Appendix B

Development of HEC-RAS Deck

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Appendix B

Development of HEC-RAS Deck

B1 Introduction

This Appendix outlines the steps taken in developing the physical component (i.e., cross-sections and their spatial representation) for the Acres' HEC-RAS backwater model. As the Acres' model builds on information developed in other models, an initial section of this Appendix has been devoted to briefly outlining those previous studies, including information that could be potentially relevant to this current study. Also included in this Appendix is a table that references the centreline location of the Acres' HEC-RAS cross-sections in UTM coordinates and river chainage, and a cross-reference of the cross-sections back to the original 1951 Red River Hydrographic Survey. The starting chainage for the cross-sections is at Goldeye Lake, located just upstream of Lake Winnipeg.

B2 Previous Backwater Modelling Studies in the City of Winnipeg

The following sub-sections outline the backwater modelling that has been carried out on the Red and Assiniboine rivers through the City of Winnipeg by others. The sequence of backwater modelling was:

1. RRBI/WRB – slide rule
2. WRB – HEC2
3. Public Works Modelling – HEC2
4. KGS – HEC-RAS
5. Acres - HEC-RAS.

As indicated in the Introduction, a portion of the above modelling effort was used in constructing the Acres' HEC-RAS model of the Red River.

B2.1 Red River Basin Investigation and Early 60's Provincial Studies

Following the 1950 flood, the Federal Government established a task force, the Red River Basin Investigation (RRBI) (1950-1953) to undertake flood proofing studies for the City of Winnipeg (Winnipeg). The hydrology and hydraulic

component of the studies were directed by R.H. Clark (Clark et. al., 1997). One of the hydraulic studies referenced in Clark et. al.(1997) was a backwater studies to determine overall feasibility of the Floodway project.

Following the completion of the 1958 Royal Commission on Flood Cost-Benefit study, the Province carried out surveys to define a new Floodway Inlet location upstream of St. Norbert and the confluence of the LaSalle River. Following approval of this new location detailed hydraulic investigations were carried out to determine "natural" conditions at the Floodway Inlet for a range of Red and Assiniboine river flows (Weber, 1973).

Channel cross-sections surveyed during the winter of 1950-1951 as part of the Red River Hydrographic Survey, and the 1950 meterings at Redwood Bridge were used for both the RRBI (1950-1953) and by the Province in the early 1960's. Both backwater studies would have been done with slide rules and lookup tables.

The cross-section information collected by the Red River Hydrographic Survey forms the basis of the channel-portion of the cross-sections used in the Acres' HEC-RAS model.

B2.2 Manitoba Water Resource Branch

As part of the Canada-Manitoba Flood Damage Reduction Program (FDR) initiated in 1976, the provincial Water Resources Branch (WRB) carried out a number of flood risk studies of urban centres within Manitoba, one of these studies was done for the Winnipeg. The focus of these studies was to consider all practical structural and non-structural alternatives, including an assessment of permissible flooding. The majority of these studies consisted of carrying out backwater studies to determine floodwater levels for the design flood. Flood risk mapping and dissemination of this information was a key component of the FDR program. Maps were developed designating the flood risk area which consisted of: (1) the floodway area, the zone where the majority of flow occurs and (2) the flood fringe area, a zone of shallow water where floodwaters will pond. This information would then be used by both the public and planners in assessing appropriate future development in the flood plain area (Zhang, 1996).

For the Winnipeg, the FDR program adopted the so-called "160-year flood" (today the flood is estimated to have a return period of 90 years – Flood Protection Studies for Winnipeg (2001) as the basis for determining flood risk areas, as permanent flood control works (i.e., Winnipeg Primary Dykes and the

Red River Floodway, Portage Diversion, etc.) would provide protection to Winnipeg urban area up to this flood level.

The Winnipeg backwater studies were carried out by Laurence Cheung of the WRB during the late 1970's with a report prepared later by John Toye (Manitoba Natural Resources Branch, 1981). The WRB study area encompassed the Red River from St. Andrews Lock and Dam to just upstream of the Floodway Inlet and on the Assiniboine River from the (Forks) Red River Confluence to Headingley. River cross-sections, from the detailed Red River Basin Investigation (RRBI) hydrographic surveys of 1951 and were coded into the format required for the HEC-2 backwater program. The RRBI, in 1951, surveyed the entire Red River at regularly spaced intervals of approximately 800 feet along the length of the river. As a check of the use of the 1951 cross-section information, WRB indicate in their report that some cross-sections were re-surveyed in the RM of Ritchot area just upstream of the Red River Floodway Inlet in 1978 and found that changes in channel geometry were found to be insignificant.

Extensions of the river cross-section into the overbank area was based on overbank surveys from the 1951 RRBI Hydrographic Survey and Winnipeg topographical mapping. All cross-sections were extended to the City's primary dyke line.

The HEC-2 model (HEC-2 was a one-dimensional steady state backwater model which was the precursor of the HEC-RAS model) was calibrated to hydrometric data collected during the 1950 flood (Clark, 1950). The rationale given for the use of the 1950 data was that it was the largest flood for which a useful amount of hydrographic data had been collected (Manitoba Natural Resources, 1981). While it is correct that the 1950 flood is the largest recent flood of record for the Winnipeg, the HEC-2 model was calibrated for a flood range of 72,000 to 78,000 cfs, where data from other years such as 1966 could also have been used to designate the "floodway area" and the "flood fringe" area. It is unfortunate that the report authors did not discuss the 1966 data, because as discussed in the main report, Section 2.3.3 and Figure B2-13, there is a significant shift in the rating curve for post 1950 meterings and the general consensus is that recorded flow in Clark's 1950 report are too low.

The report indicates that a number of techniques were tested in calibrating the HEC-2 model and the final technique chosen was to divide the river cross-section

into three zones: a river channel zone, a vegetated riverbank zone and a flood plain zone. WRB found that their modelling of the riverbank area was relatively insensitive to hydraulic roughness values, but that the channel roughness zone was. WRB's calibration found roughness values for the river channel zone varied between 0.027 and 0.033. The 0.027 value was for the Bergen Cutoff to the Norwood Bridge section of the Red River, with the other sections of the river having roughness values from 0.030 to 0.033. A vegetated roughness value of 0.06 to 0.07 was used and a "theoretical" roughness value of 0.1 was adopted for the floodplain.

It should be noted that adjustments can be made in the 'n' value to account for data error. In the case of calibrating to a lower flow estimate, the 'n' value can be adjusted upward to match the water level profile. This appears to be the case with the WRB modelling as the calibrated 'n' values in the Acres model are lower in the range of 0.027 to 0.028 (throughout the entire river reach) versus the 0.030 to 0.033 'n' used by WRB.

The HEC-2 coding of the RRBI cross-sections by WRB was used as the basis for the Acres' HEC-RAS model discussed later in Section B3.

B2.3 Public Works Low-Flow Modelling

In 1990 Grant Mohr carried out a low-flow modelling study of the Red and Assiniboine Rivers for Public Works Canada. The modelling involved, using the original WRB HEC-2 model of the rivers. In carrying out this assessment Mohr encountered a number of errors in the WRB HEC-2 data, as outlined below:

- Artificial cross-sections had been used in the Lister Rapids/Rivercrest section of the Red River for the Red River Hydographic Survey (RRHS) No. 29 through to 40. These cross-sections appear too symmetrical and uniform and were therefore different than the other irregular cross-sections of the river. Requests were made to WRB for the original cross-section data and it was found that this roll of cross-sections was missing from their set. To rectify the problem surveyors from Public Works Canada collected additional cross-section information from this section of the river.

- An error in cross-section spacing was discovered in all cross-sections of the river from Bergen Cutoff to the Redwood Bridge for RRHS mapsheet H-11 and H-12 map sheet. It appears that the spacing error arose from a scaling

change in mapsheets north of Bergen Cutoff and those, south of Bergen Cutoff when the scale changed from 1:600 to 1:500.

In carrying out the low flow modelling studies on the Assiniboine River, Mohr also encountered problems with cross-sections in the reach of the river between Omands Creek in the Route 90 Bridge section of the river, which required resurveying this section of the river. While not an issue for flood modelling it was a significant issue for low-flow modelling.

Review by Mohr of the existing water level data collected on the Red and Assiniboine River (i.e., Clark [1950], Long [1971]) indicated that no data existed for flows in the low to moderate flow range for the river. Using the same location points as the 1950 and the 1966 data collection program, a water level data collection program was initiated in the spring of 1990 by Public Works Canada and then subsequently by Mohr in the spring of 1992 as input to a Masters Thesis. The data collected in 1992 represents a flow range of 14,000 to 44,000 cfs on the Red River.

The new PWC cross-sections for the Lister Rapids/Rivercrest section of the river are incorporated in the Acres' HEC-RAS model.

B2.4 KGS HEC-RAS Model

In the late 1990's KGS carried out backwater modelling of the Red and Assiniboine Rivers to develop a hydraulic "calculator" of river stages for Red River and Assiniboine River flow contributions for the City of Winnipeg Flood Manual. KGS converted the 1978 WRB HEC-2 model data to the now HEC-RAS backwater model format. In addition, the model was converted from Imperial units of measure to Metric units of measure. According to Carson (pers. comm.) new bridges were added that did not exist during the late 1970's WRB study: Chief Pequis and Moray, and included the replacement of the Norwood and Main Street Bridges. Adjustments were made to chainages to suit topographic information. The HEC-RAS model was re-calibrated to 1997 data and represents a model calibration to approximately 80,000 cfs. which is near the City of Winnipeg's Primary Flood Protection Level.

As the Acres' model was built to represent bridge conditions that existed in 1950, any revisions made by KGS in their HEC-RAS model were not applicable to the Acres' model and were therefore not used.

B3 Acres' HEC-RAS Model

As outlined in the Introduction of the main report (i.e., Section 1.0), the purpose of the Acres' Manitoba HEC-RAS model study was to develop water surface profile for a full range of flood flows for the level of infrastructure development that existed in 1950, (i.e., bridges that existed at the time and without the Winnipeg primary dyke system that was built after the 1950 flood – see discussion Section 2.1, main report). Figure B2.1 in the main report shows the overbank flooding that occurred for a flood in the 108,500 cfs range (Section 2.3.3 and WRB estimate of 1950 peak). Extension of the backwater modelling to flows in the range of 300,000 cfs range would involve more extensive overbank flooding that occurred during the 1950 flood.

A critical component of the Acres modelling was the development of topographic information in the overbank areas and linking this with the existing river cross-section information. The steps in the development of the Acres' model are briefly outlined below and illustrated in Figure B1:

- geo-spatially locating cross-sections from the 1951 RRBI surveys and cross-linking this with the WRB original HEC-2 model of the river. See Section B2.2 for a brief outline of the WRB modelling. Table B1 show a cross-link table of this information;
- development of a Digital Terrain Model (DTM) for overbank areas which extends laterally from rivers edge to the anticipated limits of flooding. This DTM was developed from a variety of sources as discussed in Section B3.1.4.;
- use of HEC-GeoRas model (see Section B3.3.) to cut overbank cross-section data from the DTM for importing into HEC-RAS;
- viewing both overbank and in-channel cross-sections as Excel figures and making minor offset adjustments to the river cross-section to fit the river data up to elevation 734 ft. (normal summer water levels) with the overbank DTM.

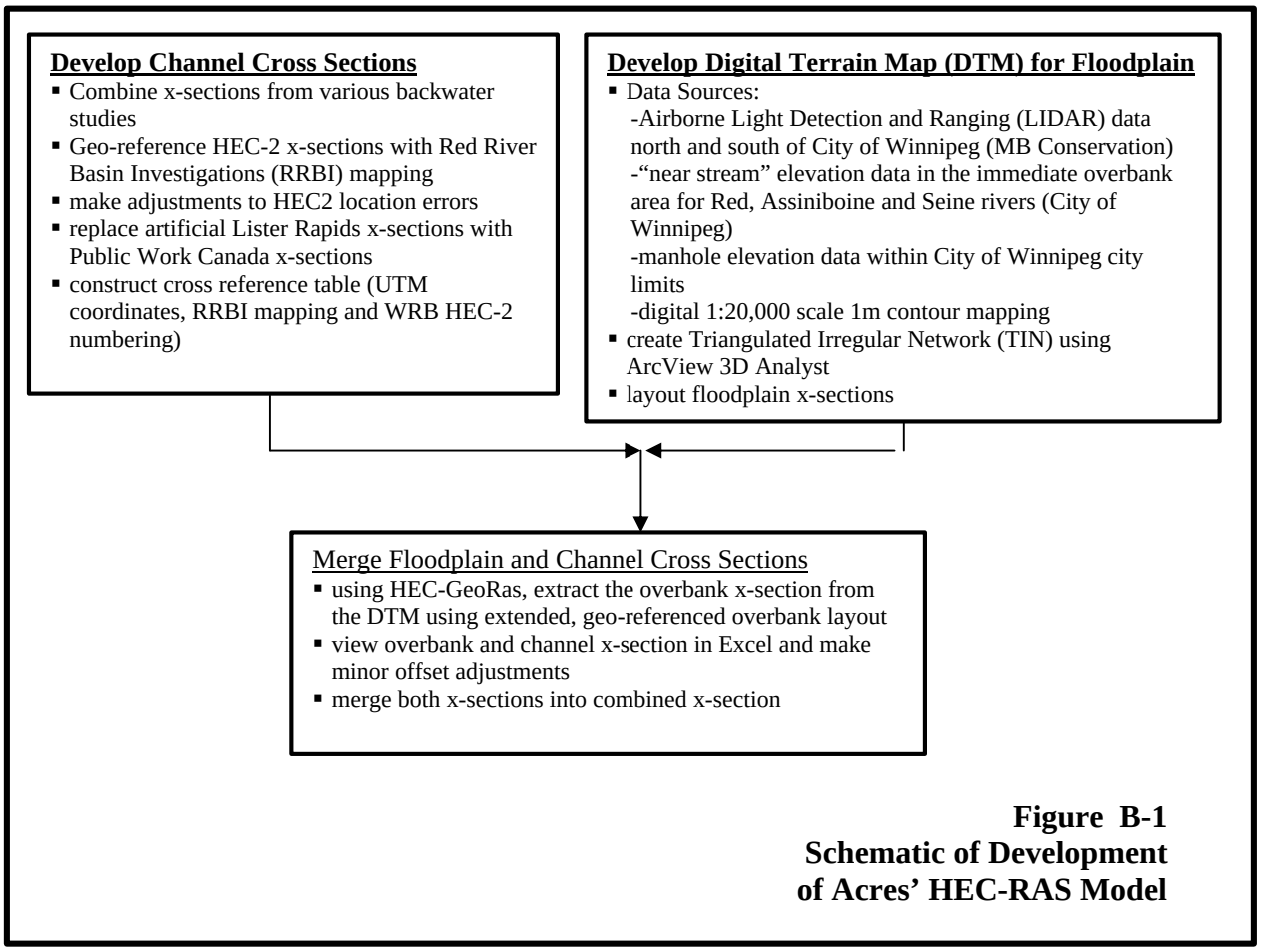

Figure B-1
Schematic of Development of Acres' HEC-RAS Model

B3.1 Overbank Geo-Spatial Elevation Data

Data from a variety of sources was used to construct the overbank topographic mapping required for the Acres HEC-RAS model. The geographic extent of these cross-sections is shown in Figure B2.

1. Airborne Light Detection and Ranging (LIDAR) data north and south of the Winnipeg, (provided by Manitoba Conservation).
2. "Near Stream" elevation data in the immediate overbank of the Red, Assiniboine and Seine Rivers through the City of Winnipeg (provided by the Winnipeg).
3. Manhole elevation data through Winnipeg (provided by the Winnipeg).

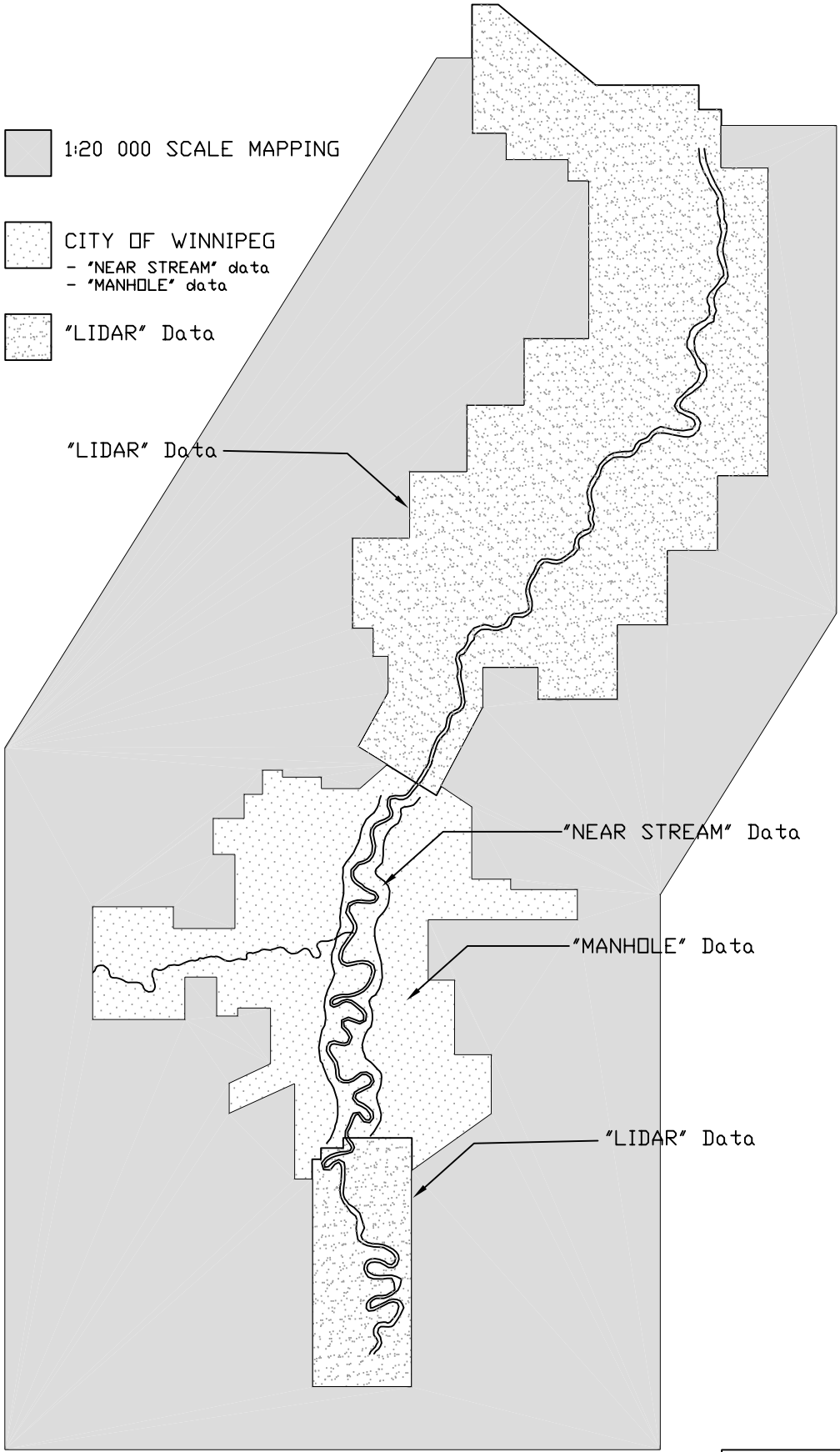

FIGURE B-2
Coverage of Survey Data

4. 1:20 000 scale mapping with spot elevation data (provided by Manitoba Conservation).

Details on these datasets are discussed in the following sub-sections.

B3.1.1 LIDAR

In June 1999, the areas immediately north and south of the Winnipeg were surveyed utilizing airborne LIDAR technology. This survey technique produces high volumes of highly accurate spatial data. The LIDAR data represents the most detailed topographic data available for these areas at this time.

Airborne LIDAR is a fast and reliable method of obtaining 3-dimensional data for the creation of Digital Terrain Models (DTM). The LIDAR system essentially sends out rapid LASER pulses and measures the time for the signal to travel from the emitter to the ground (or any intervening object) and reflect back to the receptor. This time is converted to a distance, which is then rectified using the parameters supplied by the inertial survey system and the global positioning system (GPS).

LIDAR equipped aircraft flew the areas north and south of the city and individual point density on the ground was estimated to have achieved 1.5 m spacing. Overall topographical limits for the vertical contour accuracy for the study area were estimated at 15 cm (Kozera pers comm., Water Stewardship, 2003), but the actual accuracy exceeded this in areas that were overlapped.

The spatial limits of the LIDAR are shown in Figure B2, along with the spatial limits of the other datasets.

The LIDAR data also provides highly accurate elevation data right down to the waters edge of the rivers. In areas where LIDAR data existed, this data was given the highest priority for use in constructing the overall topographic map of the area.

B3.1.2 City of Winnipeg “Near Stream” and Manhole Data

Two sources of elevation data were provided by the WINNIPEG as follows:

- "Near Stream" elevation data.
- Manhole rim elevation data.

The "Near Stream" data, which was provided in a geo-referenced format, provided very high density point elevation data along the riverbanks of the Winnipeg. The data points have a vertical accuracy of 12 cm and a horizontal accuracy 22 cm, 90% of the time (Doug McNeil, pers comm. City of Winnipeg, 2003).

The manhole rim data, which was provided in a geo-referenced format, provides data over a large area of the Winnipeg, and generally reflects ground topography. The data points are assumed to have a vertical accuracy of plus or minus 10 cm (Doug McNeil, pers comm. City of Winnipeg, 2003).

In areas where LIDAR elevation data did not exist, the above described point elevation datasets were used to construct elevation maps of these areas.

B3.1.3 Topographic Maps

Topographic mapping throughout the study area is available in a geo-referenced format. The 1:20,000scale topography, which has 1m contour intervals, was provided by Manitoba Conservation. These maps were created using aerial photogrammetry techniques from 1988 aerial photography.

This topographic data was used to define the areas outside of the spatial limits of the LIDAR, "Near Stream" and manhole rim data, as shown on Figure B2. The vertical accuracy of the contour data is approximately 30 cm.

B.3.1.4 Creation of Digital Terrain Model

The previously discussed elevation data from the LIDAR survey, the Winnipeg manhole and "Near Stream" data and the 1:20,000 topographic mapping were combined to create a Digital Terrain Model (DTM) using ArcView 3D Analyst.

3D Analyst is an ArcView extension for the creation and visualization of three-dimensional surfaces from ArcView data files. The surfaces created by 3D Analyst are represented as Triangular Irregular Networks (TIN's). These TIN surfaces are a subtype of the general DTM in that they are represented by a vector surface. The HEC-GeoRAS model (Section B3.3) uses the TIN to create the overbank cross-sections used in the final model.

The data sources used either already existed in ArcView format, or were converted into an ArcView compatible format. Specifically, 3D Analyst is able to read in point, polyline or DEM files into its procedure for producing a surface. As discussed in Section B3.1 the overbank data was ordered in priority of reliability and this information was used in generating the TIN. Where areas of overlap occurred, the dataset with the higher priority, was used and the data from the overlapping dataset was digitally "trimmed" back to eliminate the overlap. The order of priority was:

1. Airborne Light Detection and Ranging (LIDAR) data north and south of Winnipeg, (provided by Manitoba Conservation).
2. "Near Stream" elevation data in the immediate overbank of the Red, Assiniboine and Seine Rivers through the City of Winnipeg, (provided by the City of Winnipeg).
3. Manhole elevation data through Winnipeg, (provided by the City of Winnipeg).
4. 1:20 000 scale mapping with spot elevation data (provided by Manitoba Conservation).

B3.2 Geospatially Locating River Cross-Sections

The previous section described the development of the geo-spatially referenced overbank topographic model. This section describes how the previously coded channel cross-sections from the Manitoba Conservation HEC-RAS datasets were spatially referenced to the overbank topographical model.

The three HEC-RAS datasets received from Manitoba Conservation were combined into one complete HEC-RAS model. With over three hundred cross-sections to be spatially referenced, individual placement of cross-sections would have been very difficult. FloodMap was used instead to perform this task. FloodMap is an ArcView extension for spatially referencing HEC-RAS datasets (Section B2.2) along the river reach based upon the reported chainages.

A generated HEC-RAS report file provides the necessary data for FloodMap to read the cross-section information. After all cross-sections had been linked into one model and overlapping and identical cross-sections deleted along with an update to new chainages, the HEC-RAS report file was utilized by FloodMap to begin the geo-referencing of individual cross-sections to the new coordinate system.

To check that the chainages matched the mapping provided by Manitoba Conservation for each cross-section location, a check was made by "pinning" down key cross-sections in the FloodMap procedure to ensure that they exactly matched the original mapping. With a deck of over three hundred sections, approximately one in every fifteen cross-sections was "pinned" down along the river length to its precise location as shown in the RRBI mapping. If required, the intervening cross-sections were then adjusted along the river centerline based upon the computed adjustment factor calculated from the pinned down cross-section relative to the original HEC deck chainage.

This procedure of "pinning" down cross-sections noted the error of chainage distances in the Bergen Cutoff to Redwood Bridge section of the river discussed in Section B2.3 and adjustments were made accordingly.

After this procedure was completed, the geo-referenced cross-section placement created by the FloodMap procedure was visually compared to the original RRBI mapping. If the FloodMap located cross-sections were found to be slightly off-distance, they were adjusted accordingly.

Artificial geometry between riverbanks in the Lister Rapids section of the Red River, as discussed in Section B2.3, were replaced with actual surveyed cross-sections.

Table B1 shows the geo-referenced location of the cross-sections with referencing to the cross-section descriptors and map sheets from the 1951 RRHS survey.

B3.3 Layout of Overbank Cross-Section

After each of the channel cross-sections was geo-referenced into the same coordinate system as the topographic mapping, the existing overbank cross-section information was stripped from the cross-section to allow replacement with the updated overbank information provided by the new topographic data.

AutoCAD Map 5 was used to extend the overbank orientation for each section. A few rules were used in the determination of the overbank layout: no two cross-sections could be intersected, and it was generally optimal if the flow was perpendicular to the direction of the cross-section. MRSID digital ortho images from Manitoba Conservation were used to help aid the laying out of cross-sections. The widths of the cross-sections in the overbank were extended out to the furthest probable width that might have been expected for the floods being modelled.

Once the general layout of the overbank cross-section had been determined, the cross-section information was extracted from the DTM using special software called HEC-GeoRAS, as discussed in the following section.

B3.4 Extraction of the Overbank Information

To extract the “laid" out plan view of the overbank cross-section from the DTM into a format suitable for HEC-RAS, the software package HEC-GeoRAS was used. HEC-GeoRAS is an ArcView extension created by the U.S. Army Corps of Engineers used for creating a geometric cross-section for importing into HEC-RAS. The import file is created from data extracted from ArcView shapefiles and from a Digital Terrain Model (DTM). Using the overbank DTM created for this study along with ArcView themes representing the Red River centerline, bank stations, overbank flowlines, along with extensions of the overbank cross-sections, a HEC-RAS input file was created from HEC-GeoRAS. Note, however that the data extracted by HEC-GeoRAS only contains the cross section data from the overbank areas and the riverbank above normal water level. The river HEC-GeoRAS geometry data, below water, had to be inserted as discussed in the following section.

B3.5 Final Adjustment of Overbank and River Cross-Sections

The final step in the process was merging the HEC-GeoRAS created overbank cross-section with the river channel RRBI cross-section. This was done using Excel to locate the river cross-section laterally within the updated overbank cross-section and offset to centre the river channel portion of the cross-section. Once the river cross-section was centred, the extraneous overbank portions of the RRBI cross-sections were deleted, and both cross-sections merged together, to form the final cross-section.

Once this merging was complete, a final check for post-1950 flood structures in the cross-section, were made. It was in this step that the Primary Dykes, the Lyndale dyke and the presence of the Floodway were deleted from the affected cross-sections. As discussed in Section 2.4 to allow calibration of the HEC-RAS model to 1950 conditions a "wall" was inserted into the model to account for the Lyndale dyke.

B3.6 Bridges

The bridges and structures modelled in this study were as follows:

- Elm Park Bridge
- Norwood Bridge
- Provencher Bridge
- CNR – Redditt
- CPR – Keewatin
- Louise Bridge
- Redwood Bridge
- CPR – Bergen
- St. Andrews Lock and Dam
- PR 204 Bridge.

Details on the bridges that were modelled for the HEC-RAS model are discussed separately, see Appendix C.

TABLE B1

CROSS-SECTION CROSS-REFERENCE TABLE TO PREVIOUS STUDIES

RIVER STATION [m]	DESCRIPTION	UTM COORDINATES AT CENTERLINE (NAD83)		GAUGE BOARDS[1]	RRHS[2]	HEC-2 CODE[3]	RRHS MAP SHEET
		NORTHING	EASTING				
104,511	3014. XS 14 (original section 107.1 - 1951 Hydrographic Survey) - D/S side of PR 429 bridge north of St Adolphe	5504697	635502		-	-	-
103,881	3013. XS 13 (original section 107 - 1951 Hydrographic Survey)	5505142	635934		-	-	-
103,245	3012. XS 12 (original section 8 - 1951 Hydrographic Survey)	5505696	635815		-	-	-
102,897	3011. XS 11 (original section 98.3 - 1951 Hydrographic Survey)	5506023	635758		-	-	-
102,548	3010. XS 10 (original section 98.2 - 1951 Hydrographic Survey) This is a REPEATED section.	5506283	635959		-	-	-
100,820	3007. XS 7 (original section 7 - 1951 Hydrographic Survey)	5507245	637141		-	-	-
98,516	3006. XS 6 (original section 6 - 1951 Hydrographic Survey)	5507369	635377		-	-	-
96,213	3005. XS 5 (original section 5 - 1951 Hydrographic Survey)	5508667	636958		-	-	-
94,575	3004. XS 4 (original section 4 - 1951 Hydrographic Survey)	5508988	635417		-	-	-
91,599	3003. XS 3 (original section 3 - 1951 Hydrographic Survey)	5510186	636816		-	-	-
89,376	Duplicate of XS 2 (original section 2 - 1951 Hydrographic Survey) - Floodway Inlet Gauge	-	-	FLOODWAY INLET (WSC 050C026)	-	-	-
88,876	3002. XS 2 (original section 2 - 1951 Hydrographic Survey)	5511540	634918		-	-	-
87,725	3001 XS 1 - just U/S of Floodway control structure near Floodway Inlet (original section 1 - 1951 Hydrographic Survey)	5512557	634490		-	-	-
87,361	2233. D/S of Floodway Control Structure - XS 233- Red River Basin Investigation(RRBI) - Hydrographic Survey South (HSS) # 50	5512797	634217	WSC 050C020	HSS #50	233.00	H18
87,183	2232. XS 232 RRBI - HSS # 49	5512952	634129		HSS #49	232.00	H18
87,004	2231. XS 231 - confluence with La Salle River RRBI - HSS # 48	5513109	634043		HSS #48	231.00	H18
86,827	2230. XS 230 - St. Norbert Gauge RRBI - HSS # 47	5513264	633958	St. Norbert - Lot #78 Turnbull Drive	HSS #47	230.00	H18
86,650	2229. XS 229 RRBI - HSS # 46	5513440	633953		HSS #46	229.00	H18
86,472	2228. XS 228 RRBI - HSS # 45	5513617	633951		HSS #45	228.00	H18
86,295	2227. XS 227 RRBI - HSS # 44	5513795	633950		HSS #44	227.00	H18
86,117	2226. XS 226 RRBI - HSS # 43	5513972	633948		HSS #43	226.00	H18
85,942	2225. XS 225 RRBI - HSS # 42	5514147	633947		HSS #42	225.00	H18
85,763	2224. XS 224 - St Norbert area RRBI - HSS # 41	5514327	633946		HSS #41	224.00	H18
85,585	2223. XS 223 RRBI - HSS # 40	5514504	633944		HSS #40	223.00	H18
83,861	2216. XS 216 RRBI - HSS # 33	5514806	632954	Beaujelais Coulee	HSS #33	216.00	H18
82,132	2210. XS 210 RRBI - HSS # 27	5515640	634145	Cloutier Drive	HSS #27	210.00	H18
81,621	2208. XS 208 RRBI - HSS # 25	5515919	634516		HSS #25	208.00	H18
81,400	2207. XS 207 RRBI - HSS # 24	5516108	634402		HSS #24	207.00	H18
81,177	2206.75 Just U/S of the South Perimeter Bridge - Duplicate of XS 206 RRBI - HSS # 23	5516301	634291	S. Perimeter Bridge - upstream side	HSS #23	206.00	H17
80,920	2206.25 Just D/S of the South Perimeter Bridge - Duplicate of XS 206 RRBI - HSS # 23	5516539	634193		HSS #23	206.00	H17
80,660	2206. XS 206 RRBI - HSS # 23	5516780	634207		HSS #23	206.00	H17
80,403	2205. XS 205 RRBI - HSS # 22	5517019	634303		HSS #22	205.00	H17
78,599	2198. XS 198 RRBI - HSS # 15	5517352	635406		HSS #15	198.00	H17
78,343	2197. XS 197 RRBI - HSS # 14	5517560	635504		HSS #14	197.00	H17
78,085	2196. XS 196 RRBI - HSS # 13	5517806	635506		HSS #13	196.00	H17
77,769	2195. XS 195 RRBI - HSS # 12	5518050	635306		HSS #12	195.00	H17
76,814	2192. XS 192 RRBI - HSS # 9	5518597	634560		HSS #9	192.00	H17
76,518	2191. XS 191 RRBI - HSS # 8	5518860	634669	University of Manitoba - MacClean Crescent	HSS #8	191.00	H17
76,225	2190. XS 190 RRBI - HSS # 7	5519031	634896		HSS #7	190.00	H17
75,933	2189. XS 189 RRBI - HSS # 6	5519158	635160		HSS #6	189.00	H17
75,053	2186. XS 186 - University of Manitoba Campus area RRBI - HSS #3	5519808	635485		HSS #S3	186.00	H17
73,648	duplicate of 72243.04	-	-		-	-	-
72,243	2175.7 Just D/S of Bishop Grandin Bridge - South Span - Duplicate of XS 176 - Red River Basin Investigation (RRBI) - Greater Winnipeg Survey (GWS)# 33A	5520509	633547		GWS #33A	176.00	H16
72,053	2175.6 Just U/S of Bishop Grandin Bridge - North Span - Duplicate of XS 176 - Red River Basin Investigation (RRBI) - Greater Winnipeg Survey (GWS)# 33A	5520679	633461	Bishop Grandin	GWS #33A	176.00	H16
71,857	2175.4 Just D/S of Bishop Grandin Bridge - North Span - Duplicate of XS 176 - Red River Basin Investigation (RRBI) - Greater Winnipeg Survey (GWS)# 33A	5520853	633372		GWS #33A	176.00	H16
71,658	2175. XS 175 Red River Basin Investigation (RRBI) - Greater Winnipeg Survey (GWS)# 32C	5521031	633282		GWS #32C	178.00	H16
71,462	2174. XS 174 RRBI - GWS# 32B	5521211	633209		GWS #32B	174.00	H16
71,277	2173. XS 173 - Fort Garry Municipal Hall RRBI-GWS# 32A	5521391	633177	Ft. Garry Municipal Hall	GWS #32A	173.00	H16
70,083	2167. XS 167 RRBI - GWS#29	5521594	634260	Crescent Drive - Fort Garry	GWS #29A	167.00	H16
69,740	2166. XS 166 RRBI - GWS# 28C	5521914	634345		GWS #28C	166.00	H16
69,399	2165. XS 165 RRBI - GWS#28B	5522196	634164		GWS #28B	165.00	H16
69,055	2164. XS 164 RRBI - GWS#28A	5522476	633964		GWS #28A	164.00	H16

RIVER STATION [m]	DESCRIPTION	UTM COORDINATES AT CENTERLINE (NAD83)		GAUGE BOARDS[1]	RRHS[2]	HEC-2 CODE[3]	RRHS MAP SHEET
		NORTHING	EASTING				
68,729	2163. XS 163 RRBI - GWS#27A	5522792	633953		GWS #27A	163.00	H15
67,111	2158. XS 158 RRBI - GWS#24D	5523152	635169		GWS #24D	158.00	H15
66,860	2157. XS 157 RRBI - GWS#24C	5523333	635001		GWS #24C	157.00	H15
64,899	2149.66	5523716	633373		-	-	H15
64,440	2147.75 U/S of Elm Park Bridge - Duplicate of XS 147 - RRBI - GWS# 20	5524068	633546	Elm Park Bridge - upstream side	GWS #20	147.00	H15
64,431	Just U/S of Elm Park Bridge - Duplicate of XS 147 RRBI - GWS# 20	-	-		GWS #20	147.00	H15
64,426	Elm Park Bridge	-	-		-	-	H15
64,421	Just D/S of Elm Park Bridge - Duplicate of XS 147 RRBI - GWS# 20	-	-		GWS #20	147.00	H15
64,412	2147.25 D/S of Elm Park Bridge - Duplicate of XS 147 RRBI - GWS# 20	5524073	633574	Elm Park Bridge - downstream side	GWS #20	147.00	H15
63,373	2142.75 Just U/S of St Vital Bridge - Duplicate of XS 142 RRBI - GWS# 19	5524279	634592	Osborne St. (St. Vital) Bridge - upstream side	GWS #19	142.00	H14
63,276	2142.25 Just D/S of St Vital Bridge - Duplicate of XS 142 RRBI - GWS# 19	5524301	634686		GWS #19	142.00	H14
63,172	2142. XS 142 RRBI - GWS# 19	5524320	634789		GWS #19	142.00	H14
62,868	2141. XS 141 RRBI - GWS# 18C	5524487	635041		GWS #18C	141.00	H14
62,566	2140. XS 140 RRBI - GWS# 18B	5524667	635273		GWS #18B	140.00	H14
62,262	2139. XS 139 RRBI - GWS# 18	5524942	635403		GWS #18A	139.00	H14
61,959	2138. XS 138 RRBI - GWS# 17B	5525216	635532		GWS #17B	138.00	H14
61,656	2137. XS 137 - Lyndale Drive Dike removed RRBI - GWS# 17A	5525499	635593		GWS #17A	137.00	H14
60,545	Duplicate of 59433.45 - Lyndale Drive Dike removed RRBI - GWS# 14A	-	-		GWS #14A	129.00	H14
59,433	2129. XS 129 - Lyndale Drive Dike removed RRBI - GWS# 14A	5526167	633882		GWS #14A	129.00	H14
59,211	2128. XS 128 - Lyndale Drive Dike removed RRBI - GWS# 14	5526389	633880		GWS #14	128.00	H14
58,988	2127. XS 127 - Lyndale Dike removed RRBI - GWS# 13F	5526612	633877		GWS #13F	127.00	H14
58,766	2126. XS 126 - Lyndale Dike removed RRBI - GWS# 13E	5526804	633979		GWS #13E	126.00	H14
58,544	2125. XS 125 - Lyndale Dike removed RRBI - GWS# 13D	5526991	634098		GWS #13D	125.00	H14
58,235	2124. U/S of Norwood Bridge - Duplicate of XS 124 - Lyndale Dike removed RRBI - GWS# 13C	5527250	634268	Norwood Bridge - upstream side	GWS #13C	124.00	H14
58,213	Just U/S of Norwood Bridge - Duplicate of XS 124 - Lyndale Dike removed RRBI - GWS# 13C	-	-		GWS #13C	124.00	H14
58,204	Norwood Bridge (circa 1950)	-	-		-	-	H14
58,195	Just D/S of Norwood Bridge - Duplicate of XS 124 - Lyndale Dike removed RRBI - GWS#13C	-	-		GWS #13C	124.00	H14
58,175	2123.5 XS 124 - D/S of Norwood Bridge RRBI - GWS#13C	5527297	634304	Norwood Bridge - downstream side	GWS #13C	124.00	H14
57,920	2123. XS 123 RRBI - GWS#13B	5527501	634458		GWS #13B	123.00	H14
57,716	2122. XS 122 - The Forks - Assiniboine River confluence RRBI - GWS# 13A	5527663	634582		GWS #13A	122.00	H14
57,534	2121. XS 121 RRBI - GWS# 13	5527842	634600		GWS #13	121.00	H13
57,350	2120. XS 120 RRBI - GWS# 12C	5528022	634562		GWS #12C	120.00	H13
57,191	2119.9 U/S of Provencher Bridge - Duplicate of XS 120 RRBI - GWS#12C	5528176	634527	Provencher Bridge - upstream side	GWS #12C	120.00	H13
57,142	Just U/S of Provencher Bridge - Duplicate of XS 120 RRBI - GWS# 12C	-	-		GWS #12C	120.00	H13
57,134	Provencher Bridge 30 degree skew - adjusted	-	-		-	-	H13
57,126	Just D/S of Provencher Bridge - Duplicate of XS 120	-	-		-	-	H13
57,077	2119.7 Just D/S of Provencher Bridge - Duplicate of XS 120 RRBI - GWS# 12C	5528280	634477	Provencher Bridge - downstream side	GWS #12C	120.00	H13
56,897	2119. XS 119 RRBI - GWS#12B	5528441	634399		GWS #12B	119.00	H13
56,762	2118. XS 118 RRBI - GWS#12A	5528563	634340		GWS #12A	118.00	H13
56,623	2117.9 U/S of CNR Redditt Bridge - Duplicate of XS 118 RRBI - GWS# 12A	5528690	634283	CNR Redditt Bridge - upstream side	GWS #12A	118.00	H13
56,603	Just U/S of CNR Redditt Bridge - Duplicate of XS 118 RRBI - GWS#12A	-	-		GWS #12A	118.00	H13
56,597	CNR Redditt Subdivision Bridge Combination of trestle spans and through-girder spans	-	-		-	-	H13
56,591	Just D/S of CNR Redditt Bridge - Duplicate of XS 118 RRBI - GWS#12A	-	-		GWS #12A	118.00	H13
56,573	2117.7 D/S of CNR Redditt Bridge - Duplicate of XS 118 RRBI - GWS#12A	5528739	634276	CNR Redditt Bridge - downstream side	GWS #12A	118.00	H13
56,371	James Avenue Pumping Station - Duplicate cross-section						
56,171	2117. XS 117 - James Avenue RRBI - GWS#12	5529084	634355	JAMES AVENUE	GWS #12	117.00	H13
55,941	2116. XS 116 RRBI - GWS# 11A	5529225	634536		GWS #11A	116.00	H13
55,712	2115. XS 115 RRBI - GWS# 11	5529246	634762		GWS #11	115.00	H13
55,488	2114. XS 114 RRBI - GWS# 10D	5529260	634986		GWS #10D	114.00	H13
54,562	2109.3 U/S of CPR Keewatin Bridge - Duplicate of XS 109 RRBI - GWS# 9	5529508	635780	CPR Keewatin Bridge - upstream side	GWS #9A	109.00	H13
54,543	Just U/S of CPR Keewatin Bridge - Duplicate of XS 109 RRBI - GWS# 9	-	-		GWS #9A	109.00	H13
54,537	CPR Keewatin Subdivision	-	-		-	-	H13
54,531	Just D/S of CPR Keewatin Bridge - Duplicate of XS 109 RRBI - GWS# 9	-	-		GWS #9A	109.00	H13
54,511	2109.1 D/S of CPR Keewatin Bridge - Duplicate of XS 109 RRBI - GWS#9	5529554	635800	CPR Keewatin Bridge - downstream side	GWS #9A	109.00	H13

RIVER STATION [m]	DESCRIPTION	UTM COORDINATES AT CENTERLINE (NAD83)		GAUGE BOARDS[1]	RRHS[2]	HEC-2 CODE[3]	RRHS MAP SHEET
		NORTHING	EASTING				
54,073	2107.75 Just U/S of Louise Bridge - Duplicate of XS 107 RRBI - GWS#8D	5529805	635453	Louise Bridge - upstream side	GWS #8D	107.00	H13
54,057	Just U/S of Louise Bridge - Duplicate of XS 107 RRBI - GWS# 8D	-	-		GWS #8D	107.00	H13
54,051	Louise Bridge (circa 1950)	-	-		-	-	H13
54,044	Just D/S of Louise Bridge - Duplicate of XS 107 RRBI - GWS# 8D	-	-		GWS #8D	107.00	H13
54,028	2106.75 D/S of Louise Bridge - XS 107 RRBI - GWS# 8D	5529840	635424	Louise Bridge - downstream side	GWS #8D	107.00	H13
53,472	2105.25 Just U/S of Disraeli Bridge - Duplicate of D/S section RRBI - GWS#8B	5530126	634949	Disraeli Bridge - upstream side	GWS #8B	105.00	H13
53,289	2104.75 Just D/S of Disraeli Bridge RRBI - GWS# 8B	5530246	634811		GWS #8B	105.00	H13
53,108	2104. XS 104 RRBI - GWS# 8A	5530365	634675		GWS #8A	104.00	H13
52,928	2103. XS 103 RRBI - GWS# 8	5530514	634579		GWS #8	103.00	H12
52,744	2102. XS 102 RRBI - GWS# 7B	5530678	634496		GWS #7B	102.00	H12
52,467	2101.25 - U/S of Redwood Bridge - Duplicate of D/S section RRBI - GWS#7	5530954	634484	Redwood Bridge - upstream side	GWS #7	-	H12
52,456	Just U/S of Redwood Bridge - Duplicate of D/S section RRBI - GWS# 7	-	-		GWS #7	-	H12
52,448	Redwood Bridge	-	-		-	-	H12
52,441	Just D/S of Redwood Bridge - Duplicate of D/S section RRBI - GWS# 7	-	-		GWS #7	-	H12
52,428	2100.25 Just D/S of Redwood Bridge RRBI - GWS# 7	5530989	634501	Redwood Bridge - downstream side	GWS #7	-	H12
51,936	2100. XS 100 RRBI - GWS# 6A	5531309	634834		GWS #6A	100.00	H12
51,653	2099. XS 99 RRBI - GWS# 6	5531431	635091		GWS #5A	99.00	H12
51,370	2098. XS 98 RRBI - GWS# 5	5531568	635333		GWS #5	98.00	H12
51,088	2097. XS 97 RRBI - GWS# 4B	5531793	635504		GWS #4B	97.00	H12
50,865	2096. XS 96 RRBI - GWS# 4A - Old North City Limit	5531970	635639	Old North City Limits	GWS #4A	96.00	H12
50,509	2095. XS 95 RRBI - GWS# 4	5532312	635607		GWS #3B	95.00	H12
50,213	2094. XS 94 RRBI - GWS# 3A	5532608	635600		GWS #3A	94.00	H12
49,917	2093. XS 93 RRBI - GWS# 3	5532904	635592		GWS #3	93.00	H12
49,623	2092. XS 92 RRBI - GWS# 2B	5533198	635585		GWS #2D	92.00	H12
49,325	2091. XS 91 RRBI - GWS# 2C	5533396	635756		GWS #2C	91.00	H12
49,030	2090. XS 90 RRBI - GWS# 2B	5533545	636010		GWS #2B	90.00	H12
48,735	2089. XS 89 - Kildonan Park (u/s end) RRBI - GWS# 2A	5533694	636265		GWS #2A	89.00	H12
48,440	2088. XS 88 - Kildonan Park RRBI - GWS# 2	5533846	636518		GWS #2	88.00	H12
48,305	2087. XS 87 - Kildonan Park RRBI - GWS# 1B	5533974	636553		GWS #1B	87.00	H12
48,173	2086. XS 86 - Kildonan Park RRBI - GWS# 1A - D/S end of Greater Winnipeg Survey	5534103	636552		GWS #1A	86.00	H12
47,823	2084. XS 84 - Kildonan Park Golf Course - U/S of Bergen Cut-Off Red River Basin Investigation (RRBI) -Hydrographic Survey North (HSN) # 1	-	-	Bergen Cut-Off - upstream side	HSN #1	84.00	H11
47,805	Kildonan Park Golf Course - Just U/S of Bergen Cut-Off - duplicate of XS-84 RRBI - HSN # 1	-	-		HSN #1	84.00	H11
47,798	CPR Bergen Cut-Off (Bridge)	-	-		-	-	H11
47,792	Kildonan Park Golf Course - Just D/S of Bergen Cut-Off - duplicate of XS-84 RRBI - HSN # 1	-	-		HSN #1	84.00	H11
47,773	XS 84 - Kildonan Park Golf Course - D/S of Bergen Cut-Off RRBI - HSN # 1	5534495	636470	Bergen Cut-Off - downstream side	HSN #1	84.00	H11
47,420	2083.5 Just U/S of Kildonan Settlers Bridge - duplicate of XS 83 RRBI - HSN # 2	5534835	636483	Chief Peguis Bridge	HSN #2	83.00	H11
46,843	2082. XS 82 RRBI - HSN # 3	5534950	637024		HSN #3	82.00	H11
46,634	2081. XS 81 RRBI - HSN # 4	5534952	637232		HSN #4	81.00	H11
46,424	2080. XS 80 RRBI - HSN # 5	5534957	637441		HSN #5	80.00	H11
46,217	2079. XS 79 RRBI - HSN # 6	5535122	637567		HSN #6	79.00	H11
46,008	2078. XS 78 RRBI - HSN # 7	5535288	637694		HSN #7	78.00	H11
45,800	2077. XS 77 RRBI - HSN # 8	5535453	637819		HSN #8	77.00	H11
45,591	2076. XS 76 RRBI - HSN # 9	5535620	637945		HSN #9	76.00	H11
45,408	2075. XS 75 RRBI - HSN # 10	5535771	638048		HSN #10	75.00	H11
45,227	2074. XS 74 RRBI - HSN # 11	5535922	638149		HSN #11	74.00	H11
45,044	2073. RRBI - HSN # 12	5536073	638252		HSN #12	73.00	H11
44,862	2072. RRBI - HSN # 13	5536224	638354		HSN #13	72.00	H11
44,681	2071. RRBI - HSN # 14	5536374	638455		HSN #14	71.00	H11
44,499	2070. RRBI - HSN # 15	5536525	638557		HSN #15	70.00	H11
44,318	2069. RRBI - HSN # 16	5536683	638643		HSN #16	69.00	H11
44,136	2068.75 Just U/S of PTH 101 - North Permieter Bridge	5536853	638709	N. Perimeter Bridge	-	-	H11
44,083	2068.25 Just D/S of PTH 101 - North Permieter Bridge	5536904	638722		-	-	H11
44,030	2068. Should be RRBI # 17 which is located u/s of perimeter bridge?	5536955	638735		HSN #17	68.00	H11
43,947	2067. RRBI - HSN # 18	5537036	638753		HSN #18	67.00	H11
43,714	2066. RRBI - HSN # 19	5537257	638828		HSN #19	66.00	H11
43,469	2065. RRBI - HSN # 20	5537488	638907		HSN #20	65.00	H11
43,227	2064. RRBI - HSN # 21	5537717	638985		HSN #21	64.00	H11
42,985	2063. RRBI - HSN # 22 - Grassmere Drain / Middlechurch - Head of Lister Rapids - Gauge # 3	5537946	639064	Middle Church - Gauge #3	HSN #22	63.00	H11
42,741	2062. RRBI - HSN # 23	5538140	639212		HSN #23	62.00	H11
42,497	2061. RRBI - HSN # 24	5538333	639360		HSN #24	61.00	H11
42,253	2060. RRBI - HSN # 25	5538527	639509		HSN #25	60.00	H11
42,008	2059. RRBI - HSN # 26	5538747	639610		HSN #26	59.00	H11
41,763	2058. RRBI - HSN # 27	5538978	639691		HSN #27	58.00	H11
41,520	2057. RRBI - HSN # 28	5539207	639772		HSN #28	57.00	H11

RIVER STATION [m]	DESCRIPTION	UTM COORDINATES AT CENTERLINE (NAD83)		GAUGE BOARDS[1]	RRHS[2]	HEC-2 CODE[3]	RRHS MAP SHEET
		NORTHING	EASTING				
41,275	2056.93 RRBI - HSN # 29 - Replaced with Public Works Surveyed Cross-Sections (1990)	5539429	639865		HSN #29	56.93	H10
41,032	2056.86 RRBI - HSN # 30 - Replaced with Public Works Surveyed Cross-Sections (1990)	5539560	640070		HSN #30	56.86	H10
40,788	2056.78 RRBI - HSN # 31 - Replaced with Public Works Surveyed Cross-Sections (1990)	5539691	640276		HSN #31	56.78	H10
40,545	2056.71 RRBI - HSN # 32 - Replaced with Public Works Surveyed Cross-Sections (1990)	5539872	640432		HSN #32	56.71	H10
40,301	2056.61 RRBI - HSN # 33 - Replaced with Public Works Surveyed Cross-Sections (1990)	5540103	640460		HSN #33	56.61	H10
40,057	2056.53 RRBI - HSN # 34 - Replaced with Public Works Surveyed Cross-Sections (1990)	5540347	640443		HSN #34	56.53	H10
39,813	2056.46 RRBI - HSN # 35 - Replaced with Public Works Surveyed Cross-Sections (1990) - GAUGE 4B	5540590	640426	Rivercrest - Gauge #4B - 1992	HSN #35	56.46	H10
39,569	2056.38 RRBI - HSN # 36 - Replaced with Public Works Surveyed Cross-Sections (1990) - GAUGE 4A	5540833	640409	Rivercrest Gauge #4A - 1966 & 1969	HSN #36	56.38	H10
39,326	2056.3 RRBI - HSN # 37 - Replaced with Public Works Surveyed Cross-Sections (1990)	5541076	640392		HSN #37	56.30	H10
39,091	2056.22 RRBI - HSN # 38 - Replaced with Public Works Surveyed Cross-Sections (1990)	5541309	640363		HSN #38	56.22	H10
38,856	2056.16 RRBI - HSN # 39 - Replaced with Public Works Surveyed Cross-Sections (1990)	5541543	640334		HSN #39	56.16	H10
38,619	2056.08 RRBI - HSN # 40 - Replaced with Public Works Surveyed Cross-Sections (1990)	5541777	640302		HSN #40	56.08	H10
38,383	2056. RRBI - HSN # 41 - River Lot 45/46 - Gauge # 4	5542010	640266	Rivercrest Gauge # 4 - 1950 & 1979	HSN #41	56.00	H10
38,149	2055. RRBI - HSN # 42	5542242	640230		HSN #42	55.00	H10
37,916	2054. RRBI - HSN # 43	5542472	640194		HSN #43	54.00	H10
37,443	2052. RRBI - HSN # 45	5542845	640431		HSN #45	52.00	H10
37,208	2051. RRBI - HSN # 46	5543017	640590		HSN #46	51.00	H10
36,975	2050. RRBI - HSN # 47	5543224	640695		HSN #47	50.00	H10
36,737	2049. RRBI - HSN # 48	5543440	640797		HSN #48	49.00	H10
36,507	2048. RRBI - HSN # 49	5543648	640894		HSN #49	48.00	H10
36,265	2047. RRBI - HSN # 50	5543814	641068		HSN #50	47.00	H10
36,029	2046. RRBI - HSN # 51	5543970	641247		HSN #51	46.00	H10
35,793	2045. RRBI - HSN # 52	5544124	641425		HSN #52	45.00	H10
35,552	2044. RRBI - HSN # 53	5544145	641655		HSN #53	44.00	H10
35,080	2042. RRBI - HSN # 55	5544127	642127		HSN #55	42.00	H10
34,842	2041. RRBI - HSN # 56	5544135	642363		HSN #56	41.00	H10
34,604	2040. RRBI - HSN # 57	5544183	642596		HSN #57	40.00	H10
34,365	2039. RRBI - HSN # 58	5544291	642792		HSN #58	39.00	H9
34,132	2038. RRBI - HSN# 59	5544479	642930		HSN #59	38.00	H9
33,893	2037. RRBI - HSN# 60	5544671	643071		HSN #60	37.00	H9
33,660	2036. RRBI - HSN # 61 - River Lot 22 - Gauge #5	5544791	643254	River Lot 22 - Gauge #5	HSN #61	36.00	H9
33,421	2035. RRBI - HSN # 62	5544842	643487		HSN #62	35.00	H9
33,183	2034. RRBI - HSN # 63	5544892	643719		HSN #63	34.00	H9
32,949	2033. RRBI - HSN # 64	5544964	643938		HSN #64	33.00	H9
32,712	2032. RRBI - HSN # 65	5545101	644133		HSN #65	32.00	H9
32,467	2031. RRBI - HSN # 66	5545336	644162		HSN #66	31.00	H9
32,219	2030. RRBI - HSN # 67	5545575	644095		HSN #67	30.00	H9
31,970	2029. RRBI - HSN # 68	5545817	644042		HSN #68	29.00	H9
31,728	2028. RRBI - HSN # 69	5546056	644005		HSN #69	28.00	H9
31,530	2027. RRBI - HSN # 70	5546250	643994		HSN #70	27.00	H9
31,234	2026. RRBI - HSN # 71	5546519	644118		HSN #71	26.00	H9
30,986	2025. RRBI - HSN # 72	5546744	644221		HSN #72	25.00	H9
30,741	2024. RRBI - HSN # 73	5546966	644323		HSN #73	24.00	H9
30,494	2023. RRBI - HSN # 74	5547191	644427		HSN #74	23.00	H9
30,248	2022. RRBI - HSN # 75	5547415	644530		HSN #75	22.00	H9
30,003	2021. RRBI - HSN # 76	5547595	644694		HSN #76	21.00	H9
29,755	2020. RRBI - HSN # 77 - Foot of Lister Rapids - Gauge #6	5547776	644863	St. Andrews Church - Gauge #6	HSN #77	20.00	H8
29,510	2019. RRBI - HSN # 78	5547793	645101		HSN #78	19.00	H8
29,266	2018. RRBI - HSN # 79	5547793	645345		HSN #79	18.00	H8
29,020	2017. RRBI - HSN # 80	5547793	645592		HSN #80	17.00	H8
28,771	2016. RRBI - HSN # 81	5547819	645832		HSN #81	16.00	H8
28,530	2015. RRBI - HSN # 82	5547952	646033		HSN #82	15.00	H8
28,283	2014. RRBI - HSN # 83	5548089	646239		HSN #83	14.00	H8
28,040	2013. RRBI - HSN # 84	5548224	646441		HSN #84	13.00	H8
27,836	2012. RRBI - HSN # 85	5548370	646583		HSN #85	12.00	H8
27,634	2011. RRBI - HSN # 86	5548555	646661		HSN #86	11.00	H8
27,430	2010. RRBI - HSN # 87	5548755	646701		HSN #87	10.00	H8
27,227	2009. RRBI - HSN # 88	5548956	646727		HSN #88	9.00	H8
27,023	2008. RRBI - HSN # 89	5549127	646798		HSN #89	8.00	H8
26,822	2007. RRBI - HSN # 90	5549225	646975		HSN #90	7.00	H8
26,618	2005. RRBI - HSN # 91	5549324	647152		HSN #91	5.00	H8

RIVER STATION [m]	DESCRIPTION	UTM COORDINATES AT CENTERLINE (NAD83)		GAUGE BOARDS[1]	RRHS[2]	HEC-2 CODE[3]	RRHS MAP SHEET
		NORTHING	EASTING				
26,415	2004. RRBI - HSN # 92	5549423	647330		HSN #92	4.00	H8
26,214	2003. RRBI - HSN # 92A	5549585	647440		HSN #92A	3.00	H8
26,011	2002. RRBI - HSN # 93 - U/S of St Andrews Lock and Dam	5549776	647470		HSN #93	2.00	H8
25,770	2002. RRBI - HSN # 93 - Just U/S of St Andrews Lock and Dam	5550015	647439	SALD - upstream side - Gauge #7	HSN #93	2.00	H8
25,754	2001. U/S cross section of St Andrews lock and dam All bays fully open (curtains removed)	-	-		-	-	-
25,746	St. Andrews Lock and Dam - curtains assumed fully opened, locks closed	-	-		-	-	-
25,738	2000.97 D/S cross section of St Andrews lock and dam All bays fully open (curtains removed)	-	-		-	-	-
25,723	Duplicate of RRBI - HSN # 95 - Just D/S of St. Andrews Lock and Dam	5550062	647436	SALD - downstream side - Gauge #7	HSN #95	-	-
25,404	2000.3 RRBI- HSN # 95 - D/S of St. Andrews Lock and Dam	5550376	647493		HSN #95	-	-
25,202	2000.2 RRBI - HSN # 96	5550574	647522		HSN #96	0.30	-
25,000	2000.1 RRBI - HSN # 97 - D/S of Lockport	5550773	647489		HSN #97	0.20	-
24,886	1099 RRBI - HSN # 98 Red River (Lockport to Floodway Inlet) Model XS# 0.1	5550885	647471		HSN #98	0.10	-
24,768	1098 RRBI - HSN # 99 - cross section at confluence with Floodway outlet	5551002	647452		HSN #99	-	-
24,506	1097 RRBI - HSN # 100	5551246	647367		HSN #100	-	-
24,234	1096 RRBI - HSN # 101	5551518	647378		HSN #101	-	-
23,963	1094 RRBI - HSN # 103	5551780	647426		HSN #103	-	-
23,693	1093 RRBI - HSN # 104	5552024	647541	WSC Gauge 050J010	HSN #104	-	-
23,422	1092 RRBI - HSN # 105	5552269	647656		HSN #105	-	-
23,153	1091 RRBI - HSN # 106	5552512	647771		HSN #106	-	-
22,881	1090 RRBI - HSN # 107	5552759	647887		HSN #107	-	-
22,662	1089 RRBI - HSN # 108 - Boundary of RM St Clements and St Andrews	5552950	647995		HSN #108	-	-
22,223	1087 RRBI - HSN # 110	5553248	648307		HSN #110	-	-
22,004	1086 RRBI - HSN # 111	5553378	648482		HSN #111	-	-
21,785	1085 RRBI - HSN # 112 - Lower Fort Garry - Gauge #9	5553485	648668	Lower Fort Garry - Gauge #9	HSN #112	-	-
21,566	1084 RRBI - HSN # 113	5553524	648884		HSN #113	-	-
21,348	1083 RRBI - HSN # 114	5553562	649098		HSN #114	-	-
20,913	1081 RRBI - HSN # 116	5553641	649526		HSN #116	-	-
20,696	1080 RRBI - HSN # 117	5553710	649730		HSN #117	-	-
20,476	1079 RRBI - HSN # 118	5553859	649884		HSN #118	-	-
20,259	1078 RRBI - HSN # 119	5554047	649991		HSN #119	-	-
20,041	1077 RRBI - HSN # 120	5554200	650135		HSN #120	-	-
19,824	1076 RRBI - HSN # 121	5554301	650327		HSN #121	-	-
19,608	1075 RRBI - HSN # 122	5554402	650518		HSN #122	-	-
19,390	1074 RRBI - HSN # 123 - U/S end of Selkirk	5554598	650606		HSN #123	-	-
19,175	1073 RRBI - HSN # 124	5554723	650770		HSN #124	-	-
18,958	1072 RRBI - HSN # 125	5554827	650961		HSN #125	-	-
18,702	1071 RRBI - HSN # 126	5554875	651207		HSN #126	-	-
17,429	1066 RRBI - HSN # 131	5554760	652471		HSN #131	-	-
17,176	1065 RRBI - HSN # 132	5554806	652720		HSN #132	-	-
16,925	1064 RRBI - HSN # 133	5554851	652967		HSN #133	-	-
16,668	1063 RRBI - HSN # 134	5555034	653122		HSN #134	-	-
16,416	1062 RRBI - HSN # 135	5555254	653223		HSN #135	-	-
16,167	1061 RRBI - HSN # 136	5555469	653100		HSN #136	-	-
15,403	1058 RRBI - HSN # 139	5555904	652486		HSN #139	-	-
14,902	1056 RRBI - HSN # 141	5556232	652145		HSN #141	-	-
14,599	1055.5 Cross section upstream Highway 204 bridge - Selkirk - duplicate of RRBI - HSN # 142	-	-		HSN #142	-	-
14,578	Cross section just upstream Highway 204 bridge - Selkirk - duplciate of RRBI - HSN # 142	-	-		HSN #142	-	-
14,573	PR204 Bridge Selkirk, MB	-	-		-	-	-
14,568	Cross section just upstream Highway 204 bridge - Selkirk - duplciate of RRBI - HSN # 142	5556502	652249		HSN #142	-	-
14,546	1054.5 RRBI - HSN # 142 - cross section immediately downstream Highway 204 bridge - Selkirk	5556538	652289		HSN #142	-	-
14,331	1054 RRBI - HSN # 143 - Town of Selkirk - Gauge #10	5556681	652449	City of Selkirk - Gauge #10	HSN #143	-	-
14,141	1053 RRBI - HSN # 144	5556808	652590		HSN #144	-	-
13,952	1052 RRBI - HSN # 145	5556939	652727		HSN #145	-	-
13,763	1051 RRBI - HSN # 146 - D/S end of Selkirk	5557073	652860		HSN #146	-	-
13,573	1050 RRBI - HSN # 147	5557208	652993		HSN #147	-	-
13,382	1049 RRBI - HSN # 148	5557344	653128		HSN #148	-	-
13,194	1048 RRBI - HSN # 149	5557478	653260		HSN #149	-	-
13,006	1047 RRBI - HSN # 150	5557611	653392		HSN #150	-	-
12,754	1046 RRBI - HSN # 151	5557854	653437		HSN #151	-	-
12,503	1045 RRBI - HSN # 152	5558103	653466		HSN #152	-	-
12,255	1044 RRBI - HSN # 153	5558335	653399		HSN #153	-	-
12,008	1043 RRBI - HSN # 154	5558559	653297		HSN #154	-	-

RIVER STATION [m]	DESCRIPTION	UTM COORDINATES AT CENTERLINE (NAD83)		GAUGE BOARDS[1]	RRHS[2]	HEC-2 CODE[3]	RRHS MAP SHEET
		NORTHING	EASTING				
11,754	1042 RRBI - HSN # 155	5558791	653191		HSN #155	-	-
11,576	1041 RRBI - HSN # 156	5558952	653118		HSN #156	-	-
11,256	1040 RRBI - HSN # 157	5559244	652985		HSN #157	-	-
11,069	1039 RRBI - HSN # 158 - Selkirk Slough - Gauge # 11	5559419	652928	Selkirk Slough - Gauge # 11	HSN #158	-	-
10,759	1038 RRBI - HSN # 159	5559729	652903		HSN #159	-	-
10,524	1037 RRBI - HSN # 160	5559955	652967		HSN #160	-	-
10,291	1036 RRBI - HSN # 161 - Cloverdale Rd. Drain	5560173	653046		HSN #161	-	-
10,055	1035 RRBI - HSN # 162	5560349	653194		HSN #162	-	-
9,590	1033 RRBI - HSN # 164	5560654	653546		HSN #164	-	-
9,357	1032 RRBI - HSN # 165	5560806	653722		HSN #165	-	-
9,121	1031 RRBI - HSN # 166 - Cooks/Dubas Creek outlet	5560969	653892		HSN #166	-	-
8,900	1030 RRBI - HSN # 167	5561169	653986		HSN #167	-	-
8,668	1029 RRBI - HSN # 168	5561400	653994		HSN #168	-	-
8,439	1028 RRBI - HSN # 169 - near St. Peter's Church	5561629	653999		HSN #169	-	-
8,213	1027.75 Just U/S of PTH 4 Bridge - Dupicate of D/S cross section RRBI - HSN # 170	5561855	654004	PTH 4 Bridge	HSN #170	-	-
7,998	1027.25 Just D/S of PTH 4 Bridge RRBI - HSN # 170	5562071	654009		HSN #170	-	-
7,453	1026 RRBI - HSN # 171	5562551	654217		HSN #171	-	-
7,147	1025 RRBI - HSN # 172	5562796	654401		HSN #172	-	-
6,842	1024 RRBI - HSN # 173	5563040	654584		HSN #173	-	-
6,537	1023 RRBI - HSN # 174	5563284	654767		HSN #174	-	-
6,231	1022 RRBI - HSN # 175	5563584	654712		HSN #175	-	-
5,925	1021 RRBI - HSN # 176	5563884	654653		HSN #176	-	-
5,626	1020 RRBI - HSN # 177	5564178	654596		HSN #177	-	-
5,320	1019 RRBI - HSN # 178	5564478	654538		HSN #178	-	-
5,015	1018 RRBI - HSN # 179	5564778	654506		HSN #179	-	-
4,712	1017 RRBI - HSN # 180	5565077	654555		HSN #180	-	-
4,413	1016 RRBI - HSN # 181	5565372	654606		HSN #181	-	-
4,077	1015 RRBI - HSN # 182	5565692	654650		HSN #182	-	-
3,746	1014 RRBI - HSN # 183	5566016	654590		HSN #183	-	-
3,416	1013 RRBI - HSN # 184	5566341	654530		HSN #184	-	-
3,087	1012 RRBI - HSN # 185	5566667	654497		HSN #185	-	-
2,754	1011 RRBI - HSN # 186	5567000	654503		HSN #186	-	-
2,425	1010 RRBI - HSN # 187	5567329	654509		HSN #187	-	-
1,941	1008 RRBI - HSN # 189	5567778	654402		HSN #189	-	-
1,699	1007 RRBI - HSN # 190	5567993	654293		HSN #190	-	-
1,460	1006 RRBI - HSN # 191	5568207	654184		HSN #191	-	-
1,217	1005 RRBI - HSN # 192	5568423	654074		HSN #192	-	-
977	1004 RRBI - HSN # 193	5568637	653965		HSN #193	-	-
737	1003 RRBI - HSN # 194	5568852	653856		HSN #194	-	-
499	1002 RRBI - HSN # 195	5569063	653749		HSN #195	-	-
8	1001 RRBI - HSN # 196 - Downstream boundary of model - approximately 18 km u/s of Lake Winnipeg - near Goldeye Lake	5569501	653526		HSN #196	-	-

NOTES:

1 - AS DEFINED BY CLARK (1950), LONG (1971), WATER SURVEY OF CANADA (1979) AND APPENDIX D

2 - RRHS - RED RIVER HYDROGRAPHIC SURVEY (OF APPENDIX B2.2) AS PART OF THE RED RIVER BASIN INVESTIGATION

3 - HEC-2 CROSS-SECTION REFERENCE NUMBERS (OF APPENDIX B2.2)