



MEDICINE HAT RIVER HAZARD STUDY

SURVEY AND BASE DATA COLLECTION

FINAL REPORT



Prepared for:



20 August 2019

NHC Ref. No. 1003094

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Alberta Environment and Parks
Edmonton, Alberta

Prepared by:

Northwest Hydraulic Consultants Ltd.
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DISCLAIMER

This report has been prepared by Northwest Hydraulic Consultants Ltd. (NHC) in accordance with generally accepted engineering practices, for the benefit of Alberta Environment and Parks for specific application to the Medicine Hat River Hazard Study in Alberta. The information and data contained herein represent the best professional judgment of NHC, based on the knowledge and information available to NHC at the time of preparation.

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EXECUTIVE SUMMARY

Alberta Environment and Parks retained Northwest Hydraulic Consultants Ltd. in August 2017 to complete a river hazard study for the City of Medicine Hat and surrounding areas of Cypress County, including the Town of Redcliff and the Hamlet of Desert Blume. The river hazard study area includes 26 km of the South Saskatchewan River below Ross Creek, 19 km of the South Saskatchewan River above Ross Creek, 24 km of Ross Creek above the confluence with the South Saskatchewan River, 24 km of Seven Persons Creek above the confluence with Ross Creek, and 9.6 km of Bullshead Creek above the confluence with Ross Creek.

The study is being conducted under the provincial Flood Hazard Identification Program. The overall objectives of the study are to enhance public safety and to reduce potential future flood damages and disaster assistance costs.

The Medicine Hat River Hazard Study is comprised of eight major project components. This report summarizes the work of the first component, *Survey and Base Data Collection*, which includes river cross section surveys, hydraulic and flood control structure data collection, and survey and digital terrain model integration.

The majority of the survey program was carried out in October and November 2017, preceded by a site inspection at the end of September 2017. Follow-up cross section, hydraulic structure, and flood control structure survey work was completed in June 2018. A total of 610 cross sections were surveyed, including 120 on the South Saskatchewan River, 147 on Ross Creek, 240 on Seven Persons Creek, and 103 on Bullshead Creek. Survey data and reach-representative photographs are provided with the geodatabase that accompanies this report.

Additional base data collected included bridge file information from Alberta Transportation and the City of Medicine Hat, hydrometric station details and rating curves from Water Survey of Canada, and design information for flood protection structures from the City of Medicine Hat.

CREDITS AND ACKNOWLEDGEMENTS

Northwest Hydraulic Consultants Ltd. would like to express appreciation to Alberta Environment and Parks for initiating this project, making extensive background information available, and providing the project team with valuable technical input throughout the project. James Choles, P.Eng., CFM managed and directed the Medicine Hat River Hazard Study on behalf of Alberta Environment and Parks.

The following NHC personnel were part of the study team and participated in the survey and base data collection component of the study:

- Robyn Andrishak (Project Manager) – responsible for the overall direction of the project and survey program; co-author of this report.
- James Snyder (Survey Specialist) – assisted with field program coordination and surveys; reduced and post-processed survey data for subsequent use and reporting.
- Michael Brayall (Hydraulic Modelling Specialist) – participated in the site inspection and co-authored this report.
- Sarah North (GIS Specialist) – responsible for creation of base maps and map production.
- Gary Van Der Vinne (Senior Technical Reviewer) – provided senior review input and advice.

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1 INTRODUCTION

1.1 Study Objectives

The overall objective of the Medicine Hat River Hazard Study is to identify and assess river and flood hazards along the South Saskatchewan River, Ross Creek, Seven Persons Creek, and Bullshead Creek within the City of Medicine Hat and surrounding areas of Cypress County, including the Town of Redcliff and the Hamlet of Desert Blume. Results from this study are designed to inform local land use planning decisions, flood mitigation projects, and emergency response planning. This study is being undertaken as part of the Flood Hazard Identification Program (FHIP) with the intent of enhancing public safety and reducing future flood damages within the Province of Alberta.

This river hazard study is comprised of the eight major study components listed below. A report and associated deliverables have been prepared for each individual study component.

- 1) Survey and Base Data Collection
- 2) Open Water Hydrology Assessment
- 3) Hydraulic Model Creation and Calibration
- 4) Open Water Flood Inundation Map Production
- 5) Open Water Flood Hazard Identification
- 6) Governing Flood Hazard Map Production
- 7) Flood Risk Assessment and Inventory
- 8) Channel Stability Investigation

This report summarizes the work of the first component: **Survey and Base Data Collection**. The primary tasks, services, and deliverables associated with this report are:

- River cross section surveys
- Hydraulic and flood control structure data collection
- Survey and digital terrain model (DTM) data integration

The collection of survey and base data supports development of the hydraulic model and subsequent project components.

1.2 Study Area and Reach

The City of Medicine Hat is located approximately 290 km southeast of Calgary and approximately 45 km west of the Alberta-Saskatchewan border. **Figure 1** shows the location and boundaries of the river hazard study area and contributing river basins. The river hazard study area includes the following reaches: 26 km of the South Saskatchewan River below Ross Creek; 19 km of the South Saskatchewan River above Ross Creek; 24 km of Ross Creek above the confluence with the South Saskatchewan River; 24 km of Seven Persons Creek above the confluence with Ross Creek; and 9.6 km of Bullshead Creek above the confluence with Ross Creek. Municipalities along these study reaches include the City of Medicine Hat, the Town of Redcliff, the Hamlet of Desert Blume, and Cypress County.

The contributing river basins cover an area of about 61,500 km², extending from the headwaters in the Rocky Mountains to the downstream boundary of the river hazard study area. Major upstream rivers include the Bow and Oldman rivers, which join together approximately 100 km upstream of Medicine Hat to form the South Saskatchewan River. The gross drainage areas of the Bow River and Oldman River basins are 25,600 km² and 28,300 km², respectively. The Bow and Oldman rivers generally flow southeast and east through the Foothills and Grassland natural regions. Most of the runoff from these two sub-basins is typically derived from spring snowmelt augmented by rainfall within the Rocky Mountain and Foothills portions of the basin. The Grassland Region is the largest region within the South Saskatchewan River basin in Alberta, extending from just west of Calgary to the Saskatchewan border. It is the warmest and driest region in Alberta.

The Ross Creek sub-basin has a gross drainage area of 4,790 km² and includes Ross Creek, Seven Persons Creek, and Bullshead Creek. The headwaters of the sub-basin are located in the Cypress Hills, southeast of Medicine Hat. While high flows in this sub-basin more commonly occur in the spring due to snowmelt runoff with or without rainfall, intense summer rainstorm events can often result in high annual peak flows.

A number of dams and flow diversion structures have been developed throughout the South Saskatchewan River basin for various purposes including: irrigation; low-flow augmentation; water supply for industrial, municipal, and domestic users; and hydropower. These developments have altered the natural flow regime in the South Saskatchewan River basin since the beginning of the twentieth century. It is important to note, however, that the existing system was not designed to mitigate floods.

2 SURVEY PROGRAM

2.1 Methodology and Procedures

The majority of the survey program was completed between 12 October 2017 and 9 November 2017, with some follow-up work completed in June 2018. The objective of the survey program was to survey channel cross sections along the study reach to support development of a one-dimensional (1D) hydraulic model.

Ground positioning was established using Real Time Kinematic (RTK) Global Navigation Satellite Systems (GNSS) and Trimble R10 GNSS receivers. Boat-based surveys of the South Saskatchewan River were done using a Ceescope dual frequency digital echo sounder to measure water depth (in areas generally deeper than 0.30 m) and the GNSS receiver to record position and elevation of the transducer. River bed elevations were derived from depth soundings by subtracting depth from transducer elevations. Elsewhere, the GNSS receivers were mounted on a survey rod to record ground elevations directly. The channel banks and a portion of the overbank floodplains were surveyed to ensure sufficient overlap with the supplied digital terrain model (DTM).

2.1.1 Coordinate System and Datum

Horizontal positions were referenced to the local three-degree Transverse Mercator (3TM) projection of the Canadian Spatial Reference System (CSRS) North American Datum of 1983 (NAD83), which has a central meridian of 111°W. Orthometric heights are based on the Canadian Geodetic Vertical Datum of 1928 (CGVD28) and HTv2.0 geoid model.

2.1.2 Control Network

A control network was established from local Alberta Survey Control Monuments (ASCMs) and GNSS surveying to provide spatial reference for the survey program. **Table 1** lists the control point (CP) coordinates.

CP coordinates were determined by running the GNSS receivers in static mode for approximately one hour at each CP and post-processing baselines between CPs using Trimble Business Center software. The control network was adjusted to the published coordinates of ASCMs 144915 and 230581. CSRS Precise Point Positioning (PPP) was used to validate adjusted CP coordinates, as discussed in Section 2.7.1.

Table 1 Control point summary

Control Point Name	Type	Easting (m)	Northing (m)	Elevation (m)
144915	ASCM	19120.908	5552714.743	726.330
230581	ASCM	17008.792	5537823.165	723.617
863936	ASCM	14261.705	5550500.403	742.704
2	Project CP	20802.300	5545337.392	673.371
3	Project CP	25056.019	5545896.421	670.671
4	Project CP	22443.919	5550035.994	711.169
5	Project CP	24014.216	5556446.063	706.554
6	Project CP	14311.273	5546993.355	704.396
7	Project CP	18767.529	5539166.800	714.667
8	Project CP	26454.464	5543271.003	673.832
9	Project CP	21873.364	5542799.842	704.057
10	Project CP	28022.262	5537653.266	716.332
11	Project CP	31725.612	5542326.001	726.510
12	Project CP	20742.561	5541327.819	715.099

2.2 Cross Sections

Cross section locations were selected to ensure adequate representation of the channel geometry in the hydraulic model with consideration given to the location of cross sections from the most recent floodplain study (AENV, 1986). The cross section survey was divided into reaches corresponding to the river or creek being surveyed. During the planning process for the survey, each cross section was assigned a planned cross section (PXS) number in an effort to organize the cross sections sequentially on each water body. Cross section lines and associated survey points are shown in **Figure 2**.

A summary of the cross sections surveyed in each reach is provided in **Table 2**. A total of 610 cross sections were planned. During the fall 2017 survey, 588 cross sections were surveyed. The remainder of the survey was completed in June 2018. Survey point data has been assembled and provided as **Appendix A**.

Thalweg elevation was taken as the minimum surveyed elevation at each cross section. The top of bank (TOB) channel width was determined based on the survey data codes recorded by the survey crews; however, these values may be refined upon further inspection of the LiDAR-derived DTM data and cross section profiles.

The cross section properties surveyed on the South Saskatchewan River are summarized in **Table 3**. A total of 120 cross sections were planned for the South Saskatchewan River. Cross sections PXS089

through PXS092 are skewed to align with the Trans Canada Highway bridges. The planned cross sections on Ross Creek are summarized in **Table 4**. A total of 147 cross sections were planned for Ross Creek. The planned cross sections on Seven Persons Creek are summarized in **Table 5**. A total of 240 cross sections were planned for Seven Persons Creek. The planned cross sections on Bullshead Creek are summarized in **Table 6**. A total of 103 cross sections were planned for Bullshead Creek.

Table 2 Cross section survey summary

Reach	Reach Length (km)	Number of Cross Sections	Average Spacing (m)	Minimum Spacing (m)	Maximum Spacing (m)
South Saskatchewan River	45.11	120	379	8	669
Ross Creek	24.28	147	166	5	574
Seven Persons Creek	24.11	240	100	6	273
Bullshead Creek	9.69	103	93	11	158

Table 3 Cross section properties - South Saskatchewan River

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS120	45.110	07/06/2018	659.07	213.51
PXS119	44.455	07/06/2018	658.12	171.55
PXS118	43.824	07/06/2018	657.32	179.55
PXS117	43.297	07/06/2018	658.79	243.12
PXS116	42.932	07/06/2018	657.48	563.34
PXS115	42.565	07/06/2018	657.31	783.27
PXS114	42.120	07/06/2018	657.63	472.63
PXS113	41.866	07/06/2018	657.29	249.50
PXS112	41.577	07/06/2018	655.37	177.88
PXS111	41.311	07/06/2018	655.75	177.64
PXS110	41.023	07/06/2018	656.43	193.52
PXS109	40.561	07/06/2018	654.53	163.19
PXS108	40.090	07/06/2018	654.40	187.78
PXS107	39.515	07/06/2018	653.83	158.33
PXS106	38.846	07/06/2018	655.93	219.24
PXS105	38.429	07/06/2018	654.42	145.74
PXS104	38.025	07/06/2018	654.43	187.91
PXS103	37.575	24/10/2017	652.98	164.88

Table 3 Cross section properties - South Saskatchewan River (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS102	36.912	24/10/2017	655.06	245.12
PXS101	36.439	24/10/2017	655.89	276.39
PXS100	35.966	25/10/2017	655.68	246.48
PXS099	35.528	25/10/2017	654.80	225.68
PXS098	35.001	25/10/2017	654.25	214.79
PXS097	34.597	26/10/2017	652.95	166.28
PXS096	34.274	26/10/2017	651.88	154.09
PXS095	33.837	26/10/2017	652.64	186.60
PXS094	33.216	26/10/2017	654.09	254.64
PXS093	32.793	26/10/2017	651.15	195.00
PXS092	32.697	26/10/2017	651.05	196.11
PXS091	32.672	26/10/2017	651.37	200.07
PXS090	32.664	26/10/2017	651.39	196.11
PXS089	32.639	26/10/2017	650.79	182.76
PXS088	32.494	26/10/2017	650.84	140.00
PXS087	32.030	26/10/2017	652.44	178.14
PXS086	31.753	26/10/2017	653.00	198.64
PXS085	31.531	26/10/2017	653.61	212.40
PXS084	31.086	26/10/2017	654.06	264.59
PXS083	30.656	26/10/2017	653.42	231.70
PXS082	30.354	26/10/2017	652.75	198.02
PXS081	30.063	26/10/2017	651.69	191.43
PXS080	29.857	26/10/2017	651.10	164.65
PXS079	29.693	26/10/2017	651.08	160.00
PXS078	29.678	26/10/2017	651.47	160.00
PXS077	29.590	26/10/2017	652.02	177.92
PXS076	29.485	26/10/2017	651.77	190.00
PXS075	29.465	26/10/2017	651.71	190.00
PXS074	29.367	26/10/2017	652.48	197.07
PXS073	29.271	27/10/2017	652.76	195.00
PXS072	29.243	27/10/2017	652.70	195.00
PXS071	29.068	27/10/2017	652.78	240.12
PXS070	28.760	27/10/2017	651.03	168.52

Table 3 Cross section properties - South Saskatchewan River (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS069	28.559	27/10/2017	650.08	164.91
PXS068	28.296	27/10/2017	649.69	182.44
PXS067	28.052	27/10/2017	649.98	163.94
PXS066	27.726	27/10/2017	651.85	186.04
PXS065	27.447	27/10/2017	651.52	222.46
PXS064	27.201	27/10/2017	650.78	148.04
PXS063	27.039	27/10/2017	649.99	144.28
PXS062	26.881	27/10/2017	649.77	166.02
PXS061	26.620	27/10/2017	652.13	218.32
PXS060	26.381	27/10/2017	652.21	162.29
PXS059	26.123	27/10/2017	644.32	114.51
PXS058	25.647	27/10/2017	651.23	254.30
PXS057	25.250	27/10/2017	650.93	299.26
PXS056	25.053	27/10/2017	651.04	268.01
PXS055	24.634	27/10/2017	650.99	276.24
PXS054	24.121	27/10/2017	648.99	167.85
PXS053	23.540	27/10/2017	648.99	203.95
PXS052	23.144	27/10/2017	649.91	239.72
PXS051	22.488	28/10/2017	649.20	226.12
PXS050	22.111	28/10/2017	648.82	194.45
PXS049	21.734	28/10/2017	648.42	181.84
PXS048	21.212	28/10/2017	644.17	135.58
PXS047	20.938	28/10/2017	640.70	112.87
PXS046	20.732	28/10/2017	645.76	287.66
PXS045	20.418	28/10/2017	647.25	305.66
PXS044	20.026	28/10/2017	647.11	202.37
PXS043	19.634	28/10/2017	646.98	185.82
PXS042	19.157	28/10/2017	647.19	188.83
PXS041	18.680	28/10/2017	646.74	227.08
PXS040	18.374	28/10/2017	645.36	163.40
PXS039	17.915	28/10/2017	643.89	139.06
PXS038	17.456	28/10/2017	645.09	181.17
PXS037	16.992	28/10/2017	645.93	186.66

Table 3 Cross section properties - South Saskatchewan River (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS036	16.430	28/10/2017	646.40	225.77
PXS035	15.919	28/10/2017	645.40	196.06
PXS034	15.560	28/10/2017	644.12	167.38
PXS033	15.201	28/10/2017	643.14	154.14
PXS032	14.555	28/10/2017	641.97	171.67
PXS031	14.076	28/10/2017	643.27	191.24
PXS030	13.597	28/10/2017	643.82	202.75
PXS029	13.270	01/11/2017	644.05	204.86
PXS028	12.660	01/11/2017	642.43	180.56
PXS027	12.263	01/11/2017	641.12	163.86
PXS026	11.866	01/11/2017	642.44	219.51
PXS025	11.408	01/11/2017	641.93	209.22
PXS024	10.998	01/11/2017	641.25	188.80
PXS023	10.588	01/11/2017	639.82	111.00
PXS022	10.020	01/11/2017	642.13	256.27
PXS021	9.359	01/11/2017	639.39	151.59
PXS020	8.748	31/10/2017	641.07	199.18
PXS019	8.115	31/10/2017	641.25	221.41
PXS018	7.720	31/10/2017	639.86	177.16
PXS017	7.325	31/10/2017	636.59	157.75
PXS016	6.768	31/10/2017	636.73	123.63
PXS015	6.332	31/10/2017	639.32	211.58
PXS014	5.909	31/10/2017	638.42	155.38
PXS013	5.525	31/10/2017	639.33	172.85
PXS012	5.134	31/10/2017	638.24	182.42
PXS011	4.617	31/10/2017	637.33	169.78
PXS010	3.949	31/10/2017	637.68	173.97
PXS009	3.345	31/10/2017	636.95	213.67
PXS008	2.776	31/10/2017	633.35	229.08
PXS007	2.385	31/10/2017	633.15	101.59
PXS006	1.973	31/10/2017	635.84	139.75
PXS005	1.566	31/10/2017	637.05	171.49
PXS004	1.180	31/10/2017	635.65	132.49

Table 3 Cross section properties - South Saskatchewan River (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS003	0.823	31/10/2017	633.90	157.66
PXS002	0.435	31/10/2017	635.25	192.08
PXS001	0.000	31/10/2017	633.00	148.12

Table 4 Cross section properties - Ross Creek

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS266	24.282	25/10/2017	702.60	20.64
PXS265	24.138	09/11/2017	699.94	12.31
PXS264	24.026	09/11/2017	699.79	43.60
PXS263	23.869	09/11/2017	699.28	22.70
PXS262	23.784	09/11/2017	699.38	28.12
PXS261	23.759	09/11/2017	699.32	27.48
PXS260	23.661	09/11/2017	699.05	10.70
PXS259	23.527	09/11/2017	698.84	12.98
PXS258	23.335	09/11/2017	698.40	6.66
PXS257	23.172	09/11/2017	698.30	13.47
PXS256	23.033	09/11/2017	697.50	11.46
PXS255	22.873	09/11/2017	698.15	13.30
PXS254	22.758	09/11/2017	697.72	7.81
PXS253	22.568	09/11/2017	697.40	7.40
PXS252	22.356	09/11/2017	697.01	8.10
PXS251	22.100	09/11/2017	696.32	10.59
PXS250	21.945	09/11/2017	695.94	10.62
PXS249	21.788	09/11/2017	696.49	9.37
PXS248	21.633	09/11/2017	696.35	13.46
PXS247	21.492	09/11/2017	696.43	19.96
PXS246	21.333	09/11/2017	696.07	9.98
PXS245	21.158	09/11/2017	695.92	8.53
PXS244	20.983	09/11/2017	695.96	12.98
PXS243	20.744	09/11/2017	695.70	19.86

Table 4 Cross section properties - Ross Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS242	20.570	15/08/2018	694.74	13.58
PXS241	20.406	30/10/2017	695.17	16.33
PXS240	20.223	30/10/2017	695.09	8.85
PXS239	20.077	30/10/2017	694.88	13.76
PXS238	19.922	30/10/2017	694.77	17.44
PXS237	19.756	15/08/2018	694.18	13.44
PXS236	19.533	30/10/2017	694.50	15.93
PXS235	19.359	30/10/2017	694.36	15.98
PXS234	19.181	30/10/2017	694.60	26.96
PXS233	19.081	30/10/2017	694.30	12.97
PXS232	19.064	30/10/2017	695.08	11.13
PXS231	18.862	30/10/2017	694.30	17.51
PXS230	18.712	30/10/2017	693.18	11.12
PXS229	18.375	30/10/2017	692.74	14.26
PXS228	18.228	30/10/2017	692.87	12.21
PXS227	18.070	30/10/2017	692.21	12.24
PXS226	17.897	30/10/2017	692.02	18.23
PXS225	17.747	30/10/2017	692.19	11.25
PXS224	17.611	30/10/2017	691.69	15.88
PXS223	17.462	30/10/2017	691.74	13.43
PXS222	17.339	30/10/2017	691.67	11.77
PXS221	17.170	30/10/2017	691.41	26.00
PXS220	16.943	30/10/2017	691.06	13.87
PXS219	16.788	30/10/2017	690.68	7.11
PXS218	16.604	30/10/2017	690.33	9.22
PXS217	16.457	30/10/2017	690.75	16.80
PXS216	16.241	30/10/2017	690.59	13.16
PXS215	16.084	30/10/2017	690.44	15.78
PXS214	15.937	30/10/2017	690.41	9.43
PXS213	15.781	30/10/2017	689.85	21.35
PXS212	15.589	30/10/2017	690.37	9.15
PXS211	15.312	30/10/2017	690.19	23.66
PXS210	15.139	30/10/2017	689.86	16.54

Table 4 Cross section properties - Ross Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS209	15.004	30/10/2017	689.73	20.40
PXS208	14.821	30/10/2017	689.69	12.36
PXS207	14.532	30/10/2017	689.32	13.83
PXS206	14.302	30/10/2017	689.47	17.57
PXS205	14.100	30/10/2017	689.80	22.58
PXS204	14.081	30/10/2017	689.85	29.66
PXS203	13.872	28/10/2017	688.44	9.32
PXS202	13.716	28/10/2017	688.61	7.69
PXS201	13.690	28/10/2017	688.37	17.54
PXS200	13.685	28/10/2017	688.52	19.12
PXS199	13.672	28/10/2017	688.12	14.32
PXS198	13.643	28/10/2017	688.00	23.75
PXS197	13.436	28/10/2017	687.59	12.56
PXS196	13.232	28/10/2017	687.93	11.55
PXS195	13.062	28/10/2017	687.17	9.08
PXS194	12.898	28/10/2017	687.21	10.01
PXS193	12.726	28/10/2017	687.50	18.43
PXS192	12.549	28/10/2017	686.78	13.00
PXS191	12.381	28/10/2017	686.38	15.31
PXS190	12.238	28/10/2017	686.41	14.20
PXS189	12.079	28/10/2017	686.72	11.69
PXS188	11.954	28/10/2017	687.22	13.30
PXS187	11.884	28/10/2017	687.15	22.39
PXS186	11.728	28/10/2017	686.96	18.24
PXS185	11.602	28/10/2017	686.71	17.13
PXS184	11.468	28/10/2017	686.55	12.21
PXS183	11.289	28/10/2017	686.27	12.41
PXS182	11.112	28/10/2017	686.39	18.26
PXS181	10.952	28/10/2017	685.44	14.09
PXS180	10.771	28/10/2017	685.02	18.35
PXS179	10.593	28/10/2017	684.78	9.03
PXS178	10.477	28/10/2017	684.82	8.04
PXS177	10.297	28/10/2017	684.80	18.86

Table 4 Cross section properties - Ross Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS176	10.125	28/10/2017	683.68	25.36
PXS175	10.028	28/10/2017	683.77	17.88
PXS174	9.864	28/10/2017	683.93	19.94
PXS173	9.766	28/10/2017	683.64	9.19
PXS172	9.616	28/10/2017	683.20	12.41
PXS171	9.473	28/10/2017	683.04	13.52
PXS170	9.329	25/10/2017	682.83	12.72
PXS169	9.195	25/10/2017	682.40	107.51
PXS168	8.991	25/10/2017	681.69	24.32
PXS167	8.827	25/10/2017	681.93	19.45
PXS166	8.713	25/10/2017	681.48	29.83
PXS165	8.471	28/10/2017	680.73	40.00
PXS164	8.249	28/10/2017	679.44	34.27
PXS163	8.024	28/10/2017	677.90	43.46
PXS162	7.616	28/10/2017	676.41	9.65
PXS161	7.224	28/10/2017	674.10	13.43
PXS160	6.986	28/10/2017	672.82	17.02
PXS159	6.801	28/10/2017	672.75	30.96
PXS158	6.664	28/10/2017	672.02	21.21
PXS157	6.255	28/10/2017	669.90	29.54
PXS156	6.013	28/10/2017	668.12	14.02
PXS155	5.804	28/10/2017	667.76	21.43
PXS154	5.491	27/10/2017	666.99	17.10
PXS153	5.126	27/10/2017	665.56	23.94
PXS152	4.552	27/10/2017	663.28	11.89
PXS151	4.298	27/10/2017	662.40	13.81
PXS150	4.054	27/10/2017	661.70	9.53
PXS149	3.825	27/10/2017	660.94	9.36
PXS148	3.699	27/10/2017	661.12	18.25
PXS147	3.551	27/10/2017	660.52	18.24
PXS146	3.390	27/10/2017	660.15	16.93
PXS145	3.256	27/10/2017	659.63	18.84
PXS144	3.057	27/10/2017	659.23	9.89

Table 4 Cross section properties - Ross Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS143	2.931	27/10/2017	658.56	25.63
PXS142	2.914	27/10/2017	658.97	12.02
PXS141	2.788	27/10/2017	659.06	11.55
PXS140	2.580	27/10/2017	658.32	6.34
PXS139	2.389	27/10/2017	657.81	17.14
PXS138	2.283	27/10/2017	656.87	19.18
PXS137	2.180	27/10/2017	657.26	13.13
PXS136	2.156	27/10/2017	657.59	14.76
PXS135	2.056	27/10/2017	656.92	8.56
PXS134	1.800	27/10/2017	655.04	10.44
PXS133	1.685	27/10/2017	655.75	9.45
PXS132	1.628	27/10/2017	655.72	8.48
PXS131	1.609	27/10/2017	655.47	12.22
PXS130	1.541	27/10/2017	654.27	7.77
PXS129	1.461	27/10/2017	655.00	22.88
PXS128	1.320	26/10/2017	654.38	14.41
PXS127	1.135	26/10/2017	653.96	14.93
PXS126	1.041	26/10/2017	653.49	21.72
PXS125	0.896	26/10/2017	653.43	25.32
PXS124	0.768	26/10/2017	653.61	17.35
PXS123	0.548	26/10/2017	653.12	23.36
PXS122	0.435	26/10/2017	652.99	20.43
PXS121	0.280	26/10/2017	653.17	17.94

Table 5 Cross section properties - Seven Persons Creek

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS609	24.113	24/10/2017	707.32	6.65
PXS608	23.962	24/10/2017	706.22	20.44
PXS607	23.797	24/10/2017	707.51	16.84
PXS606	23.788	24/10/2017	707.22	18.00

Table 5 Cross section properties - Seven Persons Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS605	23.622	24/10/2017	706.36	21.00
PXS604	23.470	24/10/2017	705.90	8.10
PXS603	23.376	24/10/2017	704.75	11.23
PXS602	23.345	24/10/2017	704.65	9.77
PXS601	23.268	24/10/2017	705.12	13.96
PXS600	23.190	24/10/2017	704.83	8.35
PXS599	23.094	24/10/2017	704.83	9.26
PXS598	23.013	24/10/2017	705.91	22.32
PXS597	22.922	24/10/2017	704.28	10.45
PXS596	22.842	24/10/2017	703.75	17.83
PXS595	22.751	24/10/2017	703.97	7.44
PXS594	22.655	24/10/2017	702.91	11.36
PXS593	22.562	24/10/2017	702.99	5.36
PXS592	22.447	24/10/2017	702.91	14.34
PXS591	22.344	24/10/2017	702.48	16.12
PXS590	22.250	24/10/2017	702.17	11.02
PXS589	22.123	24/10/2017	702.34	14.18
PXS588	22.027	24/10/2017	702.50	11.80
PXS587	21.904	24/10/2017	702.42	5.02
PXS586	21.777	24/10/2017	700.68	14.18
PXS585	21.663	24/10/2017	700.72	9.95
PXS584	21.562	24/10/2017	701.26	15.01
PXS583	21.431	24/10/2017	700.94	13.39
PXS582	21.292	24/10/2017	700.95	14.57
PXS581	21.188	24/10/2017	700.90	9.98
PXS580	21.088	24/10/2017	700.17	9.49
PXS579	20.985	25/10/2017	700.38	9.84
PXS578	20.881	25/10/2017	700.16	9.65
PXS577	20.785	25/10/2017	700.06	7.75
PXS576	20.656	25/10/2017	699.94	4.22
PXS575	20.570	25/10/2017	699.04	9.13
PXS574	20.461	25/10/2017	699.29	7.03
PXS573	20.362	25/10/2017	699.30	8.73

Table 5 Cross section properties - Seven Persons Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS572	20.183	25/10/2017	699.40	15.10
PXS571	20.026	25/10/2017	698.42	13.10
PXS570	19.938	25/10/2017	698.76	12.46
PXS569	19.828	25/10/2017	698.44	12.05
PXS568	19.689	25/10/2017	697.92	12.30
PXS567	19.580	25/10/2017	697.58	10.09
PXS566	19.433	25/10/2017	696.91	7.71
PXS565	19.302	25/10/2017	697.03	9.07
PXS564	19.199	25/10/2017	696.94	14.66
PXS563	19.094	25/10/2017	697.24	7.18
PXS562	18.985	25/10/2017	696.76	10.92
PXS561	18.867	25/10/2017	696.48	12.77
PXS560	18.763	25/10/2017	696.64	13.21
PXS559	18.651	15/08/2018	695.86	11.13
PXS558	18.552	04/11/2017	696.34	13.42
PXS557	18.479	04/11/2017	695.52	17.66
PXS556	18.416	15/08/2018	695.16	16.03
PXS555	18.331	04/11/2017	695.06	10.30
PXS554	18.266	04/11/2017	694.68	19.34
PXS553	18.206	04/11/2017	694.24	7.42
PXS552	18.120	04/11/2017	694.03	17.11
PXS551	17.980	04/11/2017	694.24	9.15
PXS550	17.891	04/11/2017	693.96	11.10
PXS549	17.797	04/11/2017	693.38	10.21
PXS548	17.708	04/11/2017	693.57	7.63
PXS547	17.600	03/11/2017	693.17	11.75
PXS546	17.498	03/11/2017	693.12	8.04
PXS545	17.371	03/11/2017	692.60	7.06
PXS544	17.252	03/11/2017	692.09	5.77
PXS543	17.134	03/11/2017	692.05	6.20
PXS542	17.037	03/11/2017	691.81	9.03
PXS541	16.926	03/11/2017	691.26	8.87
PXS540	16.847	03/11/2017	691.62	7.04

Table 5 Cross section properties - Seven Persons Creek

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS539	16.740	03/11/2017	691.42	8.64
PXS538	16.612	03/11/2017	691.31	0.67
PXS537	16.506	03/11/2017	691.05	7.09
PXS536	16.387	03/11/2017	690.96	13.33
PXS535	16.290	03/11/2017	690.88	12.34
PXS534	16.184	03/11/2017	691.27	7.11
PXS533	16.110	03/11/2017	690.54	12.16
PXS532	16.059	03/11/2017	690.76	6.47
PXS531	15.990	03/11/2017	689.88	8.55
PXS530	15.873	03/11/2017	690.06	8.81
PXS529	15.764	03/11/2017	690.06	12.04
PXS528	15.646	03/11/2017	690.29	14.67
PXS527	15.540	03/11/2017	689.62	15.96
PXS526	15.438	03/11/2017	689.23	10.52
PXS525	15.393	03/11/2017	689.92	8.50
PXS524	15.312	03/11/2017	689.00	12.74
PXS523	15.231	25/10/2017	689.13	6.62
PXS522	15.143	03/11/2017	689.18	7.84
PXS521	15.053	13/10/2017	689.12	11.18
PXS520	14.935	13/10/2017	688.25	7.98
PXS519	14.828	13/10/2017	689.00	6.52
PXS518	14.721	13/10/2017	688.37	9.48
PXS517	14.615	13/10/2017	688.37	8.75
PXS516	14.496	13/10/2017	687.99	8.92
PXS515	14.407	13/10/2017	687.66	8.87
PXS514	14.289	13/10/2017	687.56	8.86
PXS513	14.221	13/10/2017	687.71	12.18
PXS512	14.194	13/10/2017	687.60	10.47
PXS511	14.087	13/10/2017	686.98	10.84
PXS510	13.990	13/10/2017	686.52	9.45
PXS509	13.836	13/10/2017	686.81	11.48
PXS508	13.682	13/10/2017	686.70	7.47
PXS507	13.561	13/10/2017	686.08	8.21

Table 5 Cross section properties - Seven Persons Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS506	13.445	13/10/2017	686.02	7.11
PXS505	13.337	13/10/2017	685.61	11.04
PXS504	13.254	13/10/2017	685.35	10.02
PXS503	13.114	13/10/2017	684.98	7.41
PXS502	13.003	13/10/2017	684.68	11.69
PXS501	12.889	13/10/2017	684.85	10.07
PXS500	12.768	13/10/2017	684.64	8.06
PXS499	12.616	13/10/2017	684.32	11.48
PXS498	12.419	13/10/2017	684.14	12.97
PXS497	12.267	13/10/2017	683.46	11.44
PXS496	12.174	13/10/2017	683.92	9.95
PXS495	12.053	13/10/2017	683.46	9.63
PXS494	11.887	13/10/2017	683.41	9.35
PXS493	11.778	13/10/2017	683.46	15.34
PXS492	11.653	13/10/2017	683.49	11.10
PXS491	11.483	13/10/2017	682.53	10.28
PXS490	11.345	13/10/2017	682.28	23.74
PXS489	11.240	13/10/2017	682.09	9.38
PXS488	11.164	13/10/2017	681.68	8.24
PXS487	11.056	13/10/2017	681.63	10.24
PXS486	10.933	13/10/2017	681.66	9.38
PXS485	10.831	13/10/2017	681.47	8.09
PXS484	10.756	13/10/2017	681.54	12.65
PXS483	10.649	13/10/2017	681.02	9.54
PXS482	10.512	13/10/2017	680.95	8.01
PXS481	10.402	12/10/2017	680.24	9.02
PXS480	10.253	12/10/2017	680.18	8.35
PXS479	10.113	12/10/2017	679.65	5.86
PXS478	9.986	12/10/2017	679.92	8.83
PXS477	9.884	12/10/2017	679.23	11.00
PXS476	9.764	12/10/2017	678.33	11.55
PXS475	9.642	12/10/2017	678.79	11.59
PXS474	9.492	28/10/2017	677.13	14.88

Table 5 Cross section properties - Seven Persons Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS473	9.361	02/11/2017	677.55	8.03
PXS472	9.223	02/11/2017	676.98	8.14
PXS471	9.095	31/10/2017	677.15	9.27
PXS470	8.965	04/11/2017	676.80	10.28
PXS469	8.882	04/11/2017	676.85	7.81
PXS468	8.807	04/11/2017	676.35	8.23
PXS467	8.781	05/11/2017	676.72	8.21
PXS466	8.739	05/11/2017	676.10	8.72
PXS465	8.589	05/11/2017	676.32	6.17
PXS464	8.510	05/11/2017	676.18	16.33
PXS463	8.434	05/11/2017	676.11	9.48
PXS462	8.290	05/11/2017	674.89	12.80
PXS461	8.227	05/11/2017	675.10	12.91
PXS460	8.067	05/11/2017	674.94	13.66
PXS459	7.984	05/11/2017	674.27	4.88
PXS458	7.895	05/11/2017	673.79	10.20
PXS457	7.816	05/11/2017	673.90	9.86
PXS456	7.731	05/11/2017	673.72	16.48
PXS455	7.630	05/11/2017	673.67	14.34
PXS454	7.544	06/11/2017	673.71	16.93
PXS453	7.416	06/11/2017	673.36	12.69
PXS452	7.294	06/11/2017	673.06	10.38
PXS451	7.204	06/11/2017	673.12	12.73
PXS450	7.166	06/11/2017	673.04	13.35
PXS449	7.143	06/11/2017	672.76	20.45
PXS448	7.015	06/11/2017	672.45	11.02
PXS447	6.884	06/11/2017	672.26	11.65
PXS446	6.761	06/11/2017	671.79	8.68
PXS445	6.712	06/11/2017	671.14	11.38
PXS444	6.653	06/11/2017	671.38	13.71
PXS443	6.594	06/11/2017	671.37	11.31
PXS442	6.522	06/11/2017	670.62	11.45
PXS441	6.441	06/11/2017	670.89	18.98

Table 5 Cross section properties - Seven Persons Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS440	6.332	06/11/2017	670.54	10.38
PXS439	6.261	06/11/2017	670.49	6.79
PXS438	6.222	06/11/2017	670.60	8.25
PXS437	6.110	06/11/2017	669.97	8.74
PXS436	5.995	06/11/2017	669.82	8.76
PXS435	5.722	25/10/2017	669.08	11.75
PXS434	5.566	25/10/2017	668.84	12.64
PXS433	5.408	25/10/2017	668.49	10.35
PXS432	5.237	25/10/2017	668.31	13.26
PXS431	5.144	25/10/2017	668.18	15.11
PXS430	5.000	25/10/2017	668.34	12.52
PXS429	4.875	25/10/2017	667.82	12.52
PXS428	4.739	25/10/2017	667.07	9.22
PXS427	4.618	25/10/2017	666.88	12.02
PXS426	4.543	25/10/2017	666.14	11.30
PXS425	4.526	26/10/2017	666.06	19.11
PXS424	4.510	26/10/2017	666.15	9.28
PXS423	4.488	26/10/2017	666.14	20.64
PXS422	4.404	25/10/2017	665.47	8.78
PXS421	4.305	25/10/2017	665.28	19.73
PXS420	4.186	25/10/2017	666.09	13.77
PXS419	4.180	25/10/2017	664.22	14.24
PXS418	4.130	26/10/2017	663.74	7.08
PXS417	4.091	26/10/2017	663.50	9.02
PXS416	4.025	26/10/2017	663.25	15.31
PXS415	3.934	26/10/2017	662.66	10.84
PXS414	3.818	26/10/2017	662.70	20.12
PXS413	3.708	26/10/2017	662.01	10.90
PXS412	3.605	26/10/2017	661.98	6.55
PXS411	3.460	26/10/2017	661.00	6.09
PXS410	3.437	26/10/2017	661.39	21.83
PXS409	3.400	26/10/2017	661.27	20.99
PXS408	3.286	26/10/2017	660.45	28.65

Table 5 Cross section properties - Seven Persons Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS407	3.205	27/10/2017	660.16	22.77
PXS406	3.197	27/10/2017	660.11	6.83
PXS405	3.061	27/10/2017	659.75	7.81
PXS404	2.988	27/10/2017	659.50	10.11
PXS403	2.974	27/10/2017	659.63	10.26
PXS402	2.965	27/10/2017	659.54	10.00
PXS401	2.829	27/10/2017	659.44	15.70
PXS400	2.710	27/10/2017	658.48	10.65
PXS399	2.594	27/10/2017	658.63	22.43
PXS398	2.492	27/10/2017	658.30	10.35
PXS397	2.456	26/10/2017	658.61	8.09
PXS396	2.417	26/10/2017	658.37	18.79
PXS395	2.384	26/10/2017	657.68	15.94
PXS394	2.246	26/10/2017	657.04	23.90
PXS393	2.115	26/10/2017	657.16	11.89
PXS392	2.001	26/10/2017	656.90	18.72
PXS391	1.889	26/10/2017	656.86	26.27
PXS390	1.767	26/10/2017	656.43	11.54
PXS389	1.648	26/10/2017	656.40	9.03
PXS388	1.532	26/10/2017	656.44	8.12
PXS387	1.424	26/10/2017	656.17	13.02
PXS386	1.300	26/10/2017	656.04	15.92
PXS385	1.187	26/10/2017	655.63	10.45
PXS384	1.139	26/10/2017	656.00	8.57
PXS383	1.117	26/10/2017	655.94	14.21
PXS382	1.090	26/10/2017	655.36	16.24
PXS381	1.059	26/10/2017	655.63	14.05
PXS380	1.039	26/10/2017	655.29	14.25
PXS379	0.919	26/10/2017	654.90	11.76
PXS378	0.794	26/10/2017	654.61	16.82
PXS377	0.655	26/10/2017	654.55	6.83
PXS376	0.539	26/10/2017	654.21	9.56
PXS375	0.515	26/10/2017	654.49	18.30

Table 5 Cross section properties - Seven Persons Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS374	0.439	26/10/2017	654.17	12.39
PXS373	0.340	26/10/2017	654.12	24.64
PXS372	0.328	26/10/2017	653.98	12.63
PXS371	0.219	26/10/2017	653.43	9.08
PXS370	0.113	26/10/2017	653.76	10.89

Table 6 Cross section properties - Bullshead Creek

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS369	9.694	08/11/2017	710.00	8.17
PXS368	9.626	08/11/2017	709.61	20.34
PXS367	9.586	08/11/2017	709.64	13.61
PXS366	9.522	08/11/2017	709.50	6.43
PXS365	9.446	08/11/2017	709.24	6.81
PXS364	9.355	08/11/2017	709.00	7.93
PXS363	9.266	08/11/2017	709.17	6.43
PXS362	9.182	08/11/2017	709.09	7.97
PXS361	9.091	08/11/2017	708.20	7.43
PXS360	9.011	08/11/2017	708.38	7.02
PXS359	8.937	08/11/2017	708.41	7.55
PXS358	8.859	08/11/2017	708.25	6.14
PXS357	8.798	08/11/2017	708.31	14.30
PXS356	8.709	08/11/2017	708.26	5.68
PXS355	8.633	08/11/2017	707.75	6.72
PXS354	8.503	08/11/2017	707.71	9.96
PXS353	8.389	08/11/2017	707.19	8.93
PXS352	8.321	08/11/2017	707.49	6.16
PXS351	8.239	08/11/2017	707.12	9.36
PXS350	8.146	08/11/2017	707.06	7.29
PXS349	8.072	08/11/2017	706.73	4.76
PXS348	7.975	08/11/2017	706.95	6.35

Table 6 Cross section properties - Bullshead Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS347	7.897	08/11/2017	706.78	7.17
PXS346	7.788	08/11/2017	706.62	25.24
PXS345	7.676	08/11/2017	706.55	5.94
PXS344	7.566	08/11/2017	706.31	8.98
PXS343	7.488	08/11/2017	706.06	7.80
PXS342	7.394	08/11/2017	705.97	9.67
PXS341	7.310	08/11/2017	705.49	6.30
PXS340	7.222	08/11/2017	705.68	4.44
PXS339	7.118	08/11/2017	705.41	5.98
PXS338	7.026	08/11/2017	705.40	7.21
PXS337	6.944	08/11/2017	705.21	4.27
PXS336	6.822	08/11/2017	705.07	5.09
PXS335	6.690	08/11/2017	705.17	5.77
PXS334	6.575	08/11/2017	705.04	4.11
PXS333	6.447	08/11/2017	704.84	6.12
PXS332	6.329	08/11/2017	704.70	9.02
PXS331	6.225	08/11/2017	704.28	6.39
PXS330	6.136	08/11/2017	704.34	5.40
PXS329	6.031	08/11/2017	704.22	9.01
PXS328	5.928	07/11/2017	703.98	5.85
PXS327	5.774	07/11/2017	704.11	10.53
PXS326	5.630	07/11/2017	703.42	8.74
PXS325	5.489	07/11/2017	703.41	7.50
PXS324	5.383	07/11/2017	703.39	7.58
PXS323	5.281	07/11/2017	702.95	8.63
PXS322	5.188	07/11/2017	703.05	10.60
PXS321	5.083	07/11/2017	702.43	11.56
PXS320	4.946	07/11/2017	701.75	6.30
PXS319	4.824	07/11/2017	701.88	7.23
PXS318	4.702	07/11/2017	701.65	5.24
PXS317	4.587	07/11/2017	701.64	7.09
PXS316	4.462	07/11/2017	701.63	10.57
PXS315	4.358	07/11/2017	701.45	6.64

Table 6 Cross section properties - Bullshead Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS314	4.250	07/11/2017	701.50	16.07
PXS313	4.195	07/11/2017	701.37	14.29
PXS312	4.176	07/11/2017	701.11	21.97
PXS311	4.119	07/11/2017	701.20	4.54
PXS310	4.002	07/11/2017	700.65	5.82
PXS309	3.897	07/11/2017	700.85	10.49
PXS308	3.802	07/11/2017	700.56	7.16
PXS307	3.705	07/11/2017	700.17	7.15
PXS306	3.595	07/11/2017	700.06	6.91
PXS305	3.512	07/11/2017	699.93	11.21
PXS304	3.443	07/11/2017	699.76	8.12
PXS303	3.419	07/11/2017	699.87	10.09
PXS302	3.408	07/11/2017	699.82	9.51
PXS301	3.387	07/11/2017	699.74	9.87
PXS300	3.277	07/11/2017	699.43	7.93
PXS299	3.194	07/11/2017	698.95	7.41
PXS298	3.083	07/11/2017	699.11	6.23
PXS297	2.992	07/11/2017	698.46	6.78
PXS296	2.883	07/11/2017	698.19	6.72
PXS295	2.855	07/11/2017	698.23	7.51
PXS294	2.832	07/11/2017	698.16	17.26
PXS293	2.776	07/11/2017	698.09	12.04
PXS292	2.683	07/11/2017	697.78	6.38
PXS291	2.591	07/11/2017	696.88	7.62
PXS290	2.508	07/11/2017	696.76	4.97
PXS289	2.443	07/11/2017	696.33	7.25
PXS288	2.429	07/11/2017	696.27	9.01
PXS287	2.388	07/11/2017	695.91	6.75
PXS286	2.331	07/11/2017	695.34	6.49
PXS285	2.306	25/10/2017	695.59	12.23
PXS284	2.218	25/10/2017	695.34	9.24
PXS283	2.101	25/10/2017	694.44	6.58
PXS282	2.010	25/10/2017	694.24	5.54

Table 6 Cross section properties - Bullshead Creek (continued)

Planned Cross Section	River Station (km)	Date Surveyed	Thalweg Elevation (m)	TOB Channel Width (m)
PXS281	1.902	25/10/2017	693.29	6.58
PXS280	1.771	25/10/2017	692.47	7.36
PXS279	1.666	25/10/2017	692.09	9.14
PXS278	1.543	25/10/2017	691.38	8.37
PXS277	1.440	25/10/2017	691.13	6.18
PXS276	1.327	25/10/2017	690.07	7.12
PXS275	1.219	25/10/2017	689.67	5.94
PXS274	1.061	25/10/2017	689.15	7.03
PXS273	0.984	25/10/2017	688.43	7.01
PXS272	0.883	25/10/2017	687.97	8.36
PXS271	0.734	25/10/2017	686.82	7.17
PXS270	0.625	25/10/2017	685.80	6.56
PXS269	0.485	25/10/2017	685.15	16.72
PXS268	0.341	25/10/2017	683.84	6.68
PXS267	0.190	25/10/2017	683.20	6.72

2.3 Longitudinal Profiles

Longitudinal profiles were plotted for the South Saskatchewan River (**Figure 3**), Ross Creek (**Figure 4**), Seven Persons Creek (**Figure 5**), and Bullshead Creek (**Figure 6**) based on the surveyed channel thalweg and water surface elevations.

2.4 Hydraulic Structures

Table 7 summarizes the hydraulic structures in the study reach. A total of 59 bridges, eight culverts, and one weir were identified and surveyed within the study area. Hydraulic structure locations are shown in **Figure 2**. Survey data for these structures has been assembled and provided as **Appendix A**; bridge and culvert details are provided in **Appendix B**.

Data collected at each bridge includes:

- Length of span
- Width of the bridge
- Top of curb or solid guardrail elevations (upstream and downstream)

- Low chord elevations (upstream and downstream)
- Number and width of piers
- Location of piers relative to the left abutment
- Type of piers
- Shape of piers
- Top of roadway profile (centerline)
- Photographs of the bridge

The information collected at each culvert includes:

- Culvert type
- Culvert shape
- Entrance condition
- Culvert dimensions and barrel length
- Upstream and downstream inverts
- Top of roadway profile
- Photograph of the culvert

Table 7 Hydraulic structure summary

Reach	Description	River Station (km)	Structure Type
South Saskatchewan River	BF78572 - Trans Canada Highway EB	32.685	Bridge
	BF73802 - Trans Canada Highway WB	32.655	Bridge
	Finlay Bridge	29.685	Bridge
	CPR Bridge	29.478	Bridge
	Maple Avenue Bridge	29.259	Bridge
Ross Creek	BF75672 - Highway 41	23.771	Bridge
	Private Road 1	19.070	Bridge
	Private Road 2	18.999	Bridge
	Range Road 51A	14.090	Bridge
	Private Road 3	9.774	Bridge
	Day Street Bridge	2.922	Bridge
	Industrial Avenue Bridge	2.168	Bridge
	Porcelain Avenue Bridge	1.618	Bridge

Table 7 Hydraulic structure summary (continued)

Reach	Description	River Station (km)	Structure Type
Seven Persons Creek	Private Road 1	23.792	Bridge
	BF2164 - Township Road 120 4KM S of Medicine Hat	23.361	Culvert
	Desert Blume Golf Course Bridge 1	18.476	Bridge
	Desert Blume Golf Course Bridge 2	18.263	Bridge
	Desert Blume Golf Course Bridge 3	18.117	Bridge
	Desert Blume Golf Course Bridge 4	17.794	Bridge
	Desert Blume Golf Course Bridge 5	17.597	Bridge
	Desert Blume Golf Course Bridge 6	16.923	Bridge
	Desert Blume Golf Course Bridge 7	16.108	Bridge
	Desert Blume Golf Course Bridge 8	15.435	Bridge
	BF1155 - South Boundary Road	14.208	Bridge
	Private Road 2	10.829	Bridge
	Cottonwood Coulee Golf Course Bridge 1	9.051	Bridge
	Cottonwood Coulee Golf Course Bridge 2	8.961	Bridge
	Cottonwood Coulee Golf Course Bridge 3	8.797	Bridge
	Cottonwood Coulee Golf Course Bridge 4	8.736	Bridge
	Cottonwood Coulee Golf Course Bridge 5	8.286	Bridge
	Cottonwood Coulee Golf Course Bridge 6	8.277	Bridge
	Cottonwood Coulee Golf Course Bridge 7	8.087	Bridge
	Cottonwood Coulee Golf Course Bridge 8	7.982	Bridge
	Cottonwood Coulee Golf Course Bridge 9	7.814	Bridge
	Paradise Valley Golf Course Bridge 1	7.200	Bridge
	Paradise Valley Golf Course Bridge 2	7.146	Bridge
	Paradise Valley Golf Course Bridge 3	6.707	Bridge
	Paradise Valley Golf Course Bridge 4	6.592	Bridge
	Paradise Valley Golf Course Bridge 5	6.259	Bridge
	Paradise Valley Golf Course Bridge 6	6.108	Bridge
	Pedestrian Bridge	5.246	Bridge
	Pedestrian Bridge	5.003	Bridge
	BF73807 - Trans Canada Highway	4.589	Culvert
Kin Coulee Road	4.498	Bridge	
Kin Coulee Park Weir	4.184	Weir	

Table 7 Hydraulic structure summary (continued)

Reach	Description	River Station (km)	Structure Type
Seven Persons Creek	Kin Coulee Park Pedestrian Bridge 1	4.090	Bridge
	Kin Coulee Park Pedestrian Bridge 2	3.697	Bridge
	College Avenue Bridge	3.421	Culvert
	Private Road 4	3.201	Bridge
	Private Rail Bridge	2.979	Bridge
	Pedestrian Bridge	2.962	Bridge
	Pedestrian Bridge	2.716	Bridge
	Dunmore Road	2.435	Bridge
	Pedestrian Bridge	1.764	Bridge
	BR-11 Carry Drive Bridge	1.128	Bridge
	CPR Bridge	1.050	Bridge
	Industrial Avenue Bridge	0.527	Bridge
	Abandoned Piers	0.346	Bridge
	Pedestrian Bridge	0.123	Bridge
Bullshead Creek	BF81332 - Township Road 120 2KM SW of Dunmore	9.606	Culvert
	CPR branch line	4.185	Culvert
	BF493 - Trans Canada Highway EB	3.431	Culvert
	BF493 - Trans Canada Highway WB	3.399	Bridge
	Ross Creek Golf Course Bridge 1	3.273	Bridge
	Ross Creek Golf Course Bridge 2	3.190	Bridge
	Ross Creek Golf Course Bridge 3	3.080	Bridge
	Ross Creek Golf Course Bridge 4	2.879	Bridge
	54 Street SE 1	2.843	Culvert
	CPR Bridge	2.436	Bridge
54 Street SE 2	2.320	Culvert	

2.5 Flood Control Structures

There are four dedicated flood control structures within the study reach (**Table 8**), all of which are located along the South Saskatchewan River. Crest profiles of the flood control structures were surveyed, and their alignments are shown in **Figure 7**. Survey data has been assembled and provided as

Appendix A; available flood control structure documentation obtained from the City of Medicine Hat is provided in **Appendix C**.

Table 8 Flood control structure summary

Description	Upstream River Station (km)	Downstream River Station (km)	Crest Length (m)
Harlow Area – Phase 1	32.494	31.753	775
Riverside – Phase 1	30.080	29.693	379
Lions Park Overland Flow Protection Strategy	29.092	26.903	2,315
Wastewater Treatment Plant	25.250	25.053	610

2.6 Other Data

2.6.1 Water Survey of Canada Benchmarks

WSC benchmarks were surveyed at the three gauging station locations within the study area. **Table 9** lists the benchmarks at each gauging station and compares their published and surveyed elevations. The largest difference between the surveyed and published elevations was found to be 0.035 m.

Detailed station descriptions from WSC are provided in **Appendix D**.

Table 9 Water Survey of Canada gauging station benchmark summary

Station Name (ID)	River Station (km)	Benchmark Name	Elevation (m)		
			Published	Surveyed	Difference
South Saskatchewan River at Medicine Hat (05AJ001)	29.685	*S.B.M. 90-1	662.257	N/A	N/A
		BM 10-1	660.378	660.413	0.035
		T.B.M. 83-2	659.957	659.957	0.000
Ross Creek at Highway 41 (05AH052)	23.771	*GSC BM 82A524	706.079	706.106	0.027
		B.M. 2011-1	704.331	704.355	0.024
		S.B.M. 2000-2	703.720	703.744	0.024
Seven Persons Creek at Medicine Hat (05AH005)	3.612	*BM 92-1	664.592	664.622	0.030
		SBM 93-1	663.840	663.859	0.019
		BM 2013-01	665.806	665.829	0.023

Note: 1. Primary benchmarks denoted by *.

2.6.2 Staff Gauges

The City of Medicine Hat maintains staff gauges near several bridges and culverts in the study area. The staff gauges are summarized in **Table 10**. Staff gauge elevations were surveyed to compare the reported elevations with the NHC survey elevations.

Table 10 Summary of Staff Gauges in the Study Area

Reach	River Station (km)	Description of Staff Gauge Location	Reported Elevation (m)	Surveyed Elevation (m)
South Saskatchewan River	32.655	WB Trans Canada Bridge pier near right bank	662.00	N/A
	29.678	Light pole on south side of River Road SE downstream of Finlay Bridge	661.14	660.223
	29.676	Post at top of right bank downstream of Finlay Bridge	659.00	N/A
Seven Persons Creek	14.221	Right bank upstream wingwall of Range Road 62 Bridge	N/A	689.525
	4.618	Left bank of upstream side of north opening at Trans Canada Highway	668.60	668.642
	4.618	Left bank of upstream side of south opening at Trans Canada	668.43	N/A
	3.463	Post along left bank upstream of College Avenue Bridge	664.66	664.668
	2.459	Post along right bank upstream of Dunmore Road Bridge	661.37	661.577
	1.141	Post along left bank upstream of Carry Drive SE	658.27	658.297
	0.541	Post along left bank upstream of Industrial Avenue Bridge	657.48	657.509
Ross Creek	2.931	Upstream side of left abutment of Day Street SE Bridge	661.87	661.950
	1.609	Right abutment of Porcelain Avenue SE Bridge	658.00	659.035

2.6.3 Site Photographs

Appendix E provides annotated reach representative photographs obtained during the 2017 site inspection and survey program. The location, time, and other metadata information is imbedded in the electronic images included in **Appendix E**.

2.7 Accuracy

2.7.1 Control Network

The horizontal and vertical errors in the control network after post-processing and adjustment to the reference ASCMs are summarized in **Table 11**. The largest horizontal error was 0.013 m and the largest vertical error was 0.017 m. Comparison of the adjusted CP coordinates against CSRS-PPP coordinates was within 0.037 m horizontally and 0.044 m vertically.

Table 11 Control network errors

Point Name	Easting (m)	Northing (m)	Elevation (m)
144915	0.000	0.000	0.000
230581	0.000	0.000	0.000
863936	0.007	0.007	0.013
2	0.005	0.007	0.017
3	0.006	0.008	0.016
4	0.006	0.010	0.016
5	0.008	0.013	0.015
6	0.006	0.006	0.014
7	0.002	0.003	0.011
8	0.006	0.008	0.015
9	0.004	0.006	0.014
10	0.008	0.007	0.017
11	0.009	0.010	0.015
12	0.003	0.004	0.013

Note: Control network was adjusted to match published coordinates for ASCMs 144915 and 230581.

2.7.2 Cross Sections and Other Features

The Trimble RTK GNSS receivers used for the survey are accurate to ± 0.02 m under optimal operating conditions. Optimal operating conditions are when the GNSS receiver is mounted to a tripod with a clear view of the sky and sufficient satellites to accurately establish the receiver position. Additional error may be introduced when the receiver is off-level, obstructed by nearby trees or vegetation, or the instrument height is incorrectly recorded. The overall expected accuracy of ground-based survey points is ± 0.05 m, except in rare cases when points were surveyed in tree cover or near large vertical banks resulting in less than ideal satellite coverage. The digital echo sounder used for the boat-based surveys has an expected accuracy of ± 0.01 m. Due to the pitch and roll of the boat when the boat is in motion, the overall expected accuracy of the boat-based survey is ± 0.07 m.

3 ADDITIONAL BASE DATA

3.1 Digital Terrain Model

Fully-processed bare earth and full feature digital terrain model (DTM) data sets were provided in February 2018. The bare earth DTM was compared with ground topography surveyed by NHC and found to be in good agreement with the data collected by NHC.

3.2 Aerial Imagery

Aerial imagery was acquired for AEP by OGL Engineering Ltd. on 15 July 2018. Fully-processed, orthophoto mosaics were provided to NHC by AEP on 12 January 2019.

3.3 Bridges and Culverts

NHC requested bridge files and available design drawings from Alberta Transportation and the City of Medicine Hat. Information was obtained for the following structures:

South Saskatchewan River

- Eastbound Trans Canada Highway (BF 78572)
- Westbound Trans Canada Highway (BF 73802)
- Finlay Bridge
- Maple Avenue

Ross Creek

- Highway 41 (BF 75672)
- Day Street
- Industrial Avenue
- Porcelain Avenue

Seven Persons Creek

- Township Road 120 (BF 2164)
- South Boundary Road
- Trans Canada Highway (BF 73807)
- College Avenue
- P & H Mill Bridge
- Dunmore Road
- Carry Drive
- Industrial Avenue

Bullshead Creek

- Township Road 120 (BF 81332)
- EB Trans Canada Highway (BF 493)
- WB Trans Canada Highway (BF 493)

The available bridge details and summary sheets are provided in **Appendix B**.

3.4 Hydrometric Gauging Station Information

Water level (stage) records and rating curves from WSC hydrometric gauging stations in the study area were obtained to support creation and calibration of the hydraulic model. **Table 12** lists the hydrometric gauges for which rating curves were obtained and their respective period of record.

Table 12 List of hydrometric gauges within the study area

Station Name (ID)	Period of Record
South Saskatchewan River at Medicine Hat (05AJ001)	1911-Present
Ross Creek at Highway 41 (05AH052)	2000-Present (seasonal)
Seven Persons Creek at Medicine Hat (05AH005)	1910-17, 1919-31, 1935-56, 1973-Present (seasonal)

The historical rating curves have been plotted and compared at each station in **Figure 8**, **Figure 9**, and **Figure 10**. The South Saskatchewan River rating curve historically has been quite stable for discharges up to 500 m³/s but has varied for larger discharges. Rating curves for the other two stations have varied substantially through history and only recently have the rating curves been extended into large discharges following the most recent large floods in 2010 and 2011.

3.5 Base Mapping Features

The following data sets were obtained to support modelling and mapping during the study:

- Administrative – such as city, town, and county boundaries
- Land use / land cover
- Transportation – road and rail networks
- Facilities – such as boat launches
- Historic flood reports and mapping

3.6 Highwater Mark Reports

Highwater mark reports were provided by AEP documenting water levels measured during significant flood events within the study area. Water level measurements corresponding to the peak discharge of each flood event are required to calibrate the hydraulic model. Highwater marks are available from

floods from 1952, 1975, 1986, 1994, 1995, 2002, 2010, and 2013. The 1986 event appears to be associated with ice jam conditions on the South Saskatchewan River; the remaining highwater marks are associated with open water floods. **Table 13** provides a summary of the highwater marks and the peak discharge of each flood event.

It is worth noting here that the previous floodplain study (Alberta Environment, 1986) used the 1975 flood to calibrate the hydraulic model of the South Saskatchewan River and the 1952 flood to calibrate the hydraulic model of Seven Persons Creek. The Ross Creek hydraulic model was uncalibrated.

The key recorded flood events for this study, based on the available highwater mark data, include:

- 1995 and 2013 on the South Saskatchewan River
- 2010 on Ross Creek
- 1952 and 2010 on Seven Persons Creek

One additional highwater mark appears to have been reported on Bullshead Creek at the Trans Canada Highway crossing.

Table 13 Summary of highwater marks

Flood Date	Discharge			Highwater Mark Availability		
	South Saskatchewan River	Ross Creek	Seven Persons Creek	South Saskatchewan River	Ross Creek	Seven Persons Creek
31-Mar-1952	-	-	136			Yes
23-Jun-1975	3,170	-	-	Yes		
Mar-1994	-	67	34		Yes	Yes
09-Jun-1995	5,110	-	-	Yes		
13-Jun-2002	1,990	44.6	8.27	Yes	Yes	Yes
20-Jun-2010	-	209	76.7		Yes	Yes
24-Jun-2013	5,040	2.05	-	Yes	Yes	Yes

4 CONCLUSIONS

The collection of survey and base data primarily supports the hydraulic modelling, flood mapping, flood risk assessment, and channel stability investigation components of the Medicine Hat River Hazard Study. River cross sections were surveyed along 26 km of the South Saskatchewan River below Ross Creek, 19 km of the South Saskatchewan River above Ross Creek, 24 km of Ross Creek above the confluence with the South Saskatchewan River, 24 km of Seven Persons Creek above the confluence with Ross Creek, and 9.6 km of Bullshead Creek above the confluence with Ross Creek. In total, 610 cross sections were surveyed using a combination of boat-based bathymetric and RTK GNSS ground surveys to complement the LiDAR-derived DTM. In addition, geometric details of 60 bridge crossings, 14 culverts, one weir, and four flood control structures were collected.

The overall accuracy of the measurements is considered to be ± 0.07 m horizontally and vertically for the boat-based bathymetric points and ± 0.05 m horizontally and vertically for the ground-based RTK GNSS survey points. Comparison of the LiDAR-derived DTM and ground survey points showed that the two data sets are in agreement, indicating that the DTM is suitable for use in hydraulic model development and flood mapping.

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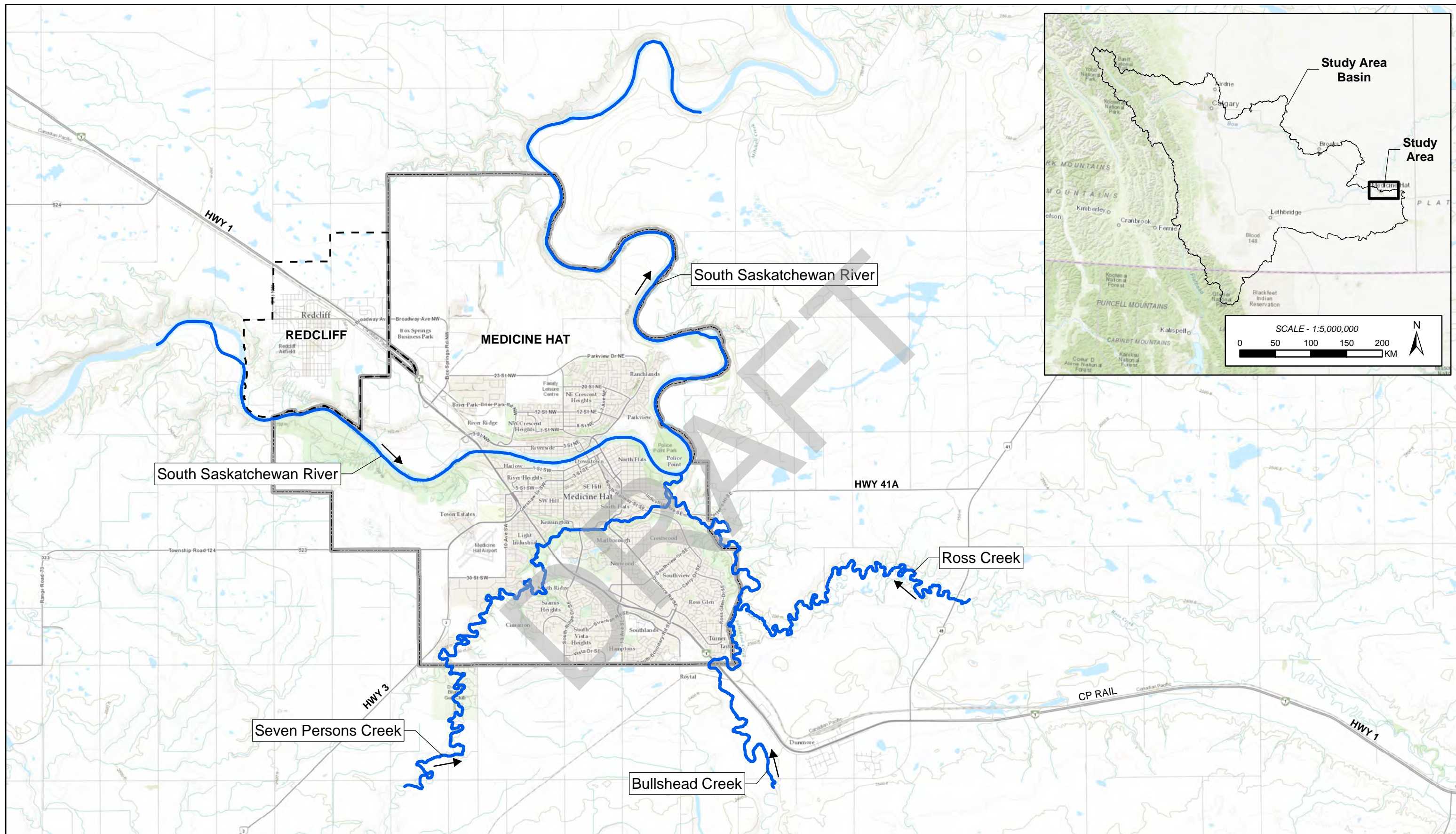
5 REFERENCES

AENV (1986). Medicine Hat Floodplain Study, Main Report. Alberta Department of Environment, Water Resources Management Services, Technical Division, May 1986.

DRAFT

Figures

DRAFT



Alberta Government

nhc
northwest hydraulic consultants

- Model Stream Network
- Redcliff Town Boundary
- Medicine Hat City Boundary

DATA SOURCES: Basemap from Esri & NRCAN.

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Units: METRES

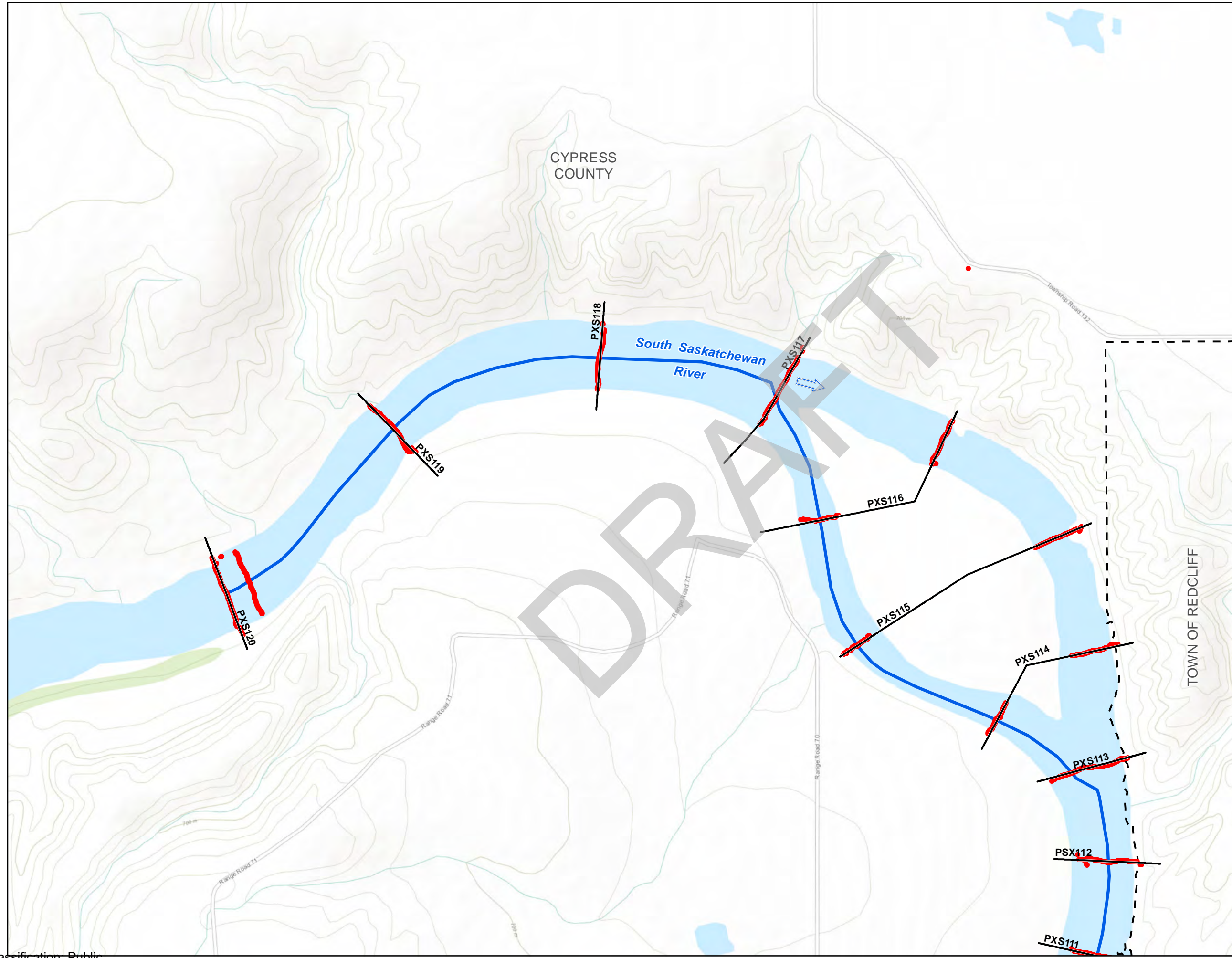
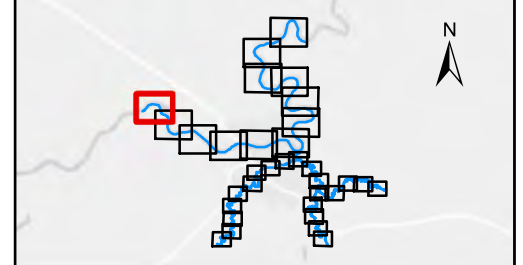
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MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION

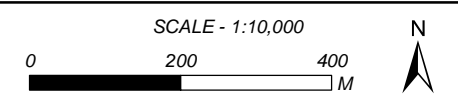
STUDY AREA

FIGURE 1



- FLOW DIRECTION
- SURVEY POINT
- FLOOD CONTROL STRUCTURE
- CROSS SECTION
- BRIDGE
- CULVERT
- WEIR
- APPROXIMATE CHANNEL CENTRELINE
- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

DATA SOURCES: Basemap from Esri.

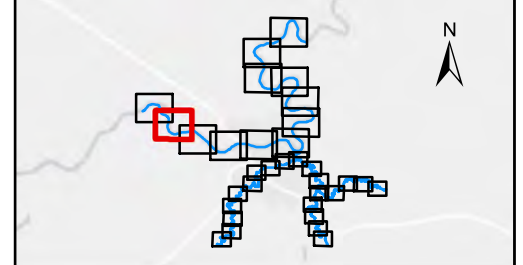
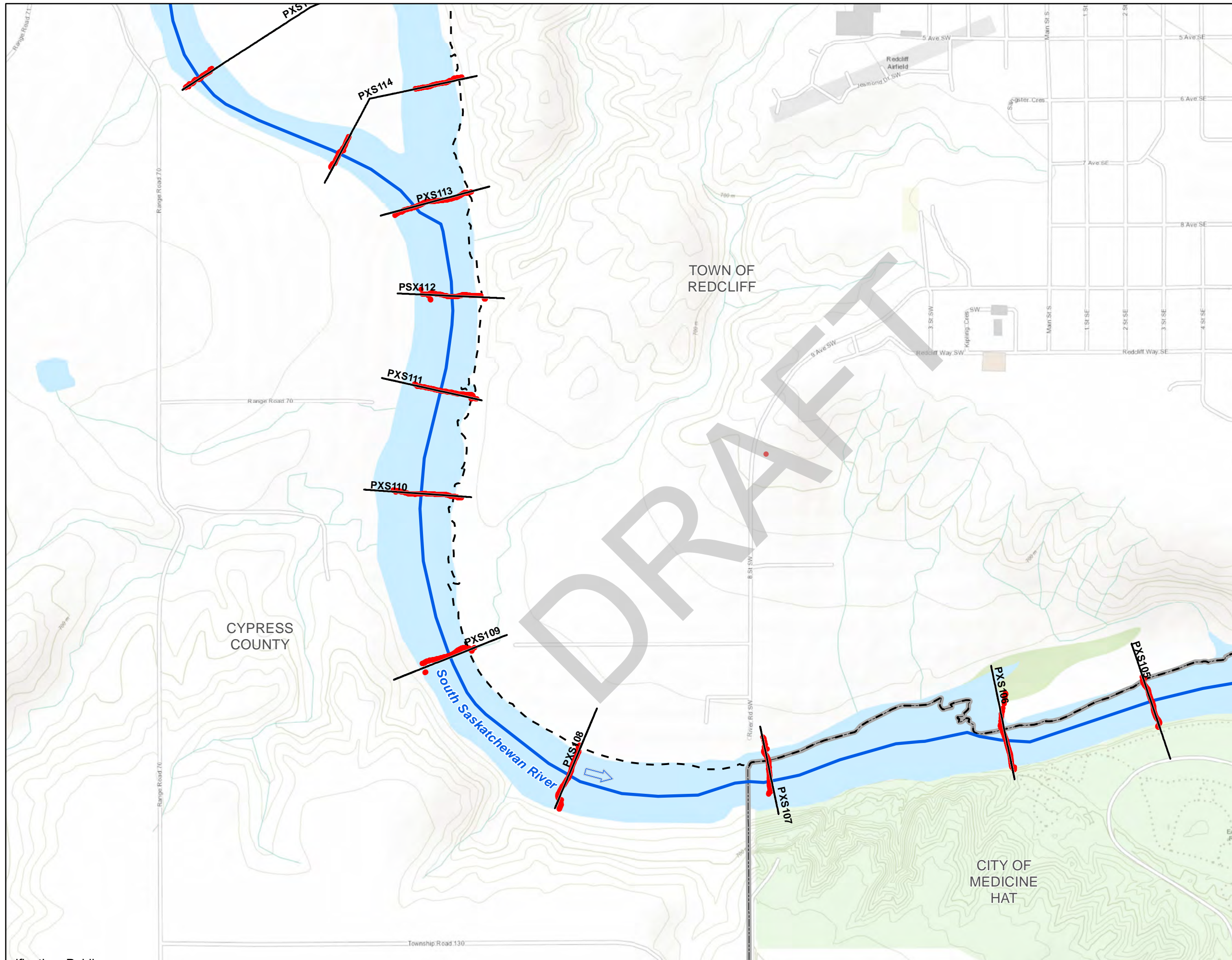


Coordinate System: NAD 1983 CSRS 3TM 111
Units: METRES

Job: 1003094 | Date: 20-AUG-2019

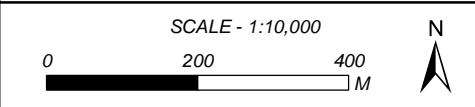
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

MSN: P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Model\GIS\1003094_Map_T100_SectionLayout_R0.mxd



- FLOW DIRECTION
- SURVEY POINT
- FLOOD CONTROL STRUCTURE
- CROSS SECTION
- BRIDGE
- CULVERT
- WEIR
- APPROXIMATE CHANNEL CENTRELINE
- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

DATA SOURCES: Basemap from Esri.

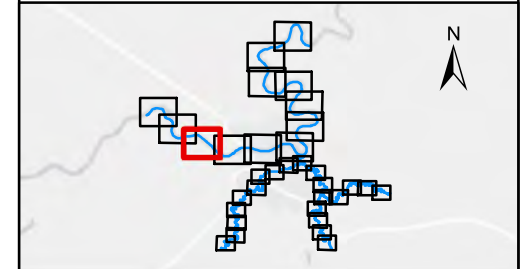
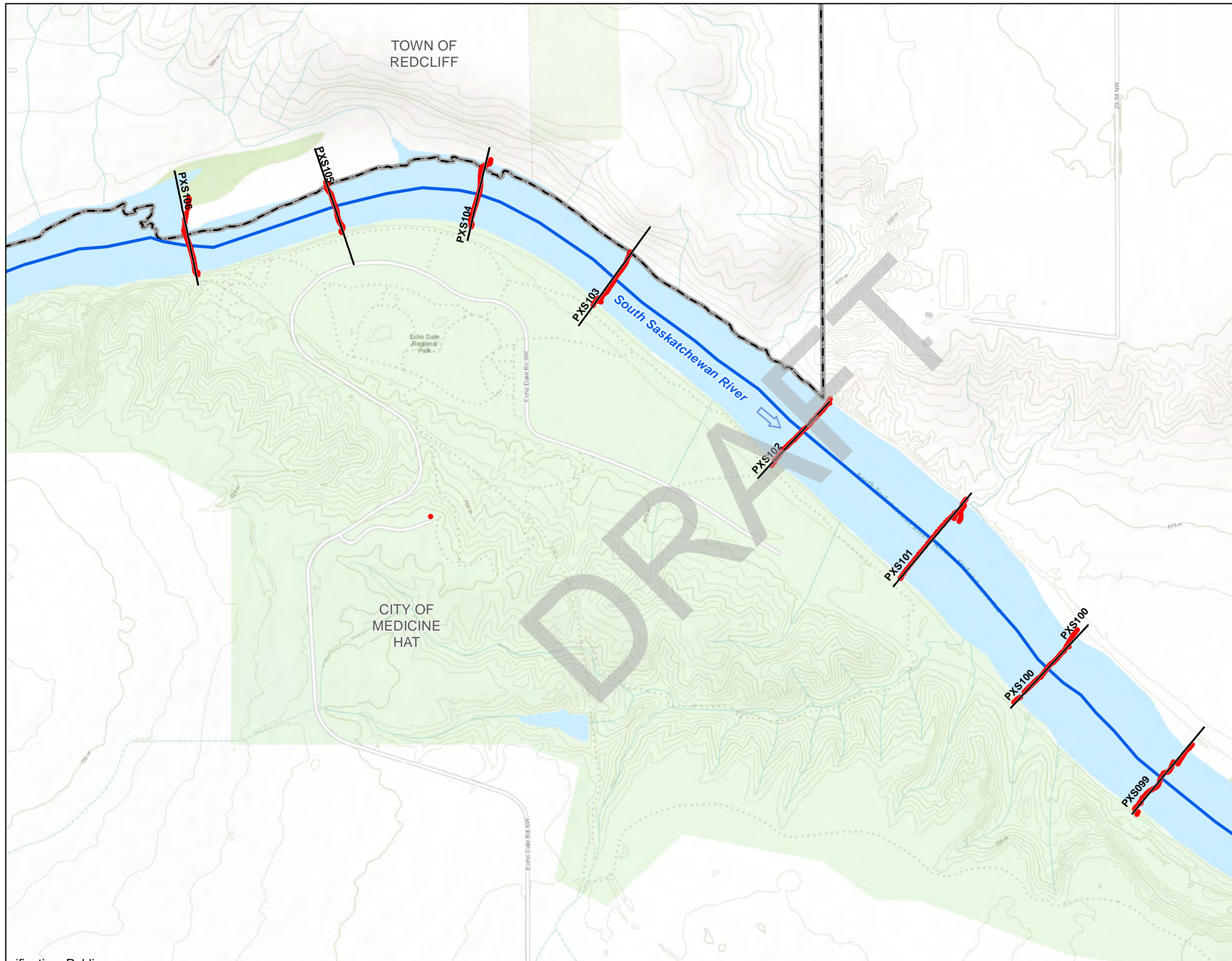












Coordinate System: NAD 1983 CSRS 3TM 111
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Job: 1003094 | Date: 20-AUG-2019

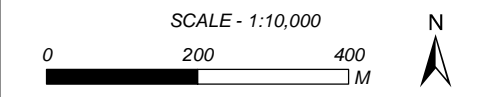
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
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MSN: P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Model\GIS\1003094_Map_T100_SectionLayout_R0.mxd



-  FLOW DIRECTION
-  SURVEY POINT
-  FLOOD CONTROL STRUCTURE
-  CROSS SECTION
-  BRIDGE
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-  WEIR
-  APPROXIMATE CHANNEL CENTRELINE
-  REDCLIFF TOWN BOUNDARY
-  MEDICINE HAT CITY BOUNDARY

DATA SOURCES: Basemap from Esri.



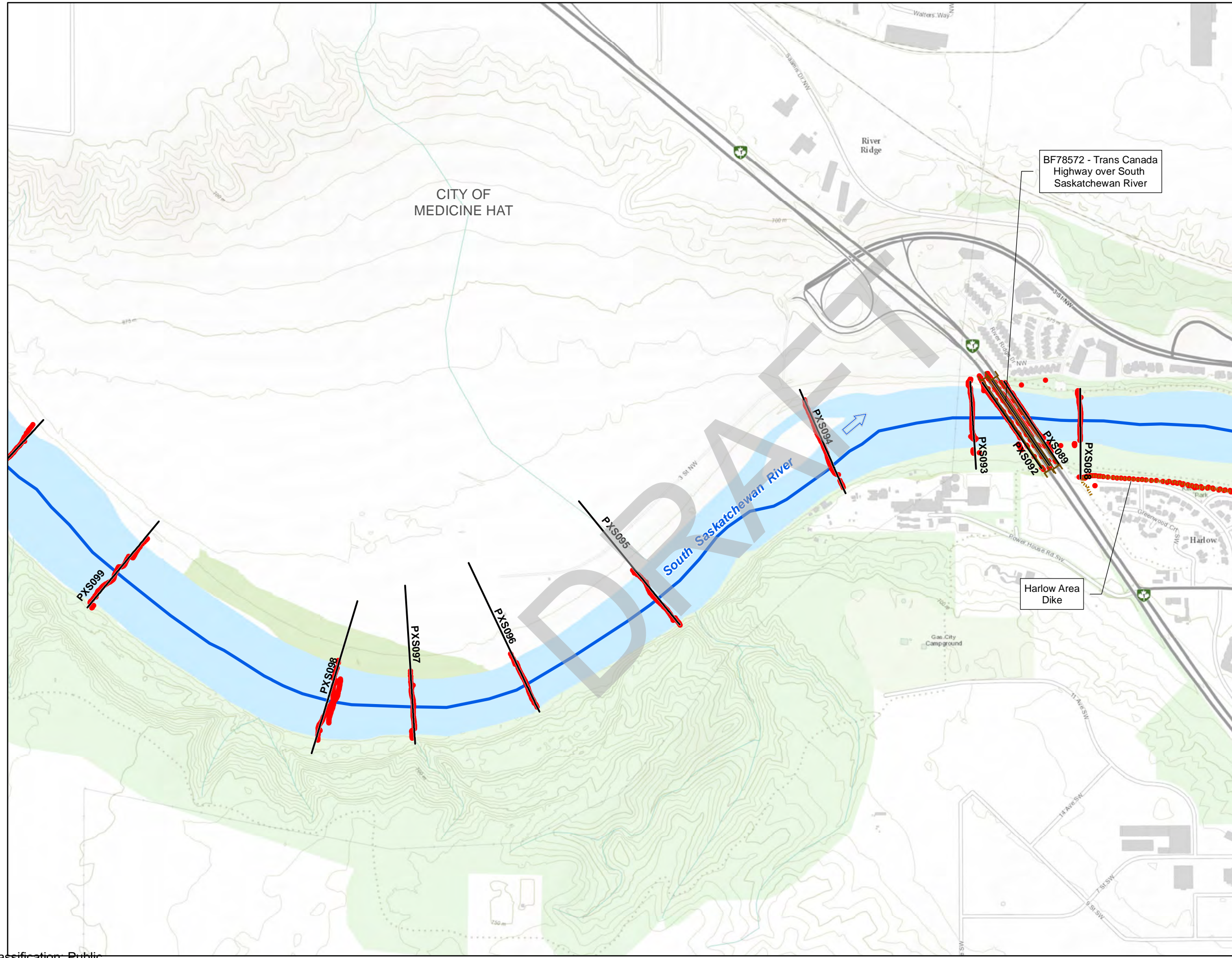
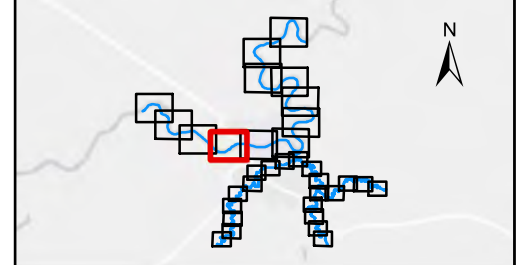
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Units: METRES

Job: 1003094 | Date: 20-AUG-2019

MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION

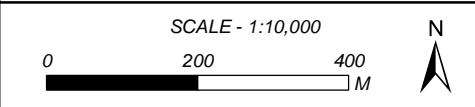
CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS

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- FLOW DIRECTION
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- MEDICINE HAT CITY BOUNDARY

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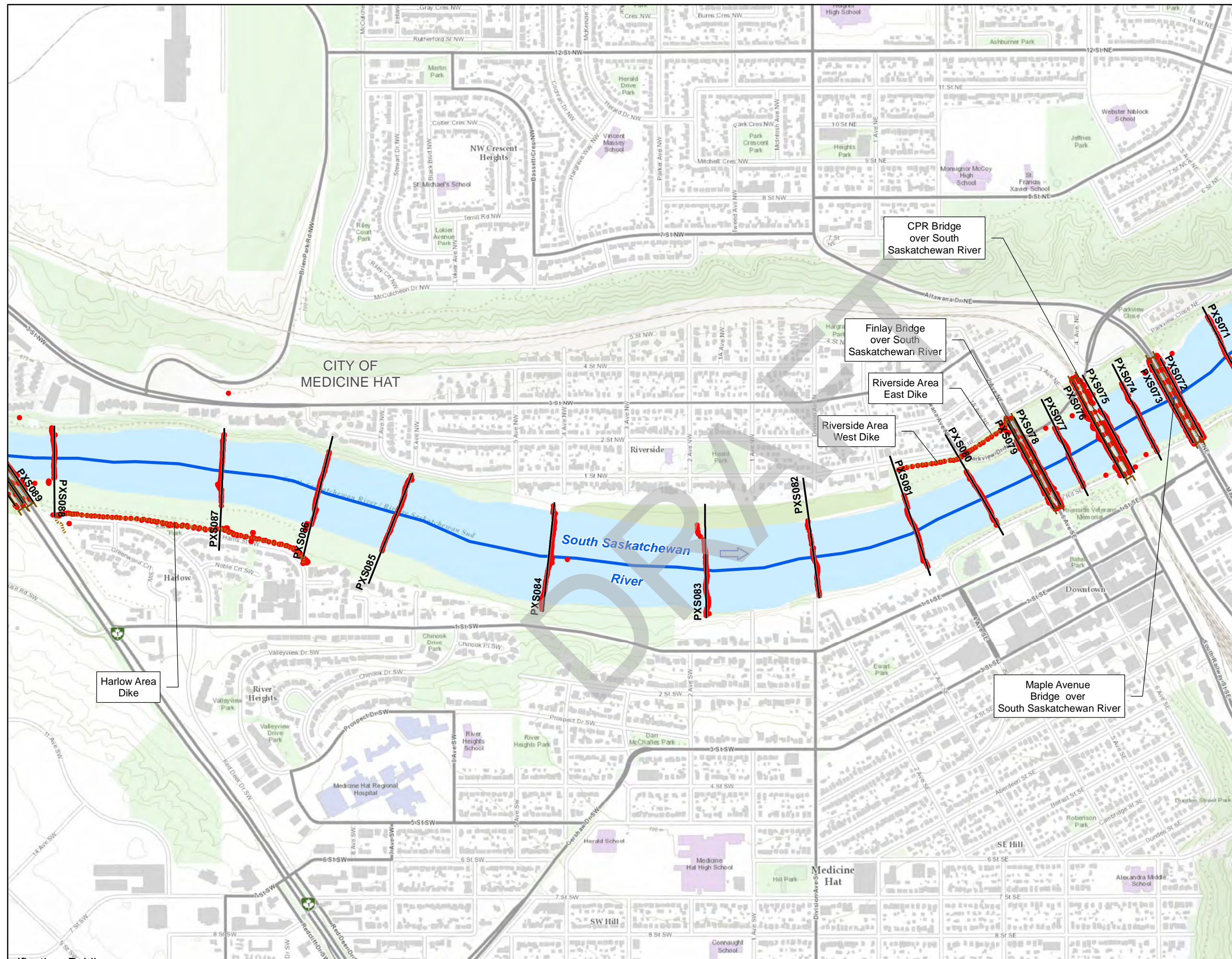
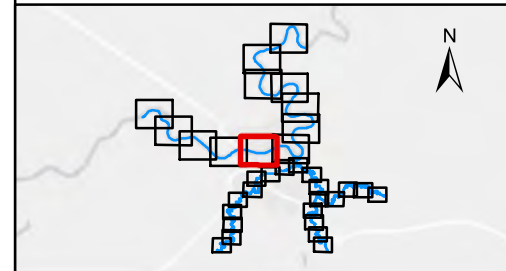


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Job: 1003094 | Date: 20-AUG-2019

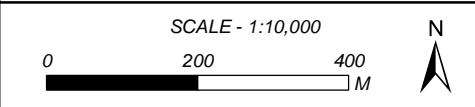
MEDICINE HAT RIVER HAZARD STUDY
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**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

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- FLOW DIRECTION
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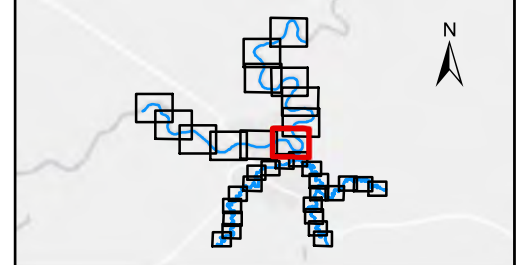
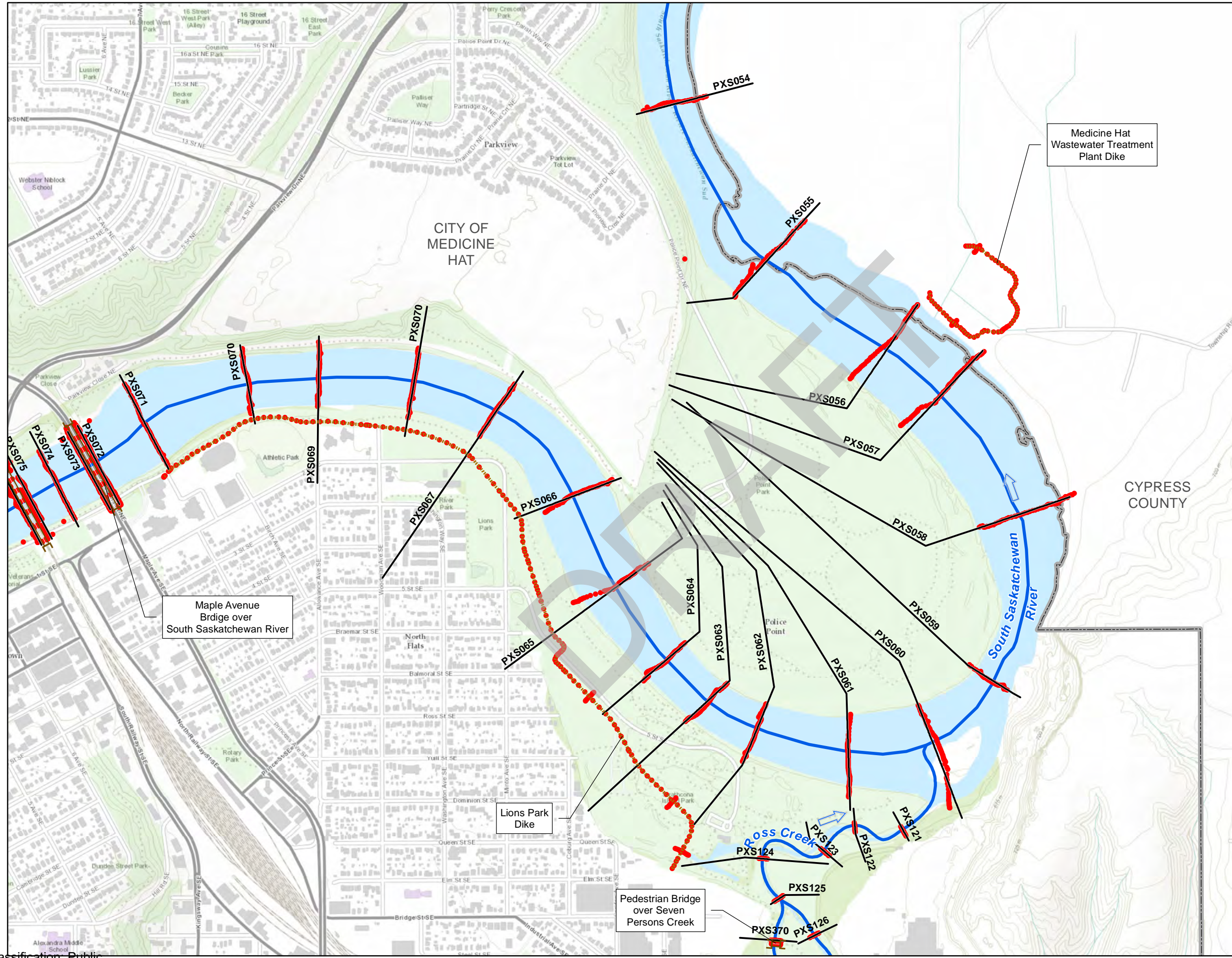


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Job: 1003094 | Date: 20-AUG-2019

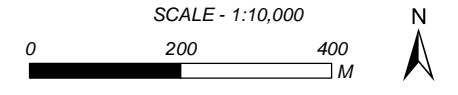
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**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

MSN: P:\Projects (Active)\1003094 - Medicine Hat River Hazard Study\04 - Models\GIS\1003094_Map_T100_SectionLayout_R0.mxd



- FLOW DIRECTION
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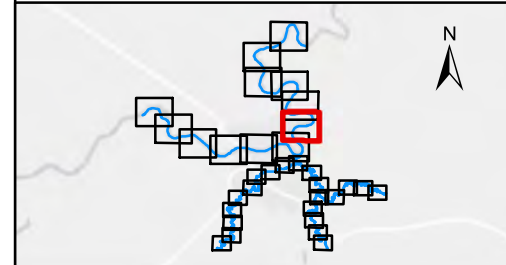
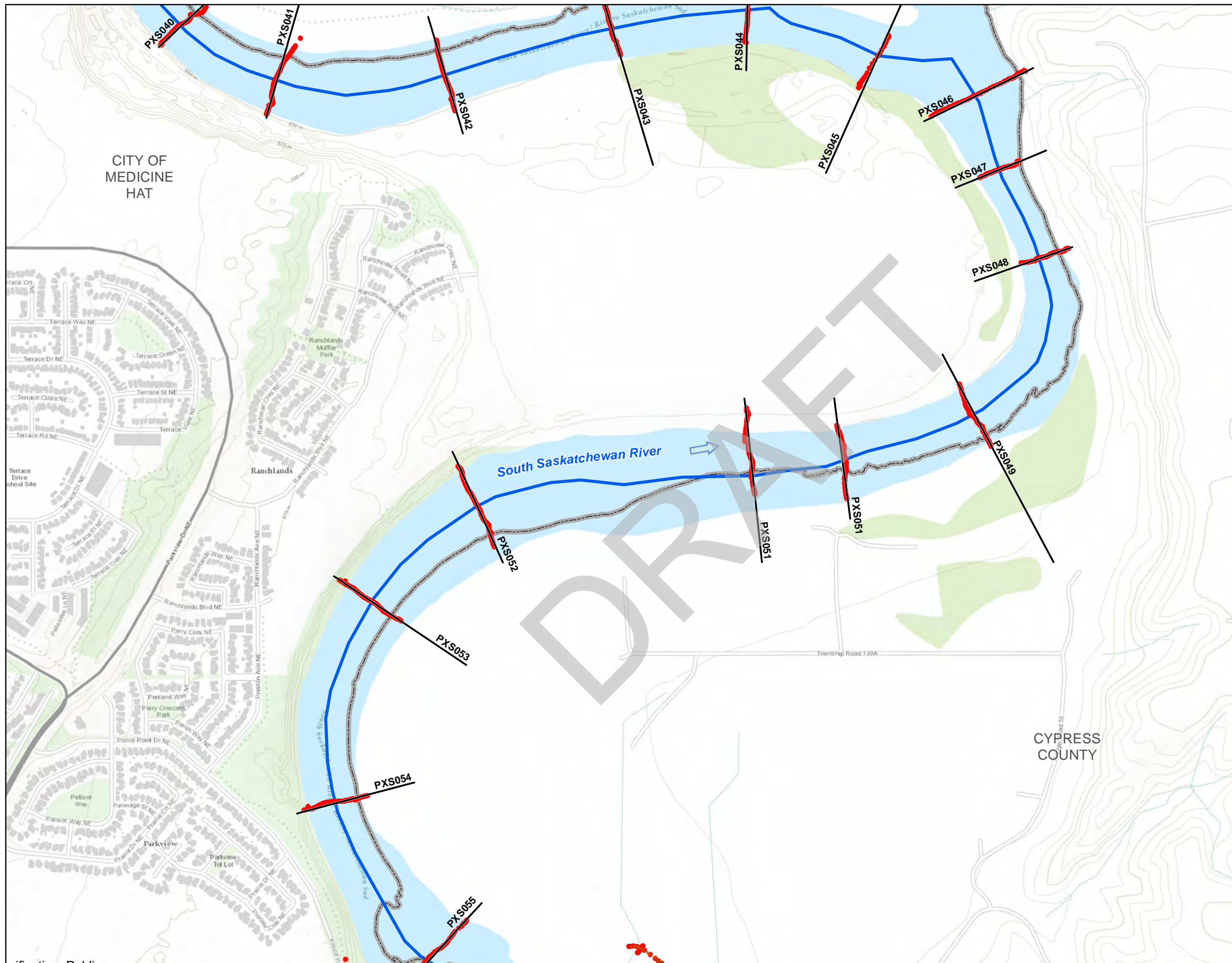


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Job: 1003094 | Date: 20-AUG-2019

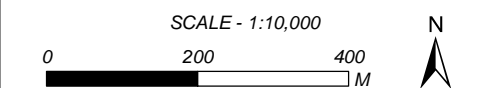
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**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

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- FLOW DIRECTION
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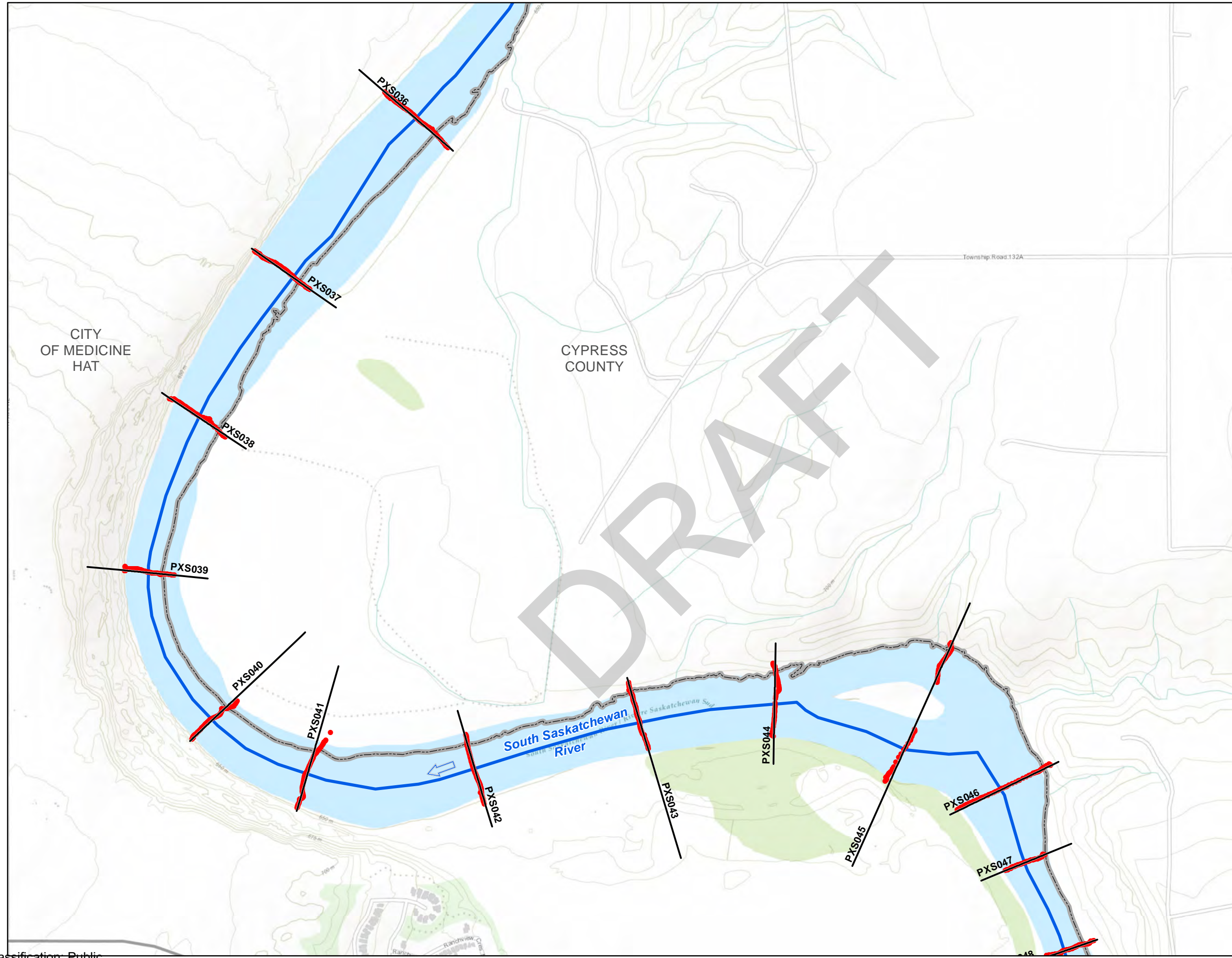
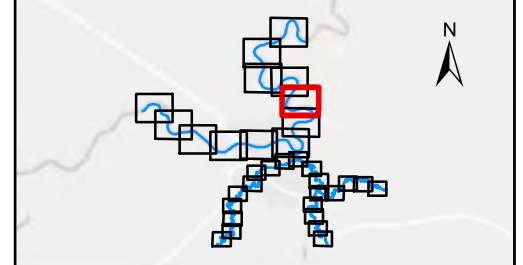
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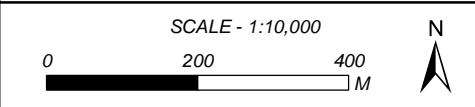
Job: 1003094 | Date: 20-AUG-2019

MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS



- FLOW DIRECTION
- SURVEY POINT
- FLOOD CONTROL STRUCTURE
- CROSS SECTION
- BRIDGE
- CULVERT
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- APPROXIMATE CHANNEL CENTRELINE
- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

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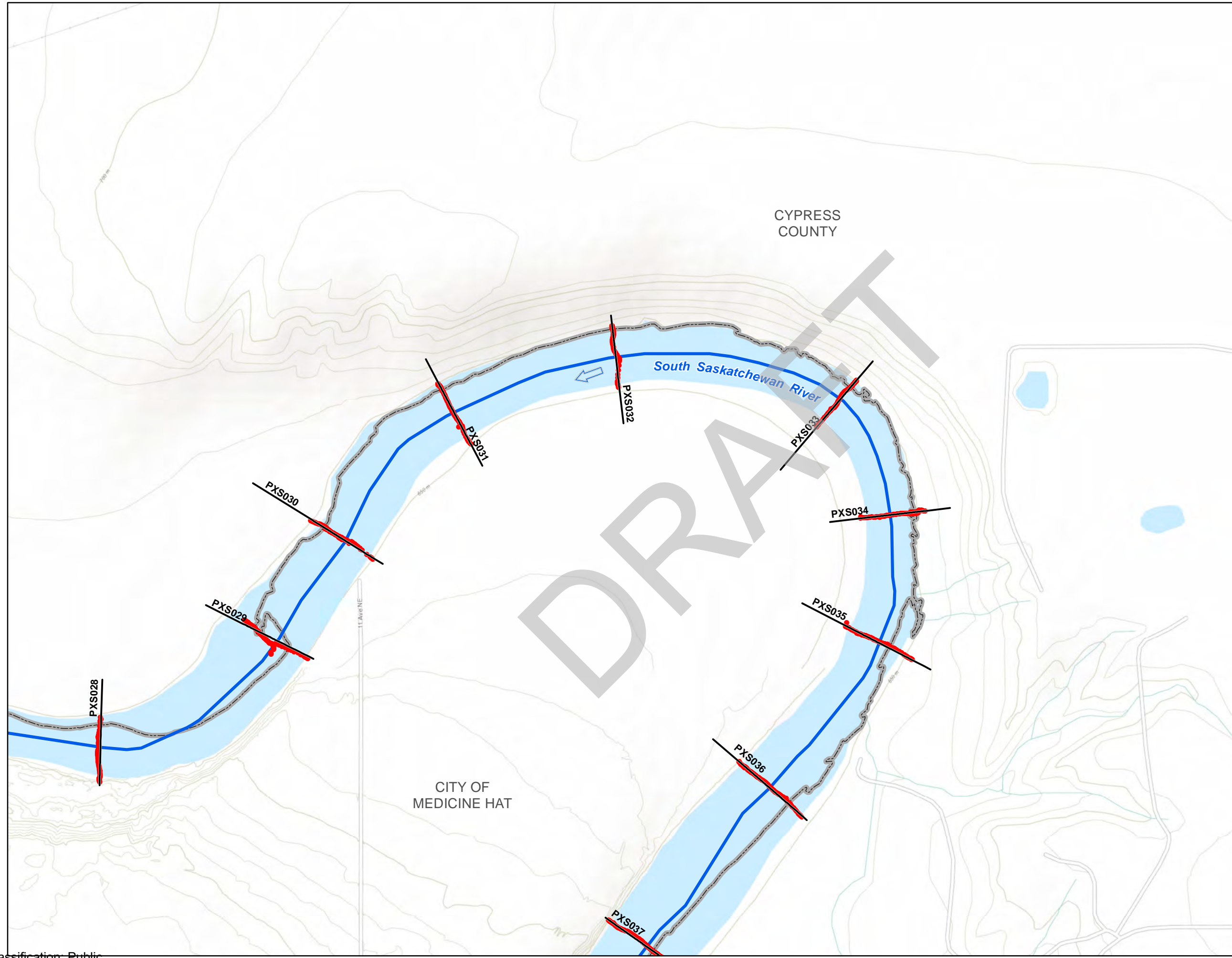
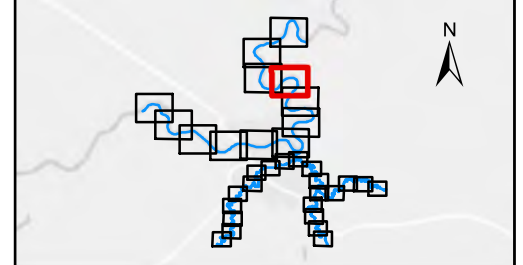


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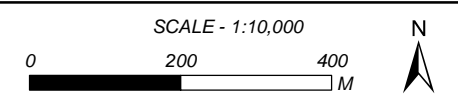
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

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- FLOW DIRECTION
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- REDCLIFF TOWN BOUNDARY
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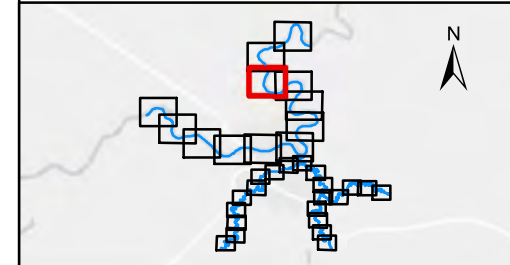
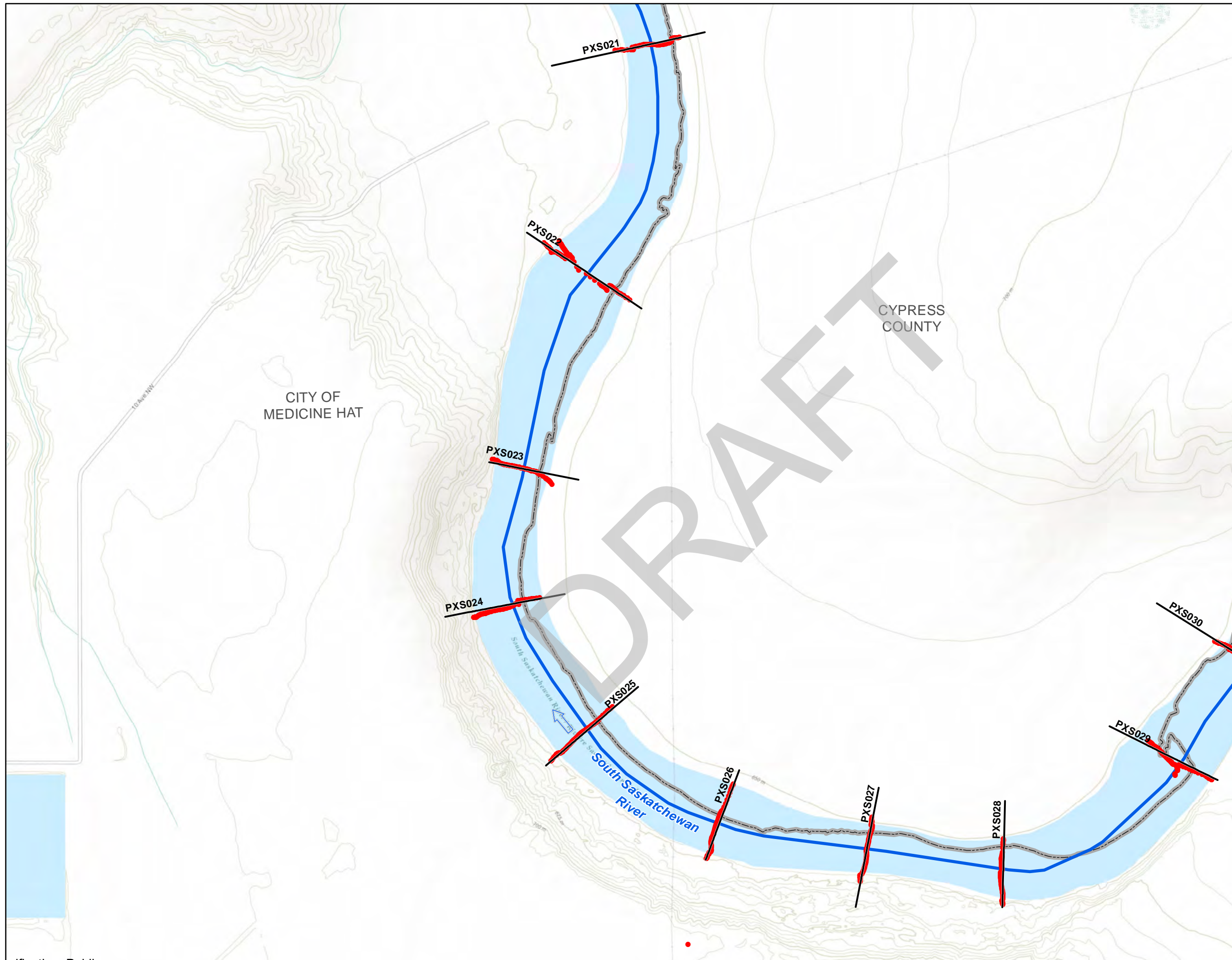












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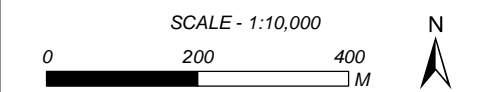
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

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-  FLOW DIRECTION
-  SURVEY POINT
-  FLOOD CONTROL STRUCTURE
-  CROSS SECTION
-  BRIDGE
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-  REDCLIFF TOWN BOUNDARY
-  MEDICINE HAT CITY BOUNDARY

DATA SOURCES: Basemap from Esri.



Coordinate System: NAD 1983 CSRS 3TM 111
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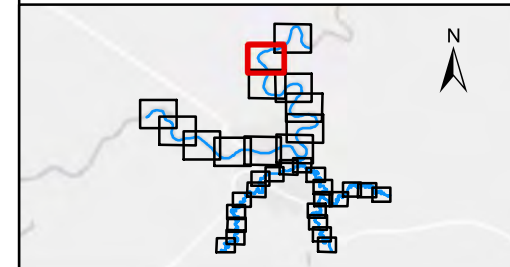
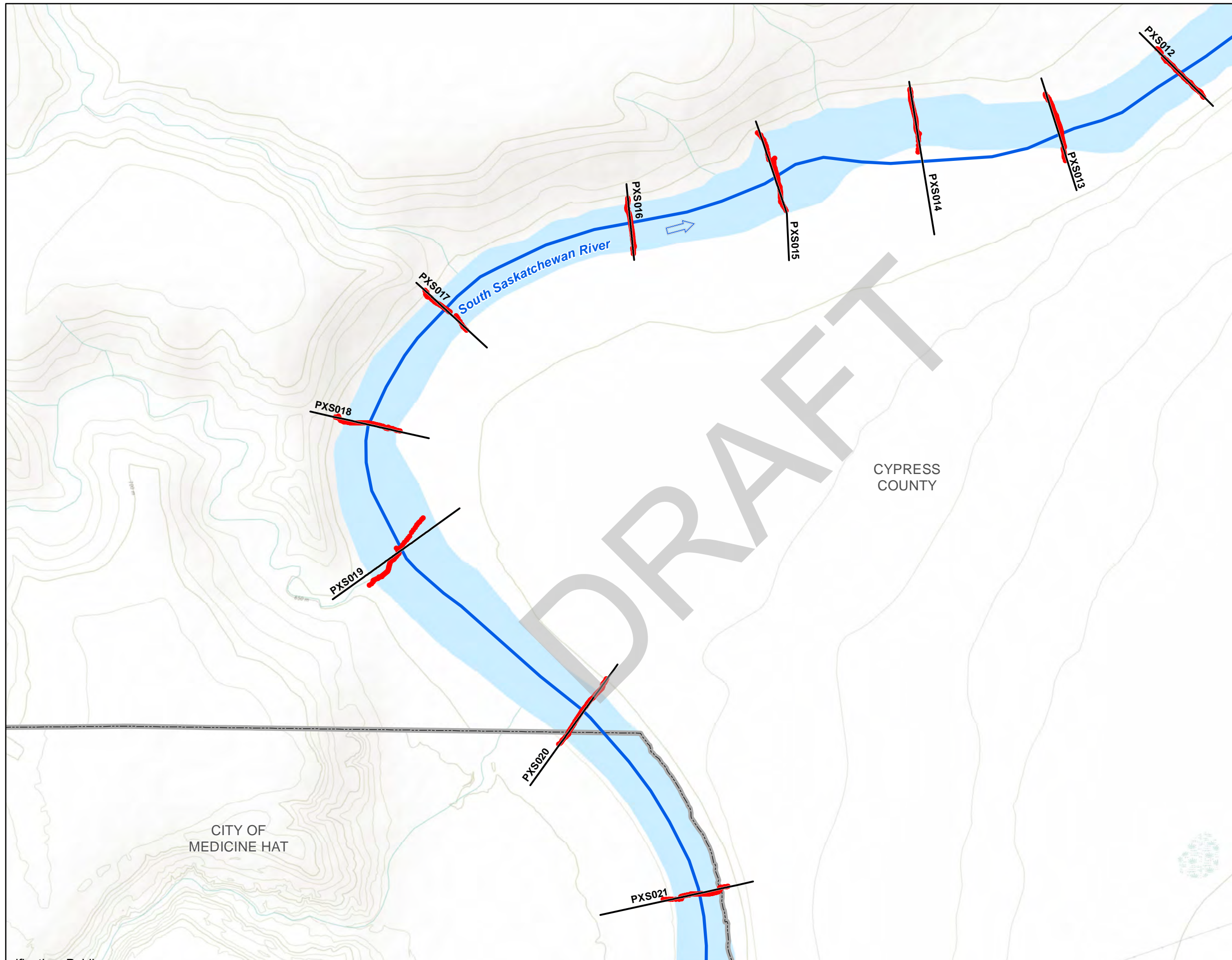
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MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION

CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS

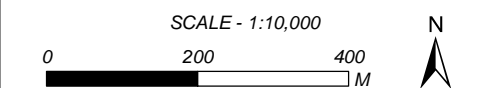
SHEET 10 OF 33 | FIGURE 2

MSN: P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Model\GIS\1003094_Map_T100_SectionLayout_R0.mxd



- FLOW DIRECTION
- SURVEY POINT
- FLOOD CONTROL STRUCTURE
- CROSS SECTION
- BRIDGE
- CULVERT
- WEIR
- APPROXIMATE CHANNEL CENTRELINE
- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

DATA SOURCES: Basemap from Esri.



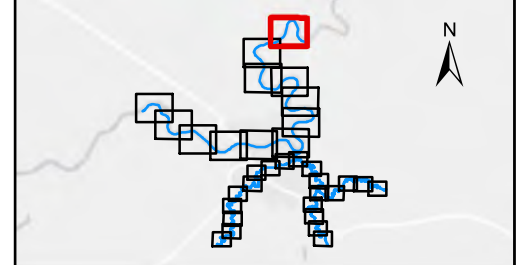
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Job: 1003094 | Date: 20-AUG-2019

MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION

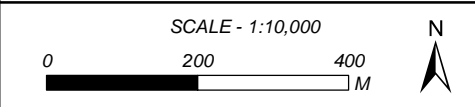
CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS

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- FLOW DIRECTION
- SURVEY POINT
- FLOOD CONTROL STRUCTURE
- CROSS SECTION
- BRIDGE
- CULVERT
- WEIR
- APPROXIMATE CHANNEL CENTRELINE
- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

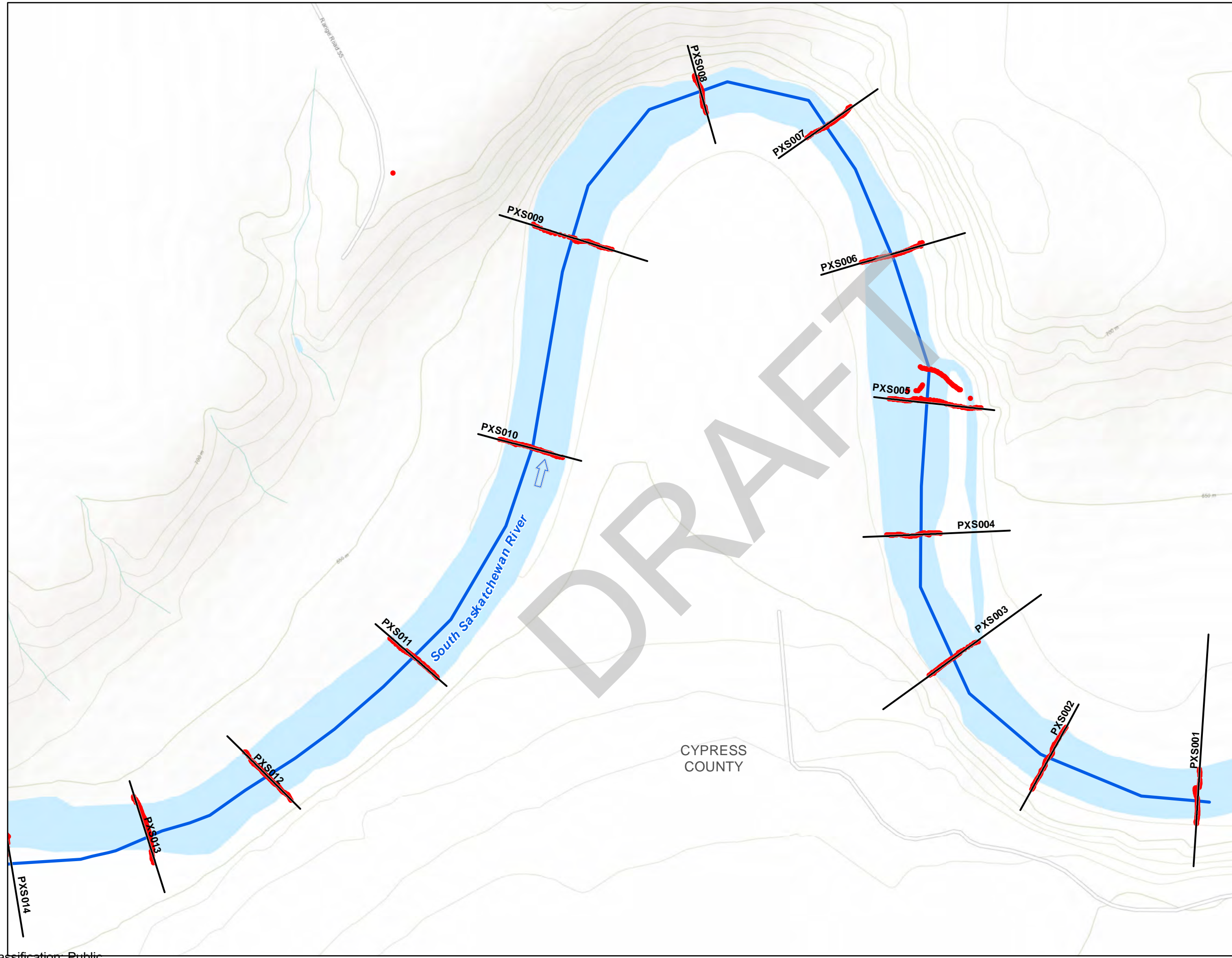
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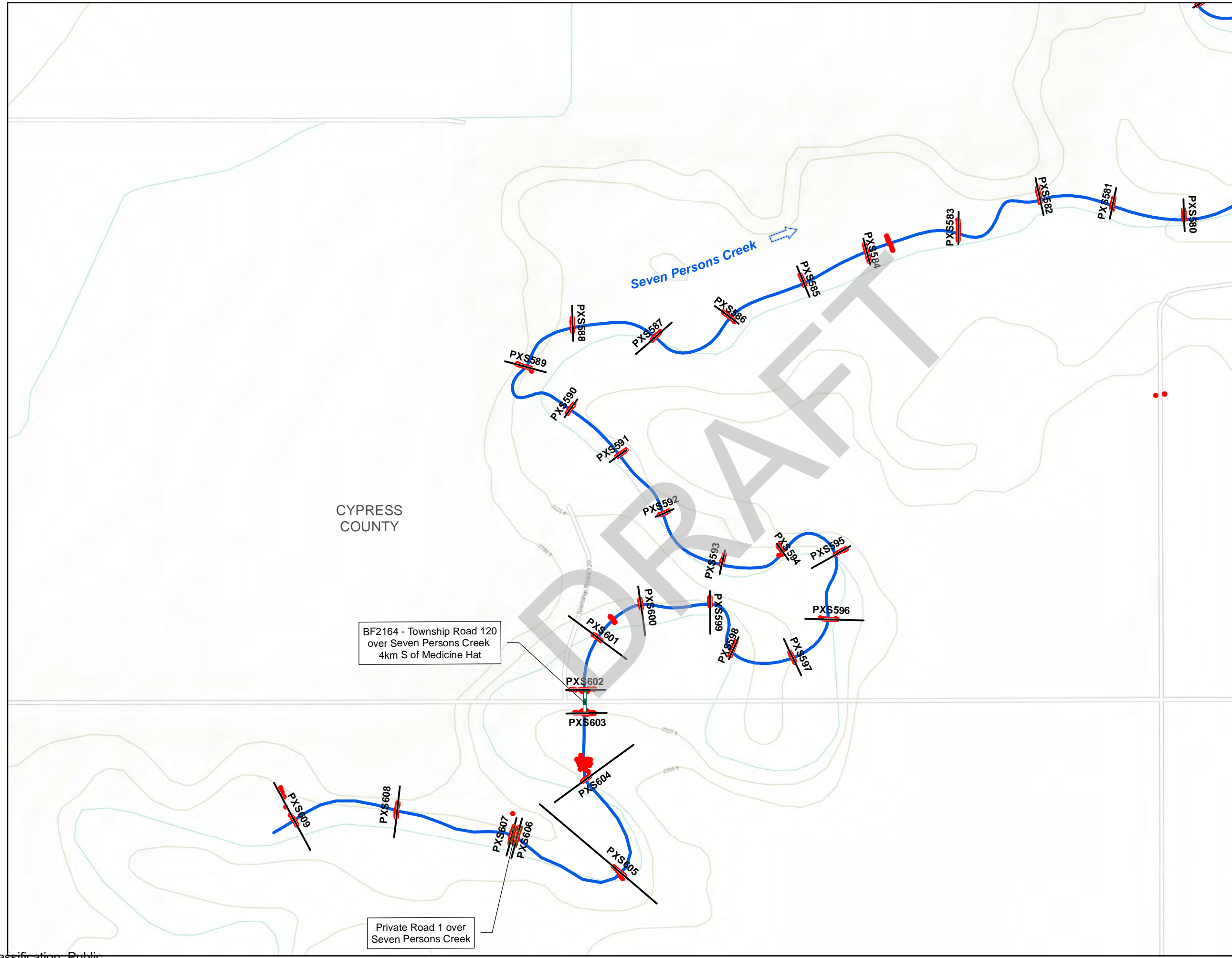
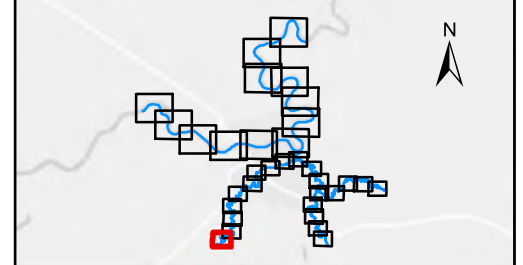
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Units: METRES

Job: 1003094 | Date: 20-AUG-2019

MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**



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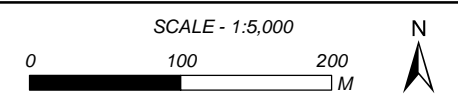
- FLOW DIRECTION
- SURVEY POINT
- FLOOD CONTROL STRUCTURE
- CROSS SECTION
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- MEDICINE HAT CITY BOUNDARY

CYPRESS COUNTY

BF2164 - Township Road 120
over Seven Persons Creek
4km S of Medicine Hat

Private Road 1 over
Seven Persons Creek

DATA SOURCES: Basemap from Esri.



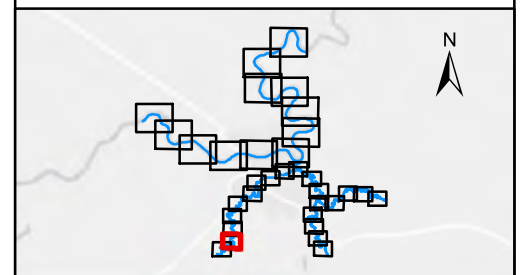
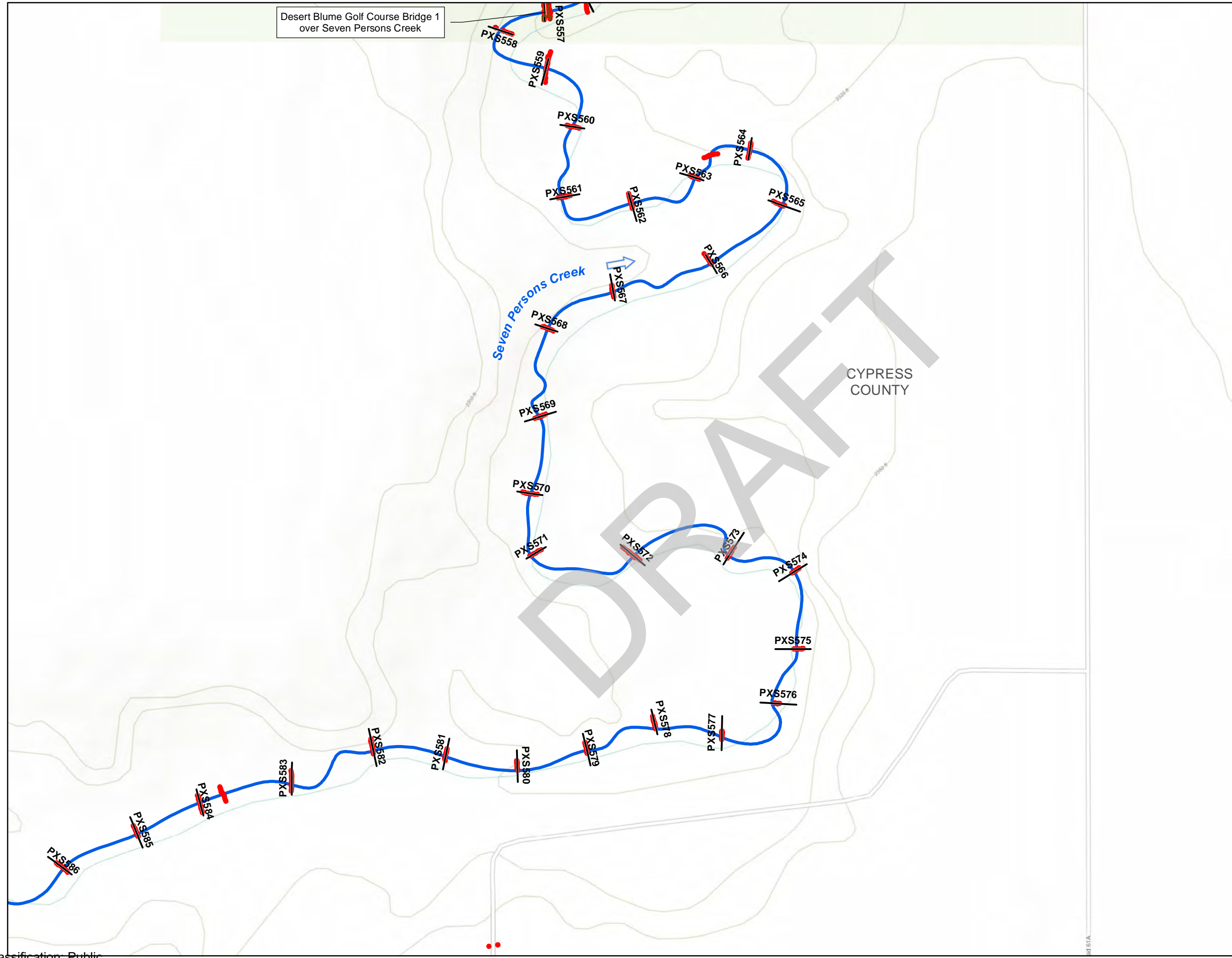
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Job: 1003094 | Date: 20-AUG-2019

MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

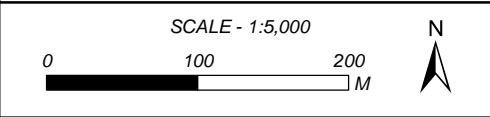
SHEET 13 OF 33 | FIGURE 2

Desert Blume Golf Course Bridge 1
over Seven Persons Creek



- FLOW DIRECTION
- SURVEY POINT
- FLOOD CONTROL STRUCTURE
- CROSS SECTION
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- WEIR
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- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

DATA SOURCES: Basemap from Esri.

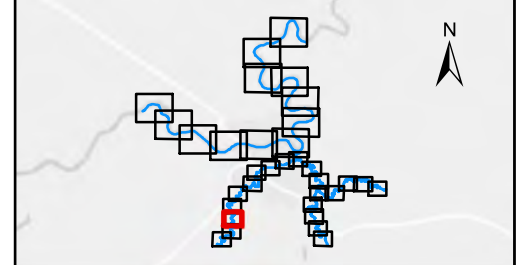
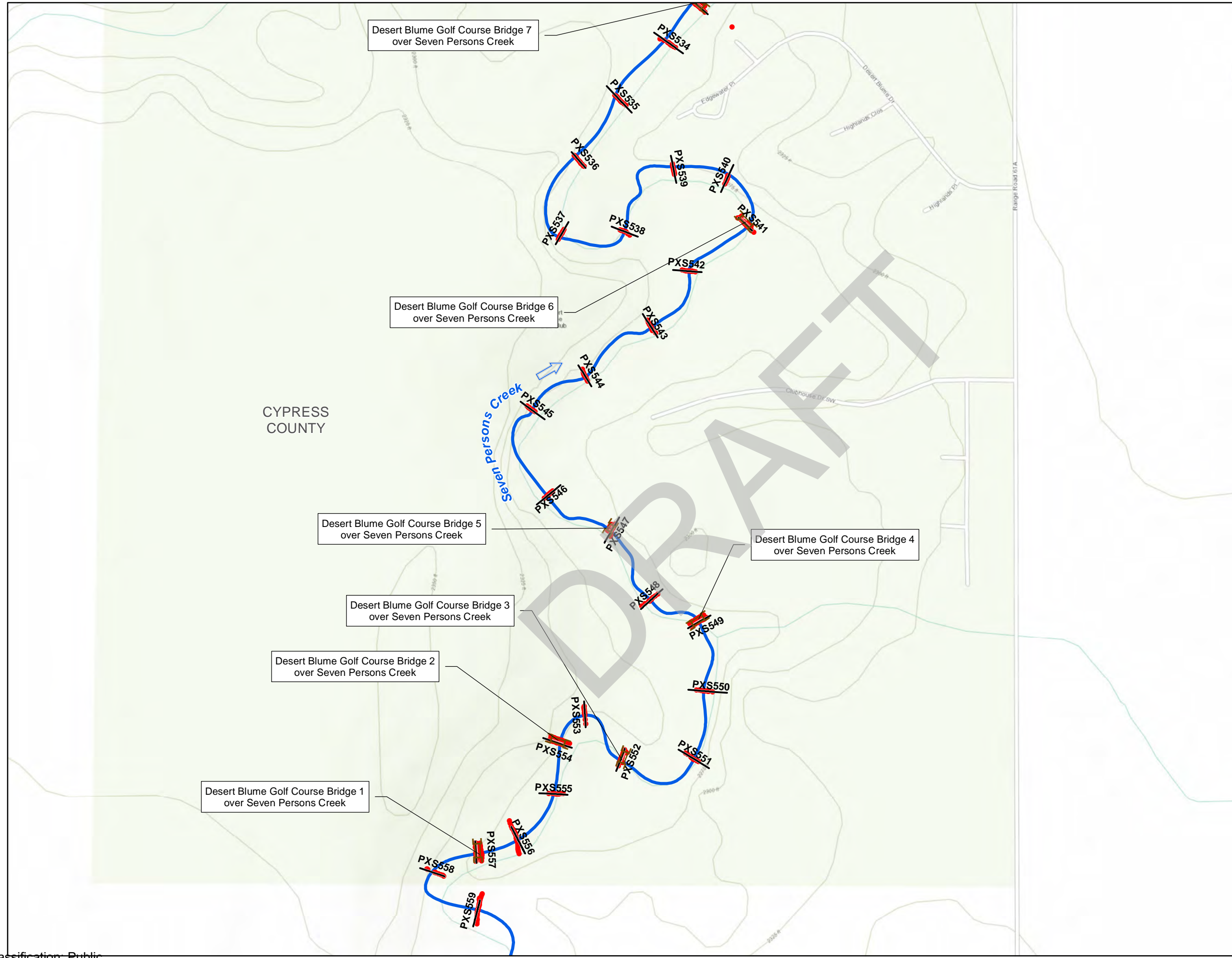


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Job: 1003094 | Date: 20-AUG-2019

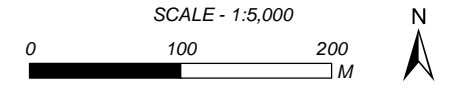
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
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- FLOW DIRECTION
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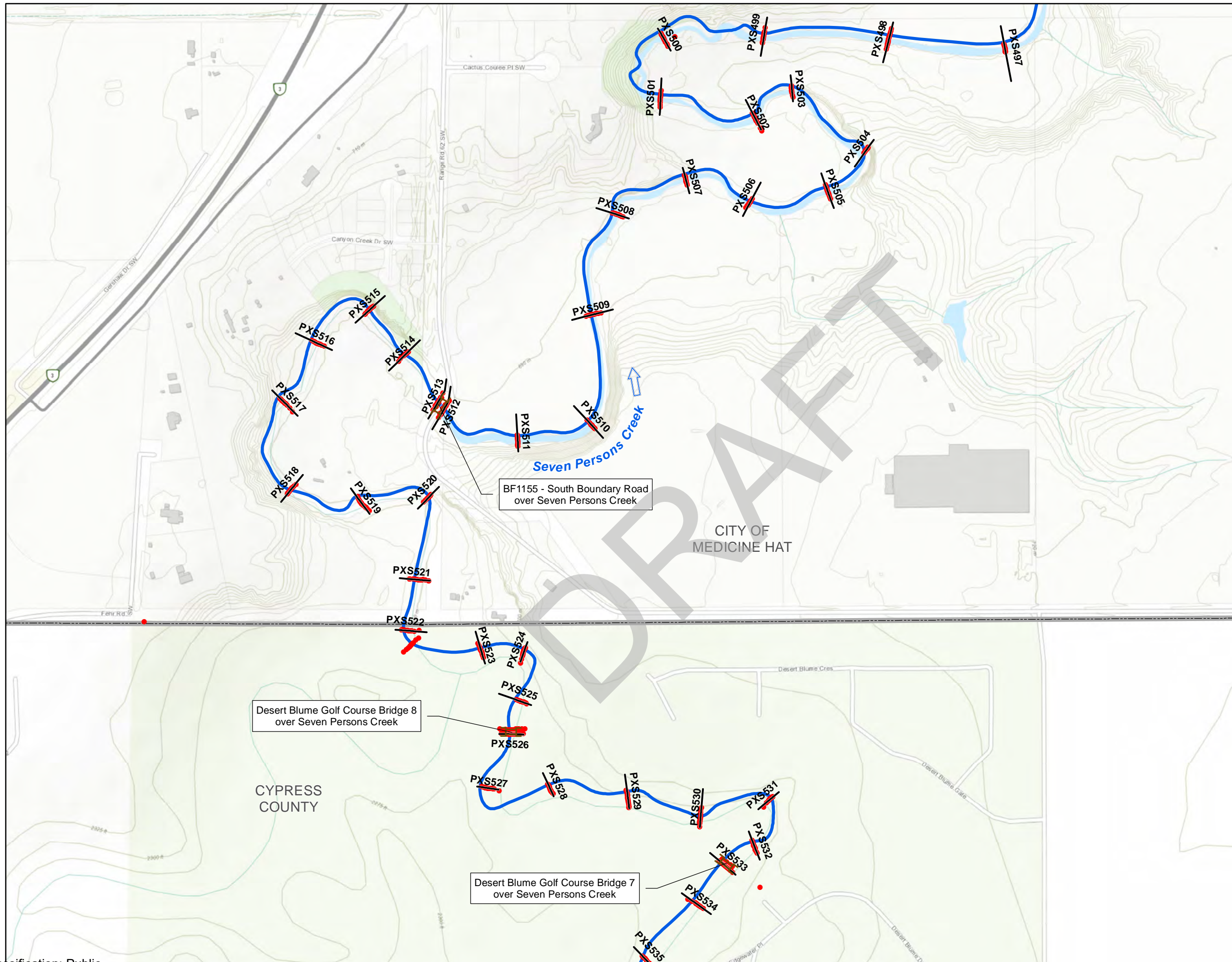
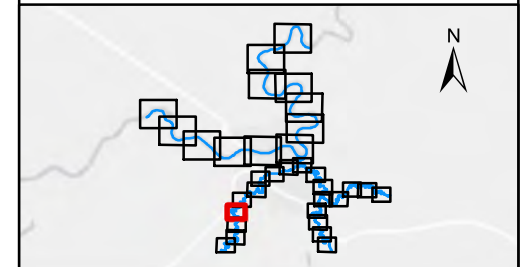


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Job: 1003094 | Date: 20-AUG-2019

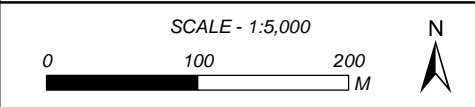
MEDICINE HAT RIVER HAZARD STUDY
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DATA SOURCES: Basemap from Esri.

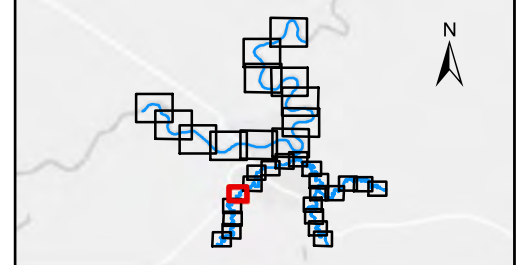
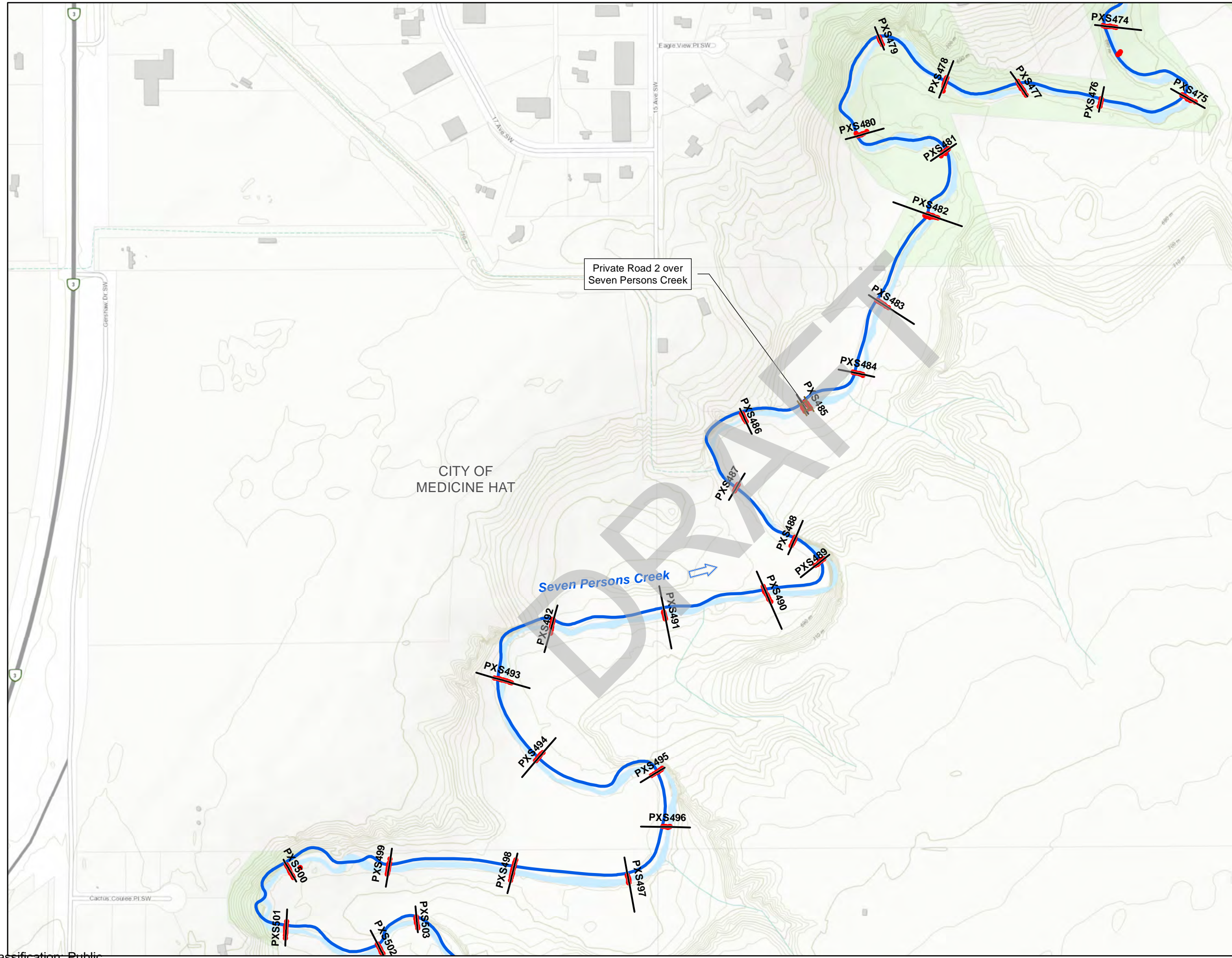


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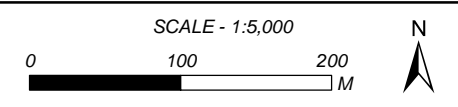
MEDICINE HAT RIVER HAZARD STUDY
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DATA SOURCES: Basemap from Esri.

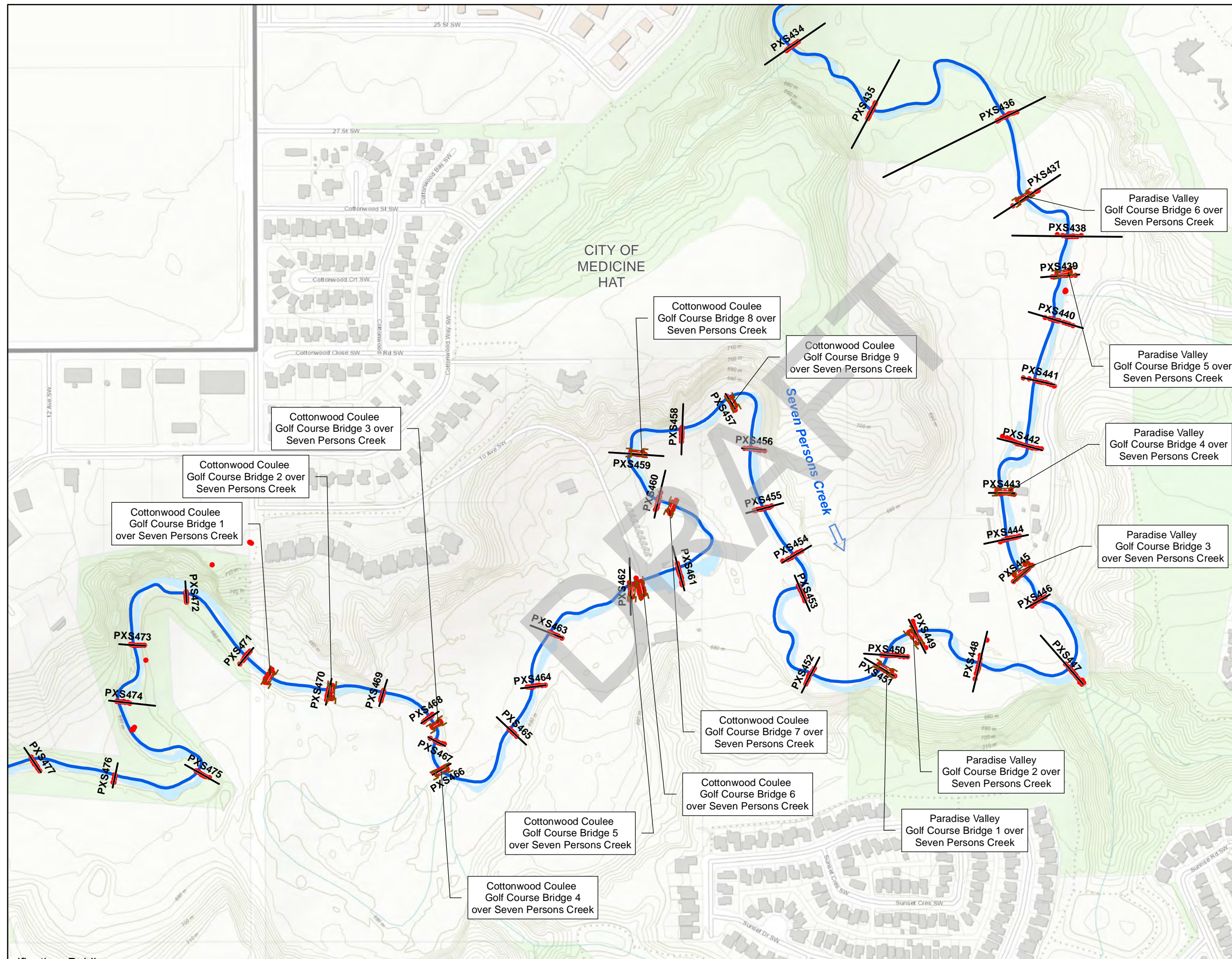
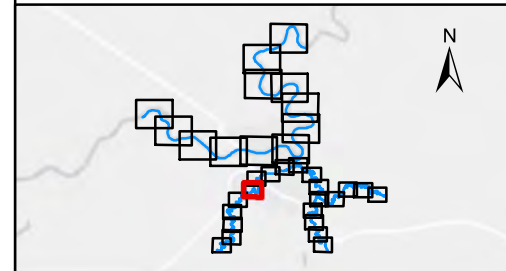


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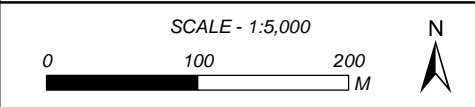
MEDICINE HAT RIVER HAZARD STUDY
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- MEDICINE HAT CITY BOUNDARY

DATA SOURCES: Basemap from Esri.

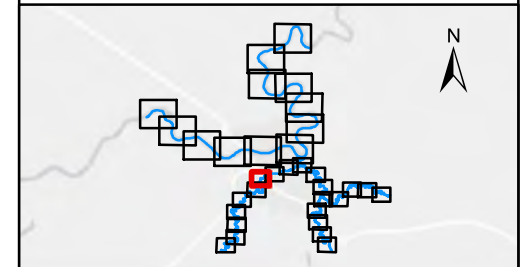
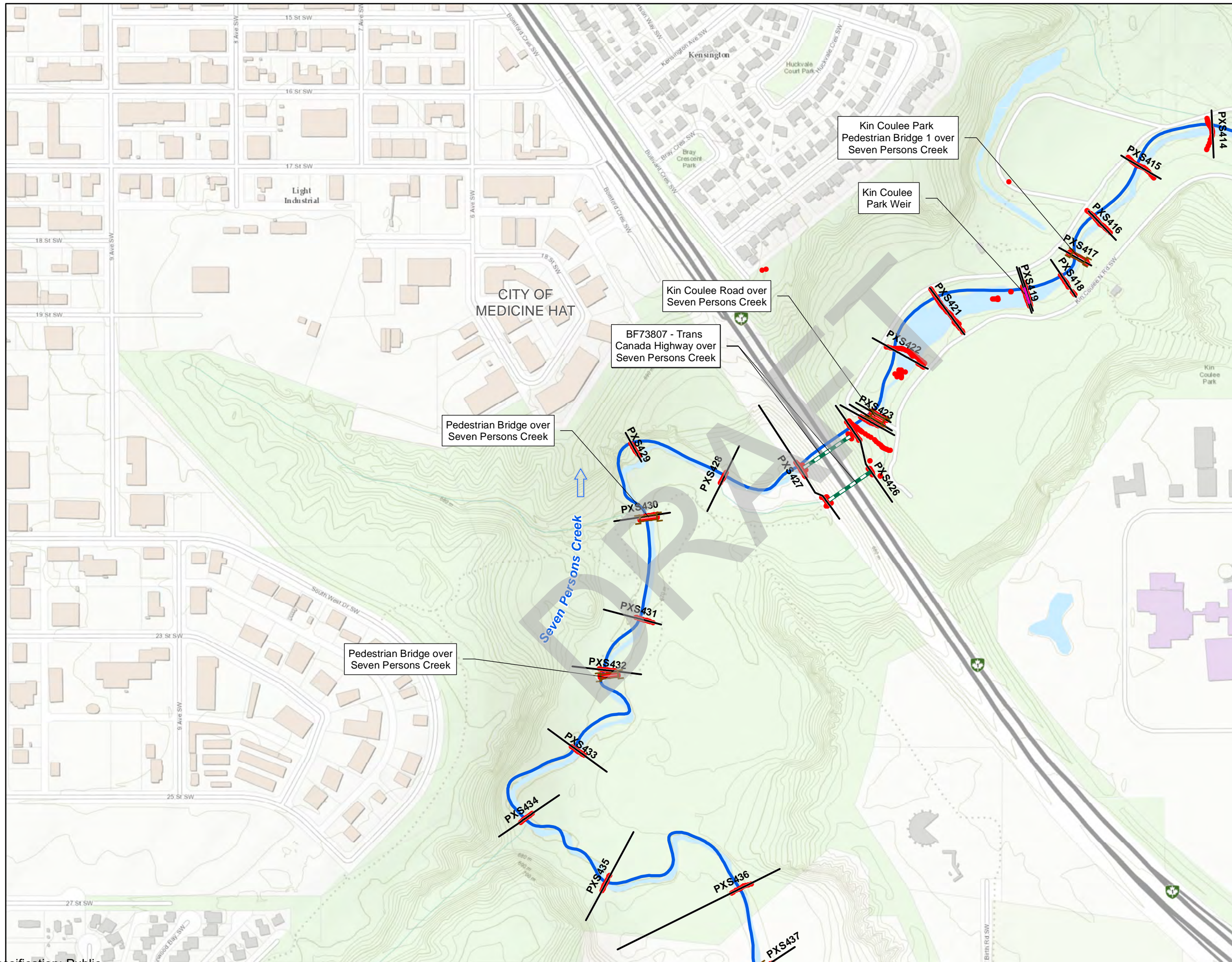


Coordinate System: NAD 1983 CSRS 3TM 111
Units: METRES

Job: 1003094 | Date: 20-AUG-2019

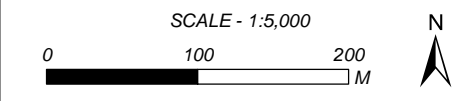
**MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION**
**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

MSN: P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Models\GIS\1003094_Map_T100_SectionLayout_R0.mxd



- FLOW DIRECTION
- SURVEY POINT
- FLOOD CONTROL STRUCTURE
- CROSS SECTION
- BRIDGE
- CULVERT
- WEIR
- APPROXIMATE CHANNEL CENTRELINE
- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

DATA SOURCES: Basemap from Esri.

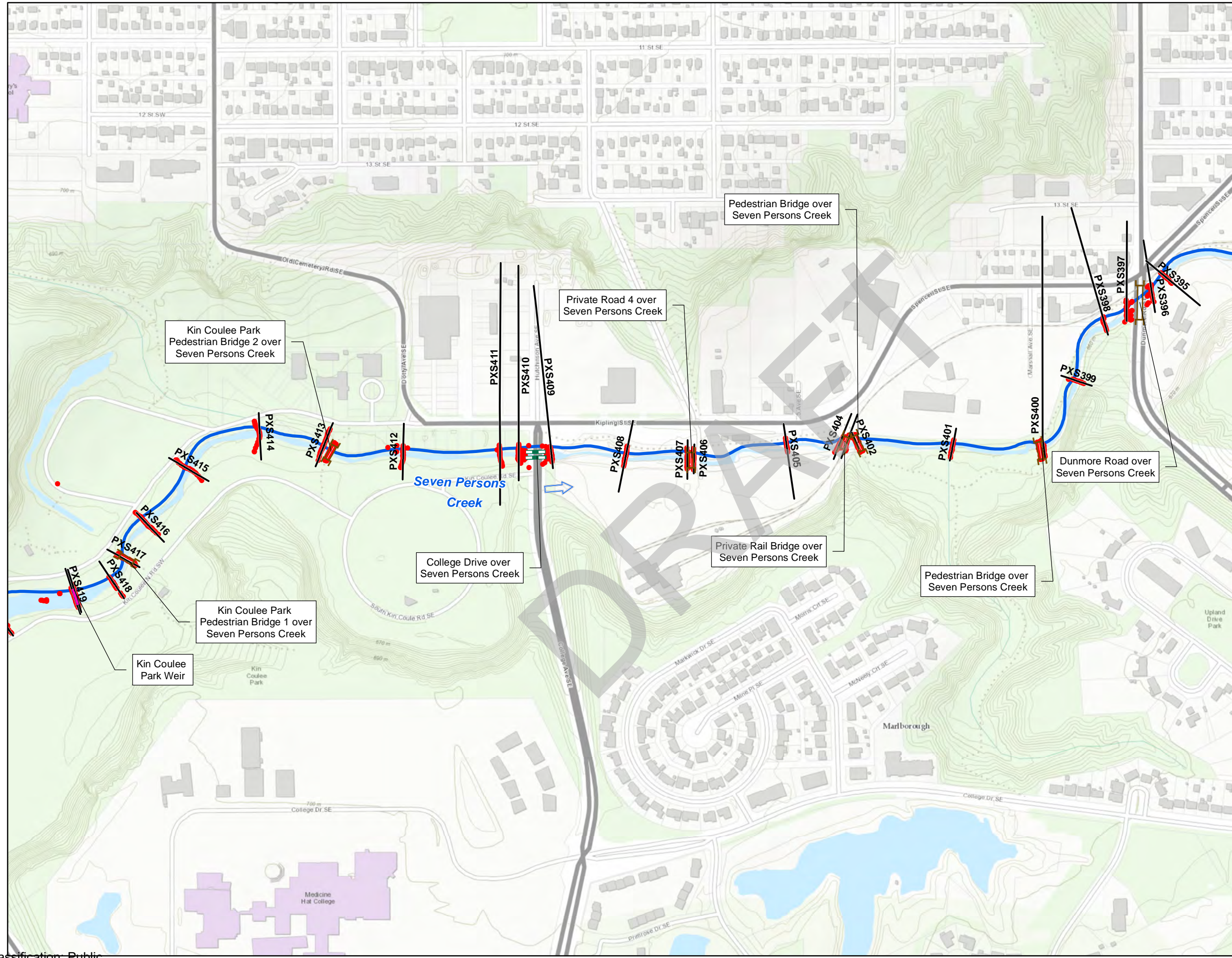
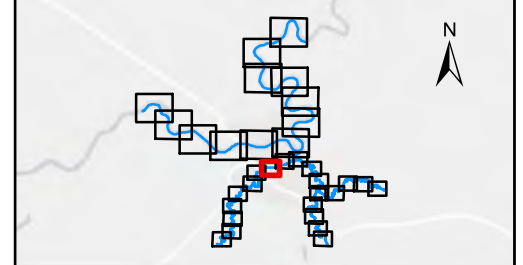


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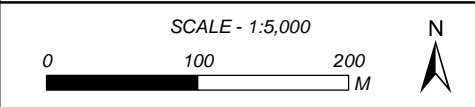
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

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- FLOW DIRECTION
- SURVEY POINT
- FLOOD CONTROL STRUCTURE
- CROSS SECTION
- BRIDGE
- CULVERT
- WEIR
- APPROXIMATE CHANNEL CENTRELINE
- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

DATA SOURCES: Basemap from Esri.

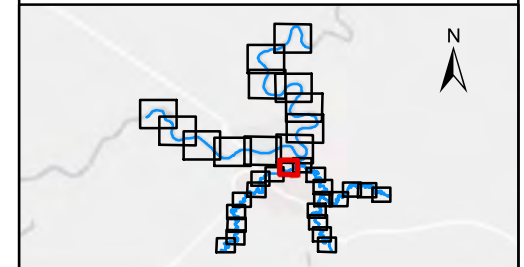


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Job: 1003094 | Date: 20-AUG-2019

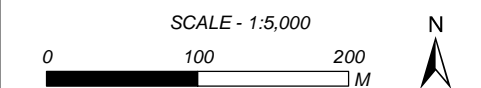
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
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- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

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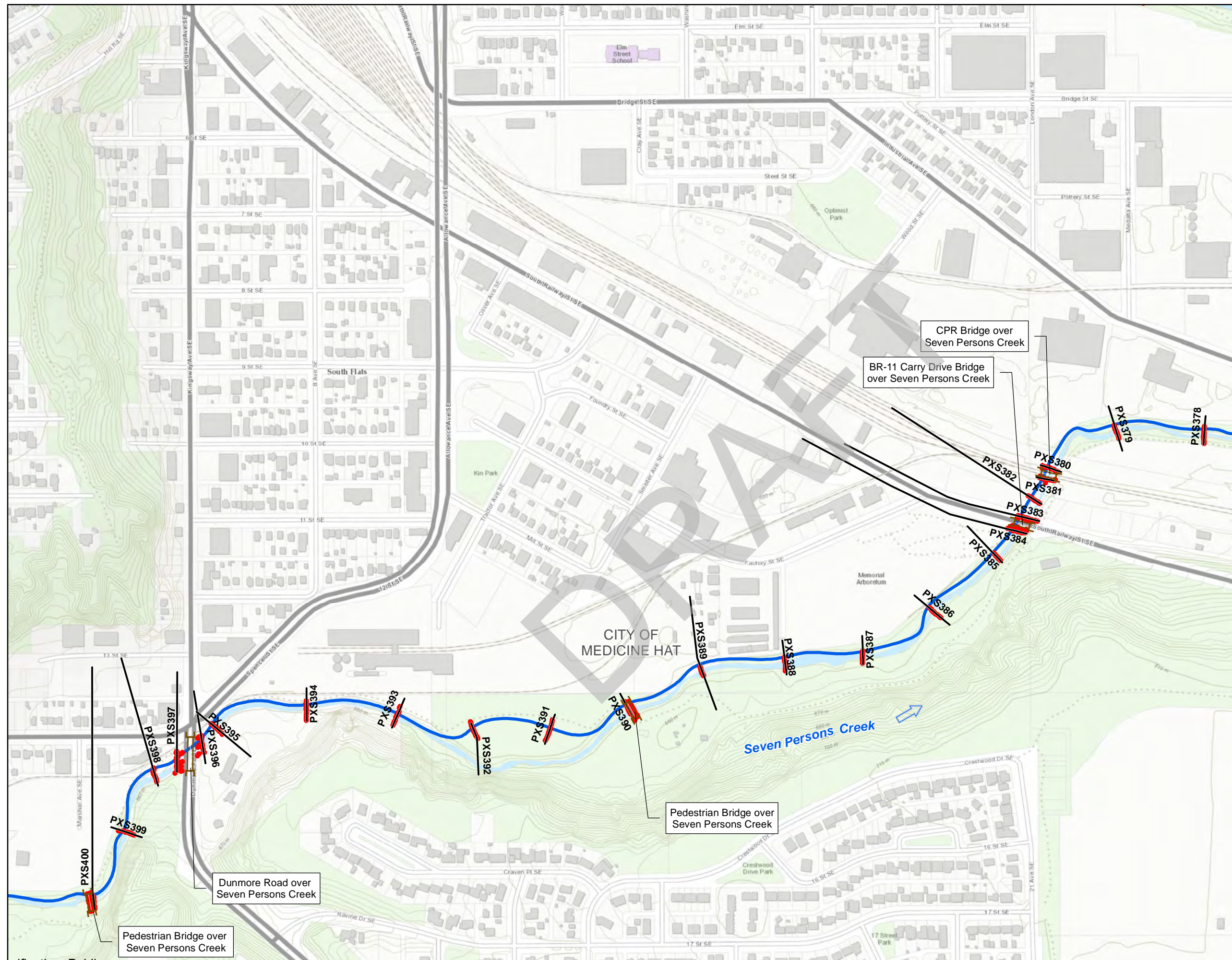
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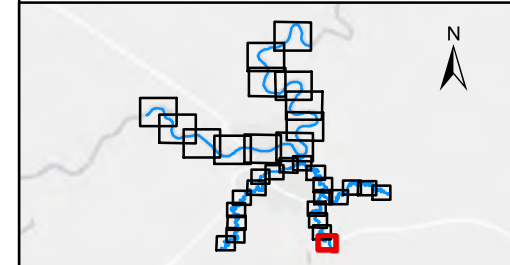
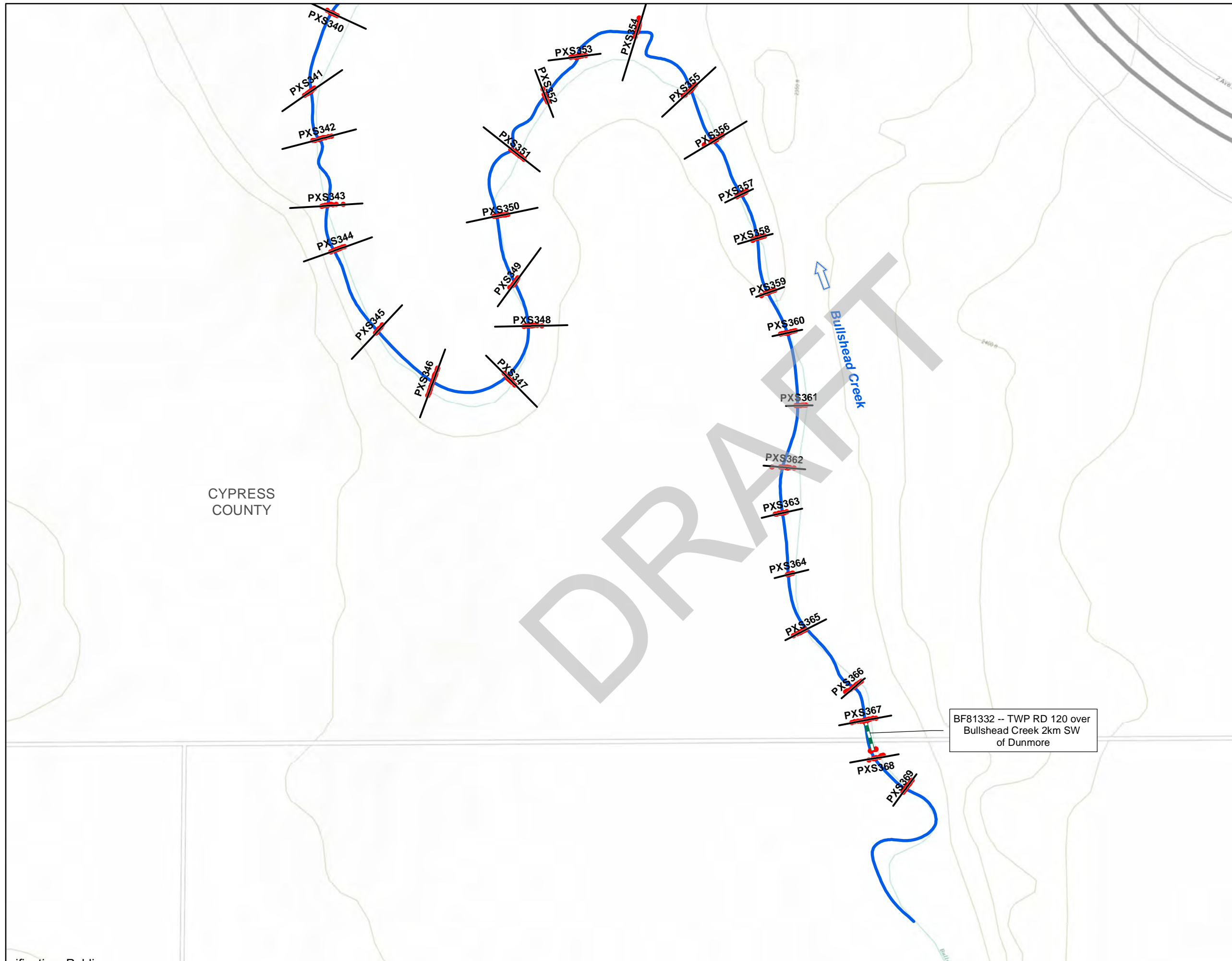
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MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION

CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS

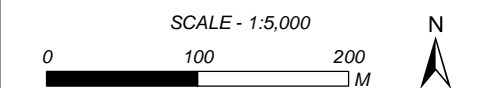
SHEET 21 OF 33 | FIGURE 2





- FLOW DIRECTION
- SURVEY POINT
- FLOOD CONTROL STRUCTURE
- CROSS SECTION
- BRIDGE
- CULVERT
- WEIR
- APPROXIMATE CHANNEL CENTRELINE
- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

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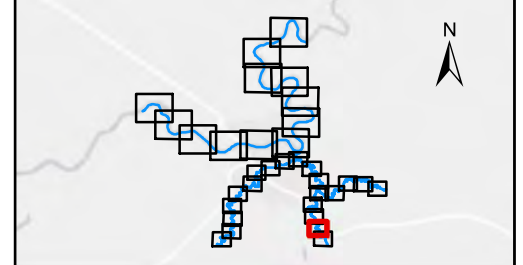
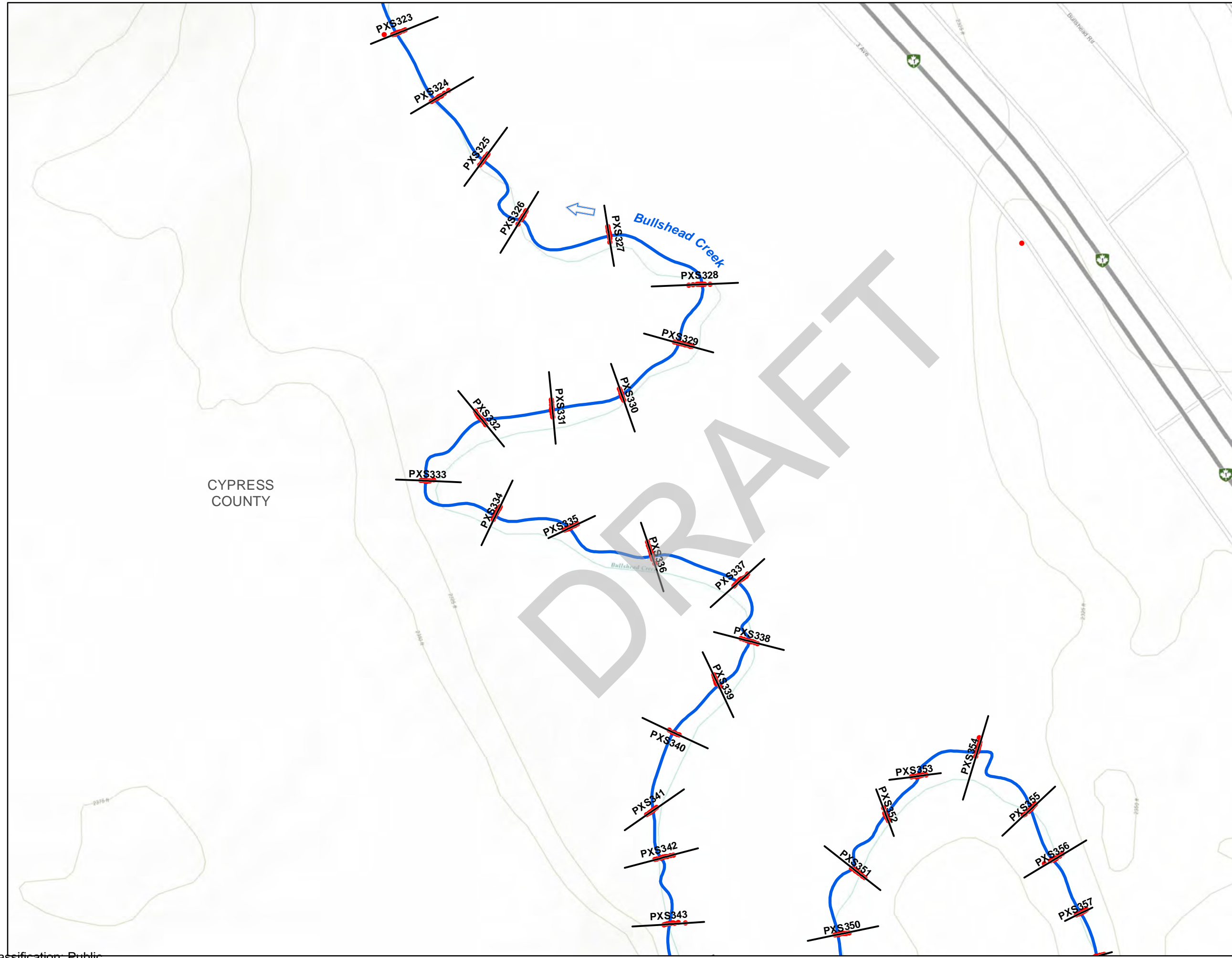


Coordinate System: NAD 1983 CSRS 3TM 111
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Job: 1003094 | Date: 20-AUG-2019

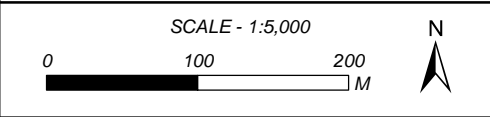
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
CROSS SECTION AND HYDRAULIC
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- FLOW DIRECTION
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- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

DATA SOURCES: Basemap from Esri.

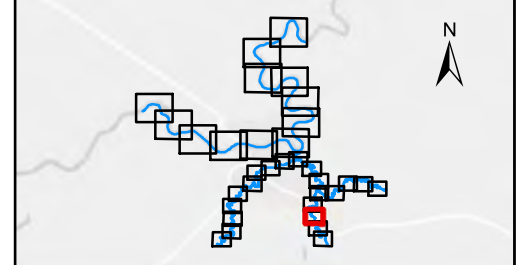
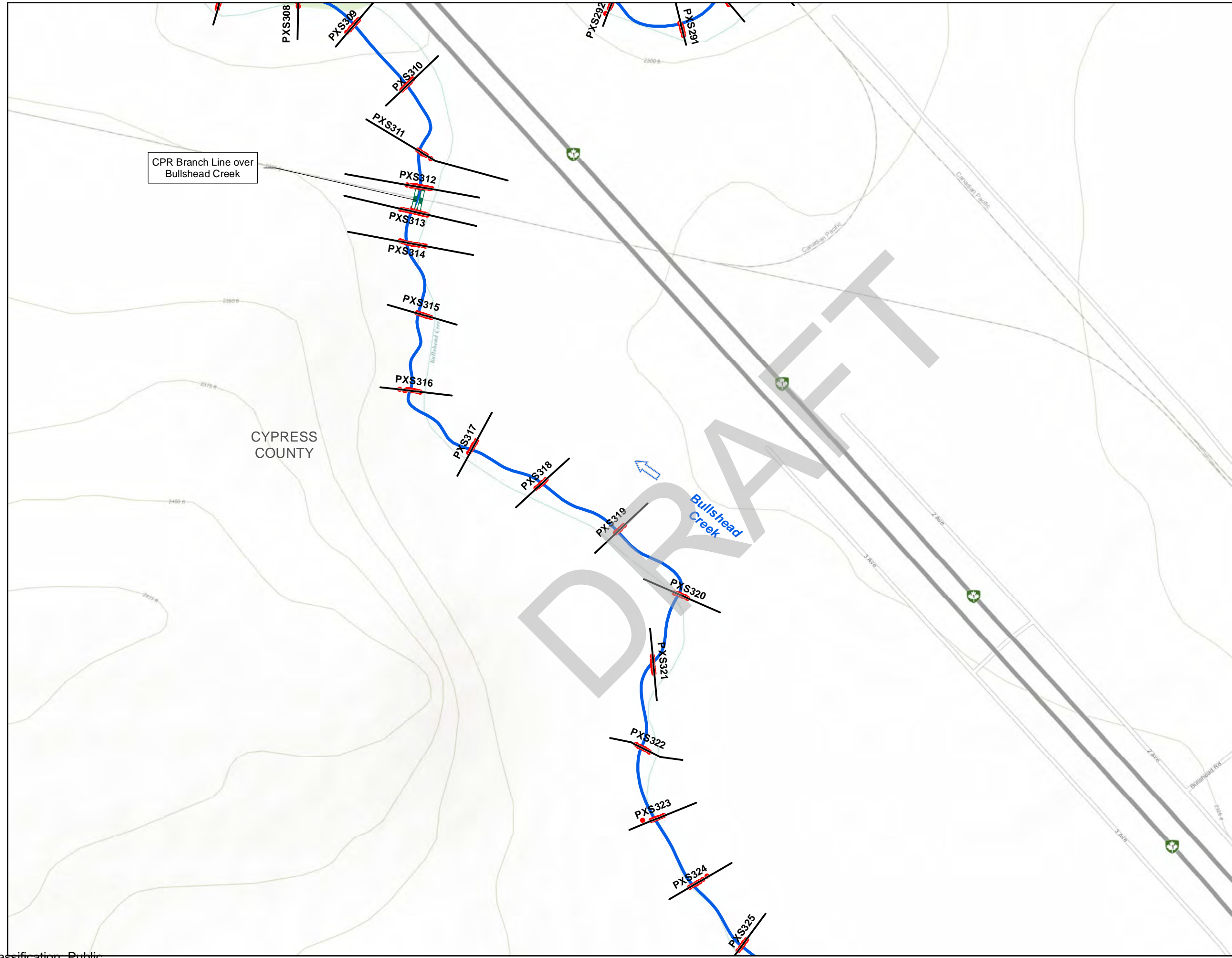


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Job: 1003094 | Date: 20-AUG-2019

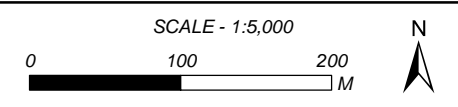
MEDICINE HAT RIVER HAZARD STUDY
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**CROSS SECTION AND HYDRAULIC
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MSN: P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Model\GIS\1003094_Map_T100_SectionLayout_R0.mxd



- FLOW DIRECTION
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- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

DATA SOURCES: Basemap from Esri.

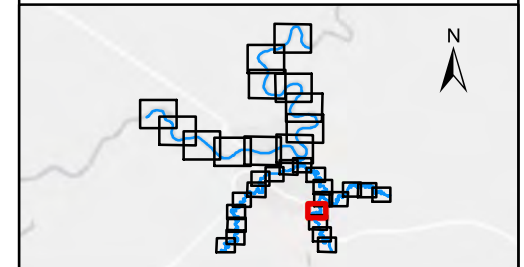


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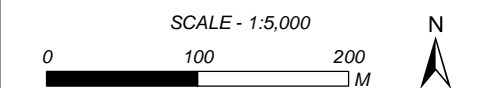
MEDICINE HAT RIVER HAZARD STUDY
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- FLOW DIRECTION
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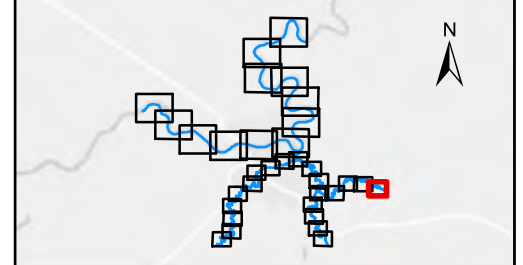
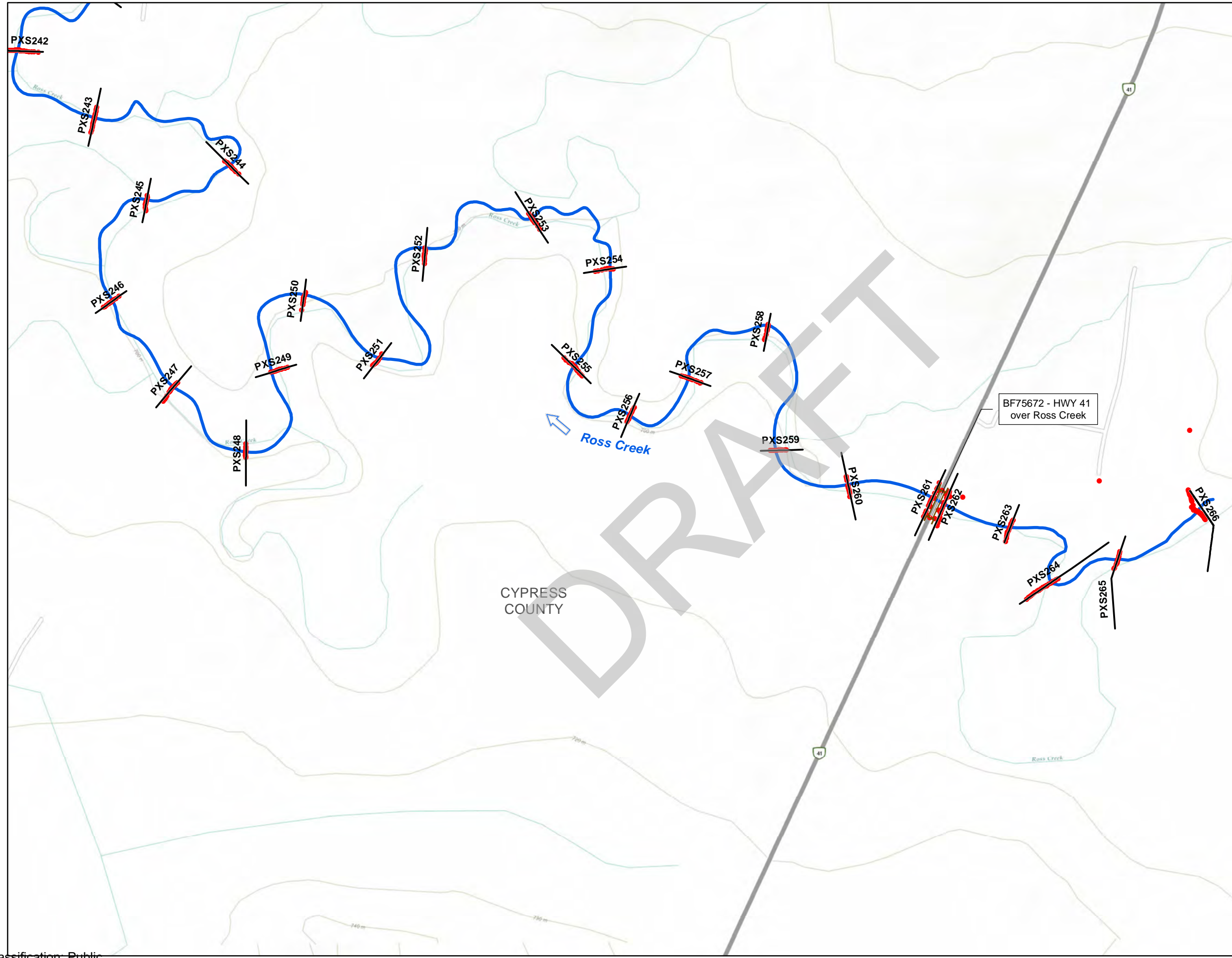


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Job: 1003094 | Date: 20-AUG-2019

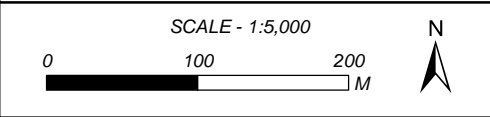
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
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- FLOW DIRECTION
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DATA SOURCES: Basemap from Esri.

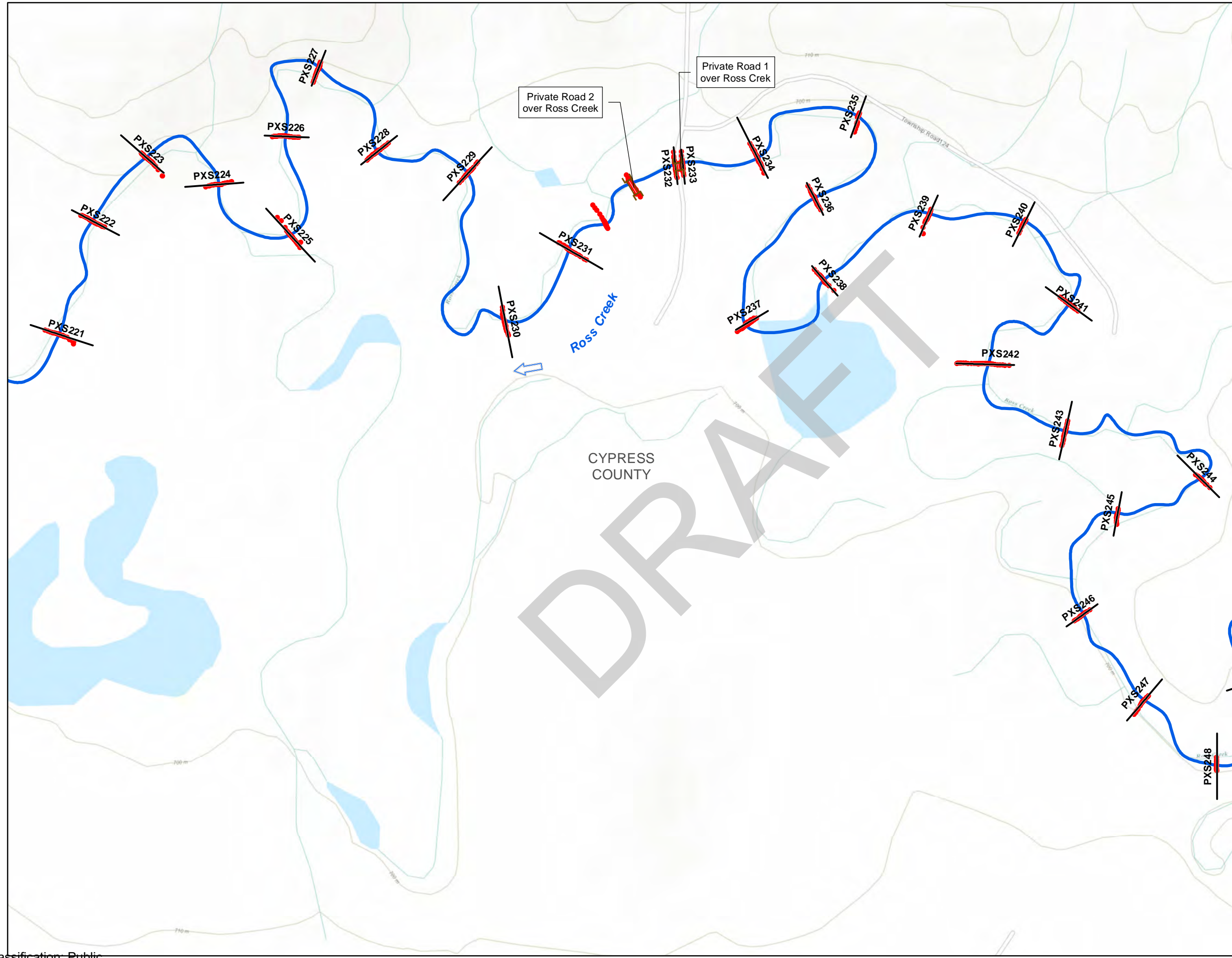
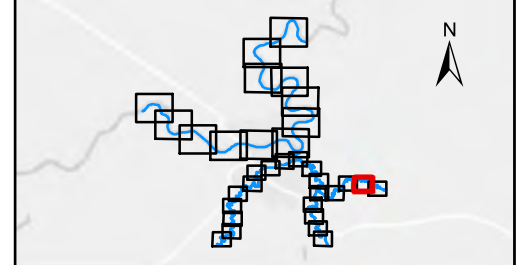


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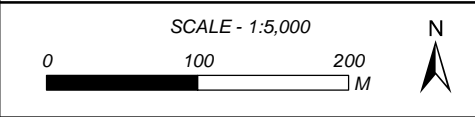
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

MSN: P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Model\GIS\1003094_Map_T100_SectionLayout_R0.mxd



- FLOW DIRECTION
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- CROSS SECTION
- BRIDGE
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- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

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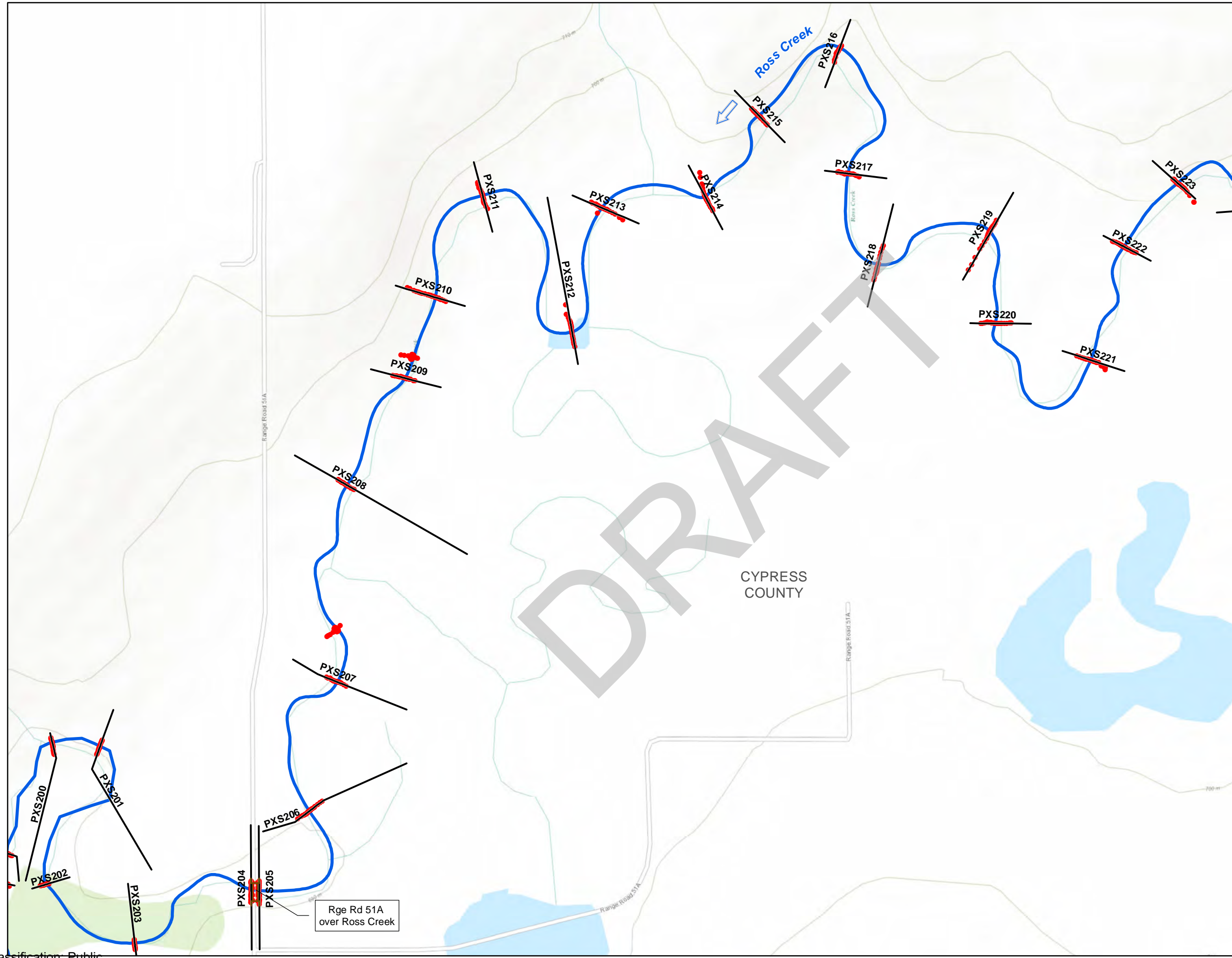
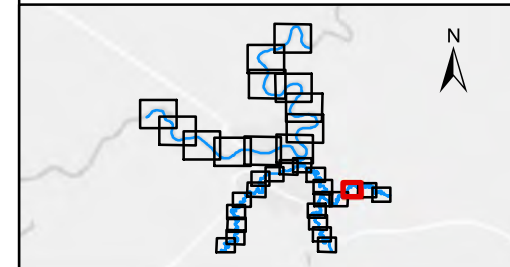


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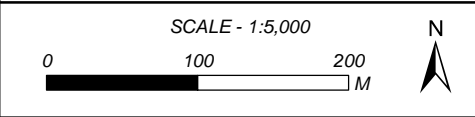
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

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- FLOW DIRECTION
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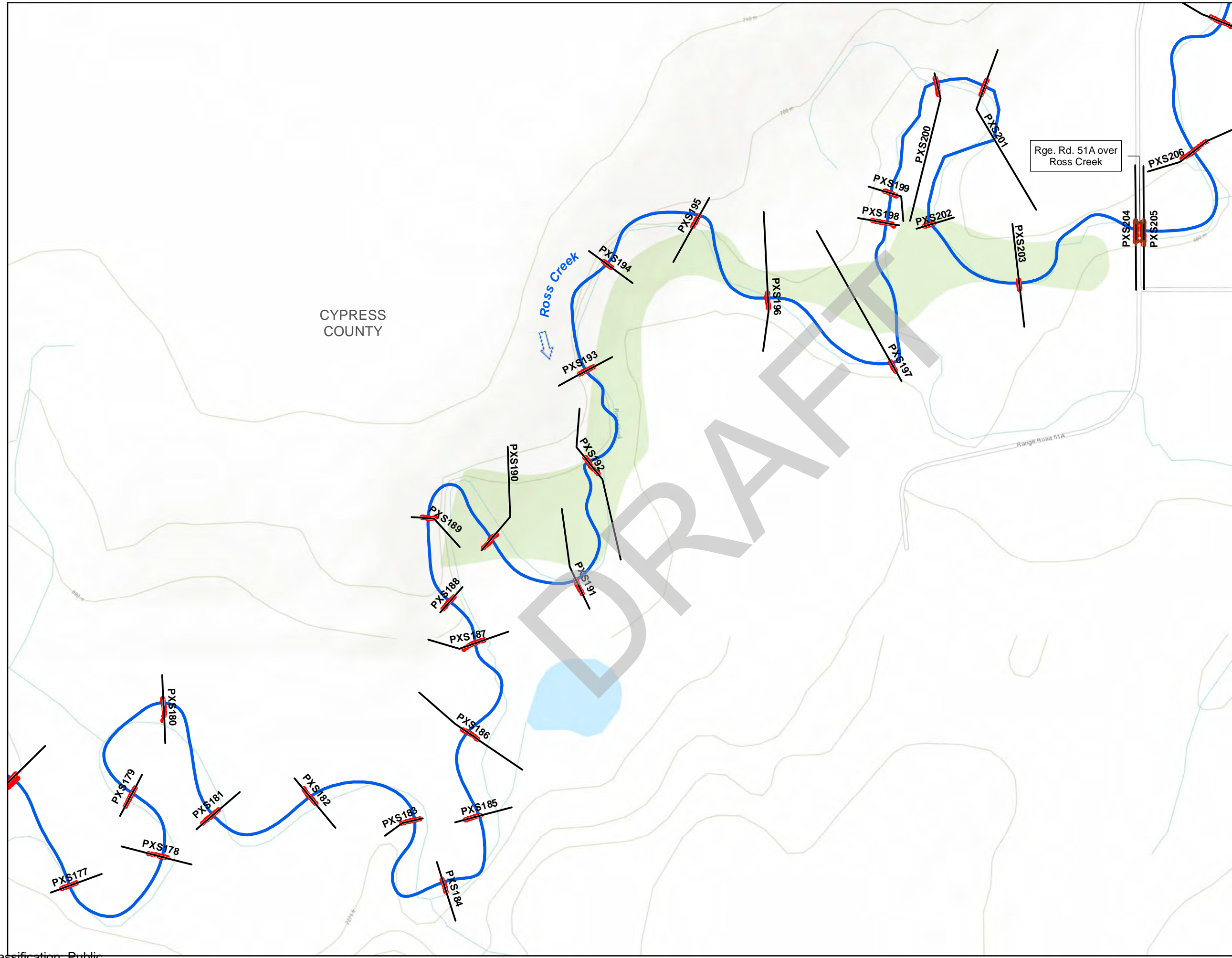
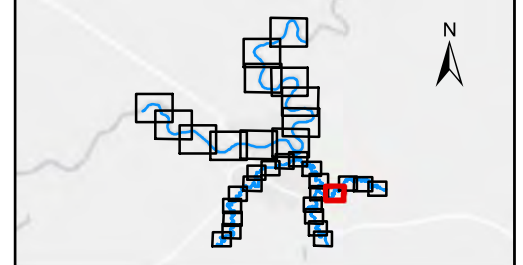


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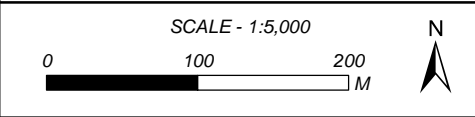
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

MSN: P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Model\GIS\1003094_Map_T100_SectionLayout_R0.mxd



- FLOW DIRECTION
- SURVEY POINT
- FLOOD CONTROL STRUCTURE
- CROSS SECTION
- BRIDGE
- CULVERT
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- APPROXIMATE CHANNEL CENTRELINE
- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

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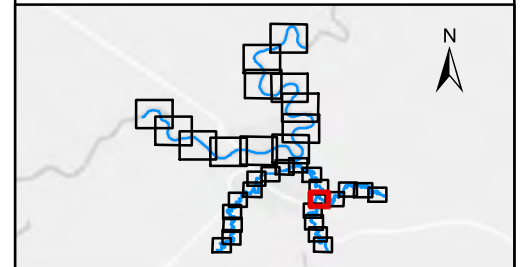
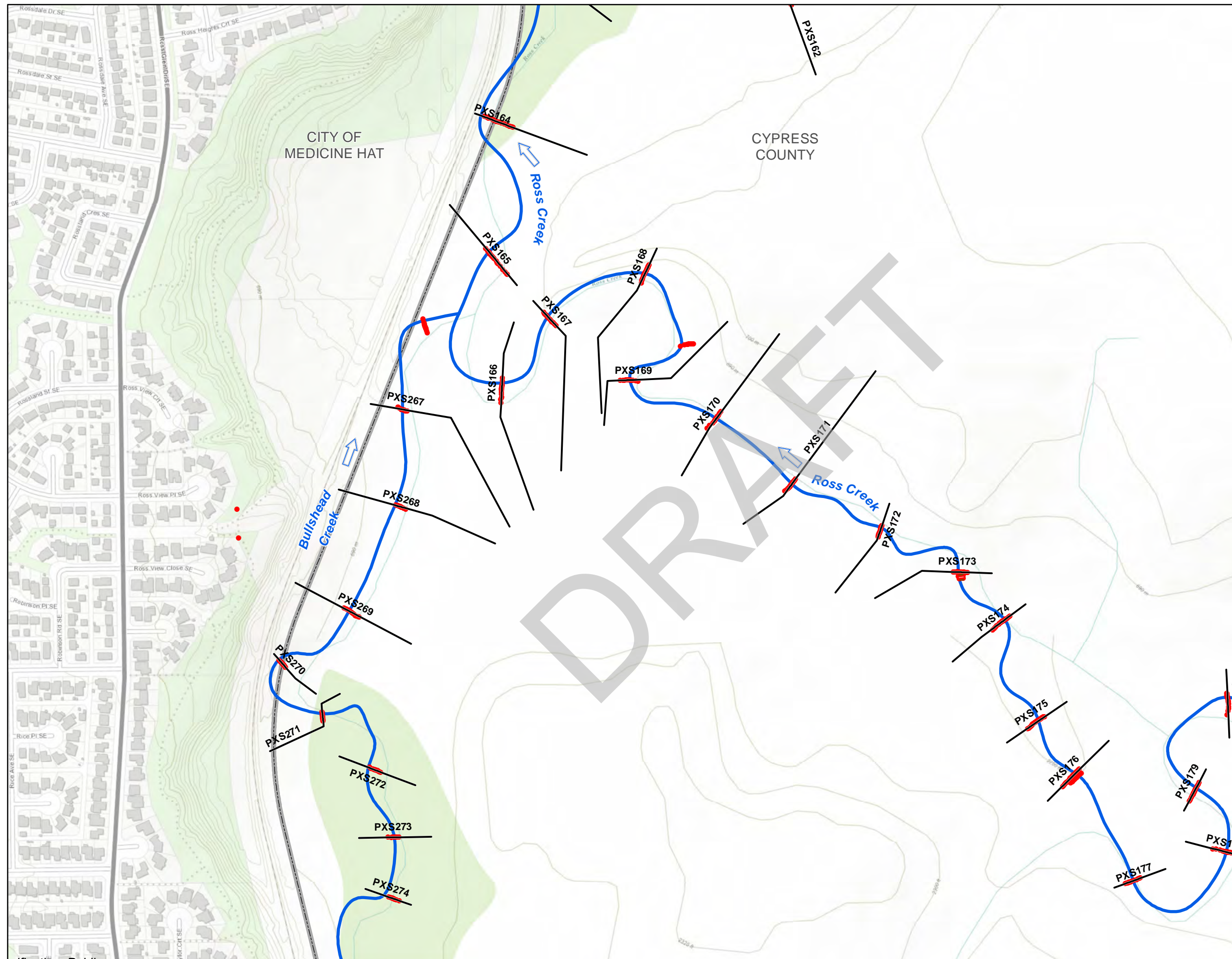


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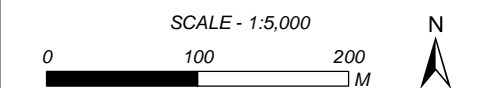
MEDICINE HAT RIVER HAZARD STUDY
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**CROSS SECTION AND HYDRAULIC
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- FLOW DIRECTION
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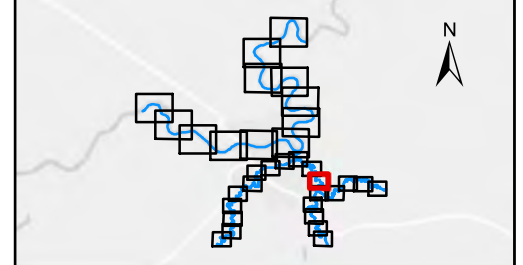













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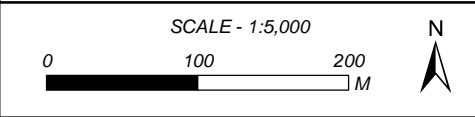
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

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-  FLOW DIRECTION
-  SURVEY POINT
-  FLOOD CONTROL STRUCTURE
-  CROSS SECTION
-  BRIDGE
-  CULVERT
-  WEIR
-  APPROXIMATE CHANNEL CENTRELINE
-  REDCLIFF TOWN BOUNDARY
-  BOUNDARY
-  MEDICINE HAT CITY BOUNDARY

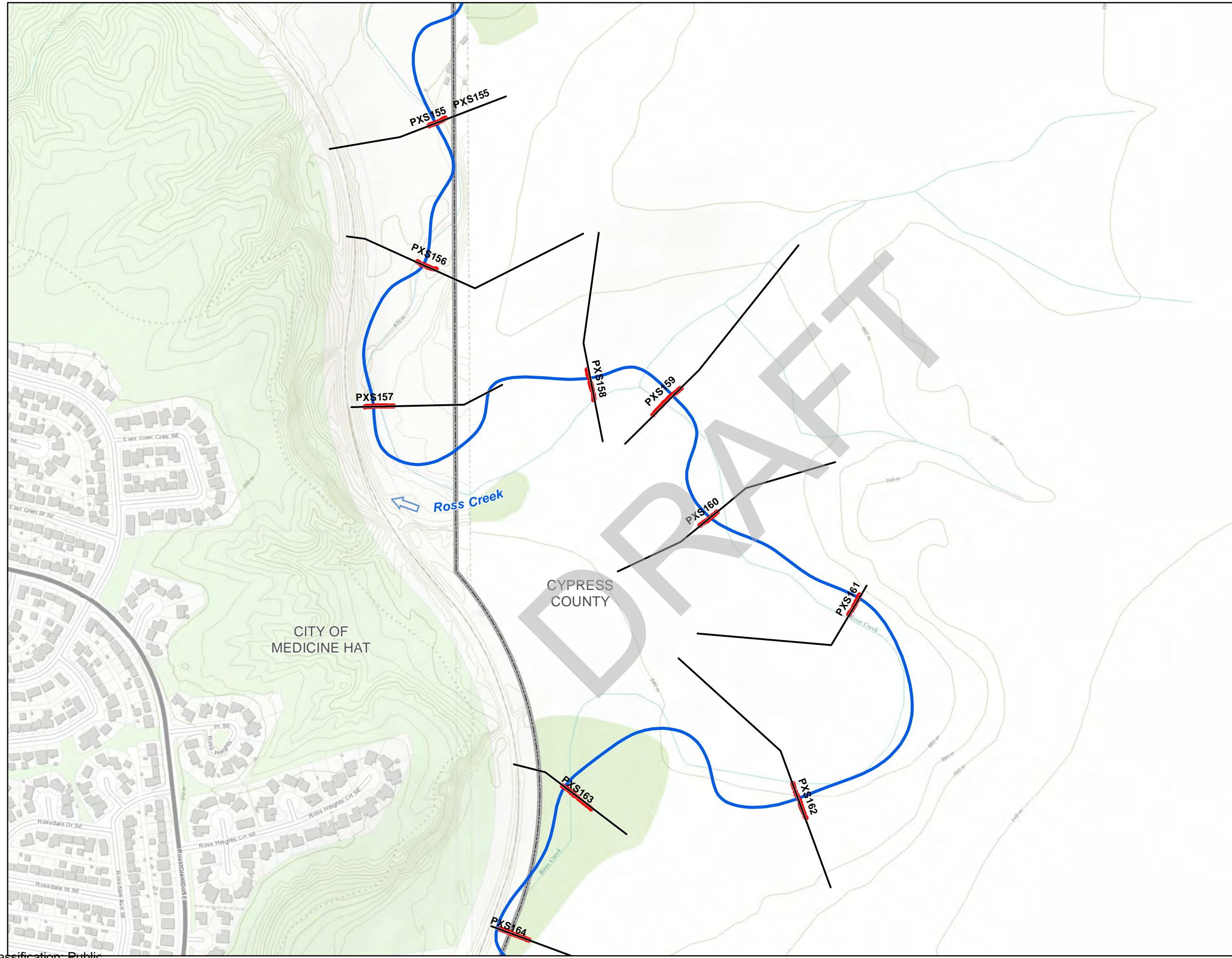
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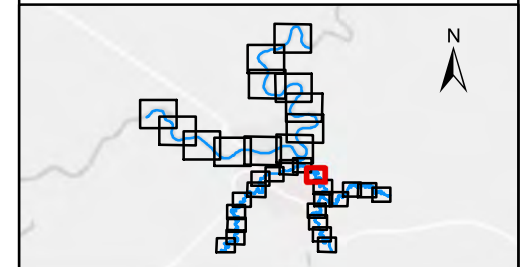
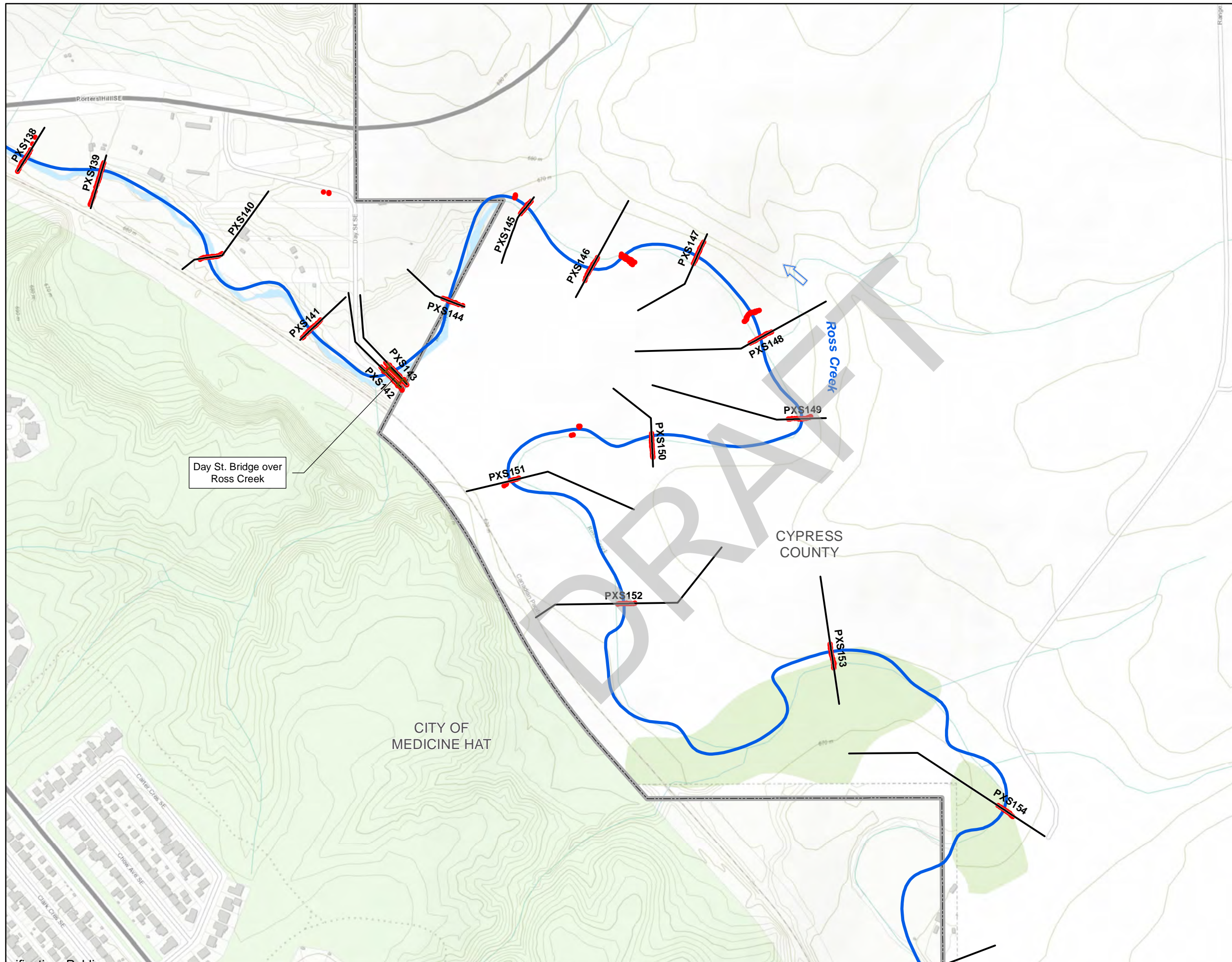


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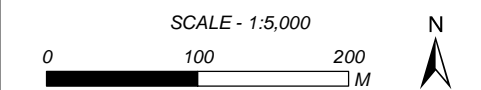
MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**





- FLOW DIRECTION
- SURVEY POINT
- FLOOD CONTROL STRUCTURE
- CROSS SECTION
- BRIDGE
- CULVERT
- WEIR
- APPROXIMATE CHANNEL CENTRELINE
- REDCLIFF TOWN BOUNDARY
- MEDICINE HAT CITY BOUNDARY

DATA SOURCES: Basemap from Esri.



Coordinate System: NAD 1983 CSRS 3TM 111
Units: METRES

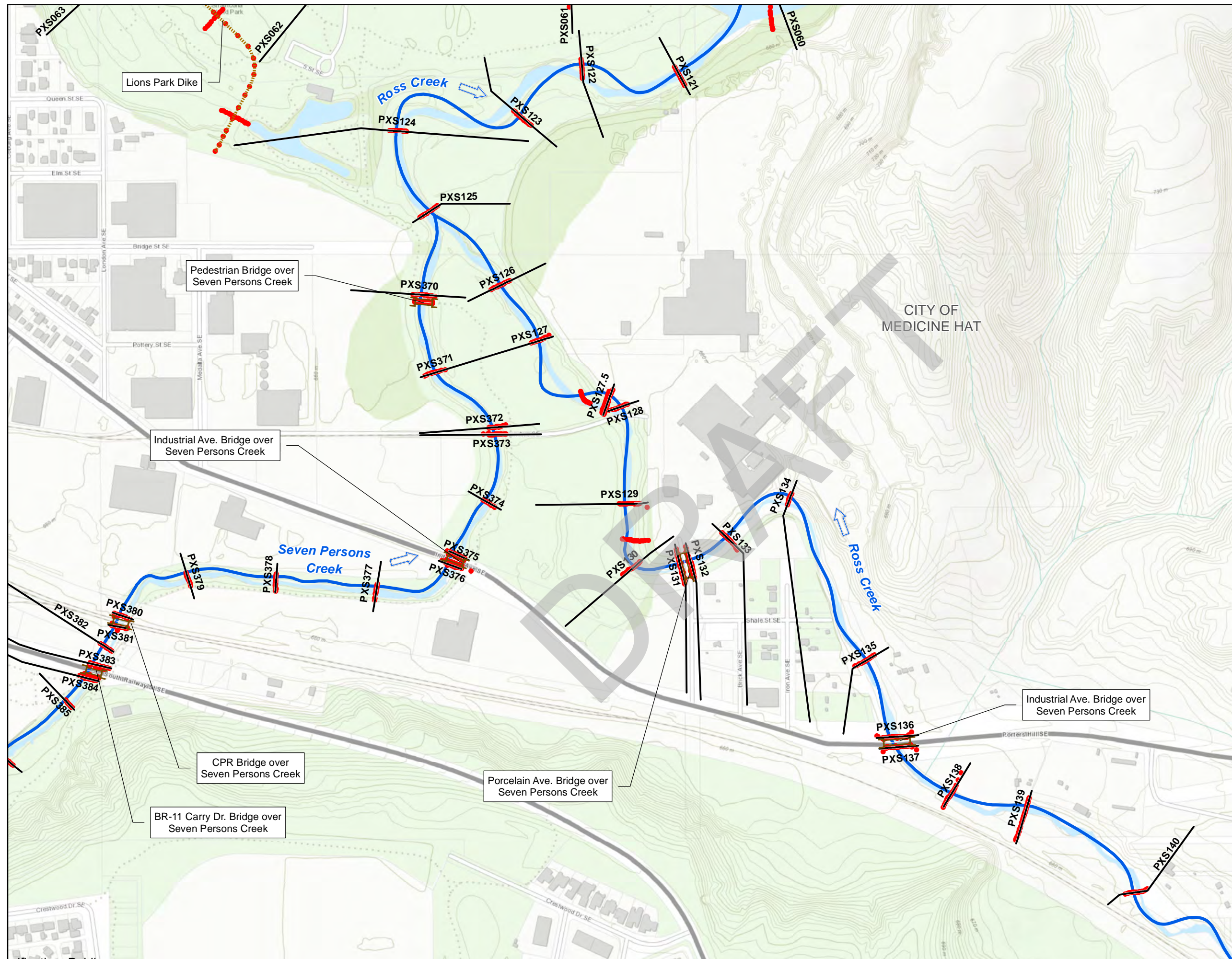
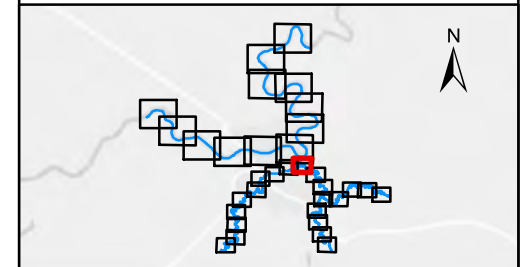
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MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION

CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS

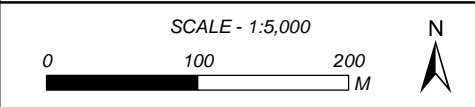
SHEET 32 OF 33 | FIGURE 2

MSN: P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Model\GIS\GIS1003094_Map_T100_SectionLayout_R0.mxd



- FLOW DIRECTION
- SURVEY POINT
- FLOOD CONTROL STRUCTURE
- CROSS SECTION
- BRIDGE
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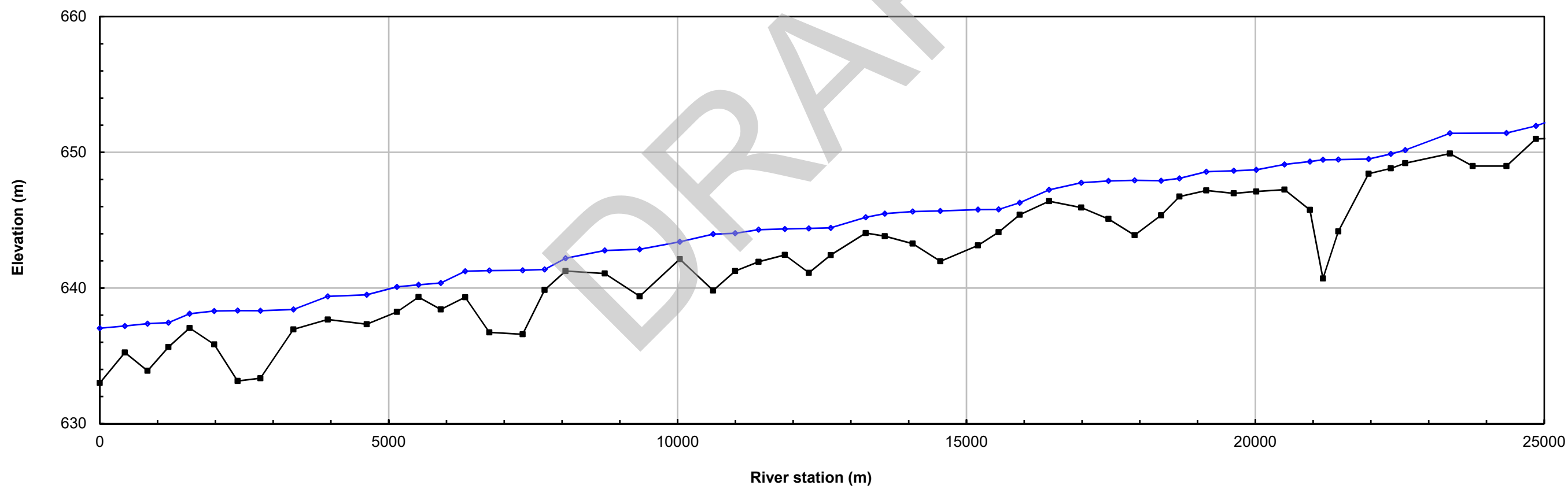
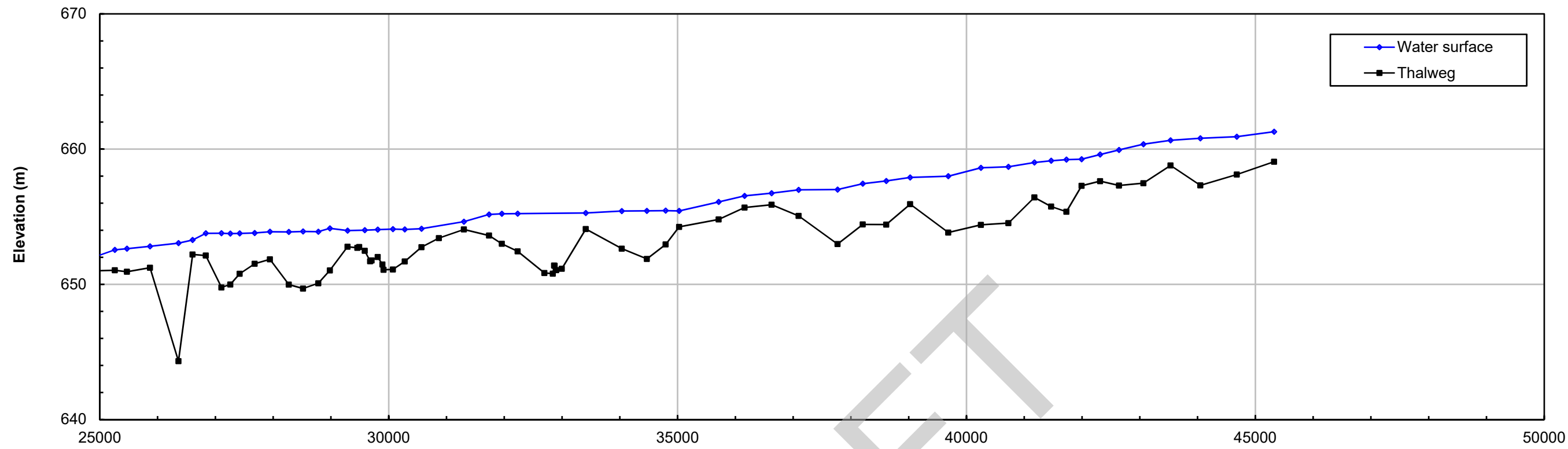


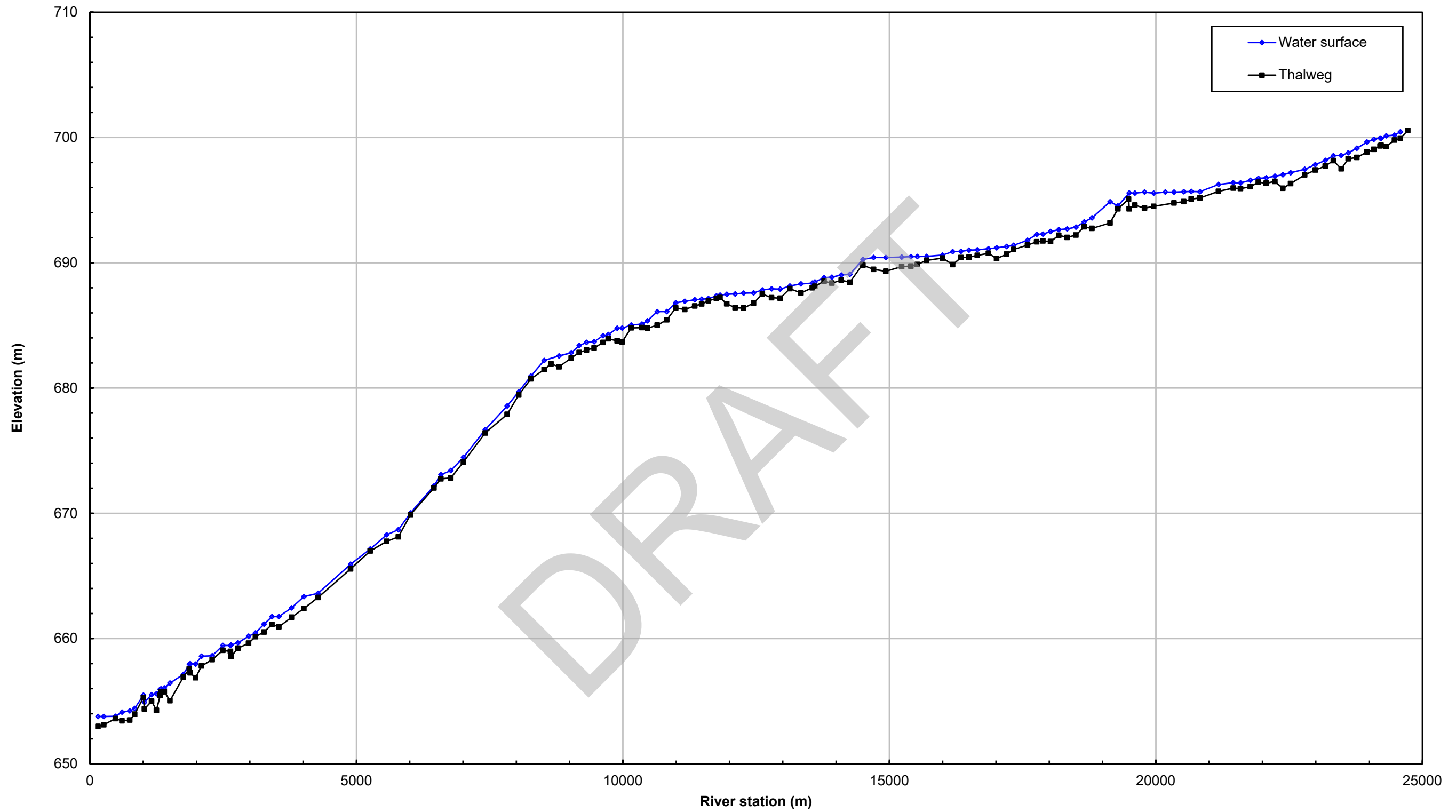
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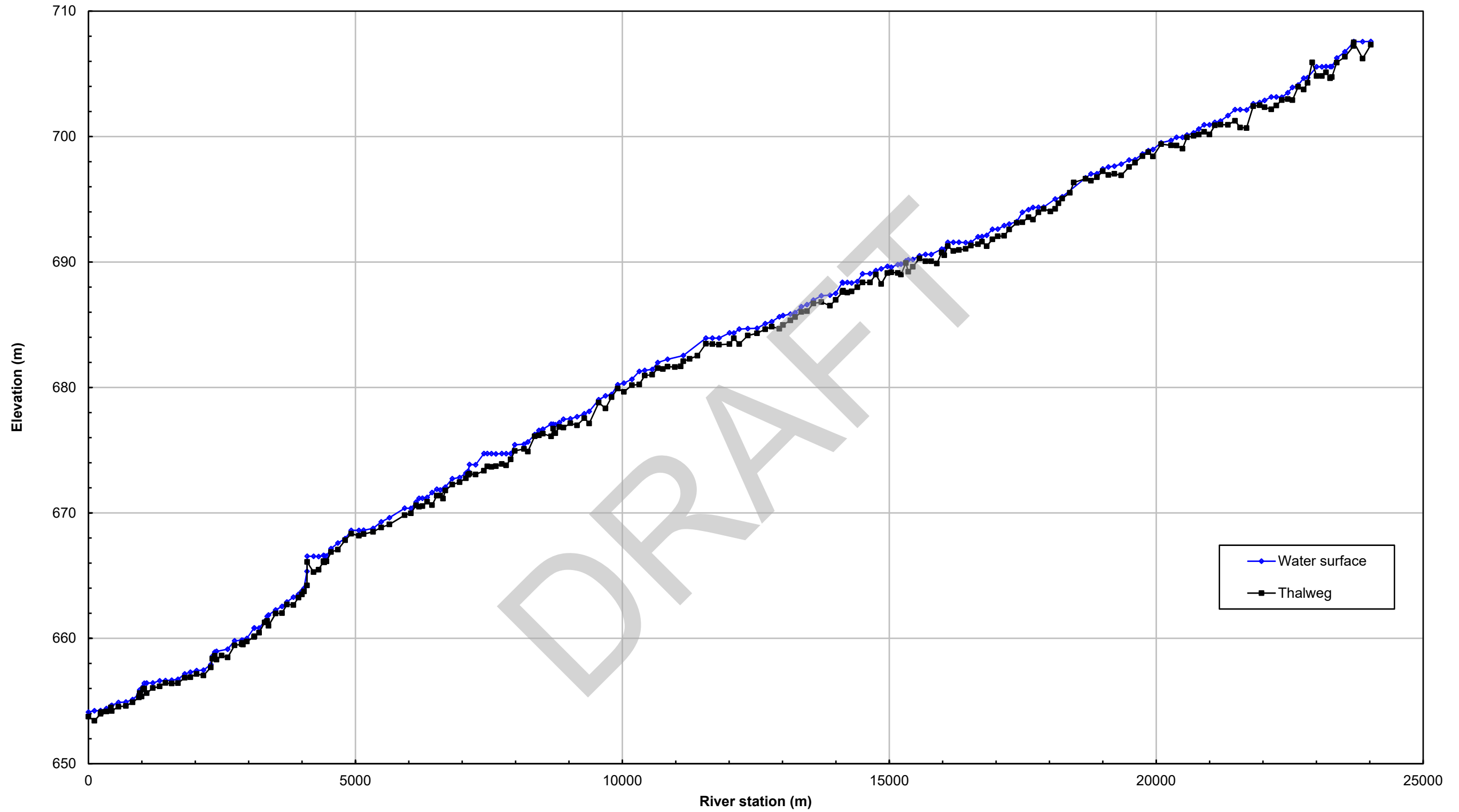
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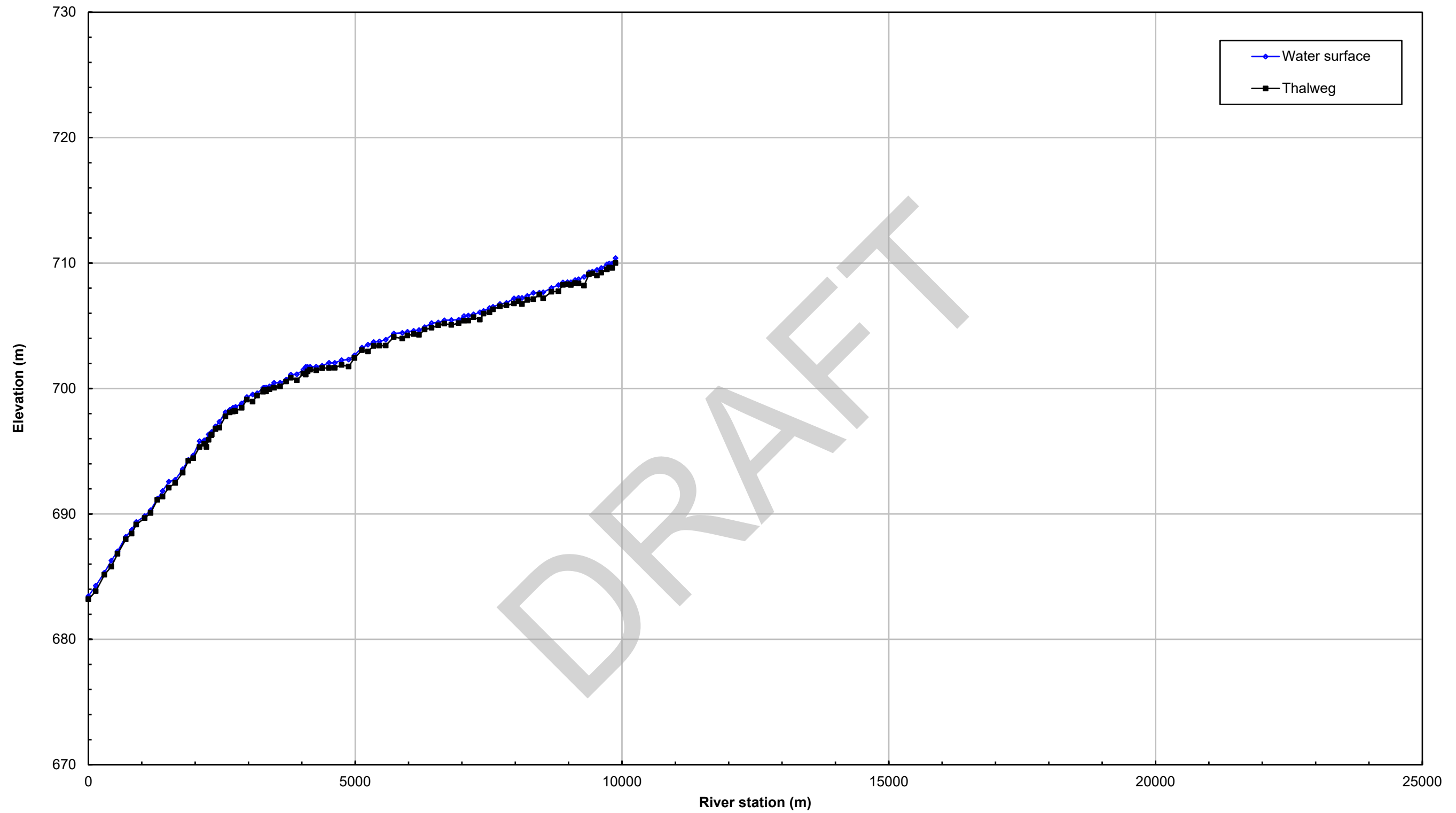
**MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION**
**CROSS SECTION AND HYDRAULIC
STRUCTURE LOCATIONS**

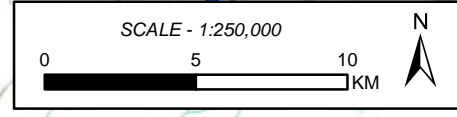
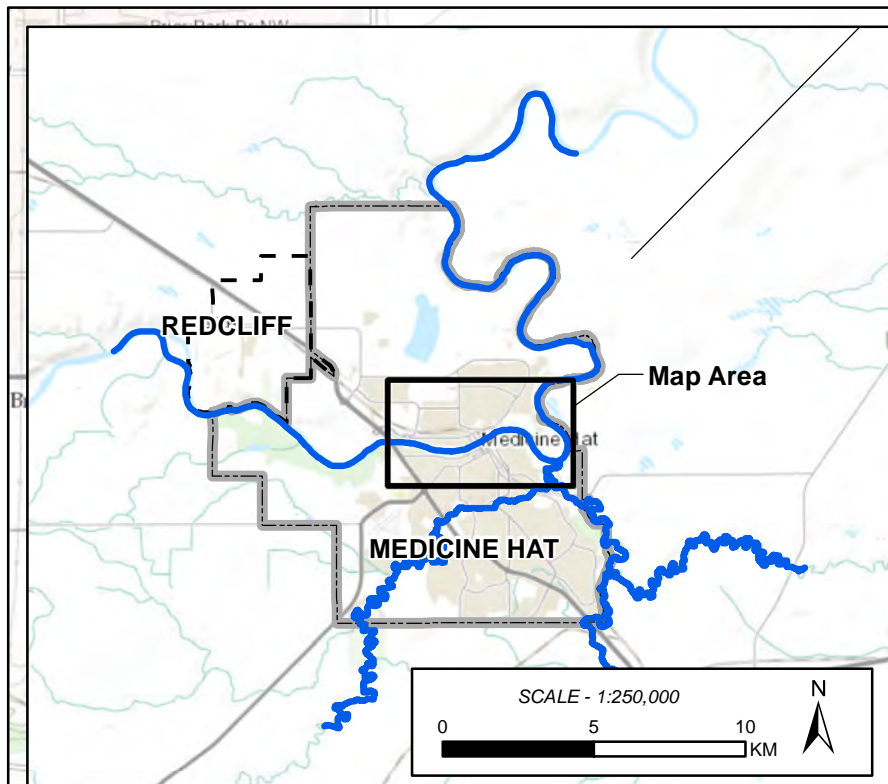
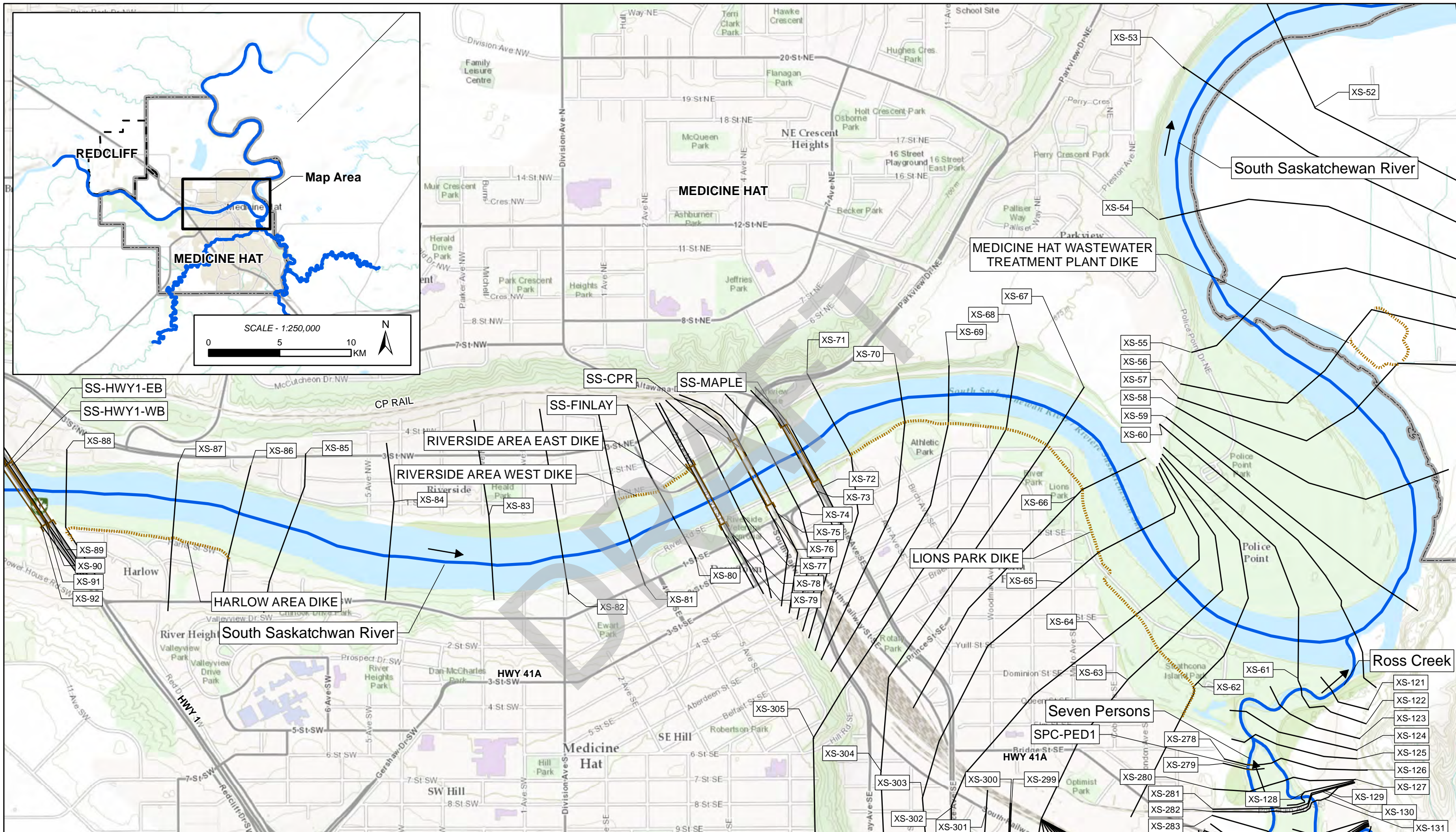
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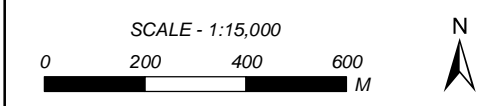






- Flood Control Structure
- Bridge
- Model Stream Network
- Model Cross Section
- Medicine Hat City Boundary

DATA SOURCES: Basemap from Esri & NRCan.



Coordinate System: NAD 1983 CSRS 3TM 111
Units: METRES

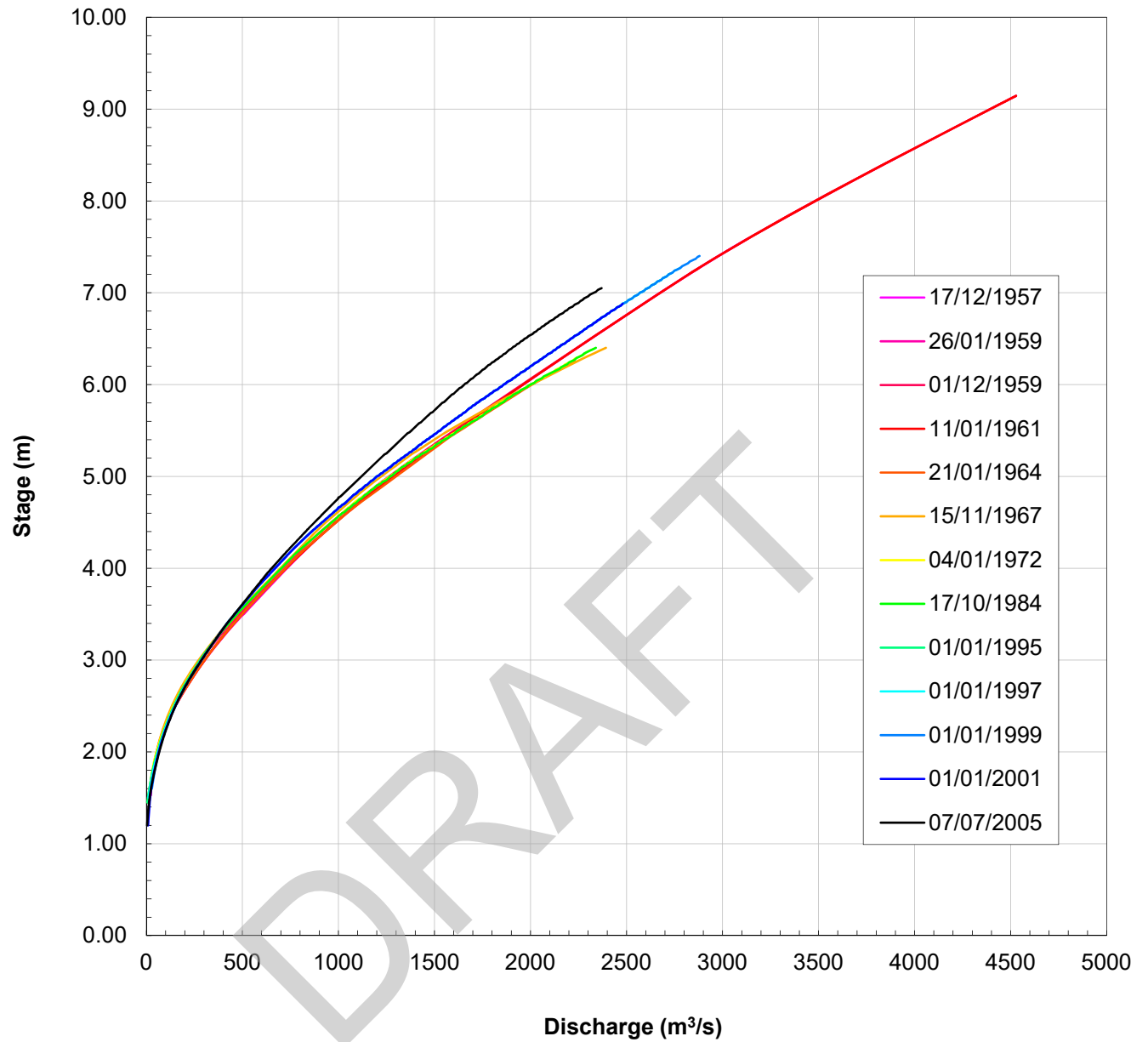
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MEDICINE HAT RIVER HAZARD STUDY
SURVEY AND BASE DATA COLLECTION
**FLOOD CONTROL
STRUCTURE LOCATIONS**

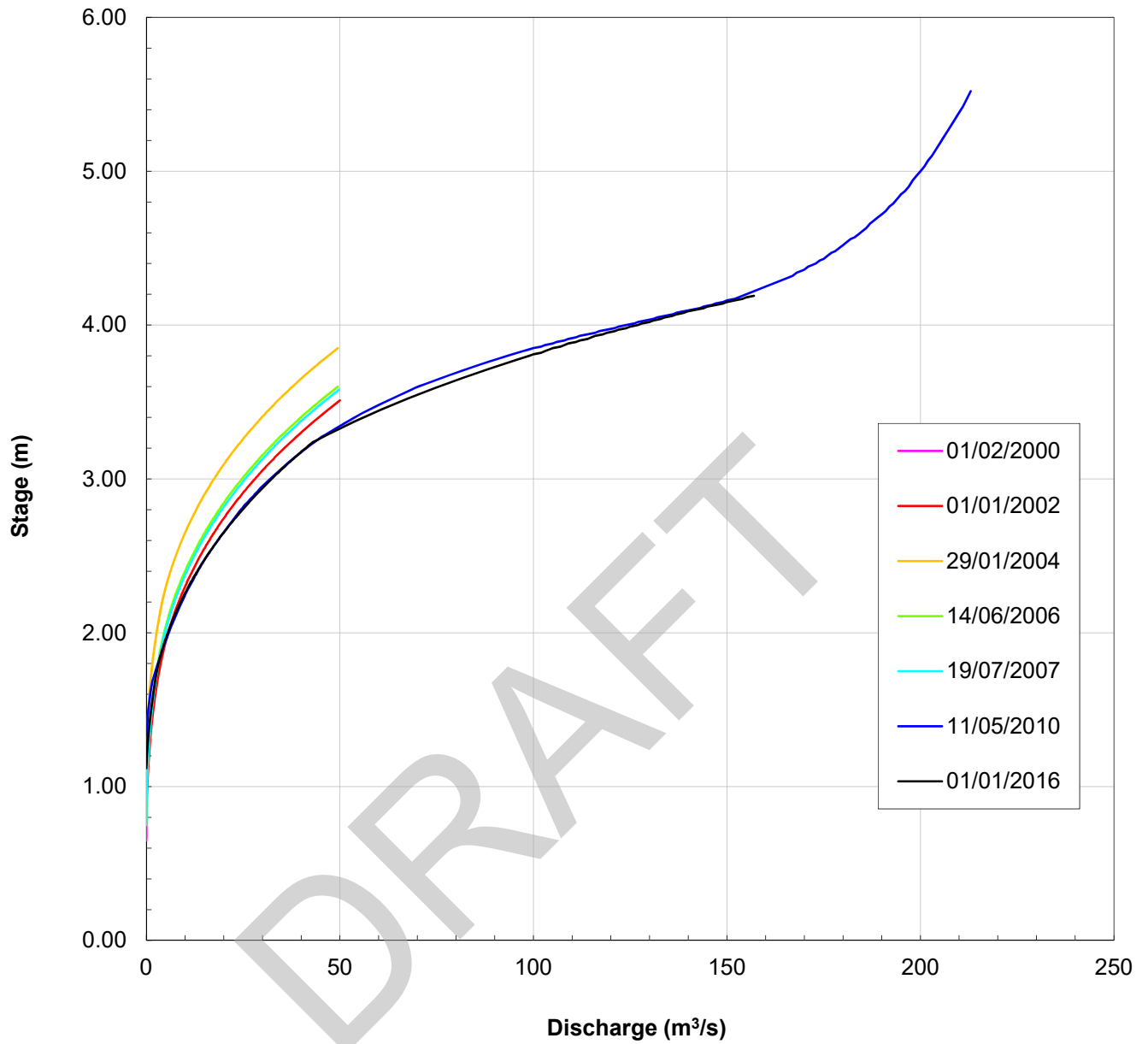
FIGURE 7

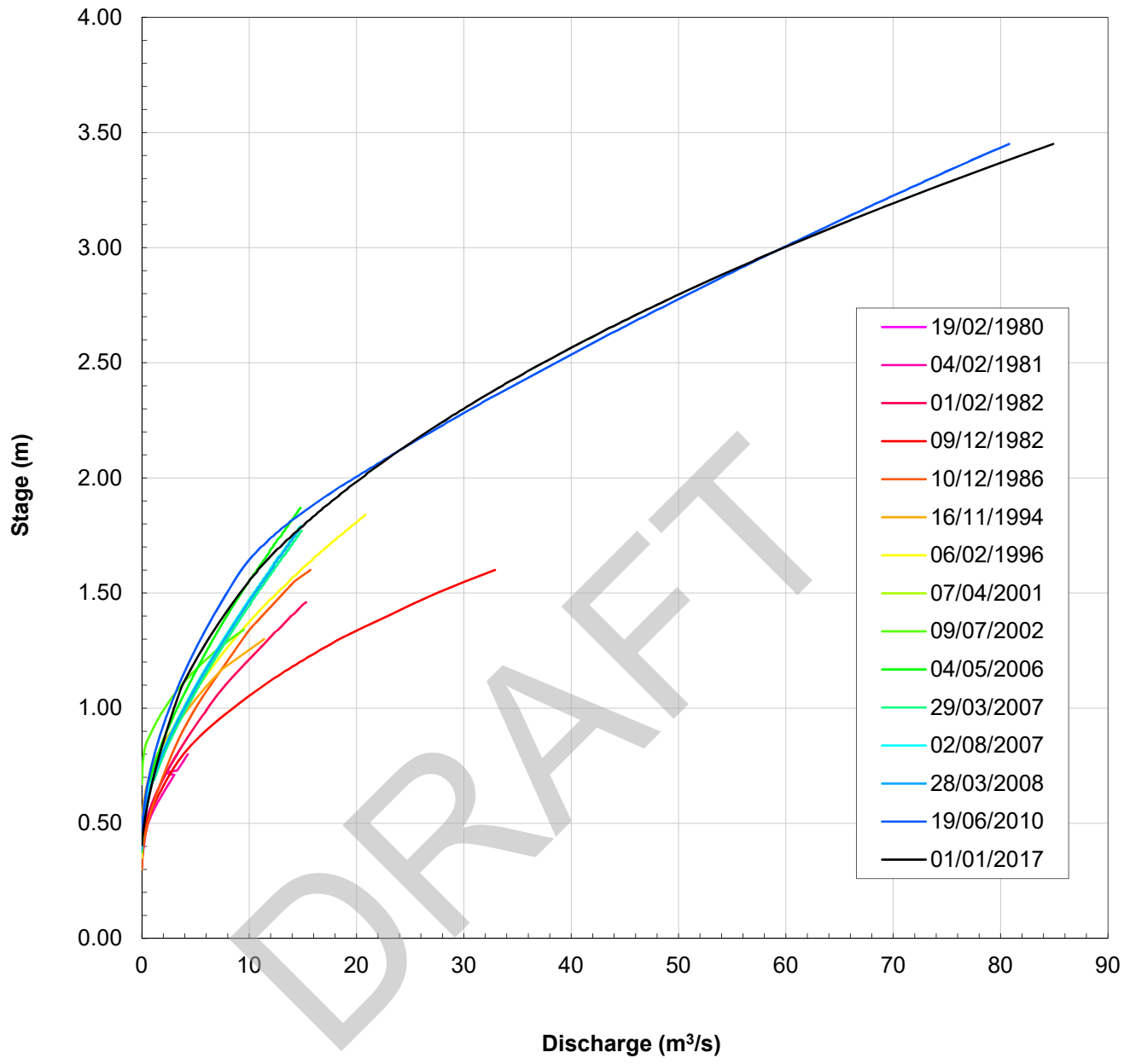


MSN: P:\Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Models\GIS\1003094_Fig_7\X00_FCS_R0.mxd



	SCALE – AS SHOWN		<p>MEDICINE HAT RIVER HAZARD STUDY SURVEY AND BASE DATA COLLECTION</p> <p>RATING CURVES SOUTH SASKATCHEWAN RIVER AT MEDICINE HAT (05AJ001)</p>
	Coordinate System: Units: As Shown		
Job: 1003094	Date: 17-JAN-2018	FIGURE 8	





DRAFT

	SCALE – AS SHOWN		MEDICINE HAT RIVER HAZARD STUDY SURVEY AND BASE DATA COLLECTION RATING CURVES SEVEN PERSONS CREEK AT MEDICINE HAT (05AH005)
		Coordinate System: Units: As Shown	
<i>Job: 1003094</i>		<i>Date: 17-JAN-2018</i>	FIGURE 10

**Appendix A
Survey Data**

DRAFT

Electronic File Submission

- Complete list of surveyed points (Medicine Hat RHS Survey Data.xlsx)
- Geodatabase containing cross section, bridge, culvert, weir, and flood control structure alignments; infrastructure and site photographs (MedicineHatRHS_Survey.gdb)

DRAFT

Appendix B
Bridge and Culvert Details

DRAFT

Bridge Description

Name: Trans Canada Highway EB
River: South Saskatchewan River

Bridge File No.: BF78572
River Station (km): 32.685

Geometry

Span (m): 312.4
Width (m): 16.5
Pier Type: concrete
Pier Shape: triangular sloping

High Chord (m): 667.13
Low Chord (m): 665.76
No. of Piers: 7
Pier Width (m): 1.2

Photo(s)

**Upstream view from the left
top of valley**



Bridge Description

Name: Trans Canada Highway WB
River: South Saskatchewan River

Bridge File No.: BF73802
River Station (km): 32.655

Geometry

Span (m): 301.9
Width (m): 12.8
Pier Type: concrete
Pier Shape: rounded

High Chord (m): 667.23
Low Chord (m): 665.22
No. of Piers: 3
Pier Width (m): 1.8

Photo(s)

**Downstream view from right
water edge**



Bridge Description

Name: Finlay Bridge
River: South Saskatchewan River

Bridge File No.: BF01114
River Station (km): 29.685

Geometry

Span (m): 277.1
Width (m): 8.1
Pier Type: concrete
Pier Shape: triangular sloping

High Chord (m): 665.79
Low Chord (m): 664.21
No. of Piers: 4
Pier Width (m): Varied (1.8/2.7)

Photo(s)

Upstream view from the left bank



Downstream view from left bank



Bridge Description

Name: CPR Bridge
River: South Saskatchewan River

Bridge File No.: N/A
River Station (km): 29.478

Geometry

Span (m): 313.4
Width (m): 6.0
Pier Type: concrete
Pier Shape: triangular sloping

High Chord (m): 1.00
Low Chord (m): 664.40
No. of Piers: 9
Pier Width (m): 3.0

Photo(s)

Upstream view from the left bank



Downstream view from the right bank



Bridge Description

Name: Maple Avenue Bridge
River: South Saskatchewan River

Bridge File No.: BF77434
River Station (km): 29.259

Geometry

Span (m): 266.7
Width (m): 21.6
Pier Type: concrete
Pier Shape: rounded

High Chord (m): 665.10
Low Chord (m): 663.05
No. of Piers: 6
Pier Width (m): 1.2

Photo(s)

Upstream view from the right bank



Bridge Description

Name: Private Road 1
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 23.792

Geometry

Span (m): 18.3
Width (m): 4.2
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 710.68
Low Chord (m): 709.75
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Downstream view from the
right bank**



Culvert Description

Name: Township Road 120 4KM
S of Medicine Hat
River: Seven Persons Creek

Bridge File No.: BF2164
River Station (km): 23.361

Geometry

Span (m): 7.6
Diameter (m): 5.2
Culvert Type: CSP
Culvert Shape: Horizontal Ellipse
Entrance Con: headwall with bevel end

Upstream Invert Elev (m): 704.81
Downstream Invert Elev (m): 704.65
Barrel Length: 28.2
Minimum Road Elevation: 711.9

Photo(s)

Upstream view of culvert from left bank



Downstream view of culvert from left bank



Bridge Description

Name: Desert Blume Golf Course Bridge 1
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 18.476

Geometry

Span (m): 19.2
Width (m): 1.9
Pier Type: steel pile
Pier Shape: circular

High Chord (m): 698.30
Low Chord (m): 697.99
No. of Piers: 1
Pier Width (m): 0.6

Photo(s)

Upstream view from the left bank



Bridge Description

Name: Desert Blume Golf Course Bridge 2
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 18.263

Geometry

Span (m): 19.5
Width (m): 2.1
Pier Type: steel pile
Pier Shape: circular

High Chord (m): 696.85
Low Chord (m): 696.53
No. of Piers: 1
Pier Width (m): 0.6

Photo(s)

Upstream view from the left bank



Bridge Description

Name: Desert Blume Golf Course Bridge 3
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 18.117

Geometry

Span (m): 15.7
Width (m): 2.4
Pier Type: steel pile
Pier Shape: circular

High Chord (m): 696.74
Low Chord (m): 696.44
No. of Piers: 1
Pier Width (m): N/A

Photo(s)

Upstream view from the right bank



Bridge Description

Name: Desert Blume Golf Course Bridge 4
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 17.794

Geometry

Span (m): 17.5
Width (m): 3.0
Pier Type: steel pile
Pier Shape: circular

High Chord (m): 695.94
Low Chord (m): 695.61
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the left bank



Bridge Description

Name: Desert Blume Golf Course Bridge 5
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 17.597

Geometry

Span (m): 9.8
Width (m): 2.1
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 695.76
Low Chord (m): 695.42
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Downstream view from the
right bank**



Bridge Description

Name: Desert Blume Golf Course Bridge 6
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 16.923

Geometry

Span (m): 19.4
Width (m): 2.4
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 694.12
Low Chord (m): 693.91
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**View looking south
(upstream)**



Bridge Description

Name: Desert Blume Golf Course Bridge 7
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 16.108

Geometry

Span (m): 17.4
Width (m): 3.7
Pier Type: steel pile
Pier Shape: circular

High Chord (m): 693.63
Low Chord (m): 693.24
No. of Piers: 1
Pier Width (m): N/A

Photo(s)

**View looking northwest
 across the bridge**



Bridge Description

Name: Desert Blume Golf Course Bridge 8
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 15.435

Geometry

Span (m): 15.2
Width (m): 1.9
Pier Type: steel pile
Pier Shape: circular

High Chord (m): 692.13
Low Chord (m): 691.83
No. of Piers: 1
Pier Width (m): 0.6

Photo(s)

**View looking northwest
(downstream)**



Source: https://www.youtube.com/watch?v=_gJG_FGWY

Bridge Description

Name: South Boundary Road
River: Seven Persons Creek

Bridge File No.: BF1155
River Station (km): 14.208

Geometry

Span (m): 20.3
Width (m): 9.9
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 691.98
Low Chord (m): 691.48
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the left bank



Downstream view from the left abutment



Bridge Description**Name:** Private Road 2**River:** Seven Persons Creek**Bridge File No.:** N/A**River Station (km):** 10.829**Geometry****Span (m):** 10.6**Width (m):** 3.2**Pier Type:** N/A**Pier Shape:** N/A**High Chord (m):** 683.86**Low Chord (m):** 683.68**No. of Piers:** 0**Pier Width (m):** N/A**Photo(s)**

**Downstream view from the
right bank**



Bridge Description

Name: Cottonwood Coulee Golf Course Bridge 1
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 9.051

Geometry

Span (m): 16.1
Width (m): 1.5
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 681.10
Low Chord (m): 680.63
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Downstream view from the left bank



Bridge Description

Name: Cottonwood Coulee Golf Course Bridge 2
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 8.961

Geometry

Span (m): 18.2
Width (m): 2.0
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 681.33
Low Chord (m): 680.91
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the left bank



Bridge Description**Name:** Cottonwood Coulee Golf Course Bridge 3**River:** Seven Persons Creek**Bridge File No.:** N/A**River Station (km):** 8.797**Geometry****Span (m):** 13.5**Width (m):** 2.0**Pier Type:** N/A**Pier Shape:** N/A**High Chord (m):** 680.12**Low Chord (m):** 679.78**No. of Piers:** 0**Pier Width (m):** N/A**Photo(s)**

**Upstream view from the right
bank**



Bridge Description

Name: Cottonwood Coulee Golf Course Bridge 4
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 8.736

Geometry

Span (m): 16.4
Width (m): 1.5
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 679.51
Low Chord (m): 678.87
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Upstream view from the right
bank**



Bridge Description

Name: Cottonwood Coulee Golf Course Bridge 5
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 8.286

Geometry

Span (m): 16.4
Width (m): 1.5
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 678.58
Low Chord (m): 678.05
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Upstream view from the left
bank**



Bridge Description

Name: Cottonwood Coulee Golf Course Bridge 6
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 8.277

Geometry

Span (m): 17.9
Width (m): 4.2
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 678.98
Low Chord (m): 678.10
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Downstream view from the left bank



Bridge Description

Name: Cottonwood Coulee Golf Course Bridge 7
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 8.087

Geometry

Span (m): 13.1
Width (m): 2.6
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 677.51
Low Chord (m): 677.13
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Downstream view from the left bank



Bridge Description

Name: Cottonwood Coulee Golf Course Bridge 8
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 7.982

Geometry

Span (m): 16.4
Width (m): 1.5
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 676.93
Low Chord (m): 676.33
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Upstream view from the right
bank**



Bridge Description

Name: Cottonwood Coulee Golf Course Bridge 9
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 7.814

Geometry

Span (m): 12.6
Width (m): 1.5
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 676.78
Low Chord (m): 676.41
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the left bank



Bridge Description

Name: Paradise Valley Golf Course Bridge 1
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 7.200

Geometry

Span (m): 19.9
Width (m): 2.4
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 675.79
Low Chord (m): 675.20
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Upstream view from the right
bank**



Bridge Description

Name: Paradise Valley Golf Course Bridge 2
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 7.146

Geometry

Span (m): 18.4
Width (m): 2.4
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 675.84
Low Chord (m): 675.20
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Downstream view from the left
bank**



Bridge Description

Name: Paradise Valley Golf Course Bridge 3
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 6.707

Geometry

Span (m): 24.0
Width (m): 3.7
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 674.54
Low Chord (m): 674.11
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Upstream view from the right
bank**



Bridge Description

Name: Paradise Valley Golf Course Bridge 4
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 6.592

Geometry

Span (m): 19.4
Width (m): 2.4
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 674.43
Low Chord (m): 673.75
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the right bank



Bridge Description

Name: Paradise Valley Golf Course Bridge 5
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 6.259

Geometry

Span (m): 17.9
Width (m): 2.4
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 673.33
Low Chord (m): 672.56
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Upstream view from the right
bank**



Bridge Description

Name: Paradise Valley Golf Course Bridge 6
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 6.108

Geometry

Span (m): 17.6
Width (m): 2.4
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 673.07
Low Chord (m): 672.31
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the right bank



Bridge Description

Name: Pedestrian Bridge
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 5.246

Geometry

Span (m): 24.3
Width (m): 2.4
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 671.48
Low Chord (m): 671.25
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Downstream view from the left bank



Bridge Description

Name: Pedestrian Bridge
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 5.003

Geometry

Span (m): 24.1
Width (m): 2.4
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 671.37
Low Chord (m): 671.14
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Downstream view from the left bank



Culvert Description

Name: Trans Canada Highway
(left arch)
River: Seven Persons Creek

Bridge File No.: BF73807
River Station (km): 4.589

Geometry

Span (m): 5.1
Diameter (m): 3.6
Culvert Type: Concrete
Culvert Shape: Vertical Ellipse/Arch
Entrance Con: headwall with square end

Upstream Invert Elev (m): 666.66
Downstream Invert Elev (m): 666.42
Barrel Length: 76.9
Minimum Road Elevation: 682.3

Photo(s)

**Upstream view of north culvert
from right bank**



**Downstream view of north
culvert from left bank**



Culvert Description

Name: Trans Canada Highway
(right arch)
River: Seven Persons Creek

Bridge File No.: BF73807
River Station (km): 4.589

Geometry

Span (m): 5.1
Diameter (m): 4.5
Culvert Type: Concrete
Culvert Shape: Vertical Ellipse/Arch
Entrance Con: headwall with square end

Upstream Invert Elev (m): 666.79
Downstream Invert Elev (m): 666.70
Barrel Length: 69.9
Minimum Road Elevation: 682.3

Photo(s)

Upstream view of south culvert from trail



Downstream view of south culvert from trail



Bridge Description

Name: Kin Coulee Road
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 4.498

Geometry

Span (m): 19.3
Width (m): 4.7
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 669.75
Low Chord (m): 668.80
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the south channel



Downstream view from the right bank



Bridge Description

Name: Kin Coulee Park Pedestrian Bridge 1
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 4.090

Geometry

Span (m): 21.3
Width (m): 1.3
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 666.81
Low Chord (m): 666.61
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the right bank



Bridge Description

Name: Kin Coulee Park Pedestrian Bridge 2
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 3.697

Geometry

Span (m): 21.3
Width (m): 1.3
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 665.24
Low Chord (m): 665.11
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Downstream view from the
right overbank**



Culvert Description

Name: College Avenue Bridge
(left barrel)
River: Seven Persons Creek

Bridge File No.: BF73884
River Station (km): 3.421

Geometry

Span (m): N/A
Diameter (m): 4.5
Culvert Type: CSP
Culvert Shape: Circular
Entrance Con: mitered to conform to slope

Upstream Invert Elev (m): 661.37
Downstream Invert Elev (m): 661.24
Barrel Length: 27.3
Minimum Road Elevation: 665.0

Photo(s)

Upstream view from left bank



Downstream view from the left bank



Culvert Description

Name: College Avenue Bridge
(right barrel)
River: Seven Persons Creek

Bridge File No.: BF73884
River Station (km): 3.421

Geometry

Span (m): N/A
Diameter (m): 4.5
Culvert Type: CSP
Culvert Shape: Circular
Entrance Con: mitered to conform to slope

Upstream Invert Elev (m): 661.46
Downstream Invert Elev (m): 661.31
Barrel Length: 28.6
Minimum Road Elevation: 665.0

Photo(s)

Upstream view from left bank



Downstream view from the left bank



Bridge Description

Name: Private Road 4
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 3.201

Geometry

Span (m): 20.7
Width (m): 5.4
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 664.69
Low Chord (m): 663.73
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the left bank



Bridge deck from the left bank approach



Bridge Description

Name: Private Rail Bridge
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 2.979

Geometry

Span (m): 17.2
Width (m): 4.8
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 663.64
Low Chord (m): 662.93
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Downstream view from
downstream pedestrian bridge**



**Bridge deck from the left bank
approach**



Bridge Description

Name: Pedestrian Bridge
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 2.962

Geometry

Span (m): 24.3
Width (m): 2.6
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 663.35
Low Chord (m): 663.08
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Downstream view from right bank



Bridge Description

Name: Pedestrian Bridge
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 2.716

Geometry

Span (m): 24.3
Width (m): 2.6
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 662.04
Low Chord (m): 661.76
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Downstream view from the left
overbank**



Bridge Description

Name: Dunmore Road
River: Seven Persons Creek

Bridge File No.: BF00659
River Station (km): 2.435

Geometry

Span (m): 47.6
Width (m): 23.4
Pier Type: steel pile
Pier Shape: circular

High Chord (m): 662.37
Low Chord (m): 661.21
No. of Piers: 1
Pier Width (m): 0.3

Photo(s)

Upstream view from the left bank



Downstream view from the right bank



Bridge Description

Name: Pedestrian Bridge
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 1.764

Geometry

Span (m): 24.3
Width (m): 2.6
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 661.30
Low Chord (m): 661.02
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Upstream view from the right
bank**



Bridge Description

Name: Carry Drive Bridge
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 1.128

Geometry

Span (m): 22.5
Width (m): 14.9
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 659.58
Low Chord (m): 658.61
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the left bank



Downstream view from the left bank



Bridge Description

Name: CPR Bridge
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 1.050

Geometry

Span (m): 21.5
Width (m): 11.0
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 662.37
Low Chord (m): 659.91
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the left bank



Downstream view from the left bank



Bridge Description

Name: Industrial Avenue Bridge
River: Seven Persons Creek

Bridge File No.: BF00624
River Station (km): 0.527

Geometry

Span (m): 22.6
Width (m): 8.7
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 659.80
Low Chord (m): 658.82
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the right bank



Downstream view from the left bank



Bridge Description

Name: Abandoned Piers
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 0.346

Geometry

Span (m): 0.0
Width (m): 0.0
Pier Type: timber pile
Pier Shape: circular

High Chord (m): N/A
Low Chord (m): 0.00
No. of Piers: 4
Pier Width (m): 0.6

Photo(s)

Upstream view from the right bank



Bridge Description

Name: Pedestrian Bridge
River: Seven Persons Creek

Bridge File No.: N/A
River Station (km): 0.123

Geometry

Span (m): 24.2
Width (m): 2.5
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 658.96
Low Chord (m): 658.70
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Upstream view from the right
bank**



Bridge Description

Name: Highway 41
River: Ross Creek

Bridge File No.: BF75672
River Station (km): 23.771

Geometry

Span (m): 41.6
Width (m): 12.6
Pier Type: steel pile
Pier Shape: circular

High Chord (m): 706.17
Low Chord (m): 705.35
No. of Piers: 2
Pier Width (m): 0.4

Photo(s)

Upstream view from the left bank



Bridge Description

Name: Private Road 1
River: Ross Creek

Bridge File No.: N/A
River Station (km): 19.070

Geometry

Span (m): 9.9
Width (m): 5.7
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 696.79
Low Chord (m): 696.26
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from right bank



Downstream view from the left water edge



Bridge Description**Name:** Private Road 2**River:** Ross Creek**Bridge File No.:** N/A**River Station (km):** 18.999**Geometry****Span (m):** 22.1**Width (m):** 1.3**Pier Type:** N/A**Pier Shape:** N/A**High Chord (m):** 697.38**Low Chord (m):** 696.81**No. of Piers:** 0**Pier Width (m):** N/A**Photo(s)****Upstream view from left bank**

Bridge Description

Name: Range Road 51A
River: Ross Creek

Bridge File No.: N/A
River Station (km): 14.090

Geometry

Span (m): 25.3
Width (m): 6.6
Pier Type: steel
Pier Shape: triangular

High Chord (m): 693.37
Low Chord (m): 692.65
No. of Piers: 2
Pier Width (m): 0.4

Photo(s)

Upstream view from the right bank



View of the upstream curb from the right bank approach



Bridge Description

Name: Private Road 3
River: Ross Creek

Bridge File No.: N/A
River Station (km): 9.774

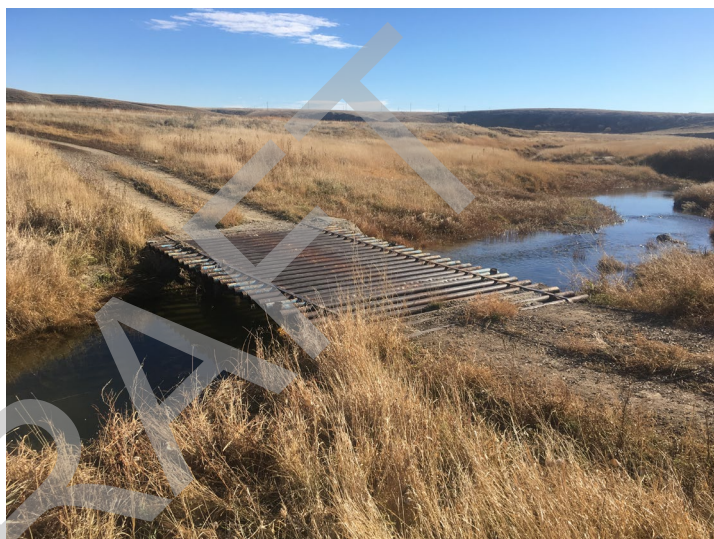
Geometry

Span (m): 6.8
Width (m): 3.9
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 684.90
Low Chord (m): 684.50
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Downstream view from the left bank



Bridge Description

Name: Day Street Bridge
River: Ross Creek

Bridge File No.: BF75576
River Station (km): 2.922

Geometry

Span (m): 24.9
Width (m): 5.6
Pier Type: timber
Pier Shape: triangular sloping

High Chord (m): 662.71
Low Chord (m): 662.11
No. of Piers: 2
Pier Width (m): Varied (1.4/1.5)

Photo(s)

Upstream view from the left bank



Bridge deck from the right bank approach



Bridge Description

Name: Industrial Avenue Bridge
River: Ross Creek

Bridge File No.: BF00658
River Station (km): 2.168

Geometry

Span (m): 36.7
Width (m): 11.4
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 665.06
Low Chord (m): 662.00
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the right bank



Downstream view from the right bank



Bridge Description

Name: Porcelain Avenue Bridge
River: Ross Creek

Bridge File No.: N/A
River Station (km): 1.618

Geometry

Span (m): 34.6
Width (m): 11.1
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 663.32
Low Chord (m): 659.99
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the right bank



Downstream view from the right bank



Culvert Description

Name: Township Road 120 2KM
SW of Dunmore
River: Bullshead Creek

Bridge File No.: BF81332
River Station (km): 9.606

Geometry

Span (m): 8.6
Diameter (m): 5.3
Culvert Type: Concrete
Culvert Shape: Horizontal Ellipse
Entrance Con: headwall with bevel end

Upstream Invert Elev (m): 709.72
Downstream Invert Elev (m): 709.57
Barrel Length: 38.5
Minimum Road Elevation: 712.8

Photo(s)

Upstream view from the right bank



Downstream view from middle of the channel



Culvert Description

Name: CPR branch line (left barrel)
River: Bullshead Creek

Bridge File No.: N/A
River Station (km): 4.185

Geometry

Span (m): N/A
Diameter (m): 3.6
Culvert Type: CSP
Culvert Shape: Circular
Entrance Con: mitered to conform to slope

Upstream Invert Elev (m): 701.35
Downstream Invert Elev (m): 701.26
Barrel Length: 27.1
Minimum Road Elevation: 709.0

Photo(s)

Downstream view from the channel centre



Culvert Description

Name: CPR branch line (right barrel)
River: Bullshead Creek

Bridge File No.: N/A
River Station (km): 4.185

Geometry

Span (m): N/A
Diameter (m): 3.6
Culvert Type: CSP
Culvert Shape: Circular
Entrance Con: mitered to conform to slope

Upstream Invert Elev (m): 701.10
Downstream Invert Elev (m): 701.21
Barrel Length: 28.2
Minimum Road Elevation: 709.0

Photo(s)

Downstream view from the channel centre



Culvert Description

Name: Trans Canada Highway EB
River: Bullshead Creek

Bridge File No.: BF493
River Station (km): 3.431

Geometry

Span (m): 9.1
Diameter (m): 5.4
Culvert Type: CSP
Culvert Shape: Horizontal Ellipse
Entrance Con: headwall with bevel end

Upstream Invert Elev (m): 698.63
Downstream Invert Elev (m): 698.57
Barrel Length: 28.6
Minimum Road Elevation: 705.7

Photo(s)

Upstream view from the right bank



Culvert barrel looking upstream



Bridge Description

Name: Trans Canada Highway WB
River: Bullshead Creek

Bridge File No.: BF493
River Station (km): 3.399

Geometry

Span (m): 28.2
Width (m): 13.4
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 705.05
Low Chord (m): 704.05
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view channel centre



Downstream view from the left overbank



Bridge Description

Name: Ross Creek Golf Course Bridge 1
River: Bullshead Creek

Bridge File No.: N/A
River Station (km): 3.273

Geometry

Span (m): 10.8
Width (m): 2.4
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 701.08
Low Chord (m): 700.91
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Downstream view from the left bank



Bridge Description

Name: Ross Creek Golf Course Bridge 2
River: Bullshead Creek

Bridge File No.: N/A
River Station (km): 3.190

Geometry

Span (m): 10.1
Width (m): 3.9
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 701.40
Low Chord (m): 701.10
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

Upstream view from the right bank



Bridge Description

Name: Ross Creek Golf Course Bridge 3
River: Bullshead Creek

Bridge File No.: N/A
River Station (km): 3.080

Geometry

Span (m): 10.8
Width (m): 2.0
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 700.90
Low Chord (m): 700.82
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Downstream view from the
right bank**



Bridge Description

Name: Ross Creek Golf Course Bridge 4
River: Bullshead Creek

Bridge File No.: N/A
River Station (km): 2.879

Geometry

Span (m): 10.1
Width (m): 2.1
Pier Type: N/A
Pier Shape: N/A

High Chord (m): 700.70
Low Chord (m): 700.57
No. of Piers: 0
Pier Width (m): N/A

Photo(s)

**Upstream view from the right
bank**



Culvert Description

Name: 54 Street SE 1 (left barrel)
River: Bullshead Creek

Bridge File No.: N/A
River Station (km): 2.843

Geometry

Span (m): N/A
Diameter (m): 2.4
Culvert Type: CSP
Culvert Shape: Circular
Entrance Con: mitered to conform to slope

Upstream Invert Elev (m): 698.17
Downstream Invert Elev (m): 698.10
Barrel Length: 20.2
Minimum Road Elevation: 700.9

Photo(s)

Upstream view from the left bank



Downstream view from the left bank



Culvert Description

Name: 54 Street SE 1 (middle barrel)
River: Bullshead Creek

Bridge File No.: N/A
River Station (km): 2.843

Geometry

Span (m): N/A
Diameter (m): 2.4
Culvert Type: CSP
Culvert Shape: Circular
Entrance Con: mitered to conform to slope

Upstream Invert Elev (m): 698.18
Downstream Invert Elev (m): 697.99
Barrel Length: 20.8
Minimum Road Elevation: 700.9

Photo(s)

Upstream view from the left bank



Downstream view from the left bank



Culvert Description

Name: 54 Street SE 1 (right barrel)
River: Bullshead Creek

Bridge File No.: N/A
River Station (km): 2.843

Geometry

Span (m): N/A
Diameter (m): 2.4
Culvert Type: CSP
Culvert Shape: Circular
Entrance Con: mitered to conform to slope

Upstream Invert Elev (m): 698.06
Downstream Invert Elev (m): 697.93
Barrel Length: 19.9
Minimum Road Elevation: 700.9

Photo(s)

Upstream view from the left bank



Downstream view from the left bank



Bridge Description

Name: CPR Bridge
River: Bullshead Creek

Bridge File No.: N/A
River Station (km): 2.436

Geometry

Span (m): 59.3
Width (m): 4.9
Pier Type: concrete
Pier Shape: square

High Chord (m): 706.50
Low Chord (m): 704.20
No. of Piers: 2
Pier Width (m): 2.3

Photo(s)

Upstream view from the left bank



Downstream view from 54 St SE



Culvert Description

Name: 54 Street SE 2 (left barrel)
River: Bullshead Creek

Bridge File No.: N/A
River Station (km): 2.320

Geometry

Span (m): N/A
Diameter (m): 1.6
Culvert Type: CSP
Culvert Shape: Circular
Entrance Con: mitered to conform to slope

Upstream Invert Elev (m): 695.60
Downstream Invert Elev (m): 695.60
Barrel Length: 30.8
Minimum Road Elevation: 699.5

Photo(s)

Upstream view from the left bank



Downstream view from the right bank



Culvert Description

Name: 54 Street SE 2 (right barrel)
River: Bullshead Creek

Bridge File No.: N/A
River Station (km): 2.320

Geometry

Span (m): N/A
Diameter (m): 3.1
Culvert Type: CSP
Culvert Shape: Circular
Entrance Con: mitered to conform to slope

Upstream Invert Elev (m): 695.10
Downstream Invert Elev (m): 695.10
Barrel Length: 32
Minimum Road Elevation: 699.5

Photo(s)

Upstream view from the left bank



Downstream view from the right bank



Appendix C
Flood Control Structure Details

DRAFT

Electronic File Submission

- City of Medicine Hat Water Treatment Plan Flood Protection Berm, Construction Completion Report, December 2015 (Engineering Report_Med_Hat_WTP_Flood_Protect_Berm_2015-12-29.pdf)
- Overland Flow Protection Strategy, Harlow Area – Phase 1, Issued for Record Drawings, October 2015 (Harlow_IFR-19Nov15_Final.pdf)
- Overland Flow Protection Strategy, Riverside – Phase 1, Issued for Construction Drawings, August 2016 (IFC_RiversidePh1_AUG 2016.pdf)
- Overland Flow Protection Strategy, River Road, Issued for Record Drawings, March 2016 (RiverRd_IFRECORD_20160516_Final.pdf)
- Overland Flow Protection Strategy, Lions Park – Phase 1, Issued for Record Drawings, January 2017 (112947348_LIONS_PARK_PHASE-1-RECORD-SIGNED-JAN262017.pdf)
- Overland Flow Protection Strategy, Lions Park – Phase 2, Issued for Record Drawings, January 2017 (112947348_LIONS_PARK_PHASE-2-RECORD-SIGNED-JAN262017.pdf)

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Appendix D
Hydrometric Gauging Station Information

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STATION NO.: 05AJ001
STATION NAME: SOUTH SASKATCHEWAN RIVER AT MEDICINE HAT
LOCATED IN SECTION NW 31 **TOWNSHIP** 12 **RANGE** 5 W 4
LATITUDE 50° 02' 31.5" N **LONGITUDE** 110° 40' 39.1" W NAD 83
 N 50.04209° W 110.67754°
ESTABLISHED May 31 1911 **BY** Water Survey of Canada
OBSERVER: **Gauge Phone:** (403) 527-5232
LAND OWNER: **PHONE NO.:**

LOCATION OF STATION WITH RESPECT TO TOWNS, ETC. :
 Concrete shelter under Finley Bridge on 1st St. S.W. and 6th Ave. in Medicine Hat.
 Parking is located on the south side of River just downstream of the gauge.
 Access to the gauge is on the downstream side of Finley Bridge.

DESCRIPTION OF GAUGE AND EQUIPMENT:
 FTS logger with an external FTS phone modem connected to a Sutron Accubar pressure transducer. Gauge also contains: AC Power and charger. The logger is set to the WWG reading. The WWG is located on the downstream side of the Bridge on walkway. **Gauge Phone: (403) 527-5232**

MEASUREMENT DESCRIPTION:
 Measurements can be taken from either the Finaly bridge (at the gauge) or 1 km downstream at the Maple Ave. Bridge. Maple Ave. is a more suitable section for ADCP measurements.
 Winter Measurements are taken approximately 10 km upstream at the Redcliff River Valley Park (1402 River Road SW Redcliff, AB)

TYPE OF CONTROL: Natural
KIND AND MATERIALS - Gravel and Rocks

PREPARED BY: Zac Bishop **DATE:** 2017-01-03

BENCH MARKS

GIVE ELEVATIONS OF BENCHMARKS TYPES AND NUMBERS OR MARKINGS.

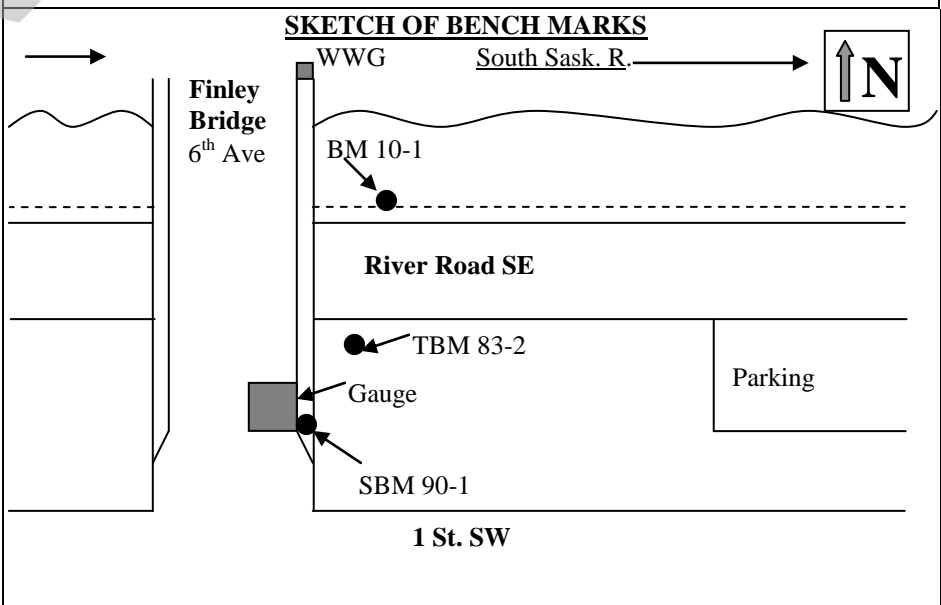
GAUGE DATUM = 652.040m GSC

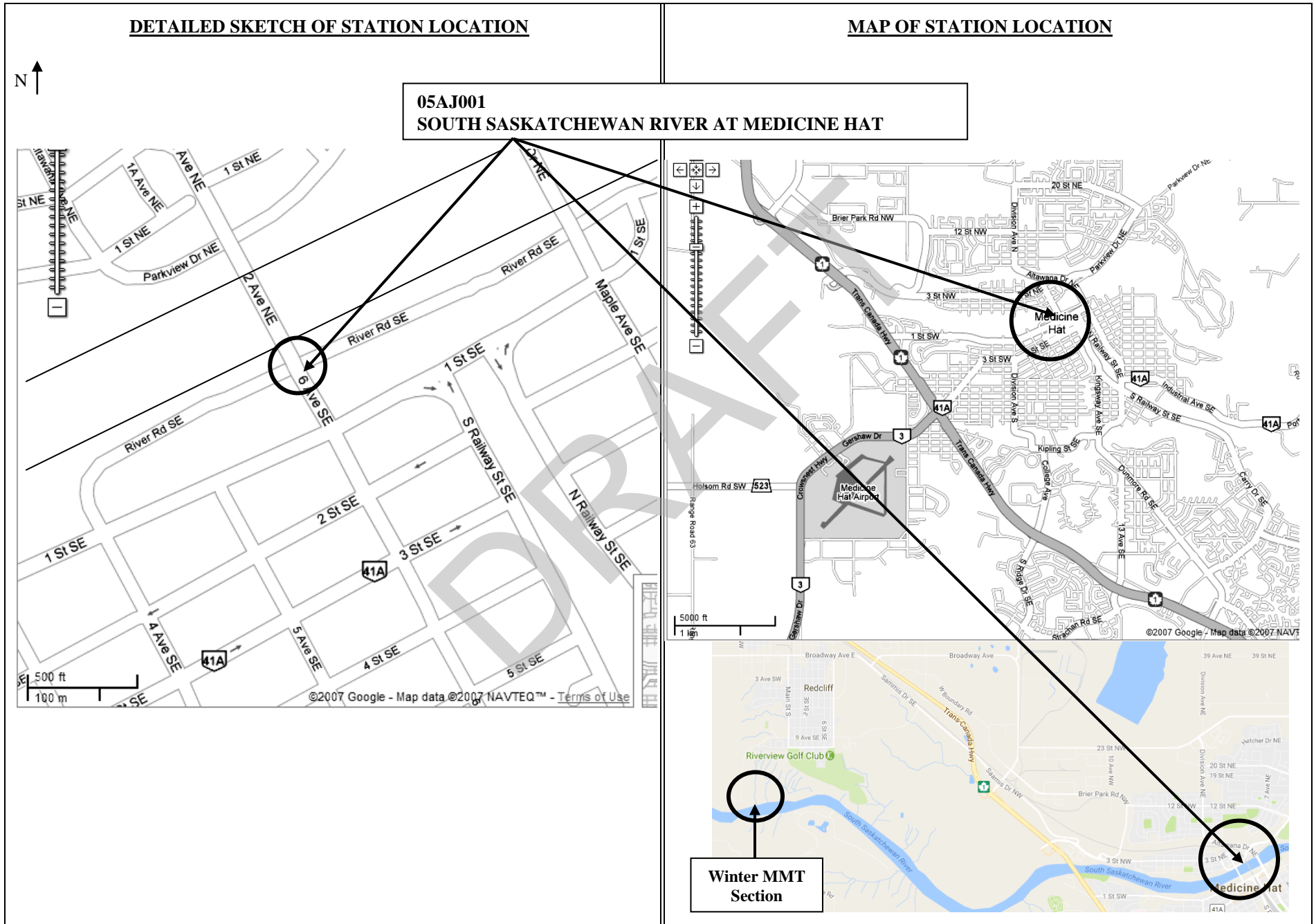
* S.B.M. 90-1: Brass cap located 2 m downstream of shelter in bridge abutment.
Elevation: 662.257 m (GSC) (Ref. to TBM 83-2)

BM 10-1: Painted bolt in guard rail post 21m Northeast of the gauge.
Elevation: 660.378 m (GSC) (Ref. to SBM 90-1)

T.B.M. 83-2: Southeast corner bolt of lamp standard painted orange. 12 meters NE of gauge.
Elevation: 659.957m (GSC) (Ref. to SIBM 83-1)

BENCH MARK CLASSIFICATION: 2 * = **PRIMARY B.M.**
REMARKS: Level check to gauges once a year during the frost-free period with all bench marks tied-in preferably at the same time.





STATION NO.: 05AH052
STATION NAME: ROSS CREEK AT HIGHWAY 41
LOCATED IN SECTION S.E. 19 **TOWNSHIP** 12 **RANGE** 4 W4
LATITUDE 50° 00' 20.0" N **LONGITUDE** 110° 31' 58.4" W
 N50.00557- NAD 83 W110.53291
ESTABLISHED 2000-05-31 **BY** Water Survey of Canada
OBSERVER: **PHONE NO.:**
LAND OWNER: **PHONE NO.:**

LOCATION OF STATION WITH RESPECT TO TOWNS, ETC. :
 From Medicine Hat (Junction Highway #1 and Dunmore road) go East on Trans Canada Highway # 1 Approx 6 kms, Turn North on Highway #41 Approx. 4 kms. Gauge is on upstream side right bank.
 Alternate route: From Medicine Hat go East on Highway # 41A Approx. 7 kms, Turn South on Highway #41 Approx 3 kms to gauge.

DESCRIPTION OF GAUGE AND EQUIPMENT:
 Vedas II logger connected to Phone Modem with Accubar and Solar Panel in Brytex shelter.
 W.W.G. on upstream side of bridge.
 Phone: 403-580-3099

MEASUREMENT DESCRIPTION:
 Bridge Approx 3 meters below gauge.
 Bridge marked in 1m sections, upstream side, double marks at 10, 20, and 30 meters.
 0.0 on left bank abutment, 37.4 m right bank abutment.
 Wading below gauge.

TYPE OF CONTROL: Natural
KIND AND MATERIALS - Gravel and Rocks

PREPARED BY: Taylor Krupa **DATE** Oct 12, 2011

BENCH MARKS

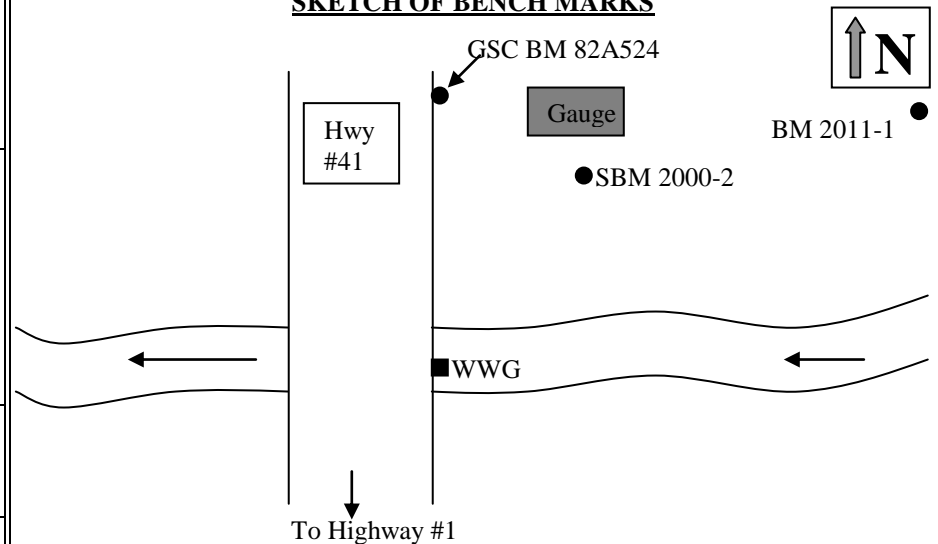
GIVE ELEVATIONS OF BENCHMARKS TYPES AND NUMBERS OR MARKINGS.

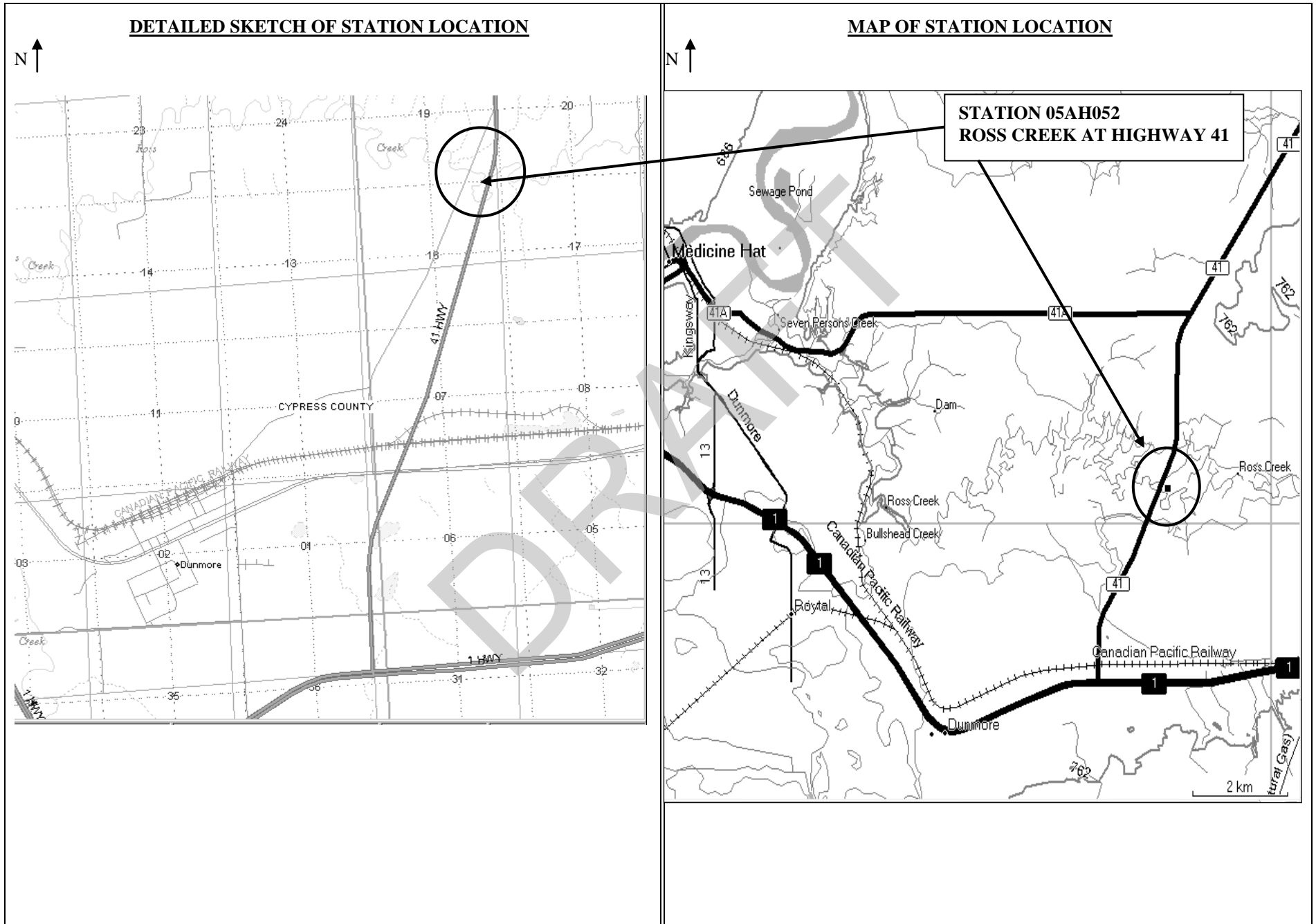
GAUGE DATUM = 698.626m G.S.C.

- * **GSC BM 82A524** : Brass cap in right bank upstream face of North East bridge abutment.
Elevation : 706.079 m G.S.C.
- B.M. 2011-1** : Brass cap on ground rod driven to refusal 17.2 m South East of North East corner of shelter.
Elevation : 704.331m G.S.C. (Ref. to GSC BM 82A524)
- S.B.M. 2000- 2** : Brass cap on ground rod driven to refusal 4.5 m South of shelter.
Elevation : 703.720m G.S.C. (Ref. to GSC BM 82A524)

BENCH MARK CLASSIFICATION: 3 * = **PRIMARY B.M.**
REMARKS: Level checks once a year. Bench Marks tied in every three years

SKETCH OF BENCH MARKS





<p>STATION NO.: 05AH005</p> <p>STATION NAME: Seven Persons Creek At Medicine Hat</p> <p>LOCATED IN SECTION SW 30 TOWNSHIP 12 RANGE 5 W 4M</p> <p>LATITUDE 50° 01' 25.1" N LONGITUDE 110° 41' 0.6" W or 50.02365 N using (NAD 83) 110.68351 W</p> <p>ESTABLISHED May 3, 1979. BY Water Survey of Canada</p> <p>Gauge \ P-Das Phone Number: (403) 528-6894</p> <p>LAND OWNER: City of Medicine Hat PHONE NO.:</p>	<p style="text-align: center;"><u>BENCH MARKS</u></p> <p style="text-align: center;">GAUGE DATUM = 661.805 m (Approx. GSC)</p> <p>* BM 92-1 – Brass cap on screw anchor 13 m upstream of the gauge, and 2.3 m south of concrete wall of skate park (paint mark on wall). Below surface grade. Elevation: 664.592 m (Ref. to BM 86-2)</p> <p>SBM 93-1 – Brass cap on 4 m of ground rod 13 m east of the shelter, and 4.3 m south of fence surrounding skate park. Below surface grade. Elevation: 663.840 m (Ref. to BM 86-2)</p> <p>BM 2013-01 – Bolt in side of concrete wall of skate park, located directly across (3.1m) from gauge door. Head of bolt is 1.06m below top of concrete wall. Elevation: 665.806 m (Ref. to BM 92-1)</p> <p>BENCHMARK CLASSIFICATION: 2 * = PRIMARY B.M. REMARKS: Level check to gauges (ECG) once a year during the frost free period with all bench marks tied-in preferably at the same time.</p>
<p>LOCATION OF STATION WITH RESPECT TO TOWNS, ETC. :</p> <p>On the left bank adjacent to the skateboard park, west of the intersection of College Avenue and Kipling Street, in the city of Medicine Hat.</p> <p>Land location: Plan 190 A.N. Block: 12 Lot: 2 Street Address: 101 Kipling Street</p>	<p style="text-align: center;"><u>SKETCH OF BENCH MARKS</u></p> <p>The sketch shows a plan view of the site. At the top is a 'Parking Lot' indicated by a dashed rectangle. Below it is 'BM 86-2' marked with a solid dot. A road, 'Kipling Street', runs horizontally across the middle. An arrow points north from Kipling Street towards 'Division Ave. Via Old Cemetery Rd.'. Below Kipling Street is a 'Skate Park' indicated by a dashed rectangle. Inside the skate park area, 'BM 2013-01' is marked with a solid dot. Below the skate park, '* BM 92-1' and 'SBM 93-1' are marked with solid dots. A 'Gauge' is shown as a hatched rectangle. At the bottom, 'Seven Persons Creek' is represented by a wavy line with an arrow pointing right.</p>
<p>DESCRIPTION OF GAUGE AND EQUIPMENT:</p> <p>Standard steel shelter with AC power on a 3.05 m x 1.5 m diameter stilling well. Shaft encoder set to the ECG reading. Continuous stage data obtained from a FTS data logger with modem. Phone Number: (403) 528-6894</p> <p>Lower intake requires frequent flushing and digging out in the stream each visit.</p> <p>Intake (Invert) Elevations: LOWER = 662.100 m UPPER = 662.570 m</p>	
<p>MEASUREMENT DESCRIPTION:</p> <p>By wading during most flows with several nearby bridges for very high flows.</p> <p>In the spring when ice conditions persist – Walk to the downstream culvert outflow.</p>	
<p>TYPE OF CONTROL: Natural</p> <p>KIND AND MATERIALS - Sand, fine gravel & silt.</p>	
<p>PREPARED BY: Zac Bishop DATE: 2016-10-27</p>	

DETAILED SKETCH OF STATION LOCATION



MAP OF STATION LOCATION



Appendix E
Reach-Representative Photographs

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South Saskatchewan River



South Saskatchewan River (downstream view) at River Valley Park in the Town of Redcliff at planned cross section 107.



South Saskatchewan River (downstream view) at Highway 1 bridge from planned cross section 94.



South Saskatchewan River (downstream view) at Finlay Bridge immediately downstream of planned cross section 81.



South Saskatchewan River (upstream view) at Strathcona Island Park between planned cross sections 64 and 65.



South Saskatchewan River (downstream view) at Police Point Park near the mouth of Ross Creek at planned cross section 60.



South Saskatchewan River (upstream view) from the wastewater treatment plant just downstream of planned cross section 57.



South Saskatchewan River (downstream view) from a gravel bar 120 m upstream of planned cross section 55.



South Saskatchewan River (upstream view) from planned cross section 27.



South Saskatchewan River (upstream view) from 100 m downstream of planned cross section 22.



South Saskatchewan River (upstream view) near planned cross section 1.

Ross Creek



Ross Creek (upstream view) from Highway 41 bridge at planned cross section 262.



Ross Creek (downstream view) from Range Road 50A bridge at planned cross section 232.



Ross Creek (upstream view) near planned cross section 230.



Ross Creek (upstream view) near planned cross section 226.



Ross Creek (downstream view) near planned cross section 225.



Ross Creek (downstream view) from Range Road 51A bridge at planned cross section 204.



Ross Creek (upstream view) near planned cross section 188.



Ross Creek (upstream view) near planned cross section 176.



Ross Creek (upstream view) looking at the right valley slope between planned cross sections 166 and 167.



Ross Creek (upstream view) looking towards the top of the left valley slope at the confluence of Ross and Bullshead creeks near planned cross sections 163 and 164.



Ross Creek (upstream view) near planned cross section 158.



Ross Creek (upstream view) from Day Street bridge at planned cross section 143.



Ross Creek (upstream view) from Porcelain Avenue bridge at planned cross section 132.



Ross Creek (upstream view) at the confluence of Ross and Seven Persons creek from downstream of planned cross section 125.

Seven Persons Creek



Seven Persons Creek (downstream view) from 40 m downstream of planned cross section 602.



Seven Persons Creek (downstream view) from planned cross section 595.



Seven Persons Creek (upstream view) from planned cross section 574.



Seven Persons Creek (upstream view) from Range Road 62 bridge from planned cross section 513.



Seven Persons Creek (downstream view) from 25 m upstream of planned cross section 485.



Seven Persons Creek (downstream view) of Cottonwood Coulee Golf Course from just downstream of planned cross section 472.



Seven Persons Creek (upstream view) Paradise Valley Golf Course from just downstream of planned cross section 434.



Seven Persons Creek (downstream view) of Kin Coulee Park from planned cross section 423.



Seven Persons Creek (downstream view) at planned cross section 412.



Seven Persons Creek (upstream view) at planned cross section 389.

Bullshead Creek



Bullshead Creek (downstream view) from Township Road 120 at planned cross section 367.



View of the Bullshead Creek floodplain from the TransCanada Highway.



Bullshead Creek (downstream view) from 54 Street SE at planned cross section 294.



Bullshead Creek (downstream view) from 54 Street SE at planned cross section 285.



Bullshead Creek (downstream view) from top of the left valley slope between planned cross sections 275 and 276.



Bullshead Creek (downstream view) from the top of the left valley slope at the Ross and Bullshead Creek confluence from planned cross section 268.