MEDICINE HAT RIVER HAZARD STUDY

FLOOD RISK INVENTORY AND ASSESSMENT

FINAL REPORT

Prepared for:

Alberta Government

30 May 2022

NHC Ref. No. 1003094

nhc
northwest hydraulic consultants
water resource specialists

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Alberta Environment and Parks
Edmonton, Alberta

Prepared by:

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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 (FHIP). 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 seventh component, *Flood Risk Inventory and Assessment*. The objectives of this study component are to compile and interpret available spatial data, to take inventory of potentially affected buildings and infrastructure and to categorize at-risk buildings, and to compute flood risk statistics for land parcels, buildings, infrastructure, and at-risk populations.

The data that was acquired and inventoried for the study included cadastral data, hydrography, roadway and railway networks, census unit boundaries and population count from the 2016 census, bridges, and culverts. All inventory data were assembled in a geodatabase.

Statistics are presented for all open water flood inundation scenarios as well as according to governing flood hazard areas. The inundation extents for each flood scenario were superimposed on the inventory data to compute the following statistics for each local authority:

- Number of at-risk land parcels;
- Number of at-risk residential buildings;
- Number of at-risk non-residential buildings;
- Number of at-risk bridges;
- Number of at-risk culverts;
- Length of at-risk roadway;
- Length of at-risk railway, and
- Estimated at-risk population.

In Medicine Hat, buildings are affected in the South Flats neighbourhood during the 20-year return period from Seven Persons Creek. At the 35-year return period, buildings become affected by flooding from the South Saskatchewan River in the Riverside neighbourhood and from Seven Persons Creek in the North Flats neighbourhood. A large increase in the inundation extents occurs at the 200-year return period as flood control structures are overtopped, resulting in most buildings in the North Flats neighbourhood being at risk.

Key buildings that are at-risk in Medicine Hat for various return periods include City Hall, a police station, two fire stations, the Remand Centre and the water treatment plant. A total of nine schools are also at-risk over a range of return periods which are located mostly in the North Flats neighbourhood but also in the South Flats and Riverside neighbourhoods.

The majority of Redcliff is located above the river valley about 1 km away from the South Saskatchewan River and is not at-risk. A small number of residential buildings are at-risk along Josephine Avenue starting at the 35-year return period.

Infrastructure in Desert Blume is not at-risk except for the bridges in Desert Blume Golf Course.

In Cypress County there are several locations where residential buildings are at-risk for various return periods. Residential buildings are at-risk along Day Street SE and near Range Road 51A from Ross Creek. On the South Saskatchewan River, residential buildings are at-risk near Range Road 71, near Paramatta Avenue, and near Township Road 132A. Structures at the Medicine Hat wastewater treatment plant are at-risk from the 200-year return period flood and above. On Seven Persons Creek, residential buildings along Township Road 120 are at-risk. Finally, on Bullshead Creek residential buildings are at-risk west of Highway 1.

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 flood risk inventory and assessment component of the study:

- Robyn Andrishak (Project Manager) – responsible for the overall direction of the project and provided advice and senior review throughout the flood risk inventory and assessment.
- Michael Brayall (Water Resources Engineer) – co-authored this report and assisted with the inventory and assessment.
- Rebecca Himsl (GIS Analyst) – conducted the inventory and assessment.
- Mary Bachynsky (Project Engineer) – co-authored this report and assisted with the assessment.

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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, assist with developing flood mitigation options, and facilitate 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 seventh component – *Flood Risk Assessment and Inventory*. The primary task, services, and deliverables associated with this report are:

- Compilation and interpretation of available spatial data;
- Inventory and categorization of buildings and infrastructure;
- Computation of flood risk statistics for different flood scenarios.

The main goal of this component is to help define flood risks in the study area. The open water flood inundation and governing design flood hazard maps were combined with the available spatial data to compute flood risk statistics for land parcels, buildings, infrastructure, and population at risk.

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 km^2, 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 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 km^2 and 28,300 km^2, 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 foothill 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 km^2 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 AVAILABLE SPATIAL DATA

Available spatial data assembled and used for this analysis are summarized below. Supporting information and digital files are provided as **Appendix A**. The geographic distribution of the spatial data is illustrated in **Appendix B**.

2.1 Cadastral

Cadastral data for this study area was acquired through three different sources. City of Medicine Hat (2019) cadastral data was provided by the City's GIS department as "Tax Parcels". Upstream of the city boundaries on the South Saskatchewan River, Seven Persons Creek, Bullshead Creek and Ross Creek, cadastral data was acquired from Altalis – a commercial provider of Alberta base mapping data (AltaLIS, 2015). This data was provided as a set of linear features identifying the boundaries of each land parcel. These linear features were converted to polygons, and polygons located along minor roads or in stream beds were removed. Rural land ownership maps from Cypress County (2019) indicated that land parcels downstream of the city limits on the South Saskatchewan River were largely coincident with the Alberta Township Survey (ATS) quarter section grid. Accordingly, quarter sections acquired through Altalis were used to approximate the land parcels in this area.

2.2 Infrastructure

The National Road Network (NRN) (Statistics Canada, 2018) provides a comprehensive geospatial record of road centerline data covering the entire country. The NRN did not capture the road geometry in areas that had undergone recent development. In these locations, NHC manually digitized the roads based on the 2018 orthoimagery and, if information was available, these roads were named using Google Maps.

Rail network spatial data was sourced from the National Railway Network (NRWN) – a GIS product created and maintained by National Resources Canada (NRCan, 2018a).

Bridges and culverts were mapped by NHC based on field surveys (NHC, 2019a) and reference data acquired from Alberta Transportation. Centroids were generated for each structure and were used in this analysis. The maximum low chord elevation of each bridge was extracted from the HEC-RAS model and joined with the bridge centroids in order to determine whether the structure will be impacted by flooding at each flood scenario. The approach road elevation – as determined by the bare earth DEM – was joined with the culverts centroid layer.

2.3 Census

The most recent census results available at the time of creating the flood risk inventory were compiled in 2016. Census results and the corresponding spatial units were downloaded from Statistics Canada (2016) and merged together. Census dissemination blocks are the smallest spatial unit for which census results

are published; they are areas defined as “bounded on all sides by roads and/or boundaries of standard geographic areas” (Statistics Canada, 2016).

In order to maintain confidentiality, if the total population in a census dissemination block is less than 15, the population count is rounded to a base of 5. A random rounding algorithm is used to either round the population count up or down so that the value will always end in a 0 or 5. As a result, the given value will always be within 5 of the true population count.

3 INTERPRETED SPATIAL DATA

3.1 Aerial Photography

OGL Engineering Ltd. completed the acquisition of new aerial imagery in July 2018 and used this imagery to generate colour-balanced ortho-rectified mosaics. A complete description of the aerial imagery acquisition and data processing procedures are provided in the *Survey and Based Data Collection* report (NHC, 2019a) provided under a separate cover. This 2018 orthoimagery was used to interpret spatial data for the flood risk assessment.

3.2 Structure Classification

3.2.1 Digitization

Building centroids were required to statistically analyse the impact of the different flood scenarios on residential and non-residential structures. The City of Medicine Hat provided spatial datasets to facilitate structure digitization and classification within the city limits; these data included building footprints, land use zoning polygons, geolocated address points and tax parcels. Building centroids were derived from the footprints layer, and centroids corresponding to garages, sheds or other accessory buildings were deleted. Referring to the 2018 orthoimagery, Google Street View and the address point file, additional centroids were added if it was deemed that a single building contained multiple residences or businesses. Outside of the Medicine Hat city limits, centroids identifying primary structures were manually digitized by NHC based on the 2018 orthoimagery. Structures were only identified and centroids digitized if the building was located within the 1000-year flood inundation extent.

3.2.2 Classification

Structures were categorized as either residential or non-residential and further sub-categorized as summarized in **Table 1**.

Table 1 Classification Scheme for Structures

Category	Sub-Category
Residential	Single family residence
	Multi family residence
	Group home
	Retirement home
Non-residential	Hospital
	School
	Commercial building
	Industrial building
	Government building
	Water treatment facility
	Wastewater treatment facility
	Other non-residential building

Residential structures were classified as single-family residences when three or fewer addresses were geolocated within a parcel. All residences in duplexes, tri-plexes, and homes with basement suites were often associated with one land parcel. Given that each unit would likely be similarly affected by a flood event, each of these residences was uniquely identified with a centroid. When more than three addresses were associated with a given parcel, it was categorized as multi-family. Given this classification, multi-family residential structures are typically multi-story buildings or apartments where a flooding event would more significantly impact the residences located at ground level. For all multi-family residences, an approximate number of units was estimated based on the provided geolocated address points and confirmed through Google Street View. Group Homes and Retirement Homes were identified through an online search and confirmed with reference to the orthoimagery and Google Street View.

The distinction between commercial and industrial buildings was made based upon zoning information and Google Street View. For schools, government buildings, and industrial buildings, only one building was recorded per land parcel. Commercial buildings were categorized based on the number of addresses within a building and cross checked against Google Street View. No hospitals were located within the 1000-year open water flood extent. However, the Medicine Hat Recovery Centre and numerous medical clinics were; these were classified as residential structures and commercial structures, respectively. Non-residential buildings that did not fit in the defined sub-categories were classified as other. Examples of non-residential buildings classified as other included churches and community leagues.

4 FLOOD RISK ASSESSMENT & INVENTORY

4.1 Methodology

Inventory data for the flood risk assessment were assembled into a geodatabase with the following feature classes: administrative boundaries, bridges, buildings, cadastral data, census dissemination blocks, culverts, rail network, and road network. A description of these data, their spatial attributes, and relevant digital file information is detailed in **Appendix A**. The geographic distribution of the spatial data is illustrated in **Appendix B**.

Flood risk statistics were computed for thirteen open water flood inundation extents (2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1000-year return period open water floods) according to the following inundation scenarios:

Direct Inundation: Corresponds to areas that are part of, or connected directly to, the river channel.

Potential flood control structure failure: Corresponds to areas that would flood in the event of the failure of a flood control structure (FCS) resulting in inundation of the area behind the FCS. When water surface elevations indicated that all or a portion of an FCS were overtopped, inundated areas behind the FCS were categorized as direct inundation areas.

Statistics were also computed for the governing flood hazard areas, where flood risk statistics associated with the floodway, flood fringe, high hazard flood fringe, and protected flood fringe were computed separately.

For each flood inundation scenario, the extent of inundation was overlain over the flood risk assessment inventory data to evaluate the following statistics:

- Number of at-risk land parcels;
- Number of at-risk residential buildings;
- Number of at-risk non-residential buildings;
- Number of at-risk bridges;
- Number of at-risk culverts;
- Length of at-risk roadway;
- Length of at-risk railway; and
- Estimated population at risk.

Risk statistics are provided as an aggregate total for the entire study area and are also summarized according to local municipal authority, as this provides more meaningful information to the stakeholders. The municipal authorities included in the study area are:

- City of Medicine Hat;
- Town of Redcliff;
- Hamlet of Desert Blume; and
- Cypress County.

For a given flood scenario, a land parcel was deemed to be at risk if it was intersected by the corresponding flood extent polygon. Portions of land parcels located within the channel, as defined by the National Hydrographic Network (NHN) (NRCan, 2018b) basins 05AK000, 05AJ000, and 05AH000, were removed. Inundated land parcels were counted for a municipality whether they lay fully or partially within its boundaries. As illustrated in **Figure 2**, the land parcels were not always coincident with administrative boundaries so that a single parcel might be counted in the risk statistics for more than one area. As a result, the total number of at-risk land parcels is not always equal to the sum of the land parcels at risk within each local municipal authority or the flood hazard area.

Buildings were considered at risk if the building centroid fell within the flood extents. Results were classified by primary category (i.e. residential or non-residential) and sub-category (e.g. single-family, multi-family, commercial, industrial). Accessory structures, such as garages, that were located on land parcels with a primary structure were not included in this analysis.

Bridges were considered at risk if the water level was greater than the bridge's low chord elevation. Culverts were considered at risk if the flood level exceeded the approach road elevation. Culverts conveying local drainage or watercourses other than the South Saskatchewan River, Ross Creek, Seven Persons Creek, or Bullshead Creek were not included in this analysis.

The inundation risk of roadways and railways were calculated by determining the total length within the extent of inundation for each flood scenario. Segments of the road or rail network that are associated with bridges were excluded from the spatial inventory. Railroad embankments were assumed to be permeable. As a result, isolated inundation areas behind railroad embankments were included in the direct inundation inventory. Isolated inundation areas behind railway embankments were included in the governing flood hazard area along with dry portions of the railway embankment that are above the governing flood level. Therefore, the length of railway at risk during the 100-yr return period is less than the length at risk during the governing flood hazard scenario.

The population at risk was estimated by multiplying the total population within each census dissemination block by the percentage of the area of the block that falls within the flood extent. Some census blocks contain water features, such as rivers or lakes, that are not populated. These areas were identified from the NHN datasets (NRCan, 2018b) and were masked out of the census blocks. The area of the dissemination blocks was recomputed after erasing the wetted areas for a more representative risk estimate.

4.2 Results

The results of the flood risk assessment are summarized into statistics based on the number of at-risk land parcels, residential and non-residential buildings, culverts and bridges as well as the length of roadway and railway and estimated affected population. Statistics are evaluated according to municipality for all thirteen flood frequencies under both direct inundation and flood control structure failure conditions; statistics for the governing design flood are also presented. The risk statistics presented are based on flood extents described in the Hydraulic Modelling and Flood Inundation Mapping Report (NHC, 2022a) and the Governing Design Flood Hazard Map Production Report (NHC, 2022b), respectively. Both reports provide a summary of the data and methodology used to derive the flood extents and prepare the accompanying maps.

4.2.1 Land Parcels

Table 2 and **Figure 3a** provide summary statistics for the number of land parcels at risk due to direct inundation in the study area.

Medicine Hat has the most land parcels at risk for all open water flood scenarios. The number of land parcels at risk increases slightly between the 2-year and 35-year return periods. The rate of increase of the number of land parcels at risk begins to increase at the 50-year return period. The number of land parcels at risk increases by a significant margin, mostly in the North Flats neighbourhood, for the 100-year and 200-year return periods. Above the 200-year return period, the increase in risk is relatively constant to the 1000-year return period.

Most land parcels in Redcliff are located above the river valley, approximately 1 km from the South Saskatchewan River, and are not at risk for the analyzed flood scenarios. However, developed parcels located near Josephine Avenue are at risk starting at the 10-year return period. By the 1000-year return period, all land parcels near Josephine Avenue with structures are at risk.

Land parcels in the Hamlet of Desert Blume are at-risk immediately adjacent to Seven Persons Creek in the Desert Blume Golf Course.

Cypress County has the second most land parcels at risk for all return periods. Due to the size of the land parcels in Cypress County, even though the area of inundation increases with return period, the number of land parcels at risk only increases slightly with return period.

Table 2 Land Parcels at Risk for Various Flood Scenarios due to Direct Inundation

Return Period	Number of Parcels by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	270	23	15	264	525
5-yr	326	25	15	295	612
10-yr	363	26	16	300	654
20-yr	407	27	16	304	703
35-yr	465	28	16	307	765
50-yr	766	28	16	310	1069
75-yr	883	30	17	314	1191
100-yr	1655	31	17	318	1968
200-yr	2644	40	18	336	2985
350-yr	2797	43	18	339	3144
500-yr	2834	43	18	346	3187
750-yr	2902	43	18	349	3258
1000-yr	2949	43	18	351	3307

Table 3 and **Figure 3b** provide summary statistics for the number of land parcels at risk due to potential flood control structure failure in the study area. Some land parcels may be at risk due to both direct inundation and potential flood control structure failure. Values reported in **Table 3** and **Figure 3b** correspond to parcels inundated only under potential flood control structure failure and not through direct inundation and should be considered as in addition to those reported previously.

All flood control structures are located within the Medicine Hat city limits.

Potential flood control structure failure affects the Medicine Hat Water Treatment Plant Dike for the 35- to 100-year return periods, the Harlow Dike for the 2- to 75-year return periods, the Riverside Dike for the 20- year return period, and the Lions Park/Industrial Ave Dike for the 5- to 100-year return periods.

Only Medicine Hat has additional land parcels at risk due to the potential failure of flood control structures. The most additional land parcels at risk due to potential flood control structure failure are for 75-year flood. All the flood control structures are overtopped during the 200-year flood and therefore no additional land parcels are at risk for the 200-year flood and above.

Table 3 Additional Land Parcels at Risk for Various Flood Scenarios due to Potential Flood Control Structure Failure

Return Period	Number of Parcels by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	0	0	0	0	0
5-yr	1	0	0	0	1
10-yr	11	0	0	0	11
20-yr	49	0	0	0	49
35-yr	237	0	0	0	237
50-yr	358	0	0	0	358
75-yr	680	0	0	0	680
100-yr	214	0	0	0	214
200-yr	0	0	0	0	0
350-yr	0	0	0	0	0
500-yr	0	0	0	0	0
750-yr	0	0	0	0	0
1000-yr	0	0	0	0	0

Table 4 and **Figure 3c** provide summary statistics for the number of land parcels at risk for the governing design flood scenario in the study area.

The largest number of land parcels at risk for the governing design flood scenario are located in Medicine Hat. Most of the developed land parcels at risk for the governing design flood scenario are located within the flood fringe with only a few at risk in the floodway. There are a few land parcels in Harlow, Riverside, North Flats, and South Flats within the high hazard flood fringe and there are a few land parcels in North Flats within the protected flood fringe.

The second most land parcels at risk for the governing design flood are located in Cypress County. Land parcels at risk in Redcliff are along Josephine Avenue and are located predominantly in the floodway. The land parcels at risk for the governing design flood scenario in Desert Blume are located immediately adjacent to Seven Persons Creek.

Table 4 Land Parcels at Risk for the Governing Design Flood Scenario

Classification	Number of Parcels by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
Floodway	368	28	14	288	651
High Hazard Flood Fringe	706	13	5	100	813
Protected Flood Fringe	398	0	0	0	398
Flood Fringe	1735	18	15	220	1968
Flood Hazard Area	1869	31	17	318	2182

4.2.2 Residential Buildings

Table 5 and **Figure 4a** provide summary statistics for the number of residential buildings at risk due to direct inundation in the study area.

The risk to residential buildings due to direct inundation is most significant in Medicine Hat with inundation beginning in the North Flats neighbourhood during the 20-year return period from Ross Creek. At the 35-year return period, residential buildings become at risk in the Riverside neighbourhood from the South Saskatchewan River and in the North and South Flats neighbourhoods from Seven Persons Creek. The number of at-risk residential buildings gradually increases until the 100-year return period. Residential buildings in the Harlow neighbourhood become at risk during the 100-year return period as the Harlow Dike is overtopped. At the 200-year return period, the number of at-risk residential buildings increases significantly because of a large increase in the inundation extent in the Downtown, North Flats and South Flats neighbourhoods.

In Redcliff, residential buildings located along Josephine Avenue are at risk starting during the 35-year return period. By the 350-year flood, all residential buildings along Josephine Avenue except for one are at risk.

Residential buildings in Desert Blume are not at risk for the analyzed return periods.

In Cypress County, during the 5-year return period, one residential building becomes at risk along Ross Creek near Day Street SE; all four residences in the area are considered at-risk by the 75-year return period. Residential buildings near Range Road 51A also become at risk from inundation from Ross Creek the 350-year return period. On the South Saskatchewan River, residential buildings are at risk near Range Road 70 (750-return period), near Paramatta Avenue (100-year return period), near Township Road 132A (200-year return period). On Seven Persons Creek, residential buildings are at risk near Township Road 120 starting at the 50-year return period. Finally, on Bullshead Creek, residential buildings are at risk west of Highway 1 starting at the 350-year return period.

Table 5 Residential Buildings at Risk for Various Flood Scenarios due to Direct Inundation

Return Period	Number of Residential Buildings by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	0	0	0	0	0
5-yr	0	0	0	1	1
10-yr	0	0	0	1	1
20-yr	3	0	0	2	5
35-yr	17	1	0	3	21
50-yr	172	3	0	4	179
75-yr	219	4	0	5	228
100-yr	841	6	0	7	854
200-yr	1952	12	0	12	1976
350-yr	2058	13	0	18	2089
500-yr	2084	13	0	19	2116
750-yr	2132	13	0	23	2168
1000-yr	2171	13	0	24	2208

Table 6 and **Figure 4b** provide summary statistics for the number of residential buildings at risk due to potential flood control structure failure in the study area. Residential buildings at risk due to potential flood control structure failure are in addition to those that are at risk due to direct inundation. Flood control structures are only located within Medicine Hat.

Table 6 Additional Residential Buildings at Risk for Various Flood Scenarios due to Potential Flood Control Structure Failure

Return Period	Number of Residential Buildings by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	0	0	0	0	0
5-yr	0	0	0	0	0
10-yr	0	0	0	0	0
20-yr	0	0	0	0	0
35-yr	63	0	0	0	63
50-yr	160	0	0	0	160
75-yr	522	0	0	0	522
100-yr	189	0	0	0	189
200-yr	0	0	0	0	0
350-yr	0	0	0	0	0
500-yr	0	0	0	0	0
750-yr	0	0	0	0	0
1000-yr	0	0	0	0	0

Table 7 and **Figure 4c** provide summary statistics for the number of residential buildings at risk for the governing design flood scenario in the study area.

The largest number of residential buildings at risk for the governing design flood scenario are located in Medicine Hat. Most of the residential buildings are risk are located in the South Flats and North Flats neighbourhoods. There are a small number of at-risk residential buildings in Redcliff and Cypress County. There are no residential buildings at risk for the governing design flood scenario in Desert Blume. Only four residential buildings at risk are located within the floodway.

Table 7 Residential buildings at Risk for the Governing Design Flood Scenario

Classification	Number of Residential Buildings by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
Floodway	2	1	0	1	4
High Hazard Flood Fringe	195	2	0	1	198
Protected Flood Fringe	189	0	0	0	189
Flood Fringe	1028	5	0	6	1039
Flood Hazard Area	1030	6	0	7	1043

4.2.3 Non-residential Buildings

Table 8 and **Figure 5a** provide summary statistics for the number of non-residential buildings at risk due to direct inundation in the study area.

In Medicine Hat, non-residential buildings in the South Flats neighbourhood become at risk during the 20-year return period from Seven Persons Creek as well as in the North Flats along Industrial Ave. SE near the Seven Persons-Ross Creek confluence. The number of non-residential buildings at risk gradually increases between the 20-year and the 100-year return periods with additional inundation occurring in the South Flats and North Flats neighbourhoods. A large increase in risk to non-residential buildings occurs during the 200-year return period with most of the increase occurring in the North Flats neighbourhood; the risk to non-residential buildings continues to gradually increase for floods above the 200-year return period. The following key non-residential buildings are at-risk for various return period floods throughout Medicine Hat:

- During the 50-year return period: a school in the South Flats neighbourhood becomes at risk from Seven Persons Creek.
- During the 75-year return period: a fire station in NE Crescent Heights becomes at risk from the South Saskatchewan River.
- During the 100-year return period: the Veiner Centre and additional school in the North Flats neighbourhood become at-risk from inundation from Seven Persons Creek.
- During the 200-year return period: the gas utility located in South Flats from Seven Persons Creek; the water treatment plant and power utility located along Power House Road from the South Saskatchewan River; City Hall, the Police Department, the Department of Justice and Solicitor General and few additional schools become at risk when the Lion's Park/Industrial Avenue Dike is overtopped; and an additional school in the Riverside neighbourhood also becomes at-risk from the South Saskatchewan River.
- During the 350-year return period: the Remand Centre and another fire station, located in the North Flats neighbourhood; the transit office and the main post office located in the South Flats neighbourhood along Seven Persons Creek, and an additional school in the South Flats neighbourhood.

Only seven at-risk, non-residential buildings are located outside of Medicine Hat. In Redcliff, a single public utilities building becomes at-risk during the 35-year return period. Non-residential buildings in Desert Blume are not at risk for the analyzed return periods. In Cypress County, four commercial buildings and one public utility building become inundated by the 1000-year flood scenario. Finally, the main wastewater treatment building and settling tanks become inundated during the 200-year flood.

Table 8 Non-residential Buildings at Risk for Various Flood Scenarios due to Direct Inundation

Return Period	Number of Non-residential Buildings by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	0	0	0	0	0
5-yr	1	0	0	0	1
10-yr	1	0	0	0	1
20-yr	21	0	0	0	21
35-yr	43	1	0	0	44
50-yr	163	1	0	0	164
75-yr	243	1	0	3	247
100-yr	313	1	0	3	317
200-yr	483	1	0	5	489
350-yr	588	1	0	6	595
500-yr	609	1	0	6	616
750-yr	633	1	0	6	640
1000-yr	644	1	0	6	651

Table 9 and **Figure 5b** provide summary statistics for the number of non-residential buildings at risk due to potential flood control structure failure in the study area. Non-residential buildings at risk due to potential flood control structure failure are in addition to those that are at risk due to direct inundation. Flood control structures are only located within Medicine Hat.

Of the flood control structures in Medicine Hat, only the Lion Park/Industrial Avenue Dike protect non-residential buildings. It protects 25 non-residential buildings during the 75-year flood and 8 non-residential buildings during the 100-year flood .

Table 9 Additional Non-residential Buildings at Risk for Various Flood Scenarios due to Potential Flood Control Structure Failure

Return Period	Number of Non-residential Buildings by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	0	0	0	0	0
5-yr	0	0	0	0	0
10-yr	0	0	0	0	0
20-yr	1	0	0	0	1
35-yr	16	0	0	0	16
50-yr	18	0	0	0	18
75-yr	25	0	0	0	25
100-yr	8	0	0	0	8
200-yr	0	0	0	0	0
350-yr	0	0	0	0	0
500-yr	0	0	0	0	0
750-yr	0	0	0	0	0
1000-yr	0	0	0	0	0

Table 10 and **Figure 5c** provide summary statistics for the number of non-residential buildings at risk for the governing design flood scenario in the study area.

The largest number of non-residential buildings at risk for the governing design flood scenario are located in Medicine Hat. Most of the non-residential buildings at-risk are located in the South Flats and North Flats neighbourhoods. There are eight non-residential buildings located within the protected flood fringe in the North Flats neighborhood. There are a very small number of at-risk non-residential buildings in Redcliff and Cypress County. There are no non-residential buildings at risk for the governing design flood scenario in Desert Blume.

Table 10 Non-residential Buildings at Risk for the Governing Design Flood Scenario

Classification	Number of Non-residential Buildings by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
Floodway	16	1	0	0	17
High Hazard Flood Fringe	70	0	0	0	70
Protected Flood Fringe	8	0	0	0	8
Flood Fringe	305	0	0	3	308
Flood Hazard Area	321	1	0	3	325

4.2.4 Bridges

Table 11 and **Figure 6a** provide summary statistics for the number of bridges at risk due to direct inundation in the study area.

In Medicine Hat, some smaller bridges become at risk on Seven Persons Creek and Bullshead Creek for the 5-year return period. The number of bridges at risk gradually increases with return period until the 200-year return period during which the bridges across the South Saskatchewan River are at risk.

In Cypress County, two private road bridges are at risk starting at the 2-year return period. All of the bridges in Cypress County are at risk for the 35-year return period.

In Desert Blume, bridges are at-risk along Desert Blume Golf Course starting during the 5-year return period. By the 10-year return period, eight bridges are at-risk in Desert Blume.

No bridges are located in Redcliff.

Table 11 Number of Bridges at Risk for Various Flood Scenarios due to Direct Inundation

Return Period	Number of Bridges by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	0	0	0	2	2
5-yr	5	0	6	3	14
10-yr	16	0	8	3	27
20-yr	23	0	8	4	35
35-yr	27	0	8	5	40
50-yr	31	0	8	5	44
75-yr	35	0	8	5	48
100-yr	36	0	8	5	49
200-yr	41	0	8	5	54
350-yr	42	0	8	5	55
500-yr	42	0	8	5	55
750-yr	42	0	8	5	55
1000-yr	43	0	8	5	56

There are no bridges at risk due to potential flood control structure failure.

Table 12 and **Figure 6c** provide summary statistics for the number of bridges at risk for the governing design flood scenario in the study area.

The largest number of bridges at risk for the governing design flood scenario are located in Medicine Hat and occur along Ross Creek, Seven Persons Creek, and Bullshead Creek. In Desert Blume there are eight bridges at risk along Seven Persons Creek and in Cypress County there are five bridges at risk.

Table 12 Number of Bridges at Risk for the Governing Design Flood Scenario

Classification	Number of Bridges by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
Floodway	36	0	8	5	49
High Hazard Flood Fringe	0	0	0	0	0
Protected Flood Fringe	0	0	0	0	0
Flood Fringe	0	0	0	0	0
Flood Hazard Area	36	0	8	5	49

4.2.5 Culverts

Table 13 and **Figure 7a** provide summary statistics for the number of culverts at risk due to direct inundation in the study area.

In Medicine Hat there is one culvert on Bullshead Creek at risk starting at the 2-year return period and one culvert on Seven Persons Creek at risk starting at the 20-year return period. In Cypress County, four culverts are at risk starting at the 20-year return period.

There are no culverts located in Redcliff and Desert Blume.

Table 13 Number of Culverts at Risk for Various Flood Scenarios due to Direct Inundation

Return Period	Number of Culverts by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	1	0	0	0	1
5-yr	1	0	0	1	2
10-yr	1	0	0	1	2
20-yr	2	0	0	2	4
35-yr	2	0	0	2	4
50-yr	2	0	0	2	4
75-yr	2	0	0	2	4
100-yr	2	0	0	2	4
200-yr	2	0	0	2	4
350-yr	2	0	0	3	5
500-yr	2	0	0	3	5
750-yr	2	0	0	4	6
1000-yr	2	0	0	4	6

There are no culverts at risk due to potential flood control structure failure.

Table 14 and **Figure 7c** provide summary statistics for the number of culverts at risk for the governing design flood scenario in the study area.

The culverts at risk for the governing design flood scenario are located in Medicine Hat and Cypress County. In Medicine Hat there is a culvert at risk on Seven Persons Creek and on Bullshead Creek. In Cypress County, two culverts are at risk on Ross Creek for the governing design flood scenario.

Table 14 Number of Culverts at Risk for the Governing Design Flood Scenario

Classification	Number of Culverts by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
Floodway	2	0	0	2	4
High Hazard Flood Fringe	0	0	0	0	0
Protected Flood Fringe	0	0	0	0	0
Flood Fringe	0	0	0	0	0
Flood Hazard Area	2	0	0	2	4

4.2.6 Roadway

Table 15 and **Figure 8a** provide summary statistics for length of roadway at risk due to direct inundation in the study area.

Small segments of road become inundated during the 5-year flood scenario in Medicine Hat. At-risk roadways are near Strathcona Island Park, along Industrial Avenue in the North Flats neighbourhood, adjacent to Seven Persons Creek in the South Flats neighbourhood, and in the Riverside neighbourhood and in Police Point Park along the South Saskatchewan River. The risk gradually increases with return period – particularly along Industrial Avenue. By the 200-year return period, most roadways in North Flats and South Flats neighbourhoods are at risk. At more extreme return periods, the extent of at-risk roadway in the Riverside and Harlow neighbourhoods and in the Echo Dale Regional Park is more extensive.

Roadways at risk in Redcliff are concentrated near the banks of the South Saskatchewan, near Josephine Avenue. No roadways in Desert Blume are at-risk in any flood return period.

In Cypress County, roadways are at risk starting at the 5-year return period. The length of roadway at risk increases slowly with return period, with the risk not being concentrated to a specific location.

Table 15 Roadway at Risk for Various Flood Scenarios due to Direct Inundation

Return Period	Length of Roadway by Local Municipal Authority (km)				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	0	0	0	0	0
5-yr	0.17	0	0	0.08	0.25
10-yr	1.41	0	0	0.17	1.58
20-yr	3.64	0	0	0.42	4.06
35-yr	6.75	0	0	0.5	7.25
50-yr	14.22	0	0	0.54	14.77
75-yr	18.57	0	0	0.6	19.17
100-yr	33.47	0	0	0.69	34.16
200-yr	54.73	0.27	0	0.86	55.86
350-yr	60.06	0.45	0	1.03	61.54
500-yr	61.44	0.55	0	1.21	63.2
750-yr	63.98	0.71	0	1.41	66.1
1000-yr	65.47	0.73	0	1.51	67.71

Table 16 and **Figure 8b** provide summary statistics for the length of roadway at risk due to potential flood control structure failure in the study area. The length of roadway at risk due to potential flood control structure failure is in addition to the length at risk due to direct inundation. Flood control structures are only located within Medicine Hat.

Roadways affected by potential flood control structure failure are located behind the Harlow, Riverside, and Lion's Park/Industrial Avenue Dikes. The length of roadway at risk due to potential failure of the Lions Park/Industrial Avenue Flood Control Structure is the most severe.

Table 16 Additional Roadway at Risk for Various Flood Scenarios due to Potential Flood Control Structure Failure

Return Period	Length of Roadway by Local Municipal Authority (km)				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	0	0	0	0	0
5-yr	0	0	0	0	0
10-yr	0.25	0	0	0	0.25
20-yr	1.27	0	0	0	1.27
35-yr	4.39	0	0	0	4.39
50-yr	6.28	0	0	0	6.28
75-yr	12	0	0	0	12
100-yr	5.16	0	0	0	5.16
200-yr	0	0	0	0	0
350-yr	0	0	0	0	0
500-yr	0	0	0	0	0
750-yr	0	0	0	0	0
1000-yr	0	0	0	0	0

Table 17 and **Figure 8c** provide summary statistics for the length of roadway at risk for the governing design flood scenario in the study area.

The largest length of roadway at risk for the governing design flood scenario is in Medicine Hat. Most of the at-risk roadway is located in the South Flats and North Flats neighbourhoods with a small length of roadway at risk in the Harlow and Riverside neighbourhoods. A short length of roadway is at risk in Cypress County. There is no roadway at risk for the governing design flood scenario in Redcliff and Desert Blume.

Table 17 Roadway at Risk for the Governing Design Flood Scenario

Classification	Length of Roadway by Local Municipal Authority (km)				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
Floodway	3.4	0	0	0.24	3.64
High Hazard Flood Fringe	11.94	0	0	0	11.94
Protected Flood Fringe	5.16	0	0	0	5.16
Flood Fringe	35.34	0	0	0.45	35.79
Flood Hazard Area	38.74	0	0	0.69	39.43

4.2.7 Railway

Table 18 and **Figure 9a** provide summary statistics for length of railway at risk due to direct inundation in the study area.

Railway is only at risk in Medicine Hat. Beginning during the 20-year return period, flooding begins along Seven Persons Creek in the South Flats neighbourhood. The length of railway at risk gradually increases to the 100-year return period. At the 200-year return period there is large increase in the length of railway at risk due to a large increase in the inundation extent in the North Flats neighbourhood when the Lions Park/Industrial Avenue Dike is overtopped.

Table 18 Railway at Risk for Various Flood Scenarios due to Direct Inundation

Return Period	Length of Railway by Local Municipal Authority (km)				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	0	0	0	0	0
5-yr	0	0	0	0	0
10-yr	0	0	0	0	0
20-yr	0.43	0	0	0	0.43
35-yr	0.77	0	0	0	0.77
50-yr	1.84	0	0	0	1.84
75-yr	3.88	0	0	0	3.88
100-yr	8.04	0	0	0	8.04
200-yr	18.18	0	0	0	18.18
350-yr	25.70	0	0	0	25.70
500-yr	28.82	0	0	0	28.82
750-yr	31.07	0	0	0	31.07
1000-yr	31.52	0	0	0	31.52

Table 19 and **Figure 9b** provide summary statistics for the length of railway at risk due to potential flood control structure failure in the study area. The length of railway at risk due to potential flood control structure failure is in addition to the length at risk due to direct inundation. Flood control structures are only located within Medicine Hat.

The maximum length of additional railway at risk to potential flood control structure failure in Medicine Hat is 0.68 km, all of which is located behind the Lions Park/Industrial Avenue dike in the North Flats neighbourhood. The other flood control structures in Medicine Hat do not protect railway.

Table 19 Additional Railway at Risk for Various Flood Scenarios due to Potential Flood Control Structure Failure

Return Period	Length of Railway by Local Municipal Authority (km)				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	0	0	0	0	0
5-yr	0	0	0	0	0
10-yr	0	0	0	0	0
20-yr	0.07	0	0	0	0.07
35-yr	0.62	0	0	0	0.62
50-yr	0.63	0	0	0	0.63
75-yr	0.68	0	0	0	0.68
100-yr	0.04	0	0	0	0.04
200-yr	0	0	0	0	0
350-yr	0	0	0	0	0
500-yr	0	0	0	0	0
750-yr	0	0	0	0	0
1000-yr	0	0	0	0	0

Table 20 and **Figure 9c** provide summary statistics for the length of railway at risk for the governing design flood scenario in the study area.

The railway at risk for the governing design flood scenario is located in Medicine Hat with the majority in the flood fringe; a very small proportion is located within the floodway. Most of the at-risk railway is in the North Flats neighbourhood. There is no railway at risk for the governing design flood scenario in Redcliff Desert Blume, and Cypress County.

Table 20 Railway at Risk for the Governing Design Flood Scenario

Classification	Length of Railway by Local Municipal Authority (km)				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
Floodway	1.99	0	0	0	1.99
High Hazard Flood Fringe	1.11	0	0	0	1.11
Protected Flood Fringe	0.04	0	0	0	0.04
Flood Fringe	6.23	0	0	0	6.23
Flood Hazard Area	8.21	0	0	0	8.21

4.2.8 Population

Table 21 and **Figure 10a** provide summary statistics for the estimated population at risk due to direct inundation in the study area.

All four municipalities have at-risk populations across all flood scenarios. Medicine Hat has the highest at-risk population across all flood scenarios with estimates ranging between 159 and 5,978 for the 2-year and 1000-year flood scenarios, respectively. Most of the population at risk resides in the North Flats neighbourhood which is nearly completely inundated during the 200-year return period.

In Cypress County, the estimated population at risk ranges from 9 to 53 for the 2-year to 1000-year return periods, respectively. The estimated at-risk population in Redcliff reside near Josephine Avenue and is from 9 to 69 for the 2-year to 1000-year return periods, respectively. In Desert Blume, the estimated at-risk population is from 11 to 50 for the 2-year to 1000-year return periods, however it is important to note that no buildings are at-risk in the hamlet.

Table 21 Population at Risk for Various Flood Scenarios due to Direct Inundation

Return Period	Estimated Population by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	159	9	11	9	188
5-yr	363	26	23	20	434
10-yr	457	28	33	28	547
20-yr	576	32	38	31	679
35-yr	722	35	40	35	834
50-yr	1207	37	41	36	1321
75-yr	1516	39	43	39	1637
100-yr	2979	42	44	41	3106
200-yr	5238	57	45	45	5384
350-yr	5580	61	47	50	5738
500-yr	5671	63	48	50	5833
750-yr	5847	66	49	51	6012
1000-yr	5978	69	50	53	6147

Table 22 and **Figure 10b** provide summary statistics for the estimated population at risk due to potential flood control structure failure in the study area. The estimated population at risk due to potential flood control structure failure is in addition to the estimated population at risk due to direct inundation. Flood control structures are only located within Medicine Hat. The potential failure of the Lions Park/Industrial Avenue dike results in the largest at-risk population when compared to the other flood control structures.

Table 22 Additional Population at Risk for Various Flood Scenarios due to Potential Flood Control Structure Failure

Return Period	Estimated Population by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
2-yr	2	0	0	0	2
5-yr	5	0	0	0	5
10-yr	33	0	0	0	33
20-yr	102	0	0	0	102
35-yr	372	0	0	0	372
50-yr	585	0	0	0	585
75-yr	1244	0	0	0	1244
100-yr	456	0	0	0	456
200-yr	0	0	0	0	0
350-yr	0	0	0	0	0
500-yr	0	0	0	0	0
750-yr	0	0	0	0	0
1000-yr	0	0	0	0	0

Table 23 and **Figure 10c** provide summary statistics for the estimated population at risk for the governing design flood scenario in the study area.

The largest estimated population at risk for the governing design flood scenario is located in Medicine Hat. The neighbourhoods with the highest estimated population at risk are the South Flats and North Flats; a small portion of which resides within the floodway. There is a small at-risk estimated population in Redcliff, Desert Blume, and Cypress County.

Table 23 Population at Risk for the Governing Design Flood Scenario

Classification	Population by Local Municipal Authority				Total
	Medicine Hat	Redcliff	Desert Blume	Cypress County	
Floodway	576	36	34	22	668
High Hazard Flood Fringe	715	1	0	0	716
Protected Flood Fringe	456	0	0	0	456
Flood Fringe	2829	4	8	6	2847
Flood Hazard Area	3405	40	42	28	3515

5 CONCLUSIONS

The objectives of this study were to assess river-flood-related hazards along the South Saskatchewan River, Ross Creek, Seven Persons Creek, and Bullshead Creek within the City of Medicine Hat and the surrounding areas of Cypress County, including the Town of Redcliff and the Hamlet of Desert Blume. The Medicine Hat River Hazard Study was divided into eight major project components. This report summarizes the work of the *Flood Risk Assessment and Inventory* component in which infrastructure at risk was analyzed and summarized.

Available spatial data were compiled to develop an inventory of potentially at-risk buildings and infrastructure, and to compute flood risk statistics for land parcels, buildings, infrastructure, and at-risk populations. The spatial data that was compiled from cadastral data, township grids, census results, the National Road Network, the National Railway Network, as well as bridge and culvert assets surveyed by NHC (NHC 2019). The inundation extents for each of the thirteen flood return periods and the governing design flood were superimposed on the inventory data to compute the following statistics according to the boundaries of each local municipal authority:

- Number of at-risk land parcels;
- Number of at-risk residential buildings;
- Number of at-risk non-residential buildings;
- Number of at-risk bridges;
- Number of at-risk culverts;
- Length of at-risk roadway;
- Length of at-risk railway; and
- Estimated population at risk.

No hospitals were found to be at risk of flooding for any of the flood scenarios analyzed. A summary of infrastructure at risk by municipality is provided below.

Medicine Hat

In Medicine Hat residential and non-residential buildings are affected in the South Flats neighbourhood during the 20-year return period from Seven Persons Creek. At the 35-year return period, buildings become affected in the Riverside neighbourhood via the South Saskatchewan River and in the North Flats neighbourhood via Seven Persons Creek. A large increase in the inundation extents occurs at the 200-year return period as flood control structures are overtopped with most of the buildings in the North Flats neighbourhood being at risk.

Key buildings that are at-risk in Medicine Hat for various return periods include City Hall, a police station, two fire stations, the Remand Centre, and the water treatment plant. Numerous schools are also at-risk over a range of return periods which are located mostly in the North Flats neighbourhood but also in the South Flats and Riverside neighbourhoods.

Within Medicine Hat, potential flood control structure failure affects the area behind the Water Treatment Plant Dike from the 35- to the 100-year, Harlow Flood Control Structure from the 2- to the 75-year return periods, Riverside dike at 20-year, and behind the Lions Park/Industrial Avenue dike from the 5-year to the 100-year return period. Among all the flood control structures, failure of the Lions Park/Industrial Avenue Flood Control Structure puts numerous residential and non-residential buildings at-risk in the North Flats neighbourhood.

Redcliff

The majority of Redcliff is located above the South Saskatchewan River valley and is not at-risk. However, a small number of residential buildings are at-risk along Josephine Avenue starting at the 35-year return period.

Desert Blume

With the exception of the bridges in Desert Blume Golf Course, no infrastructure in Desert Blume is at risk of inundation.

Cypress County

In Cypress County there are several locations where residential buildings are at-risk for various return periods. Residential buildings are at-risk along Day Street SE and near Range Road 51A from Ross Creek. On the South Saskatchewan River, residential buildings are at-risk near Range Road 71, near Paramatta Avenue, and near Township Road 132A. Structures at the Medicine Hat wastewater treatment plant are at-risk starting during the 200-year return period. On Seven Persons Creek, residential buildings near Township Road 120 are at-risk. Finally, on Bullshead Creek residential buildings are at-risk west of Highway 1.

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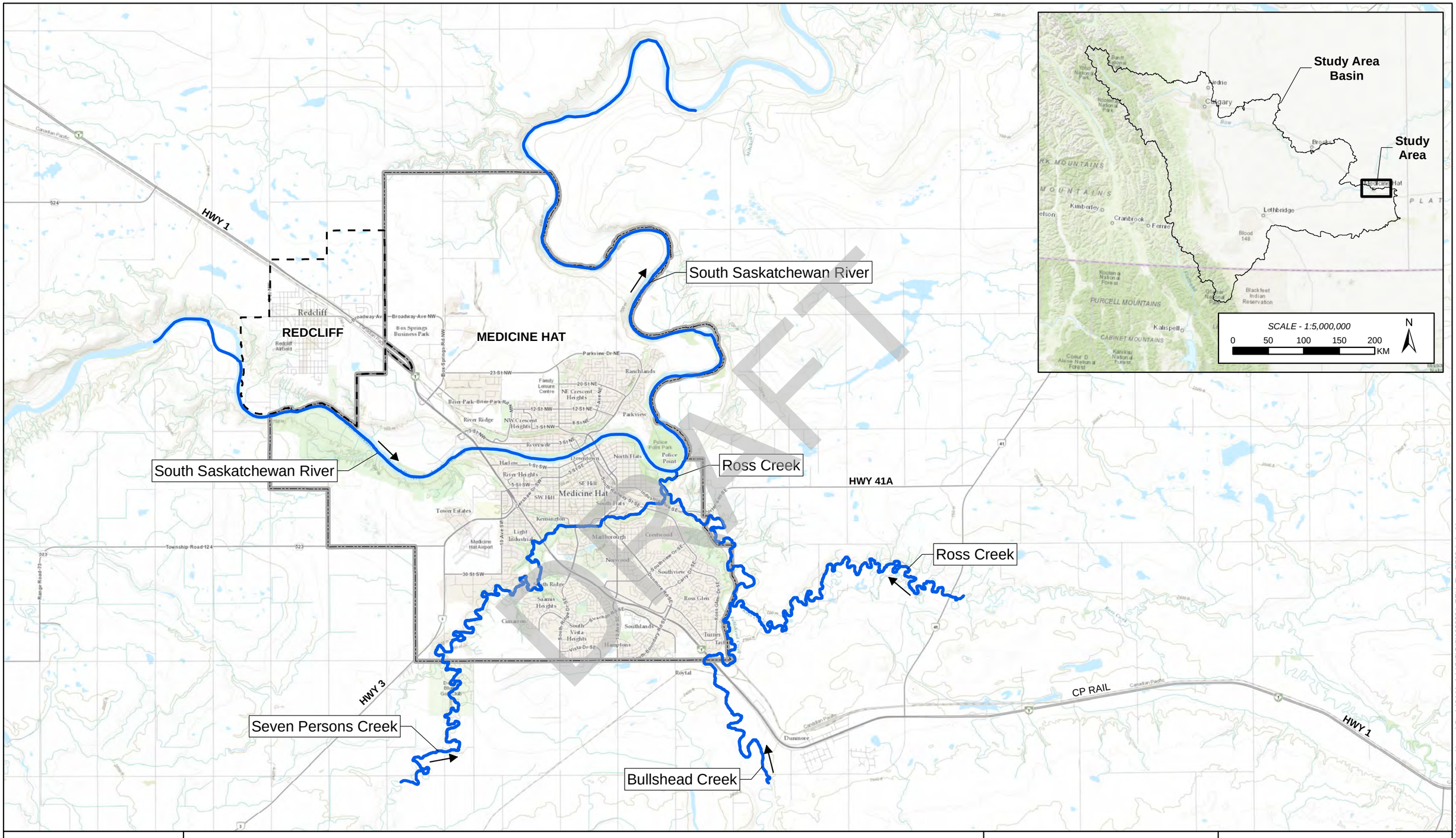
Figures



Alberta Government

nhc northwest hydraulic consultants

Model Stream Network
Redcliff Town Boundary
Medicine Hat City Boundary

DATA SOURCES: Basemap from Esri & NRCAN.

SCALE - 1:100,000
0 1 2 3 4 KM
N

Coordinate System: NAD 1983 CSRS 3TM 111
Units: METRES; Vertical Datum: CGVD28 HTv2.0

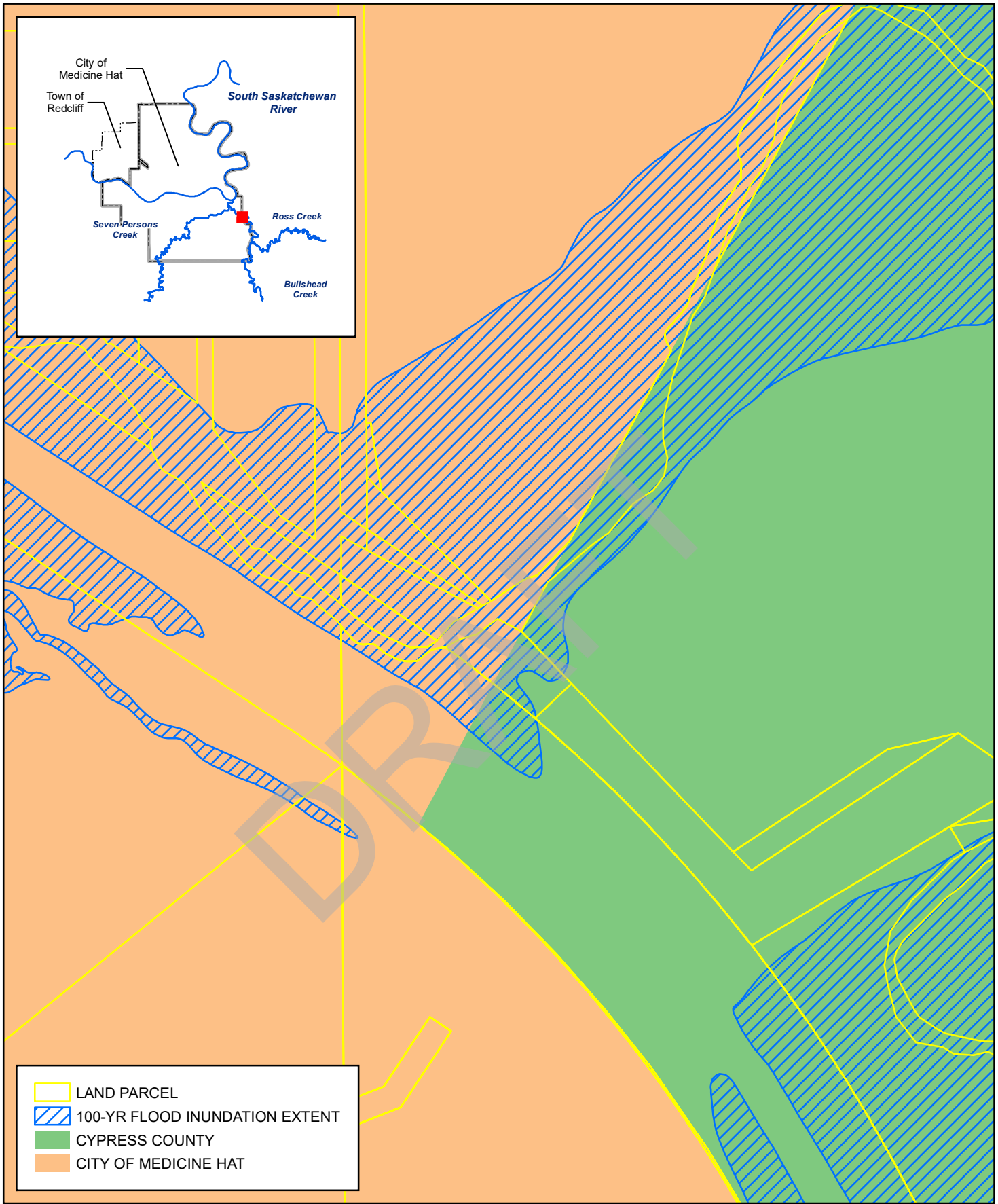
Job: 1003094 | Date: 25-JUL-2019

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

STUDY AREA

FIGURE 1

MSN, P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Models\GIS\GIS\1003094_REH_Fig_T700_IndexMap.mxd



Alberta Government

SCALE - 1:2,000

0 50 100 M

N

nhc northwest hydraulic consultants

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

Job: 1003094

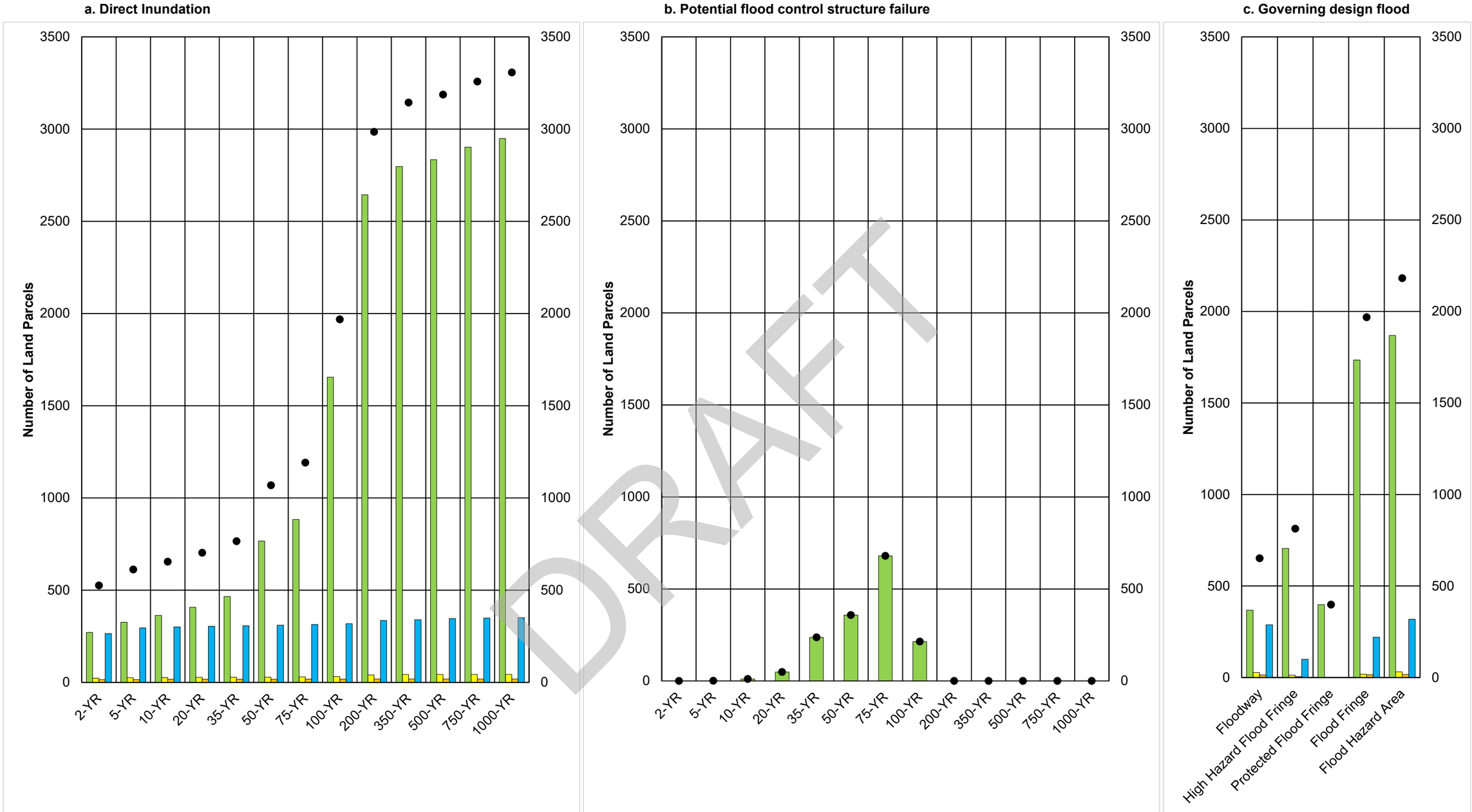
Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

LAND PARCEL & ADMINISTRATIVE UNIT BOUNDARY OVERLAP

FIGURE 2

P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Models\GIS\GIS\1003094_REH_Fig_T700_RiskAssessmentParcels_2021Update.mxd



Alberta Government

nhc northwest hydraulic consultants

Legend

Medicine Hat | Desert Blume | Total
Redcliff | Cypress County

SCALE – AS SHOWN

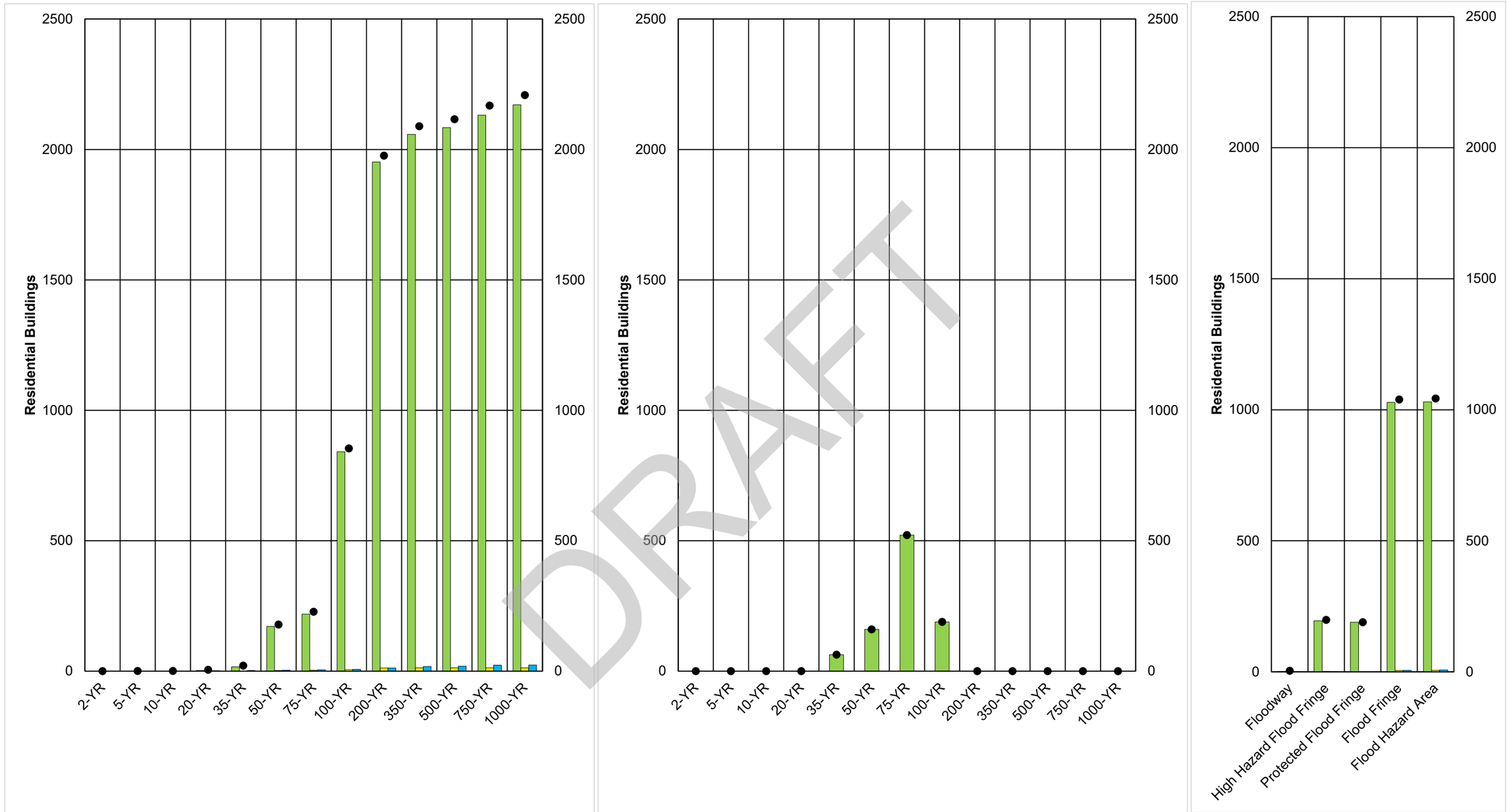
Coordinate System:
Units: As Shown

Job: 1003094 | Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY AND ASSESSMENT

LAND PARCELS AT RISK DUE TO FLOODING

FIGURE 3



Legend

Medicine Hat
Cypress County
Total
Redcliff

Notes

1. No residential buildings at risk in Desert Blume.

Alberta Government

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SCALE – AS SHOWN

Coordinate System:
Units: As Shown

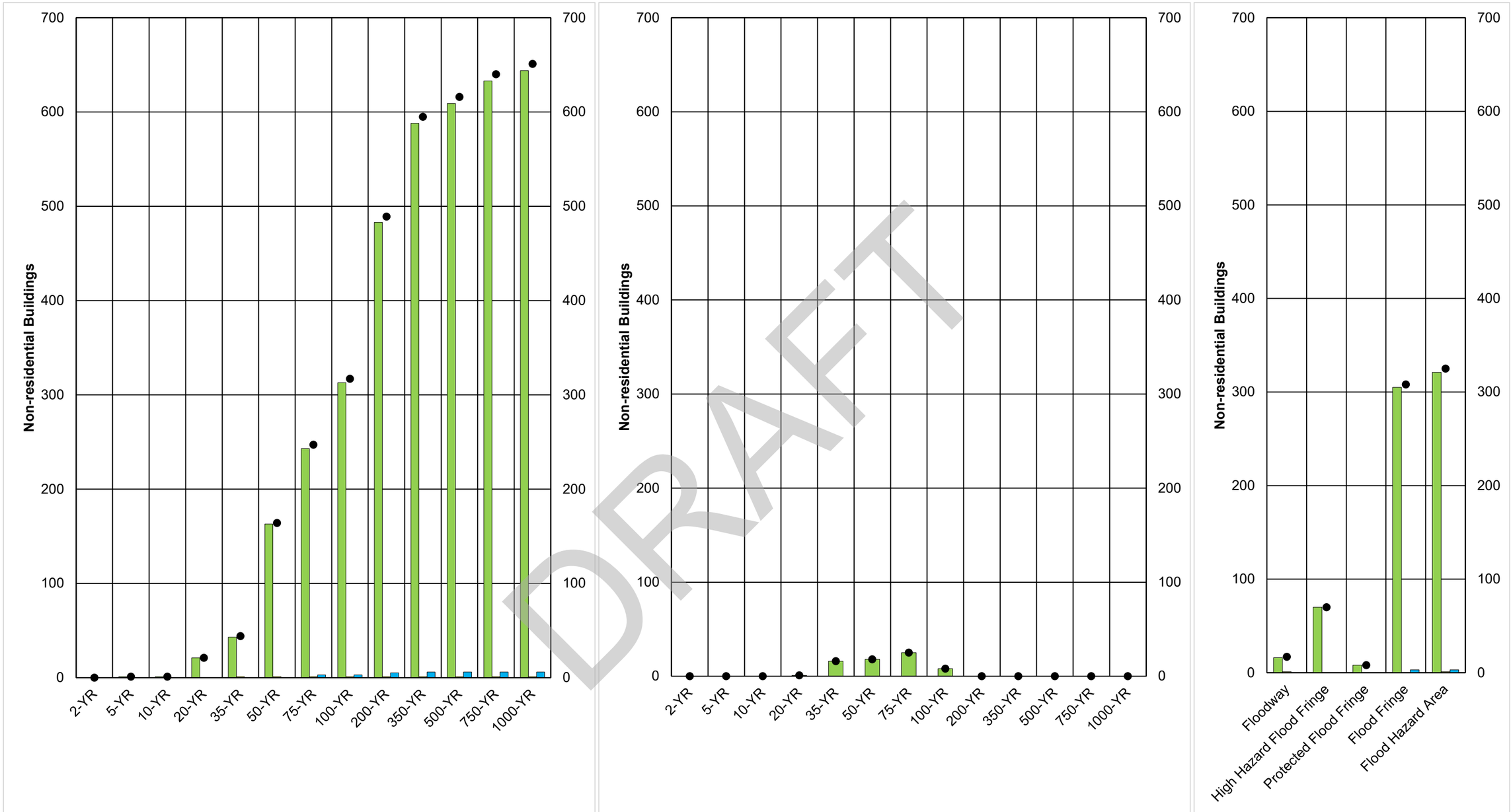
Job: 1003094

Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY AND ASSESSMENT

RESIDENTIAL BUILDINGS AT RISK DUE TO FLOODING

FIGURE 4



Alberta Government

nhc northwest hydraulic consultants

Legend

Medicine Hat
Cypress County
Total
Redcliff

Notes

1. No non-residential buildings at risk in Desert Blume.

SCALE – AS SHOWN

Coordinate System:
Units: As Shown

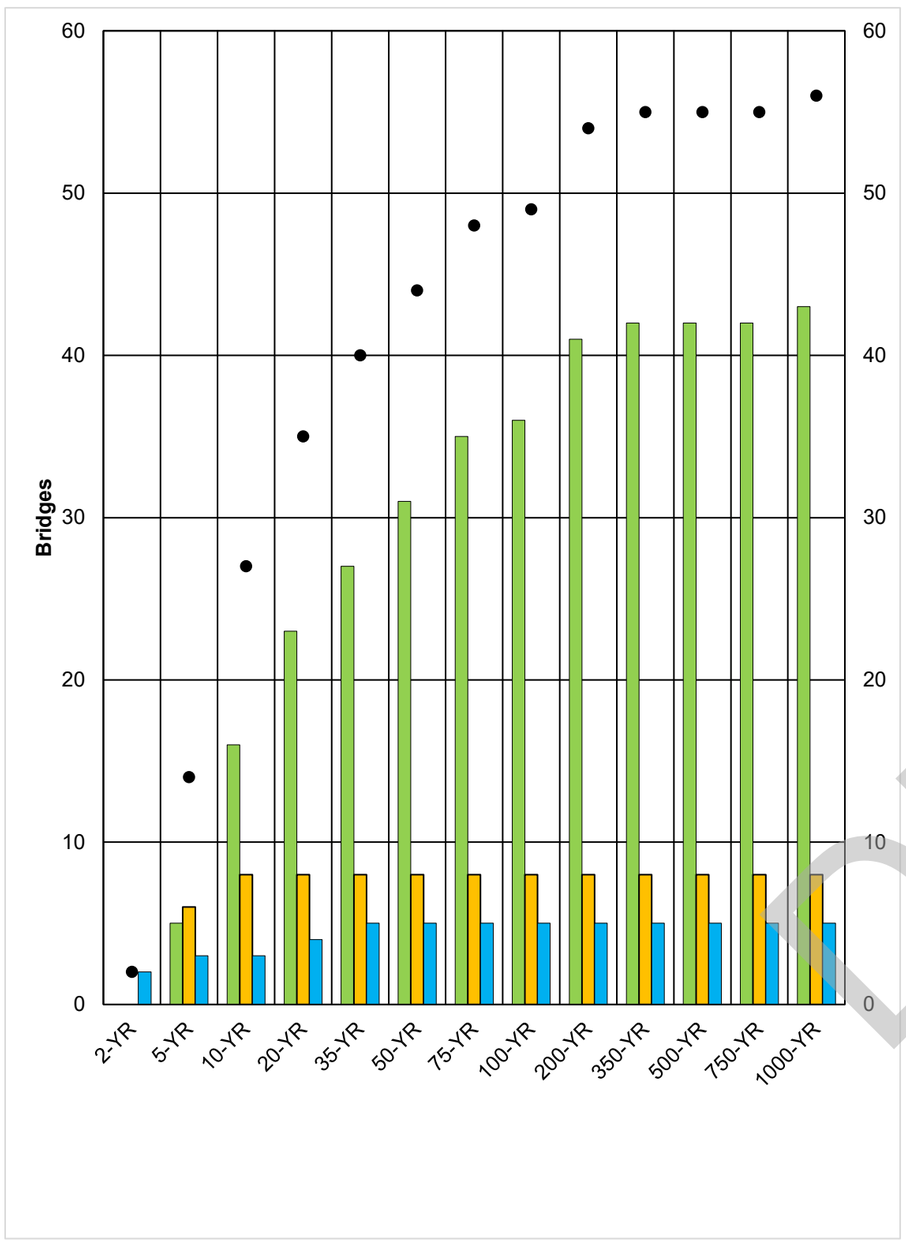
Job: 1003094

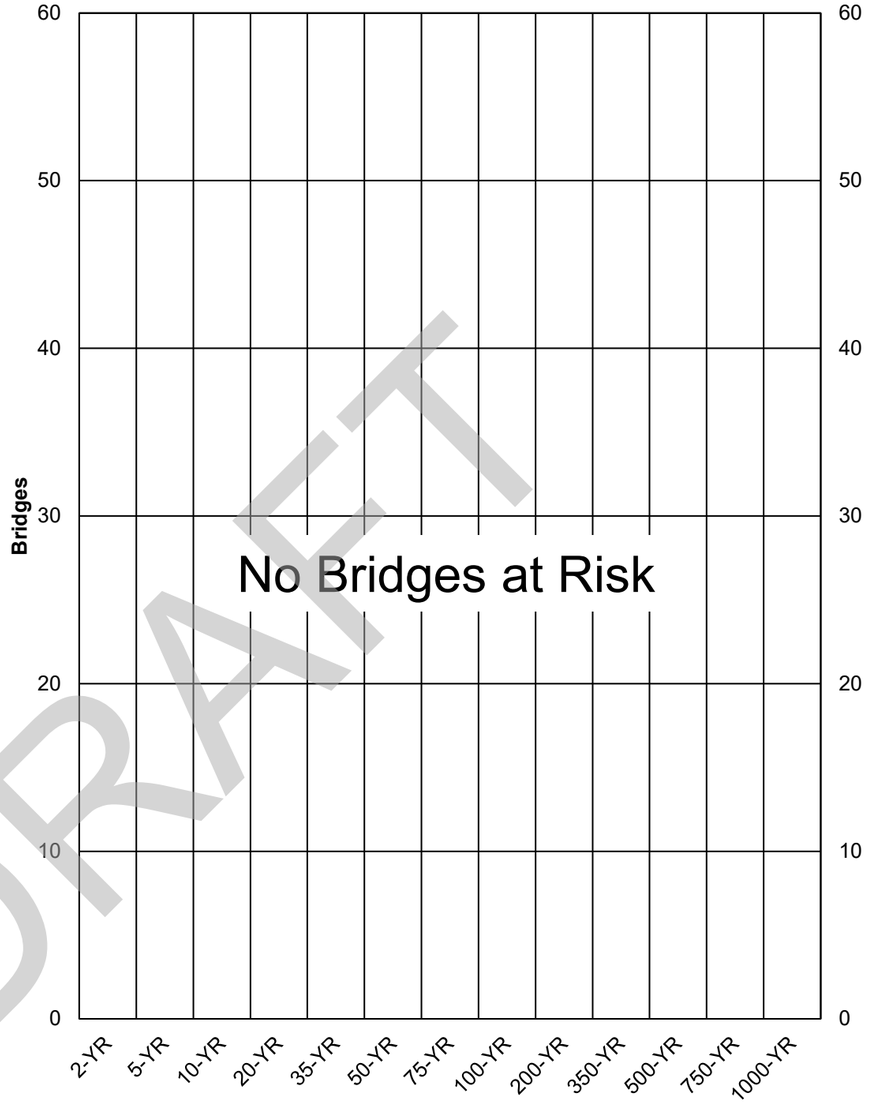
Date: 16-MAY-2022

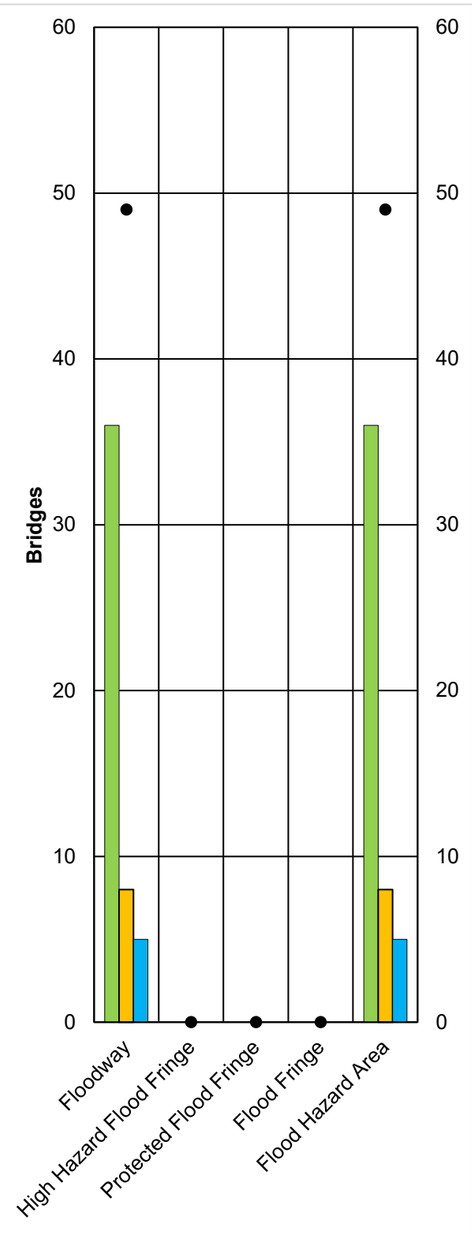
MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY AND ASSESSMENT

NON-RESIDENTIAL BUILDINGS AT RISK DUE TO FLOODING

FIGURE 5







Alberta Government

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Legend

Medicine Hat | Desert Blume | Total | Cypress County

Notes

1. No bridges at risk in Redcliff.

SCALE – AS SHOWN

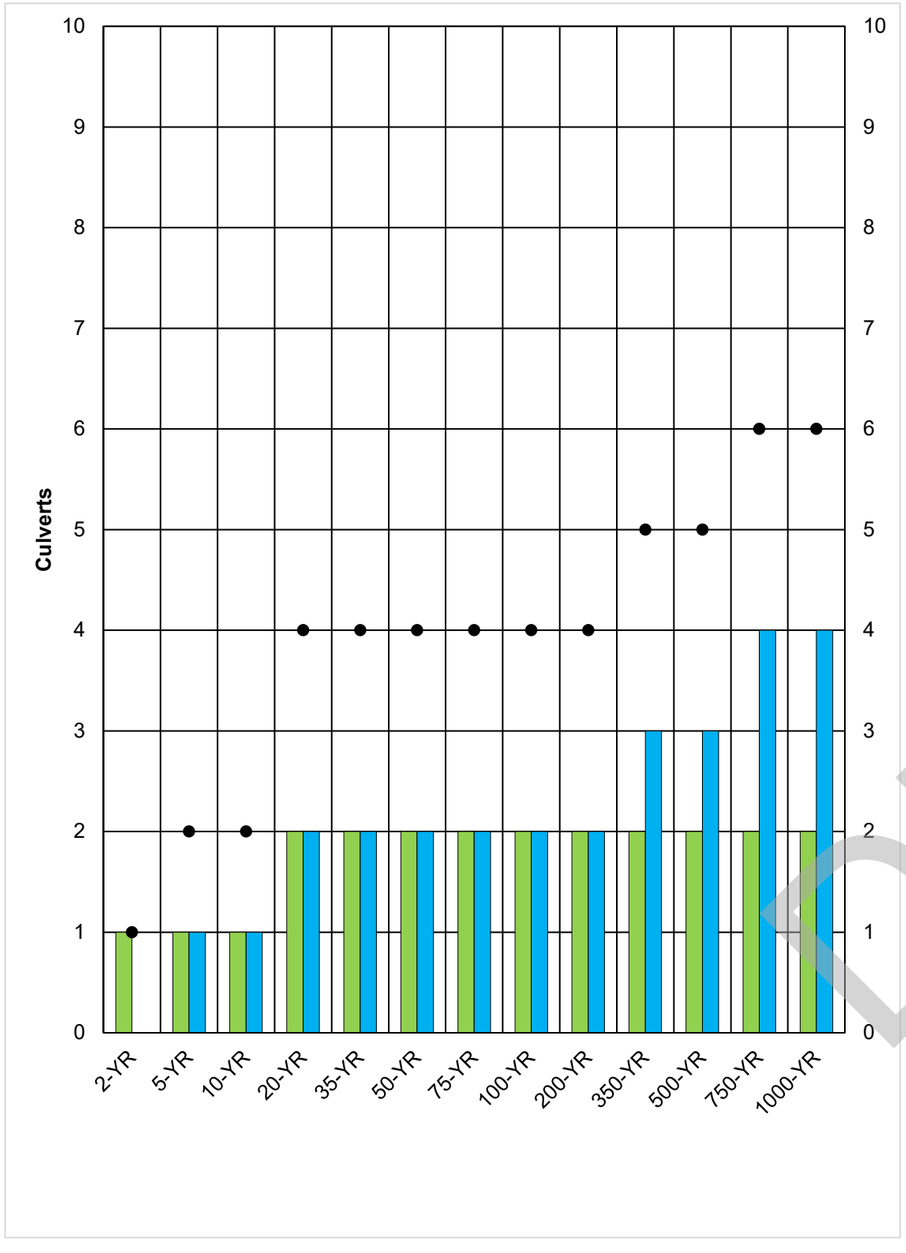
Coordinate System:
Units: As Shown

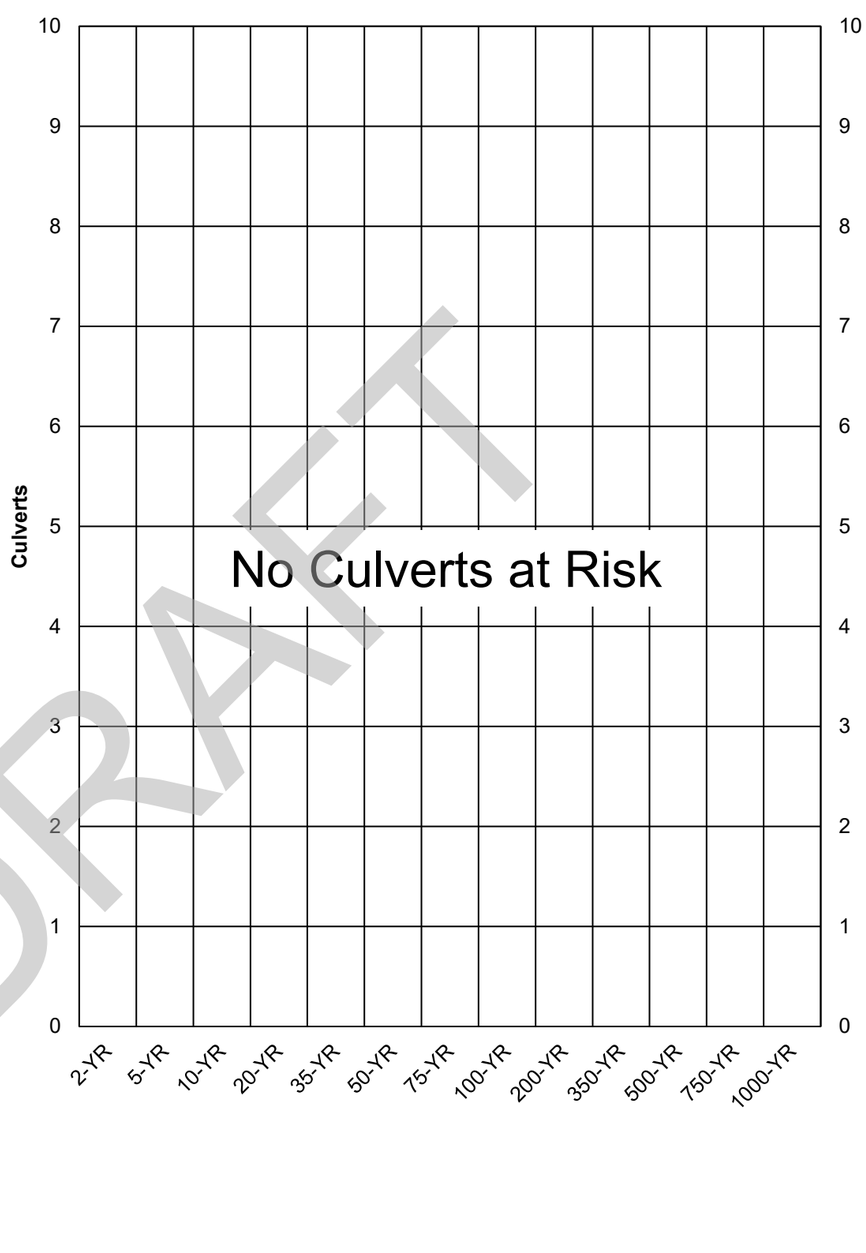
Job: 1003094 | Date: 16-MAY-2022

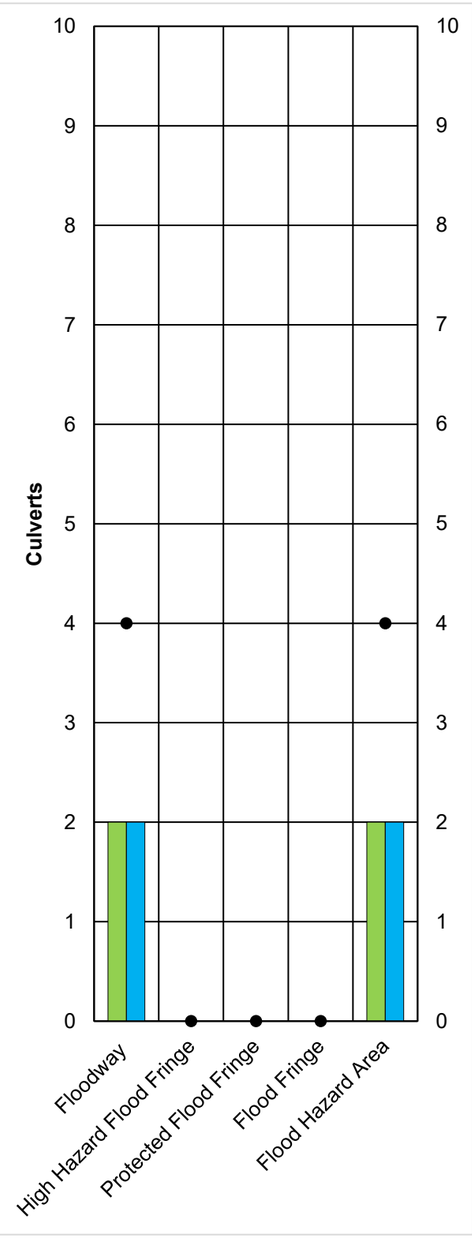
MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY AND ASSESSMENT

BRIDGES AT RISK DUE TO FLOODING

FIGURE 6







Alberta Government

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Legend

Medicine Hat | Cypress County | Total

Notes

1. No culverts at risk in Redcliff and Desert Blume.

SCALE – AS SHOWN

Coordinate System:
Units: As Shown

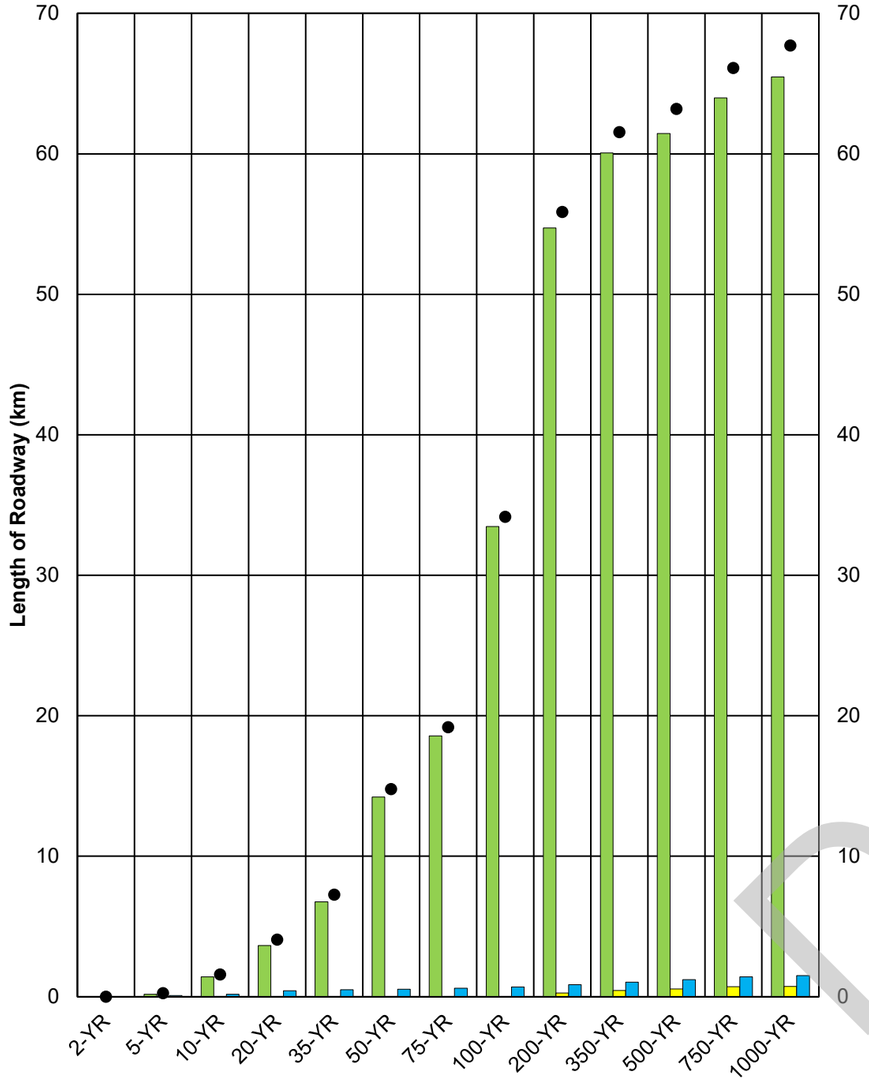
Job: 1003094 | Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY AND ASSESSMENT

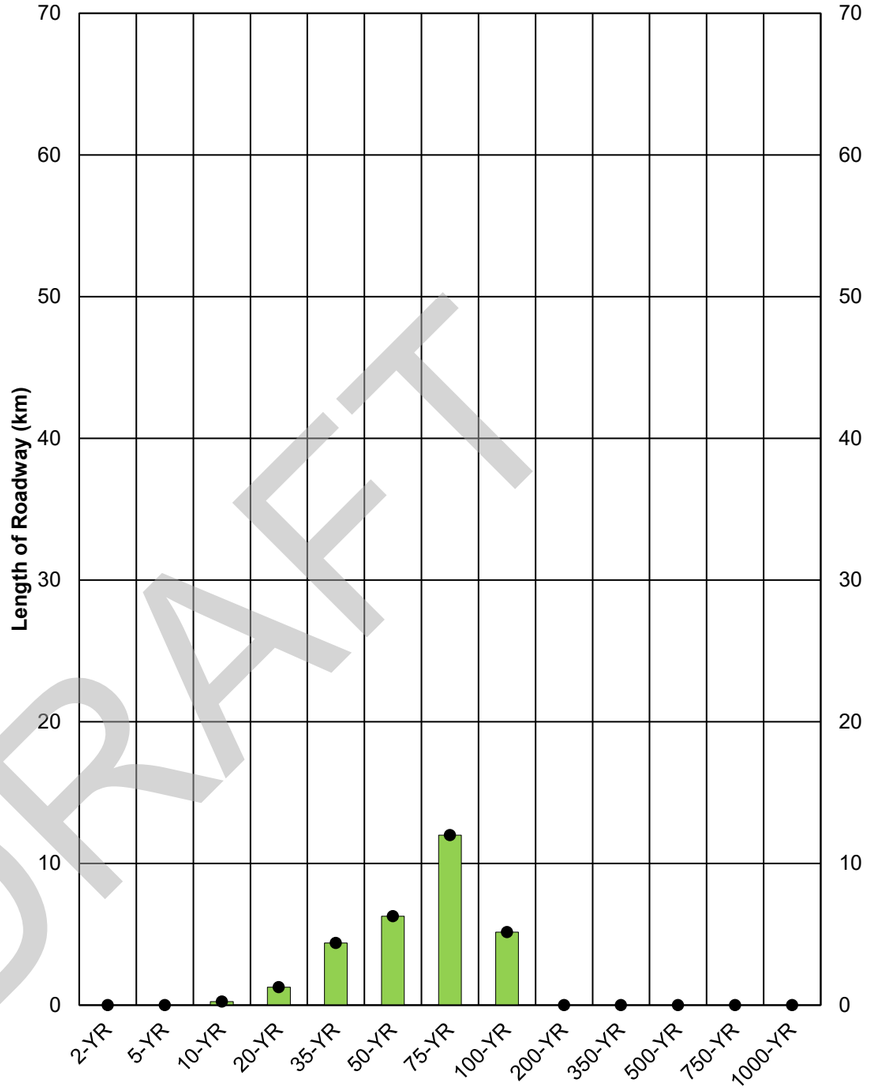
CULVERTS AT RISK DUE TO FLOODING

FIGURE 7

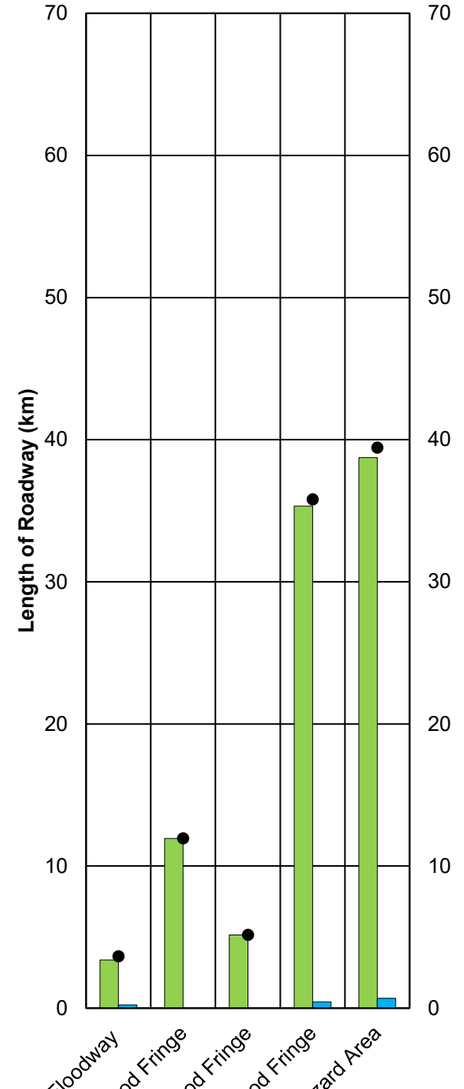
a. Direct Inundation



b. Potential flood control structure failure



c. Governing design flood



Alberta Government

nhc northwest hydraulic consultants

Legend

Medicine Hat
Redcliff
Cypress County
Total

Notes

1. No roadway at risk in Desert Blume.

SCALE – AS SHOWN

Coordinate System:
Units: As Shown

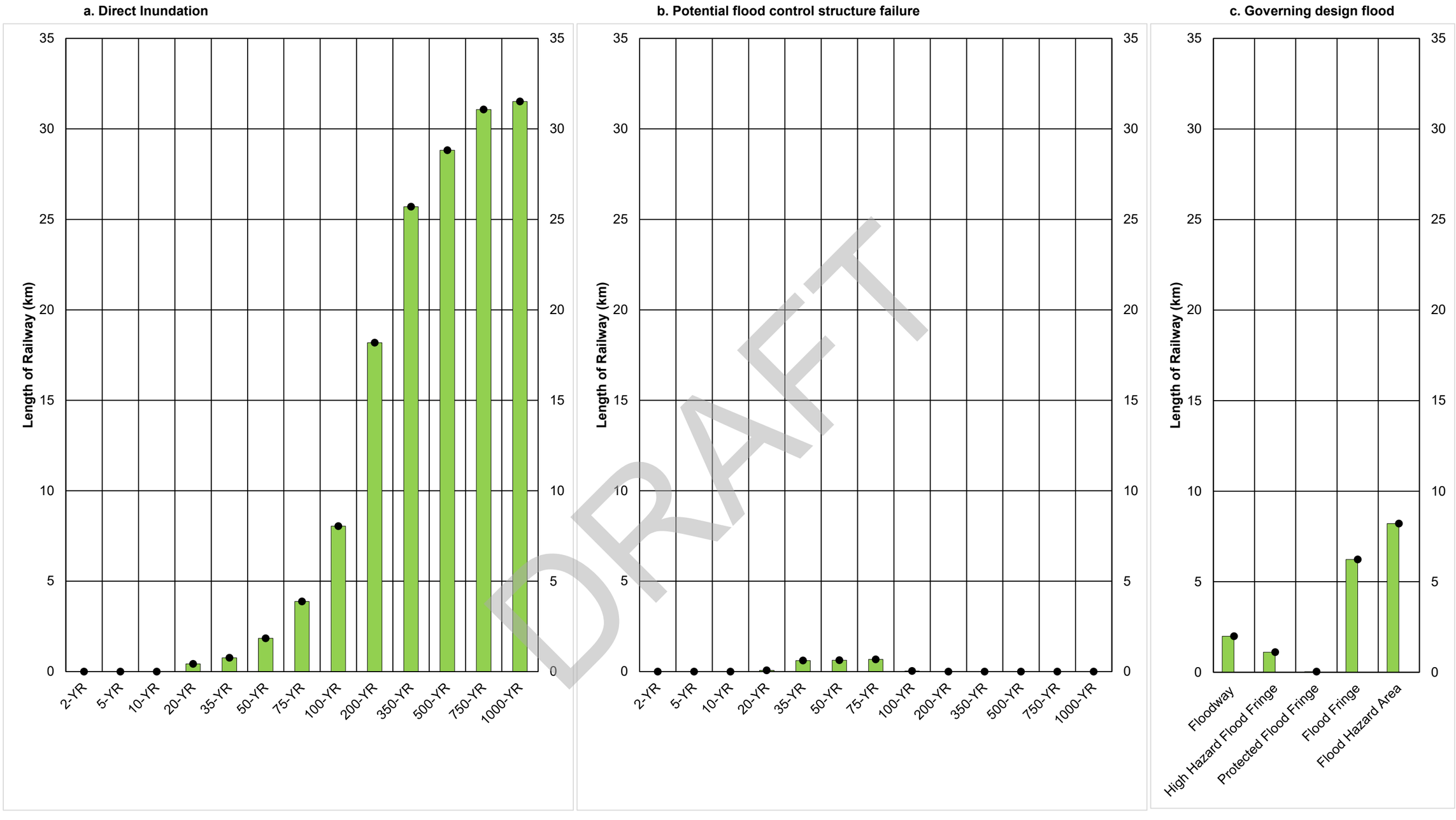
Job: 1003094

Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY AND ASSESSMENT

ROADWAY AT RISK DUE TO FLOODING

FIGURE 8



Alberta Government

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Legend

- Medicine Hat
- Desert Blume
- Total
- Redcliff
- Cypress County

Notes

1. No railway at risk in Desert Blume and Redcliff.

SCALE – AS SHOWN

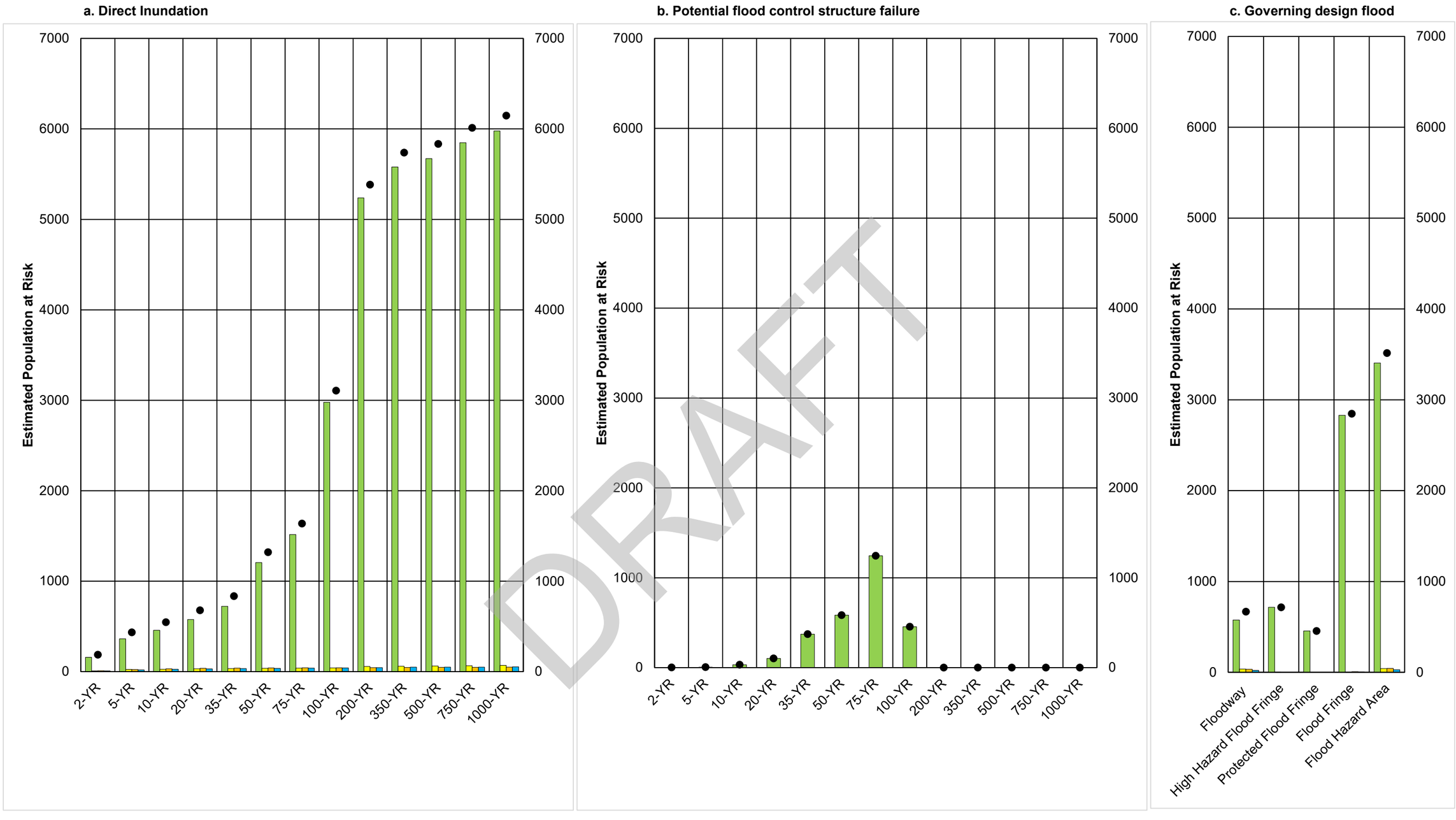
Coordinate System:
Units: As Shown

Job: 1003094 | Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY AND ASSESSMENT

RAILWAY AT RISK DUE TO FLOODING

FIGURE 9



Alberta Government

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Legend

- Medicine Hat
- Desert Blume
- Total
- Redcliff
- Cypress County

SCALE – AS SHOWN

Coordinate System:
Units: As Shown

Job: 1003094

Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY AND ASSESSMENT

POPULATION AT RISK DUE TO FLOODING

FIGURE 10

Appendix A
Spatial Data Digital Files

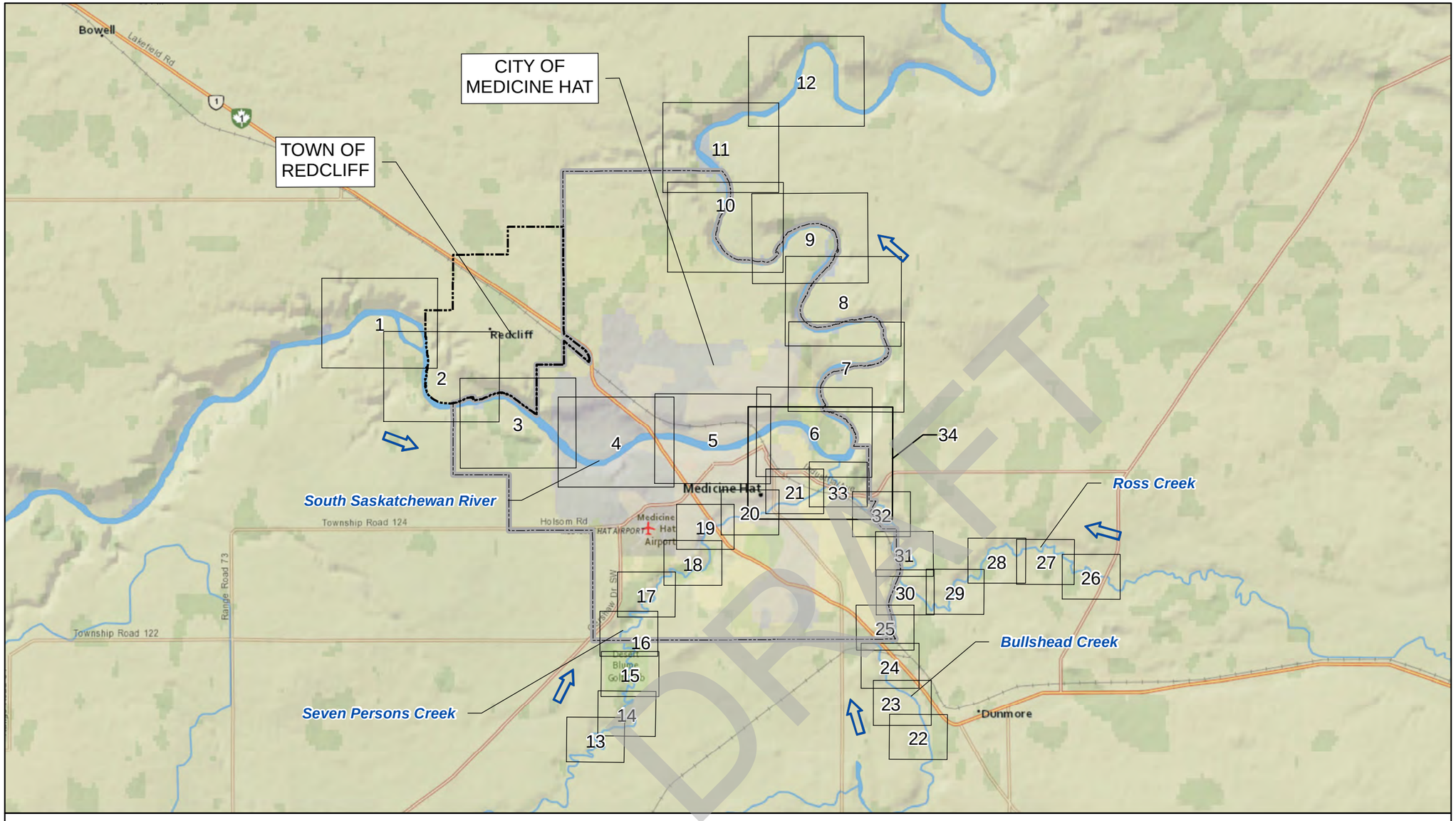
Spatial Data Summary - Risk Assessment

TITLE	DESCRIPTION	KEY ATTRIBUTE DESCRIPTION	FOLDER or GDB	FILE
Cadastral Data	Land parcels located within the 1000-year flood extent. Parcels located within the Medicine Hat boundaries acquired from the City of Medicine Hat. Parcels located upstream of the city boundaries on Seven Persons Creek, Bullshead Creek, Ross Creek and South Saskatchewan River acquired from Altalis. Downstream of the city boundary on the South Saskatchewan River quarter sections are used. Portions of land parcels located within the main channel (as defined by NRCan's National Hydrology Network), are removed. *Esri file geodatabase feature class.*	PARCELID: unique parcel ID (only available for parcels in Medicine Hat city boundaries); SOURCE: data source for parcel.	/MHRHS_RiskAssessment.gdb	LandParcels
Buildings	Building centroid of residential and non-residential structures located within the 1000-year flood extent. Centroids digitized and classified by NHC based on 2018 orthoimagery, Google Street View, land use data, building footprints and geolocated adresses. *Esri file geodatabase point feature class.*	CATEGORY: building type (RESIDENTIAL or NON-RESIDENTIAL); SUB_CATEGORY: building sub-type (SINGLE FAMILY, RETIREMENT HOME. SCHOOL, INDUSTRIAL, etc…); LUD: land-use classification of parcel (only available for parcels within Medicine Hat city boundaries); COMMENT: For MULTI FAMILY residential structures - indicates approximate number of units in building; For OTHER non-residential structures - describes type of structure; For GOVERNMENT non-residential structures - describes type of structure; For SCHOOL non-residential structures - provides name of school; STATUS: INCLUDE indicates structures included in risk analysis.	/MHRHS_RiskAssessment.gdb	Buildings
Bridges	Centroids of bridges located along study reaches - as determined by field survey. *Esri file geodatabase point feature class.*	NAME: Unique ID assigned by NHC; DESCRIP: Bridge description; REACH: Study reach that the bridge is located on; ADMIN_UNIT: Administrative unit bridge is located within; WIDTH: Bridge width in metres; LENGTH: Bridge length in metres; US_RS: River station upstream of bridge; LOW_CHORD: maximum low chord elevation from HEC-RAS model (in metres). Value is compared with water surface elevation to determine if structure is impacted by flooding.	/MHRHS_RiskAssessment.gdb	Bridges

Spatial Data Summary - Risk Assessment

TITLE	DESCRIPTION	KEY ATTRIBUTE DESCRIPTION	FOLDER or GDB	FILE
Culverts	Centroids of culverts located along study reaches - as determined by field survey. Esri file geodatabase point feature class.	NAME: Unique ID assigned by NHC; DESCRIP: Culvert description REACH: Study reach that culvert is located on; ADMIN_UNIT: Administrative unit the culvert is located within; DIAMETER: Culvert diameter in metres; LENGTH: Culvert length in metres; US_RS: River station upstream of culvert; OVERTOP_ELV: Elevation of approach road determined from bare earth DEM. Value is compared with water surface elevation to determine mine if structure is impacted by flooding.	/MHRHS_RiskAssessment.gdb	Culverts
Census Dissemination Blocks	Census dissemination blocks that intersect the 1000-year flood extent. Dissemination block geometry and 2016 census results were downloaded from Statistics Canada and merged. Portions of dissemination blocks located within the main channel (as defined by NRCan's National Hydrology Network), were removed. *Esri file geodatabase polygon feature class.*	DBUID: unique dissemination block ID; DB_POP2016: population residing in dissemination block as per 2016 census (Statistics Canada); ADMIN_UNIT: Administrative unit in which dissemination block is located.	/MHRHS_RiskAssessment.gdb	CensusPopulation
Administrative Boundaries	Boundaries of Cypress County, City of Medicine Hat and the Town of Redcliff. Acquired from Altalis. *Esri file geodatabase polygon feature class.*	NAME: Name of administrative unit TYPE: Type of administrative unit (County, Town, City)	/MHRHS_RiskAssessment.gdb	AdminBoundary
Rail Network	Railway lines that intersect the 1000-year flood extent. Data is from the National Railway Network (NRCan). Rail sections that are located on bridges were removed to ensure these areas were not double-counted. *Esri file geodatabase line feature class.*	ACQTECH: How rail network data was acquired OPERATOR: Who operates track TRACKCLASS: Type of rail structure (Yard, Main, Spur, Crossover, etc…); TRACKNAME: Track name.	/MHRHS_RiskAssessment.gdb	Rail
Road Network	Segments of the road network that intersect the 1000-year flood extent. Data is from the National Road Network (NRCan). Sections of roadway that are located on bridges were removed to ensure that they were not double-counted. *Esri file geodatabase line feature class.*	ACQTECH: How road data was acquired PROVIDER: Road ownership ROADCLASS: Type of road (Collector, Local / Street, Expressway / Highway, etc…) STREET_NAME: Street name ADMIN_UNIT: Administrative unit in which road is primarily located.	/MHRHS_RiskAssessment.gdb	Road

Appendix B
Flood Risk Assessment and Inventory Spatial Data Maps



Note to Users:

1. Please refer to the accompanying **Medicine Hat River Hazard Study - Flood Risk Inventory and Assessment Report** for important information concerning these maps.

Data Sources and References:

1. Land parcels acquired from the City of Medicine Hat and Altalis.
2. Road (National Road Network) and rail (National Railway Network) data acquired from NRCan.
3. Census dissemination blocks and 2016 census results acquired from Statistics Canada.
4. Orthoimagery acquired by OGL Engineering for Alberta Environment and Parks.
5. Residential and non-residential structures digitized by NHC based on 2018 orthoimagery and Google Street View as well as land use and address data provided by the City of Medicine Hat.
6. Additional base spatial data acquired from City of Medicine Hat, Altalis and NRCan.
7. Additional basemap imagery from Esri.

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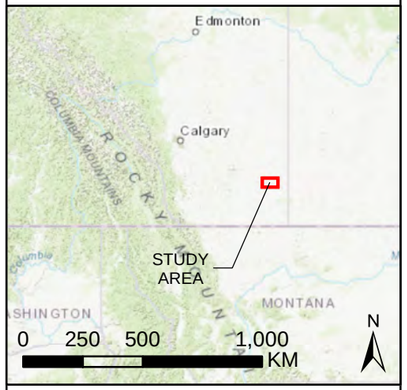

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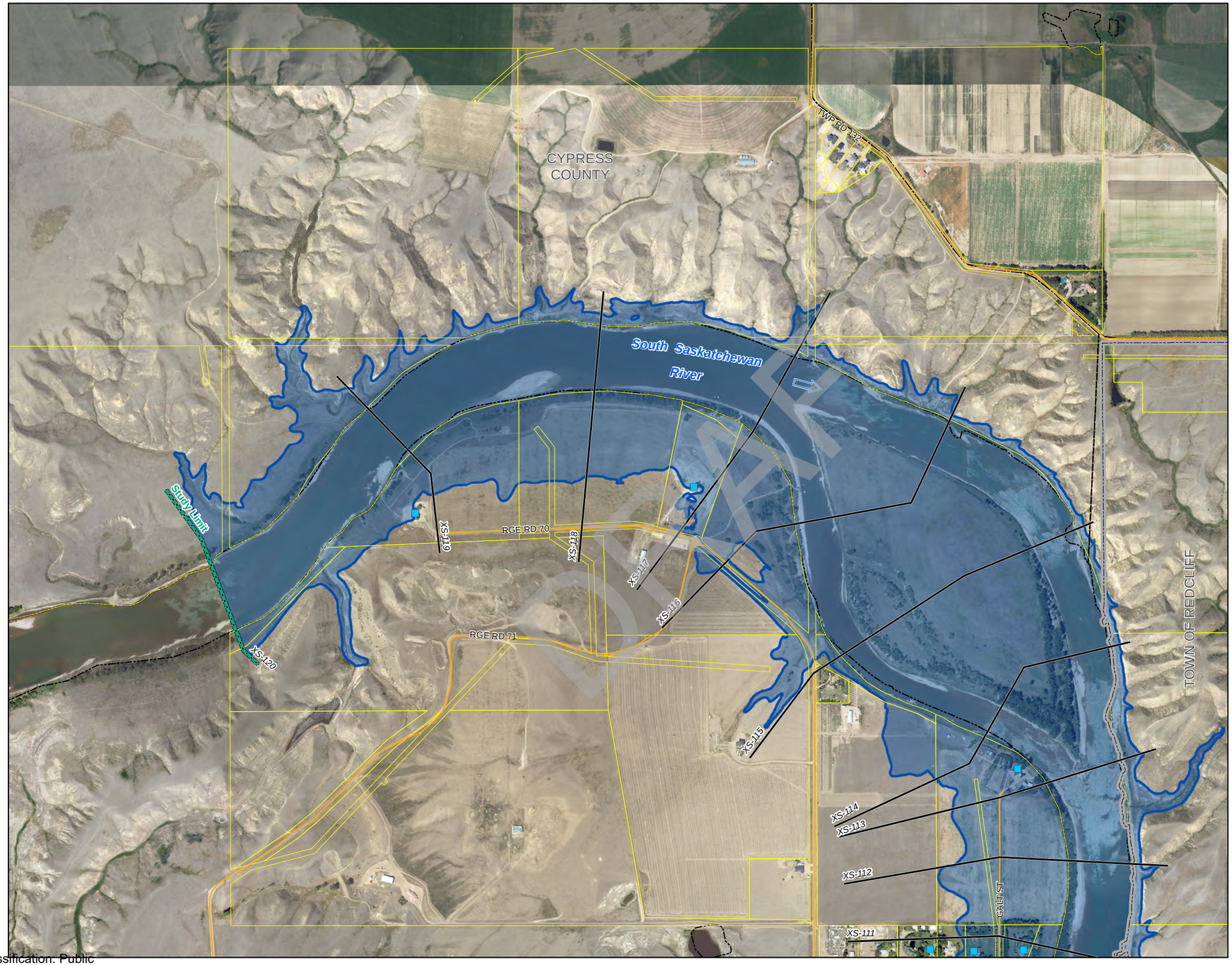
Coordinate System: NAD 1983 CSRS 3TM 111
Units: METRES; Vertical Datum: CGVD28 HTv2.0

Job: 1003094 | Date: 03-OCT-2019

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

SPATIAL DATA INVENTORY

INDEX MAP



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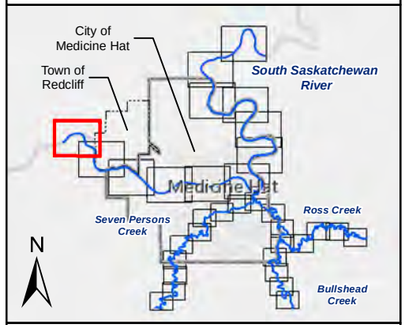

- FLOW DIRECTION
- MAJOR ROAD
- LOCAL ROAD
- RAILWAY
- CROSS SECTION
- FLOOD CONTROL STRUCTURE
- BRIDGE
- CULVERT
- CENSUS UNIT
- LAND PARCEL
- ADMINISTRATIVE BOUNDARY
- NEIGHBOURHOOD
- 1000-YEAR FLOOD INUNDATION EXTENT

STRUCTURES

School	WW treatment
Commercial	Other
Government	Single family
Industrial	Multi-family
Water treatment	Group home
	Retirement home

SCALE - 1:10,000
0 100 200 400 M
N

Coordinate System: NAD 1983 CSRS 3TM 111
Units: METRES; Vertical Datum: CGVD28 HTv2.0

Engineer	GIS	Reviewer
MGB	REH	RBA

Job: 1003094 | Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

SPATIAL DATA INVENTORY

SHEET 1 OF 34

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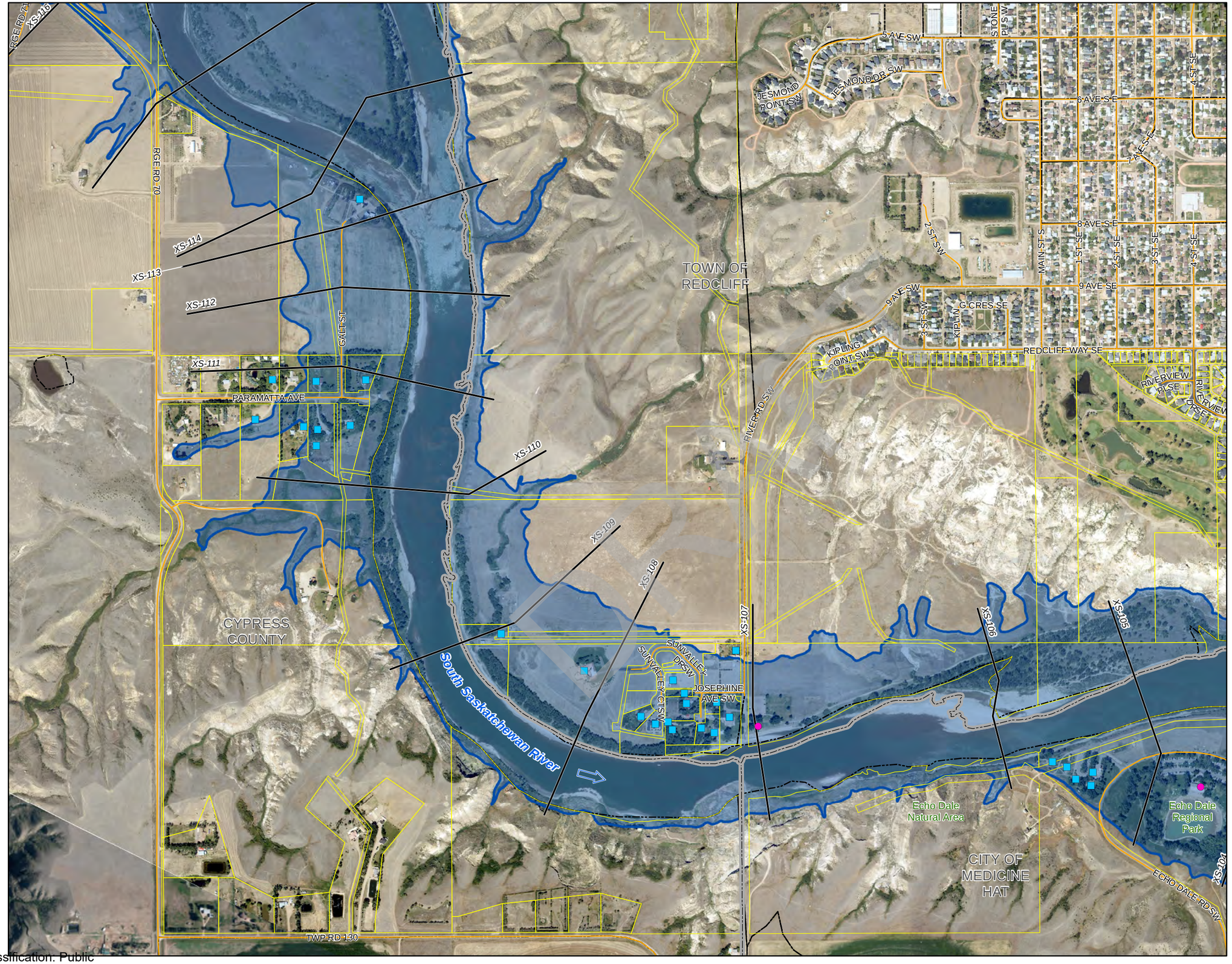

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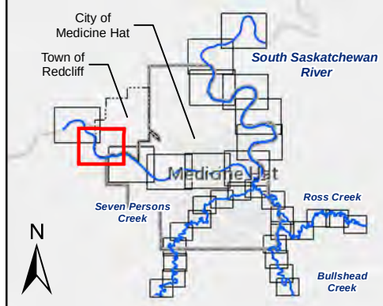
northwest hydraulic consultants



- FLOW DIRECTION
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- RAILWAY
- CROSS SECTION
- FLOOD CONTROL STRUCTURE
- BRIDGE
- CULVERT
- CENSUS UNIT
- LAND PARCEL
- ADMINISTRATIVE BOUNDARY
- NEIGHBOURHOOD
- 1000-YEAR FLOOD INUNDATION EXTENT

STRUCTURES

School	WW treatment
Commercial	Other
Government	Single family
Industrial	Multi-family
Water treatment	Group home
	Retirement home

SCALE - 1:10,000
0 100 200 400 M
N

Coordinate System: NAD 1983 CSRS 3TM 111
Units: METRES; Vertical Datum: CGVD28 HTv2.0

Engineer	GIS	Reviewer
MGB	REH	RBA

Job: 1003094 | Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

SPATIAL DATA INVENTORY

SHEET 2 OF 34

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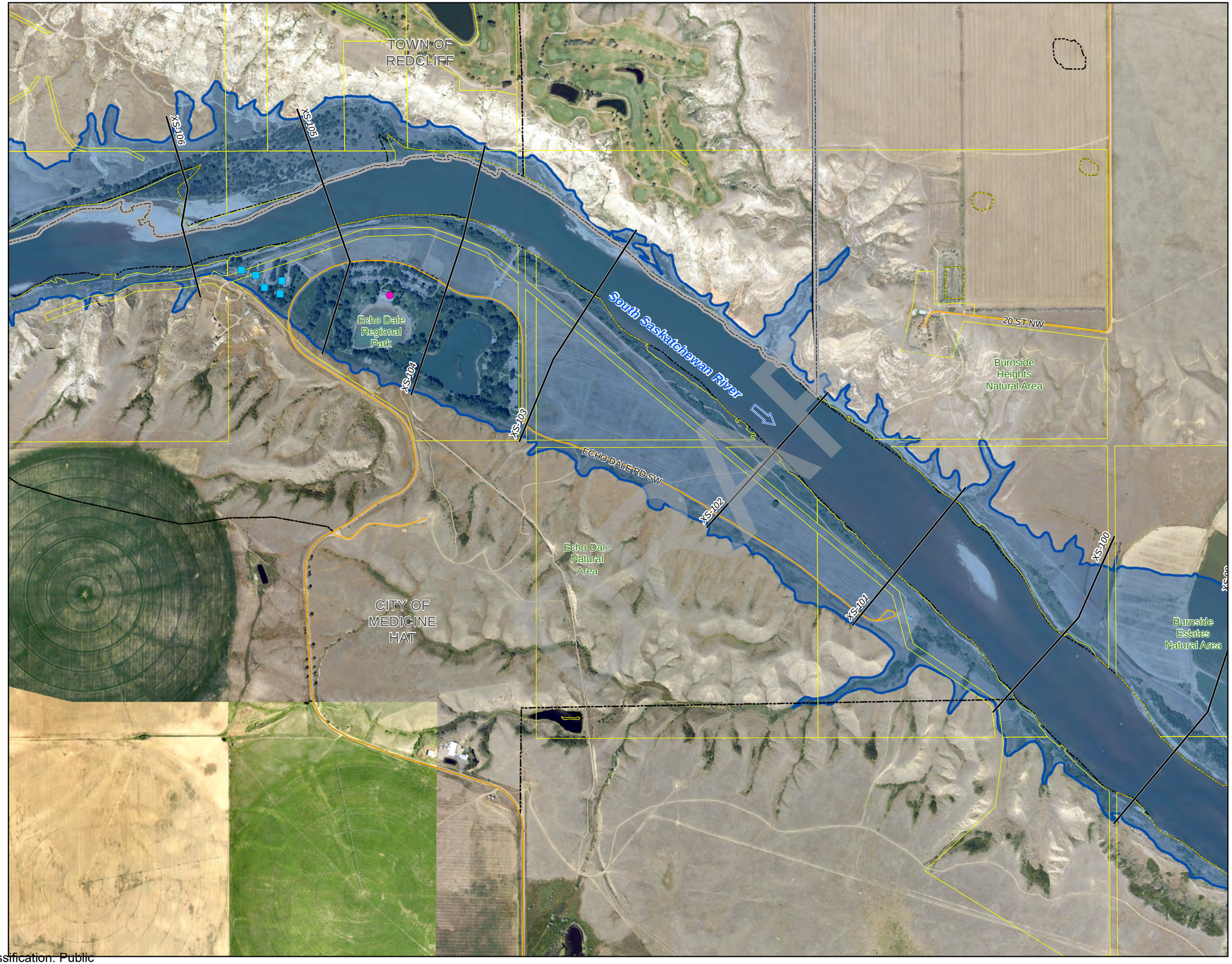

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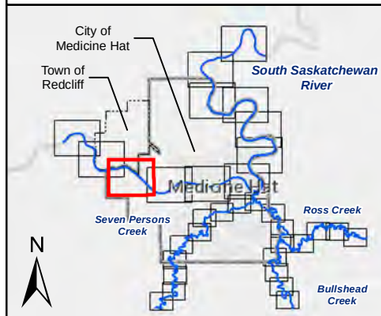

- FLOW DIRECTION
- MAJOR ROAD
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- CULVERT
- CENSUS UNIT
- LAND PARCEL
- ADMINISTRATIVE BOUNDARY
- NEIGHBOURHOOD
- 1000-YEAR FLOOD INUNDATION EXTENT

STRUCTURES

- School
- Commercial
- Government
- Industrial
- Water treatment
- WW treatment
- Other
- Single family
- Multi-family
- Group home
- Retirement home

SCALE - 1:10,000
0 100 200 400 M
N

Coordinate System: NAD 1983 CSRS 3TM 111
Units: METRES; Vertical Datum: CGVD28 HTv2.0

Engineer	GIS	Reviewer
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Job: 1003094 | Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

SPATIAL DATA INVENTORY

SHEET 3 OF 34

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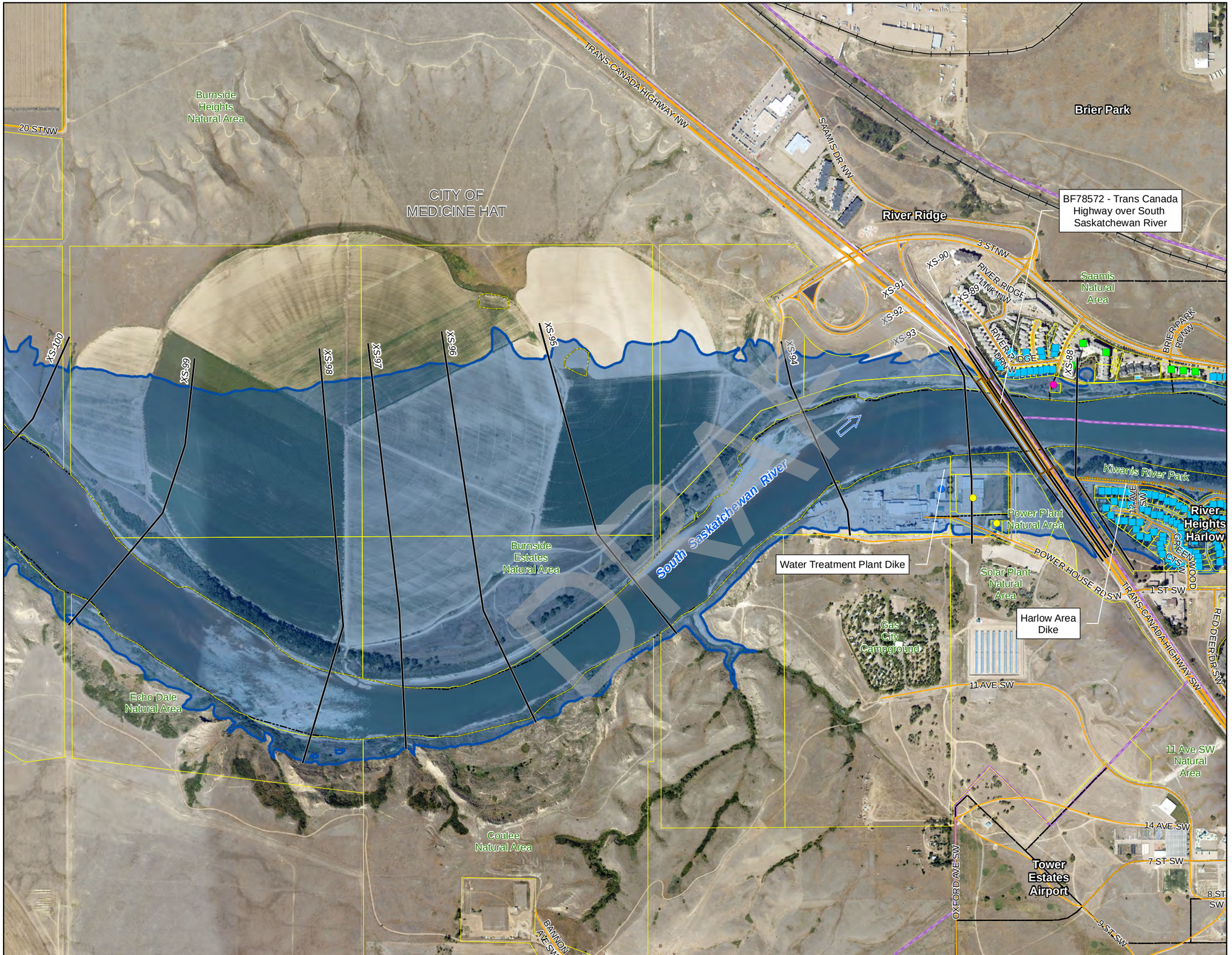

Alberta Government

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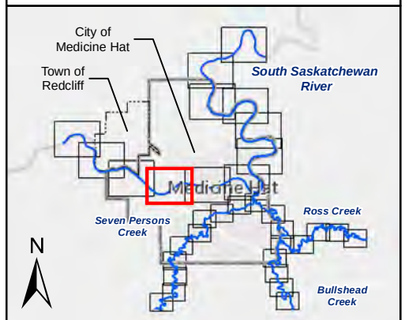
northwest hydraulic consultants



- FLOW DIRECTION
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- CULVERT
- CENSUS UNIT
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STRUCTURES

School	WW treatment
Commercial	Other
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Industrial	Multi-family
Water treatment	Group home
	Retirement home

SCALE - 1:10,000

0 100 200 400 M

N

Coordinate System: NAD 1983 CSRS 3TM 111
Units: METRES; Vertical Datum: CGVD28 HTv2.0

Engineer	GIS	Reviewer
MGB	REH	RBA

Job: 1003094 | *Date: 16-MAY-2022*

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

SPATIAL DATA INVENTORY

SHEET 4 OF 34

REH, P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Models\GIS\GIS_1006302_REH_Map_T700_RiskAssessment2021Update.mxd

Alberta Government

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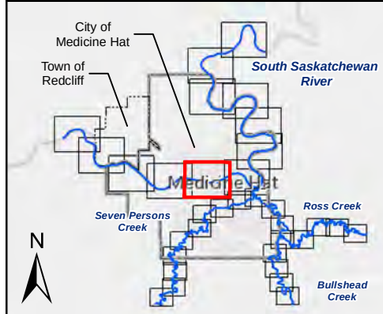

FLOW DIRECTION
MAJOR ROAD
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Engineer	GIS	Reviewer
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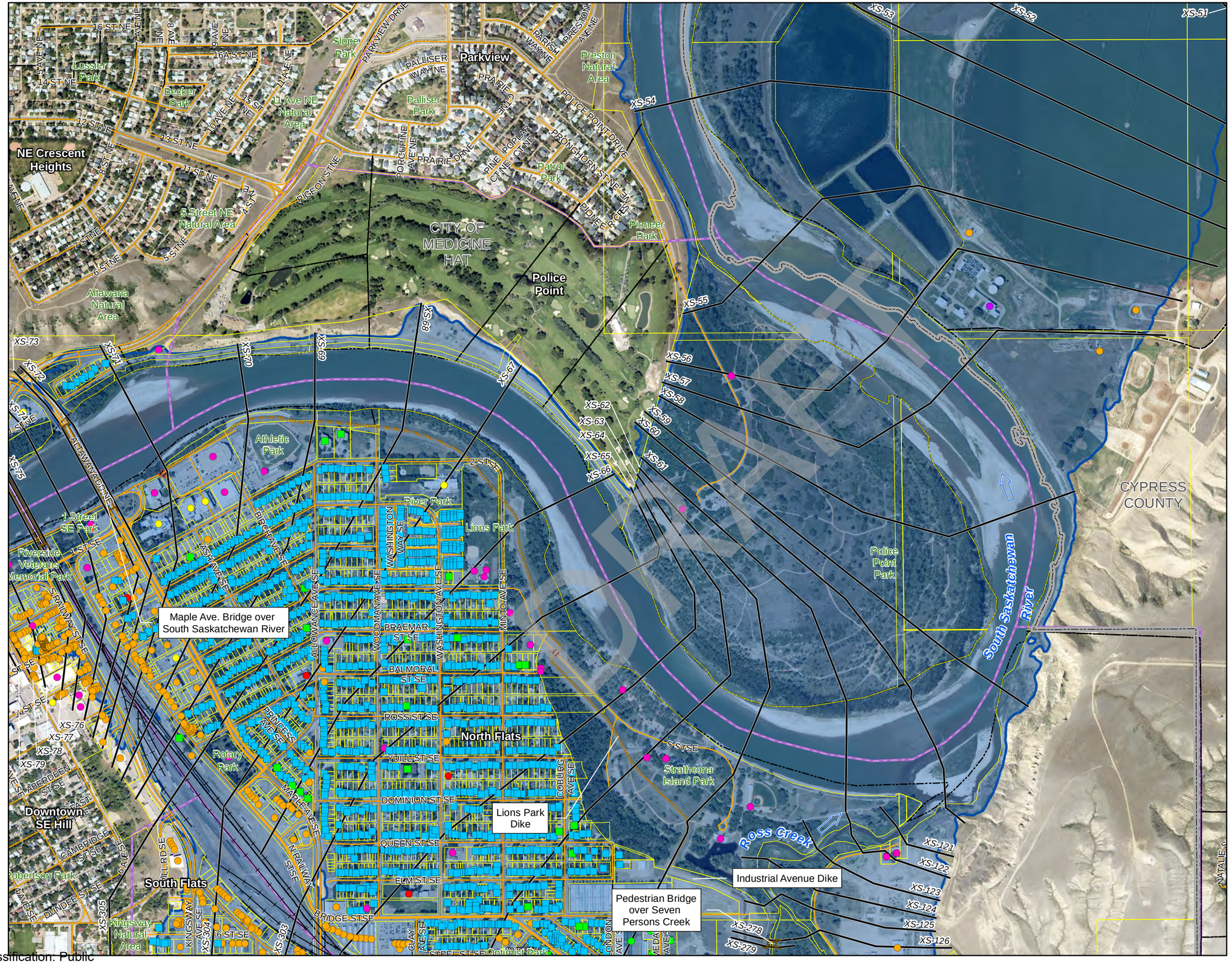
Job: 1003094 | Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

SPATIAL DATA INVENTORY

SHEET 5 OF 34

REH, P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Models\GIS\GIS_1006302_REH_Map_T700_RiskAssessment2021Update.mxd



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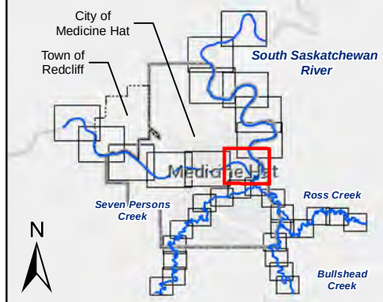

- FLOW DIRECTION
- MAJOR ROAD
- LOCAL ROAD
- RAILWAY
- CROSS SECTION
- FLOOD CONTROL STRUCTURE
- BRIDGE
- CULVERT
- CENSUS UNIT
- LAND PARCEL
- ADMINISTRATIVE BOUNDARY
- NEIGHBOURHOOD
- 1000-YEAR FLOOD INUNDATION EXTENT

STRUCTURES

- School
- Commercial
- Government
- Industrial
- Water treatment
- WW treatment
- Other
- Single family
- Multi-family
- Group home
- Retirement home

SCALE - 1:10,000
0 100 200 400 M
N

Coordinate System: NAD 1983 CSRS 3TM 111
Units: METRES; Vertical Datum: CGVD28 HTv2.0

Engineer	GIS	Reviewer
MGB	REH	RBA

Job: 1003094 | Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

SPATIAL DATA INVENTORY

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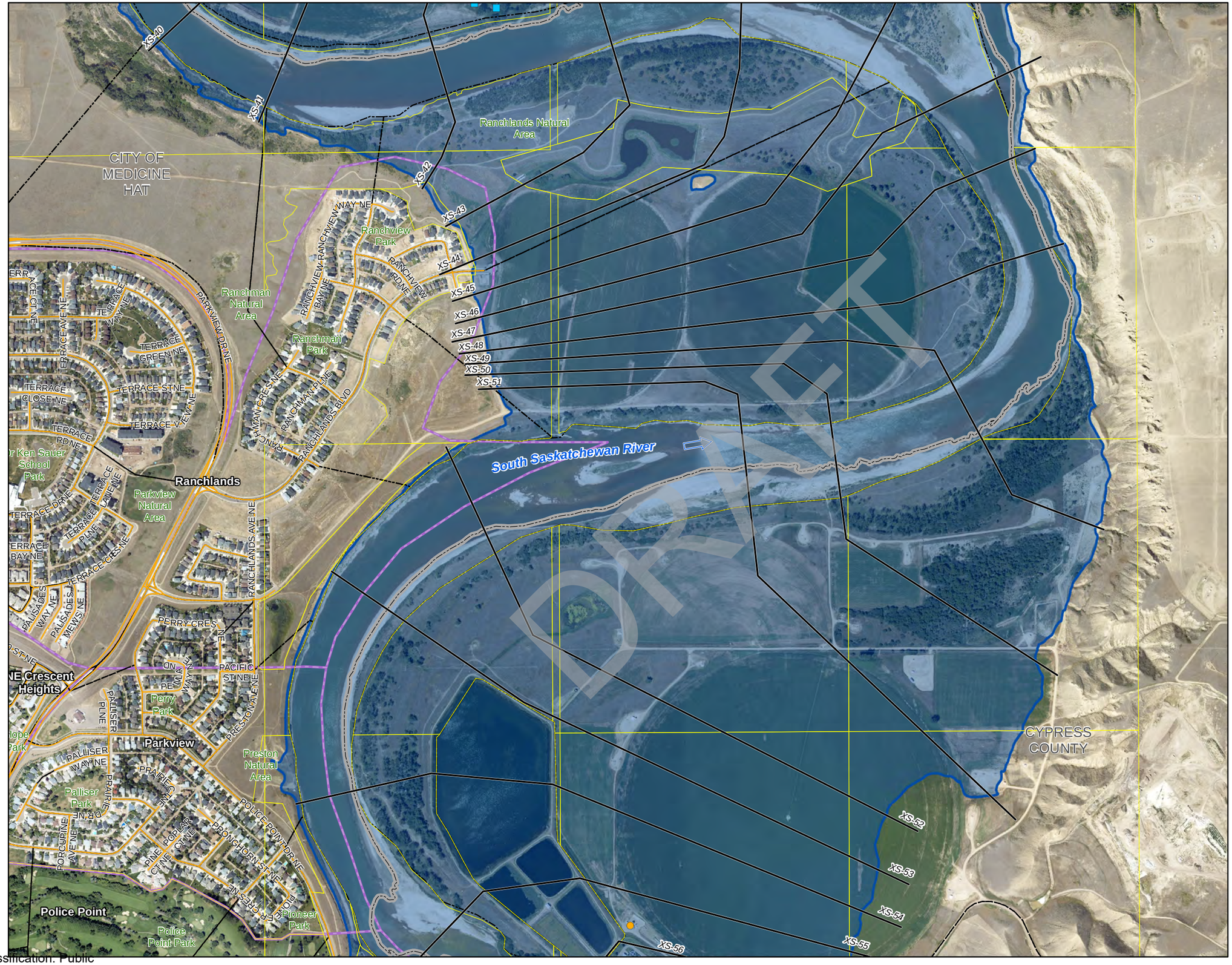

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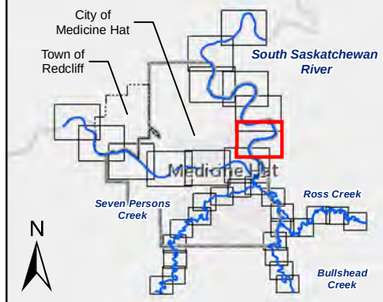

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MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

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SHEET 7 OF 34

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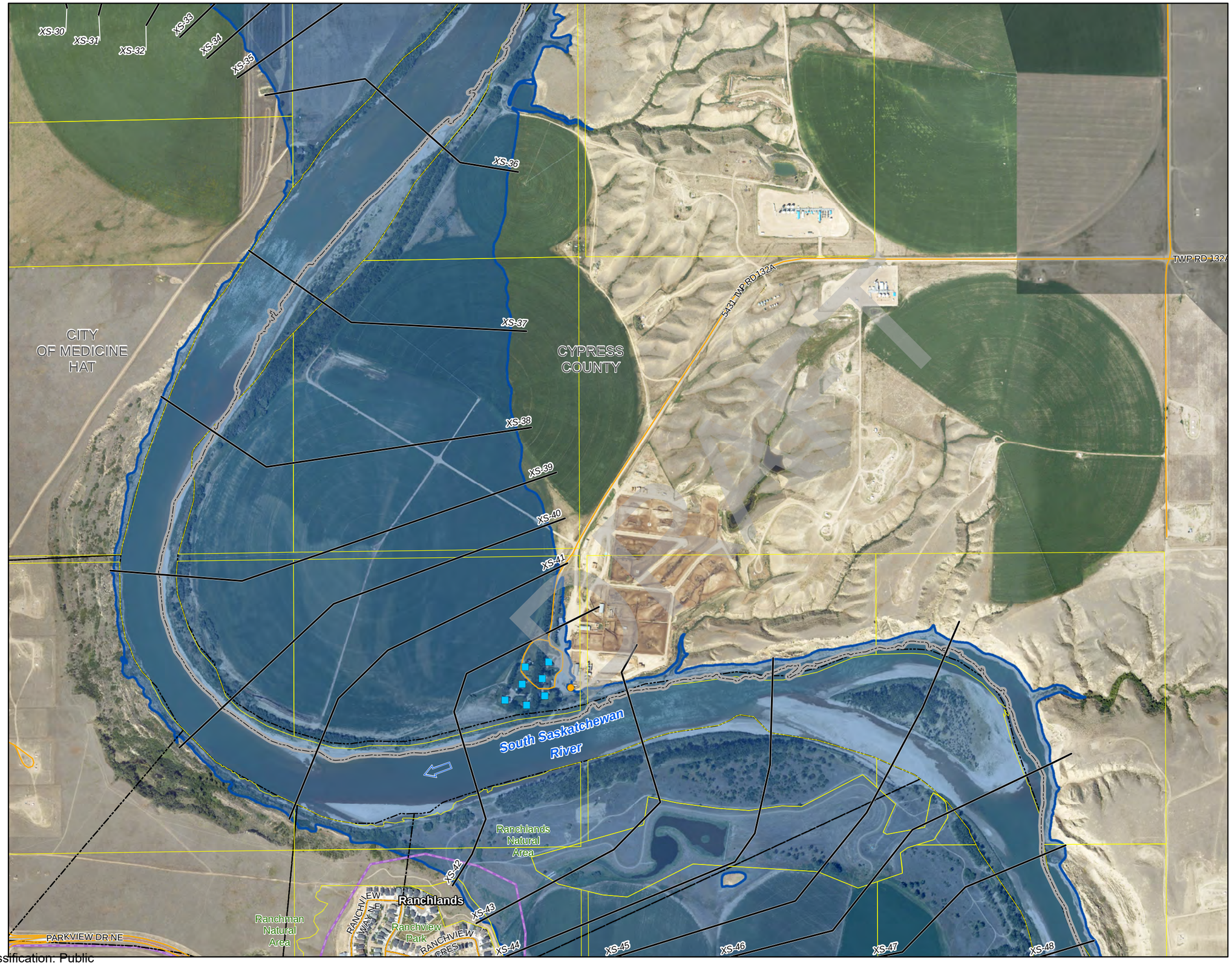

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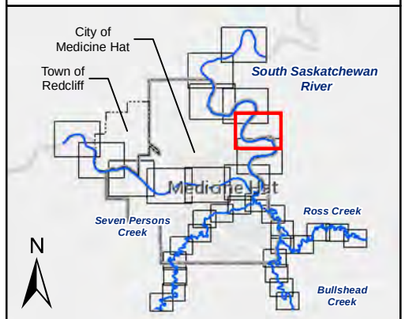

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STRUCTURES

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Commercial	Other
Government	Single family
Industrial	Multi-family
Water treatment	Group home
	Retirement home

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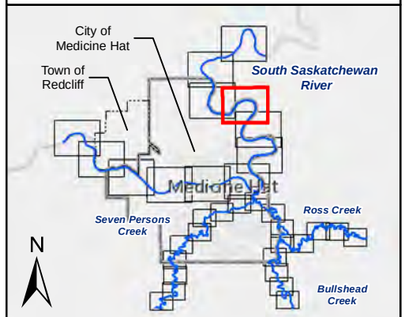

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FLOOD RISK INVENTORY & ASSESSMENT

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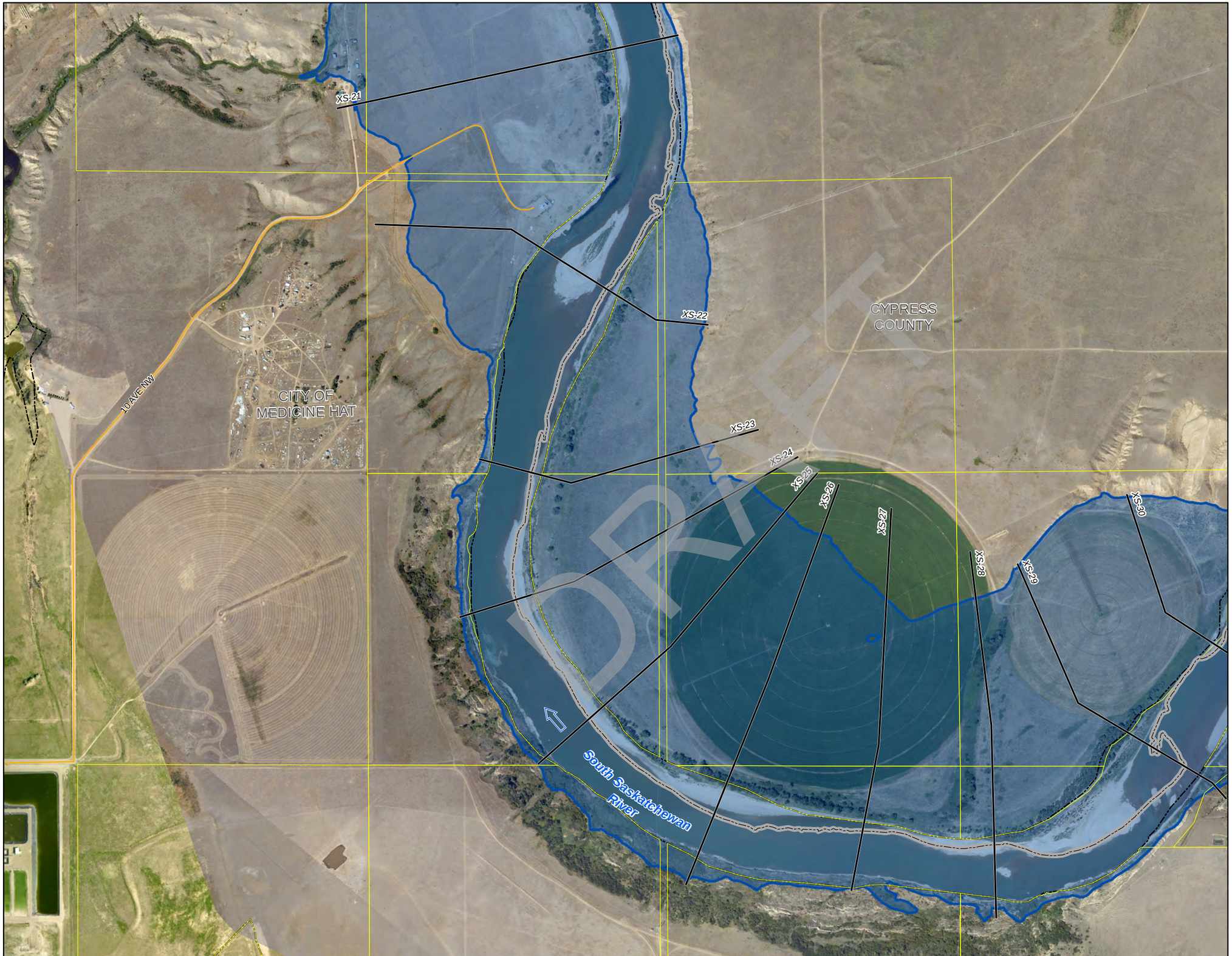

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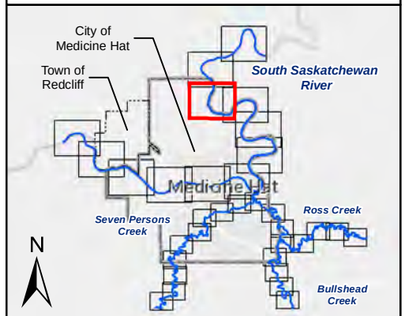

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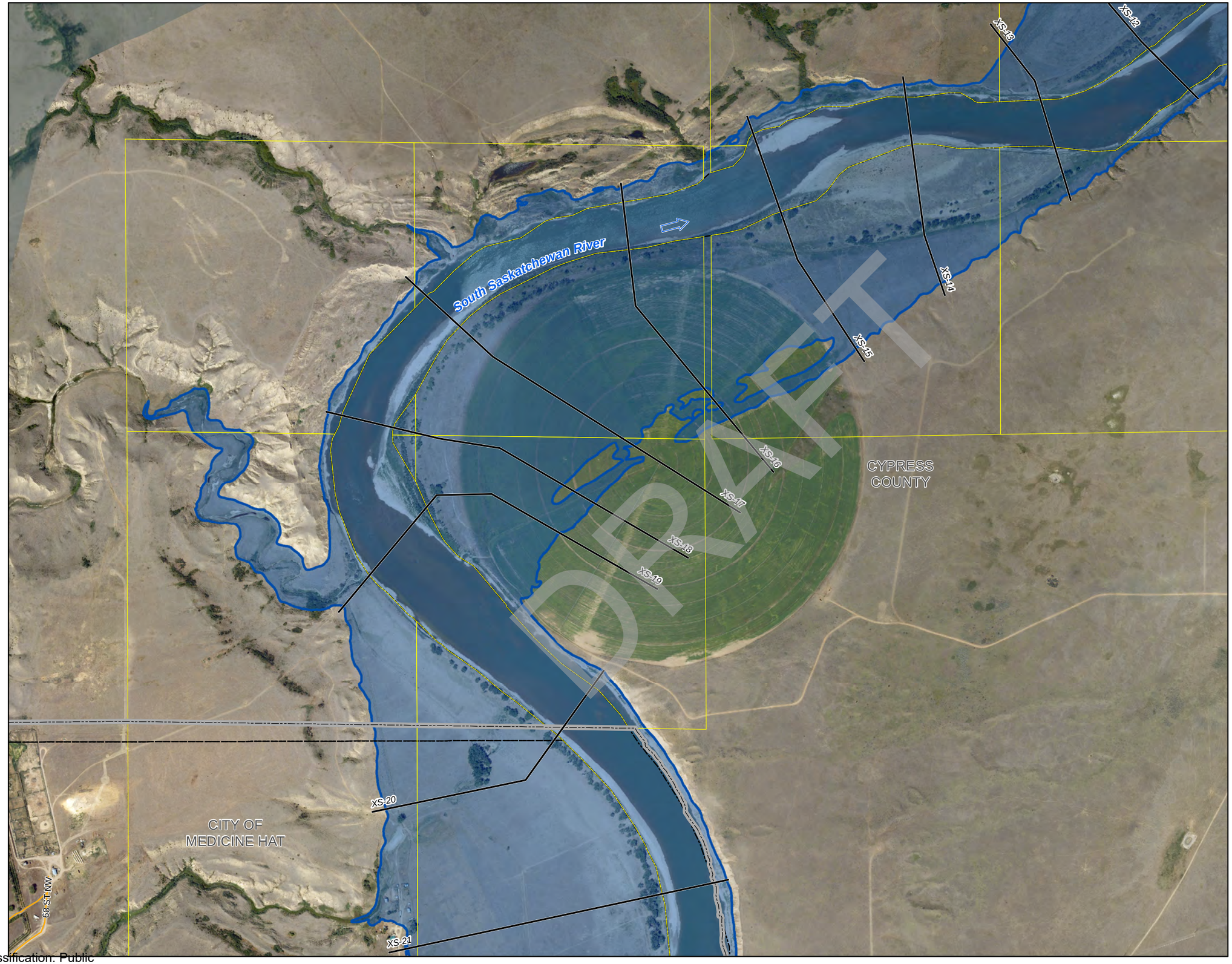
Job: 1003094 | Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

SPATIAL DATA INVENTORY

SHEET 10 OF 34

REH. P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Models\GIS\GIS_1006302_REH_Map_T700_RiskAssessment2021Update.mxd



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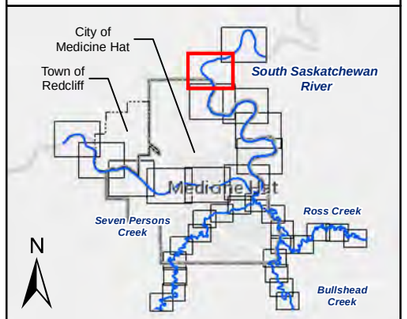

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Job: 1003094 | Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

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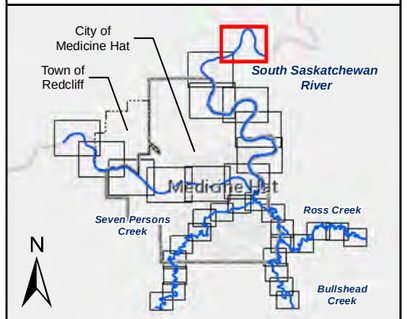

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MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

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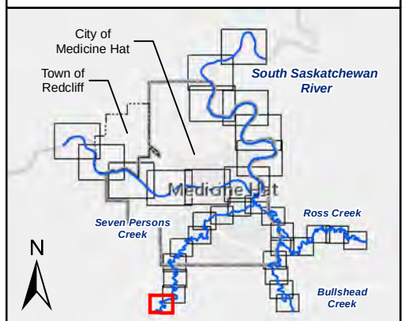

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MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

SPATIAL DATA INVENTORY

SHEET 13 OF 34

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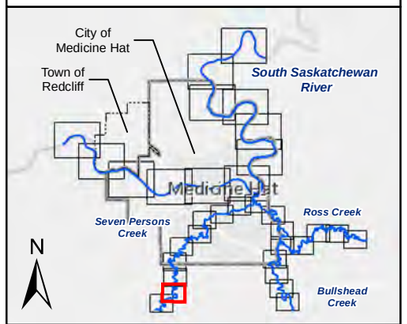

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MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

SPATIAL DATA INVENTORY

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Desert Blume Golf Course Bridge 7 over Seven Persons Creek

Desert Blume Golf Course Bridge 6 over Seven Persons Creek

Desert Blume Golf Course Bridge 5 over Seven Persons Creek

Desert Blume Golf Course Bridge 4 over Seven Persons Creek

Desert Blume Golf Course Bridge 3 over Seven Persons Creek

Desert Blume Golf Course Bridge 2 over Seven Persons Creek

Desert Blume Golf Course Bridge 1 over Seven Persons Creek

CYPRESS COUNTY

Seven Persons Creek

DESERT BLUME DR

EDGEWATER PL

HIGHLANDS CL

HIGHLANDS PL

CLUBHOUSE DR

LINKS BAY

LINKS PL

RGE RD 61A

XS-470 XS-471 XS-472 XS-473 XS-474 XS-475 XS-476 XS-477 XS-478 XS-479 XS-480 XS-481 XS-482 XS-483 XS-484 XS-485 XS-486 XS-487 XS-488 XS-489 XS-490 XS-491 XS-492 XS-493 XS-494 XS-495 XS-496 XS-497 XS-498 XS-499 XS-500 XS-501 XS-502 XS-503 XS-504 XS-505

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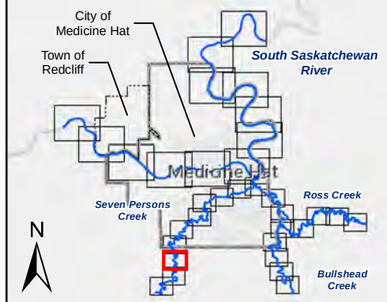

FLOW DIRECTION
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FLOOD RISK INVENTORY & ASSESSMENT

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SHEET 15 OF 34

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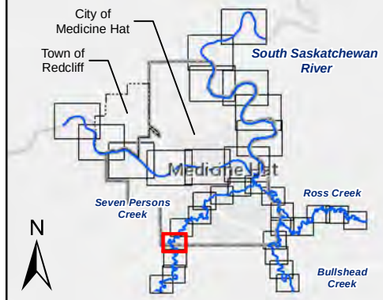

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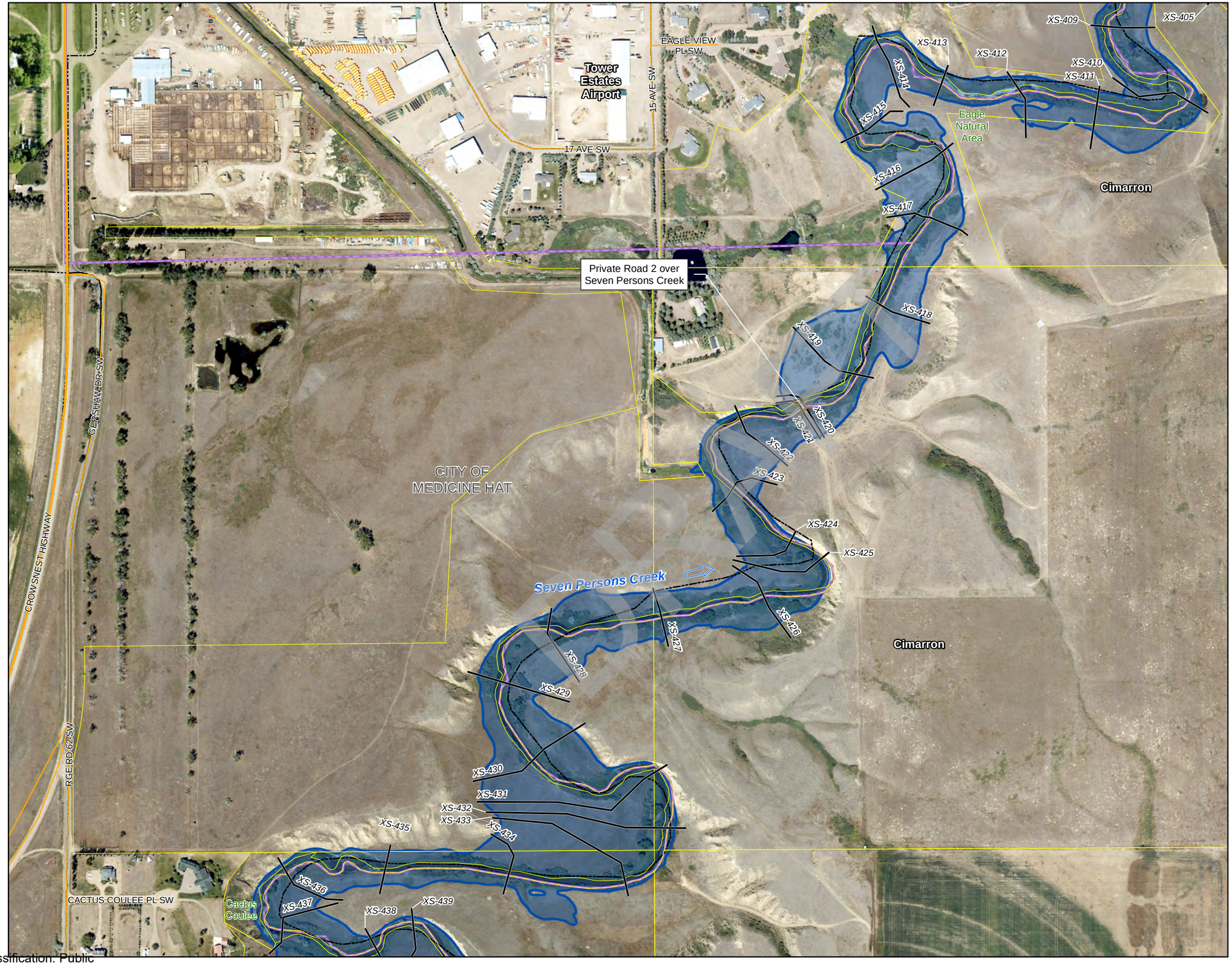
FLOOD RISK INVENTORY & ASSESSMENT

SPATIAL DATA INVENTORY

SHEET 16 OF 34



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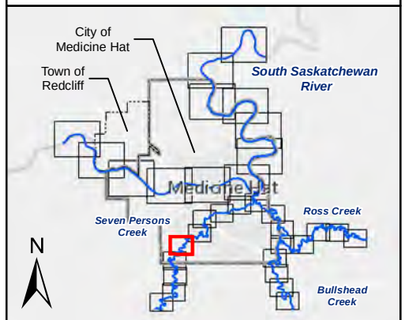

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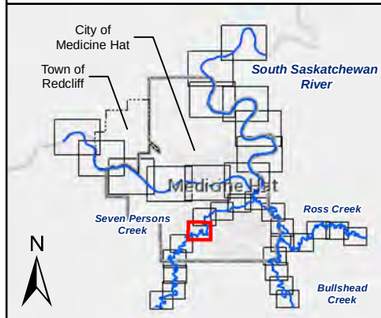

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MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

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Classification: Public

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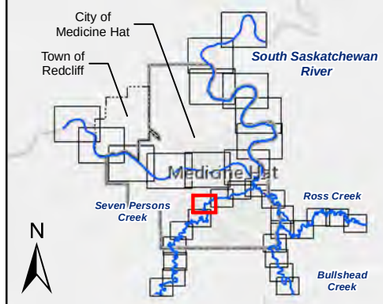

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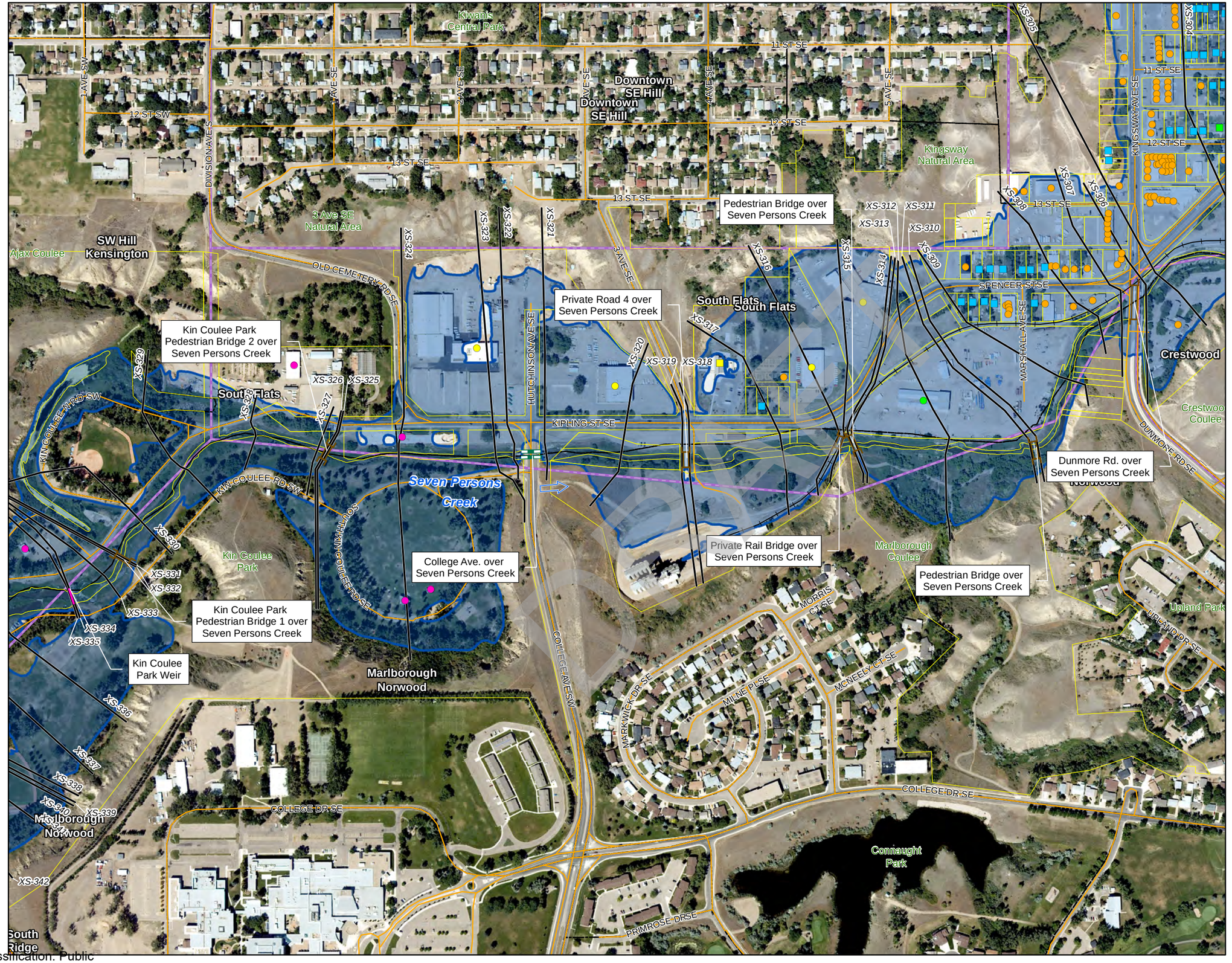

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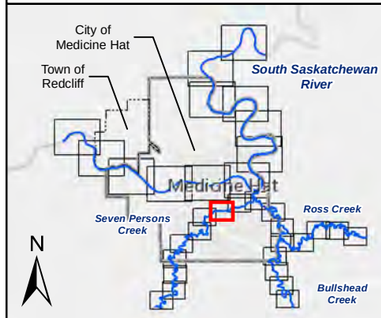

- FLOW DIRECTION
- MAJOR ROAD
- LOCAL ROAD
- RAILWAY
- CROSS SECTION
- FLOOD CONTROL STRUCTURE
- BRIDGE
- CULVERT
- CENSUS UNIT
- LAND PARCEL
- ADMINISTRATIVE BOUNDARY
- NEIGHBOURHOOD
- 1000-YEAR FLOOD INUNDATION EXTENT

STRUCTURES

- School
- Commercial
- Government
- Industrial
- Water treatment
- WW treatment
- Other
- Single family
- Multi-family
- Group home
- Retirement home

SCALE - 1:5,000

0 100 200 M

N

Coordinate System: NAD 1983 CSRS 3TM 111
Units: METRES; Vertical Datum: CGVD28 HTv2.0

Engineer	GIS	Reviewer
MGB	REH	RBA

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MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

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SHEET 20 OF 34

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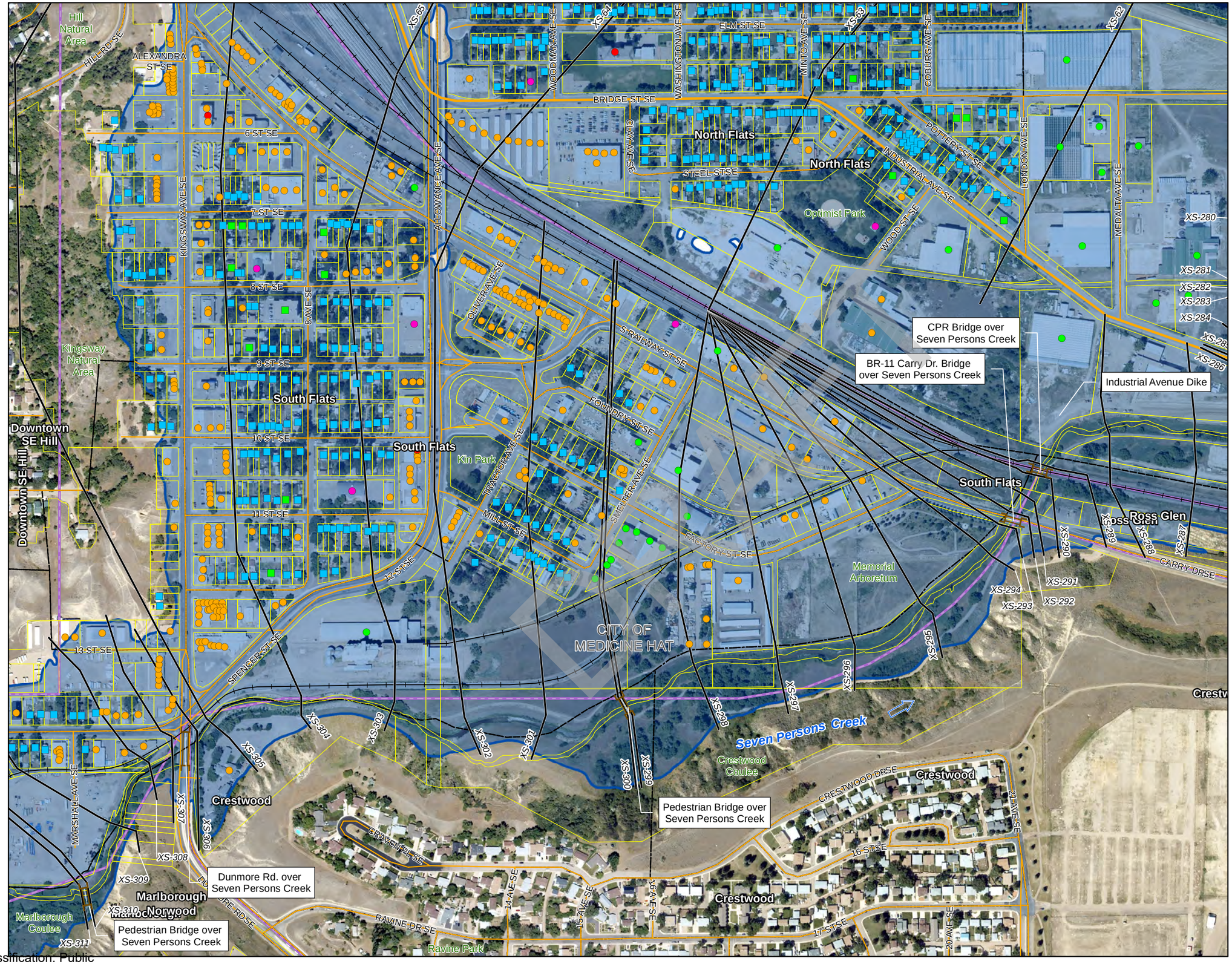

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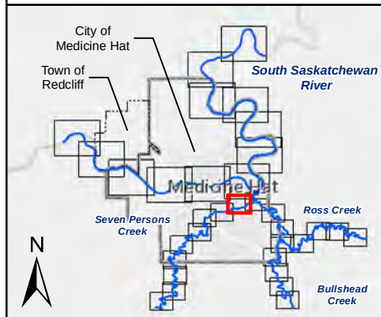

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SHEET 21 OF 34

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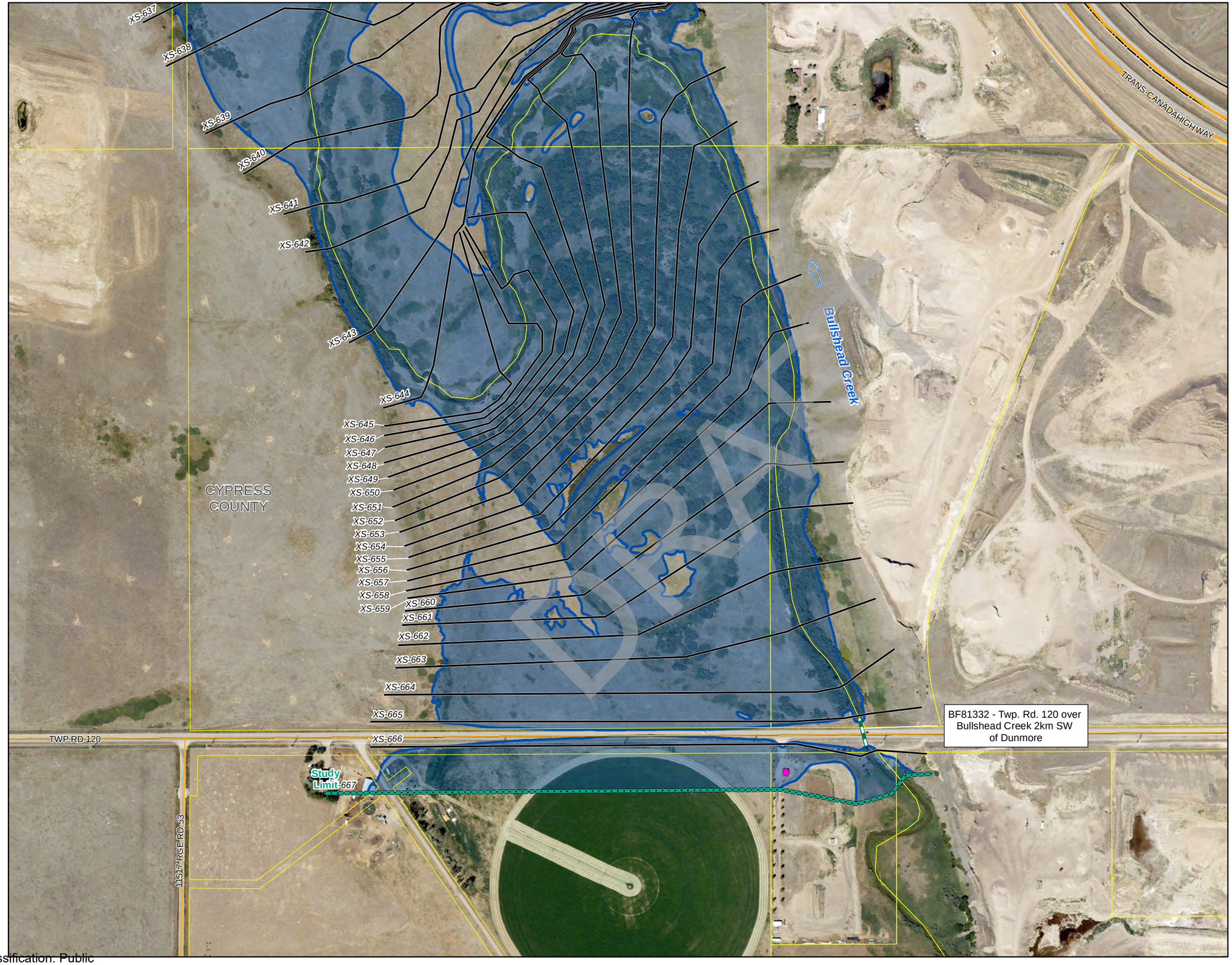

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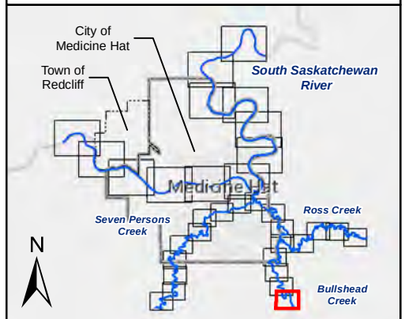

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FLOOD RISK INVENTORY & ASSESSMENT

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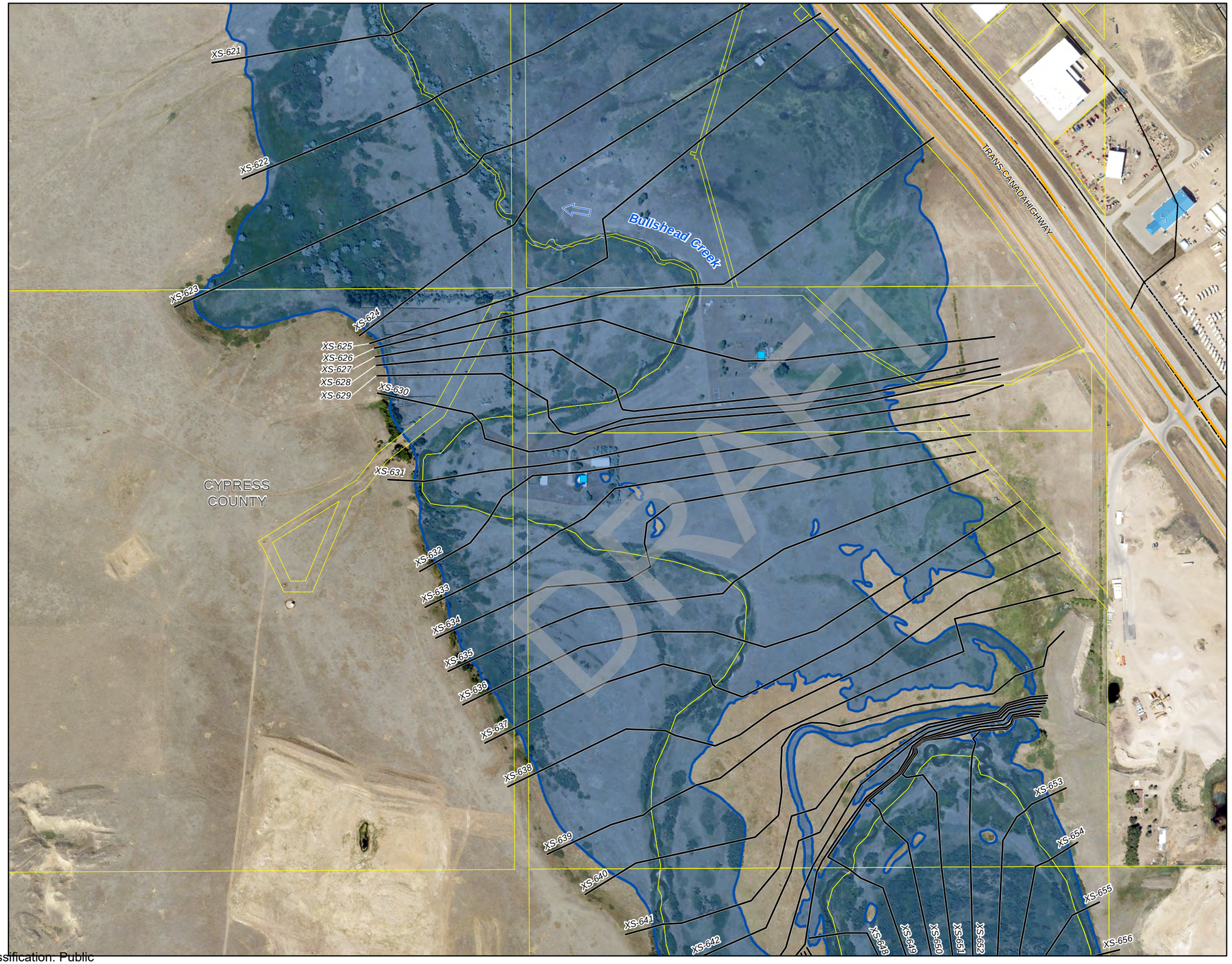

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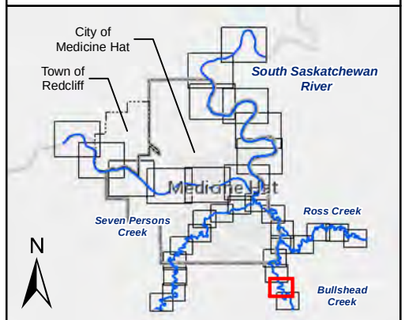

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STRUCTURES

School	WW treatment
Commercial	Other
Government	Single family
Industrial	Multi-family
Water treatment	Group home
	Retirement home

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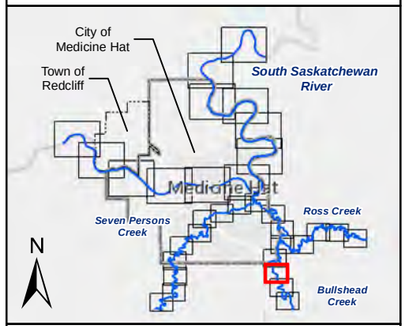

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MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

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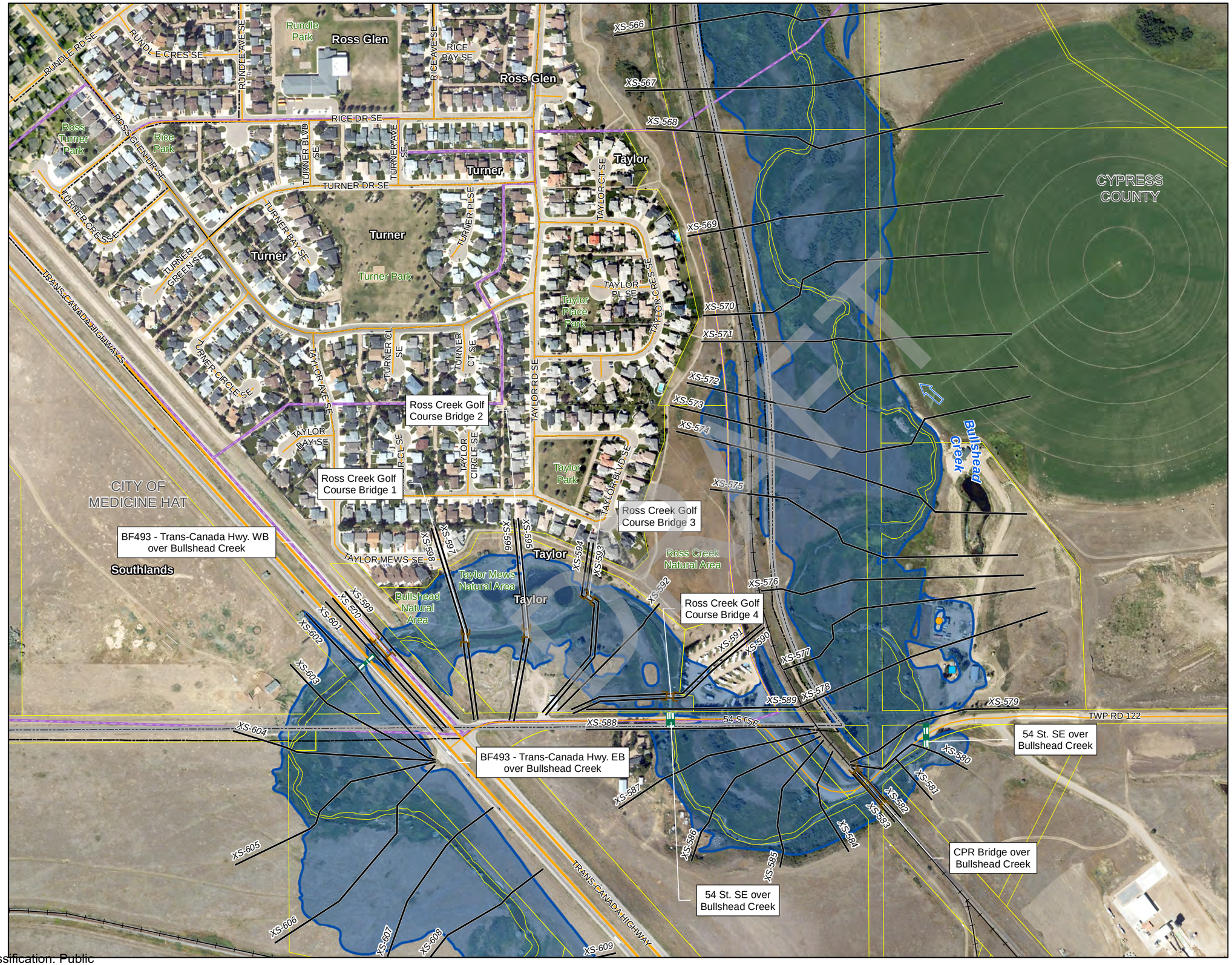

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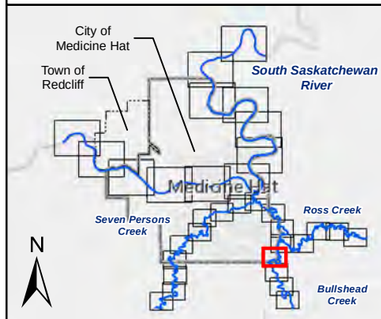

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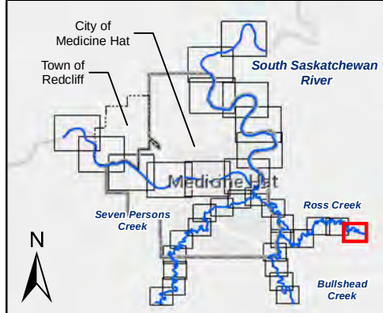

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MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

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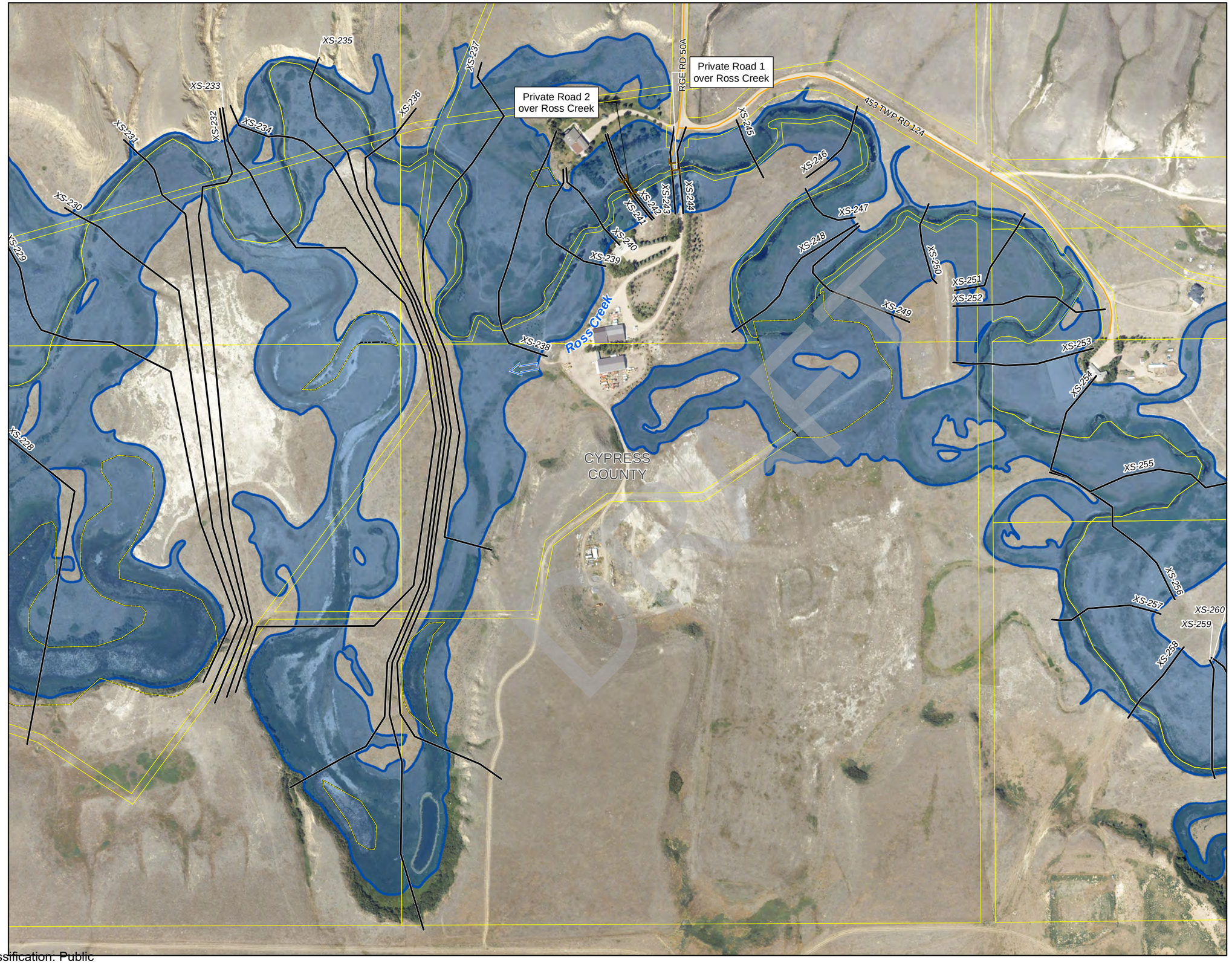

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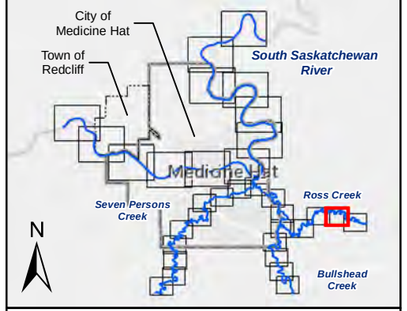

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MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

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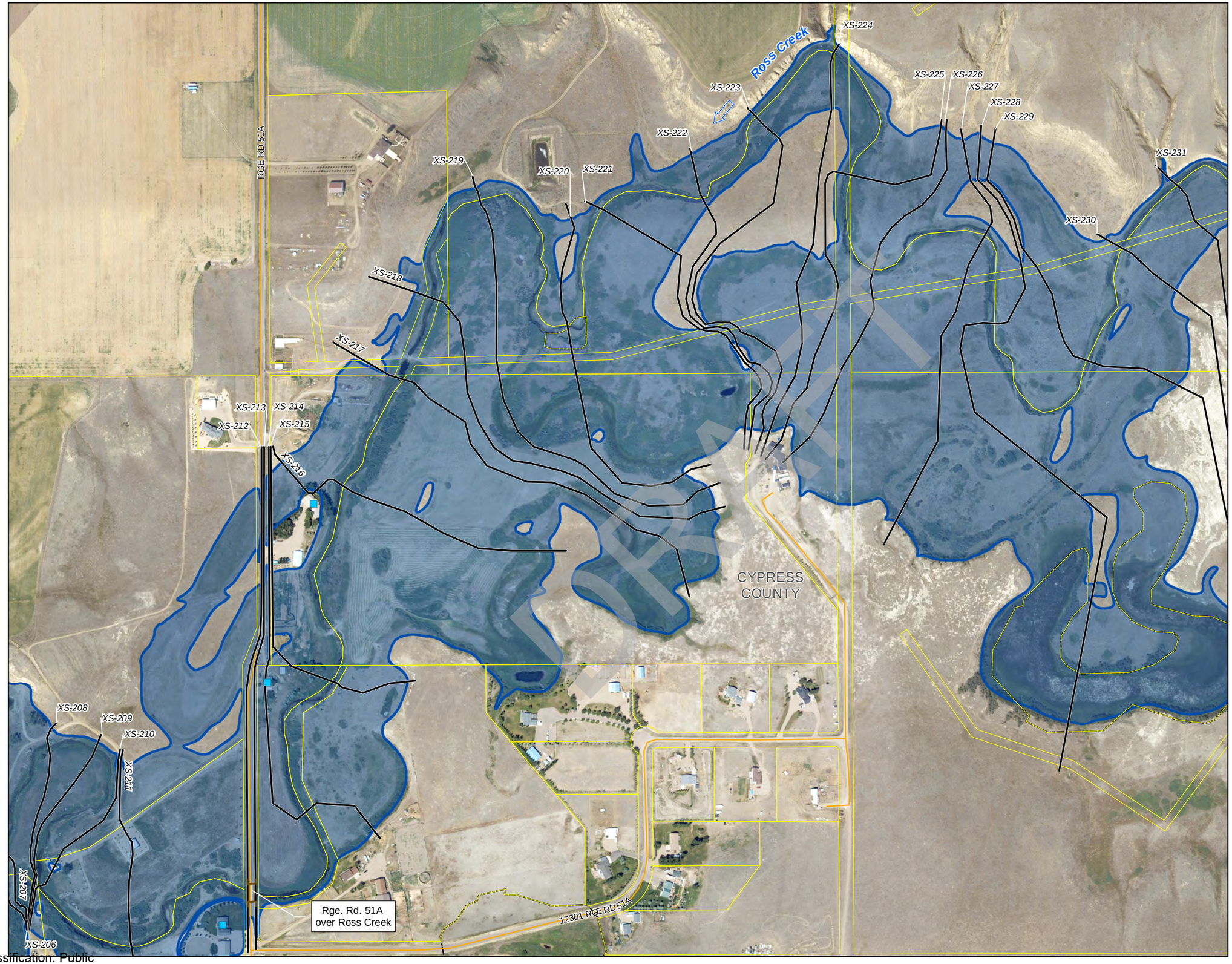

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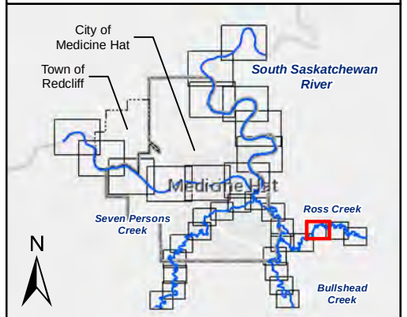

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MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

SPATIAL DATA INVENTORY

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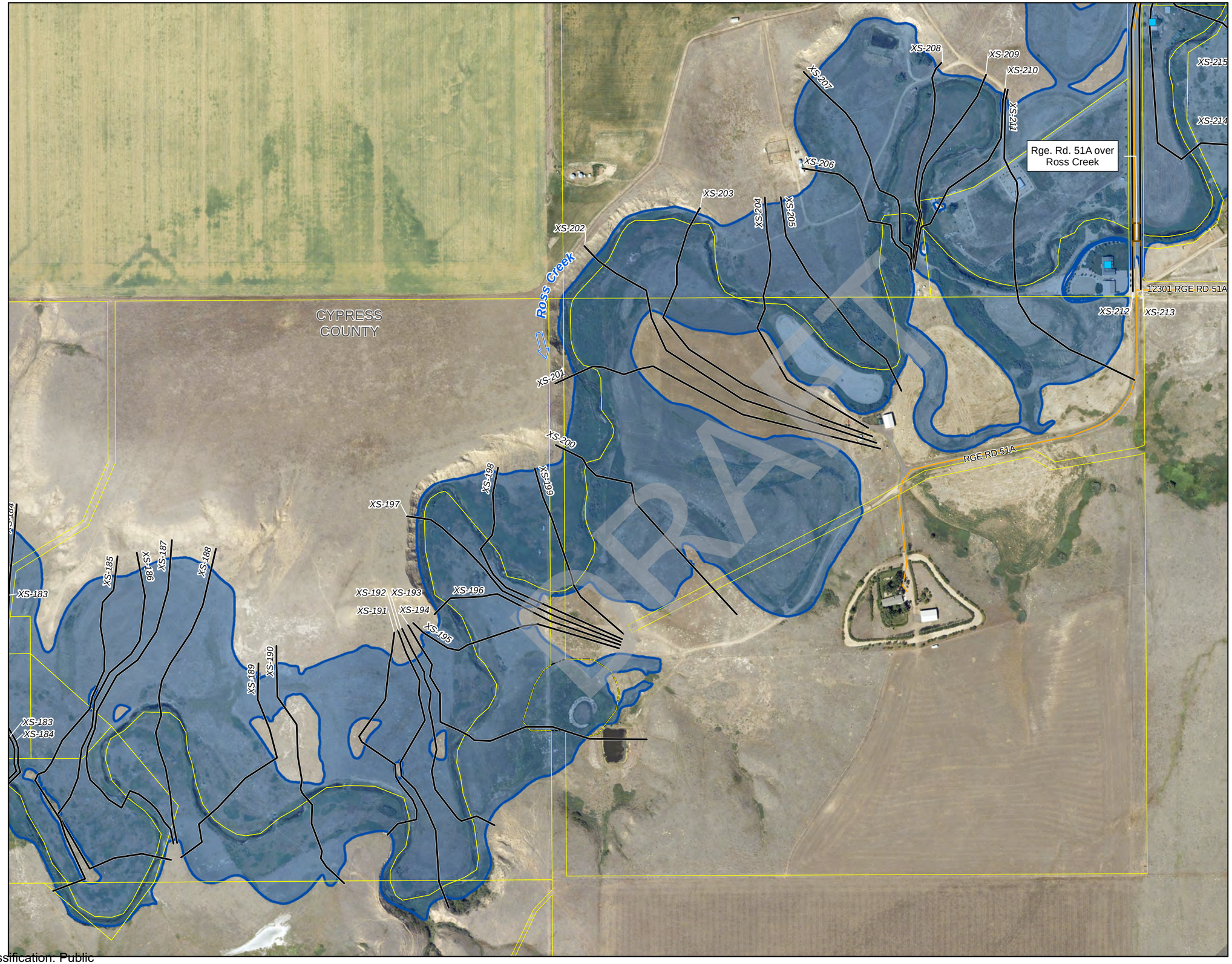

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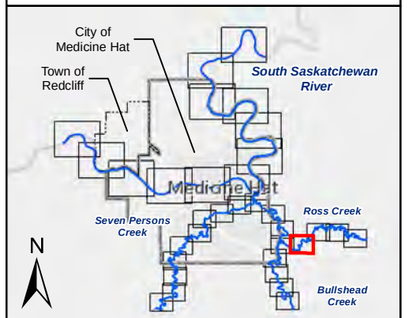

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MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

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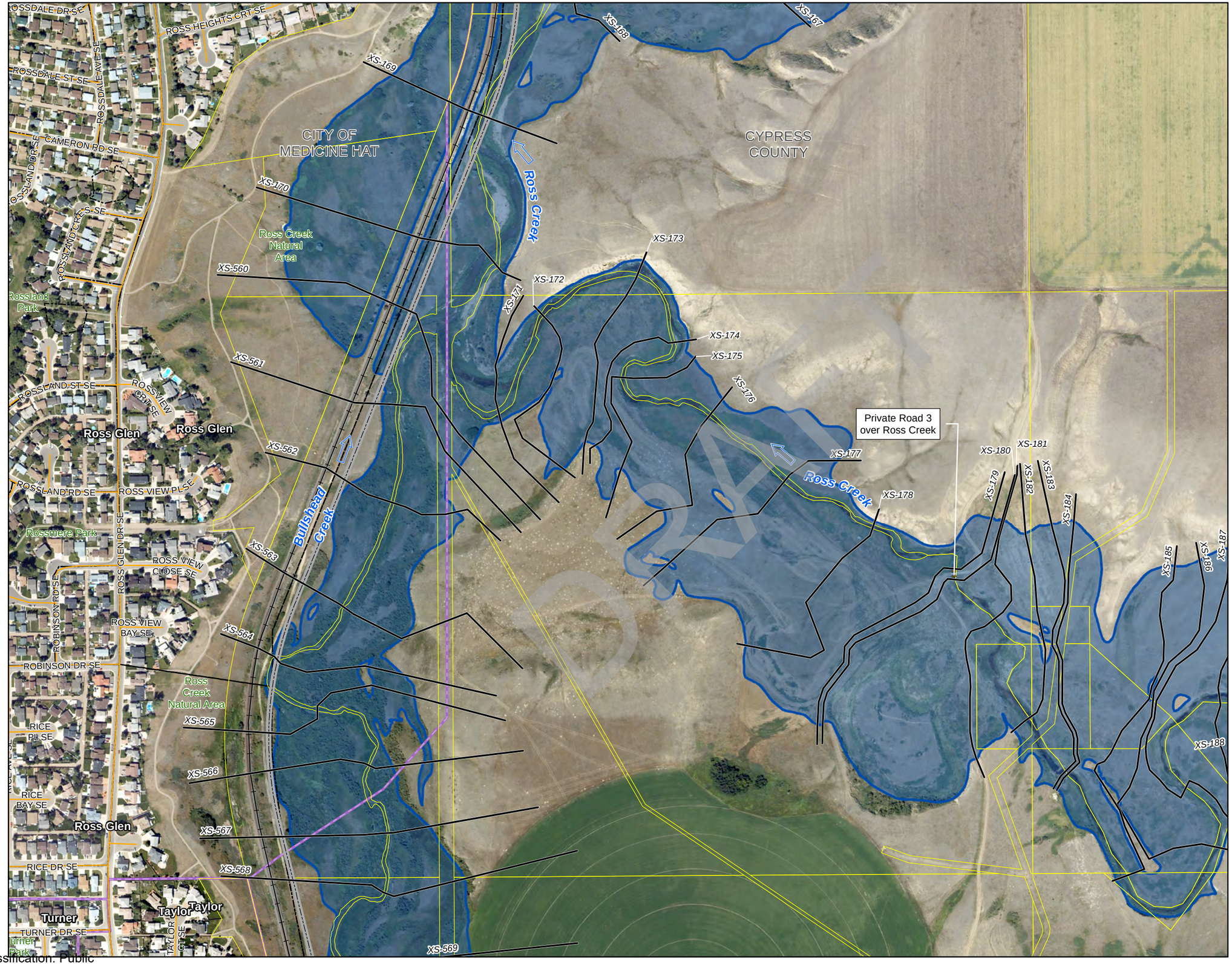

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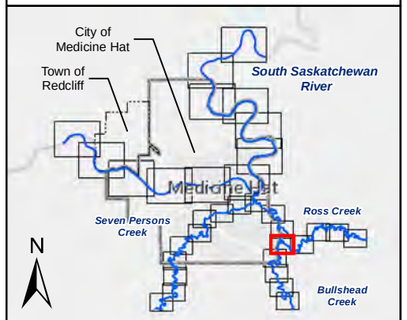

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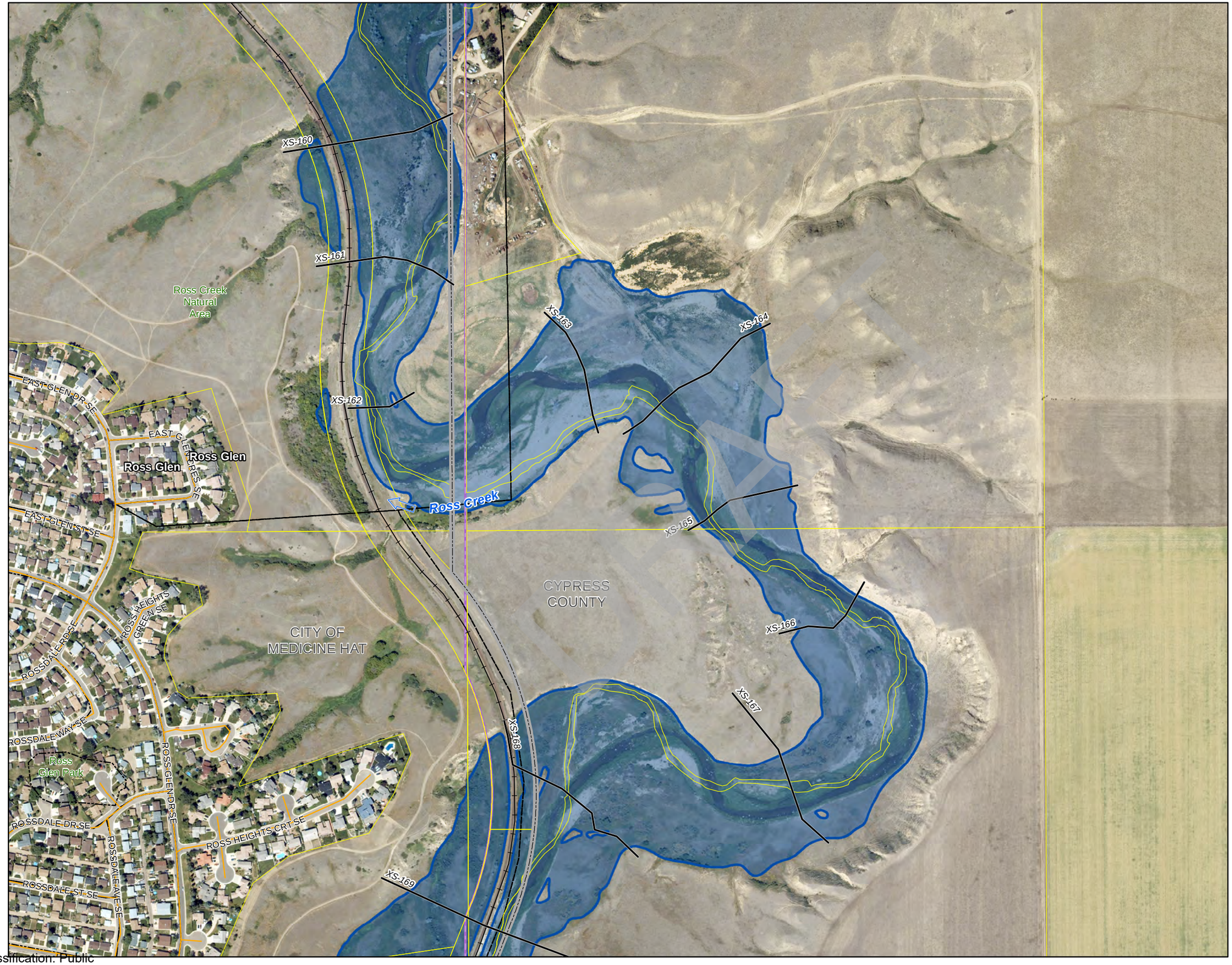

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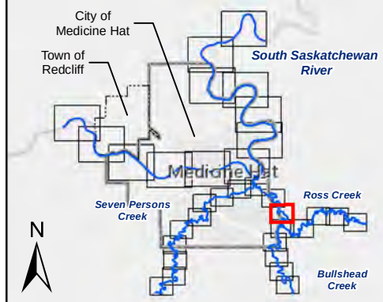

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STRUCTURES

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FLOOD RISK INVENTORY & ASSESSMENT

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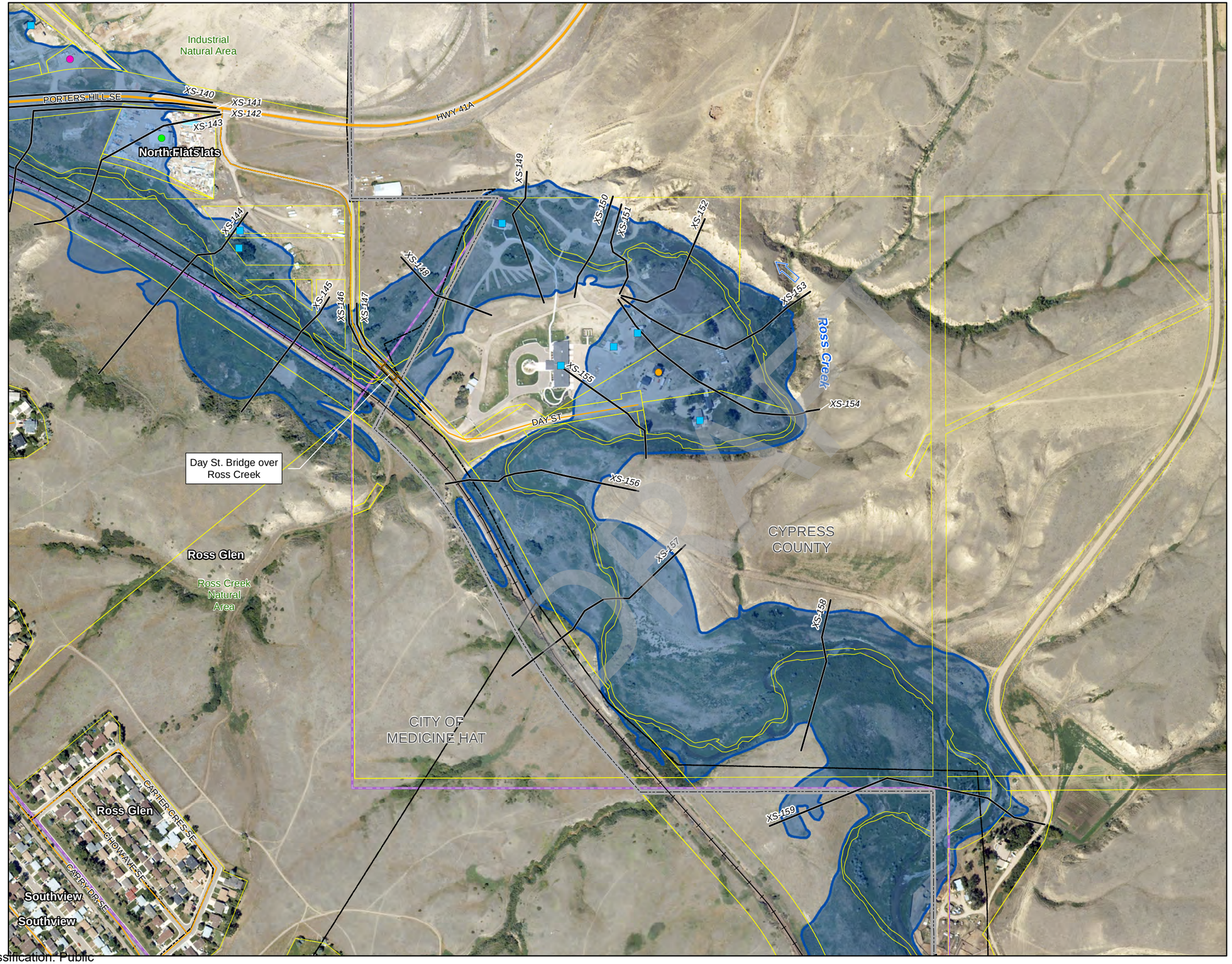

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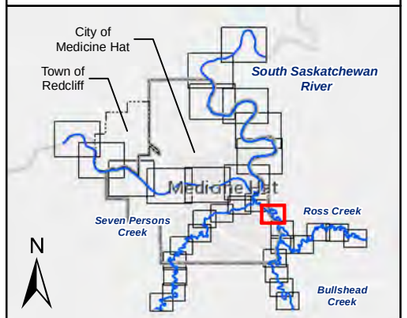

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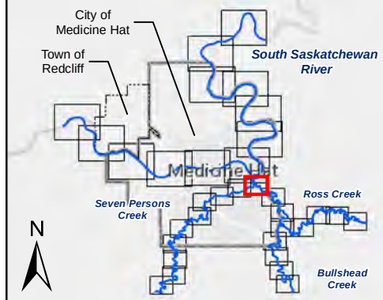

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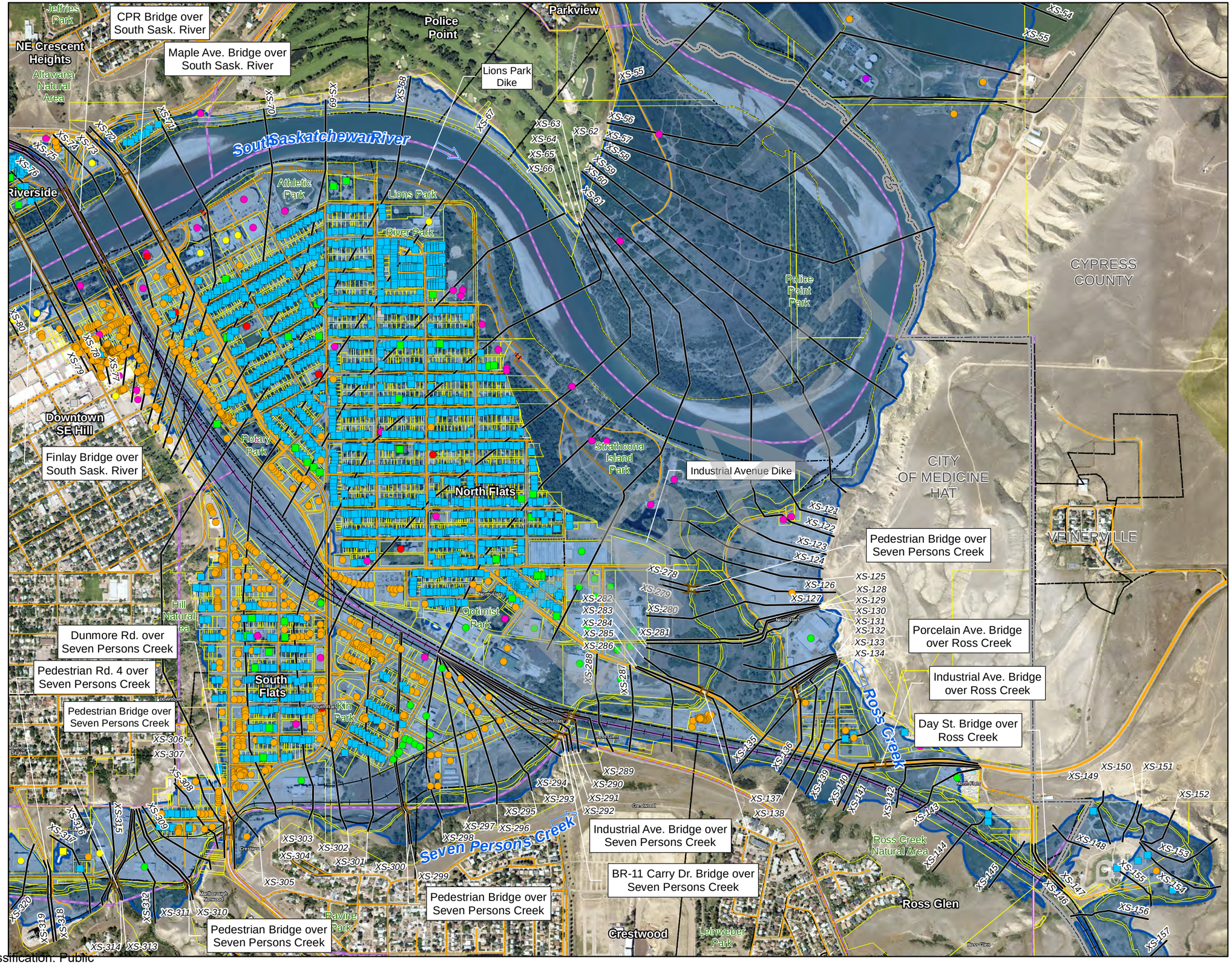

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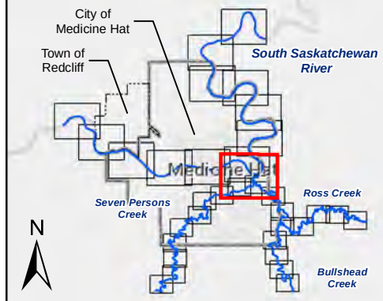

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- LAND PARCEL
- ADMINISTRATIVE BOUNDARY
- NEIGHBOURHOOD
- 1000-YEAR FLOOD INUNDATION EXTENT

STRUCTURES

School	WW treatment
Commercial	Other
Government	Single family
Industrial	Multi-family
Water treatment	Group home
	Retirement home

SCALE - 1:12,500
0 100 200 400 M
N

Coordinate System: NAD 1983 CSRS 3TM 111
Units: METRES; Vertical Datum: CGVD28 HTv2.0

Engineer	GIS	Reviewer
MGB	REH	RBA

Job: 1003094 | Date: 16-MAY-2022

MEDICINE HAT RIVER HAZARD STUDY
FLOOD RISK INVENTORY & ASSESSMENT

SPATIAL DATA INVENTORY

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REH, P:_Projects (Active)\1003094 Medicine Hat River Hazard Study\04 Models\GIS\GIS_1006302_REH_Map_T700_RiskAssessment20211Update.mxd

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water resource specialists