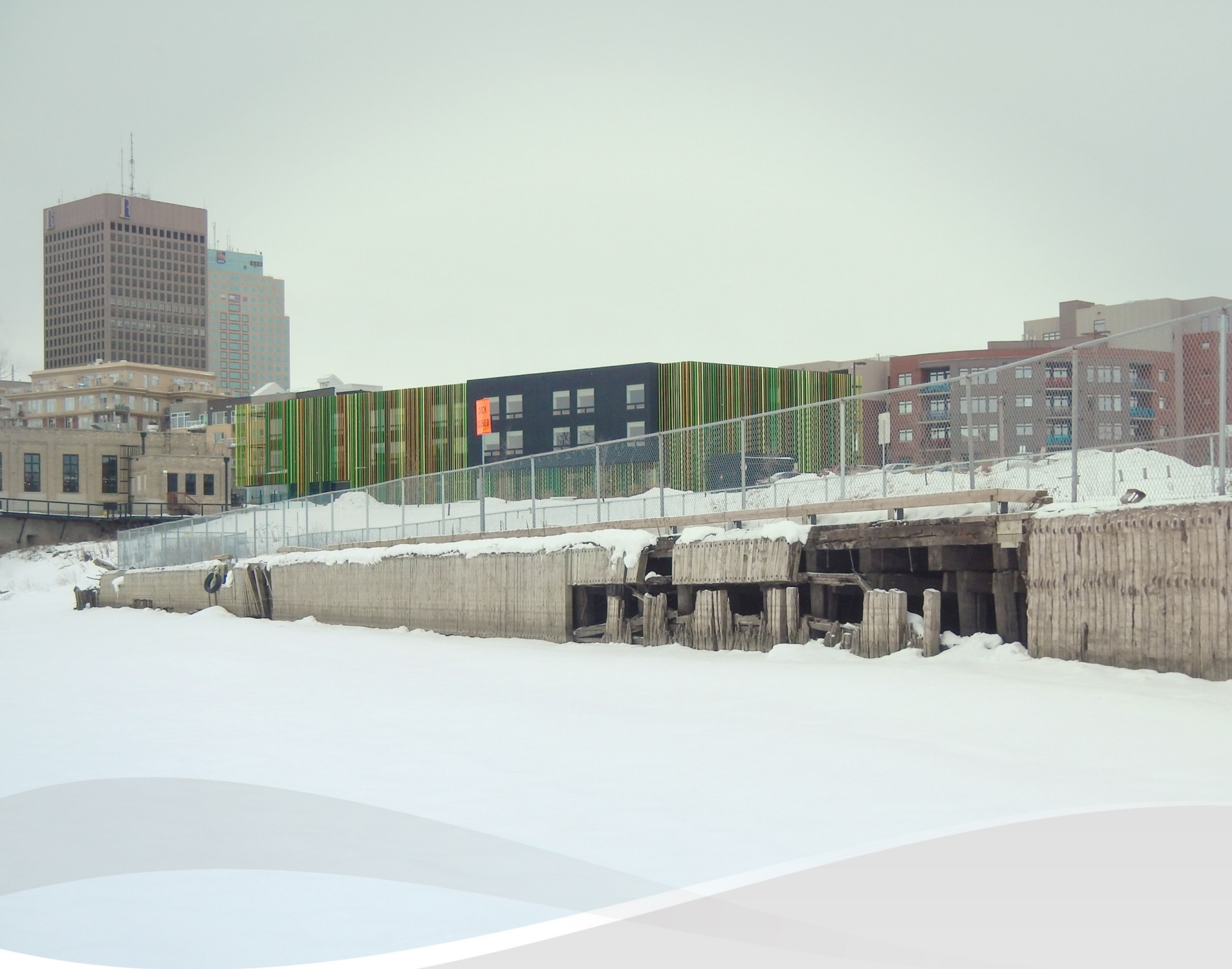

City of Winnipeg - Alexander Docks Demolition

Environmental Site Characterization

REPORT

Prepared for the City of Winnipeg • May 2017

North/South Consultants Inc. • 83 Scurfield Blvd. • Winnipeg, MB • R3Y 1G4

ALEXANDER DOCKS DEMOLITION
RED RIVER, MANITOBA

Environmental Site Characterization

May 2017

Prepared for

The City of Winnipeg

by

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EXECUTIVE SUMMARY

The City of Winnipeg is investigating the removal of the Alexander Docks. The removal of the Alexander Docks has the potential to affect fish and fish habitat through the release of sediments to the Red River during removal of dock pilings and through infilling below the high water mark due to bank stabilization. Additional concerns include the potential that the sediments in the vicinity of the dock may be contaminated (e.g., hydrocarbons) and that habitat in proximity to the dock may support the Mapleleaf mussel, a species listed as endangered under both the federal *Species at Risk Act* (SARA) and the Manitoba *Endangered Species and Ecosystem Act*.

An environmental site characterization of the Alexander Docks area was conducted on February 15, 2017 to characterize the aquatic habitat that would be disturbed during dock removal, to collect substrate samples along the outer face of the Alexander Docks for analysis of sediment quality, and to assess potential habitat suitability for the Mapleleaf in the vicinity of the docks.

The field survey consisted of the collection of 20 sediment samples along five transects spaced approximately 30 m apart along the length of the Alexander Docks at a distance of 1, 5, 10, and 15 m from the dock face, and an additional six samples along transects immediately upstream and downstream of the dock.

The five nearshore sites were sampled within 1 m of the dock face and as close to existing wooden vertical pillars as possible for analysis of sediment quality. The upper 10 cm of sediment was collected from each sampling site and submitted for analysis of metals, benzene, toluene, ethylbenzene, and xylene, F1-F4 petroleum hydrocarbons, polycyclic aromatic hydrocarbons, and supporting variables. Several metals and a number of hydrocarbons found in sediment samples collected adjacent to the Alexander Docks exceeded sediment quality benchmarks. However, comparison of the results of the present study with those of similar studies suggested that metals and hydrocarbons present in the study area are similar to conditions measured in other areas of the Red River within the City of Winnipeg and do not suggest localized contamination that may pose a substantive risk to aquatic biota.

At the remaining sites, substrate samples were collected from each sampling site using either a weighted Ekman dredge or a petite Ponar grab sampler (0.023 m^2 surface area) for substrate classification. Substrates transitioned from loosely compacted silt and clay deposits along the face of the dock to a mixture of loosely compacted clay/silt or hard rocky substrate 5 m from the dock to primarily hard substrate 15 m from the dock. Substrates within the footprint of the existing Alexander Docks are not likely to support Mapleleaf. However, the rapid transition from soft to harder substrates as close as 5 m offshore from the dock suggests that habitat suitable for Mapleleaf may exist within 2-5 m from the dock face.

Although detailed design of the site rehabilitation is yet to be determined, in general the project is expected to result in a net benefit to fish habitat. The removal of the dock will restore fish habitat within the existing dock footprint and the placement of bank armouring material will provide habitat diversification. Once the overall scope of the project has been finalized, results from this environmental site characterization will provide the basis for the preparation of a DFO self-assessment.

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1.0 INTRODUCTION

The City of Winnipeg is proposing to remove the Alexander Docks on the Red River located near the intersection of Alexander Avenue and Waterfront Drive in Winnipeg, MB (N 49.899569° W 97.130660°; Figure 1). The existing docks are situated along the west bank of the Red River spanning 124 m long and 13.5 m wide. The docks were originally constructed in 1929 with additional sections constructed in 1939 and 1953. Despite rehabilitation works conducted by the City of Winnipeg in the early 2000s, continued deterioration of key supporting elements and resulting concerns over public safety prompted further assessment of the overall condition of the docks in 2014 (KGS 2015). Results from this survey identified numerous structural and public safety concerns leading to the closure of the docks by the City of Winnipeg in 2015.

Although project designs and implementation have not been finalized, preliminary assessment has indicated that certain aspects of the dock removal may have the potential to affect fish and fish habitat in the Red River. It is anticipated that these impacts would contravene Section 35(1) of the Federal *Fisheries Act*. In particular, the removal of the Alexander Docks has the potential to affect fish and fish habitat through:

- Release of sediments into the Red River during removal of dock pilings; and
- Infilling below the high water mark due to bank stabilization.

It is suspected that sediments in the vicinity of the docks may also be contaminated (e.g. hydrocarbons), which may affect removal of the docks and potentially raise other environmental concerns at the site.

Furthermore, benthic habitat in the vicinity of the docks may support Mapleleaf (*Quadrula quadrula*), a freshwater mussel species known to inhabit the Red River and listed as "endangered" under both the Federal *Species at Risk Act* (SARA) and the Manitoba *Endangered Species and Ecosystem Act* (ESEA). Permitting under SARA will require a habitat survey to assess the potential for Mapleleaf in the project area and may require a mussel relocation and monitoring plan should suitable habitat be identified.

An environmental site characterization of the Alexander Docks area was conducted by North/South Consultants Inc. on February 15, 2017 to:

- Characterize the aquatic habitat that would be disturbed during dock removal;
- Collect substrate samples along the outer face of the Alexander Docks for contaminant analysis; and
- Characterize substrate composition and compaction in the vicinity of the docks to assess potential habitat suitability for Mapleleaf.

This report presents the results of the environmental site characterization and provides a brief summary of existing fish community and commercial, recreational, and Aboriginal fisheries information for the Red River near the Alexander Docks.

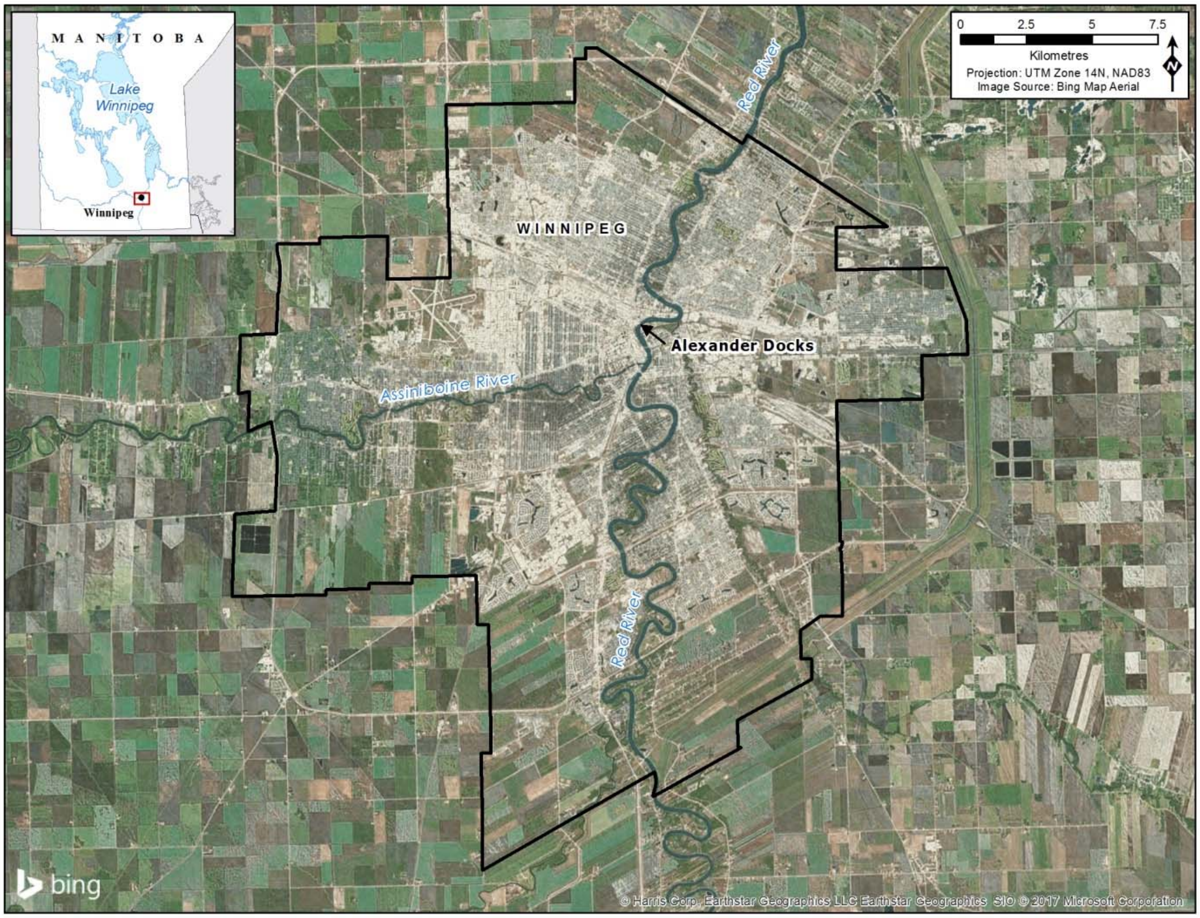

Figure 1. Location of the Alexander Docks on the Red River, Manitoba.

2.0 PROJECT DESCRIPTION

Although detailed plans are not yet available, it is understood that the dock removal will include two main components:

- Removal of the existing Alexander Docks including all supporting pillars and decking; and
- Shoreline stabilization work which may include placement of limestone rip rap along the west shoreline of the Red River.

Once final project details and scope are determined, information gathered during the environmental site characterization will provide the basis for the conduct of the second part of the assessment, which would include the preparation of self-assessment to determine if the project requires a review by Fisheries and Oceans Canada (DFO).

3.0 METHODS

A brief site visit was conducted on January 26, 2017 to assess ice and water conditions near the Alexander Docks. It was determined that sufficient ice and water depth under the ice was present to proceed with winter surveys. Subsequent sediment quality and substrate characterization surveys were conducted on February 15, 2017. The following provides descriptions of the field and data analysis methods.

3.1 AQUATIC HABITAT

Physical characteristics of the study area were recorded at each respective site including:

- Snow depth;
- Ice thickness;
- Water depth (below ice); and
- UTM location (recorded using a Garmin GPS78 hand-held device).

3.2 SEDIMENT QUALITY

The field survey consisted of the collection of five benthic sediment samples along the length of the Alexander Docks (Figure 2). Four sampling sites were established along the face of the docks beginning at the downstream end (AD-1) and at approximately 30 m intervals thereafter (AD-2, 3, and 4 respectively; Figure 2). Two attempts to establish the fifth site (AD-5a and AD-5b) yielded unsuitable substrate and therefore the final site was established slightly downstream of the south end of the dock at site AD-5c. Sampling sites were selected within one meter of the dock face and as close to existing wooden vertical pillars as possible.

The upper 10 cm of sediment was collected from each sampling site using a weighted Ekman dredge (0.023 m^2 surface area). Sediment samples were photographed and examined in the field for texture, compaction, and particle size composition. Samples were partitioned into provided containers and submitted to ALS Laboratories (Winnipeg, MB) for analysis of benzene, toluene, ethylbenzene, and xylene (BTEX), petroleum hydrocarbon (PHC) fractions F1-F4, polycyclic aromatic hydrocarbons (PAHs), metals, moisture, total nitrogen, total organic (TOC), and particle size.

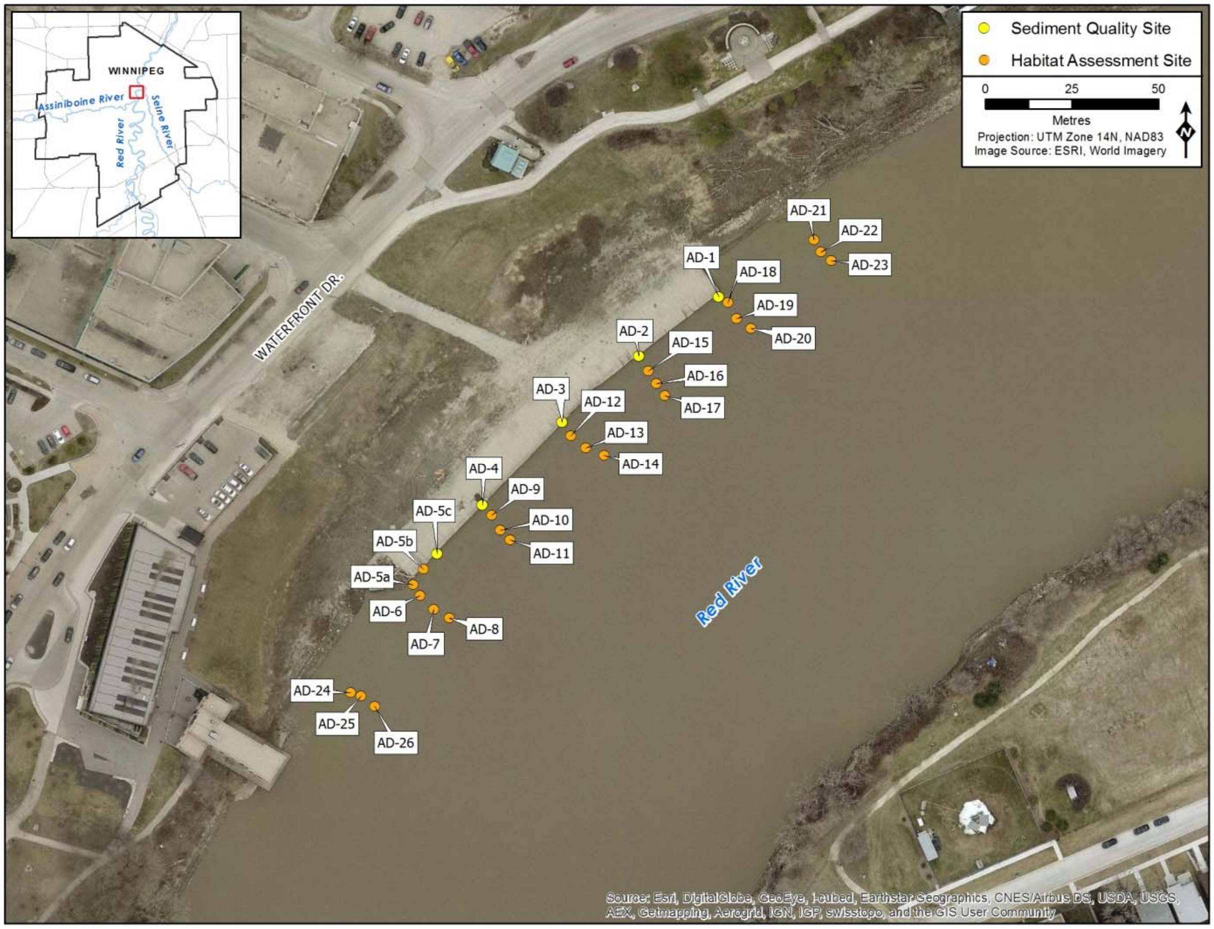

Figure 2. Location of sediment quality and habitat assessment sites on the Red River at the Alexander Docks, Feb. 15, 2017.

3.2.1 Data Analysis

PAH and metal concentrations in sediments were compared to the Canadian Council for Ministers of the Environment (CCME) Interim Sediment Quality Guidelines (ISQGs) and Probable Effect Levels (PELs) where available (CCME 1999; updated to 2017). The CCME defines the ISQGs as “the minimum effect range within which adverse effects rarely occur (i.e., fewer than 25% [of] adverse effects)” and the PELs as “the range within which adverse biological effects frequently occur (i.e., more than 50% of adverse effects).” Concentrations lying between the ISQG and the PEL reflect a condition of increased risk of adverse effects.

CCME sediment quality guidelines (SQGs; 1999; updated to 2017) were applied for metals for which they are available. For additional metals, guidelines applied by other jurisdictions in Canada were considered. Briefly, benchmarks considered in the assessment were, in the following order:

- CCME SQGs (arsenic, cadmium, chromium, copper, lead, mercury, and zinc; CCME 1999; updated to 2017);
- Ontario sediment quality standards (cobalt, nickel, and silver; Ontario Ministry of the Environment [MOE] 2011);
- Ontario SQGs (iron and manganese; Persaud et al. 1993; Fletcher et al. 2008); and
- the British Columbia Ministry of Environment (BCMOE) sediment alert concentration (SAC) for selenium (BCMOE 2014, 2016), recently adopted as an interim sediment quality guideline by Alberta Environment and Sustainable Resource Development (2014).

Similar to CCME SQGs, Ontario SQGs specify a lowest effect level (LEL) and a severe effect level (SEL). The interpretation of these two thresholds is consistent with the CCME ISQG and PEL, respectively.

PAHs in sediments were compared first to CCME SQGs where available (CCME 1999; updated to 2017) and then to Ontario sediment quality standards (Ontario MOE 2011) and the BCMOE sediment quality guidelines (BCMOE 2016) for PAHs with no CCME SQGs.

There are no CCME guidelines for BTEX and PHCs in sediments. To provide some interpretation of the sampling results, comparisons were made to CCME soil quality guidelines for the protection of environmental health for BTEX (CCME 1999; updated to 2017) and the CCME petroleum hydrocarbon Tier 1 levels for F1-F4 for the residential/parkland land use category (i.e., Canada-Wide Standards for PHCs; CCME 2001; updated to 2017).

3.2.2 Quality Assurance/Quality Control

Standard procedures for the control of sample contamination were adhered to throughout the sampling program including:

- Use of nitrile gloves during sample collection;
- Avoiding contact with the inside of samplers or sample bottles;
- Site wash and rinse of sampling equipment between sampling locations using Contrex soap and site water; and
- Submission of samples to an analytical laboratory accredited with the Canadian Association for Laboratory Accreditation Inc.

3.3 SUBSTRATE CHARACTERIZATION

River substrate was assessed along seven transects within an area extending up to 30 m upstream and 30 m downstream of the Alexander Docks (Figure 2). Transects were oriented perpendicular to the shoreline and distributed at approximately 30 m intervals along the shoreline. Within each transect, sampling sites were established at intervals of 1, 5, 10, and 15 m from either the dock face or the upper limit of wetted substrate under the ice. Data collected at sites previously established along the dock face during sediment quality sampling (AD-1 to AD-5) were also incorporated into the substrate transects as the 1 m interval sites.

Substrate samples were collected from each sampling site using either a weighted Ekman dredge or a petite Ponar grab sampler (0.023 m^2 surface area). Successful substrate grabs were photographed in the field and classified by primary and secondary substrate type according to particle size (Wentworth 1922). Substrate compaction was also noted when possible.

Additional substrate information was also collected under the existing dock where possible. Deteriorated sections of dock face and several access holes along the face allowed visual surveys of the shoreline composition above the ice level (Photo 1).

Photo 1. Photo illustrating a deteriorated section of the Alexander Dock allowing access under the dock, Feb. 15, 2017.

3.4 FISH COMMUNITY

A literature review was conducted to describe the fish community and habitat usage in the Red River near the Alexander Docks. A brief summary of existing commercial, recreational, and Aboriginal fisheries in the area was also compiled.

3.5 AQUATIC INVASIVE SPECIES

The Red River from the U.S border to its mouth at Lake Winnipeg falls under the Central Control Zone for aquatic invasive species in Manitoba (*The Water Protection Act: Aquatic Species Regulation 173/2015*). Species of particular concern within this zone include spiny waterflea (*Bythotrephes cederstroemi*) and zebra mussel (*Dreissena polymorpha*). In compliance with Manitoba's Aquatic Species Regulations (ASR), all water-related equipment used during field studies was either new or previously decontaminated following procedures outlined in Schedule C of the ASR. Immediately following field surveys all water-related equipment was again decontaminated following similar procedures.

4.0 RESULTS

4.1 AQUATIC HABITAT

Physical characteristics recorded at each of the sediment quality and aquatic habitat sites are presented in Table 1. River ice was generally thickest along the dock face (~1 m) with a notable drop in bottom elevation and thickness approximately 2-3 m from the dock face. On average, ice thickness at sites further offshore was consistently around 0.5 m. Water depth below the ice varied along the dock face; with little to no water at the south end of the dock (sites AD-5a and AD-5b) and a maximum depth of 2.6 m at site AD-5c. Maximum water depth (5.3 m) was recorded at site AD-19, located approximately 10 m instream from the northern tip of the dock.

4.2 SEDIMENT QUALITY

Sediment sampled for analysis of metals and hydrocarbons was comprised predominantly of silt and had a relatively low concentration of TOC (Table 2).

All but one metal (arsenic) were below CCME ISQG values across all sites (Table 3). Arsenic slightly exceeded the CCME ISQG (5.90 µg/g) at each site (mean = 7.38 µg/g) but was well below the PEL (17.0 µg/g).

Concentrations of cobalt and silver were below Ontario sediment quality standards, iron and manganese were below the Ontario LELs, and selenium was below the BCMOE SAC in all samples. Manganese (mean = 721 µg/g) exceeded the Ontario LEL (460 µg/g) and nickel (18.8 µg/g) exceeded the Ontario sediment quality standard/LEL (16 µg/g) in each sample.

Eleven PAHs, including acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorine, naphthalene, phenanthrene, and pyrene, exceeded the CCME ISQGs in one to three samples (Table 4). In general, the highest concentrations of PAHs occurred at sites AD-1 and AD-2 and the lowest at sites AD-3 and AD-5c.

There were no detections of BTEX F1-F4 in sediments from the study area indicating low levels of petroleum hydrocarbons (Table 5). Though, as previously noted, there are no Canada-wide standards or SQGs for F1-F4 or BTEX in sediments, comparisons made to available benchmarks for soils was conducted to provide context. As all measurements of BTEX and F1-F4 were below analytical detection and all detection limits were well below the soil benchmarks, there was no indication of BTEX or F1-F4 contamination.

4.3 SUBSTRATE CHARACTERIZATION

In addition to the five sediment quality sites, 21 substrate characterization sites were also established within the study area (Figure 2). Successful substrate grabs were obtained in less than half of all sites attempted (43%; n=9). Substrate at the remaining sites (n=12) was either too hard (i.e., hard packed sand/gravel) or comprised of larger substrate types (i.e., cobble or boulder) yielding unsuccessful grabs (Table 6). Photos of successful substrate grabs are provided in Appendix 1.

Substrate along the dock face was generally comprised of loosely compacted silt and clay deposits. Three sites located 5 m from the dock face were comprised of a mixture of loosely compacted clay/silt while the remaining four sites were comprised of hard rocky substrate. Sites located 10 m from the dock were generally hard rocky substrate; some sites having softer silt/clay or gravel deposits interspersed among the harder substrate. All sites located 15 m from the dock yielded hard substrate with only two successful grabs in areas where smaller cobble, pebble, and gravel were present.

No live or remnant native mussel species were observed in any substrate grabs.

Shoreline habitat under the Alexander Docks was also noted where possible; however, thick ice conditions under the dock prevented any assessment of wetted substrates. Shoreline substrates above the ice level were comprised of silt/clay (Photo 2). A large aggregation of woody debris was present at the south end of the dock and refuse (discarded drinking containers, plastic bags, etc.) was prevalent throughout the length of the dock.

Photo 2. Shoreline conditions under the Alexander Docks, Feb. 15, 2017.

4.4 FISH COMMUNITY

The Red River near Winnipeg supports a diverse fish community comprised of over 50 species (Appendix 2). During the City of Winnipeg Ammonia Criteria Study (1999/2000) Remnant et al. (2000) reported catches of large-bodied fish in the Red River dominated by Channel Catfish (*Ictalurus punctatus*), Sauger (*Sander canadensis*), Goldeye (*Hiodon alosoides),* and White Sucker (*Catostomus commersoni*). Similar species were also observed during boat electrofishing surveys in the vicinity of the Alexander Docks in summer 2001; including all of the aforementioned species and also Walleye (*Sander vitreus*) in the catch (Watkinson et al. 2004).

The Southern region of Manitoba, including the Red and Assiniboine rivers, represents approximately 20-40 % of annual angling effort in Manitoba (1985-2005; Manitoba Department of Natural Resources 1995; Manitoba Water Stewardship 2005). The Red River itself supports a vibrant recreational fishery with most angling effort occurring downstream of the St. Andrews Dam at Lockport, MB (Tetr*ES* and North/South Consultants 2000). The Alexander Docks has historically provided one of many popular locations along the Red River for urban anglers. Notable sport fish species sought by anglers include Channel Catfish, Common Carp (*Cyprinus carpio*), Freshwater Drum (*Aplodinotus grunniens*), Goldeye, Lake Sturgeon (*Acipenser fulvescens*), Northern Pike (*Esox lucius)*, and Walleye (Tetr*ES* and North/South Consultants 2000).

Commercial fish harvest in the Red River is limited to bait fishing, mostly occurring in the lower reaches of the river, north of Selkirk, MB (Tetr*ES* and North/South Consultants 2000). In 1998 an estimated 6.5 million bait fish were harvested from the Red River; presumably comprised primarily of Emerald Shiner (*Notropis atherinoides)* and Spottail Shiner (*Notropis hudsonius;* TetrES and North/South Consultants 2000). Although harvest occurs in the Red River, the fish stocks likely originate in Lake Winnipeg (Lysack 1987 in Franzin et al. 2003).

Guided recreational fishing targeting trophy Channel Catfish is popular in the Red River, but is mostly restricted to the lower reaches, downstream of Lockport, MB.

Although once serving as an important subsistence fishery to local Aboriginal communities, it is not known whether the Red River presently supports a substantive Aboriginal fishery.

4.5 AQUATIC INVASIVE SPECIES

Two zebra mussel were incidentally collected at site AD-7 during substrate surveys. Both individuals were found attached to a discarded pop can which was picked up by the Ekman dredge (Photo 3). Both specimens were transported to the North/South Consultants Inc. laboratory and destroyed.

Photo 3. Zebra mussel collected from the Red River near the Alexander Docks, Feb. 15, 2017.

5.0 DISCUSSION

Several metals and a number of PAHs exceeded sediment quality benchmarks in the study area. In all instances where a sediment quality benchmark exists, metals and PAHs were either below the lowest benchmark (which reflects conditions where adverse effects rarely occur), or where exceedances occurred, the values were between the lowest and highest effects benchmarks (which reflects conditions with an increased risk of biological effects). Three metals (arsenic, manganese, and nickel) exceeded the lower sediment quality benchmark at all five sites. Concentrations of each of these metals were also at or above the CCME ISQG or Ontario LEL in sediments collected from the Red River in 2003 upstream and downstream of the Disraeli Bridge, indicating conditions at the Alexander Docks site are similar to those observed in sediments in adjacent areas (NSC 2003). Similarly, most PAHs that were present in one or more sediment samples from the Alexander Docks area at concentrations exceeding the CCME ISQGs were also reported to be above these benchmarks in some samples collected from the Red River upstream and downstream of the Disraeli Bridge (NSC 2003). Collectively, these results, and the lack of detectable concentrations of BTEX F1-F4, indicate that metals and hydrocarbons present in the Alexander Docks sediments are similar to conditions measured in other areas of the Red River within the City of Winnipeg and do not suggest localized contamination that may pose a substantive risk to aquatic biota.

Remnant et al. (2000) classified substrates in the Red River between the City of Winnipeg North and South End Water Pollution Control Centers (including the Alexander Docks site) as generally having medium compaction with sand/mud/silt/clay as primary substrate types. Gravel was also noted as a secondary or tertiary substrate type. Although these classifications are fairly generalized and may not necessarily apply to specific sections of the Red River, such as the area surrounding the Alexander Docks, they do help to describe potential fish and mussel habitats.

Mapleleaf have been reported in substrates ranging from mud and sand (Clarke 1981) to mud, sand or gravel (Cummings and Mayer 1992). In the Assiniboine River Watson et al. (1998) observed individuals in primarily cobble/sand substrates with fewer occurrences in clay/cobble/sand and sand/clay habitat. Although few records exist for the Red River in Manitoba, Clarke (1973) reported individual accounts in reaches of the Red River in southern Manitoba and south of the U.S border. Mapleleaf in the Red River were found in primarily mud or sand substrates with or without secondary clay, gravel, or rock.

Substrates within the footprint of the existing Alexander Docks (soft clay/silt [muck]) are not conducive to supporting Mapleleaf. However, substrates instream of the docks transform inconsistently, but rather quickly, into more compact substrates suitable to this species. Mapleleaf may be present in these harder substrates, and particularly in areas where the softer silt/clay substrates bordering the docks transition into the rocky substrates. Although this survey did not specifically delineate these areas, they appear to be most prominent within 2-5 m from the dock face.

Although detailed design of the site rehabilitation is yet to be determined, in general the project is expected to result in a net benefit to fish habitat. The removal of the dock will restore fish habitat within the existing dock footprint and the placement of bank armouring material will provide habitat diversification. Once the overall scope of the project has been finalized, results from this environmental site characterization will provide the basis for the preparation of self-assessment to determine if the project requires a review by DFO.

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TABLES

Table 1. Physical characteristics of sample site locations.

Transect	Site ID	Distance from Dock Face (m)	Snow Depth (m)	Water Depth (m)	Ice Thickness (m)
1	**AD-1**	<1	0.25	1.80	>1
	AD-18	5	0.19	3.80	0.56
	AD-19	10	0.14	5.30	0.52
	AD-20	15	0.15	4.70	0.64
2	**AD-2**	<1	0.30	0.90	0.72
	AD-15	5	0.12	3.20	0.46
	AD-16	10	0.17	2.90	0.54
	AD-17	15	0.15	3.30	0.56
3	**AD-3**	<1	0.30	1.10	1.00
	AD-12	5	0.20	2.30	0.50
	AD-13	10	0.17	3.20	0.55
	AD-14	15	0.15	3.50	0.55
4	**AD-4**	<1	0.14	1.70	1.00
	AD-9	5	0.17	3.30	0.51
	AD-10	10	0.19	3.10	0.56
	AD-11	15	0.19	2.50	0.56
5	**AD-5a**	<1	0.30	0.00	1.10
	AD-5b	<1	0.30	<0.10	1.10
	AD-5c	<1	0.30	2.60	1.10
	AD-6	5	0.20	1.40	0.58
	AD-7	10	0.20	2.00	0.56
	AD-8	15	0.20	2.00	0.53
6	**AD-21**	5	0.20	0.90	0.55
	AD-22	10	0.17	1.80	0.56
	AD-23	15	0.14	4.00	0.62
7	**AD-24**	5	0.17	0.65	0.53
	AD-25	10	0.07	2.10	0.54
	AD-26	15	0.18	3.30	0.66

Table 2. Particle size, carbon, and nutrients in sediments adjacent to the Alexander Docks.

Site ID	Moisture	Particle Size			Texture	Total Organic Carbon	Total Inorganic Carbon	Total Inorganic Carbon ($CaCO_3$ equivalent)	Total Carbon	Total Nitrogen	Total Phosphorus
		Sand	Silt	Clay							
	(%)	(%)	(%)	(%)		(%)	(%)	(%)	(%)	(µg/g DW)	(µg/g DW)
AD-1	36.8	15.3	68.4	16.3	Silt loam	2.01	0.997	8.30	3.01	900	670
AD-2	36.0	4.4	83.8	11.9	Silt	2.03	0.968	8.06	3.00	870	650
AD-3	31.7	18.8	67.4	13.8	Silt loam	1.75	0.893	7.44	2.64	490	710
AD-4	35.0	18.2	70.0	11.8	Silt loam	1.92	0.913	7.61	2.83	760	660
AD-5c	36.8	10.9	76.6	12.5	Silt loam	1.93	0.960	8.00	2.89	830	100
MDL	0.1	1.0	1.0	1.0	n/a	0.05	0.05	0.4	0.05	200	670

DW = dry weight

Table 3. Metals in sediments adjacent to the Alexander Docks.

Site ID	Metals (µg/g DW)																	
	Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum
AD-1	8270	0.36	7.86	204	0.47	0.126	11	0.313	44100	15.9	7.67	14.0	15700	8.72	17500	731	0.0439	0.602
AD-2	8120	0.33	7.81	218	0.46	0.123	11	0.310	46400	15.5	7.35	13.7	15900	8.30	18500	834	0.0426	0.617
AD-3	6510	0.26	6.35	188	0.37	0.097	<10	0.246	48100	13.0	6.27	10.0	13000	6.58	18700	607	0.0297	0.477
AD-4	7480	0.32	7.73	209	0.43	0.120	<10	0.297	45100	14.5	7.55	14.8	15300	8.42	17100	724	0.0390	0.566
AD-5c	7450	0.3	7.15	205	0.42	0.111	<10	0.280	47400	14.3	6.91	14.2	14400	7.41	18600	710	0.0373	0.566
MDL	5	0.1	0.1	0.5	0.1	0.02	10	0.02	100	1	0.02	1	25	0.2	10	0.5	0.005	0.02
CCME [1]																		
ISQG [2]	-	-	5.90	-	-	-	-	0.60	-	37.3	-	35.7	-	35.0	-	-	0.170	-
PEL [3]	-	-	17.0	-	-	-	-	3.50	-	90.0	-	197	-	91.3	-	-	0.486	-
Ontario MOE [4]																		
Standard [5]	-	-	-	-	-	-	-	-	-	-	50	-	-	-	-	-	-	-
LEL [6]	-	-	-	-	-	-	-	-	-	-	-	-	20000	-	-	460	-	-
SEL [7]	-	-	-	-	-	-	-	-	-	-	-	-	40000	-	-	1100	-	-
BCMOE [8]																		
SAC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

MDL = Method Detection Limit = Lowest level of the parameter that can be quantified with confidence.
DW = Dry weight
"-" = No Data
1. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines (CCME 1999; updated to 2017).
2. ISQG - Interim Sediment Quality Guideline
3. PEL - Probable Effect Level
4. Ontario Ministry of the Environment
5. Sediment standard (OMOE 2011)
6. LEL - Lowest Effect Level (Persaud et al. 1993)
7. SEL - Severe Effect Level (Persaud et al. 1993)
8. BCMOE sediment alert concentration (BCMOE 2014, 2016)

- Exceedance of CCME ISQG
- Exceedance of CCME PEL
- Exceedance of Ontario MOE Standard
- Exceedance of Ontario MOE LEL
- Exceedance of Ontario MOE SEL
- Exceedance of BCMOE SAC

Table 3. Continued.

Site ID	Metals (µg/g DW)												
	Molybdenum	**Nickel**	**Potassium**	**Selenium**	**Silver**	**Sodium**	**Strontium**	**Thallium**	**Tin**	**Titanium**	**Uranium**	**Vanadium**	**Zinc**
AD-1	0.602	20.2	1690	<0.50	<0.10	242	61.5	0.22	<5.0	94.6	1.34	31.2	61
AD-2	0.617	19.6	1620	<0.50	<0.10	245	60.2	0.21	<5.0	80.3	1.26	29.8	56
AD-3	0.477	16.1	1320	<0.50	<0.10	213	56.1	0.18	<5.0	87.8	1.26	24.3	46
AD-4	0.566	19.6	1550	<0.50	0.10	239	58.2	0.21	<5.0	79.3	1.31	28.1	55
AD-5c	0.566	18.4	1520	<0.50	<0.10	235	59.5	0.2	<5.0	87.0	1.31	27.6	52
MDL	0.02	0.5	25	0.5	0.1	10	0.1	0.1	5	0.5	0.02	0.5	10
CCME (1)													
ISQG (2)	-	-	-	-	-	-	-	-	-	-	-	-	123
PEL (3)	-	-	-	-	-	-	-	-	-	-	-	-	315
Ontario MOE (4)													
Standard (5)	-	16	-	-	0.5	-	-	-	-	-	-	-	-
LEL (6)	-	16	-	-	-	-	-	-	-	-	-	-	-
SEL (7)	-	75	-	-	-	-	-	-	-	-	-	-	-
BCMOE (8)													
SAC	-	-	-	2	-	-	-	-	-	-	-	-	-

Table 4. PAHs in sediments adjacent to the Alexander Docks.

Site ID	PAH (µg/g DW)														
	Acenaphthene	Acenaphthylene	Acridine	Anthracene	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b&j) fluoranthene	Benzo(b+j+k) fluoranthene	Benzo(g,h,i) perylene	Benzo(k) fluoranthene	Chrysene	Dibenzo(a,h) anthracene	Fluoranthene	Fluorene	Indeno (1,2,3-c,d) pyrene
AD-1	0.0138	0.0185	<0.010	0.0458	0.150	0.096	0.207	0.275	0.056	0.068	0.235	0.0168	0.912	0.015	0.070
AD-2	0.0905	0.0129	<0.010	0.108	0.119	0.070	0.098	0.131	0.033	0.033	0.107	0.0099	0.531	0.069	0.033
AD-3	<0.0050	<0.0050	0.012	<0.0040	<0.010	<0.010	<0.010	<0.014	<0.010	<0.010	<0.010	<0.0050	0.014	<0.010	<0.010
AD-4	<0.0050	0.0101 *	<0.010	0.0181	0.012	0.013	0.015	0.015	<0.010	<0.010	0.012	<0.0050	0.038	0.013	<0.010
AD-5c	<0.0050	<0.0050	<0.010	<0.0040	<0.010	<0.010	0.011	<0.014	<0.010	<0.010	<0.010	<0.0050	0.023	<0.010	<0.010
MDL	0.0050	0.0050	0.010	0.004	0.010	0.010	0.010	0.014	0.010	0.010	0.010	0.005	0.010	0.010	0.010
CCME (1)															
ISQG (2)	0.00671	0.00587	-	0.0469	0.0317	0.0319	-	-	-	-	0.0571	0.00622	0.111	0.0212	-
PEL (3)	0.0889	0.128	-	0.245	0.385	0.782	-	-	-	-	0.862	0.135	2.355	0.144	-
Ontario MOE (4)															
Standard (5)	-	-	-	-	-	-	-	-	0.17	0.24	-	-	-	-	0.2
BCMOE (6)															
SQG (7)	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-

MDL = Method Detection Limit = Lowest level of the parameter that can be quantified with confidence.
DW = Dry weight
* Result Qualified: Estimated Maximum Possible Concentration. Parameter detected but didn't meet all criteria for positive identification.
1. CCME - Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines (CCME 1999; updated to 2017).
2. ISQG - Interim Sediment Quality Guideline
3. PEL - Probable Effect Level
4. Ontario Ministry of the Environment
5. Sediment standard (OMOE 2011)
6. BCMOE sediment quality guideline (BCMOE 2016)
7. SQG - Sediment quality guideline

- Exceedance of CCME ISQG
- Exceedance of CCME PEL
- Exceedance of Ontario MOE Standard
- Exceedance of BCMOE SQG

Table 4. Continued.

Site ID	PAH (µg/g DW)						
	1-Methyl-naphthalene	2-Methyl-naphthalene	Naphthalene	Phenanthrene	Pyrene	Quinoline	PAH16
AD-1	<0.010	<0.010	<0.010	0.333	0.621	<0.010	2.87
AD-2	<0.010	<0.010	<0.010	0.099	0.382	<0.010	1.81
AD-3	<0.010	<0.010	<0.010	<0.010	0.011	<0.010	0.14
AD-4	<0.010	0.019	0.071	0.054	0.029	<0.010	0.32
AD-5c	<0.010	<0.010	<0.010	0.013	0.017	<0.010	0.16
MDL	0.010	0.010	0.010	0.010	0.010	0.010	0.13
CCME (1)							
ISQG (2)	-	0.0202	0.0346	0.0419	0.053	-	
PEL (3)	-	0.201	0.391	0.515	0.875	-	
Ontario MOE (4)							
Standard (5)	-	-	-	-	-	-	
BCMOE (6)							
SQG (7)	-	-	-	-	-	-	

Table 5. BTEX F1-F4 in sediments adjacent to the Alexander Docks.

Site ID		Benzene	Toluene	Ethyl-benzene	o-Xylene	m+p-Xylenes	Xylenes (Total)	F1 (C6-C10)	F1-BTEX	F2 (C10-C16)	F2-Napthalene	F3 (C16-C34)	F3-PAH (1)	F4 (C34-C50)	Sum of PHC Fractions
		Hydrocarbons (µg/g DW)													
AD-1		<0.0050	<0.050	<0.015	<0.050	<0.050	<0.071	<10	<10	<25	<25	<50	<50	<50	<76
AD-2		<0.0050	<0.050	<0.015	<0.050	<0.050	<0.071	<10	<10	<25	<25	<50	<50	<50	<76
AD-3		<0.0050	<0.050	<0.015	<0.050	<0.050	<0.071	<10	<10	<25	<25	<50	<50	<50	<76
AD-4		<0.0050	<0.050	<0.015	<0.050	<0.050	<0.071	<10	<10	<25	<25	<50	<50	<50	<76
AD-5c		<0.0050	<0.050	<0.015	<0.050	<0.050	<0.071	<10	<10	<25	<25	<50	<50	<50	<76
MDL		0.0050	0.050	0.015	0.050	0.050	0.071	10	10	25	25	50	50	50	76
Guidelines															
Residential/Parkland CCME Soil PHC Tier 1 Levels	Fine-grained Soil	-	-	-	-	-	-	210	-	150	-	1300	-	5600	-
	Coarse-grained Soil	-	-	-	-	-	-	30	-	150	-	300	-	2800	-
CCME Soil quality guideline for protection of environmental health (Residential/Parkland)	Fine-grained Soil	60	110	120	-	-	65	-	-	-		-		-	-
	Coarse-grained Soil	31	75	55	-	-	95	-	-	-		-		-	-

Notes:
MDL = Method Detection Limit = Lowest level of the parameter that can be quantified with confidence.
DW = Dry weight
* Result Qualified: Detection limit adjusted due to sample matrix effects.

- (blue) - Exceedance of CCME Soil PHC Tier 1 Levels Fine-grained soil (CCME 2001; updated to 2017)
- (pink) - Exceedance of CCME Soil PHC Tier 1 Levels Coarse-grained soil (CCME 2001; updated to 2017)
- (green) - Exceedance of CCME Soil quality guideline for protection of environmental health Fine-grained soil (CCME 1999; updated to 2017)
- (orange) - Exceedance of CCME Soil quality guideline for protection of environmental health Coarse-grained soil (CCME 1999; updated to 2017)

Table 6. Results of substrate characterization in the Red River near the Alexander Docks.

Transect	Site ID	Primary Substrate	Secondary Substrate	Compaction	Comments
1	**AD-1**	Clay	Silt	Soft	-
	AD-18	-	-	Hard	Hard substrate, however some clay stuck to Ekman
	AD-19	Silt	Gravel	Moderate	-
	AD-20	Cobble	Silt	Hard	Gravel/Pebble also present
2	**AD-2**	Clay	Silt	Soft	-
	AD-15	Boulder	Clay	Hard	Hard substrate, however some clay stuck to Ekman
	AD-16	-	-	Hard	No Grab, Rocky Substrate
	AD-17	-	-	Hard	No Grab, Rocky Substrate
3	**AD-3**	Clay	Silt	Soft	-
	AD-12	-	-	Hard	No Grab, Rocky Substrate
	AD-13	-	-	Hard	No Grab, Rocky Substrate
	AD-14	-	-	Hard	No Grab, Rocky Substrate
4	**AD-4**	Clay	Silt	Soft	-
	AD-9	Clay	Silt	Moderate	-
	AD-10	-	-	Hard	No Grab, Rocky Substrate
	AD-11	-	-	Hard	No Grab, Rocky Substrate
5	**AD-5a**	-	-	-	Substrate Frozen
	AD-5b	-	-	-	< 10 cm water below ice
	AD-5c	Clay	Silt	Soft	-
	AD-6	Clay	Silt	Soft	-
	AD-7	Clay	Silt	Soft/Hard	Hard substrate under thin soft layer
	AD-8	-	-	Hard	No Grab, Rocky Substrate
6	**AD-21**	Silt	Clay	Soft	-
	AD-22	-	-	-	No Grab, Rocky Substrate with small woody debris and gravel/silt/clay layer on top
	AD-23	-	-	-	No Grab, Rocky Substrate
7	**AD-24**	-	-	Hard	No Grab, Rocky Substrate
	AD-25	Clay	Silt	Soft	Some boulder present
	AD-26	Pebble	Gravel	Hard	Pebble/Gravel mixed with silt

APPENDICES

Appendix 1:
Site Photos

Photo A1-1.   Site AD-1 substrate.

Photo A1-2.   Site AD-2 substrate.

Photo A1-3. Site AD-3 Substrate.

Photo A1-4. Site AD-4 Substrate.

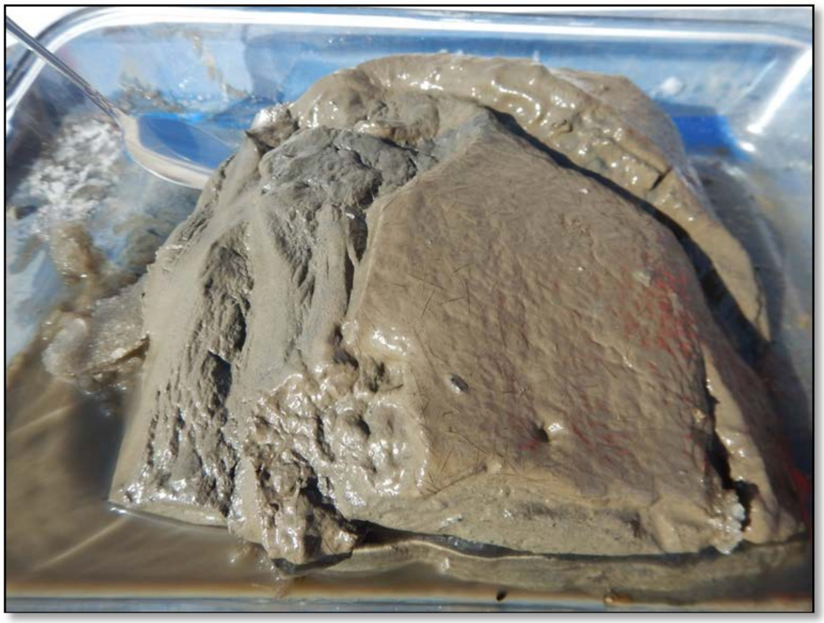

Photo A1-5. Site AD-5c Substrate.

Photo A1-6. Site AD-6 Substrate.

Photo A1-7. Site AD-7 Substrate.

Photo A1-8. Site AD-9 Substrate.

Photo A1-9. Site AD-19 Substrate.

Photo A1-10. Site AD-20 Substrate.

Photo A1-11. Site AD-21 Substrate.

Photo A1-12. Site AD-25 Substrate.

Photo A1-13. Site AD-26 Substrate.

Appendix 2:
Fish Species Known or Expected to Occur in the Red River

Table A2-1. Fish species known or expected to occur in the Red River near the City of Winnipeg.

Common Name	**Scientific Name**	**Stewart and Watkinson (2004)**	**Watkinson et al. (2004)**	**Remnant et al. (2000)**	**Clarke et al. (1980)**
Bigmouth Buffalo	*Ictobus fulvescens*	X	X	X	
Black Crappie	*Pomoxis nigromaculatus*	X		X	X
Blackside Darter	*Percina maculata*	X			
Black Bullhead	*Ameiurus melas*	X		X	X
Bluegill	*Lepomis macrochirus*	X			
Brook Stickleback	*Culaea inconstans*	X		X	
Brown Bullhead	*Ameiurus nebulosus*	X		X	X
Burbot	*Lota lota*	X	X	X	X
Central Mudminnow	*Umbra limi*	X			
Channel Catfish	*Ictalurus punctatus*	X	X	X	X
Chestnut Lamprey	*Ichthyomyzon castaneus*	X			X
Cisco	*Coregonus artedi*	X		X	
Common Carp	*Cyprinus carpio*	X	X	X	X
Common Shiner	*Luxilus cornutus*	X			
Creek Chub	*Semotilus atromaculatus*	X			
Emerald Shiner	*Notropis atherinoides*	X	X	X	X
Fathead Minnow	*Pimephales promelas*	X		X	X
Flathead Chub	*Platygobio gracilis*	X		X	
Freshwater Drum	*Aplodinotus grunniens*	X	X	X	X
Golden Redhorse	*Moxostoma erythrurum*	X		X	
Golden Shiner	*Notemigonus crysoleucas*	X			
Goldeye	*Hiodon alosoides*	X	X	X	X
Goldfish	*Carassius auratus*	X			
Hornyhead Chub	*Nocomus Biguttatus*				X
Iowa Darter	*Etheostoma exile*	X			
Johnny Darter	*Etheostoma nigrum*	X			X
Lake Chub	*Couesius plumbeus*				X
Lake Sturgeon	*Acipenser fulvescens*	X			
Lake Whitefish	*Coregonus clupeaformis*	X			
Largemouth Bass	*Micopterus salmoides*	X			
Logperch	*Percina caprodes*	X			
Longnose Dace	*Rhinichthys cataractae*	X			X
Mooneye	*Hiodon tergisus*	X		X	X
Northern Pike	*Esox lucius*	X	X	X	X
Pumpkinseed	*Lepomis gibbosus*				X
Quillback	*Carpiodes cyprinus*	X	X	X	X
River Darter	*Percina shumardi*	X		X	X
River Shiner	*Notropis blennius*	X		X	X
Rock Bass	*Ambloplites rupestris*	X		X	X
Sand Shiner	*Notropis stramineus*	X			
Sauger	*Sander canadensis*	X	X	X	X
Shorthead Redhorse	*Moxostoma macrolepidotum*	X	X	X	X
Silver Chub	*Macrhybopsis storeriana*	X	X	X	X
Silver Redhorse	*Moxostoma anisurum*	X	X	X	X
Silver Lamprey	*Ichthyomyzon unicuspis*	X			
Smallmouth Bass	*Micropterus dolomieu*	X			
Spottail Shiner	*Notropis hudsonius*	X			X
Spotfin Shiner	*Cyprinella spiloptera*	X		X	
Stonecat	*Noturus flavus*	X		X	X
Tadpole Madtom	*Noturus gyrinus*	X			X
Troutperch	*Percopsis omiscomaycus*	X		X	X
Walleye	*Sander vitreus*	X		X	X
Western Blacknose Dace	*Rhinivhthys obtusus*	X			
White Crappie	*Pomoxis annularis*	X			
White Bass	*Morone chrysops*	X		X	X
White Sucker	*Catostomus commersonii*	X	X	X	X
Yellow Perch	*Perca flavescens*	X			X