Stantec

AERIAL ASSESSMENT OF RIPARIAN AREAS IN THE SEVEN PERSONS CREEK WATERSHED, AB

Final Report

For: South East Alberta Watershed Alliance

Submission Date: May 4, 2018

Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

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Prepared for:

South East Alberta Watershed Alliance (SEAWA)

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Sign-off Sheet

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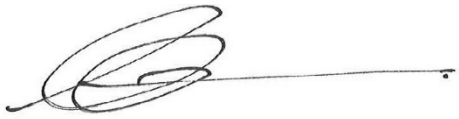
Reviewed by 

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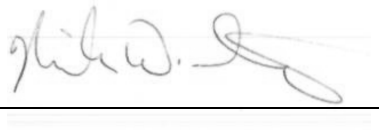
Approved by 

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Nick DeCarlo, B.Sc., P. Biol., QWSP

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SEAWA

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Executive Summary

Stantec Consulting Ltd. (Stantec) prepared this project report, an *Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed (SPCW), Alberta,* for the South East Alberta Watershed Alliance (SEAWA). SEAWA, one of the eleven Watershed Planning and Advisory Councils (WPACs) in Alberta, has an on-going partnership with the Government of Alberta, through Alberta Environment and Parks to help achieve the three goals of the provincial Water for Life policy. The three goals of the policy are: (1) Healthy aquatic ecosystems; (2) Reliable, quality water supplies for a sustainable economy; and (3) Safe, secure drinking water.

Seven Persons Creek is a major tributary of the South Saskatchewan River, intersecting the City of Medicine Hat, providing off-stream storage for irrigation, and discharging to the South Saskatchewan River. SEAWA needed a watershed-scale assessment of the riparian areas condition in the SPCW.

This report documents the steps that Stantec has taken to assess and classify the riparian areas condition of streams and lakes/reservoirs within the watershed using remote sensing applications. This aerial assessment is meant to assist SEAWA in identifying riparian areas of the watershed that need restoration and/or conservation, and to provide a baseline data set for future assessment.

Stantec provided insights into riparian conditions within the SPCW using an object-based image analysis (OBIA) and the Alberta Cows & Fish Riparian Health Assessment (RHA) lotic and lentic field surveys.

There are **23,016 km** of streams in the sub-watershed of which **702 km or 3%** have been assigned riparian habitat ratings based on selected Strahler stream orders 6 through 8.

Stantec identified and classified a total of **15,473** riparian sites with **81%** defined as lotic **(12,568)** and **19%** defined as lentic **(2,905)** within the SPCW. The Lotic Riparian Habitat Model identified **1,550 (10%) Healthy** riparian areas, **4,263 (27%) Healthy with Problems** riparian areas and **6,755 (44%) Unhealthy** riparian areas within SPCW. The Lentic Riparian Habitat Model identified **653 Healthy (4%)** riparian areas, **1,217 (8%) Healthy with Problems** riparian areas and **1,035 (7%) Unhealthy** riparian areas within SPCW.

1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) has prepared this project report, an *Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed (SPCW), Alberta,* for the South East Alberta Watershed Alliance (SEAWA). SEAWA, one of the eleven Watershed Planning and Advisory Councils (WPACs) in Alberta, has a on-going partnership with the Government of Alberta, through Alberta Environment and Parks to achieve the three goals of the provincial Water for Life policy. The three goals of the policy are: (1) Healthy aquatic ecosystems; (2) Reliable, quality water supplies for a sustainable economy; and (3) Safe, secure drinking water.

Seven Persons Creek is a major tributary of the South Saskatchewan River, intersecting the City of Medicine Hat, providing off-stream storage for irrigation, and discharging to the South Saskatchewan River. SEAWA needed a watershed-scale assessment of the riparian areas condition in the SPCW.

In the following sections, Stantec provides insight into riparian health trends within the Seven Persons Creek Watershed (SPCW) using an object-based image analysis (OBIA) and the Alberta Cows & Fish Riparian Health Assessment (RHA) lotic and lentic field surveys to characterize and assess riparian habitat and ecosystem health.

2.0 PROJECT BACKGROUND

SEAWA has received funding from the Government of Alberta to perform aerial riparian condition assessment, and restoration of degraded riparian areas within the SPWC watershed. This report documents the steps that Stantec has taken to assess and classify the riparian area's condition of streams and lakes/reservoirs within the watershed using remote sensing applications. The aerial assessment component is meant to help SEAWA identify possible problems in the riparian health of the watershed, and to provide a baseline data set for future evaluation. The evaluation and ratings of these sites were done to assist SEAWA in prioritizing areas which would benefit from riparian area restoration and allow future assessment of the condition of these sites.

3.0 OBJECTIVES

The main objectives of the study were to:

1. Identify riparian areas for restoration and conservation.

2. Establish baseline information in a digital format that would be used for future planning and monitoring.

3. Provide context for current land use effects on riparian and aquatic ecosystems associated with the SPCW.

The following tasks were undertaken to meet the Project objectives:

1. Delineation of riparian areas, their associated flood plains, and relevant geomorphic features.

2. Assessment and habitat condition rating of all riparian areas in the watershed using geo-referenced aerial imagery methods.

3. Identification of in-stream or riparian human disturbances (e.g., water control structures, wastewater lagoons, storm water discharge outlets, crossings, trails and irrigation structures and networks) and natural landscape surface form features susceptible to slumping or hill slides.

4. Obtain information relevant to riparian area conditions (e.g., adjacent land uses, water quality, and landscape surface form features.).

   Stantec completed the tasks listed above using OBIA and the RHA field surveys. Stantec also reviewed publicly available data sources and imagery to rank riparian condition, identify human disturbances (irrigation canals, dams, water control devices, etc.), natural disturbances (vegetation presence and homogeneity, slope and asymmetry), delineated riparian areas (floodplains) and assess overall riparian condition. A RHA field survey of selected riparian areas “trained” the OBIA software to assign riparian health.

   A detailed description of the above tasks and objectives are provided throughout the following Sections.

4.0 STUDY AREA

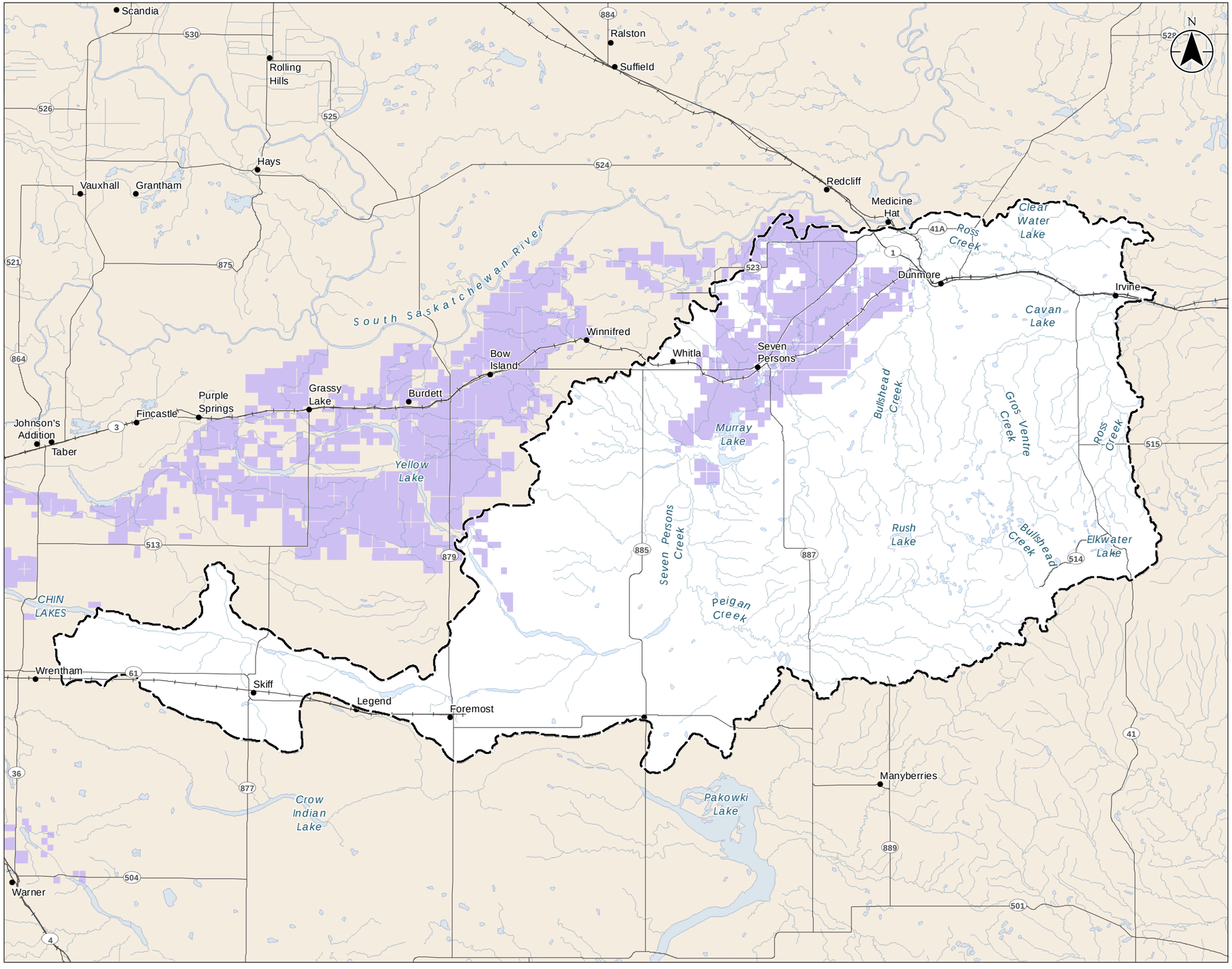
4.1 OVERVIEW

The Seven Persons Creek sub-watershed, is a sub-watershed of the South Saskatchewan River Sub-Basin but in this study, it is referred to as the Seven Persons Creek watershed. It is located primarily southwest of Medicine Hat and includes parts of the City of Medicine Hat, Cypress County and the County of Forty Mile. The watershed also includes a small piece of the County of Warner and a small portion of the M.D. of Taber along the western edge of a narrow band that stretches towards Lethbridge **(Map 1 – Study Area of the Seven Persons Creek Watershed)**

The Seven Persons Creek watershed (SPCW) is 4,785.01 km^2 in size and comprises 3.28% of the South Saskatchewan River Basin (146,100 km^2). The watershed consists of a topography of slightly rolling grassy hills and deep coulees which is similar to other South Saskatchewan River Sub-Basin regional watersheds; land that was glacially scoured and subsequently shaped by huge volumes of meltwater which occasionally cut through the glacial debris to form long and narrow, now typically dry, flat-floored valleys **(Map 2 – Digital Elevation Model, Appendix A)**. In this corner of the province, several of these long glacial spillways—including Forty Mile, Verdigris, Chin and Etzikom Coulees have been dammed to form reservoirs **(Map 3 – Locations of Man Made Drainage Features in the Seven Persons Creek Watershed, Appendix A)**. There are several other water bodies within the watershed including Cavan Lake, which is included in the Cavan Lake Municipal Recreation Area, Elkwater Lake at the base of Cypress Hills, and Bullshead Reservoir west of Elkwater. The development of irrigation throughout Alberta led to the construction of several reservoirs in the area, many of which are linked to the St. Mary River Irrigation District irrigation network. District and private irrigation are used to supply water for agriculture and a number of other uses including: commercial activities like golfing, parks and recreation; industry; oil and gas production; and habitat enhancement projects.

On average, the Medicine Hat weather station receives 330 sunny days (90.4%) and 2,544 sunshine hours annually based on 30 years of data (Environment Canada 2018). The warmest month of the year is July, with an average temperature of 20°C and January as the coldest month, with temperatures averaging -8°C. SPCW receives 323 mm of precipitation per year. Majority of wind speed is between 19-28 km\h coming primarily from the southwest. The SPCW is considered a semi-arid climate (Natural Region Committee 2006). Drying winds, low summer precipitation, high summer temperatures and intense sunshine contribute to significant moisture deficits in mid summer, and many native plants are deep-rooted, short-lived or physiologically adapted (e.g., assume a dormant condition in dry periods). Moisture deficiencies are severely limiting to crop production, and irrigation is often necessary. (Natural Region Committee 2006)

The watershed is located in the Dry Mixed Grass natural sub-region of Alberta and native areas are predominantly drought tolerant mixed grass communities (Natural Region Committee 2006). The highlands of the Cypress Hills, however, are a biodiverse mix of highly productive forests, wetlands and



Stantec

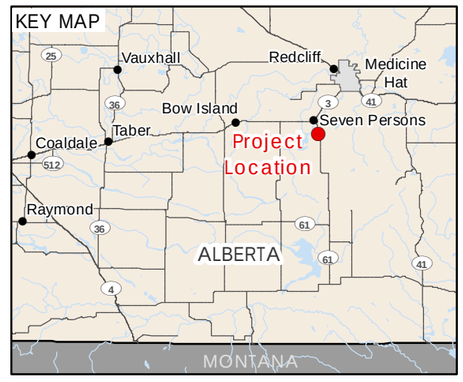
PROJECT DATA

- Seven Persons Creek Watershed
- St.Mary River Irrigation District Parcels

LANDBASE

- Community
- Major Road
- Rail
- Watercourse
- Waterbody

KEY MAP



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Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features obtained from the Government of Canada.

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-26
Review by gkroupa on 2018-04-26

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

1

Title

Project Study Area
Seven Persons Creek Watershed

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grasslands. The combination of plant and animal species living in the subregion is unlike any other in Canada.

4.2 WATER QUALITY

Irrigated agriculture is an intensive and highly valued industry, which accounts for a large portion of agricultural production in Alberta. Water quality is intricately linked to agricultural production. Quality production is reliant upon clean source water. Water quality deterioration can occur in several ways, including land use impacts from agricultural, industrial, urban, and rural development.

A 2006 study by Alberta Agriculture and Rural Development (Little et al. 2010.) assessed the quality of source water used for irrigation from a food production perspective; assessed changes in water quality as water traveled through the irrigation infrastructure, from source water to return flow; determined if there were differences in water quality among the irrigation districts; and determined if there were differences in water quality between two types of conveyance systems. Seven sites within the St. Mary River Irrigation District (SMRID) were sampled to determine differences in water quality between closed pipeline and open channel canals, and seasonal trends in water quality parameters. Seven Persons Creek is connected to one of the main canals of the St. Mary Irrigation network at the hamlet of Seven Persons. Representative samples in the SMRID were grabbed at seven sites every two weeks from May to September in 2006 and 2007. Samples were analyzed for a suite of nutrient, metal, major ion, salinity, pesticide, and bacterial indicators. (Little et al. 2010.).

Figure 4-1 below shows a simplified irrigation distribution system and typical sampling sites.

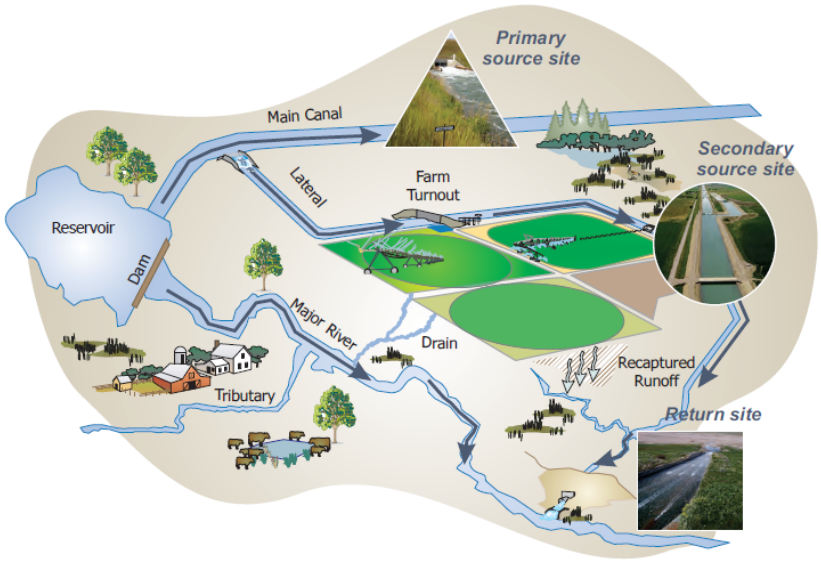

Figure 4-1 Simplified Irrigation Distribution System and Typical Sampling Sites

An Alberta irrigation water quality index was developed to summarize quality as assessed by irrigation guidelines. The index included metal, ion, salinity, pesticide, and bacterial indicators. Data were categorized as either 'excellent', 'good', 'fair', 'marginal', or 'poor' based on the scope, frequency, and magnitude of guideline exceedance (Little et al. 2010). Overall, water quality for irrigation was 'good' or 'excellent' for Seven Persons Creek **(Figure 4-2).**

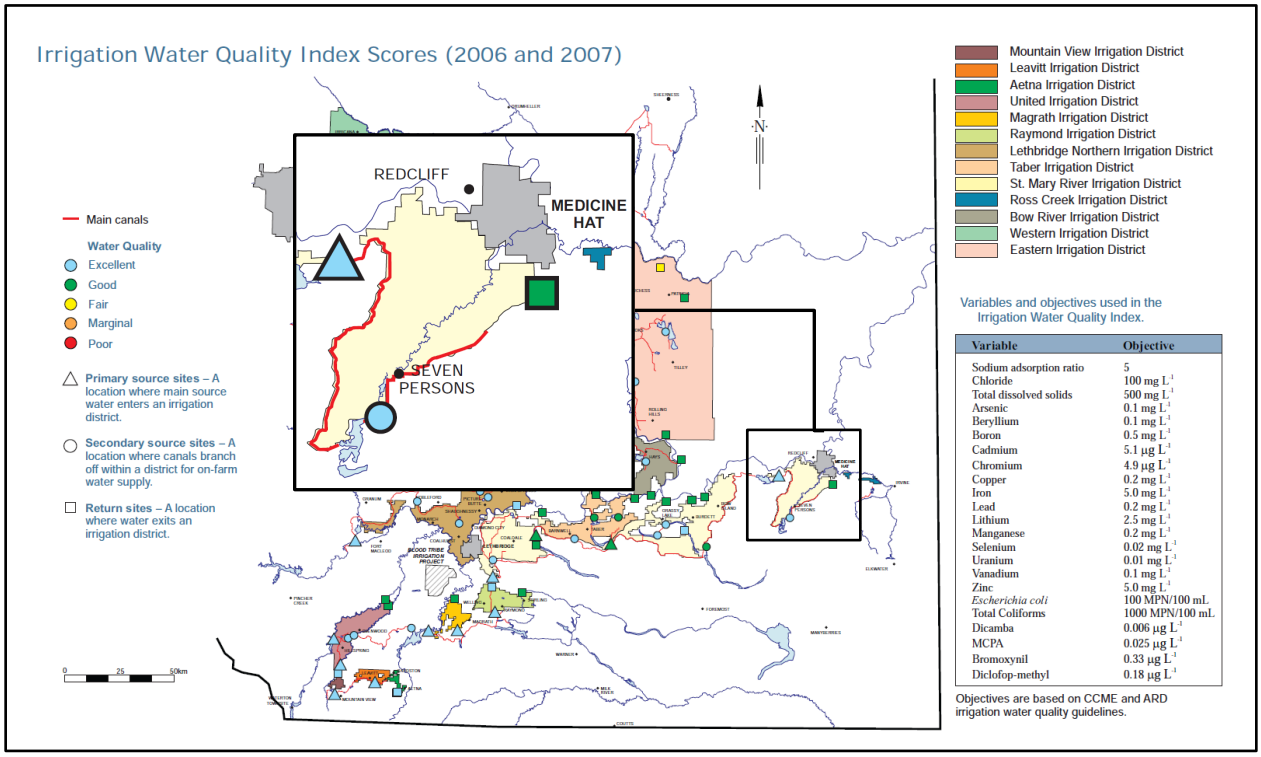

Figure 4-2 Irrigation Water Quality Index Scores (2006 and 2007)

4.3 WATER FLOWS

Reservoirs or water storage sites such as Murray Reservoir on Seven Persons Creek have contributed to the level of water management and economic development that has been attained in southern Alberta. For instance, without coulee storage, the St. Mary Project (irrigation) would not have attained the size it is today, nor would it have its current high level of water-use efficiency. Strategically located reservoirs within irrigated areas are used to capture surplus irrigation deliveries for later release and downstream use. Also, reservoirs located close to demands make it easier for operators to match releases with requirements, which reduces over-deliveries and return flows. The South Saskatchewan River Sub-basin where the Seven Persons Creek watershed is located, receives an average annual precipitation of

278 mm. The hydrology of the sub-basin has been an enigma for hydrologists and water management planners. The median natural local inflow for the sub-basin is estimated to be 3662 dam^3 (AMEC 2009).

4.4 LAND USE AND LAND COVER

The SPCW belongs to the Mixedgrass Natural Subregion and is the most intensively cultivated Subregion in Alberta, with about 85% of the area planted to annual crops. The principal crop is wheat, but significant barley and canola production also occurs. About 5% of the land is under irrigation. Oil and gas exploration and development is common throughout (Natural Regions Committee 2006).

There is only about 1% open water in the Mixedgrass Natural Subregion; it is confined to a few irrigation structures and a few rivers (St. Mary, Oldman, and Bow Rivers). Wetlands cover about 5% of the Mixedgrass Natural Subregion. They are somewhat more common here than in the Dry Mixedgrass Natural Subregion due to slightly increased precipitation; however, they are still mainly ephemeral wetlands and more permanent marshes (Natural Regions Committee 2006).

Locally, landscape pressures mirror those of other regional sub-watersheds and are primarily related to agricultural development and oil and gas development (SEAWA 2018.) Oil and gas activity impacts the landscape through road construction and creek crossings, alteration of native habitat **(Map 4 – Land Use/Land Cover, Appendix A)**, and introduction of invasive species. Livestock activity and recreation have also affected the integrity of streams in the area. However, irrigation districts that supply water to the acres of farm land in the province are responsible for a large portion of Alberta's productivity. Along with its added benefits for crops, irrigation also works to provide agricultural processors with water that would not be available otherwise.

5.0 METHODS

5.1 BACKGROUND

Stantec's aerial assessment methods utilized the Cows & Fish protocols and Riparian Health Assessment (RHA) surveys in developing riparian health scores for the SPCW (Fitch et al. 2009). The assessment methods provide a riparian health score based on the riparian functions of sites. Given the vast landscape of the SPCW watershed, it is nearly impossible to assess the tens of thousands of kilometers of riparian areas with RHA site visits. As a result, Stantec built upon the Alberta Cows & Fish RHA and developed a Riparian Health Model (RHM) that uses high resolution imagery and detailed elevation data to assess individual riparian areas across entire watersheds. This approach was used previously by Agriculture and Agri-Food Canada in Manitoba and Quebec (Wiseman et al. 2009; Clare and Sass 2012) and by the Manitoba Habitat Heritage Group for areas in Manitoba (MHHC 2009). This method has also been used in Australia for mapping riparian biophysical parameters and land cover types in savanna environments using Light Detection and Ranging (LiDAR) and high resolution satellite imagery (Johansen et al. 2008; Arroyo et al. 2010). The advantage of utilizing the modified approach is that many riparian areas can be assessed for riparian health in a timely, cost effective and consistent manner. However, the approach will never be as detailed or specific as having a multidisciplinary team that may include expertise in riparian vegetation, wildlife, hydrology, and geomorphology.

Stantec completed the aerial riparian health assessment by using OBIA technology and data collected during the RHA field survey program. Publicly available data sources, elevation data and imagery were also evaluated by desktop to rank riparian condition, identify human and natural disturbances, and wildlife presence, delineate riparian areas and associated floodplains and assess overall riparian condition. A RHA field survey of selected riparian areas was used to train the OBIA software to assign riparian health to the entire SPCW. The assessment helped improve riparian assessment accuracy and aid in evaluation of future changes in riparian condition. **Figure 5-1** presents a flow chart of the steps involved:

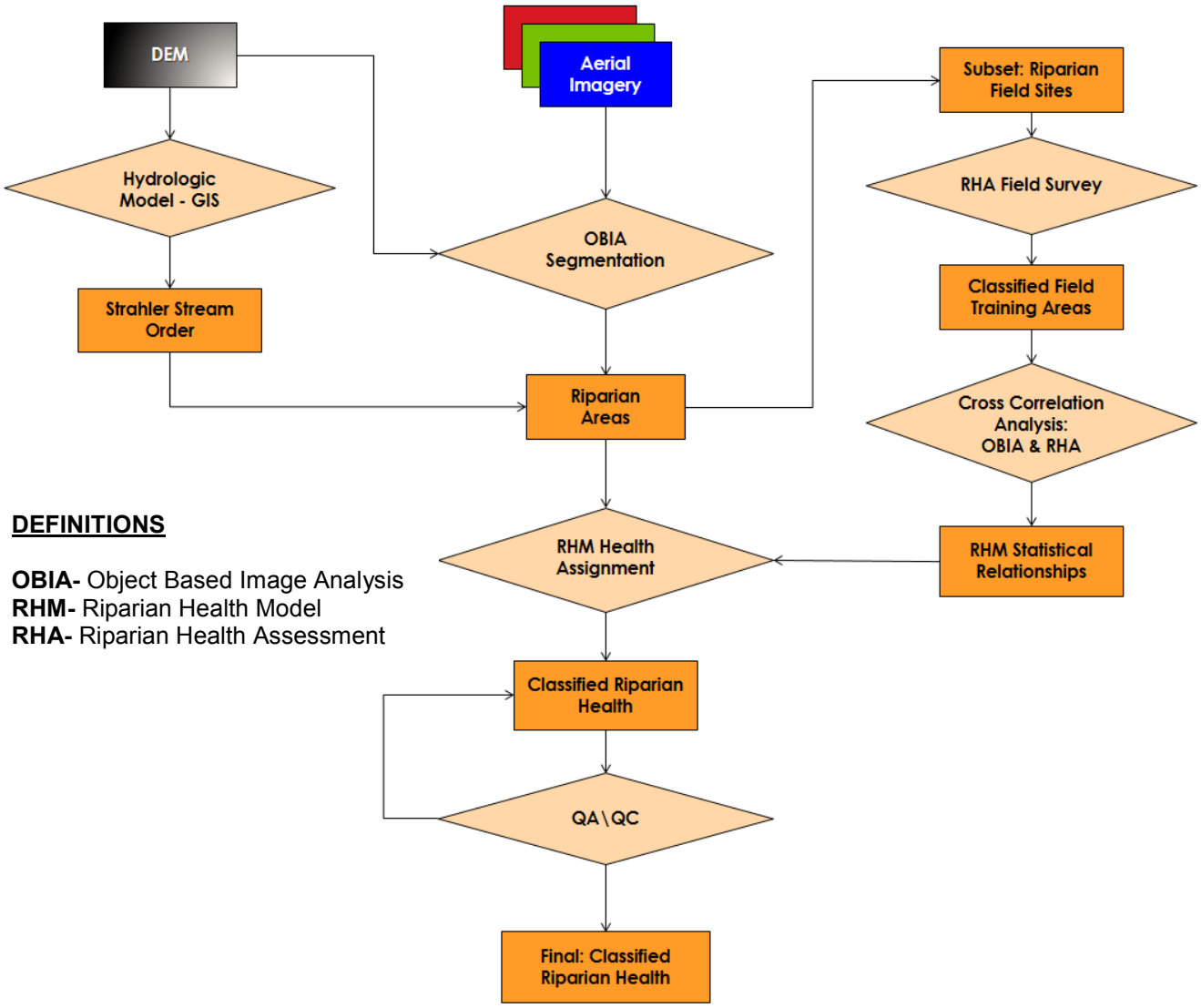

Figure 5-1 Flow Chart Outlining the Steps Involved to Derive Riparian Health Classifications

5.2 GEOSPATIAL DATASET

5.2.1 Aerial Photos

Stantec accessed aerial imagery for the study from the Alberta Municipal Data Sharing Partnership (AMDSP). The Municipal District of Willow Creek 2015 ortho-based imagery covered more than 98% of our Project area. The 25- to 50-cm image resolution is ideal for riparian classification and condition

assessment as it is the most recent with the highest spatial resolution. The 2015 imagery also covers all southern Alberta and allows for other watersheds to be evaluated in a similar fashion.

5.2.2 Digital Elevation Model

A Light Detection and Ranging (LiDAR) derived digital elevation model (DEM) from 2010 was sourced from AltaLIS Geomatics (the Agent for Alberta Data Partnerships Ltd.).The DEM is at a suitable resolution (5 m) for riparian area delineation and stream order development.

The DEM, collected with LiDAR technology offers a very high vertical accuracy, which enhances the quality of relief, hydrological features, sub-catchment boundaries (basins and watersheds) and drainage networks. The AltaLIS DEM product consists of grid points, break lines, and spot heights that have been compiled using 1:60 000 aerial photography.

5.2.3 Desktop Review

Stantec collected, reviewed and utilized information from publicly available data sources, the Province of Alberta and other government data sources, including:

- Lotic Riparian Digital Elevation Model (Derived)
- Lotic Riparian Strahler Order (Derived)
- Grassland Vegetation Index (GVI)
- National Land and Water Information Service (NLWIS) of Agriculture and Agri-Food Canada (AAFC)
- Alberta Environment and Parks Alberta Merged Wetland Inventory
- Alberta Environment and Parks Flood Hazard Mapping
- AltaLIS 1:20,000 Base Feature Topographic Data:
    - Irrigation network – major and minor dams, reservoirs (Murray Lake, Seven Persons Lake, Bullshead reservoir), spill pipelines and discharge points
    - Road, rail, trails and well pads
    - Hydrography network
        - Single Line Network (canals, spillways and aqueducts)

5.3 RIPARIAN HEALTH ANALYSIS

5.3.1 Stream Order

Stantec acquired a 5 m DEM for the entire study area **(Map 2 – Digital Elevation Model, Appendix A)** and ran a hydrologic model in ArcGIS, ArcHydro to generate stream order of the project area. The hydrologic model created a stream order with eight levels of branches. Branch level one is comprised of the smallest tributary streams or smallest stream order increasing in tributary size to branch level eight representing the largest stream order. There was a total of **28,520 km** of tributaries in the SPCW with over half consisting of stream order one. Because stream orders one through five were ephemeral or no longer existed, it was decided with SEAWA that only stream orders six to eight would be evaluated for riparian health assessment **(Map 5 – Strahler Stream Order, Appendix A**) as these classes best captured the riparian areas of concern for SEAWA.

5.3.2 Riparian Area Delineation

SPCW aerial photos and the DEM were segmented into riparian areas using an OBIA. Equal weight was given to each aerial photo channel (RGB) and the DEM layer during segmentation. Spectral reflectance of the geospatial dataset was given a weight of 0.75 and shape was given a factor of 0.25. The shape property was broken down by 0.75 to linear shapes and 0.25 to compact shapes. Essentially, photo colour and the DEM elevation had three times the weight of shape properties. The size property which is relative to image resolution was given a value of 80. Given the SPCW, imagery resolution was 1 m by 1 m. Stantec segmented riparian areas to have an approximate size of 80 m by 80 m or 6,400 m^2. (**Figure 5-2**).

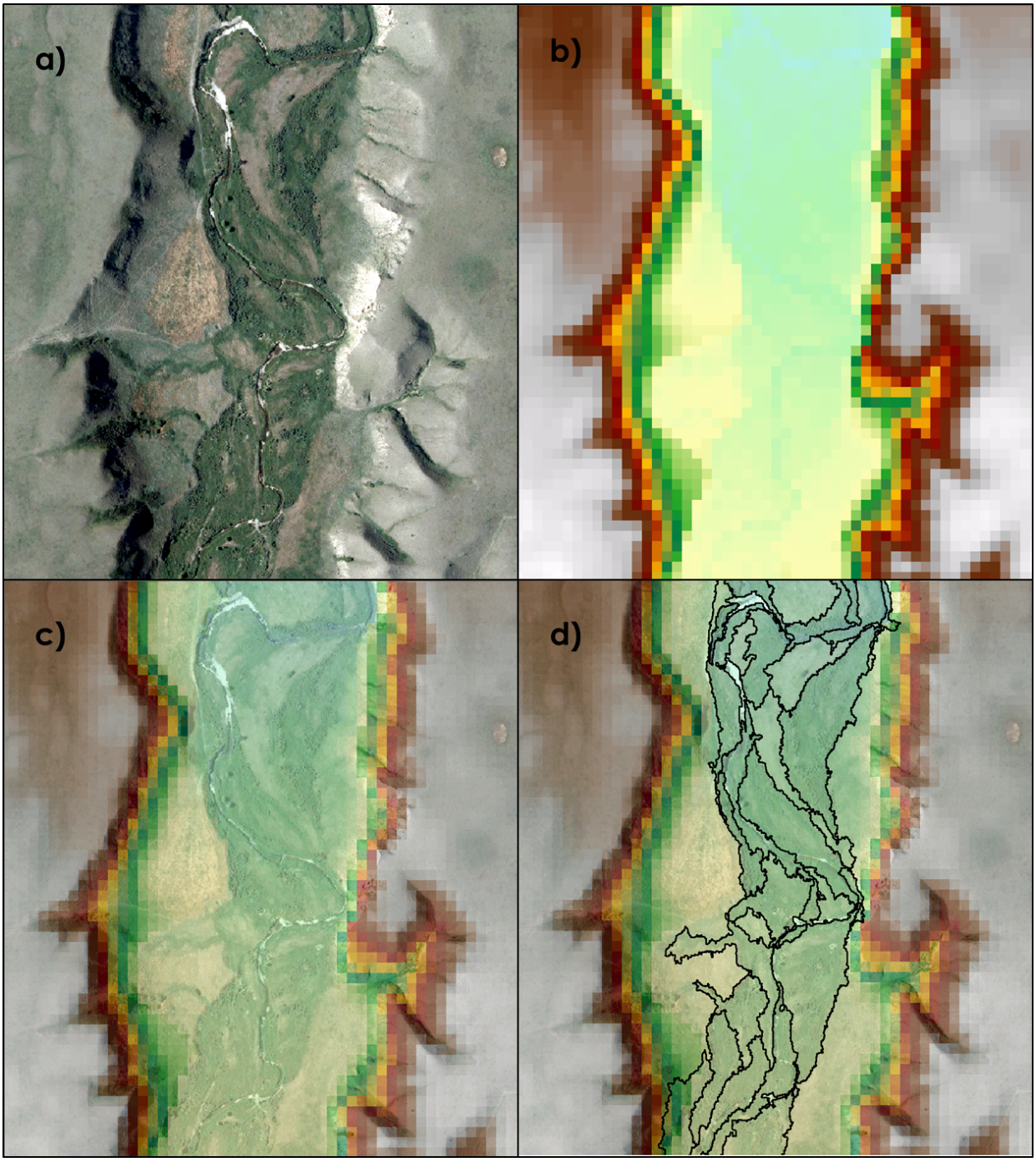

Figure 5-2 Visual Display of Riparian Area Segmentation Process

a) SPCW aerial photo tile 405-011, b) SPCW DEM of tile 405-011, c) Combined view of aerial photo and DEM used in the riparian segmentation, d) Segmented riparian areas (black)

The Strahler stream order level 6-8 streams and the National Hydrological Network (NHN) streams were used to isolate riparian areas from surrounding objects in a GIS overlay process. A variety of geospatial statistics were generated for each riparian zone in SPCW (**Table 5-1**).

Table 5-1 OBIA Statistics Generated for each Riparian Area during the OBIA Segmentation Process

Spectral Reflectance	
Brightness, Blue, Green and Red Mean	Amount of vegetation cover in riparian area
Elevation Mean	Elevation average of the riparian area
Texture	
Blue, Green and Red Standard Deviation	Distribution of vegetation within riparian area homogeneous/ heterogeneous)
DEM Standard Deviation	Mean slope within riparian area
Shape	
Asymmetry	How parallel the area is to waterbody
Compactness	How square or round is the riparian area
Size	
Length	How long is the riparian area
Width	How wide is the riparian area

5.3.3 Riparian Field Assessment

Following segmentation of riparian areas, locations with land access were selected for field RHA. Our riparian assessment method required a representative sample of the riparian variability within SPCW. Twelve general riparian areas were selected with different stream\lake sizes, vegetation cover, degrees of slope, and human impacts). Individual riparian areas were assessed for health using either the Alberta Cows & Fish Alberta Riparian Heath Assessment (RHA) Lotic or Lentic assessment survey (Fitch et al. 2009; Ambrose et al. 2009). At each site, the field crew walked the entire riparian area assessing vegetation conditions, looking for signs of human disturbance and scoring the entire area for overall health. The RHA lotic survey required field personnel to score the riparian zone on 11 detailed criteria for small river and streams. Each question was weighted (3, 6 or 9) and the survey was used as a tool to generate a quantitative riparian condition score (**Table 5-2**). Photographs of each riparian area were also taken looking north, south, east and west, as well as upstream and downstream **(Photos, Appendix B).**

Table 5-2 The 11 Weighted Criteria of the Alberta Lotic Wetland Health Assessment Survey (RHA)

RHA1	**Vegetative Cover of Floodplain and Streambanks**
	6 = > 95% of the reach soil surface is covered by live plant growth
	4 = 85%-95% of the reach soil surface is covered by live plant growth
	2 = 75%-85% of the reach soil surface is covered by live plant growth
	0 = Less than 75% of the reach soil surface is covered by live plant growth
RHA2a	**Total Canopy Cover of Invasive Plant Species (Weeds)**
	3 = No invasive plant species (weeds) on the site
	2 = Invasive plants present with total canopy cover less than 1% of the polygon area
	1 = Invasive plants present with total canopy cover between 1-15% of the polygon area
	0 = Invasive plants present with total canopy cover> 15% of the polygon area
RHA2b	**Density/Distribution Pattern of Invasive Plant Species (Weeds)**
	3 = No invasive plant species (weeds) on the site
	2 = Invasive plants present with density/distribution between 1-5%
	1 = Invasive plants present with density/distribution between 5-25%
	0 = Invasive plants present with density/distribution 25% or higher
RHA3	**Disturbance-Increaser Undesirable Herbaceous Species**
	3 = Less than 5% of the site covered by disturbance-increaser undesirable herbaceous species
	2 = 5-25% of the site covered by disturbance-increaser undesirable herbaceous species
	1 = 25-50% of the site covered by disturbance-increaser undesirable herbaceous species
	0 = > 50% of the site covered by disturbance-increaser undesirable herbaceous species
RHA4	**Preferred Tree and Shrub Establishment and/or Regeneration**
	6 = > 15% of the total canopy cover of preferred trees/shrubs is seedlings and saplings
	4 = 5-15% of the total canopy cover of preferred trees/shrubs is seedlings and saplings
	2 = Less than 5% of the total canopy cover of preferred tree/shrubs is seedlings and saplings
	0 = Preferred tree/shrub seedlings or saplings absent
RHA5a	**Browse Utilization of Preferred Trees and Shrubs**
	3 = None (0-5% of available second year and older leaders of preferred species are browsed)
	2 = Light (5-25% of available second year and older leaders of preferred species are browsed)
	1 = Moderate (25-50% of available second year and older leaders of preferred species are browsed)
	0 = Heavy (> 50% of available second year and older leaders of preferred species are browsed)
RHA5b	**Live Woody Vegetation Removal by Other Than Browsing**
	3 = None (0-5% of live woody vegetation expected on the site is lacking due-cutting)
	2 = Light (5-25% of live woody vegetation expected on the site is lacking due-cutting)
	1 = Moderate (25-50% of live woody vegetation expected on the site
	0 = Heavy (> 50% of live woody vegetation expected on the site

Table 5-2 The 11 Weighted Criteria of the Alberta Lotic Wetland Health Assessment Survey (RHA)

RHA6	**Standing Decadent and Dead Woody Material**
	3 = Less than 5% of the total canopy cover of woody species is decadent
	2 = 5-25% of the total canopy cover of woody species is decadent
	1 = 25-50% of the total canopy cover of woody species is decadent
	0 = > 50% of the total canopy cover of woody species is and/or dead
RHA7	**Streambank Root Mass Protection**
	6 = > 85% of the streambank has a deep, binding root mass
	4 = 65-85% of the streambank has a deep, binding root mass
	2 = 35-65% of the streambank has a deep, binding root mass
	0 = Less than 35% of the streambank has a deep, binding root mass
RHA8	**Human-Caused Bare Ground**
	6 = Less than 1% of the polygon is human-caused bare ground
	4 = 1-5% of the polygon is human-caused bare ground
	2 = 5-15% of the polygon is human-caused bare ground
	0 = > 15% of the polygon is human-caused bare ground
RHA9	**Streambank Structurally Altered by Human Activity**
	6 = Less than 5% of the bank is structurally altered by human activity
	4 = 5-15% of the bank is structurally altered by human activity
	2 = 15-35% of the bank is structurally altered by human activity
	0 = > 35% of the bank is structurally altered by human activity
RHA10	**Human Physical Alteration-the Rest of the Polygon**
	3 = Less than 5% of the polygon is altered by human causes
	2 = 5-15% of the polygon is altered by human causes
	1 = 15-25% of the polygon is altered by human causes
	0 = > 25% of the polygon is altered by human causes
RHA11	**Stream Channel Incisement (Vertical Stability)**
	9 = Not incised
	6 = Slightly incised
	3 = Moderately incised
	0 = Severely incised

Stantec also employed RHA surveys for Lentic systems (Fitch et al. 2001; Ambrose et al. 2004) for Murray Lake and wetlands encountered. The RHA lentic survey required field personnel to score the riparian zone on 9 detailed criteria for lakes. Each question was weighted (3, 6, 9 or 12) and the survey was used as a tool to generate a quantitative riparian condition score (**Table 5-3**). Eighty-eight RHA

riparian areas, 63 lotic and 25 lentic, were assessed in the field (**Map 6 – Field Assessment Sites, Appendix A**).

Table 5-3 The 9 Weighted Criteria of the Alberta Lotic Wetland Health Assessment Survey (RHA)

RHA1	**Vegetative Cover of the Polygon**
	6 = > 95% of the reach soil surface is covered by live plant growth
	4 = 85%-95% of the reach soil surface is covered by live plant growth
	2 = 75%-85% of the reach soil surface is covered by live plant growth
	0 = Less than 75% of the reach soil surface is covered by live plant growth
RHA2a	**Total Canopy Cover of Invasive Plant Species (Weeds)**
	3 = No invasive plant species (weeds) on the site
	2 = Invasive plants present with total canopy cover less than 1% of the polygon area
	1 = Invasive plants present with total canopy cover between 1-15% of the polygon area
	0 = Invasive plants present with total canopy cover> 15% of the polygon area
RHA2b	**Density/Distribution Pattern of Invasive Plant Species (Weeds)**
	3 = No invasive plant species (weeds) on the site
	2 = Invasive plants present with density/distribution between 1-5%
	1 = Invasive plants present with density/distribution between 5-25%
	0 = Invasive plants present with density/distribution 25% or higher
RHA3	**Disturbance-Increaser Undesirable Herbaceous Species**
	3 = Less than 5% of the site covered by disturbance-increaser undesirable herbaceous species
	2 = 5-25% of the site covered by disturbance-increaser undesirable herbaceous species
	1 = 25-50% of the site covered by disturbance-increaser undesirable herbaceous species
	0 = > 50% of the site covered by disturbance-increaser undesirable herbaceous species
RHA4	**Preferred Tree and Shrub Establishment and/or Regeneration**
	6 = > 15% of the total canopy cover of preferred trees/shrubs is seedlings and saplings
	4 = 5-15% of the total canopy cover of preferred trees/shrubs is seedlings and saplings
	2 = Less than 5% of the total canopy cover of preferred tree/shrubs is seedlings and saplings
	0 = Preferred tree/shrub seedlings or saplings absent
RHA5a	**Browse Utilization of Preferred Trees and Shrubs**
	3 = None (0-5% of available 2nd year and older leaders of preferred species are browsed)
	2 = Light (5-25% of available 2nd year and older leaders of preferred species are browsed)
	1 = Moderate (25-50% of available 2nd year and older leaders of preferred species are browsed)
	0 = Heavy (> 50% of available 2nd year and older leaders of preferred species are browsed)
RHA5b	**Live Woody Vegetation Removal by Other Than Browsing**
	3 = None (0-5% of live woody vegetation expected on the site is lacking due-cutting)
	2 = Light (5-25% of live woody vegetation expected on the site is lacking due-cutting)

Table 5-3 The 9 Weighted Criteria of the Alberta Lotic Wetland Health Assessment Survey (RHA)

	1 = Moderate (25-50% of live woody vegetation expected on the site
	0 = Heavy (> 50% of live woody vegetation expected on the site
RHA 6	**Human Alteration of Polygon Vegetation Community Composition**
	6 = Less than 5% of polygon vegetation community composition is altered by human activity
	4 = 5%-15% of polygon vegetation community composition is altered by human activity
	2 = 15%-35% of polygon vegetation community composition is altered by human activity
	0 = 35% or more of polygon vegetation community composition is altered by human activity
RHA7a	**Percent of Polygon Physical Site Altered by Human Activity**
	12 = Less than 5% of the polygon is physically altered by human activity
	8 = 5%-15% of the polygon is physically altered by human activity
	4 = 15%-35% of the polygon is physically altered by human activity
	0 = More than 35% of the polygon is physically altered by human activity
RHA7b	**Severity of Human-Caused Alteration of Polygon Physical Site (Regardless of Percent Area)**
	3 = No physical alterations-the site by human activity
	2 = Human alterations-the physical site are slight in effect
	1 = Human alterations-the physical site are moderate in effect
	0 = Human alterations-the physical site are severe in effect
RHA8	**Human-Caused Bare Ground**
	6 = Less than 1% of the polygon is human-caused bare ground
	4 = 1%-5% of the polygon is human-caused bare ground
	2 = 5%-15% of the polygon is human-caused bare ground
	0 = 15% or more of the polygon is human-caused bare ground
RHA9	**Degree of Artificial Withdrawal or Raising of Water Level**
	9 = The water body, or wetland, is not subjected to artificial water level change
	6 = The degree of artificial water level change is minor
	3 = The degree of artificial water level change is moderate
	0 = The degree of artificial water level change is extreme

5.3.4 Riparian Health Model (RHM) Calibration

Field data survey questions collected within OBIA segmented riparian zones were used to develop a Riparian Health Model (RHM) to predict the health score of all remaining riparian areas within SPCW. A cross correlation analysis was administered comparing the RHA survey questions (lotic 11, lentic 9) with the OBIA statistics to determine which OBIA statistics were most correlated to riparian health. OBIA statistics with the highest correlation values to field lotic and lentic RHA scores possessed the greatest

probability of predicting riparian health and were used to calibrate the RHM. Photographs taken at the field sites were used to facilitate our understanding of riparian conditions to assist in the calibration process. Representative riparian areas are found in **Appendix B, Photos.**

The Alberta Cows & Fish health classification defines riparian areas with RHA scores of 100-80% as healthy, 80-60% as healthy with problems and 60-0% as unhealthy. Stantec health categories follow similar properties and guidelines of the Alberta Cows & Fish health class system. However, given the SPCW is located in a semi-arid coulee-system landscape and has a lack of naturally occurring trees and shrubs, Stantec has reduced the minimum requirement for the healthy and healthy with problems categories by 5% each (**Table 5-4**). This is the only deviation from the Alberta Cows & Fish system and was done to accommodate the semi-arid coulee-system landscape.

Table 5-4 Riparian Health Assessment Scores and Classification

Percentage RHM Score*	Riparian Health Classification
100-75%	Healthy
75-55%	Healthy with Problems
55-0%	Unhealthy
*Riparian percentage scores have decimal level precision therefore no overlap between health classes is possible.	

5.4 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Each RHM classification was QA/QC reviewed to identify any riparian areas that did not appear to have the correct riparian health designation. The QA/QC process was as follows:

1. The entire OBIA derived RHA database assessment ratings were compared to the ortho-base at scales between 1:2000 to 1:10,000.
2. Land use and land cover information was used to facilitate in understanding landscape dynamics (**Map 4 – Land Use/Land Cover, Appendix A**).
3. Change to the RHM upper and lower statistical limits for each health class were adjusted to accommodate systematic changes where required.
4. Riparian area outliners were hand edited into the most appropriate health class as determined by surrounding riparian health designations.

6.0 RESULTS

6.1 STREAM ORDER RESULTS

The Strahler stream order was generated using the SPCW 5-m resolution DEM in ArcGIS and ArcHydro, resulting in eight order classes and totaling over 28,500 km of waterways. Class one represented the smallest initial tributaries and class eight represented the largest final streams within SPCW (**Table 6-1**).

Table 6-1 Results of the Strahler Stream Order Generated using the SPCW 5-m Resolution DEM in ArcGIS, ArcHydro

Strahler Order	km
8	124.4
7	215.0
6	362.5
5	703.7
4	1,402.8
3	2,798.5
2	5,741.5
1	11,667.9
Total	**23,016.1**

Strahler classes 6-8 totaled over 700 km (**Table 6-2**) (**Map 5 – Strahler Stream Order, Appendix A**).

Table 6-2 Results of the Strahler Stream Order for Classes 6-8 in Linear km with Average Elevation

Strahler order	Linear km	Mean Elevation (m)
8	124.4	744.9
7	215.0	793.2
6	362.5	892.6
Total	**701.8**	**836.9**

6.2 RIPARIAN AREA SEGMENTATION

The segmentation of the SPCW aerial photos and DEM resulted in 13,030 lotic riparian areas which totaled 7,114.1 ha. The average size of a lotic riparian area was 0.55 ha.

6.3 FIELD ASSESSMENT RESULTS

Eighty-eight riparian areas (63 lotic and 25 lentic) were field assessed (**Map 6 – Field Assessment Sites in Seven Persons Creek Watershed**). Of the 63 lotic riparian areas surveyed, 34 sites scored between 100% and 80% and were classified as healthy riparian areas. Nineteen sites scored between 75% and 55% and were classified as healthy with problems and 10 sites were classed as unhealthy (scoring between 54% and 0%) (**Table 6-3**). Of the 25 lentic riparian areas surveyed, seven sites scored between 100% and 80% and were classified as healthy. Eleven sites scored in the healthy with problems range (75% to 55%) and seven scored in the unhealthy range (55% to 0%).

Table 6-3 Lotic and Lentic RHA Field Data Scores used in Model Calibration

Riparian Area	Healthy	Healthy with Problems	Unhealthy	Total
Lotic	34	19	10	63
Lentic	7	11	7	25

6.4 RIPARIAN HEALTH MODEL CALIBRATION RESULTS

The Lotic cross correlation analysis was performed using all OBIA statistics and all RHA survey question values for the 63 lotic OBIA segmented riparian areas. Brightness mean had the highest correlation to RHA cumulative health scores followed by blue mean for spectral reflectance statistics. Red standard deviation had the highest correlation for texture statistics and DEM standard deviation had the highest correlation for elevation statistics. Width and length size values did not have a significant influence of riparian health while asymmetry had the highest correlation for shape values (**Table 6-4**).

Table 6-4 Lotic Cross Correlation Analysis Results with RHA Health Scores

OBIA Riparian Property	Lotic OBIA Statistic	RHA Health Score
Spectral Reflectance	Brightness Mean	-0.5134
Spectral Reflectance	Blue Mean	-0.3875
Spectral Reflectance	Green Mean	-0.3670
Spectral Reflectance	Red Mean	-0.2193
Spectral Reflectance	DEM Mean	-0.1983
Texture	Blue Standard Deviation	-0.0600
Texture	Green Standard Deviation	-0.0434
Texture	Red Standard Deviation	0.1260
Texture	DEM Standard Deviation	-0.2737
Size	Width	0.0542
Size	Length	0.0279

Table 6-4 Lotic Cross Correlation Analysis Results with RHA Health Scores

OBIA Riparian Property	Lotic OBIA Statistic	RHA Health Score
Shape	Asymmetry	0.2082
Shape	Compactness	0.0874

Figure 6-1 represents each lotic OBIA statistic separated by field RHA survey riparian health category normalized by overall OBIA statistic mean. The lotic brightness mean, blue mean, red standard deviation, DEM standard deviation and asymmetry OBIA statistics show a linear trend with RHA health scores. These linear trends explain the higher OBIA and RHA score correlations values for these OBIA stats as seen in **Table 6-4** above. The combination of higher correlation values and linear trend patterns demonstrate the five selected OBIA statistics have the most available lotic predictive riparian health modelling capability. As a result, these five OBIA statistics were used in the Riparian Health Model (RHM) to predict riparian health score for all remaining SPCW lotic riparian areas.

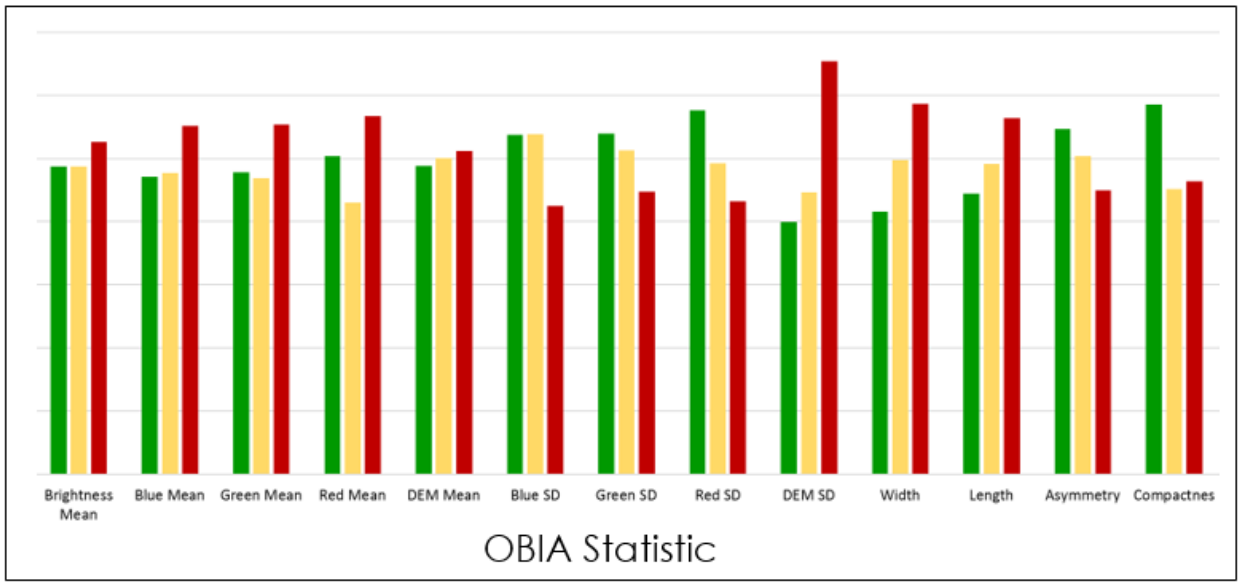

Figure 6-1 Normalized Lotic Riparian Area Field Data OBIA Statistics Broken Down by Health Designation: Healthy (green), Healthy with Problems (yellow), Unhealthy (red). Class averages of Normalized Correlation Values to Lotic field data RHA scores

The Lentic cross correlation analysis was performed using all OBIA statistics and all RHA survey question values for the 25 lentic OBIA segmented riparian areas. Brightness mean had the highest correlation to RHA cumulative health scores for spectral reflectance statistics. Blue and green standard deviation had the highest correlation for texture statistics and DEM mean had the highest correlation for elevation

statistics. Width and length size values did not have a significant influence of riparian health while asymmetry had the highest correlation for shape values (**Table 6-5**).

Table 6-5 Lentic Cross Correlation Analysis Results with RHA Health Scores

OBIA Riparian Property	Lentic OBIA Statistic	RHA Health Score
Spectral Reflectance	Brightness Mean	0.1998
Spectral Reflectance	Blue Mean	0.3009
Spectral Reflectance	Green Mean	0.2231
Spectral Reflectance	Red Mean	0.0717
Spectral Reflectance	DEM Mean	0.1117
Texture	Blue Standard Deviation	0.0319
Texture	Green Standard Deviation	0.1192
Texture	Red Standard Deviation	0.1268
Texture	DEM Standard Deviation	0.2553
Size	Width	-0.1870
Size	Length	0.1350
Shape	Asymmetry	0.3467
Shape	Compactness	0.2588

Figure 6-2 represents each lentic OBIA statistic separated by field RHA survey riparian health category normalized by overall OBIA statistic mean (for a visual display of the cross-correlation analysis results). The lentic blue mean, green mean, DEM standard deviation, asymmetry, and compactness OBIA statistics separated by health class which show a linear trend with RHA scores. These linear trends explain the higher OBIA and RHA score correlations values for these OBIA stats as seen in Table 6-6. The combination of higher correlation values and linear trend patterns show the five selected OBIA statistics have the most available lentic predictive riparian health modelling capability. For this reason, these OBIA statistics were used in the Riparian Health Model (RHM) to predict riparian health score for all remaining SPCW lentic riparian areas.

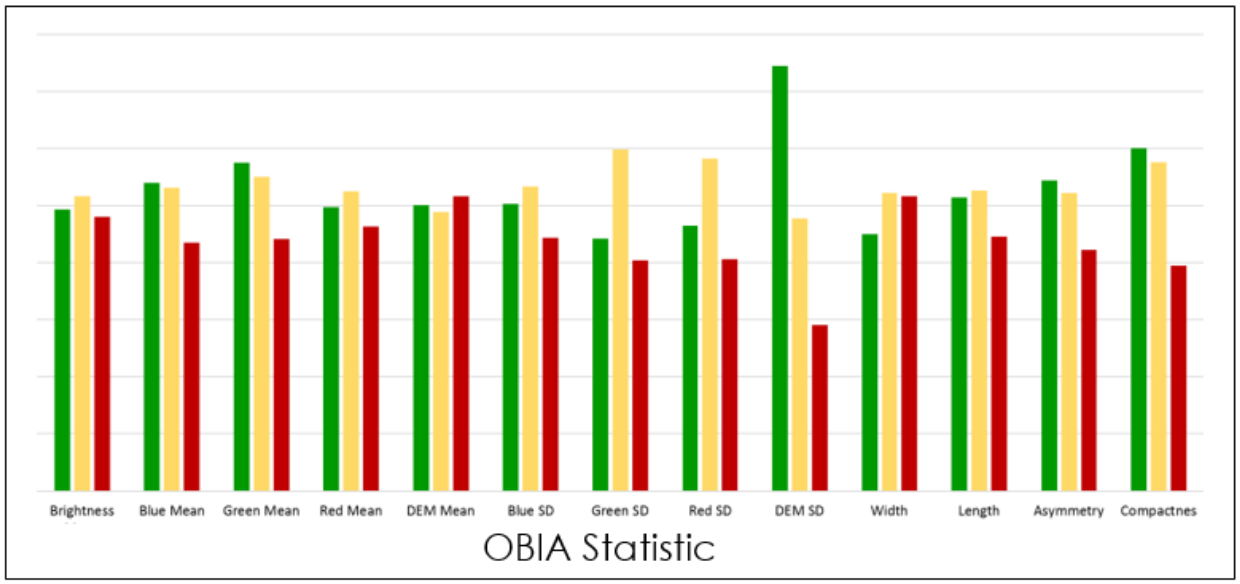

Figure 6-2 Normalized Lentic Riparian Area Field Data OBIA Statistics Broken Down by Health Designation: (Healthy (green), Healthy with Problems (yellow), Unhealthy (red). Class averages of Normalized Correlation Values to Lentic field data RHA scores

By constraining each of these OBIA statistics by RHA health classification (Healthy, Healthy with Problems and Unhealthy), Stantec generated upper and lower statistical limits for each OBIA stat by health class in the RHM based on field RMA survey results (**Tables 6-6 and 6-7**).

Table 6-6 Upper and Lower Lotic Riparian OBIA Statistical Limits for each Riparian Health Designation

Lotic Riparian OBIA Statistics	Upper and Lower OBIA Statistical Limits		
	Healthy	Healthy with Problems	Unhealthy
Brightness Mean	216.6 to 239.6	239.6 to 250.1	250.1 to 270
Blue Mean	46.1 to 72.2	72.2 to 81.4	81.4 to 110
Red STD	25 to 10.5	10.5 to 9.4	9.4 to 3.0
DEM STD	0.4 to 1.05	1.05 to 1.96	1.96 to 4.00
Asymmetry	0.98 to 0.84	0.84 to 0.77	0.77 to 0.20

Table 6-7 Upper and Lower Lentic Riparian OBIA Statistical Limits for each Riparian Health Designation

Lentic Riparian OBIA Statistics	Upper and Lower OBIA Statistical Limits		
	Health	Healthy with Problems	Unhealthy
Blue Mean	150.0 to 89.0	89.0 to 75.0	75.0 to 50.0
Green Mean	140.0 to 92.0	92.0 to 85.0	85.0 to 50.0
DEM STD	4.0 to 0.8	0.8 to 0.6	0.6 to 0.1
Asymmetry	0.98 to 0.84	0.84 to 0.77	0.77 to 0.20
Compactness	8.0 to 3.6	3.6 to 2.8	2.8 to 1.0

Based on each lotic OBIA statistical value, each riparian area was given a score for brightness mean, blue mean, red standard deviation, DEM standard deviation and asymmetry. All OBIA health scores range from Healthy (3), Healthy with Problems (2), Unhealthy (1) and values outside overall upper and lower limits (0). During the lotic cross correlation analysis, the brightness mean statistic exuded the highest correlation with riparian health than any other OBIA property and was given an increased amount of influence (6). Individual riparian area OBIA scores were summed and divided by 18 (lotic highest possible score) and converted to percentages (**Table 6-8**). Lotic riparian scores were assigned to riparian areas in a GIS attribute table.

Table 6-8 Riparian Values Assigned to each Lotic Riparian Area based on the RHM Statistical Categories for each OBIA Statistic

Lotic riparian areas were given an overall health classification based on combined score out of 18

Lotic Riparian OBIA Statistics	Lotic Riparian Score			
	Healthy	Healthy with Problems	Unhealthy	Other
Brightness Mean	6	4	2	0
Blue Mean	3	2	1	0
Red STD	3	2	1	0
DEM STD	3	2	1	0
Asymmetry	3	2	1	0

Based on each lentic OBIA statistical value, each riparian area was given a score for blue mean, green mean, DEM standard deviation, asymmetry and compactness. Individual riparian area OBIA scores were summed and divided by 15 (lentic highest possible score) and converted to percentages (**Table 6-9**). Lentic riparian scores were assigned to riparian areas in a GIS attribute table.

Table 6-9 Riparian Values Assigned to each Lentic Riparian Area based on the RHM Statistical Categories for each OBIA Statistic

Lentic riparian areas were given an overall health classification based on combined score out of 15

Lentic Riparian OBIA Statistics	Lentic Riparian Score			
	Healthy	Healthy with Problems	Unhealthy	Other
Blue Mean	3	2	1	0
Green Mean	3	2	1	0
DEM STD	3	2	1	0
Asymmetry	3	2	1	0
Compactness	3	2	1	0

6.5 RIPARIAN CLASSIFICATION RESULTS

The results of the Lotic RHM identified 1,550 Healthy riparian areas, 4,263 Healthy with Problem riparian areas and 6,755 Unhealthy riparian areas within SPCW (**Tables 6-10 and 6-11, Figure 6-3 to 6-7**). The results of the Lentic RHM identified 653 Healthy riparian areas, 1,217 Healthy with Problem riparian areas and 1,035 Unhealthy riparian areas within SPCW (**Tables 6-10 and 6-11, Figure 6-3 to 6-7**). **Map Series 7, Maps 7-1 to 7-36 in Appendix A** display the results of the lotic RHM classification of SPCW boundary into the following categories: Green - Healthy, Orange-Healthy with Problems and Red-Unhealthy.

Table 6-10 RHM Classification of Lotic and Lentic Systems in the SPCW

RHM Classification	Lotic Riparian Sites		Lentic Riparian Sites	
	Count*	Percentage	Count*	Percentage
Healthy	1550	12.33%	653	22.48%
Healthy with Problems	4263	33.92%	1217	41.89%
Unhealthy	6755	53.75%	1035	35.62%
Total	**12568**	**100.00%**	**2905**	**100.00%**
* Count refers to the total number of sites of each classification category				

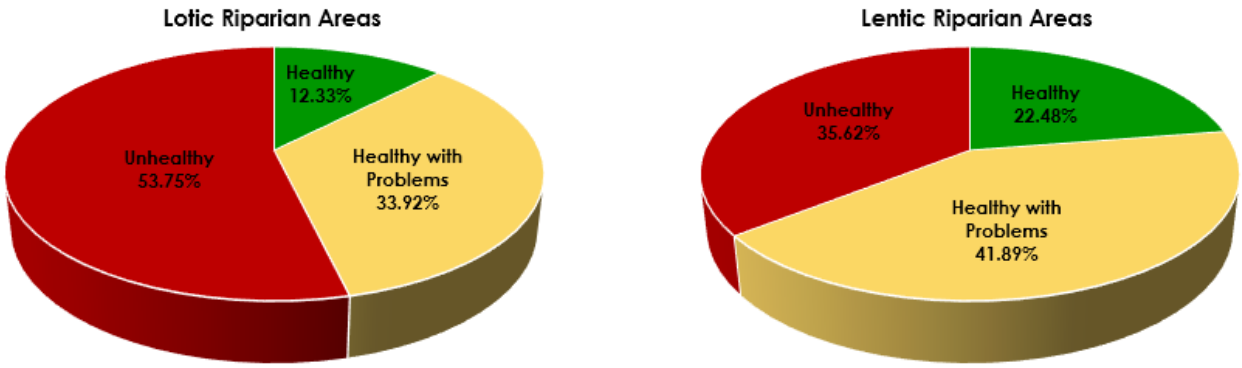

Figure 6-3 RHM Classification of both Lotic and Lentic Systems Results in the SPCW

A further summary of riparian health classifications for SPCW all riparian areas can be found in **Appendix C – RHM Classification Results**. SPCW individual waterbody results can be found in the following **Tables 6-11 to 6-18** and **Figures 6-4 to 6-11**.

Table 6-11 Results of the Lotic RHM Classification for each Health Class for Seven Person Creek

RHM Classification	Lotic Riparian Sites	
	Count	Percentage
Healthy	529	44.08%
Healthy with Problems	494	41.16%
Unhealthy	177	14.75%
Total	**1200**	**100.00%**

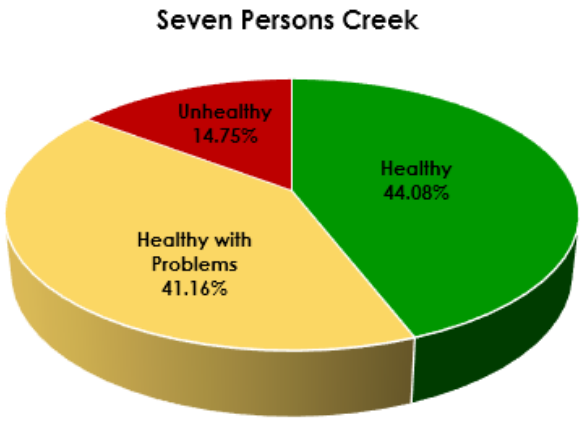

Figure 6-4 RHM Classification for each Health Class in Seven Persons Creek

Table 6-12 Results of the Lentic RHM Classification for each Health Class for Murray Lake

RHM Classification	Lentic Riparian Sites	
	Count	Percentage
Healthy	72	10.47%
Healthy with Problems	214	31.10%
Unhealthy	402	58.43%
Total	**688**	**100.00%**

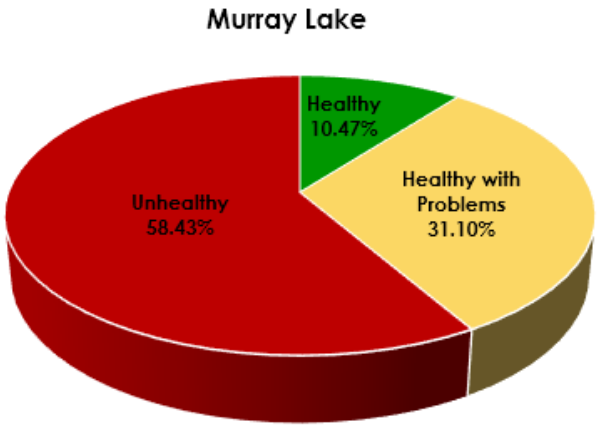

Figure 6-5 RHM Classification for each Health Class in Murray Lake

Table 6-13 Results of the Lotic RHM Classification for each Health Class for Bullshead Creek

RHM Classification	Lotic Riparian Sites	
	Count	Percentage
Healthy	202	10.41%
Healthy with Problems	571	29.43%
Unhealthy	1,167	60.15%
Total	**1,940**	**100.00%**

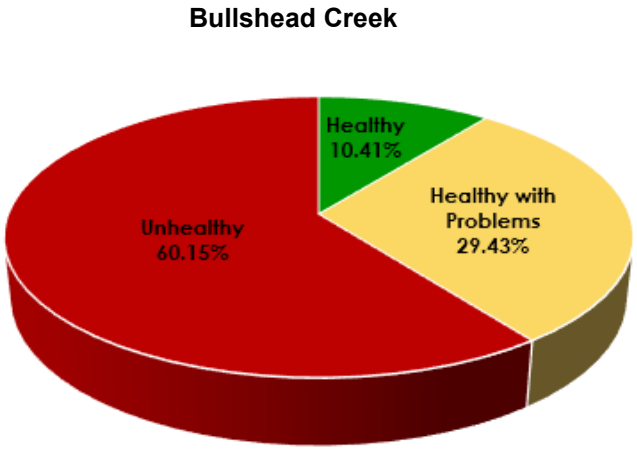

Figure 6-6 RHM Classification for each Health Class in Bullshead Creek

Table 6-14 Results of the Lotic RHM Classification for each Health Class for Ross Creek

RHM Classification	Lotic Riparian Sites	
	Count	Percentage
Healthy	165	15.29%
Healthy with Problems	358	33.18%
Unhealthy	556	51.53%
Total	**1,079**	**100.00%**

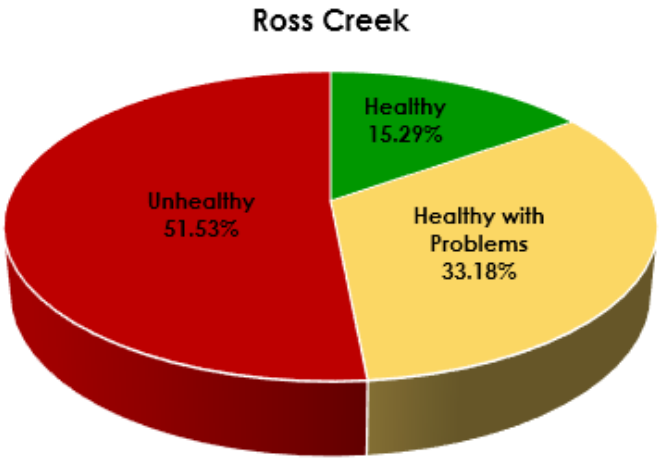

Figure 6-7 RHM Classification for each Health Class in Ross Creek

Table 6-15 Results of the Lentic RHM Classification for each Health Class for Elkwater Lake

RHM Classification	Lentic Riparian Sites	
	Count	Percentage
Healthy	48	29.27%
Healthy with Problems	70	42.68%
Unhealthy	46	28.05%
Total	**164**	**100.00%**

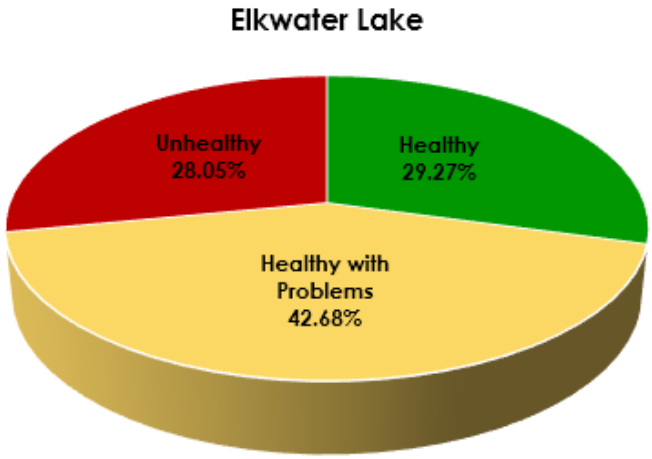

Figure 6-8 RHM Classification for each Health Class in Elkwater Lake

Table 6-16 Results of the Lentic RHM Classification for each Health Class for Cavan Lake

RHM Classification	Lentic Riparian Sites	
	Count	Percentage
Healthy	55	36.19%
Healthy with Problems	70	46.05%
Unhealthy	27	17.76%
Total	**152**	**100.00%**

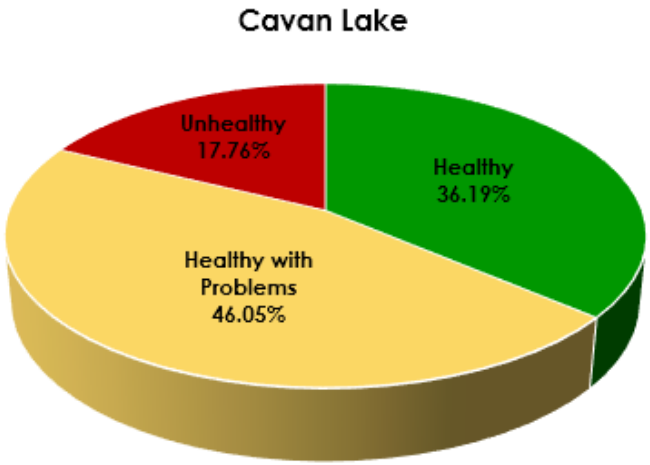

Figure 6-9 RHM Classification for each Health Class in Cavan Lake

Table 6-17 Results of the Lotic RHM Classification for each Health Class for Peigan Creek

RHM Classification	Lotic Riparian Sites	
	Count	Percentage
Healthy	12	2.82%
Healthy with Problems	232	54.59%
Unhealthy	181	42.59%
Total	**425**	**100.00%**

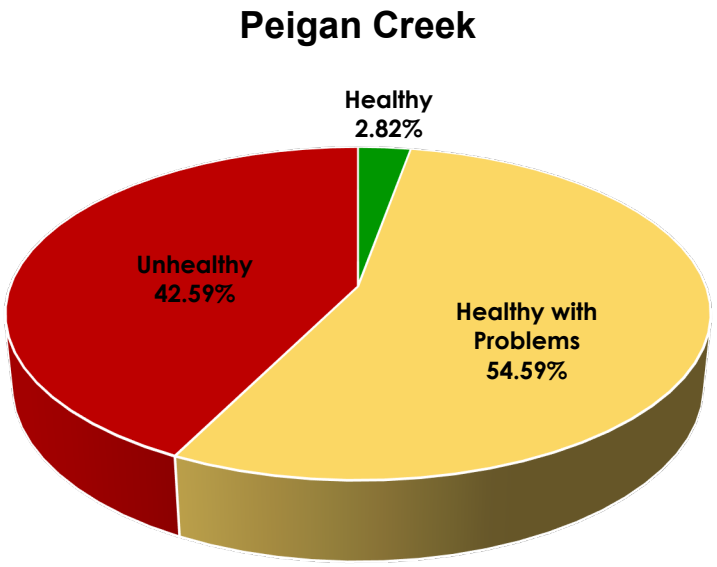

Figure 6-10 RHM Classification for each Health Class in Peigan Creek

Table 6-18 Results of the Lotic RHM Classification for each Health Class for Gros Ventre Creek

RHM Classification	Lotic Riparian Sites	
	Count	Percentage
Healthy	50	3.88%
Healthy with Problems	448	34.78%
Unhealthy	790	61.34%
Total	**1288**	**100.00%**

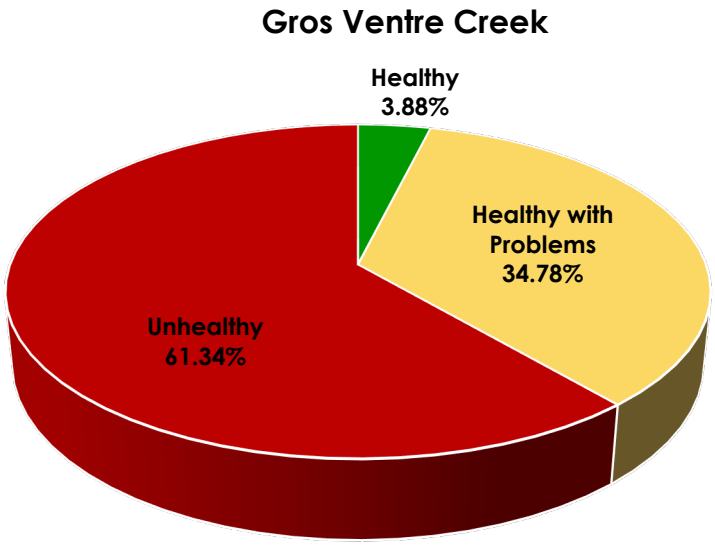

Figure 6-11 RHM Classification for each Health Class in Gros Ventre Creek

7.0 DISCUSSION

Stantec's aerial assessment was meant to help SEAWA identify possible problem areas in the riparian health of the watershed and provide a baseline data set for future evaluation. The assessment was also meant to help prioritize areas which may benefit from restoration in the future.

Further elaboration on the lotic and lentic areas is found in the following sub sections.

7.1 LOTIC RIPARIAN AREAS

Healthy

Lotic riparian areas, with vegetative cover in the form of trees or shrubs, had a higher probability of good riparian health. Woody vegetation cover corresponds with Lotic RHA questions 1, 4, 5, 6, and 7 (**Table 5-2**) (Fitch et al. 2009). Tree and shrub roots provide soil binding mass protection, allowing soils to filter out nitrogen and phosphorus chemicals that are typical in heavy agricultural systems. Roots also prevent incisement of the streambank shoreline, reducing erosion and preventing sediments from entering the water course. This information was captured in the brightness mean, blue mean and red standard deviation scores of the RHM. Healthy riparian areas also typically had high asymmetry, meaning they paralleled the natural meandering of rivers and streams and were long and linear. High asymmetry corresponds with Lotic RHA questions 9 and 10 (**Table 5-2**). Healthy lotic sites comprised 15.42% (**Table C-1, Appendix C**) of linear Kms in SPCW as opposed to 12.33% **(Table 6-10)** of total lotic site count. This is due to healthy lotic sites having long and linear riparian properties. These areas were also relatively flat (low slope) given their low elevation standard deviation. These healthy low slope areas would allow flood waters to rise and fall on an annual basis allowing floodplain vegetation to perform its nutrient removal function. Within the SPCW, these healthy lotic riparian characteristics seem to support one another in a cyclical ecologic relationship. Low slope corresponds with Lotic RHA question 11 which has the highest weight (9) of all RHA lotic questions (**Table 5-2**).

Healthy with Problems (HWP)

Healthy with problem (HWP) lotic riparian areas shared many of the same properties as the Healthy class riparian areas but to a lesser degree. There was not as much wooded vegetation present, represented by lower red standard deviation values. The shape of the riparian areas was less linear and rounder and/or had high higher elevation heterogeneity. There was visual evidence of anthropogenic activity with many HWP riparian zones in the form of trails, equipment and trampling of vegetation which increased the brightness and blue mean values. Within the SPCW, these HWP lotic riparian sites seem to be under represented in a key component of the healthy area characteristics (vegetation cover, gentle degree of slope, or natural meandering shape) misaligning the functionality of the riparian area. The general trend would suggest there is a lack of woody vegetation throughout the SPCW that is preventing many of the Healthy with Problems sites from becoming healthy riparian areas. Even though the SPCW lacks woody vegetation and health designation categories have been adjusted to compensate for landscape

deficiencies, there is a still a need for the positive riparian functions woody biomass performs for these areas to be considered healthy riparian sites.

Unhealthy

Unhealthy lotic riparian areas either lacked significant woody vegetation, had poor shape correlation to rivers and streams or had a high degree elevation change possibly related to streambank incisement issues or human alteration. Unhealthy areas had high brightness and blue mean values indicative of trampled grass, bare soil, or anthropogenic influenced ground surfaces. This severely inhibits the soil from its nutrient filtering function resulting in a lack of any noteworthy woody vegetation. When asymmetry values were linear they were extremely straight and overly long as result of human activity (irrigation channel) and were given an Unhealthy designation. Unhealthy sites also had higher slope values resulting in difficulties for annual spring melt water to naturally expand onto the flood plain. Instead, water is forced to stay within the defined water course causing an increased rate of erosion resulting in incisement issues and greater water turbidity. Minor differences in local slope and aspect can produce significant changes to plant communities, as can changes in parent material texture and chemistry. Soils at lower slope positions receive more runoff water, with corresponding differences in both plant community and soil development from the top to the bottom of a slope. Sand dunes are rapidly drained and very dry; saline parent materials make water uptake more difficult and halophytic (salt-tolerant) plants are dominant. In addition, grazing can have a marked and long-lasting influence on plant community composition, and short-growing species that are not as subject to grazing pressure as the mid-grasses may assume dominance (Natural Regions Committee 2006).

There were also a number of riparian areas that were in annual cropland, forage, or rangeland fields and were given an Unhealthy designation. The general trend would suggest there is a high occurrence of human activity throughout the SPCW that is preventing many of the Unhealthy areas from becoming healthier riparian areas.

Figure C-3, Appendix C represents the lotic riparian area percentages that had maximum scores per OBIA statistic per health class. The brightness and blue mean statistics represents the amount of woody vegetation present within a riparian area. These two OBIA statistics demonstrate there is a high degree of vegetation for the healthy class; 65% for brightness mean and 83% for blue mean. These maximum score percentages drop in the “Healthy with Problems” riparian category by 50% for the brightness mean over 20% for blue mean **(Figure C-3, Appendix C)**. This indicates there is significantly less woody vegetation in these riparian areas. The brightness mean is also the steepest drop for any OBIA statistic. In the unhealthy class brightness mean only had 0.7% maximum score results indicating there is a serious lack of vegetative biomass in these riparian areas. The change in percentage values from healthy to unhealthy were much less dramatic for red and DEM standard deviation, and asymmetry.

The red standard deviation statistic represents how homogeneous the vegetation cover is including grass, hay, and bare soil areas. This is the reason the unhealthy class had the highest score possible in 46.05% of its riparian areas **(Figure C-3, Appendix C).** DEM standard deviation represents slope and riparian areas with minimal slope and they were valued higher than areas with a high degree of slope. This demonstrates slope was important but did not have as much influence of woody biomass in determining

riparian health. Finally, asymmetry is a measure of how meandering a riparian area is in relation to the waterbody. Asymmetry was also important for healthy riparian function, but it too was not as influential as brightness and blue mean representing woody vegetation.

7.2 LENTIC RIPARIAN AREAS

Low blue and green mean statistics are indications of natural vegetation cover. High blue and green mean values suggest agricultural crop or hay land, bare soil, or human activities. Therefore, low blue and green values for lentic riparian zones are weighted for the healthy class and conversely, high blue and green mean values are not weighted and intended for the unhealthy riparian category. Vegetation cover corresponds with Lentic RHA questions 1, 4, 6, and 8 **(Table 5-3).**

The natural landscape of SPCW lakes and wetland areas is relatively flat compared to river and stream areas that occur within riverbed valleys. For lentic areas within the SPCW, any indication of slope correlated strongly with healthy sites and areas with little to no slope correlated to unhealthy lentic sites. Lentic areas of low slope were either subject to agricultural activity or had poor vegetative cover. Lentic areas with slope had well-established naturally occurring vegetation. This information was captured by the DEM standard deviation OBIA statistic. High DEM standard deviation values represent areas with higher than average slope while low values represent areas of little to no slope.

Healthy lentic riparian areas also typically had high asymmetry, meaning they paralleled the natural meandering of lakes and wetlands and were long and linear. Conversely, compactness is a measure of how grid-like a riparian area is. The lowest possible compactness score is one and would be a perfect square. Low compactness scores represent areas that are short and box-like. High compactness scores are long and linear with curvature. Similar to lotic riparian areas, lentic riparian areas of the SPCW that scored within the healthy range had high asymmetry and compactness while unhealthy riparian areas had low asymmetry and compactness (**Table 6-5, Figure 6-2**). High asymmetry and low compactness correspond with Lentic RHA questions 7a (highest weighted RHA question, 12) and 7b (**Table 5-3**). Healthy lentic sites comprised 24.86% of linear km in SPCW as opposed to 22.48% of total lentic site count (**Table C-1, Appendix C**). This is due to healthy lentic sites having linear and non-compact riparian properties.

Figure C-4, Appendix C represents lentic riparian area percentages that had maximum scores per OBIA statistic per health class. The blue and green mean statistics represents the amount of natural vegetation present within a riparian area. These two OBIA statistics demonstrate there is a high degree of vegetation for the healthy class; 76% for brightness mean and 95% for blue mean (**Figure C-4, Appendix C**). This indicates natural vegetation had an even greater positive influence on lentic riparian health than woody biomass on lotic riparian health (**Figure C-3, Appendix C**).

DEM standard deviation for lentic areas represents slope with high scores for riparian areas with slope and low scores for riparian locations with low slope. Since SPCW lentic areas were extremely flat relative to lotic sites and lentic slopes were given a healthier riparian designation. The healthy class had 59% of areas with the maximum score for DEM standard deviation while the healthy with problems and unhealthy classes had just 25% and 5% of areas with the highest possible slope score. Asymmetry and

compactness represent shape characteristics of riparian areas. Each OBIA shape statistic showed long, meandering and non-compact riparian areas where more present in healthy riparian class (76% and 53%) areas than the healthy with problems class (42% and 27%) and the unhealthy class (26% and 11%) (**Figure C-4, Appendix C**). This suggests lentic riparian areas that are short, square, and compact are impacted by some type human activity.

8.0 CONCLUSION

The overall health of riparian areas in the SPCW was low (**Figure 6-3, Figures C-1 to C-2, Appendix C** and **Map Series 7, Maps 7-1 to 7-36, Appendix A**). This is most likely due to agricultural pressure on the landscape from annual cropland, irrigation and related infrastructure, forage, and rangeland fields. Much of the watershed's natural vegetation has been altered or removed by the agricultural industry along with many wetlands being partially or completely drained. According to data from Agriculture Canada (2003), agricultural land makes up 57% of the landcover type in the sub watershed while grassland areas make up 39% of the total area (**Map 4 – Landcover, Appendix A**). The other eight landcover categories (developed, coniferous, shrub land, water, wetland, broadleaf, non-vegetated and mixed wood) make up the remaining 4%. Many lakes only exist due to damming for irrigation, resulting in natural flood plains and riparian areas of river and stream systems to be either flooded or deprived of water. Where the landscape was unaltered by human activities, the riparian areas were in good health, providing natural benefits to water quality and wildlife habitat.

The SPCW coulee-dominated landscape has many areas deficient of vegetation (i.e., hilltops and large proportions of exposed bare soil) **(Map Series 8 and Maps 8-1 to Map 8-36, Landscape Model-Surface Form Assessment, Appendix A**). Coulee tops and steep sides devoid of vegetation are exposed to the natural elements of water and wind erosion making it difficult for vegetation to take root and become established. This naturally occurring phenomenon is unrelated to anthropogenic or human activities. Riparian areas that are absent of vegetation cover and with exposed bare soil were given a low riparian health score regardless of whether these were naturally occurring or not. It is likely that some of the low rating was due to naturally occurring site characteristics.

9.0 LIMITATIONS

Limitations to the study have been described in the sections below.

9.1 GEOSPATIAL DATA

There were limitations with the geospatial dataset in that the aerial imagery is two years old and the DEM is seven years old. These datasets were used because of budget constraints (too expensive to fly and collect new imagery) and best available data (DEM). It has been commonplace to assess riparian areas from imagery of different years and uphold accurate and reliable riparian assessment analyses. Although not ideal, Stantec did not find any discrepancies using the 2015 aerial photos and the 2010 DEM.

The pixel resolution of the aerial imagery was 1 m by 1 m. This made it difficult to segment riparian areas on either side of a waterbody when the waterbody in question was less than 1 m in width. In these instances, the riparian area was segmented as one riparian area without the waterbody separating the two banks.

There is currently no geospatial method to distinguish invasive species from non-invasive species in a 1-m resolution image. In fact, differentiating invasive verses non-invasive species at 10-cm resolution is a difficult task. The Alberta Cows & Fish RHA has three questions dedicated to invasive species that cannot be addressed using our method.

Aerial photos of SPCW were captured at different times of the year, resulting in sections of the watershed having slightly different spectral reflectance values. It is common for aerial image mosaics of large areas to have varying camera aperture exposure rates which cause minor shifts in the pixel value readings. Stantec overcame this issue by adjusting RHM statistical upper and lower limits where necessary to ensure accurate and reliable riparian health designations. Time of year has no effect on elevation data. However, time of year will influence imagery values and must be accounted for. This is addressed by adjusting the upper\lower limits of the RHM statistical values.

9.2 FIELD DATA COLLECTION

The Stantec field teams had a difficult time gaining permission from land owners to conduct the RHA survey within SPCW. Assistance from SEAWA was greatly appreciated and highly valued, but Stantec was only able to collect data from three producers for an area over 4,700 km^2. SEAWA also directed field crews to collect riparian data from public areas, which was of great assistance.

10.0 RECOMMENDATIONS FOR FUTURE WORK

10.1 GEOSPATIAL DATA

The LiDAR derived 2010 DEM proved to be a useful dataset for the Strahler Stream order process and riparian area segmentation, characterization, and classification. The age of the dataset was not an issue as described in Section 8.1. The 5-m resolution of the DEM proved to be satisfactory; however, a finer resolution DEM could improve the stream order and riparian area delineation process. DEM costs increase as DEM resolution improves and given the restricted SEAWA upper limit budget, a more detail DEM was not possible for this project but recommended for future work. A 2017 flight would have also captured the most recent changes to the land base.

10.2 FIELD DATA COLLECTION

Future work should include RHA surveys from a greater number of private land owners as these riparian areas historically experience the most anthropogenic impact and pressure from the agricultural industries. With assistance from SEAWA, perhaps more land owners could be included for future riparian studies. A total of 88 RHA surveys were conduct within the SPCW. For future studies of similar watershed size, perhaps 100-150 RHA surveys would be recommended to help capture riparian area diversity for each health designation.

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AERIAL ASSESSMENT OF RIPARIAN AREAS IN THE SEVEN PERSONS CREEK WATERSHED, ALBERTA

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May 4, 2018

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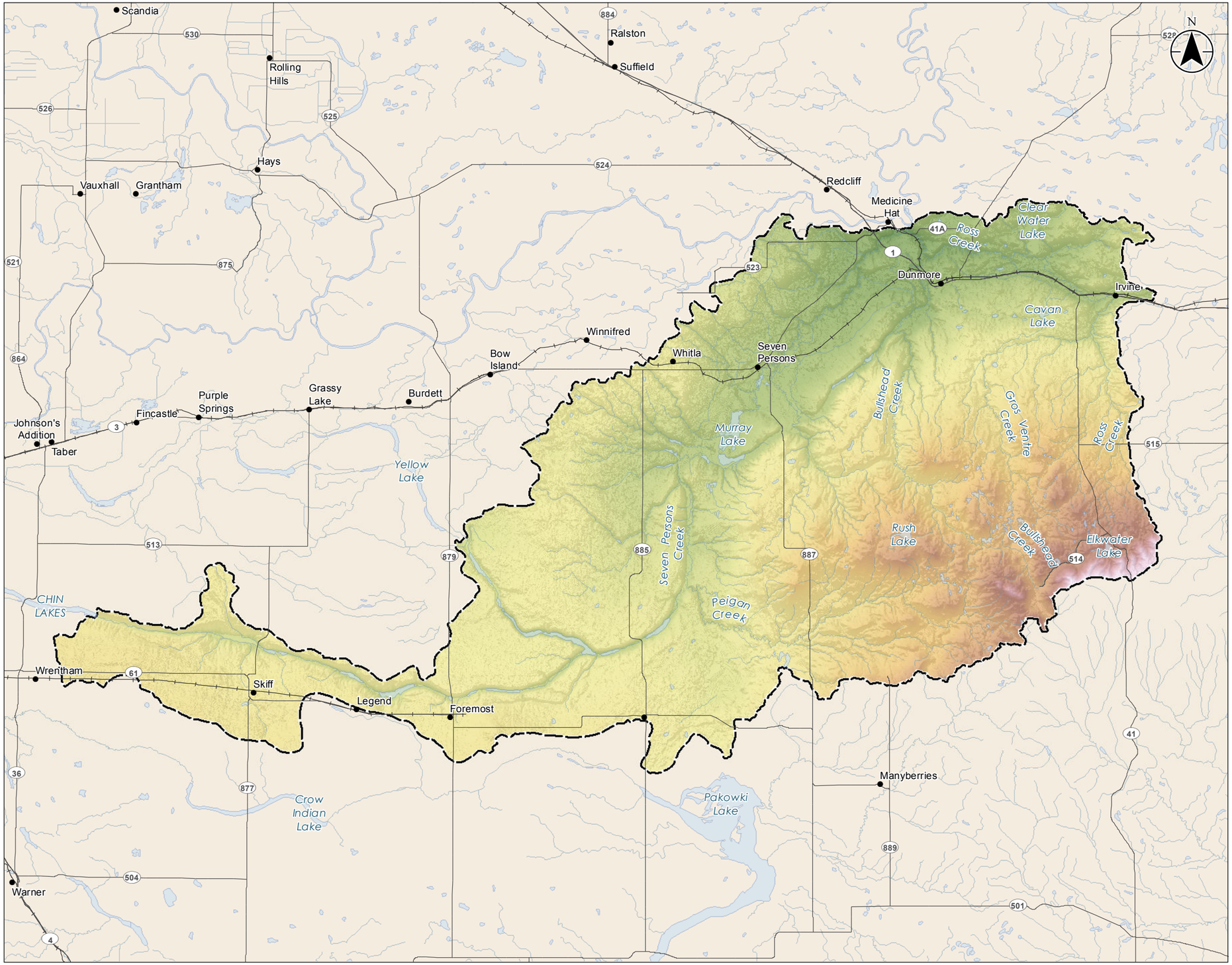
Appendix A MAPS



Stantec

PROJECT DATA

Seven Persons Creek Watershed

Surface Elevation (masl)

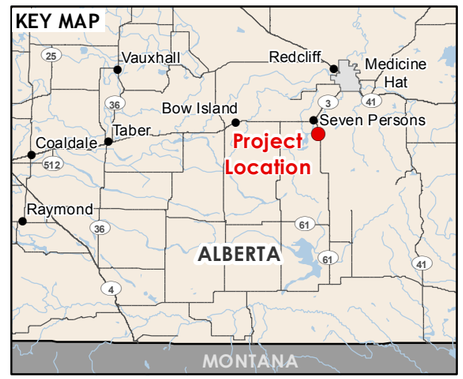
High : 1465

Low : 655

LANDBASE

- Community
- Major Road
- Rail
- Watercourse
- Waterbody

KEY MAP



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Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features obtained from the Government of Canada.

111475212

Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-03-28
Review by gkroupa on 2018-03-28

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

2

Title

Digital Elevation Model of the Seven Persons Creek Watershed

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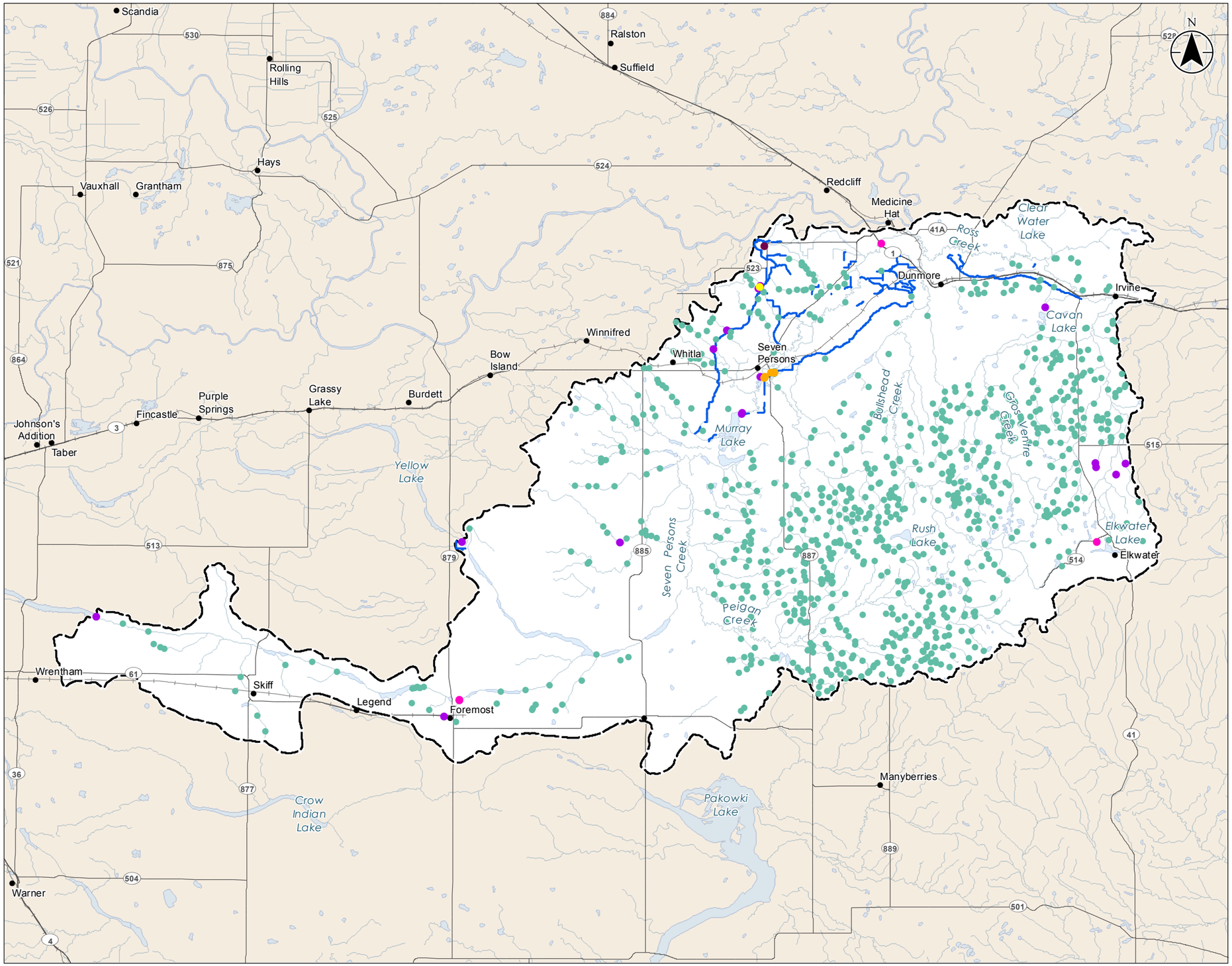

Stantec

PROJECT DATA

- Seven Persons Creek Watershed

Man Made Drainage Features

- Major Dam
- Minor Dam
- Water Control Device
- Dugout
- Lagoon
- Spillway
- Irrigation Canals

LANDBASE

- Community
- Major Road
- Rail
- Watercourse
- Waterbody

0 10 20 Kilometres

1:500,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features obtained from the Government of Canada, the Government of Alberta and AltaLIS Ltd.

111475212

Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-03-24
Review by gkroupa on 2018-03-24

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

3

Title

Locations of Man Made Drainage Features in the Seven Persons Creek Watershed

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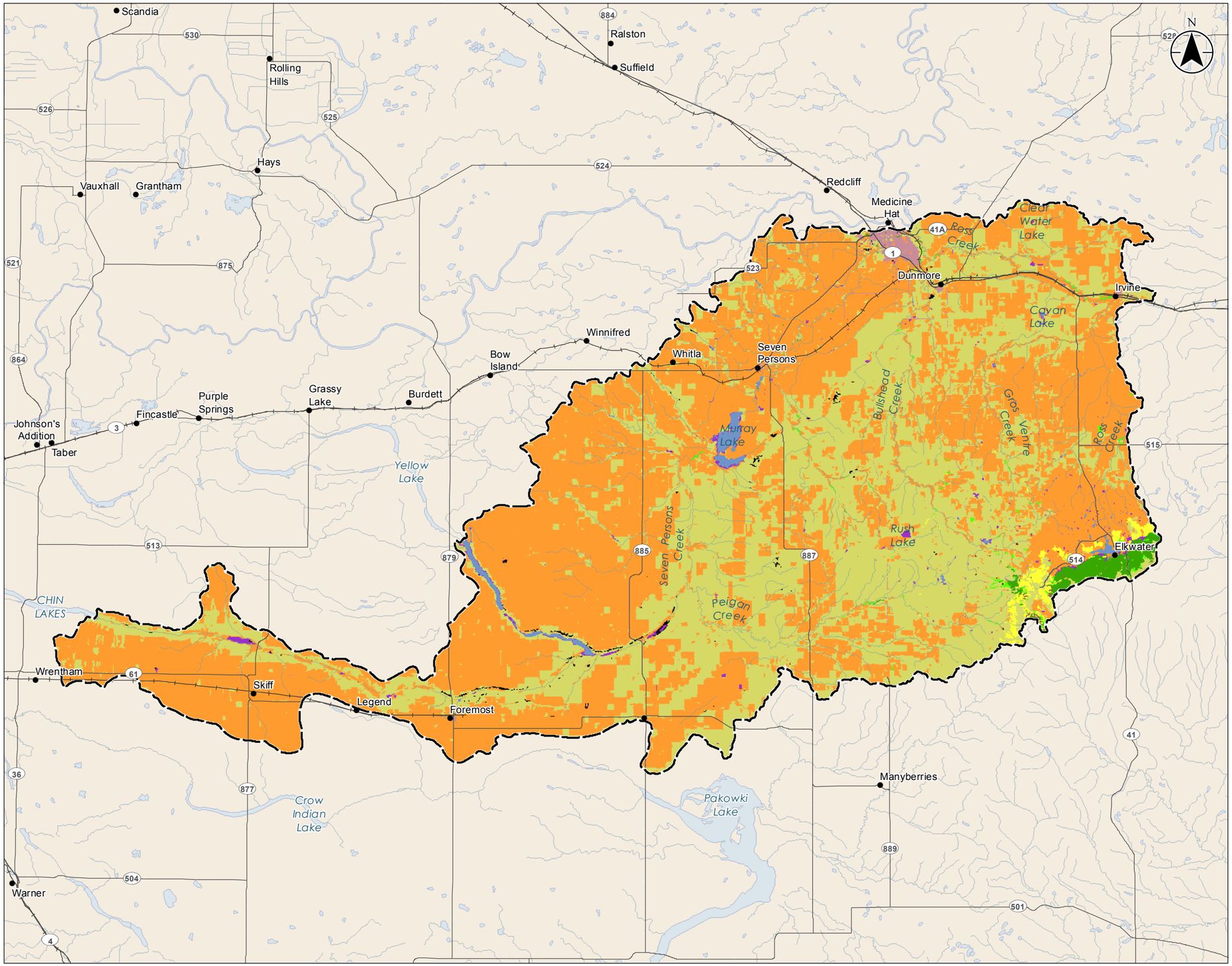

Stantec

PROJECT DATA

Seven Persons Creek Watershed

LANDCOVER

- Water
- Non-Vegetated
- Rock/Rubble
- Exposed Land
- Developed
- Bryoids
- Shrubland
- Wetland
- Herb
- Grassland
- Agriculture
- Coniferous
- Broadleaf
- Mixedwood

LANDBASE

- Community
- Major Road
- Rail
- Watercourse
- Waterbody

0 10 20 Kilometres

1:500,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features and landcover information obtained from the Government of Canada.

111475212

Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-03-28
Review by gkroupa on 2018-03-28

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

4

Title

Landcover in the Seven Persons Creek Watershed

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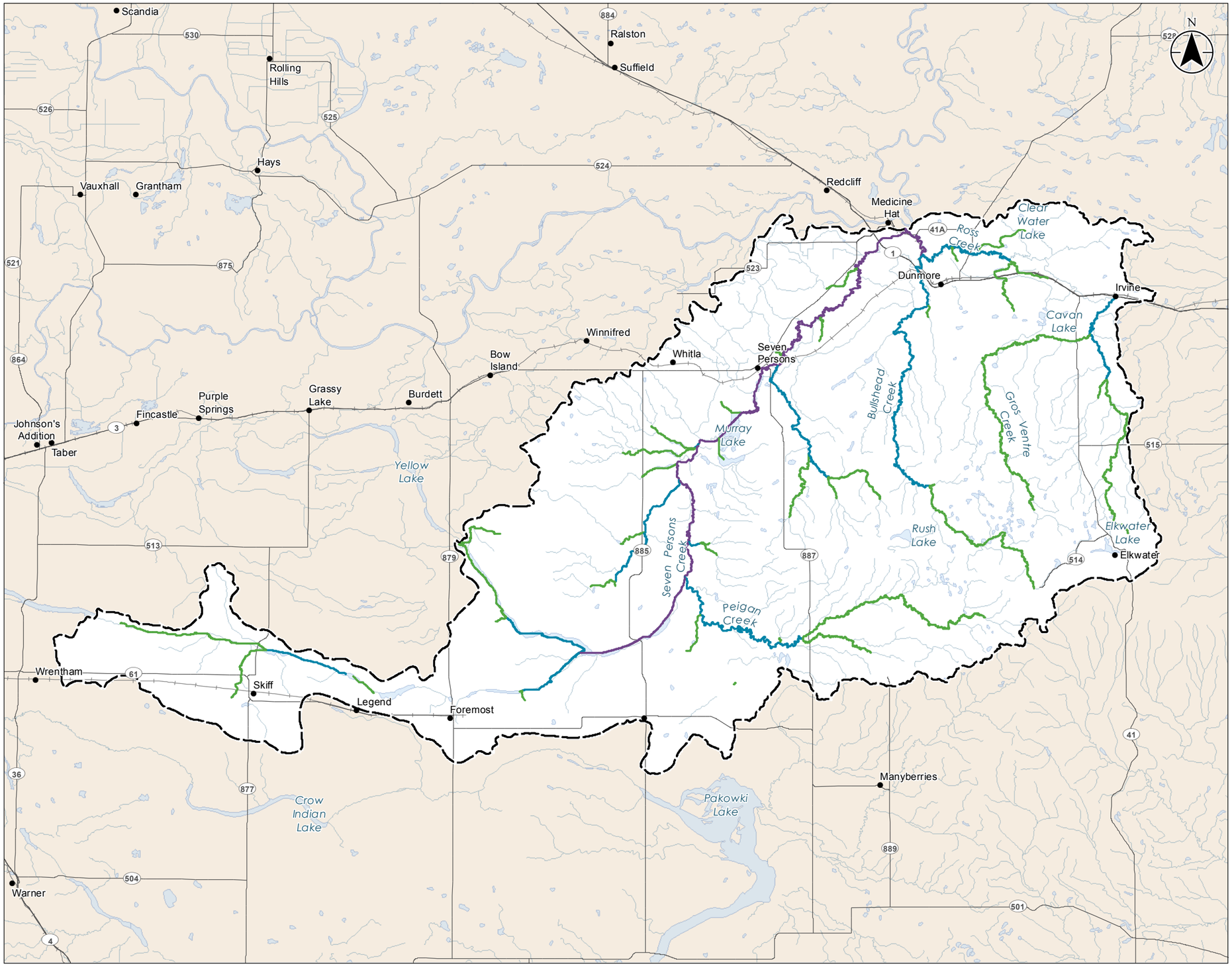


Stantec

PROJECT DATA

Seven Persons Creek Watershed

Strahler Stream Order

- 6
- 7
- 8

LANDBASE

- Community
- Major Road
- Rail
- Watercourse
- Waterbody

0 10 20 Kilometres

1:500,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features obtained from the Government of Canada, the Government of Alberta and AltaLIS Ltd.

111475212

Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-03-28
Review by gkroupa on 2018-03-28

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

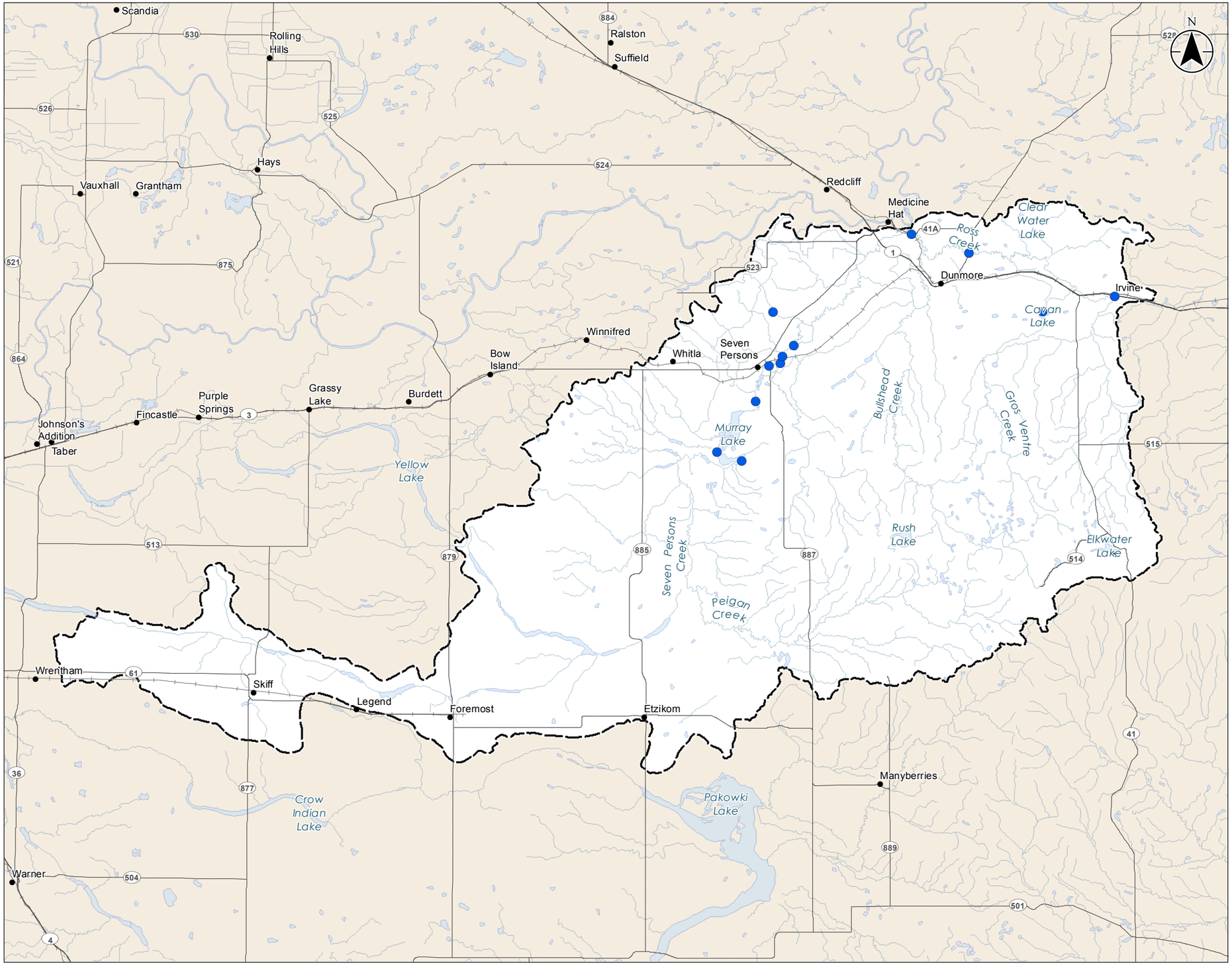
Map No.

5

Title

Strahler Stream Orders Used in the Riparian Health Assessment of the Seven Persons Creek Watershed

G:\...\GIS Project Folder\SEAWA\ArcMaps\Final Report Draft ANSEAWA_Strahler_Stream_Order_Overview_20180327.mxd Revised: 2018-03-28 By: jhiebert



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PROJECT DATA

- Seven Persons Creek Watershed
- Field Assessment Sites

LANDBASE

- Community
- Major Road
- Rail
- Watercourse
- Waterbody

0 10 20 Kilometres

1:500,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features obtained from the Government of Canada, the Government of Alberta and AltaLIS Ltd.

111475212

Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-03-28
Review by gkroupa on 2018-03-28

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

6

Title

Field Assessment Sites in the Seven Persons Creek Watershed

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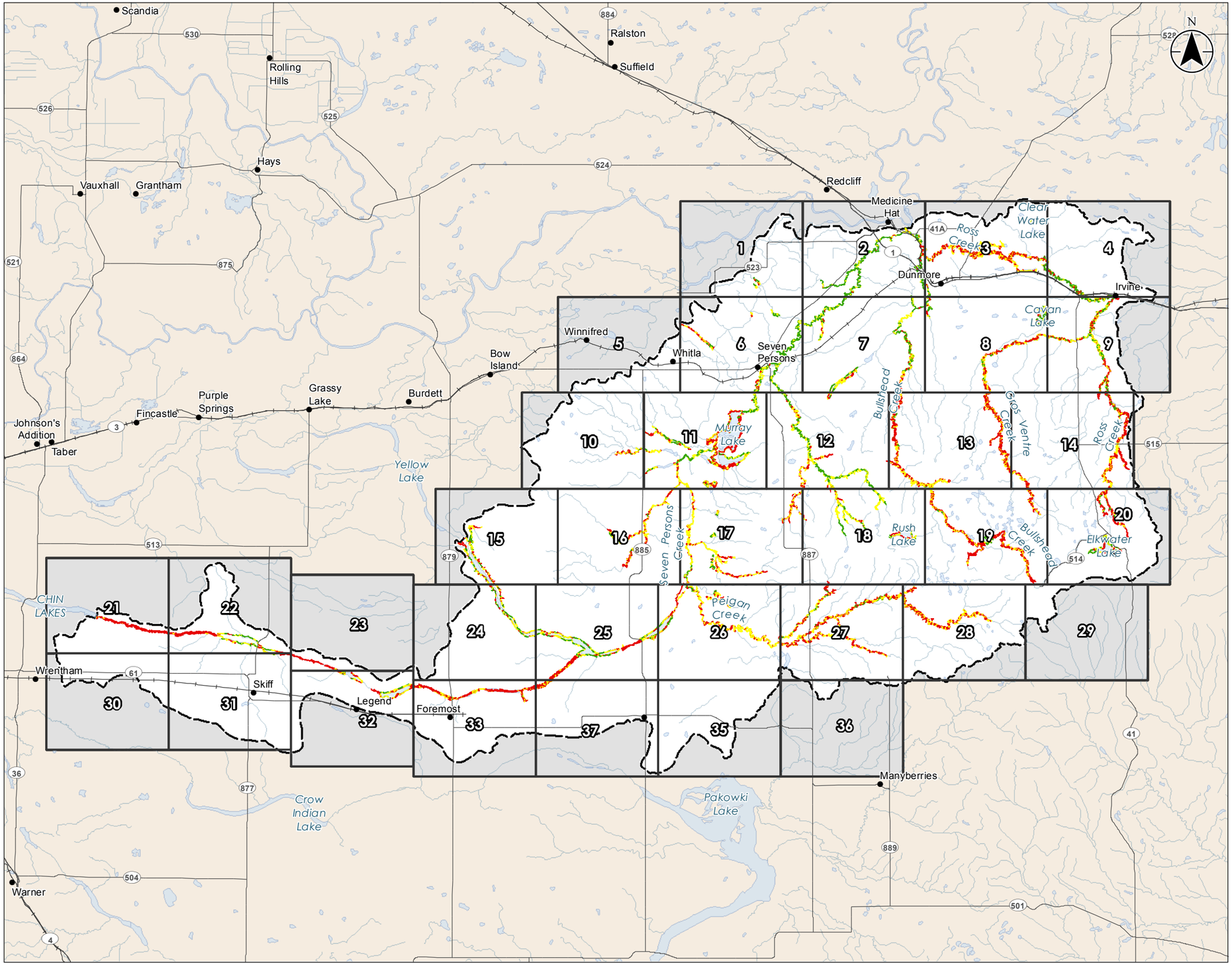

Stantec

PROJECT DATA

- Seven Persons Creek Watershed
- Map Index (1:50,000)

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Community
- Major Road
- Rail
- Watercourse
- Waterbody

0 10 20 Kilometres

1:500,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features obtained from the Government of Canada.

111475212

Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-03-28
Review by gkroupa on 2018-03-28

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7

Title

Index Map for Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

C:\...GIS Project Folder\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_MapGrid_20180328.mxd Revised: 2018-03-28 By: jhiebert

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

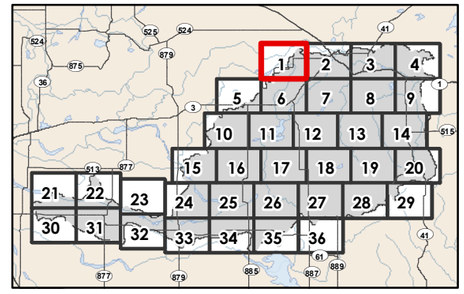
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features courtesy of Geogratis and CANVEC.
3. Orthoimagery within the Seven Persons Creek Watershed provided by the South East Alberta Watershed Alliance. Imagery beyond the SPCW boundary is provided by BING: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

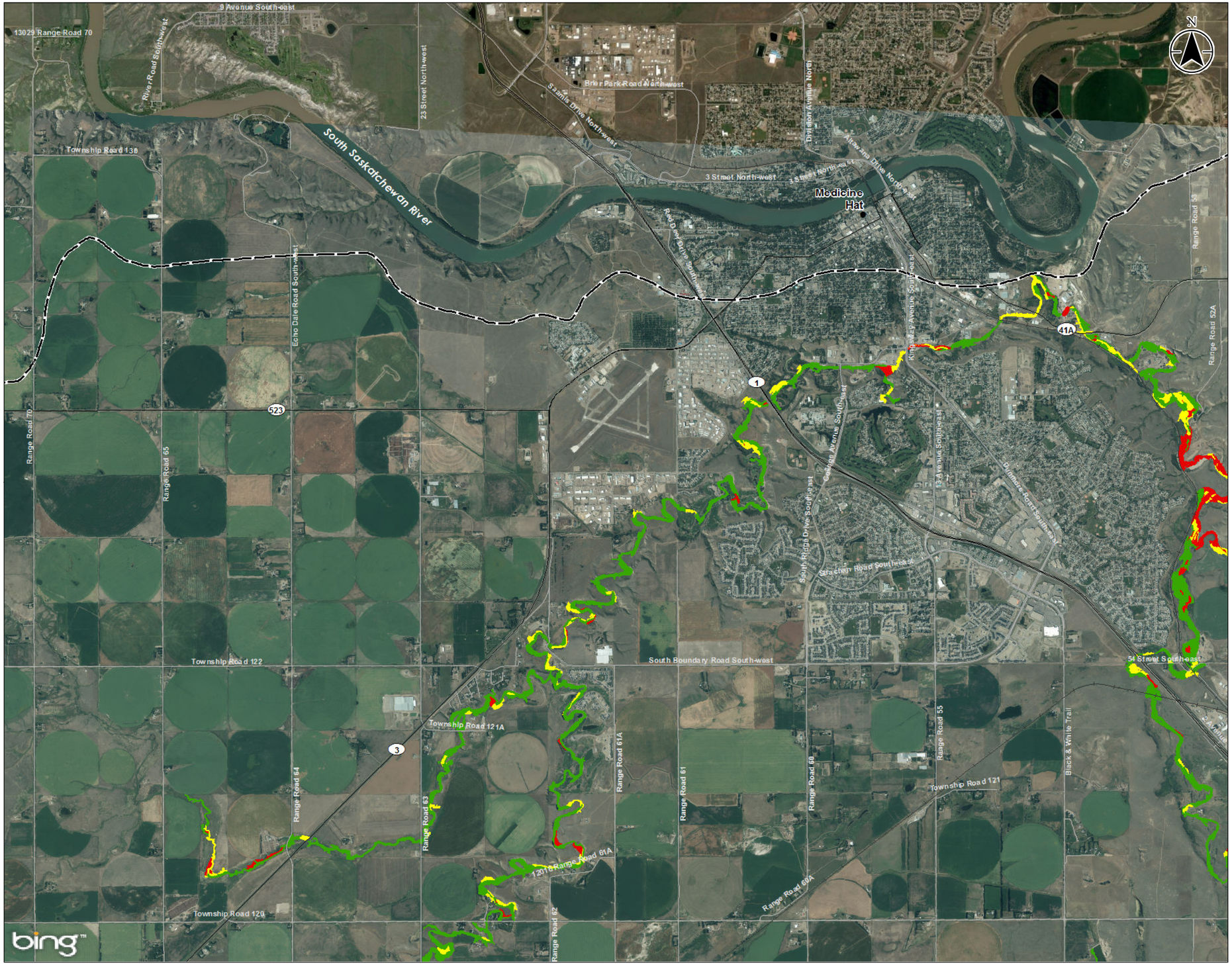
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 1

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

C:\...\GIS_Project_Folder\...\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_AIRiparian Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa



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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

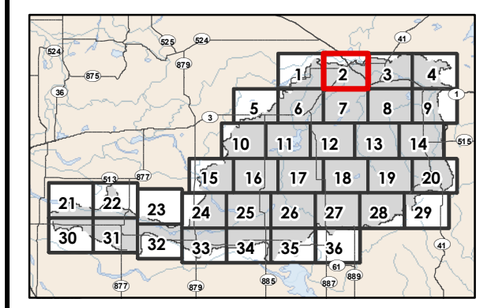
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features courtesy of Geogratis and CANVEC.
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Seven Persons Creek Sub-watershed, Alberta

111475212

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

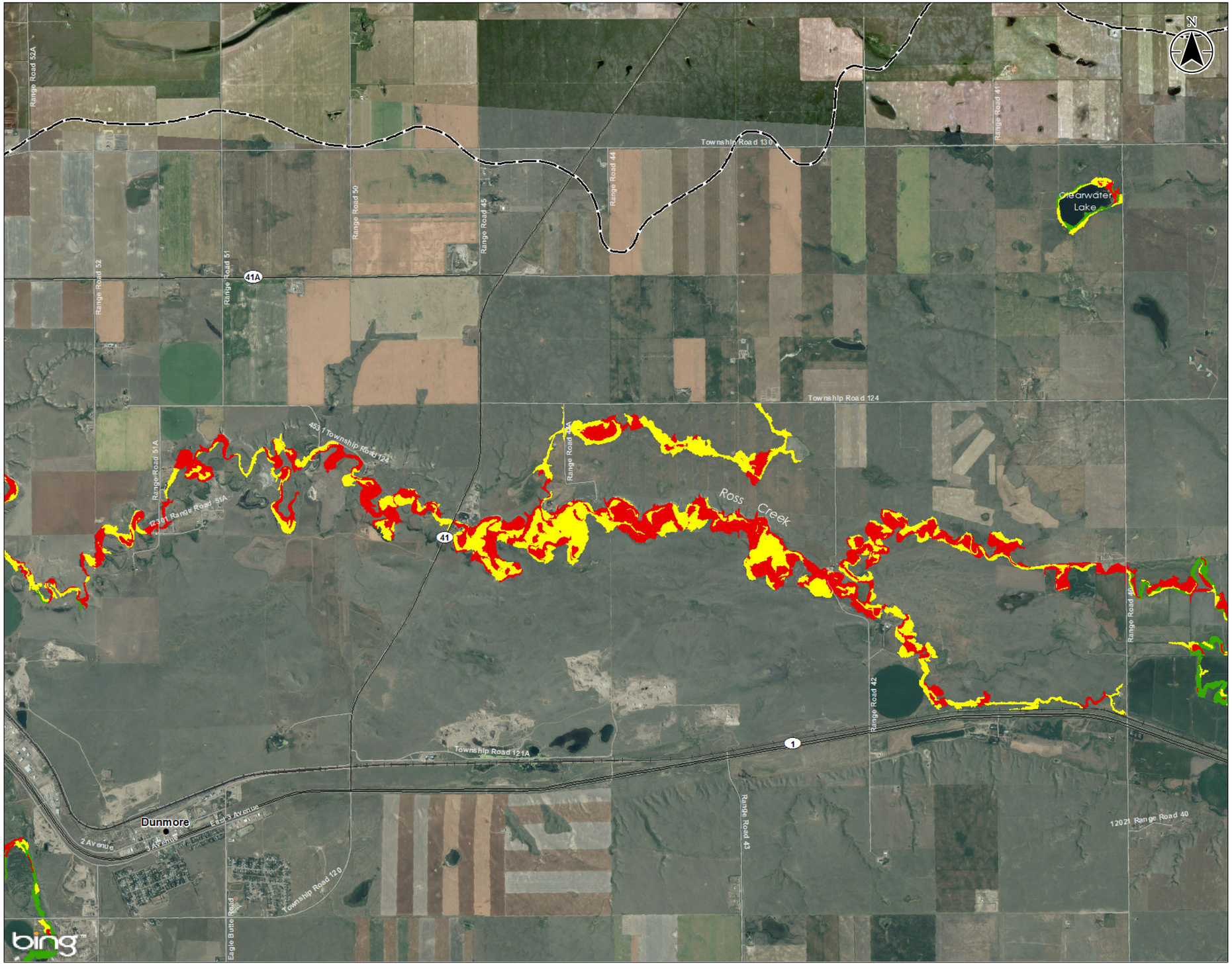
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 2

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

G:_GIS_Project_Folder\SEAWA\ArcMaps\Final Report\Draft 2\SEAWA_AllRiparian_Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa



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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

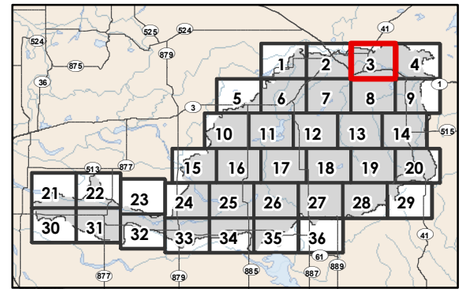
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

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2. Base features courtesy of Geogratis and CANVEC.
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Seven Persons Creek Sub-watershed, Alberta

111475212

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 3

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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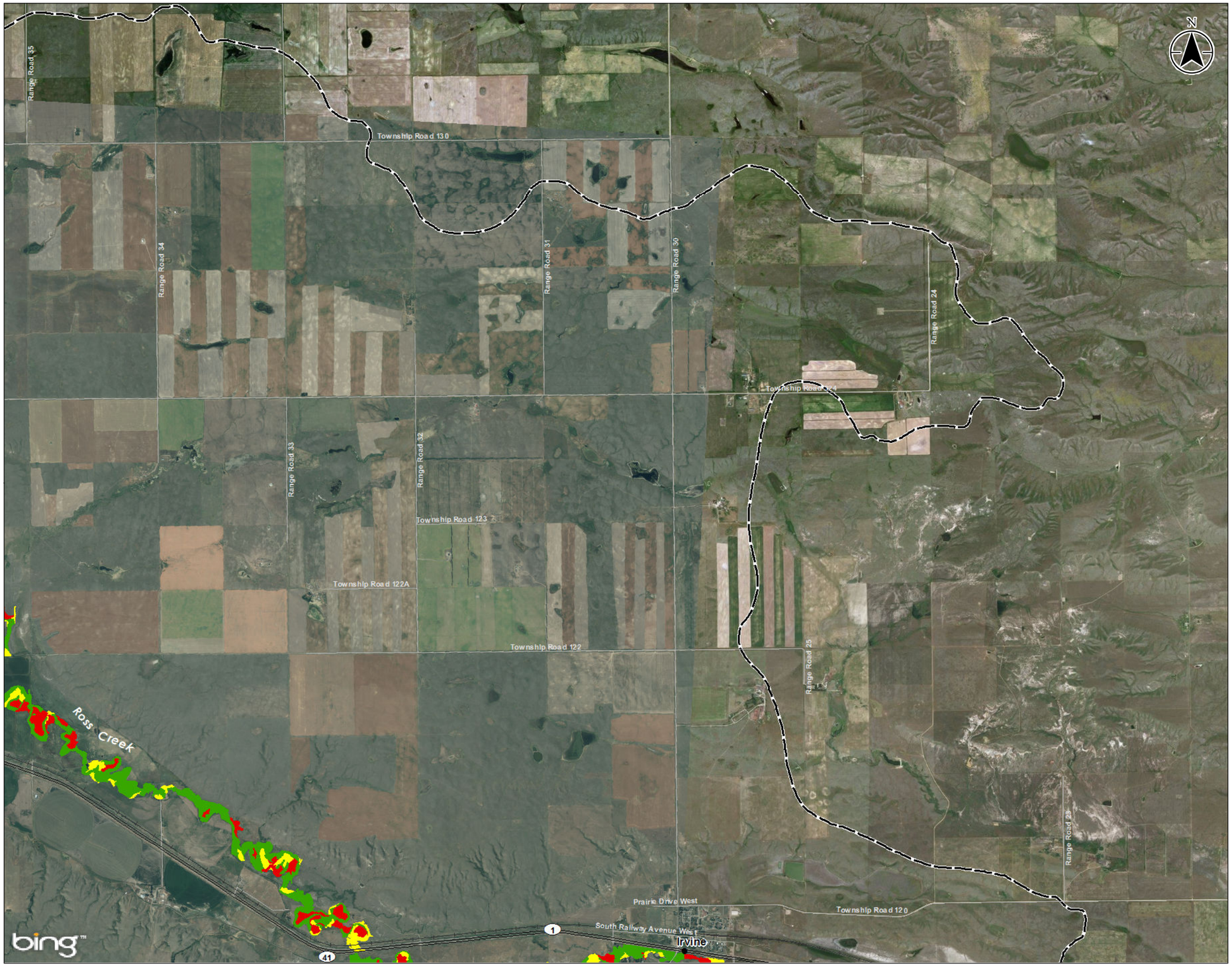

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

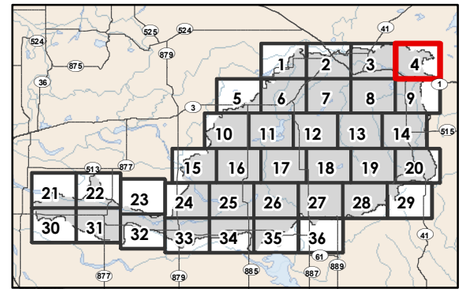
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 4

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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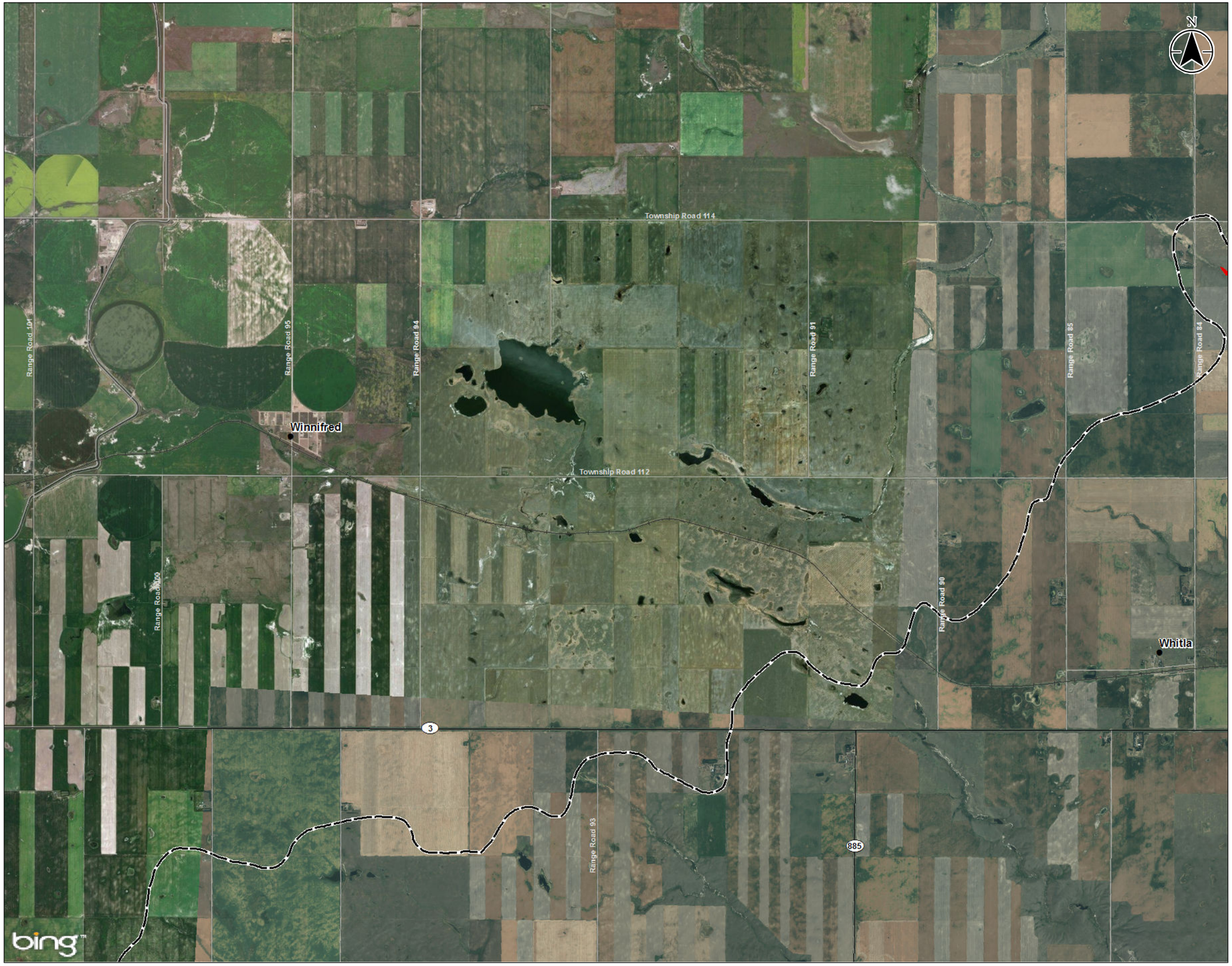

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

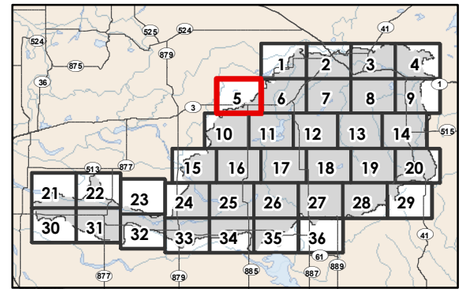
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
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3. Orthoimagery within the Seven Persons Creek Watershed provided by the South East Alberta Watershed Alliance. Imagery beyond the SPCW boundary is provided by BING: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

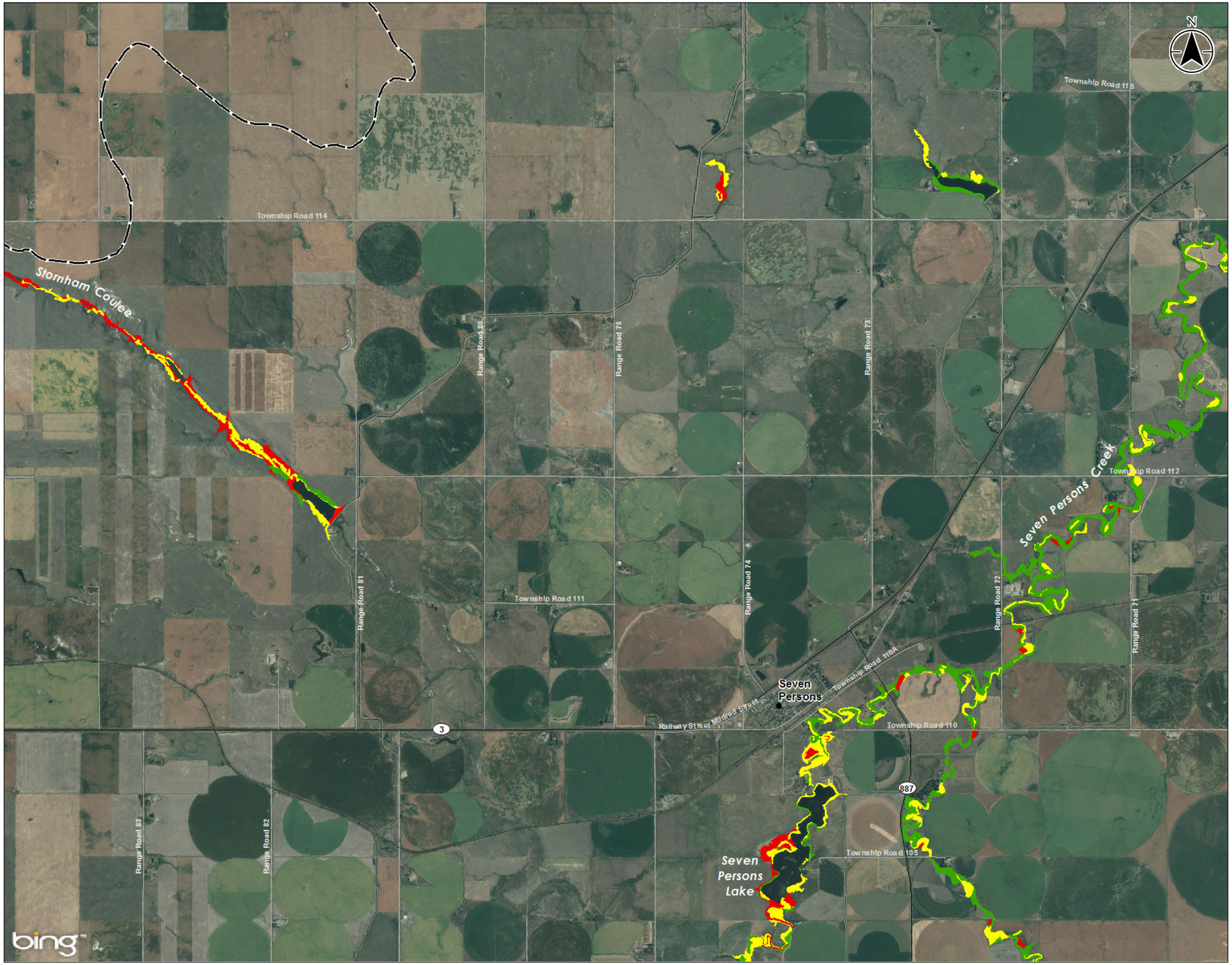
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 5

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

G:\...\GIS_Project_Folder\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_AllRiparian Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa



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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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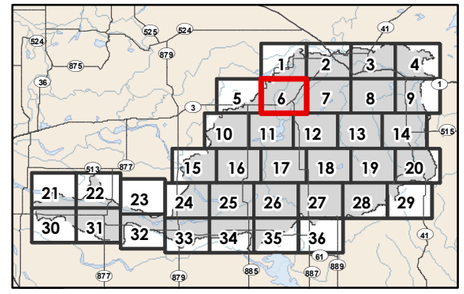

Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features courtesy of Geogratis and CANVEC.
3. Orthoimagery within the Seven Persons Creek Watershed provided by the South East Alberta Watershed Alliance. Imagery beyond the SPCW boundary is provided by BING: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 6

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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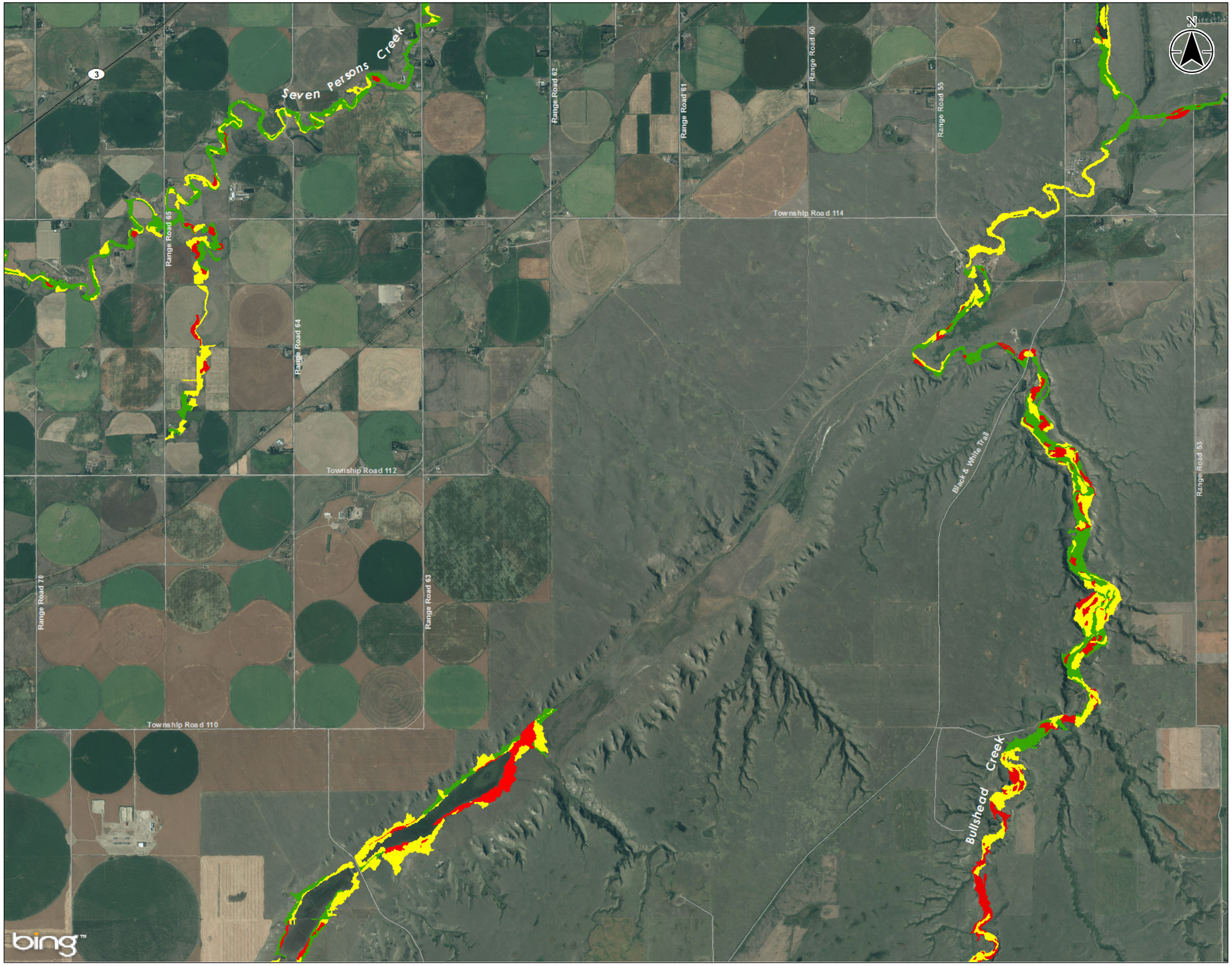

Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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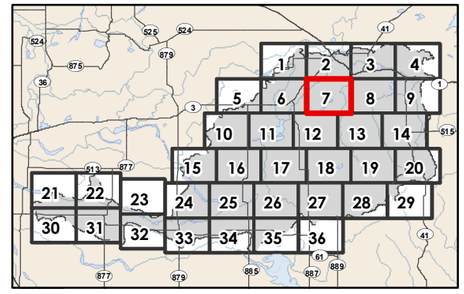

Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features courtesy of Geogratis and CANVEC.
3. Orthoimagery within the Seven Persons Creek Watershed provided by the South East Alberta Watershed Alliance. Imagery beyond the SPCW boundary is provided by BING: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 7

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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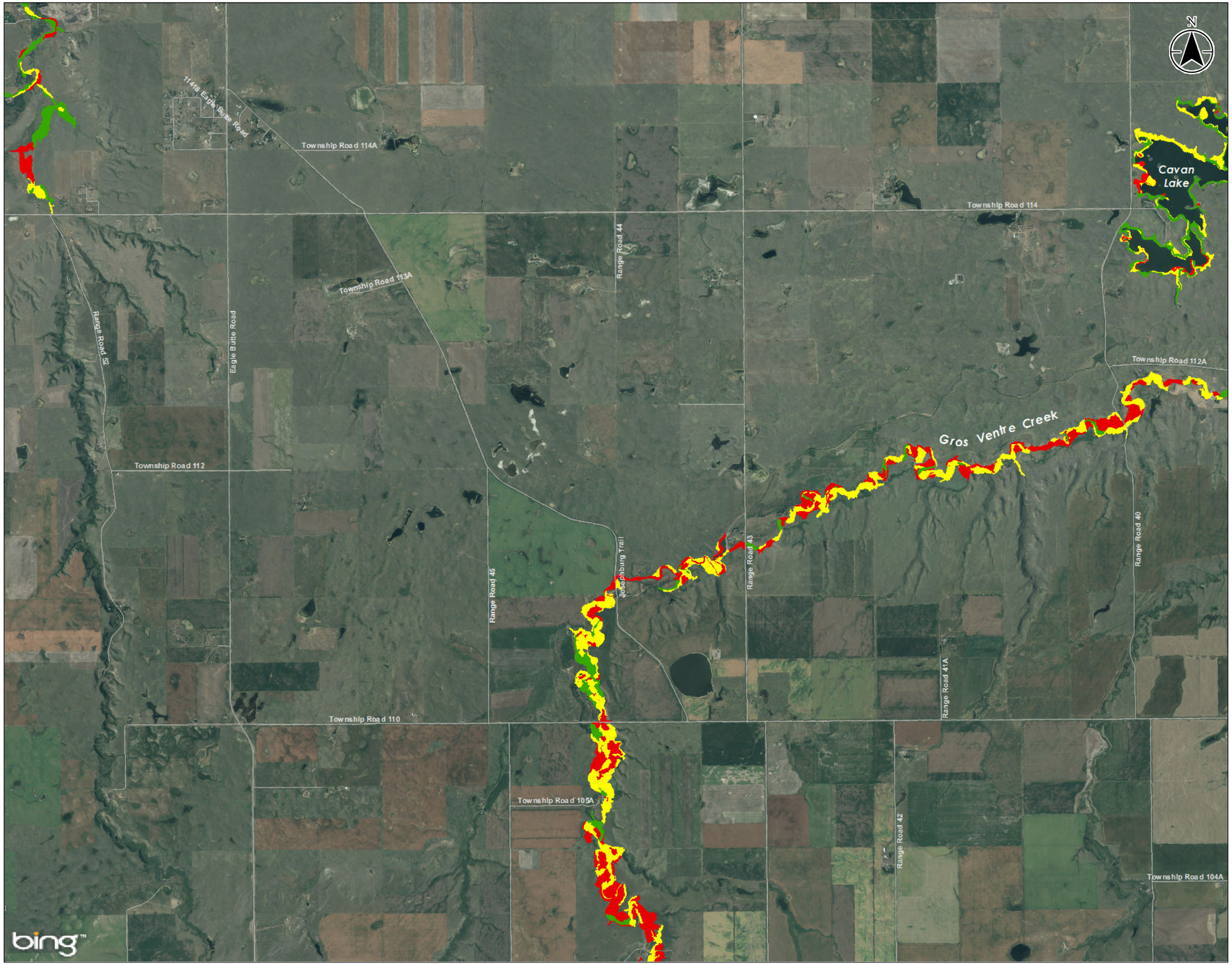

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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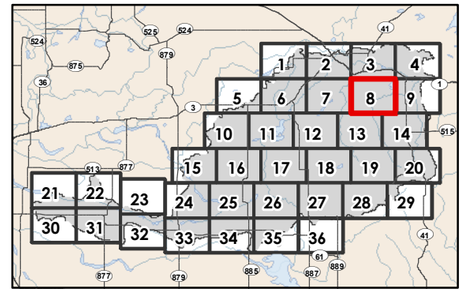

Notes

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3. Orthoimagery within the Seven Persons Creek Watershed provided by the South East Alberta Watershed Alliance. Imagery beyond the SPCW boundary is provided by BING: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

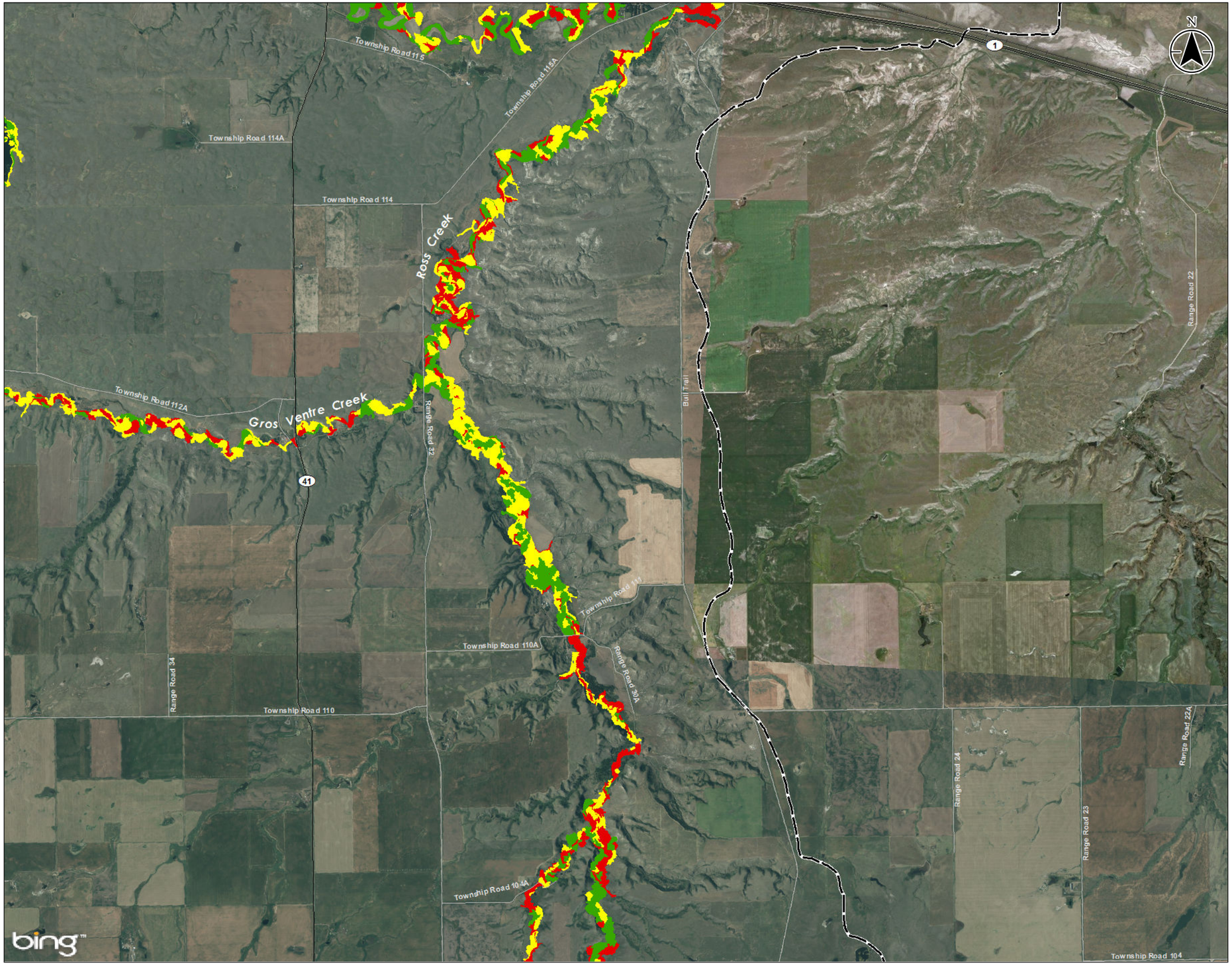
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 8

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

C:\...GIS_Project_Folder\...\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_AllRiparian Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa



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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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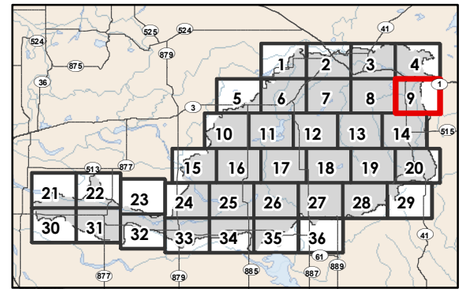

Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 9

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

C:\...GIS_Project_Folder\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_AERiparian Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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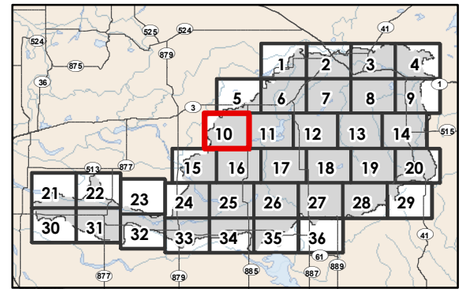

Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 10

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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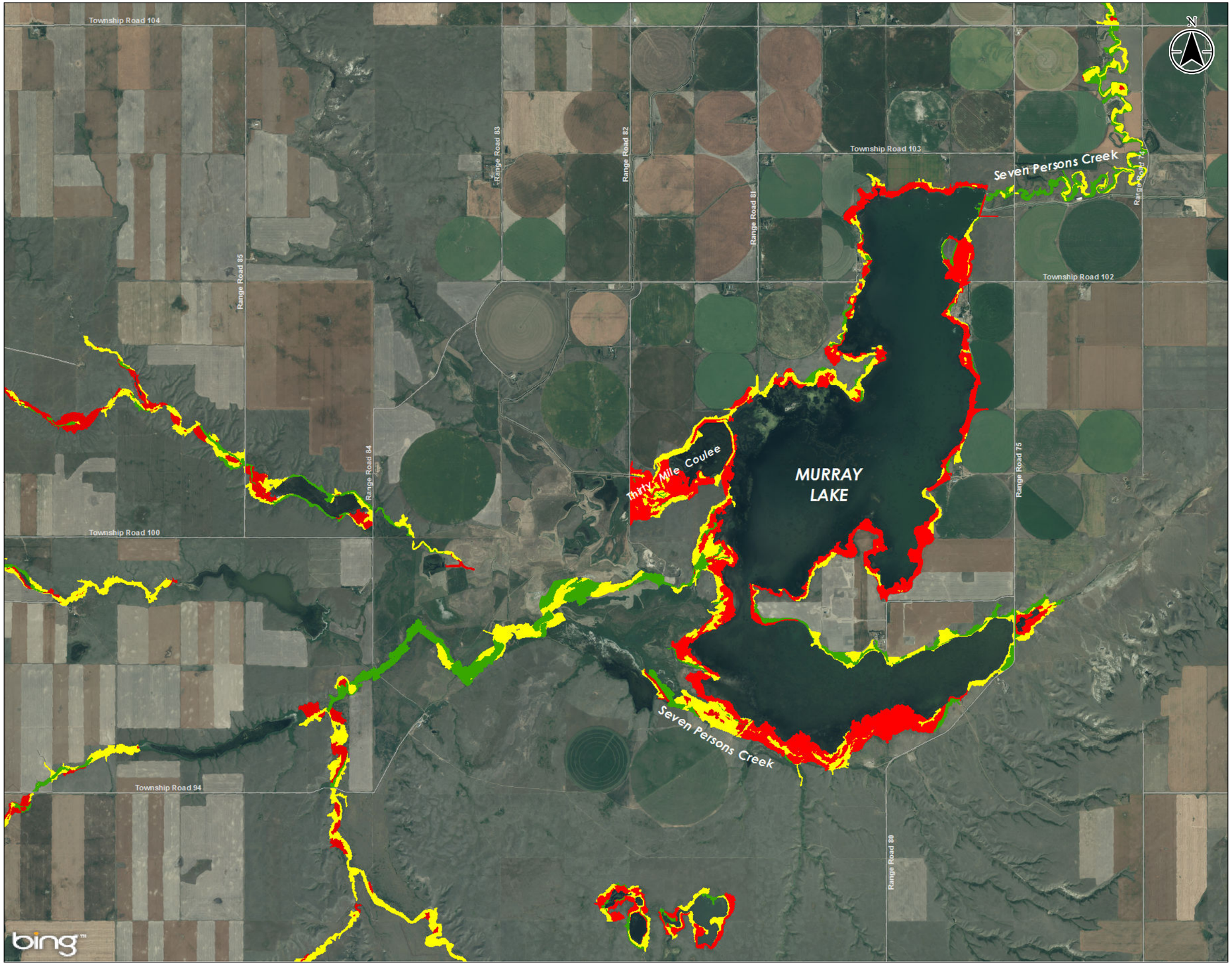

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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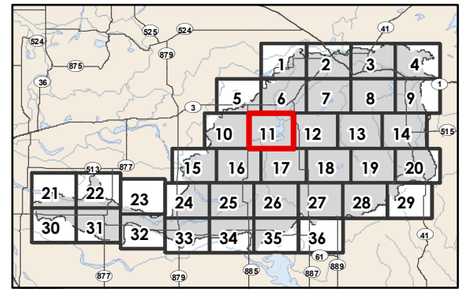

Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 11

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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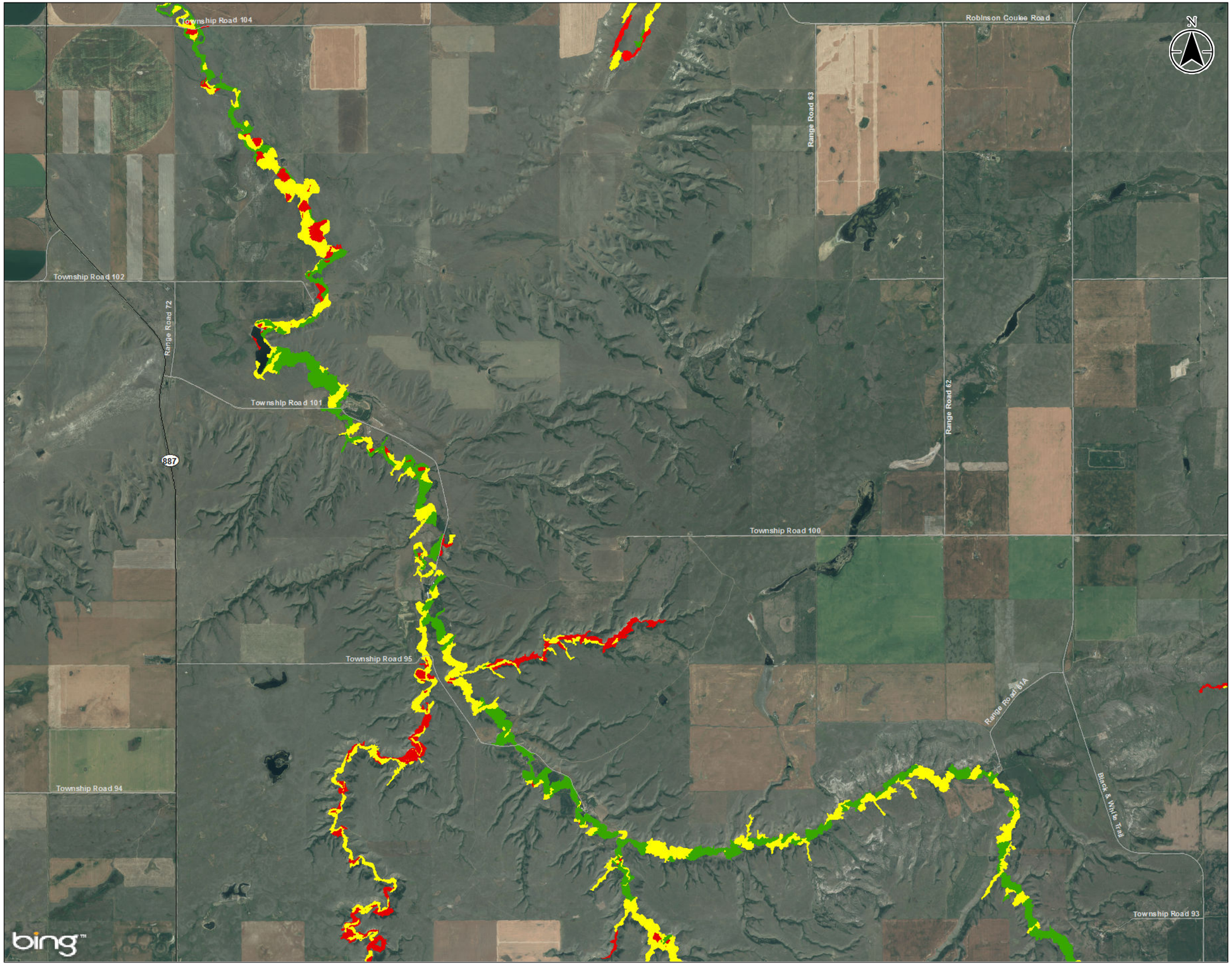

Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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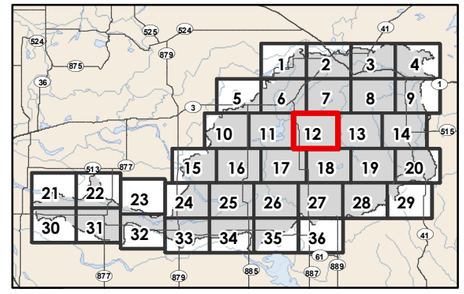

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Review by gkroupa on 2018-04-30

Client/Project

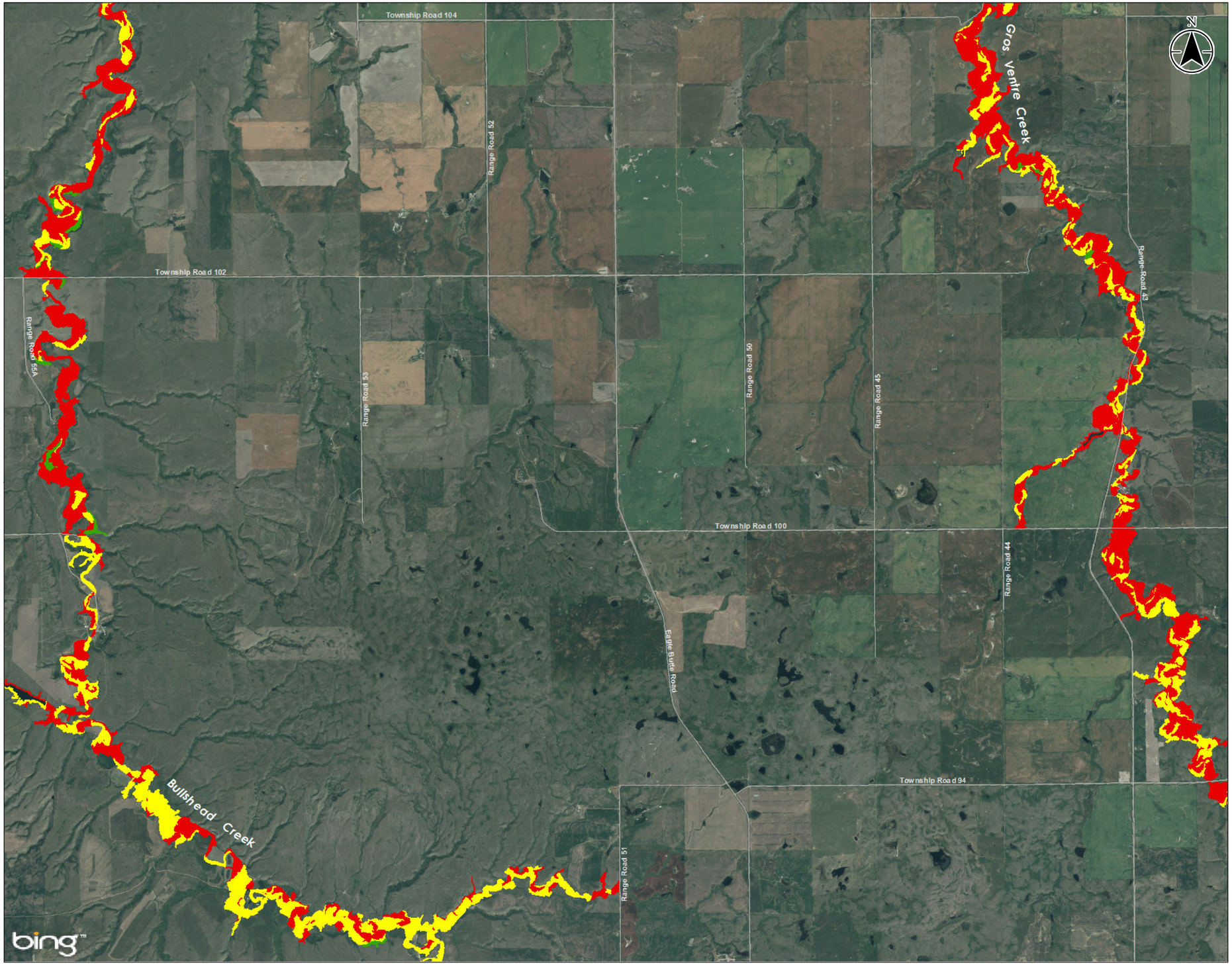
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 12

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

G:\...\GIS_Project_Folder\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_AIRiparian Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa



Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

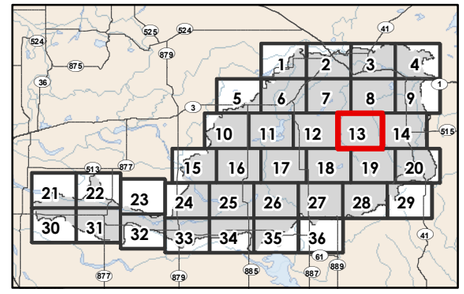
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features courtesy of Geogratis and CANVEC.
3. Orthoimagery within the Seven Persons Creek Watershed provided by the South East Alberta Watershed Alliance. Imagery beyond the SPCW boundary is provided by BING: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

111475212

Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

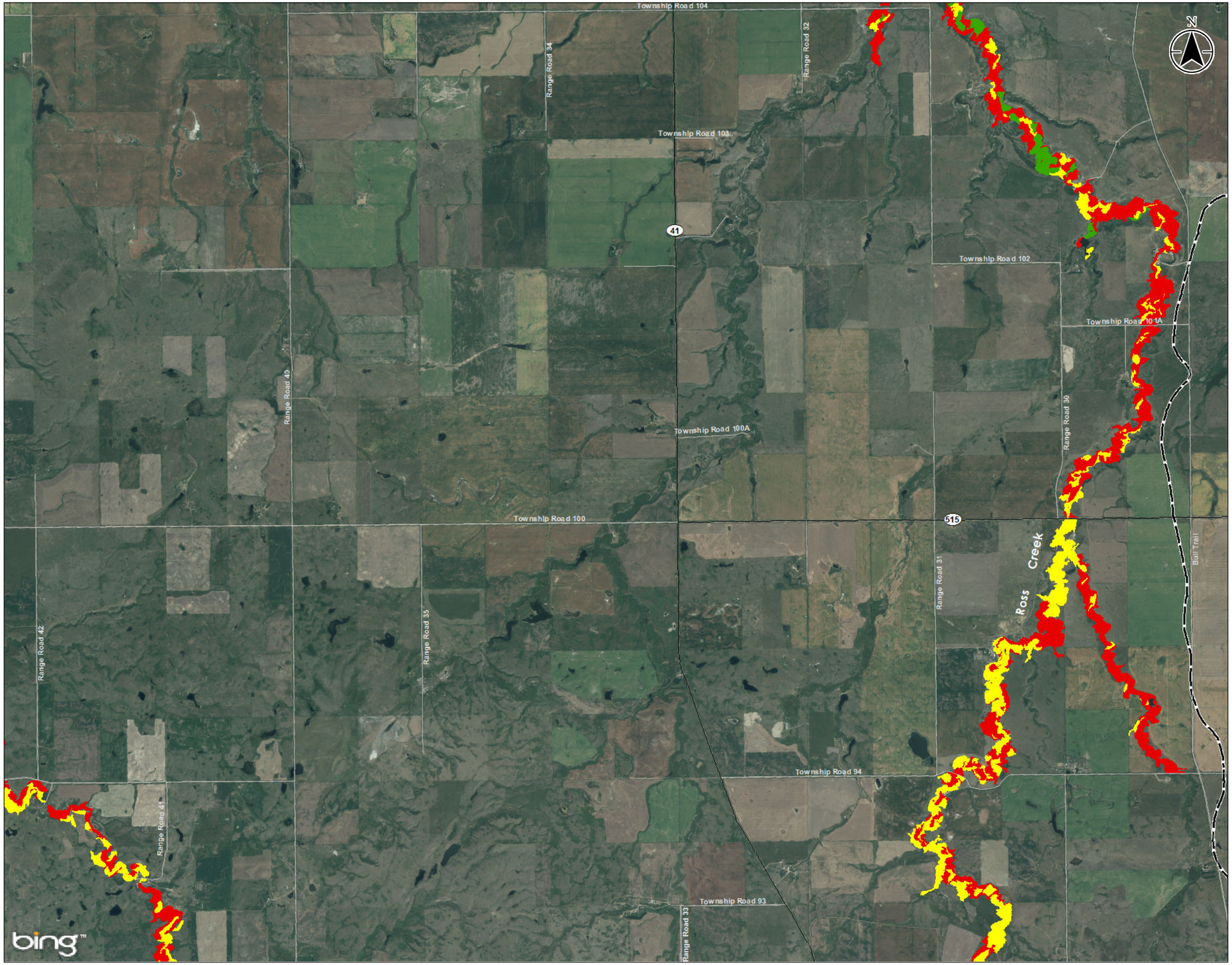
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 13

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

C:\...GIS_Project_Folder\SEAWA\ArcMaps\Final Report\Draft 2\SEAWA_AERiparian Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa



Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

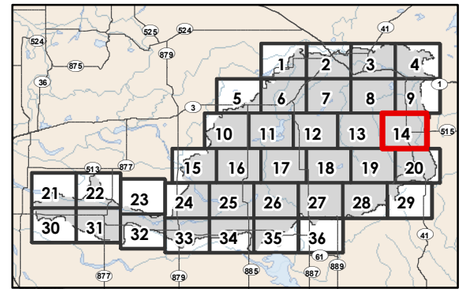
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

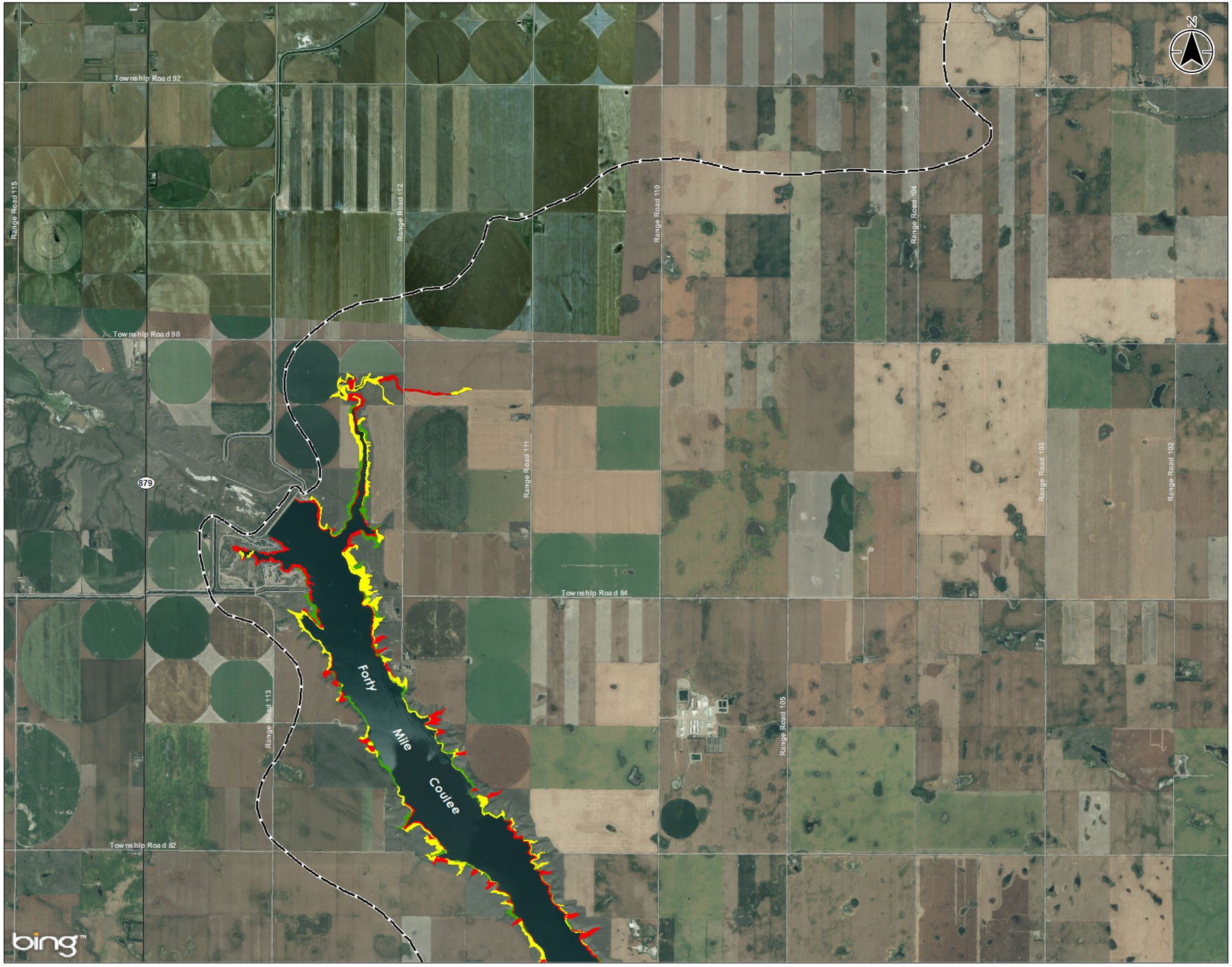
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 14

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

G:\...GIS_Project_Folder\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_AllRiparian Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa



Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

Healthy

Healthy With Problems

Unhealthy

LANDBASE

Major Road

Minor Road

Rail

0 1 2 Kilometres

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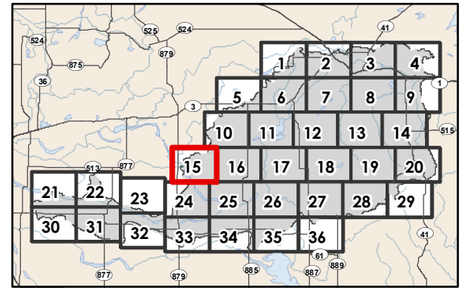

Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 15

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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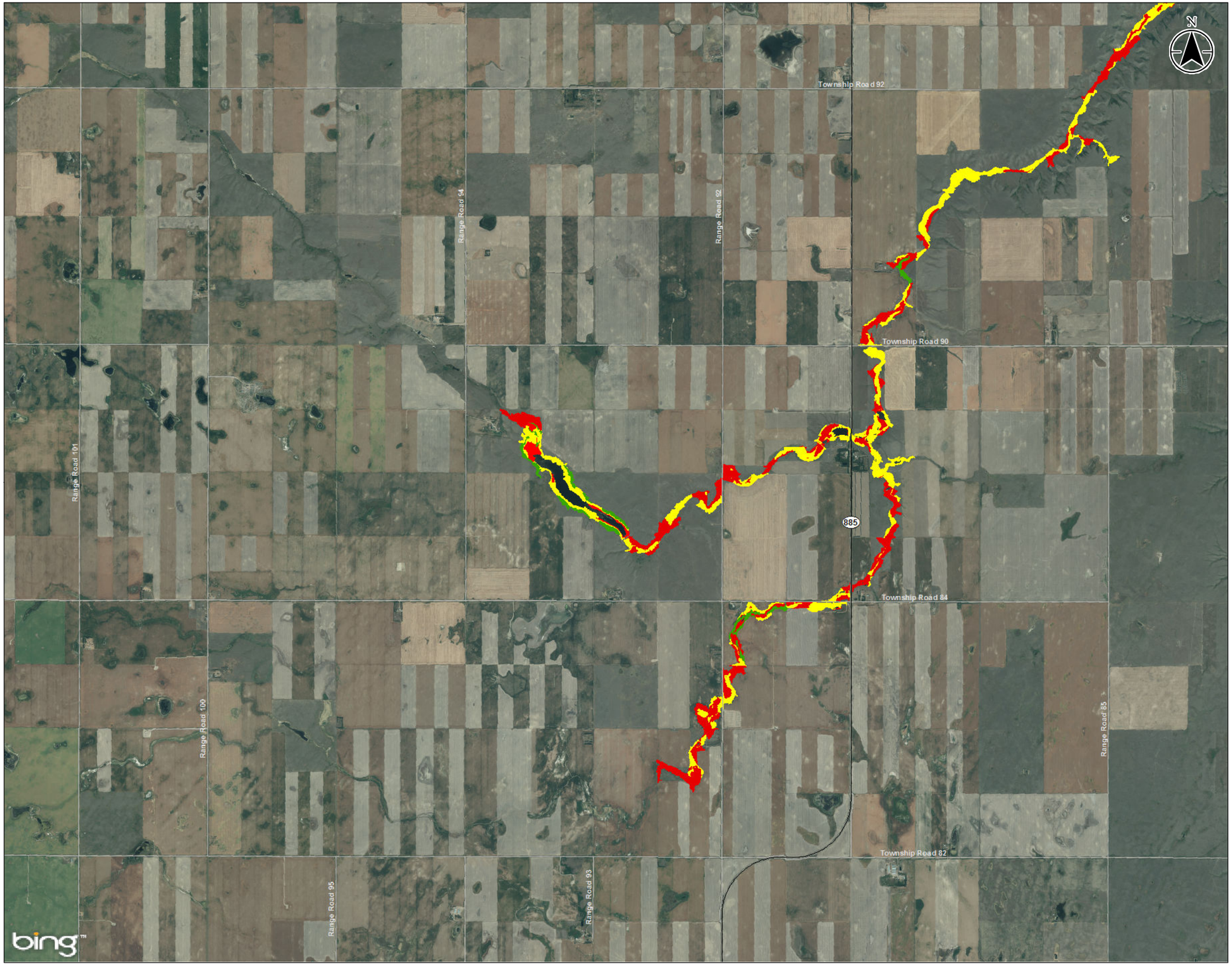

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

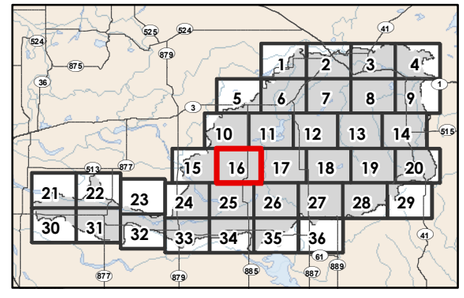
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 16

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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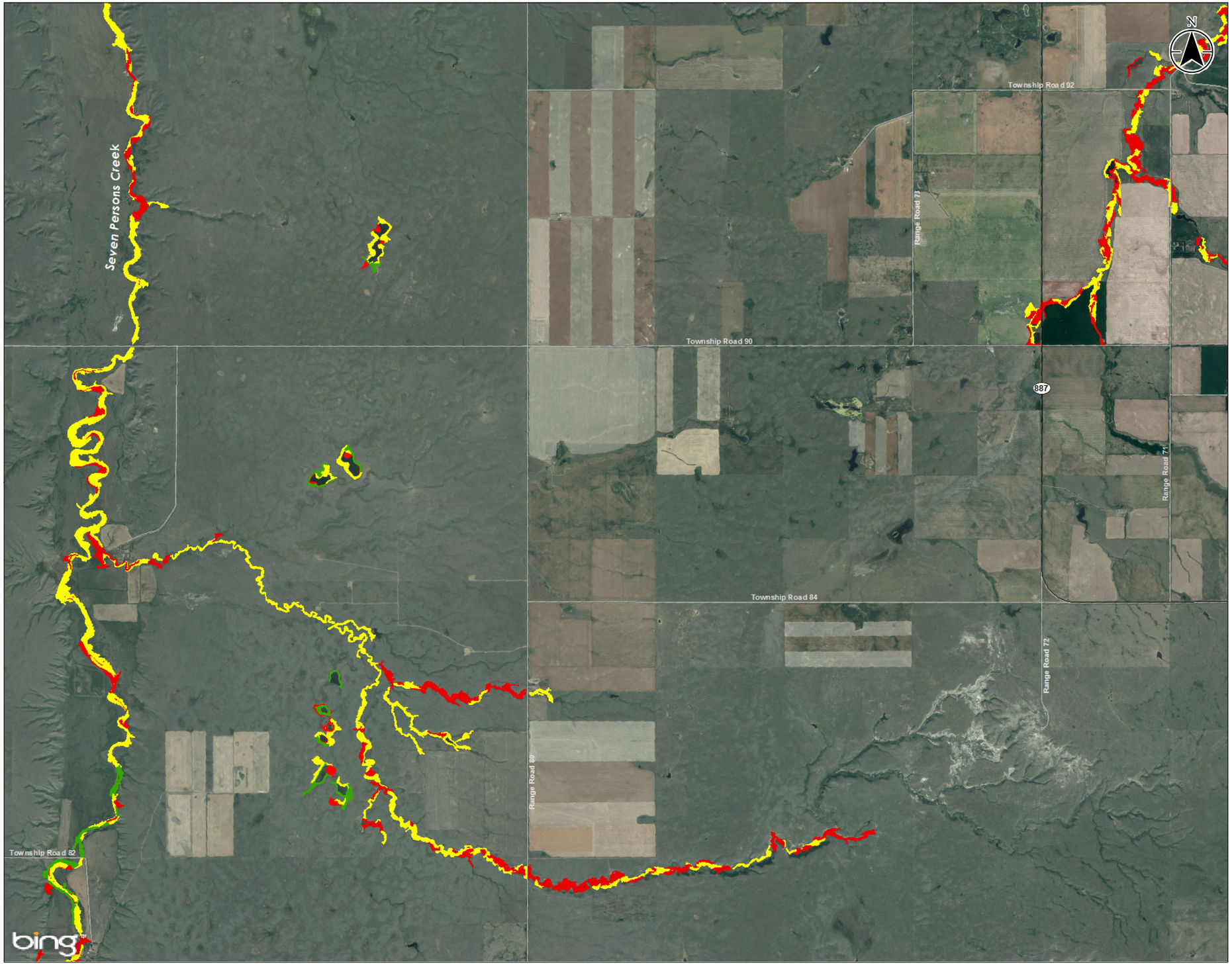

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

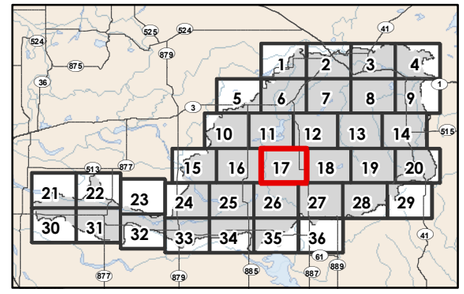
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 17

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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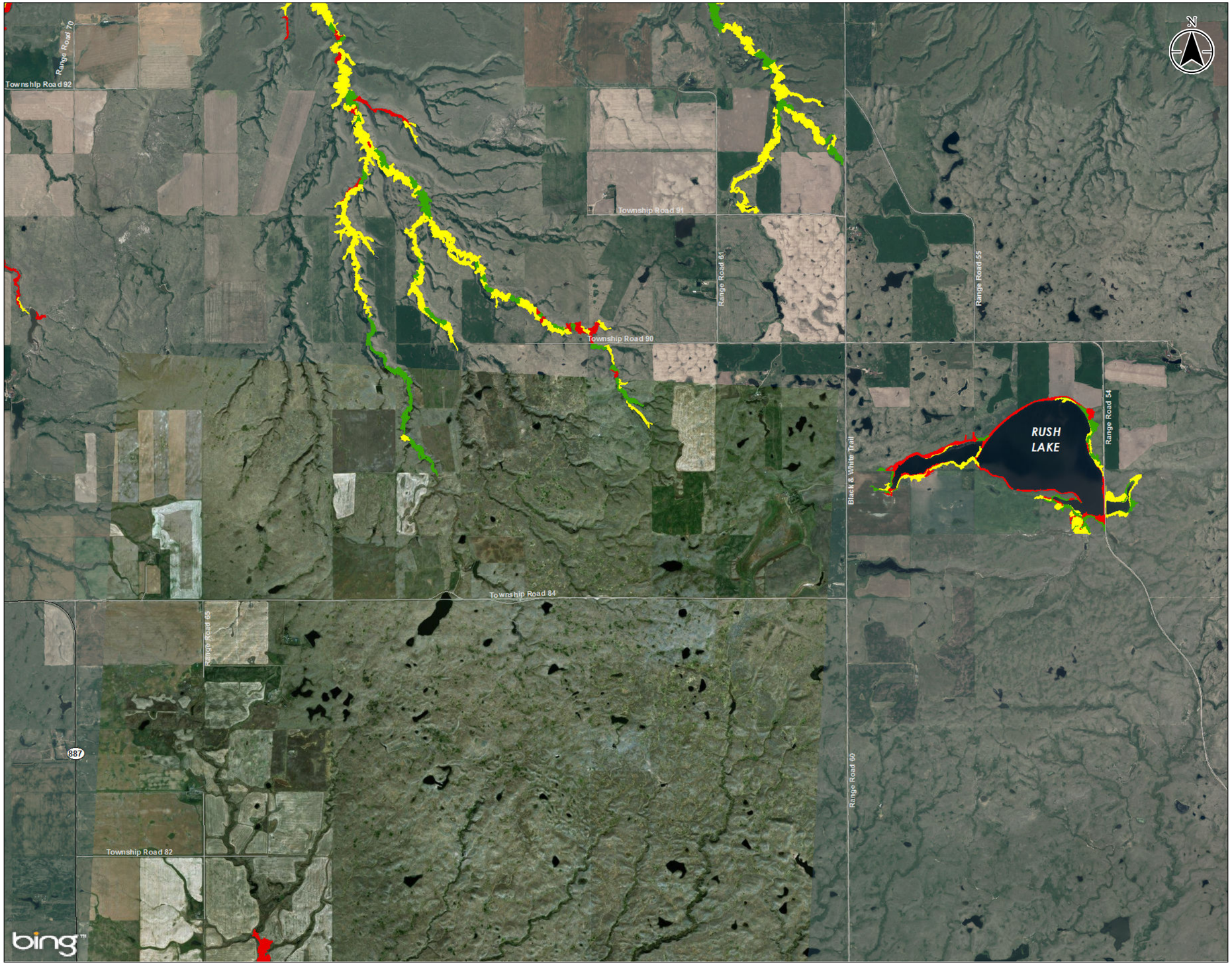

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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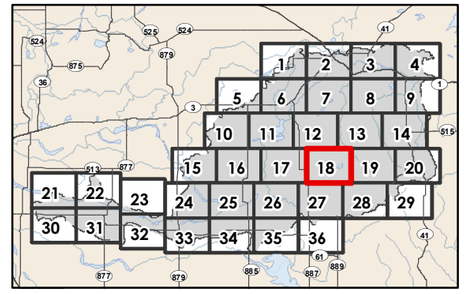

Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 18

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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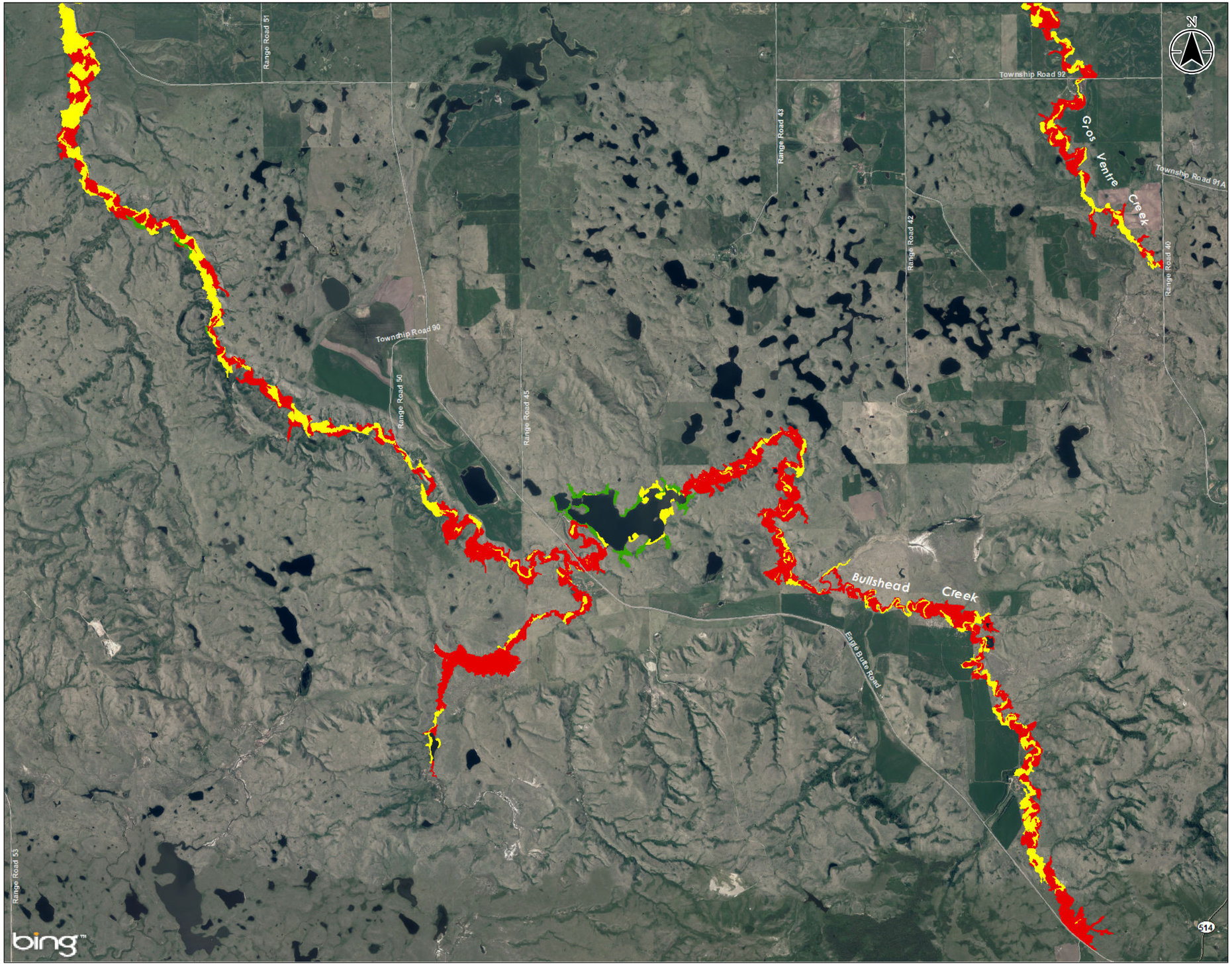

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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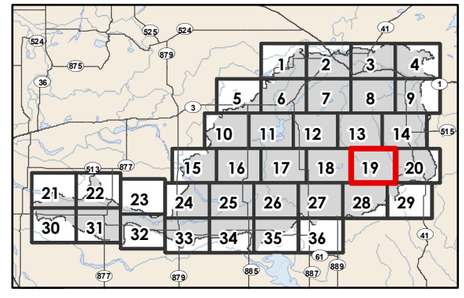

Notes

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Seven Persons Creek Sub-watershed, Alberta

111475212

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 19

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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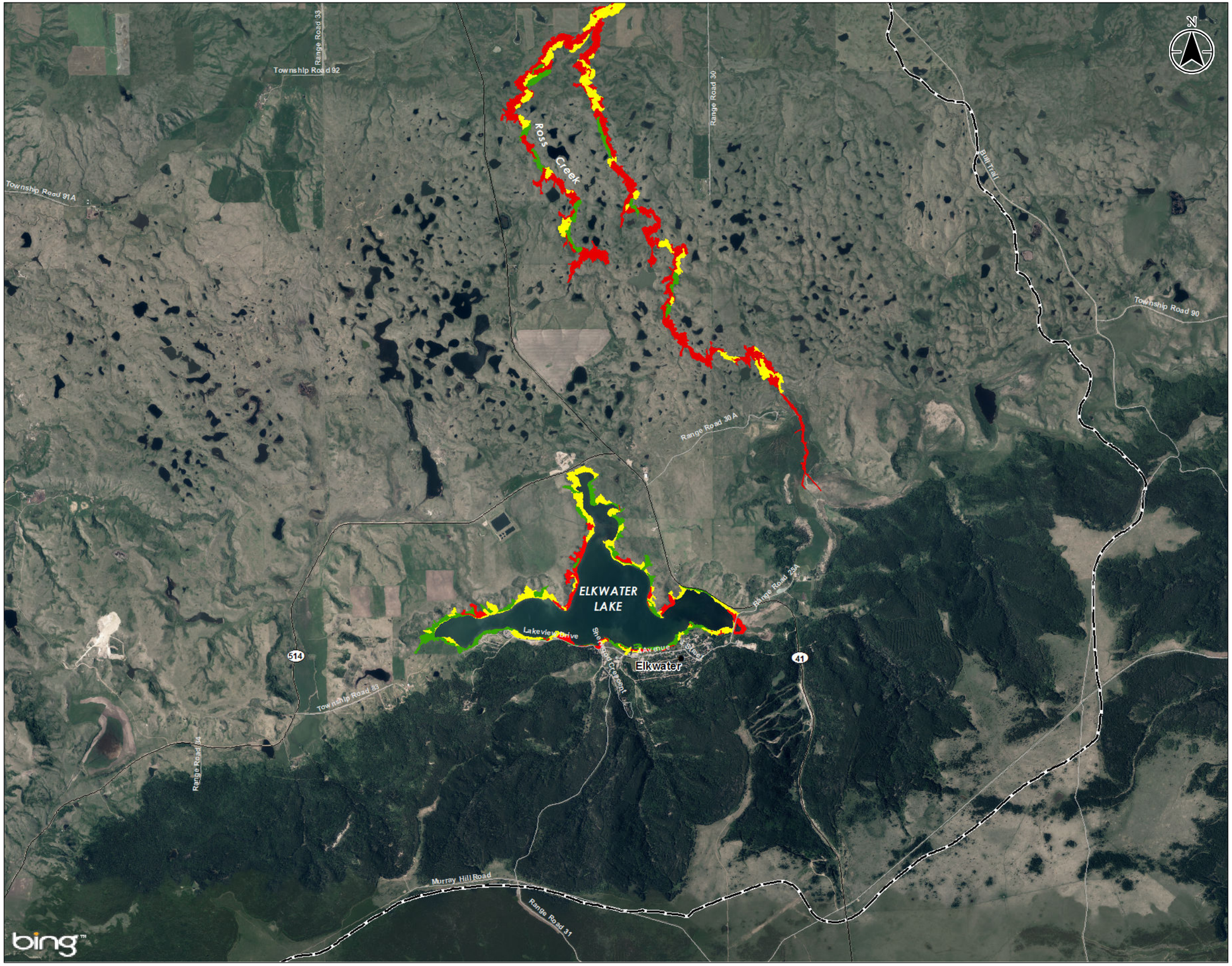

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

Healthy

Healthy With Problems

Unhealthy

LANDBASE

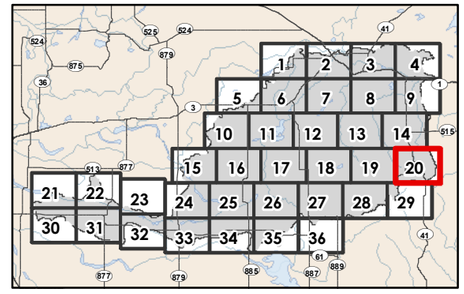
Major Road

Minor Road

Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

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Seven Persons Creek Sub-watershed, Alberta

111475212

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 20

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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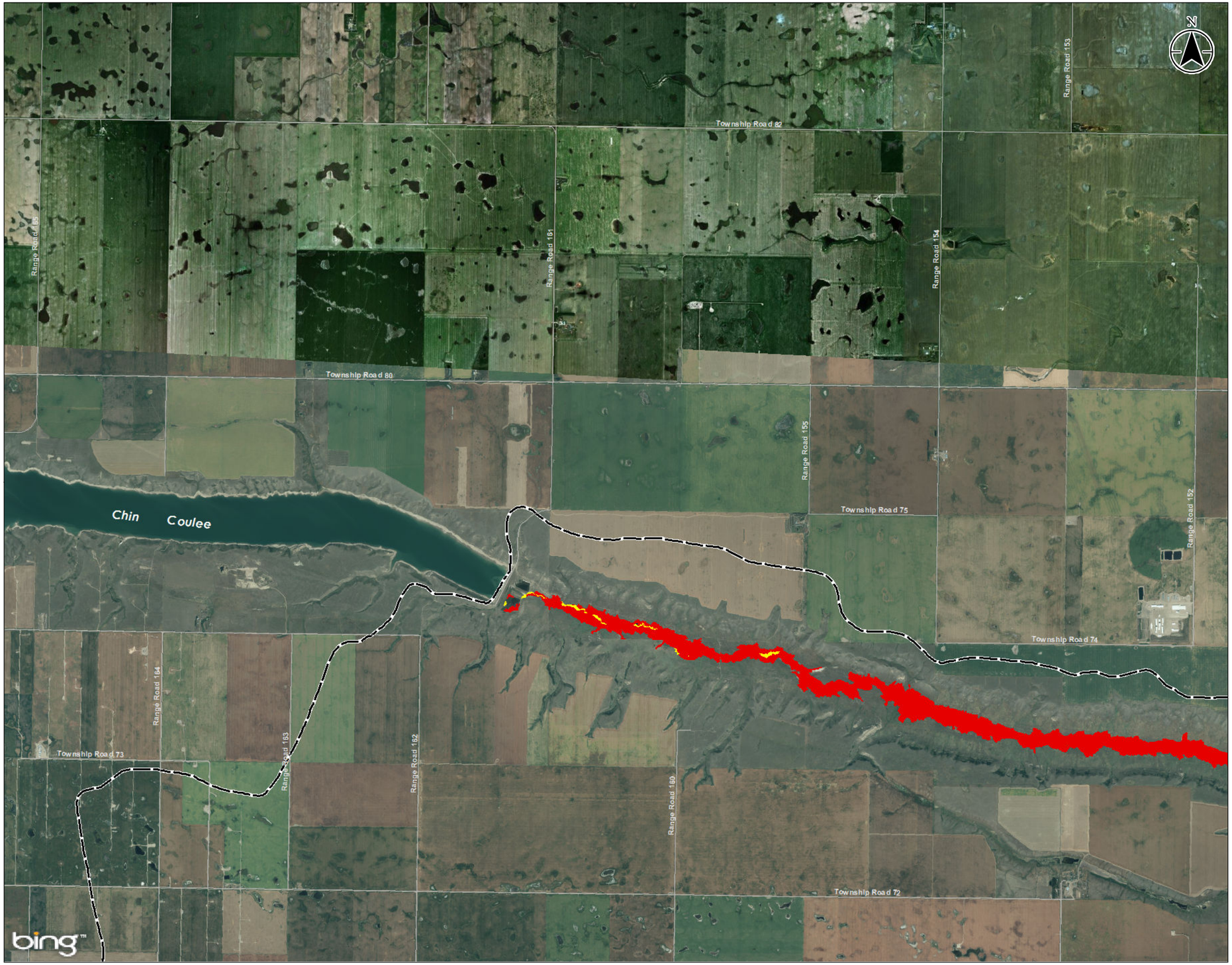

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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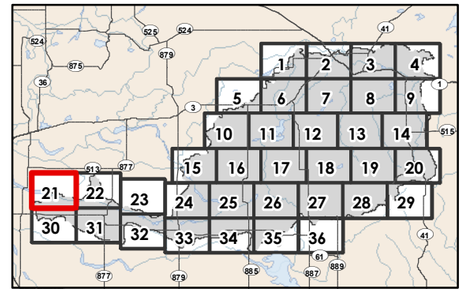

Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 21

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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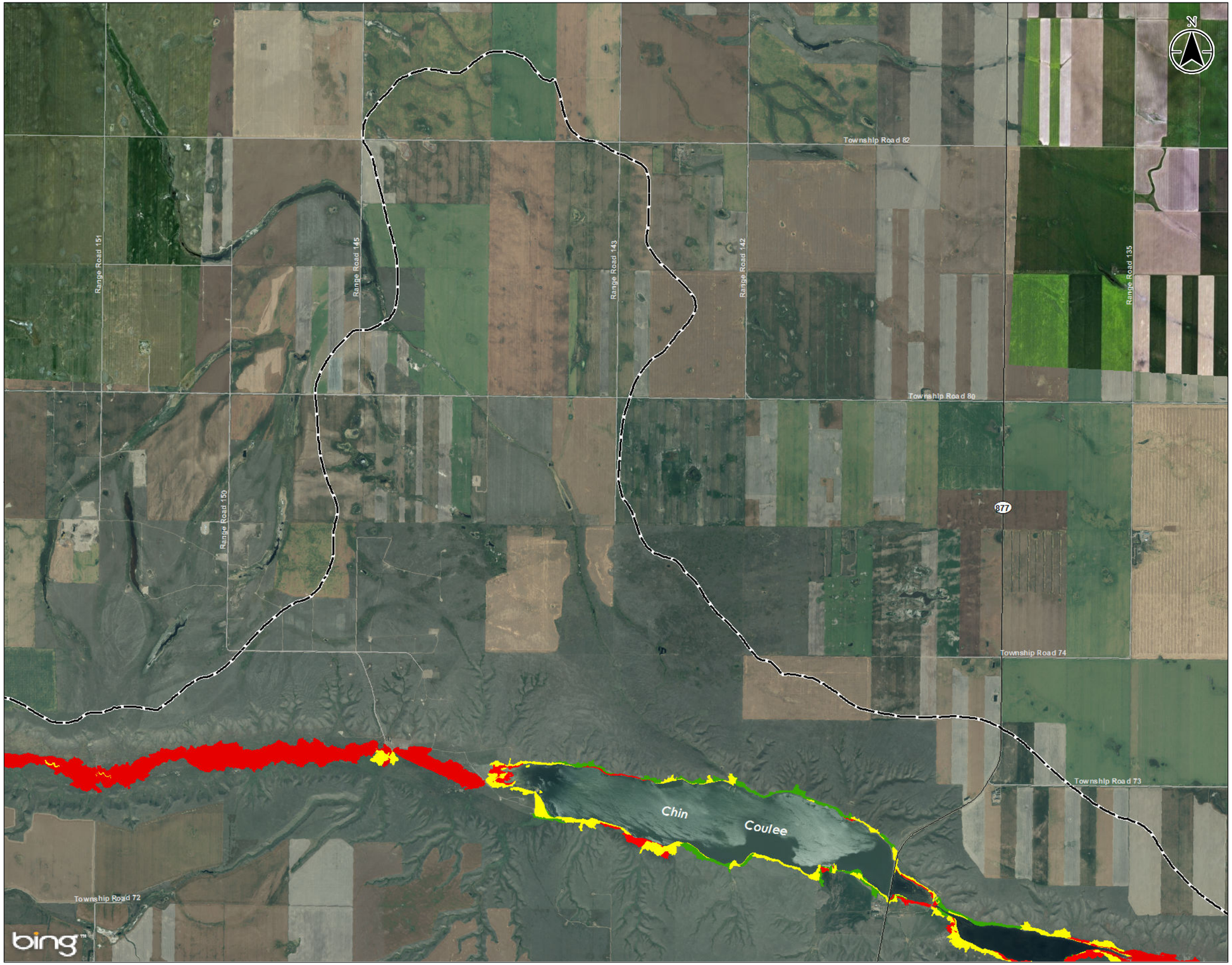

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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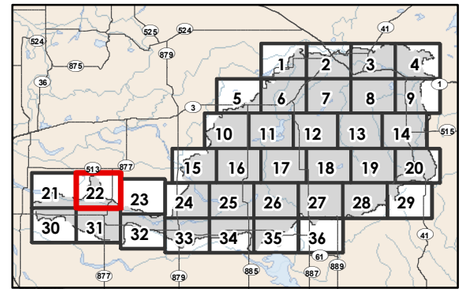

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 22

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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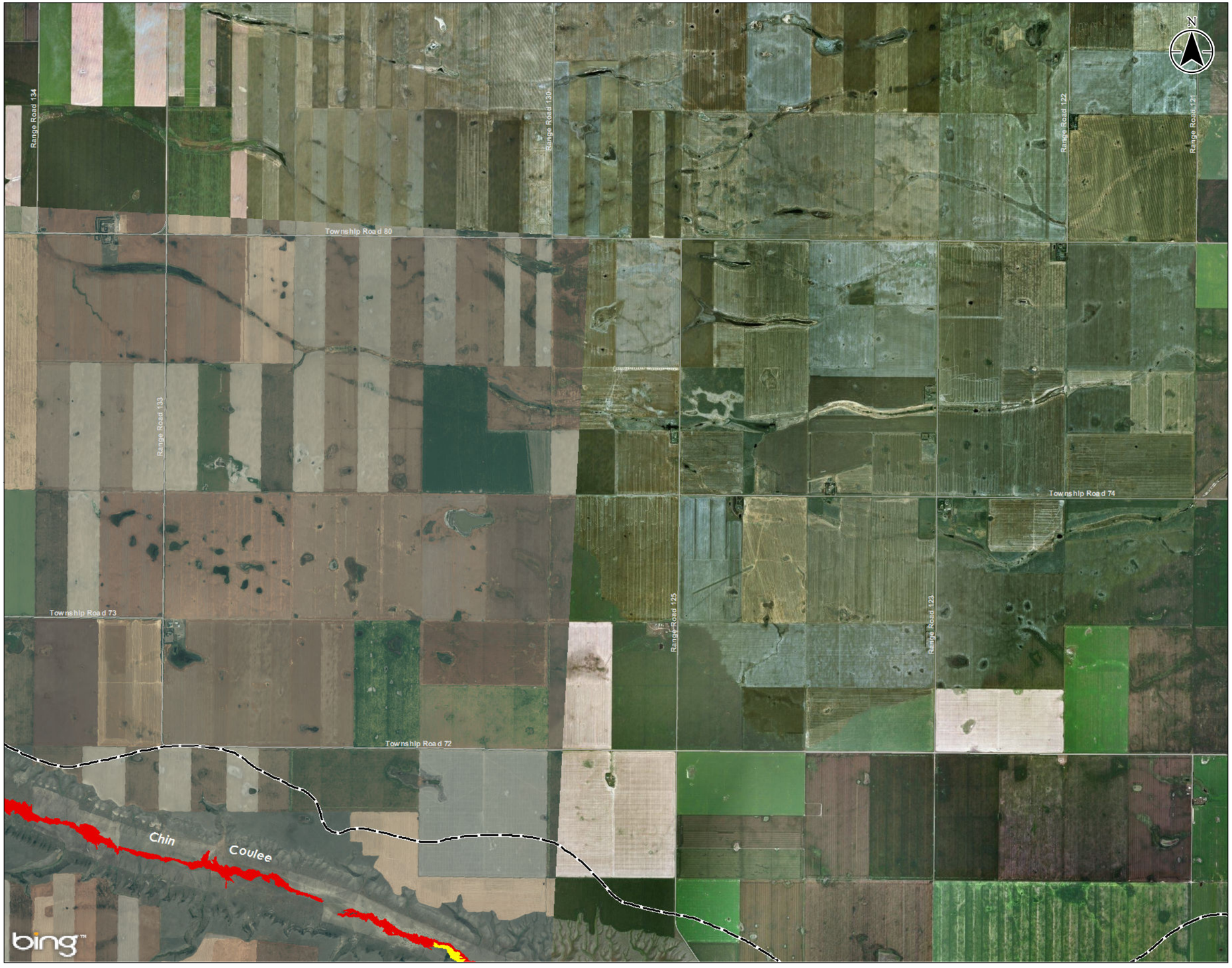


Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

Healthy

Healthy With Problems

Unhealthy

LANDBASE

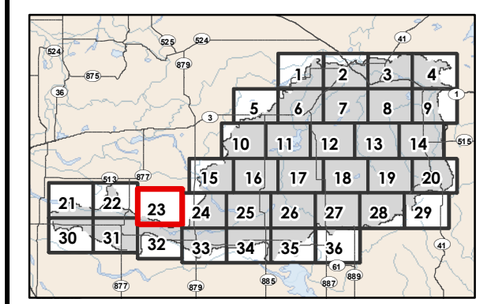
Major Road

Minor Road

Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

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Seven Persons Creek Sub-watershed, Alberta

111475212

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 23

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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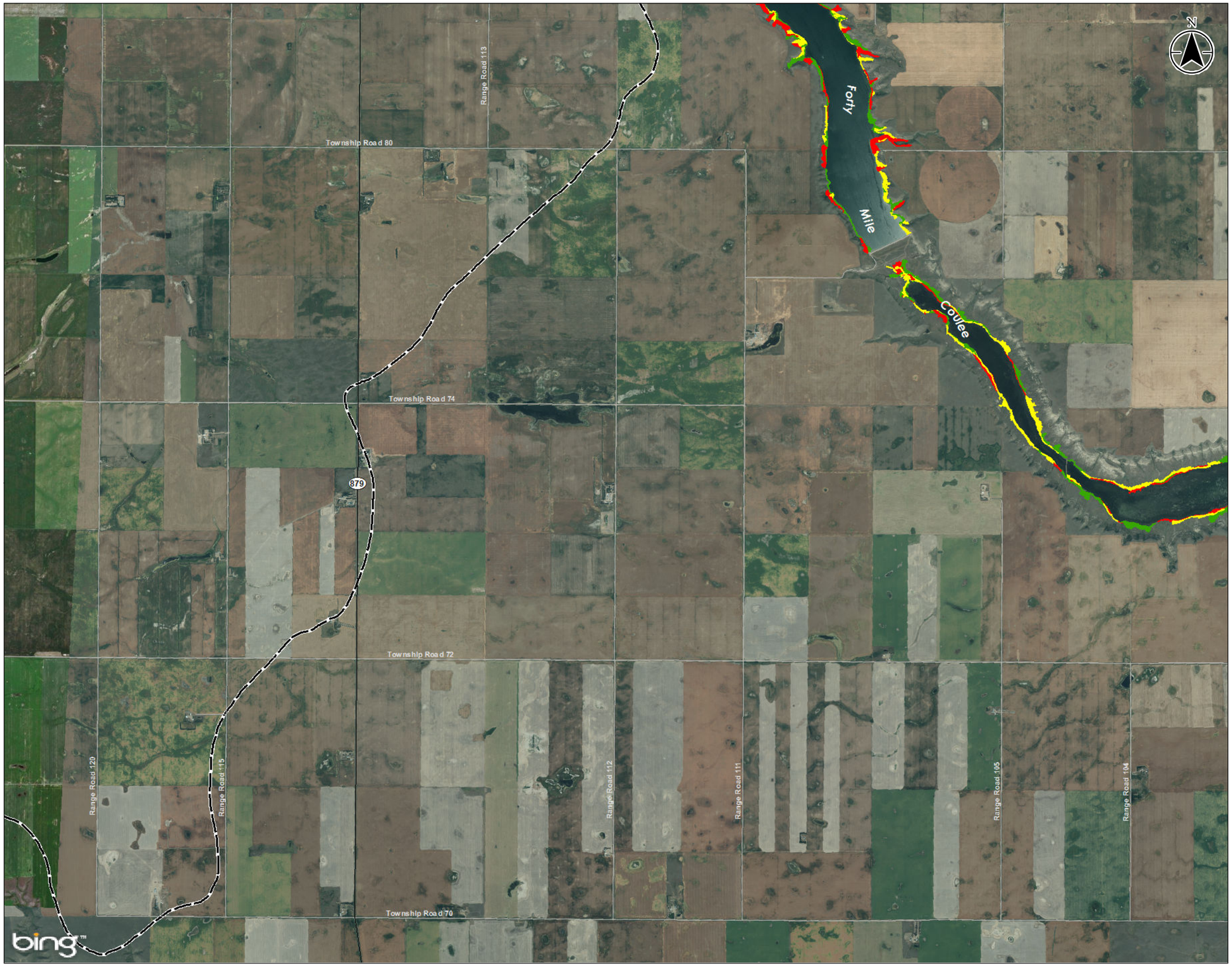


Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

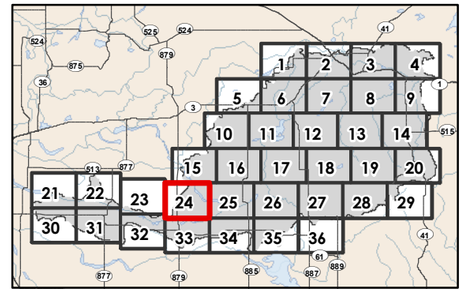
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 24

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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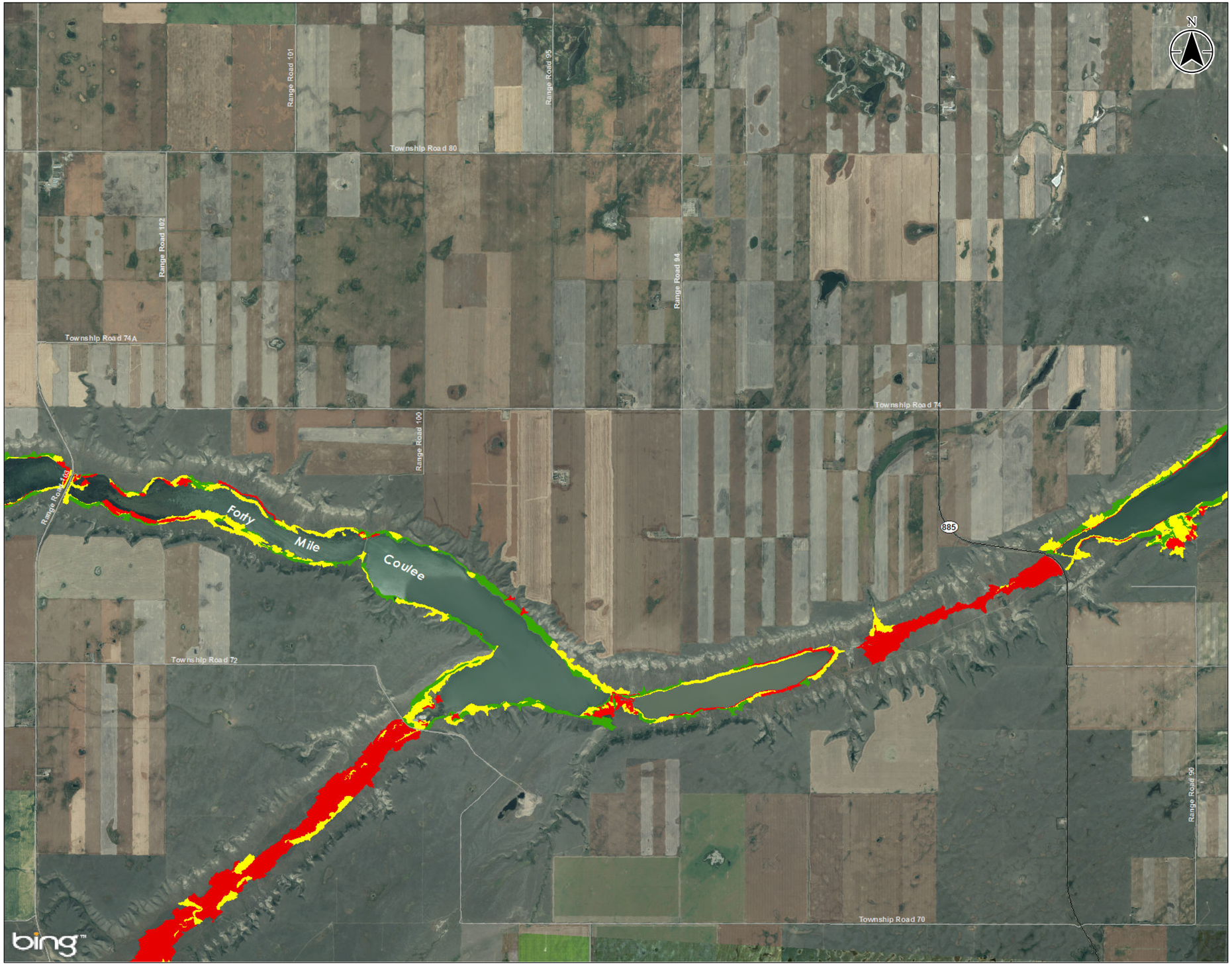


Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

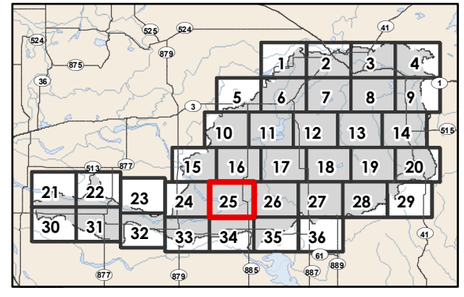
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features courtesy of Geogratis and CANVEC.
3. Orthoimagery within the Seven Persons Creek Watershed provided by the South East Alberta Watershed Alliance. Imagery beyond the SPCW boundary is provided by BING: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

Seven Persons Creek Sub-watershed, Alberta

111475212

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

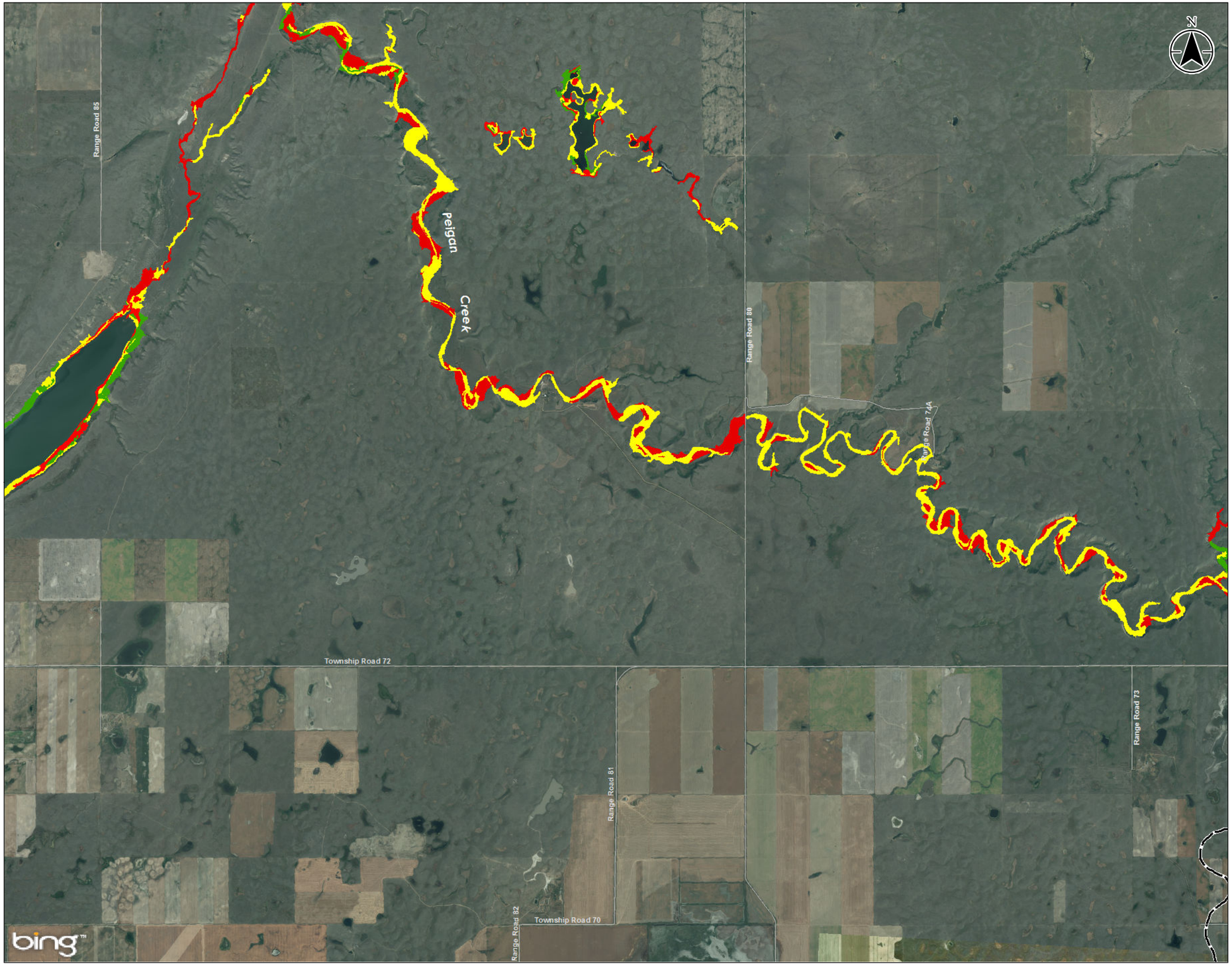
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 25

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

G:\...GIS Project Folder\SEAWA ArcMaps\Final Report\Draft 2\SEAWA_AERIparian Health - Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa



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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

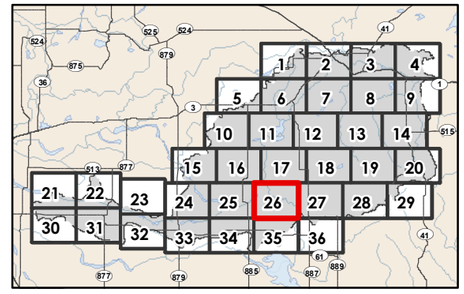
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

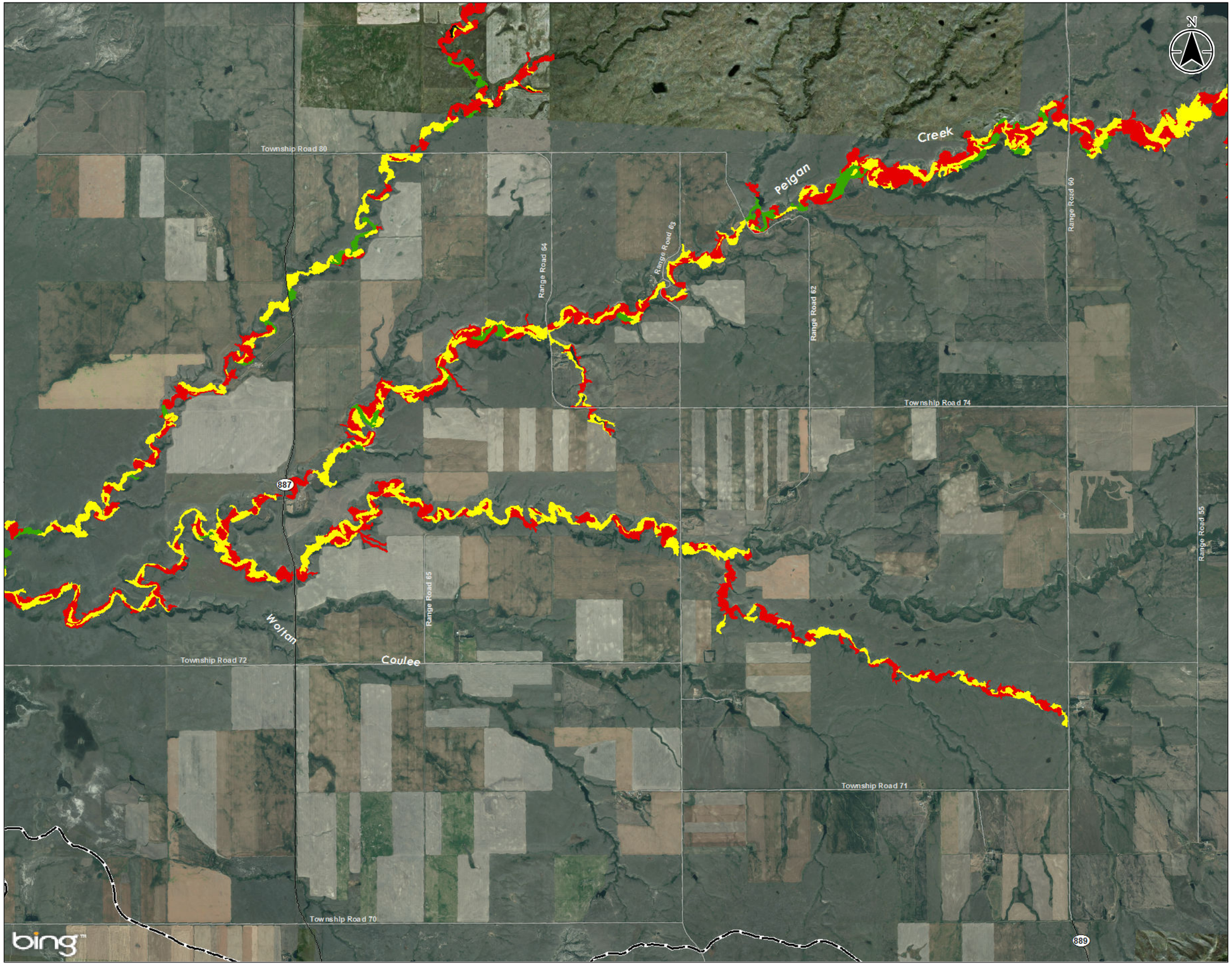
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 26

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

C:\...GIS_Project_Folder\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_AERiparian Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa



Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

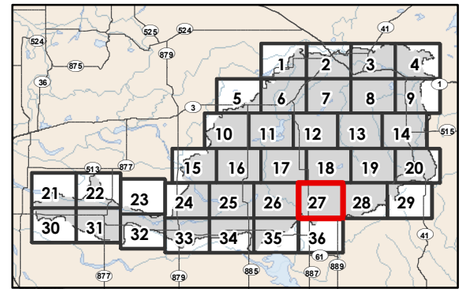
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

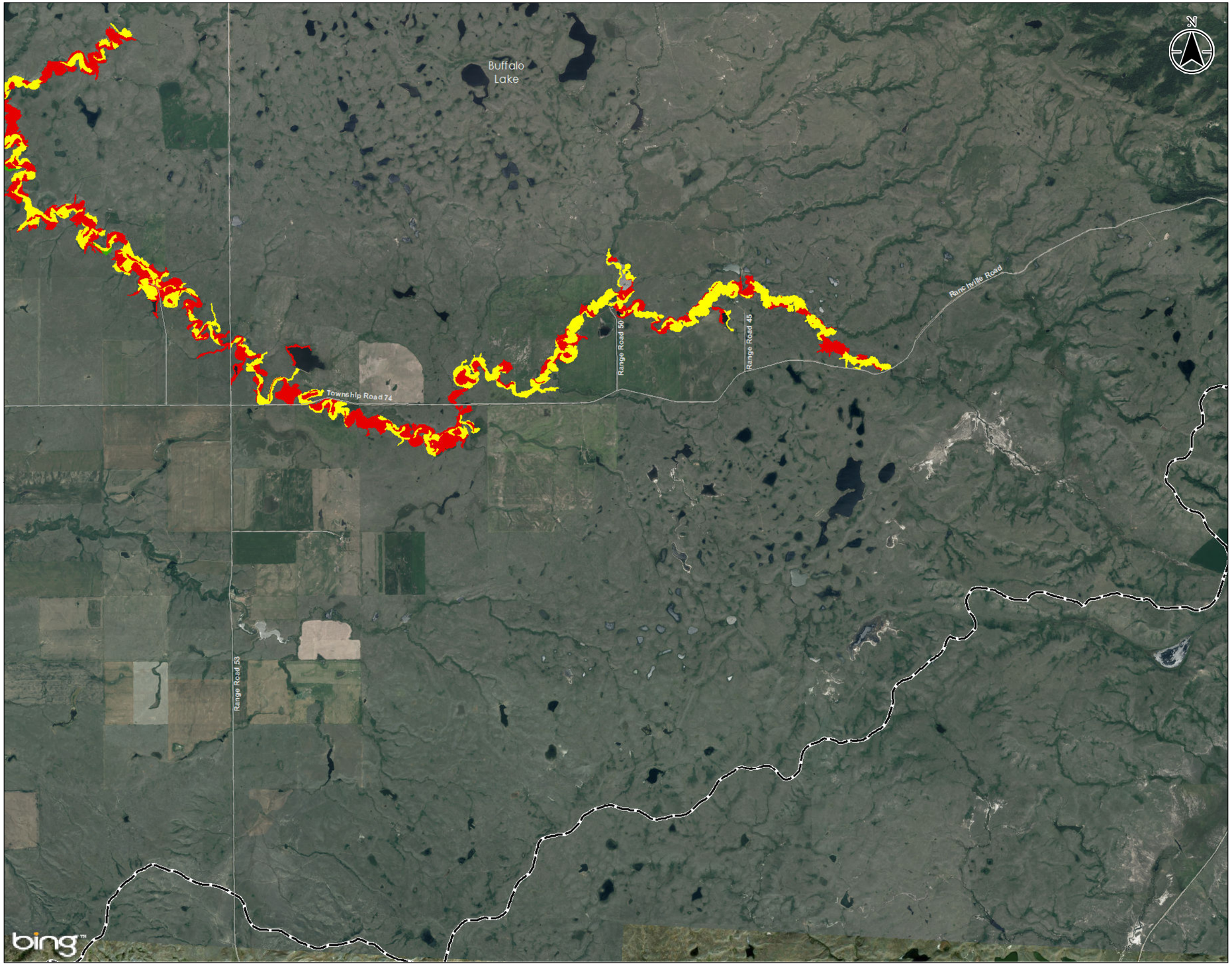
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 27

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

C:\...\GIS_Project_Folder\...\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_AERiparian Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa



Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

Healthy

Healthy With Problems

Unhealthy

LANDBASE

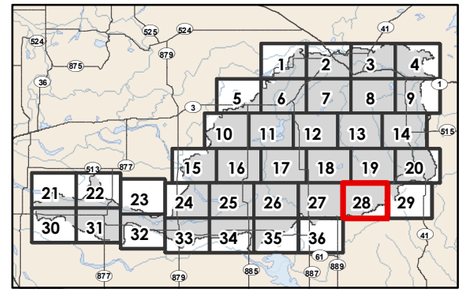
Major Road

Minor Road

Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 28

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

C:\...GIS_Project_Folder\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_AllRiparian Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa

Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

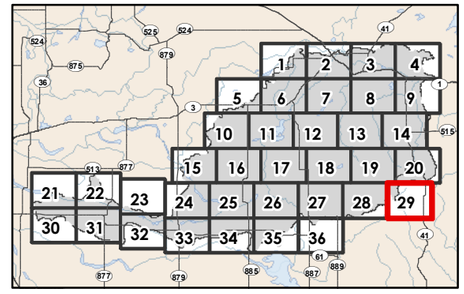
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 29

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

G:\...\GIS_Project_Folder\SEAWA\ArcMap\Final Report Draft 2\SEAWA_AllRiparian Health_Mapbook_20180327.mxd Revised 2018-04-30 By: gkroupa

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

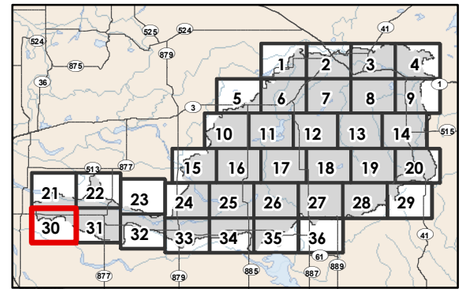
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 30

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

C:\ GIS Project Folders\SEAWA\ArcMaps\Final Report\Draft 2\SEAWA_AIRiparian Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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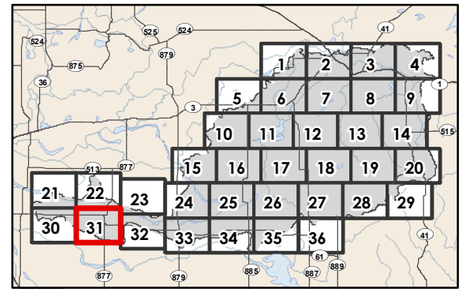

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 31

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

G:\...\GIS_Project_Folder\SEAWA\ArcMap\Final Report Draft 2\SEAWA_AIRiparian Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

Healthy

Healthy With Problems

Unhealthy

LANDBASE

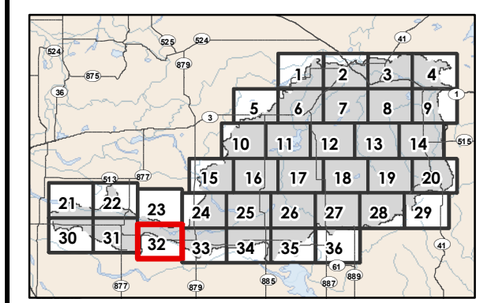
Major Road

Minor Road

Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

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Seven Persons Creek Sub-watershed, Alberta

111475212

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 32

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

G:_GIS_Project_Folder\SEAWA\ArcMaps\Final Report\Draft 2\SEAWA_AllRiparian_Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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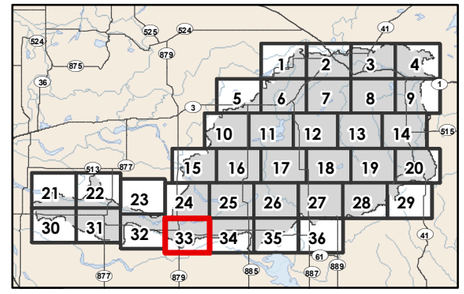

Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 33

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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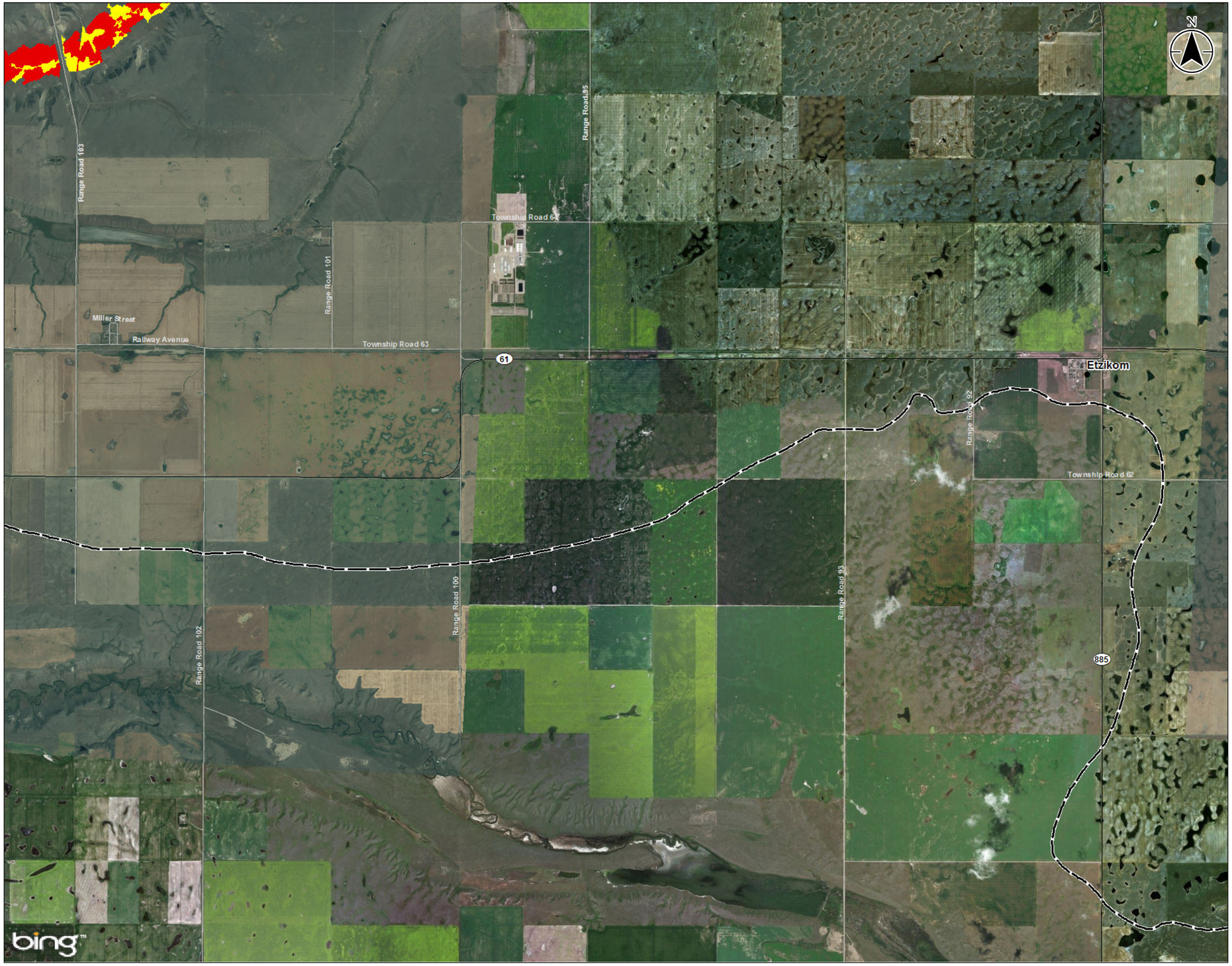

Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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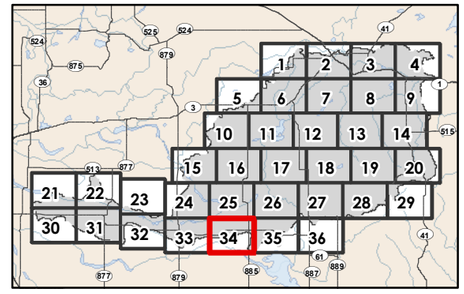

Notes

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 34

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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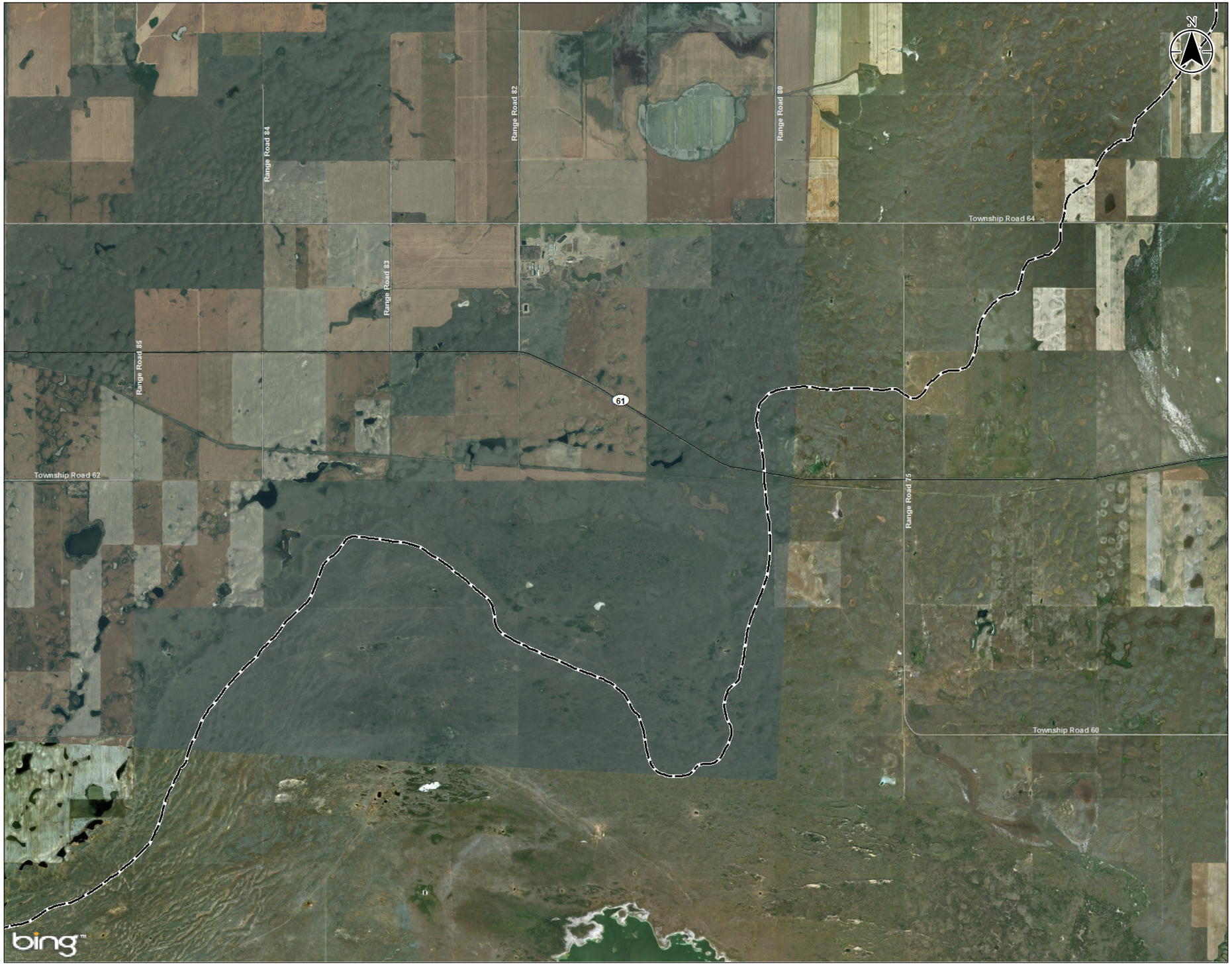

Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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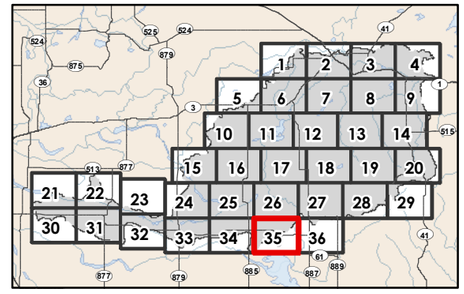

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 35

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

G:\...\GIS_Project_Folder\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_AllRiparian Health_Mapbook_20180327.mxd Revised: 2018-04-30 By: gkroupa

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

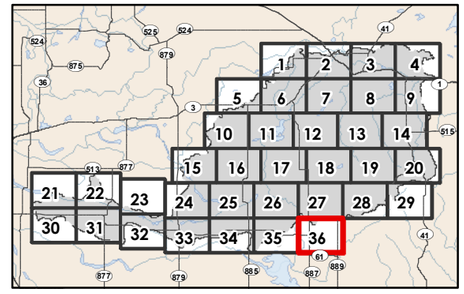
- Healthy
- Healthy With Problems
- Unhealthy

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

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Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

7 - 36

Lotic & Lentic Riparian Health Assessment in the Seven Persons Creek Watershed

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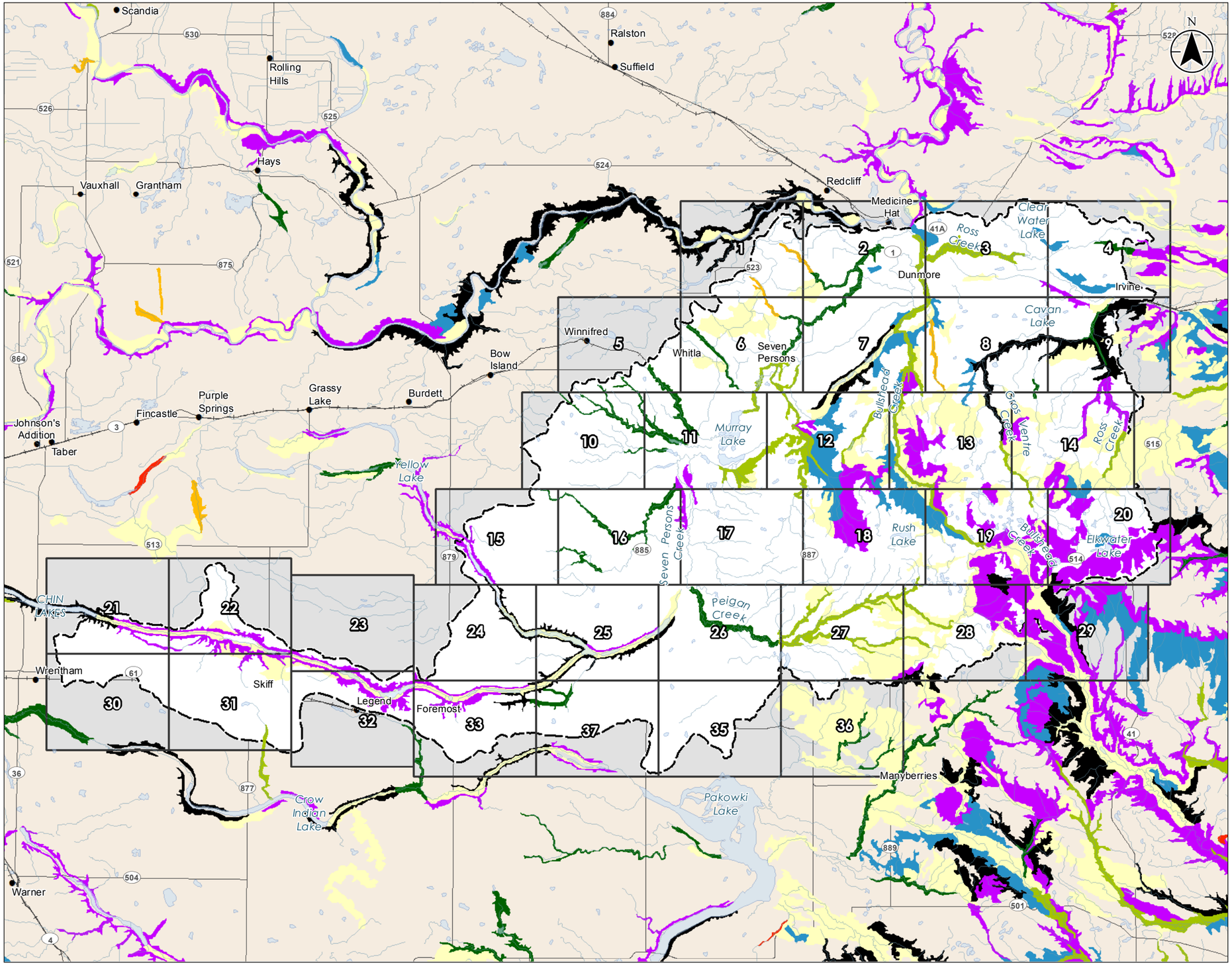

Stantec

PROJECT DATA

- Seven Persons Creek Watershed
- Map Index (1:50,000)

LANDSCAPE MODEL - SURFACE FORM

- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE

- Community
- Major Road
- Rail
- Watercourse
- Waterbody

0 10 20 Kilometres

1:500,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features obtained from the Government of Canada.

111475212

Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-10
Review by gkroupa on 2018-04-10

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8

Title

Index Map for Landscape Model Surface Form in the Seven Persons Creek Watershed

G:_GIS_Project_Folder\SEAWA\ArcMaps\Final Reports\Draft 2\SEAWA_Landform_MapGrid_20180410.mxd Revised: 2018-04-10 By: GKroupa

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PROJECT DATA

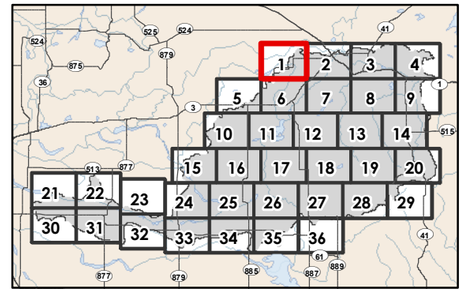
Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres
1:50,000 (At original document size of 11x17)



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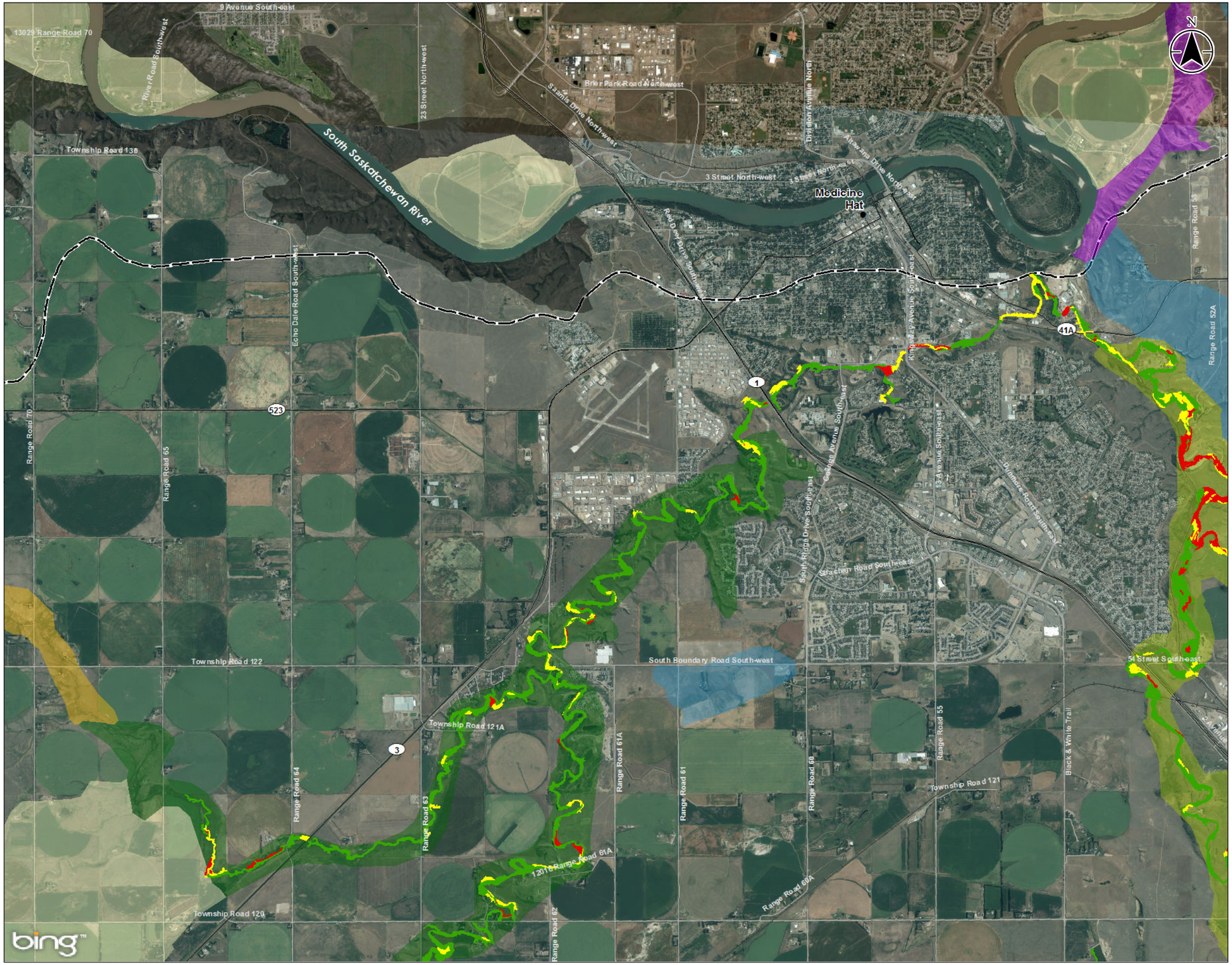
Client/Project
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.
8 - 1

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

C:\...GIS_Project_Folder\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_LandItem_Mapbook_20180410.mxd Revised 2018-04-30 By: gkroupa



Stantec

PROJECT DATA

Seven Persons Creek Watershed

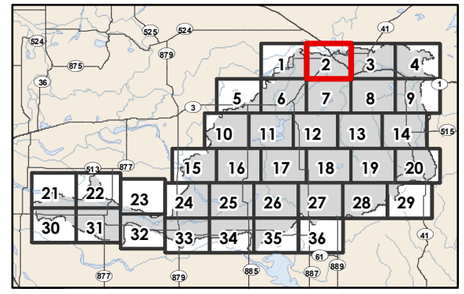
Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Client/Project

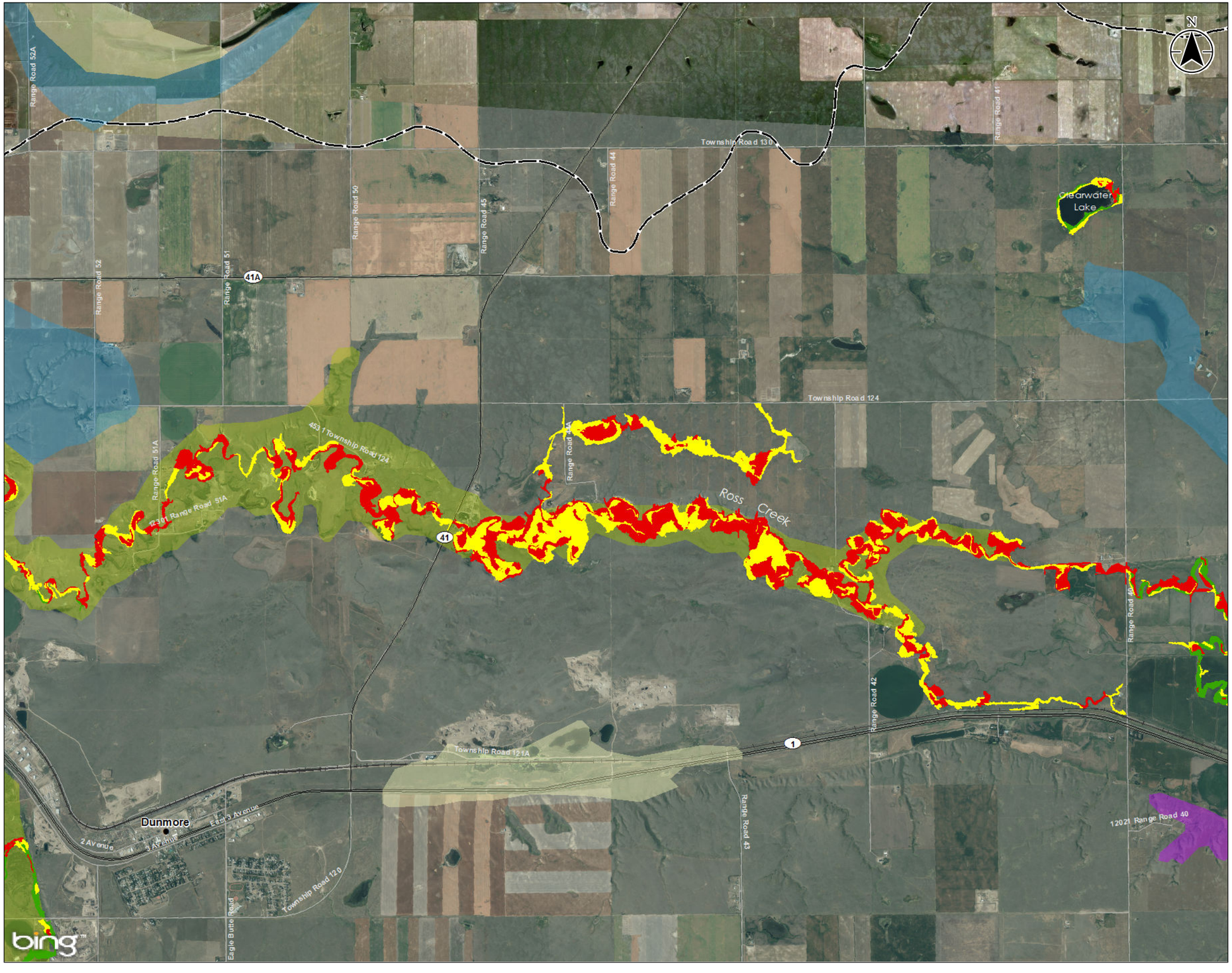
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 2

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

C:\...GIS_Project_Folder\SEAWA\ArcMaps\Final Report\Draft 2\SEAWA_Landform_Mapbook_20180410.mxd Revised 2018-04-30 By: gkroupa



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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form

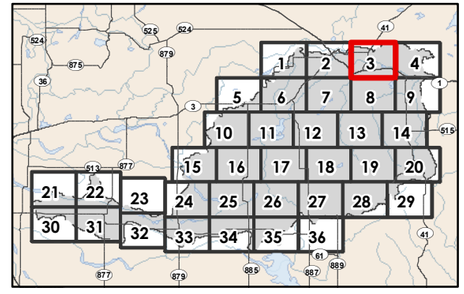
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features courtesy of Geogratis and CANVEC.
3. Orthoimagery within the Seven Persons Creek Watershed provided by the South East Alberta Watershed Alliance. Imagery beyond the SPCW boundary is provided by BING: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

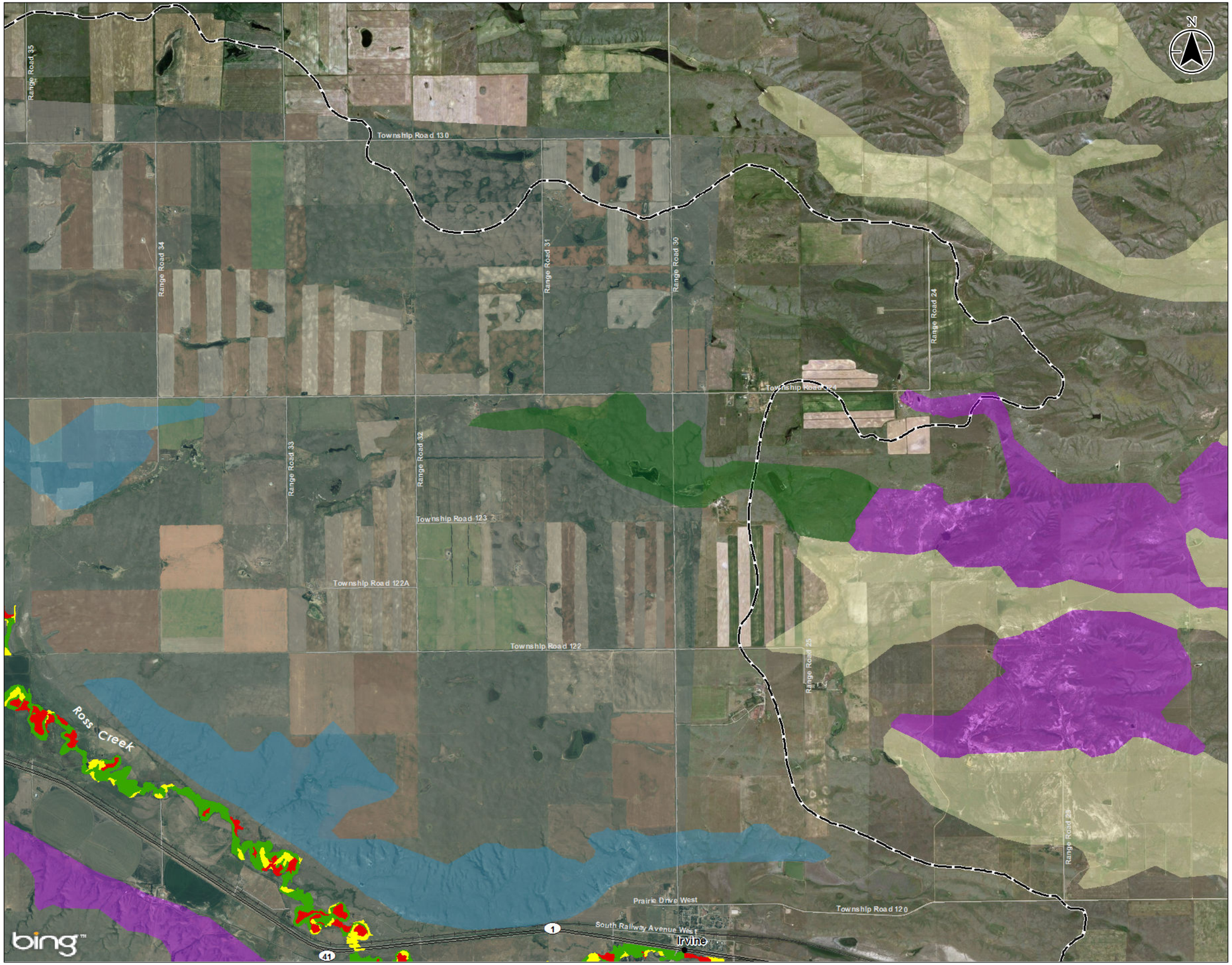
Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 3

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed



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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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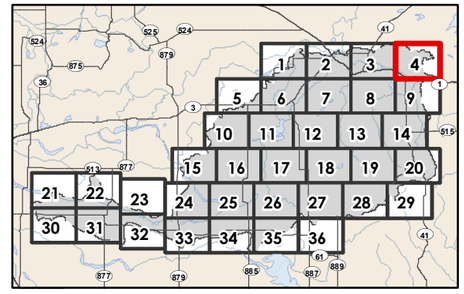

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 4

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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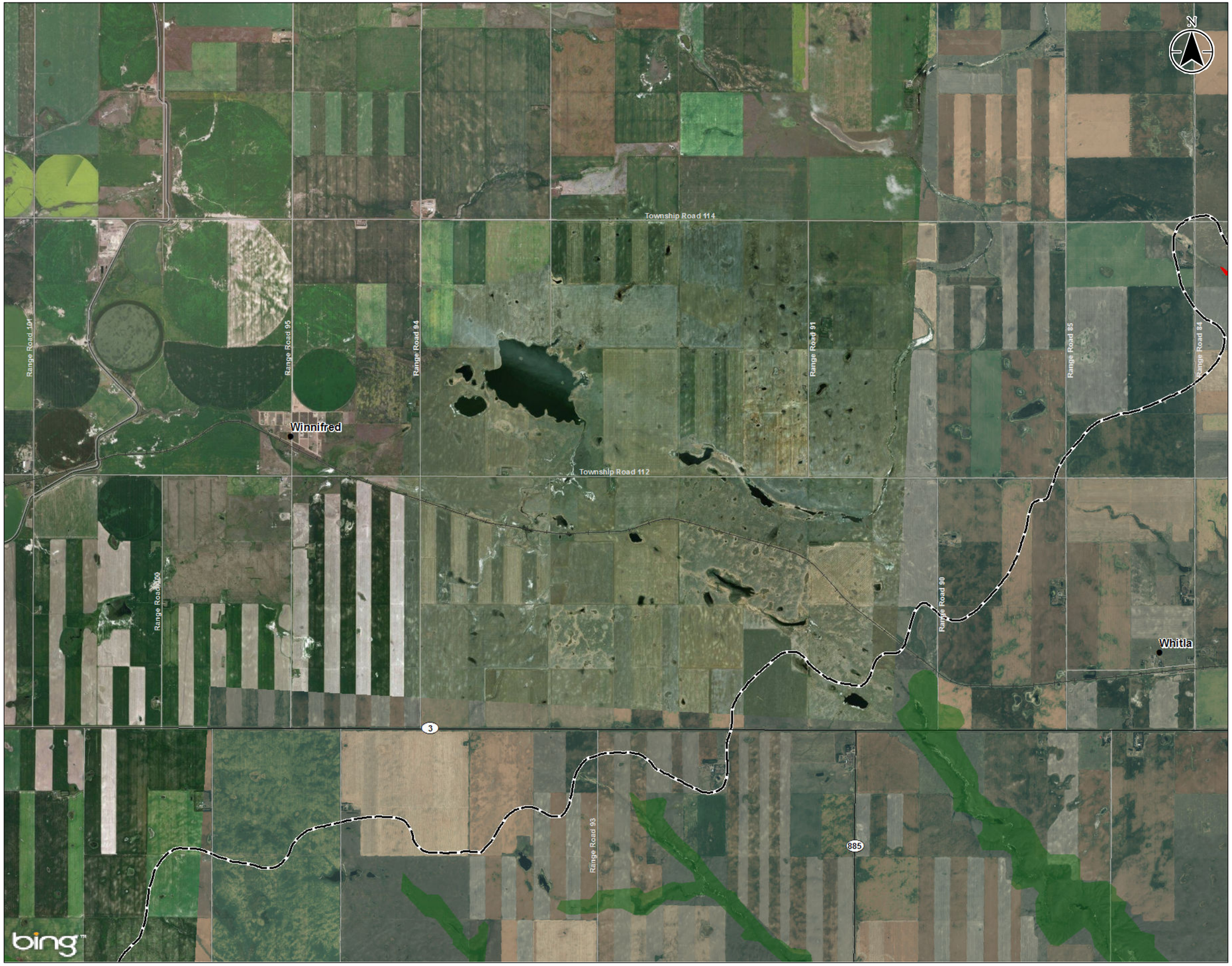

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE

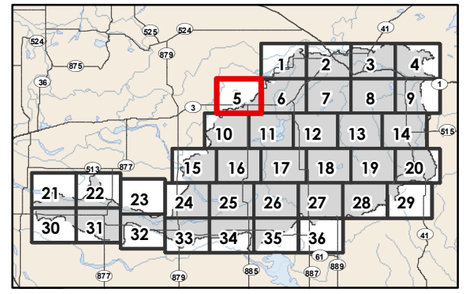
Major Road

Minor Road

Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 5

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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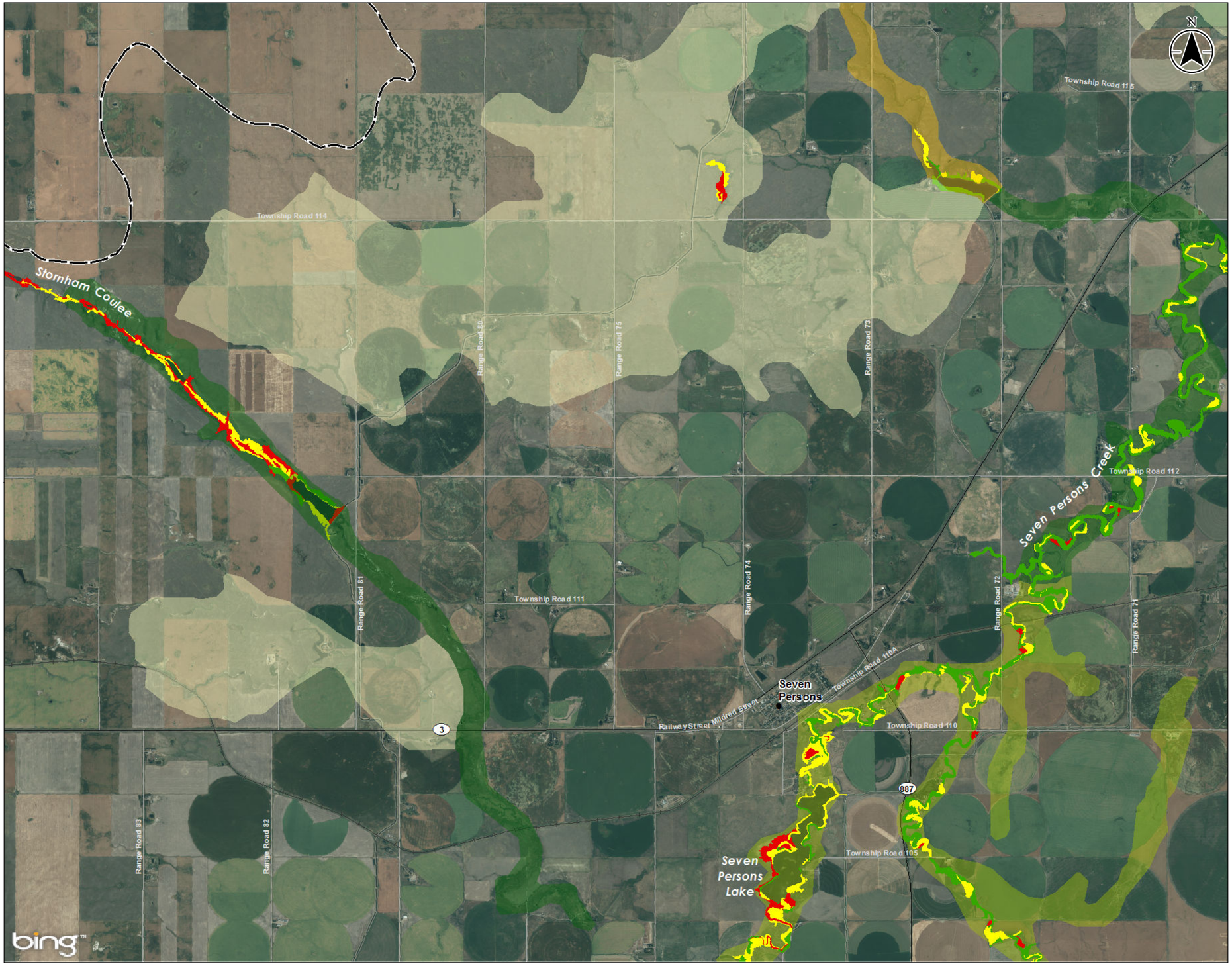

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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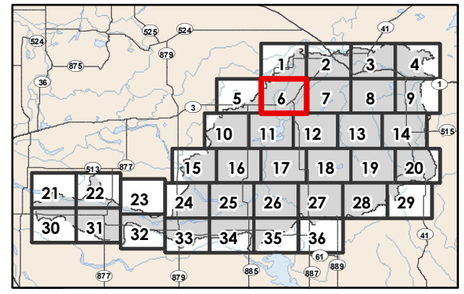

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

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SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 6

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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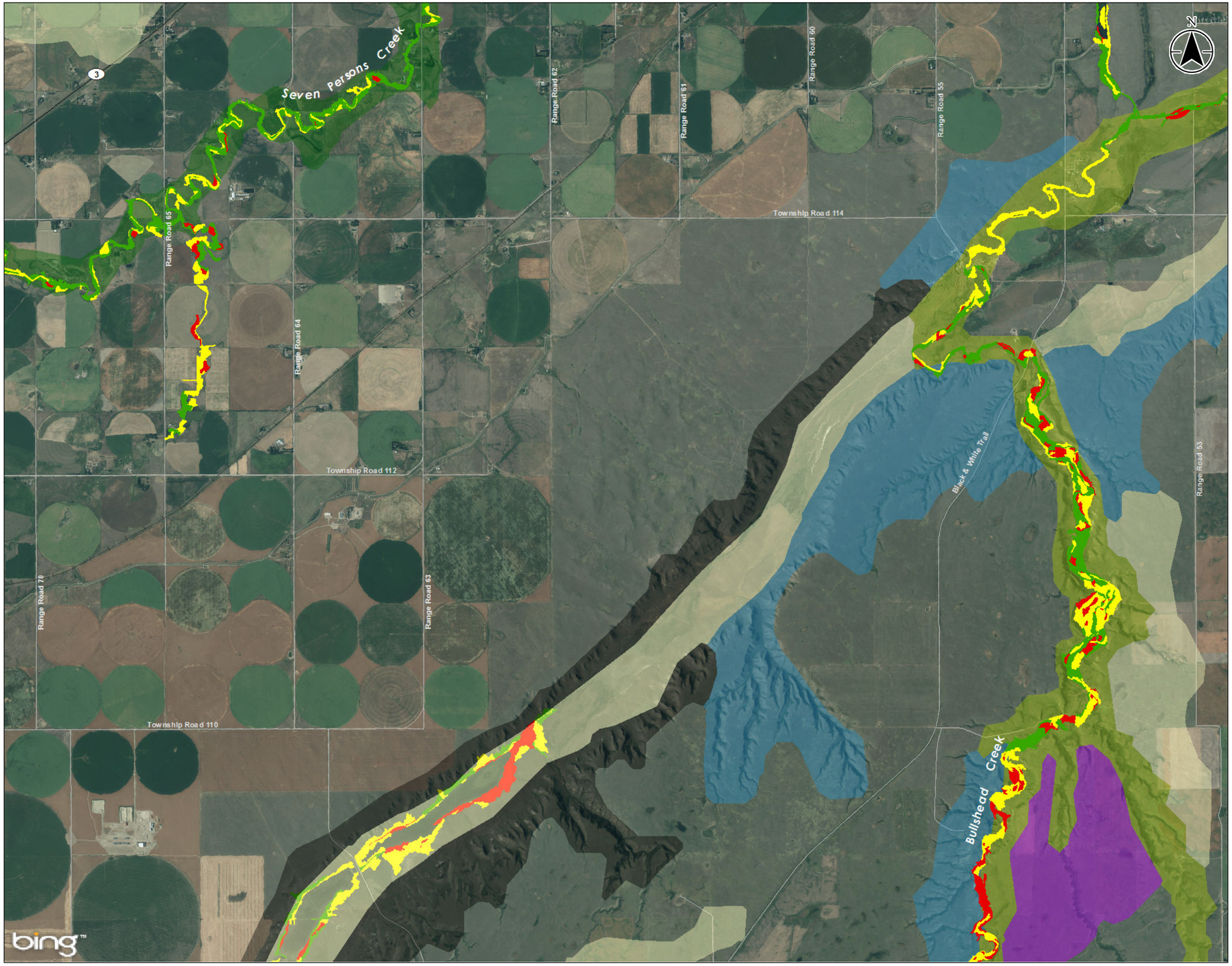

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form

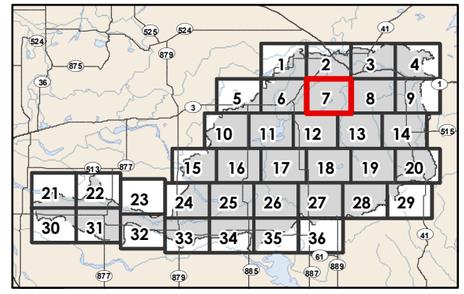
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 7

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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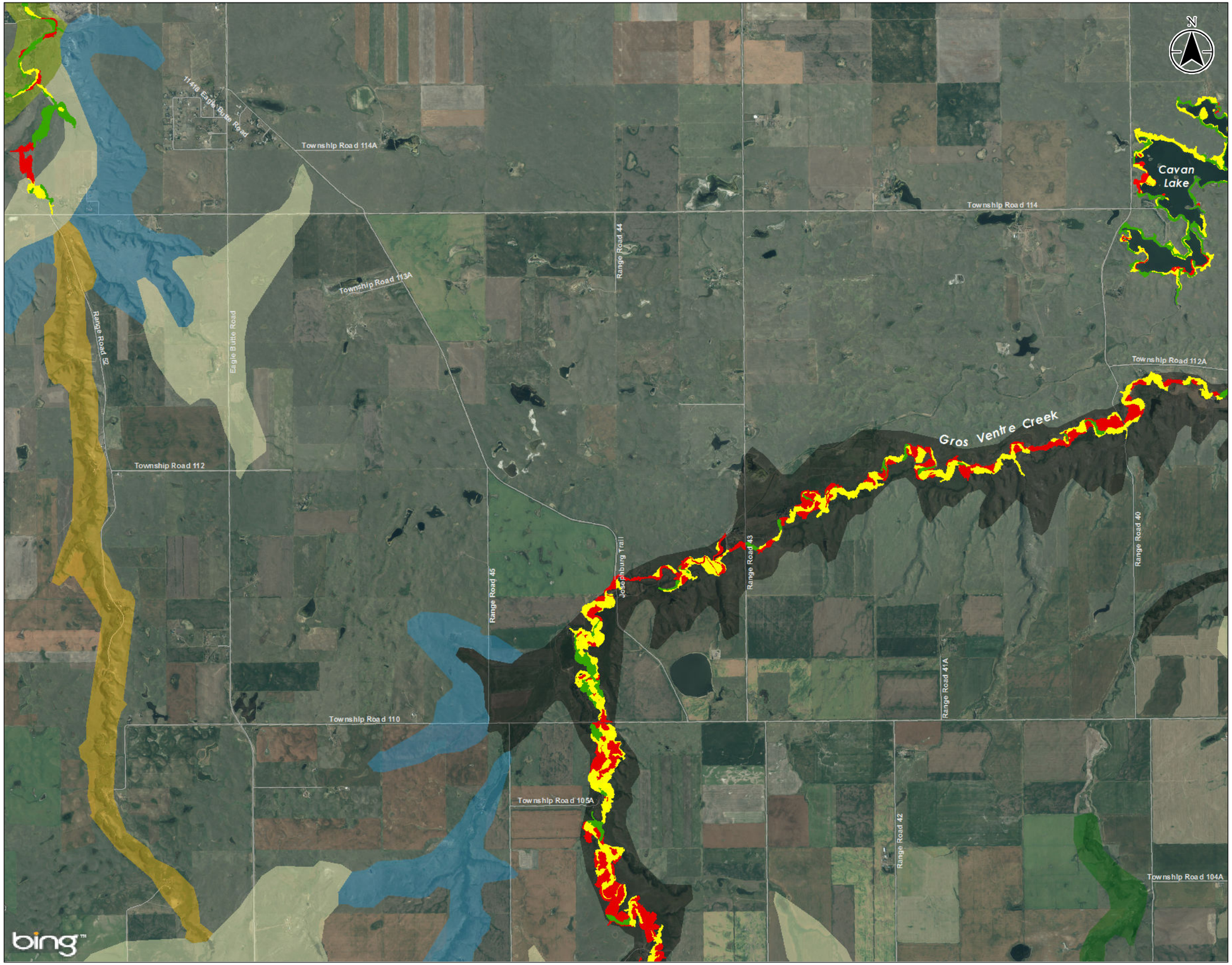

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
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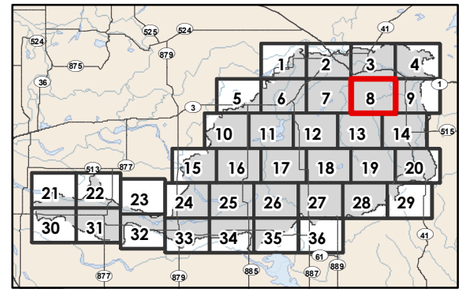
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

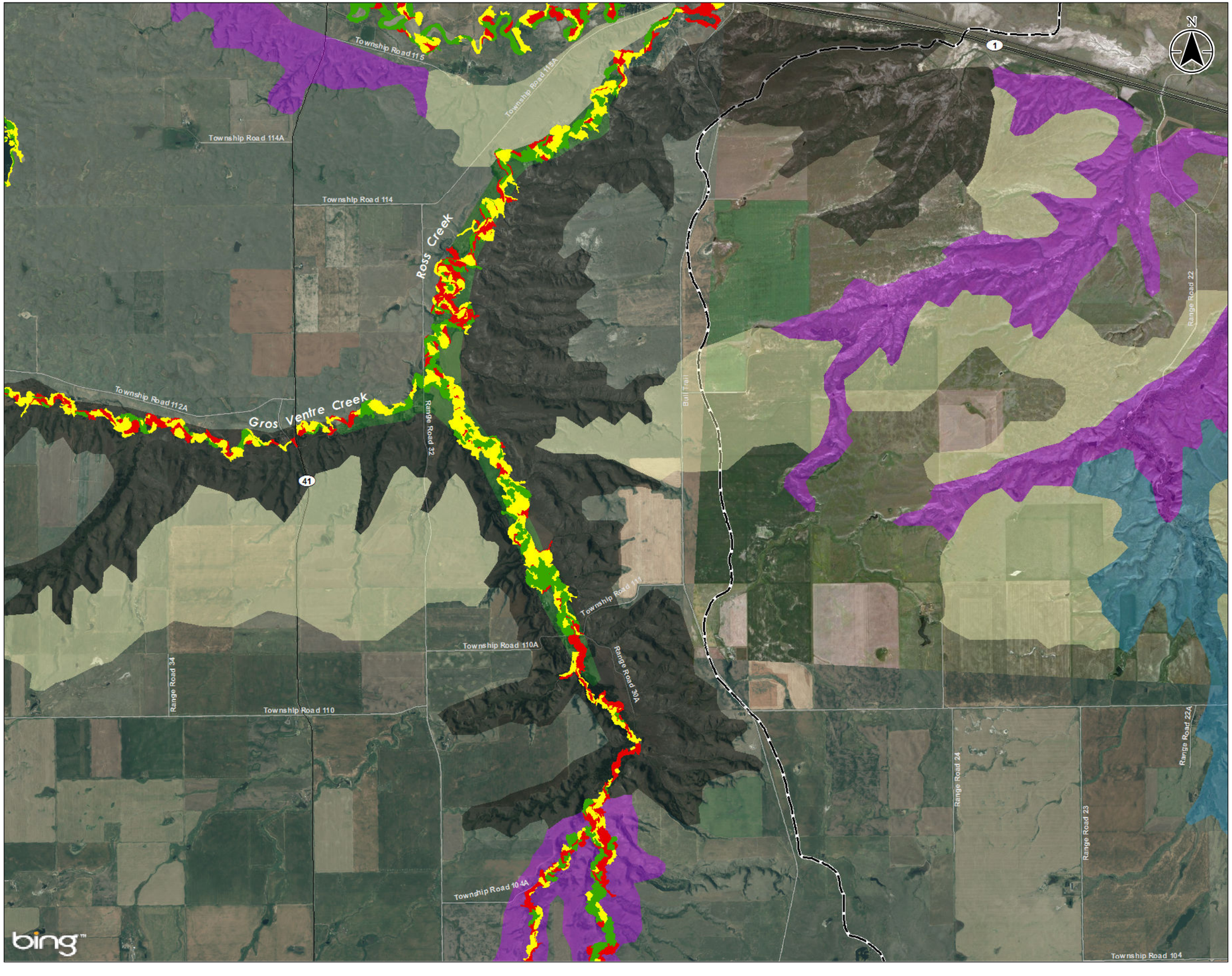
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 8

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

G:\...\GIS_Project_Folder\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_Landform_Mapbook_20180410.mxd Revised 2018-04-30 By: gkroupa



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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

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Landscape Model- Surface Form

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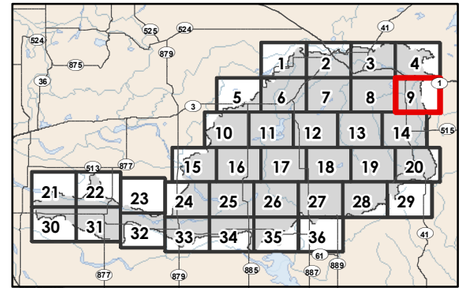
- Sub-glacial Channel (incised)

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes

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Seven Persons Creek Sub-watershed, Alberta

111475212

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 9

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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PROJECT DATA

Seven Persons Creek Watershed

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Landscape Model- Surface Form
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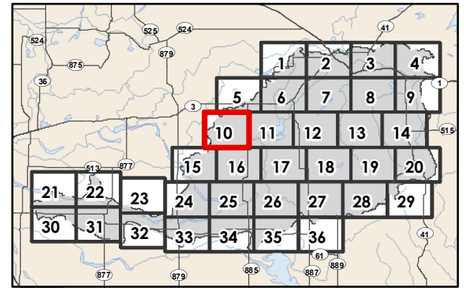
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres
1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 10

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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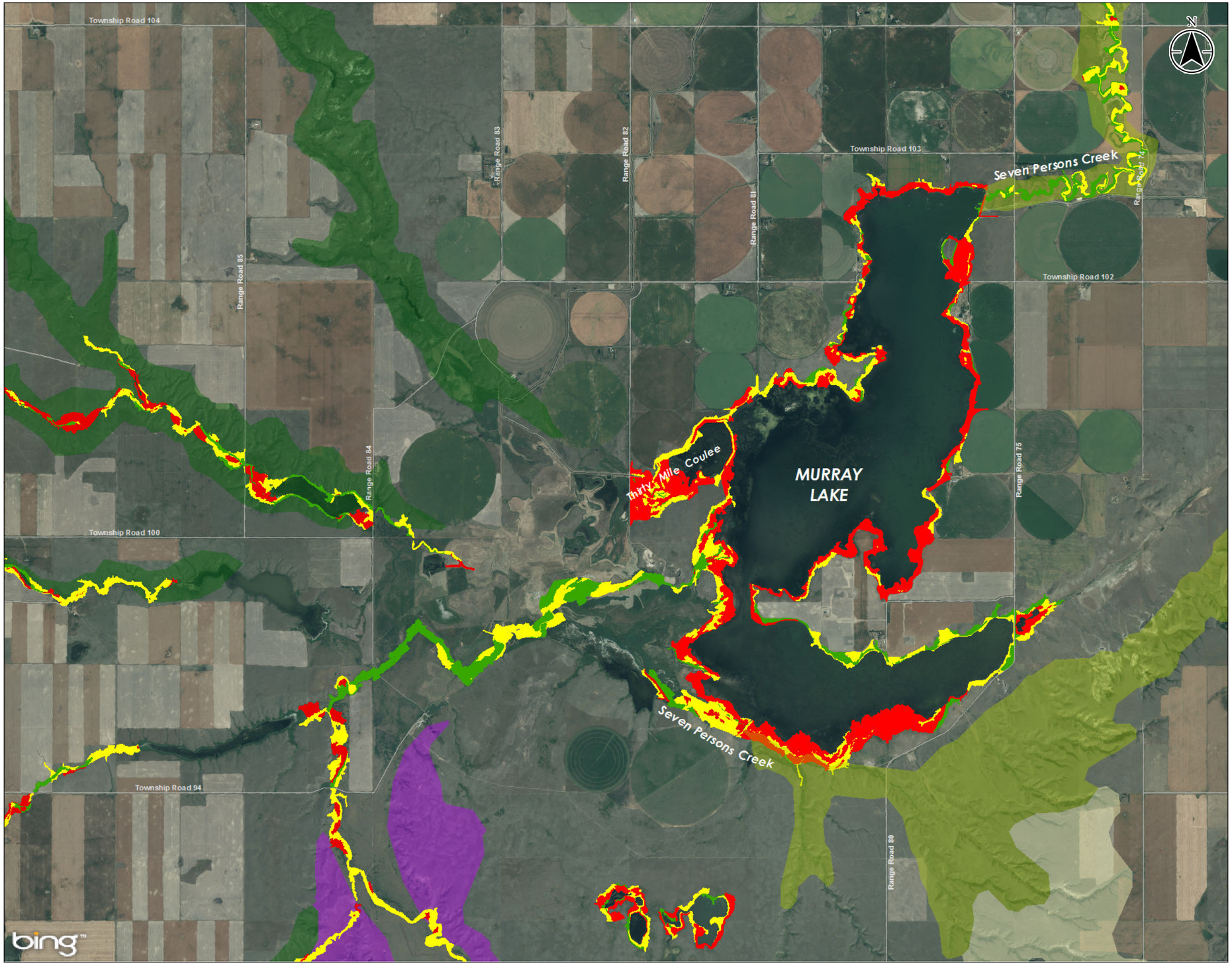

Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
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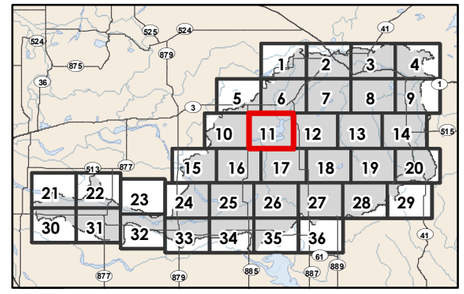
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 11

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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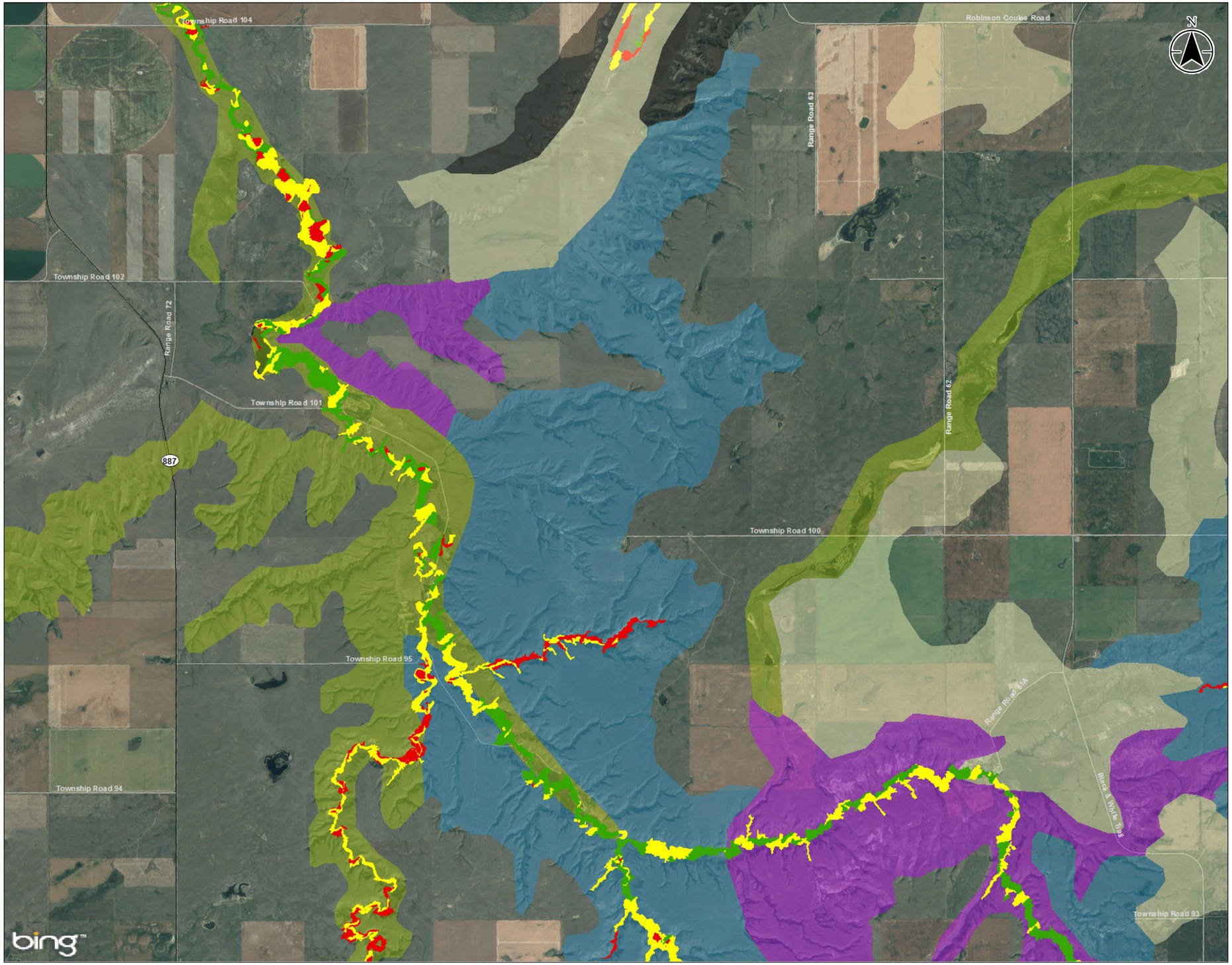

Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
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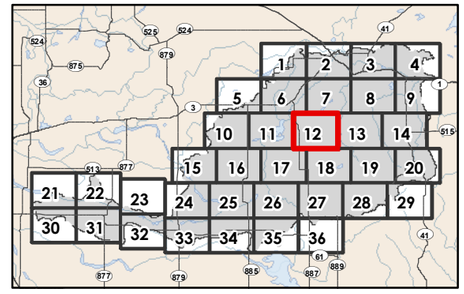
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres
1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 12

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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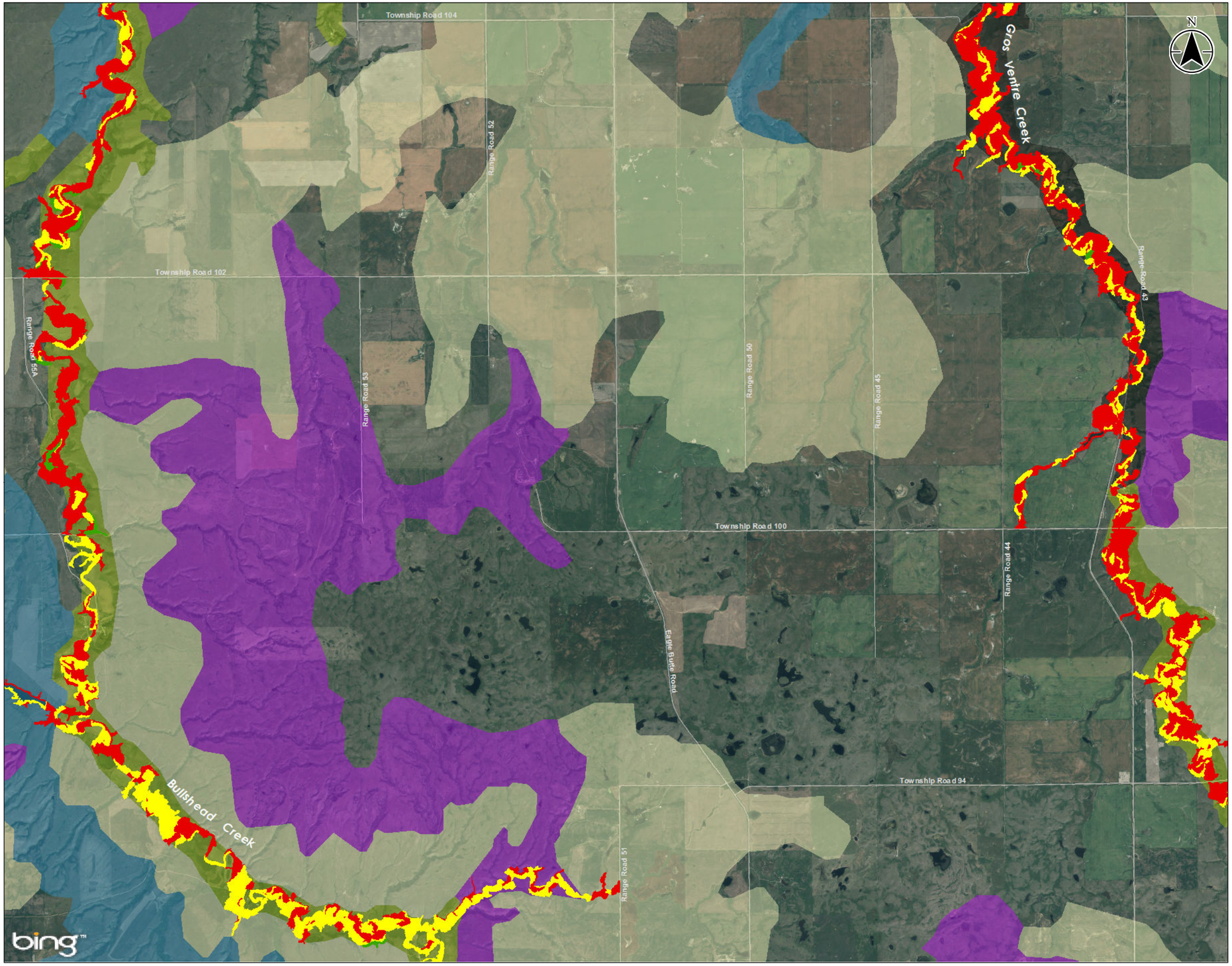

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
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LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

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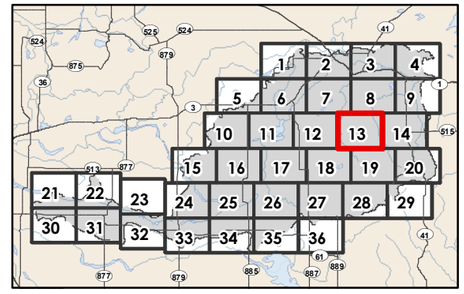

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Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 13

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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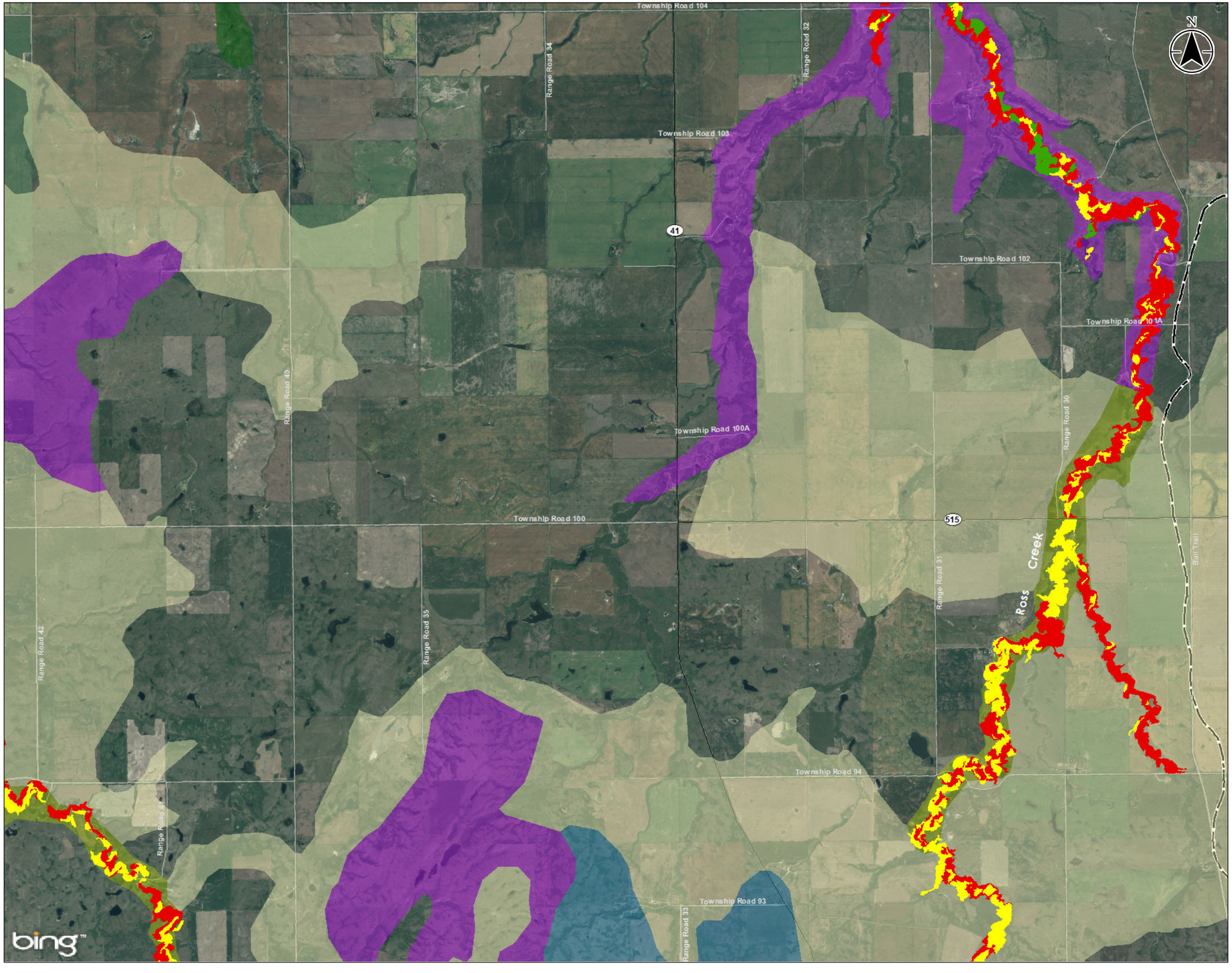


Stantec

PROJECT DATA

Seven Persons Creek Watershed

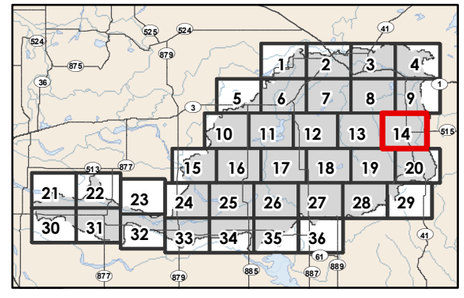
Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



Notes
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3. Orthoimagery within the Seven Persons Creek Watershed provided by the South East Alberta Watershed Alliance. Imagery beyond the SPCW boundary is provided by BING: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

Seven Persons Creek Sub-watershed, Alberta

111475212

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

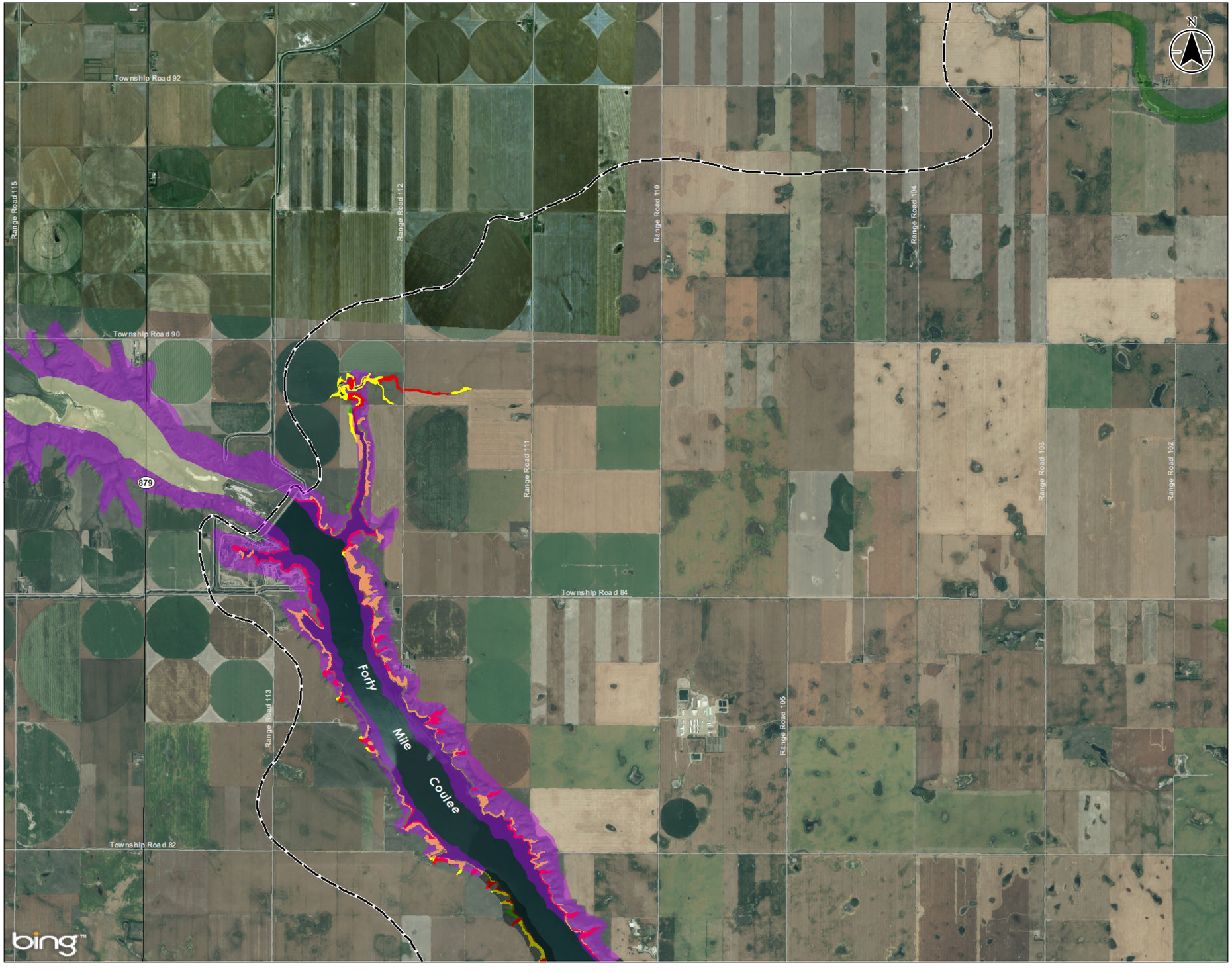
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 14

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

G:\...\GIS_Project_Folder\SEAWA\ArcMaps\Final Report\Draft2\SEAWA Landform_Mapbook_20180410.mxd Revised 2018-04-30 By: gkroupa



Stantec

PROJECT DATA

Seven Persons Creek Watershed

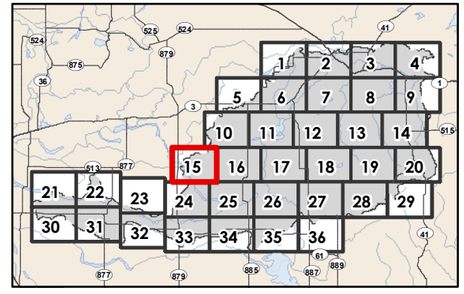
Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres
1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

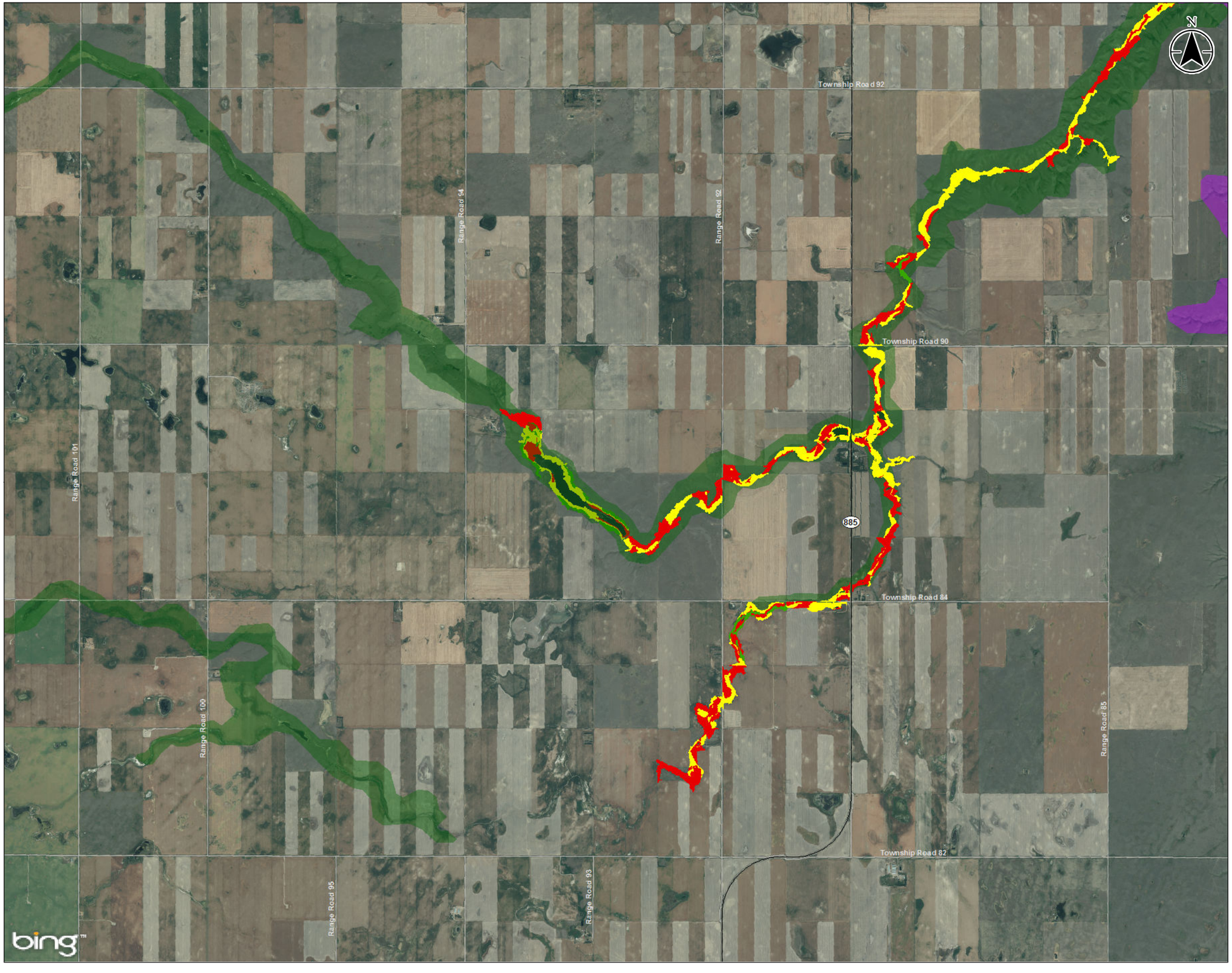
Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.
8 - 15

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

G:_GIS_Project_Folders\SEAWA ArcMaps\Final Reports\Draft 2\SEAWA_LandForm_Mapbook_20180410.mxd Revised: 2018-04-30 By: gkroupa



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PROJECT DATA

Seven Persons Creek Watershed

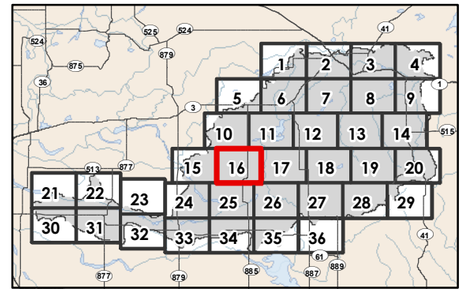
Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

111475212

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

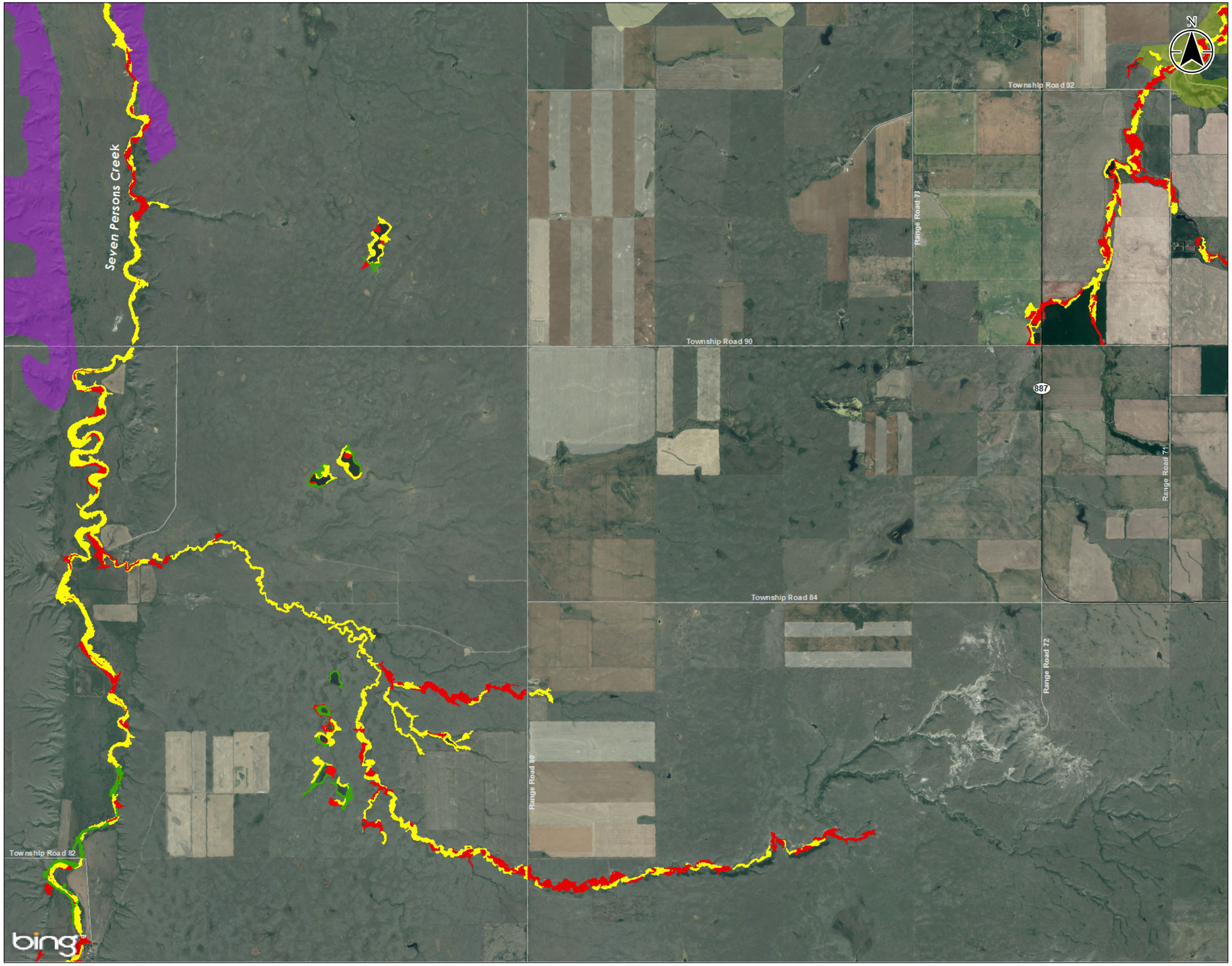
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 16

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

G:_GIS_Project_Folder\SEAWA\ArcMaps\Final Report\Draft 2\SEAWA Landform_Mapbook_20180410.mxd Revised 2018-04-30 By: gkroupa



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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

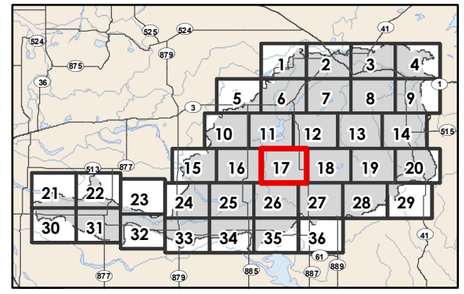
Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 17

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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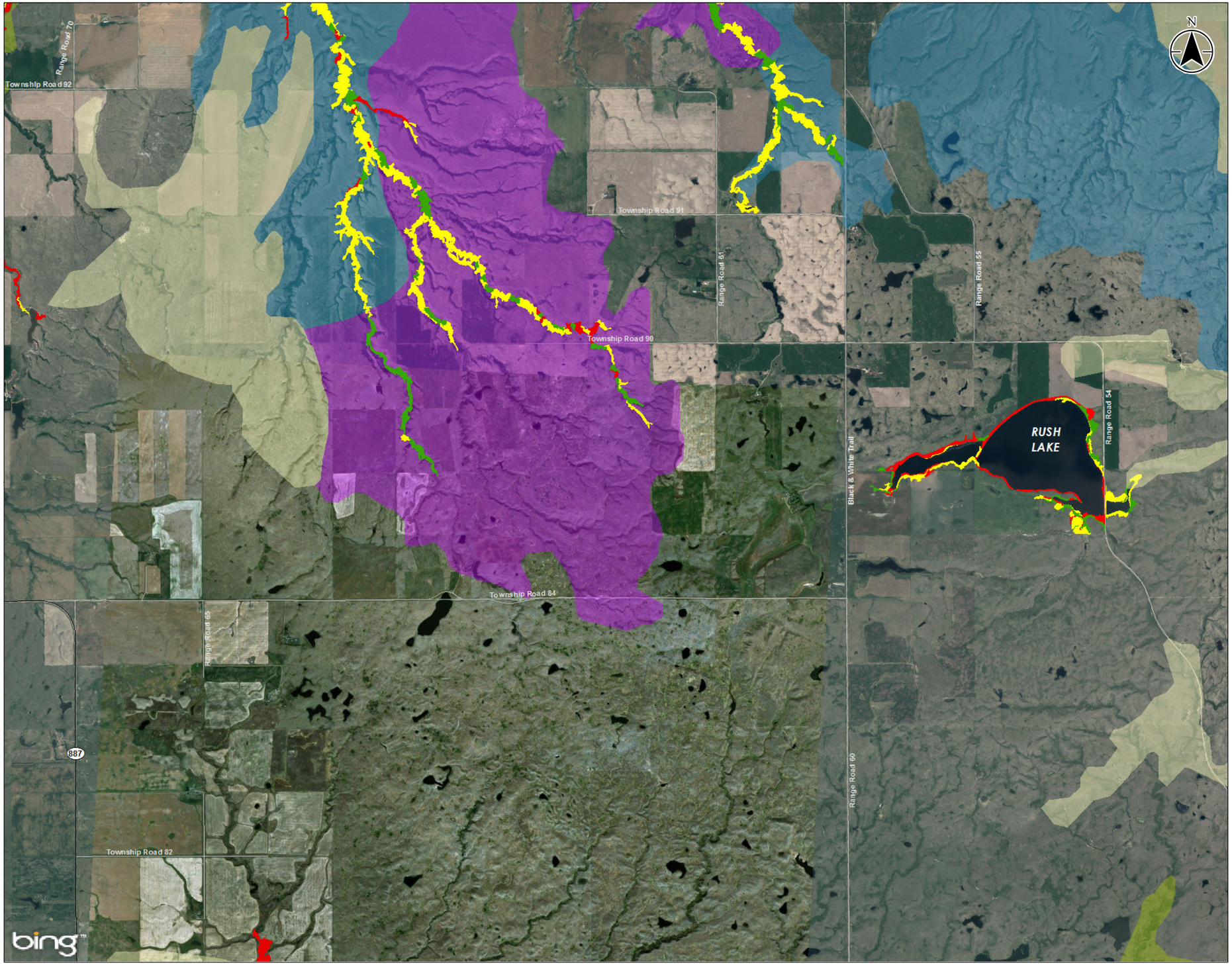


Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE

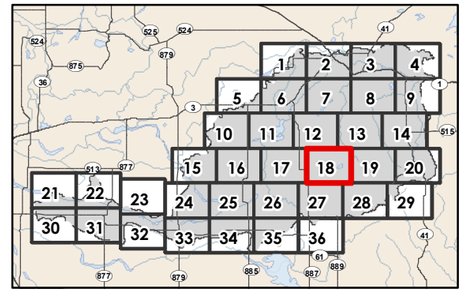
Major Road

Minor Road

Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

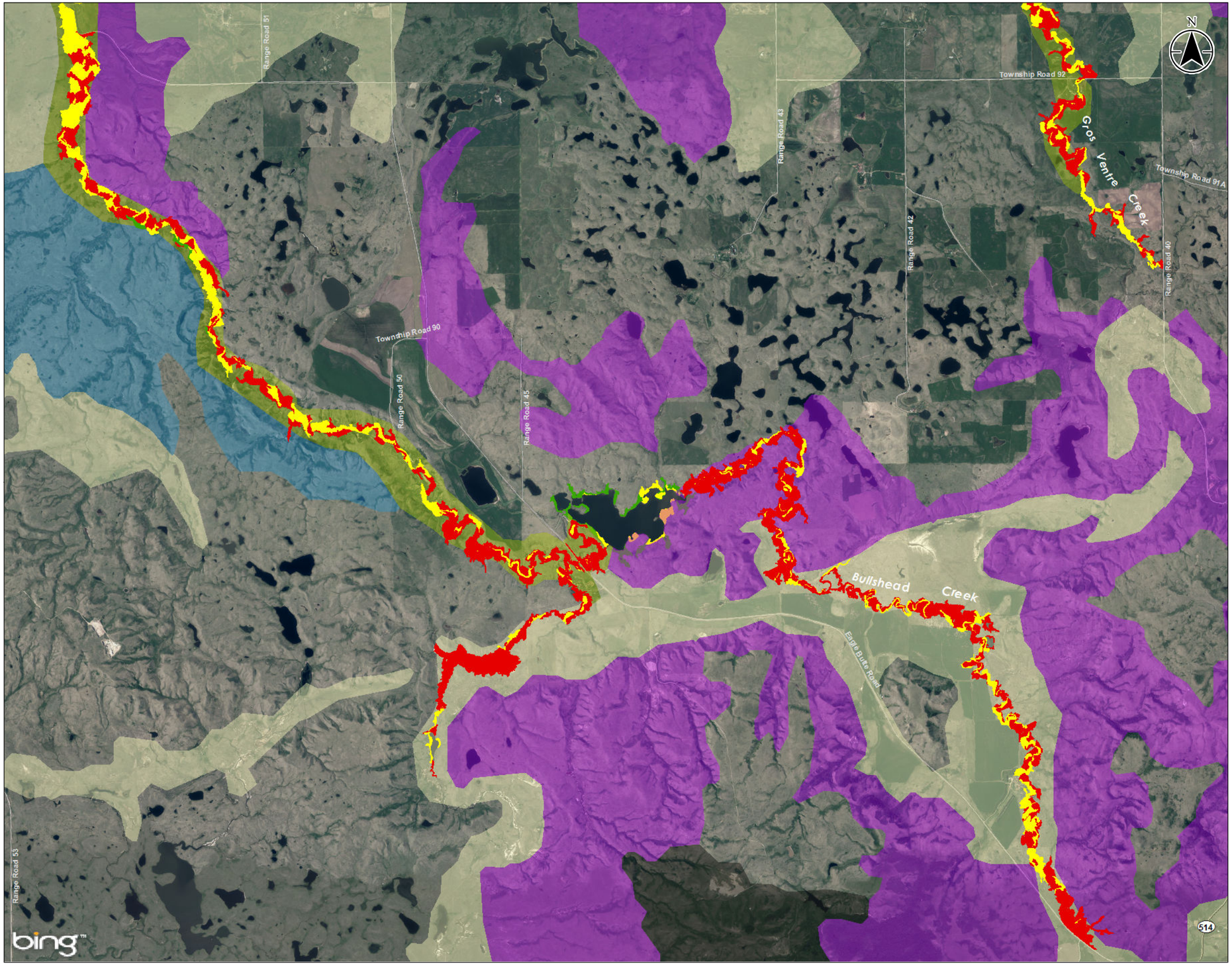
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 18

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

C:\...GIS_Project_Folder\SEAWA\ArcMap\ps\Final Report\Draft 2\SEAWA_Landform_Mapbook_20180410.mxd Revised 2018-04-30 By: gkroupa



Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form

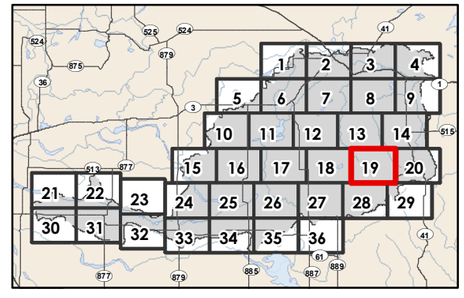
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

111475212

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

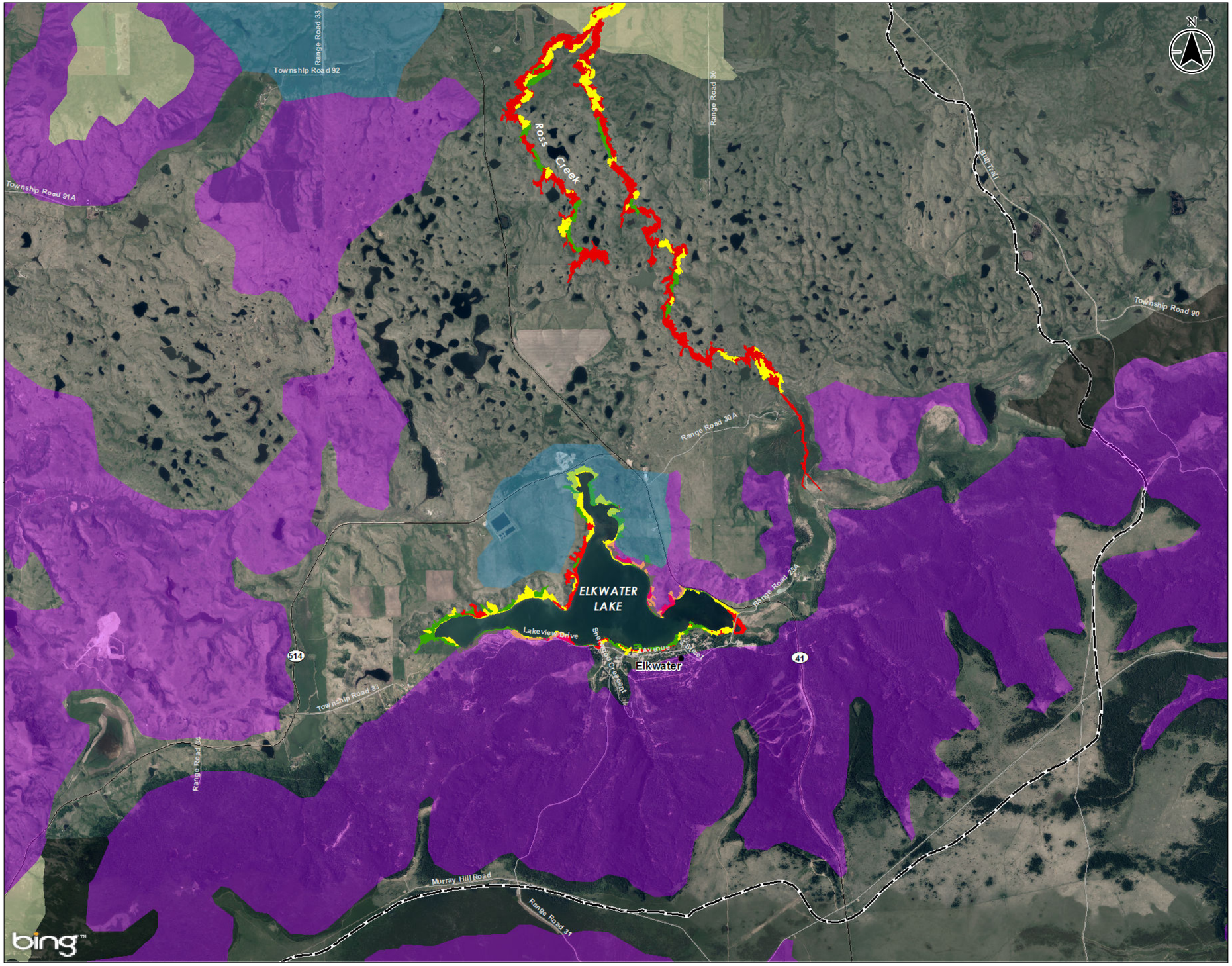
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 19

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

G:\...\GIS_Project_Folder\SEAWA\ArcMaps\Final Report\Draft 2\SEAWA Landform_Mapbook_20180410.mxd Revised 2018-04-30 By: gkroupa



Stantec

PROJECT DATA

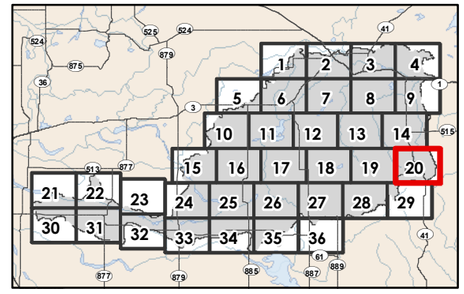
Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres
1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 20

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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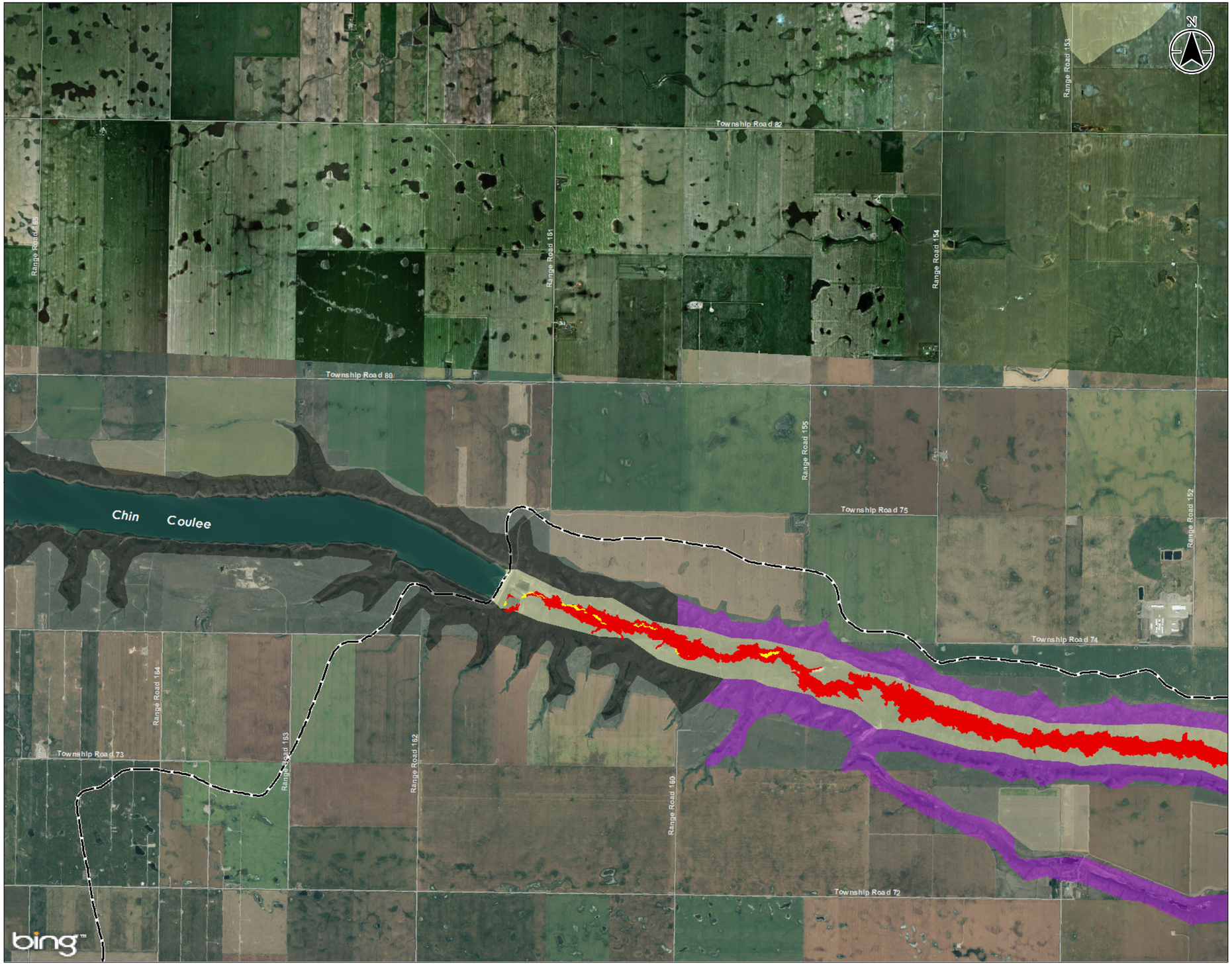

Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
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Landscape Model- Surface Form
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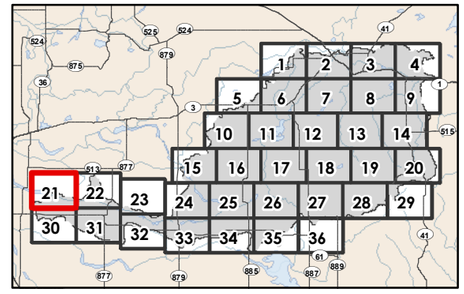
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres
1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.
8 - 21

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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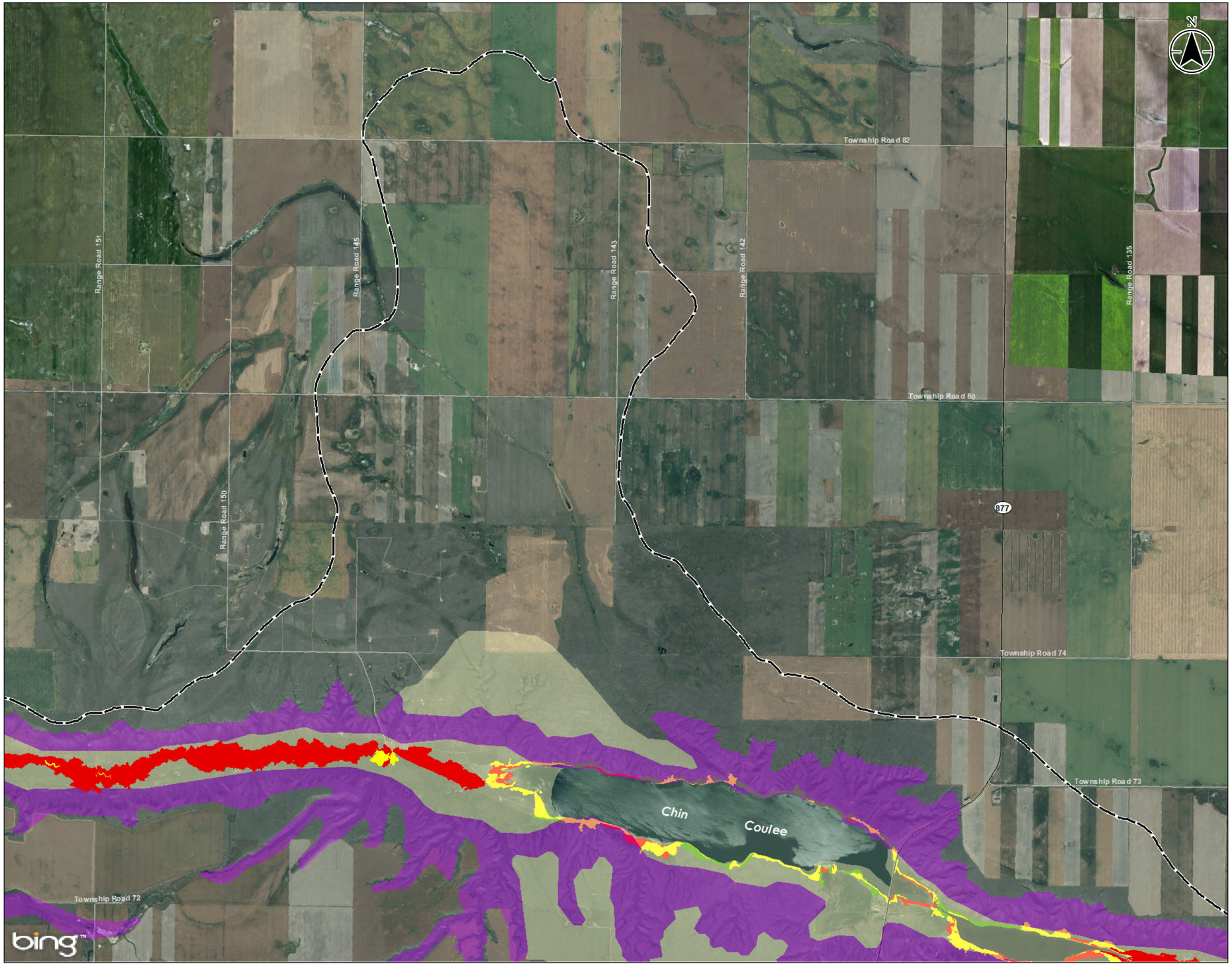

Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
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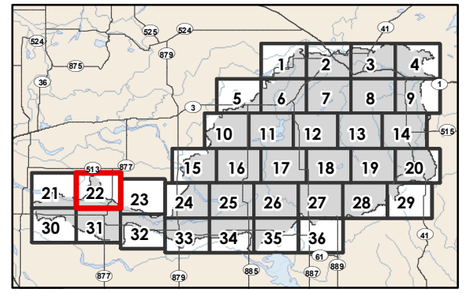
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

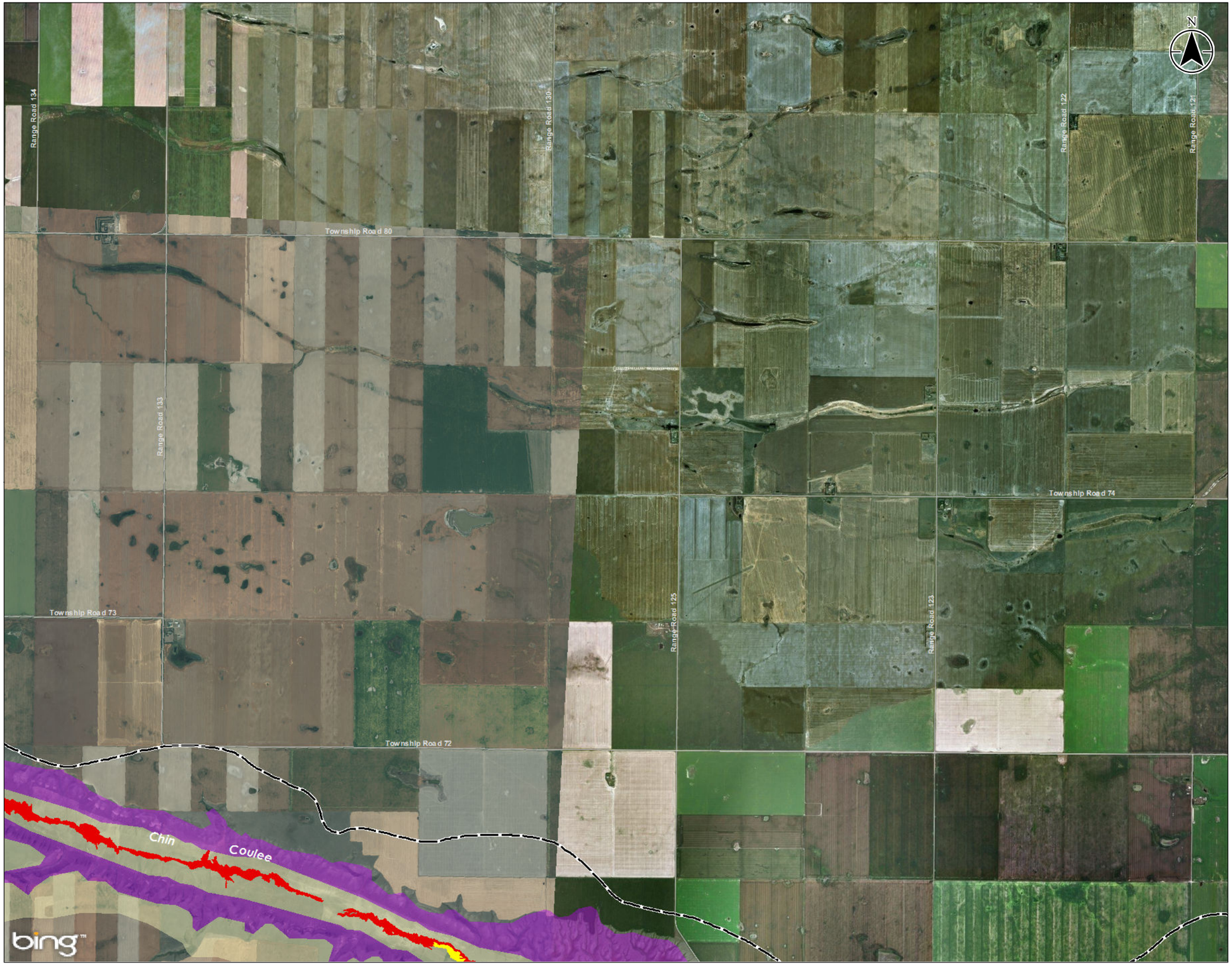
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 22

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

C:\...\GIS_Project_Folder\SEAWA\ArcMaps\Final Report Draft 2\SEAWA_Landform_Mapbook_20180410.mxd Revised 2018-04-30 By: gkroupa



Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
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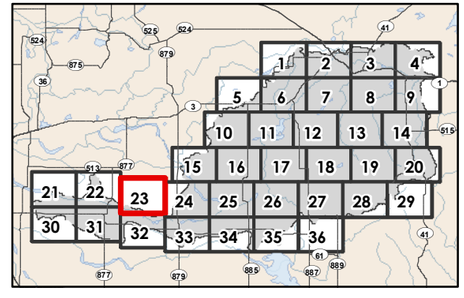
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

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Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 23

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
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- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE

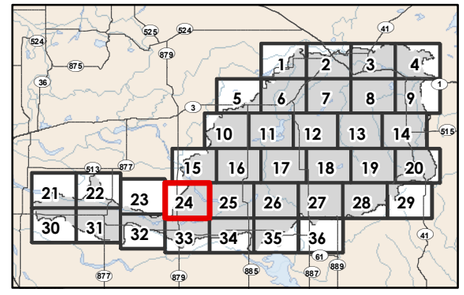
Major Road

Minor Road

Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Client/Project

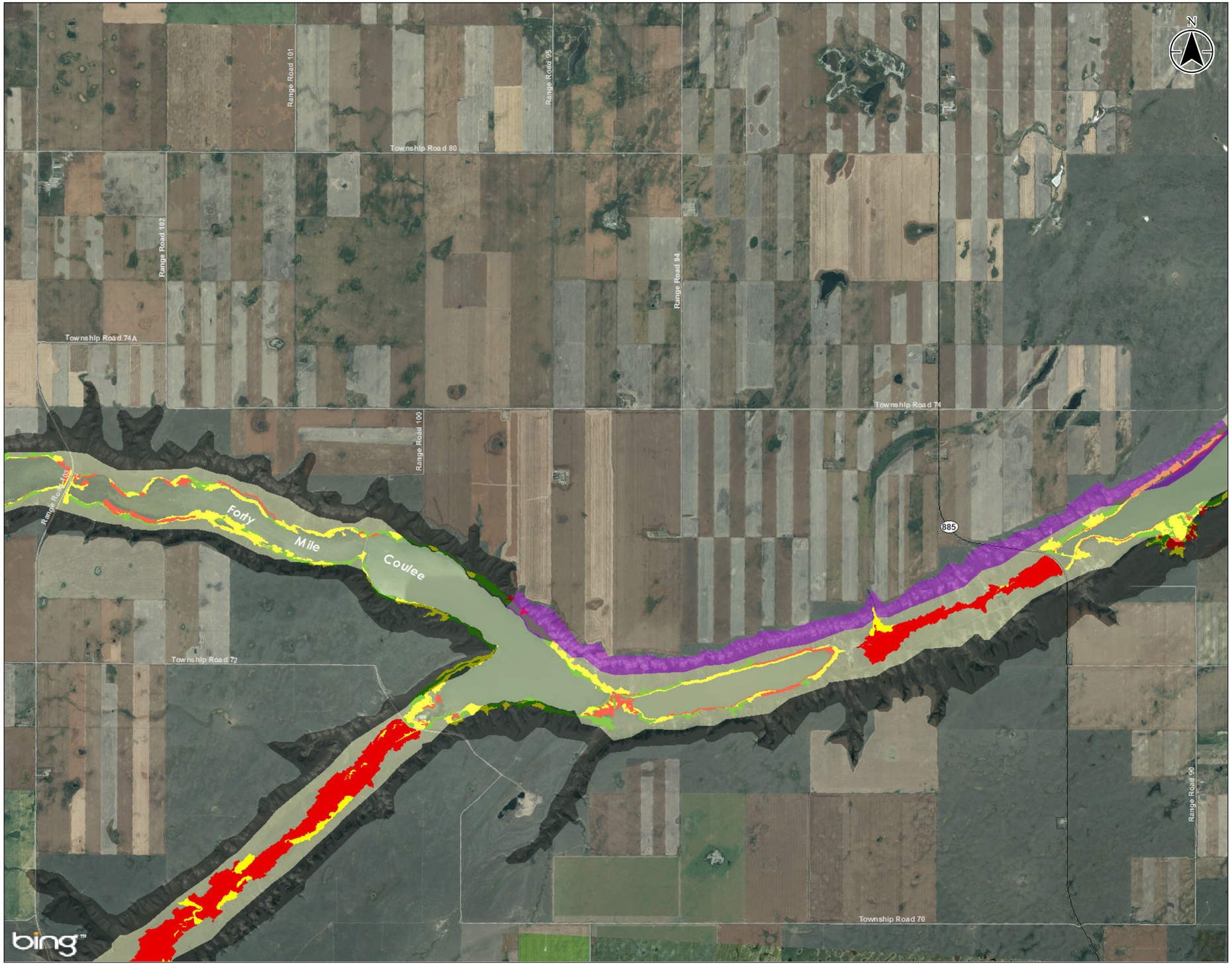
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 24

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

G:_GIS_Project Folder\SEAWA\Arcmaps\Final Report\Draft 2\SEAWA_landform_Mapbook_20180410.mxd Revised 2018-04-30 By: gkroupa



Stantec

PROJECT DATA

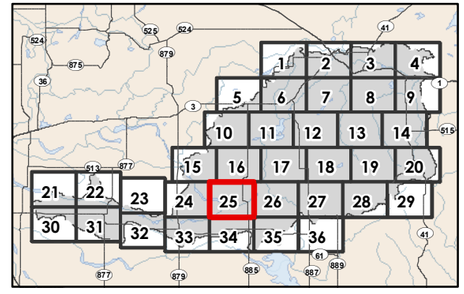
Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres
1:50,000 (At original document size of 11x17)



Notes
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2. Base features courtesy of Geogratis and CANVEC.
3. Orthoimagery within the Seven Persons Creek Watershed provided by the South East Alberta Watershed Alliance. Imagery beyond the SPCW boundary is provided by BING: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

Seven Persons Creek Sub-watershed, Alberta

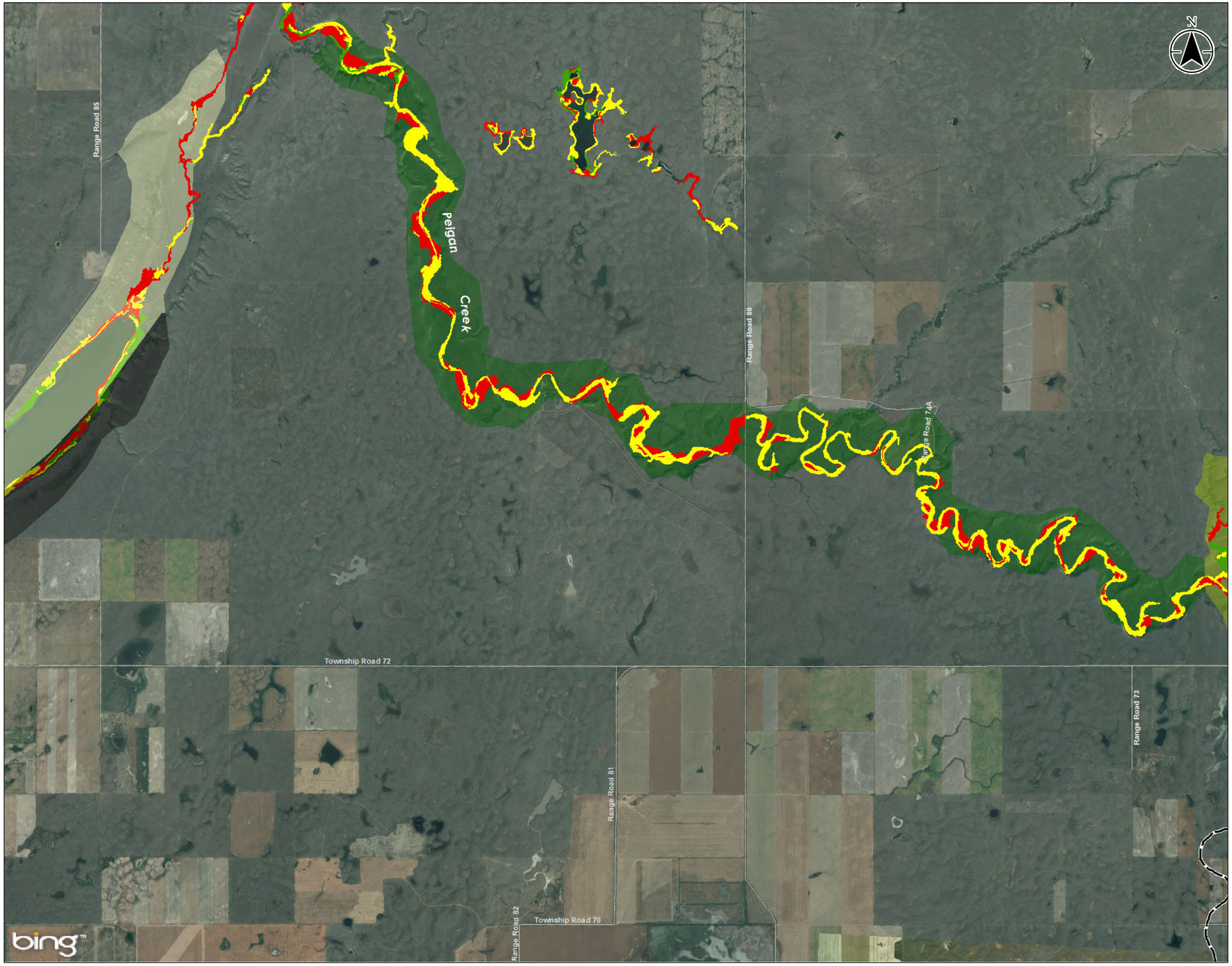
111475212
Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.
8 - 25

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

G:_GIS_Project_Folder\SEAWA Arcmaps\Final Report\Draft 2\SEAWA_Landform_Mapbook_20180410.mxd Revised: 2018-04-30 By: gkroupa



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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
- Healthy With Problems
- Unhealthy

Landscape Model- Surface Form
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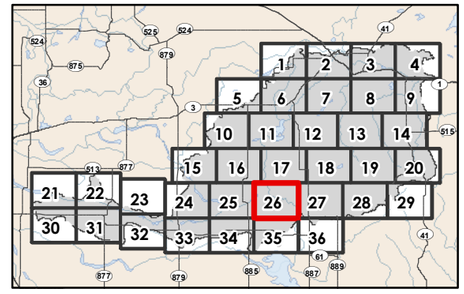
- Sub-glacial Channel (incised)

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres
1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

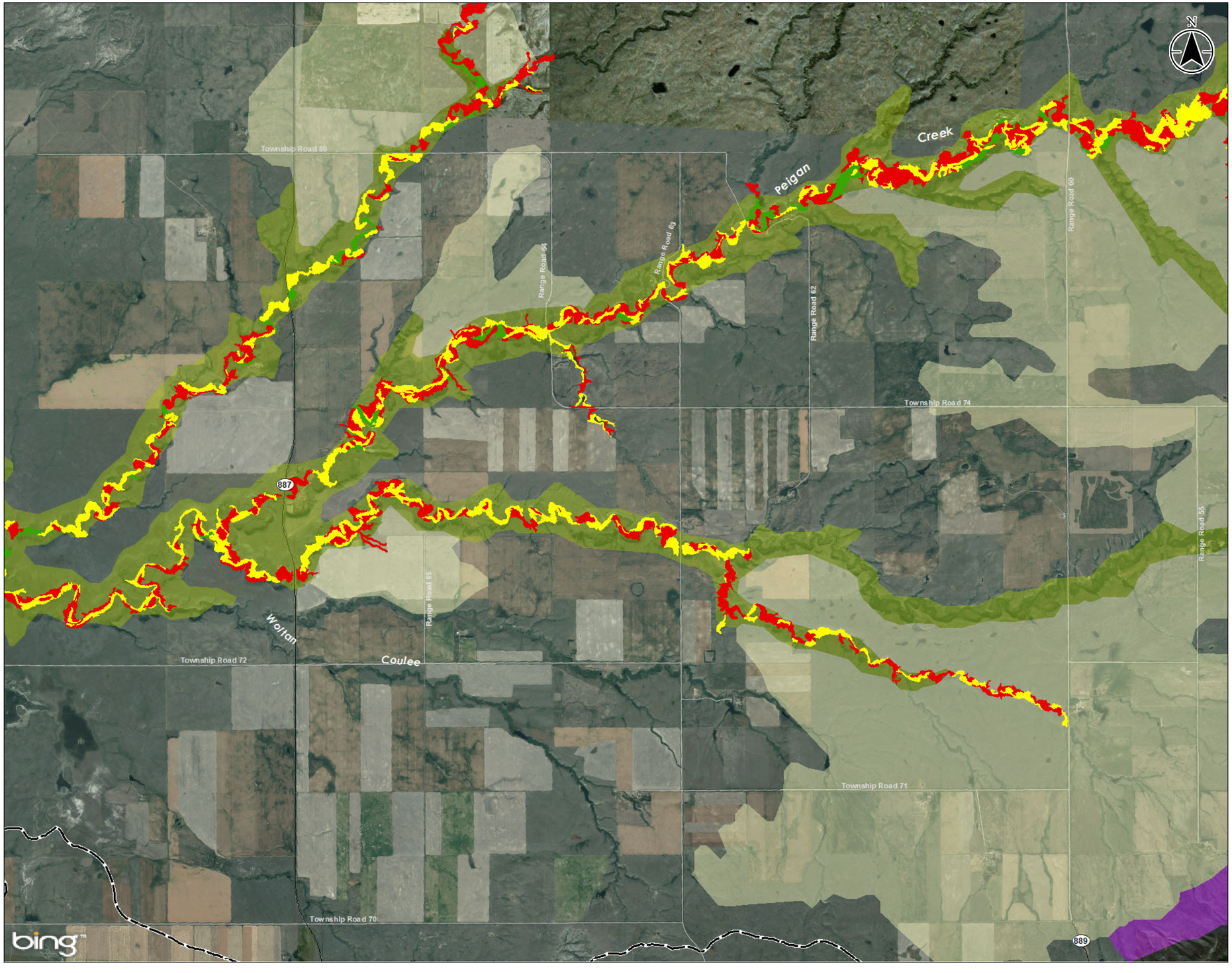
Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.
8 - 26

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

C:\...GIS_Project_Folder\SEAWA\ArcMaps\Final Report\Draft 2\SEAWA_Landform_Mapbook_20180410.mxd Revised 2018-04-30 By: gkroupa



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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

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Landscape Model- Surface Form

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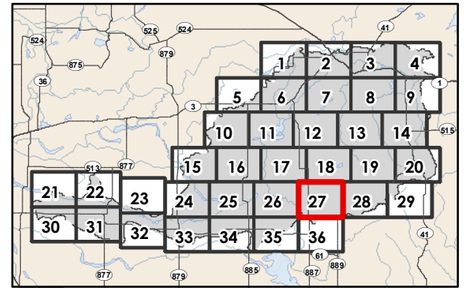
LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

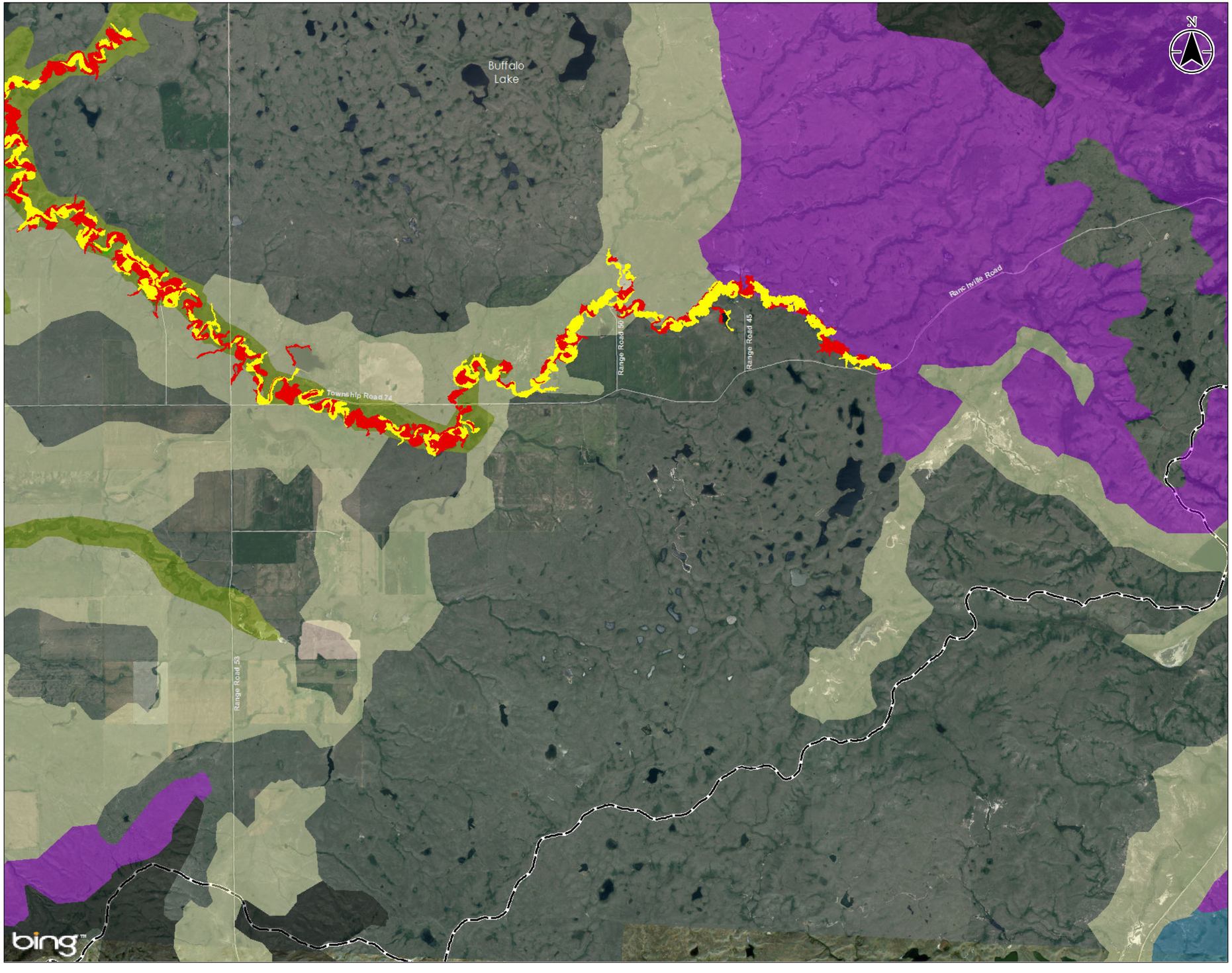
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 27

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

G:_GIS_Project_Folders\SEAWA ArcMaps\Final Reports\Draft 2\SEAWA_LandForm_Mapbook_20180410.mxd Revised 2018-04-30 by: gkroupa



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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment

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Landscape Model- Surface Form

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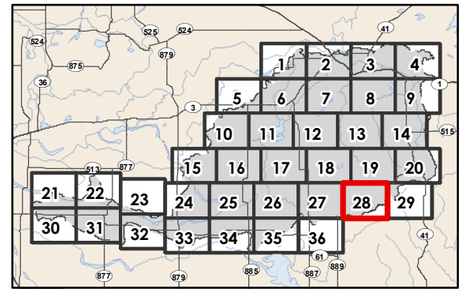
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

111475212

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 28

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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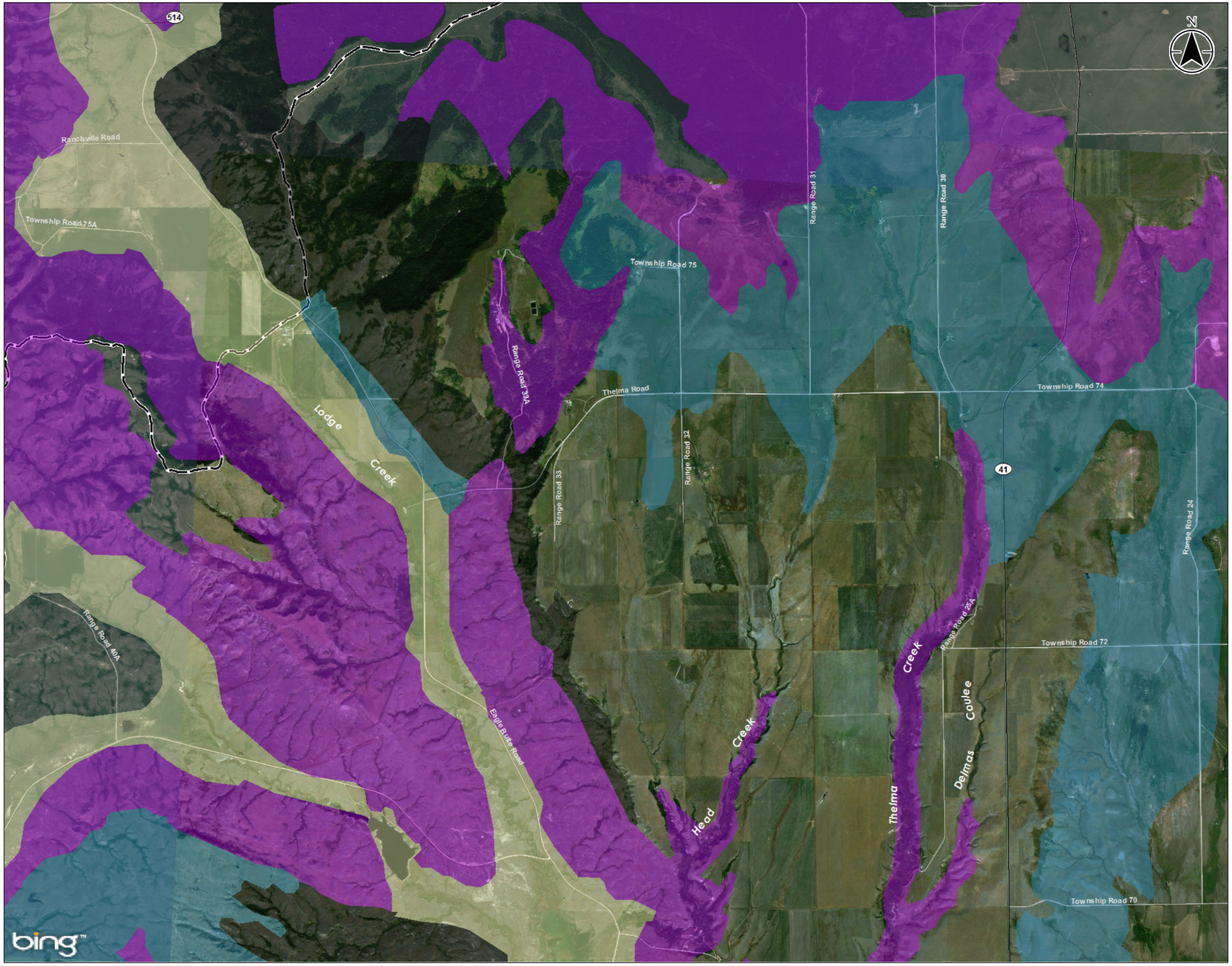

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PROJECT DATA

Seven Persons Creek Watershed

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- Healthy
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Landscape Model- Surface Form
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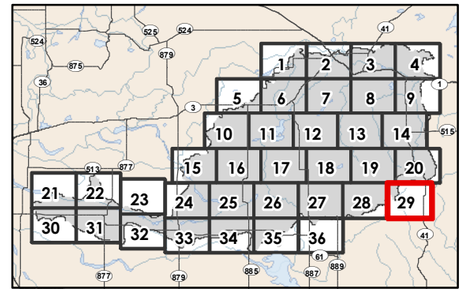
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres
1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 29

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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PROJECT DATA

Seven Persons Creek Watershed

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Landscape Model- Surface Form
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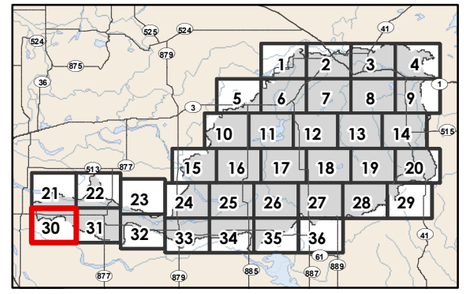
LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

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Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 30

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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PROJECT DATA

Seven Persons Creek Watershed

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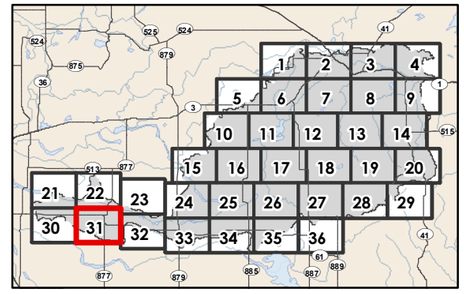
LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres
1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 31

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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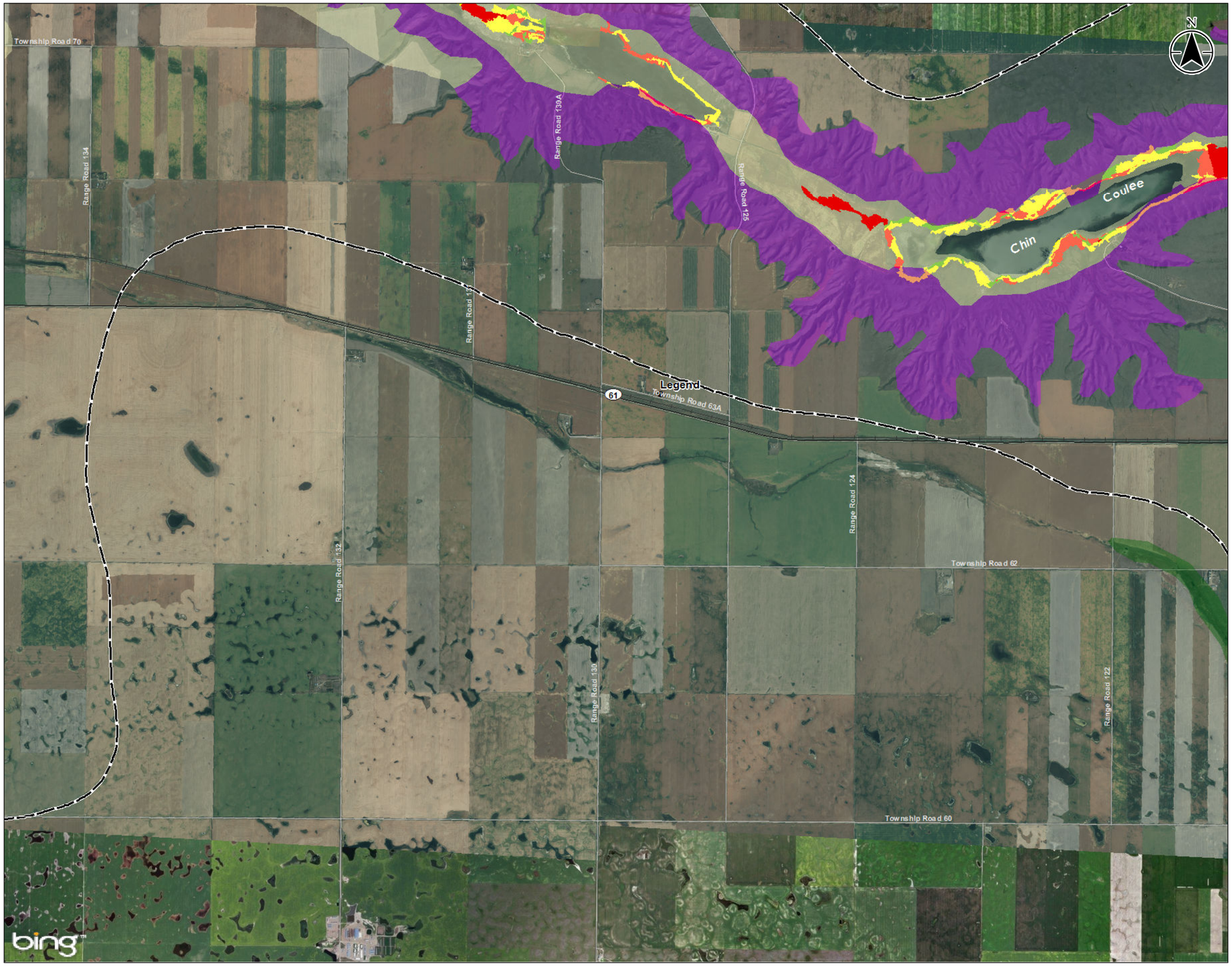

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PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
- Healthy
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Landscape Model- Surface Form
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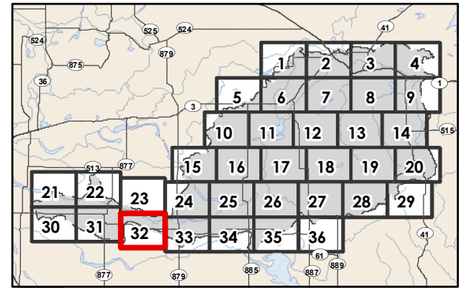
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE

- Major Road
- Minor Road
- Rail

0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Seven Persons Creek Sub-watershed, Alberta

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Review by gkroupa on 2018-04-30

Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 32

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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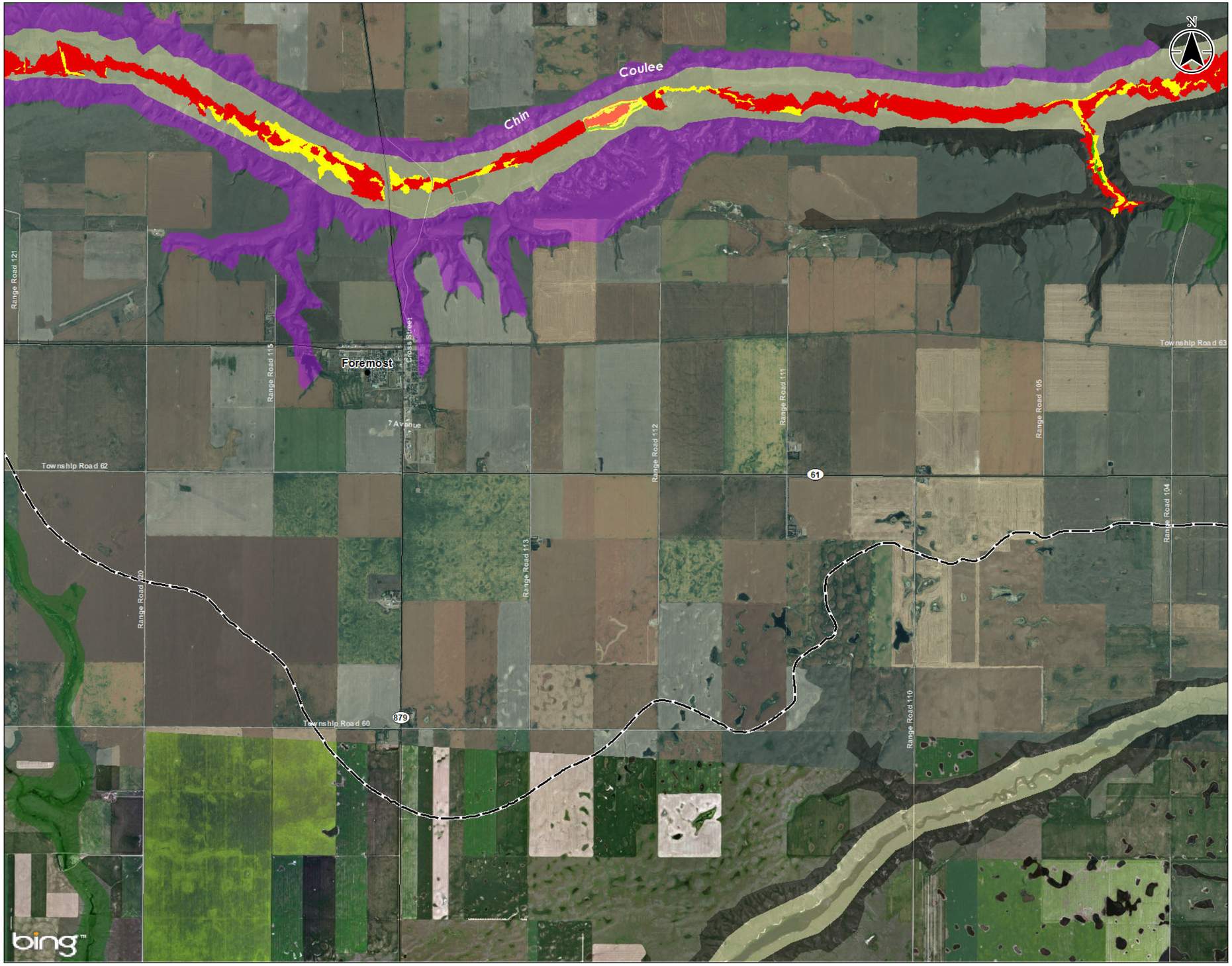

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Stantec

PROJECT DATA

Seven Persons Creek Watershed

Lotic & Lentic Riparian Health Assessment
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Landscape Model- Surface Form
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LANDBASE
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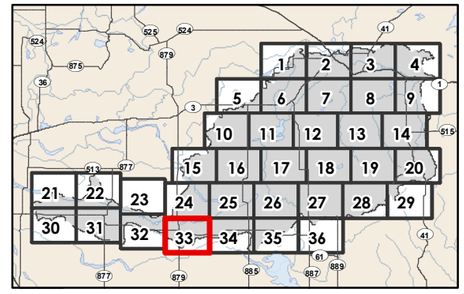
0 1 2 Kilometres

1:50,000 (At original document size of 11x17)



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Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 33

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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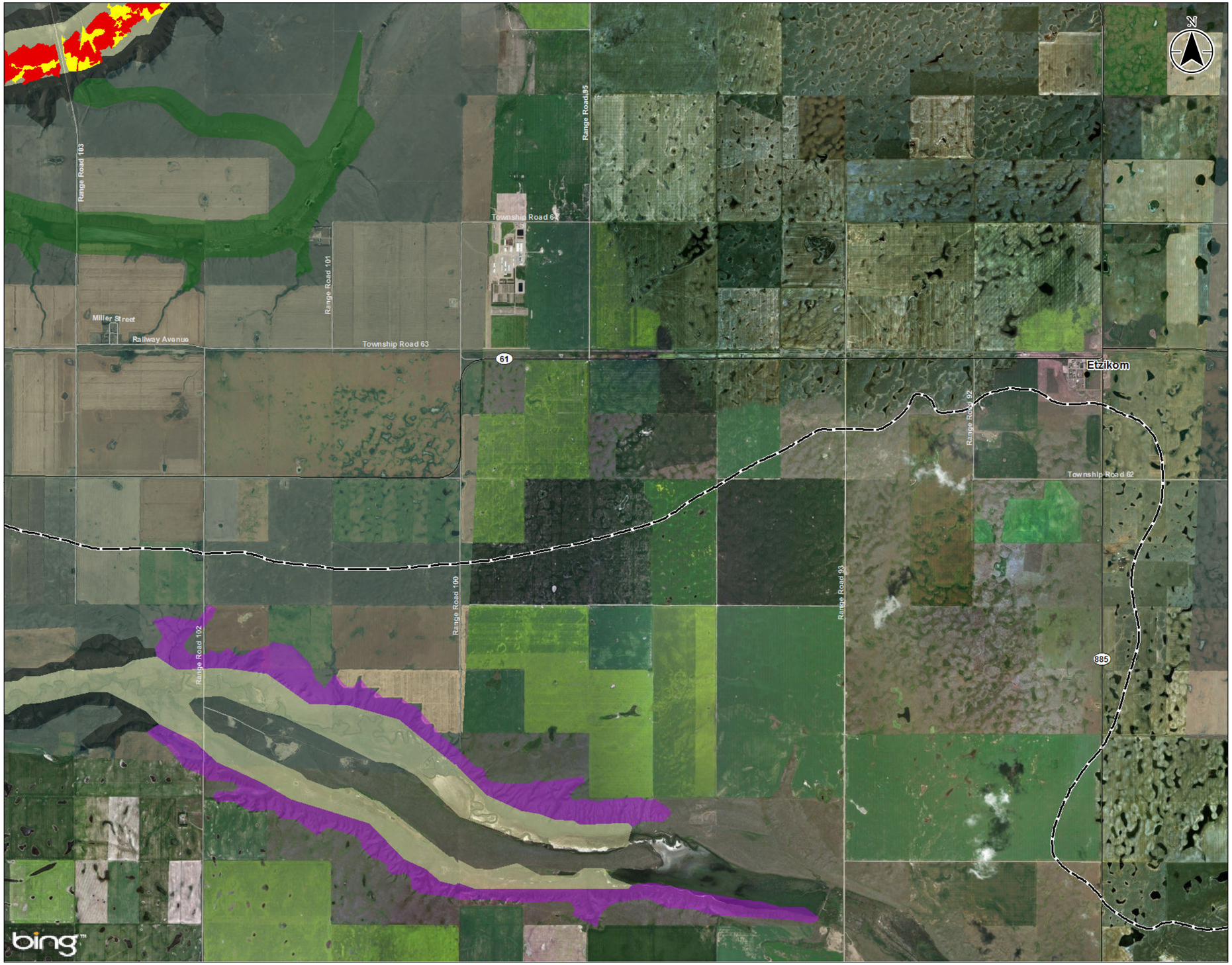

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PROJECT DATA

Seven Persons Creek Watershed

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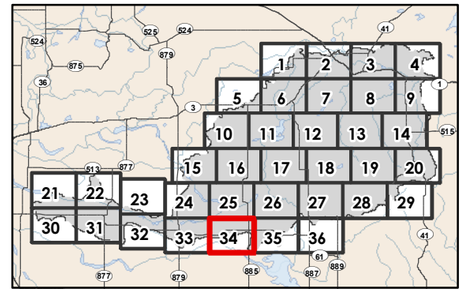

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Client/Project

SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 34

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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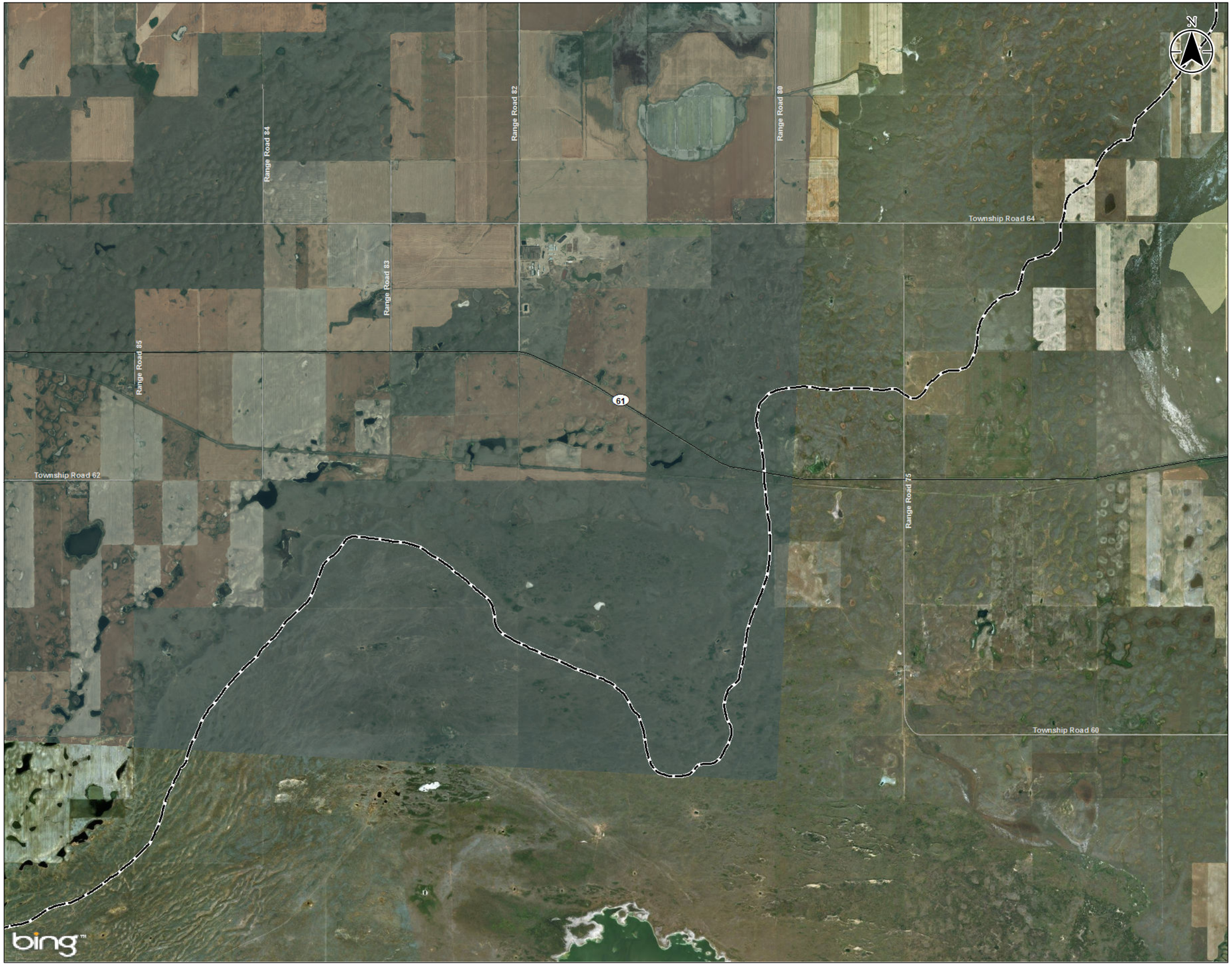

Stantec

PROJECT DATA

Seven Persons Creek Watershed

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LANDBASE

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- Minor Road
- Rail

0 1 2 Kilometres

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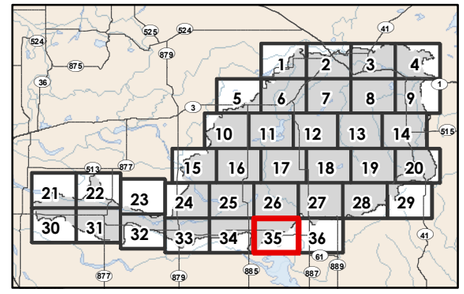

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SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.

8 - 35

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

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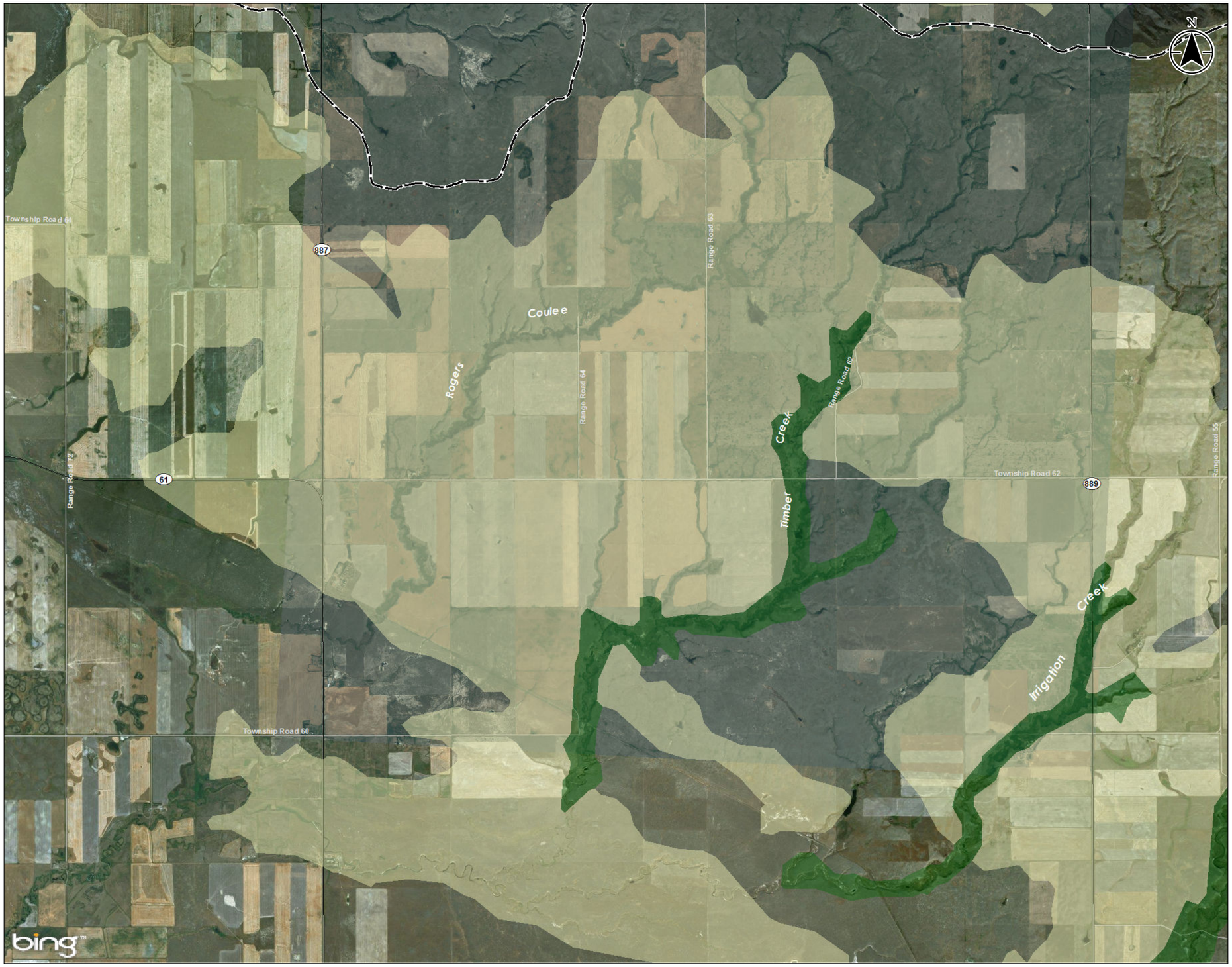

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PROJECT DATA

Seven Persons Creek Watershed

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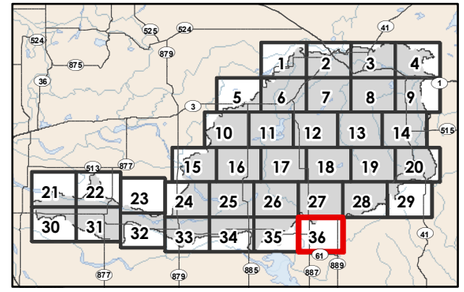
- Unhealthy

Landscape Model- Surface Form
- Inclined to Steep - Low Relief (ex. fans and aprons)
- Inclined to Steep - Moderate Relief
- Inclined to Steep - High Relief
- Steep - Potential of Failure Slump
- Valley with Confined Floodplain
- Wide Valley (Coulees) with Terraces
- V-Shaped Valley- No Terraces or Floodplain
- Sub-glacial Channel (incised)

LANDBASE
- Major Road
- Minor Road
- Rail

0 1 2 Kilometres
1:50,000 (At original document size of 11x17)



Notes
1. Coordinate System: NAD 1983 UTM Zone 12N.
2. Base features courtesy of Geogratis and CANVEC.
3. Orthoimagery within the Seven Persons Creek Watershed provided by the South East Alberta Watershed Alliance. Imagery beyond the SPCW boundary is provided by BING: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

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Seven Persons Creek Sub-watershed, Alberta

Prepared by jhiebert on 2018-04-30
Review by gkroupa on 2018-04-30

Client/Project
SOUTH EAST ALBERTA WATERSHED ALLIANCE
Aerial Assessment of Riparian Areas in the Seven Persons Creek Watershed, Alberta

Map No.
8 - 36

Landscape Model - Surface Form Assessment in the Seven Persons Creek Watershed

G:\...\GIS_Project Folder\SEAWA\Arcmaps\Final Report\Draft 2\SEAWA_Landform_Mapbook_20180410.mxd Revised 2018-04-30 By: gkroupa

Appendix B PHOTOS

Appendix B- Samples of Representative Riparian Field Assessment Conditions/Sites

The following figures are a series of representative field photos taken during the RHA survey campaign in September, 2017. Each field photo example was used to calibrate the upper and lower limits of the RHM for each OBIA statistic and each RHM health designation (Healthy, Healthy with Problems, Unhealthy).

Lotic Riparian Areas

Figure 1-1. Riparian areas on both sides of the water body were classified as **Healthy** with a strong presence of shrub vegetation and the shape of the riparian area followed the natural meandering of the stream. These riparian areas had low brightness mean, blue mean values, high red standard deviation values and high asymmetry.

Figure 1-2. The riparian area on the immediate right was designated as **Unhealthy** with a lack of woody vegetation and a high degree of slope. This riparian area had high brightness mean, blue mean values, low red standard deviation low and high DEM standard deviation values.

Figure 1-3. The riparian area on immediate left was designated as **Healthy with Problems (HWP)** with a moderate amount of woody vegetation and a high degree of slope. This riparian area had moderate brightness mean, blue mean, moderate red standard deviation values and high DEM standard deviation.

Figure 1-4. The riparian area on right was designated as **Healthy with Problems (HWP)** with a low to moderate amount of woody vegetation, a moderate degree of slope, and high asymmetry with the water course. This riparian area had low to moderate brightness mean, blue mean values, moderate red standard deviation values, moderate DEM standard deviation and high asymmetry values.

Figure 1-5. The riparian area on immediate left was designated as **Unhealthy** with a little woody vegetation, exposed bare soil, a high degree of incisement from erosion. This riparian area had extremely high brightness mean, blue mean values, low red standard deviation from lack of vegetation and high DEM standard deviation from incisement issues. The riparian area in the upper right was classified as **Healthy** with a moderate amount of woody vegetation, low slope, and good asymmetry. This riparian area had low brightness mean, blue mean values, high red standard deviation, low DEM standard deviation, high asymmetry values.

Lentic Riparian Areas

Figure 2-1. This lentic riparian area was categorized as **Healthy** with a high degree of naturally occurring vegetation cover, moderate amount of slope and has natural asymmetry to the water body without being compact. Vegetation captured by low blue and green mean OBIA statistic values covered greater than 95% of the reach soil surface and was unaltered by human activity indicating good riparian health. High asymmetry and low compactness readings indicate the riparian area's physical outline was not impact by human activity.

Figure 2-2. This lentic riparian area was classified as **Healthy with Problems** with a moderate amount of naturally occurring vegetation cover, lowered amount of slope and had natural asymmetry to the water body without being compact. Vegetation captured by average blue and green mean OBIA statistic values covering much of the reach soil surface and was unaltered by human activity. High asymmetry and low compactness readings indicate the riparian area's physical outline was not impact by human activity. This riparian area lacked denser vegetation and greater slope to be considered healthy.

Figure 2-3. This lentic riparian area was designated as **Healthy with Problems** with moderate to low amounts of vegetation cover, moderate amount of slope and had meandering asymmetry to the water body without being compact. Vegetation was lacking near shoreline with exposed soils and only short grass in other areas. This may be caused by grazing or mowing of vegetation or altering of water body levels. This was captured by moderate to high blue and green mean OBIA values. High asymmetry and low compactness readings indicate the riparian area's physical outline was not impact by human activity. This riparian area lacked denser vegetation to be considered healthy.

Figure 2-4. This riparian area was classified as **Unhealthy** with a poor vegetation canopy, moderate slope, and moderate asymmetry and compactness values. High blue and green mean values indicate a low amount of naturally occurring vegetation and is an indication of hayland\pasture usage. The moderate asymmetry and compact shape of the riparian area's outline indicates an impact from human activities.

Appendix C RHM Classification Results

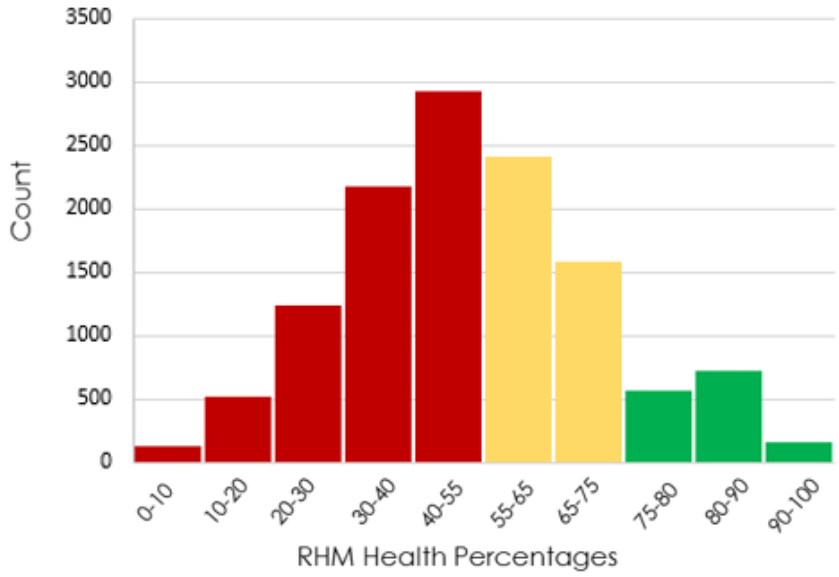

Figure C-1 Distribution of Lotic Riparian Health Model Classifications in SPCW

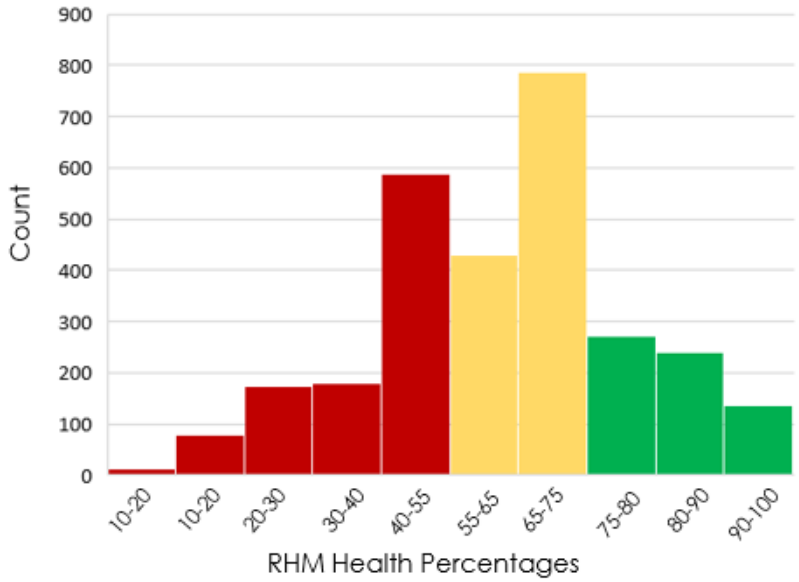

Figure C-2 Distribution of Lentic Riparian Health Model Classifications in SPCW

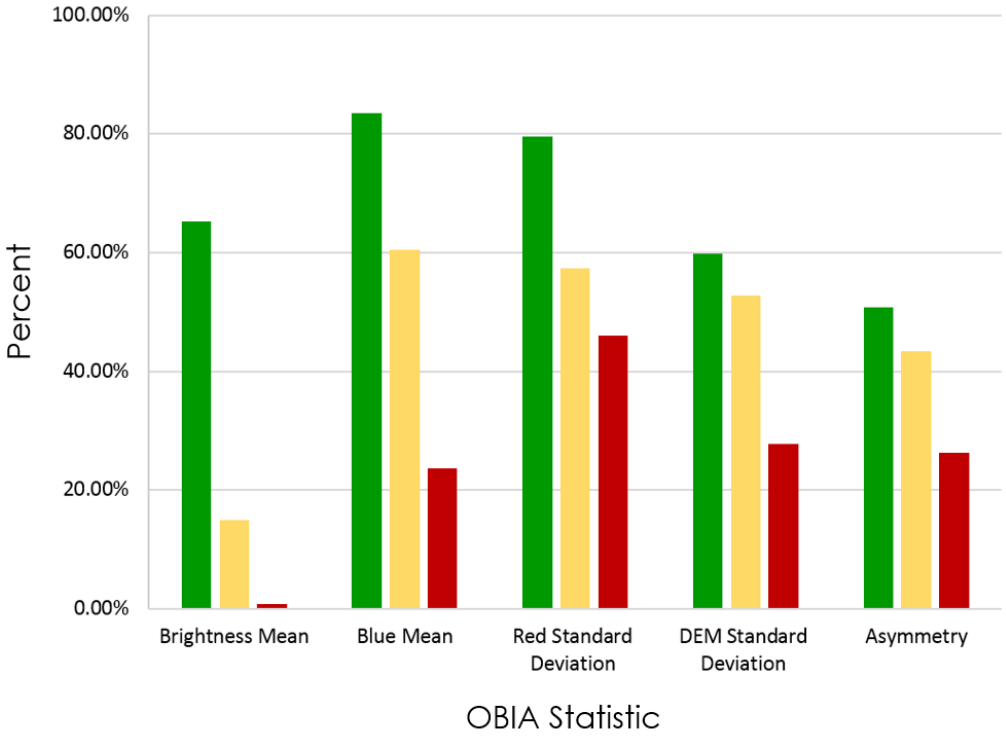

Figure C-3 Quantity of Maximum Scores of Lotic Riparian Health Model Classifications for Each OBIA Statistic (%)

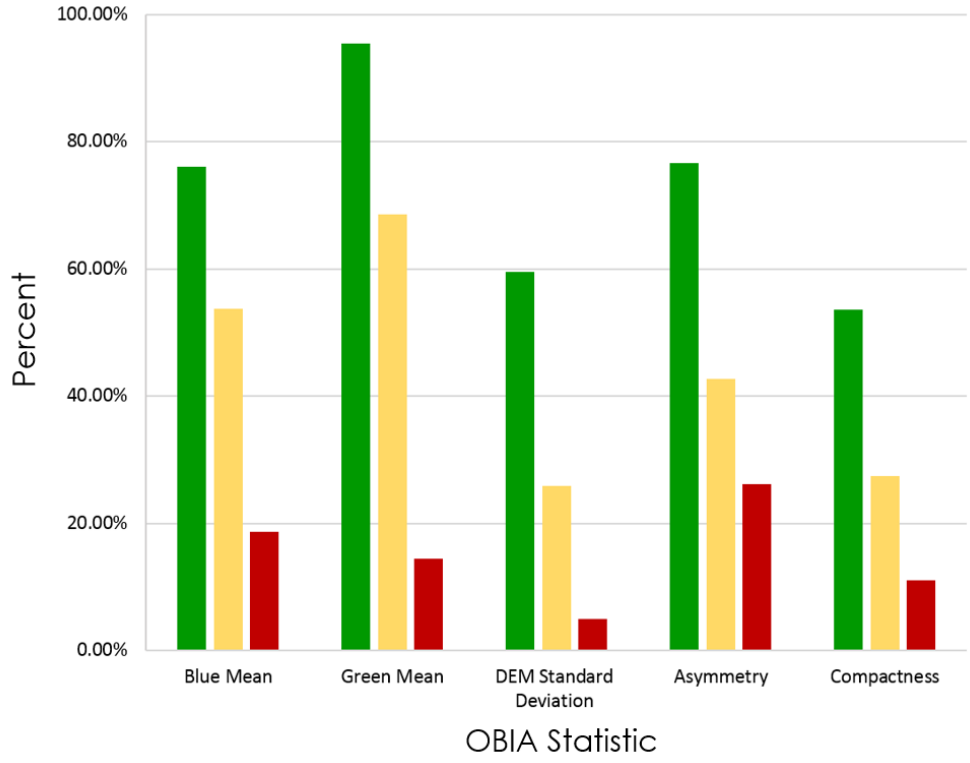

Figure C-4 Quantity of Maximum Scores of Lentic Riparian Health Model Classifications for Each OBIA Statistic (%)

Table C-1 Results of the Lotic and Lentic RHM Classification for each Health Class within SPCW by Linear km

RHM Classification	Lotic Riparian Sites		Lentic Riparian Sites	
	Linear km	Percentage	Linear km	Percentage
Healthy	358.78	15.42%	159.65	24.86%
HWP	893.01	38.37%	270.74	42.15%
Unhealthy	1,075.65	46.21%	211.89	32.99%
Total	**2,327.44**	**100.00%**	**642.28**	**100.00%**

Table C-2 Results of the Lotic and Lentic RHM Classification for each Health Class within SPCW by Square Km

RHM Classification	Lotic Riparian Sites		Lentic Riparian Sites	
	Square Km	Percentage	Square Km	Percentage
Healthy	10.85	15.56%	3.06	21.98%
HWP	26.55	38.09%	5.73	41.16%
Unhealthy	32.40	46.48%	5.13	36.85%
Total	**69.70**	**100.00%**	**13.92**	**100.00%**