction phase of the Project.

Operation

There are no anticipated residual effects due to an accidental release of hazardous materials during the operation phase of the Project. It is anticipated that the possibility of a spill is even lower post construction.

7.6 EFFECT OF THE ENVIRONMENT ON THE PROJECT

7.6.1 CLIMATE CHANGE

7.6.1.1 EFFECTS AND MITIGATION

Manitoba's central location in North America and our northerly latitude means that the province will face earlier and more severe changes to our climate than many other parts of the world (Manitoba Climate Change and Green Initiatives 2010). Predictions suggest that Manitoba will see warmer and wetter winters along with longer, warmer and drier summers. In the winter and spring, Manitoba will likely experience an increase in flooding due to warmer temperatures that will increase rain-on-snow precipitation and the frequency of winter thaws.

Changes in precipitation patterns have the potential to affect transportation infrastructure (Government of Canada 2010). Future increases in the intensity and frequency of heavy rainfall events could have implications on stormwater management and accelerated deterioration of transportation infrastructure, such as bridges, may occur where precipitation events become more frequent.

There are currently no published design criteria for bridges that incorporate climate change considerations. However because flood water flows in the Red River are controlled by the recently upgraded Winnipeg Floodway, any potential flow changes as a result of climate change do not need to be considered in the bridge design.

The Disraeli Bridge Project has been designed to minimize its effect on the environment. The Project has been designed to use recycled materials in the structures (e.g., structural steel). These materials will also be able to be recovered and recycled at the end of the structures service life. Because the Project is a P3, the Project was designed such that maintenance requirements over the life of the Project will be minimized thus minimizing emissions from maintenance activities over the life of the Project.

7.6.1.2 RESIDUAL EFFECTS

A switch to active modes of transportation has the potential to contribute to reduced greenhouse gas emissions and have a positive residual effect.

7.7 CUMULATIVE EFFECTS

There are several projects in or outside the City of Winnipeg that are being considered for cumulative effects with the Disraeli Bridges Project, including: the Osborne Street Bridge Rehabilitation Project, replacement of the Louise Bridge, replacement of the Letellier Bridge, repairs to the Pierre Delorme Bridge, the Winnipeg Floodway, and the St. Andrews Lock and Dam.

The Osborne Street Bridge Rehabilitation Project is scheduled to commence at the beginning of 2011. The project extends from River Avenue to Broadway along Osborne Street, and will involve developing measures to preserve and upgrade the bridge and its approach roadways. Widening the bridge substructure (foundations and piers) is outside the project scope, although ideas are being considered to widen the usable area of the existing bridge without adding additional girders or substructure. This project does not include any in-water works and is not expected to have an effect on aquatic resources. It will likely have a negative effect on traffic flow during the construction phase, but the bridge connects commuters from the south end of the City as opposed to the Disraeli Bridges Project which connects commuters from the northeast end of the City. There are no anticipated cumulative effects from interaction of the Osborne Bridge Rehabilitation with the Disraeli Bridges Project.

The two-lane Louise Bridge is being considered for replacement by a new four-lane bridge over the Red River beginning in 2015 or 2016. Detailed planning for this project is not expected to begin until the Disraeli Bridges Project has been completed and there is no information on the nature of the potential works. It is therefore not possible to determine what if any interaction is possible between the Louise Bridge Project and the Disraeli Bridges Project.

The Letellier Bridge is being replaced with a new bridge across the Red River along Provincial Road #201, north of Emerson. The project is slated for completion in spring 2011. In water-works for this project have the potential to affect aquatic resources such as fish habitat, riparian vegetation, surface water quality and aquatic biota, but the project is approximately 70 km south of the Project, hence, there are no anticipated cumulative effects from the interaction of this project with the Disraeli Bridges Project.

The Pierre Delorme Bridge, St. Adolph, partly collapsed in the summer of 2009 due to riverbank instability; three spans were torn down and the piers supporting them are being replaced. There are also ground stabilization works to prevent the riverbank from moving under the bridge's supports. Repairs began in 2009 and the bridge is slated to re-open by the end of 2010. In water-works for this project have the potential to affect

aquatic resources such as fish habitat, riparian vegetation, surface water quality and aquatic biota. The project is located approximately 25 km south of the Disraeli Bridges Project and will be completed well in advance of in-water works for the Disraeli Bridges Project; hence, there are no anticipated cumulative effects from the interaction of these two projects.

The St. Andrews Lock and Dam (SALD) is located on the Red River at Lockport, MB, 27 km north of the City of Winnipeg. It was built to flood Lister Rapids to a depth of 2.74 m to improve navigation and allow passage of deep draught vessels. It is a unique "Camere" style dam that uses moveable curtains, which are raised or lowered to control water flows. The back flooding in the Red River resulting from the SALD can be observed as far south as St. Agathe, 25 km south of the City. Historically, the SALD has affected the Red River within the City by creating a seasonal riverine reservoir. There are no anticipated interactions between the SALD and the Project.

The Winnipeg Floodway is periodically operated during high flow events to reduce the volume and velocity of water passing through the City. Gates placed within the Red River riverbed south of the City are used to divert flow into a channel that carries the water east and north around the city. The Red River Floodway Expansion Project is a major expansion of the existing floodway protection system that began in 2005 and is currently in its final stages; it includes modifications to the Floodway Channel, replacement and upgrade of six bridge crossings (including PTH 15 bridge and PTH 44 bridge, improvements to the Inlet and Outlet control works, modifications to utilities and services, and the expansion of the West Dike. Construction is continuing on the final stages of the project including: construction of the PTH 44 and PTH 15 Highway Bridges (expected to be completed in the fall of 2010), improvements to the Inlet Control Structure, expansion of the West Dike, and re-vegetation and landscaping of various section of the channel. The floodway is isolated from the Red River at the Project site: the inlet is located upstream of the Project site and the outlet is located downstream. The expansion works are therefore not expected to interact with the Project. Historically, the floodway has had an effect on the Red River in the City through the attenuation of flood events that typical scour sediment from structure and coarse substrate in the river channel. The expanded capacity of the floodway will further reduce the possibility of future flood events scouring sediment from in-stream structure and substrate within the City.

7.8 MONITORING

Manitoba Hydro has prepared and submitted to Manitoba Conservation in 2006 a Comprehensive Environmental Management Plan (CEMP) outlining a proposed monitoring strategy for the former MGP site and the adjacent Red River. The CEMP is currently under consideration by the TAC established by Manitoba Conservation. It is expected that final comments on the TAC review will be compiled and provided to Manitoba Hydro in the coming months and that a final decision on the proposed CEMP will be made by the end of 2010. Because a comprehensive monitoring plan will soon

be in place that will include the Project area, no additional monitoring is proposed except where described.

7.8.1 SOIL CHEMISTRY AND QUALITY

Soil monitoring in the vicinity of the Project has been conducted by Centra Gas and Manitoba Hydro since contaminated soil was initially encountered in the area in 1994. Manitoba Hydro plans to continue soil chemistry and quality monitoring as outlined in the proposed CEMP.

7.8.2 HYDROGEOLOGY

Groundwater monitoring in the vicinity of the Project has been conducted by Centra Gas and Manitoba Hydro since contaminated soil was initially encountered in the area in 1994. Manitoba Hydro plans to continue hydrogeology as outlined in the proposed CEMP.

7.8.3 SHORELINE AND RIVERBANK STABILITY

Two slope inclinometers and several piezometers will be installed in the east riverbank downstream of the existing bridge. The instrumentation will monitor slope movement during the riverbank stabilization activities. The instrumentation will remain in place for monitoring during and after future bridge construction phases.

7.8.4 SURFACE WATER QUALITY

Water quality will be monitored before, during, and after construction of the temporary work bridges. Surface water samples will be collected at monitoring stations on both the east and west banks of the Red River, 25 m upstream and 10 m downstream of the construction zone (total of four stations) and analyzed for the parameters in Table 7.6. Temperature, conductance, dissolved oxygen, TDS, and pH will be measured at each station on each sampling date. The water column will be profiled for these parameters at the surface (0.25 m depth) and 0.25 m above the riverbed.

Water samples will be collected once prior to construction to establish baseline values. Water will be collected daily for five days during the construction phase of the temporary work bridges, and once after construction of the work bridges is complete. Results of the downstream water quality will be compared to baseline and upstream station data, and to the *Manitoba Water Quality Standards, Objectives and Guidelines* for the protection of aquatic life. If data indicate a change in the water quality occurred following construction, which is unrelated to seasonal or weather related events, the frequency of post-construction water quality monitoring will be increased to once per week until baseline values return to pre-construction levels or a probable cause is identified.

Table 7.6 Water quality parameters

Water Quality Parameter	
Major Ions	**Total and Dissolved Metals**
Chloride, dissolved	Aluminum (Al)
Sulphate, dissolved	Antimony (Sb)
Nutrients	Arsenic (As)
Organic Carbon, dissolved	Barium (Ba)
Organic Carbon, total	Beryllium (Be)
Nitrite	Bismuth (Bi)
Nitrate	Boron (B)
Nitrate_Nitrite	Cadmium (Cd)
Ammonia	Calcium (Ca)
Total Kjeldahl Nitrogen	Chromium (Cr)
Total Nitrogen	Cobalt (Co)
Phosphorus, total dissolved	Copper (Cu)
Phosphorus, total	Iron (Fe)
Hydrocarbons	Lead (Pb)
Benzene	Lithium (Li)
Toluene	Magnesium (Mg)
Ethylbenzene	Manganese (Mn)
Xylenes	Mercury (Hg)
2-Methyl Naphthalene	Molybdenum (Mo)
1-Methyl Naphthalene	Nickel (Ni)
Acenaphthylene	Potassium (K)
Acenaphthene	Selenium (Se)
Fluorene	Silicon (Si)
Phenanthrene	Sodium (Na)
Anthracene	Sulphur (S)
Fluoranthene	Tin (Sn)
Pyrene	Zinc (Zn)
Benzo(a)anthracene	**Physicochemical**
Chrysene	pH (pH units)
Benzo(b)fluoranthene	Conductivity (µS/cm @ 25^{o}C)
Benzo(k)fluoranthene	Total Dissolved Solids
Benzo(a)pyrene	Hardness, total
Indeno(1,2,3-cd)pyrene	Total Suspended Solids
Dibenzo(a,h)anthracene	
Benzo(g,h,i)perylene	

7.8.5 *SEDIMENT QUALITY*

Sediment quality monitoring in the vicinity of the Project has been conducted by Centra Gas and Manitoba Hydro since contaminated soil was initially encountered in the area in 1994. Manitoba Hydro plans to continue sediment quality monitoring as outlined in the proposed CEMP.

7.8.6 ROADWAY AND BRIDGES MAINTENANCE & INSPECTION

PRW will conduct bridge maintenance and inspection for the Disraeli Bridges Project during the construction phase (two and a half years) and for 30 years of the operation phase. The City of Winnipeg will be responsible for maintenance and inspection of the Disraeli Bridges Project beyond the initial 30-year period.

Construction

PRW will perform regular maintenance and inspection of the bridge during the construction phase of the Project, including:

- Visual bridge inspections
- Operation maintenance, including regular roadway patrols, streetscape maintenance, drain cleaning, pavement markings and navigation lights
- Minor rehabilitative maintenance such as sidewalk repairs, curb and gutter repairs, barrier repairs and traffic rail repairs

Operation

PRW will establish an Operational Maintenance and Response Team (OMRT) to provide or otherwise procure all inspection and maintenance responsibilities for a period of 30 years after construction.

Bridge maintenance and inspection activities are listed in Table 7.7. These include: (a) operational maintenance such as regular bridge inspections to monitor the current status, identify maintenance issues and perform any necessary repairs and maintenance; (b) preventative maintenance; and (c) rehabilitative maintenance and renewal work. Large repairs and rehabilitative maintenance will be initiated by engineering reports on lifecycle performance of infrastructure and damage reports. In addition, PRW will implement a dedicated local or “1-800 number” hotline (24/7/365 day) for rapid reporting of emergency and maintenance issues identified by the public.

PRW’s design for the bridge structures minimizes the rehabilitative requirements for the Project. However, PRW plans to perform rehabilitative works during the last five years of the 30-year term in order to facilitate hand-back of the Project to the City of Winnipeg in the contracted condition. The work performed will be based on the performance required as set out in the Technical Requirements for the Project.

Table 7.7 Regular inspection and maintenance schedule for the Project

Operational Maintenance	Schedule
Routine roadway inspections to assess condition of infrastructure including, but not limited to: • road/pavement conditions • cleanliness/litter/graffiti • lighting system and lighting & signalization poles • signs • identify safety hazards/damages to structures • drainage systems • roadside/median barriers • grass, weed & landscape condition • snow and ice conditions • bridge structure components	bi-weekly visual inspections
General maintenance, including: • litter cleanup/graffiti removal • sign cleaning/repair • drainage system maintenance/cleaning • embankment slope monitoring/evaluation • curb and gutter monitoring/evaluation • guardrail monitoring/evaluation/repair • bus stop inspection/cleaning/repair • lighting system maintenance/repairs/replacements • pavement and sidewalk maintenance • bridge maintenance • right-of-way maintenance	as required
Bridge inspections and testing to assess the condition, functionality and safety of the bridge structures	annually during the summer months
Confirm the retro-reflectivity of guide signs at night-time	every 60 days
Inspect rutting performance of wearing roadway surface	as required
Pavement marking painting	annually
Street sweeping	weekly, weather permitting
Overall clean-ups	3 times/year
Winter maintenance including: • Ice control (salt, sand) • Snow clearing	as required
Grass cutting, weed control & landscape maintenance	as required
Emergency Response	as required
Preventative Maintenance	
Preventative Maintenance including: • asphalt and concrete crack repair and sealing • pads & bearings • mill and fill and micro-surfacing of asphalt overlay • expansion joint seal replacement	as required
Rehabilitative Maintenance	

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