6.0 EXISTING ENVIRONMENT

6.1 PHYSICAL ENVIRONMENT

6.1.1 CLIMATE

The Disraeli Bridges Project is located in the Winnipeg Ecodistrict of the Lake Manitoba Plain Ecoregion of the Prairies Ecozone. The Winnipeg Ecodistrict belongs to the Grassland Transition Ecoclimatic Region in southern Manitoba. The mid-continental climate is characterized by four seasons with short, hot summers and long, cold winters. Baseline climate data for the regional study area were obtained from the Environment Canada (EC) meteorological station located at the James Armstrong Richardson International Airport in Winnipeg (49° 55.2' N / 97° 13.8' W).

Data were assembled for the 30 year period from 1978 to 2007. Monthly averages (Table 6.1) were calculated from daily data supplied by EC.

Hourly wind data were assembled for the years 2003 to 2007. Monthly averages (Table 6.2) were calculated from hourly data supplied by EC. Windrose Pro Ver 2.3.20 was used to create a windrose plot and determine prevailing wind direction for the region. Mean monthly wind speed varied little over the year, ranging from 14.8 km/hr in July to 19.9 km/hr in April, and mean annual wind speed was 17.8 km/hr. Maximum wind gusts reached 119 km/hr. The prevailing wind direction is primarily from the south and secondarily from the north and northwest in the winter and spring months (Table 6.2; Figure 6.1).

In general, precipitation falls primarily as snow during the winter months, with the greatest snowfalls occurring in November, December and January. Annual average precipitation is 512.4 mm with precipitation peaking in June, July and August (Table 6.1). The most recent rainfall frequency data were available up to the year 1996. Mean 24-hour rainfall intensity was 55.1 mm (Table 6.3; Environment Canada 2010).

Table 6.1 Summary of historical meteorological data collected at Winnipeg, MB (1978-2007) (calculated from daily data supplied by Environment Canada 2010)

	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature - Mean	°C	-16.8	-13.7	-6.2	4.3	11.7	16.9	19.7	18.6	12.8	5.0	-4.9	-13.3	2.8
Temperature - Mean Min	°C	-21.8	-18.8	-11.2	-2.1	4.6	10.6	13.5	12.0	6.4	-0.5	-9.3	-18.0	-2.9
Temperature - Extreme Min	°C	-41.0	-41.8	-37.4	-26.3	-10.1	-1.0	2.7	0.0	-7.0	-17.0	-34.0	-37.0	-41.8
Temperature - Mean Max	°C	-11.7	-8.6	-1.1	10.7	18.7	23.2	25.9	25.1	19.0	10.5	-0.5	-8.6	8.6
Temperature - Extreme Max	°C	7.3	9.0	17.0	34.3	37.0	37.8	35.9	38.7	38.8	30.5	18.2	9.7	38.8
Rainfall - Total	mm	0.2	2.4	9.3	19.5	55.7	86.4	75.1	76.1	47.4	30.4	6.6	1.5	410.6
Snowfall - Total	cm	22.8	12.8	16.7	10.4	2.7	0.0	0.0	0.0	0.2	4.5	20.3	22.0	112.3
Precipitation - Total	mm	19.4	13.9	24.3	30.2	58.5	86.4	75.1	76.1	47.6	34.8	25.2	20.8	512.4
Wind Gust - Maximum	km/h	106	80	106	104	98	115	109	98	98	119	106	98	119

Table 6.2 Monthly prevailing wind conditions at Winnipeg, MB (2003-2007) (calculated from hourly data supplied by Environment Canada 2010)

	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Wind Speed - Mean	km/hr	18.5	16.7	18.5	19.9	18.9	16.9	14.8	16.6	17.3	18.3	18.5	18.1	17.8
Wind Speed - Mean Max	km/hr	56	59	65	63	59	63	57	65	59	63	63	65	65
Wind Direction		WNW & S	S	S	S & N	N & S	S	S	S	S	S	S	S	S

Table 6.3 Rainfall intensity (mm) at Winnipeg, MB (1967-1996) (Environment Canada 2010)

Year	5 Min	10 Min	15 Min	30 Min	1H	2H	6H	12H	24H
1967	12.2	24.1	25.9	31.7	33.0	57.9	63.2	63.5	63.5
1968	17.8	24.6	35.3	39.4	39.4	39.4	48.3	61.2	84.3
1969	7.1	10.4	12.7	15.2	21.8	23.4	25.4	39.1	49.3
1970	11.2	20.8	29.0	37.8	41.1	49.8	54.9	60.5	62.2
1971	4.6	6.1	8.4	11.7	14.5	19.8	25.4	29.0	31.0
1972	9.1	16.5	20.3	35.6	35.6	35.8	35.8	35.8	35.8
1973	6.3	10.4	14.5	19.8	29.7	40.4	45.7	45.7	45.7
1974	9.4	16.3	18.8	25.1	28.7	33.0	37.1	38.9	55.4
1975	9.4	14.5	17.8	22.6	27.9	27.9	44.7	53.8	54.4
1976	15.0	15.7	18.0	21.8	22.1	24.1	26.2	33.3	42.7
1977	7.4	12.4	15.2	19.8	21.6	32.5	50.3	57.7	61.7
1978	10.6	17.6	21.6	24.5	28.0	41.7	52.6	52.6	60.4
1979	10.6	19.1	25.4	36.3	39.3	39.8	40.7	40.7	40.7
1980	7.4	8.8	10.4	15.0	19.3	24.5	25.6	26.6	30.5
1981	10.6	12.4	15.9	18.2	24.1	29.0	53.3	53.4	63.0
1982	8.6	13.0	16.2	22.6	22.7	22.7	32.5	34.9	36.8
1983	13.2	17.2	19.3	23.2	28.0	30.9	51.9	52.3	52.3
1984	12.6	19.0	22.8	39.5	56.2	56.9	60.2	69.5	69.7
1985	5.0	7.3	9.3	12.4	18.4	33.1	61.5	84.0	97.4
1986	10.0	11.8	13.9	16.7	18.5	19.7	28.7	35.4	41.6
1987	7.1	9.0	10.4	20.8	24.8	36.6	46.2	57.2	57.3
1988	7.9	15.8	18.5	22.7	34.8	36.9	39.7	49.7	49.7
1989	4.4	7.7	10.4	12.3	14.1	16.2	34.6	41.1	53.5
1990	9.8	12.7	16.2	19.0	22.0	22.0	22.0	22.5	36.9
1991	11.6	16.4	18.0	18.2	19.3	31.2	43.1	43.5	64.0
1992	8.6	10.2	11.2	17.2	18.0	19.3	21.2	25.2	35.6
1993	6.2	12.4	18.6	29.0	41.6	70.1	72.2	78.4	87.4
1994	8.8	13.1	15.4	24.2	32.2	55.5	67.0	68.2	68.2
1995	7.5	9.9	12.0	18.0	23.0	23.4	35.6	44.0	63.9
1996	8.1	16.1	21.9	43.8	58.6	58.6	58.8	58.8	58.8
MEAN	**9.3**	**14.0**	**17.4**	**23.8**	**28.6**	**35.1**	**43.5**	**48.6**	**55.1**
SD	**3.0**	**4.7**	**6.1**	**8.9**	**11.0**	**13.9**	**14.3**	**15.6**	**16.4**

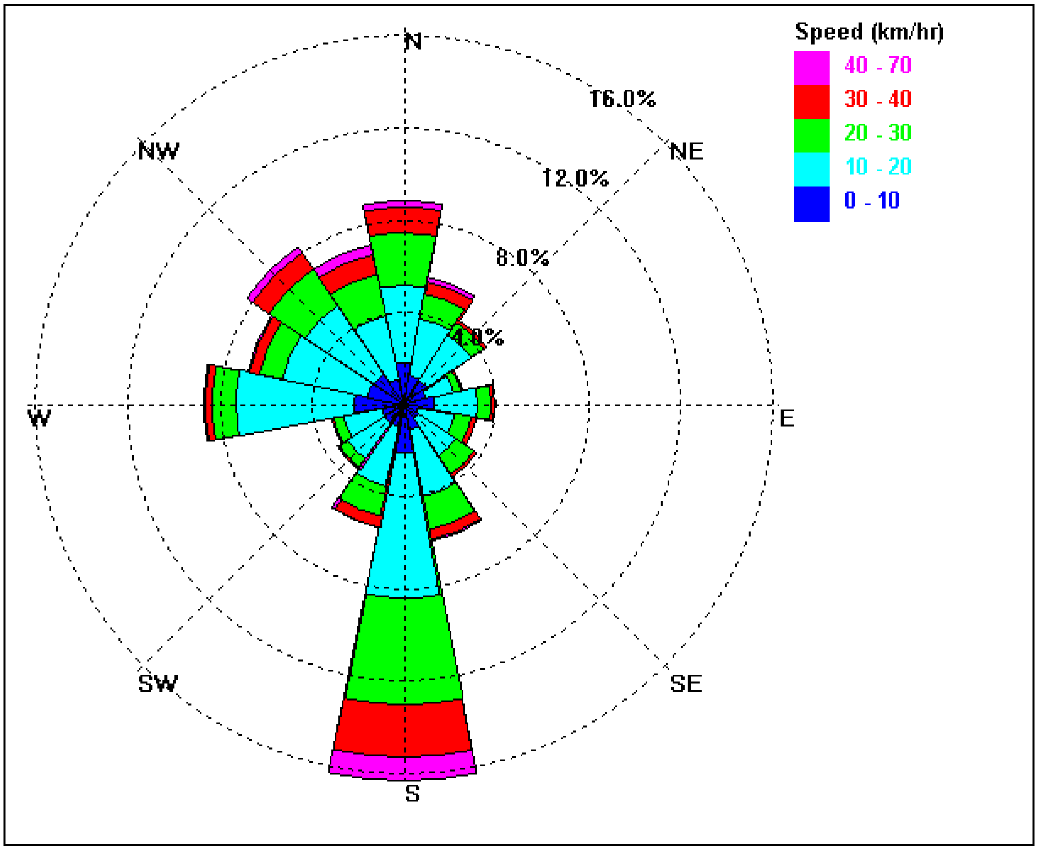


Figure 6.1 Windrose (2003-2007), Winnipeg, Manitoba

6.1.2 *AIR QUALITY*

In general, Winnipeg has excellent air quality. The sources of airborne pollutants typically include industrial operations, vehicle and equipment emissions, fires, and other specific activities. Ambient air quality in Winnipeg is continuously monitored by two air quality monitoring stations, located at 65 Ellen Street in downtown Winnipeg (approximately 2.0 km northwest of the Project Site) and 229 Scotia Street in a residential area (approximately 5.5 km north of the Project Site). Data for these stations are collected by Manitoba Conservation (2008) and the National Air Pollution Surveillance (2008).

Maximum short-term (1 to 24-hour averages) and annual mean concentrations of air contaminants for the Winnipeg stations are summarized in Table 6.4. There were no exceedances of Manitoba's Air Quality Objectives for carbon monoxide (CO) or nitrogen dioxide (NO_2). In 2005, there was a single exceedance of the 24 hour Canada Wide Standard for Particulate Matter 2.5 ($PM_{2.5}$). The only parameter that regularly exceeds guidelines levels is ground level ozone (O_3) – a product primarily of vehicle emissions.

Table 6.4 Summary of short-term maximum and annual average observed concentrations of air pollutants at Winnipeg monitoring sites for 2003-2006 (from NAPS 2008)

Pollutant	Period	Station / Year								Manitoba Air Quality Objective - MTL	Manitoba Air Quality Objective - MAL	Manitoba Air Quality Objective - MDL
		Winnipeg NAPS-070118-R Residential				Winnipeg NAPS-070119-C Downtown						
		2003	2004	2005	2006	2003	2004	2005	2006			
CO (ppm)	1 hour	3.3	2.6	2.9	2.0	4.7	3.5	3.4	2.8	-	31	13
	8 hour	2.0	1.47	1.5	1.3	2.4	1.38	1.9	1.4	17	13	5
	24 hour	-	-	0.9	0.8	-	-	1.0	1.2			
	Annual	0.29	0.24	0.2	0.2	0.52	0.36	0.3	0.4	-	-	-
NO_2 (ppb)	1 hour	93	56	64	54	126	99	67	91	530	213	-
	24 hour	36	32.5*	36	32	40	45	40	36	-	106	-
	Annual	9.7	8.6	8	7	14.2	13.3	12	13	-	53	32
NO (ppb)	1 hour	249	242	249	120	312	282	336	240	-	-	-
	24 hour	71.2	70.9*	56	47	80	95.3*	75	67	-	-	-
	Annual	4.4	4.5	5	3	8.9	9.3	8	7	-	-	-
O_3 (ppb)	1 hour	68	57	60	63	70	53	128	63	200	82	50
	8 hour	-	-	56	57	-	-	53	60		65^	
	24 hour	54	42*	48	48	49	38*	46	44	-	-	-
	Annual	22.9	19.9	20	23	20.5	17.4	19	21	-	15	-
$PM_{2.5}$ (µg/m^3)	1 hour	-	-	53	59	-	-	391	55			
	24 hour	-	-	22	26	-	-	38	24		30•	
	98th percentile (year)	14	13	14	14	14	13	-	15			
	98th percentile (last 3 years)	-	-	14	14	-	-	14	14			
	Annual	-	-	5	5	-	-	5	5			

MDL - the maximum desirable level is the long-term goal for air quality and provides a basis for an anti-degradation policy for unpolluted parts of the country and for the continuing development of pollution control technology

MAL - The maximum acceptable level is intended to provide adequate protection against effects on soil, water, vegetation, materials, animals, visibility, and personal comfort and well-being

MTL - The maximum tolerable level denotes time-based concentrations of air contaminants beyond which, owing to a diminishing margin of safety, appropriate action is required without delay to protect the health of the general population

*24-hour moving average

^Canada-Wide Standard for ozone: 3-year average of the fourth highest daily maximum 8-hour averages

•Canada-Wide Standard for PM2.5: 3-year average of the annual 98th percentile of daily 24-hour averages

6.1.3 Soils and Geology

The general stratigraphy in the Winnipeg area consists of Pleistocene drift composed of Lake Agassiz silt and clay overlying silty till and Paleozoic carbonate bedrock.

The native subsurface soils in the general area of the Project site are highly variable and consist of interbedded layers of low to high plastic clay, low plastic silt, and fine grained sand. Glacial till underlies the lacustrine materials at depths ranging from 8.2 m to 15.6 m below grade, and consists primarily of silt, although some gravel and sand are also present. According to the *Geological Engineering Maps and Report* (University of Manitoba 1983), the carbonate bedrock in the area of the site is of the Selkirk Member and consists of mottled, fossiliferous dolomitic limestone, with abundant chert nodules in the upper limestone layer. Based on previous investigations in the vicinity of the site, bedrock is encountered at approximately 33 m below grade.

Based on the Wardrop investigation in February 2010, the site stratigraphy is comprised of clay fill from grade to a depth ranging from 0.8 m to 1.8 m below grade, underlain by silt, with varying percentages of clay to the maximum depth of the boreholes (3 m to 6 m below grade) for boreholes advanced in planned substructure locations SU1 to SU4. The remaining borehole was advanced in the planned pier location SU5 at the interface of the river bank and shoreline, which comprised silt with varying amounts of clay from grade to the depth of the borehole at 2 m below grade.

6.1.3.1 Contaminated Soils

Contamination is present in soil of the upland area of the former MGP and along the west river bank adjacent to the Sutherland site (Figures 5.1 and 6.2).

Site Investigations

UMA (2003 and 2006) summarized the numerous investigations that have been conducted at the site of the former MGP and along the river bank adjacent to Rover Avenue. The following summarizes the investigations in the area of the Disraeli Bridge Project site located to the west of the existing river bridge. Historic soil sample locations are shown in Figure 6.3.

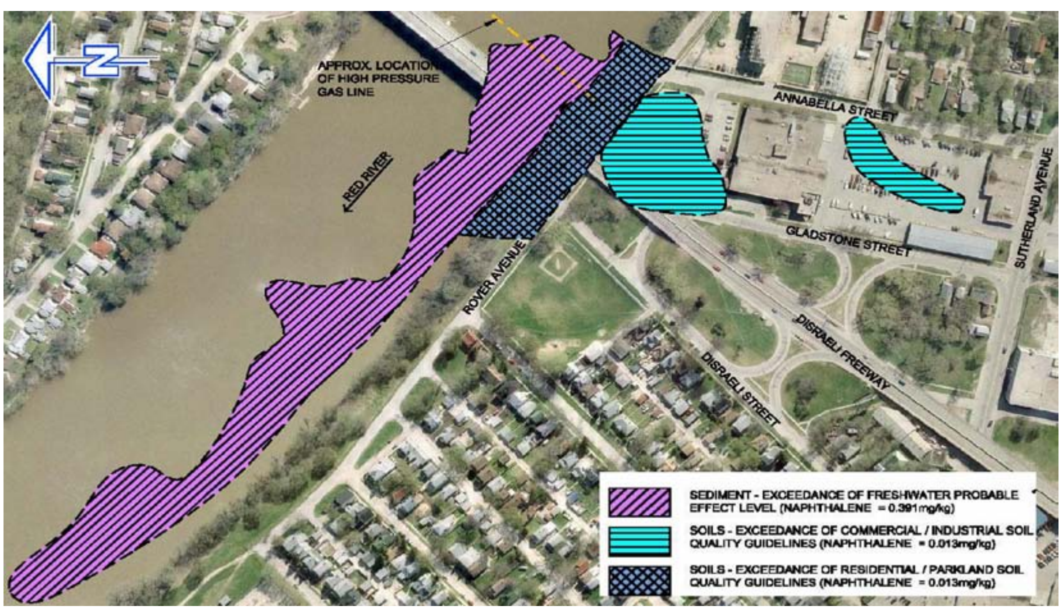
The occurrence of contamination along Disraeli Street was assessed by the City of Winnipeg during a sewer upgrade program. The date of the assessment is unknown. Test drilling was conducted along Disraeli Street, and with the exception of contaminated soils near the gate chamber and outfall structure at the intersection of Disraeli Street and Rover Avenue, no other evidence of contamination was detected within the remaining test holes.

An investigation west of the existing river bridge along the bank of the river was conducted in 2000. Eight boreholes (TH2K-11 to TH2K-16, TH2K-19 and TH2K-20) and one test pit (TP99-2) were advanced within the immediate area of existing river bridge pier 5. Visual impacts of liquid coal tar, staining, and odours were noted in all boreholes at depths between 1.1 m and 4.6 m below grade. Surface staining at a depth of 0.3 m below grade was noted in borehole TP99-2.

In 2001, an investigation was conducted on the west bank of the Red River, west of the Disraeli Bridge. The assessment included the advancement of a test pit (TP01-01) at the base of the excavation for the construction of the outfall structure and two boreholes (BH01-47 and BH01-48) west of the outfall structure. Coal tar related hydrocarbon contamination was detected in soil samples recovered from test pit TP01-01, and from borehole BH01-47. Liquid coal tar was also observed within the excavated test pit.

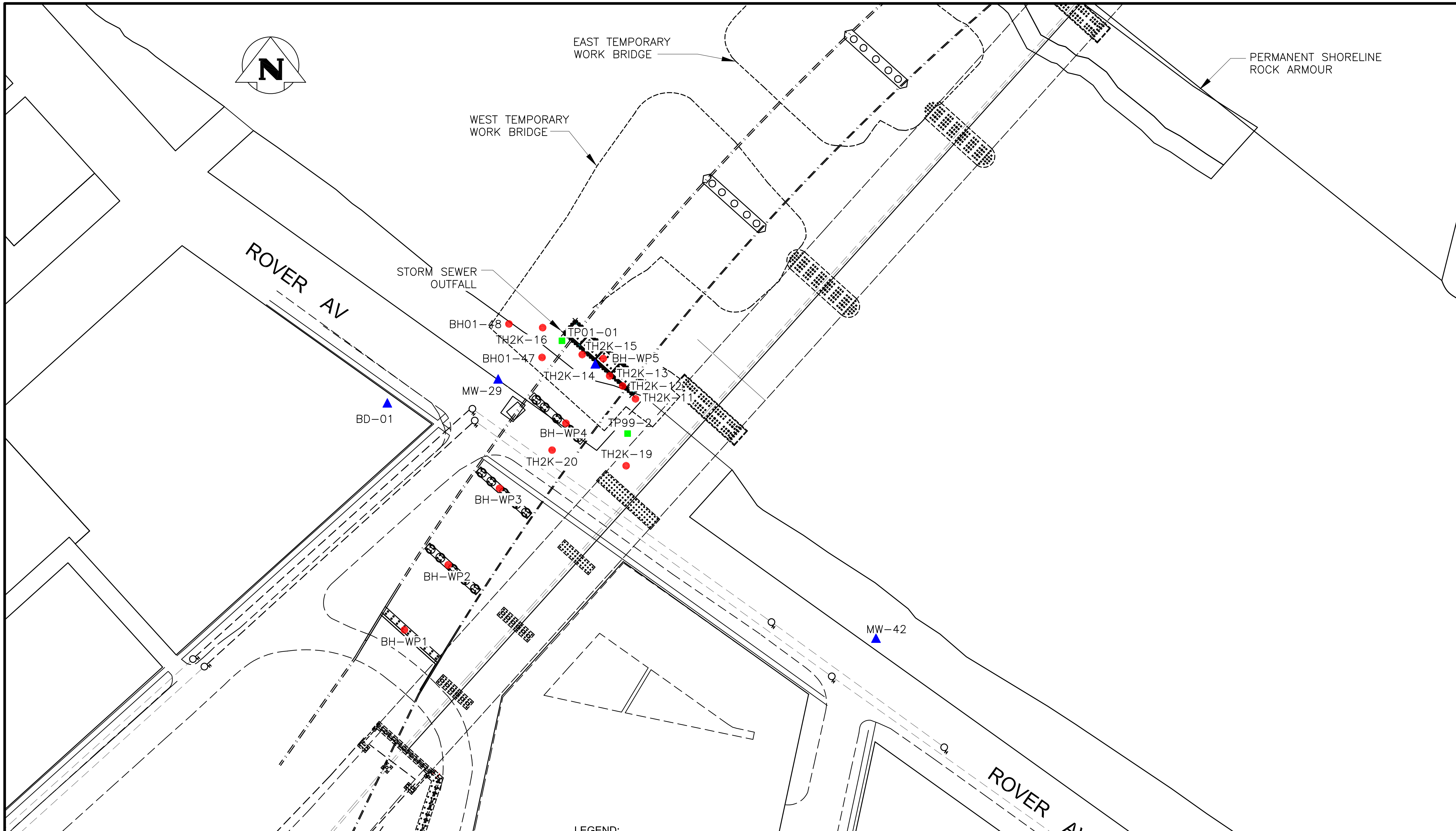
In 2002, an investigation included the advancement of borehole MW-29 to the southwest of the outfall structure and completion of the borehole as a nested piezometer. Naphthalene and BTEX were detected in soil samples recovered from the borehole at depths greater than 5 m.

In February 2010, Wardrop completed a limited subsurface investigation at five of the planned substructure units for the new river bridge. The investigation was conducted to the west of the existing river bridge on the west bank of the Red River. The purpose of the investigation was to characterize the occurrence of contamination (if any) within the soils that will be excavated during the installation of the piles and substructure footings SU1 to SU5. The investigation included the manual advancement of one borehole to a depth of 2 m below grade in the location of SU5; the mechanical advancement of three boreholes to a depth of 3 m below grade in the location of SU2, SU3, and SU4; and the mechanical advancement of one borehole to a depth of 6 m below grade in the location of SU1 (Figure 6.3; boreholes BH-WP1 to BH-WP5). The area of the land-based construction activities is shown on Figure 6.3.



Source: Manitoba Hydro 2009

Figure 6.2 Pre-existing soil and sediment contamination in the Project area



WARDROP A TETRA TECH COMPANY

PEOPLE, PASSION, PERFORMANCE, TRUSTED GLOBALLY

FIGURE 6.3
DISRAELI BRIDGES PROJECT
SOIL SAMPLE LOCATIONS

1000070301-SKT-V0079-A

Overview of Site Contamination

Based on information presented 2003 and 2006 UMA reports, the contaminants in the area of the land-based construction activities can be summarized as follows:

- Maximum historical naphthalene concentration of 8890 mg/kg in test pit TP01-01 at 0.6 m below the base of the excavation for the outfall structure, and a concentration of 1300 mg/kg at 1.2 m below grade in borehole TH2K-14.
- Maximum historical benzo(a)pyrene concentration of 346 mg/kg at 0.6 m below grade in test pit TP01-01, and a concentration of 628 mg/kg at 2.0 m below grade within the test pit.
- Maximum historical ethylbenzene and xylene concentrations of 2.95 mg/kg and 1.55 mg/kg, respectively, in borehole BH01-47 at 1.4 m below grade.
- Maximum historical concentrations of PAHs, phenanthrene; pyrene, benzo(a)anthracene; benzo(b)fluoranthene; benzo(k)fluoranthene; indeno(1,2,3-cd)pyrene; and dibenzo(a,h)anthracene of 2250 mg/kg, 1230 mg/kg, 311 mg/kg, 225 mg/kg, 134 mg/kg, 133 mg/kg, and 25.1 mg/kg in borehole TH2K-14 at 1.22 m to 1.52 m below grade, respectively.

The results of the limited site investigation conducted by Wardrop in February 2010 in the area of the land-based construction activities can be summarized as follows:

- An apparent odour and/or petroleum hydrocarbon sheen was noted at 0.8 m and 1.6 m below grade.
- The soil sample collected from borehole BH-WP3 at 1.5 m below grade exhibited a naphthalene concentration of 0.270 mg/kg and a phenanthrene concentration of 0.278 mg/kg.
- The soil sample collected from borehole BH-WP4 at 1.5 m below grade exhibited an indeno(1,2,3-cd)pyrene concentration of 2.61 mg/kg, a benzo(a)pyrene concentration of 2.74 mg/kg, a naphthalene concentration of 0.051 mg/kg, and a phenanthrene concentration of 0.382 mg/kg.
- The soil sample collected from borehole BH-WP5 at 0.8 m below grade revealed a benzene concentration of 2.1 mg/kg, a toluene concentration of 1.6 mg/kg, a naphthalene concentration of 4.95 mg/kg, and a phenanthrene concentration of 0.218 mg/kg.
- The soil sample collected from borehole BH-WP5 at 1.6 m below grade exhibited a benzene concentration of 6.2 mg/kg, a toluene concentration of 3.6 mg/kg, and PHC fractions F2 and F3 concentrations of 549 mg/kg and 463 mg/kg, respectively. Acenaphthene, benzo(a)pyrene, fluorene, naphthalene and phenanthrene were detected at concentrations of 2.30 mg/kg, 1.23 mg/kg, 1.50 mg/kg, 22.7 mg/kg, and 3.55 mg/kg, respectively, within the soil sample.
- The analytical results are presented on Table 6.5.

The results of the investigation conducted by AECOM in February 2010 in the area of the substructure pier location SU5 can be summarized as follows:

- The soil sample collected from borehole TH10-01 at 0.10 m to 0.30 m below grade exhibited PAHs including a naphthalene concentration of 1260 mg/kg and a benzo(a)pyrene concentration of 134 mg/kg.
- The sample collected from borehole TH10-01 at 1.8 m to 2.0 m below grade exhibited PAHs including a naphthalene concentration of 4600 mg/kg and a benzo(a)pyrene concentration of 702 mg/kg. This sample was reportedly recovered from a coal tar seam.
- Applicable excerpts from the AECOM analytical tables are presented in Appendix E - Table 2.

Table 6.5 Soil sample laboratory analytical results, February 2010; Disraeli Bridge – West River Bank / West of Bridge

Laboratory Analyses	Laboratory Analytical Results (mg/kg)						Environmental Quality Guidelines [1, 2, 3] (mg/kg)
	BH-WP1	BH-WP2	BH-WP3	BH-WP4	BH-WP5		
	3.8 m	1.5 m	1.5 m	1.5 m	0.8 m	1.6 m	
BTEX							
Benzene	<0.0050	<0.0050	0.010	0.007	***2.1***	***6.2***	60 / 1.0
Toluene	<0.010	<0.010	0.01	<0.010	***1.6***	***3.6***	110 / 0.10
Ethylbenzene	<0.050	<0.050	<0.050	<0.050	<0.050	0.2	120 / 50
Xylenes	<0.10	<0.10	<0.10	<0.10	0.2	1.7	65 / 37
CCME Fractions							
F1 - BTEX ($>nC_{6}$-nC_{10})	<10	<10	<10	<10	<10	<10	210 / 970
F2 ($>nC_{10}$-nC_{16})	<10	<10	<10	<10	106	***549***	150 / 150
F3 ($>nC_{16}$-nC_{34})	56	<50	57	250	118	***463***	1300 / 300
F4 ($>nC_{34}$)	<50	<50	<50	122	<50	109	5600 / 2800
PAH							
Acenaphthene	<0.010	<0.010	<0.010	<0.010	0.051	***2.30***	0.28
Acenaphthylene	<0.010	<0.010	0.118	0.687	0.036	0.135	320
Acridine	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	NG
Anthracene	<0.010	<0.010	0.100	0.136	0.114	1.22	2.5
Benzo(a)anthracene	<0.010	0.017	0.539	0.757	0.357	1.37	6.2
Benzo(a)pyrene	<0.010	<0.010	0.595	***2.74***	0.331	***1.23***	0.6
Benzo(b)fluoranthene	<0.010	<0.010	0.678	2.18	0.281	1.14	6.2
Benzo(ghi)perylene	<0.010	<0.010	0.344	4.06	0.111	0.661	NG
Benzo(k)fluoranthene	<0.010	<0.010	0.235	0.941	0.141	0.740	6.2
Chrysene	<0.010	<0.010	0.236	0.701	0.194	1.40	6.2
Dibenzo(ah)anthracene	<0.010	<0.010	0.055	0.356	0.020	0.115	1.0
Fluoranthene	<0.010	0.013	0.474	0.762	0.411	3.09	15.4
Fluorene	<0.010	<0.010	<0.010	<0.010	0.052	***1.50***	0.3
Indeno(1,2,3 cd)pyrene	<0.010	<0.010	0.375	***2.61***	0.152	0.940	1.0
1-Methyl Naphthalene	<0.010	<0.010	0.064	<0.010	0.047	2.61	NG
2-Methyl Naphthalene	<0.010	<0.010	0.053	<0.010	0.042	2.47	NG
Naphthalene	<0.010	<0.010	***0.270***	***0.051***	***4.95***	***22.7***	0.013
Phenanthrene	<0.010	<0.010	***0.278***	***0.382***	***0.218***	***3.55***	0.046
Pyrene	<0.010	0.014	0.527	1.08	0.373	2.35	7.7
Quinoline	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	NG
Grain Size							
<75 um	40.0	98.0	84.0	76.0	84.0	84.0	NG
>75 um	60.0	2.0	6.0	24.0	6.0	6.0	NG
Moisture Content (%)	24.2	24.1	17.6	25.4	33.3	39.4	NG

[1] CCME, *Canadian Environmental Quality Guidelines* (2007), Residential / Parkland, fine-grained / coarse-grained, eco soil contact and groundwater check (aquatic life)

[2] CCME, *Canada-Wide Standard for Petroleum Hydrocarbons in Soil* (2008), Residential, fine-grained / coarse-grained, eco soil contact and protection of aquatic life,

[3] CCME, *Carcinogenic and Other Polycyclic Aromatic Hydrocarbons* (PAHs) (2008), Residential / Parkland, soil contact and protection of freshwater life

NG = No Guideline; Bold Text = Laboratory analytical results in excess of the referenced guidelines

6.1.4 HYDROGEOLOGY

Bedrock in the Winnipeg region consists of limestones, dolomites, and calcareous shales. Glaciers deposited the layer of till that presently overlies the bedrock in the Winnipeg area. Meltwater from the last retreating glacier formed Glacial Lake Agassiz, and the sediments deposited in the lake formed the Agassiz clay deposits in the Winnipeg area. Weathering of the Agassiz clay deposits, combined with deposition from periodic flooding of the Red and Assiniboine Rivers, resulted in the current surficial deposits, which include the surface soils of the Winnipeg area (Grove and Pupp 1995).

There are three main lithologic units that control the hydrogeologic conditions in the City of Winnipeg (Grove and Pupp 1995).

(1) The upper unit consists of glaciolacustrine clay deposits, with occasional silt horizons, that contain variable shallow 'perched' water table conditions created by infiltration of surface waters.

(2) A complex till zone with intertill sand and gravel deposits underlies the clays at a depth of 15 m to 20 m. The composition of the basal till is highly variable and localized aquifers may exist where the till is predominantly sand and gravel. The bedrock is composed of carbonate and sandstone deposits and occurs at a depth of approximately 20 m to 25 m.

(3) The bedrock aquifers are confined, with the dominant groundwater flow direction towards the centre of the Winnipeg draw down cone near the confluence of the Red and Assiniboine rivers.

Clay/Till Aquifers

The tills and glaciolacustrine silt and clay deposits that dominate the area surrounding the Disraeli Bridge have low permeabilities, with the exception of locations along the floodplains of the river where permeabilities may be greater. Fractures in the glaciolacustrine silts and clays, as well as in the till deposit, can be a source of greater permeabilities. The groundwater present in the shallow clay and till deposits is not currently utilized, as the quality and anticipated low well yields of the groundwater is not directly suitable for potable domestic purposes.

The upper clay deposits act as an aquitard that restricts groundwater flow and provides moderate protection with respect to potential vertical migration of contaminants. Since desiccation fractures can be present within the clays, some vertical migration could occur in the fracture networks under dry conditions (UMA 2003).

Bedrock Aquifers

The major underlying aquifer in the Winnipeg area is the upper 15 m to 30 m fractured zone of the Upper Carbonate Aquifer. The aquifer is somewhat confined by the overburden and underlying lower permeability carbonate bedrock. Transmissivity in the aquifer ranges from 2.9 x 10^{-4} m^2/s to 2.9 x 10^{-2} m^2/s (Dillon 2009).

Prior to the development of the aqueduct system which supplies the City of Winnipeg with potable water, the Upper Carbonate Aquifer was an important source of water for both municipal and industrial use. The Upper Carbonate Aquifer remains a potable water source in areas bordering the City (east of the Red River) and for some industrial use within Winnipeg. It is known that the Red River supplied process water to the former MGP.

The Lower Carbonate Aquifer occurs within fractured networks in the bottom 7.5 m to 15 m of the Red River formation, along the interface of the upper shale unit of the Winnipeg formation. Transmissivities in the aquifer are generally less than 7.0 x 10^{-5} m^2/s (Dillon 2009). This aquifer is of limited use for potable water supply.

The Winnipeg Formation contains an Upper Sandstone Aquifer, 6 m to 12 m thick, and a Lower Sandstone Aquifer, approximately 3 m thick. Both sandstone aquifers contain non-potable saline waters. Transmissivities vary from approximately 1.4 x 10^{-3} m^2/s in the Upper Sandstone aquifer to 1.4 x 10^{-4} m^2/s in the Lower Sandstone aquifer. The Pre-Cambrian basement lies beneath this aquifer.

6.1.4.1 Contaminated Groundwater

There have been numerous investigations of the shallow groundwater quality across the Surtherland site and along the riverbank (CH2M Hill 1994 and 1995; UMA 2003 to 2008). It was determined that shallow groundwater along the riverbank contains chemicals, particularly naphthalene, in excess of the CCME guidelines for freshwater aquatic life between wells MW-42 and BD-01 (Figure 6.3; UMA 2006). Naphthalenes were abundant in the coal tar historically produced at the MGP and have greater solubility relative to other PAHs of higher molecular weight. In addition to naphthalene, other PAH concentrations, and benzene, toluene and ethylbenzene concentrations exceed the applicable CCME criteria along the riverbank. Well MW-41 likely marks the western limit of the contaminated groundwater plume (UMA 2006).

Using vertical hydraulic gradients and flow directions, groundwater was determined to flow laterally towards the river and downwards towards the till unit (UMA 2008). The river is a significant influence on groundwater flow and is expected to be a discharge boundary for all overburden groundwater and from the upper bedrock aquifer. An estimated 0.37 kg of naphthalene enters the Red River annually through the shallow groundwater, but this is very small relative to the mass of PAHs in the riverbed sediments (UMA 2006).

Groundwater quality in the carbonate bedrock was assessed in 2002 and PAHs were not detected at concentrations exceeding the laboratory detection limits (UMA 2008).

UMA 2006 provides a more detailed discussion of groundwater conditions beneath the contaminated site.

6.1.5 Noise and Vibration

The Local Study Area is surrounded by mixed land uses - residential, industrial and commercial. The area is currently subject to noise and vibration from the Disraeli Freeway and the CPR mainline, as well as other industries associated with the railway. Daytime average background noise levels from road and rail traffic would range from approximately 62 dB to 70 dB (Dillon 2009). Single peak event noise levels are approximately 80 dB when a train is passing.

6.2 Terrestrial Environment

6.2.1 Vegetation and Habitat

As a result of historical agricultural activities and urban development in the area, natural vegetation in the Local Study Area is limited. Along the Red River, a survey conducted by the City of Winnipeg's Naturalist Services identified some mixed river-bottom natural vegetation on the banks; however they concluded that the terrestrial environment was of low natural ecological quality (City of Winnipeg Naturalist Services 2009). The area was graded C or C/D using the City's classification system, indicating that the vegetation has been disturbed with many non-native species. The vegetated areas along the Red River are described by type and grade in Figures 6.4, 6.5 and 6.6 and in Table 6.6 (Quigley, pers comms. 2009). A full list of vegetative species for these areas is supplied in Appendix F.

The existing habitat provided by the low-quality river valley vegetative community found at this location is not believed to provide critical habitat for endangered or threatened species (City Naturalists Services 2009).

In 2003, the City of Winnipeg Naturalist Services conducted an extensive review of the surrounding area of a site located 5 km upstream of the Disraeli Bridges Project, and have subsequently conducted periodic site visits. During this time, no plant species listed on Manitoba's *Endangered Species Act* or on the *Species at Risk Act* (Schedule 1) were observed.

Figure 6.4a-b North bank looking: (a) downstream west of and (b) upstream east of existing river bridge (Dillon 2009)

Figure 6.5a-b South bank looking: (a) downstream west of and (b) upstream east of existing river bridge (Dillon 2009)

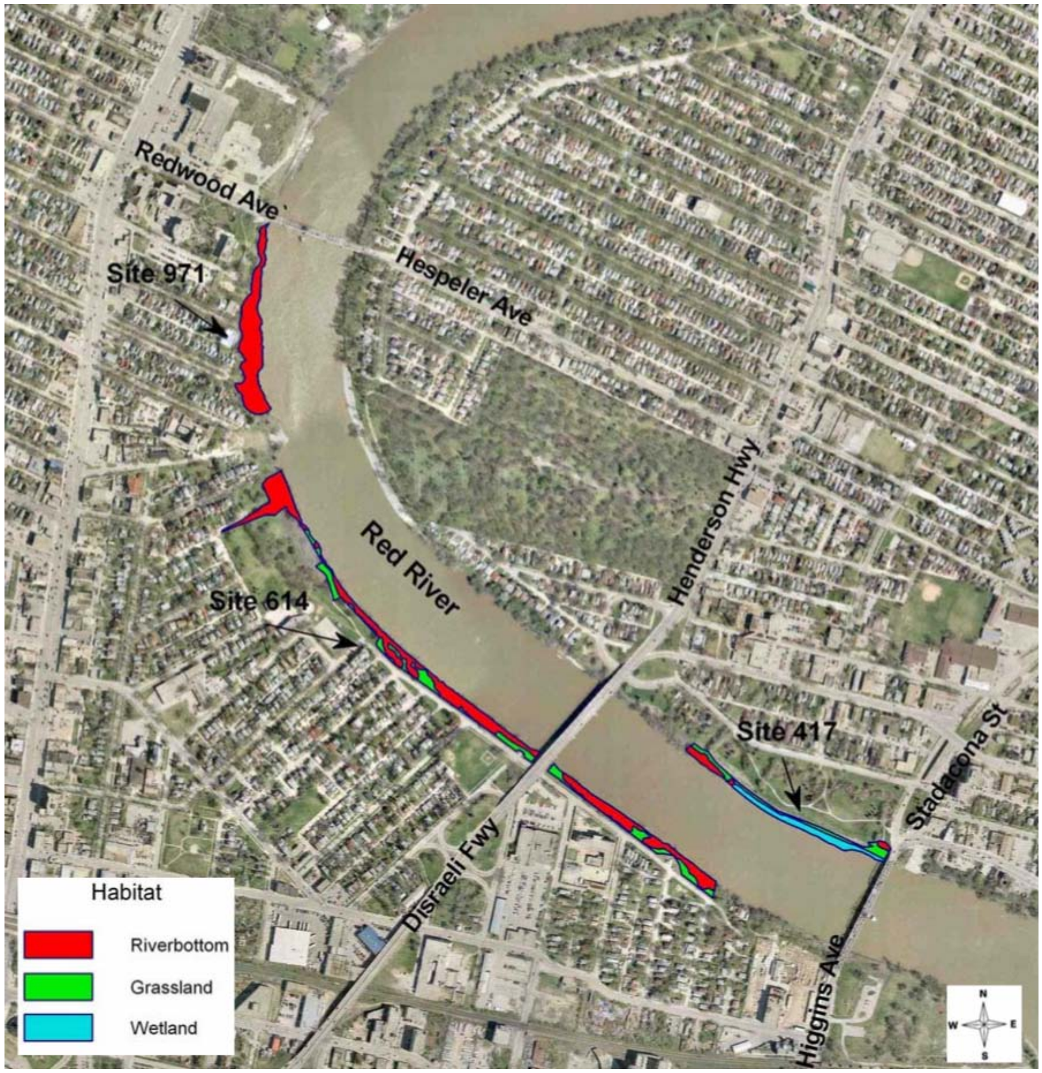


Figure 6.6 Vegetation classification (City of Winnipeg Naturalist Services 2009)

Table 6.6 Red River vegetation description and classification in the Local Study Area (from Dillon 2009)

Site #	Location	Site Description	Habitat Type	Grade	Area (ha)
417	Ernie O'Dowda Park - east bank of the Red River, southwest of the corner of Stadacona St. and Midwinter Ave.	narrow band of disturbed riverbottom forest	riverbottom forest	C/D	0.62
614	Rover Ave. - southwest bank of Red River, between Selkirk Ave. and the Louise Bridge	narrow band of riverbottom forest that has experienced some disturbance and has a low diversity of species	riverbottom forest	C/D	1.97
971	Redwood Park - southwest bank of Red River, south of Redwood Ave.	riverbottom forest with disturbed understory	riverbottom forest	C	0.83

Source: City of Winnipeg Naturalist Services, 2009

6.2.2 WILDLIFE

The Winnipeg Ecodistrict includes habitat for a variety of wildlife species including nine species of amphibians, six species of reptiles, 342 species of birds, and 46 species of mammals as residents or migrants (Banfield 1974; Preston 1982; Sibley 2000; Cleveland et al. 1988; Root 1988; Morgan 1988). More than 90 of these bird species are known to overwinter in the Winnipeg area. A much smaller subset of these species are likely to occur at the Project site given the narrow, limited extent of habitat and the extensive impacts from urban development in the local study area. Studies conducted for the Main Street and Norwood Bridges Project (MacPlan 1994) and the Provencher Bridges Project (InterGroup 2001) found one species of reptile, 71 species of birds, and 16 species of mammals (Table 6.7). The results of this survey are likely representative of the riverbank wildlife community in the City of Winnipeg.

The wildlife habitat in the local study area is disturbed and fragmented to varying degrees and occurring as a narrow band along the banks of the Red River. Wildlife movements in the area are limited by human developments such as residential, commercial, and industrial developments inland and by noise and traffic along adjacent roads. The trees and shrubs in the riparian zone along the riverbanks therefore provide the best nesting areas for birds. The under-structure of the existing river bridge spans is used for nesting and roosting by Rock Dove (*Columba livia*) and as a roosting spot by European Starlings (*Stumus vulgaris)*, particularly in the winter (Dillon 2009). This is consistent with other studies in the area such as the Main and Norwood bridges where the most common bird species observed was Rock Dove roosting and nesting under the bridges (MacPlan 1994) and the Provencher Bridge (InterGroup 2001).

Table 6.7 **Wildlife species observed along the Red River riparian zone in the fall, 1992 (after MacPlan 1994 and InterGroup 2001)**

Common Name	Scientific Name	Main & Norwood	Provencher
Reptiles			
Western Painted Turtle	*Chrysemys picta belli*	X	
Birds			
Alder Flycatcher	*Empidonax alnorum*	X	
American Crow	*Corvus brachyrhynchos*	X	X
American Goldfinch	*Carduelis tristis*		X
American Kestrel	*Falco sparverius*		X
American Robin	*Turdus migratorius*	X	X
Bank Swallow	*Riparia riparia*		X
Bard Swallow	*Hirundo rustica*	X	
Belted Kingfisher	*Ceryle alcyon*	X	X
Blackbird sp.	*Agelaius spp.*	X	
Black Tern	*Chlidonias niger*	X	
Black-and-white Warbler	*Mniotilta varia*	X	
Black-capped Chickadee	*Poecile atricapilla*	X	
Blue Jay	*Cyanocitta cristata*		X
Brewer's Blackbird	*Euphagus cyanocephalus*	X	
Brown-headed Cowbird	*Molothrus ater*		X
Bufflehead	*Bucephala albeola*	X	
Canada Goose	*Branta canadensis*		X
Cedar Waxwing	*Bombycilla cedrorum*		X
Chipping Sparrow	*Spizella passerine*	X	X
Chimney Swift	*Chaetura pelagic*		X
Cliff Swallow	*Hirundo pyrrhonota*		X
Common Grackle	*Quiscalus quiscula*	X	X
Common Merganser	*Mergus merganser*	X	
Common Nighthawk	*Chordeiles minor*		X
Common Yellowthroat	*Geothlypis trichas*	X	
Cooper's Hawk	*Accipiter cooperi*		X
Dark-eyed Junco	*Junco hyemalis*	X	
Double-crested Cormorant	*Phalacrocorax auritus*		X
Downy Woodpecker	*Picoides pubescens*		X
Eastern Pheobe	*Sayornis phoebe*		X
Eastern Screech-owl	*Otus asio*		X
European Starling	*Stumus vulgaris*	X	X
Franklin's Gull	*Larus pipixan*	X	X
Gray Catbird	*Dumetella carolinensis*	X	X
Green-winged Teal	*Anas crecca*		X

Table 6.7 (cont'd) Wildlife species observed along the Red River riparian zone in the fall, 1992 (after MacPlan 1994 and InterGroup 2001)

Common Name	Scientific Name	Main & Norwood	Provencher
Gull spp.	*Larus sp.*	X	
Hairy Woodpecker	*Picoides villosus*		X
Herring Gull	*Larus argentatus*		X
Horned Grebe	*Podiceps auritus*	X	
House Finch	*Carpodacus mexicanus*		X
House Sparrow	*Passer domesticus*	X	X
Killdeer	*Charadrius vociferous*		X
Least Flycatcher	*Empidonax minimus*	X	
Lesser Scaup	*Aythya affinis*	X	
Mallard	*Anas platyrhyncos*	X	X
Merlin	*Falco columbarius*		X
Mourning Dove	*Zenaida macroura*		X
Northern Flicker	*Colaptes auratus*		X
Orchard Oriole	*Icterus spurious*		X
Palm Warbler	*Dendroica palmarum*	X	
Peregrine Falcon	*Falco peregrines*		X
Pine Siskin	*Carduelis pinus*		X
Purple Martin	*Progne subis*	X	X
Red-eye Vireo	*Vireo olivaceus*		X
Red-winged Blackbird	*Agelaius phoeniceus*	X	X
Ring-billed Gull	*Larus delawarensis*	X	X
Rock Dove	*Columba livia*	X	
Ruby-throated Hummingbird	*Archilochus colubris*		X
Rusty Blackbird	*Euphagus carolinus*	X	
Ruby-crowned Kinglet	*Regulus calendula*	X	
Shorebird spp.		X	
Song Sparrow	*Melospiza melodia*		X
Spotted Sandpiper	*Actitis macularia*	X	X
Swallow spp.		X	
Tree Swallow	*Tachycineta bicolor*		X
Warbler spp.		X	
Warbling Vireo	*Vireo gilvus*		X
White-breasted Nuthatch	*Sita carolinensis*	X	X
White-crowned Sparrow	*Zonotrichia leucophrys*	X	
Wood Duck	*Aix sponsa*	X	X
Yellow-bellied Sapsucker	*Spyrapicus varius*	X	
Yellow-rumped Warbler	*Dendroica coronata*	X	
Yellow Warbler	*Dendroica petechia*	X	X

Table 6.7 (cont'd) Wildlife species observed along the Red River riparian zone in the fall, 1992 (after MacPlan 1994 and InterGroup 2001)

Common Name	Scientific Name	Main & Norwood	Provencher
Mammals			
American Beaver	*Castor canadensis*	X	X
American Mink	*Mustela vison*	X	
American Red Squirrel	*Tamiasciurus hudsonicus*	X	X
Deer Mouse	*Peromyscus maniculatus*		X
Eastern Chipmunk	*Tamias striatus*	X	X
Eastern Cottontail	*Sylvilagus floridanus*	X	X
Ermine	*Mustela ermine*	X	
Meadow Vole	*Microtus pennsylvanicus*		X
Microtine		X	
Muskrat	*Ondatra zibethicus*	X	X
Raccoon	*Procyon lotor*	X	X
Red Fox	*Vulpes vulpes*	X	
River Otter	*Lontra canadensis*	X	
Striped Skunk	*Mephitis mephitis*		X
Thirteen-lined Ground Squirrel	*Spermophilus tridecemlineatus*	X	
Woodchuck	*Marmota monax*		X

6.2.3 TERRESTRIAL SPECIES OF CONCERN

A review conducted by the Manitoba Conservation Data Centre found no listed plant species or terrestrial wildlife of concern within the Project Site or surrounding area.

6.3 AQUATIC ENVIRONMENT

6.3.1 HYDROLOGY

The Red River is a large, meandering, prairie river that flows 515 km north from its origin in the United States into the south basin of Lake Winnipeg. Typical of prairie rivers, the channel gradient is low along most of the river length (less than 0.008%). Outside of Winnipeg, the Red River watershed is extensively developed for agriculture. The most significant tributaries near the Project site are the Seine and Assiniboine rivers, 1.3 and 4.4 km upstream, respectively.

The volume, velocity, and water level of the Red River in the reach that includes Winnipeg have been historically altered to provide river navigation and flood protection. Historically, Lister Rapids near Lockport, Manitoba provided the hydraulic control for the upstream reach of the Red River. The St. Andrews Lock and Dam, opened in 1910 and currently operated by Public Works and Government Services Canada, was installed with the purpose of providing navigational passage over Lister Rapids and to improve navigation between Winnipeg and Lake Winnipeg. The facility is a Camere dam with wood slat curtains that are raised and lowered to control the water level upstream of the dam. During normal operating conditions, when the curtains are lowered the dam back-floods Lister Rapids to a depth of 2.74 m. As a result, the facility has created a riverine reservoir that is characterized by reduced water velocities, higher water levels, and increased sedimentation. Back-flooding in the Red River can be observed as far south as St. Agathe, 25 km south of Winnipeg.

The Winnipeg Floodway, completed in 1968, is periodically operated during high flow events to reduce the volume and velocity of water passing through Winnipeg. Gates placed within the bed of the Red River south of the city are used to divert river flow into a channel that carries the water east and north around the city. The flow is returned to the river 800 m north of the St. Andrews Lock and Dam. The capacity of the floodway was recently upgraded from 1,700 m^3/s to 4,000 m^3/s.

The following summarizes the hydrology of the Red River at the Disraeli Bridge from Bruce Harding (2010); the full report can be found in Appendix D.

The hydrology of the Red River is complicated by the operation of the Floodway and the St. Andrews Lock and Dam located downstream of the City of Winnipeg. The Floodway diverts flow around the City during floods and the St. Andrews Lock and Dam controls river levels to a target level of 223.7 m during the open water season.

The average monthly flows for the Red River at the Disraeli Bridge are listed in Table 6.8. The data are based on historical data from the Lockport gauge streamflow records while considering the diversion of flows to the Floodway. Flood discharges in the Red River at the Disraeli Bridge and downstream of St. Andrews Lock and Dam are listed in Table 6.9. The data are based on Manitoba Water Stewardship hydrology for the Red River at James Avenue and the Floodway discharge.

Table 6.8 **Red River monthly average discharge at the Disraeli Bridge (from Bruce Harding 2010)**

Month	Discharge (m^3/s)
January	57
February	54
March	148
April	789
May	677
June	348
July	281
August	154
September	109
October	107
November	103
December	70
Annual	241

*Based on analyses of the Red River near Lockport (WSC 05OJ010) streamflow gauge

Table 6.9 Red River Flood Hydrology (from Bruce Harding 2010)

Flood Event	Red River at Disraeli Bridge* (m^3/s)	Red River downstream of St. Andrews Lock and Dam** (m^3/s)
50% Flood	1005	1005
20% Flood	1361	1597
10% Flood	1401	2033
5% Flood	1453	2597
2% Flood	1810	3452
1% Flood	2292	4225
0.625% (160 Year) Flood	2331	4775

*Red River at James Ave, Manitoba Water Stewardship, Updated Red River Hydrology – February 2010

**Sum of Red River at James Ave discharge and Floodway discharge, Manitoba Water Stewardship, Updated Red River Hydrology – February 2010

6.3.2 WATER QUALITY

Water quality was assessed in 1995 and 2007 (CH2M Hill 1995; ENSR 2007; and UMA 2007b) at various locations in the Red River within 200 m upstream and 500 m downstream of the existing river bridge, including stations adjacent to the former MGP. Water quality was also assessed in 2009 by the City of Winnipeg (2010b) approximately 1000 m downstream at the Redwood Bridge. This location is outside of the baseline study area, but the data are included here to provide data for additional parameters that were not analyzed in the other studies. Collection methods and data were summarized and consolidated from these reports. Data were compared to the draft *Manitoba Water*

Quality Standards, Objectives and Guidelines (MWQSOG; Williamson 2002), where possible.

Water samples were collected between March 17 and 20, 1994 (CH2M Hill 1995) at one or more locations along five transects (L01, L02, L04, L05 and L07; Figure 6.7), 7 m from the south shore of the Red River, and 0.5 m above the river bottom. Additional samples were collected at one station along a single transect (L04-01, L04-03 and Lo4-15; summarized in Figure 6.7) adjacent to the former MGP. Water was sampled using a “jar and stopper assembly” and analyzed for hydrocarbons (Table 6.10; CH2M Hill 1995).

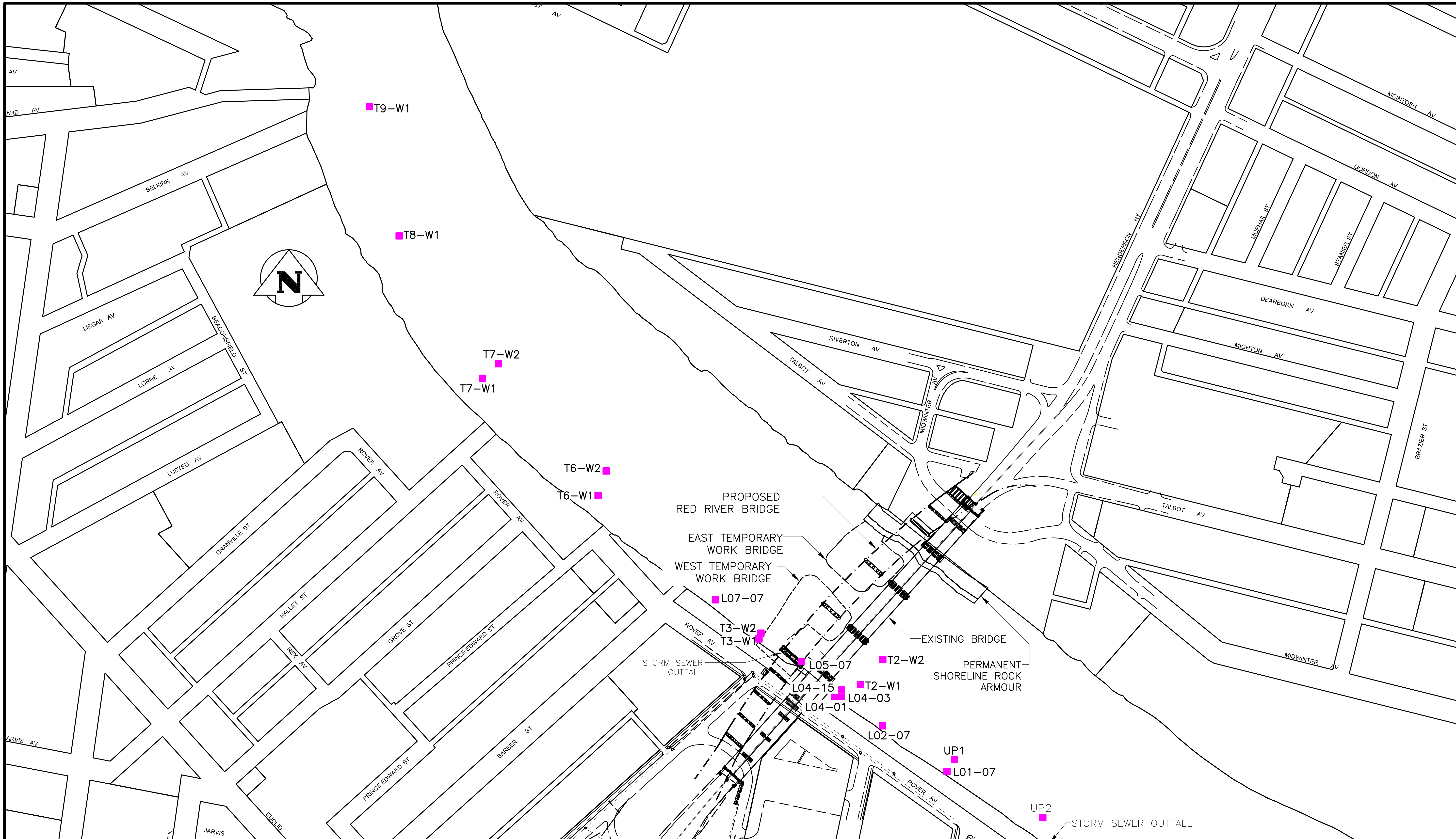
Concentrations of PAHs in all samples were less than reported detection limits, with the exception of naphthalene (Table 6.10). Naphthalene was detected at concentrations (0.004 µg/L - 0.006 µg/L) marginally higher than the reported detection limit (RDL; 0.004 µg/L). However, naphthalene was also detected in the laboratory blank at a similar concentration (0.006 µg/L; CH2M Hill 1995). This suggests the naphthalene detected in the river samples may be an artefact of the laboratory analysis and was not attributed to the actual presence of naphthalene in the river.

Water quality was more recently sampled on March 12 and 13, 2007, upstream and downstream of the former MGP site and Disraeli Bridge (UMA 2007b). Samples were collected at 12 stations (UP1, UP2, T2 (W1 and W2), T3 (W1 and W2), T6 (W1 and W2), T7 (W1 and W2), T8 and T9; Figure 6.7) using a “sampling tube” and a peristaltic low flow pump at two depths; 1.0 m below the ice surface, and 0.15 m to 0.30 m above the river bottom. A total of 25 samples (including two duplicates) were shipped to ALS Laboratories for the analysis of benzene, toluene, ethylene, xylene (BTEX), total volatile hydrocarbons (TVH), total extractable hydrocarbons (TEH), PAHs, total dissolved solids (TDS), TSS and metals. Consolidated hydrocarbon, TDS, TSS and metal concentration data are reported for eight of the 12 stations (UP1, UP2, T2, T3, T6, T7, T8 and T9; Tables 6.10 and 6.11).

Concentrations of TSS (25 mg/L - 50 mg/L; Table 6.12; UMA 2007b) were similar at all upstream and downstream stations, and were comparable to the lower range reported by City of Winnipeg (2010b). Additionally, concentrations of TDS ranged from 610 mg/L to 670 mg/L (UMA 2007b) and were also similar at all upstream and downstream stations. There were no detectable PAHs in the majority of water samples upstream and downstream of the existing river bridge with one exception; detectable concentrations of PAHs (benzo(a)anthracene, fluoranthene, pyrene, and benzo(a)pyrene) were reported in one of the three replicate samples collected under ice, at two stations (T3 and T6; Table 6.10). The four detected PAH concentrations exceeded the MWQSOG. Total aluminum concentrations were over 10 times higher than the MWQSOG, while total iron were over 2.5 times higher than the guideline (Table 6.11). Both metals consistently exceeded the MWQSOG at all stations. Total selenium occasionally exceeded the MWQSOG but only at the upstream stations. The surface water quality data shows no evidence of correlation between PAH concentrations in surface water and PAH concentrations in sediment (UMA, 2008).

Water quality was sampled for physicochemical parameters between August 28 and 29, 2007 at 20 stations (MH01 - MH20; Figure 6.7; ENSR 2007), upstream and downstream of the existing river bridge. Measurements of temperature, dissolved oxygen, pH and conductance were taken with a YSI 556 MPS at two depths; 0.5 m under the water surface and 0.5 m above the sediment surface. Mean temperature, dissolved oxygen and pH were slightly higher compared to the 2009 mean data (Table 6.12).

The most recent water quality data were collected by the City of Winnipeg between May and November 2009, downstream of the study area at the Redwood Bridge (City of Winnipeg 2010b) which included physicochemical, nutrients and biological parameters (Table 6.12). Water quality was characterized as alkaline (mean pH 8.25) and moderately oxygenated (mean dissolved oxygen 8.57 mg/L). Concentrations of total suspended solids (TSS) ranged from low to moderately high with a mean deviation of 70% over the seven months sampled (mean 114.8 ± 80.6 mg/L). The mean concentration of total phosphorous (0.27 mg/L) exceeded the MWQSOG for rivers and streams (0.05 mg/L; Williamson 2002).



LEGEND:

■ SURFACE WATER SAMPLE

WARDROP
A TETRA TECH COMPANY

PEOPLE, PASSION, PERFORMANCE,
TRUSTED GLOBALLY

FIGURE 6.7
DISRAELI BRIDGES PROJECT
HISTORIC WATER SAMPLE LOCATIONS

1000070301–SKT–V0080–A

Table 6.10 **Monocyclic and polycyclic aromatic hydrocarbon (MAH and PAH) concentrations in surface water upstream (US) and downstream (DS) of the existing river bridge; 1994 and 2007. Units are µg/L unless otherwise noted. See Figure 6.7 for station locations. Values in boldfaced type exceed the *Manitoba Water Quality Standards, Objectives and Guidelines* (MWQSOG) for the protection of aquatic life. Data summarized from CH2M Hill (1995) and UMA (2007b).**

Sampling Date	March 17-20, 1994					March 12, 2007					March 13, 2007			
Station	L01	L02	L04 [b]	L05	L07	UP1 [c]	UP2 [c]	T2 [d]	T3 [e]	T6 [d]	T7 [d]	T8 [c]	T9 [c]	
Station Location [a]	US	US	US	DS	DS	US	US	US	DS	DS	DS	DS	DS	MWQSOG
MAH														
Benzene	--	--	--	--	--	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**370**
Toluene	--	--	--	--	--	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**2.0**
Ethylbenzene	--	--	--	--	--	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**90**
Xylenes	--	--	--	--	--	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
TVH	--	--	--	--	--	<100	<100	<100	<100	<100	<100	<100	<100	
TEH	--	--	--	--	--	<100	<100	<100	<100	<100	<100	<100	<100	
PAH														
Naphthalene	0.006	0.005	0.004 - 0.006	0.005	<0.004	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**1.1**
1-Methyl Naphthalene	--	--	--	--	--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
2-Methyl Naphthalene	--	--	--	--	--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Acenaphthlene	<0.008	<0.008	<0.008	<0.008	<0.008	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**5.8**
Acenaphthylene	<0.004	<0.004	<0.004	<0.004	<0.004	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Anthracene	<0.008	<0.008	<0.008	<0.008	<0.008	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.012**
Benzo(a)anthracene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01 **- 0.06**	<0.01 **- 0.03**	<0.01	<0.01	<0.01	**0.018**
Dibenzo(a,h)anthracene	<0.008	<0.008	<0.008	<0.008	<0.008	<0.01	<0.01	<0.01	<0.01 - 0.06	<0.01 - 0.02	<0.01	<0.01	<0.01	
Chrysene	<0.007	<0.007	<0.007	<0.007	<0.007	<0.05	<0.05	<0.05	<0.05 - 0.08	<0.05	<0.05	<0.05	<0.05	
Fluoranthene	<0.006	<0.006	<0.006	<0.006	<0.006	<0.01	<0.01	<0.01	<0.01 **- 0.13**	<0.01 **- 0.06**	<0.01	<0.01	<0.01	**0.04**
Benzo(b)fluoranthene	<0.007	<0.007	<0.007	<0.007	<0.007	<0.01	<0.01	<0.01	<0.01 - 0.06	<0.01 - 0.02	<0.01	<0.01	<0.01	
Benzo(k)fluoranthene	<0.007	<0.007	<0.007	<0.007	<0.007	<0.01	<0.01	<0.01	<0.01 - 0.06	<0.01 - 0.02	<0.01	<0.01	<0.01	
Fluorene	<0.004	<0.004	<0.004	<0.004	<0.004	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**3.0**
Phenanthrene	<0.007	<0.007	<0.007	<0.007	<0.007	<0.01	<0.01	<0.01	<0.01 - 0.03	<0.01 - 0.03	<0.01	<0.01	<0.01	**0.4**
Benzo(g,h,i)perylene	<0.009	<0.009	<0.009	<0.009	<0.009	<0.01	<0.01	<0.01	<0.01 - 0.04	<0.01	<0.01	<0.01	<0.01	
Pyrene	<0.004	<0.004	<0.004	<0.004	<0.004	<0.01	<0.01	<0.01	<0.01 **- 0.08**	<0.01 **- 0.04**	<0.01	<0.01	<0.01	**0.025**
Benzo(a)pyrene	<0.006	<0.006	<0.006	<0.006	<0.006	<0.01	<0.01	<0.01	<0.01 **- 0.02**	<0.01	<0.01	<0.01	<0.01	**0.015**
Indeno(1,2,3-cd)pyrene	<0.011	<0.011	<0.011	<0.011	<0.011	<0.01	<0.01	<0.01	<0.01 - 0.05	<0.01 - 0.01	<0.01	<0.01	<0.01	
Quinoline	--	--	--	--	--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**3.4**
Acridine	--	--	--	--	--	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**4.4**

[a] relative to the existing river bridge

[b] average of 3 samples along transect

[c] average of 2 samples, one sample approximately 1 m below ice level and one sample approximately 0.15 to 0.30 m above sediment

[d] average of 4 samples along transect; two sample locations with two samples approximately 1 m below ice level and two samples approximately 0.15 to 0.30 m above sediment

[e] average of 3 samples along transect; two sample locations with two samples approximately 1 m below ice level and one sample approximately 0.15 to 0.30 m above sediment

Table 6.11 **Total metal concentrations in surface water upstream (US) and downstream (DS) of the existing river bridge; 2007. Units are µg/L unless otherwise noted. See Figure 6. 7 for station locations. Bolded values exceed the *Manitoba Water Quality Standards, Objectives and Guidelines* (MWQSOG) for the protection of aquatic life. Data summarized from UMA (2007b).**

Sampling Date	March 12, 2007					March 13, 2007			
Station	UP1 [b]	UP2 [b]	T2 [c]	T3 [d]	T6 [c]	T7 [c]	T8 [b]	T9 [b]	
Station Location [a]	US	US	US	DS	DS	DS	DS	DS	MWQSOG
Total Metals									
Aluminum	**1510 - 2410**	**1220 - 1250**	**1240 - 1520**	**930 - 1480**	**1060 - 1510**	**1100 - 1380**	**1280 - 1370**	**1030 - 1450**	**100**
Antimony	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	
Arsenic	3.8 - 4.1	3.6	3.6 - 3.8	3.4 - 3.7	3.5 - 3.9	3.5 - 3.6	3.6 - 3.7	2.6 - 2.9	**150**
Boron	100 - 110	110	110 - 120	110	110	100 - 110	100	100	
Barium	88.9 - 99.8	85.7 - 87.5	87.7 - 90.1	83.5 - 87.6	83.8 - 86.9	81.0 - 86.4	85.0 - 86.4	81.7 - 86.9	
Beryllium	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	
Bismuth	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	
Calcium	81300 - 82300	78100 - 81500	78800 - 82600	78400 - 79400	76700 - 82200	78000 - 80200	79200 - 80900	75900 - 81800	
Cadmium	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	**5.70**
Cobalt	0.6 - 0.8	0.4 - 0.6	0.5 - 0.6	0.5 - 0.7	0.5 - 0.6	0.5 - 0.6	0.6	0.5	
Chromium	< 1 - 2	< 1	< 1	< 1 - 1	< 1 - 1	< 1	< 1 - 1	< 1	**210**
Cesium	0.2 - 0.3	0.1 - 0.2	0.1 - 0.2	0.1 - 0.2	0.1 - 1	0.1	0.1	0.1 - 0.2	
Copper	4 - 5	4	4	4	4	4	4	3 - 4	**26**
Iron	**1210 - 1970**	**960 - 1160**	**1010 - 1370**	**730 - 1170**	**850 - 1200**	**850 - 1040**	**960 - 110**	**840 - 1090**	**300**
Lead	0.6 - 1.0	0.5 - 0.7	0.5 - 0.7	0.5 - 0.6	0.6 - 1.0	0.7	0.7 - 0.8	0.8	**9.7**
Magnesium	42000 - 42200	42400 - 42500	42200 - 43200	42300 - 42500	41900 - 43900	41800 - 44400	43400 - 44200	40800 - 42700	
Manganese	80.0 - 114	68.9 - 77.2	77.1 - 94.0	56.3 - 75.6	68.5 - 78.5	65.2 - 70.1	66.7 - 76.3	63.2 - 74.4	
Molybdenum	2.6	2.7	2.7 - 2.8	2.6 - 2.7	2.6 - 2.7	2.6 - 2.8	2.7 - 2.8	2.7 - 2.8	**73**
Nickel	5	4	4 - 5	4	4	4 - 5	4	3 - 4	**152**
Phosphorus	290 - 310	270 - 290	280 - 300	280 - 290	290 - 310	260 - 300	280 - 290	220 - 250	
Potassium	10600 - 10800	10100 - 10600	10200 - 10900	10300 - 10600	9900 - 10900	10300 - 10600	10300 - 10600	9800 - 10600	
Rubidium	5.0 - 6.5	4.6 - 4.8	4.6 - 5.4	4.0 - 5.0	4.2 - 4.9	4.3 - 4.6	4.6	4.9 - 5.5	
Selenium	**< 1 - 2**	**< 1 - 2**	**1 - 2**	< 1 - 1	< 1	< 1 - 1	< 1	< 1	**1.0**
Silver	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	**0.1**
Sodium	53100 - 53800	52000 - 55000	52600 - 56600	51900 - 57100	50800 - 58600	61800 - 64300	61600 - 6200	58900 - 64200	
Strontium	312 - 323	315 - 322	321 - 329	308 - 320	302 - 317	302 - 316	310 - 315	332 - 339	
Tellurium	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	
Tin	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6 - 0.8	< 0.6	< 0.6	
Titanium	44.0 - 51.9	33.0 - 33.4	31.6 - 45.5	27.2 - 44.4	30.0 - 304	40.3 - 280	35.7 - 39.4	28.1 - 33.7	
Thallium	0.2	0.2 - 0.3	0.2 - 0.5	0.3 - 0.4	0.2 - 0.3	0.3	0.2	0.2 - 0.3	**0.8**
Tungsten	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	
Uranium	3.1 - 3.2	2.9 - 3.1	3.1	2.9 - 3	2.9 - 3	3	3 - 3.1	3.4 - 3.5	
Vanadium	6 - 10	4 - 5	4 - 6	4 - 6	4 -6	4 - 5	5	4 - 6	
Zinc	20 - 30	< 10	< 10 - 30	< 10 - 20	< 10 - 20	< 10 - 20	10	10 - 50	**345**
Zirconium	1.7 - 2.3	1.4	1.3 - 3.6	1.1 - 2.1	1.0 - 1.5	1.2 - 1.4	1.3 - 1.4	1.3 - 1.5	

[a] relative to the existing river bridge
[b] summary of 2 samples, one sample approximately 1 m below ice level and one sample approximately 0.15 to 0.30 m above sediment
[c] summary of 4 samples along transect; two sample locations with two samples approximately 1 m below ice level and two samples approximately 0.15 to 0.30 m above sediment
[d] summary of 3 samples along transect; two sample locations with two samples approximately 1 m below ice level and one sample approximately 0.15 to 0.30 m above sediment

Table 6.12 **Red River water quality in the vicinity of the Disraeli Bridge in 2007 (March 12-13 and August 28-29) and the Redwood Bridge in 2009 (May to November). Values are the mean, standard deviation (SD), minimum and maximum values. Units are mg/L unless otherwise noted. See Figure 6. 7 for station locations. Bolded values exceed the *Manitoba Water Quality Standards, Objectives and Guidelines* (MWQSOG) for the protection of aquatic life. Data used to calculate the mean, SD, minimum and maximum values are from ENSR (2007), UMA (2007b) and City of Winnipeg (2010b).**

	Mar 2007				Aug 2007				May - Nov 2009				
Parameter	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**MWQSOG**
Physiochemical													
Temperature (ºC)	--	--	--	--	18.9	0.3	18.0	19.8	16.8	5.9	4.8	22.3	
Dissolved Oxygen	--	--	--	--	10.8	0.7	9.8	12.2	8.57	1.85	6.30	12.70	**6.5** [a]
pH (pH units)	--	--	--	--	8.5	0.2	7.7	8.7	8.25	0.22	7.88	8.57	**6.5 - 9.0**
Conductance (µS/cm)	--	--	--	--	750	3	745	762	--	--	--	--	
Total Dissolved Solids	635	16	610	670	--	--	--	--	--	--	--	--	
Total Suspended Solids	36	7	25	50	--	--	--	--	115	81	31	268	[b]
Turbidity (NTU)	--	--	--	--	--	--	--	--	80.0	49.0	20.0	184.0	
Nutrients													
Organic Carbon, dissolved	--	--	--	--	--	--	--	--	--	--	--	--	
Organic Carbon, total	--	--	--	--	--	--	--	--	12.92	4.98	10.00	28.00	
Nitrate	--	--	--	--	--	--	--	--	0.41	0.19	0.12	0.67	
Ammonia	--	--	--	--	--	--	--	--	0.069	0.050	<0.003	0.188	**1.428 - 5.197** [c]
Total Kjeldahl Nitrogen	--	--	--	--	--	--	--	--	1.1	0.5	<2.0	2.6	
Total Nitrogen	--	--	--	--	--	--	--	--	1.2	0.5	<2.0	2.9	
Phosphorus, total dissolved	--	--	--	--	--	--	--	--	0.16	0.03	0.13	0.22	
Phosphorus, total	--	--	--	--	--	--	--	--	**0.27**	0.11	<0.30	0.40	**0.05**
Biological	--	--	--	--									
Chlorophyll a	--	--	--	--	--	--	--	--	0.023	0.015	0.007	0.058	

[a] Guideline for mature life stages (water temperature > 5ºC), 30 day average duration

[b] 25 mg/L induced change from background for more than 1 day duration

[c] range for all life stages and averaging durations determined using mean pH and temperature

6.3.3 SEDIMENT QUALITY

Surficial sediment quality (i.e., the upper 0.3 m of sediment) was sampled between 1995 and 2010 at various locations in the Red River upstream and downstream of the existing river bridge (Agassiz 1996; North/South 2003; UMA 2003, ENSR 2007; UMA 2007b, AECOM 2008-2010 unpublished data). Data have been summarized from these reports for stations within the areas of the planned work bridges and river piers for the new river bridge. Data were compared to the interim sediment quality guidelines (ISQG) and the probable effect levels (PEL) established by the Canadian Council of Ministers for the Environment (CCME 2001), where possible. See Figure 6.8 for station locations.

Sediment samples were collected October 9 to 10, 1995, at eight stations (T-S13, T-S14, T-S16, T-S17, T-D19, T-D20, T-D22, and T-D23; Agassiz 1996) in both shallow (T-S) and deep (T-D) water zones. Shallow stations (within 20 m of the shore) were sampled using a stainless steel Wildco hand corer (5.1 cm I.D.) equipped with a 4.8 cm I.D. cellulose acetate butyrate (CAB) core liner. Deep stations (20 m - 50 m offshore) were sampled using a stainless steel Ekman dredge (15 cm x 15 cm x 26 cm tall, sampling area 0.023 m^2). Sub-samples of the dredge material were collected using a 5 cm length of CAB core tube. Two cores were collected and composited at each station and the upper 5 cm of sediment were analyzed for PAH and total organic carbon (TOC).

Visual assessments of hydrocarbon contamination were made at six of eight stations in the study site (T-S16, T-S17, T-S19, T-S20, T-S22, and T-S23; Agassiz 1996).

The majority of polycyclic aromatic hydrocarbons (PAH) occurred at concentrations in excess of the ISQG (Table 6.13; Figure 6.8). Seven PAHs occurred at concentrations in excess of the PEL at station T-S16. Concentrations of acenaphthene exceeded the guideline by more than three orders of magnitude (1000x), while flourene, phenanthrene and anthracene concentrations were 500 to 850 times higher than the PEL. Naphthalene, acenaphthene and fluorene concentrations also exceeded the PEL at stations T-D19 and T-D20 but at concentrations notably lower than station T-S16. Conversely, two stations in the study site (T-S13 and T-D22) had measurable concentrations of PAHs except for acenaphthene which did not exceed the reported detection limits for both stations. Additionally, none of the PAH at these two stations exceeded the CCME guidelines. Total organic carbon values were similar among the stations ranging from 8.35% to 12.26%.

Borehole sediment samples were collected from two stations within the study area (T3-1 and T3-3; Figure 6.8) in February 2002 (UMA 2003) using a skid mounted auger rig with a continuous sampler inserted inside hollow stem augers. Sediments were retained inside the sampler in a CAB sleeve further contained with polyethylene caps. Samples were analyzed for PAH, BTEX (benzene, toluene, ethylbenzene and xylene), and metals.

Similar to the 1995 sediment samples, the majority of PAH concentrations exceeded the ISQG with 13 of 18 PAH concentrations exceeding the CCME PEL, by several orders of magnitude (Table 6.13). Concentrations of 1-methyl naphthalene, benzo(b+k)fluoranthene, indeno (1, 2, 3-cd) pyrene and benzo(g,h,i)perylene did not exceed the CCME guidelines for sediment quality. Generally, concentrations of PAH in 2002 sediment samples were approximately 1000 times higher compared to the sediment samples collected in 1995, but the station locations were different. There were measurable concentrations of BTEX in the sediment but concentrations were notably less than the PAH, suggesting a greater presence of weathered hydrocarbons as indicated by the smaller fraction of volatile components. Metal concentrations did not exceed the CCME guidelines (Table 6.14).

Sediment samples were also collected February 3 and March 3, 2003 at two stations within the study site (T3-3a and T3-4a; North/South 2003; Figure 6.8). Five replicate samples per station were collected from the surficial sediments (approximately 5 cm depth below the sediment-water interface) using a petite Ponar dredge (15 cm 15 cm; sampling area 0.023 m^2) and analyzed for TOC, particle size analysis, PAH, and metals.

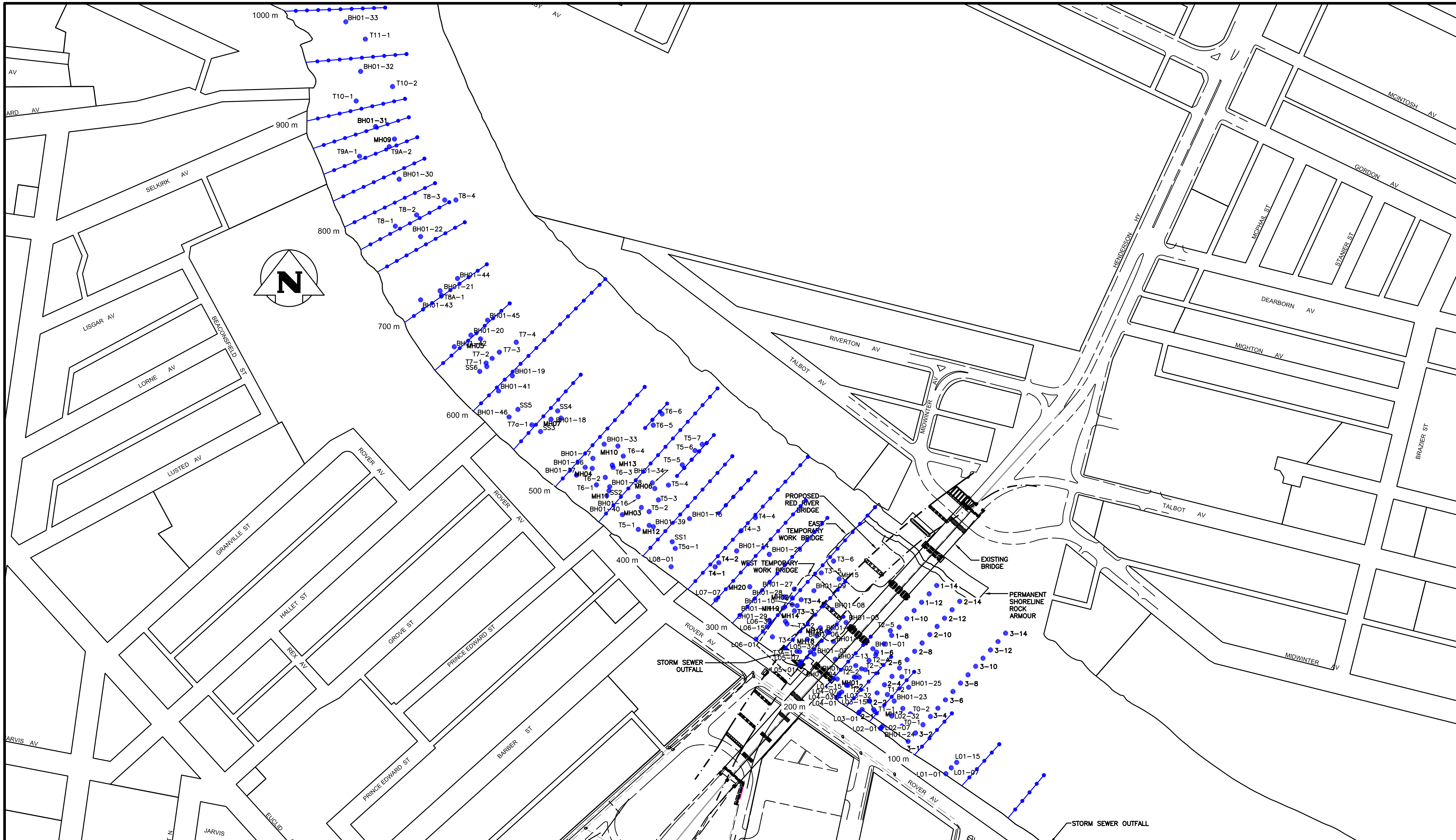
Sediment particle sizes at both stations were dominated by clay (63% to 64%) and silt (28% to 31%) with a lesser proportion of sand (6% to 8%; Table 6.13). Gravel was observed in one replicate sample from station T3-4 (North/South 2003). Total organic carbon content was low but similar for both stations ranging from 1.70% to 2.48%. Similar to the 1995 and 2002 sediment samples, the majority of PAH concentrations exceeded the ISQG with 13 of 18 PAH concentrations exceeding the CCME PEL at both stations, by several orders of magnitude. Concentrations of 1-methyl naphthalene, benzo(b+k)fluoranthene, indeno (1, 2, 3-cd)pyrene and benzo(g,h,i)perylene did not exceed the CCME guidelines for sediment quality. Generally, concentrations of PAHs were approximately 10 times higher compared to the sediment samples collected in 1995 and 100 times less than the values measured in 2002. The 2003 station locations were different from the 1995 stations, but would have been located within a few metres of the 2002 sampling stations. Metal concentrations did not exceed the CCME guidelines with the exception of arsenic at station T3-4A (6.4 mg/kg) which was marginally higher than the ISQG (5.9 mg/kg; Table 6.14). Metal concentrations in sediments were similar to the values measured in 2002.

Surface sediment quality was sampled on August 28 to 29, 2007 along the south shore of the Red River near the Disraeli Bridge study site (ENSR 2007). Surface sediment (0 m to 0.10 m) samples were collected using a petite Ponar dredge (15 cm x 15 cm; sampling area 0.023 m^2) and analyzed for PAH and TOC. Sediment samples from four stations within the study area (MH02, MH14, MH16, and MH19; Figure 6.9) were submitted for detailed chemical analysis.

Total organic carbon content was low (6.44%; Table 6.13) but between the range observed by Agassiz (1996) and North/South (2003; min. 1.70% and max.12.26%). Similar to the 1995, 2002 and 2003 sediment samples, the majority of PAH concentrations exceeded the ISQG with 13 of 18 PAH concentrations exceeding the CCME PEL at three of the four stations, by several orders of magnitude. Concentrations of 1-methyl naphthalene, benzo(b+k)fluoranthene, indeno (1, 2, 3-cd)pyrene and benzo(g,h,i)perylene at all four stations did not exceed the CCME guidelines for sediment quality. Additionally, concentrations of fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(a)pyrene and dibenzo(a,h)anthracene were also less than the ISQG at station MH02. PAH concentrations were highest in sediment collected at station MH16, which were similar to, or slightly less than, the PAH concentrations observed by UMA (2003; Table 6.13).

Sediment quality was sampled annually from 2008 to 2010 (AECOM 2008 to 2010 unpublished data), along the third transect (T3) established by North/South (2003) and UMA (2003). Surface sediments were collected (≤ 0.3 m depth) at seven stations along T3 within the study site (T3-1, T3-2, T3-3, T3-4, T3-5, T3-6, and T3A-2; Figure 6.9). In 2008 to 2009, samples were collected using a Petite Ponar dredge (dimensions unreported). In 2010, samples were collected using a hollow stem auger. Sediments were analysed for PAHs and particle size.

Clay and silt dominated the sediment particle size composition at all sample depths for the two stations closest to shore (T3-1 and T3-2; Tables 6.15). The sediment particle size composition transitioned to sand at stations farther out from the shore (T3-3 to T3-6). The CCME ISQG and PEL for PAH were commonly exceeded at stations T3-1, T3-3, T3-4 and T3-5). Similar to the 1995 to 2007 sediment samples, 12 to 13 of 18 PAH concentrations exceeded the ISQG at one or more sediment depths, at least once at all stations except for samples collected at stations T3-6 and T3A-2. The concentrations of PAH were notably and consistently higher (by several magnitudes) at station T3-3 compared to any other station. Conversely, only three PAH sediment concentrations exceeded the ISQG at station T3-6, and none exceeded the guidelines at station T3A-2. Concentrations of PAH generally declined with increasing sediment sample depth. For example, only the ISQG for naphthalene was exceeded at station T3-4 in the 0.20 m to 0.30 m sediment sample, while PAH concentrations consistently did not exceed the reported detection limits in sediments sampled deeper than 0.10 m at station T3-2 and none exceeded the ISQG.



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LEGEND:

- SEDIMENT SAMPLE
- TRANSECTS SAMPLED BY AGASSIZ 2000

FIGURE 6.8

DISRAELI BRIDGES PROJECT

HISTORIC SEDIMENT SAMPLE LOCATIONS

1000070301-SKT-V0081-A

Table 6.13 **Grain particle size composition, total organic carbon and hydrocarbon concentrations in sediment sampled from the Red River within the Disraeli Bridge study site; 1995-2007. Values are mg/kg (dry weight) unless otherwise noted. Shaded and bolded values exceed the CCME interim sediment quality guideline (ISQG) and the probable effect level (PEL), respectively. Data from Agassiz (1996), North/South (2003), UMA (2003) and ENSR (2007).**

Reference	Agassiz 1996								UMA 2003	North/South 2003		ENSR 2007				CCME	
Sampling Date	9/10-Oct-95								Feb-02	28-Feb-03	03-Mar-03	28/29-Aug-07					
Station	T-S13	T-S14	T-S16	T-S17	T-D19	T-D20	T-D22	T-D23	T3-3	T3-3A	T3-4A	MH02 [a]	MH14 [a]	MH16 [a]	MH19 [a]	ISQG [b]	PEL [b]
Sample Depth (m)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.3	<0.10	<0.10	0.1	0.1	0.1	0.1		
Sand (%)	--	--	--	--	--	--	--	--	--	8	6	--	--	--	--		
Silt (%)	--	--	--	--	--	--	--	--	--	28	31	--	--	--	--		
Clay (%)	--	--	--	--	--	--	--	--	--	64	63	--	--	--	--		
Total organic carbon (%)	8.35	8.55	8.96	9.43	9.88	12.09	12.16	12.26	--	2.48	1.70	--	6.44	--	--		
Naphthalene	0.0052	0.0075	**5.1600**	0.0669	**1.3800**	**2.9400**	0.0089	0.1300	**11600**	16.9	**42.7**	2.11	1260	4695	**590**	0.0346	**0.391**
2-Methyl Naphthalene	--	--	--	--	--	--	--	--	**2550**	**3.07**	**12.3**	**0.5065**	**378**	**1270**	**148.5**	0.0202	**0.201**
1-Methyl Naphthalene	--	--	--	--	--	--	--	--	1340	1.95	6.36	0.292	207	675.5	76.5		
Acenaphthylene	0.0041	0.0702	0.1060	0.0535	0.0244	0.1140	0.0037	0.0081	**1670**	**1.20**	**4.92**	**0.937**	**377**	**1370**	**151**	0.00587	**0.128**
Acenaphthene	<0.00112	0.0122	**1.0600**	0.0112	**0.1160**	**0.3130**	<0.00112	0.0098	**1200**	**3.80**	**16.2**	**0.2735**	**105**	**282**	**39.65**	0.00671	**0.0889**
Fluorene	0.0032	0.0556	**1.3800**	0.0217	0.0833	**0.2530**	0.0031	0.0129	**1860**	**2.66**	**10.4**	**0.4325**	**272**	**785**	**111**	0.0212	**0.144**
Phenanthrene	0.0192	0.4410	**3.1400**	0.1040	0.2540	0.1300	0.0243	0.0682	**6670**	**8.97**	**40.0**	**1.76**	**859**	**2995**	**408**	0.0419	**0.515**
Anthracene	0.0040	0.0690	**1.5400**	0.2220	0.0895	0.1370	0.0051	0.0147	**2080**	**2.66**	**6.40**	**0.527**	**441**	**1750**	**181**	0.0469	**0.245**
Fluoranthene	0.0329	0.5060	1.6100	0.4120	0.2310	0.3020	0.0421	0.0722	**4200**	**4.90**	**24.8**	0.8325	**450**	**974**	**251**	0.111	**2.355**
Pyrene	0.0306	0.4120	**1.0800**	0.3540	0.1870	0.2370	0.0364	0.0603	**3160**	**3.95**	**18.8**	0.6345	**481**	**890.5**	**216.5**	0.0530	**0.875**
Benzo(a)anthracene	0.0146	0.2180	**0.4800**	0.3050	0.0902	0.0748	0.0168	0.0266	**1310**	**1.90**	**8.96**	0.302	**236**	**614**	**104.5**	0.0317	**0.385**
Chrysene	0.0167	0.1590	0.4240	0.2390	0.0838	0.0709	0.0232	0.0329	**1090**	**1.49**	**6.52**	0.2605	**209**	**666.5**	**79.75**	0.0571	**0.862**
Benzo(b)fluoranthene	0.0177	0.1700	0.3750	0.2630	0.0831	0.0623	0.0234	0.0312	1190	1.38	6.04	0.3255 [c]	291 [c]	717.5 [c]	113.5 [c]		
Benzo(k)fluoranthene	0.0109	0.1380	0.3070	0.2190	0.0668	0.0479	0.0134	0.0182	480	1.42	6.36						
Benzo(a)pyrene	0.0153	0.2070	0.4190	0.3440	0.0927	0.0667	0.0189	0.0251	**1040**	**2.04**	**8.26**	0.286	**261**	**683.5**	**100.55**	0.0319	**0.782**
Indeno(1,2,3-cd)pyrene	0.0111	0.1110	0.3450	0.2060	0.0663	0.0426	0.0190	0.0180	581	1.19	5.37	0.2985	294	864	126		
Dibenzo(a,h)anthracene	0.0034	0.0283	0.1220	0.0498	0.0142	0.0164	0.0052	0.0041	**110**	**0.216**	**0.88**	0.057	**51.5**	**189**	**18.7**	0.00622	**0.135**
Benzo(g,h,i)perylene	0.0113	0.1150	0.3440	0.2110	0.0654	0.0400	0.0171	0.0177	421	1.03	4.74	0.1405	129	401.5	50.1		
Benzene	--	--	--	--	--	--	--	--	161	--	--	--	--	--	--		
Toluene	--	--	--	--	--	--	--	--	210	--	--	--	--	--	--		
Ethylbenzene	--	--	--	--	--	--	--	--	69.6	--	--	--	--	--	--		
Xylenes	--	--	--	--	--	--	--	--	450	--	--	--	--	--	--		
Total PAH_{16} [d]	0.200	2.72	17.89	3.08	2.93	4.85	0.261	0.550	*38662*	55.71	211.35	9.18	*11400*	*17878*	*2541*		*285* [e]

[a] mean of two samples

[b] Values are the same as *Manitoba Water Quality Standards, Objectives and Guidelines* (Williamson 2002).

[c] sum of b & k isomer concentrations

[d] sum of 16 EPA priority pollutant PAH including naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k) fluoranthene, benzo(a)pyrene, indeno [1,2,3-cd]pyrene, dibenz[ah]anthracene, benzo[ghi]perylene

[e] Value where bulk sediment PAH_{16} concentration would likely result in mortality to benthic invertebrates (ENSR 2007)

Table 6.14 **Total organic carbon and metal concentrations in sediment sampled from the Red River within the Disraeli Bridge study site; 2003. Values are mg/kg (dry weight) unless otherwise noted. Shaded and bolded values exceed the CCME interim sediment quality guideline (ISQG) and the probable effect level (PEL), respectively. Data from North/South (2003) and UMA (2003).**

Reference	UMA 2003		North/South 2003				
Sampling Date	Feb-02		23-Mar-03	28-Feb-03	CCME		
Station	T3-1	T3-3		T3-3A	T3-4A	ISQG [a]	PEL [a]
Sample Depth (m)	1.3	0.3		<0.10	<0.10		
Total organic carbon (%)	--	--		2.48	1.70		
Aluminum (Al)	11900	4200		14300	15700		
Arsenic (As)	--	--		5.4	6.4	5.9	**17**
Barium (Ba)	215	90		158	159		
Berylium (Be)	0.6	0.2		0.7	0.8		
Cadmium (Cd)	<0.5	<0.5		<0.5	0.6	0.6	**3.5**
Calcium (Ca)	--	--		36600	37900		
Chromium (Cr)	21	9		27	28	37.3	**90**
Cobalt (Co)	7	5		9	9		
Copper (Cu)	28	15		27	25	35.7	**197**
Iron (Fe)	20700	8600		22100	24600		
Lead (Pb)	13	10		14	9	35	**91.3**
Magnesium (Mg)	--	--		15900	17300		
Manganese (Mn)	743	331		945	992		
Mercury (Hg)	--	--		0.10	0.10	0.17	**0.486**
Molybdenum (Mo)	<3	<3		<3	<3		
Nickel (Ni)	22	13		26	27		
Phosphorus (P)	702	406		728	694		
Potassium (K)	--	--		2960	3210		
Selenium (Se)	--	--		0.5	0.7		
Silver (Ag)	<1	<1		<1	<1		
Sodium (Na)	--	--		357	377		
Strontium (Sr)	--	--		60.4	64.1		
Titanium (Ti)	124	146		154	156		
Vanadium (V)	40	13		52	56		
Zinc (Zn)	77	34		85	84	123	**315**

[a] Values are the same as *Manitoba Water Quality Standards, Objectives and Guidelines* (Williamson 2002).

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Table 6.15 **Grain particle size composition, and hydrocarbon concentrations in sediment sampled from the Red River within the Disraeli Bridge study site; 2008-2010. Values are mg/kg (dry weight) unless otherwise noted. Shaded and bolded values exceed the CCME interim sediment quality guideline (ISQG) and the probable effect level (PEL), respectively. Data from AECOM (2008-2010 unpublished data).**

Station	T3-1					T3 - 2						T3 - 3						CCME	
Sampling Date	20-Feb-09			02-Mar-10		05-Mar-08	20-Feb-09			02-Mar-10		04-Mar-08			20-Feb-09	24-Feb-10			
Sample Depth (m)	0-0.1	0.1-0.2	0.2-0.3	0-0.1	0.1-0.3	0-0.05	0-0.1	0.1-0.2	0.2-0.3	0-0.1	0.1-0.3	0-0.05	0.05-0.1	0.1-0.2	0-0.1	0-0.1	0.1-0.3	ISQG [a]	PEL [a]
Sand (%)	26	15	26	5	13	31	30	6	12	25	12	72	80	46	88	88	80		
Silt (%)	23	23	36	26	25	31	22	22	28	30	42	26	17	45	6	5	12		
Clay (%)	52	62	38	69	62	38	48	73	59	45	46	2	2	10	6	7	7		
Naphthalene	**0.53**	**0.83**	**5.6**	<0.010	**1260**	**0.83**	0.09	0.02	0.03	<0.010	<0.010	**40000**	**32000**	**9100**	**9500**	**3710**	**11700**	0.0346	**0.391**
2-Methyl Naphthalene	0.08	0.1	**0.83**	<0.010	**180**	0.16	<0.01	<0.01	<0.01	<0.010	<0.010	**7400**	**6900**	**2000**	**2700**	**377**	**1550**	0.0202	**0.201**
1-Methyl Naphthalene	0.07	0.11	1	<0.010	119	0.11	0.01	<0.01	<0.01	<0.010	<0.010	3900	3400	1000	1300	353	1220		
Acenaphthylene	**0.41**	**0.32**	0.11	<0.010	**46.4**	**0.27**	**0.15**	<0.01	<0.01	<0.010	<0.010	**5100**	**6100**	**1400**	**2200**	**399**	**1460**	0.00587	**0.128**
Acenaphthene	**0.81**	**1.2**	**2**	0.011	**195**	**1**	**0.18**	<0.01	<0.01	**0.127**	<0.010	**4400**	**1900**	**1200**	**740**	**130**	**356**	0.00671	**0.0889**
Fluorene	**0.62**	**0.79**	**1.2**	<0.010	**141**	**0.31**	0.04	<0.01	<0.01	0.02	<0.010	**6100**	**5200**	**1600**	**1900**	**350**	**1130**	0.0212	**0.144**
Phenanthrene	**2.5**	**1.7**	**3.8**	<0.010	**589**	**0.66**	0.4	<0.01	<0.01	0.045	<0.010	**24000**	**19000**	**6000**	**6600**	**1320**	**4840**	0.0419	**0.515**
Anthracene	**1**	**0.68**	**1.1**	<0.010	**169**	**0.3**	0.18	<0.01	<0.01	0.025	<0.010	**9200**	**5700**	**2200**	**2000**	**477**	**1840**	0.0469	**0.245**
Fluoranthene	**3.7**	**3.2**	2.3	<0.010	**385**	1.1	1.2	<0.01	<0.01	0.063	<0.010	**16000**	**12000**	**3900**	**4400**	**747**	**3020**	0.111	**2.355**
Pyrene	**3**	**2.6**	**1.8**	<0.010	**335**	**1.1**	**1**	<0.01	<0.01	0.065	<0.010	**12000**	**9300**	**3000**	**3400**	**723**	**2310**	0.0530	**0.875**
Benzo(a)anthracene	**1.3**	**1.2**	**0.73**	<0.010	**145**	**0.73**	**0.62**	<0.01	<0.01	0.058	<0.010	**6500**	**4700**	**1600**	**1400**	**325**	**1160**	0.0317	**0.385**
Chrysene	**1.3**	**1.3**	0.55	<0.010	**129**	0.48	0.42	<0.01	<0.01	0.033	<0.010	**4600**	**3800**	**1200**	**1100**	**266**	**1030**	0.0571	**0.862**
Benzo(b)fluoranthene	1.7	1.6	0.69	<0.010	149	0.67	0.67	<0.01	<0.01	0.029	<0.010	5100	4100	1400	1200	234	904		
Benzo(k)fluoranthene	0.64	0.6	0.29	<0.010	43	0.24	0.27	<0.01	<0.01	0.011	<0.010	1800	1500	470	610	91.9	333		
Benzo(a)pyrene	**1.3**	**1.2**	0.51	<0.010	**134**	0.6	0.64	<0.01	<0.01	0.029	<0.010	**4200**	**3300**	**1200**	**980**	**246**	**859**	0.0319	**0.782**
Indeno(1,2,3-cd)pyrene	0.74	0.66	0.26	<0.010	97.2	0.36	0.42	<0.01	<0.01	0.018	<0.010	2300	1900	770	450	132	640		
Dibenzo(a,h)anthracene	0.12	0.12	0.08	<0.010	**12.9**	0.03	0.09	<0.01	<0.01	<0.010	<0.010	**180**	**160**	**67**	<2	**28.9**	**99.1**	0.00622	**0.135**
Benzo(g,h,i)perylene	0.52	0.48	0.18	<0.010	55.6	0.32	0.42	<0.01	0.01	0.012	<0.010	1800	1800	560	370	82.2	373		
Benzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
Toluene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
Ethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
Xylenes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
Total PAH_{16} [b]	20.19	18.48	21.20	0.161	*3886*	9.000	6.79	0.170	0.180	0.565	0.160	*143280*	*112460*	*35667*	*36852*	*9262*	*32054*		*285* [c]

[a] Values are the same as *Manitoba Water Quality Standards, Objectives and Guidelines* (Williamson 2002).

[b] sum of 16 EPA priority pollutant PAH including naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno [1,2,3-cd]pyrene, dibenz[ah]anthracene, benzo[ghi]perylene

[c] Value where bulk sediment PAH_{16} concentration would likely result in mortality to benthic invertebrates (ENSR 2007)

Table 6.15 (cont'd) **Grain particle size composition, and hydrocarbon concentrations in sediment sampled from the Red River within the Disraeli Bridge study site; 2008-2010. Values are mg/kg (dry weight) unless otherwise noted. Shaded and bolded values exceed the CCME interim sediment quality guideline (ISQG) and the probable effect level (PEL), respectively. Data from AECOM (2008-2010 unpublished data).**

Station	**T3 - 4**						**T3 - 5**				**T3 - 6**	**T3A-2**		**CCME**	
Sampling Date	**04-Mar-08**	**20-Feb-09**			**02-Mar-10**		**11-Mar-08**	**19-Feb-09**		**02-Mar-10**	**11-Mar-08**	**02-Mar-10**			
Sample Depth (m)	**0-0.05**	**0-0.1**	**0.1-0.2**	**0.2-0.3**	**0-0.1**	**0.1-0.2**	**0-0.05**	**0-0.1**	**0.1-0.2**	**0-0.1**	**0-0.05**	**0-0.1**	**0.1-0.3**	**ISQG [a]**	**PEL [a]**
Sand (%)	61	24	6	37	88	48	43	72	75	84	93	88	60		
Silt (%)	26	46	59	37	4	37	28	13	12	6	4	4	27		
Clay (%)	14	30	35	26	9	15	28	15	13	10	3	9	13		
Naphthalene	**480**	**2.6**	**2.3**	0.26	**5.71**	<0.010	<0.01	**2.6**	<0.1	0.014	0.02	<0.010	0.018	0.0346	**0.391**
2-Methyl Naphthalene	**140**	0.13	0.07	<0.01	**1.02**	<0.010	<0.01	**0.3**	<0.1	<0.010	<0.01	<0.010	<0.010	0.0202	**0.201**
1-Methyl Naphthalene	79	0.11	0.1	<0.01	0.873	<0.010	<0.01	0.3	<0.1	<0.010	<0.01	<0.010	<0.010		
Acenaphthylene	**160**	**0.14**	0.07	<0.01	**0.778**	<0.010	<0.01	**0.2**	<0.1	0.022	<0.01	<0.010	<0.010	0.00587	**0.128**
Acenaphthene	**74**	0.07	0.03	<0.01	**1.39**	<0.010	<0.01	**0.2**	<0.1	0.036	0.01	<0.010	<0.010	0.00671	**0.0889**
Fluorene	**160**	0.12	0.04	<0.01	**1.24**	<0.010	<0.01	**0.3**	<0.1	0.062	0.01	<0.010	<0.010	0.0212	**0.144**
Phenanthrene	**630**	**0.64**	0.22	0.01	**5.07**	<0.010	0.02	**1**	<0.1	0.253	0.02	<0.010	<0.010	0.0419	**0.515**
Anthracene	**180**	0.22	0.08	<0.01	**1.16**	<0.010	<0.01	**0.4**	<0.1	0.131	0.01	<0.010	<0.010	0.0469	**0.245**
Fluoranthene	**450**	0.59	0.17	<0.01	**3.15**	<0.010	0.02	2.1	0.2	0.416	0.4	<0.010	<0.010	0.111	**2.355**
Pyrene	**300**	0.46	0.15	<0.01	**2.64**	<0.010	0.02	**1.8**	0.2	0.336	0.33	<0.010	<0.010	0.0530	**0.875**
Benzo(a)anthracene	**180**	0.21	0.05	<0.01	**1.12**	<0.010	<0.01	**0.7**	<0.1	0.216	0.02	<0.010	<0.010	0.0317	**0.385**
Chrysene	**110**	0.16	0.07	<0.01	0.825	<0.010	<0.01	0.8	0.1	0.147	0.02	<0.010	<0.010	0.0571	**0.862**
Benzo(b)fluoranthene	150	0.23	0.06	<0.01	0.894	<0.010	<0.01	0.9	0.1	0.208	0.01	<0.010	<0.010		
Benzo(k)fluoranthene	51	0.11	0.05	<0.01	0.535	<0.010	<0.01	0.6	0.1	0.085	<0.01	<0.010	<0.010		
Benzo(a)pyrene	**130**	0.2	0.07	<0.01	**1.06**	<0.010	<0.01	0.7	<0.1	0.236	<0.01	<0.010	<0.010	0.0319	**0.782**
Indeno(1,2,3-cd)pyrene	73	0.1	<0.01	<0.01	0.777	<0.010	<0.01	<0.1	<0.1	0.103	<0.01	<0.010	<0.010		
Dibenzo(a,h)anthracene	**9.7**	0.03	<0.01	<0.01	0.101	<0.010	<0.01	<0.1	<0.1	<0.010	<0.01	<0.010	<0.010	0.00622	**0.135**
Benzo(g,h,i)perylene	57	0.11	<0.01	<0.01	0.671	<0.010	<0.01	0.2	<0.1	0.09	<0.01	<0.010	<0.010		
Benzene	--	--	--	--	--	--	--	--	--	--	--	--	--		
Toluene	--	--	--	--	--	--	--	--	--	--	--	--	--		
Ethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	--		
Xylenes	--	--	--	--	--	--	--	--	--	--	--	--	--		
Total PAH_{16} [b]	*3195*	5.99	3.39	0.410	27.12	0.160	0.190	12.70	1.80	2.37	0.910	0.160	0.168		*285* [c]

[a] Values are the same as *Manitoba Water Quality Standards, Objectives and Guidelines* (Williamson 2002).
[b] sum of 16 EPA priority pollutant PAH including naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno [1,2,3-cd]pyrene, dibenz[ah]anthracene, benzo[ghi]perylene
[c] Value where bulk sediment PAH_{16} concentration would likely result in mortality to benthic invertebrates (ENSR 2007)

6.3.4 BENTHIC COMMUNITY

The benthic invertebrate community in the Red River is generally considered to be productive and diverse (Chambers et al. 2009). In comparison, periodic surveys of the benthic community in the vicinity of the existing Disraeli Bridge over the past 15 years have found low benthic invertebrate density and richness (number of taxa observed). Recent studies have found the benthic community in the local study area is comprised of six main phyla and approximately 50 families (UMA 2006).

Twenty-three species of freshwater clams and mussels have been observed in the Red River in Manitoba however occurrences are often discontinuous. The soft silt/clay substrate would be expected to support species such as fingernail clams. Previous surveys in the local study area recovered fingernail clams in patchy and relatively low densities (Chambers et al. 2009). The most recent surveys did not recover any live mussels in the local study area (Chambers et al. 2009).

One species known to occur in the Red River, Mapleleaf Mussel (*Quadrula quadrula*), was designated in 2006 as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), but has not been scheduled and therefore has no status or protection under the *Species at Risk Act* (SARA; COSEWIC 2006a). There have been no recent reports of Mapleleaf Mussel occurrences in the Red River within Winnipeg and none was observed during the extensive studies associated with the MGP, the Centra Gas Pipeline, or the Disraeli Bridges Project (COSEWIC 2006a; UMA 2006; Chambers et al. 2009).

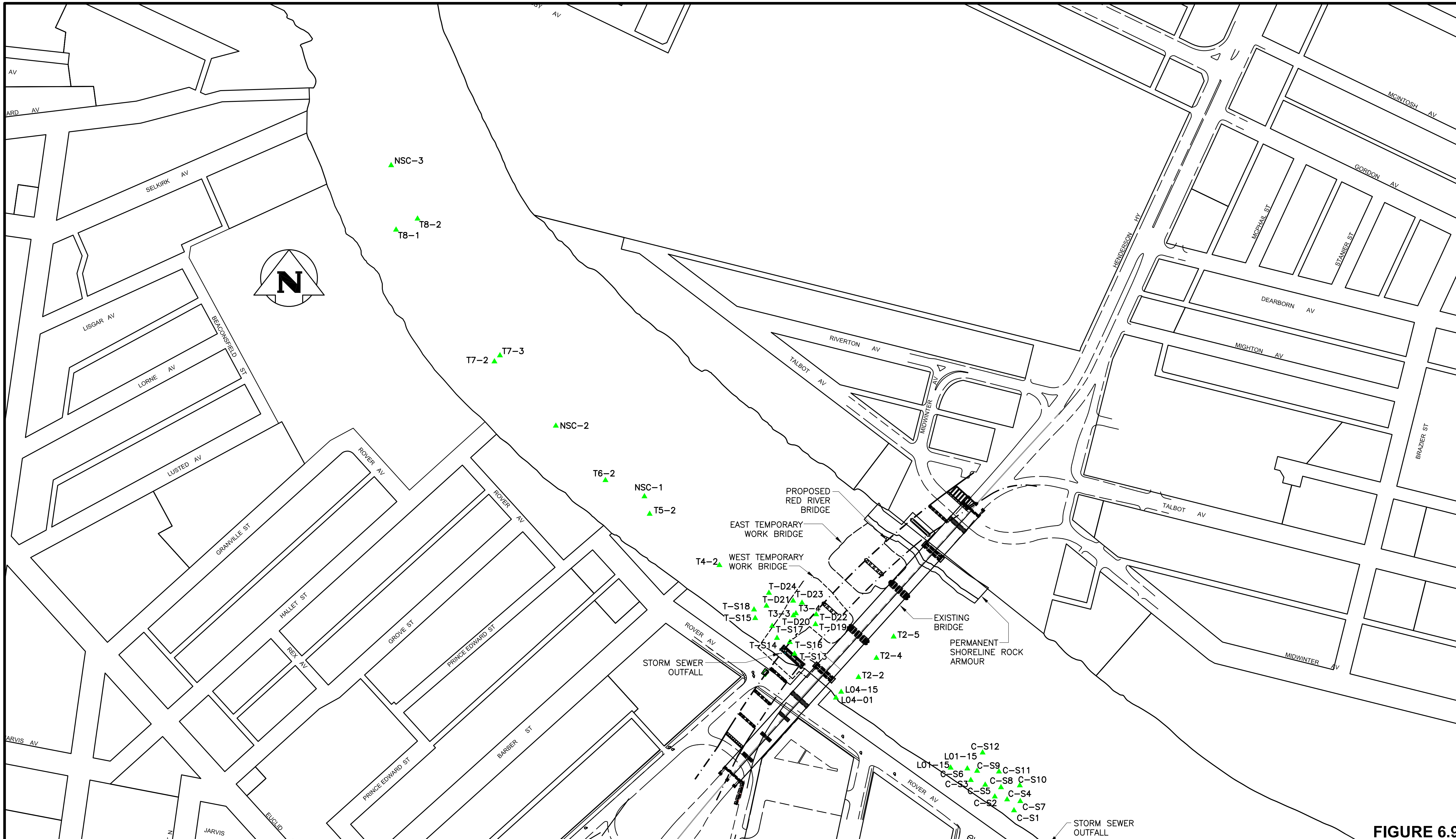
Benthic invertebrate communities were surveyed in 1995 and 2003 (Agassiz 1996; North/South 2003) at various locations in the Red River upstream and downstream of the existing river bridge. Data collected within the planned footprint of the east and west temporary work bridges and river piers were compiled from these reports. See Figure 6.9 for station locations.

Benthic invertebrates were collected September 29, 1995, along the west shore of the Red River near the Disraeli Bridge in both shallow and deep zones. Single dredge samples were collected at eight stations within the study site (T-S13, T-S14, T-S16, T-S17, T-D19, T-D20, T-D22, and T-D23; Agassiz 1996) using a stainless steel Ekman dredge (15 cm x 15 cm x 26 cm tall; sampling area 0.023 m^2). Samples were sieved with 400 μm mesh and preserved with 70% ethanol in polyethylene storage bags. Benthos were identified to Family in all cases, and to Genus for some taxa.

Benthic invertebrates were also collected between February 25 and March 3, 2003 at two stations within the study site (T3-3 and T3-4; North/South 2003). Five replicate samples per station were collected from the surficial sediments (approximately 5 cm depth below the sediment- water interface) using a petite Ponar dredge (15 cm x 15 cm; sampling area 0.023 m^2). Samples were sieved with 500 μm mesh and preserved with 10% formalin for one week, then transferred to 70% ethanol in plastic jars.

Benthos were identified to Genus and/or species for all taxa. Exceptions included the identification of chironomids to sub-Family, and oligochaetes to Family.

Six taxa were identified in samples collected in 2003, while three were observed in samples collected in 1995 (Table 6.16). The common taxa collected included Chironomidae, Ephemeroptera, and Oligochaeta (Ephemeroptera identified in the 1996 samples included *Hexagenia sp;* Agassiz 1996). The taxa observed only in the 2003 samples included Coleoptera, Trichoptera and Bivalvia. Bivalvia were also captured in 1995 at one station outside of, but adjacent to, the Project site (Agassiz 1996) and that all Bivalvia captured in distal upstream and downstream stations were identified as Sphaeriidae (North/South 2003). The benthic communities were dominated by Oligochaeta, followed by Chironomidae in both 1995 and 2003 (Table 6.16). Mean densities of Oligochaeta, and Ephemeroptera were similar among the stations and between years although there was a wide variation in the number of individuals among samples. In general, greater densities of chironomids were observed in 2003 compared to 1995.



WARDROP A TETRA TECH COMPANY

PEOPLE, PASSION, PERFORMANCE, TRUSTED GLOBALLY

LEGEND:
▲ BENTHIC INVERTEBRATE SAMPLE

FIGURE 6.9
DISRAELI BRIDGES PROJECT
HISTORIC BENTHIC INVERTEBRATE SAMPLE LOCATIONS

1000070301-SKT-V0082-A

Winnipeg

Table 6.16 **Mean density (individuals/ m^2) of benthic invertebrates collected in 1995 and 2003 within the proposed Disraeli Bridge study area. See Figure 6.9 for station locations. Data from Agassiz (1996) and North/South (2003).**

					Agassiz- 1995 [a]		North/South -2003			
							T3-3 [b]		T3-4 [b]	
Phylum	**Class**	**Subclass**	**Order**	**Family**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Anthropoda	Insecta		Coleoptera				70	156		
			Diptera	Chaoboridae						
				Ceratopogonidae						
				Chironomidae	103	84	183	209	191	147
				Empididae						
			Ephemeroptera		49 [c]	54	17	39	9	19
			Plecoptera							
			Trichoptera				130	292	17	24
Annelida		Oligochaeta			261	720	287	522	452	358
Mollusca	Bivalvia						61 [d]	114	9 [d]	19

[a] summary of 8 stations (n=8)

[b] summary of 1 station, 5 replicates per station (n=5)

[c] specifically *Hexagenia*

[d] reported only as Bivalvia for these stations, but all distal upstream and downstream station samples were identified as Sphaeriidae

6.3.5 Fish Community

The Red River watershed in Manitoba supports a diverse fish community of 70 native and non-native species, 57 of which have been observed in the Red River (Table 6.17; Stewart and Watkinson 2004). Of the species occurring in the Red River, 51 are native and six species are introduced. Seven species, six native and one introduced, are rare, incidental (preferring tributaries), known form a single record, or of questionable identification. A recent fish community survey found 31 fish species in the Red River within the City of Winnipeg (Remnant et al. 2000).

There are five fish species occurring in the Red River in Manitoba that have status under COSEWIC, SARA, or both (Table 6.18). COSEWIC designated the Red-Assiniboine Rivers – Lake Winnipeg populations of Lake Sturgeon (*Acipenser fulvescens*) as Endangered in 2006 however this species has not been scheduled and therefore has no status or protection under SARA (COSEWIC 2006b). Three species have been designated Special Concern by COSEWIC: Chestnut Lamprey (*Ichthyomyzon castaneus*), Silver Chub (*Macrhybopsis storeriana*), and Bigmouth Buffalo (*Ictiobus cyprinellus*). Chestnut Lamprey was designated as Special Concern by COSEWIC in 1991 therefore it was automatically added to Schedule 3 as Special Concern when SARA came into force. Schedule 3 does not provide official protection under SARA but provides a holding area until species are reassessed. Silver Chub was designated Special Concern by COSEWIC in 1985 and added to Schedule 1 as Special Concern when SARA came into force. A management plan has been developed but critical habitat has not been identified (Boyko and Staton 2010). Bigmouth Buffalo was designated as Special Concern in 2009 by COSEWIC (2009) but has not been scheduled and therefore does not have status under SARA. Bigmouth Shiner (*Notropis dorsalis*) was originally designated as Special Concern by COSEWIC in 1985 but was reevaluated in 2003 and downgraded to Not at Risk (COSEWIC 2003). This species however remains on Schedule 3 under SARA with the status of Special Concern.

The majority of the fish species spawn in the spring or summer (Stewart and Watkinson 2004). Lake Whitefish (*Coregonus clupeaformis*) and Cisco (*Coregonus artedi*) spawn in the fall however these species are usually found in the lower Red River (Stewart and Watkinson 2004). Burbot (*Lota lota*) spawn in midwinter, broadcasting semipelagic, non-adhesive eggs over sand or gravel substrates (Stewart and Watkinson 2004).

Table 6.17 Fish species occurring in the Red River watershed in Manitoba (after Stewart and Watkinson 2004)

Common Name	Scientific Name	Status	Within Winnipeg
Petromyzontidae			
Chestnut Lamprey	*Ichthyomyzon castaneus*	N	
Silver Lamprey	*Ichthyomyzon unicuspis*	N	
Acipenseridae			
Lake Sturgeon	*Acipenser fulvescens*	N-R	
Hiodontidae			
Goldeye	*Hiodon alosoides*	N	X
Mooneye	*Hiodon tergisus*	N	X
Cyprinidae			
Goldfish	*Carassius auratus*	I	
Spotfin Shiner	*Cyprinella spiloptera*	N	X
Common Carp	*Cyprinus carpio*	I	X
Brassy Minnow	*Hybognathus hankinsoni*	N-T	
Common Shiner	*Luxilus cornutus*	N-T	
Silver Chub	*Macrhybopsis storeriana*	N	X
Hornyhead chub	*Nocomis biguttatus*	N-E	
Pearl Dace	*Margariscus margarita*	N-T	
Golden Shiner	*Notemigonus crysoleucas*	N-R	
Emerald Shiner	*Notropis atherinoides*	N	X
River Shiner	*Notropis blennius*	N	X
Bigmouth Shiner	*Notropis dorsalis*	N-T	
Spottail Shiner	*Notropis hudsonius*	N	
Sand Shiner	*Notropis stramineus*	N-U	
Northern Redbelly Dace	*Phoxinus eos*	N-T	
Finescale Dace	*Phoxinus neogaeus*	N-T	
Bluntnose Minnow	*Pimephales notatus*	N-1R	
Fathead Minnow	*Pimephales promelas*	N	X
Flathead Chub	*Platygobio gracilis*	N	X
Longnose Dace	*Rhinichthys cataractae*	N	
Western Blacknose Dace	*Rhinichthys obtusus*	N	
Creek Chub	*Semotilus atromaculatus*	N-U	
Catostomidae			
Quillback	*Carpiodes cyprinus*	N	X
White Sucker	*Catostomus commersoni*	N	X
Bigmouth Buffalo	*Ictiobus cyprinellus*	N	X
Silver Redhorse	*Moxostoma anisurum*	N	X
Golden Redhorse	*Moxostoma erythrurum*	N	X
Shorthead Redhorse	*Moxostoma macrolepidotum*	N	X
Ictaluridae			
Black Bullhead	*Ameiurus melas*	N	X
Brown Bullhead	*Ameiurus nebulosus*	N	X

Table 6.17 (cont'd) **Fish species occurring in the Red River watershed in Manitoba (after Stewart and Watkinson 2004)**

Common Name	Scientific Name	Status	Within Winnipeg
Brown Bullhead	*Ameiurus nebulosus*	N	X
Channel Catfish	*Ictalurus punctatus*	N	X
Stonecat	*Noturus flavus*	N	X
Tadpole Madtom	*Noturus gyrinus*	N	
Esocidae			
Northern Pike	*Esox lucius*	N	X
Umbridae			
Central Mudminnow	*Umbra limi*	N	
Osmeridae			
Rainbow Smelt	*Osmerus mordax*	I-1R	
Salmonidae			
Cisco	*Coregonus artedi*	N	X
Lake Whitefish	*Coregonus clupeaformis*	N	
Arctic Grayling	*Thymallus arcticus*	Tr	
Cutthroat Trout	*Oncorhynchus clarki*	I-T	
Rainbow Trout	*Oncorhynchus mykiss*	I-T	
Brown Trout	*Salmo trutta*	I-T	
Arctic Char	*Salvelinus alpinus*	Tr	
Brook Trout	*Salvelinus fontinalis*	Tr	
Percopsidae			
Trout-perch	*Percopsis omiscomaycus*	N	X
Gadidae			
Burbot	*Lota lota*	N	X
Fundulidae			
Banded Killifish	*Fundulus diaphanus*	N-1R	
Gasterosteidae			
Brook Stickleback	*Culea inconstans*	N	X
Moronidae			
White Bass	*Morone crysops*	I	X
Centrarchidae			
Rock Bass	*Amboplites rupestris*	N	X
Pumpkinseed	*Lepomis gibbosus*	Tr-T	
Bluegill	*Lepomis macrochirus*	N	
Smallmouth Bass	*Micropterus dolomieu*	I	
Largemounth Bass	*Micropterus salmoides*	I	
White Crappie	*Pomoxis annularis*	N-R	
Black Crappie	*Pomoxis nigromaculatus*	N	X
Percidae			
Iowa Darter	*Ethiostoma exile*	N	
Johnny Darter	*Ethiostoma nigrum*	N	

Table 6.17 (cont'd) Fish species occurring in the Red River watershed in Manitoba (after Stewart and Watkinson 2004)

Common Name	Scientific Name	Status	Within Winnipeg
Yellow Perch	*Perca flavescens*	N	
Logperch	*Percina caprodes*	N	
Blackside Darter	*Percina maculata*	N	
River Darter	*Percina shumardi*	N	X
Sauger	*Sander canadensis*	N	X
Walleye	*Sander vitreus*	N	X
<u>*Sciaenidae*</u>			
Freshwater Drum	*Aplodinotus grunniens*	N	X

N - native; I - introduced; Tr - transfer 1R - 1 record; E - erroneous?; R - rare; T - tributaries only; U - uncommon

Table 6.18 COSEWIC and SARA status of aquatic fauna in the Red River at Winnipeg

Common Name	Scientific Name	COSEWIC Status	SARA Schedule	SARA Status
Mapleleaf Mussel	*Quadrula quadrula*	Endangered	None	None
Chestnut Lamprey	*Ichthyomyzon castaneus*	Special Concern	3	Special Concern
Lake Sturgeon	*Acipenser Fulvescens*	Endangered	None	None
Silver Chub	*Macrhybopsis storeriana*	Special Concern	1	Special Concern
Bigmouth Shiner	*Notropis dorsalis*	Not at Risk	3	Special Concern
Bigmouth Buffalo	*Ictiobus cyprinellus*	Special Concern	None	None

6.3.6 FISH HABITAT

Riparian vegetation along the east and west banks of the Red River in the Project area (footprint) is comprised of a thin band of occasional trees interspersed with shrubs and grasses. Behind this band, the west bank is covered by low shrubs and grasses while the east bank is covered by grasses. Though fallen trees are incidental along the river banks upstream and downstream of the Project area there are no significant shoreline structures providing cover in the local study area. Detailed bathymetric surveys of the local study area in 2003 and 2009 did not reveal any significant submerged structures (Chambers et al. 2009). No submerged or emergent aquatic vegetation was observed within the local study area.

At normal summer water level (NSWL), the river channel in the Project area has a mean width of 150 m and is characterized by a broad, deep thalweg. The mean channel depth is 5.0 m with a maximum depth of 7.2 m and the mean annual flows are 200 m^3/s.

When the curtains are lifted at the St. Andrews Lock and Dam each October, the river level falls 2.0 m over a period of two weeks. Each year, the littoral zone above the 2.0 m isobath is exposed and frozen which reduces the productivity of this zone relative to the permanently wetted portion of the channel.

Over 90% of the river substrate in the local study area is composed of silt and clay (Table 6.19; Figure 6.10). The next most abundant substrate, sand/gravel embedded in silt/clay, accounts for 5.65% of the substrate but most of this is located upstream of the Project area. A few, scattered patches of cobble occur through the study area but with the greatest concentration located on the east bank at the bridge crossing (Figure 6.10). The remaining substrate types compose less than 2% of the substrate. In general, the substrate is firmer, dominated sand and gravel upstream of the Project area, and becomes softer and finer downstream. Within the project site, substrate is generally firmer along the banks, giving way to softer silt/clay in the thalweg.

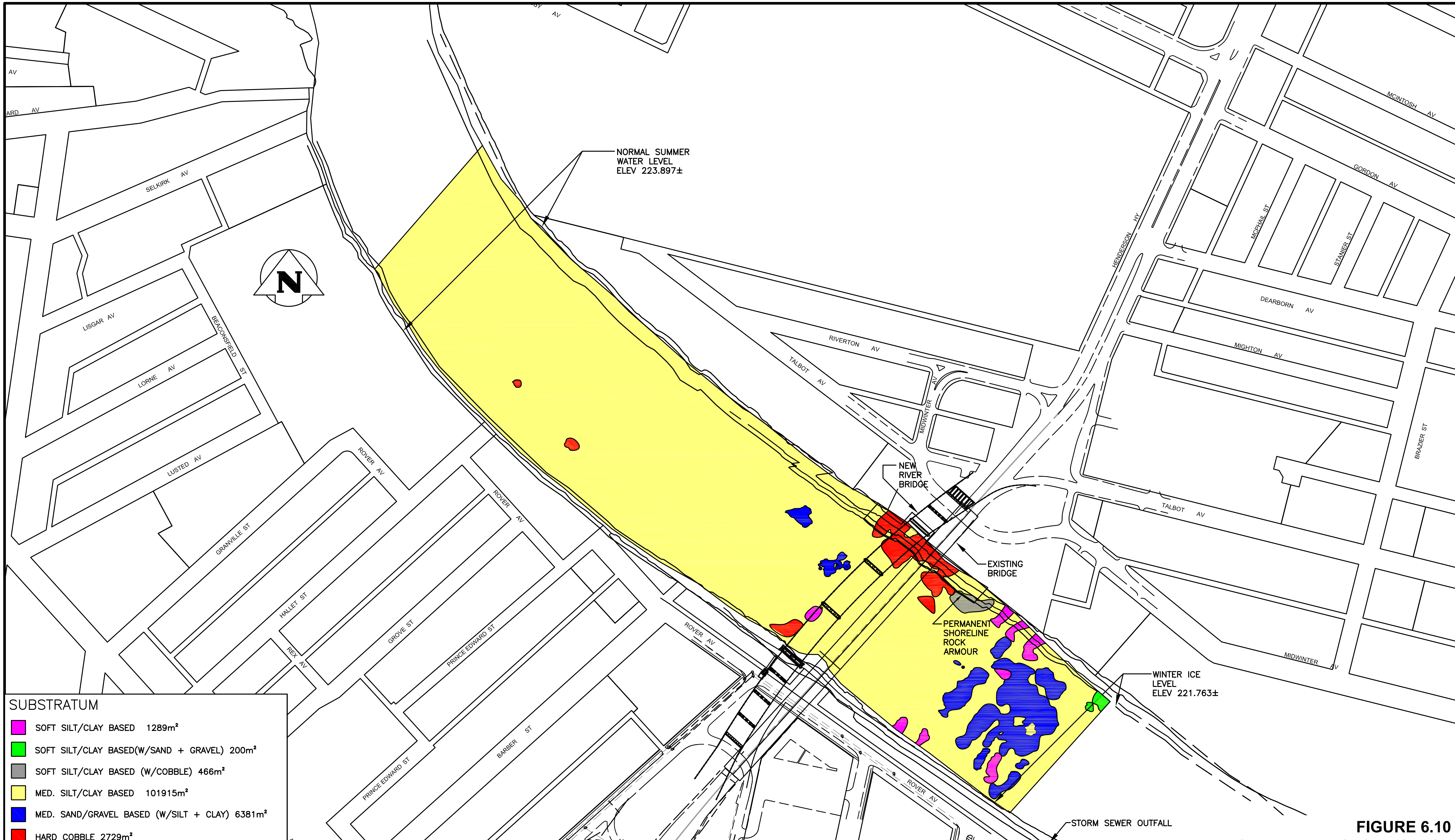
Table 6.19 River substrate within the local study area at the Project

Substrate	Area (m^2)	Proportion
Soft silt/clay	1,289	1.14%
Soft silt/clay with sand/gravel	200	0.18%
Soft silt/clay with cobble	466	0.41%
Medium silt/clay	101,915	90.21%
Medium sand/gravel with silt/clay	6,381	5.65%
Hard cobble	2,729	2.42%
Total	**112,980**	

Historically, fish habitat in the Red River was much more diverse than what currently exists in the reach that includes the City (Toews and Davies 2000). The substrate in the river channel was likely similar to the substrate that can be observed upstream of St. Agathe (immediately upstream of the effects of St. Andrews Dam impoundment and the floodway) where till materials such as boulders, cobble, gravel, and sand are much more prevalent in the substrate composition (Stewart and Watkinson 2004). The Red River in Winnipeg was therefore narrower and shallower with higher flow velocities and subject to periodic scouring that cleared silt and clay from coarser substrates and thus maintained much higher proportions of boulder, cobble, gravel, and sand. Water control structures, such as the St. Andrews Lock and Dam and the Winnipeg Floodway, have altered the fish habitat in the Red River within the City. The construction of the St. Andrews Lock and Dam impounded the river reducing water velocities, increasing siltation, and covering the historic habit in silt and clay. The operation of the Winnipeg Floodway attenuates natural flood events to such an extent that accumulated silt and clay sediment is no longer scoured from the original glacial till substrate, even by extreme flood events such as the 1997 freshet (L.A.B. Consulting 2009). As a result, the riverbed in the Project area has, through the sedimentation of silt and clay, risen between 0.6 and 1.5 m since the construction of the existing river bridge in 1959 (L.A.B.

Consulting 2009). Historic habitat features have therefore been buried under sediment and overall habitat diversity within Winnipeg has declined. With the floodway expansion, periodic floods will continue to be attenuated, silt and clay will continue to accumulate.

The local study area likely provides spawning, rearing, feeding, migration, and overwintering habitat components for a variety of fish species. Most species are highly mobile and therefore do not reside in any given location for an extended period of time (Clarke et al. 1980; Barth and Lawrence 2000). Fish distributions have been observed to be relatively even, a result of there being few distinct habitat features within the Red River in Winnipeg (Remnant et al. 2000). In the fall, when water levels are reduced by 2.0 m following the lifting of curtains at the St. Andrews Lock and Dam, there is a migration of resident fishes downstream to overwinter north of the city (Remnant et al. 2000).



LEGEND:
● SEDIMENT LOCATION
—•—•—•— TRANSECTS SAMPLED BY AGASSIZ 2000

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FIGURE 6.10
DISRAELI BRIDGES PROJECT
RED RIVER SUBSTRATE
(AFTER NORTH/SOUTH 2003)

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6.4 HUMAN ENVIRONMENT

6.4.1 *REGIONAL ECONOMY*

Manitoba has a well diversified economy. Major industries include: agri-foods, transportation equipment, resource-based industries, chemicals, machinery and equipment, furniture and building products, paper products, fabricated metal products, plastics, printing, apparel, electronics, information technology and telecommunications, aerospace, farm equipment, hydroelectric generation, life sciences and biotechnology, environmental services, and culture and tourism. Manufacturing is Manitoba's largest industry, accounting for approximately 12% of the province's GDP, followed by the province's primary industries (mining, agriculture and forestry) which account for approximately 7% of the economy (Province of Manitoba 2010). Service industries account for 72% of the GDP. Provincial GDP, employment and import/export statistics for the years 2004 to 2008 are detailed in Table 6.20.

Table 6.20 Manitoba Economic Characteristics (2004 - 2008)

Economic Indicators	2004	2005	2006	2007	2008
Real GDP (mkt prices) % growth	2.2	2.7	3.9	3.1	2.2
Real GDP per Capita (mkt prices) $	32,009	32,753	33,851	34,627	34,955
Employed (thousands)	577	580	587	597	607
Unemployment Rate (%)	5.3	4.8	4.3	4.4	4.2
CPI, All Items (2002 =100)	104	107	109	111	113
Total Private Investment ($ million)	5,082	5,091	5,811	6,267	7,221
Manufacturing shipments ($ million)	13,262	13,702	14,854	16,111	16,409
Exports ($ million)	9,297	9,301	10,195	12,192	12,830
Imports ($ million)	10,565	11,796	12,426	13,151	15,292

Source: Province of Manitoba 2010

In the Winnipeg Census Metropolitan Area (CMA), healthcare, manufacturing, business and finance, government, transportation, and sales and services are the largest employers. Winnipeg's diverse economy experienced significant growth in recent years and was one of only a few Canadian cities to experience any overall growth in 2009. The unemployment rate in the third quarter of 2009 was 5.1% compared to the national average of 8.2% (Destination Winnipeg 2010).

6.4.2 COMMUNITY AND NEIGHBOURHOOD CHARACTERISTICS

6.4.2.1 REGIONAL STUDY AREA

The Regional Study Area includes all or part of six City of Winnipeg 'Neighbourhood Clusters'; these are further subdivided into 'Neighbourhoods' (Figure 6.11 and 6.12). Twenty-four neighbourhoods are located in the Regional Study Area:

- River East West: Valhalla, Kildonan Drive, River East, Rossmere-A, Rossmere-B and Munroe West
- River East East: Springfield North, McLeod Industrial, Springfield South, Valley Garden, Munroe East, Kildonan Crossing, Eaglemere
- River East South: Chalmers, East Elmwood, Glenelm and Talbot-Grey
- St. Boniface West: North St. Boniface
- Downtown East: Civic Centre, Exchange District, Portage & Main and The Forks
- Point Douglas South: North Point Douglas and South Point Douglas

These neighbourhoods comprise 13% of the City's total population with a combined population of 83,060, but only 6.2% of the City's total land area with a population density of 2804 people per square kilometre (Table 6.21; Statistics Canada 2006).

In the regional study area, the dominant mode of transportation to work is by automobile, with 77% of the employed labour force travelling to work by car, truck or van (Statistics Canada 2006). Only 15% of the employed labour force travels to work using public transit and 7% walk or cycle to work (Table 6.22). These numbers are on par with the City average.

6.4.2.2 LOCAL NEIGHBOURHOODS

There are three neighbourhoods in the Local Study Area, referred to here as local neighbourhoods: North Point Douglas, Chalmers and Glenelm (Figure 6.12).

The local neighbourhoods comprise 2.2% of the City's total population with a combined population of 13,895 people, but only 0.9% of the City's total land area with a population density of 3,083 people per square kilometre (Table 6.21; Statistics Canada 2006).
In the local neighbourhoods, the dominant mode of transportation to work is by automobile, with 69% of the employed labour force travelling to work by car, truck or van; this is lower than the City's average (77%) (Statistics Canada 2006). Twenty-one percent of the employed labour force travels to work using public transit and 7% walk or cycle to work (Table 6.22).

The local neighbourhoods have average incomes below the City's average of $33,457. Their before tax gross average incomes are $18,090 in North Point Douglas, $23,889 in Chalmers and $28,205 in Glenelm (Statistics Canada 2006).

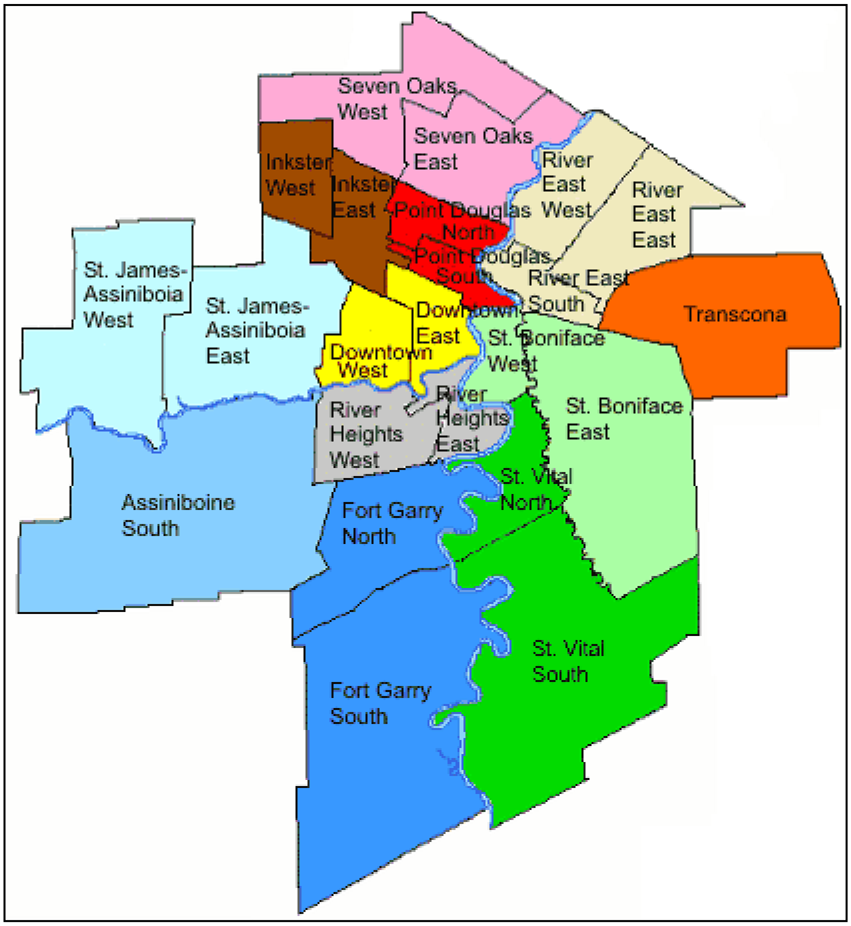
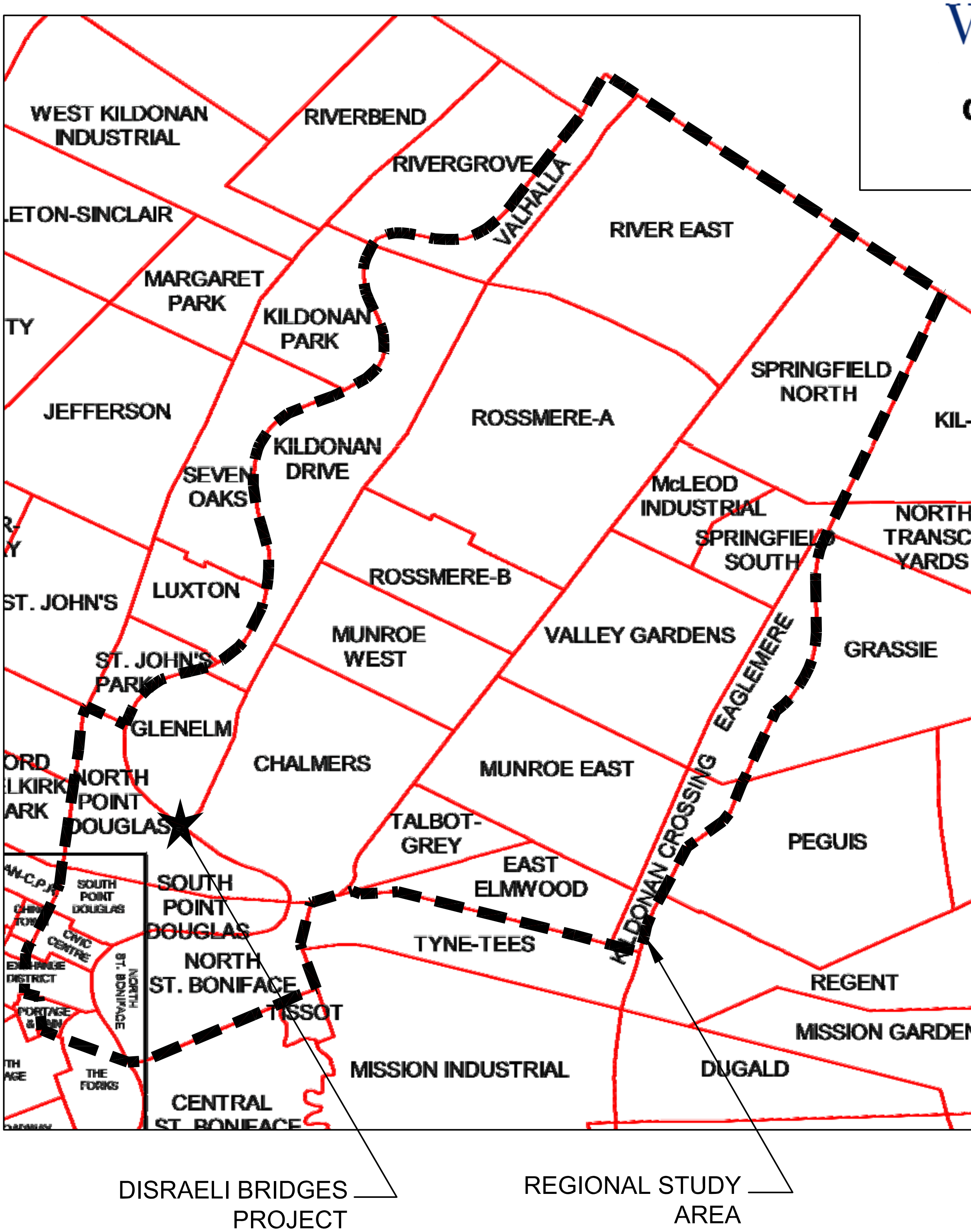


Figure 6.11 City of Winnipeg Neighbourhood Clusters Map (City of Winnipeg 2006)

Winnipeg Neighbourhoods

2006 Census
City of Winnipeg



Legend

Neighbourhoods

FIGURE 6.12
DISRAELI BRIDGES PROJECT NEIGHBORHOODS IN THE REGIONAL STUDY AREA

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Table 6.21 Population and population density for neighbourhoods within the Regional Study Area

Neighbourhood Cluster	Neighbourhood	2006 Census	Land Area (km^2)	Population Density (per km^2)
City of Winnipeg		**633,451**	**475.2**	**1,333.0**
River East West	Valhalla	2,905	0.7	4,311.5
	Kildonan Drive	4,855	2.3	2,139.3
	River East	8,350	3.4	2,439.9
	Rossmere-A	13,350	4.0	3,353.2
	Rossmere-B	3,885	1.2	3,148.8
	Munroe West	3,020	1.3	2,313.6
River East East	Springfield North	5,245	2.5	2,104.2
	McLeod Industrial*	-	-	-
	Springfield South	1,555	0.6	2,409.3
	Valley Gardens	8,250	2.3	3,512.3
	Munroe East	8,460	2.0	4,174.2
	Kildonan Crossing*	-	-	-
	Eaglemere	1,460	0.8	1,799.7
River East South	Chalmers	9,475	2.5	3,756.1
	East Elmwood	3,110	0.9	3,471.1
	Glenelm	2,195	0.8	2,613.6
	Talbot-Grey	2,295	0.6	3,824.4
St. Boniface West	North St. Boniface	1,775	1.4	1,266.2
Downtown East	Civic Centre*	-	-	-
	Exchange District	420	0.3	1,314.8
	Portage & Main *	-	-	-
	The Forks*	-	-	-
Point Douglas South	North Point Douglas	2,225	1.1	1,943.0
	South Point Douglas	230	0.7	337.4
Regional Study Area		**83,060**	**30**	**2,804.4**
Local Neighbourhoods		**14,125**	**4.5**	**3,082.6**

Source: Statistics Canada 2006

*Neighbourhoods are either unpopulated or have insufficient population to produce a demographic profile

Table 6.22 Mode of transportation to place of work for neighbourhoods in the regional study area; includes employed labour force that is 15 years and older

		Car, truck, van, as driver	Public transit	Car, truck, van, as passenger	Walk	Bicycle	Taxicab	Motorcycle	Other method	Total
City Of Winnipeg		**214,685**	**44,730**	**28,475**	**19,555**	**5,645**	**540**	**290**	**1,915**	**315,835**
River East West	Valhalla	710	100	100	35	10	-	-	-	955
	Kildonan Drive	1,485	325	170	120	15	-	-	25	2,140
	River East	3,535	360	400	115	30	-	-	10	4,450
	Rossmere-A	4,025	1,235	580	330	50	-	-	20	6,240
	Rossmere-B	1,305	270	140	70	55	-	-	10	1,850
	Munroe West	1,040	270	120	80	30	-	-	10	1,550
River East East	Springfield North	2,300	215	315	65	30	10	20	15	2,970
	Springfield South	675	90	90	-	-	-	10	-	865
	Valley Gardens	3,080	490	410	235	45	10	-	20	4,290
	Munroe East	2,780	775	325	375	65	-	-	30	4,350
	Eaglemere	675	60	100	-	-	10	-	-	845
River East South	Chalmers	2,960	1,010	425	245	75	10	10	20	4,755
	East Elmwood	1,010	265	145	105	30	-	10	-	1,565
	Glenelm	820	190	80	45	30	-	-	60	1,225
	Talbot-Grey	805	180	80	65	-	-	-	25	1,155
St. Boniface West	North St. Boniface	600	135	65	155	50	-	-	-	1,005
Downtown East	Exchange District	80	10	-	105	10	-	-	-	205
Point Douglas South	North Point Douglas	405	245	40	80	25	-	-	10	805
	South Point Douglas	35	35	20	10	-	-	-	-	100
Regional Study Area		**28,325**	**6,260**	**3,605**	**2,235**	**550**	**40**	**50**	**255**	**41,320**
Local Neighbourhoods		**4,185**	**1,445**	**545**	**370**	**130**	**10**	**10**	**90**	**6,785**

Source: Statistics Canada 2006

6.4.3 ROLE OF THE BRIDGE IN THE COMMUNITY

The Disraeli Bridge is a major traffic artery in the City's northeast quadrant, connecting the Disraeli Freeway to Henderson Highway. The route is highlighted under Plan Winnipeg 2020 Vision for transit priority measures (i.e., diamond lanes and transit priority signals) and as a high speed transit network for the transportation concept plan to 2020 and beyond.

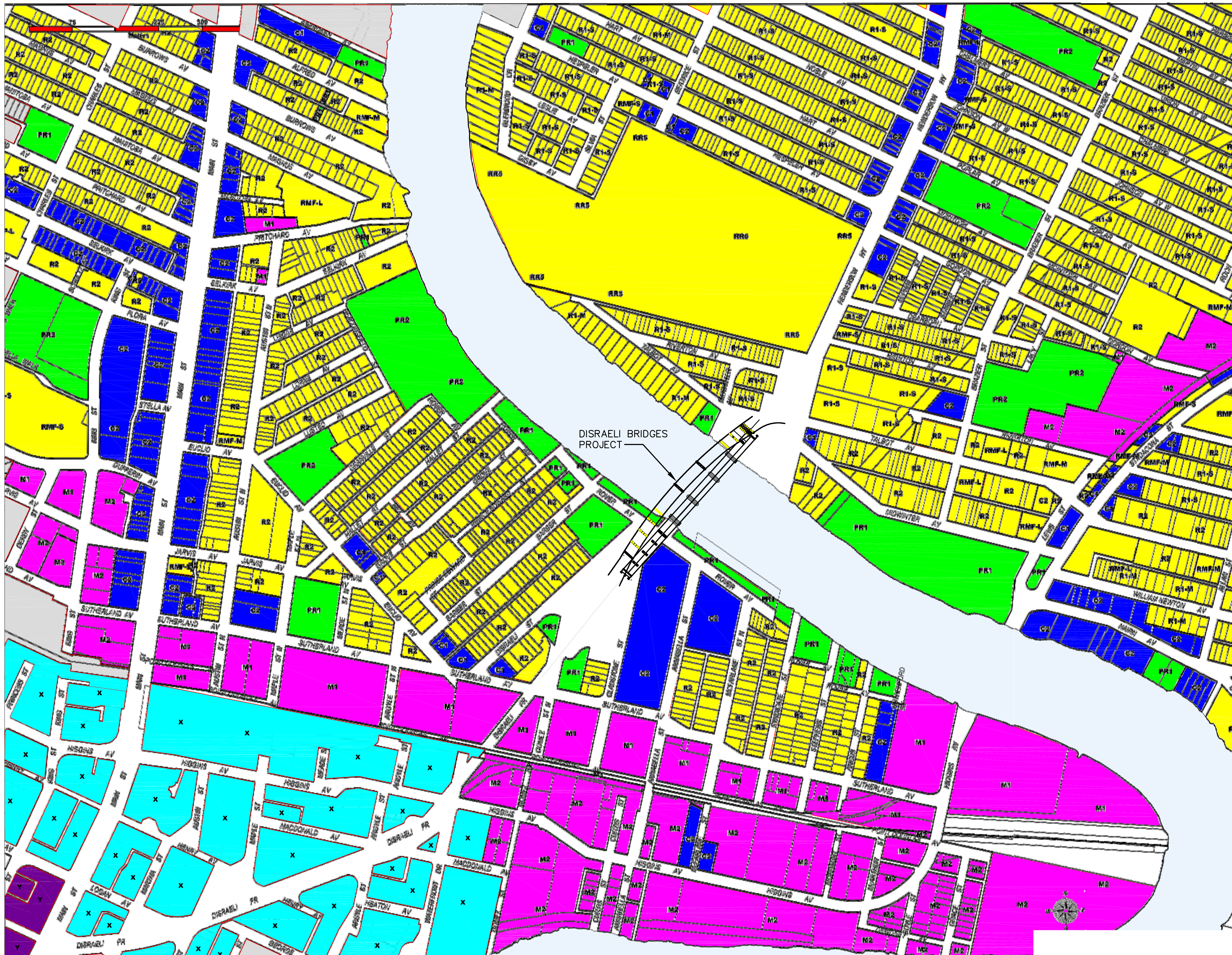
Residents in the Regional Study Area and throughout the City of Winnipeg use the Disraeli Bridge as the primary access point into the downtown area from northeast Winnipeg, with an estimated traffic volume of over 42,000 vehicles per day (City of Winnipeg 2008). There are four public transportation routes crossing the bridge, including two express routes. Cyclists also use the bridge as part of the City's bike network connecting existing and proposed bike paths in the northeast to the downtown area.

6.4.4 LAND USE

6.4.4.1 EXISTING LAND USE

The Disraeli Bridges Project is located in Central/Northeast Winnipeg. The surrounding area is a well developed urban environment initially developed over 100 years ago. Land use in the area consists of commercial, industrial, parks and recreation, a substantial residential area, and the downtown multiple-use sector.

The Local Study Area is comprised of parcels zoned as residential, commercial, industrial and parks and recreation. The main commercial land use in the Project area is located south of the bridge, at the Disraeli Freeway on/off ramp near Annabella Street in North Point Douglas. Other small commercial land use zones are scattered throughout the local neighbourhoods (Figure 6.13).



LEGEND:

RESIDENTIAL	R
COMMERCIAL	C
INDUSTRIAL	M
PARKS/RECREATION	PR
MULTIPLE USE SECTOR	X
CHARACTER SECTOR	Y

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FIGURE 6.13
DISRAELI BRIDGES PROJECT
LAND ZONING
(CITY OF WINNIPEG 2010c)

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6.4.4.2 PLANNED LAND USE

Plan Winnipeg 2020 designates most of the land surrounding the Disraeli Bridges Project as 'Neighbourhood' (City of Winnipeg 2010d). 'Neighbourhood' describes areas including a mix of residential with a variety of educational, recreational, institutional, commercial and possibly industrial uses, at a scale and density compatible with each other.

The Chalmers/Glenelm neighbourhood on the east side of the Red River will likely remain a neighbourhood of detached and multi-family housing, with the possibility of further office and retail development along Talbot Avenue. There is also some potential for further residential intensification and redevelopment given its location relative to the downtown area.

The west side of the Red River near the Project is anticipated to evolve from heavy industrial as businesses relocate to other areas of the City and are replaced with high and medium density condominium and apartment developments. Waterfront Drive, south of the Project along the Red River, is anticipated to stimulate future redevelopment as it progresses north converting some existing buildings to residential and commercial uses. North of the CPR tracks, the neighbourhood will see limited redevelopment and intensification until land values and demand for housing in this area increases.

6.4.5 ARCHAEOLOGICAL RESOURCES

The Disraeli Bridges Project is located in a highly impacted area from over a century of residential, commercial and industrial land uses. The Canadian Pacific Railway, built in the 1880's, runs south of the Local Study Area and crosses the Red River approximately one kilometre upstream of the Disraeli Bridges Project. Construction of the Canadian Pacific Railway crossing, the current Disraeli Bridge and other infrastructure on the Red River have disturbed the natural environment.

Manitoba's Historic Resources Branch confirmed that there are no known or anticipated historical cultural or archaeological resources of significance within 150 m of the Project site.

6.4.6 ABORIGINAL INTERESTS

The City of Winnipeg is located in Treaty No.1, signed in 1871 between the Government of Canada and the Chippewa and Swampy Cree Indian Tribes. The nearest reserve lands are located over 50 kilometres outside the City of Winnipeg (Table 6.23; INAC 2010). There are no known outstanding aboriginal land claims or active traditional use for lands in the Regional Area.

Table 6.23 Proximity to First Nations Reserves

Reserve Name	First Nations Band	Distance from Winnipeg (km)	Direction
Broken Head Indian Reserve 4	Brokenhead Ojibway Nation	64	NE
Dakota Plains 6A	Dakota Plains	74	W
Roseau River 2	Roseau River Anishinabe First Nation Government	80	S

Source: Indian and Northern Affairs Canada (INAC) 2010