Leduc County Environmentally Significant Areas Study

PREPARED FOR
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Glossary of Terms

Biodiversity- Diversity within and among plant and animal species within an environment.

Biota- The animals, plants, and life forms found within a region or time period.

DEM- Digital Elevation Model, a representation of the elevation and terrain of the earths surface.

Ecohydrologic- The interaction between ecosystems and water.

Ecological Integrity- The ecological processes, patterns, and structural attributes responsible for biodiversity and ecosystem resilience.

Ecosystem- A biological community of organisms and their physical environment.

Endism- The ecological state of a species that is unique to a defined geographic location or habitat type.

Error of Commission- Used in remote sensing to quantify the false identification of pixels or features (e.g. indication of presence of a feature where none exists)

Error of Omission- Used in remote sensing to quantify the extent to which pixels or features are missed or not adequately identified (e.g. a tree exists but was not detected).

Flow Accumulation- A measurement of the amount of water accumulated in overland flow over a surface.

GPS- Global Positioning System, a navigational tool that utilizes space-based satellites to accurately determine the location of a user on the earths surface.

Ground-truthing- The process of gathering data to test the accuracy of a remote sensing output or scientific model.

Groundwater Discharge- The hydrologic process whereby groundwater flows through an aquifer to the earth surface thereby replenishing surface water.

Groundwater Recharge-The hydrologic process whereby surface water percolates into the ground thereby recharging groundwater and aquifers.

Habitat- The natural environment of a plant, animal, or other organism.

Land Cover Classification- The cartographic representation of land surfaces into different distinct categories as determined by remote sensing.

LiDAR- Light Detection and Ranging, a scientific instrument used to predict earth surface properties and height using the principles of radar, but utilizing light from a laser. Often used in the creation of DEMs.

Rarity- The state or condition of being rare.

Niche- The place or function of a given organism within its ecosystem.

Pixel- A cell of an array, from a remotely sensed image or raster dataset.

Remote Sensing- The collection of data from an instrument that is not in direct contact with the object being measured. Often used to refer to the monitoring of earth surface processes via satellites.

Riparian- of, relating to, or situated on the banks of a river, or adjacent to wetlands and lakes.

Strahler Order- The measure or definition of the hierarchical structure of tributaries and streams first developed by R. Horton (1945) and A. Strahler (1952). Strahler orders progress from the smallest initial tributaries to the largest trunks of stream networks.

Terrain Analysis- The analysis, evaluation and interpretation of geographic information about the surface elevation of the earth surface. Used in hydrology to evaluate the location of depressions, rises and hydrological characteristics.

1. Introduction

1.1. Background

Environmentally significant areas (ESA) are defined as areas that are vital to the long term maintenance of biological diversity, physical landscape features, and/or other natural processes at multiple spatial scales (Jennings and Reganold 1991). Early work on identifying ESAs in Alberta occurred in the 1980s and 1990s, and this work was conducted by both the provincial government and municipalities in different areas of the province. In 2009, a provincial ESA update was conducted using GIS technology and systematic conservation planning principals that allowed for the use of more rigorous, objective, and repeatable methods to identify and prioritize ESAs (Fiera Biological 2009). This provincial update was followed in 2010 by the identification of provincial Aquatic ESAs (AESA) using the same criteria and indicators framework that was developed in 2009 (Fiera Biological 2010). Most recently, the 2009 ESA and the 2010 AESA studies have been combined and updated in a new provincial ESA study that utilized the most up to date data and methods for identifying ESAs in Alberta (Fiera Biological 2014). The identification of ESAs using credible, broadly supported methods enables decision makers to rapidly progress through the planning process where informed trade-offs can be discussed, priorities set, and clear policy direction achieved.

While ESAs have been identified throughout Alberta, provincial ESAs do not consider the ecology or soci-economic context that is specific to a municipality. As a result, many municipalities throughout Alberta have undertaken their own ESA studies, including Leduc County. In 1990, Leduc County commissioned an Environmentally Sensitive Areas Study (Westworth 1990), which has been used to help guide policy and land use decisions throughout the county. While this document has served to help inform decision making over the last two decades, there is a need to update the study to reflect current management priorities, as well as the condition and distribution of natural habitats in Leduc County. In order to achieve these objectives, Fiera Biological was retained by Leduc County to complete an ESA study, the goals of which included:

1. Identify ESAs in Leduc County using an approach that is objective, repeatable, and consistent with provincial methodology,

2. Create an up-to-date land cover and wetland inventory that could be used to identify ESAs in Leduc County,

3. Develop ESA criteria and indicators that are relevant within the Leduc County context, and use these indicators to identify ESAs at the scale of the County.

The methods and process used to identify ESAs in Leduc County are similar to those that were used to identify ESAs in the province of Alberta; however, the ESA outputs created in this study are specific to Leduc County. While the criteria that were used to identify ESAs in Leduc County are the same as those used to identify provincial ESAs, the selected indicators were, in some cases, different than those used in the most recently completed provincial study (Fiera Biological 2014). This is because the indicators used to identify ESAs in Leduc County had to be *relevant* to the local ecology, as well as to the local management context. For example, the provincial study considered grizzly bear habitat an important ESA indicator; however, grizzly bear do not occur within Leduc County, making this species indicator irrelevant in the local context. Thus, consideration of the place-based priorities as they relate to the identification of ESAs is critical for creating information that is meaningful and useful to local land users and managers.

It is important to note that while the previous Environmentally Sensitive Areas study (Westworth 1990) in Leduc County considered environmental, cultural, and historic features, this study considered ecological criteria and indicators only. The exclusion of cultural and historical features from this study does not imply that these features are not important or significant. Rather, the intent of this study was to focus on ecological and environmental criteria, as the regulatory and policy mechanisms and processes that are available to manage environmental versus cultural/historical sites within Leduc County are distinct. We

did not feel that combining environmental, cultural, and historical criteria and indicators in this study was warranted, nor would it have been methodologically appropriate.

1.2. Public Engagement

In order to ensure that the criteria and indicators selected for use in this study were relevant within the local context, consultation with key stakeholders and the general public was conducted throughout the project. Two half-day workshops were held to consult with key stakeholders at critical points in the project. The first workshop was held on March 10, 2014, and the objective of this workshop was to discuss the criteria and indicators that would be selected to define and identify ESAs in Leduc County, as well as to discuss the current and future disturbance risk to ESAs. The membership for this workshop was determined by members of the Leduc County Steering Committee, and included representatives from the Government of Alberta, industry, Non-government and Environmental Non-government Organizations, and Leduc County. Feedback from this first workshop was considered and the list of indicators for selecting ESAs was revised to include stakeholder uinput. The second workshop was held on May 8, 2014, and the focus of the meeting was to describe the methods used to identify ESAs, and to present the preliminary results of the study to stakeholders for general feedback and comment. This workshop was attended by representatives of the same organizations that were included in the first workshop.

In addition to the workshops, information about the ESAs study was provided to the public via the Leduc County website. The website included a general overview of the study, as well as presentation materials from the workshops held with key stakeholders. The website also included a link to a web-based interactive mapping application that allowed the public to identify areas that they considered to be of environmental significance in the County. The information that was collected through the mapping helped to inform, but did not drive, the final identification of ESAs in Leduc County.

1.3. Intended Use of ESAs in Leduc County

The information contained in this report is intended to identify general areas within Leduc County that contain significant environmental elements, such that this information can be used to help guide future land use decisions and development. At present, the Municipal Development Plan (MDP) provides general direction for how ESAs should be considered during the development process; however, the MDP is somewhat dated as it relates to the management of environmental resources. and will be under review in 2015. As part of the Municipal Development Plan review process, this study will be considered in conjunction with other economic and growth studies to help develop a growth management framework that will address questions around how ESAs should be assessed and managed in Leduc County. This process will consider how impacts to ESAs can be minimized or avoided through the development of new policy or procedures, and should ensure that the important ecological values of ESAs can be conserved for the present and future benefit of the residents and visitors of Leduc County.

2. Study Area

Leduc County is situated in central Alberta, immediately south of the City of Edmonton. The county covers an area of approximately 259,170 ha (2591.7 km^2), with a population of just over 13, 500. Large areas of intact natural habitat are found in the western and eastern portions of the county and surrounding major rivers and lakes; however, the majority of the county is dominated by agricultural land use (Figure 1). Population and business centres within the County include Nisku, Buford, Looma, Kavanagh, Rolly View, Sunnybrook, and New Sarepta. Other major population centres and industrial areas, including Leduc, Devon, Beaumont, Thorsby, Calmar, and Warburg, are located outside the municipal boundaries of Leduc County and were excluded from this study. Despite lying outside the county limits, Pigeon Lake and the surrounding lands were included in the study area because of the ecological influence of the lake on lands in Leduc County. Areas of large-scale surface disturbance, including the Genesee mine and the Burnco gravel extraction operation, were removed from the study area (Figure 2). As the study represents a snapshot in time, areas that may be earmarked for development, but have not yet experienced large-scale surface disturbance, were retained in the study. In total, 4529 full or partial quarter-sections were included in the ESA study, covering a total area of 275, 255 ha.
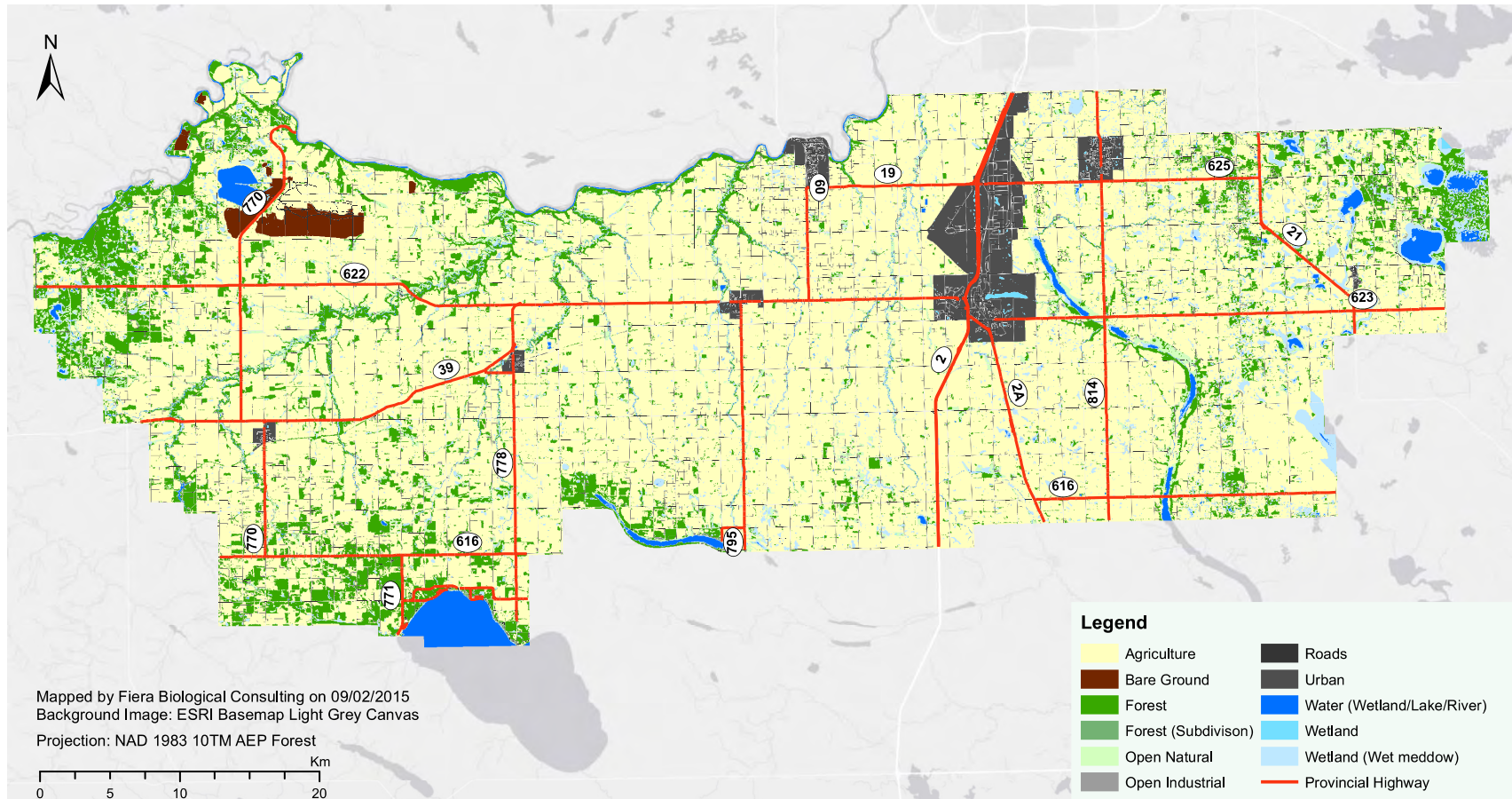
Figure 1. Overview map of Leduc County showing major land use and land cover, as well as the location of major roads and municipalities.

Legend

▨ Municipalities outside Leduc County
▭ Leduc County 2014 Boundary
▭ Areas Not Included in Analysis
▭ Modeled Area
— Provincial Highway

Mapped by Fiera Biological Consulting on 09/02/2015
Background Image: ESRI Basemap Light Grey Canvas

Projection: NAD 1983 10TM AEP Forest

Figure 2. Areas included in the ESA study of Leduc County. Municipalities located outside of the county boundaries were removed from the study, as well as large areas that are actively being surfaced mined.

3. Leduc County ESA Criteria and Indicators

3.1. Conceptual Framework

Environmentally Significant Areas in Leduc County were identified using a Criteria & Indicators (C&I) conceptual framework. Criteria are categories of conditions or processes that characterize the natural environment and are related to, or representative of, a specific element of interest (e.g. water quality, biodiversity, etc.). Each criterion is associated with one or more specific indicator, which are measureable or descriptive variables that can be used to observe, evaluate, or describe trends over time. Within this framework, indicators are characterized as being representative of a specific criterion; however, in reality, indicators are closely related, and there may be some overlap in what an indicator represents or measures. Ultimately, the goal of this approach is to simplify and summarize complex ecological information so that it can be used by managers and planners in Leduc County to help guide land use decisions.

3.2. Selected Criteria and Indicators

The following is a list of criteria and indicators that were used to identify ESAs in Leduc County. Given that a single criterion is unlikely to be representative of all desired components of an ESA, multiple criteria and indicators were integrated into the ESA framework. This multi-tiered approach ensures that important ecological and evolutionary processes at different levels of organization and spatial scales are captured and incorporated into ESAs in Leduc County (Groves et al. 2000; Poiani et al. 2000). In addition, the criteria selected to identify ESAs in Leduc County included both coarse-filter and fine-filter indicators. Coarse-filter criteria were developed with the goal of maintaining native biota and natural ecosystem function, while fine-filter criteria were developed to capture environmental features that are required to maintain populations, species, ecosystems, or other special features that are not accounted for under coarse filter criteria (Groves et al. 2000). In total, four main criteria and 17 indicators were used to identify ESAs in Leduc County:

Criterion 1: Areas that contain focal species, species groups, or their habitats

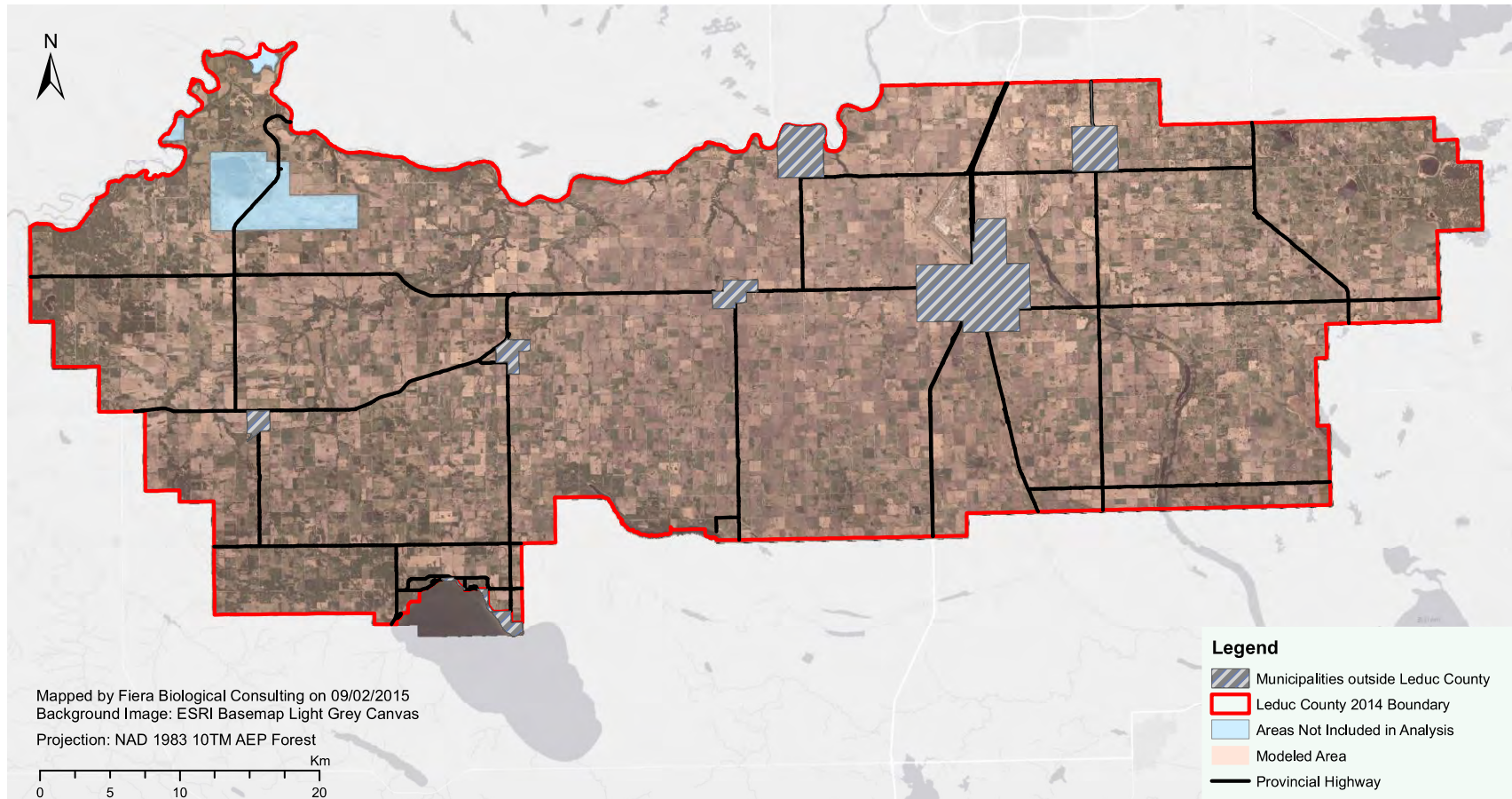The capacity of locations to support biodiversity was considered an important determinant of environmental significance in Leduc County. While there may be an interdependency between different measures of biodiversity (e.g., endemism and rarity), previous research has demonstrated the importance of combining multiple measures of biodiversity in modeling efforts to ensure that different dimensions of biodiversity are adequately represented (Ricketts et al. 1999; Caro 2010). As such, Criterion 1 includes indicators that represent different aspects of biodiversity.

> Indicator 1a: Rare, Threatened, or Endangered Species
> Indicator 1b: Fish-bearing water bodies & water courses
> Indicator 1c: Waterfowl staging, foraging & breeding areas

Criterion 2: Areas that contain rare or unique geology or habitats

Rare and unique habitats and landforms are important components of landscape diversity as they play a significant role in ecosystem functioning, provide habitat for specialist or niche species, and contribute to the aesthetic value of a region. Ecological representation forms the foundation for ensuring the persistence of biodiversity and ecosystem function, and a key component of this is representation of a variety of landscape types, process, patterns, and structures (O'Neil et al. 1995; Noss 1999). Thus, selecting indicators that represent unique or outstanding examples of landscape features is an important component of identifying environmentally significant areas. Habitats that are identified under this criterion have only a few recorded locations in Leduc County, have only a few occurrences in the province of Alberta, or are considered essential for meeting the requisites of certain species at specific times of the year. These rare habitats are considered to be areas that are irreplaceable within the ecological network, and their presence ensures that a full range of ecosystems and habitats are represented in Leduc County.

> Indicator 2a: Surficial geology & landforms

Indicator 2b: High productivity soils
Indicator 2c: Vegetation communities
Indicator 2d: Peatlands

Criterion 3: Areas with ecological integrity

Ecological integrity in both terrestrial and aquatic ecosystems can be measured either directly (e.g. nutrient and sediment loading), or indirectly using proxy indicators for ecological integrity such as land cover or road density. The ability of an ecosystem to maintain its core ecological functions and services (or resiliency) shows a strong correlation to habitat intactness and habitat patch size (Noss 1990; Anderson 1991). Additionally, the connectivity of watersheds or catchments is critical for the maintenance of natural processes and functions in both river and wetland communities (Linke et al. 2008; Nel et al. 2009). Criterion 3 contains indicators that are designed to quantify both aquatic and terrestrial habitat connectivity and ecological integrity.

Indicator 3a: Terrestrial habitat cover
Indicator 3b: Aquatic habitat cover
Indicator 3c: Within-stream habitat connectivity
Indicator 3d: Lake & wetland connectivity
Indicator 3e: Landscape connectivity

Criterion 4: Areas that contribute to water quality and quantity

The concept of ecological integrity is well established for freshwater ecosystems, and a key component of the ecological health of aquatic systems is the role of water quality and quantity to maintain ecological and hydrological functions and processes that in turn support both aquatic and terrestrial ecosystems and biodiversity (Linke et al. 2007; Nel et al. 2009).

Indicator 4a: River and stream density
Indicator 4b: Riparian habitat intactness (streams & rivers)
Indicator 4c: Riparian habitat intactness (wetlands & lakes)
Indicator 4d: Water storage potential
Indicator 4e: Discharge potential

4. Methods

4.1. Data Assembly and Management

Spatial data for each indicator was compiled from a variety of sources, and all available data was assessed for its quality, completeness, coverage, reliability and accuracy. In cases were required data was unavailable, or was of insufficient quality, new datasets were created using remote sensing methods. These new datasets included: 2013 Land Cover Classification, 2013 Wetland and Peatland Inventory, 2013 Stream and River Inventory, and a Groundwater Recharge Discharge Map. The methods used to create these new datasets are provided in Section 4.2. In total, over 20 datasets were compiled or created for use in this ESA study (Table 1).

Table 1. Spatial data used to quantify each indicator included in the Leduc County ESA study.

Indicator	Data Source
1a: Rare, Threatened, or Endangered Species	ACIMS, FWMIS, Leduc County Land Cover classification
1b Fish-bearing water bodies and water courses	AESRD Code of Practice management maps, Leduc County stream Layer
1c Waterfowl staging, foraging and breeding areas	Important Bird Areas of Canada (IBA), NAWMP staging areas, AESRD Trumpeter Swan Waterbodies & Watercourses, AESRD Piping Plover Waterbodies, AESRD Colonial Nesting Birds, , FWMIS
2a Surficial Geology and Landforms	Alberta Geological Survey; Surficial Geology of Alberta, 1:1,00,00 scale (Fenton et al. 2013), Quaternary Geology of Central Alberta- Meltwater deltas and fans (Shetsen 2007), Quaternary Geology of central Alberta- linear landform features (Shetsen 2007), Quaternary Geology of Central Alberta – Deposits (Shetsen 2002)
2b High productivity soils	Alberta Soils Information Viewer (AGRISID), Alberta Agriculture and Rural Development
2c Vegetation communities	ESRD Central Parkland Vegetation Inventory
2d Peatlands	ACIMS, Leduc County Peatland Inventory
3a Terrestrial habitat cover	Leduc County Land Cover Classification
3b Aquatic habitat cover	Leduc County Wetland Inventory & Land Cover Classification
3c Within-stream habitat connectivity	Leduc County Road Layer and Stream Inventory
3d Lake and wetland connectivity	Leduc County Wetland Inventory
3e Landscape connectivity	Leduc County Land Cover Classification
4a River and stream density	Leduc County Stream Inventory
4b Riparian habitat intactness (streams and rivers)	Leduc County Land Cover Classification & Stream Inventory
4c Riparian habitat intactness (wetlands and lakes)	Leduc County Land Cover Classification & Wetland Inventory
4d Water storage potential	Leduc County Wetland Inventory, Provincial Hydrography polygons (Lakes)
4e Discharge potential	Leduc County Recharge-Discharge maps

4.2. Remote Sensing Methodology

4.2.1. Land Cover Classification

Land cover in Leduc County was mapped using a combination of remote sensing (2013 pan-sharpened Landsat 8 satellite image) and GIS datasets. Eight major land cover types were initially identified, including:

1. Open water
2. Wet meadow zone (wetland influenced vegetation)
3. Open natural (grass/herbaceous)
4. Forest
5. Agricultural crops
6. Roads
7. Urban areas
8. Bare ground

Open areas could not be accurately classified using automated methods, therefore manual digitization of all open areas along all stream corridors was performed. Open water was identified using a combination of satellite images and air photos from 2013, and higher order streams and rivers were identified using the provincial stream network layer. Wetlands and wet meadow zones were identified using the 2013 wetland inventory that was created for Leduc County as part of this study (see Section 4.2). Areas of bare ground areas were also classified and delineated manually. Roads and urban areas were identified using layers provided by Leduc County.

Following ground truthing and manual and automated cleanup of the land cover layer (see Section 4.2.5), the land cover categories were refined to include 12 land cover categories, which are defined as follows:

1. **Open water**: areas of standing water including lakes, rivers, and wetlands with open water present

2. **Wetland wet meadow**: areas not typically covered by open water, but characterized by saturated soils and wetland-dependent vegetation

3. **Wetland**: areas classified as wetlands within the wetland inventory that were not captured by either the open water or wetland wet meadow class

4. **Open natural**: areas devoid of trees but covered by low-growing natural vegetation such as grass, forbs, and/or shrubs

5. **Open industrial**: areas covered by low-growing natural vegetation such as grass, forbs, and/or shrubs that also contain human footprint, such as well sites or farm yards

6. **Forest**: areas covered by deciduous or coniferous trees

7. **Forest (subdivision)**: coniferous and/or deciduous treed areas within residential subdivisions

8. **Agriculture**: agricultural areas including both arable and pasture lands

9. **Vegetated verge**: vegetated ditches along roadways

10. **Roads**: paved and unimproved road surfaces

11. **Urban**: built up urban and paved environments

12. **Bare ground**: areas of disturbed ground including Genesee mine and the Burnco gravel extraction operation

4.2.2. Wetland Inventory

The wetland inventory was created by identifying, delineating, and classifying all wetlands and lakes in Leduc County using a combination of terrain analysis, remote sensing, and color air photo interpretation. The methods used were based on the most recent wetland mapping techniques that have been developed and published in the scientific literature (Creed and Sass 2011; Sass and Creed 2011; Clare and Creed 2014; Sass et al. 2013).

The wetland inventory was created using two principal analysis: a terrain analysis (probability of depression) that identified areas of depression, and a probability of open water analysis that calculated the probability of open water from air photographs and satellite imagery. For the probability of depression (P_{dep}) analysis, a 15m resolution LiDAR DEM was used as an input to automatically delineate all probable depressions (i.e., low lying areas including wetlands, lakes and linear features such as riparian corridors) within Leduc County. The advantage of using LiDAR DEM to detect wetlands is the ability to detect wetlands under tree canopy, which is much more difficult when using aerial photographs alone (Lindsay et al. 2004). This terrain mapping resulted in a raster layer for Leduc County that identified low-lying areas were the probability of depression suggested the presence of a wetland.

A probability of open water map was derived from a combination of air photographs and satellite imagery. Six air photographs were available for Leduc County covering the period 1999 to 2013 (1999, 2005, 2007, 2009, 2011, 2013). These air photos were resampled to a standard 5m pixel resolution. Additionally 9 spring Landsat images (30m resolution) were used in this analysis covering the period 1986 to 2010 (1986, 1988, 1990, 1994, 1997, 1998, 2001, 2005, 2010). For each image, open water was classified by applying a threshold chosen from the image histogram. Pixels that were classified as open water were assigned a score of 1, with all other pixels being assigned a score of 0. The six air photograph open water layer scores were averaged, resulting in a range of values between 0 to 1. Similarly an average open water layer was determined from the 9 satellite images. The two probability of open water layers were combined to create a final probability of open water layer by assigning the maximum value from either the satellite or air photograph probability of open water layer to each 5m pixel. This map provided information about the frequency with which each pixel was "wet", giving some indication of the hydrological dynamics and water permanence within each wetland.

To identify individual wetlands, all pixels with a permanence value of >0.2 and a P_{dep} value of >0.4 were selected and were grouped into polygons. This initial wetland layer was systematically checked visually (on-screen) against the most recent high-resolution air photo (2013) to confirm wetland occurrence. Both errors of commission and errors of omission were considered. The biggest source of commission error included areas of shadows and low reflectance (e.g., forests) that that were confused with open water. Most of these areas were identified and deleted. Common omission errors included forested wetlands (e.g., bogs and fens) that were not detected by the automated procedures.

After visual inspection of the Wetland Inventory against the high resolution 2013 air photograph, it was determined that small wetlands (<0.1 ha) had been missed by automated procedures. These small wetlands were captured by setting new thresholds for P_{dep} (>0.3) and open water permanence (>0.3) to identify missing wetlands. Newly identified wetlands were manually checked against the 2013 air photo, and any commission errors were manually removed. At the same time, any wetland that was missed using the new threshold values (i.e., omission errors) were recorded with a point located within the center of the wetland. These wetland points were buffered by 20m and appended to the wetland inventory.

The manual check of the wetland inventory also revealed omission errors associated with forested wetlands (bogs and fens). In order to identify potential peatlands in Leduc County, we identified those areas of forest (as defined through the land cover classification) that overlapped areas with a P_{dep} >0.5. This gave a list of candidate areas that were visually inspected against the high resolution 2013 air photograph. All candidate areas that were located on steep slopes (>5%) and/or were located within a riparian corridor were removed from the candidate list. A subsample of these candidate areas were

validated through ground-truthing, and refinements were made to the slope and P_{dep} cut-off values. The boundary of two candidate peatlands was delineated using GPS locations in the field, and these boundary delineations were used as training for the manual classification of all remaining candidate peatland sites. Further ground-truthing was undertaken to confirm both the accuracy and location of identified peatlands.

It should be noted that the focus of this wetland inventory was to identify the location and estimate the class of wetlands present within the county. Wetland boundaries in this inventory were primarily determined using automated mapping procedures, with some on-screen modifications for striking errors. The emphasis was on wetland detection and not on precise boundary delineation. Given the large spatial extent of the county, and the large number of wetland identified in the inventory, it was not possible to visit each wetland in the field to confirm the location, class, or boundary. Thus, more accurate wetland mapping should be performed at the local-scale using both desktop and field-based methods to support small scale land use decisions.

Estimating Wetland Class

The probability of open water map was used to estimate Stewart and Kantrud wetland class (I/II, III, IV/V) based on a correlation between permanence and wetland class. For each wetland polygon we derived the maximum permanence value and the average permanence of all pixels within a wetland. These values were used to predict wetland class using specific decision rules (Table 2).

Table 2. Heuristics that were used to assign class (based on Steward and Kantrud 1971) to wetlands in Leduc County using probability of open water mapping.

WETLAND CLASS	QUANTIFICATION
LAKES	permanence (max) =1
	permanence (avg) > 0.45
	Area >25 ha
CLASS IV/V	permanence (max) >0.8
	permanence (avg) > 0.2
CLASS III	permanence (max) >0.8
	permanence (avg) < 0.2
	OR
	permanence (max) 0.5-0.8
	permanence (avg) 0.2-0.75
CLASS I/II	permanence (max) 0.5-0.8
	permanence (avg) 0.1 - 0.2
	OR
	permanence (max) 0.1 - 0.5

4.2.3. River and Stream Inventory

Streams were delineated based on terrain analysis using a 15m LiDAR DEM. Specific contributing areas were derived, and a flow accumulation value of 10,000 was used as a cut-off to identify streams (Strahler Order 1 through 7). A flow accumulation value of 10,000 was not appropriate for all parts of the watershed so visual inspection was performed against the 2013 high resolution air photograph and the resulting drainage network was modified, where appropriate. Most first-order stream segments identified using this methodology are ephemeral channels that are only inundated in high water conditions; however, they may play important roles in nutrient, sediment, and species transport.

4.2.4. Groundwater Recharge-Discharge Map

We used the methods of Sass et al. (2013) to compute discharge areas using wintertime Landsat 7 ETM+ thermal imagery acquired January 14, 2002, November 30 2002, and January 1, 2003. The discharge map detected some strong areas of discharge within the study area, especially in the western portion of Leduc County. We used the satellite image to classify the areas with the highest temperatures (>3.5°C) as 'high potential for discharge' zones and a transitional zone (-5.5°C to -3.5°C) as 'moderate potential for discharge'. The remainder of the county was considered to be an area of recharge, with areas with high recharge identified where Alberta Geological Survey Surficial geology maps showed coarse sediment (sand, gravel etc.) and low recharge potential where surficial sediments as identified in the AGS surficial geology maps were fine-grained (silt, clay etc.)

4.2.5. Remote Sensing Ground Truthing & Accuracy Assessment

Ground-truthing of the Wetland Inventory, Land Cover Classification, and the Peatland Inventory was undertaken with the objective of ensuring that the datasets used as an input to the ESA model were accurate. In order to achieve these objectives, we targeted areas for ground-truthing that had a range of land cover types, peatlands, and high numbers of wetlands. In total, 142 ground control locations were visited to verify the accuracy of the land cover classification, in addition to visiting 81 wetlands located throughout the county.

Wetlands

Of the 81 wetlands that were assessed, 97.5% were correctly identified as water bodies, with 46% of the wetlands visited having the correct wetland class assigned. Whilst we are very confident in the location and identification of the wetland inventory created for this study, the class of the wetlands should be treated as an estimate only. Further field investigation to confirm the estimated wetland class should be performed.

Land Cover Classification

The accuracy of the land cover classification was determined based on the correct or incorrect identification of each land cover type in the field. The overall accuracy of the land cover classification was 53.5%; however, the performance of the land cover classification varied significantly by land cover type, with very accurate estimates of bare ground and forest, and low accuracy for Open categories (Table 3). It is important to note, that the reported accuracy estimates are also subject to a sampling bias, as it was more common to record instances of an incorrect land cover classification, than to record locations where the land cover was accurately estimated.

Table 3. Accuracy results for the Land Cover Classification developed for Leduc County, as determined through a ground truthing campaign in which 142 ground control points were visited and assessed in the field.

Land Cover Type	Number of Locations Assessed in the Field	Correct Classifications	Accuracy (%)
Agriculture	34	17	50.0
Forest	52	36	69.2
Water/Wetland	24	10	41.7
Open	27	9	33.3
Bare Ground	5	4	80.0
Overall	142	76	53.5

The most important finding of the ground-truthing was that the open category was consistently miss-classifying non-natural features, such as well pads, industrial areas, and farm yards as open natural areas. As a result of the ground-truthing campaign several refinements to the Open class of the land cover classification were made;

- Misclassified slivers were removed from the *Open* class by merging any *Open* polygons that were less than100m by 100m with the largest neighbouring land cover polygon.

- Industrial, residential, and well pad areas within the *Open* category were identified using the 2013 air photo, manually delineated, and re-classified in the land cover classification as *Open Industrial*.

- Agricultural areas that were within the *Open* class were identified using the ABMI Human Footprint layer and reclassified as *Open Agricultural*.

- All remaining *Open* class areas that were not covered by agriculture or industrial regions were taken to be true representations of grass/herbaceous and reclassified as *Open Natural*.

In addition to refinements made to the Open class, the following adjustments were made to the land cover classification as a result of the ground truthing campaign:

- The Forest class was adjusted where forests intersected with subdivisions of less than 0.75 ha, and where subdivisions were found around Wizard and Pigeon Lake. The forest class in these residential areas was re-classified as Forest(Subdivision) and were excluded from any natural area calculations.

- The updated wetland inventory was burned in to the original land cover classification to ensure that all of the smaller wetlands were captured in the final land cover classification.

A second accuracy assessment was performed on the revised land cover classification using a standard classification accuracy assessment procedure that used the 2013 high resolution air photo for validation of the land cover classes. The detailed revision of the land cover classification resulted in significant accuracy improvements, with an overall classification accuracy of 92.3%. The most significant improvement in the classification were made in the Open categories (Table 4)

Table 4. Revised Land Cover Classification Accuracy assessment validated against 2013 air photograph.

Land Cover Type	Number of Random Sample Points	Correct Classifications	Accuracy (%)
Agriculture	90	83	92.2
Forest	80	76	95.0
Water/Wetland	109	98	89.9
Open Natural	82	78	95.1
Open Agriculture	81	67	93.1
Open Industrial	72	76	93.8
Bare Ground	100	89	89.0
Overall	142	76	92.3

4.3. ESA Indicator Quantification & Scoring

The Alberta Township System (ATS) quarter section grid was used as the initial basis for conducting the ESA modeling in Leduc County. This provided a sampling unit that is understandable and functional in an administrative context. Quarter-sections that contained active mine sites were removed from the analysis, in addition to municipalities that are not considered part of Leduc County. A total of 4,529 quarter-sections were analyzed for each of the 17 indicators that were used in the ESA model. Once indicators were quantified and scored at the quarter-section scale, the scores were reassigned to the natural habitat located within each quarter section. This ensured that ESAs within Leduc county were predominately composed of natural habitat, rather than areas of human disturbance or human-modified habitats.

Indicators were quantified for each quarter section in Leduc County using methods that were appropriate for the metric used to quantify each indicator, as well as the type of data used to do so (e.g. area-weighted average, count, density, total area, total length, etc.). Where possible and appropriate to do so, the methods used to quantify ESAs in Leduc County followed those that were developed and applied to model ESAs at the provincial scale (Fiera Biological 2014). Once quantified, each indicator was assigned a score ranging between 1 (low score) and 3 (high score) using either Boolean Algebra or Jenks Natural Breaks Classification (Jenks 1977).

Boolean algebra was applied in cases where an indicator was quantified by a "presence" or "absence" result (e.g., the quarter-section overlapped a peatland inventory polygon). In these cases, quarter-sections with a recorded "presence" received a score of 3, while all remaining quarter-sections scored 0. For indicators that were quantified using continuous numerical values (e.g., total length of stream sections within a quarter-section), a Jenks classification was used to determine quarter-section scores. A Jenks classification uses a statistical method to subdivide data into "natural" classes by minimizing the average deviation from the class mean and maximizing the deviation from the means of the other groups, thereby reducing variance within classes and maximizing variance between classes (Jenks 1977). For all indicators with continuous quantification scores, a Jenks classification was used to split indicator values into three classes that were scored as 1, 2, or 3. For indicators with a non-normal distribution of values, quantification values were first transformed using the most appropriate transformation method before determining scores using a three-class Jenks classification. An explanation for the rationale behind the selection of each criteria and indicator, along with a detailed rule-set for how each indicator was quantified and scored, is provided in Appendix A.

4.4. Indicator and Criterion Weighting

The importance of a particular variable relative to others that are under consideration can be determined via the weighting of variables (Malczewski 1999). The weighting of criteria and the application of multi-criteria decision analysis is becoming increasingly common in modeling exercises (Mendoza and Martins 2006; Malczewski 2006; Greene et al. 2011). In any weighting exercise, there is a certain amount of subjectivity applied to the ranking of variables, and this subjectivity is used to better reflect the place-based values that underlie the identification of important environmental resources (Greene et al. 2011).

A ranking method, where all attributes under consideration are ranked according to the decision maker's preference, was used to prioritize criteria and indicators because it is one of the simplest methods for calculating weights (Drobne and Lisec 2009; Greene et al. 2011). Ranking for criteria and indicators was developed through consultation with stakeholders at a criteria workshop, in addition to giving consideration to the ecological importance of the indicator, and the reliability of the data being used to quantify each indicators. Once the final ranking for all indicators and criteria was determined using best professional judgment, a rank sum approach was used to calculate the final weights. Rank sum weights were calculated using the following formula:

$$\omega_i = \frac{(n - r_j + 1)}{\sum(n - r_k + 1)}$$

where:
ω_i = normalized weight for the jth criterion or indicator
n = the number of criteria or indicators under consideration
r_j = the rank position of the criterion
$\sum(n - r_k + 1)$ = the sum of all weights

All calculated weights were organized in accordance with the analytic hierarchy process method (AHP) to ensure mathematical consistency throughout the framework (Drobne and Lisec 2009). All criteria and indicator weights obtained from the ranking exercise were normalized, meaning that the sum of all indicator values related to a criterion were equal to the weight of that criterion. Finally, the sum of all criteria weights was equal to 1 (Figure 1).

Figure 3. Final weighting values applied to each criteria and indicator used to identify Environmentally Significant Areas in Leduc County.

4.5. Indicator and Criteria Aggregation

Once indicators were quantified and the weighting determined, final values for each indicator were calculated using weighted linear combination, which first required the normalization of indicator scores into a common numeric range (Greene et al. 2011). This was done using linear scale transformation, which employed a score range procedure that standardized scores into values that ranging between 0 and 1 (Drobne and Lisec 2009). Specifically, indicator scores were normalized as follows: Class 1 = 0.15; Class 2 = 0.35; Class 3 = 0.50. Indicator scores and weightings were then combined using the following mathematical expression (Drobne and Lisec 2009):

$$\mathrm{Iv} = \sum w_i\, x_i$$

where:

Iv = Indicator value
w_i = Indicator weight
x_i = Indicator score

For each quarter-section in Leduc County, weighted indicator values were aggregated for each criteria to determine a final criteria value. Criteria values were then summed by quarter-section to calculate a final ESA value. This resulted in an ESA map with a continuous surface of values, with values ranging between 0 and 0.50.

4.6. Assigning ESA Score

Once final ESA values were calculated and a continuous ESA value surface was produced for Leduc County, an ESA cut-off value was determined. The distribution of ESA scores was examined and a variety of methods were examined to objectively assign an ESA cut-off value, including percentile ranks, Jenks, and Quartiles. Ultimately, the ESA score distribution was determined statistically using quartile breaks (Figure 4), with the top quartile (top 25%) of quarter-sections deemed to be ESAs. The final ESA raw score cut-off value of ≥ 0.153 was used and areas identified as ESAs were visually inspected in the GIS to ensure that the cut-off value resulted in ESA areas that appeared to be reasonable given the types and amounts of cover present within each quarter section. Raw scores were converted to a scale ranging between 0 and 100 for mapping purposes.

4.7. Ground-Truthing & ESA Model Revisions

Ground-truthing of ESA scores was undertaken with the objective of ensuring that the ESA model outputs were accurate and appropriate. In order to achieve these objectives we targeted areas for ground-truthing that had high quarter-section ESA scores, quarter-section ESA scores close to the ESA cut-off value, and low-scoring ESA quarter-sections. A total of 44 complete quarter-sections were visited and assessed for ground-truthing purposes. Two qualified biologist visited each of the quarter sections and assessed the overall ecological condition of the quarter section, as well as the condition of any natural habitats or features contained within the quarter section. Based upon best professional judgement, the overall condition of each quarter section was assessed, and the ESA score was evaluated. Results of the field assessment were used to assess the performance of the ESA model, as well as to direct refinements that were made to the model.

Ground truthing of Environmentally Significant Areas scores revealed three major findings. The first major finding of the ground truthing campaign was that in general, the model performed well and the ESA scores were generally considered appropriate and reflective of the ecological condition observed in each QS. In particular, high scoring quarter-sections accurately reflected the quality and the amount of habitat present. A second major finding was that many of the high scoring quarter-sections contained a mix of natural and non-natural cover, and while the natural cover was typically considered to be of high quality and deserving of ESA status, the remainder of the non-natural areas within the quarter-section were not considered to be ESAs in and of themselves. Finally, the ground-truthing exercise revealed that some of the larger wetland complexes within the County were being consistently underscored in the model,

meaning that the ecological importance of these habitats were not being adequately reflected in the scores assigned by the model.

As a result of the ground-truthing the ESA model was modified to reflect the importance of large water bodies and wetland complexes through the development and inclusion of a new indicator (Indicator 3b: Aquatic habitat cover). Other ESA model improvements that were a direct result of the ground validation included the development and inclusion of Indicator 3e (Habitat connectivity), and the refinement of Indicator 3a (Terrestrial habitat cover) to consider only quarter-sections with > 25% natural terrestrial habitat cover.
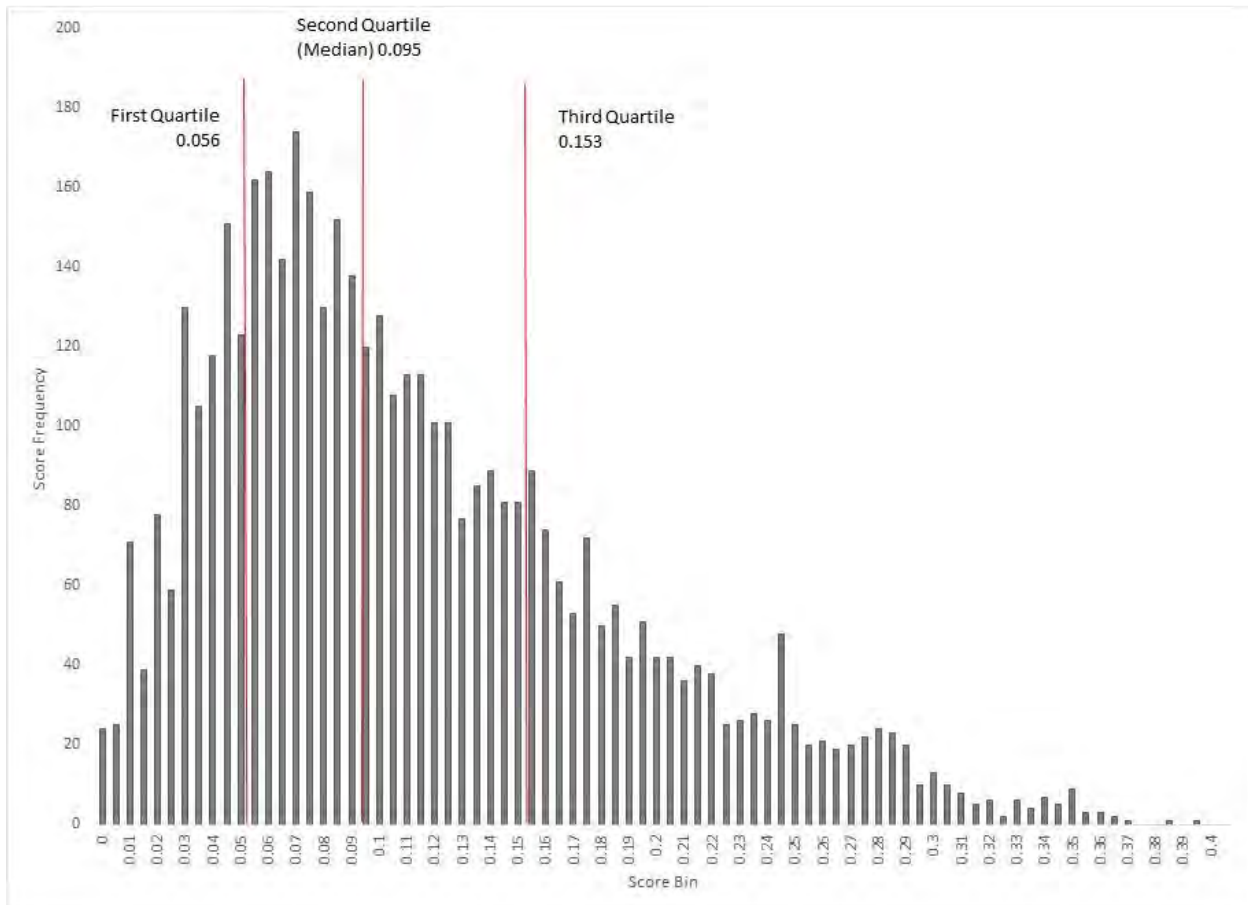
Figure 4. Histogram of modeled Environmentally Significant Areas quarter-section scores with the Quartile breaks identified.

4.8. Defining ESAs Using Natural Cover

Visual inspection of ESA areas within Leduc County and ground-truthing of quarter-section ESA scores revealed that whilst the model accurately predicted Environmentally Significant Areas, not all portions of a quarter-section that were identified as an ESA were true environmentally significant areas (e.g. agricultural fields adjoining riparian areas within a quarter-section). In order to refine the areas that were considered ESAs within a quarter-section, ESA scores were re-assigned from the quarter section to the natural habitat cover present within the quarter section. This reduced the amount of agricultural fields or other anthropogenic features that were classed as an ESA.

ESA scores were assigned to the natural cover within each quarter section by first identifying the natural habitat types using the Leduc Land Cover Inventory. From this land cover classification four natural feature types were considered; water, wetlands/wet meadow, open natural, and forest. All of these features were buffered by 30 meters to remove errors associated with border accuracy, with 30 meters being the resolution of the land cover classification. Each individual buffered feature was intersected with the final Leduc ESA quarter-section scores, and the natural areas were assigned the maximum ESA score with which it intersected. This ensured that continuous natural habitat covering more than one quarter section was treated as a single, continuous ESA polygon. All natural habitat polygons with a maximum quarter-section score greater than the cut-off value of 0.153 were selected as an ESA. All ESA polygons merged, dissolved, and holes more than 100m^2 were filled, resulting in a continuous ESA surface for Leduc County composed of natural cover.

5. Wetlands in Leduc County

At a global scale, wetlands are being lost and degraded more quickly than any other type of ecosystem, and it is estimated that between 60 and 70% of wetlands have been lost in the central and southern regions of Alberta since European settlement (Dahl and Watmough 2007). The high rates of wetland loss in central and southern Alberta have largely been driven by agricultural land conversion and urban development (Clare and Creed 2014). In turn, these losses have had profound impacts on human communities, as wetlands are critical to the hydrological systems that provide important ecosystem services, such as water filtration and treatment, stabilization of water supplies (i.e., reduction of flooding and drought), erosion control, and nutrient abatement. Ecologically, wetlands serve as critically important habitat to a variety of aquatic, semi-aquatic, and terrestrial wildlife and vegetation species, and the loss of wetland habitat has driven declines in the occurrence of many species across Alberta.

Based on the wetland inventory that was created as part of this study, the existing cover of lakes and wetlands in Leduc County is estimated to be approximately 5%, with the highest density of water bodies located in the eastern and north western portions of the County (Table 5; Figure 5). Approximately 1.7% of wetlands identified in the inventory are estimated to be Class I, II, or III, which are those wetlands that are considered to be seasonal or temporary in nature, i.e., open water is present for days or weeks in the spring or after major precipitation events, and wetlands are typically dry by August (with the exception of very wet years). Semi-permanent or permanent wetlands, i.e., wetlands where open water is typically persistent throughout the year (Class IV and V), are estimated to cover approximately 1.8% of the County. Peatlands, which include wetlands that are dominated by moss and are comprised of both bogs and fens, are the rarest type of wetlands, covering approximately 0.3% of the County. Large named lakes were estimated to cover just over 1% of the County.

It is important to note that while the accuracy of the wetland inventory created for Leduc County is very good as it relates to identifying the location and presence of wetlands, the accuracy associated with predicting the wetland class is low. Thus, we grouped similar wetland classes together to improve the predictive capacity of the inventory. Further, given the methods and the resolution of the data that were used to develop the wetland inventory, it was not possible to accurately delineate the boundaries of each wetland. As such, the wetland areas provided here are estimates only. Despite the uncertainties associated with these estimates, this inventory does provide a general understanding of the existing types and coverage of wetlands in Leduc County.

Table 5. Number and area of wetlands estimated to occur in Leduc County based on a remotely sensed inventory.

Stewart & Kantrud Class	Water Body Description	Estimated Area (ha)	Estimated Number	Percent Cover
LAKE*	Provincially named lakes	2,819.9	19	1.1
VII	Peatlands (bog or fen)	834.9	269	0.3
IV / V	Semi-permanent or permanent wetlands	4,628.5	994	1.8
I / II / III	Ephemeral, seasonal, & temporary wetlands	4,521.4	5,985	1.7
Unclassified	No wetland class assigned (class unknown)	421.0	2284	0.2
	Total:	**13,226.0**	**9,551**	**5.0**

*Includes area of Genesee Lake, which has been modified as part of the Genesee Mine operation.
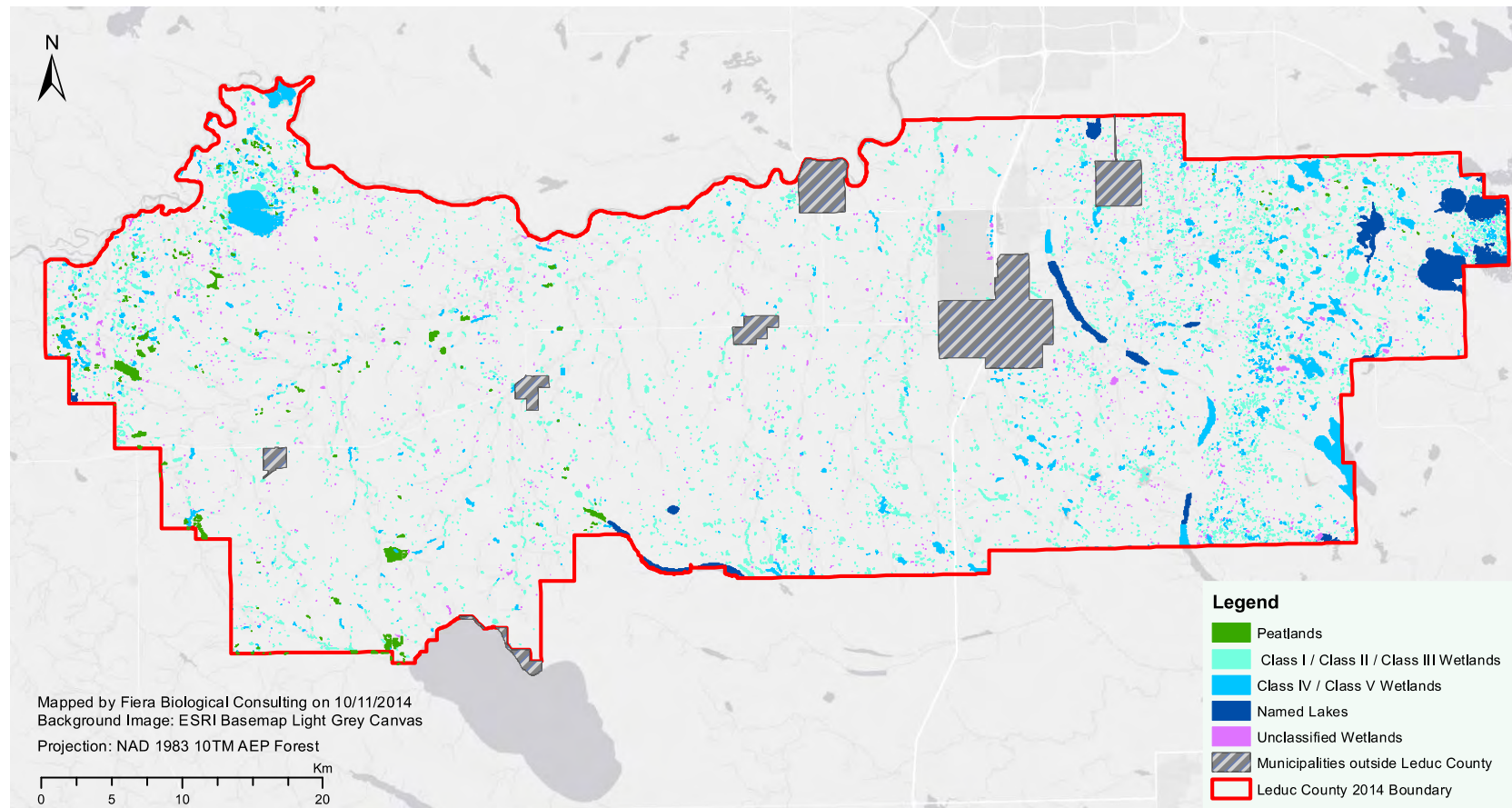
Figure 5. Location of lakes, wetlands, and peatlands identified in Leduc County using remote sensing methods.

6. ESAs in Leduc County

6.1. Criteria Scores

Indicators included under each of the four ESA criterion were quantified and summed to calculate a quarter section score for each criteria. A summary of the results by criteria are presented below.

Criterion 1

Criterion 1 received a final weighting of 20% in the Leduc County ESA model. Final criteria values ranged between 0 and 83, with a mean value of 28 (Figure 6). This criterion covered a total of 154,890 hectares (56% of Leduc County).

Criterion 2

Criterion 2 received a final weighting of 10% in the Leduc county ESA model. Final criteria values ranged between 0 and 100, with a mean value of 21 (Figure 7). This criterion covered a total of 265,704 hectares (96% of Leduc County).

Criterion 3

Criterion 3 received a weighting of 40%, which was the highest weighting value of all criteria included in the ESA model. Final criteria values ranged between 0 and 85, with a mean value of 21 (Figure 8). The total area of Leduc County covered by Criteria 3 was 244,499 hectares or 89% of the total county area.

Criterion 4

Criterion 4 received a weighting of 30%, which was the second highest weighting value of all criteria included in the Leduc County ESA model (Figure 9). Final criteria values ranged between 0 and 100, with a mean value of 34. Criterion 4 covered a total of 267,484 hectares or 97% of the County.
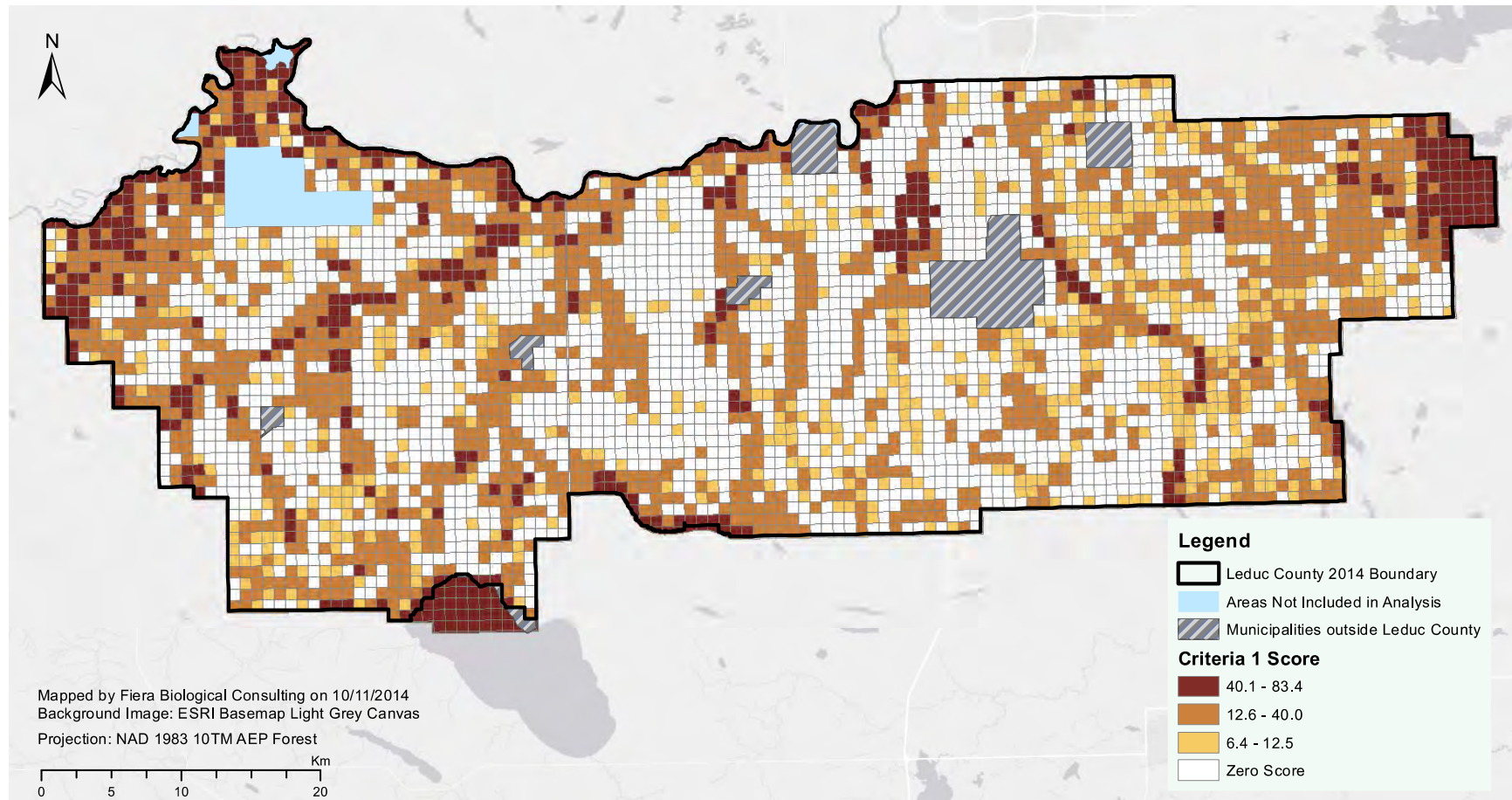
Figure 6. Final ESA model output map for Criterion 1: Areas that contain focal species, species groups, or their habitats.

Legend

- Leduc County 2014 Boundary
- Areas Not Included in Analysis
- Municipalities outside Leduc County

Criteria 2 Score
- 47.0 - 100.0
- 21.8 - 46.9
- 3.1 - 21.7
- Zero Score

Mapped by Fiera Biological Consulting on 10/11/2014
Background Image: ESRI Basemap Light Grey Canvas

Projection: NAD 1983 10TM AEP Forest

Km

0   5   10   20
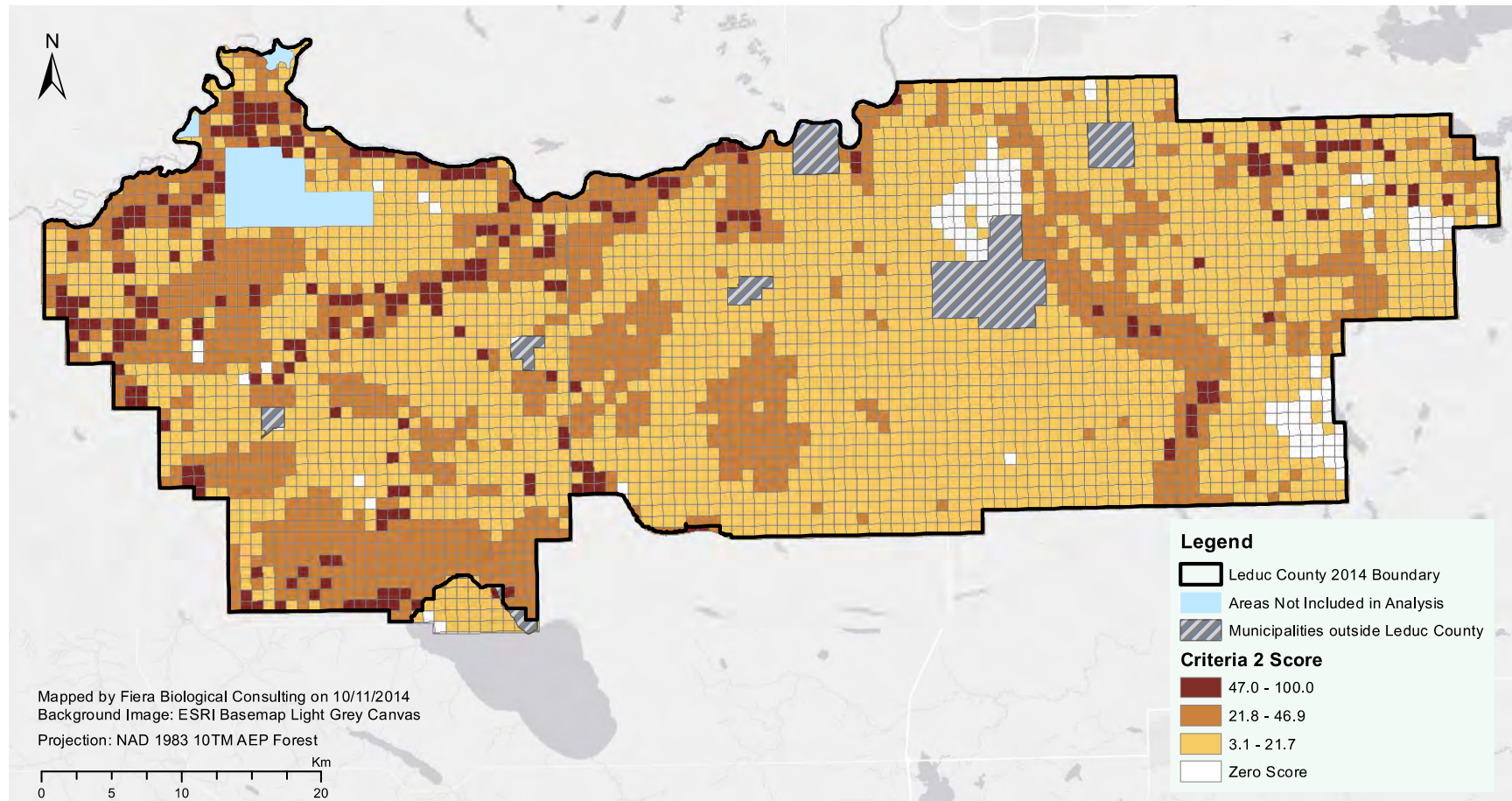
Figure 7. Final ESA model output map for Criterion 2: Areas that contain rare or unique geology or habitats.

Legend

— Leduc County 2014 Boundary

Areas Not Included in Analysis

Municipalities outside Leduc County

Criteria 3 Score

39.1 - 84.5

15.8 - 39.0

3.2 - 15.7

Zero Score

Mapped by Fiera Biological Consulting on 10/11/2014
Background Image: ESRI Basemap Light Grey Canvas

Projection: NAD 1983 10TM AEP Forest

Km
0   5   10   20
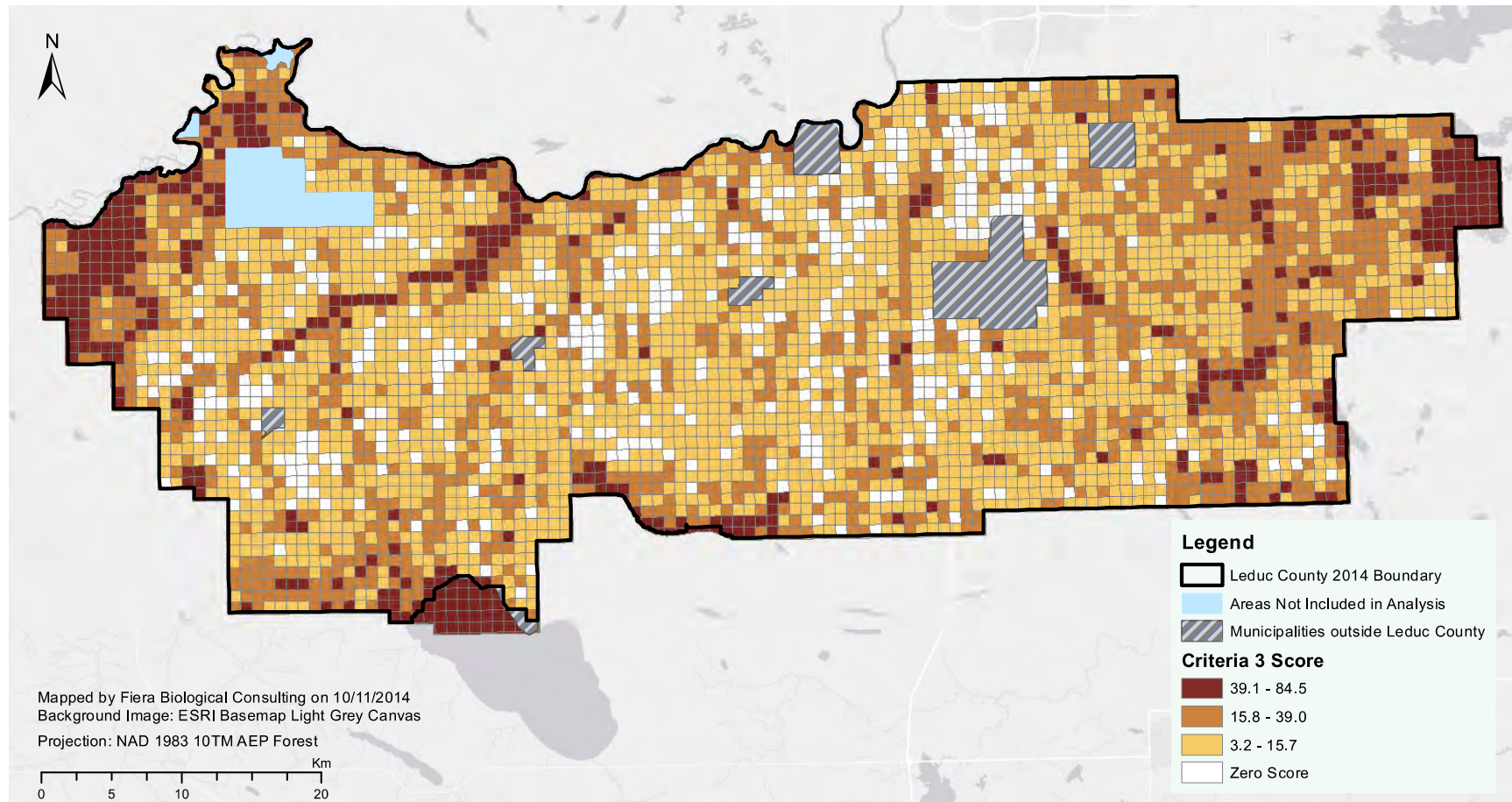
Figure 8. Final ESA model output map for Criterion 3: Areas with ecological integrity.
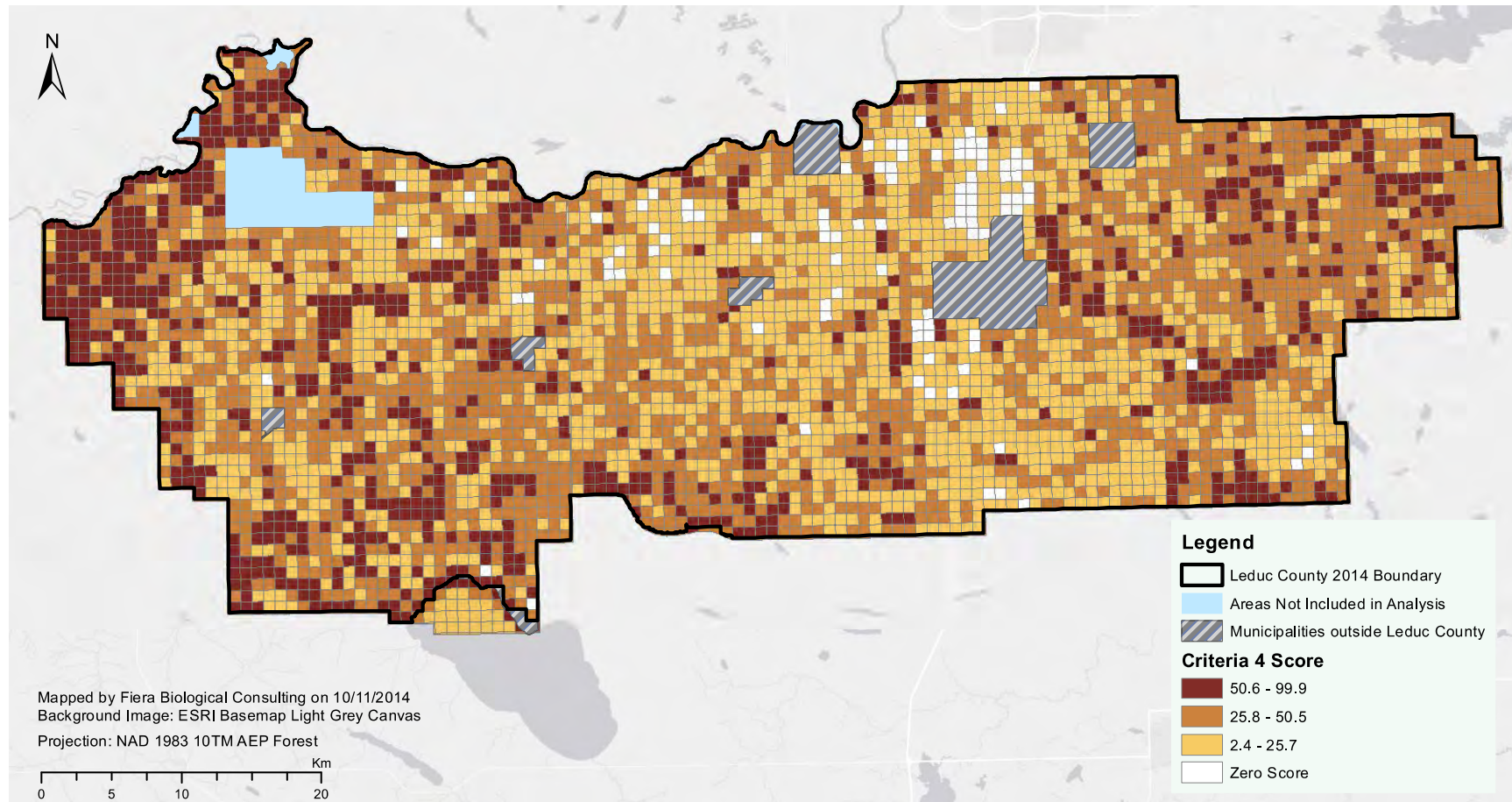
Figure 9. Final ESA model output map for Criterion 4: Areas that contribute to water quality and quantity.

6.2. Environmentally Significant Areas

Final ESA quarter-section scores ranged between 0 and 78, with a mean value of 22 (Table 8; Figure 10). When natural cover was used to define ESA boundaries within quarter sections that met the ESA cut-off value, the total area of ESA in Leduc County was calculated to be 61,325 ha, or ~24% of the County (Table 6; Figure 11). The Environmentally Significant Areas identified in this study are generally concentrated at the western and north eastern portions of the County, while in the central region, ESAs tend to be concentrated along riparian corridors of major rivers or streams (Figure 12).

The proportion of Leduc County identified as an ESA in this study is ~12% higher than the total ESA area identified by Westworth (1990; Table 8). New areas of ESAs identified in this study, as compared to the Westworth (1990) study, are concentrated in the south western, north western, and north eastern regions of the County (Figure 13). Areas of greatest disagreement between the two studies are primarily located along the edges of river and stream networks, and along the shores of large lakes. These differences are likely a result of habitat loss that has occurred in these areas since 1990, or may be a result of different mapping methods and technology.

Table 6. Comparison of Environmentally Significant Areas identified in Leduc County by the 2014 study and the 1990 study, as well as a comparison of the amount of area identified as ESA in studies done for the Province of Alberta in 2009 and 2014.

ESA Study	Proportion (%) of Leduc County Covered by ESAs
1990 Leduc County ESA Study (Westworth)	11.8
2014 Leduc County ESA Study (this report)	23.7
	Proportion (%) of Alberta Covered by ESAs
2009 Provincial ESA (Fiera Biological 2009)	28.8
2014 Provincial ESA (Fiera Biological 2014)	44.5

Mapped by Fiera Biological Consulting on 10/11/2014
Background Image: ESRI Basemap Light Grey Canvas

Projection: NAD 1983 10TM AEP Forest

Legend

☐ Leduc County 2014 Boundary

☐ Areas Not Included in Analysis

▨ Municipalities outside Leduc County

ESA Score

■ 38.0 - 78.4

■ 18.9 - 37.9

☐ 0.5 - 18.8

☐ Zero Score
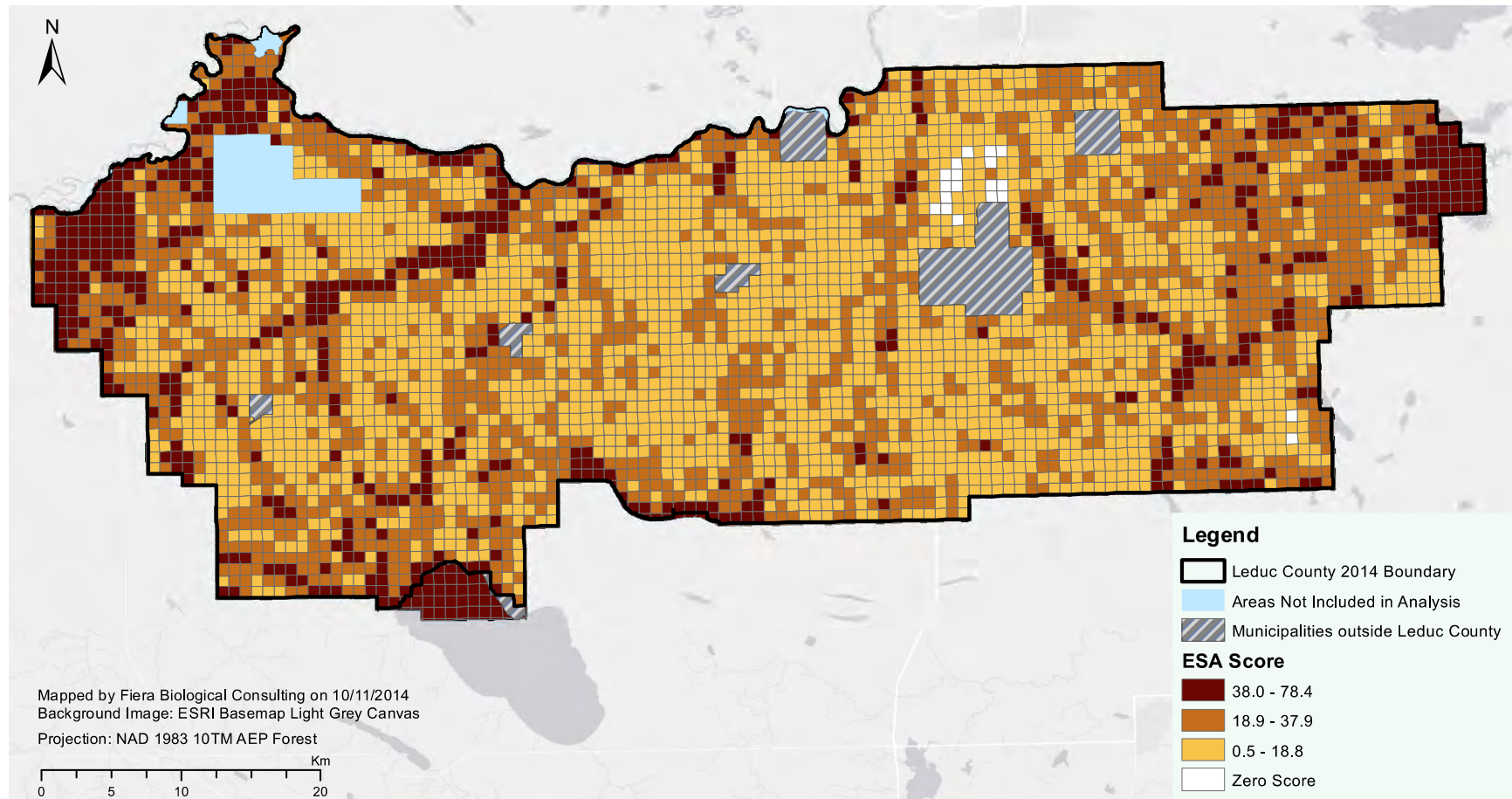
Figure 10. ESA model output map displaying ESA quarter section scores as quartile breaks.
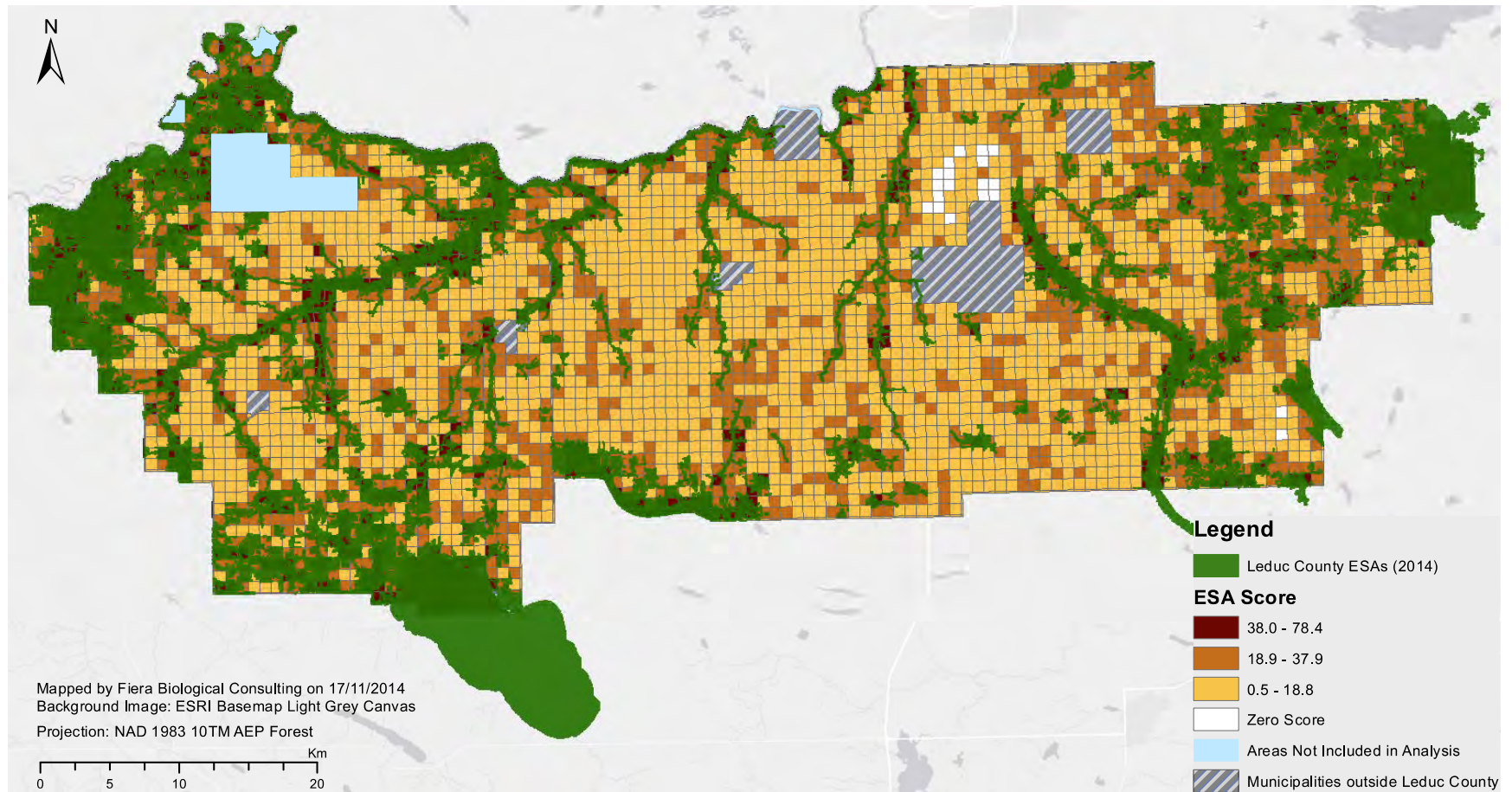
Figure 11. Final ESA model output map identifying Environmentally Significant Areas in Leduc County as delineated using natural cover within quarter sections. Quarter section scores underlying the ESA area delineation highlight areas adjacent to ESAs that are also considered of higher value, but did not meet the ESA cut-off value. These quarter sections represent locations were restoration efforts could be prioritized to improve the overall condition of ESAs in Leduc County.

Mapped by Fiera Biological Consulting on 10/11/2014
Background Image: ESRI Basemap Light Grey Canvas

Projection: NAD 1983 10TM AEP Forest

Km

0   5   10   20

Legend

Leduc County ESAs (2014)

Municipalities outside Leduc County

Areas Not Included in Analysis

Leduc County 2014 Boundary
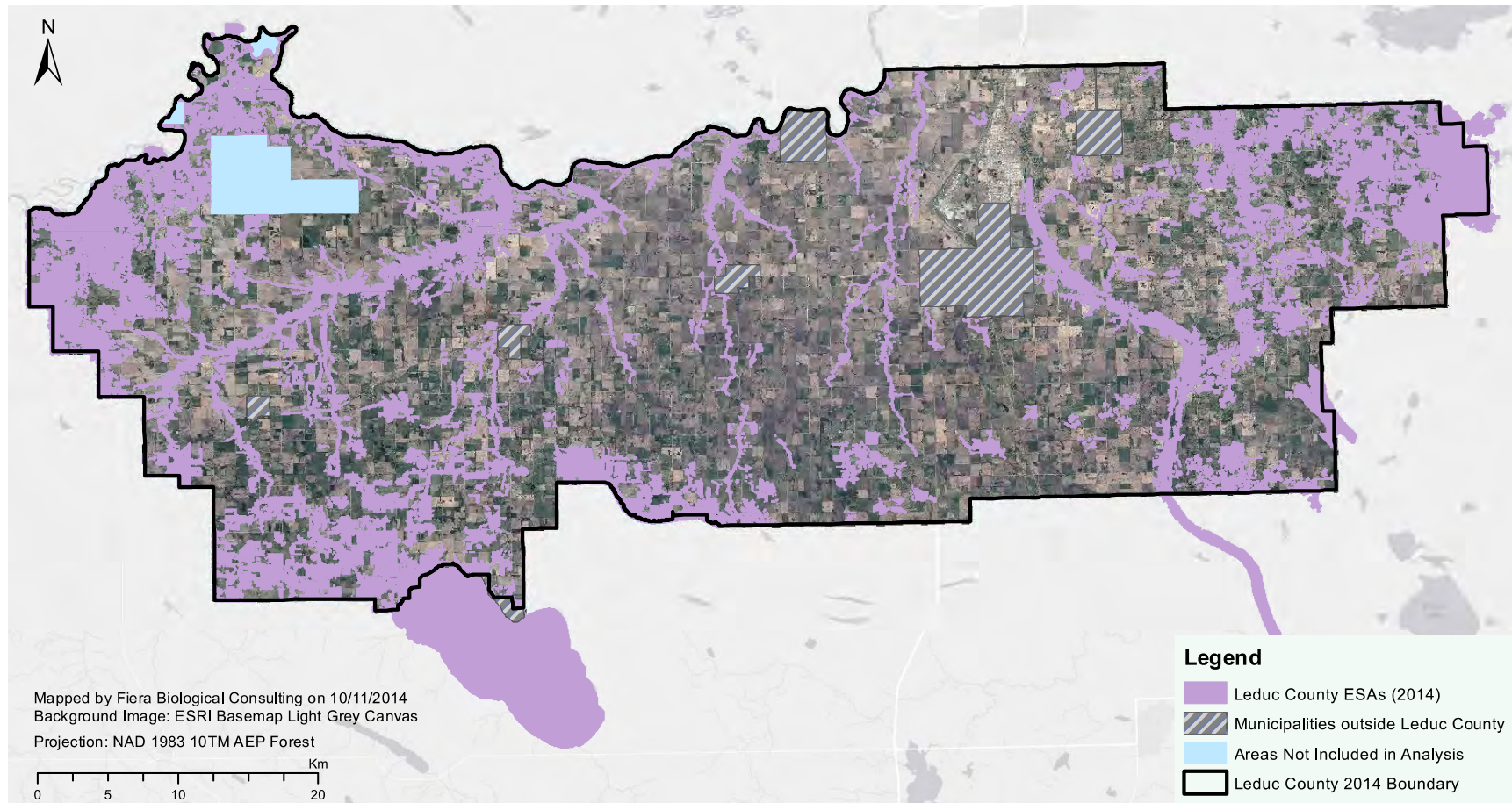
Figure 12. Final ESA model output map identifying Environmentally Significant Areas in Leduc County as delineated using natural cover boundaries.

Legend

New ESA Area (2014)

ESA Overlap (2014 &1990)

1990 ESA Area (no overlap)

Leduc County 2014 Boundary

Municipalities outside Leduc County

Mapped by Fiera Biological Consulting on 10/11/2014
Background Image: ESRI Basemap Light Grey Canvas

Projection: NAD 1983 10TM AEP Forest

Km

0   5   10   20
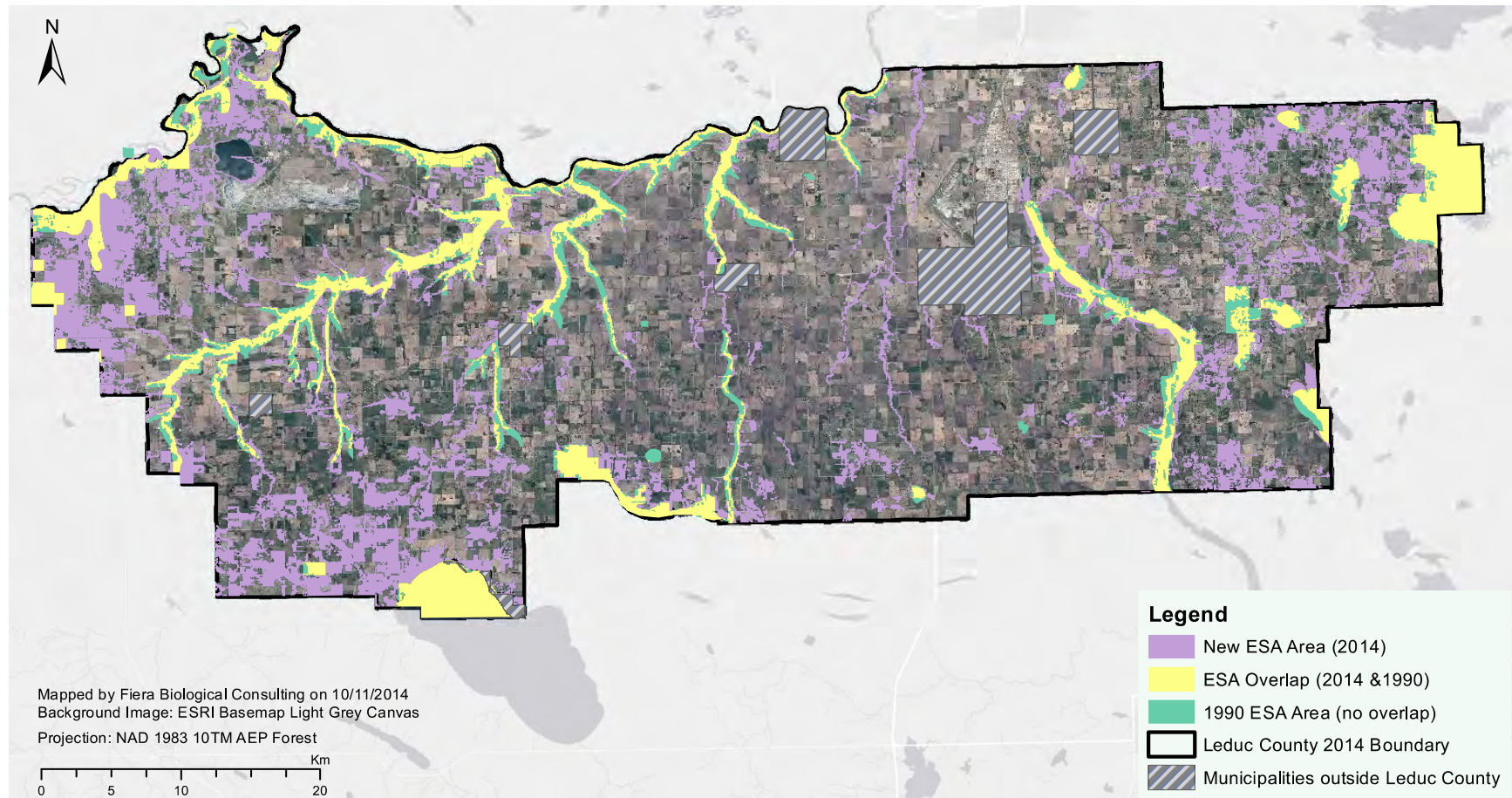
Figure 13. Similarities and differences between ESAs identified in this 2014 Leduc County ESA study and the previous 1990 ESA study.

6.3. Identification & Delineation of ESAs

6.3.1. ESA Areas

Individual Environmentally Significant Areas within Leduc County were defined and delineated using both areas of continuous natural cover and the underlying quarter-section scores. For regions where the continuous ESA habitat or high quarter-section scores resulted in very large individual ESA polygons, low scoring quarter-sections separating high scoring regions, major roads, or high intensity land use boundaries were used to subdivide large ESA polygons into smaller ESA polygons.

In total, 120 individual ESAs were identified within 26 distinct areas throughout Leduc County (Table 7; Figure 14; Appendix B). ESA Areas were named to reflect the nearest major natural or geographic feature, and individual ESAs were grouped within these areas based primarily based on proximity. Given the large number of individual ESAs identified in the County, each ESA was assigned a number as a unique identifier, rather than a name.

Table 7. Names and number of individual ESAs contained within each distinct ESA Area located within Leduc County.

ESA Area Name	Number of Individual ESAs within Area
Coyote Lake	4
North Coyote Lake	2
West Genesee	2
North Genesee	2
Strawberry Creek	14
North Saskatchewan	6
West Pigeon Lake	7
Pigeon Lake	1
Weed Creek	16
Wizard Lake	1
Conjuring Creek	9
Whitemud Creek	7
South Whitemud Creek	5
Northwest Coal	6
Irvine/Blackmud Creek	7
Saunders Lake	9
Coal Lake	2
North Labyrinth	2
Northwest Hay	1
Big Hay Lake	1
Eagle Rock	4
Looking Back Lake	3
New Sarepta	2
South Sarepta	2
Southwest Sarepta	1
Joseph Lake	4
TOTAL	120

6.3.2. Individual ESAs

Individual ESAs were classified into one of the following habitat categories: Aquatic, Riparian, Mixed, or Upland, based upon the percent coverage of each distinct habitat type within the ESA polygon. The Aquatic habitat class was defined using the wetland and lake inventory, and included a 30 m buffer on each feature that was intended to capture all or a portion of the riparian habitat associated with these features. The Riparian habitat class was defined as river and stream habitat, in addition to the riparian

habitat located adjacent to these features. Riparian habitat was defined by buffering the Leduc County stream and river network layer based upon Strahler Order, where:

- Strahler Order 1-2 were buffered by 30m;
- Strahler Order 3-5 were buffered by 50m and;
- Strahler Order 5+ were buffered by 100m.

Individual ESAs were categorized as either Aquatic, Riparian, Mixed, or Upland based upon the percent cover of each habitat type present within the ESA following the habitat class qualification rules outlined in Table 8 below. The majority of ESAs identified in Leduc County were classified as "Mixed" habitats (46%), with Upland ESAs making up the smallest proportion (16%) of ESAs in Leduc County (Table 9). In addition, each ESA was assigned an "Overall ESA Rank", based on the individual ESA score, out of 120. This ranking represents the relative position of the ESA compared to all other ESAs, with the overall ranking of 1/120 representing the ESA with the highest score in Leduc County, and the ESA with a ranking of 120/120 representing the ESA with the lowest score in the County. Similarly, each ESA was assigned an "Area ESA Ranking", representing the relative ranking of that particular ESA within the defined ESA Area (see Table 7 and Figure 14 for ESA Areas).

Individual maps for each ESA identified in Leduc County are presented in Appendix B.

Table 8. Classification rules used to determine the four ESA region classes.

ESA Habitat Class	Habitat Class Qualification
Aquatic	Total Aquatic Cover > 50%
Riparian	Total Riparian Cover >30%
Mixed	Total Aquatic Cover >25% AND <50% OR Total Riparian Cover >15% AND< 30%
Upland	Total Aquatic Cover <25% AND Total Riparian Cover <15%

Table 9. Total number of ESA regions classed into the four ESA categories with the total area of each category and the total cover of each category of ESA region in Leduc County.

ESA Class	Total number of ESAs within Each Class	Total Area (ha) of ESAs within Each Class	Proportion of ESAs within Each Class
Aquatic	24	11,418	18
Riparian	32	13,330	20
Upland	16	10,420	16
Mixed	48	30,188	46
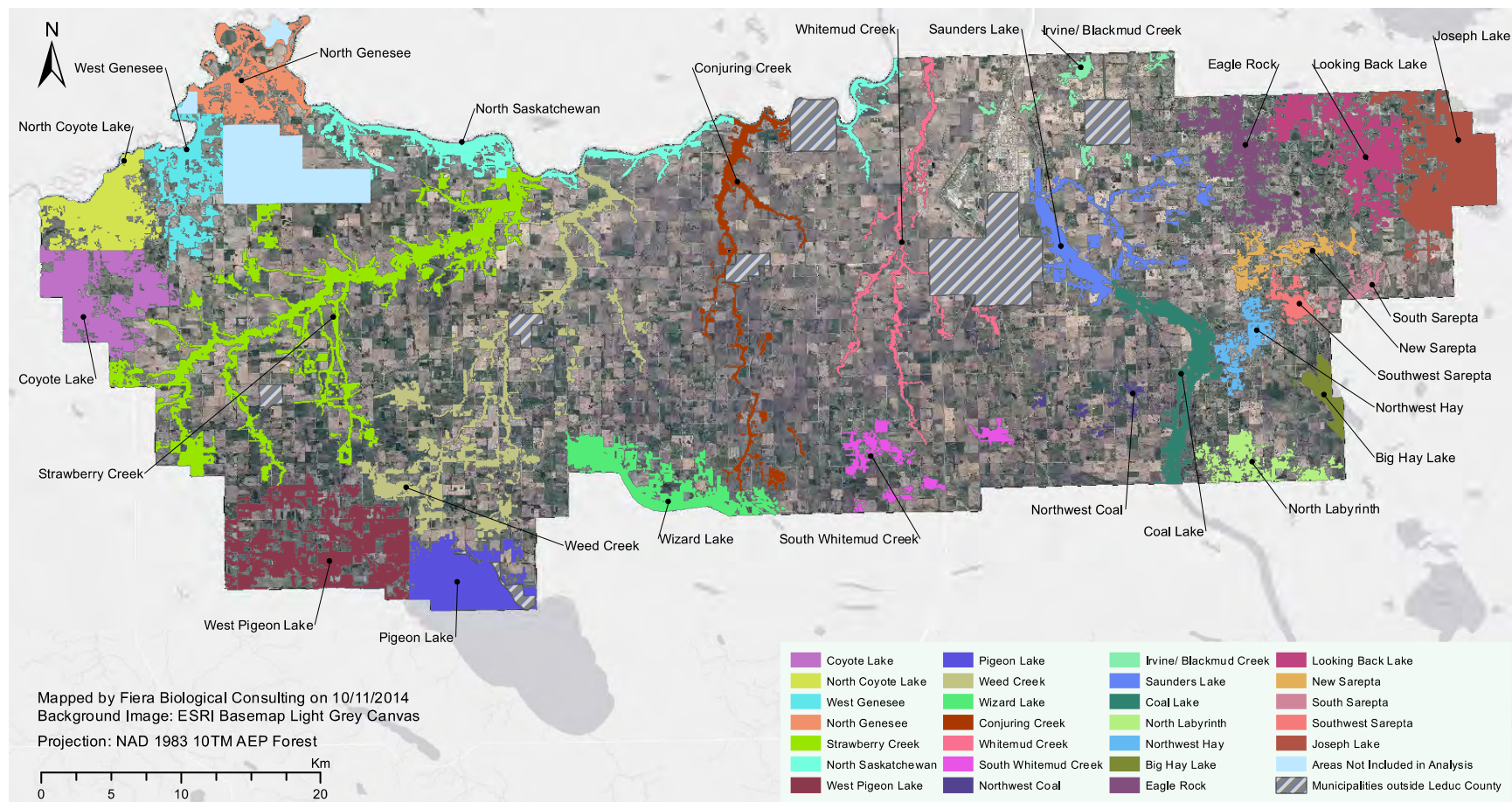
Figure 14. Location of each of the 26 distinct ESA Areas identified in Leduc County. Smaller individual ESAs have been identified within each ESA Area. Maps for individual ESAs can be found in Appendix B.

7. Assigning Disturbance Risk to ESAs in Leduc County

In order to properly manage and develop meaningful policies that can be used to help guide land management decisions within or adjacent to Environmentally Significant Areas, it is important to understand disturbance risk associated with current and future land use in Leduc County. This risk classification can then be used to identify ESAs that are most vulnerable to human disturbance or development, thus providing land managers with information that can be used to prioritize ESAs for special management or conservation. Environmentally Significant Areas in Leduc County were classified into three disturbance risk categories: High, Medium, and Low disturbance risk, and risk was primarily defined based upon current land use designations and future growth projections over the next 20 years.

High Disturbance Risk was assigned to ESAs that fell within quarter sections that have been identified or designated for development through existing and approved statutory documents, including Area Structure Plans (ASP) or Local Areas Structure Plans (LASP). In addition, ESAs that were located within quarter sections that have been identified as "priority growth areas" through the Capital Region Board Growth Plan were considered to be High Development Risk (Table 11).

Low Development Risk ESAs were those that were located within privately owned quarter sections that have been legally designated as a conservation easement. In addition, ESAs that fell within Provincial Parks, Provincial Recreation Areas, or designated provincial Natural Areas were considered to be at low risk of development.

ESAs that were considered to be Medium Development Risk included provincial crown reservations where Alberta Parks has registered an interest in the land through a Protective Notation (Table 11). These lands have been identified by Alberta Parks as areas that are suitable for designation as a Natural Area or Provincial Park, but these lands have not yet been secured for management under the *Parks Act*. In these locations, special conditions may be placed on industrial activity, but where such activity is not prohibited. All other ESAs not identified as High or Low development risk were also assigned to the Medium Development Risk category (Figure 15).

Using these classification criteria, a total of 1,503 ha, or 2% of the ESAs identified in Leduc County are considered to be Low Development Risk (Table 10). The majority of ESAs (67%) are considered to be Medium Development Risk, while over 20,000 ha (31%) of the ESAs identified in the study area were considered to be High Development Risk when considering the current and future approved and projected growth in Leduc County.

Table 10. Total area and proportion of ESAs in Leduc County designated as High, Medium or Low Development Risk.

Development Risk Category	Total Area (ha) of ESAs within Risk Category	Proportion (%) ESAs within Risk Category
High	20,167	31%
Medium	43,711	67%
Low	1,503	2%

Table 11. Land use types and designations that were used to determine development risk categories in Leduc County.

High Development Risk Land Uses	Low Development Risk Land Uses	Medium Development Risk Land Uses
AG-CR Transitional	Alsike Bat Lake Natural Area	Coyote Lake Natural Area (PNT)
Blackmud Creek ASP	Coyote Lake Natural Area	Strawberry Creek Natural
BP - Business Park	Genesee Natural Area	Area (PNT)
C1 - Commercial	St. Francis Natural Area	Telfordville Natural Area
C2 - Commercial	Thorsby Natural Area	(PNT)
CH - Highway Commercial	Coal Lake North Provincial Recreation Area	
Crossroads ASP	Pigeon Lake Provincial Park	All other ESAs not classified
CS - Service Commercial	The Nature Conservancy of Canada Lands	as High or Low Risk
DC - Direct Control	Ducks Unlimited Canada Lands	
East Vistas LASP		
Genesee ASP		
Genesee Current Mine Permit		
Genesee Proposed Permit Extension		
GI - General Industrial		
GP - Genesee Power Project Overlay		
IAR - Industrial-Agricultural-Resource		
IB - Industrial Business		
IND - Industrial		
LI - Light Industrial		
M1 - Industrial		
M-R - Industrial Reserve		
Nisku ASP		
Nisku West ASP		
North Major ASP		
Pigeon Lake ASP		
Priority Growth Area Ce		
Priority Growth Area Cw		
Priority Growth Area E		
QE 2 Business Park LASP		
R1A - Residential		
R1B - Residential		
R1D - Residential		
R2 - Residential		
R3 - Residential		
RA - Acreage Residential		
RC - Country Residential		
RCM - Rural Centre Mixed District		
RE - Estate Residential		
RM1		
RMH - Manufactured Home Residential		
R-MHC - Mobile Home		
RR - Resort Residential		
RU2		
RU3		
Sand and Gravel Deposit		
Saunders Lake ASP		
UC2		
UC3 - Urban Commercial 3		
UR - Urban Reserve		
U-S - Urban Services		
WAM LASP		
Wizard Lake ASP		

Legend

Disturbance Risk

- High
- Medium
- Low
- Municipalities outside Leduc County
- Areas Not Included in Analysis

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: ESRI Basemap Light Grey Canvas

Projection: NAD 1983 10TM AEP Forest

Km

0   5   10   20
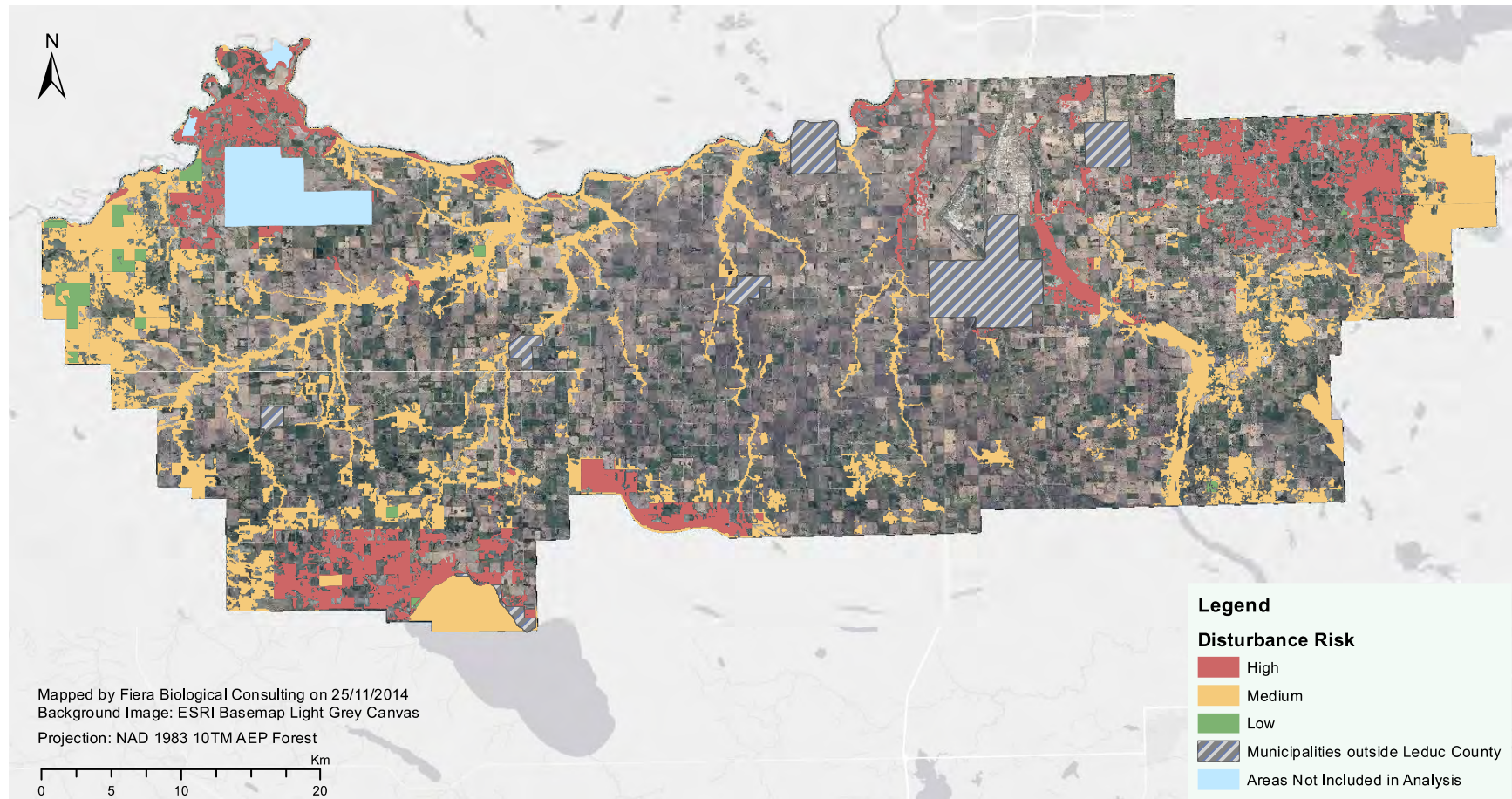
Figure 15. Environmentally Significant Areas subdivided into High, Medium, and Low development risk categories.

8. ESA Management Recommendations

In order to maintain or enhance the ecological function and value of ESAs in Leduc County, special management considerations and/or County policies may need to be developed and employed to reduce impacts of development on these natural features. This section provides general planning considerations and recommendations that can be used to help guide decision making as it relates to land use decisions that may impact ESAs in Leduc County.

8.1. Aquatic and Riparian ESAs

Within the context of this study, Aquatic ESAs are characterized as lands that are dominated by wetlands or lakes (as well as their associated riparian habitat), while Riparian ESAs are defined as riparian lands adjacent to river and stream habitat (see Section 6.3 for full definitions of Aquatic and Riparian ESAs). Aquatic and riparian habitats support a variety of aquatic and terrestrial organisms, and compared to upland habitats of equivalent size, aquatic and riparian lands generally support a higher level of biodiversity. Hydrologically, aquatic and riparian habitats are important components of both local and regional watersheds, and provide important ecosystem services to human communities, such as water filtration and water treatment. In addition, wetlands contribute to the amelioration of both floods and droughts by stabilizing water supplies. Human activity that results in the disruption of hydrologic regimes through diversion or impoundment of surface or groundwater flows, as well as dredging or filling of streams, wetlands, and other water bodies, can severely impact Aquatic and Riparian ESAs not only in the immediate vicinity, but also downstream of the activity. Changes in water quantity and quality, as well the duration and frequency of hydrologic flows across the landscape, can also have significant impacts on the ecological health of terrestrial habitats in proximity to Aquatic and Riparian ESAs.

Municipal governments play a critical role in the conservation and management of aquatic habitats and riparian lands. Under the *Municipal Government Act*, each municipality is required to develop statutory planning documents that provide a framework and vision for land use and land development within their jurisdiction. Within these statutory documents, municipalities are required to provide specific direction for development requirements in or near lakes, wetlands, and riparian lands, and can set forth minimum development setback widths on Environmental Reserve (ER), environmentally sensitive land, or water bodies and watercourses. Within these planning documents, municipalities can provide specific direction for development requirements that may impact aquatic or riparian habitat. In addition to statutory planning documents, municipalities can influence the management of aquatic and riparian habitat by enacting Land Use Bylaws that set forth requirements for conservation of, or development setbacks on, environmentally sensitive lands.

Under the direction set out by the *Municipal Government Act* and the municipal Land Use Policies, many municipalities throughout the province have taken the initiative to enact policies that provide guidance on how wetlands and riparian lands should be managed within their jurisdictional boundaries. For example, several municipalities across Alberta, including but not limited to Edmonton, Calgary, Strathcona County, and Chestermere have municipal wetland or riparian policies that provide direction for designating wetlands as Environmental Reserve at subdivision. In addition, several municipalities have riparian management policies that provide direction for placing development setbacks on water bodies for the protection of aquatic and riparian habitat (Clare and Sass 2012). These policies include minimum development setbacks (i.e., static buffers) or variable setbacks that are determined through consideration of site-specific conditions that may influence buffer widths, such as slope, soil type, and vegetative cover.

Given the important ecological, economic, and social values associated with healthily aquatic and riparian habitat, the conservation of Aquatic and Riparian ESAs should be high priority for Leduc County. In order to conserve these areas, the following are provided as considerations and recommendations for management of Aquatic and Riparian ESAs:

- Aquatic and Riparian ESAs should be identified, considered, and prioritized during the planning and development of Area Structure Plans.

    o The identification and prioritization of these areas should be supported by the mapping information provided in Appendix B.

    o Prioritization of Aquatic and Riparian ESAs should be based on a number of considerations, including (but not limited to) the following:

        ▪ Condition and quality of existing habitat, including large and relatively undisturbed areas
        ▪ Potential to support rare, threatened, or endangered species
        ▪ Proximity to other natural habitats and position within local and regional habitat corridors (e.g., movement corridors or stop over habitats)
        ▪ Presence of rare, unique, or under-represented habitats
        ▪ Contribution to vital ecological or hydrological processes

- Priority Aquatic and Riparian ESAs should be further mapped and assessed in the field by qualified professionals during the development of LASPs, or ASPs when LASPs are not applicable.

    o Priority Aquatic or Riparian ESAs that are not claimed as crown land under the *Public Lands Act* and contain Class III, IV, V, and/or VII wetlands, or steep, unstable slopes should be identified, and consideration should be given to dedicating these areas as Environmental Reserve or Environmental Reserve Easement at the time of subdivision.

    o Priority Aquatic or Riparian ESAs that contain Class I or II wetlands or ephemeral streams should be identified, and consideration should be given to dedicating these areas as Environmental Reserve or Environmental Reserve Easement.

    o Priority Riparian ESAs that contain areas prone to flooding or steep, unstable slopes should be identified, and consideration should be given to dedicating these areas as Environmental Reserve or Environmental Reserve Easement at the time of subdivision.

- To ensure that aquatic habitats and associated riparian lands are protected from the impacts of development, appropriate development setbacks on aquatic habitats should be established.

    o Setbacks may be established through the use of a riparian matrix setback model, or through the application of static buffers.

    o In absence of the existence of a riparian matrix setback model, the following buffers are provided as guidelines, as per the recommendations outlined in (Government of Alberta 2012), for application of static buffers for ESAs that contain aquatic or riparian habitats:

        ▪ A minimum setback of 50 metres on any named Lake or major river
        ▪ A minimum setback of 30 metres on any Class III, IV, V, or VII wetland, or any permanent river or stream
        ▪ A minimum setback of 10 metres on any Class I or II wetland, or any ephemeral or intermittent stream

- These setback distances may be increased should it be deemed necessary by a professional given considerations for bank stability or water quality

- Conservation of Aquatic and Riparian ESAs can also be achieved though the adoption of other land use planning tools, such as conservation easements, tax incentives, transfer of development credits, and/or other applicable policy instruments where suitable policy exists.

- To ensure the maintenance of water quality, no untreated wastewater or stormwater should be discharged onto lands designated as an Aquatic or Riparian ESA.

- In addition to providing development setbacks, intensive land uses (e.g., roads, industrial lots, and/or land uses with a high proportion of impermeable surfaces) should be minimized upstream of, and adjacent to, Aquatic and Riparian ESAs, where practical.

- Ensure adequate pollution prevention and water treatment measures are applied in proximity to ESAs through the application and adoption of Low Impact Development principles. Though emphasis should be placed on minimizing the impacts of development and activity in close proximity to Aquatic and Riparian ESAs, the mobility of waterborne pollutants necessitates adequate control measures at a regional level.

8.2. Upland ESAs

Upland ESAs are defined as areas within Leduc County that contain terrestrial habitat. These areas are typically characterized by forested areas that contain coniferous, deciduous, or mixed stands of various ages. These lands provide critical wildlife habitat for forest-dependent species in Leduc County, and facilitate the movement of semi-aquatic, terrestrial, and aerial species across the landscape. Given that the current land use in Leduc County is dominated by agriculture, the prevalence of large, undisturbed tracts of forested land is low, which places a high ecological value on those areas in the County where forest cover remains. Despite the ecological importance and value of upland habitats, there are limited means through which these lands can be conserved by Leduc County, with the primary conservation mechanisms being land securement, Municipal Reserve dedication, or municipal policies that promote conservation practices, such as the Wizard Lake Conservation District.

The following are provided as recommendations for the management and conservation of Upland ESAs in Leduc County:

- Upland ESAs should be identified, considered, and prioritized during the planning and development of Area Structure Plans.

    o The identification and prioritization of Upland ESAs should be supported by the mapping information provided in Appendix B.

    o Prioritization of Upland ESAs should be based on a number of considerations, including (but not limited to) the following:

        - Condition and quality of existing habitat, including large and relatively undisturbed areas
        - Potential to support rare, threatened, or endangered species
        - Proximity to other natural habitats and position within local and regional habitat corridors (e.g., movement corridors or stop over habitats)
        - Presence of rare, unique, or under-represented habitats
        - Contribution to vital ecological processes

- Priority Upland ESAs should be further mapped and assessed in the field by qualified professionals during the development of LASPs or ASPs, where LASPs are not applicable.

    o Priority Upland ESAs may be conserved or protected through the following mechanisms:

- Land purchase
- Conservation easement
- Municipal Reserve dedication
- Restrictive covenant
- Municipal policies such as the Municipal Development Plan or Land Use Bylaws

- Conservation of Upland ESAs can also be achieved though the adoption of other land use planning tools, such as tax incentives, transfer of development credits, and/or other applicable policy instruments.

- In addition to providing development setbacks, intensive land uses (e.g., roads, industrial lots, and/or land uses with a high proportion of impermeable surfaces) should be minimized in locations that are adjacent to Upland ESAs, where practical.

- Minimize intensive land uses (e.g., roads, industrial lots, and/or land uses with a high proportion of impermeable surfaces) immediately adjacent to Upland ESAs.

- Maintain connectivity between Upland ESAs and other natural or semi-natural habitats at the local and regional scale.

8.3. Mixed ESAs

Habitat diversity is important at both the local and regional scale, as more diverse habitats support a wider range of species that have different habitat requirements for the completion of their life cycles (e.g., amphibians). As a result, ESAs that contain a combination of Upland, Aquatic, and/or Riparian habitats are good candidates for prioritization and conservation. Given that Mixed ESAs contain a combination of aquatic, riparian, and upland habitat, the mechanisms through which these ESAs can be managed and conserved will vary, and may include Environmental Reserve or Municipal Reserve dedication or land securement.

- Mixed ESAs should be identified, considered, and prioritized during the planning and development of Area Structure Plans.
  - o The identification and prioritization of these areas should be supported by the mapping information provided in Appendix B.
  - o Prioritization of Mixed ESAs should be based on a number of considerations, including (but not limited to) the following:
    - Condition and quality of existing habitat, including large and relatively undisturbed areas
    - Potential to support rare, threatened, or endangered species
    - Proximity to other natural habitats and position within local and regional habitat corridors (e.g., movement corridors or stop over habitats)
    - Presence of rare, unique, or under-represented habitats
    - Contribution to vital ecological or hydrological processes

- Priority Mixed ESAs should be further mapped and assessed in the field by qualified professionals during the development of LASPs or ASPs, when LASPs are not applicable.
  - o Priority Mixed ESAs that contain Class III, IV, V, and/or VII wetlands, or steep, unstable slopes should be identified, and consideration should be given to dedicating these areas as Environmental Reserve or Environmental Reserve Easement at the time of subdivision.
  - o Priority Mixed ESAs that contain Class I or II wetlands or ephemeral streams should

be identified, and consideration should be given to dedicating these areas as Environmental Reserve or Environmental Reserve Easement.

- o Priority Mixed ESAs that contain areas prone to flooding or steep, unstable slopes should be identified, and consideration should be given to dedicating these areas as Environmental Reserve or Environmental Reserve Easement at the time of subdivision.

- o Upland areas within priority Mixed ESAs should be identified and consideration should be given to securing these lands through purchase, conservation easement, or dedication as Municipal Reserve.

- To ensure that aquatic habitats and associated riparian lands that are protected from the impacts of development, appropriate development setbacks on aquatic habitats should be established.

  - o Setbacks may be established through the use of a riparian matrix setback model, or through the application of static buffers.

  - o In absence of the existence of a riparian matrix setback model, the following buffers are provided as guidelines, as per the recommendations outlined in (Government of Alberta 2012), for application of static buffers for ESAs that contain aquatic or riparian habitats:

    - A minimum setback of 50 metres on any named Lake or major river
    - A minimum setback of 30 metres on any Class III, IV, V, or VII wetland, or any permanent river or stream
    - A minimum setback of 10 metres on any Class I or II wetland, or any ephemeral or intermittent stream
    - These setback distances may be increased should it be deemed necessary by a professional given considerations for bank stability or water quality

- Conservation of Mixed ESAs can also be achieved though the adoption of other land use planning tools, such as tax incentives, transfer of development credits, and/or other applicable policy instruments.

- Minimize intensive land uses (e.g., roads, industrial lots, and/or land uses with a high proportion of impermeable surfaces) immediately adjacent to, and upstream of, Mixed ESAs.

- Maintain connectivity between Mixed ESAs and other natural or semi-natural habitats at the local and regional scale.

- To ensure the maintenance of water quality, no untreated wastewater or stormwater should be discharged onto Mixed ESAs that contain aquatic or riparian habitat.

8.4. General Considerations for Management of ESAs in Leduc County

In addition to the recommendations outlined, the following are general recommendations for the management of ESAs in Leduc County.

- Concentrate human activity and development, or other intensive land uses, in planned development areas, such that contiguous natural areas are maintained to the greatest extent possible.

- Ensure ESAs are separated from human activity and development by buffer zones. Buffer zones can consist of additional natural habitat, such as a riparian zone adjacent to sensitive wetland habitat, or of semi-natural uses, such as recreational park spaces. Agricultural lands can often be restored or naturalized into highly functional buffer zones. The size and location of the buffer area will depend on the type, severity, size, and proximity of the human activity or development, as well as the type of habitat within the ESA, and the sensitivity of that habitat to disturbance.

- Provide connectivity between ESAs by maintaining, creating, or restoring naturalized corridors. In particular, quarter sections that do not qualify as an ESA, but have relatively high scores and connect areas that have been identified as an ESA, should be targeted for restoration (Figure 16). This is particularly true of quarter sections situated along stream or river corridors, where lower scoring quarter sections could be restored to create a larger, more contiguous ESA area.

- Minimize linear disturbances within ESAs, such as seismic lines and roads.

- Where linear disturbance cannot be avoided, ensure that restoration within the disturbed area is conducted immediately following construction or project completion. Wildlife passage structures (e.g., wildlife overpass, amphibian tunnels, etc.) should be considered wherever roads intersect ESAs, or where roads are placed between multiple ESA habitat patches.

- Consider the cumulative impacts of human development at multiple spatial scales (e.g., within the same waterbody, catchment basin, or watershed), and how these activities may cumulatively impact the hydrology of aquatic or riparian ESAs.

- Habitat restoration or compensation, including the creation of new habitats or cash-in-lieu payments, is often required as part of municipal, provincial, or federal regulatory approvals processes for development activities. Municipal policy and land use planning tools should ensure that, whenever possible, compensation activities take place within Leduc County. This will help prevent a net loss of ESAs and habitats within the County.
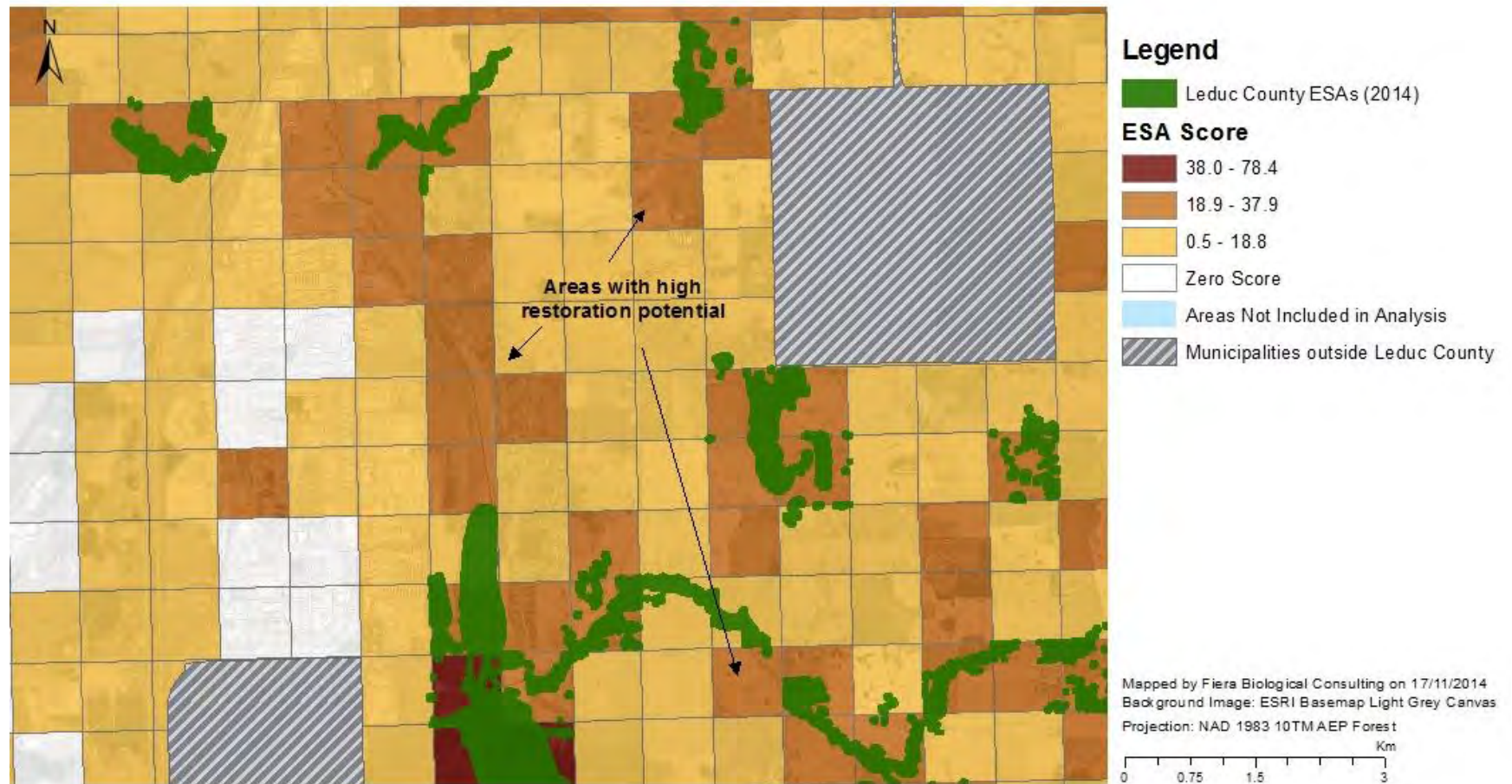
Figure 16. Example of quarter sections that do not meet the ESA score cut-off, but that are considered to be high priority for restoration. These areas have relative high quarter section scores, and once restored, would create larger habitat patches, and more continuous corridors.

8.5. Disturbance Risk

8.5.1. High Disturbance Risk

ESAs were designated as High Development Risk if they were considered to fall within areas that have been identified as areas that will experience high growth pressure over the short-term (within 3-years). This included ESAs that fall within quarter sections that are included in an approved statutory document (e.g., Area Structure Plans or Local Areas Structure Plans), or if they are located within quarter sections that have been identified as "priority growth areas" in the Capital Region Board Growth Plan. As such, there is a high likelihood that these ESAs will either be lost or impacted by development in over the short- or medium-term. In these cases, attention should be given to the management and conservation of ESAs with the highest ESA scores and rank, and efforts should be made to conserve highly rated ESAs through dedication as Environmental Reserve or Municipal Reserve wherever feasible.

8.5.2. Medium Disturbance Risk

A small proportion of ESAs that were assigned to the Medium Disturbance Risk category are located within provincial crown reservations where Alberta Parks has registered an interest in the land through a Protective Notation (Table 11). These lands have been identified by Alberta Parks as areas that are suitable for designation as a Natural Area or Provincial Park, but these lands have not yet been secured for management under the *Parks Act* and are currently managed as public land under the governance of the *Public Lands Act.* As such, these lands are unlikely to be subject to intensive development over the short- or medium-term unless they are purchased by private interest.

The majority of ESAs assigned to the Medium Disturbance Risk category are privately owned lands that are located outside of areas that are expected to be developed over the short- or medium-term. These Medium risk ESAs may be subject to development in the future, but the horizon for this development is anticipated to be longer term (10+ years). As such, there are more opportunities to thoughtfully integrate these ESAs into future ASPs or LASPs, and any land development in proximity to these ESAs may be informed through new policy and procedure that may be developed as part of the MDP review in 2015.

8.5.3. Low Disturbance Risk

Low Development Risk ESAs are located within privately owned quarter sections that have been legally designated as a conservation easement, or are located within Provincial Parks, Provincial Recreation Areas, or provincially designated Natural Areas. As such, ESAs that fall on lands designated as low risk are unlikely to be subject to intense development over the long-term.

Low Development Risk ESAs should be considered core environmental areas within Leduc County, and planning efforts should be concentrated towards ensuring that any development on lands in proximity to these areas are compatible with the goal of maintaining ecological function of these ESAs. This includes ensuring that adjacent development does not adversely impact the ecological function or connectivity of Low Development Risk ESAs. This can be achieved in part by prioritizing land securement in areas adjacent to, or in close proximity to, ESAs designated as Low risk in an effort to expand the existing network of Low Development Risk ESAs in Leduc County.

9. Data Gaps & Model Limitations

While every effort was made to create the most up-to-date and comprehensive ESA model for Leduc County possible, it should be noted that there are several limitations of both the model result and input datasets that should be fully considered when using and interpreting the final results of this study:

1. The unit of analysis for the ESA model was the quarter-section. As such, this analysis provides a coarse-scale assessment of environmental values in Leduc County, and the resulting quarter section ESA map highlights *general* areas that contain environmentally significant elements. This map was then used to identify natural habitats within each quarter section to provide a finer-scale delineation of specific natural areas that are considered to be significant. It should be noted that there may be environmentally significant areas in Leduc County that have not been identified in this study. These omissions may be due to a lack of inventory data that documents the location and/or significance of important features or habitats. Further, it is important to note that all ecosystems in Leduc County, including those that fall outside of designated ESAs, should be considered in the land use planning process, particularly those areas that may provide critical linkages to ESAs at the landscape scale.

2. The boundary accuracy of Environmentally Significant Areas is constrained by the accuracy of the land cover data, which has a locational accuracy of ± 30m. As such, the location and boundaries of ESAs provide a general estimate of the location of each ESAs, which should be confirmed by further ground validation. In particular, the boundaries of wetlands identified by this study are approximate only, and boundary delineation should be carried out using appropriate, standardized field methods to determine the exact extent and area of each wetland.

3. Some of the indicators used to identify ESAs within Leduc County rely on species occurrence and observation records. Whilst these datasets provide a good basis for the indicators assessed, they provide "presence only" data. The use of presence-only data can be problematic because there is no reliable information about where a particular species is absent, and these types of data often exhibit strong spatial bias related to survey effort. While there are various statistical ways of accounting for and dealing with this spatial bias (e.g. Pearce and Boyce 2005; Phillips et al. 2009), applying these techniques to the datasets used in this assessment was outside the scope of work. As a result, indicators that are solely based on presence only data should be interpreted cautiously, and likely do not represent the full extent of rare species occurrence or distribution in Leduc County.

4. The final indicator values assigned to each quarter-section in Leduc County are *relative values*, and for many of the indicators, the Class score determination (i.e., assigning scores of 1, 2, or 3) were based on cut off values that were statistically determined, rather than determined through application of ecological thresholds. As a result, it is conceivable that for some indicators, quarter-sections that received a high score represent areas where ecological integrity thresholds have already been exceeded for a particular species or habitat.

5. Whilst the location and accuracy of the Wetland Inventory created for this study is very good (97%), the accuracy associated with wetland class predictions is low and are provided as estimates only. Wetland class estimates should be interpreted with caution and should be further validated in the field by qualified personnel before they are used to direct any regulatory or land use planning decisions.

6. Quantification of several indicators in this ESA analysis relied on land cover data and inventories of natural areas. Whilst we have confidence in the ability of these datasets to accurately identify different land cover types such as wetlands, forest, and streams, this data does not provide any information on the condition of the natural habitat. Hence, neither the designation of ESA in Leduc County, nor the final ESA value assigned to a natural area or quarter-section should be considered synonymous with pristine or undisturbed habitat. It is conceivable that areas identified

as ESAs in this study have been negatively impacted by direct or indirect disturbance, and may require some level of restoration.

10.   Next Steps & Other Considerations

1. Prior to making any final management or policy decisions based on the ESA scores presented here, Leduc County should require land development proponents to provide information to corroborate ESA scores. This should be done using standardized field assessment methods that would produce standardized condition scores, allowing for direct comparisons between ESAs throughout the study area. Developing a standardized ESA assessment method for use by all organizations conducting field assessments is critical to this corroboration process, and will ensure that the site-specific ecological condition of each ESAs is better understood in advance of land development.

2. In order to facilitate the appreciation, conservation, and evaluation of ESAs in Leduc County, the information produced as part of this study should be made available to the public, and should be reviewed and updated every 5-years to ensure the information remains relevant and current.

3. Low Impact Development principals and practices should be developed and integrated into ASP and/or LASP planning where adjacent development has the potential to impact the quality or condition of ESAs.

11.   Conclusions

The primary objective of this project was to update the existing inventory of Environmentally Significant Areas in Leduc County using an objective, repeatable and scientifically valid framework. To achieve this, we employed a GIS-based multi-criteria decision analysis as the foundation for quantifying, weighting, and identifying Environmentally Significant Areas in Leduc County. The criteria and indicators selected to identify ESAs in Leduc County represent a broad range of important environmental elements, and include both coarse-filter and fine-filter indicators. Coarse-filter criteria were developed with the goal of maintaining native biota and natural ecosystem function, while fine-filter criteria were developed to capture environmental features that are required to maintain populations, species, ecosystems, or other special features that are not accounted for under coarse filter criteria (Groves et al. 2000). In total, four main criteria and 17 indicators were used to identify ESAs in Leduc County. The application of objective, well-defined criteria to systematically identify significant aquatic and terrestrial ecosystems has resulted in a transparent and repeatable process that can be easily updated with new data and/or new criteria and indicators.

This study represents a major advance in the approach and methods used to previously identify ESAs in Leduc County. Specifically, this update provides a current representation of ESAs within the county using recent and newly created land cover data and natural area inventories. Using an advanced GIS-based modeling approach, and a continuous ESA value surface was created for each quarter-section in Leduc County, allowing for a more comprehensive understanding of the location of environmental elements that are considered to be significant based on the criteria and indicators included in this update. In addition, this update includes criteria weights that are reflective of existing priorities as expressed by key stakeholders in Leduc County.

Moving forward, land-use planning in Leduc County must incorporate social, economic, cultural, and environmental values to produce a multifunctional landscape that supports all of these functions (Lovell and Johnston 2009). This ESA mapping product represents scientifically defensible information that can be integrated into future land-use planning decisions. The consideration of these important environmental areas as part of a larger planning process will increase the probability that the ecosystem goods and services that flow from these areas can be maintained and enjoyed by citizens of Leduc County over the long-term.

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Appendix A: Detailed Methods

CRITERION 1: Areas that contain focal species, species groups, or their habitats

1a: Rare, Threatened, or Endangered Species
Given that rare, threatened, or endangered species may require special management consideration to ensure their long-term persistence, elements of provincial, federal, and global conservation concern were included as an indicator under Criterion 1. As the absence of records of such sensitive species does not *de facto* exclude the possibility of the presence of such species, the percentage cover of natural habitat within each quarter section was also included in this indicator to predict locations were the occurrence of rare species was highly probable.

Data source:	• ACIMS, FWMIS
Quantification:	• Species with a ranking of S1, S1?, S2, S2?, S1S2, S2S3, G1?, G2?, G1G2, G2G3, or a Provincial/Federal ranking of Special Concern, Threatened, At Risk, or Endangered were identified
	• FWMIS data was buffered by 250m
	• For all polygons that touched a quarter-section, a score of 3 was assigned. Given the sampling bias associated with the data (i.e., the County has not been systematically sampled for rare species), we cannot be confident than an absence of a record is a true absence. Thus, we evaluated the % cover of natural habitat in each quarter-section and used this as a proxy to predict areas that had the potential to support species at risk.
Indicator Scoring:	• 3 = Quarter section (QS) with a record of a rare, threatened, or endangered species, or a score of 3 for Indicator 3A (>67.45% natural cover)
	• 2 = QS with a score of 2 for Indicator 3A (47.74 – 67.45% natural cover)
	• 1 = QS with a score of 1 for Indicator 3A (<25 - 47.74%)

1b: Fish-bearing water bodies and water courses
Alberta Environment and Sustainable Resource Development (AESRD) Code of Practice data was used to identify water bodies and water courses that are considered critical fish habitat protection areas or have fish habitat that is considered important to the continued viability of a species. Whilst these areas of special concern are particularly significant, all water courses that were of a high Strahler order were identified as potential fish-bearing water courses, as these larger and persistent stream and river segments were assumed to represent potential habitat for fish species.

Data source:	• AESRD Code of Practice management maps, Leduc County River and Stream Network Layer
Quantification:	• Quarter-sections (QS) that intersected a Class A, B, C or D stream or river, tributary, or lake were selected
	• Water bodies were assigned a Class following the provincial Code of Practice designation for unmapped and un-coded water bodies, as follows:

- All QS intersecting a mapped Class A water body were designated Class A
  - where a tributary stream entered a quarter-section designated as Class A, the tributary and its associated QS were assigned Class A for a distance of 2 kilometers upstream from the mouth. All other portions of the tributary and associated QS were designated Class B
- All QS intersecting a mapped Class B water body were designated Class B
  - where a tributary stream entered a quarter-section designated as Class B, the tributary and its associated QS were assigned Class B for a distance of 2 kilometers upstream from the mouth. All other portions of the tributary and associated QS were designated Class C
- For all water bodies that entered a mapped Class C water body, the associated

QS were designated Class C for all portions of the water body

- For all water bodies that entered a mapped Class D water body, the associated QS were designated Class D for all portions of the water body

Indicator Scoring:
- 3 = QS touching a Class A or B river, stream, or lake
- 2 = QS touching a Class C river, stream, or lake
- 1 = QS touching an unclassified stream or river of Strahler number 3 or greater.
- QS with multiple designations took on the highest score

1c: Waterfowl staging, foraging, and breeding areas

Waterfowl staging, foraging and breeding areas were identified using both provincial species occurrence data and modeled species distributions. Additionally, potential habitat for waterfowl was categorized by identifying and including large semi-permanent or permanent wetlands and lakes. Staging areas include large lakes, semi-permanent, or permanent wetlands that are used by a large concentration of waterfowl during the spring and fall migration. Many species of waterfowl complete their wing and body molt on staging areas before the start of the fall migration. In addition, staging areas that are ice free early in the season provide important food resources to a wide diversity of species during the spring migration.

Data source:
- Important Bird Areas of Canada (IBA), NAWMP staging areas, AESRD Trumpeter Swan Waterbodies and Watercourse, AESRD Piping Plover Waterbodies, AESRD Colonial Nesting Birds, FWMIS, ACIMS

Quantification:
- Quarter sections of high value to staging, foraging and breeding waterfowl were identified by combining and dissolving the following data sets:

  - IBAs, NAWMP Staging Areas, AESRD Trumpeter Swan Waterbodies and Watercourse, AESRD Piping Plover Waterbodies, AESRD Colonial Nesting Birds, ACMIS bird colony polygons

  - An aquatic bird foraging guild layer that was created using FWMIS and ACIMS observation/occurrence data (see Table 12 for list of bird species included in the aquatic bird foraging guild). This layer included QS with a count of ≥2 UNIQUE species

- Quarter sections of moderate value to waterfowl were considered those that contained wetlands and/or lakes ≥4 ha in size

- Quarter sections of lower value to waterfowl were identified as Class IV and V wetlands between 0.5 and 3.9ha in size

Indicator Scoring:
- 3 = QS intersecting high value staging, foraging and breeding waterfowl habitat
- 2 = QS intersecting moderate value staging, foraging and breeding waterfowl habitat
- 1 = QS intersecting low value staging, foraging and breeding waterfowl habitat

Table 12. Species included in the aquatic bird foraging guild that were used in combination with other spatial layers to identify important areas for waterfowl staging and foraging in Leduc County.

Diving Carnivores	
Common loon (*Gavia immer*)	Horned grebe (*Podiceps auritus*)
Common merganser (*Mergus merganser*)	Pied-billed grebe (*Podilymbus podiceps*)
Double-crested cormorant (*Phalacrocorax auritus*)	Red-necked grebe (*Podiceps grisegena*)
Eared grebe (*Podiceps nigricollis*)	Western grebe (*Aechmophorus occidentalis*)
Diving Omnivores	
Bufflehead (*Bucephala albeola*)	Redhead (*Aythya americana*)
Canvasback (*Aythya valisineria*)	Ring-necked duck (*Aythya collaris*)
Common goldeneye (*Bucephala clangula*)	Ruddy duck (*Oxyura jamaicensis*)
Harlequin duck (*Histrionicus histrionicus*)	White-winged scoter (*Melanitta fusca*)
Lesser scaup (*Aythya affinis*)	
Dabbling Omnivores	
American coot (*Fulica americana*)	Gadwall (*Anas strepera*)
American wigeon (*Anas americana*)	Green-winged teal (*Anas crecca*)
Blue-winged teal (*Anas discors*)	Mallard (*Anas platyrhynchos*)
Canada goose (*Branta canadensis*)	Northern pintail (*Anas acuta*)
Cinnamon teal (*Anas cyanoptera*)	Trumpeter swan (*Cygnus buccinator*)
Surface-foraging Carnivores	
American bittern (*Botaurus lentiginosus*)	Bonaparte's gull (*Larus philadelphia*)
American dipper (*Cinclus mexicanus*)	Common tern (*Sterna hirundo*)
American white pelican (*Pelecanus erythrorhynchos*)	Forster's tern (*Sterna forsteri*)
Belted kingfisher (*Ceryle alcyon*)	Franklin's gull (*Larus pipixcan*)
Black tern (*Chlidonias niger*)	Great blue heron (*Ardea herodias*)
Black-crowned night-heron (*Nycticorax nycticorax*)	Osprey (*Pandion haliaetus*)
Shoreline Omnivores	
American avocet (*Recurvirostra americana*)	Solitary sandpiper (*Tringa solitaria*)
Black-necked stilt (*Himantopus mexicanus*)	Sora (*Porzana carolina*)
Greater yellowlegs (*Tringa melanoleuca*)	Spotted sandpiper (*Actitis macularia*)
Lesser yellowlegs (*Tringa flavipes*)	Virginia rail (*Rallus limicola*)
Marbled godwit (*Limosa fedoa*)	Willet (*Catoptrophorus semipalmatus*)
Sandhill crane (*Grus canadensis*)	Wilson's phalarope (*Phalaropus tricolor*)
Riparian Omnivores	
Marsh wren (*Cistothorus palustris*)	
Red-winged blackbird (*Agelaius phoeniceus*)	
Yellow-headed blackbird (*Xanthocephalus xanthocephalus*)	

CRITERION 2: Areas that contain rare or unique geology or habitats

2a: Surficial geology & landforms

Rare or unique landforms and geology are important components of environmental significance, as these areas typically support unique or important ecological communities, species, or populations. Rare or unique landscape features in Leduc County were considered to be places that have been internationally, nationally or provincially recognized, or are considered to be underrepresented in Leduc County relative to the larger region.

Data source:	• AGS Surficial geology line features (landforms), AGS surficial geology polygons (geologic units)
Quantification:	• A representation analysis was conducted to identify rare geologic units within Leduc County.
	• The total cover of each geologic unit present within the Central geologic unit was calculated and three rarity classes were identified using a Jenks analysis, as follows:

- <2% cover = Very Rare
- 2-3% cover = Rare
- >3-10% cover: Uncommon

• Any QS within Leduc County that intersected a very rare, rare, or occasional geologic unit

was identified

- In addition, all quaternary landforms located within Leduc County were considered rare, and were buffered based on the feature type. Buffer widths were determined based on literature (Deynoux, M., J. M. G. Miller, and E. W. Domack. *Earth's Glacial Record*. Cambridge University Press, 2004.), air photographs, and expert opinion (buffers ranged between 20 and 600 m).

Indicator Scoring:
- 3 = QS touching very rare surficial geology type (<2% representation) AND/OR touching a rare landform or landform buffer
- 2 = QS touching rare surficial geology type (2-3%)
- 1 = QS touching uncommon surficial geology type (3-10%)

2b: High productivity soils

High soil productivity provides a wide range of socio-economic benefits to Leduc County, including increased economic output and food security. In addition, areas of high soil productivity provides ecological benefits, particularly within terrestrial ecosystems, through increases in plant productivity, plant diversity and species richness (Van Der Heijden et al. 2008).

Data source:
- Alberta Soils Information Viewer (AGRISID)

Quantification:
- For each AGRISID polygon, an average soil productivity value was calculated based on the proportion and type of soil present

- The average soil productivity layer was intersected with the Leduc County quarter section layer, and the soil productivity score within each QS was calculated using an area-weight average. All quarter-sections with a weighted average of score <2 were removed to account for regions without assigned productivity values (e.g., wetlands, roads, urban areas). All QS with a soil productivity value above 4.3, (where 4 is marginal and 5-7 is non-productive) were assigned an indicator score of 0.

- A three category Jenks analysis was run to determine class breaks for scores 1-3

Indicator Scoring:
- 3 = QS with high soil productivity (≥2-2.5)
- 2 = QS with moderate soil productivity (>2.5-3.1)
- 1 = QS with low soil productivity (>3.1- 4.3)

2c: Vegetation communities

Rare terrestrial and aquatic vegetation communities offer important habitat to a diverse range of species and populations that may not be captured or represented in more common habitat or community types.

Data source:
- Central Parkland Vegetation inventory

Quantification:
- A representation analysis was conducted using the Central Parkland Vegetation Inventory (CPVI) and all vegetation types that comprised ≤1% of the vegetation within the Central Parkland were identified as very rare. These very rare vegetation types included deciduous trees bordering a water body (B_decid) and native coniferous (N_coniferous).

- In order to account for areas that may have been lost since the creation of the CPVI, the CPVI was overlain with the Leduc County Land Cover and any areas of human footprint were removed from the CPVI

- Within each quarter section, the percent cover of very rare vegetation types was calculated. Values were log transformed and any zero values were removed.

- A three class Jenks was run to determine class breaks, and indicator scores were assigned based on class break values

Indicator Scoring:
- 3 = QS with a high amount of cover of very rare vegetation types (>5.41%)
- 2 = QS with a moderate amount of cover of very rare vegetation types (>1.14 to 5.41%)
- 1 = QS with a low amount of cover of very rare vegetation types (0 to 1.14%)

2d: Peatlands

Peatlands contribute to ecosystem diversity and contribute to, or support, a range of important landscape processes, patterns, and structure. Given that peatlands are considered to be rare habitats in the Central Parkland region, these habitats were identified as an important component of environmental significance.

Data source: • Alberta peatland inventory with human footprint removed, Leduc County Peatland Inventory, Central Parkland Vegetation Inventory

Quantification: • Revised the Alberta peatland inventory and the Central Parkland Vegetation Inventory to remove any areas that have been disturbed by anthropogenic activity

•Identified all quarter-sections that touched a peatland polygon identified in any of the peatland inventories.

Indicator Scoring: • 3 = Quarter-sections touching a peatland polygon

CRITERION 3: Areas with ecological integrity

3a: Natural terrestrial habitat cover

The area of natural terrestrial cover is considered to be an important indicator of habitat intactness, and many species require large tracts of undisturbed habitat to meet their life requisites. Furthermore, larger terrestrial habitat patches can provide a greater diversity of habitat niches and interior habitat. As a result, larger areas of terrestrial habitat cover generally support a greater species diversity and richness than smaller areas of habitat cover (Environment Canada 2013).

Data source: • Leduc County Land Cover Classification

Quantification: • The Leduc land cover classification layer was used to identify areas of forest cover and natural open vegetation, which together were considered to represent natural terrestrial habitat

• The percentage of natural terrestrial cover was calculated for each QS

• A threshold value of 25% was selected, and all quarter sections with <25% cover of natural terrestrial habitat were removed from further analysis, as these quarter sections were not considered to provide suitable habitat for species that require undisturbed or natural habitat cover

• A three class Jenks analysis was conducted to determine final indicator scores

Indicator Scoring: • 3 = QS with a high proportion of natural terrestrial habitat cover (>67%)
• 2 = QS with a moderate proportion of natural terrestrial habitat cover (>48 to 67%)
• 1 = QS with a low proportion of natural terrestrial habitat cover (25 to 48%)

3b: Natural aquatic habitat cover

Aquatic habitat, including wetlands, lakes, rivers, and streams, play a critical role in a number of ecosystem processes at a variety of spatial scales. These habitats not only support biodiversity by providing important habitat for a variety of species, but also help to moderate the climate system and serve as critical components of the hydrological system by providing a wide variety of ecosystem goods and services.

Data source: • Leduc County Land Cover classification

Quantification: • All rivers, streams, lakes, and wetlands were identified using the Leduc land cover classification, and the percentage of natural aquatic cover was calculated for each QS, and all QS with a zero value were removed

• The percent cover values were log transformed and a six class Jenks analysis was conducted to determine natural area coverage classes. Indicator scores were assigned using the top three classes

Indicator Scoring: • 3 = QS with a high proportion of natural aquatic habitat cover (>37%)
• 2 = QS with a moderate proportion of natural aquatic habitat cover (>12-37)
• 1 = QS with a low proportion of natural aquatic habitat cover (>5-12)

3d: Lake & wetland connectivity

Many aquatic and semi-aquatic species (e.g., amphibians) exist in small disjunct populations (Möller and Rørdam 1985; Dodd 1990; Sjörgren 1991 in Gibbs 2000), and these local populations combine to form a larger metapopulation that is sustained by the movement of individuals between aquatic habitats (Ricklefs 1993). Given that many of these species are small and limited in their ability to disperse, the distance between suitable habitats is a critical component of population success. Thus, natural or human-induced disturbance events that result in the alteration or loss of wetlands on the landscape can not only eliminate local populations, but also increase the risk of extirpation of entire metapopulations (Semlitsch 2000). Clusters or "Communities" of wetlands and lakes therefore represent important locations for the persistence of aquatic and semi-aquatic species.

Data source: • Leduc County Wetland inventory

Quantification: • The wetland inventory was converted to a polyline feature and the kernel density was calculated with a 1000m range and 15m grid spacing. The resulting raster was converted to point features and the point kernel density was intersected with the wetland layer to determine average Kernel density for each lake and wetland

• For each QS with a Lake or wetland present, the average kernel density score was re-assigned to the QS

• Any QS with a score of zero was removed, and a three class Jenks analysis was used to determine indicator score classes

Indicator Scoring: • 3= High density of wetlands
• 2= Moderate density of wetlands
• 1= Low density of wetlands

3d: Within stream habitat connectivity

Whole catchment connectivity is critical for effective conservation of river and stream networks to ensure natural processes (e.g. upstream connectivity, fish migratory routes, free-flowing rivers) are maintained, along with all elements of biodiversity (Linke et al. 2007; Nel et al. 2009). Given the importance of habitat connectivity to the function and health of lotic ecosystems, in-stream habitat connectivity was considered an important indicator in this assessment.

Data source: • Leduc County River and Stream Network Layer, Leduc County Road Layer

Quantification: • All QS intersecting a stream or river of Strahler Order 2, 3, or 4 were selected and the length (km) of the stream/river segment unimpeded by a road crossing was calculated

• A three class Jenks analysis was conducted for each Strahler order to determine unimpeded stream length categories

• For all higher order water courses (Strahler 5-7), we assumed all road crossings would be composed of a bridge structure; therefore, these water courses were given a score of 3 to reflect the unimpeded nature of these features

Indicator Scoring: • 3 = Quarter-sections with the longest unimpeded stream length segments
• 2 = Quarter-sections with moderate unimpeded stream length segments
• 1 = Quarter-sections with low unimpeded stream length segments

Table 13. Final lotic habitat connectivity scores by Strahler stream order.

Stream Order	Unimpeded Stream Length (km) by Quarter Section		
	Class 1	Class 2	Class 3
2	0.856 - 1.560	1.561 - 2.552	>2.552
3	1.096 - 2.127	2.128 - 3.726	>3.726
4	1.373 - 2.795	2.796- 4.779	> 4.779
>5			>0

3e: Habitat connectivity

An important component of landscape intactness is the connectivity of natural habitat on the landscape. Terrestrial habitat patches that are highly connected are more resilient to local and landscape-level change. As a result, larger and more connected patches are more likely to maintain a wider range of ecological processes which, in turn, are critical to the persistence of a wide range of flora and fauna (Nel et al. 2007; Nel et al. 2009).

Data source: • Leduc County Wetland inventory, Leduc County Land Cover classification

Quantification: • Natural habitat was calculated by combining the wetland inventory and aquatic habitat with the terrestrial habitat areas (Forest and Open Natural)

• In order to determine the connectivity of habitat within a QS the total natural area surrounding the QS was calculated by finding the total percent cover of natural area within a buffer 800m surrounding each QS excluding the actual QS area

• The buffer area was clipped by the extent of the land cover classification

• The percentage area of natural habitat surrounding each QS was calculated

• Values with a score of zero were removed, and a Jenks analysis was used to classify into six classes. The top three classes were used to score indicators according to the cutoff values below

Indicator Scoring: • 3= Proportion of Natural cover surrounding QS (≥ 76%)
• 2= Proportion of Natural cover surrounding QS (>51 and 76%)
• 1= Proportion of Natural cover surrounding QS (>34 and 51%)

CRITERION 4: Areas that contribute to water quality and quantity

4a: River and stream density

River and stream network density is considered to be an important indicator of the vulnerability of a watershed to land use change (Elmore et al. 2013). Furthermore, river and stream network density exerts a strong influence on ecohydrologic processes in watersheds. Stream network density dictates both the aquatic and terrestrial influences on stream water quality and residence time within watersheds (Elmore et al. 2013), which in turn controls the processes that support a variety of fauna and flora. Of particular importance for assessing the contribution of an area to the maintenance of local and regional water quality and quantity is the number, length, and density of headwater streams (Elmore et al. 2013).

Data source: • Leduc County River and Stream Network Layer

Quantification: • The density (km/km^2) of streams and rivers contained within each quarter-section was calculated and log transformed

• Zero values removed and a three class Jenks was performed to determine class breaks for indicator scoring

Indicator Scoring: • 3 = QS with a high density of streams and rivers (>2.4 km/ km^2)
• 2 = QS with a moderate density of streams and rivers (>1.0 and 2.4km/km^2)
• 1 = QS with a low density of streams and rivers (>0 and 1.0 km/km^2)

4b: Riparian habitat intactness (streams & rivers)

The intactness of riparian habitat surrounding rivers and streams is of critical importance to maintaining ecological function. Riparian areas provide a collection of diverse habitats and biological communities, with the intactness of riparian corridors affecting both the function and structure of aquatic and terrestrial ecosystems and the integrity of their biological communities (Brooks 2013). These areas can act as important wildlife corridors, and can significantly improve water quality as freshwater travels through riparian vegetation into river and stream networks (Linke et al. 2007; Nel et al. 2007; Norris et al. 2007). Riparian habitats also provide important ecosystem goods and services, including nutrient and sediment storage, filtering of non-point source pollution, and the dissipation of flood energy (Jones et al. 2010).

Data source:	Leduc County Land Cover Classification, Leduc County River and Stream Network Layer

Quantification:	• Buffered stream network using Strahler order as follows:
	    • Order 1,2,3 were buffered by 100m
	    • Order >4 were buffered by 250m
	
	• Buffered stream networks were clipped by the extent of the land cover classification, and lentic features were removed
	
	• The total riparian buffer area within in each QS was calculated
	
	• For each QS, the percentage natural cover (forest and open natural) within the buffer was calculated. The values were log transformed and the zeros were removed
	
	• A Jenks analysis using six classes was performed and the top three classes were taken to inform the indicator scores

Indicator Scoring:	• 3 = Quarter-sections with highly intact riparian areas (>48% cover) • 2 = Quarter-sections with moderately intact riparian areas (>22 to 48% cover) • 1 = Quarter-sections with low riparian area intactness (>10 to 22% cover)

4c: Riparian habitat intactness (wetlands & lakes)

Riparian lands have a disproportionately greater influence on aquatic ecosystems than other terrestrial lands, and in many landscapes, riparian habitats are more biologically productive and support a higher level of biodiversity than other habitats of comparable size. Within Leduc County, historic loss of wetlands and associated riparian habitats, as well as rapid lakeshore development, have seriously impacted the amount and the intactness of remaining riparian lands. Given the importance of riparian habitat to supporting biodiversity, improving water quality, and reducing floods, the amount of riparian habitat surrounding wetlands and lakes in Leduc County was considered an important element of environmental significance.

Data source:	• Leduc County Land Cover Classification, Leduc County Wetland Inventory.

Quantification:	• Selected any lakes or wetlands with an estimated Stewart & Kantrud Class of III, IV, or V and buffered each feature based on size, as follows:
	    • Wetlands or lakes <4ha = 100m buffer
	    • Wetland or lakes >4ha = 250m buffer
	
	• The percentage of natural cover (forest and open natural) within the buffer area was calculated for each water body feature, and this was intersected with the QS layer to calculate and area-weighted average for each QS
	
	• Calculated values were log transformed and zero values were removed
	
	• The riparian intactness values assigned to each QS were used to classify QS scores using a Jenks analysis into 4 breaks taking the top three classes.

Indicator Scoring:	• 3 = Quarter-sections with riparian intactness (>33%) • 2 = Quarter-sections with riparian intactness (>11 to 33%) • 1 = Quarter-sections with riparian intactness (≥3 to 11%)

4d: Water storage potential

Wetlands and lakes contribute to the water storage potential of a region, as runoff can be intercepted and stored in digressional wetlands and lakes. This provides a significant benefit for water quality by removing nutrients, biological oxygen demand, suspended solids, metals, and pollutants (Hemond and Benoit 1988; Whigham et al. 1988). In addition, wetlands and lakes reduce the frequency of flood events by intercepting and storing surface water and decreasing watershed discharge (Hubbard and Linder 1986). Furthermore, the water storage potential of wetlands and lakes is beneficial not only for flood prevention, but wetlands and lakes can also recharge groundwater supplies, which in turn support agricultural and biological productivity (Hubbard and Linder 1986).

Data source:	• Province hydrology Lakes layer, Leduc County Wetland Inventory
Quantification:	• Lakes and wetlands were merged and dissolved to remove overlapping areas. A minimum size threshold of 0.01ha was imposed, and all lakes/wetlands <0.01ha were removed
	• The total area of lakes and wetlands within each QS was calculated and values were log transformed. QS that did not contain any lakes or wetlands were removed and were assigned a score of zero
	• Values were log transformed and a Jenks analysis was performed using four classes to assign indicator scores. The top two Jenks classes were combined and assigned a score of 3.
Indicator Scoring:	• 3 = QS where water storage potential is high (>4.0 ha of wetland or lake)
	• 2 = QS where water storage potential is high (>1.0 to 4.0 ha of wetland or lake)
	• 1 = (0.01-to 1.0 ha of wetland or lake)

4e: Discharge potential

Groundwater discharge is a key component of the hydrologic system and replenishes wetlands and lakes during periods of low precipitation. Areas of groundwater discharge are thus of great importance as they maintain ecologically important discharge wetlands. Discharge wetlands are also important for controlling erosion and maintaining water quality.

Data source:	• Leduc County Recharge-Discharge Layer
Quantification:	• Overlay QS layer with discharge layer and assign discharge potential to each QS based on area-weighted discharge values
	• Calculate the % cover of discharge potential for each QS and all QS with <25% cover by the discharge layer were removed
	• Weighted discharge score was multiplied by % cover value to calculate a weighted QS score
	• A four class Jenks analysis was performed to determine indicator scores, with the three classes being retained to determine class breaks
Indicator Scoring:	• 3 = QS with high discharge potential
	• 2 = QS with moderate discharge potential
	• 1 = QS with low discharge potential

Appendix B: ESA Maps

ESA Number	ESA Area	ESA Type	Page Number
1	Coyote Lake	Upland	A-1
2	Coyote Lake	Upland	A-2
3	Coyote Lake	Upland	A-3
4	Coyote Lake	Mixed	A-4
5	North Coyote Lake	Mixed	A-5
6	North Coyote Lake	Upland	A-6
7	West Genesee	Mixed	A-7
8	West Genesee	Mixed	A-8
9	North Genesee	Mixed	A-9
10	North Genesee	Mixed	A-10
11	Strawberry Creek	Mixed	A-11
12	Strawberry Creek	Riparian	A-12
13	Strawberry Creek	Upland	A-13
14	Strawberry Creek	Upland	A-14
15	Strawberry Creek	Riparian	A-15
16	Strawberry Creek	Riparian	A-16
17	Strawberry Creek	Riparian	A-17
18	Strawberry Creek	Mixed	A-18
19	Strawberry Creek	Mixed	A-19
20	Strawberry Creek	Riparian	A-20
21	Strawberry Creek	Riparian	A-21
22	Strawberry Creek	Riparian	A-22
23	Strawberry Creek	Mixed	A-23
24	Strawberry Creek	Riparian	A-24
25	North Saskatchewan	Mixed	A-25
26	North Saskatchewan	Riparian	A-26
27	North Saskatchewan	Mixed	A-27
28	North Saskatchewan	Mixed	A-28
29	North Saskatchewan	Mixed	A-29
30	North Saskatchewan	Riparian	A-30
31	West Pigeon Lake	Mixed	A-31
32	West Pigeon Lake	Mixed	A-32
33	West Pigeon Lake	Upland	A-33
34	West Pigeon Lake	Upland	A-34
35	West Pigeon Lake	Upland	A-35
36	West Pigeon Lake	Mixed	A-36
37	West Pigeon Lake	Mixed	A-37
38	Pigeon Lake	Aquatic	A-38
39	Weed Creek	Mixed	A-39
40	Weed Creek	Upland	A-40
41	Weed Creek	Upland	A-41
42	Weed Creek	Riparian	A-42
43	Weed Creek	Upland	A-43
44	Weed Creek	Mixed	A-44
45	Weed Creek	Riparian	A-45
46	Weed Creek	Mixed	A-46
47	Weed Creek	Mixed	A-47

ESA Number	ESA Area	ESA Type	Page Number
48	Weed Creek	Mixed	A-48
49	Weed Creek	Riparian	A-49
50	Weed Creek	Riparian	A-50
51	Weed Creek	Riparian	A-51
52	Weed Creek	Riparian	A-52
53	Weed Creek	Riparian	A-53
54	Weed Creek	Mixed	A-54
55	Wizard Lake	Mixed	A-55
56	Conjuring Creek	Riparian	A-56
57	Conjuring Creek	Mixed	A-57
58	Conjuring Creek	Riparian	A-58
59	Conjuring Creek	Mixed	A-59
60	Conjuring Creek	Riparian	A-60
61	Conjuring Creek	Mixed	A-61
62	Conjuring Creek	Riparian	A-62
63	Conjuring Creek	Riparian	A-63
64	Conjuring Creek	Riparian	A-64
65	Whitemud Creek	Riparian	A-65
66	Whitemud Creek	Riparian	A-66
67	Whitemud Creek	Mixed	A-67
68	Whitemud Creek	Riparian	A-68
69	Whitemud Creek	Riparian	A-69
70	Whitemud Creek	Riparian	A-70
71	Whitemud Creek	Riparian	A-71
72	South Whitemud Creek	Aquatic	A-72
73	South Whitemud Creek	Aquatic	A-73
74	South Whitemud Creek	Aquatic	A-74
75	South Whitemud Creek	Mixed	A-75
76	South Whitemud Creek	Mixed	A-76
77	Northwest Coal	Aquatic	A-77
78	Northwest Coal	Aquatic	A-78
79	Northwest Coal	Aquatic	A-79
80	Northwest Coal	Mixed	A-80
81	Northwest Coal	Aquatic	A-81
82	Northwest Coal	Aquatic	A-82
83	Irvine/ Blackmud Creek	Aquatic	A-83
84	Irvine/ Blackmud Creek	Aquatic	A-84
85	Irvine/ Blackmud Creek	Mixed	A-85
86	Irvine/ Blackmud Creek	Riparian	A-86
87	Irvine/ Blackmud Creek	Aquatic	A-87
88	Irvine/ Blackmud Creek	Aquatic	A-88
89	Irvine/ Blackmud Creek	Mixed	A-89
90	Saunders Lake	Aquatic	A-90
91	Saunders Lake	Mixed	A-91
92	Saunders Lake	Upland	A-92
93	Saunders Lake	Mixed	A-93
94	Saunders Lake	Riparian	A-94
95	Saunders Lake	Aquatic	A-95

Mapped by Fiera Biological Consulting on 17/11/2014
Background Image: ESRI Basemap Light Grey Canvas
Projection: NAD 1983 10TM AEP Forest

Km

| 0 | 5 | 10 | 20 |

Legend

Leduc County ESAs (2014)

ESA Score

38.0 - 78.4

18.9 - 37.9

0.5 - 18.8

Zero Score

Areas Not Included in Analysis

Municipalities outside Leduc County

Mapped by Fiera Biological Consulting on 17/11/2014
Background Image: ESRI Basemap Light Grey Canvas

Projection: NAD 1983 10TM AEP Forest

West Genesee
A7- A8

North Genesee
A9 - A10

Whitemud Creek
A65 - A71

Saunders Lake
A90 - A98

Irvine/ Blackmud Creek
A83 - A89

Eagle Rock
A106 - A109

Looking Back Lake
A110 - A112

Joseph Lake
A117 - A120

North Coyote Lake
A5 - A6

North Saskatchewan
A25 - A30

Conjuring Creek
A56 - A64

Coyote Lake
A1 - A4

Strawberry Creek
A11- A24

Weed Creek
A39 - A54

Wizard Lake
A55

South Whitemud Creek
A72 - A76

Northwest Coal
A77 - A82

Coal Lake
A99 - A100

North Labyrinth
A101 - A102

South Sarepta
A113 - A114

New Sarepta
A104 - A105

Southwest Sarepta
A116

Northwest Hay
A103

Big Hay Lake
A115

West Pigeon Lake
A31 - A37

Pigeon Lake
A38

Km
0   5   10   20

Coyote Lake	Pigeon Lake	Irvine/ Blackmud Creek	Looking Back Lake
North Coyote Lake	Weed Creek	Saunders Lake	New Sarepta
West Genesee	Wizard Lake	Coal Lake	South Sarepta
North Genesee	Conjuring Creek	North Labyrinth	Southwest Sarepta
Strawberry Creek	Whitemud Creek	Northwest Hay	Joseph Lake
North Saskatchewan	South Whitemud Creek	Big Hay Lake	Areas Not Included in Analysis
West Pigeon Lake	Northwest Coal	Eagle Rock	Municipalities outside Leduc County

ESA Index Map of Coyote Lake Area

4

1

2

3

N

Legend

Individual ESA Type

Aquatic

Mixed

Riparian

Upland

Major Roads

Highlighted ESA Area

Other ESA Areas

Leduc County 2014 Boundary

Km

0　　　1　　　2　　　4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area

ESA Number: 1

Coyote Lake Area

ESA Type: Upland
- Upland : 70.2%
- Aquatic : 20.9%
- Riparian : 14.2%

Disturbance Risk: Medium
- High : 0.1%
- Moderate : 99.8%
- Low : 0%

ESA Area (ha): 971

ESA Score: 67.8/100

Overall ESA Rank: 11/120

Area ESA Rank: 2/ 4

Legend

☐ Highlighted ESA
— Streams and Rivers
☐ Wetlands and Lakes
— Roads
☐ High Risk Area
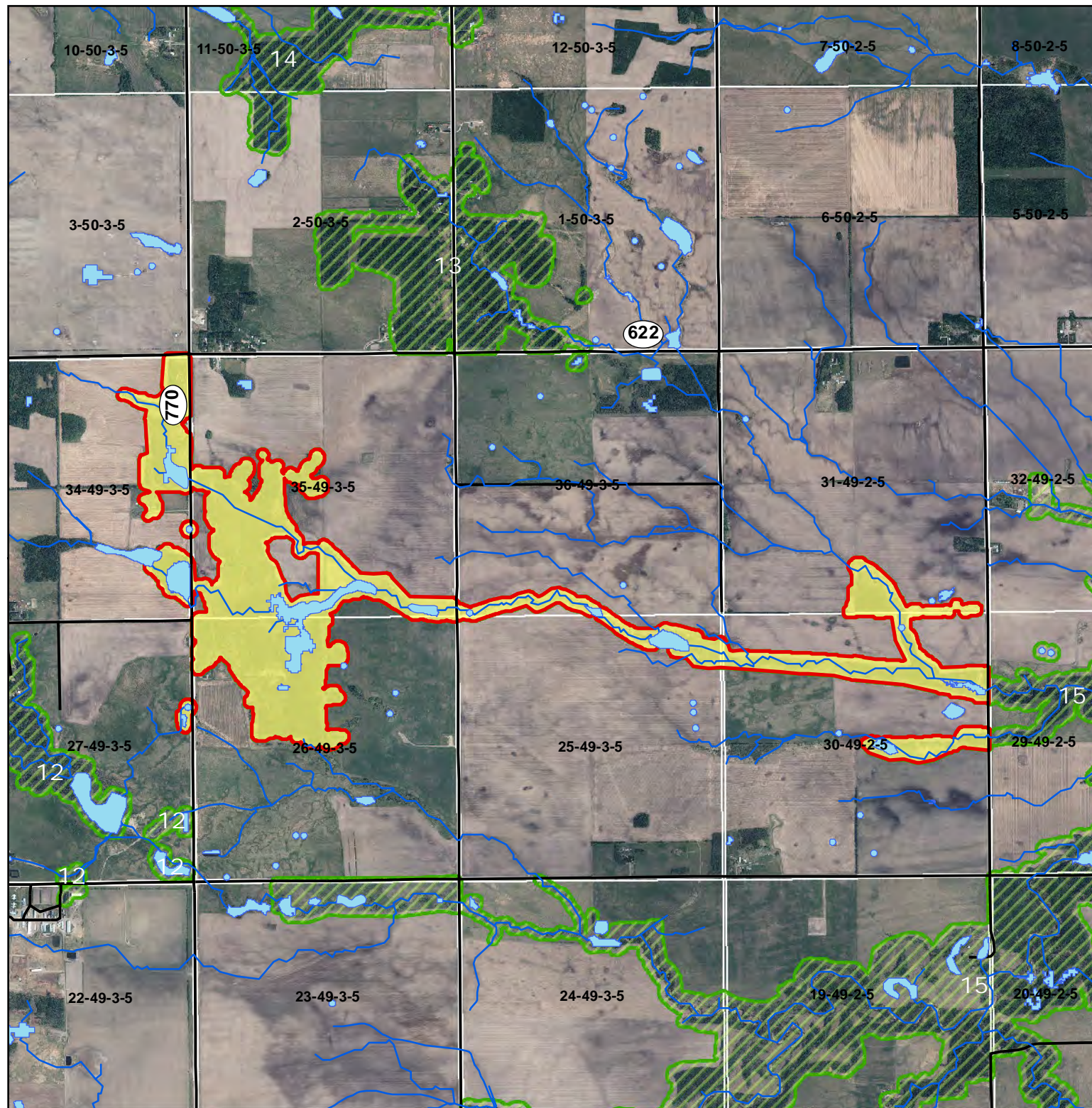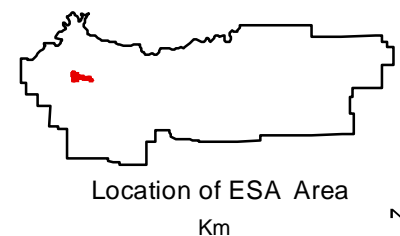☐ Medium Risk Area
☐ Low Risk Area
▨ Other ESAs

Location of ESA Area

Km
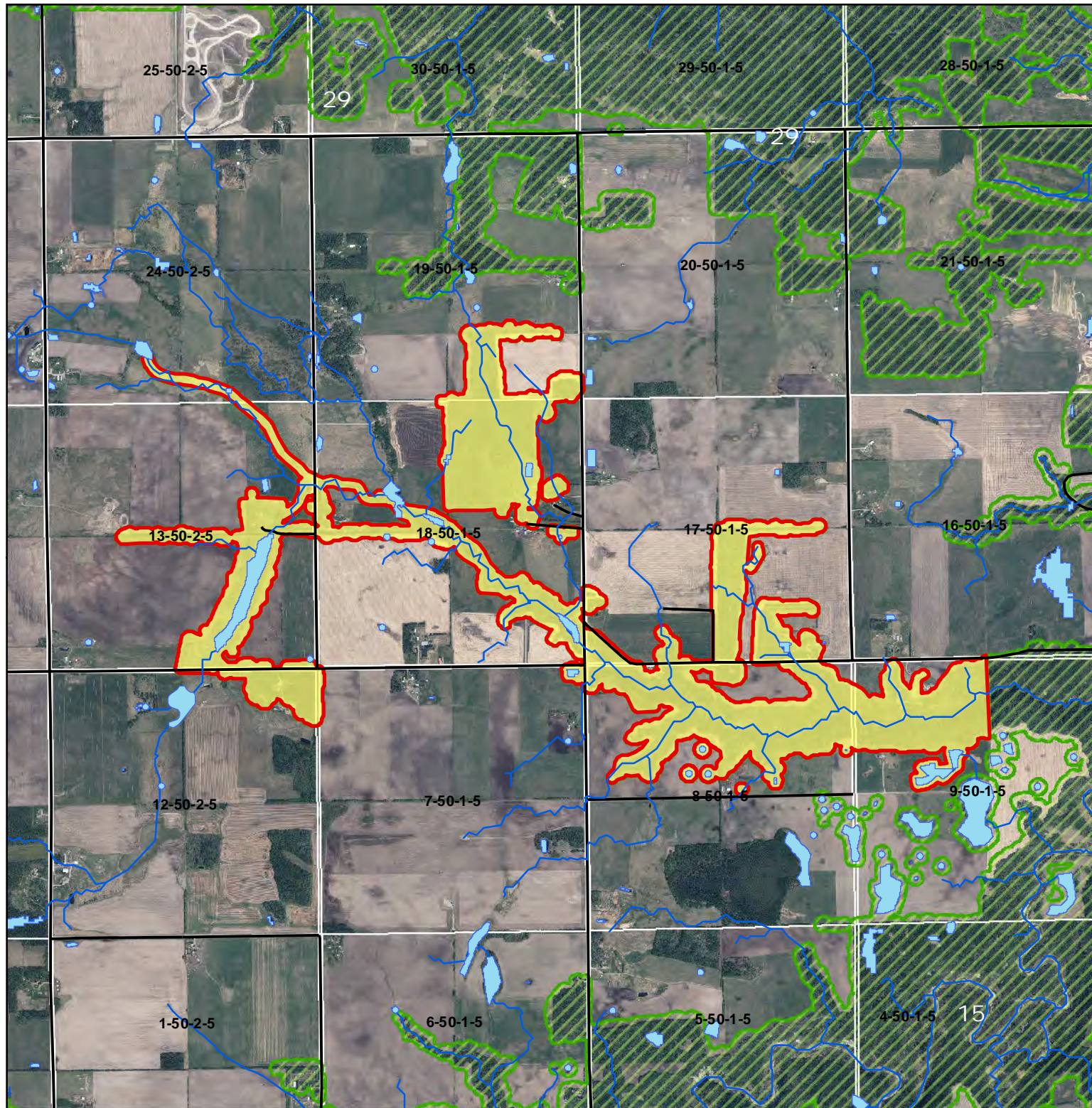
0   0.425   0.85   1.7

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-1
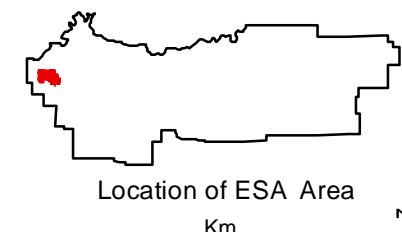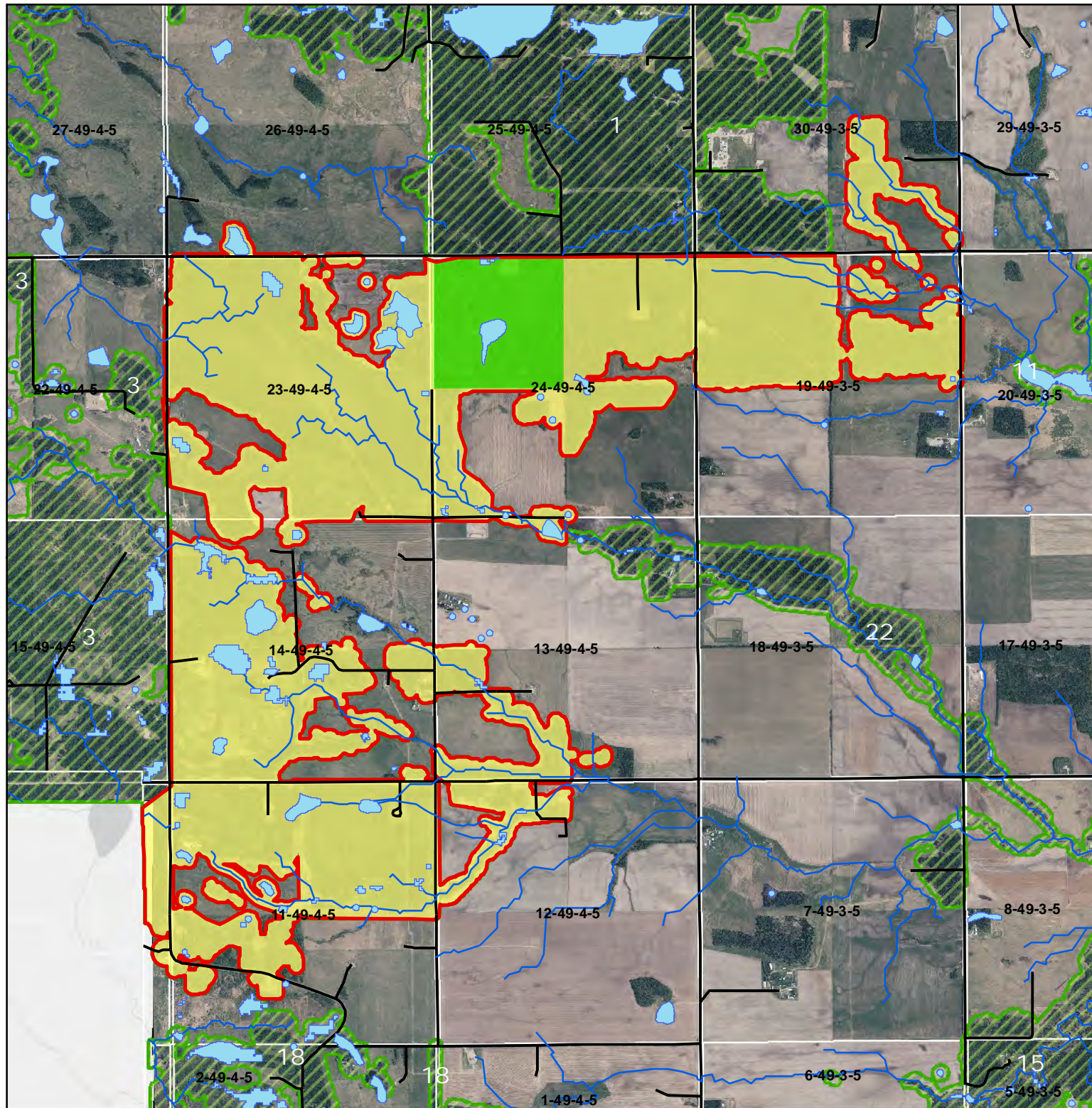
ESA Number: 2

Coyote Lake Area

ESA Type: Upland
- Upland : 76.6%
- Aquatic : 11%
- Riparian : 14.5%

Disturbance Risk: Medium
- High : 0%
- Moderate : 92.9%
- Low : 7%

ESA Area (ha): 913

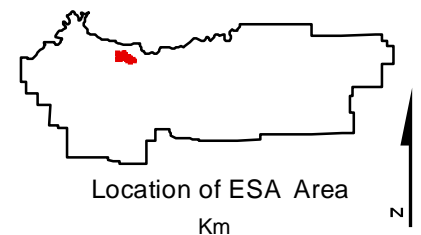ESA Score: 57.9/100

Overall ESA Rank: 26/120

Area ESA Rank: 4/ 4

Legend

▭	Highlighted ESA
—	Streams and Rivers
�	Wetlands and Lakes
—	Roads
■	High Risk Area
■	Medium Risk Area
■	Low Risk Area
▨	Other ESAs

Location of ESA Area
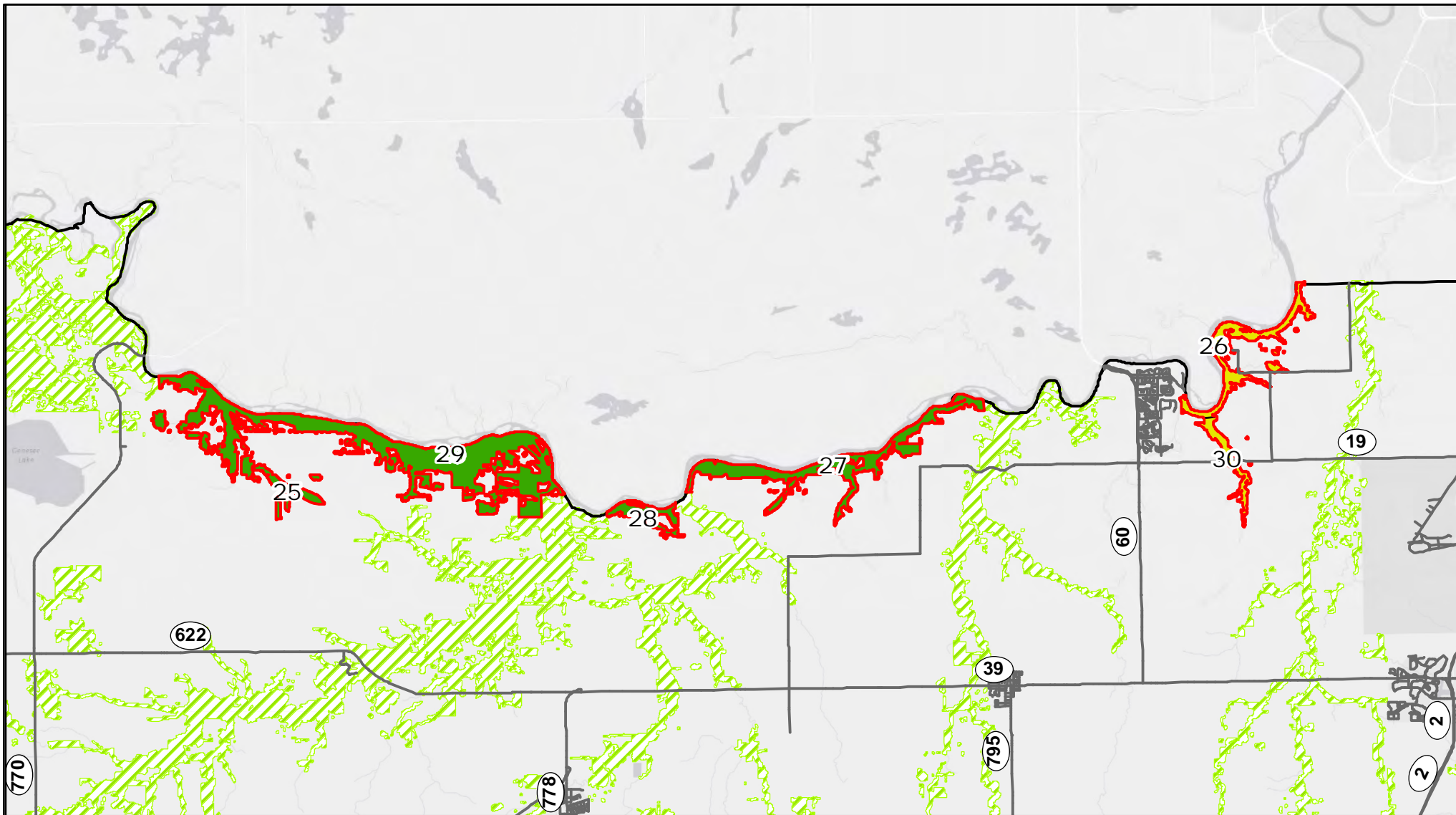
Km

0   0.4   0.8   1.6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-2
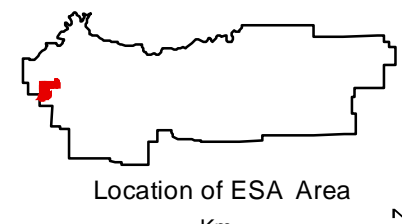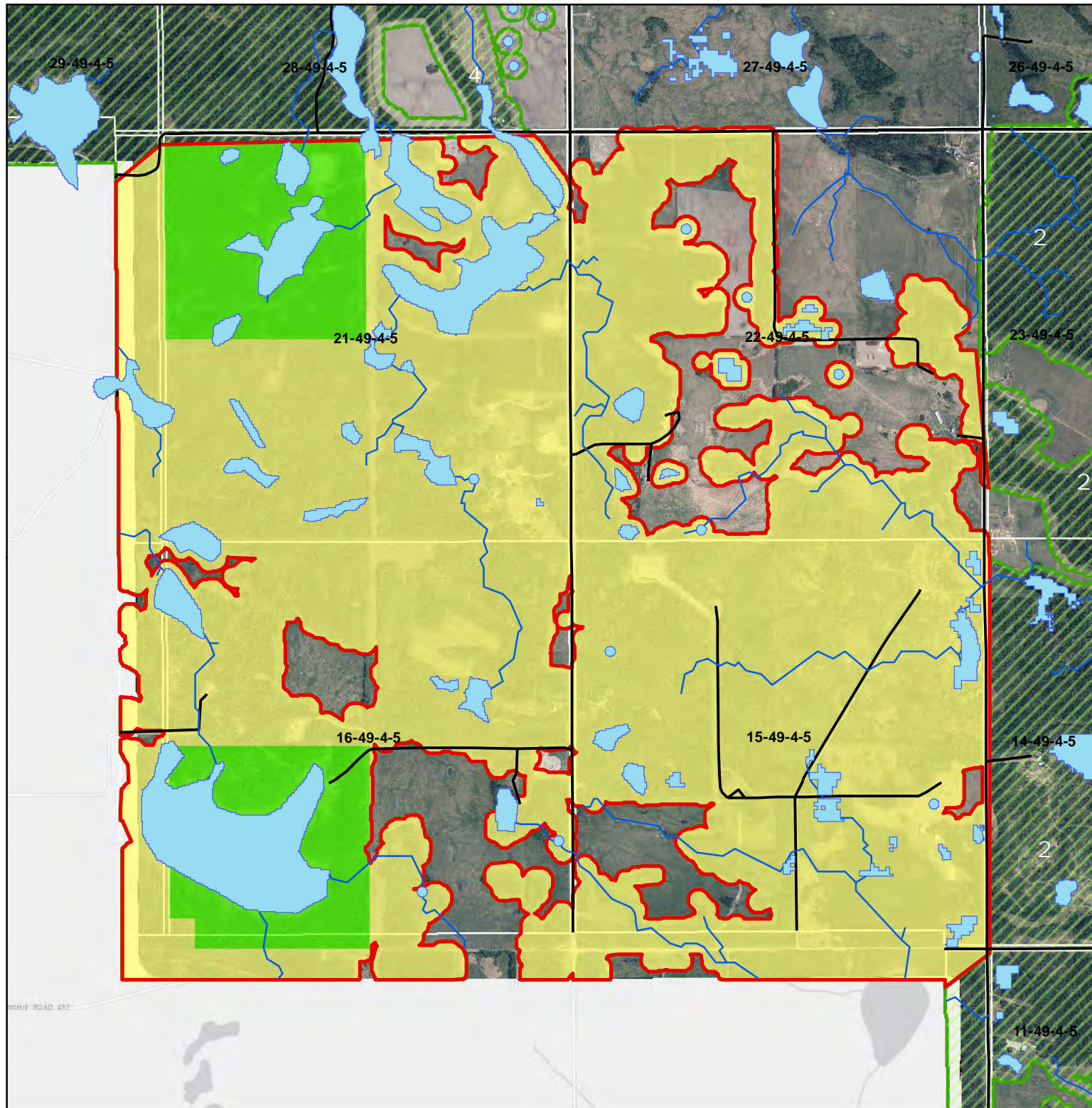
ESA Number: 3

Coyote Lake Area

ESA Type: Upland
- Upland : 73.5%
- Aquatic : 19.3%
- Riparian : 10.9%

Disturbance Risk: Medium
- High : 0%
- Moderate : 87.6%
- Low : 12.4%

ESA Area (ha): 937

ESA Score: 67.5/100

Overall ESA Rank: 13/120

Area ESA Rank: 3/ 4

Legend

▭	Highlighted ESA
—	Streams and Rivers
▬	Wetlands and Lakes
—	Roads
▬	High Risk Area
▬	Medium Risk Area
▬	Low Risk Area
▨	Other ESAs

Location of ESA Area

Km
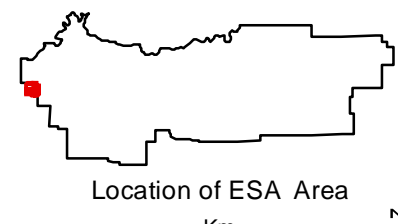
0   0.25   0.5   1

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
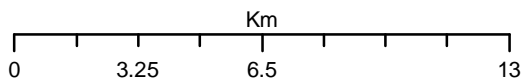Provided by Leduc County
Basemap:ESRI Light Grey Canvas
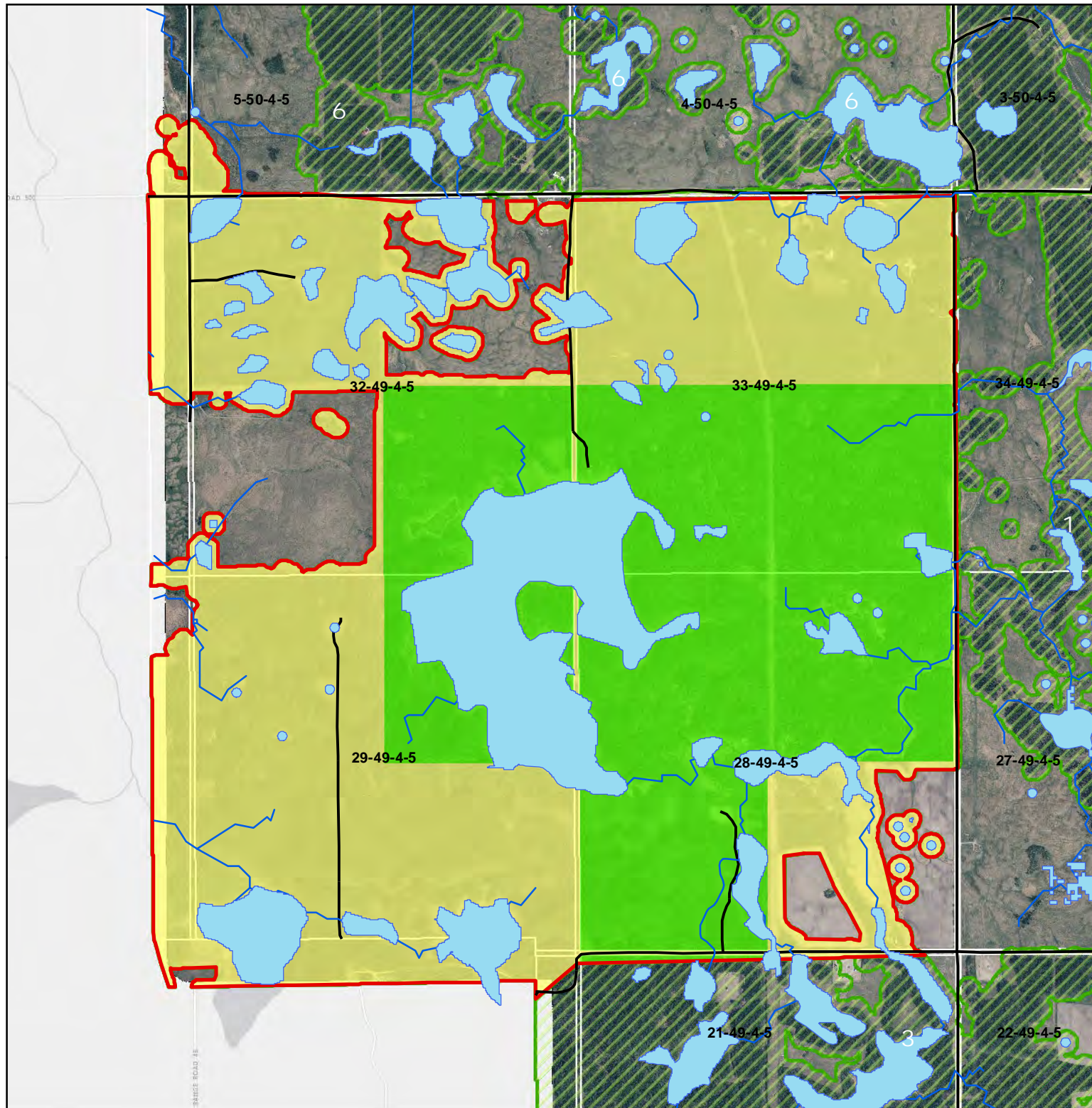
ESA Number: 4

Coyote Lake Area

ESA Type: Mixed
- Upland : 67.8%
- Aquatic : 27.4%
- Riparian : 9.5%

Disturbance Risk: Medium
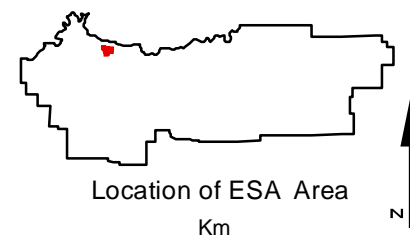- High : 0%
- Moderate : 59.9%
- Low : 40%

ESA Area (ha): 1013

ESA Score: 76.2/100

Overall ESA Rank: 2/120

Area ESA Rank: 1/ 4

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▬ Wetlands and Lakes
- — Roads
- ▬ High Risk Area
- ▬ Medium Risk Area
- ▬ Low Risk Area
- ▨ Other ESAs

Location of ESA Area
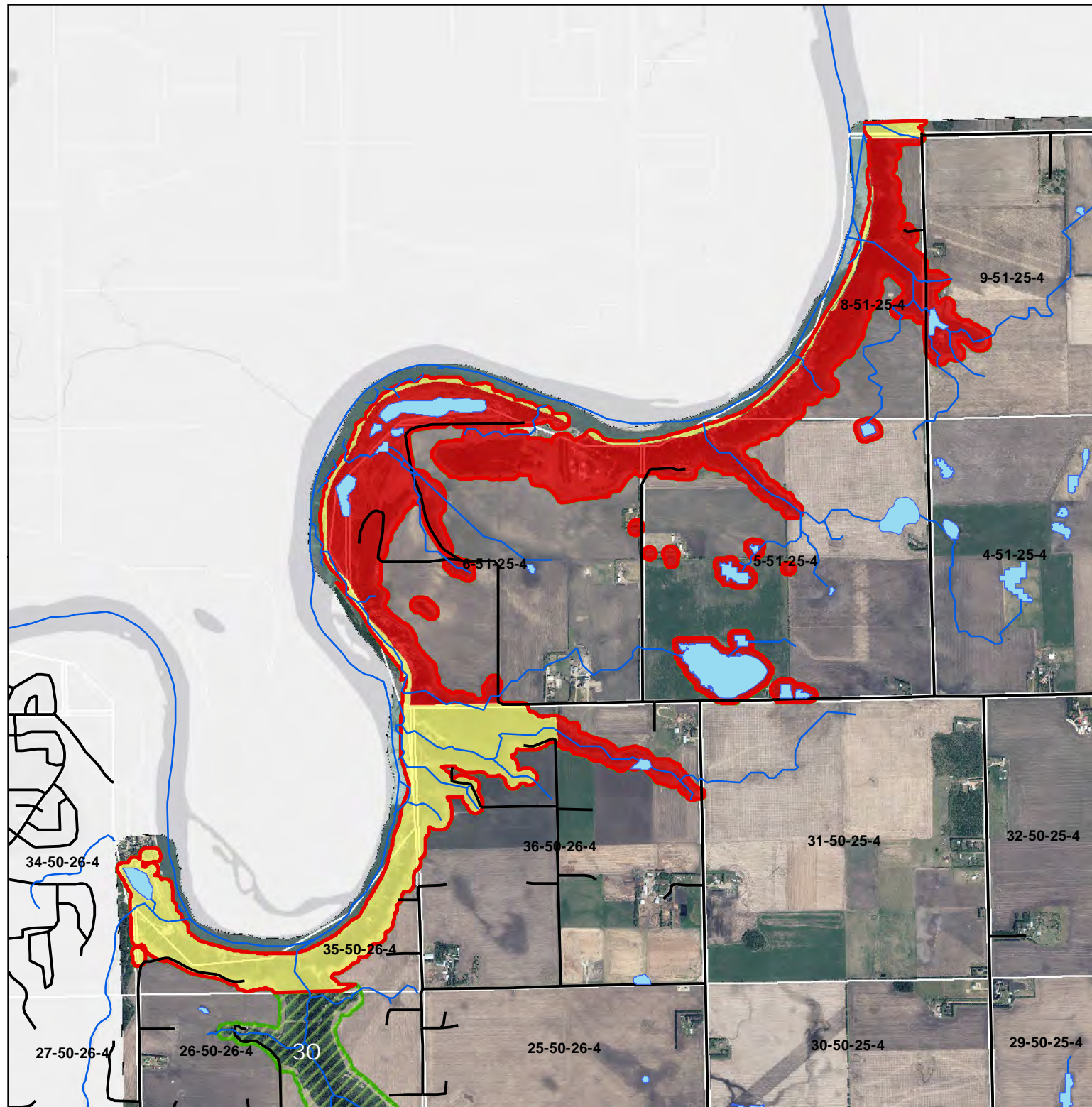
Km

0   0.275   0.55   1.1

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-4

ESA Index Map of North Coyote Lake Area

N

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

— Major Roads

☐ Highlighted ESA Area

▨ Other ESA Areas

☐ Leduc County 2014 Boundary

Km

0   1   2   4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 04/11/2014

Basemap: ESRI Light Grey Canvas
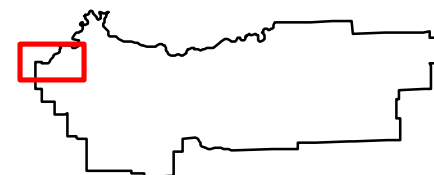
Location of ESA Area

ESA Number: 5

North Coyote Lake Area

ESA Type: Mixed
- Upland : 70%
- Aquatic : 18.7%
- Riparian : 15.5%

Disturbance Risk: Medium
- High : 2.7%
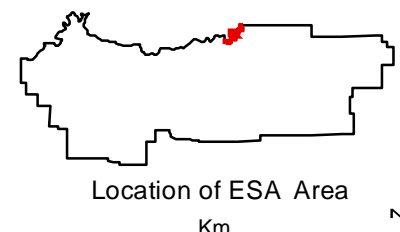- Moderate : 75.4%
- Low : 21.9%

ESA Area (ha): 1945

ESA Score: 78.4/100

Overall ESA Rank: 1/120

Area ESA Rank: 1/ 2

Legend

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
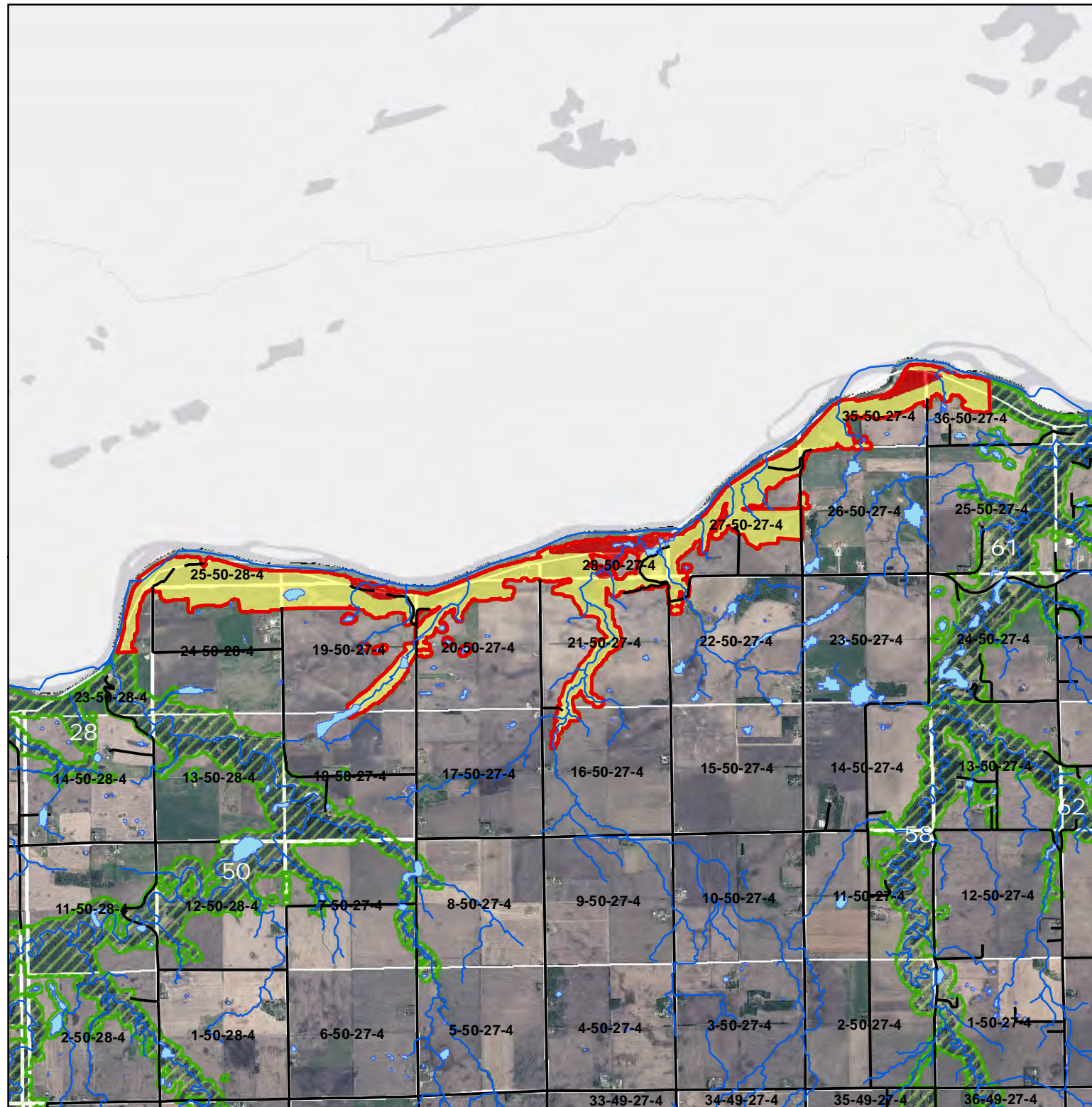Low Risk Area
Other ESAs

Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-5
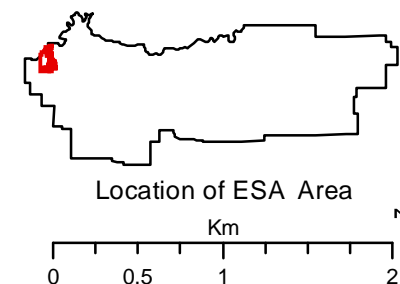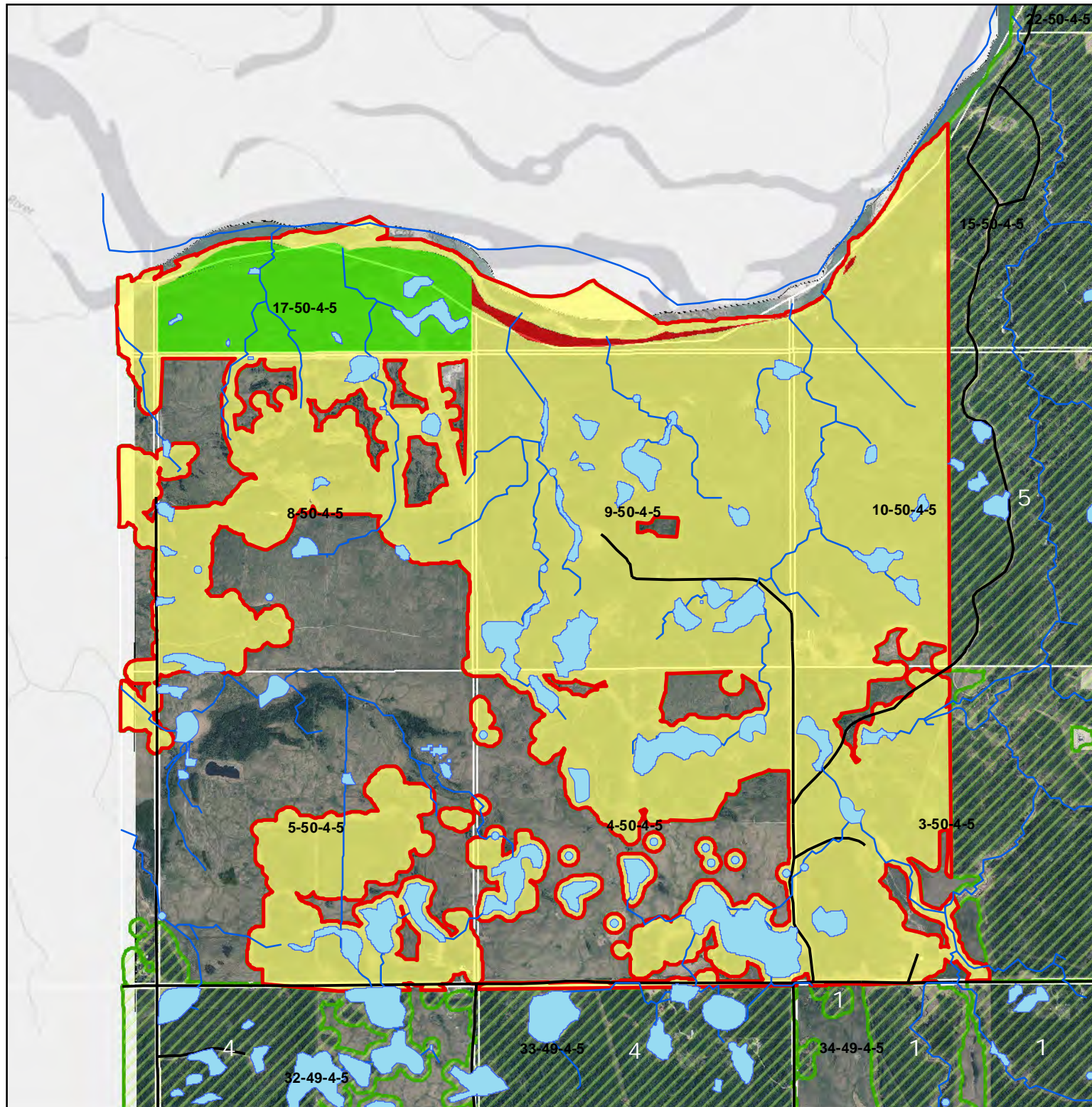
ESA Number: 6

North Coyote Lake Area

ESA Type: Upland
- Upland : 70.1%
- Aquatic : 19.8%
- Riparian : 14.9%

Disturbance Risk: Medium
- High : 0.6%
- Moderate : 91.9%
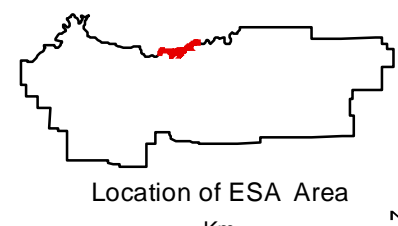- Low : 7.4%

ESA Area (ha): 1092
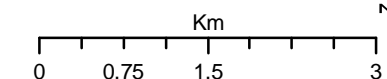
ESA Score: 70.5/100

Overall ESA Rank: 8/120

Area ESA Rank: 2/ 2

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▬ Wetlands and Lakes
- — Roads
- ▬ High Risk Area
- ▬ Medium Risk Area
- ▬ Low Risk Area
- ▨ Other ESAs

Location of ESA Area

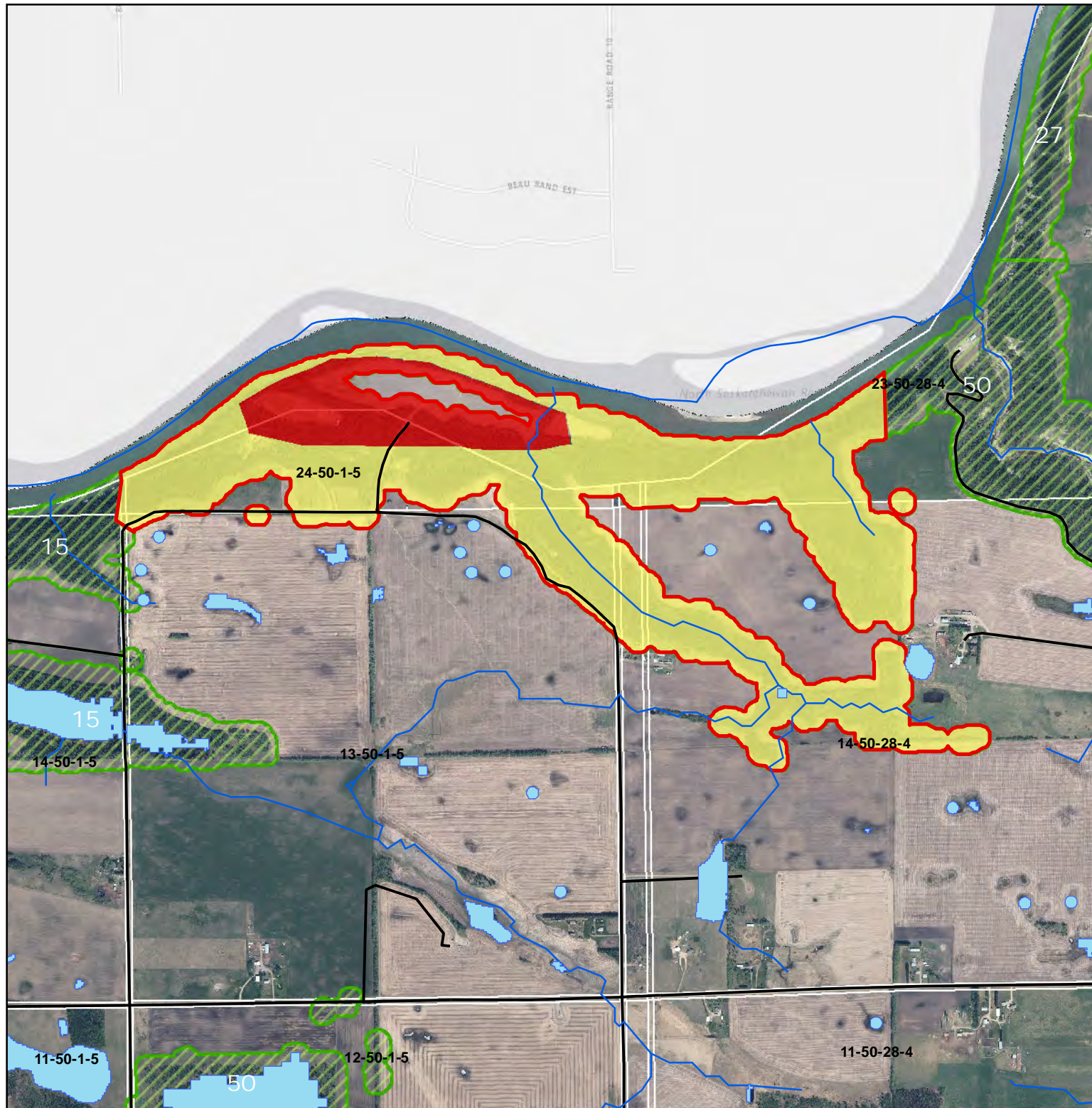Km

0   0.325   0.65   1.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-6

ESA Index Map of
West Genesee Area

N

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

Major Roads

Highlighted ESA Area

Other ESA Areas

Leduc County 2014 Boundary

Km

0   1.5   3   6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas
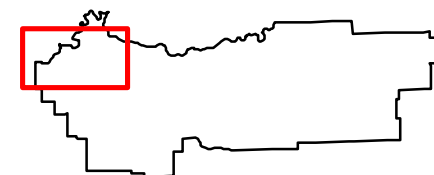
Location of ESA Area

ESA Number: 7

West Genesee Area

ESA Type: Mixed
- Upland : 71%
- Aquatic : 14%
- Riparian : 19%

  Disturbance Risk: High
- High : 57.8%
- Moderate : 31.5%
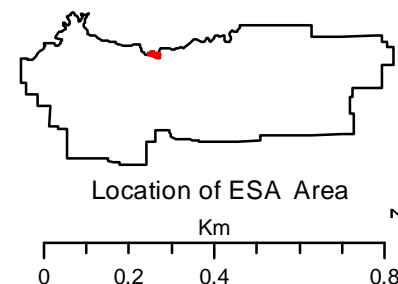- Low : 10.7%

ESA Area (ha): 1684

ESA Score: 59.3/100

Overall ESA Rank: 25/120

Area ESA Rank: 1/ 2

Legend

▭ Highlighted ESA

— Streams and Rivers

▬ Wetlands and Lakes

— Roads

▬ High Risk Area

▬ Medium Risk Area

▬ Low Risk Area

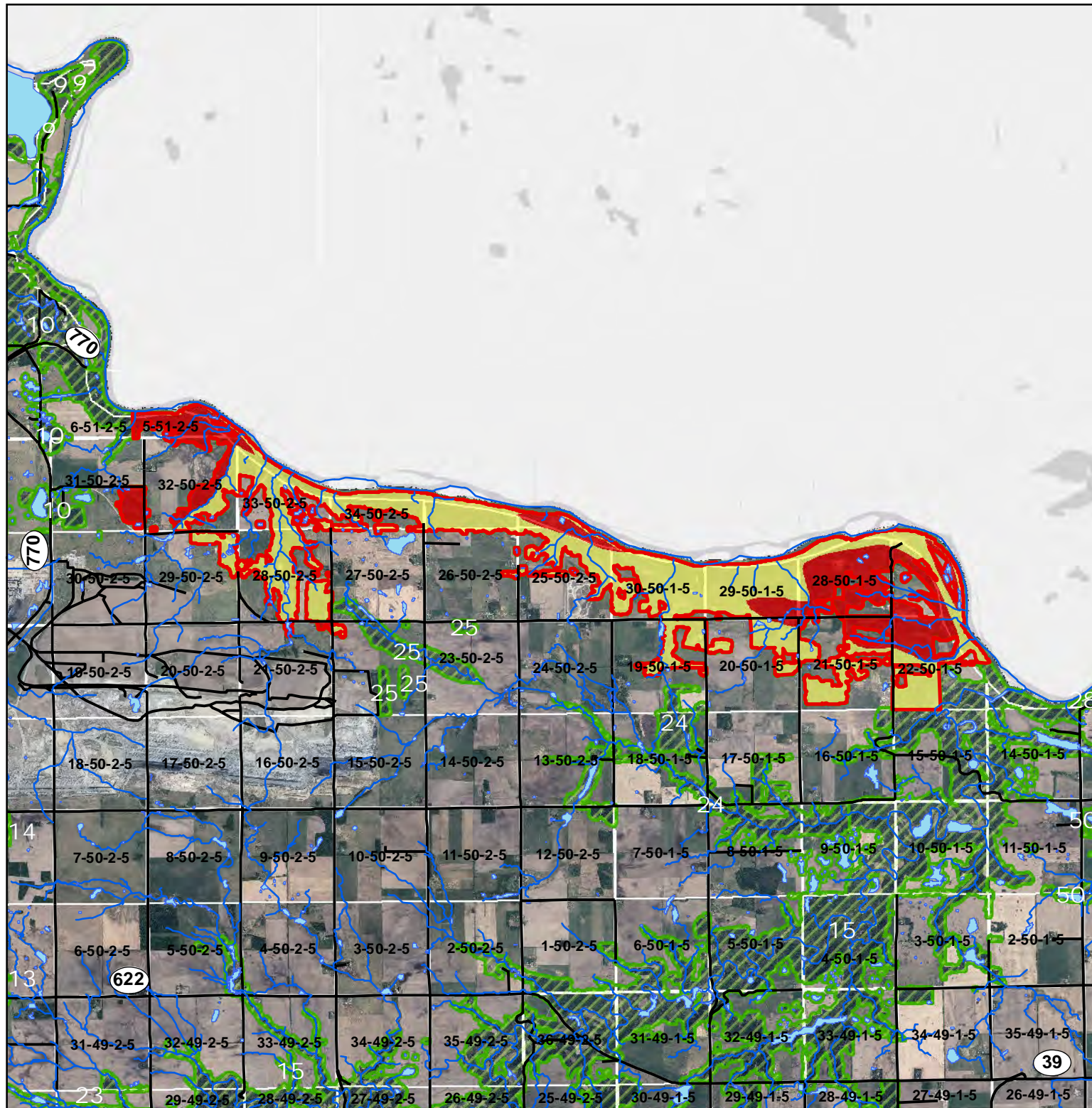▨ Other ESAs

Location of ESA Area

Km
0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-7
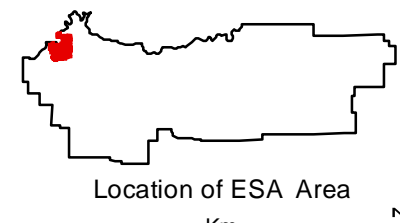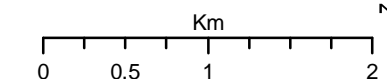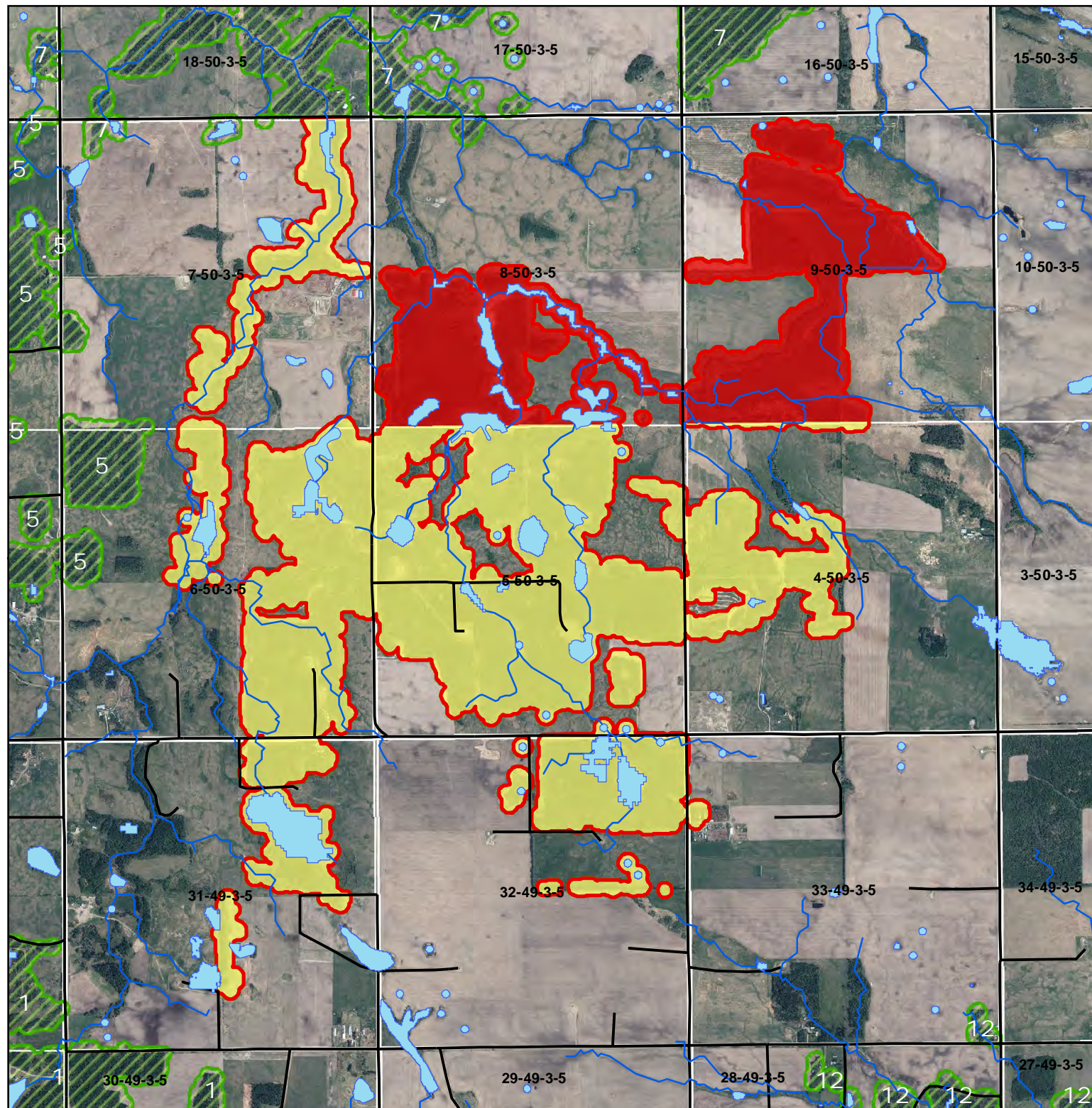
ESA Number: 8

West Genesee Area

ESA Type: Mixed
- Upland : 68.5%
- Aquatic : 17.1%
- Riparian : 20.7%

Disturbance Risk: Medium
- High : 27.5%
- Moderate : 72.5%
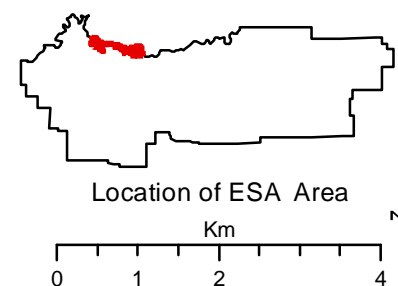- Low : 0%

ESA Area (ha): 655

ESA Score: 49.7/100

Overall ESA Rank: 45/120

Area ESA Rank: 2/ 2

Legend

▭ Highlighted ESA
— Streams and Rivers
▬ Wetlands and Lakes
— Roads
▮ High Risk Area
▮ Medium Risk Area
▮ Low Risk Area
▨ Other ESAs
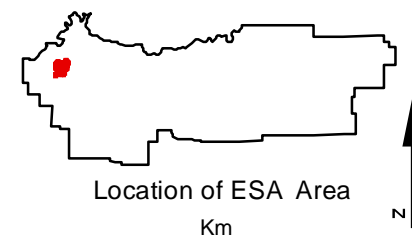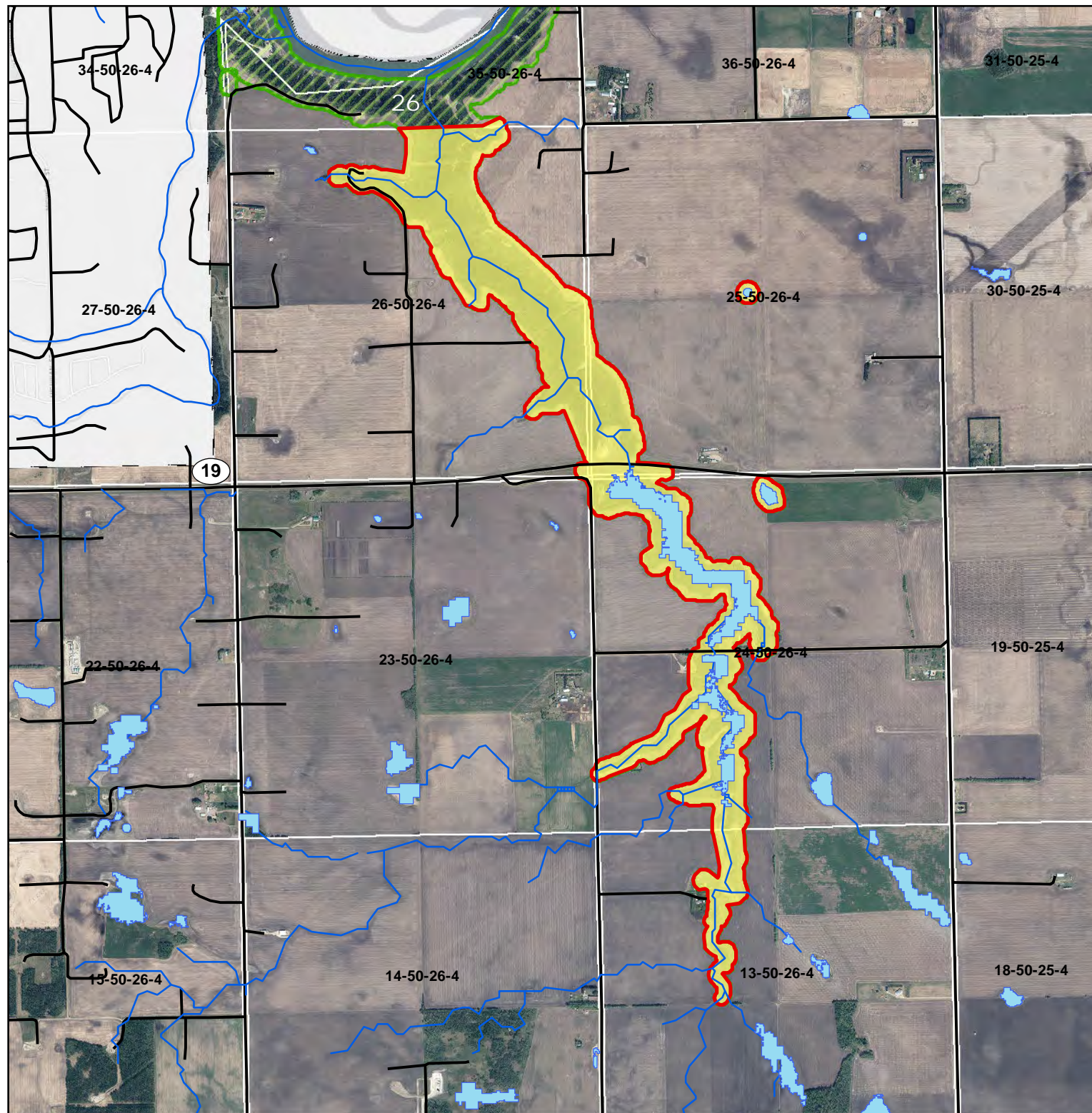
Location of ESA Area

Km

0   0.35   0.7   1.4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-8

ESA Index Map of
North Genesee Area

9

10

770

Genesee
Lake

N

Legend

Individual ESA Type

Aquatic

Mixed

Riparian

Upland

Major Roads

Highlighted ESA Area

Other ESA Areas

Leduc County 2014 Boundary

Km

0   1   2   4
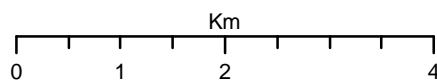
Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area
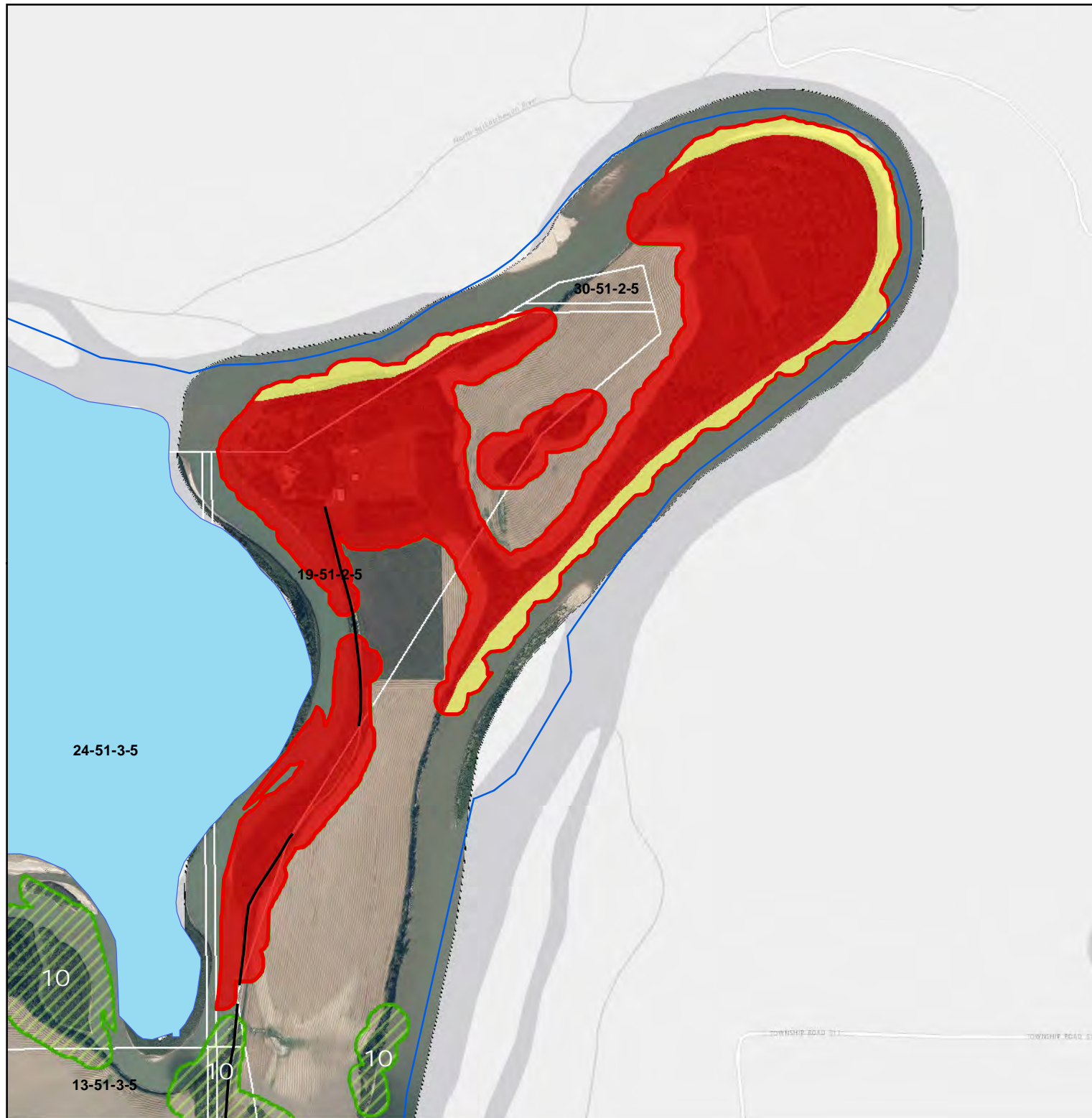
ESA Number: 9

North Genesee Area

ESA Type: Mixed
- Upland : 82.4%
- Aquatic : 0.5%
- Riparian : 17.1%

Disturbance Risk: High
- High : 87%
- Moderate : 12.9%
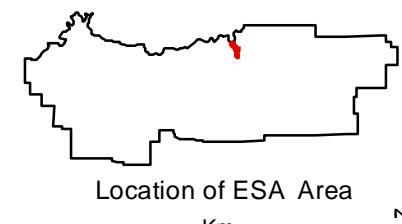- Low : 0%

ESA Area (ha): 74

ESA Score: 40.2/100

Overall ESA Rank: 73/120

Area ESA Rank: 2/ 2

Legend

☐ Highlighted ESA
— Streams and Rivers
☐ Wetlands and Lakes
— Roads
☐ High Risk Area
☐ Medium Risk Area
☐ Low Risk Area
☐ Other ESAs
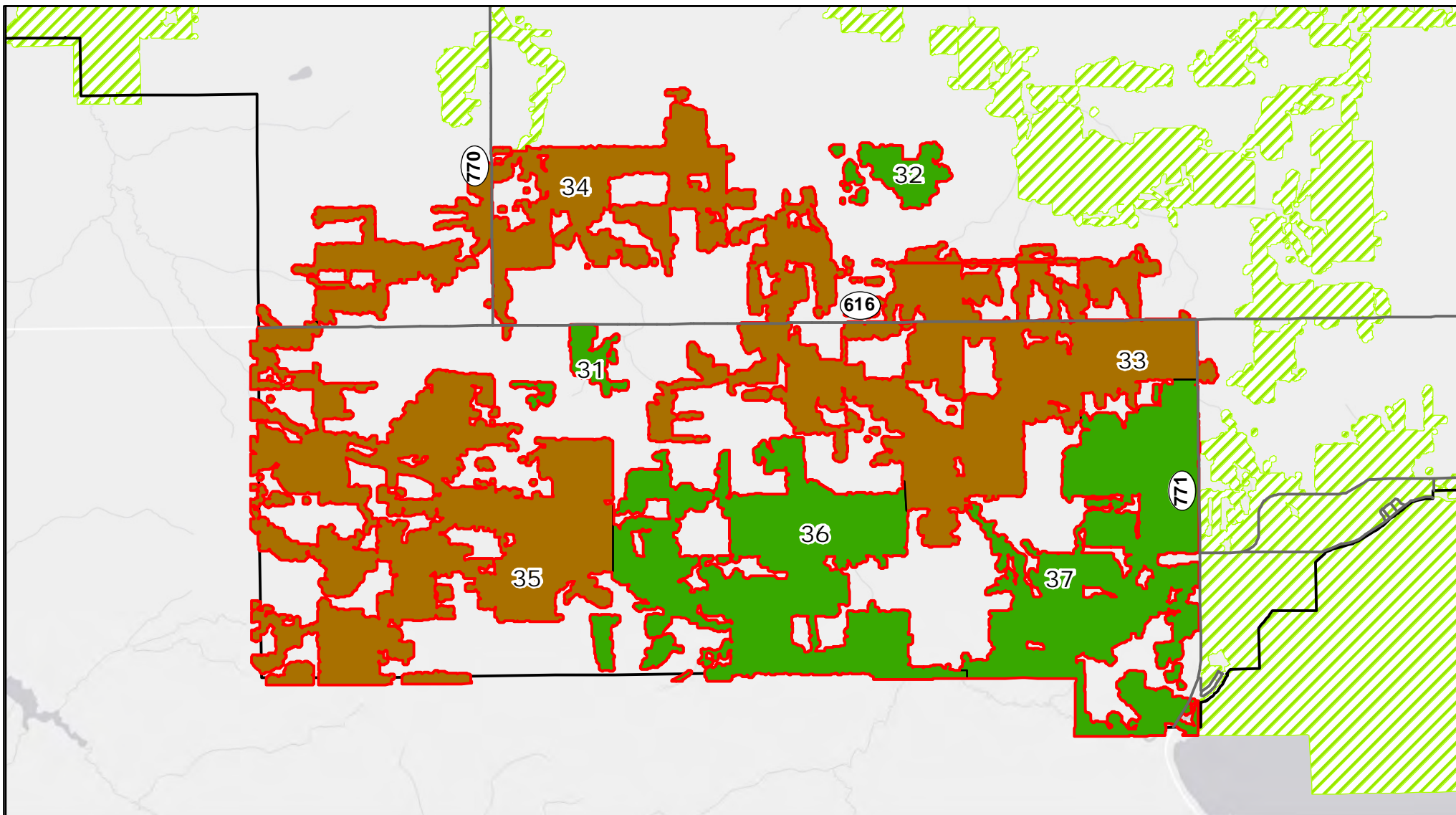
Location of ESA Area

Km

0   0.15   0.3   0.6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
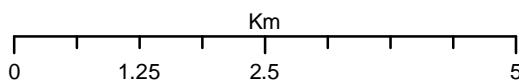Provided by Leduc County
Basemap:ESRI Light Grey Canvas

30-51-2-5

19-51-2-5

24-51-3-5

13-51-3-5

10

10

10
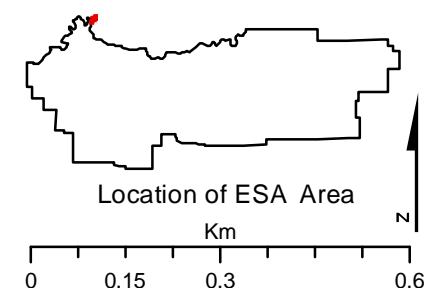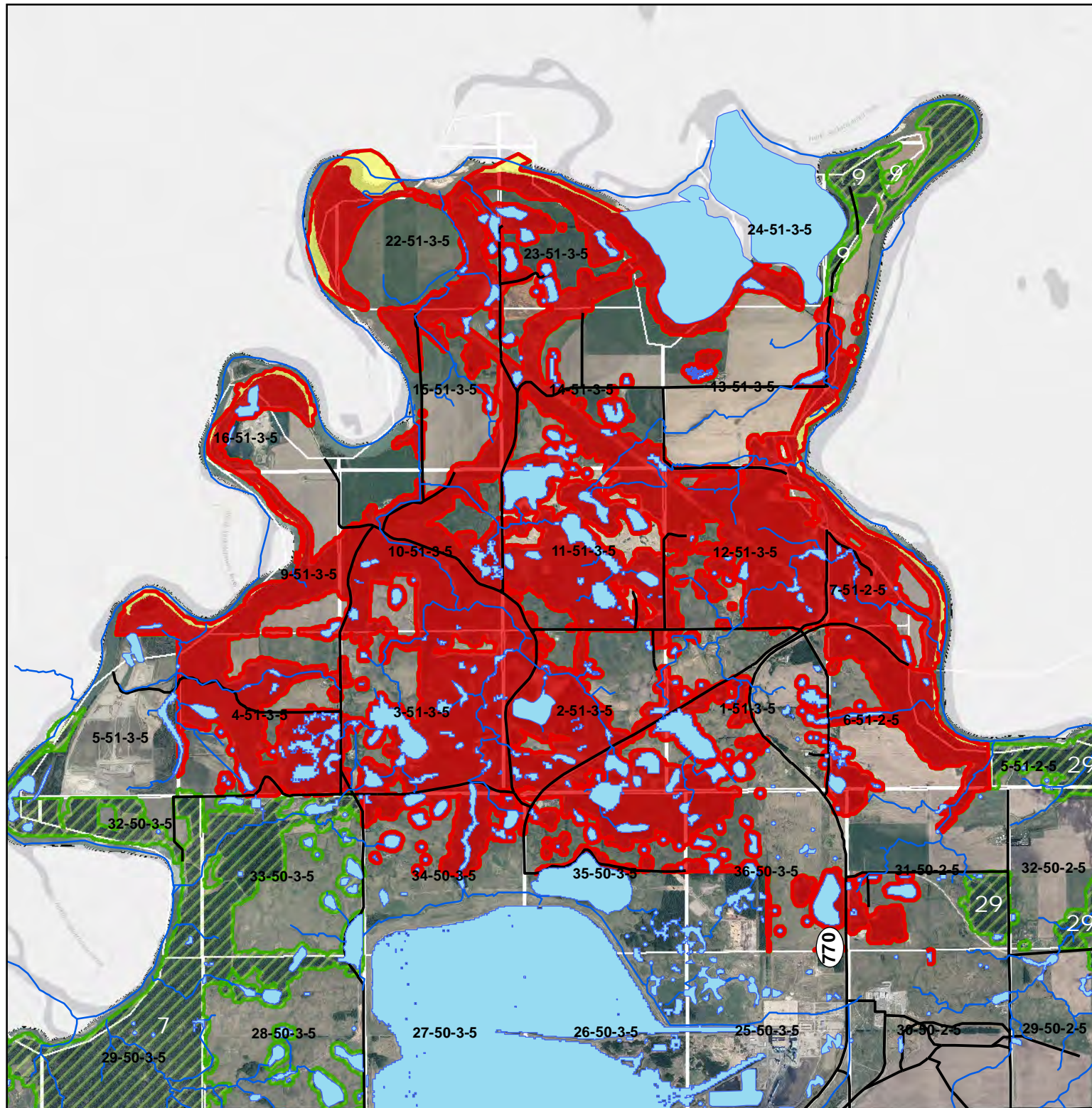
ESA Number: 10

North Genesee Area

ESA Type: Mixed
- Upland : 63.3%
- Aquatic : 25.9%
- Riparian : 14.9%

Disturbance Risk: High
- High : 97%
- Moderate : 2.9%
- Low : 0%

ESA Area (ha): 2385

ESA Score: 71/100

Overall ESA Rank: 7/120

Area ESA Rank: 1/ 2

Legend

☐ Highlighted ESA
— Streams and Rivers
☐ Wetlands and Lakes
— Roads
☐ High Risk Area
☐ Medium Risk Area
☐ Low Risk Area
▨ Other ESAs

Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-10

ESA Index Map of Strawberry Creek Area

Legend

Individual ESA Type

- Aquatic
- Mixed
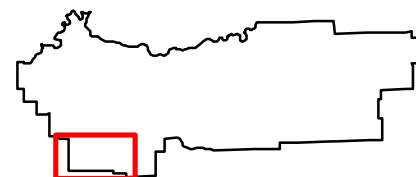- Riparian
- Upland

Major Roads
Highlighted ESA Area
Other ESA Areas
Leduc County 2014 Boundary
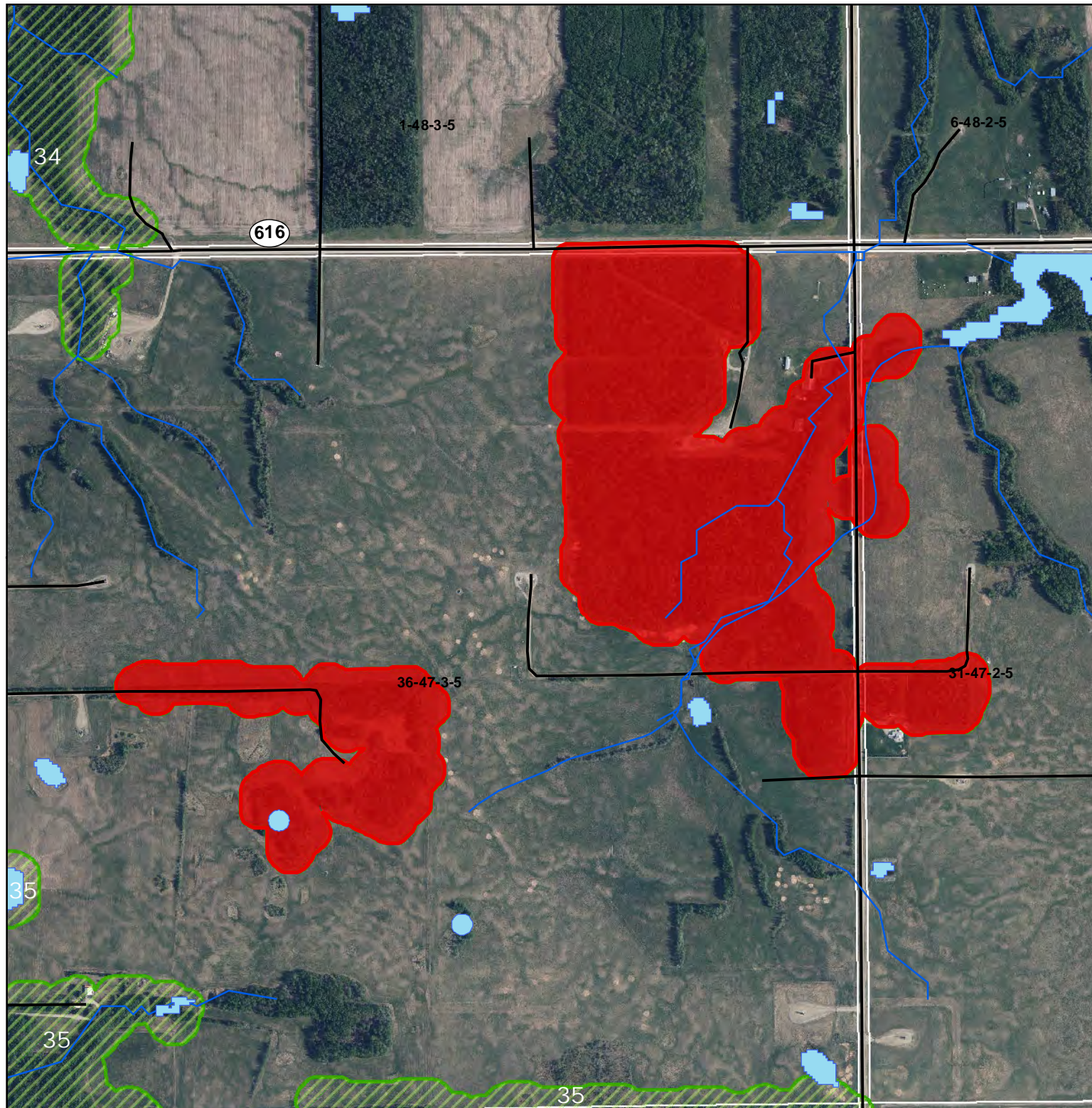
Km
0   3   6   12

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas
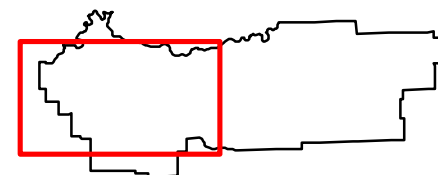
Location of ESA Area
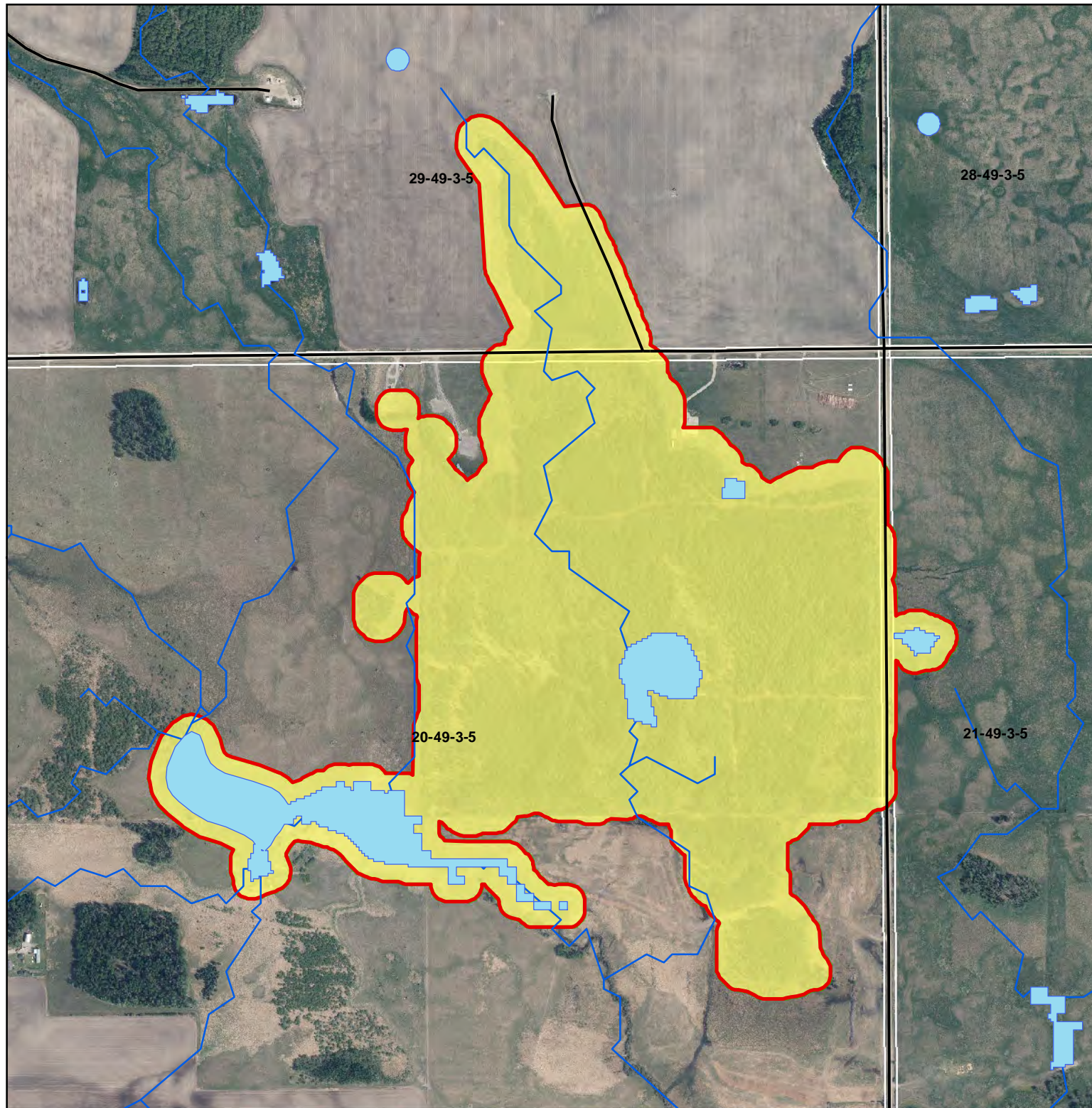
ESA Number: 11

Strawberry Creek Area

ESA Type: Mixed
- Upland : 66.8%
- Aquatic : 19.3%
- Riparian : 24%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
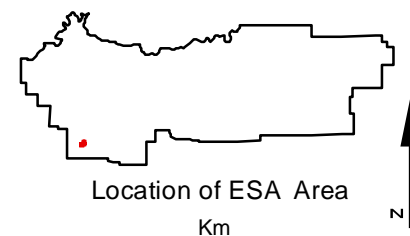- Low : 0%

ESA Area (ha): 88

ESA Score: 52.4/100

Overall ESA Rank: 41/120

Area ESA Rank: 7/ 14

Legend

▭ Highlighted ESA
— Streams and Rivers
▢ Wetlands and Lakes
— Roads
▮ High Risk Area
▮ Medium Risk Area
▮ Low Risk Area
▨ Other ESAs
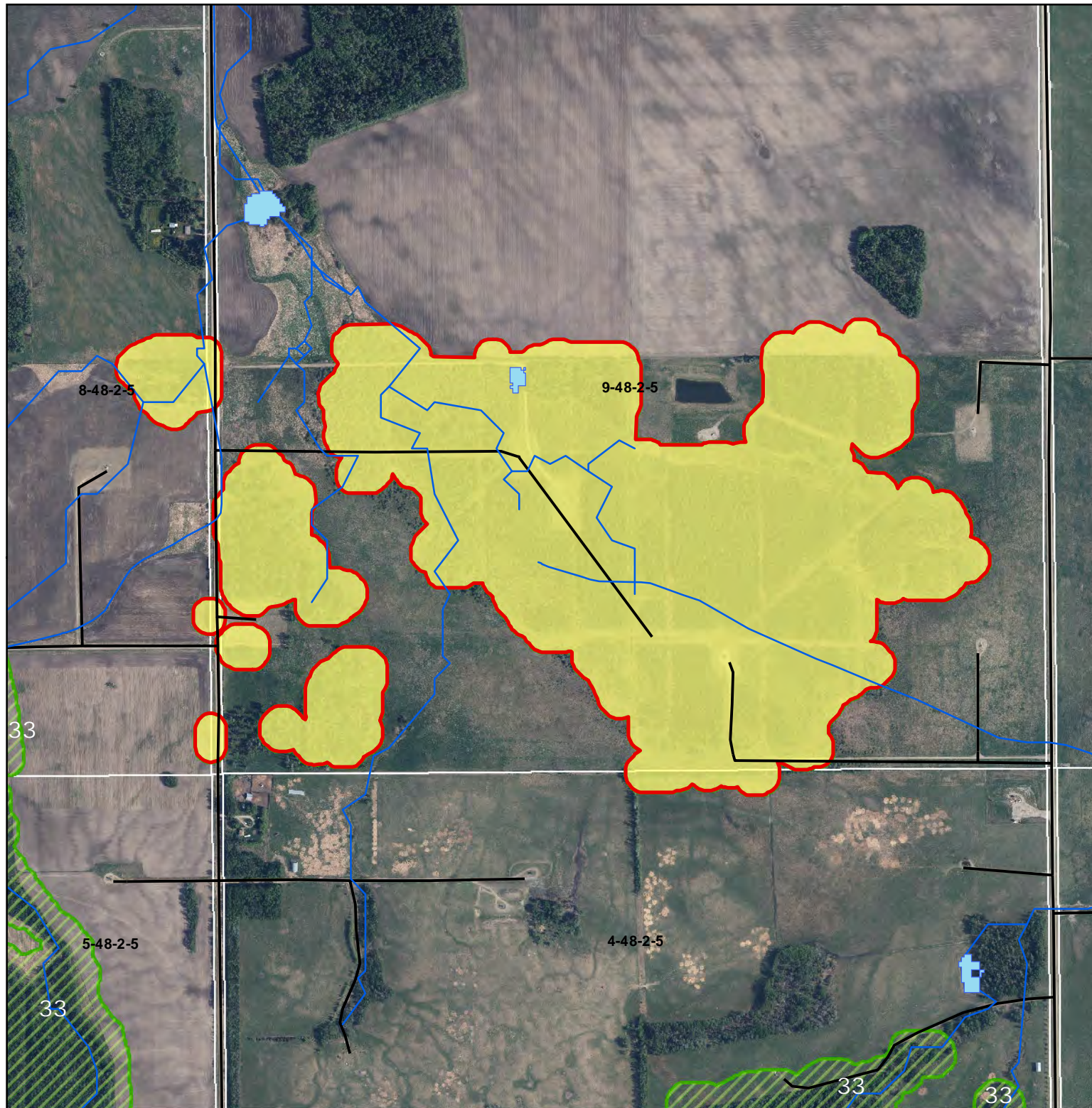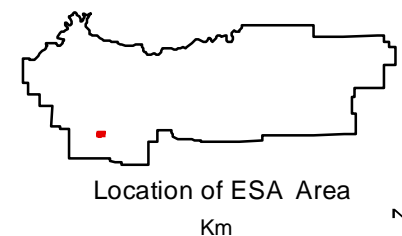
Location of ESA Area

Km

0   0.1   0.2   0.4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

29-49-3-5

28-49-3-5

20-49-3-5

21-49-3-5
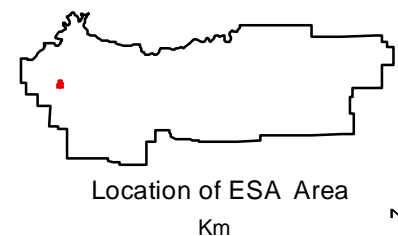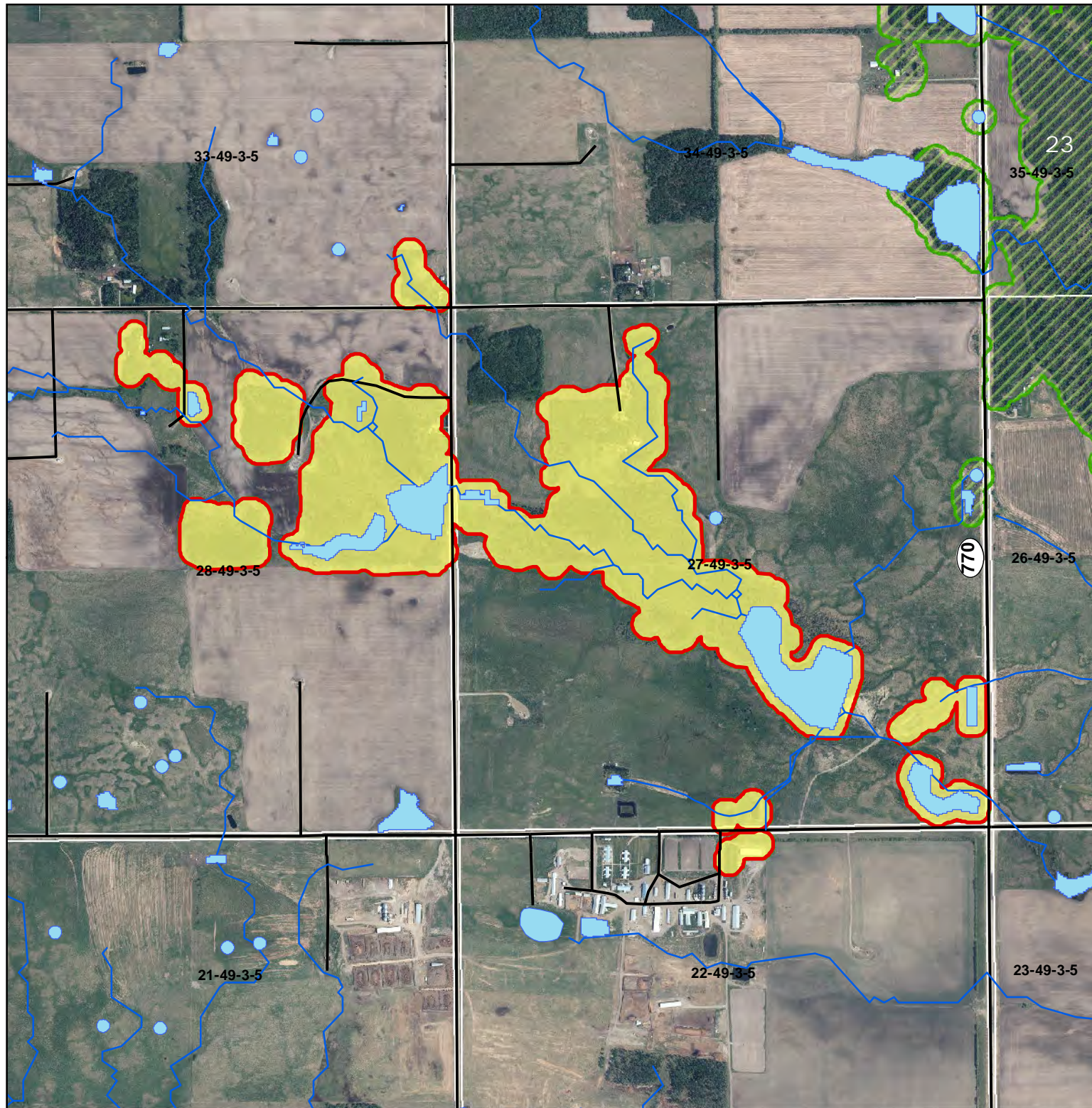
ESA Number: 12

Strawberry Creek Area

ESA Type: Riparian
- Upland : 49.7%
- Aquatic : 26.6%
- Riparian : 37.1%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 105

ESA Score: 45.7/100

Overall ESA Rank: 54/120

Area ESA Rank: 10/ 14

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- � Wetlands and Lakes
- — Roads
- ▮ High Risk Area
- ▮ Medium Risk Area
- ▮ Low Risk Area
- ▨ Other ESAs
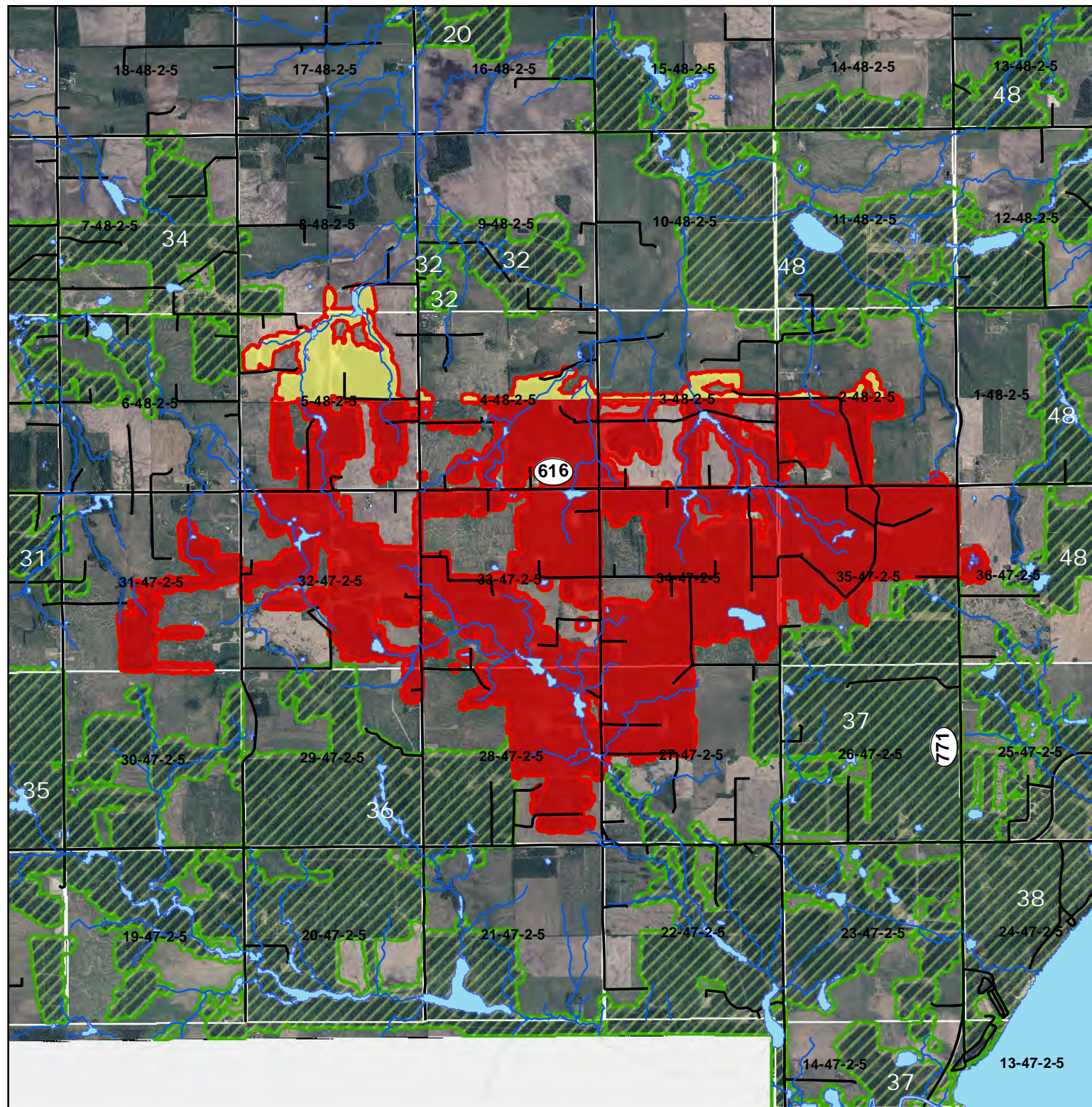
Location of ESA Area

Km

0   0.2   0.4   0.8

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-12
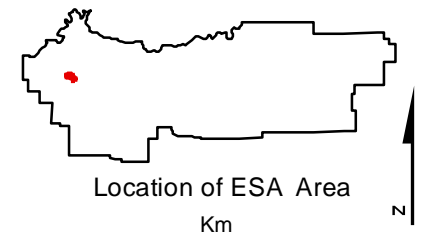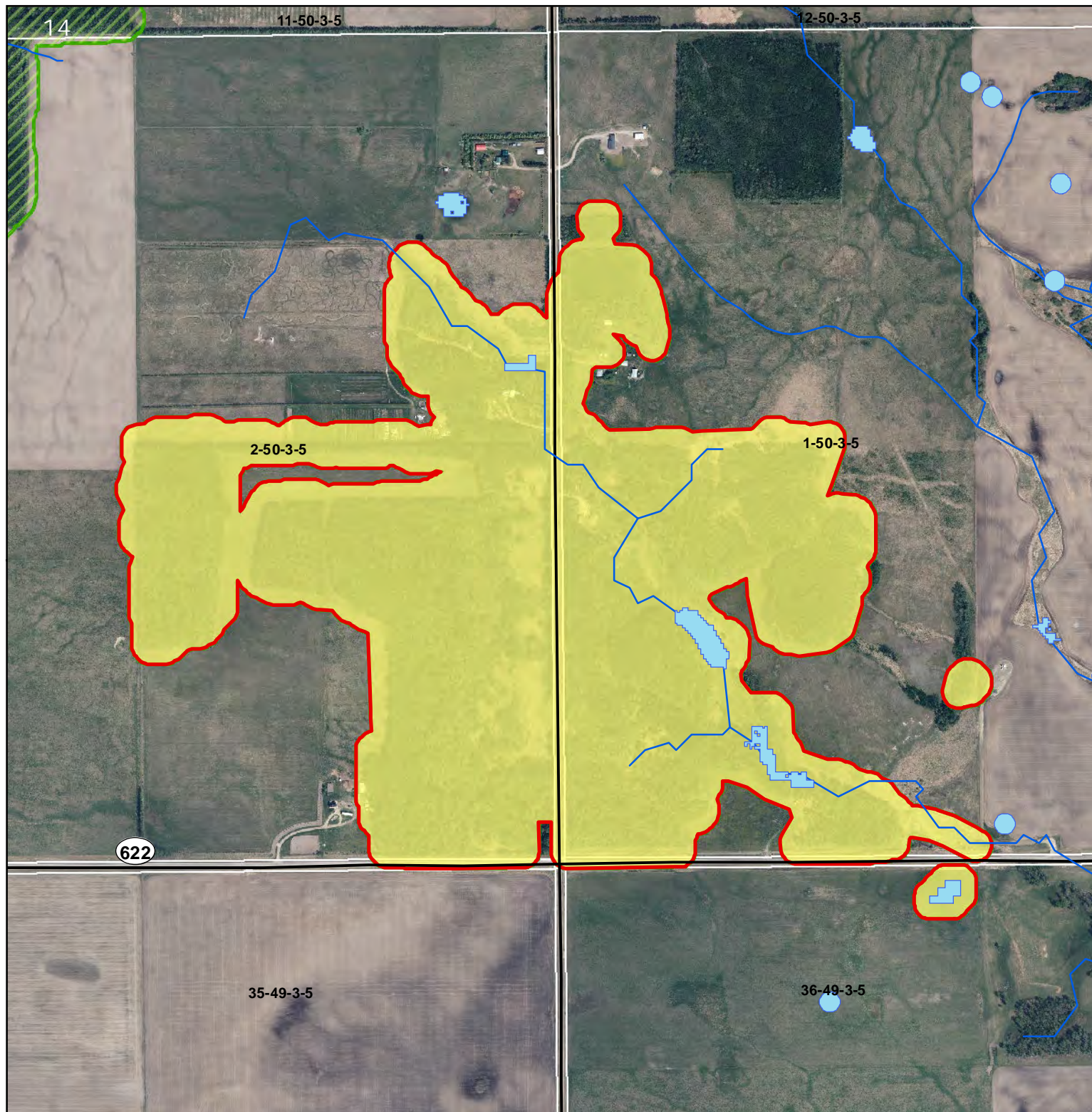
ESA Number: 13

Strawberry Creek Area

ESA Type: Upland
- Upland : 85.4%
- Aquatic : 5.4%
- Riparian : 12.2%

Disturbance Risk: Medium
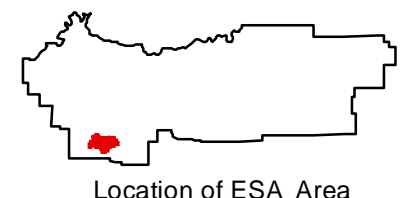- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 112

ESA Score: 42.8/100

Overall ESA Rank: 64/120
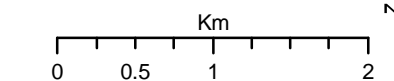
Area ESA Rank: 11/ 14

Legend

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
Low Risk Area
Other ESAs

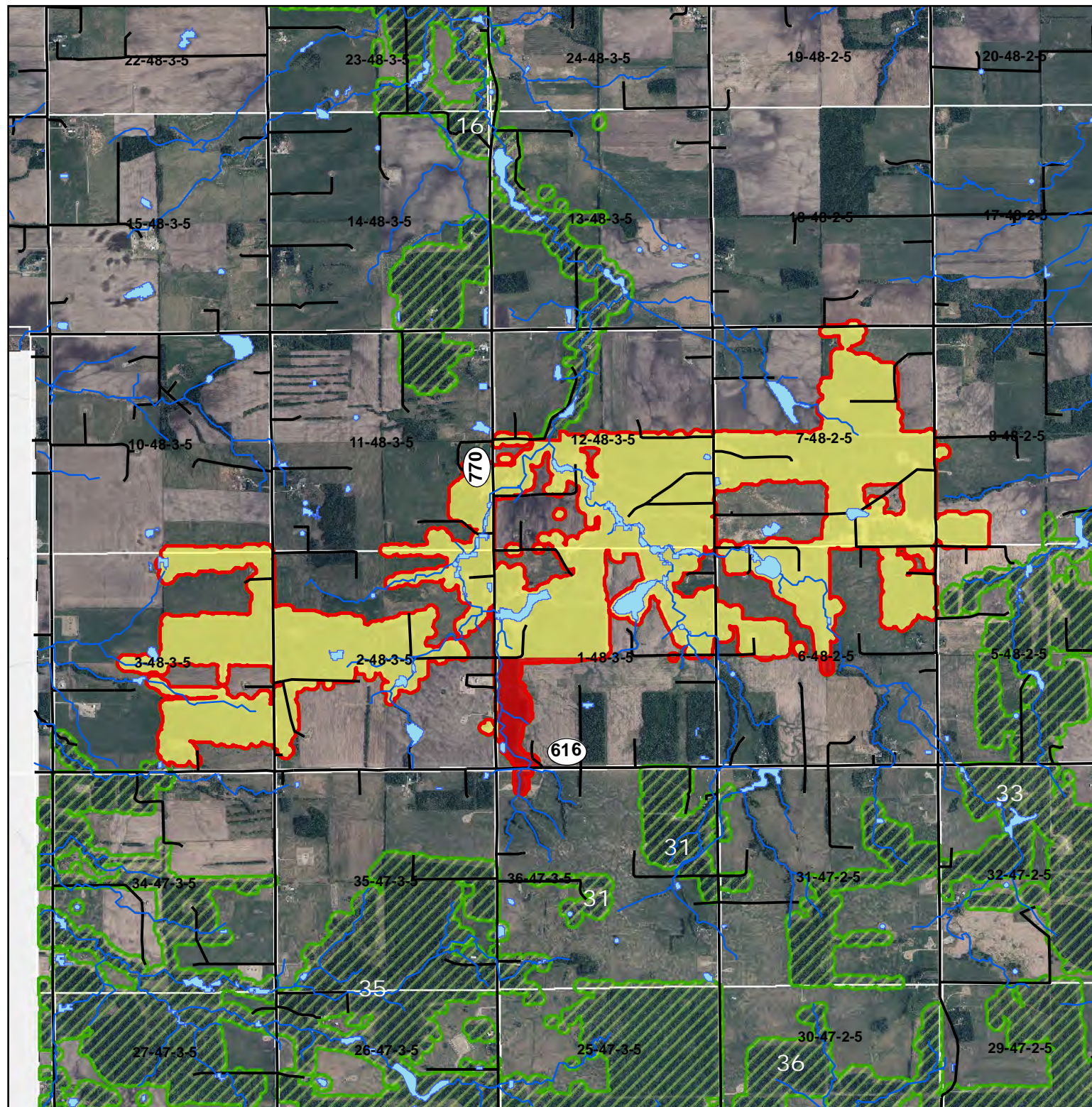Location of ESA Area

Km

0   0.125   0.25   0.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-13
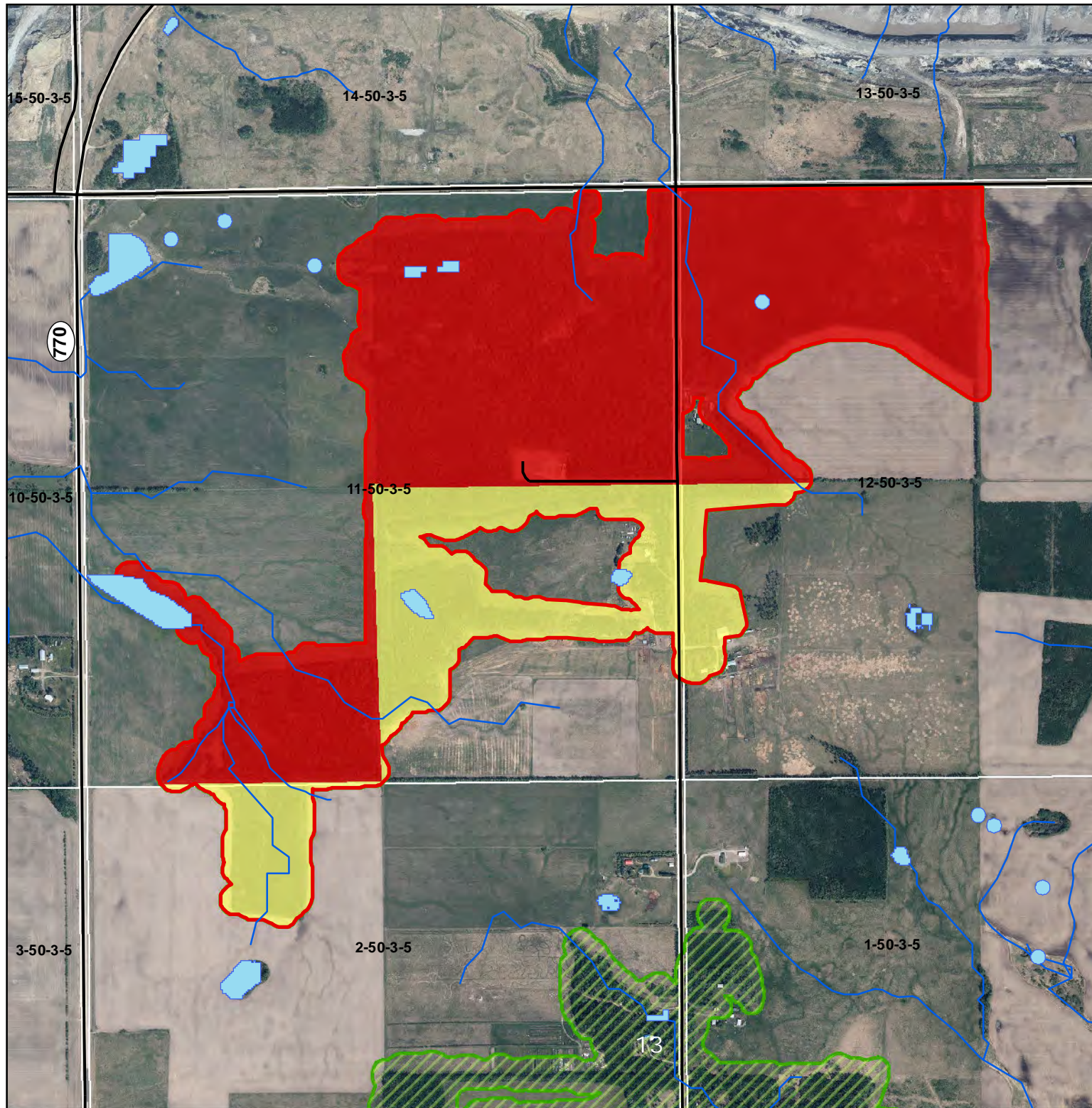
ESA Number: 14

Strawberry Creek Area

ESA Type: Upland
- Upland : 85.1%
- Aquatic : 3.6%
- Riparian : 12%

Disturbance Risk: High
- High : 73.8%
- Moderate : 26.2%
- Low : 0%

ESA Area (ha): 180
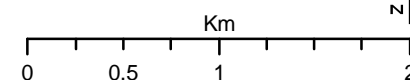
ESA Score: 31.3/100

Overall ESA Rank: 114/120

Area ESA Rank: 14/ 14

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▢ Wetlands and Lakes
- — Roads
- ▮ High Risk Area
- ▮ Medium Risk Area
- ▮ Low Risk Area
- ▨ Other ESAs

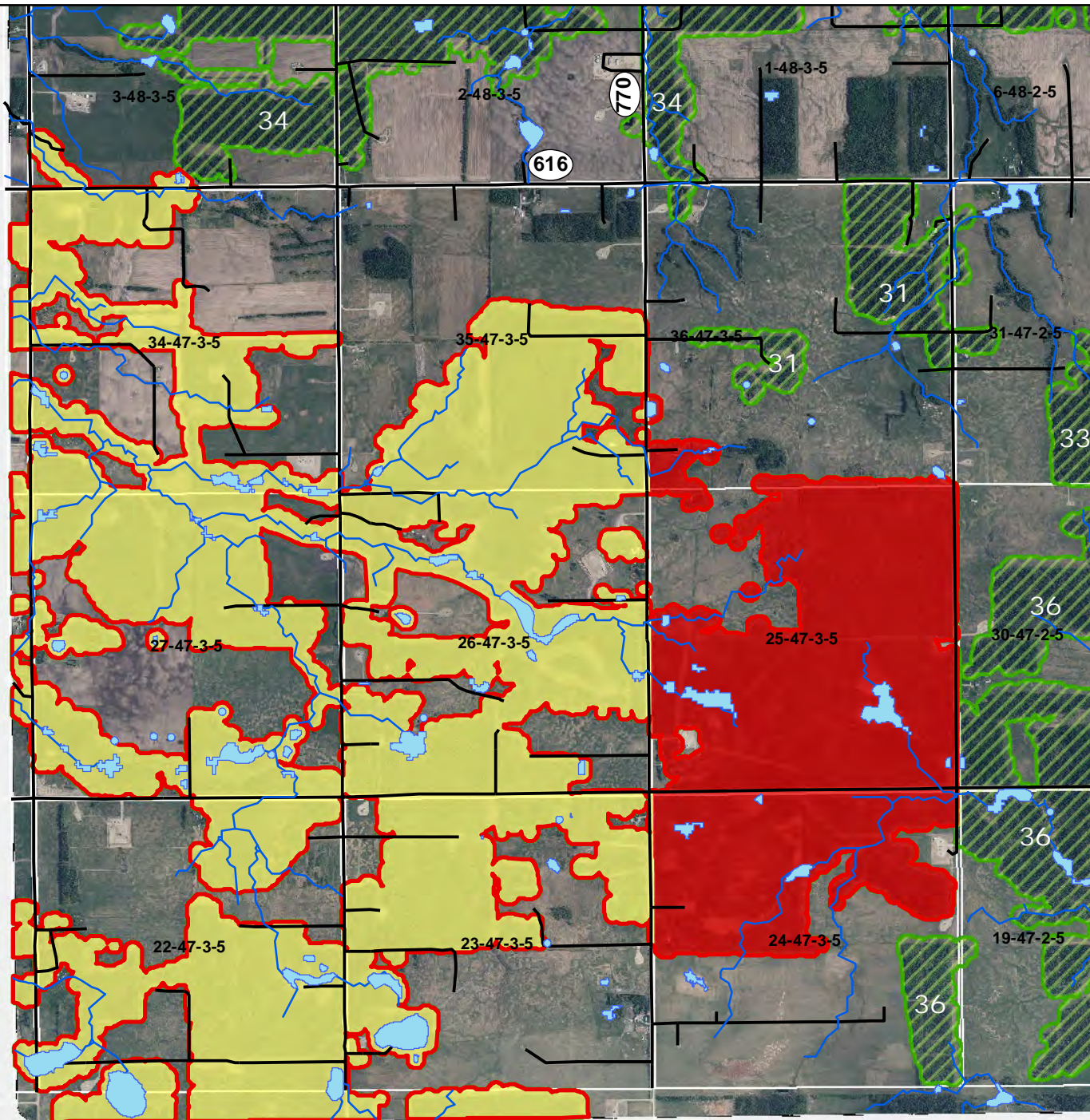Location of ESA Area

Km

0   0.175   0.35   0.7

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-14
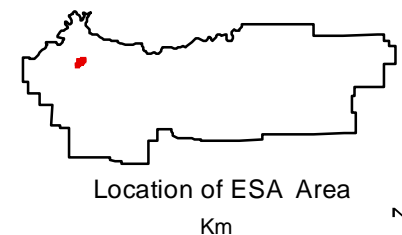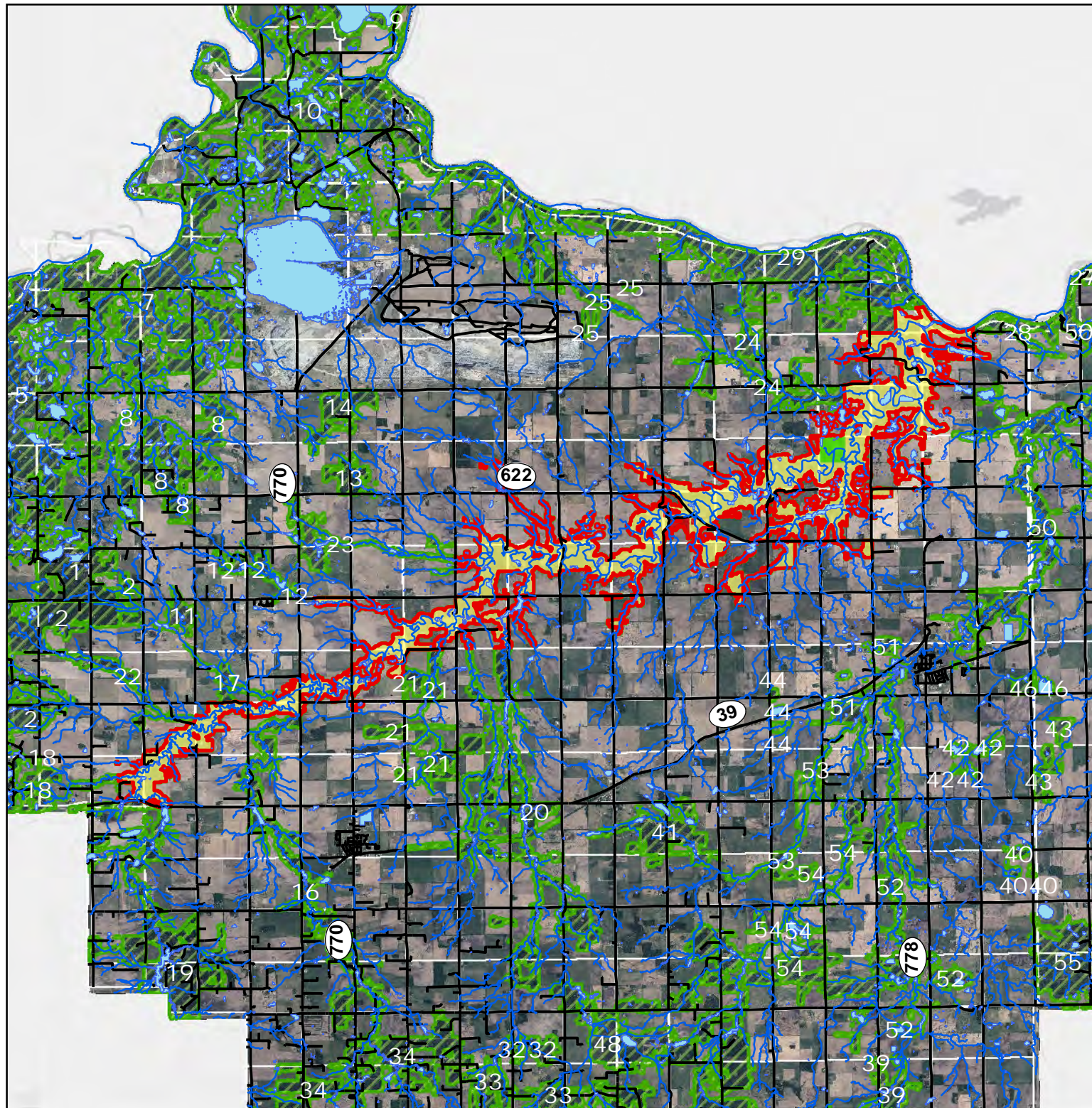
ESA Number: 15

Strawberry Creek Area

ESA Type: Riparian
- Upland : 49.5%
- Aquatic : 10.6%
- Riparian : 44.8%

Disturbance Risk: Medium
- High : 1.7%
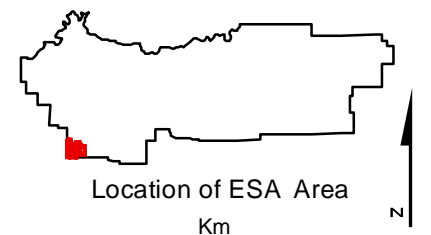- Moderate : 96.7%
- Low : 1.5%

ESA Area (ha): 4309

ESA Score: 71.7/100

Overall ESA Rank: 5/120

Area ESA Rank: 2/ 14

Legend

Highlighted ESA

Streams and Rivers

Wetlands and Lakes

Roads

High Risk Area

Medium Risk Area

Low Risk Area

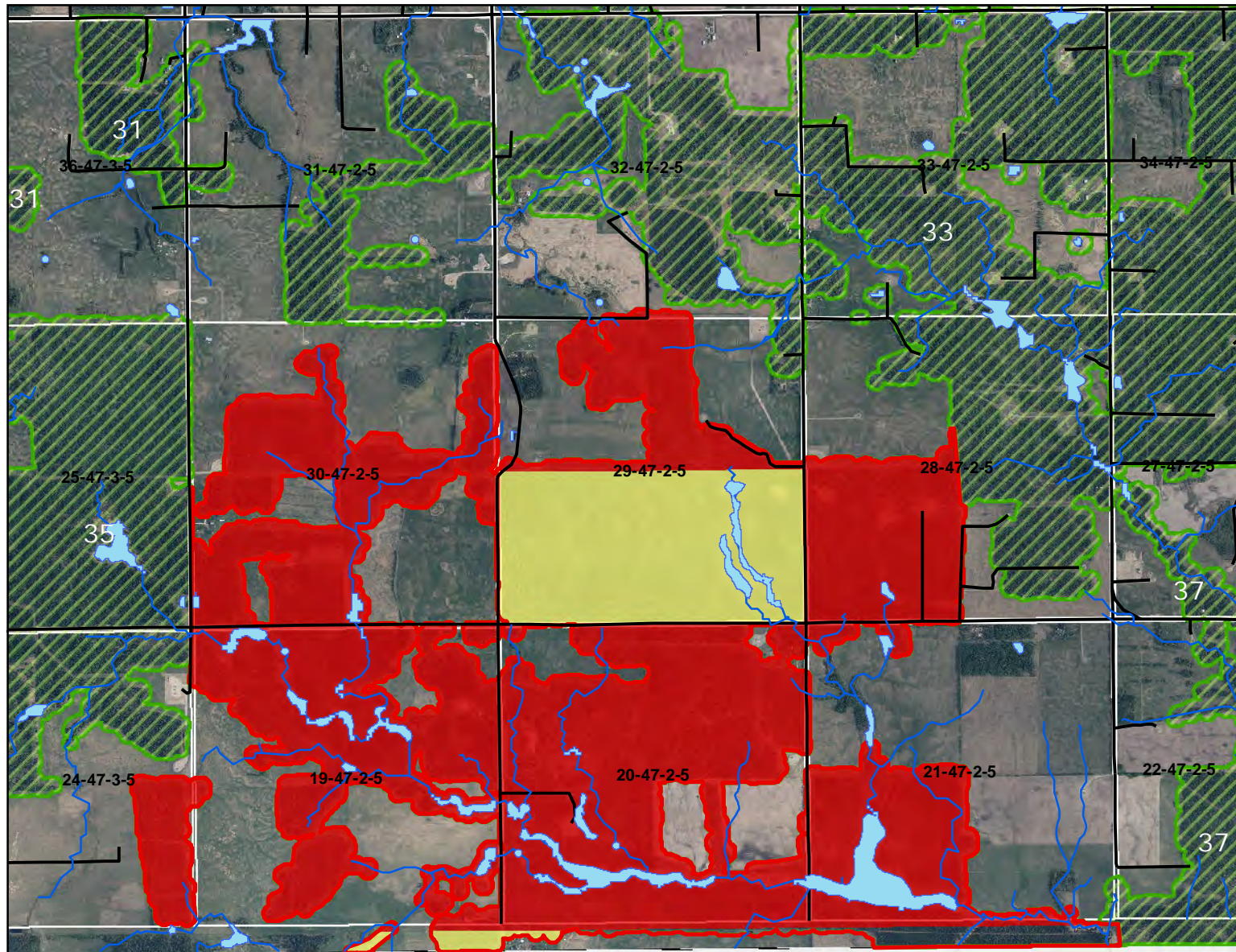Other ESAs

Location of ESA Area

Km

0   2   4   6   8

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-15
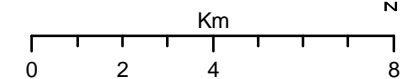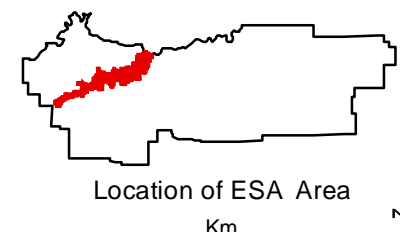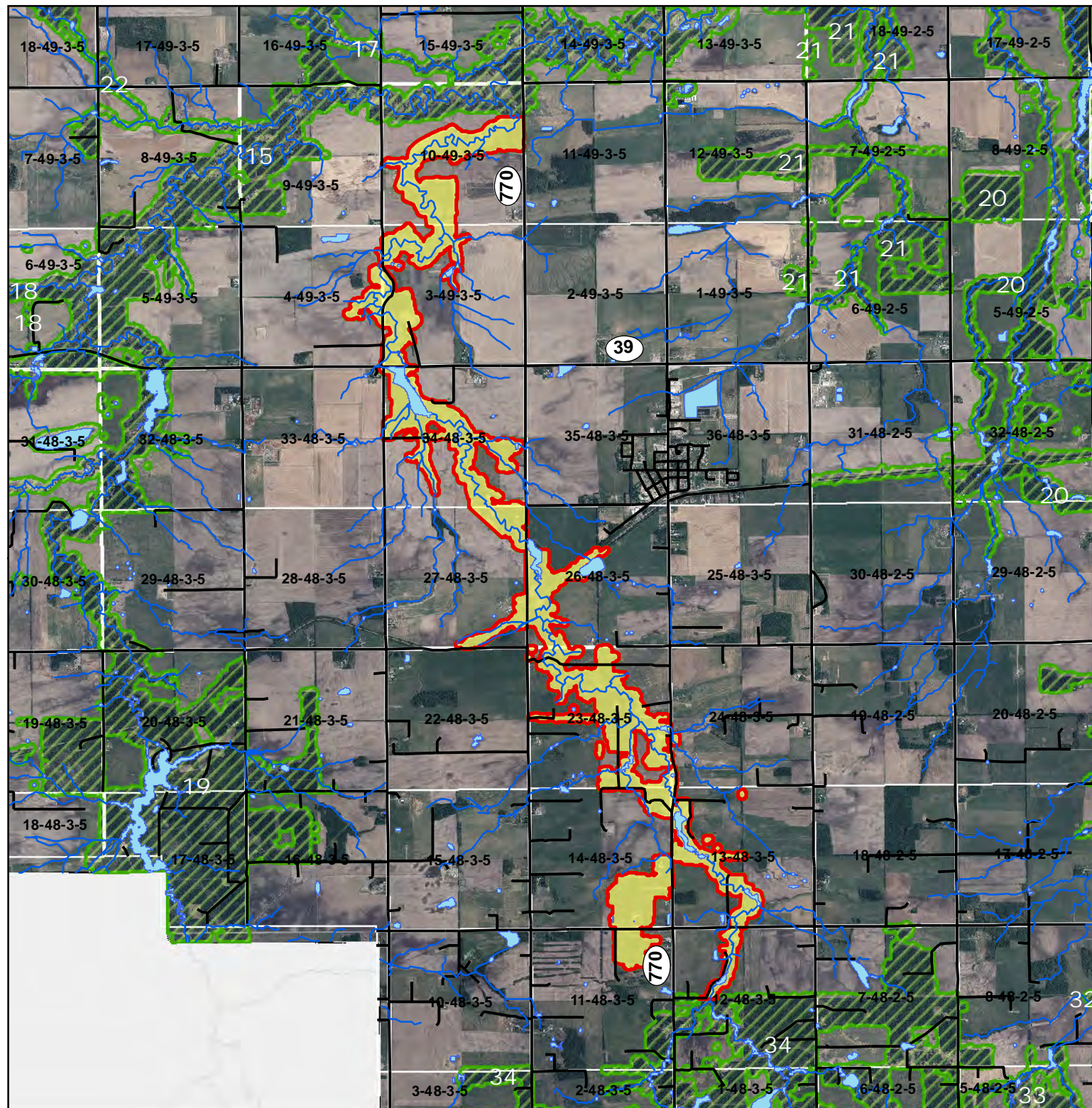
ESA Number: 16

Strawberry Creek Area

ESA Type: Riparian
- Upland : 54.1%
- Aquatic : 8.7%
- Riparian : 43%

Disturbance Risk: Medium
- High : 0.1%
- Moderate : 99.8%
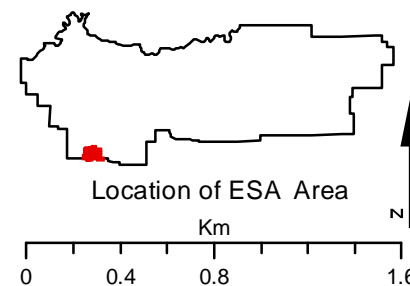- Low : 0%

ESA Area (ha): 604

ESA Score: 46/100

Overall ESA Rank: 53/120

Area ESA Rank: 9/ 14

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▭ Wetlands and Lakes
- — Roads
- ▮ High Risk Area
- ▮ Medium Risk Area
- ▮ Low Risk Area
- ▨ Other ESAs

Location of ESA Area
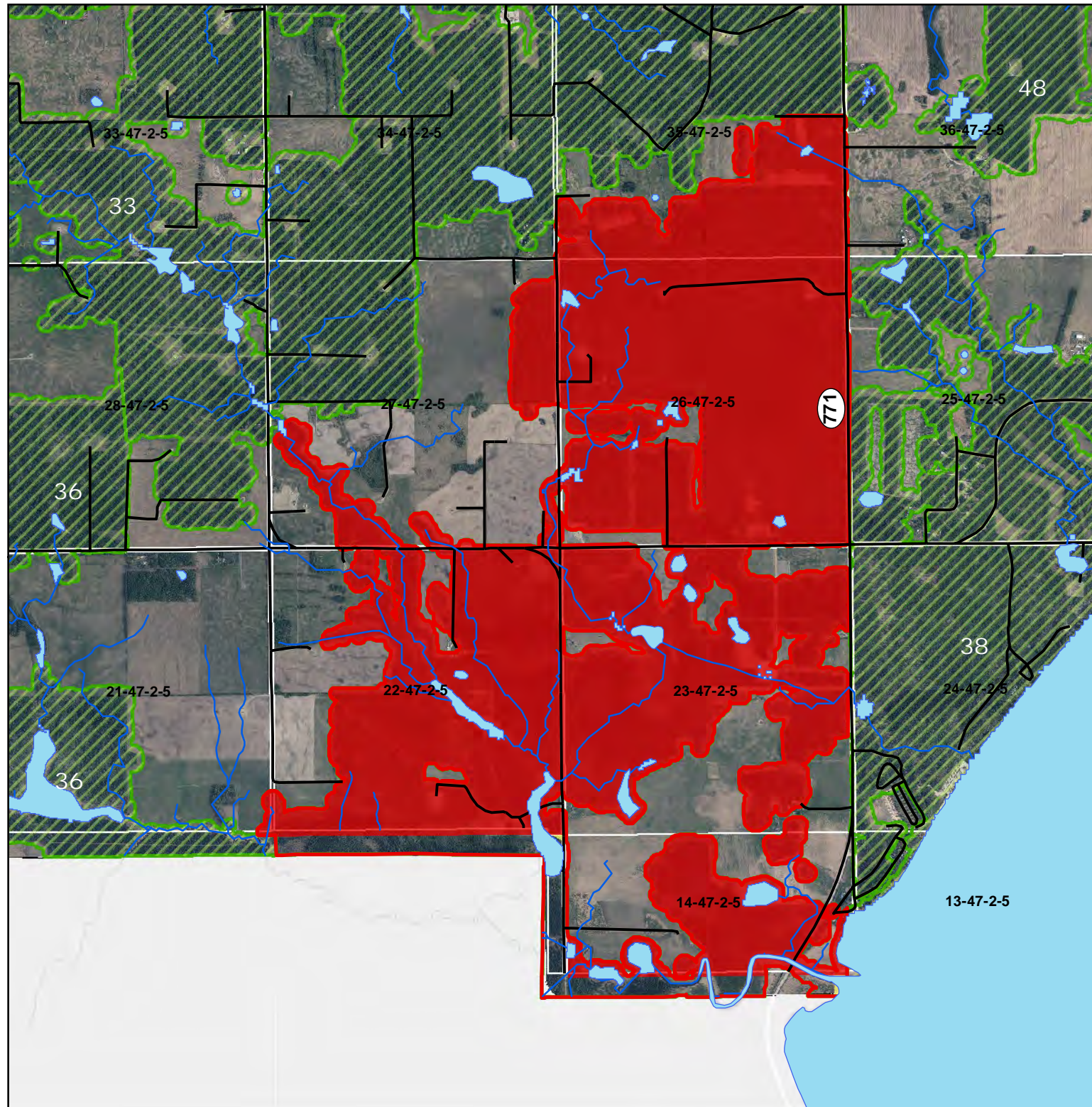
Km

0   0.75   1.5   3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-16
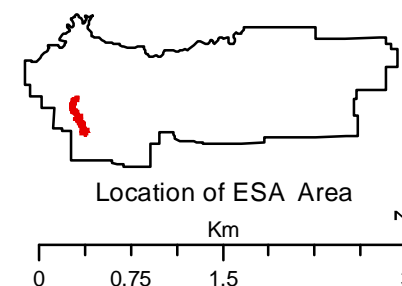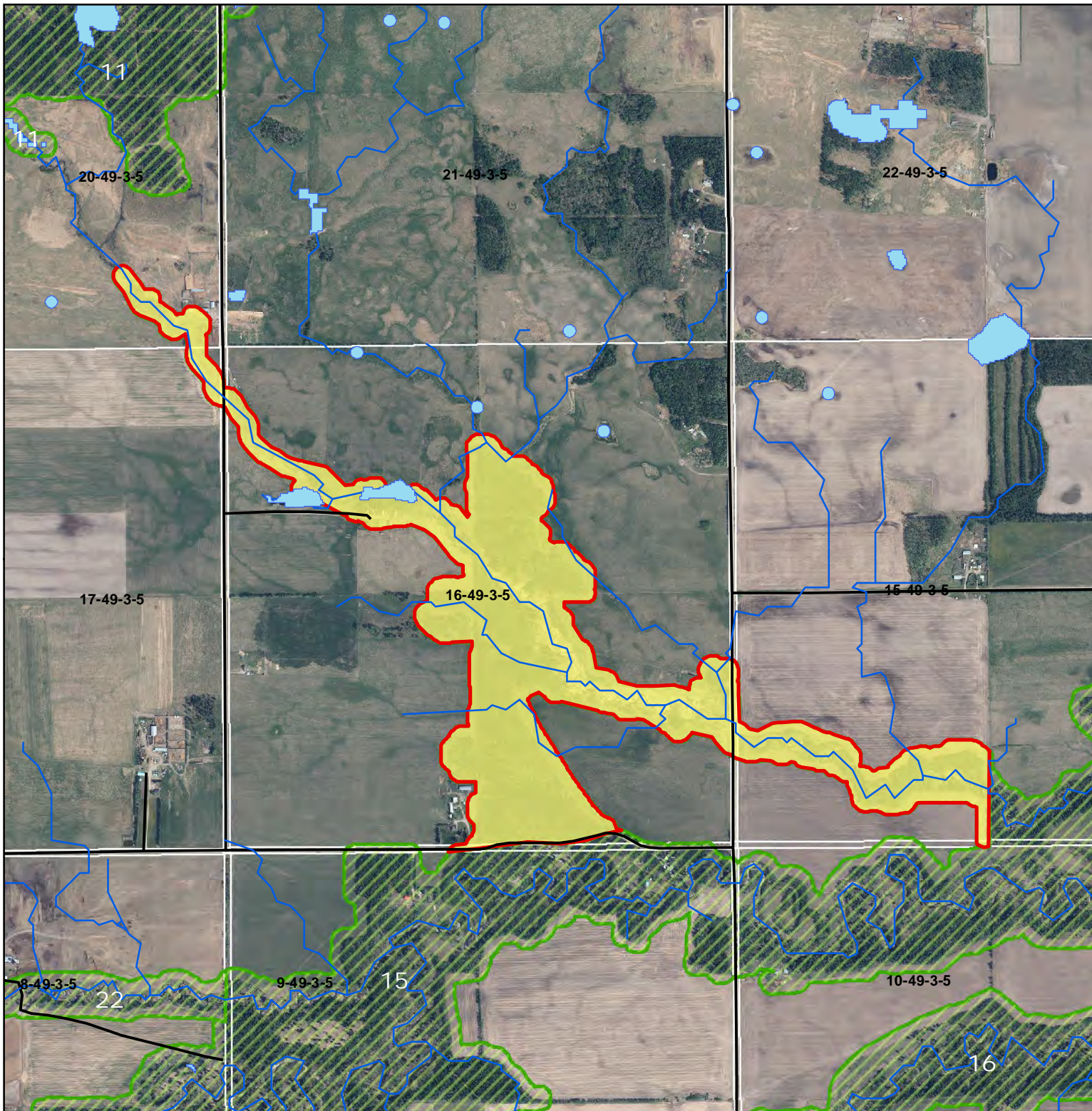
ESA Number: 17

Strawberry Creek Area

ESA Type: Riparian
- Upland : 45.4%
- Aquatic : 3.3%
- Riparian : 54.3%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
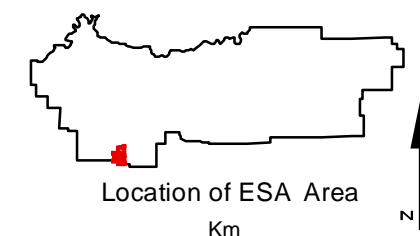- Low : 0%

ESA Area (ha): 82

ESA Score: 33.1/100

Overall ESA Rank: 104/120

Area ESA Rank: 13/ 14

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area

Km

0   0.2   0.4   0.6   0.8

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-17
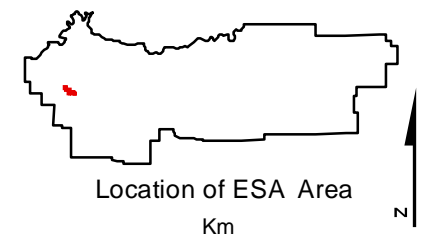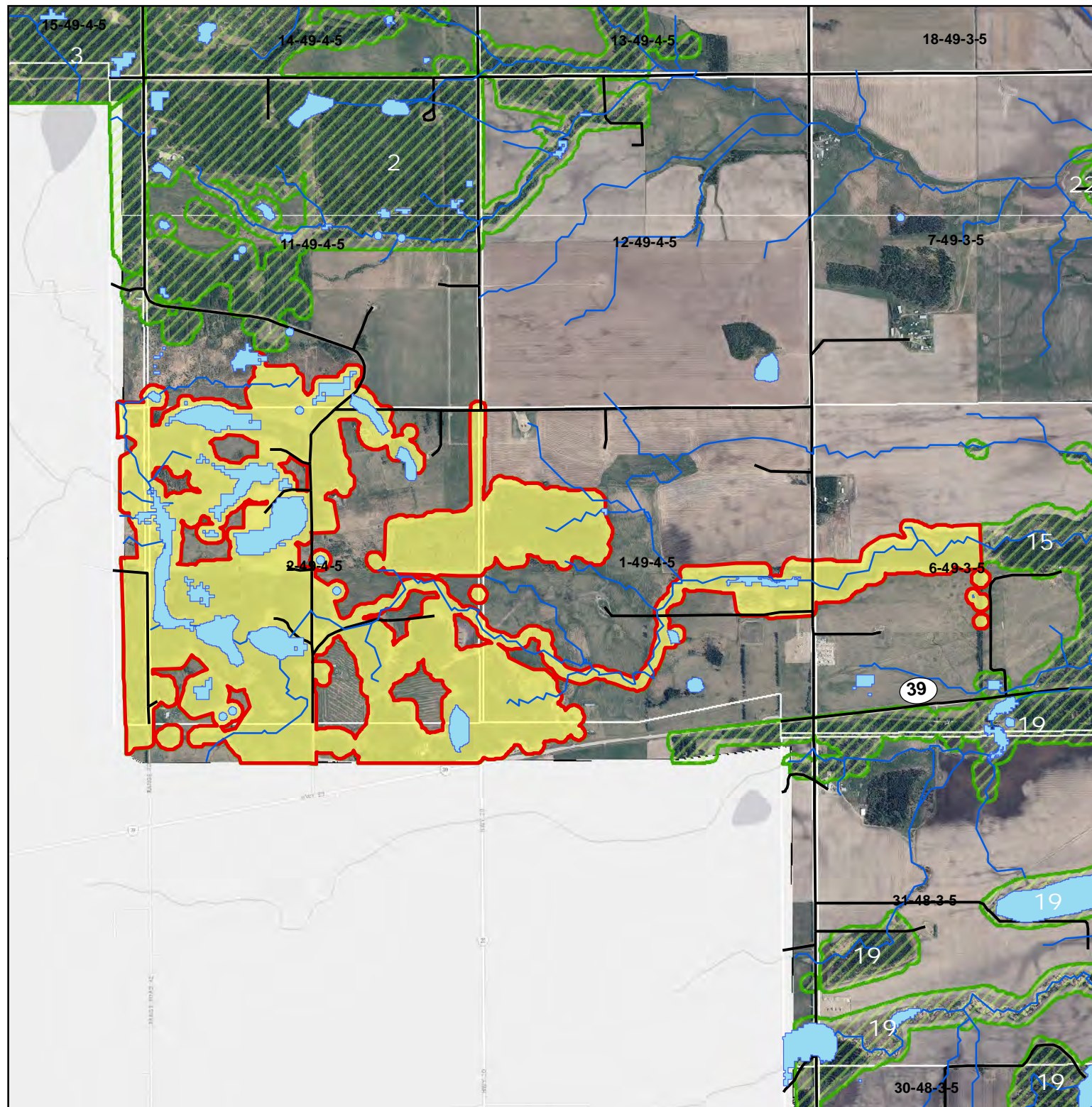
ESA Number: 18

Strawberry Creek Area

ESA Type: Mixed
- Upland : 60.1%
- Aquatic : 23.8%
- Riparian : 22.6%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 325

ESA Score: 65.2/100

Overall ESA Rank: 16/120

Area ESA Rank: 3/ 14

Legend

▭	Highlighted ESA
—	Streams and Rivers
▮	Wetlands and Lakes
—	Roads
▮	High Risk Area
▮	Medium Risk Area
▮	Low Risk Area
▨	Other ESAs

Location of ESA Area
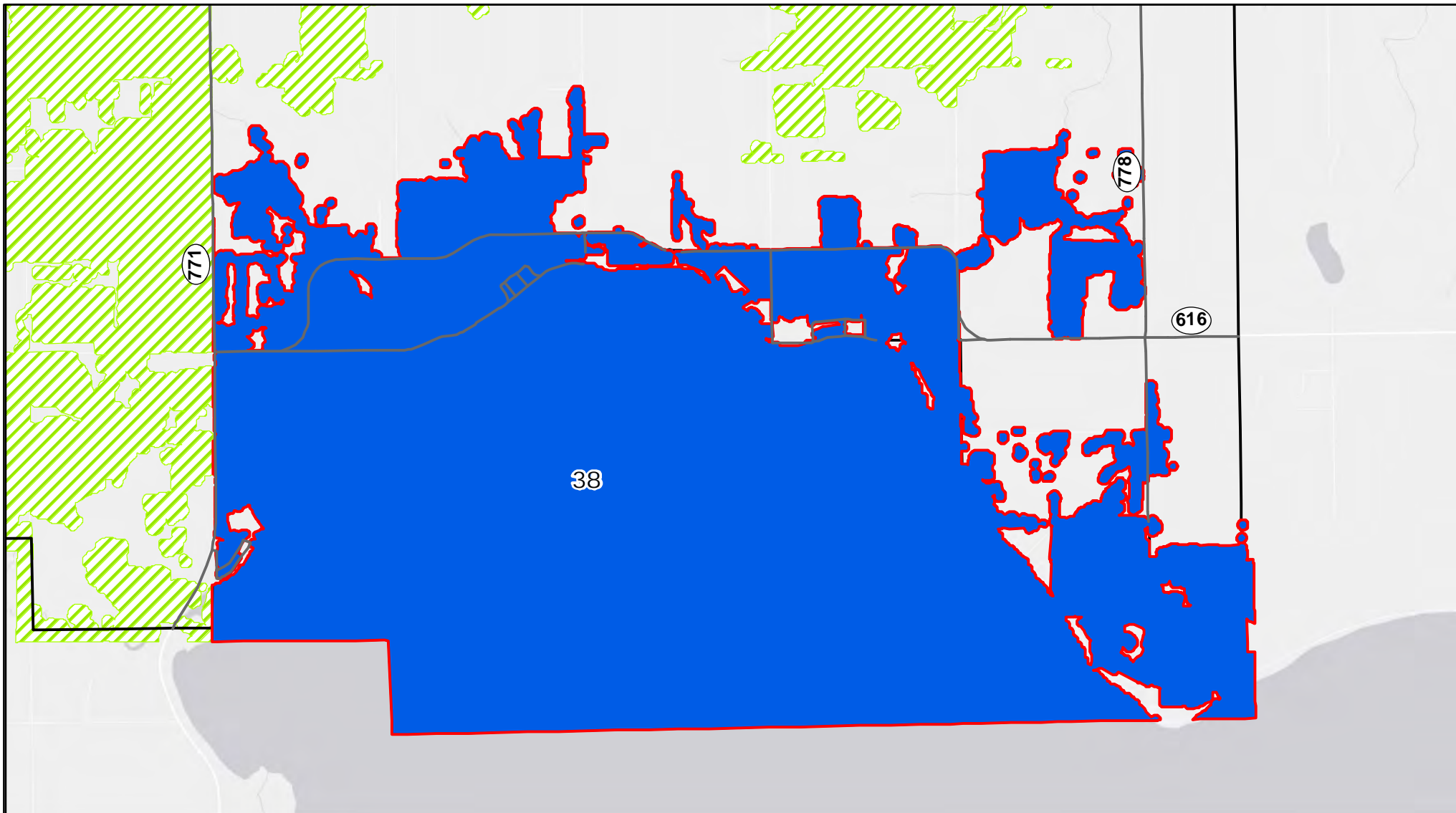
Km

0   0.325   0.65   1.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
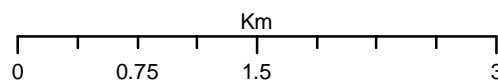Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-18
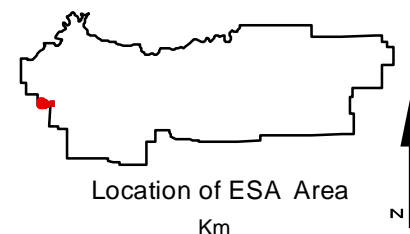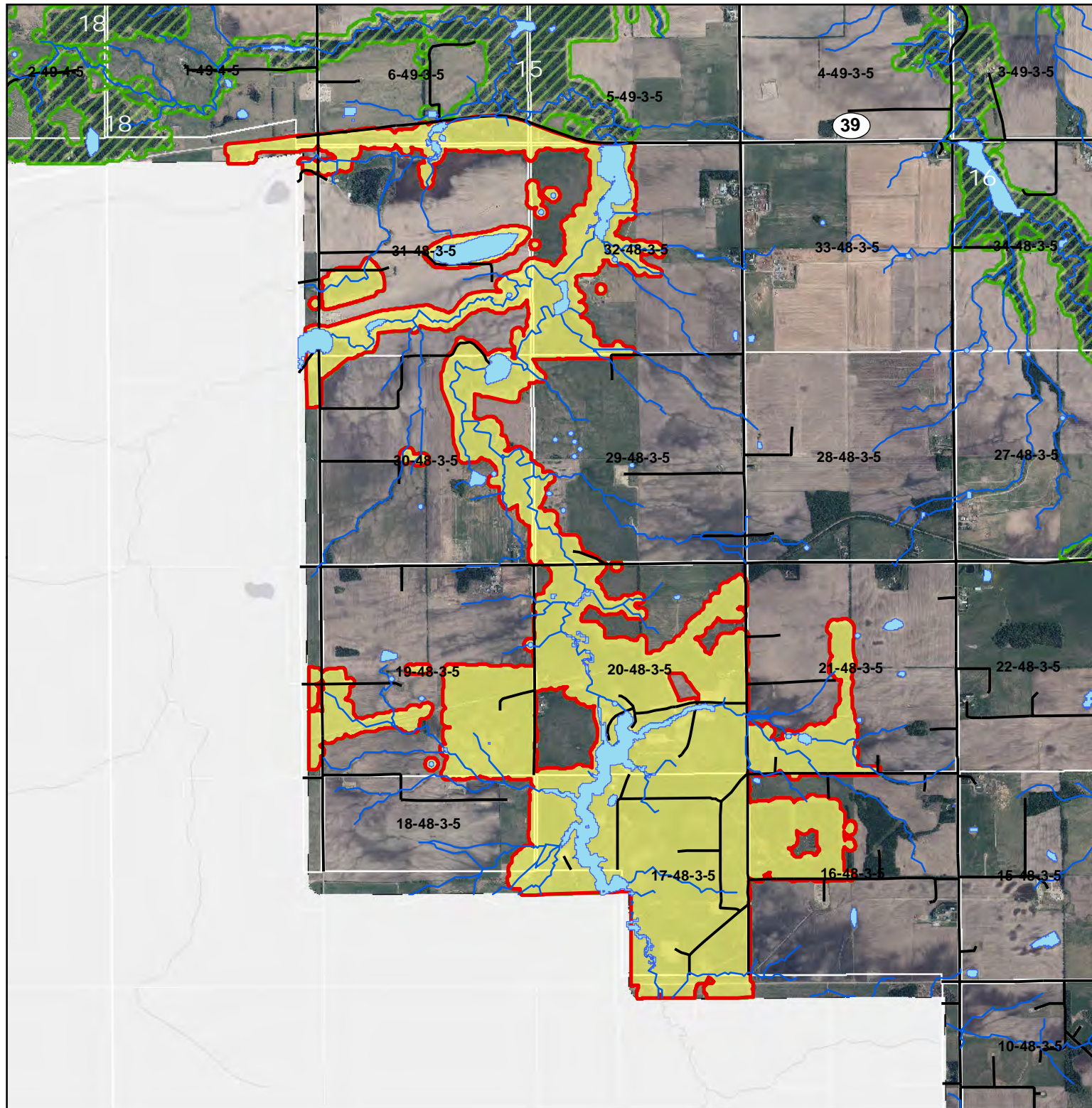
ESA Number: 19

Strawberry Creek Area

ESA Type: Mixed
- Upland : 66.8%
- Aquatic : 15%
- Riparian : 26%

Disturbance Risk: Medium
- High : 0%
- Moderate : 100%
- Low : 0%

ESA Area (ha): 898

ESA Score: 72.4/100

Overall ESA Rank: 4/120

Area ESA Rank: 1/ 14

Legend

☐ Highlighted ESA
— Streams and Rivers
▆ Wetlands and Lakes
— Roads
▆ High Risk Area
▆ Medium Risk Area
▆ Low Risk Area
▨ Other ESAs

Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-19
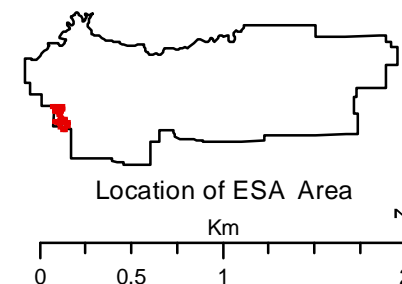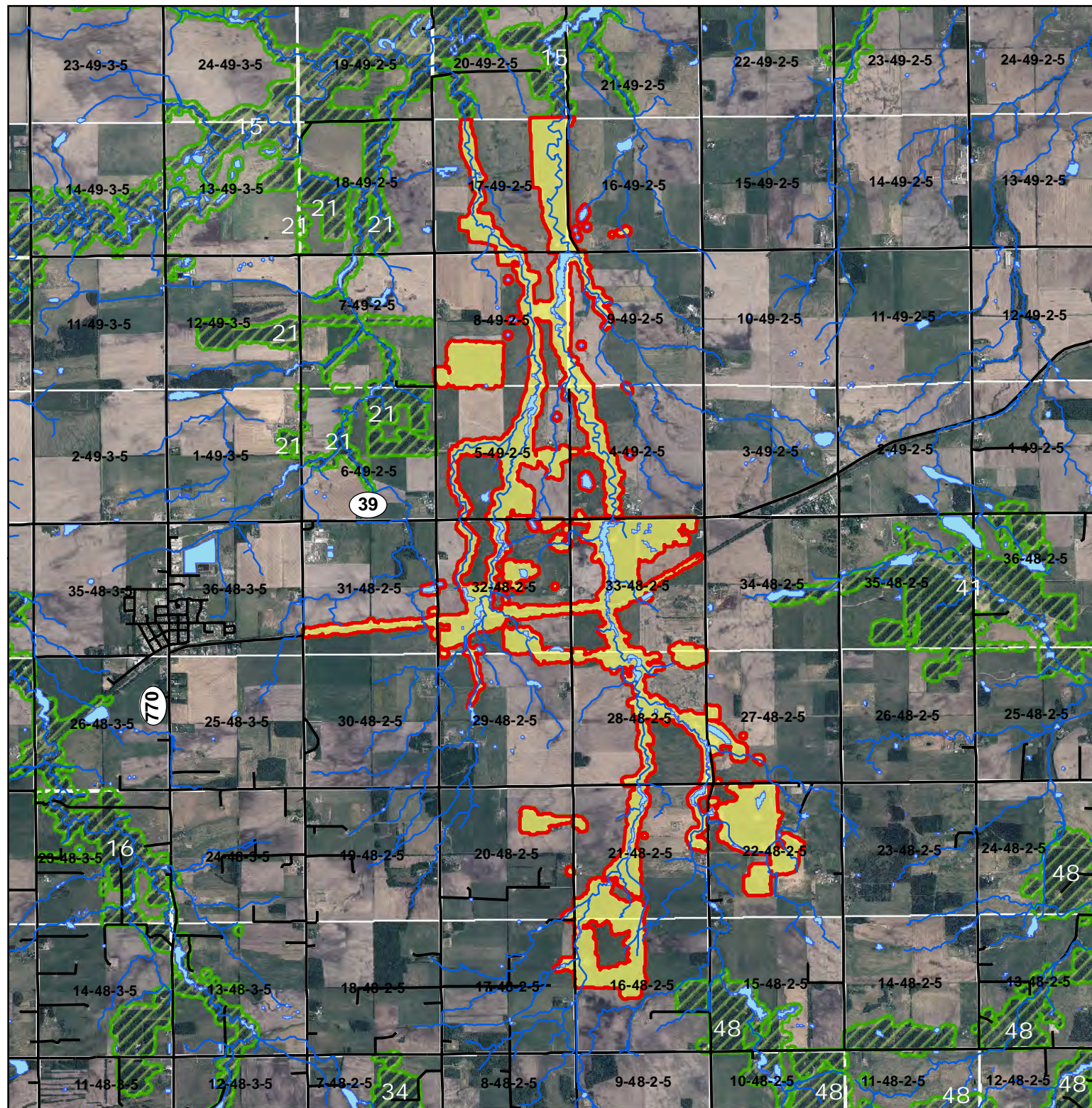
ESA Number: 20

Strawberry Creek Area

ESA Type: Riparian
- Upland : 58.3%
- Aquatic : 15.4%
- Riparian : 35.4%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%
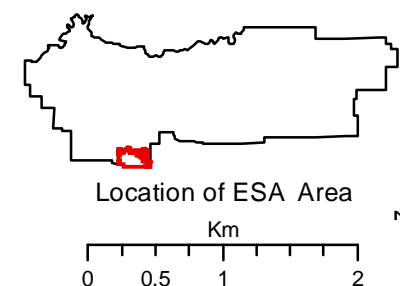
ESA Area (ha): 983

ESA Score: 63/100

Overall ESA Rank: 20/120

Area ESA Rank: 4/ 14

Legend

▭ Highlighted ESA
— Streams and Rivers
▬ Wetlands and Lakes
— Roads
▬ High Risk Area
▬ Medium Risk Area
▬ Low Risk Area
▨ Other ESAs

Location of ESA Area
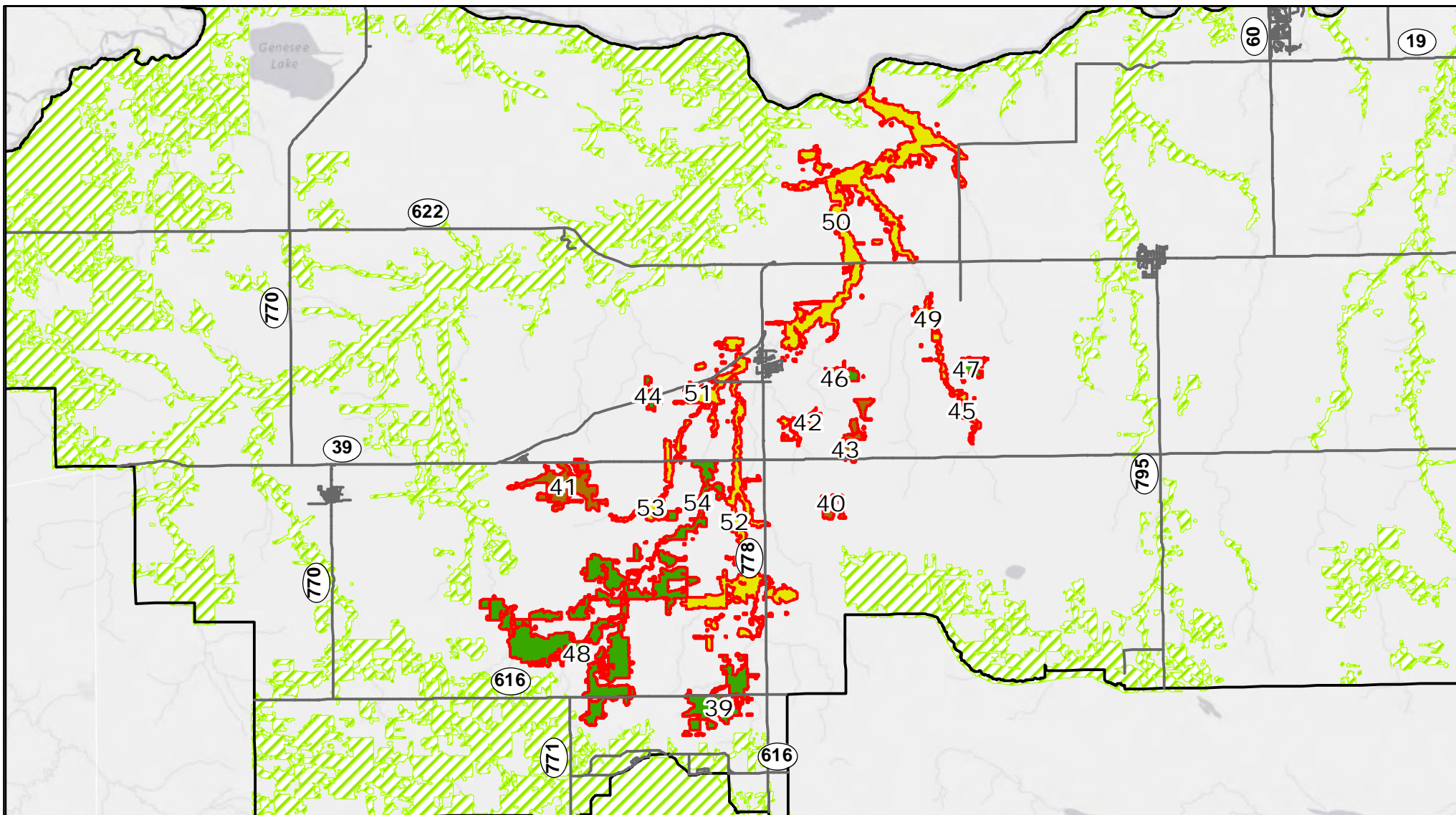
Km

0   0.75   1.5   3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
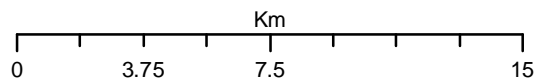Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-20
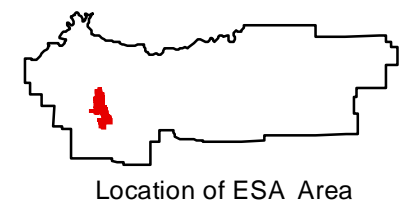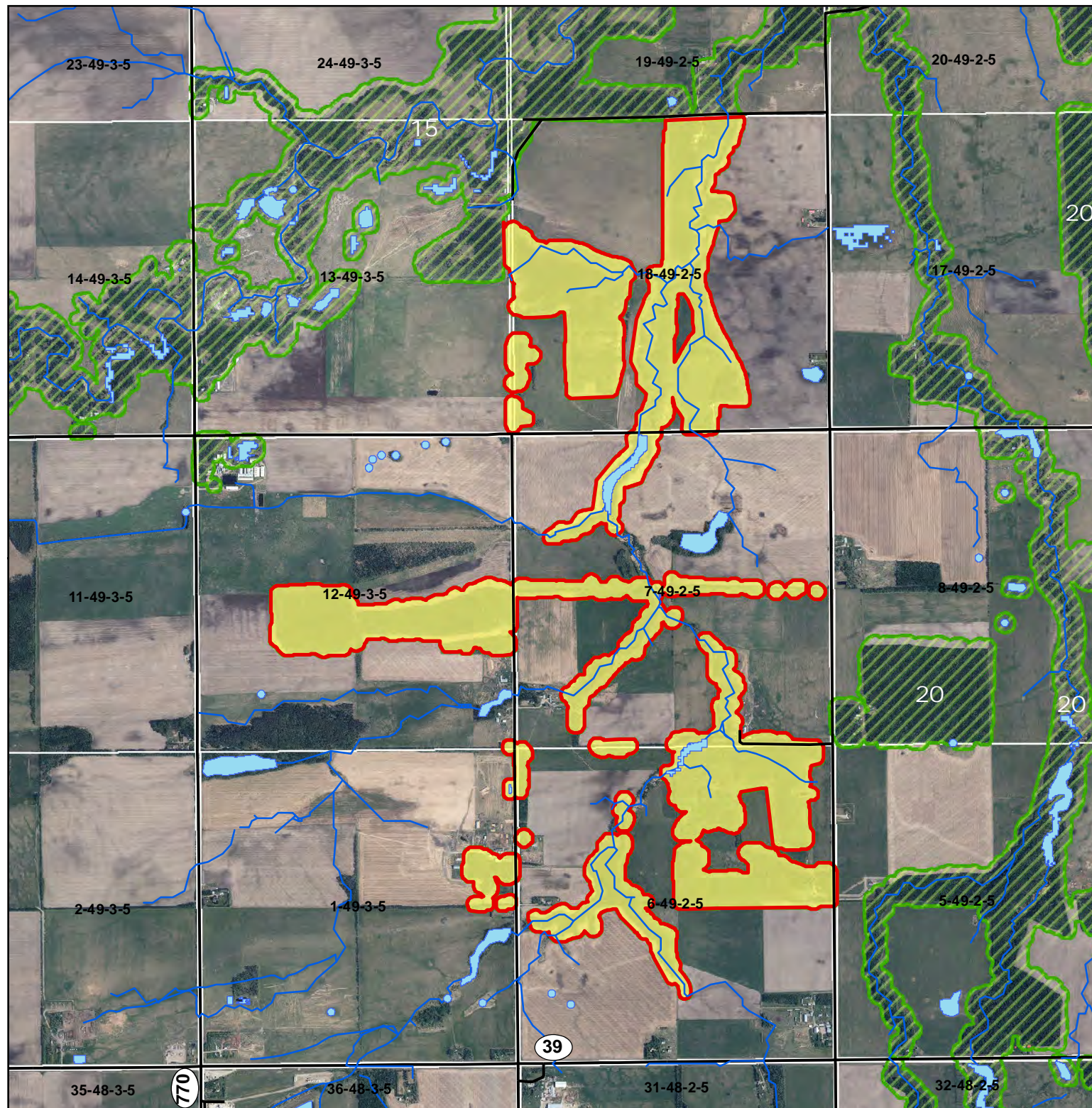
ESA Number: 21

Strawberry Creek Area

ESA Type: Riparian
- Upland : 69.4%
- Aquatic : 3.6%
- Riparian : 30%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 276

ESA Score: 52.7/100

Overall ESA Rank: 39/120

Area ESA Rank: 6/ 14

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area

Km

0   0.325   0.65   1.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-21
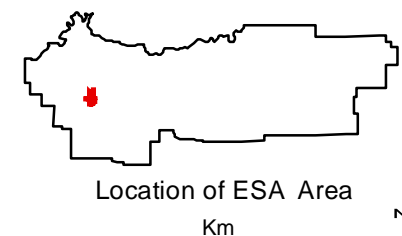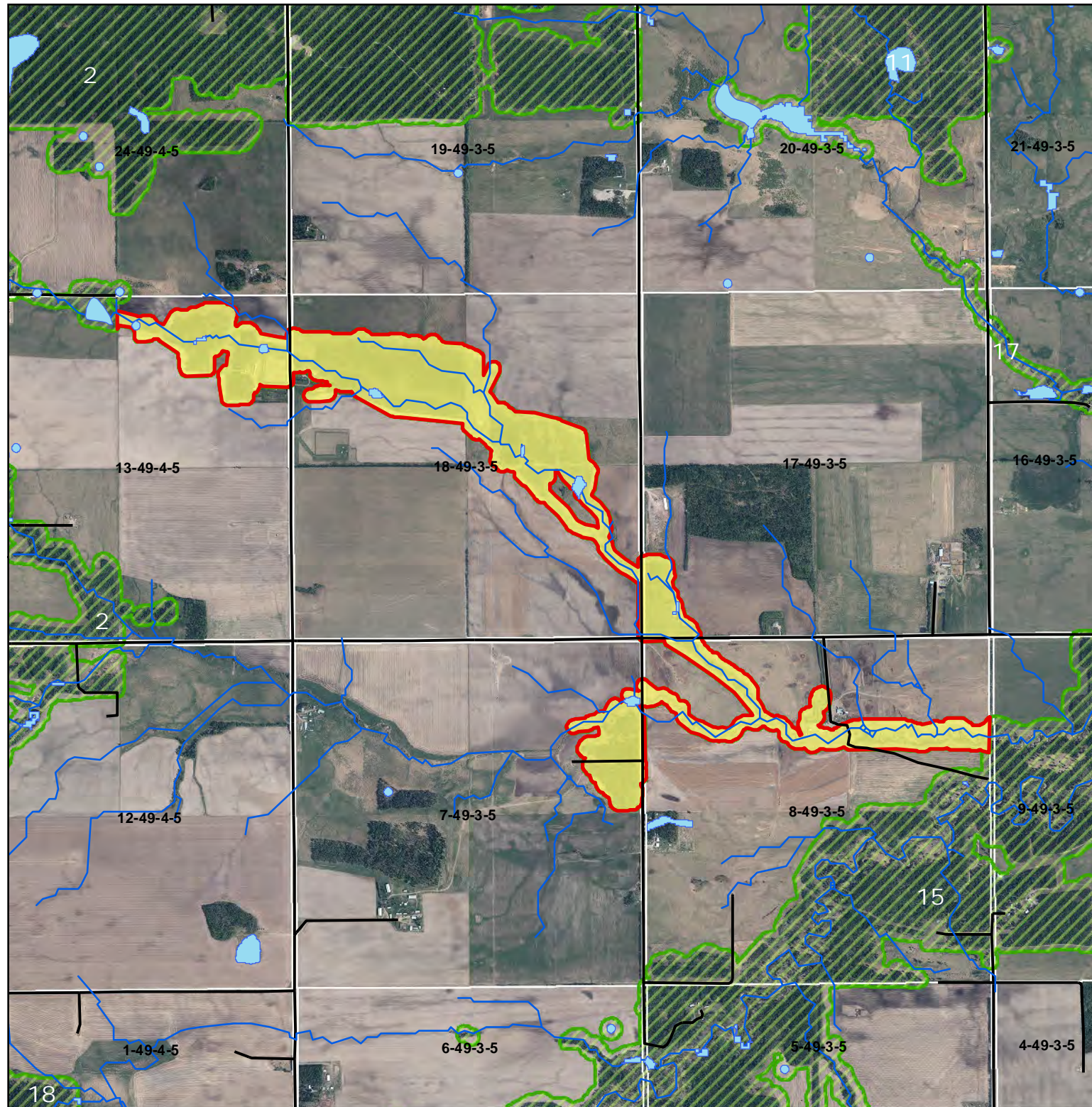
ESA Number: 22

Strawberry Creek Area

ESA Type: Riparian
- Upland : 55.9%
- Aquatic : 6.4%
- Riparian : 42.5%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
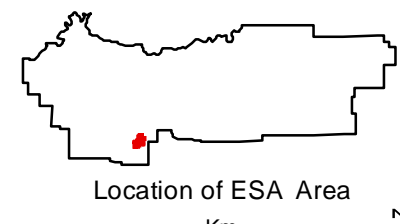- Low : 0%

ESA Area (ha): 118

ESA Score: 34.7/100

Overall ESA Rank: 90/120

Area ESA Rank: 12/ 14

Legend

▢ Highlighted ESA
— Streams and Rivers
▢ Wetlands and Lakes
— Roads
▢ High Risk Area
▢ Medium Risk Area
▢ Low Risk Area
▨ Other ESAs

Location of ESA Area
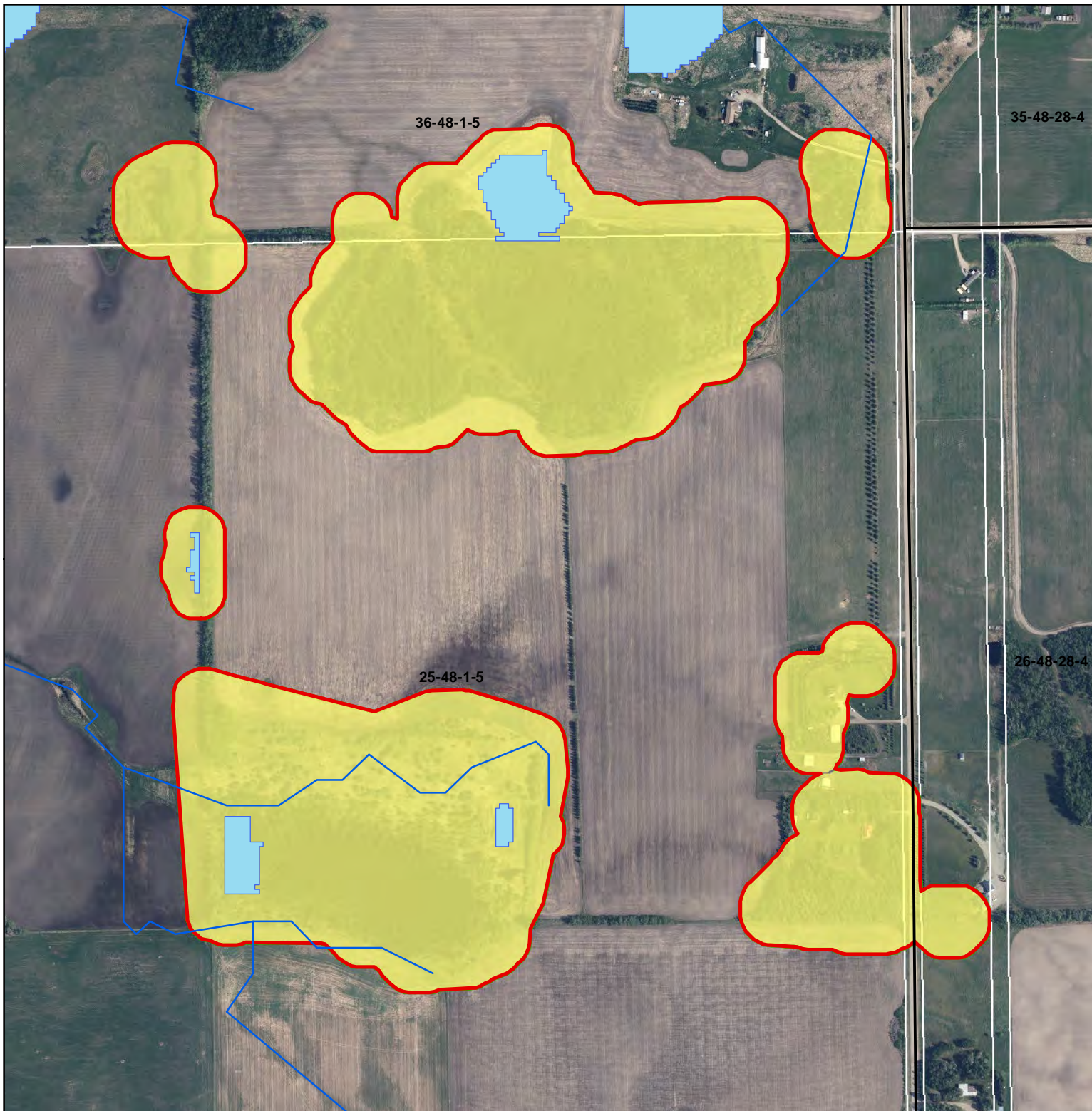
Km

0   0.3   0.6   1.2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-22
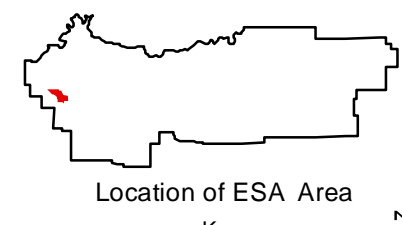
ESA Number: 23

Strawberry Creek Area

ESA Type: Mixed
- Upland : 58.8%
- Aquatic : 20.4%
- Riparian : 29.4%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 230

ESA Score: 49.7/100

Overall ESA Rank: 44/120

Area ESA Rank: 8/ 14

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▮ Wetlands and Lakes
- — Roads
- ▮ High Risk Area
- ▮ Medium Risk Area
- ▮ Low Risk Area
- ▨ Other ESAs

Location of ESA Area

Km

0   0.4   0.8   1.6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-23

ESA Number: 24

Strawberry Creek Area

ESA Type: Riparian
- Upland : 63.1%
- Aquatic : 10.2%
- Riparian : 32.7%

Disturbance Risk: Medium
- High : 0%
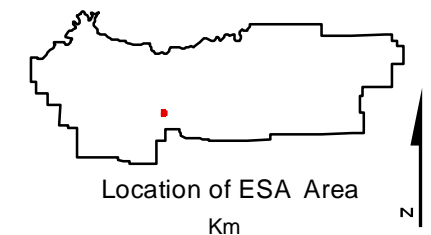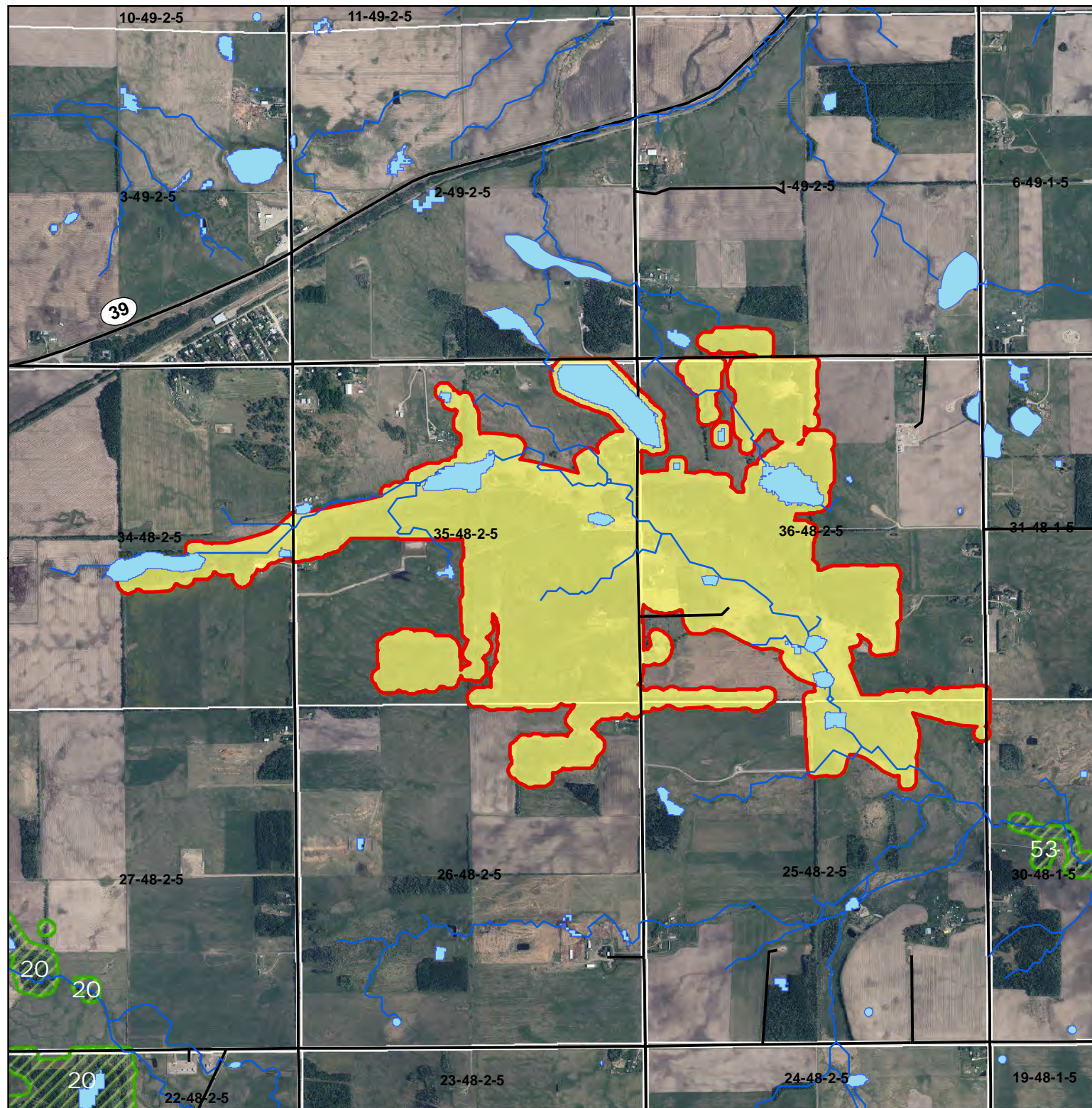- Moderate : 99.9%
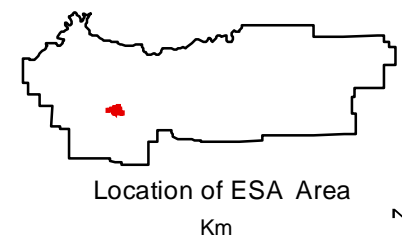- Low : 0%

ESA Area (ha): 334

ESA Score: 52.9/100

Overall ESA Rank: 38/120

Area ESA Rank: 5/ 14

Legend

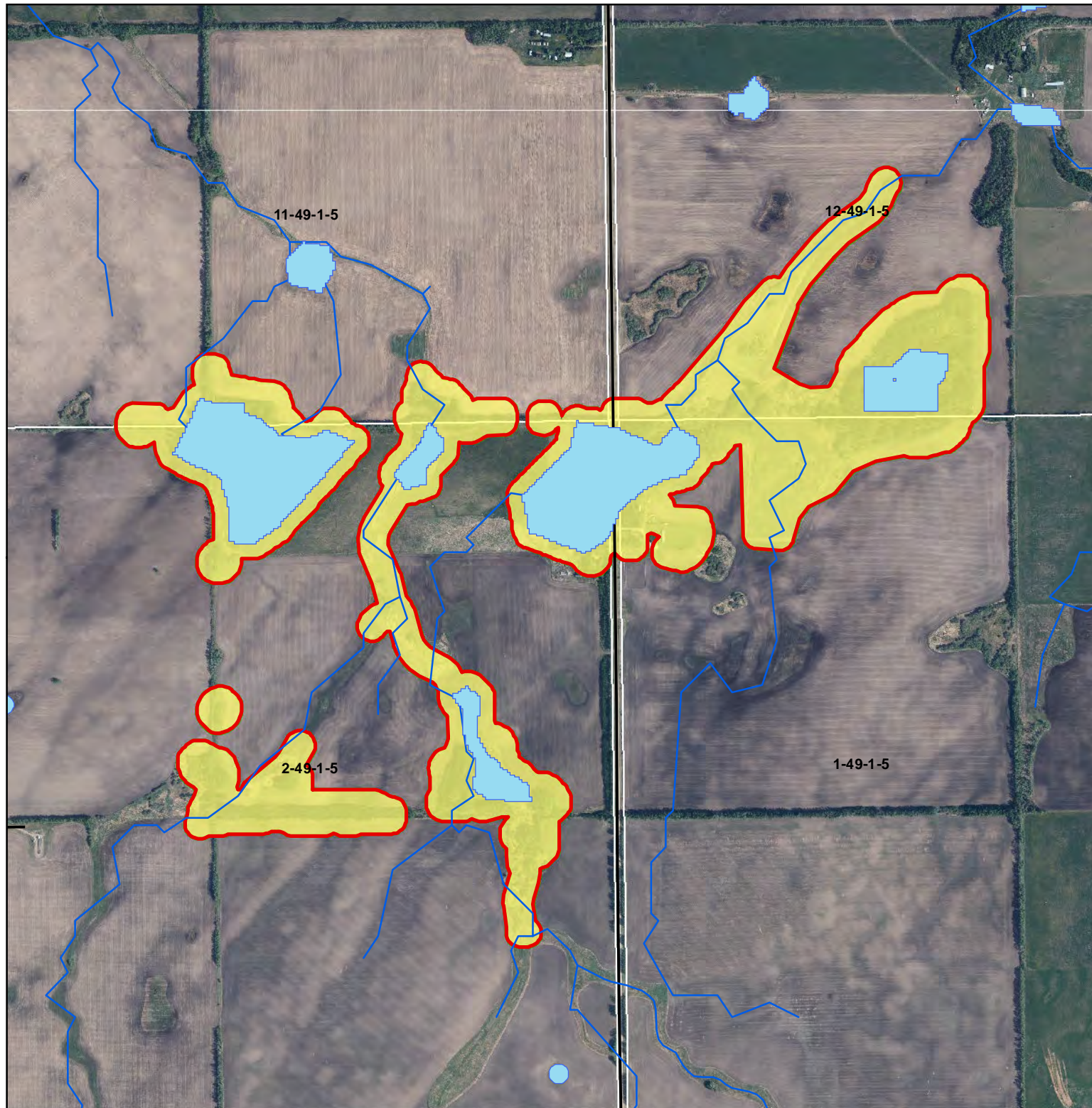- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area

Km

0   0.4   0.8   1.6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-24

ESA Index Map of
North Saskatchewan Area

N

Legend

Individual ESA Type

Aquatic

Mixed

Riparian

Upland

Major Roads

Highlighted ESA Area

Other ESA Areas

Leduc County 2014 Boundary

Km

0   3.25   6.5   13

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas
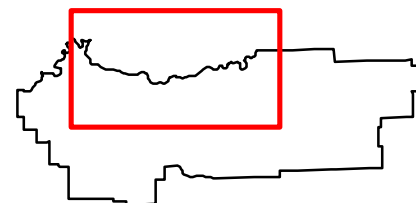
Location of ESA Area
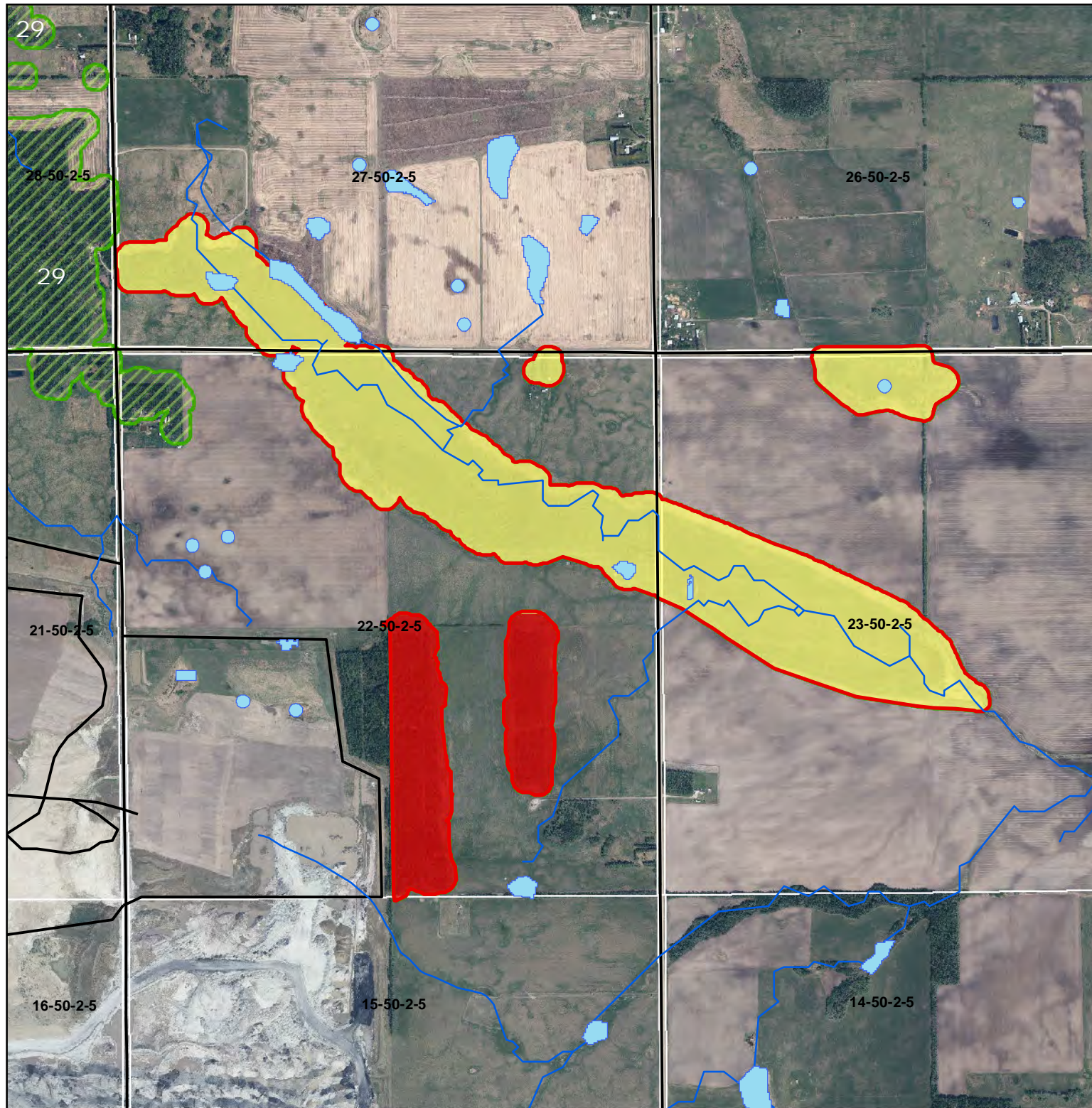
ESA Number: 25

North Saskatchewan Area

ESA Type: Mixed
- Upland : 69.9%
- Aquatic : 6.9%
- Riparian : 26%

Disturbance Risk: Medium
- High : 18.9%
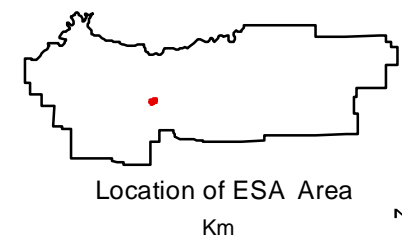- Moderate : 80.9%
- Low : 0%

ESA Area (ha): 109

ESA Score: 39.3/100

Overall ESA Rank: 76/120

Area ESA Rank: 6/ 6

Legend

- ▭ Highlighted ESA
- ─── Streams and Rivers
- ▢ Wetlands and Lakes
- ─── Roads
- ▮ High Risk Area
- ▮ Medium Risk Area
- ▮ Low Risk Area
- ▨ Other ESAs

Location of ESA Area

Km

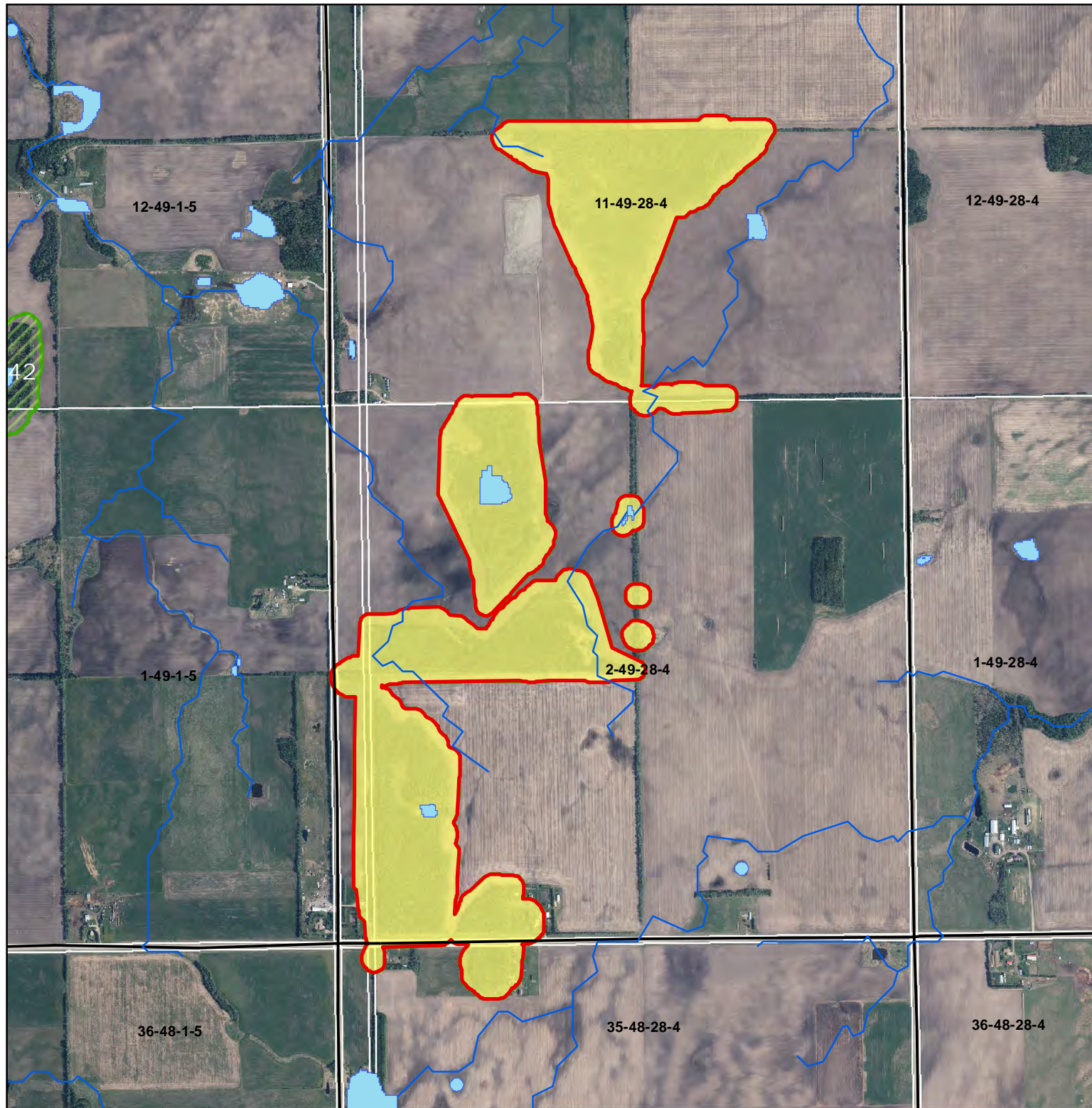0   0.2   0.4   0.8

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-25

ESA Number: 26

North Saskatchewan Area

ESA Type: Riparian
- Upland : 57%
- Aquatic : 14.4%
- Riparian : 32.1%

Disturbance Risk: High
- High : 65.8%
- Moderate : 33.9%
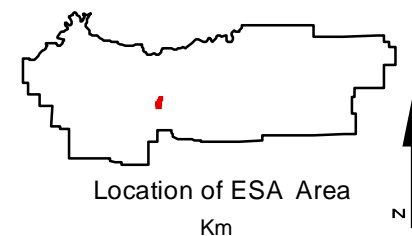- Low : 0%

ESA Area (ha): 337

ESA Score: 65/100

Overall ESA Rank: 17/120

Area ESA Rank: 2/ 6

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area
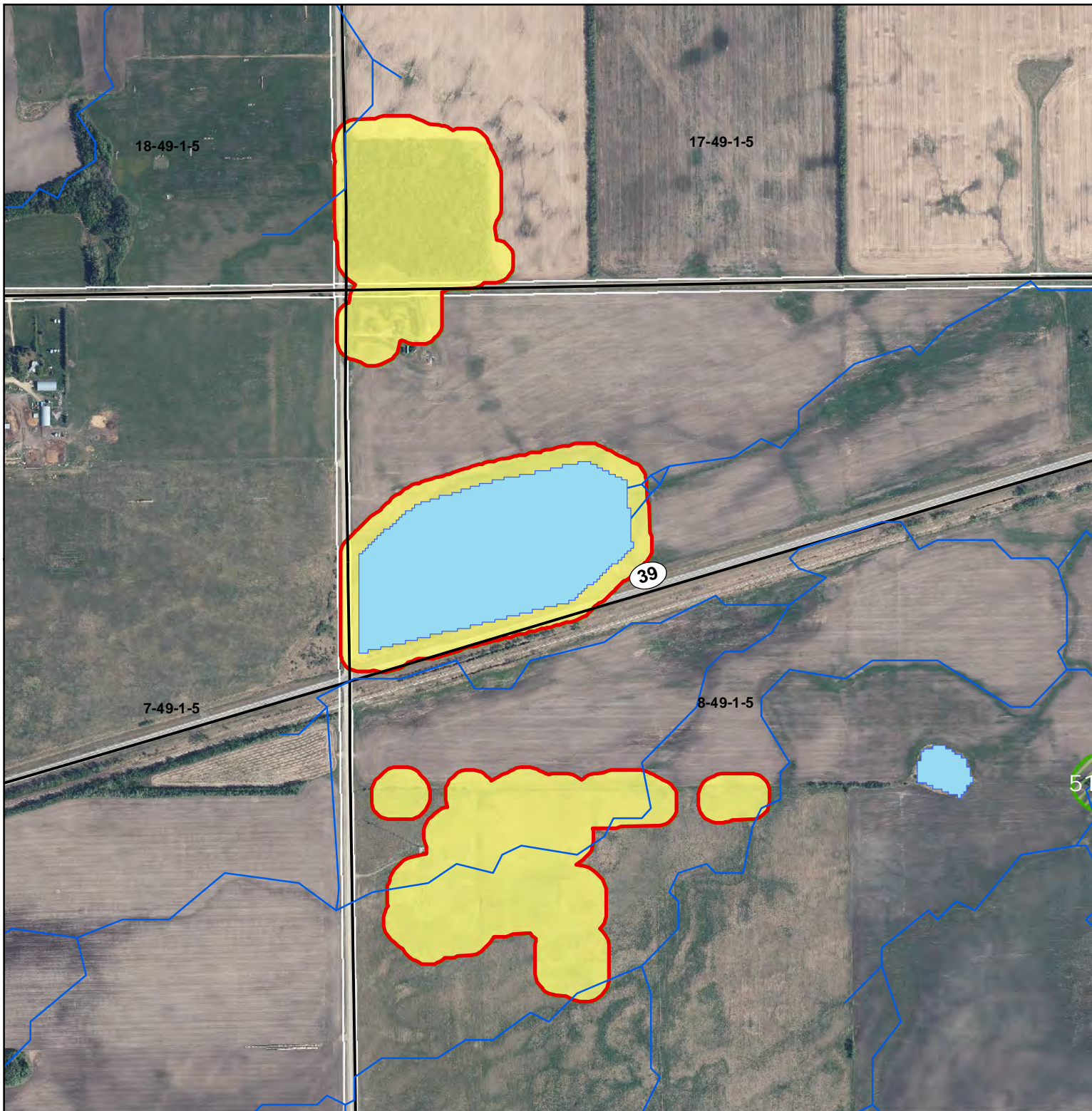
Km

0   0.375   0.75   1.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-26

ESA Number: 27

North Saskatchewan Area

ESA Type: Mixed
- Upland : 75.4%
- Aquatic : 5%
- Riparian : 21.4%

Disturbance Risk: Medium
- High : 7.5%
- Moderate : 92.4%
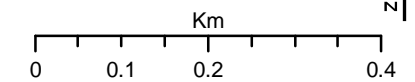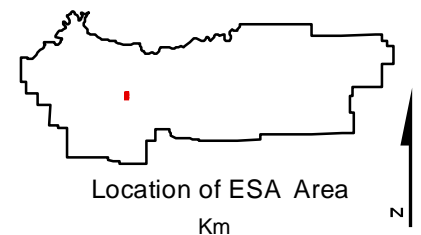- Low : 0%

ESA Area (ha): 615

ESA Score: 56.8/100

Overall ESA Rank: 30/120

Area ESA Rank: 3/ 6

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area
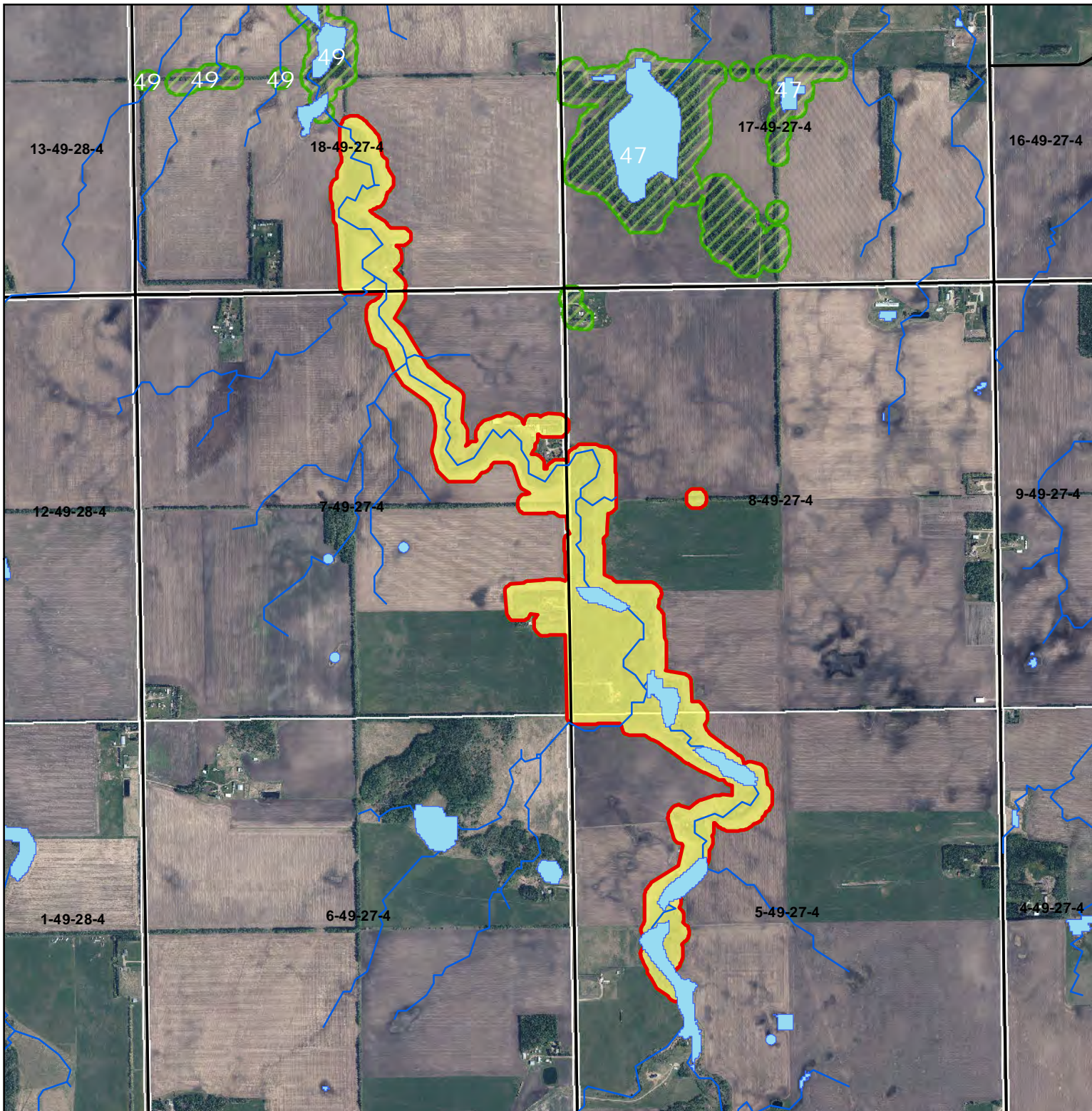
Km

0   0.75   1.5   3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

ESA Number: 28

North Saskatchewan Area

ESA Type: Mixed
- Upland : 81.2%
- Aquatic : 0.8%
- Riparian : 18.4%

Disturbance Risk: Medium
- High : 15.6%
- Moderate : 84.2%
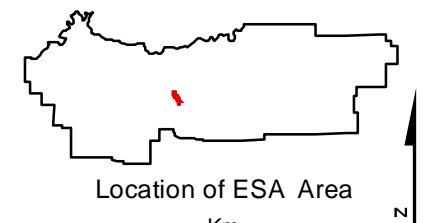- Low : 0%

ESA Area (ha): 134

ESA Score: 47.7/100

Overall ESA Rank: 47/120

Area ESA Rank: 4/ 6

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area

Km

0   0.2   0.4   0.8

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

ESA Number: 29

North Saskatchewan Area

ESA Type: Mixed
- Upland : 79.8%
- Aquatic : 4.4%
- Riparian : 16.9%

Disturbance Risk: Medium
- High : 30%
- Moderate : 69.9%
- Low : 0%

ESA Area (ha): 1744

ESA Score: 68.4/100

Overall ESA Rank: 10/120

Area ESA Rank: 1/ 6

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
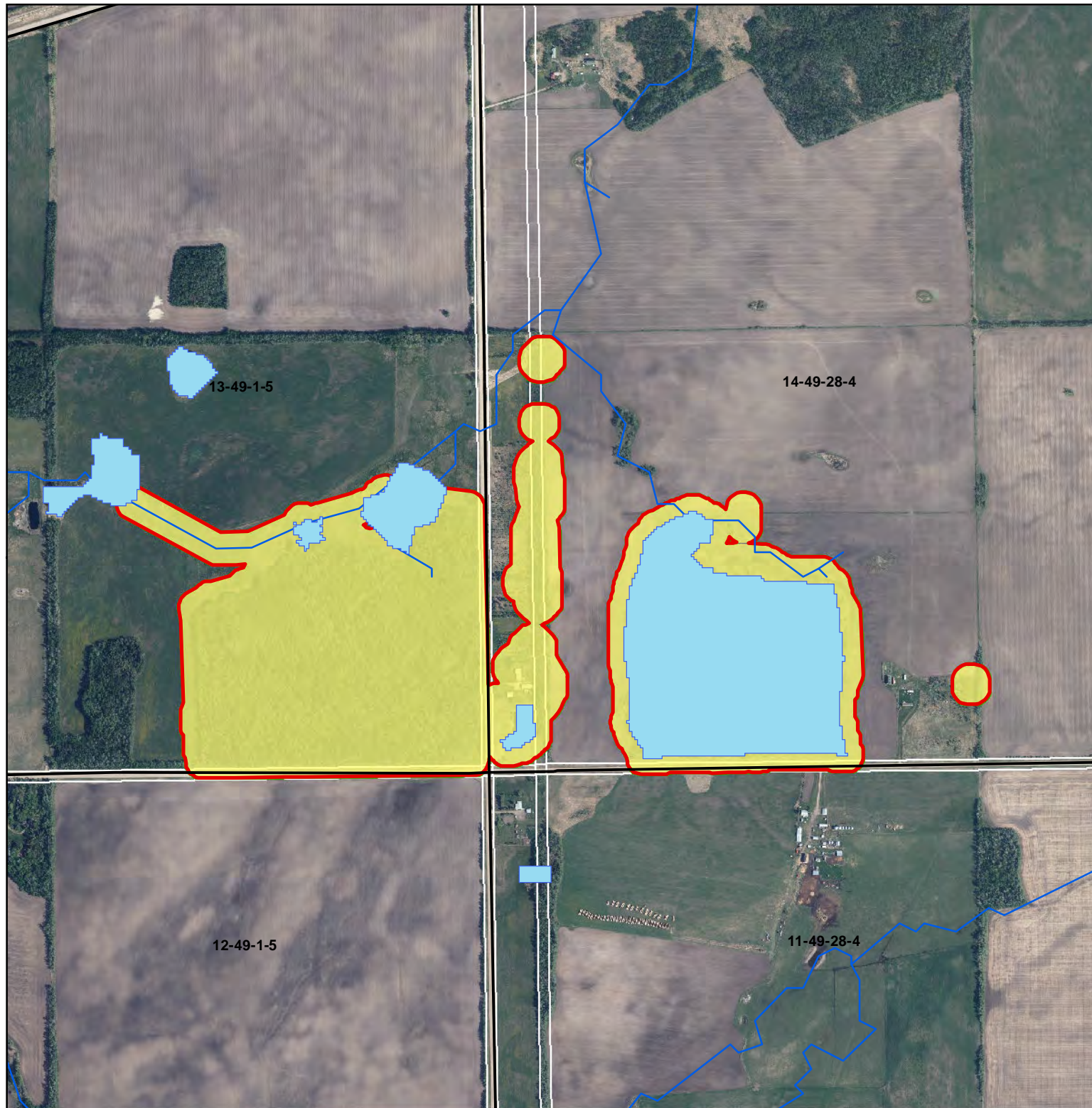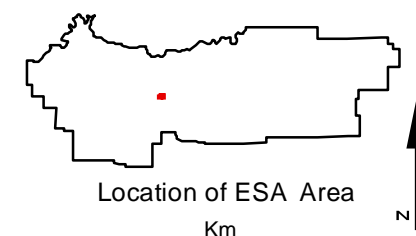- Other ESAs

Location of ESA Area

Km

0   1   2   4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-29

ESA Number: 30

North Saskatchewan Area

ESA Type: Riparian
- Upland : 49.7%
- Aquatic : 25.4%
- Riparian : 35.9%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 130

ESA Score: 47.5/100

Overall ESA Rank: 48/120

Area ESA Rank: 5/ 6

Legend

▭ Highlighted ESA

— Streams and Rivers

▭ Wetlands and Lakes

— Roads

▭ High Risk Area

▭ Medium Risk Area

▭ Low Risk Area

▨ Other ESAs

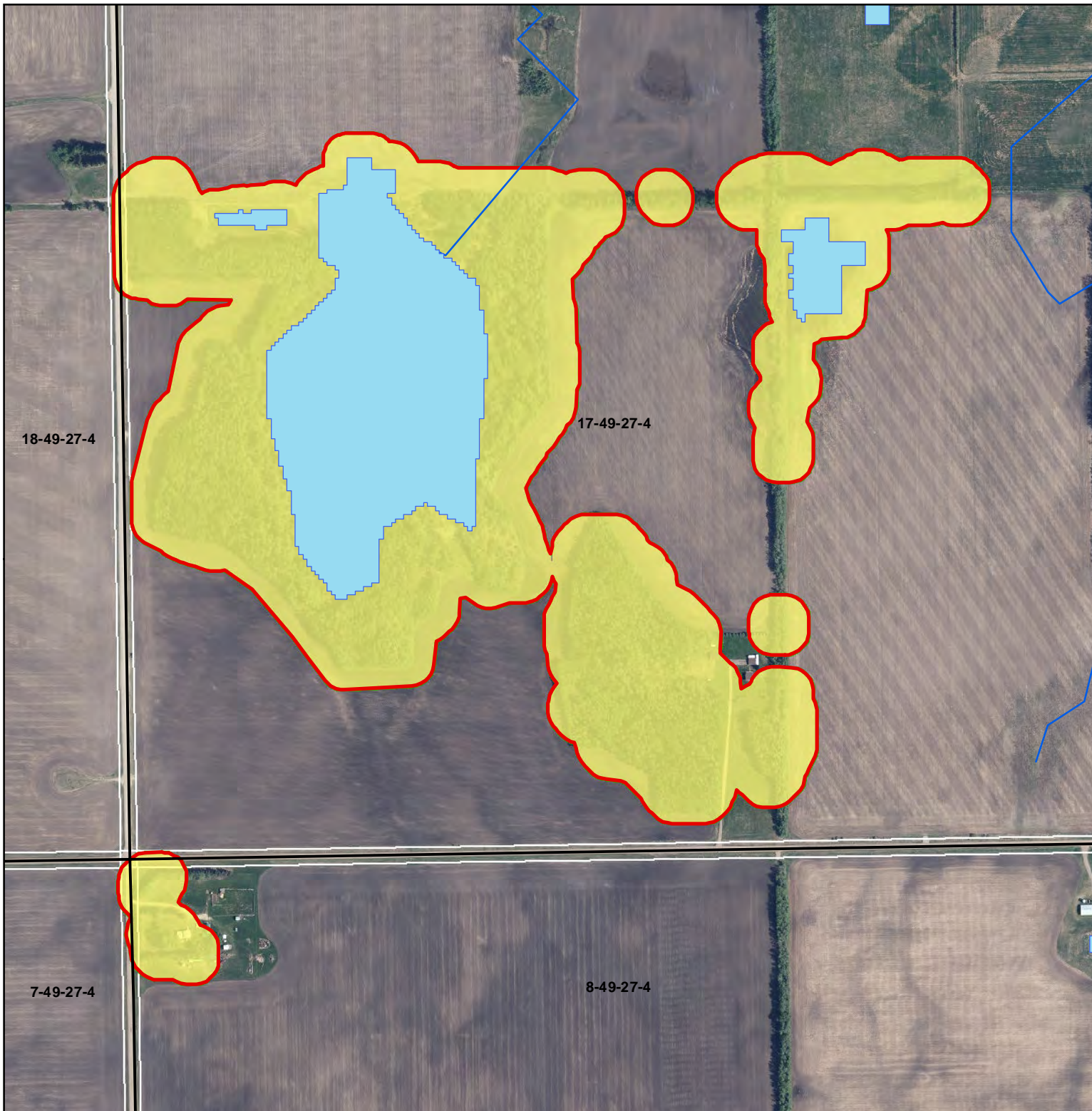Location of ESA Area

Km

0   0.3   0.6   1.2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-30

ESA Index Map of
West Pigeon Lake Area

Legend

Individual ESA Type

![blue] Aquatic	—— Major Roads
![green] Mixed	▭ Highlighted ESA Area
![yellow] Riparian	▨ Other ESA Areas
![brown] Upland	▭ Leduc County 2014 Boundary

Km
0   1.25   2.5   5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area

ESA Number: 31

West Pigeon Lake Area

ESA Type: Mixed
- Upland : 82.5%
- Aquatic : 1.3%
- Riparian : 16.2%

  Disturbance Risk: High
- High : 99.9%
- Moderate : 0%
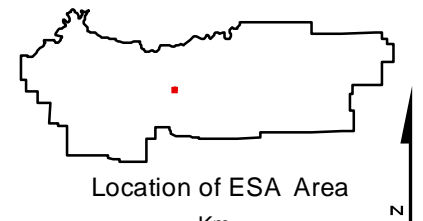- Low : 0%

ESA Area (ha): 57

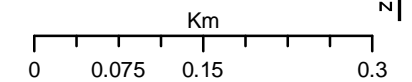ESA Score: 34.9/100

Overall ESA Rank: 89/120

Area ESA Rank: 7/ 7

Legend

▢ Highlighted ESA

— Streams and Rivers

▢ Wetlands and Lakes

— Roads

▢ High Risk Area

▢ Medium Risk Area

▢ Low Risk Area

▨ Other ESAs

Location of ESA Area
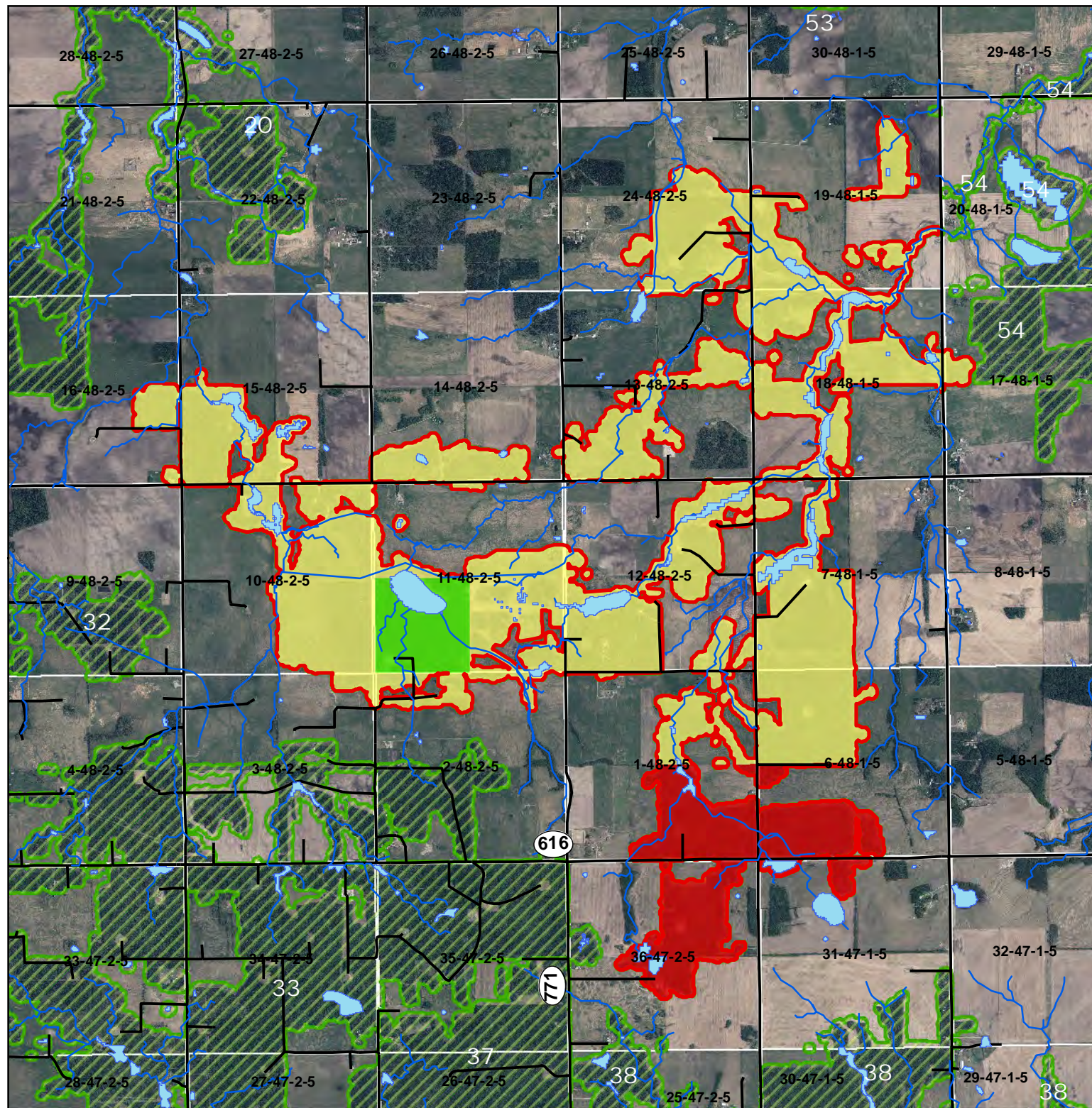
Km

0   0.125   0.25   0.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-31

ESA Number: 32

West Pigeon Lake Area

ESA Type: Mixed
- Upland : 78%
- Aquatic : 1%
- Riparian : 21%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 86

ESA Score: 36.5/100
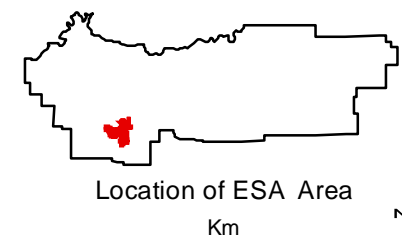
Overall ESA Rank: 80/120

Area ESA Rank: 6/ 7

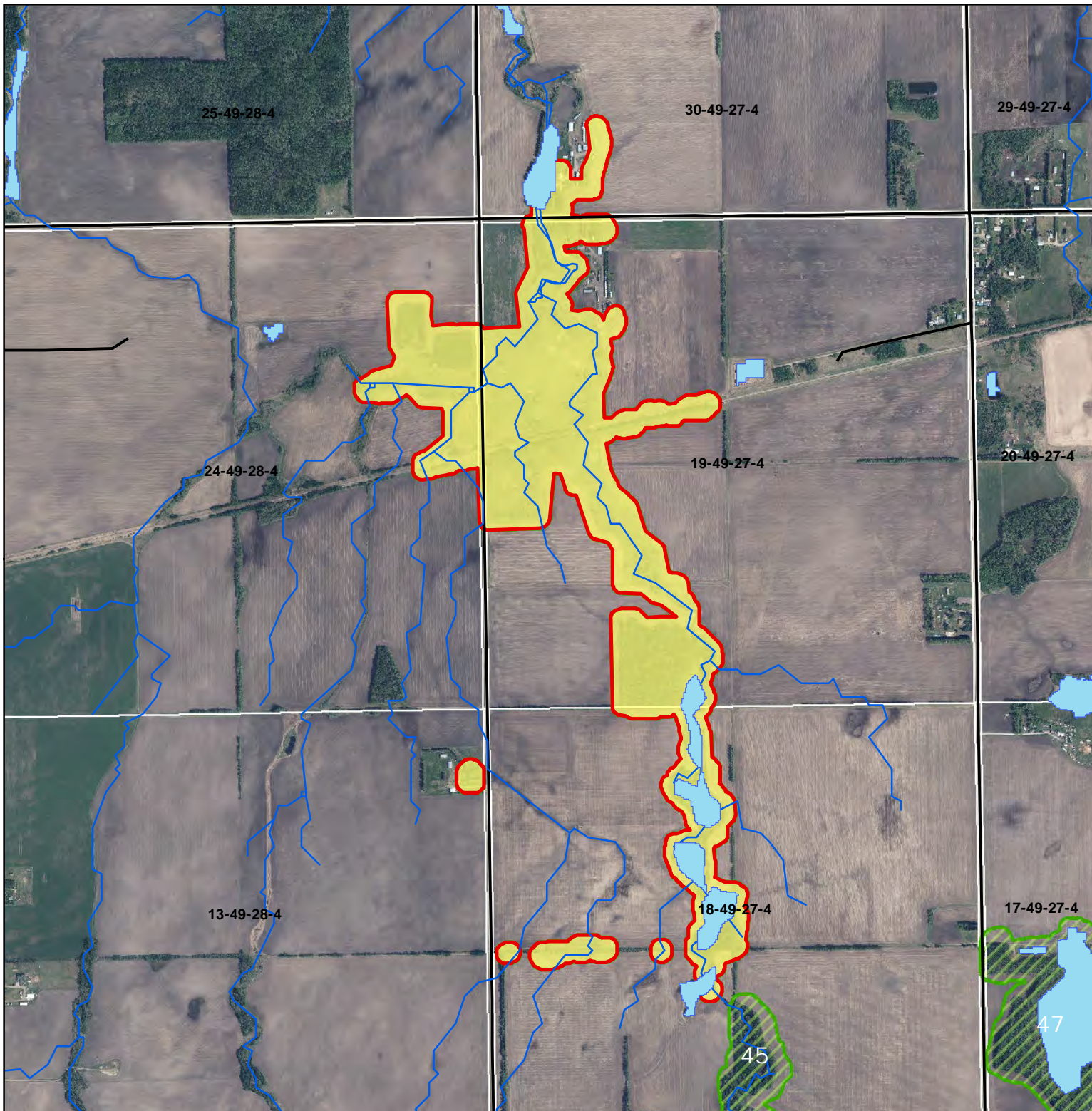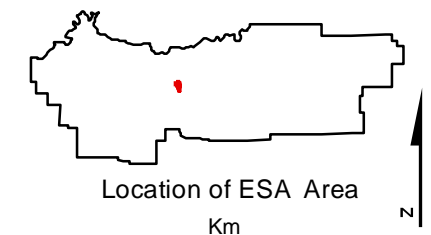**Legend**

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
Low Risk Area
Other ESAs

Location of ESA Area

Km

0   0.125   0.25   0.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-32

ESA Number: 33

West Pigeon Lake Area

ESA Type: Upland
- Upland : 84.2%
- Aquatic : 5.1%
- Riparian : 12.9%

  Disturbance Risk: High
- High : 91.4%
- Moderate : 8.6%
- Low : 0%

ESA Area (ha): 1369

ESA Score: 56.5/100

Overall ESA Rank: 31/120

Area ESA Rank: 3/ 7

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▬ Wetlands and Lakes
- — Roads
- ▮ High Risk Area
- ▮ Medium Risk Area
- ▮ Low Risk Area
- ▨ Other ESAs

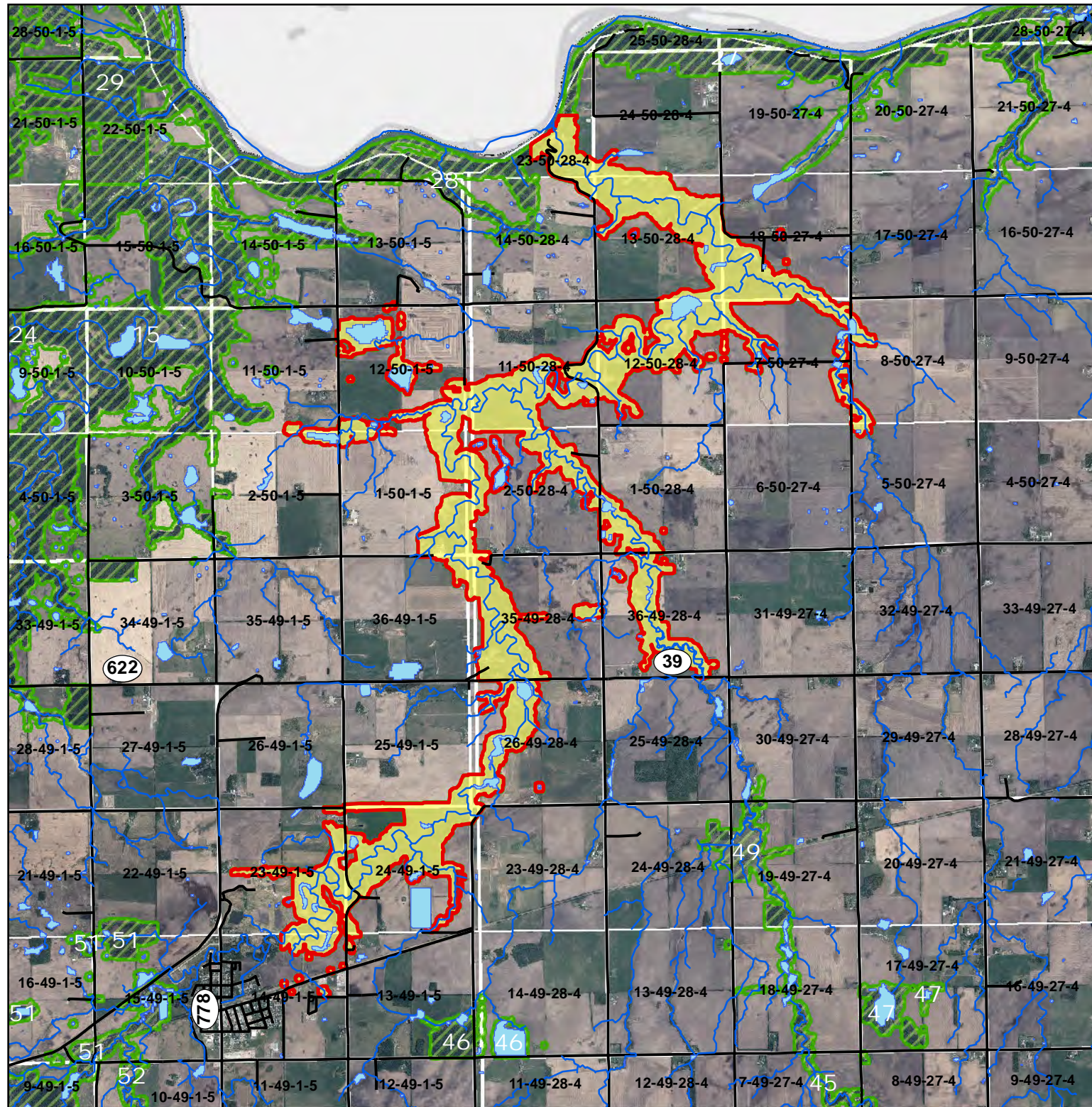Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-33

ESA Number: 34

West Pigeon Lake Area

ESA Type: Upland
- Upland : 82.3%
- Aquatic : 9.3%
- Riparian : 13.3%

Disturbance Risk: Medium
- High : 3.2%
- Moderate : 96.7%
- Low : 0%

ESA Area (ha): 669

ESA Score: 52/100

Overall ESA Rank: 42/120

Area ESA Rank: 4/ 7

Legend

▭	Highlighted ESA
—	Streams and Rivers
▬	Wetlands and Lakes
—	Roads
▬	High Risk Area
▬	Medium Risk Area
▬	Low Risk Area
▨	Other ESAs

Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-34

ESA Number: 35

West Pigeon Lake Area

ESA Type: Upland
- Upland : 79.2%
- Aquatic : 9.3%
- Riparian : 14.6%

Disturbance Risk: Medium
- High : 27.1%
- Moderate : 72.9%
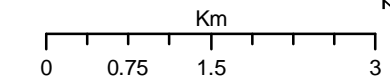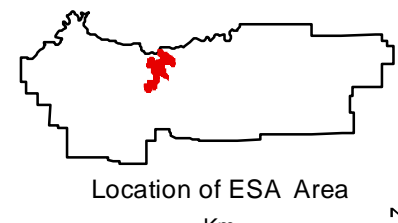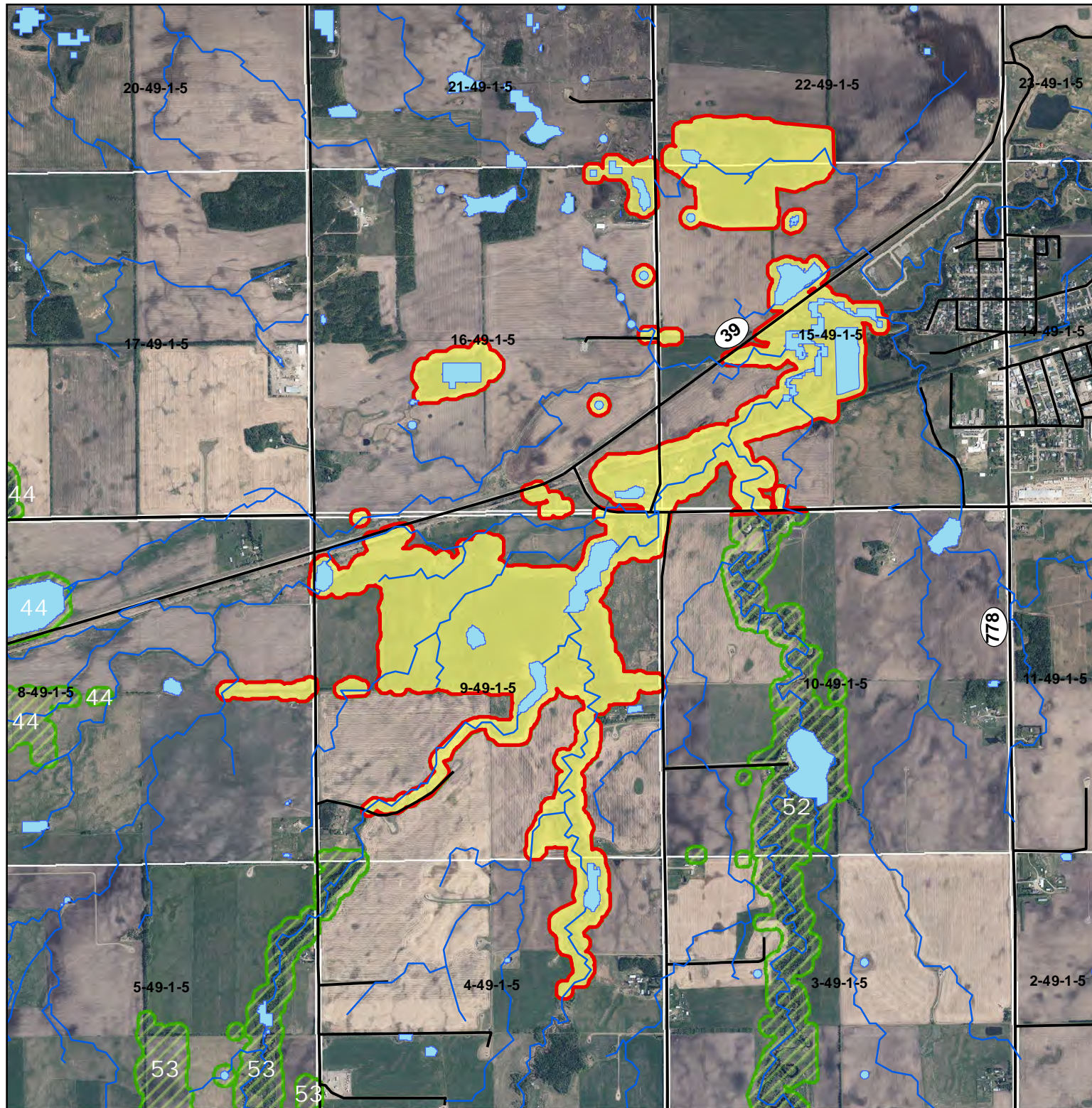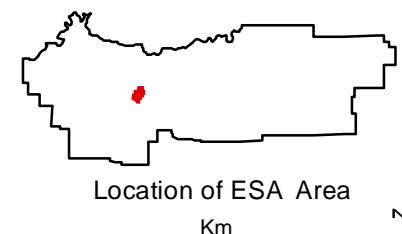- Low : 0%

ESA Area (ha): 1271

ESA Score: 50.4/100

Overall ESA Rank: 43/120

Area ESA Rank: 5/ 7

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area
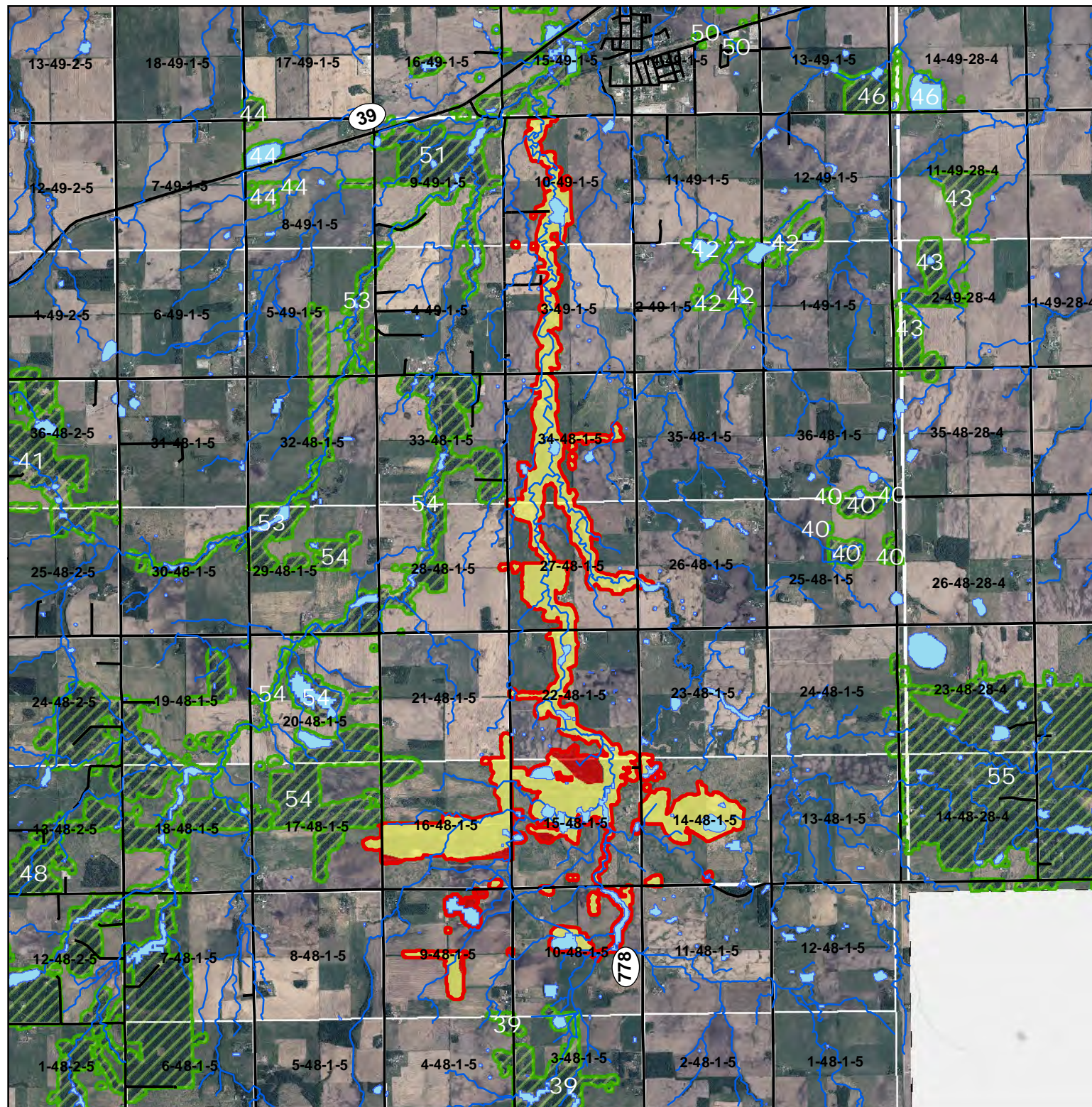
Km

0   0.4   0.8   1.6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-35

ESA Number: 36

West Pigeon Lake Area

ESA Type: Mixed
- Upland : 79.6%
- Aquatic : 10.1%
- Riparian : 16.7%

Disturbance Risk: High
- High : 82.5%
- Moderate : 15.4%
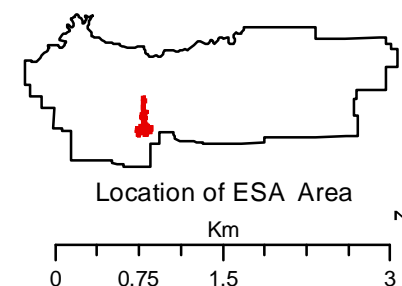- Low : 0%

ESA Area (ha): 880

ESA Score: 65.6/100

Overall ESA Rank: 14/120

Area ESA Rank: 2/ 7

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▭ Wetlands and Lakes
- — Roads
- ▮ High Risk Area
- ▮ Medium Risk Area
- ▮ Low Risk Area
- ▨ Other ESAs

Location of ESA Area
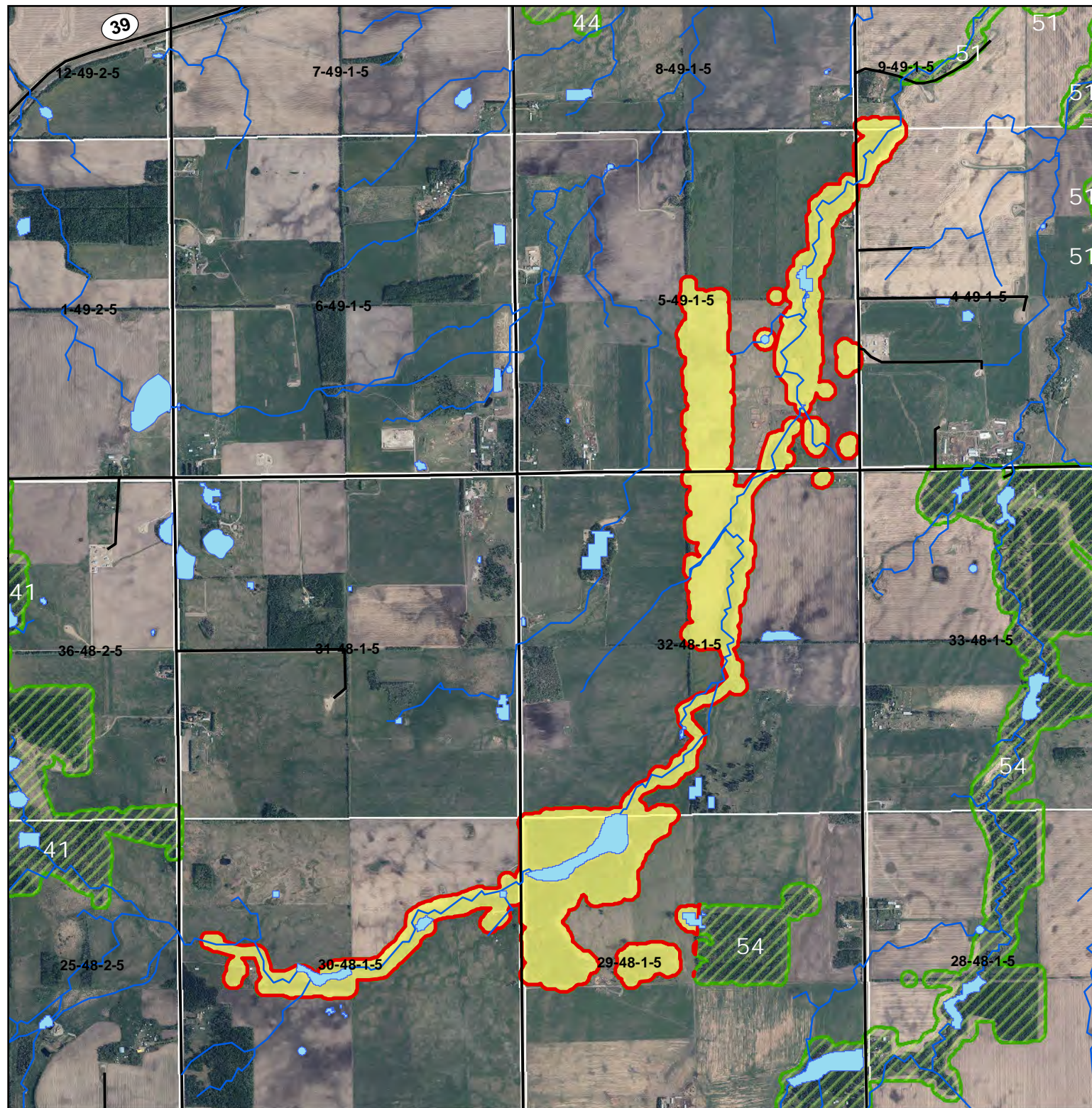
Km

0   0.4   0.8   1.6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-36

ESA Number: 37

West Pigeon Lake Area

ESA Type: Mixed
- Upland : 80.2%
- Aquatic : 8.4%
- Riparian : 15.5%

   Disturbance Risk: High
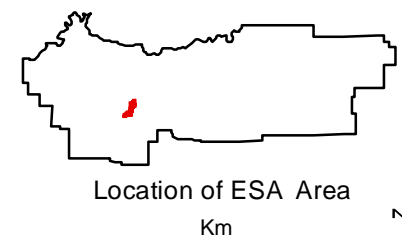- High : 94.8%
- Moderate : 0.2%
- Low : 0%

ESA Area (ha): 858

ESA Score: 69.1/100

 Overall ESA Rank: 9/120

Area ESA Rank: 1/ 7

Legend

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
Low Risk Area
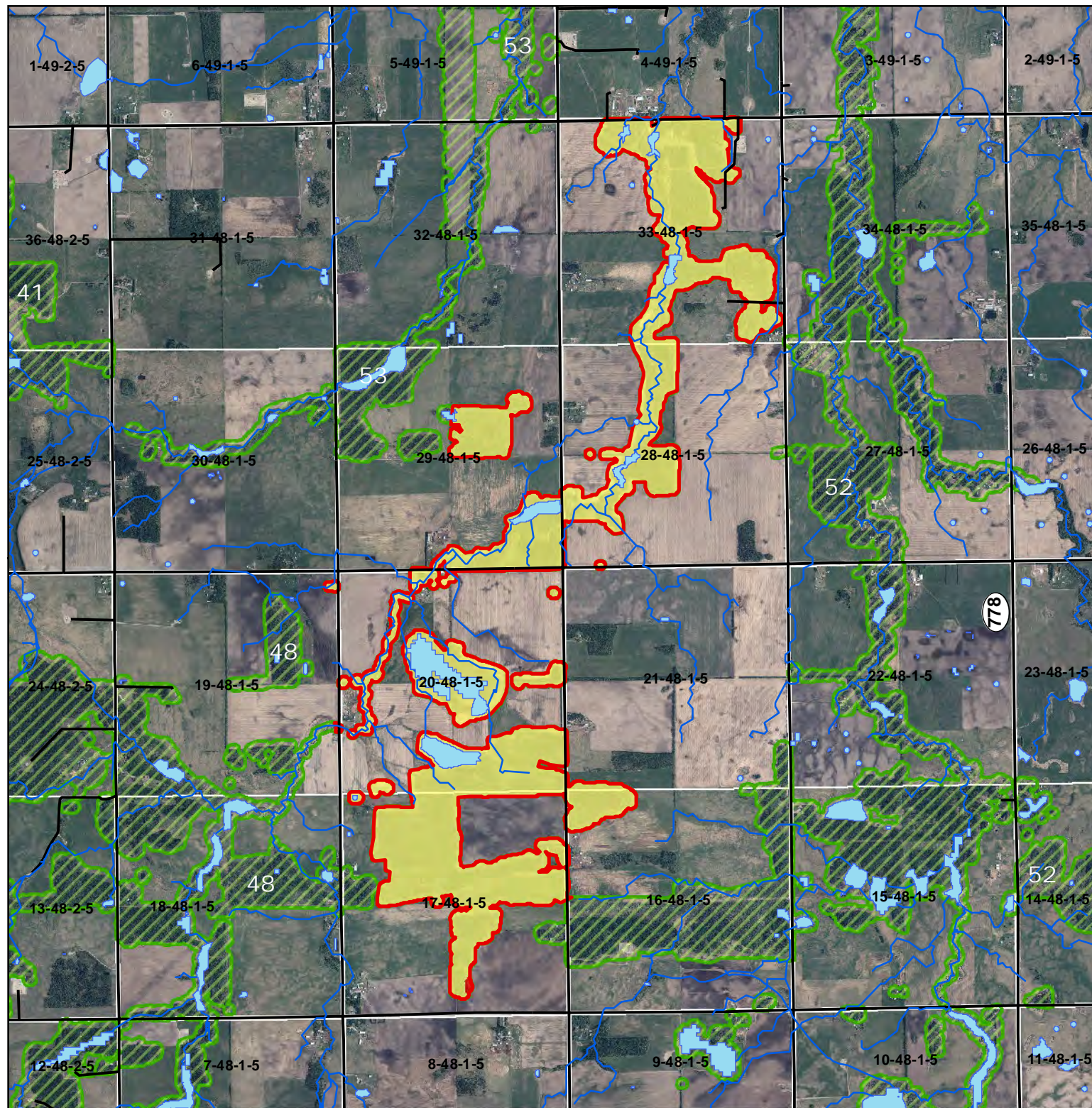Other ESAs

Location of ESA Area

Km

0   0.375   0.75   1.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

ESA Index Map of Pigeon Lake Area

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

Major Roads

Highlighted ESA Area

Other ESA Areas

Leduc County 2014 Boundary

Km

0   0.75   1.5   3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 04/11/2014

Basemap: ESRI Light Grey Canvas

N

38

771

778

616

Location of ESA Area

ESA Number: 38

Pigeon Lake Area

ESA Type: Aquatic
- Upland : 28.9%
- Aquatic : 66.6%
- Riparian : 5.7%

Disturbance Risk: Medium
- High : 29%
- Moderate : 69.5%
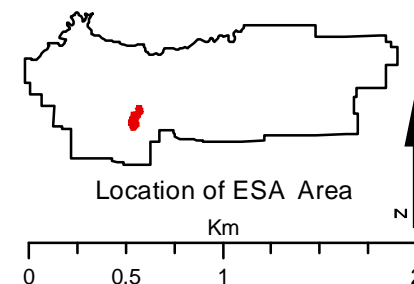- Low : 1.2%

ESA Area (ha): 3428

ESA Score: 71.3/100

Overall ESA Rank: 6/120

Area ESA Rank: 1/ 1

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▭ Wetlands and Lakes
- — Roads
- ▭ High Risk Area
- ▭ Medium Risk Area
- ▭ Low Risk Area
- ▨ Other ESAs

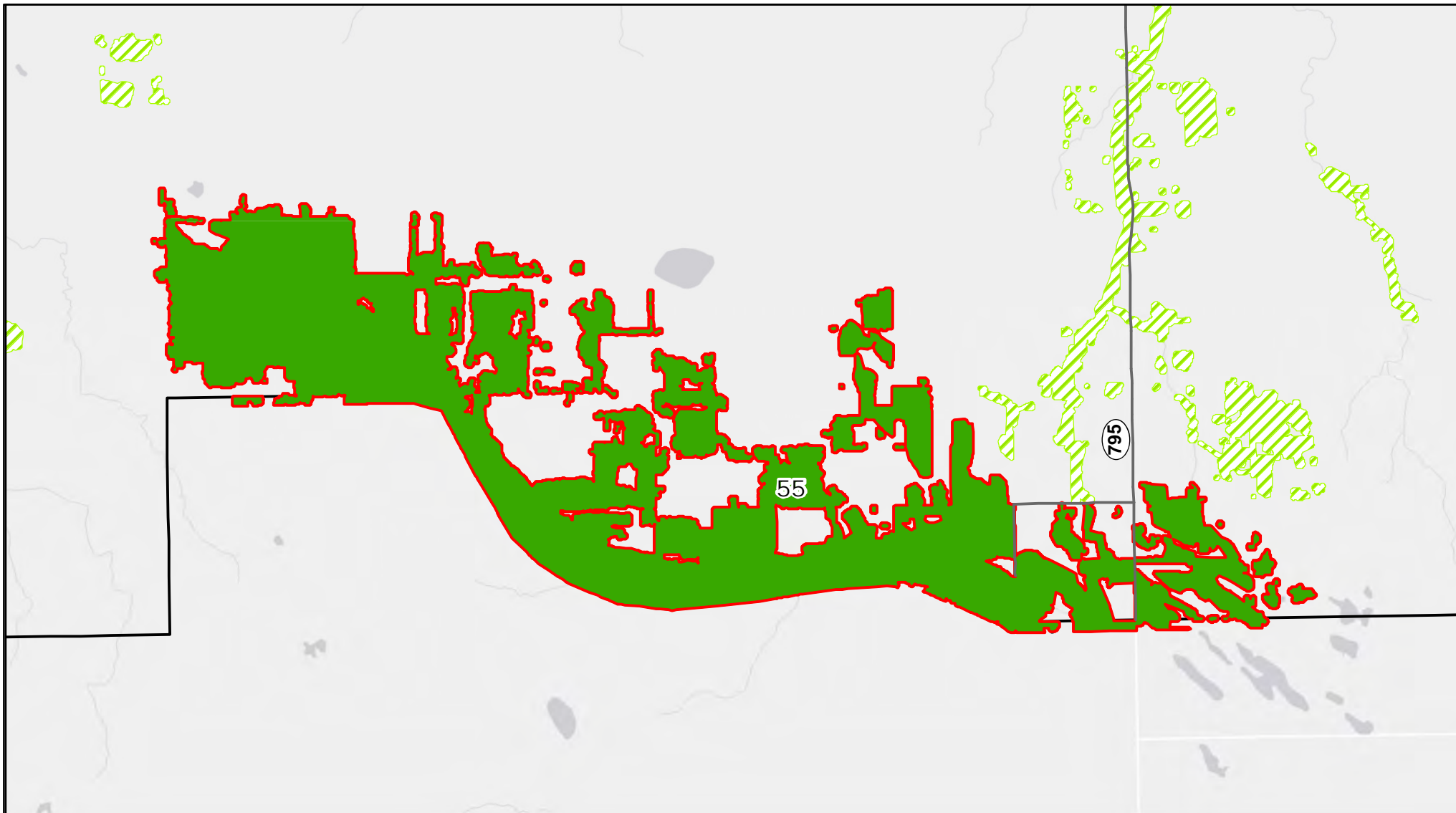Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
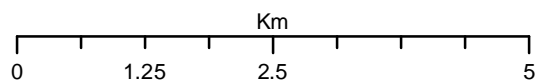Basemap:ESRI Light Grey Canvas

A-38

ESA Index Map of Weed Creek Area

Genesee Lake

Legend

Individual ESA Type

- Aquatic
- Mixed
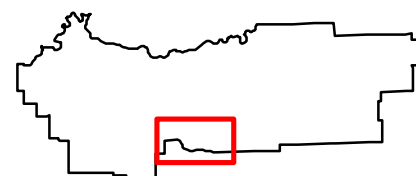- Riparian
- Upland

— Major Roads

▭ Highlighted ESA Area

▨ Other ESA Areas

▭ Leduc County 2014 Boundary
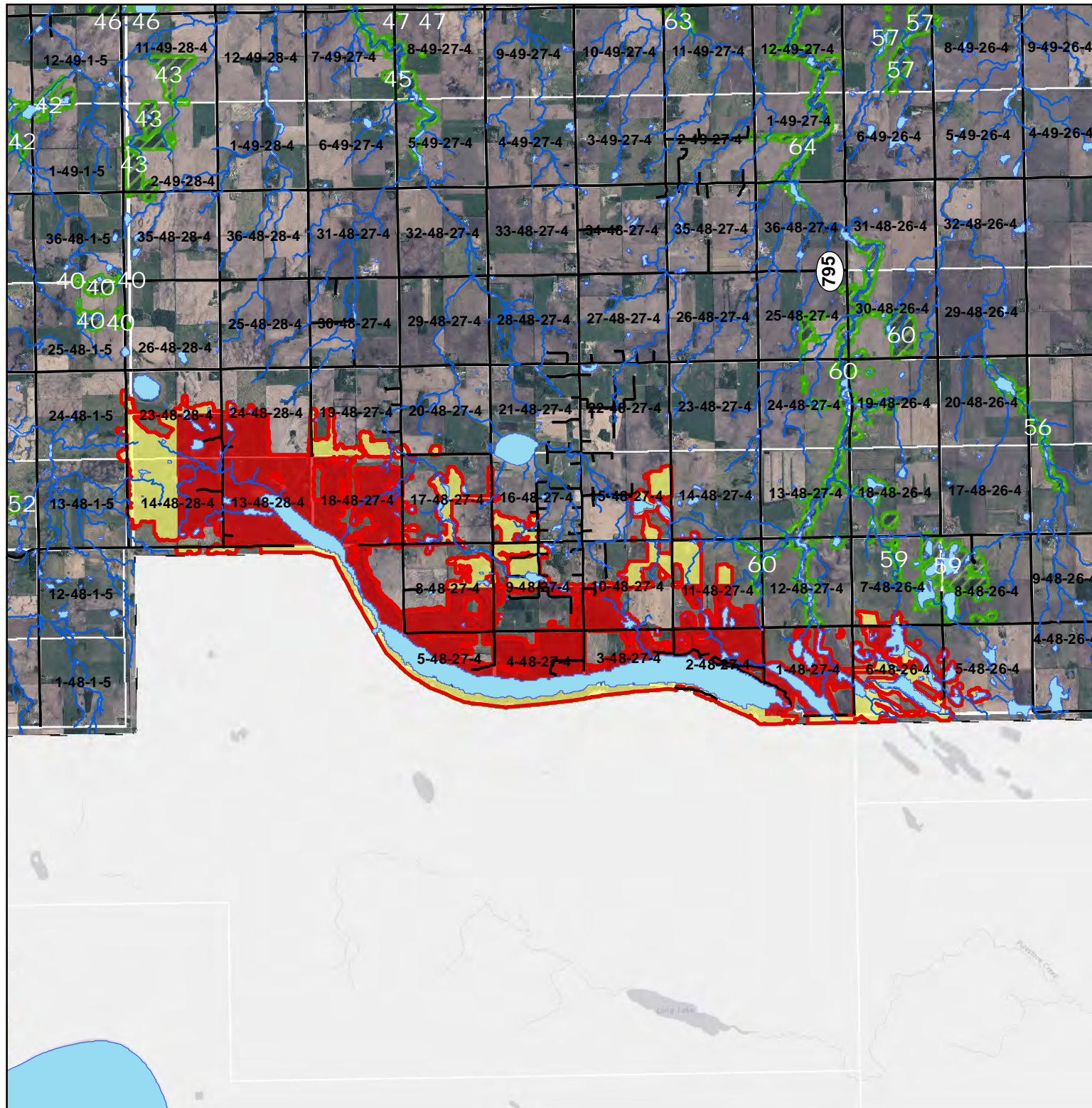
Km

0   3.75   7.5   15

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 04/11/2014

Basemap: ESRI Light Grey Canvas
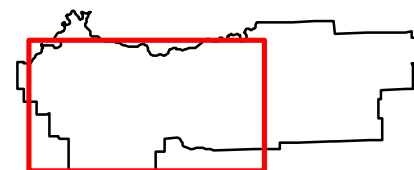
Location of ESA Area
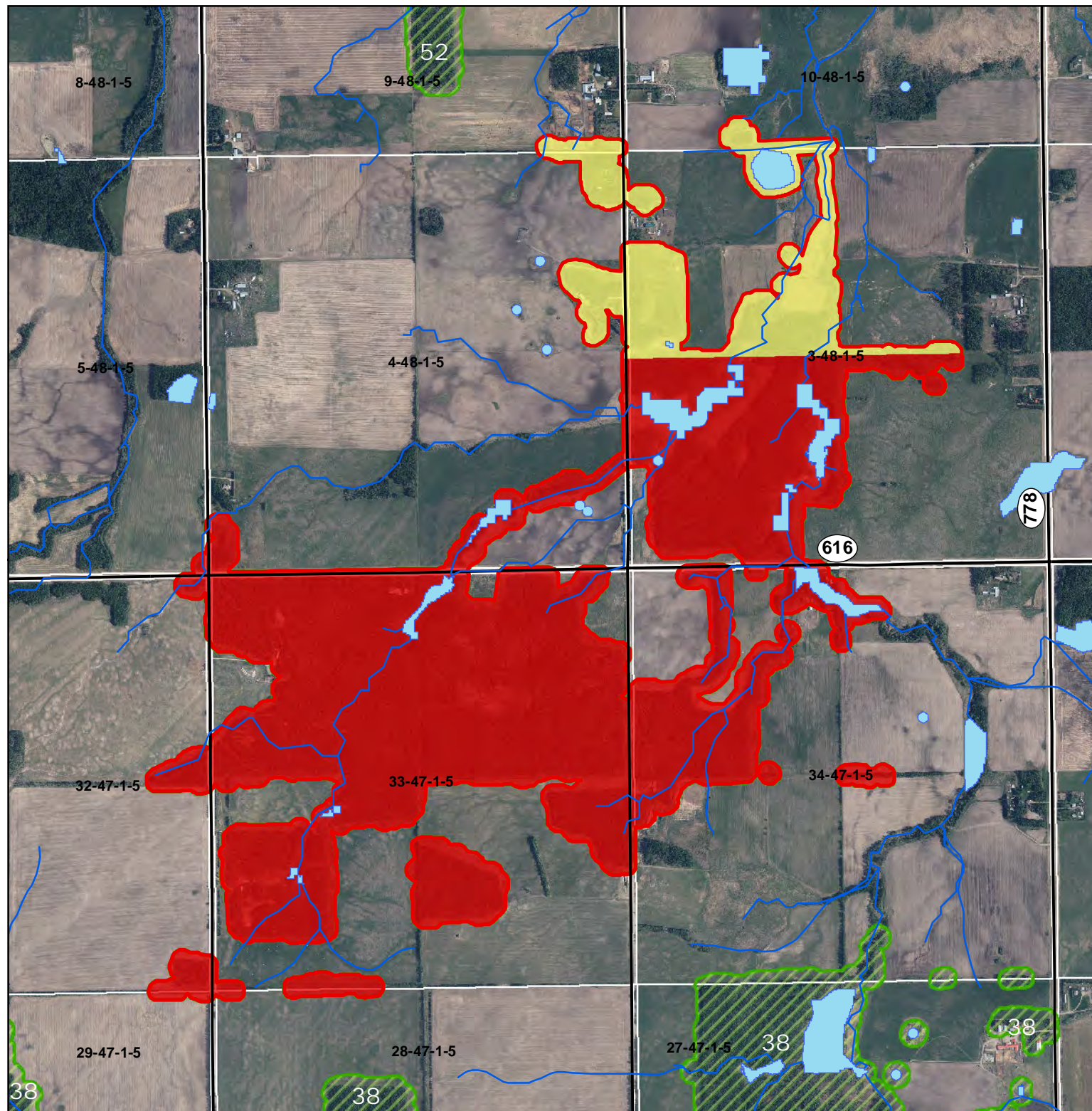
ESA Number: 39

Weed Creek Area

ESA Type: Mixed
- Upland : 73.9%
- Aquatic : 10.3%
- Riparian : 23%

  Disturbance Risk: High
- High : 85.7%
- Moderate : 14.2%
- Low : 0%

ESA Area (ha): 347

ESA Score: 59.5/100

Overall ESA Rank: 24/120

Area ESA Rank: 2/ 16

Legend

Highlighted ESA

Streams and Rivers

Wetlands and Lakes

Roads

High Risk Area

Medium Risk Area

Low Risk Area

Other ESAs

Location of ESA Area

Km

0   0.25   0.5   1

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-39

ESA Number: 40

Weed Creek Area

ESA Type: Upland
- Upland : 73.4%
- Aquatic : 13.4%
- Riparian : 14.9%

Disturbance Risk: Medium
- High : 0%
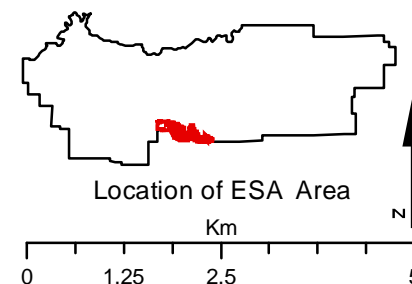- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 39

ESA Score: 33.9/100

Overall ESA Rank: 99/120

Area ESA Rank: 11/ 16

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs
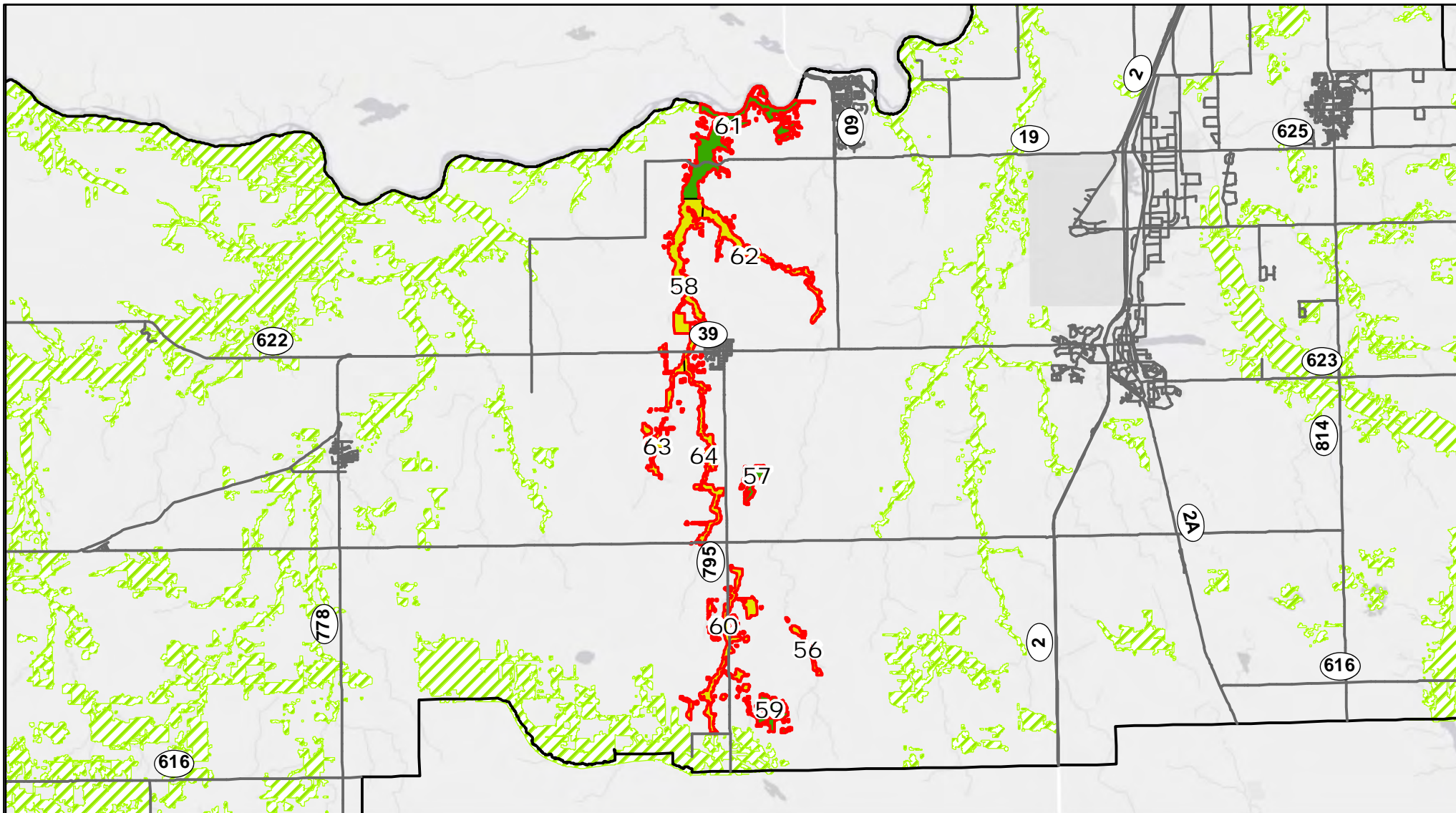
Location of ESA Area

Km

0   0.075   0.15   0.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
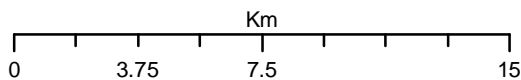Provided by Leduc County
Basemap:ESRI Light Grey Canvas

36-48-1-5

35-48-28-4

25-48-1-5

26-48-28-4

A-40

ESA Number: 41

Weed Creek Area

ESA Type: Upland
- Upland : 76.5%
- Aquatic : 13.4%
- Riparian : 13.3%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 324

ESA Score: 46.2/100

Overall ESA Rank: 50/120

Area ESA Rank: 6/ 16

Legend

▭ Highlighted ESA
── Streams and Rivers
▬ Wetlands and Lakes
── Roads
▬ High Risk Area
▬ Medium Risk Area
▬ Low Risk Area
▨ Other ESAs

Location of ESA Area

Km

0   0.3   0.6   1.2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-41

ESA Number: 42

Weed Creek Area

ESA Type: Riparian
- Upland : 38.7%
- Aquatic : 41.4%
- Riparian : 31.9%

Disturbance Risk: Medium
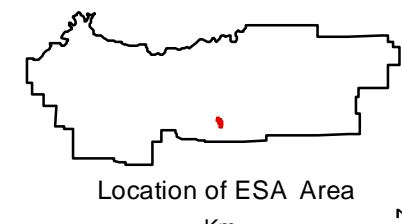- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 66

ESA Score: 34.2/100

Overall ESA Rank: 97/120

Area ESA Rank: 10/ 16

Legend

▭ Highlighted ESA
── Streams and Rivers
▬ Wetlands and Lakes
── Roads
▮ High Risk Area
▮ Medium Risk Area
▮ Low Risk Area
▨ Other ESAs

Location of ESA Area
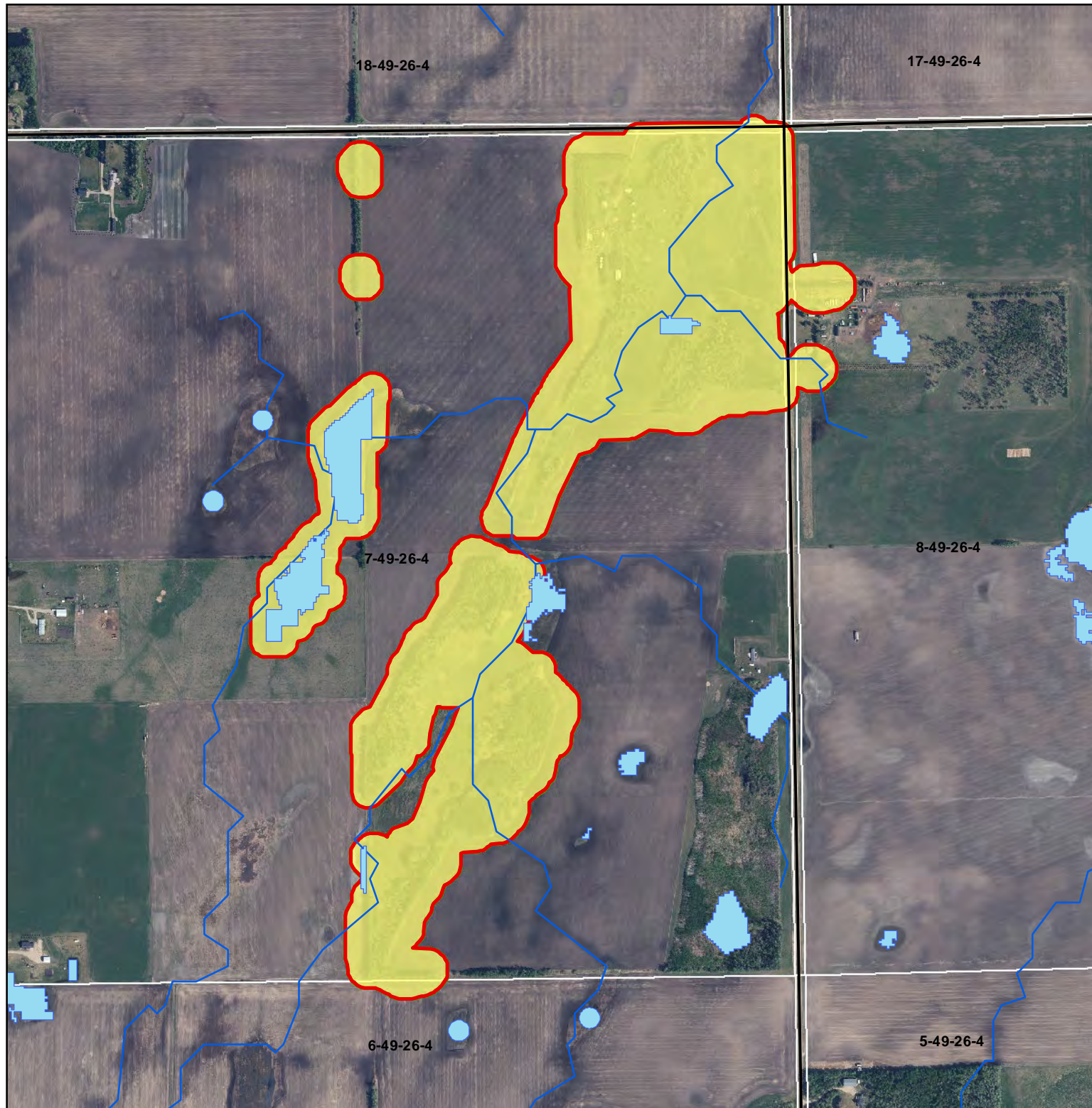
Km

0   0.125   0.25   0.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-42

ESA Number: 43

Weed Creek Area

ESA Type: Upland
- Upland : 89.4%
- Aquatic : 4%
- Riparian : 7.3%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 99

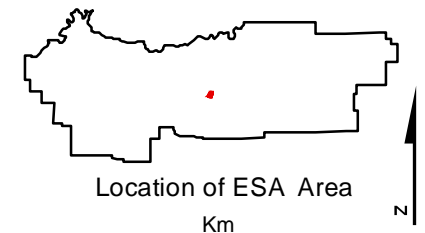ESA Score: 32/100

Overall ESA Rank: 107/120

Area ESA Rank: 12/ 16

Legend

▢ Highlighted ESA
— Streams and Rivers
▢ Wetlands and Lakes
— Roads
▢ High Risk Area
▢ Medium Risk Area
▢ Low Risk Area
▨ Other ESAs

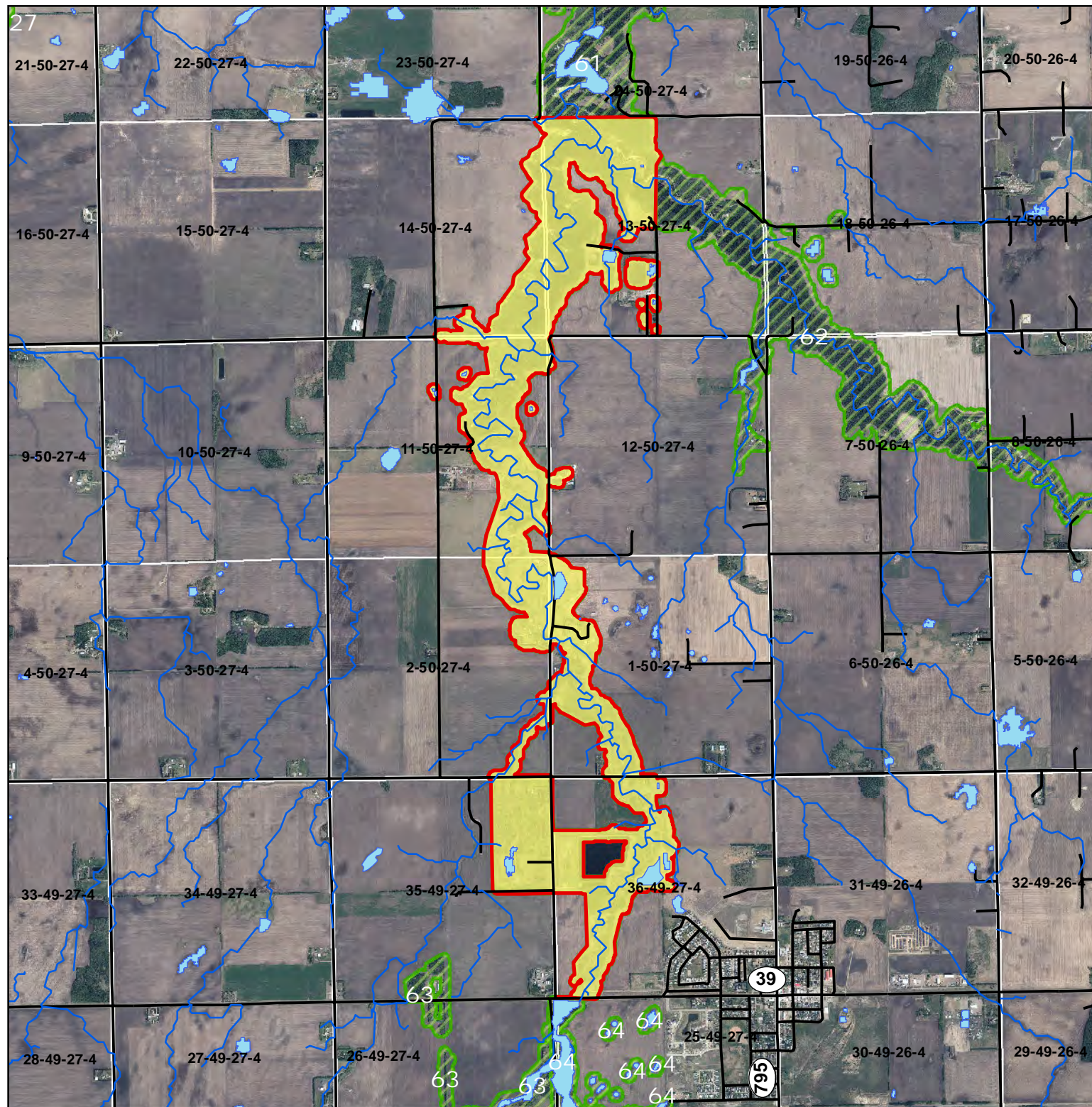Location of ESA Area

Km

0   0.2   0.4   0.8

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

Map labels: 12-49-1-5, 12-49-28-4, 11-49-28-4, 42, 1-49-1-5, 2-49-28-4, 1-49-28-4, 36-48-1-5, 35-48-28-4, 36-48-28-4

ESA Number: 44

Weed Creek Area

ESA Type: Mixed
- Upland : 48.8%
- Aquatic : 38.6%
- Riparian : 17%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 34

ESA Score: 31/100

Overall ESA Rank: 116/120

Area ESA Rank: 15/ 16

Legend

▭ Highlighted ESA
— Streams and Rivers
▨ Wetlands and Lakes
— Roads
▨ High Risk Area
▨ Medium Risk Area
▨ Low Risk Area
▨ Other ESAs

Location of ESA Area

Km

0   0.1   0.2   0.4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-44

ESA Number: 45

Weed Creek Area

ESA Type: Riparian
- Upland : 34.2%
- Aquatic : 17.5%
- Riparian : 63.6%

Disturbance Risk: Medium
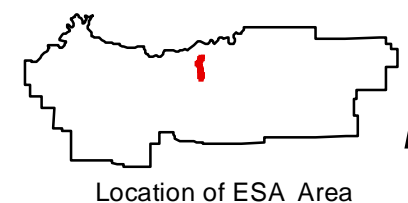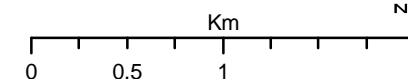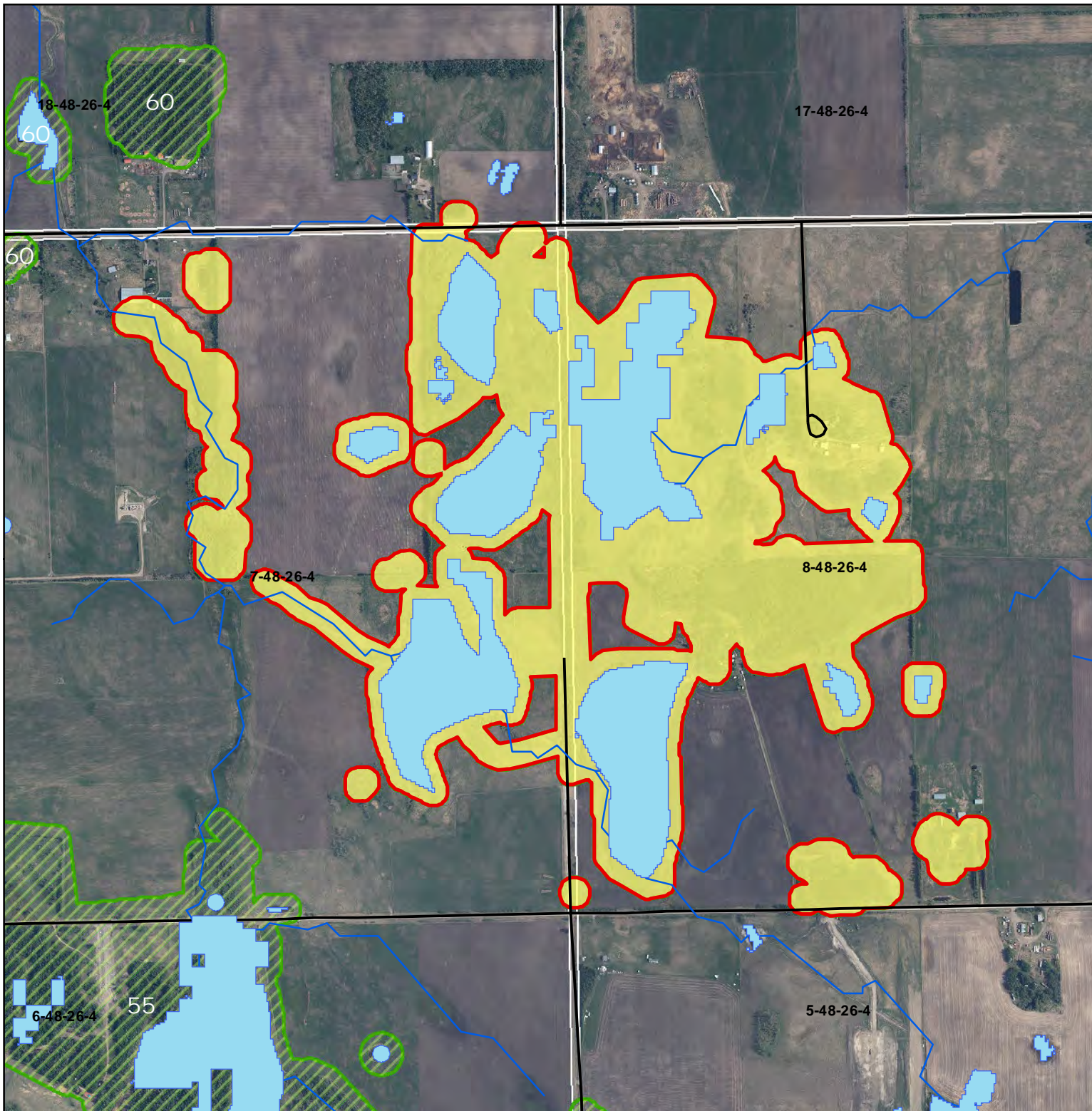- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 86

ESA Score: 30.6/100

Overall ESA Rank: 120/120

Area ESA Rank: 16/ 16

Legend

⬜ Highlighted ESA

— Streams and Rivers

🟦 Wetlands and Lakes

— Roads

🟥 High Risk Area

🟨 Medium Risk Area

🟩 Low Risk Area

▨ Other ESAs

Location of ESA Area

Km

0   0.25   0.5   1

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-45

ESA Number: 46

Weed Creek Area

ESA Type: Mixed
- Upland : 51.7%
- Aquatic : 42.9%
- Riparian : 12%

Disturbance Risk: Medium
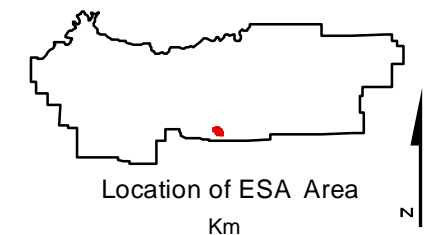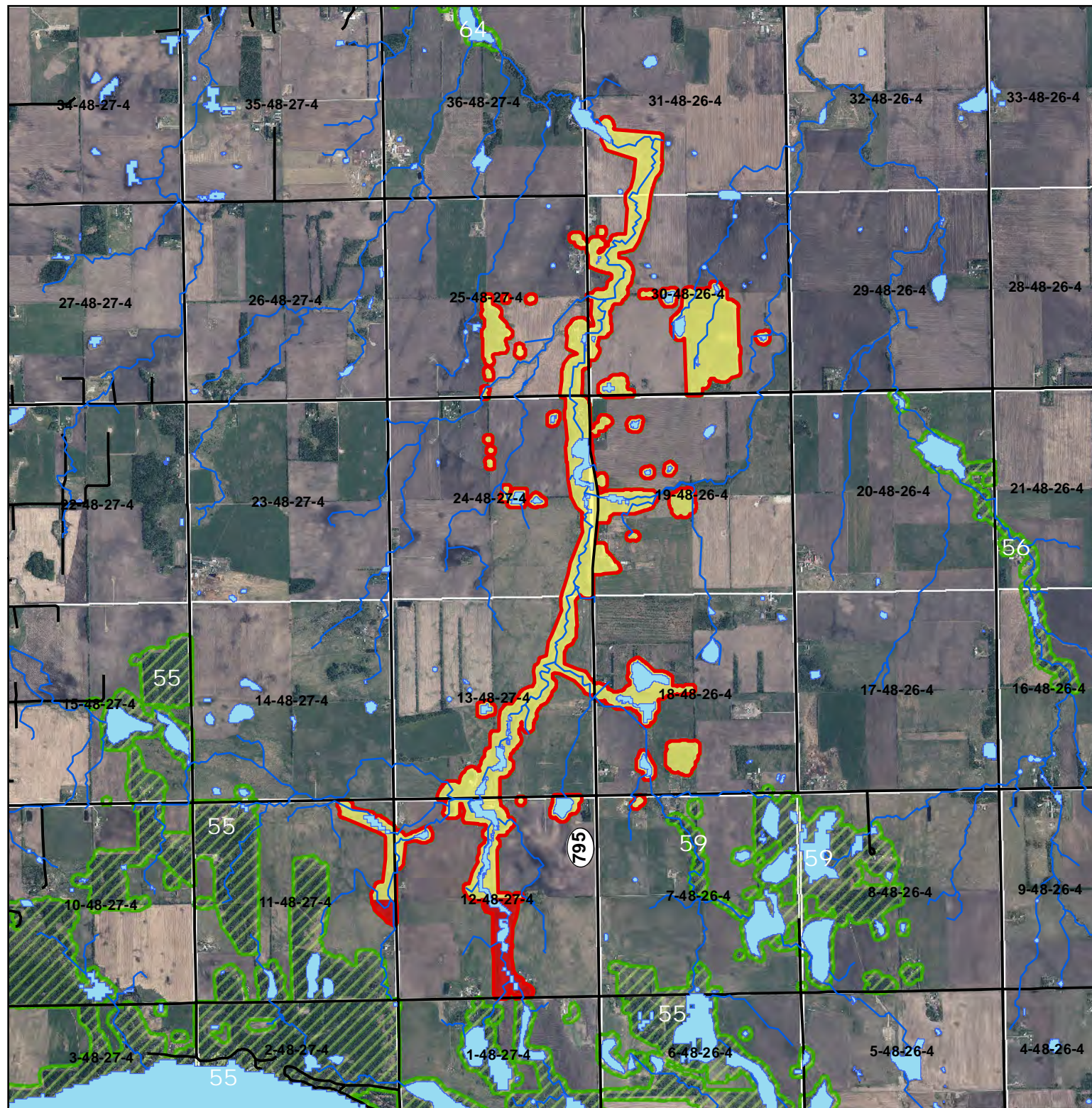- High : 0%
- Moderate : 99.9%
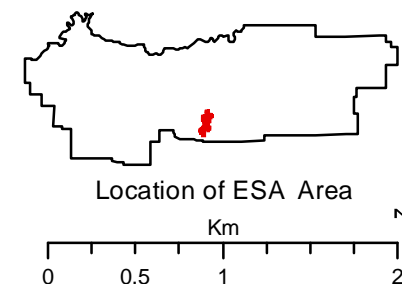- Low : 0%

ESA Area (ha): 57

ESA Score: 31.4/100

Overall ESA Rank: 113/120

Area ESA Rank: 14/ 16

Legend

☐ Highlighted ESA
— Streams and Rivers
☐ Wetlands and Lakes
— Roads
☐ High Risk Area
☐ Medium Risk Area
☐ Low Risk Area
▨ Other ESAs

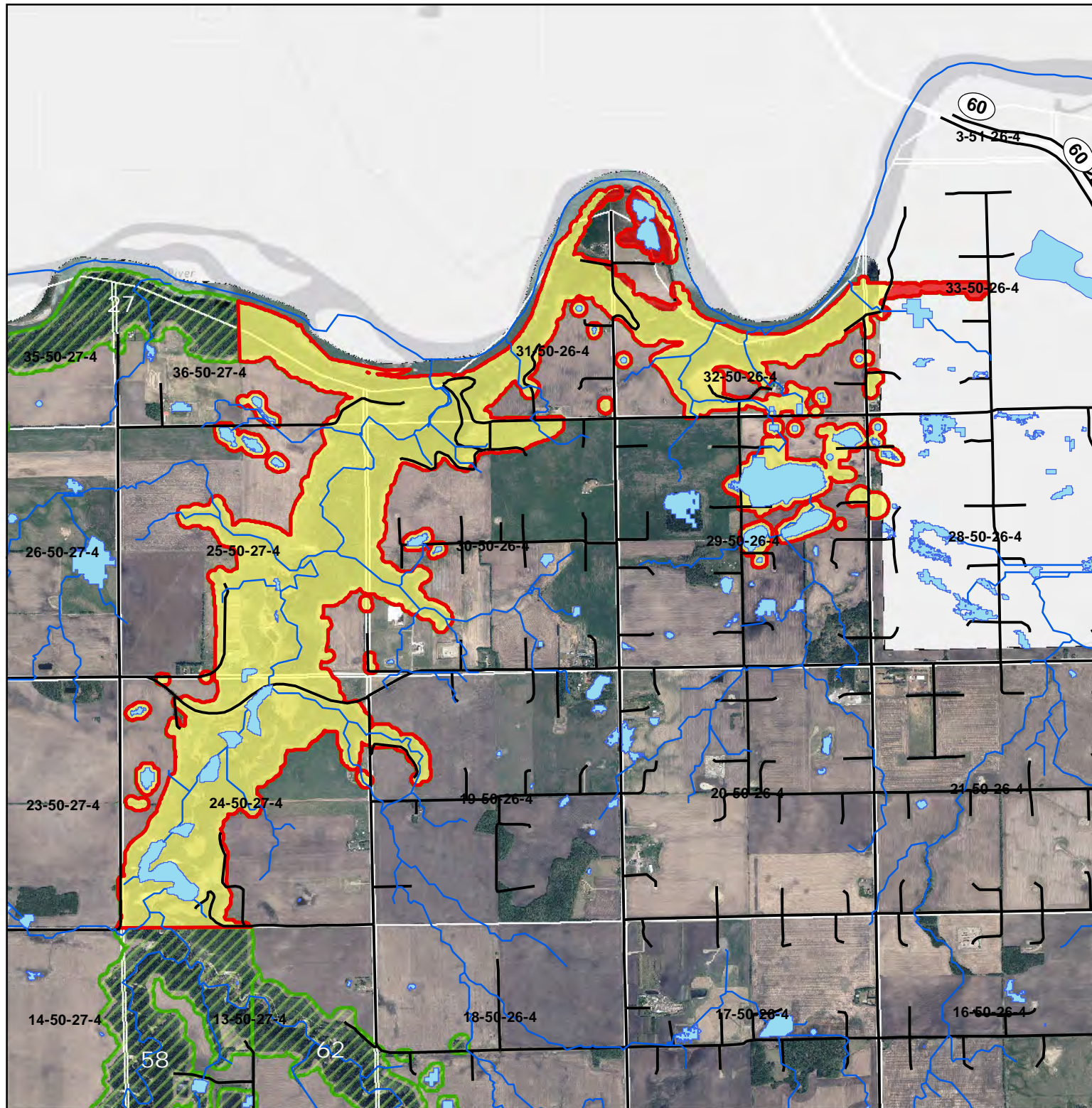Location of ESA Area

Km

0   0.125   0.25   0.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

13-49-1-5

14-49-28-4

12-49-1-5

11-49-28-4

A-46

ESA Number: 47

Weed Creek Area

ESA Type: Mixed
- Upland : 60.6%
- Aquatic : 38%
- Riparian : 3.2%

Disturbance Risk: Medium
- High : 0%
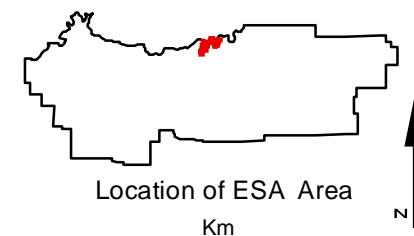- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 47

ESA Score: 32/100

Overall ESA Rank: 108/120

Area ESA Rank: 13/ 16

Legend

▭ Highlighted ESA
— Streams and Rivers
▭ Wetlands and Lakes
— Roads
▮ High Risk Area
▮ Medium Risk Area
▮ Low Risk Area
▨ Other ESAs

Location of ESA Area

Km

0   0.075   0.15   0.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

18-49-27-4

17-49-27-4

7-49-27-4

8-49-27-4

A-47

ESA Number: 48

Weed Creek Area

ESA Type: Mixed
- Upland : 76.6%
- Aquatic : 10.5%
- Riparian : 17.7%

Disturbance Risk: Medium
- High : 14.3%
- Moderate : 80.8%
- Low : 4.9%

ESA Area (ha): 1327

ESA Score: 67.6/100

Overall ESA Rank: 12/120

Area ESA Rank: 1/ 16

Legend

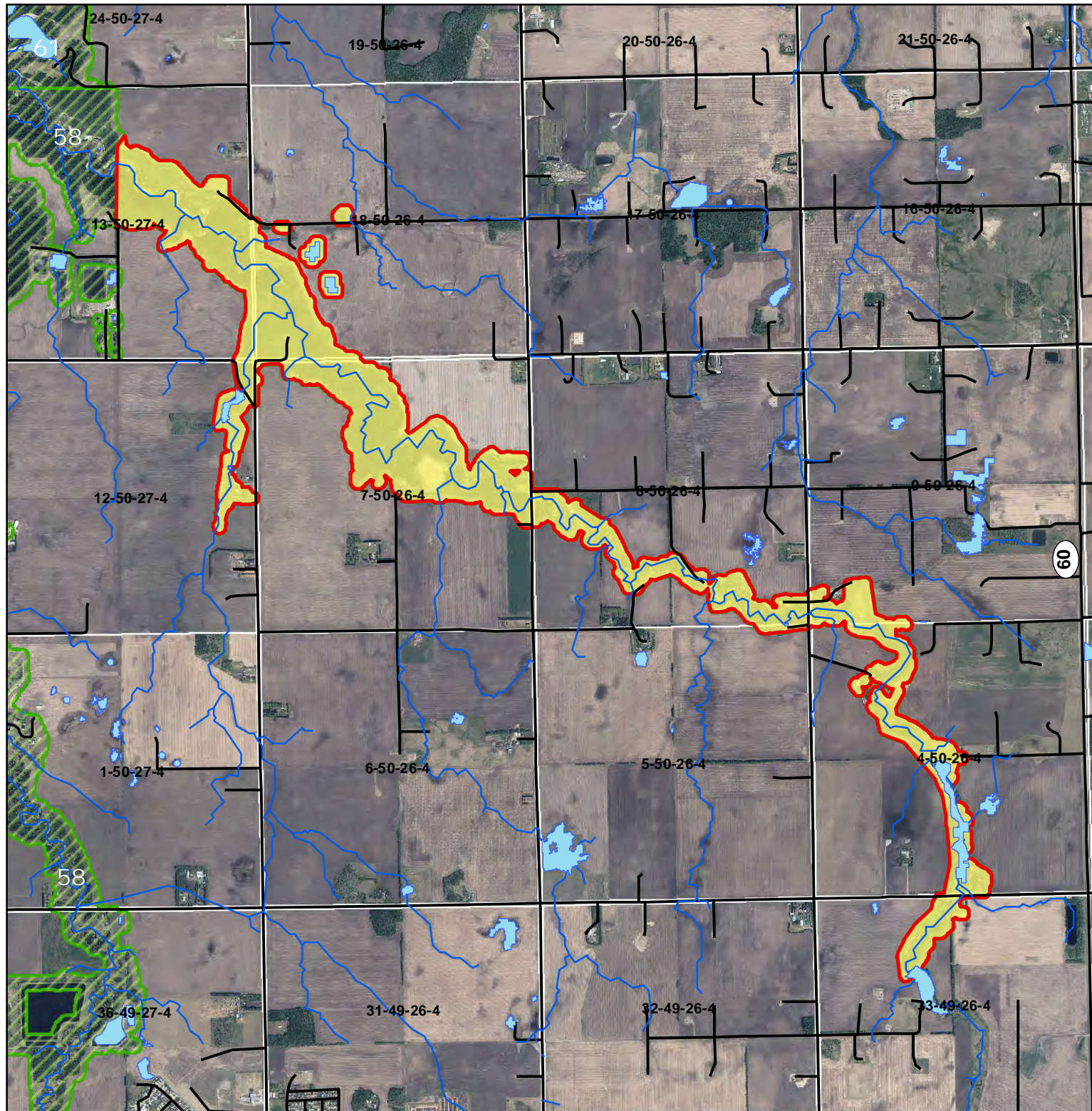|	
▭	Highlighted ESA
——	Streams and Rivers
▮	Wetlands and Lakes
——	Roads
▮	High Risk Area
▮	Medium Risk Area
▮	Low Risk Area
▨	Other ESAs

Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-48

ESA Number: 49

Weed Creek Area

ESA Type: Riparian
- Upland : 42.7%
- Aquatic : 16.4%
- Riparian : 56.1%

Disturbance Risk: Medium
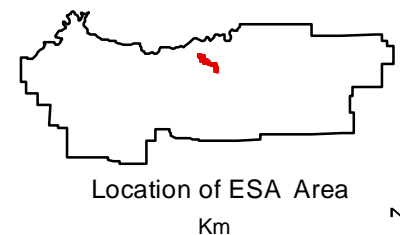- High : 0%
- Moderate : 99.9%
- Low : 0%

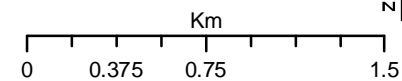ESA Area (ha): 94

ESA Score: 34.5/100

Overall ESA Rank: 94/120

Area ESA Rank: 9/ 16

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▦ Wetlands and Lakes
- — Roads
- ▦ High Risk Area
- ▦ Medium Risk Area
- ▦ Low Risk Area
- ▨ Other ESAs

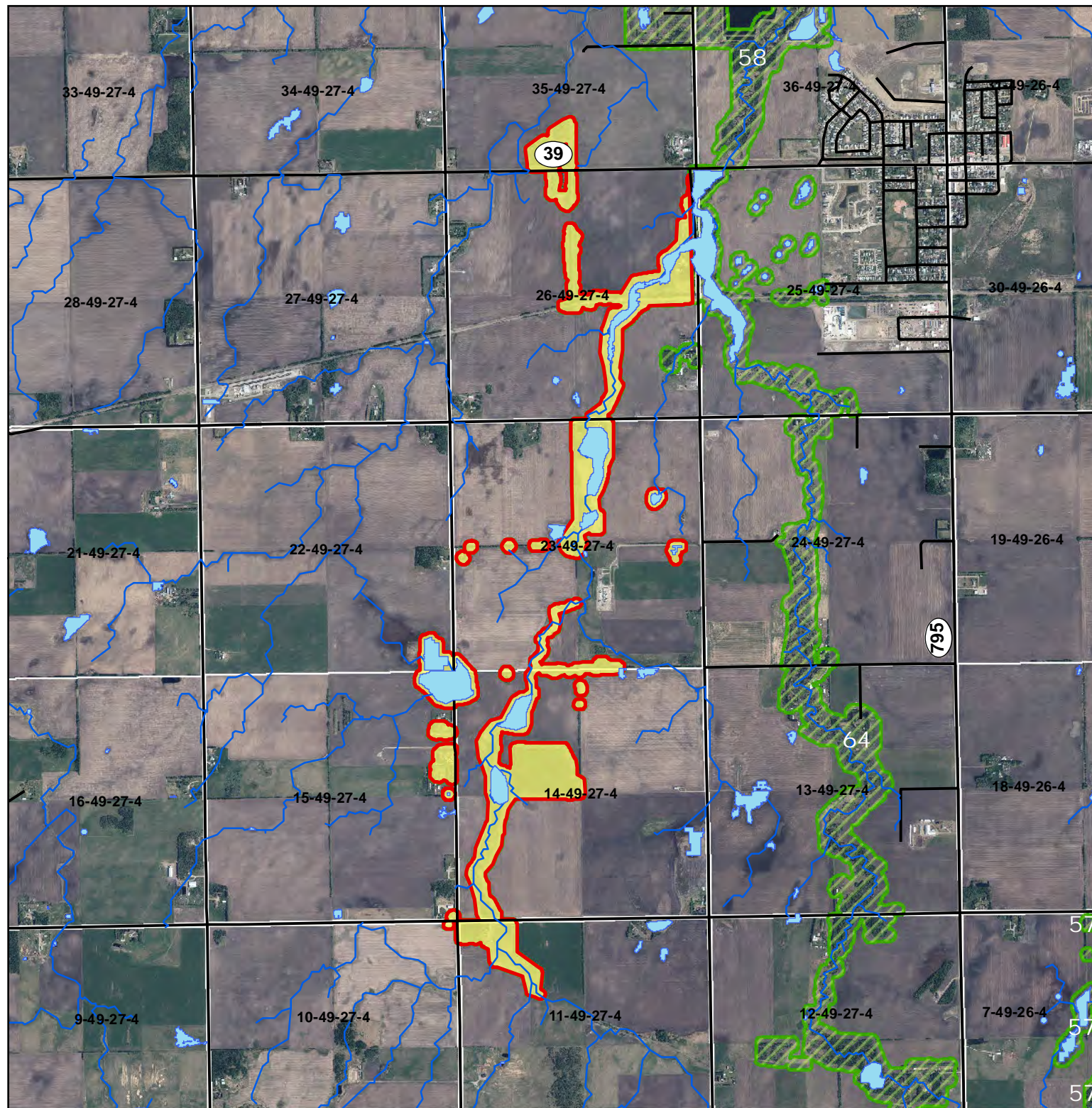Location of ESA Area

Km

0   0.2   0.4   0.6   0.8

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-49

ESA Number: 50

Weed Creek Area

ESA Type: Riparian
- Upland : 42.9%
- Aquatic : 11.1%
- Riparian : 50.3%

Disturbance Risk: Medium
- High : 0.3%
- Moderate : 99.6%
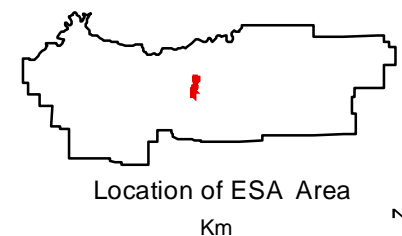- Low : 0%

ESA Area (ha): 1310

ESA Score: 52.5/100

Overall ESA Rank: 40/120

Area ESA Rank: 4/ 16

Legend

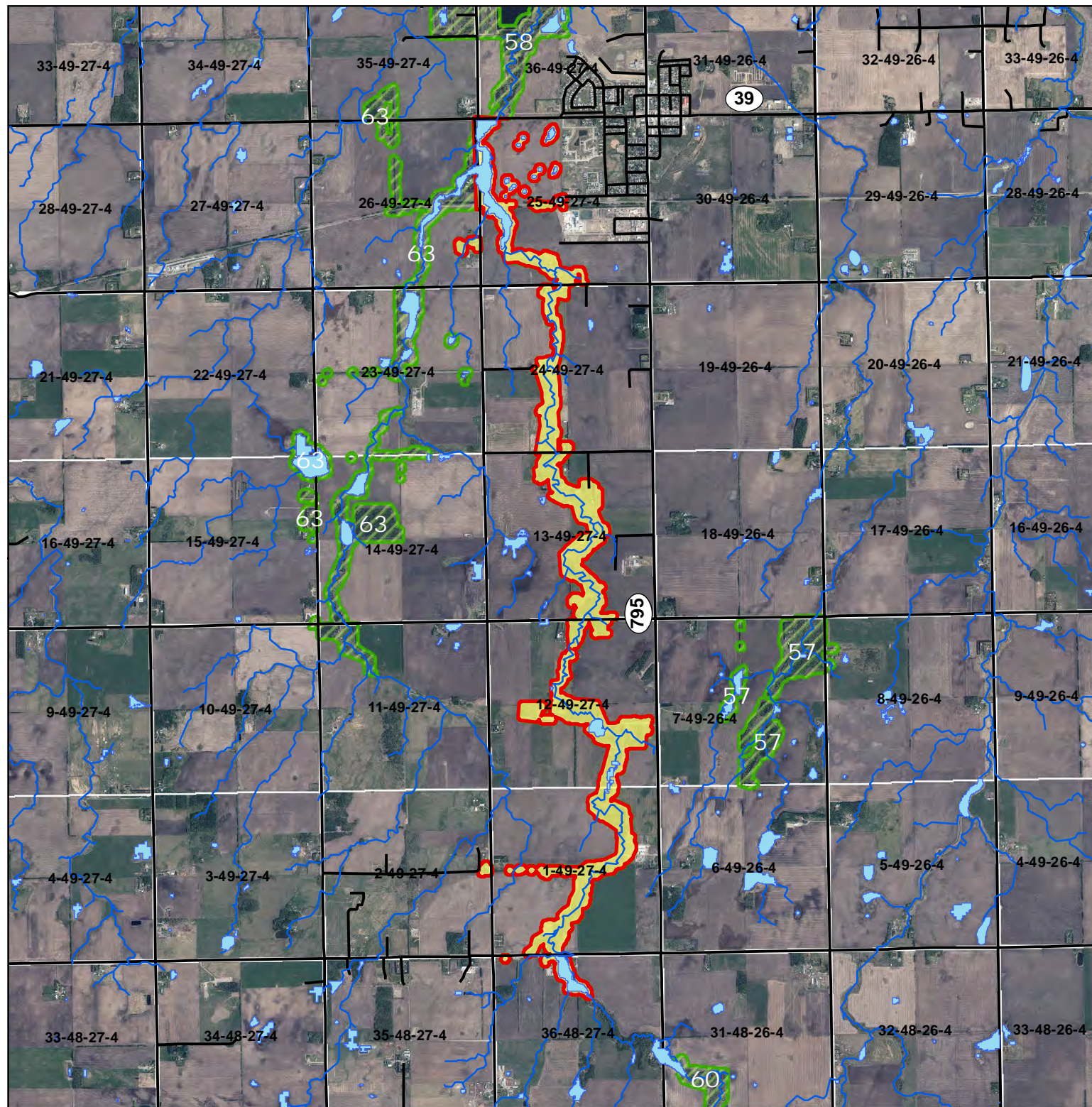|	
▭	Highlighted ESA
—	Streams and Rivers
▬	Wetlands and Lakes
—	Roads
▬	High Risk Area
▬	Medium Risk Area
▬	Low Risk Area
▨	Other ESAs

Location of ESA Area

Km

0   0.75   1.5   3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-50

ESA Number: 51

Weed Creek Area

ESA Type: Riparian
- Upland : 48.3%
- Aquatic : 23.1%
- Riparian : 38.8%

Disturbance Risk: Medium
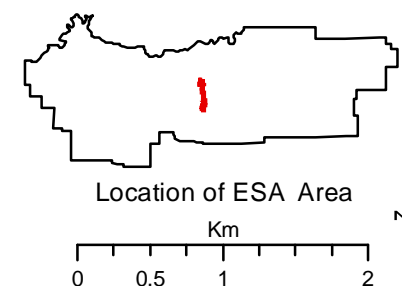- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 241

ESA Score: 54.2/100

Overall ESA Rank: 37/120

Area ESA Rank: 3/ 16

Legend

▭	Highlighted ESA
—	Streams and Rivers
▬	Wetlands and Lakes
—	Roads
▬	High Risk Area
▬	Medium Risk Area
▬	Low Risk Area
▨	Other ESAs

Location of ESA Area
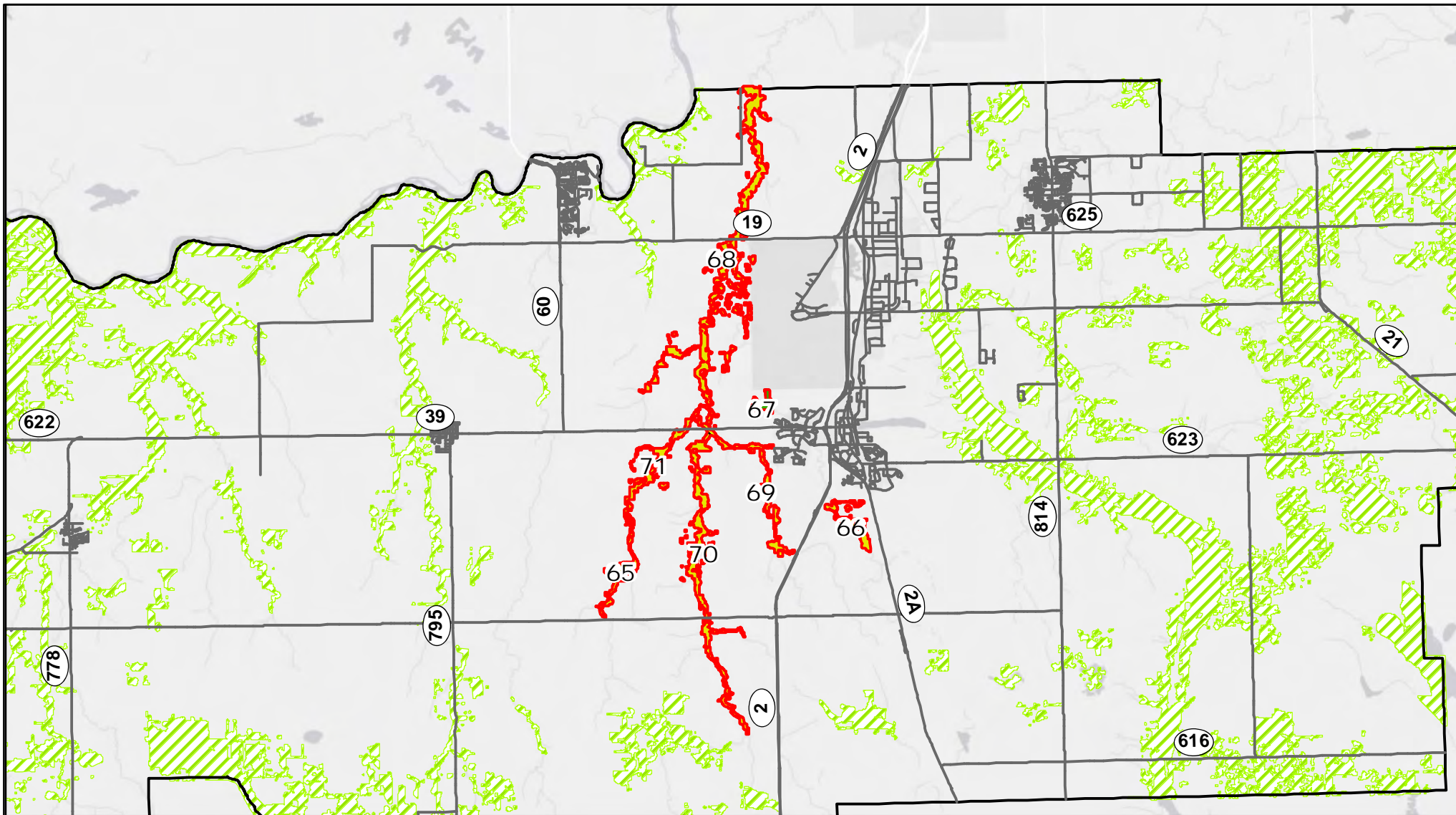
Km

0   0.3   0.6   1.2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
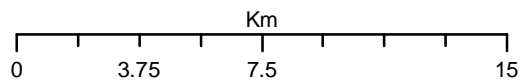Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-51

ESA Number: 52

Weed Creek Area

ESA Type: Riparian
- Upland : 55.1%
- Aquatic : 16.7%
- Riparian : 36.5%

Disturbance Risk: Medium
- High : 6.5%
- Moderate : 93.4%
- Low : 0%

ESA Area (ha): 674

ESA Score: 49.6/100

Overall ESA Rank: 46/120

Area ESA Rank: 5/ 16

Legend

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
Low Risk Area
Other ESAs

Location of ESA Area

Km

0   0.75   1.5   3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-52

ESA Number: 53

Weed Creek Area

ESA Type: Riparian
- Upland : 64.5%
- Aquatic : 12%
- Riparian : 30.4%

Disturbance Risk: Medium
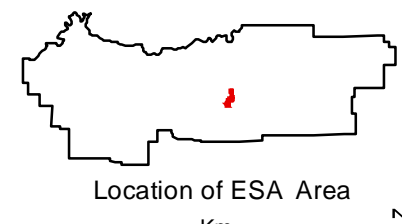- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 156

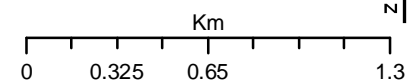ESA Score: 36.9/100

Overall ESA Rank: 78/120

Area ESA Rank: 8/ 16

Legend

- ⬛ Highlighted ESA
- — Streams and Rivers
- ⬛ Wetlands and Lakes
- — Roads
- ⬛ High Risk Area
- ⬛ Medium Risk Area
- ⬛ Low Risk Area
- ⬛ Other ESAs

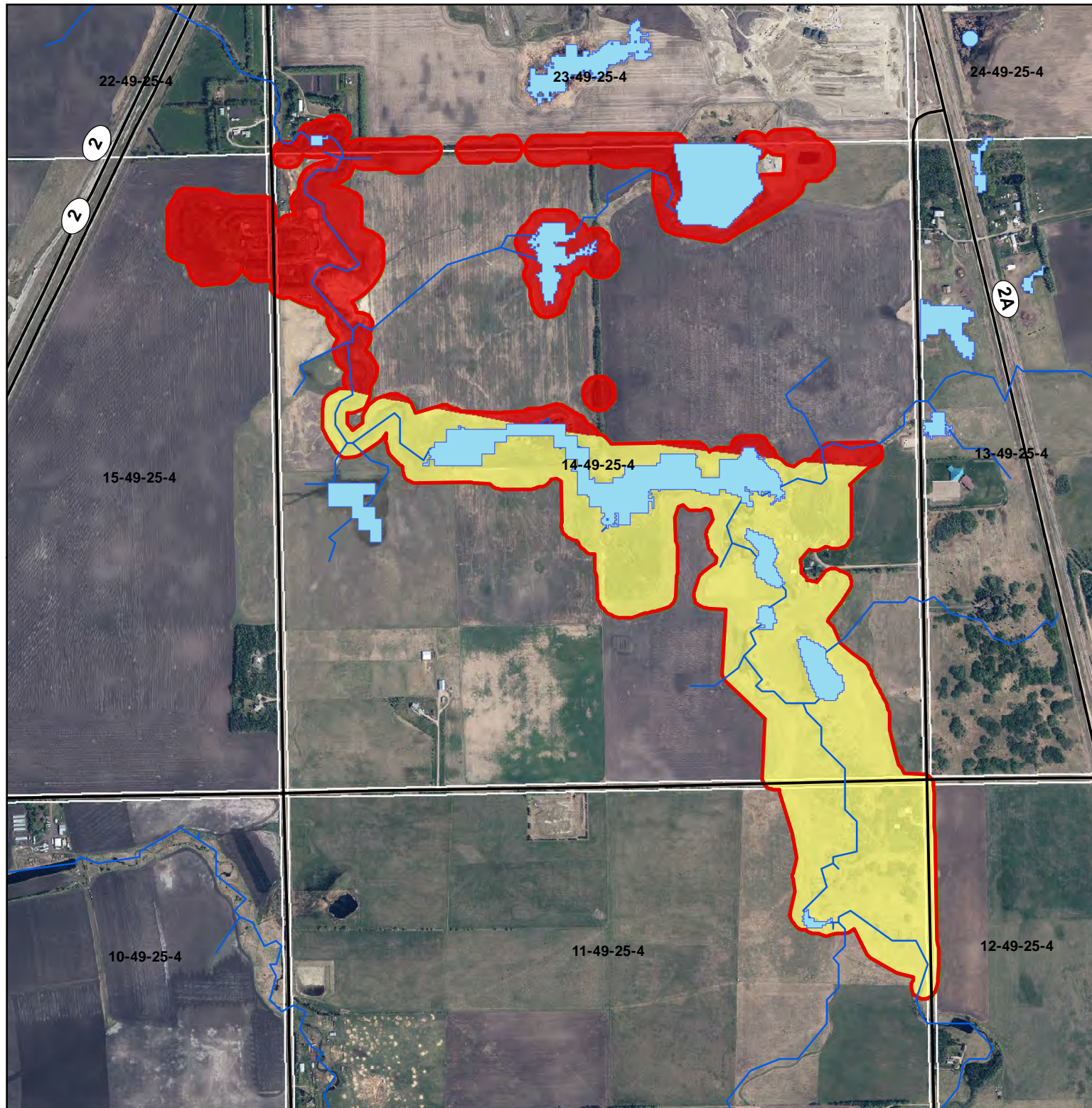Location of ESA Area

Km

0   0.3   0.6   1.2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-53

ESA Number: 54

Weed Creek Area

ESA Type: Mixed
- Upland : 69.4%
- Aquatic : 12.8%
- Riparian : 22.2%

Disturbance Risk: Medium
- High : 0.1%
- Moderate : 99.8%
- Low : 0%

ESA Area (ha): 392
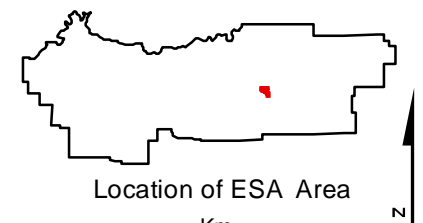
ESA Score: 44.7/100

Overall ESA Rank: 60/120

Area ESA Rank: 7/ 16

Legend

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
Low Risk Area
Other ESAs

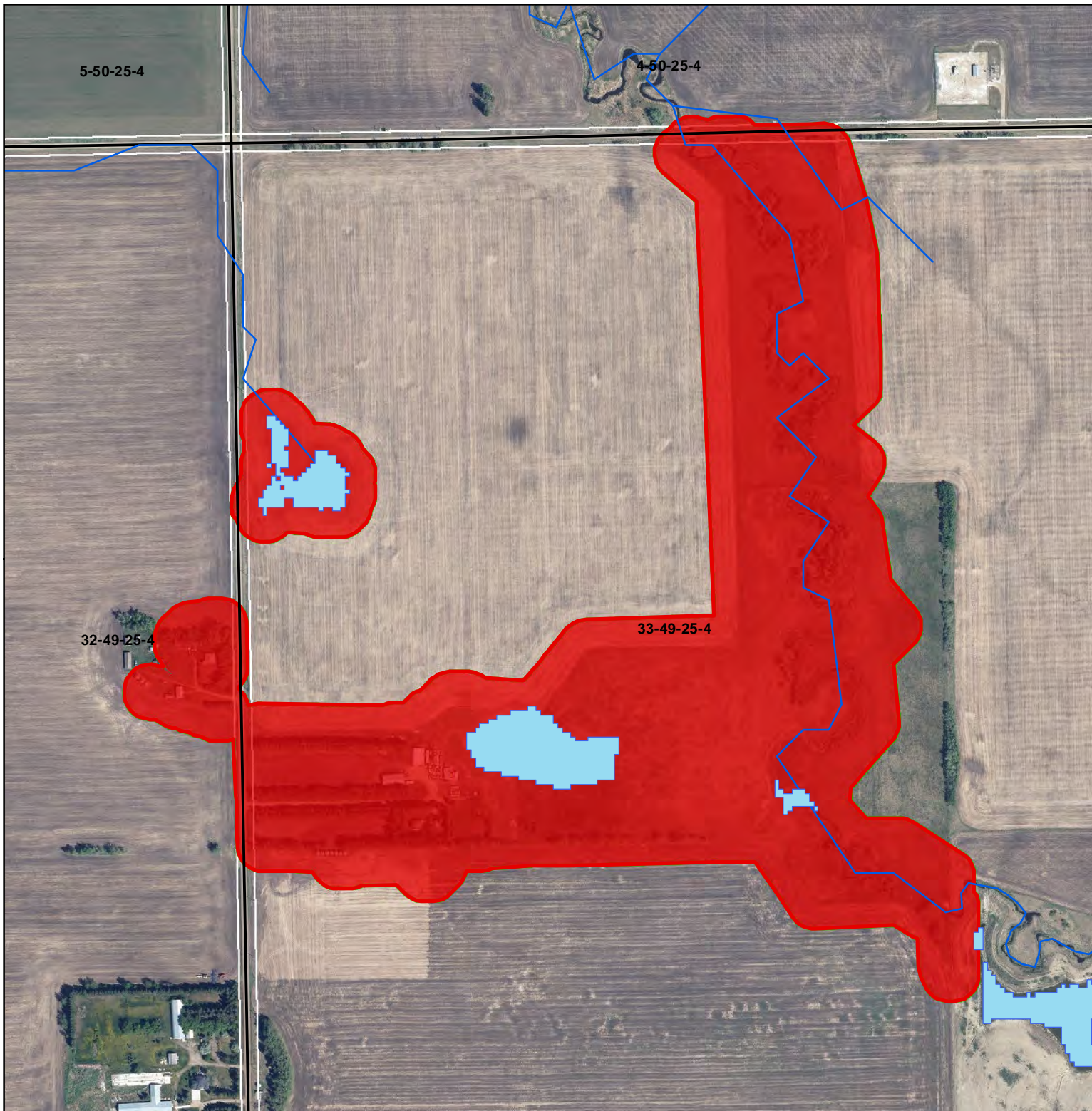Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

ESA Index Map of Wizard Lake Area

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

Major Roads
Highlighted ESA Area
Other ESA Areas
Leduc County 2014 Boundary

Km
0   1.25   2.5   5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area

ESA Number: 55

Wizard Lake Area

ESA Type: Mixed
- Upland : 67.8%
- Aquatic : 27%
- Riparian : 8.7%

Disturbance Risk: High
- High : 64.6%
- Moderate : 35.4%
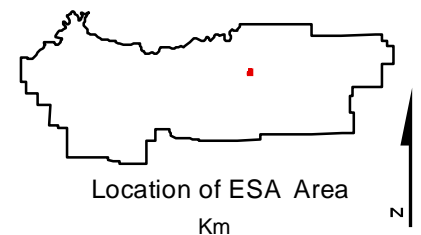- Low : 0%

ESA Area (ha): 2817

ESA Score: 72.8/100

Overall ESA Rank: 3/120

Area ESA Rank: 1/ 1

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs
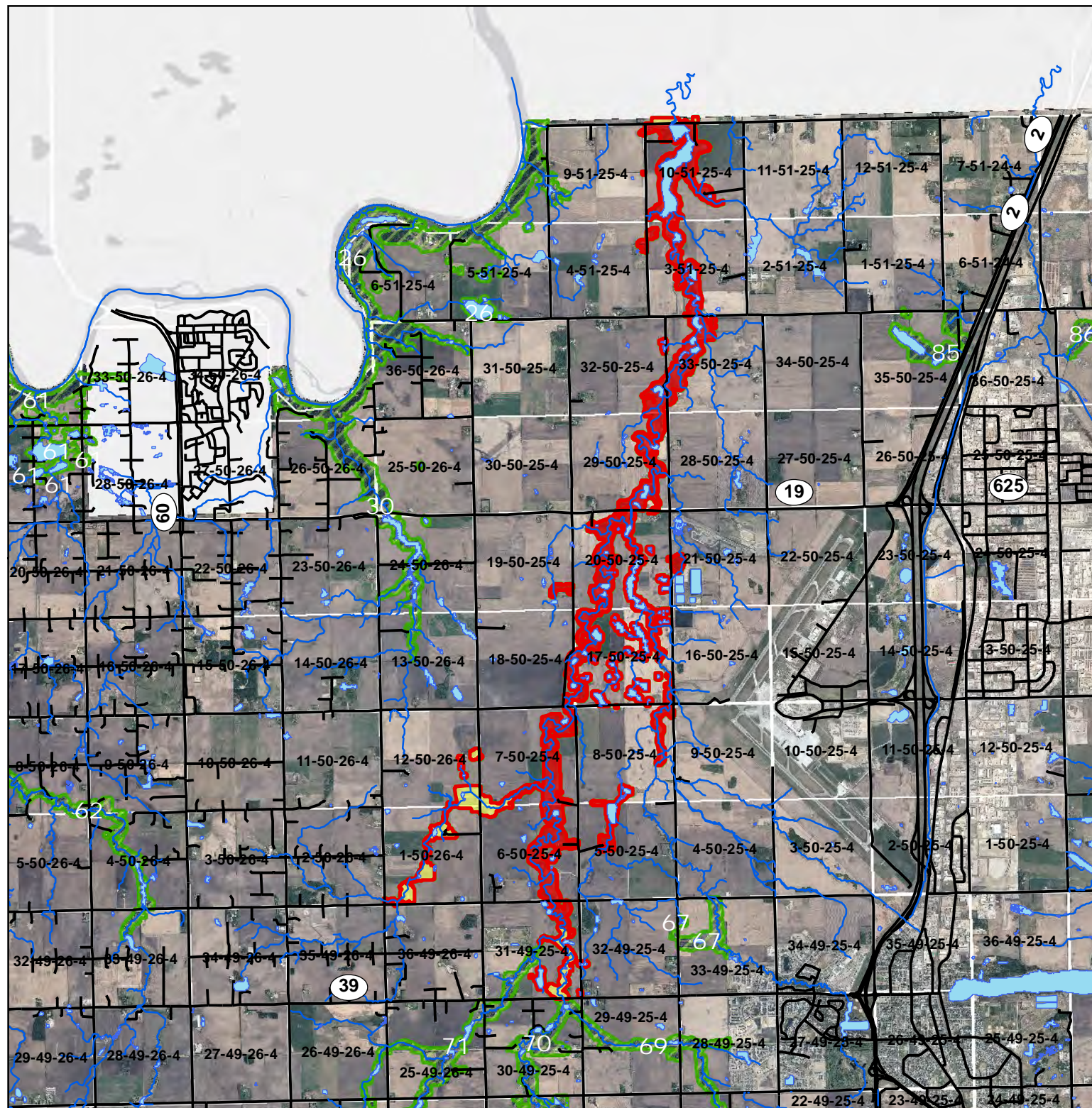
Location of ESA Area

Km

0   1.25   2.5   5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-55

ESA Index Map of Conjuring Creek Area

N

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

—— Major Roads

▭ Highlighted ESA Area

▨ Other ESA Areas

▭ Leduc County 2014 Boundary

Km

0   3.75   7.5   15

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area
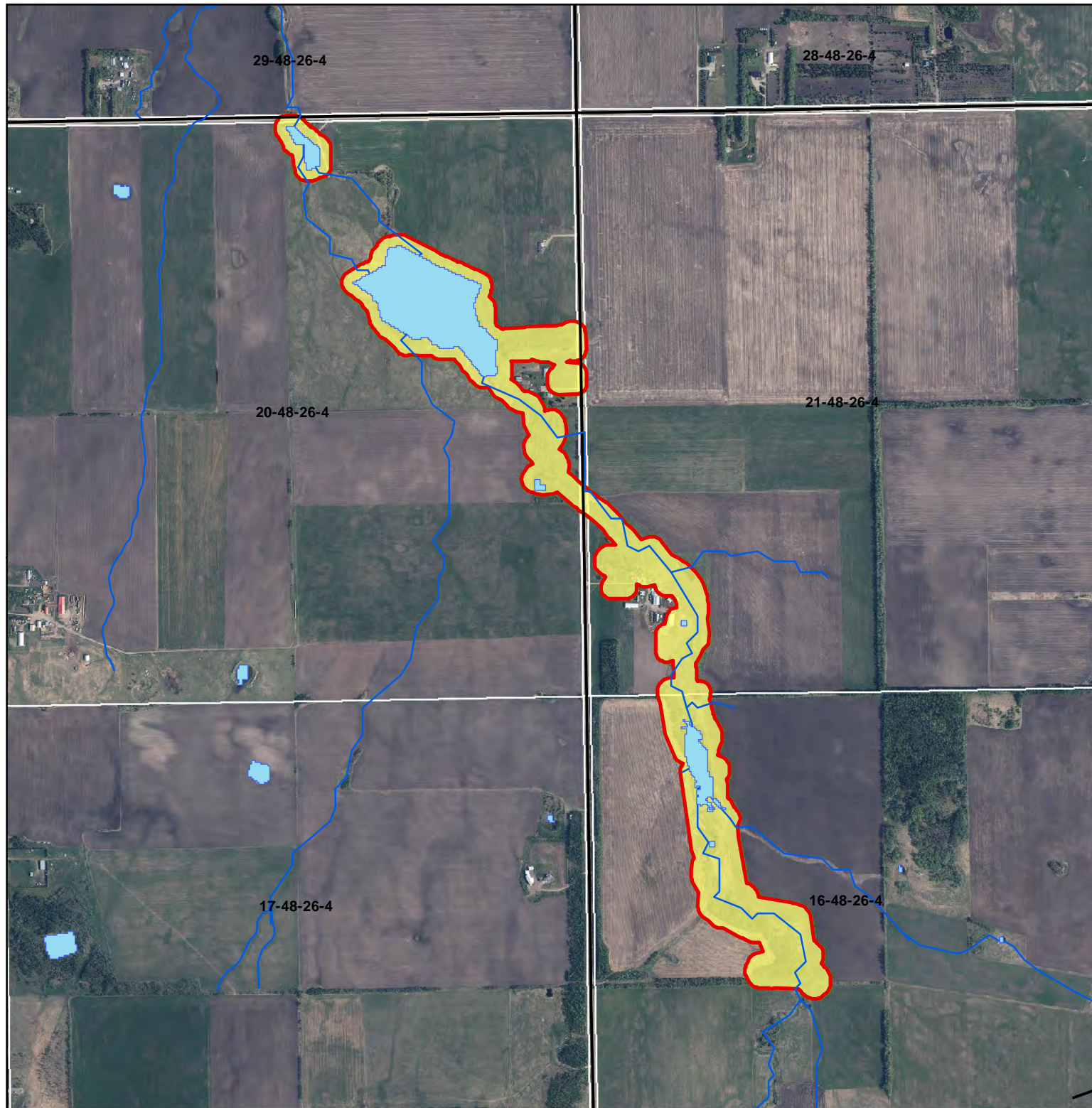
ESA Number: 56

Conjuring Creek Area

ESA Type: Riparian
- Upland : 21.5%
- Aquatic : 43.1%
- Riparian : 68.1%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 42
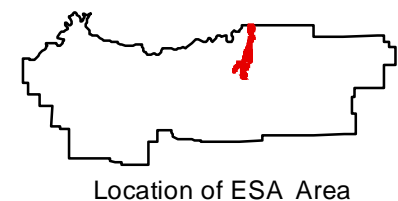
ESA Score: 31.5/100

Overall ESA Rank: 112/120
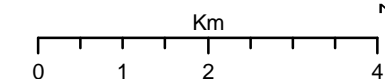
Area ESA Rank: 9/ 9

Legend

Highlighted ESA

Streams and Rivers

Wetlands and Lakes

Roads

High Risk Area

Medium Risk Area

Low Risk Area

Other ESAs

Location of ESA Area

Km

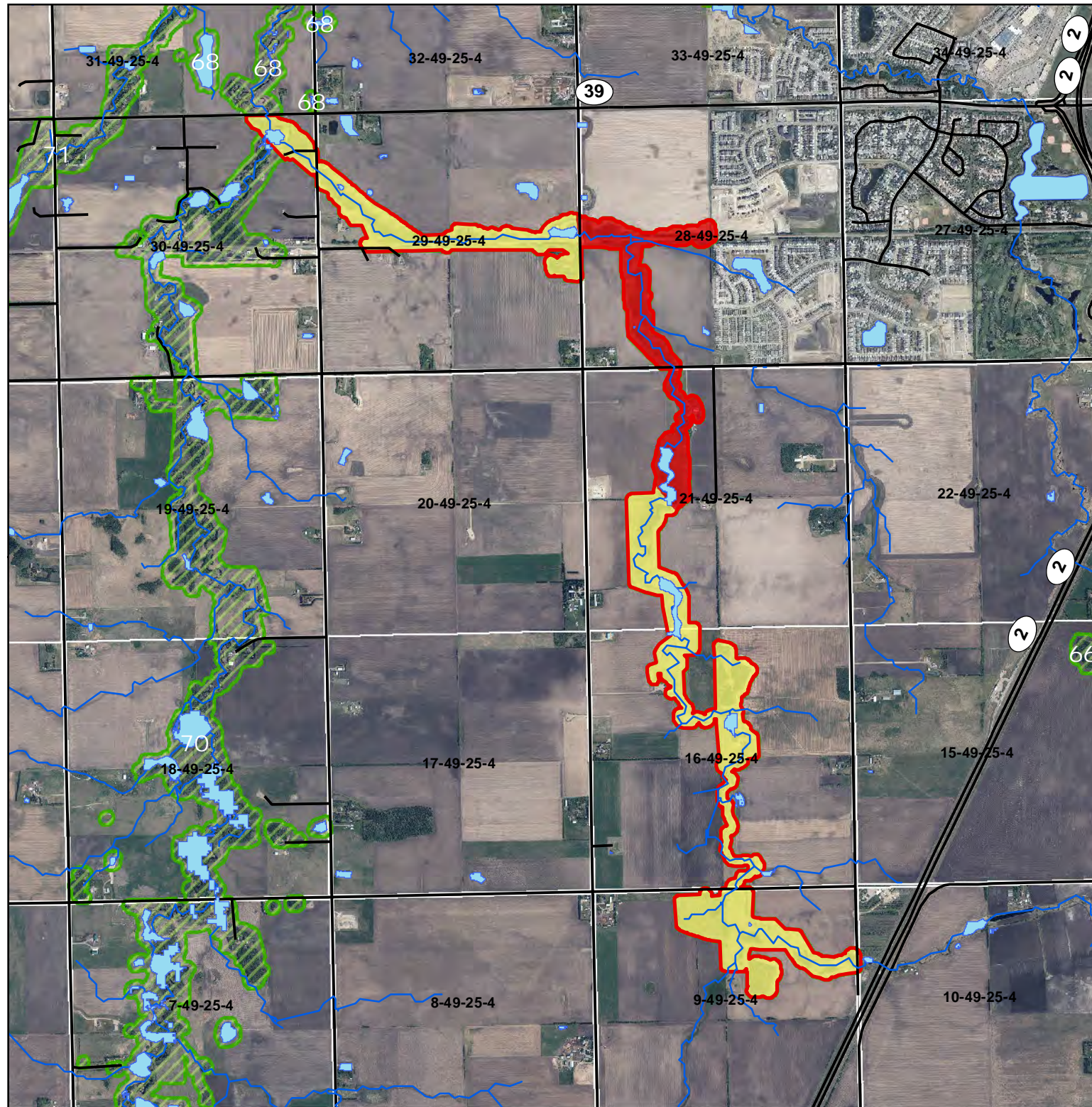0   0.175   0.35   0.7

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

29-48-26-4

28-48-26-4

20-48-26-4

21-48-26-4

17-48-26-4

16-48-26-4

ESA Number: 57

Conjuring Creek Area

ESA Type: Mixed
- Upland : 63.4%
- Aquatic : 15.8%
- Riparian : 29.4%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
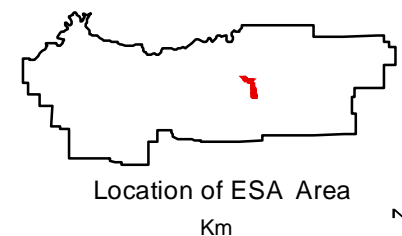- Low : 0%

ESA Area (ha): 59

ESA Score: 33.5/100

Overall ESA Rank: 101/120

Area ESA Rank: 8/ 9

Legend

⬛ Highlighted ESA
— Streams and Rivers
🟦 Wetlands and Lakes
— Roads
🟥 High Risk Area
🟨 Medium Risk Area
🟩 Low Risk Area
▨ Other ESAs

Location of ESA Area

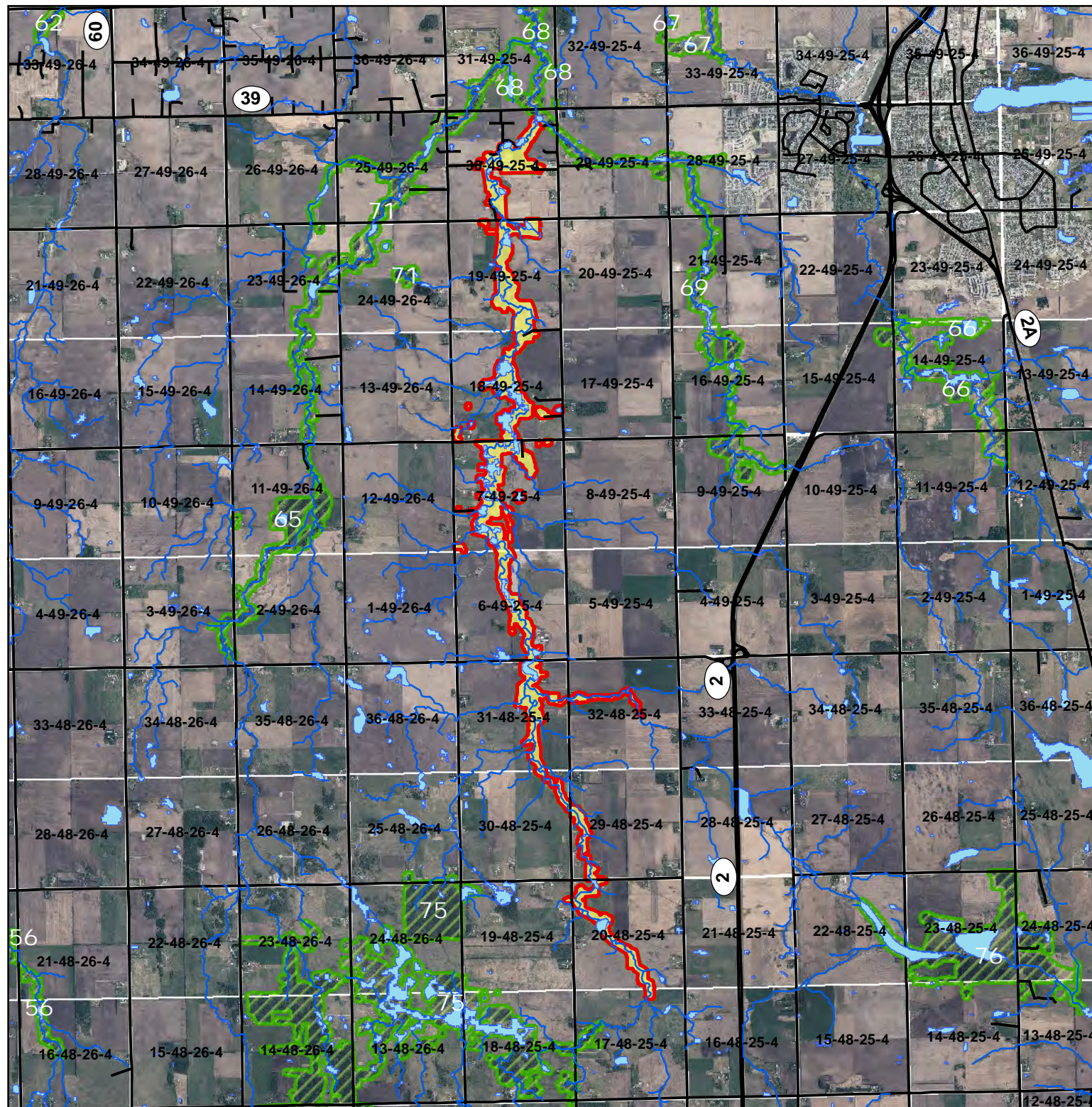Km

0   0.125   0.25   0.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

18-49-26-4   17-49-26-4

7-49-26-4   8-49-26-4

6-49-26-4   5-49-26-4

ESA Number: 58

Conjuring Creek Area

ESA Type: Riparian
- Upland : 55.1%
- Aquatic : 5.5%
- Riparian : 40.5%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
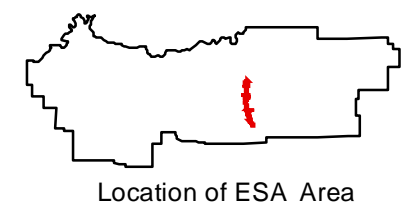- Low : 0%

ESA Area (ha): 381
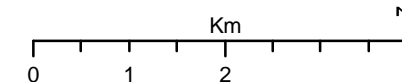
ESA Score: 63.1/100

Overall ESA Rank: 19/120

Area ESA Rank: 2/ 9

Legend

▭	Highlighted ESA
—	Streams and Rivers
▮	Wetlands and Lakes
—	Roads
▮	High Risk Area
▮	Medium Risk Area
▮	Low Risk Area
▨	Other ESAs

Location of ESA Area
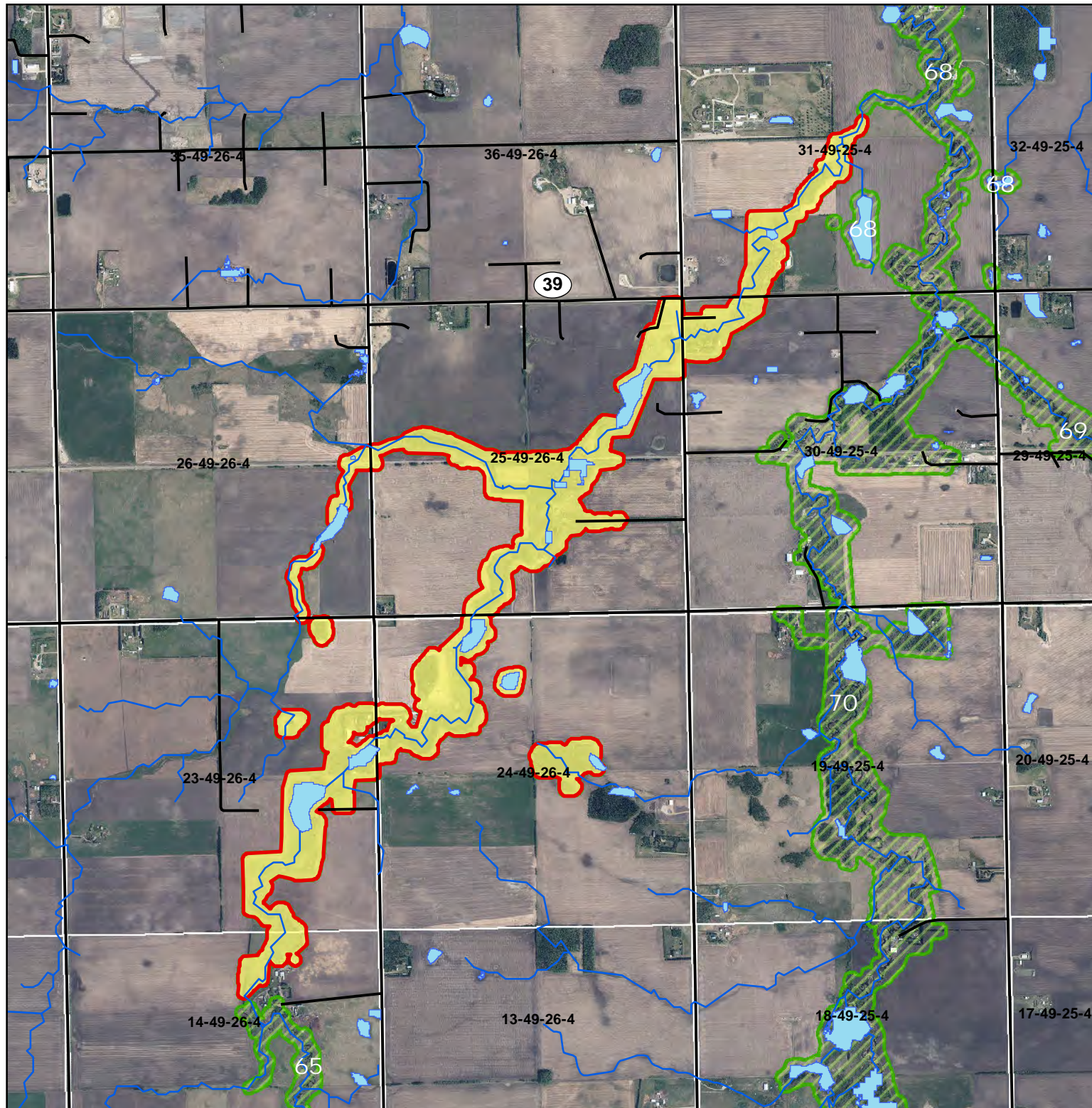
Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-58

ESA Number: 59

Conjuring Creek Area

ESA Type: Mixed
- Upland : 43%
- Aquatic : 49.7%
- Riparian : 15.2%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 140

ESA Score: 40.8/100

Overall ESA Rank: 69/120

Area ESA Rank: 4/ 9

Legend

⬜ Highlighted ESA
— Streams and Rivers
⬛ Wetlands and Lakes
— Roads
🟥 High Risk Area
🟨 Medium Risk Area
🟩 Low Risk Area
▨ Other ESAs

Location of ESA Area

Km

0   0.15   0.3   0.6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-59

ESA Number: 60

Conjuring Creek Area

ESA Type: Riparian
- Upland : 44.1%
- Aquatic : 28.6%
- Riparian : 42.6%

Disturbance Risk: Medium
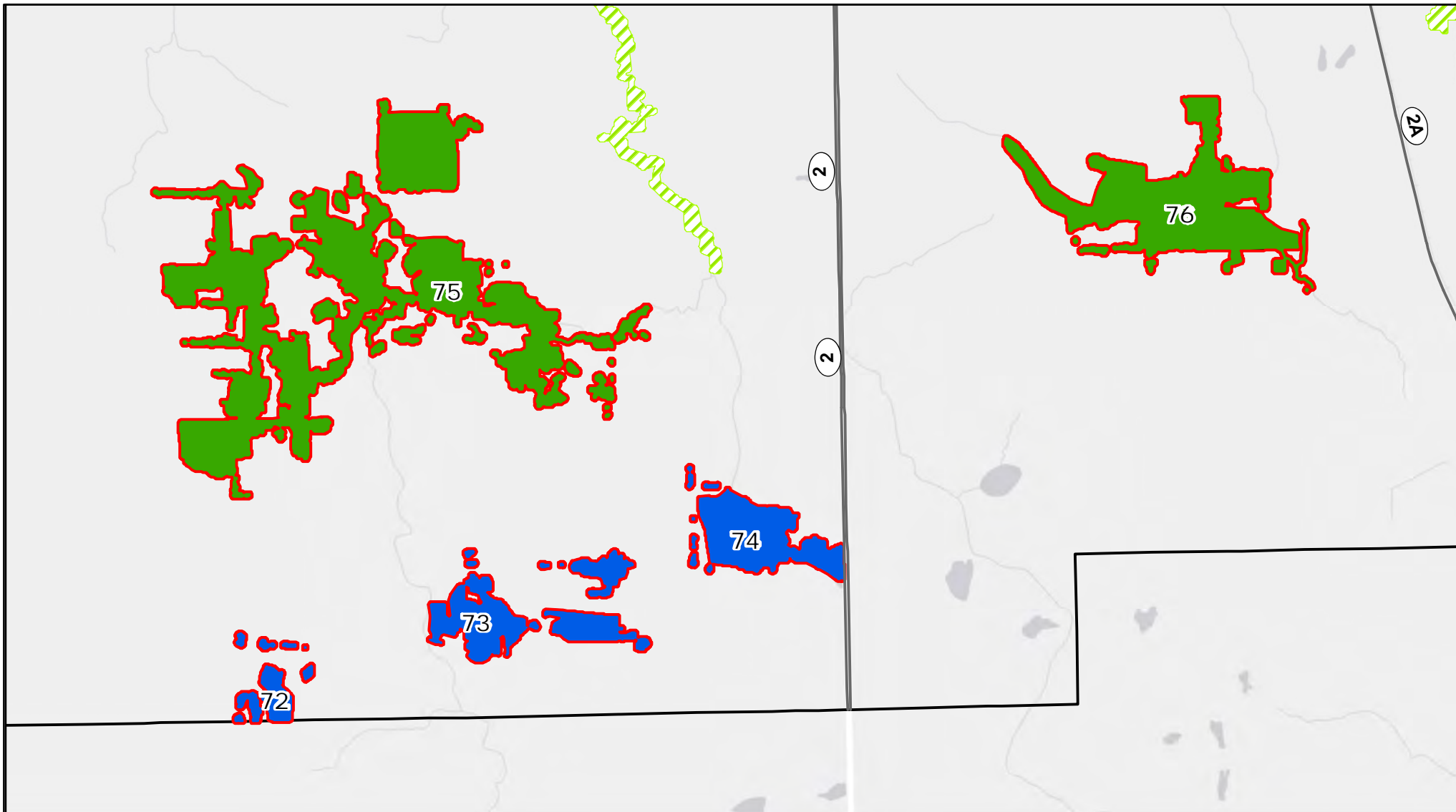- High : 6.3%
- Moderate : 93.6%
- Low : 0%

ESA Area (ha): 312

ESA Score: 46.2/100

Overall ESA Rank: 51/120

Area ESA Rank: 3/ 9

Legend

▭ Highlighted ESA
— Streams and Rivers
▨ Wetlands and Lakes
— Roads
▮ High Risk Area
▮ Medium Risk Area
▮ Low Risk Area
▨ Other ESAs

Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
25/11/2014
Background Image: 2013 Air Photo
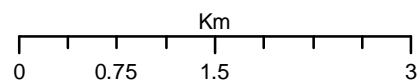Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-60

ESA Number: 61

Conjuring Creek Area

ESA Type: Mixed
- Upland : 59.4%
- Aquatic : 17.6%
- Riparian : 28.7%

Disturbance Risk: Medium
- High : 3.2%
- Moderate : 96.7%
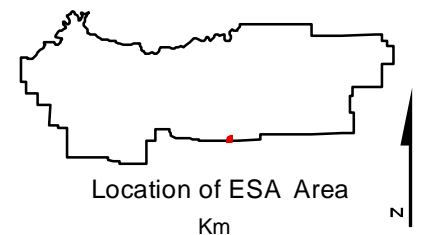- Low : 0%

ESA Area (ha): 543

ESA Score: 63.1/100

Overall ESA Rank: 19/120

Area ESA Rank: 2/ 9

Legend

▭ Highlighted ESA

— Streams and Rivers

▮ Wetlands and Lakes

— Roads

▮ High Risk Area

▮ Medium Risk Area

▮ Low Risk Area

▨ Other ESAs

Location of ESA Area

Km

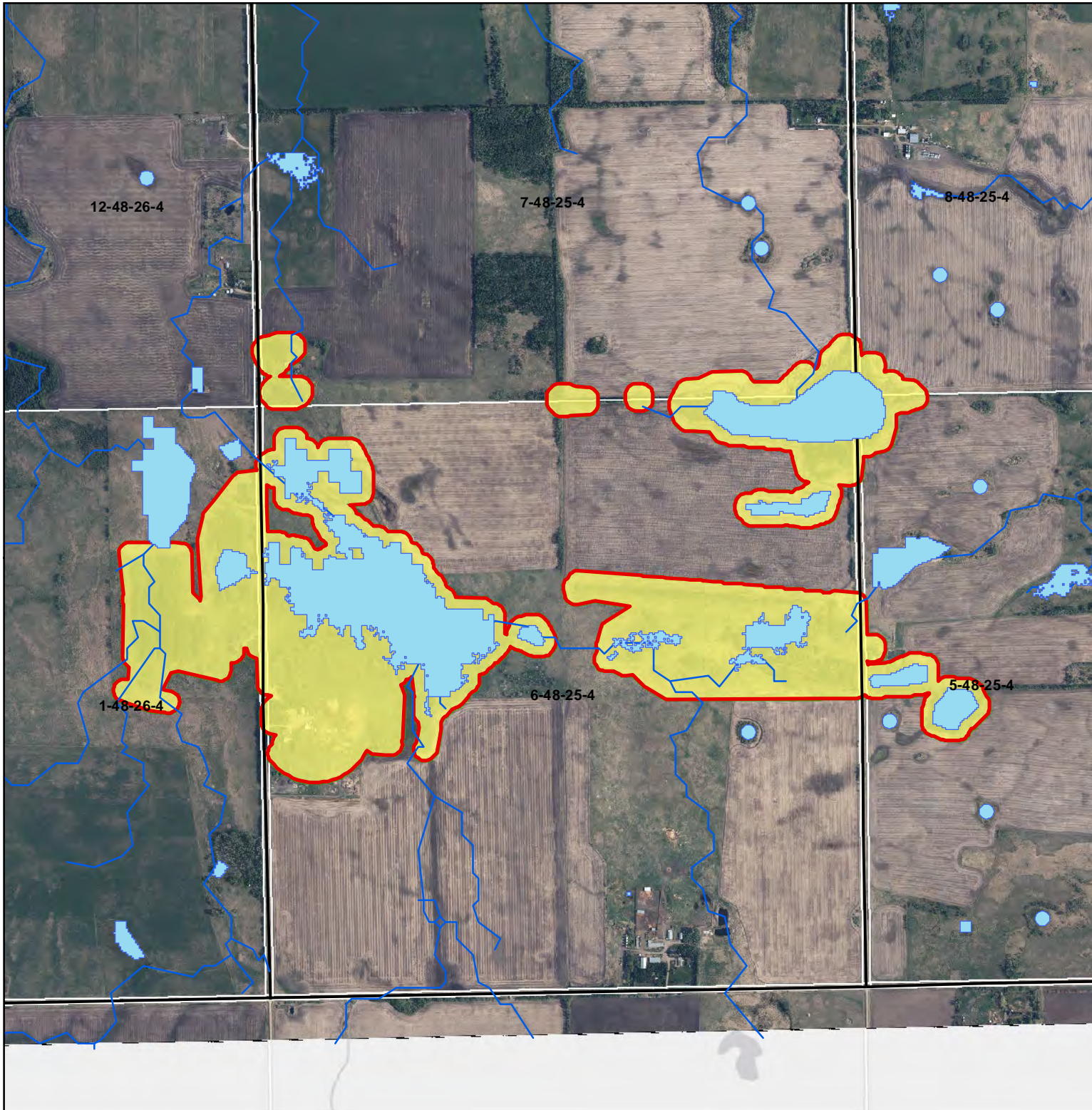0   0.425   0.85   1.7

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-61

ESA Number: 62

Conjuring Creek Area

ESA Type: Riparian
- Upland : 45.5%
- Aquatic : 7.8%
- Riparian : 51.6%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 231

ESA Score: 33.8/100

Overall ESA Rank: 100/120

Area ESA Rank: 7/ 9

Legend

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
Low Risk Area
Other ESAs

Location of ESA Area

Km

0   0.375   0.75   1.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-62

ESA Number: 63

Conjuring Creek Area

ESA Type: Riparian
- Upland : 46.7%
- Aquatic : 32.4%
- Riparian : 40.6%

Disturbance Risk: Medium
- High : 0%
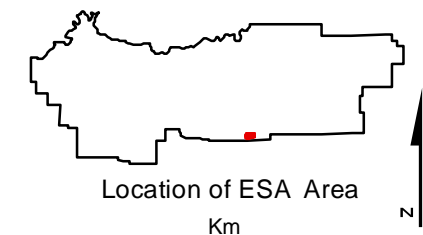- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 156

ESA Score: 36.4/100

Overall ESA Rank: 82/120

Area ESA Rank: 6/ 9

Legend

Highlighted ESA

Streams and Rivers

Wetlands and Lakes

Roads

High Risk Area

Medium Risk Area

Low Risk Area

Other ESAs
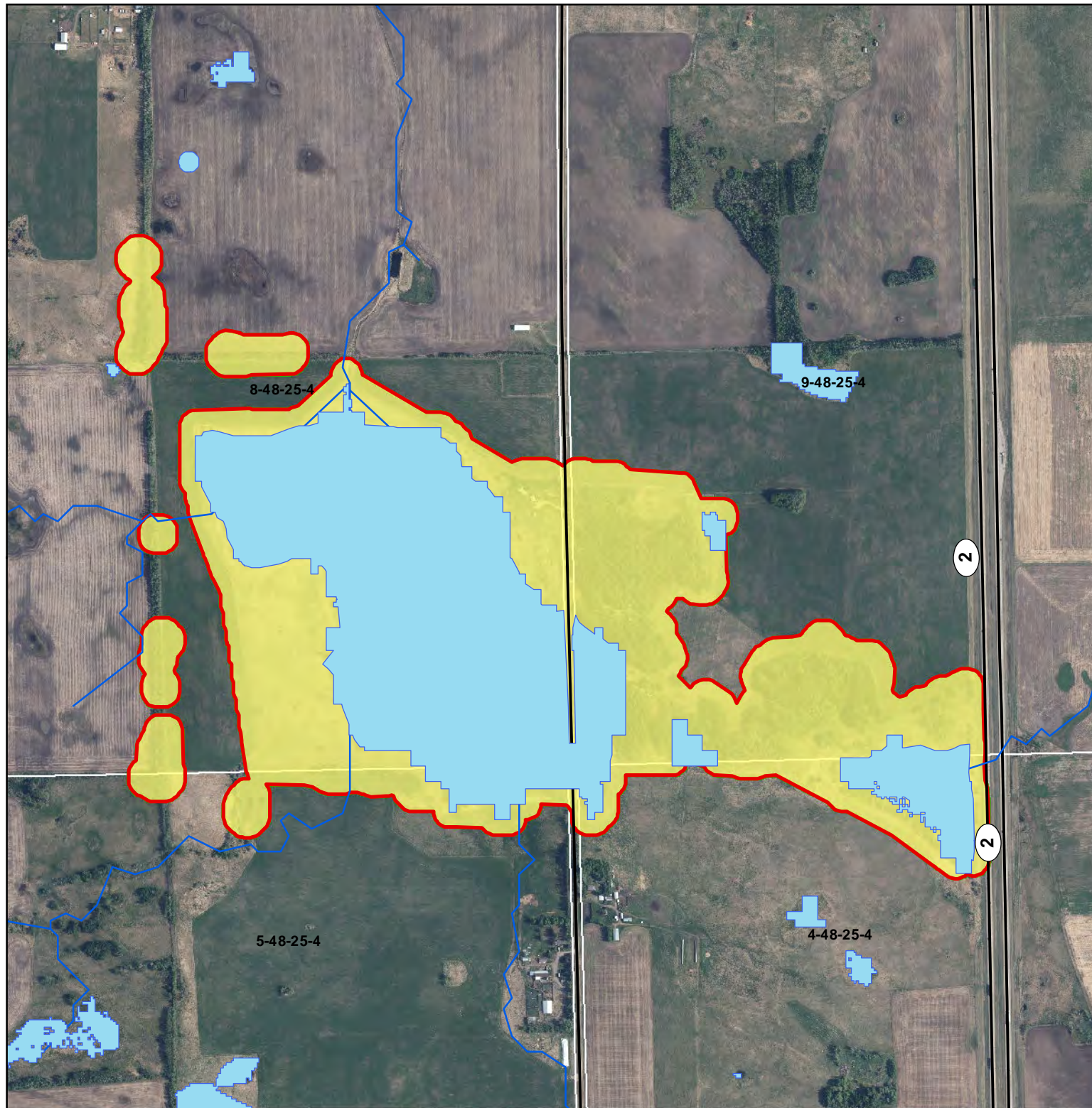
Location of ESA Area

Km

0   0.425   0.85   1.7

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-63

ESA Number: 64

Conjuring Creek Area

ESA Type: Riparian
- Upland : 37%
- Aquatic : 20.3%
- Riparian : 54.9%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
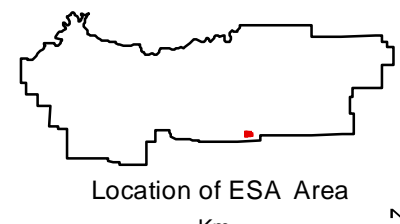- Low : 0%

ESA Area (ha): 251
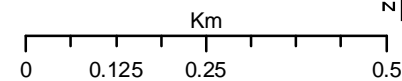
ESA Score: 39.6/100

Overall ESA Rank: 75/120

Area ESA Rank: 5/ 9

Legend

⬛ Highlighted ESA

— Streams and Rivers

🟦 Wetlands and Lakes

— Roads

🟥 High Risk Area

🟨 Medium Risk Area

🟩 Low Risk Area

▨ Other ESAs

Location of ESA Area
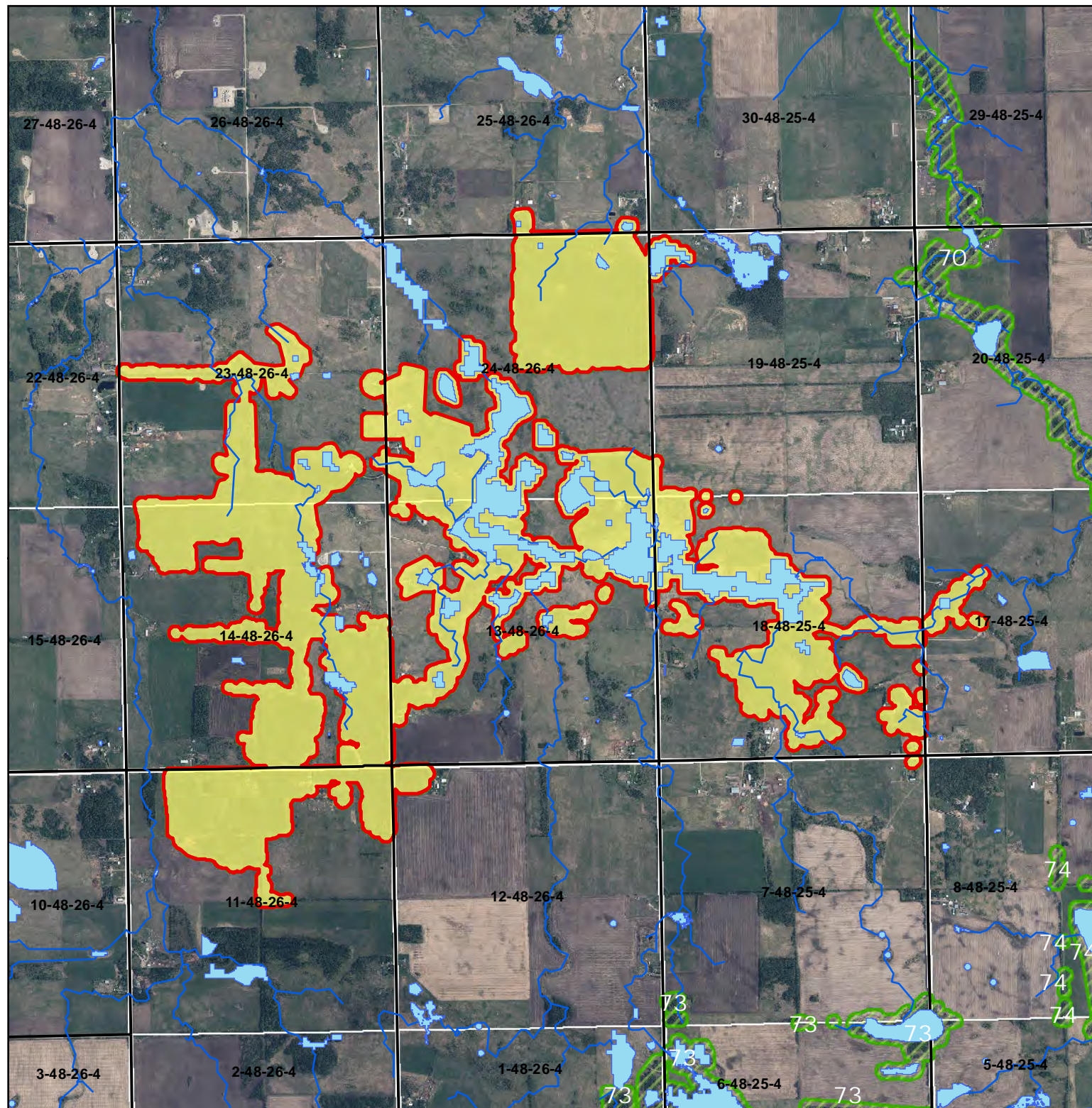
Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-64

ESA Index Map of
Whitemud Creek Area

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

— Major Roads

Highlighted ESA Area

Other ESA Areas

Leduc County 2014 Boundary

Km

0   3.75   7.5   15

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area

N
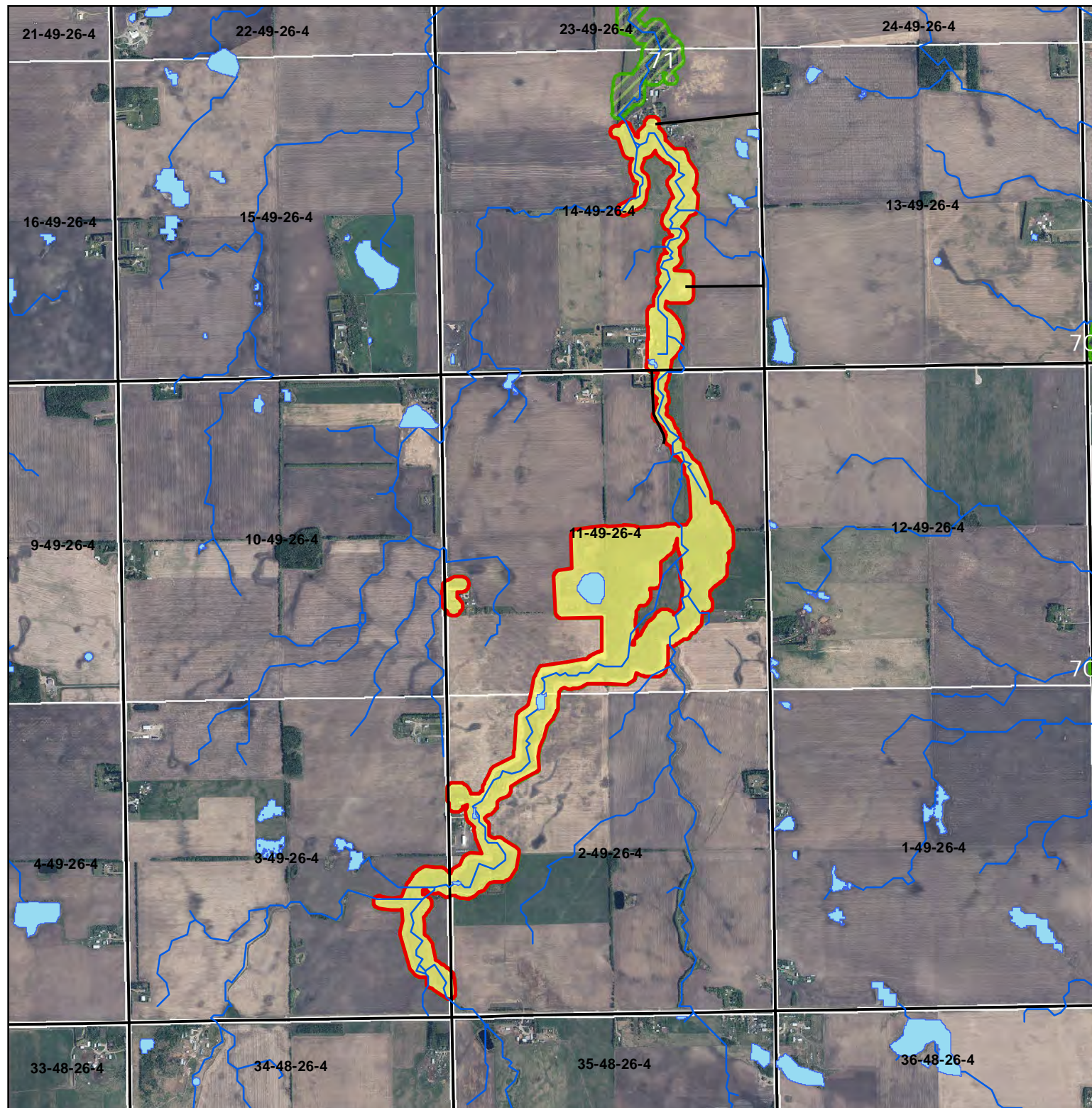
ESA Number: 65

Whitemud Creek Area

ESA Type: Riparian
- Upland : 43.3%
- Aquatic : 6.4%
- Riparian : 53%

Disturbance Risk: Medium
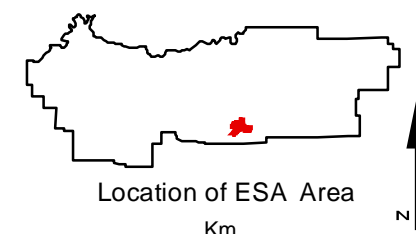- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 110

ESA Score: 30.9/100

Overall ESA Rank: 117/120

Area ESA Rank: 7/ 7

Legend

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
Low Risk Area
Other ESAs

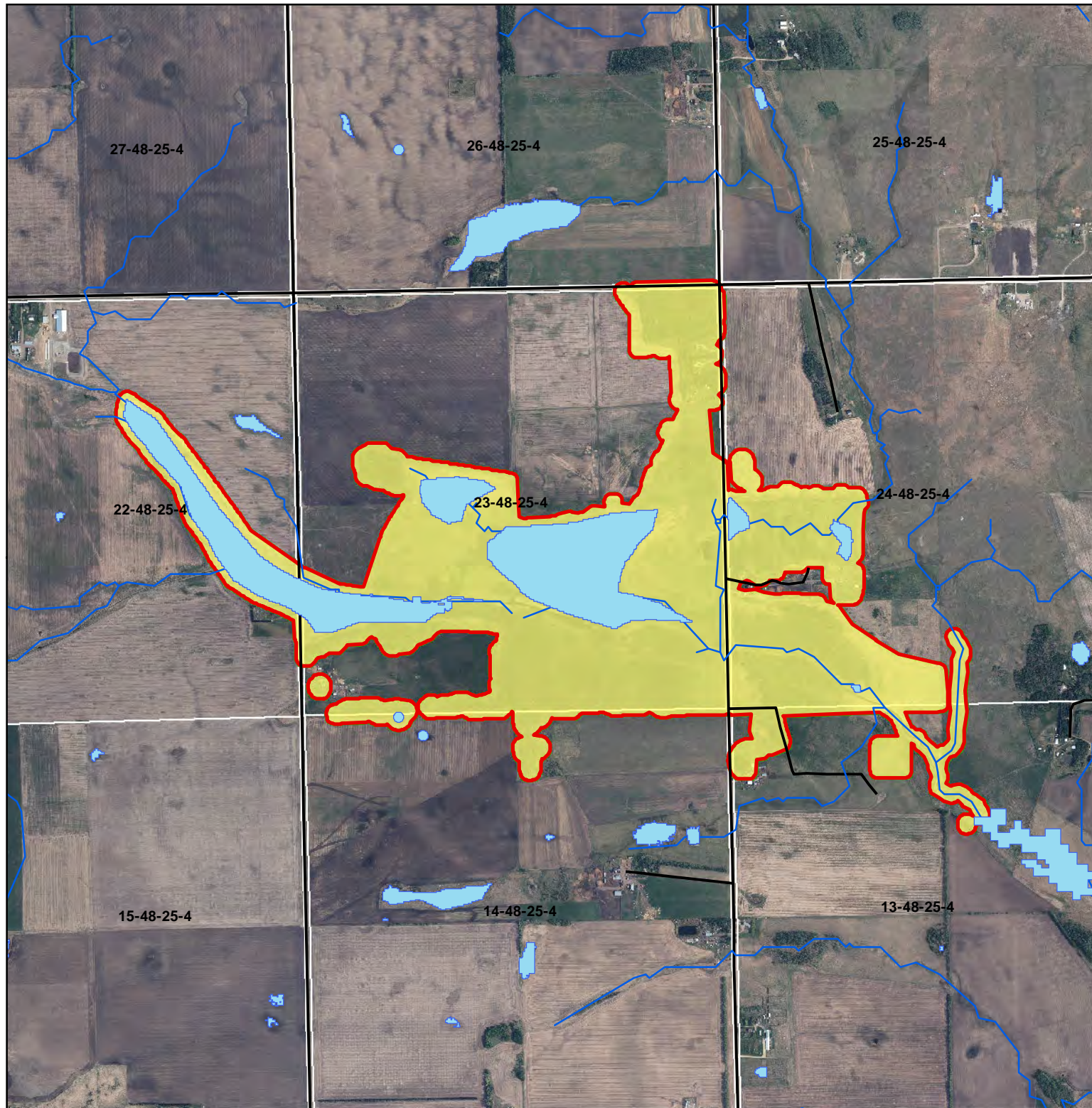Location of ESA Area

Km

0   0.325   0.65   1.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-65

ESA Number: 66

Whitemud Creek Area

ESA Type: Riparian
- Upland : 50.5%
- Aquatic : 30.4%
- Riparian : 34%

Disturbance Risk: Medium
- High : 35.6%
- Moderate : 64.3%
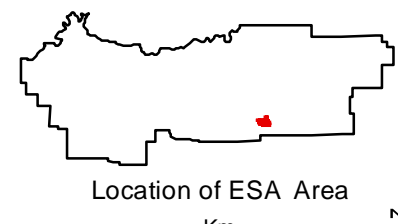- Low : 0%

ESA Area (ha): 102
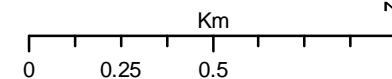
ESA Score: 40.4/100

Overall ESA Rank: 71/120

Area ESA Rank: 3/ 7

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area
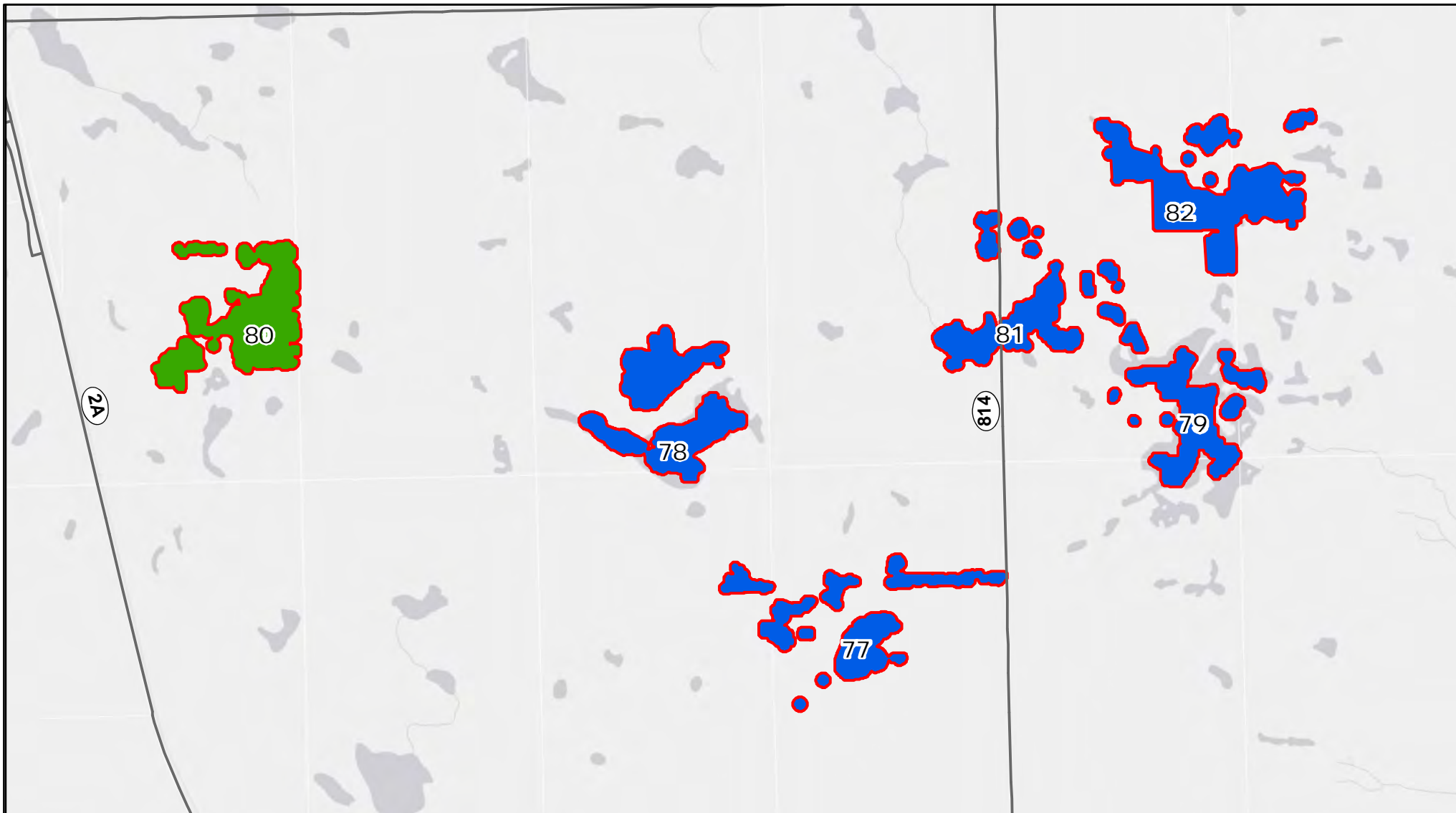
Km

0   0.15   0.3   0.6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
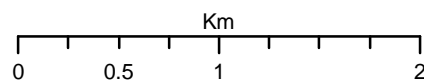Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-66

ESA Number: 67

Whitemud Creek Area

ESA Type: Mixed
- Upland : 61.3%
- Aquatic : 17.5%
- Riparian : 26.2%

Disturbance Risk: High
- High : 99.9%
- Moderate : 0%
- Low : 0%

ESA Area (ha): 37

ESA Score: 36.3/100

Overall ESA Rank: 85/120

Area ESA Rank: 4/ 7

Legend

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
Low Risk Area
Other ESAs

Location of ESA Area

Km

0   0.075   0.15   0.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-67

ESA Number: 68

Whitemud Creek Area

ESA Type: Riparian
- Upland : 28.9%
- Aquatic : 31%
- Riparian : 57.1%

Disturbance Risk: High
- High : 85.5%
- Moderate : 14.4%
- Low : 0%

ESA Area (ha): 732

ESA Score: 46.1/100

Overall ESA Rank: 52/120

Area ESA Rank: 1/ 7

Legend

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
Low Risk Area
Other ESAs

Location of ESA Area

Km

0   1   2   4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-68

ESA Number: 69

Whitemud Creek Area

ESA Type: Riparian
- Upland : 53.8%
- Aquatic : 11.7%
- Riparian : 42.1%

Disturbance Risk: Medium
- High : 22.6%
- Moderate : 77.3%
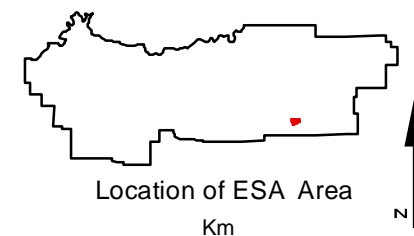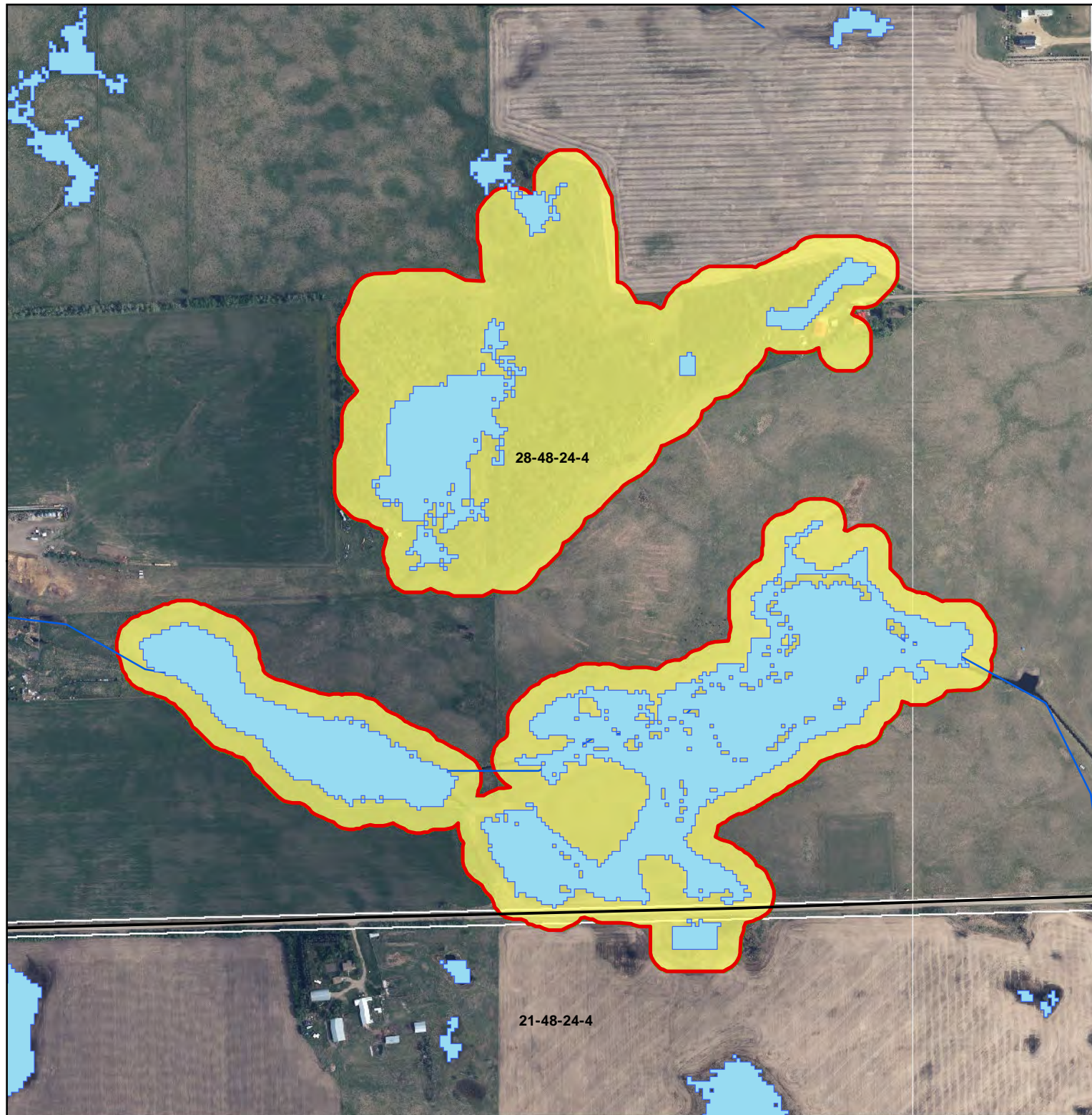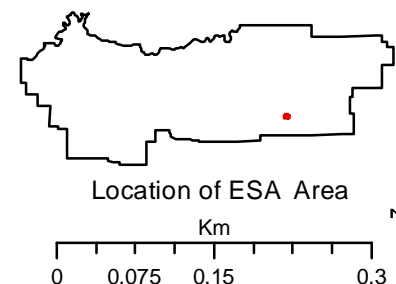- Low : 0%

ESA Area (ha): 164

ESA Score: 31.1/100

Overall ESA Rank: 115/120

Area ESA Rank: 6/ 7

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area
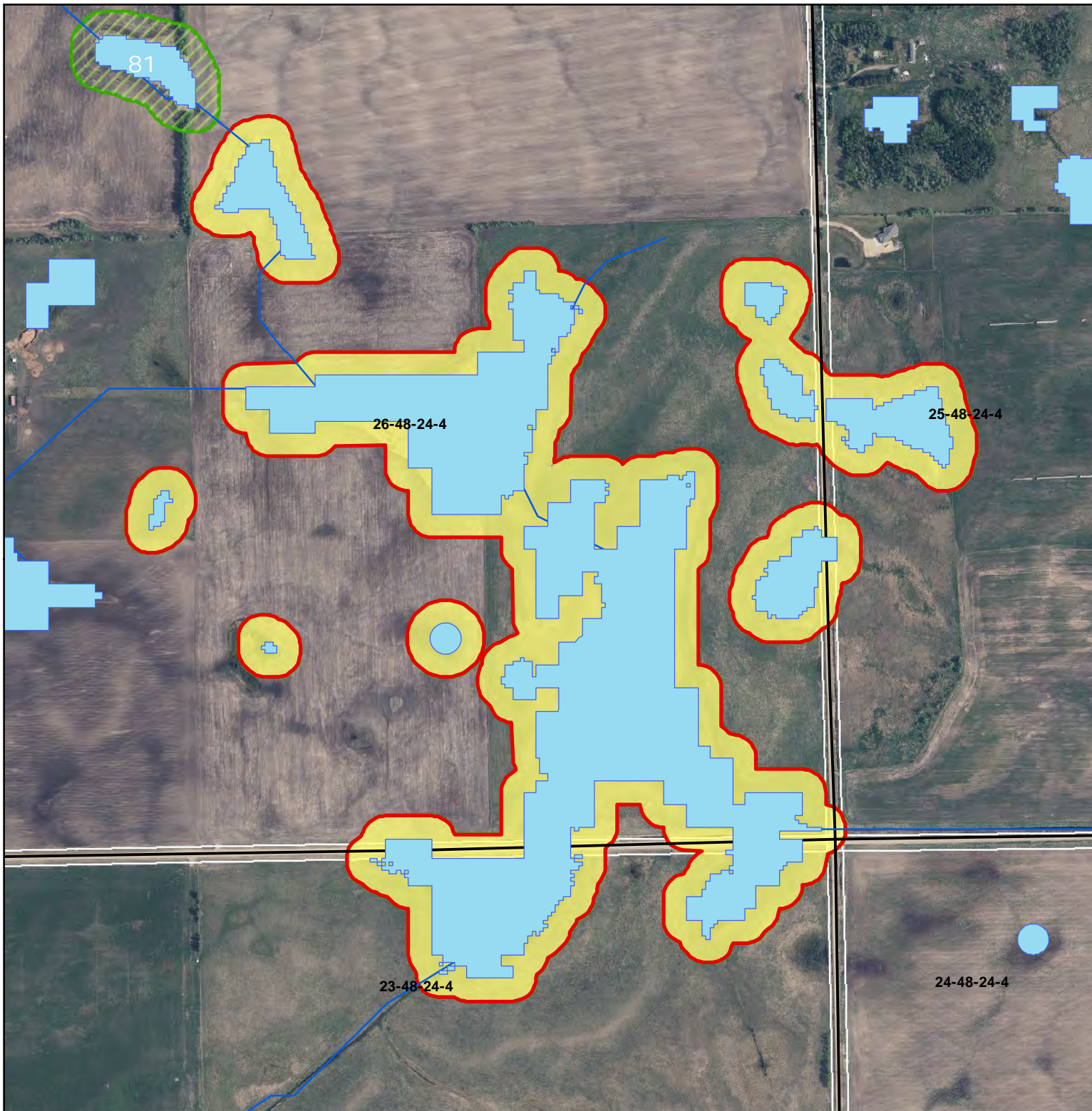
Km

0   0.4   0.8   1.6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-69

ESA Number: 70

Whitemud Creek Area

ESA Type: Riparian
- Upland : 33%
- Aquatic : 27%
- Riparian : 58.5%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
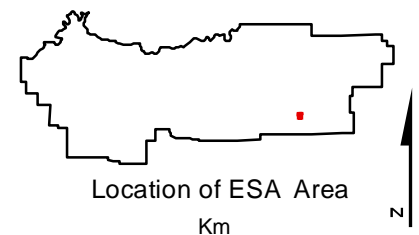- Low : 0%

ESA Area (ha): 399

ESA Score: 45.7/100

Overall ESA Rank: 55/120

Area ESA Rank: 2/ 7

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area

Km

0   1   2   4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-70

ESA Number: 71

Whitemud Creek Area

ESA Type: Riparian
- Upland : 41.6%
- Aquatic : 16.4%
- Riparian : 52.5%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 163

ESA Score: 34.6/100

Overall ESA Rank: 92/120

Area ESA Rank: 5/ 7

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▬ Wetlands and Lakes
- — Roads
- ▬ High Risk Area
- ▬ Medium Risk Area
- ▬ Low Risk Area
- ▨ Other ESAs

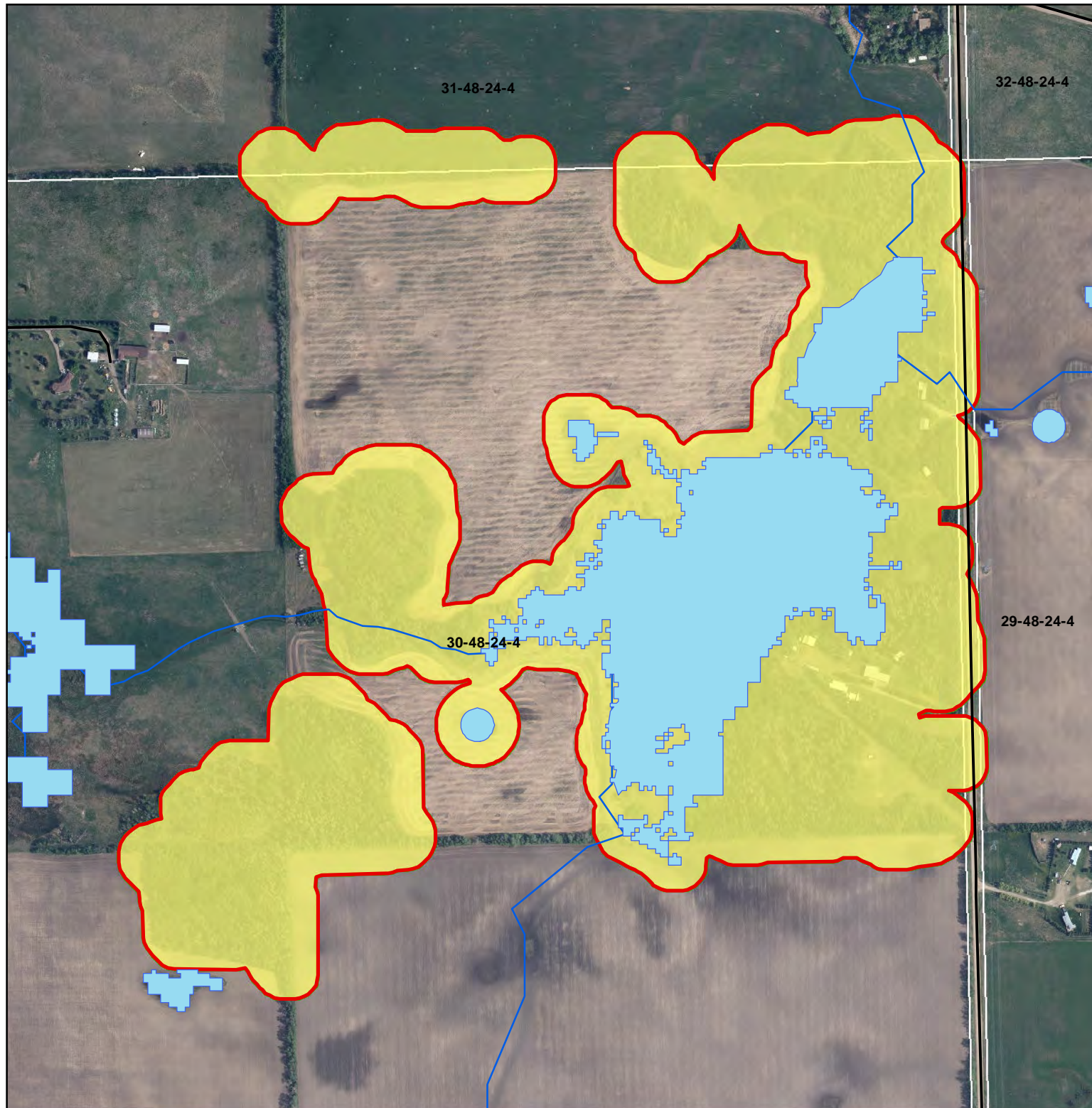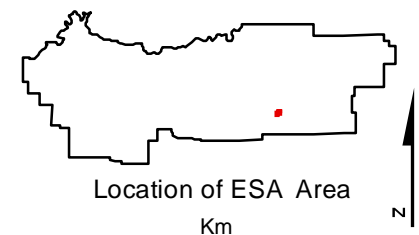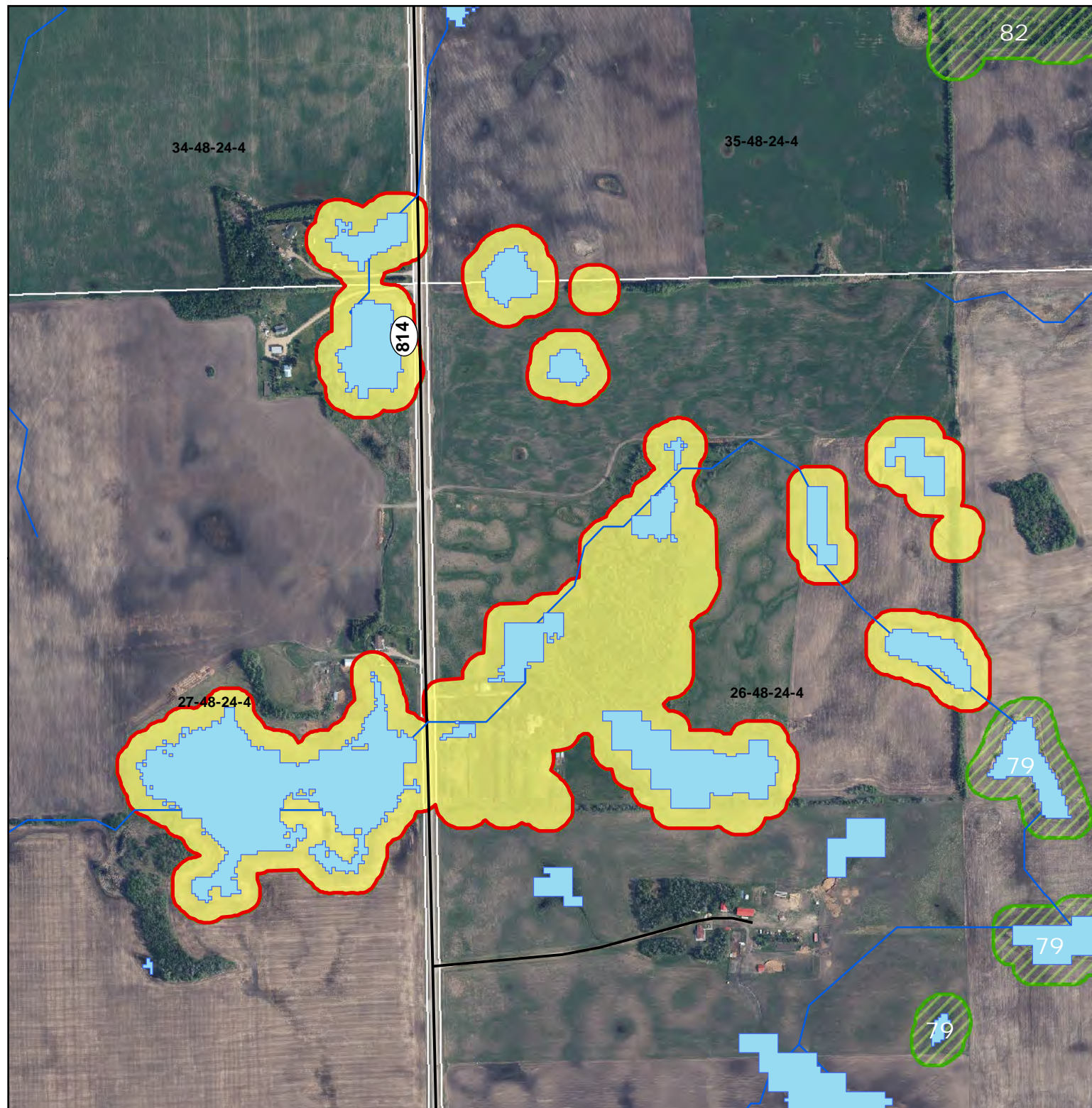Location of ESA Area

Km

0   0.325   0.65   1.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-71
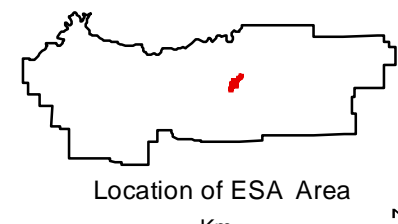
ESA Index Map of
South Whitemud Creek Area

N

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

— Major Roads

Highlighted ESA Area

Other ESA Areas

Leduc County 2014 Boundary

Km

0   0.75   1.5   3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas
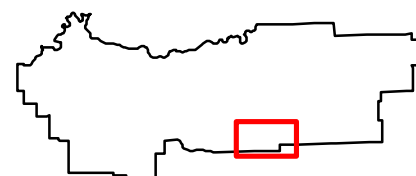
Location of ESA Area

ESA Number: 72

South Whitemud Creek Area

ESA Type: Aquatic
- Upland : 27.6%
- Aquatic : 69.3%
- Riparian : 24.3%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.8%
- Low : 0%

ESA Area (ha): 32

ESA Score: 34.4/100

Overall ESA Rank: 95/120

Area ESA Rank: 5/ 5

Legend

⬜ Highlighted ESA
— Streams and Rivers
⬛ Wetlands and Lakes
— Roads
🟥 High Risk Area
🟨 Medium Risk Area
🟩 Low Risk Area
▨ Other ESAs

Location of ESA Area

Km

0   0.075   0.15   0.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

2-48-26-4

1-48-26-4

A-72

ESA Number: 73

South Whitemud Creek Area

ESA Type: Aquatic
- Upland : 39.3%
- Aquatic : 51.1%
- Riparian : 23.2%

Disturbance Risk: Medium
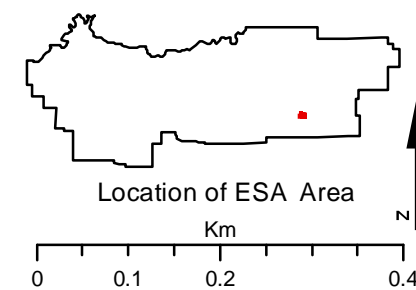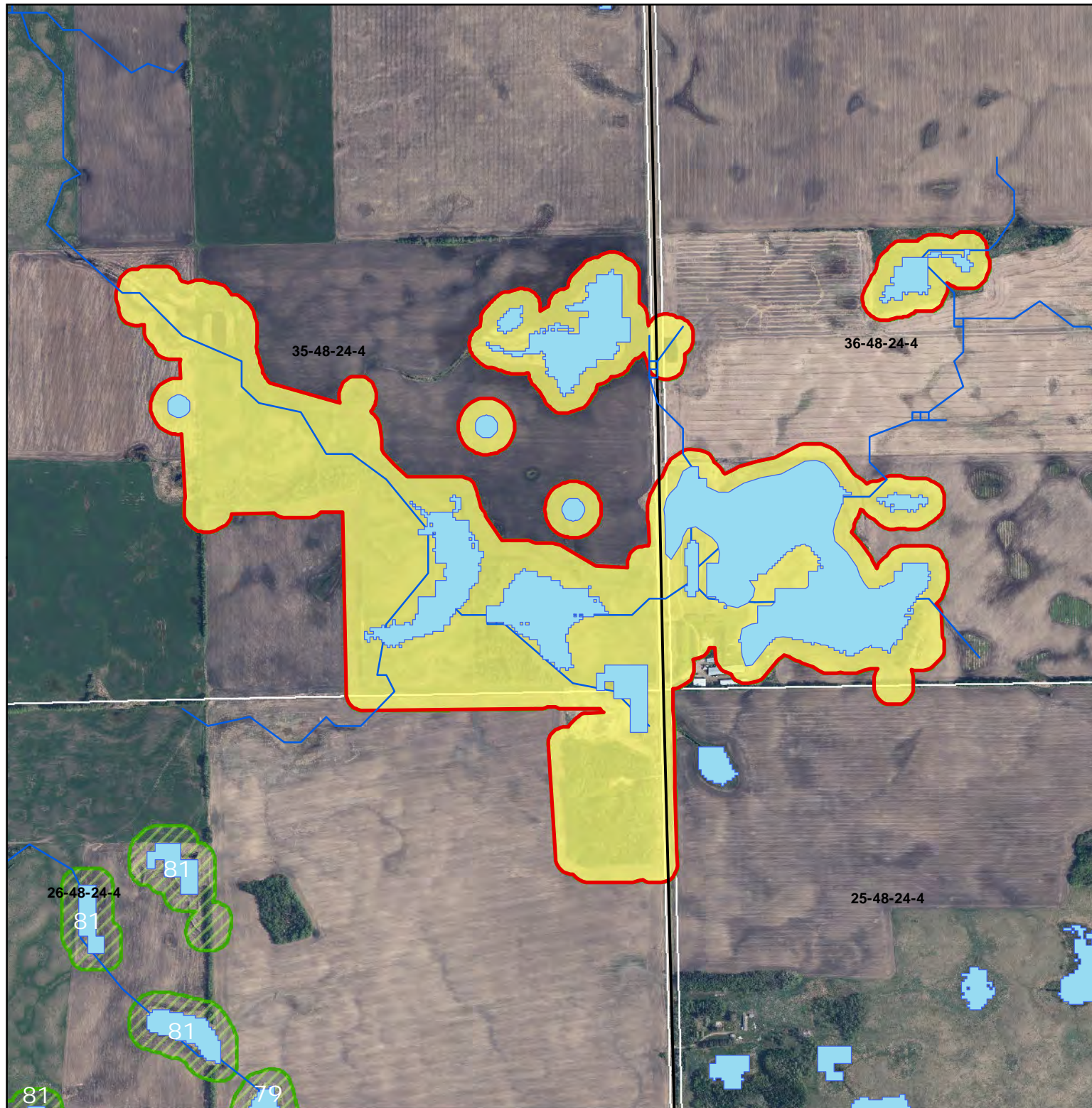- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 109

ESA Score: 40.4/100

Overall ESA Rank: 72/120

Area ESA Rank: 2/ 5

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area

Km

0   0.175   0.35   0.7

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

12-48-26-4   7-48-25-4   8-48-25-4

1-48-26-4   6-48-25-4   5-48-25-4

A-73

ESA Number: 74

South Whitemud Creek Area

ESA Type: Aquatic
- Upland : 39.6%
- Aquatic : 58.8%
- Riparian : 5.4%

Disturbance Risk: Medium
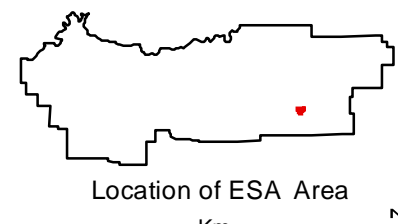- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 95

ESA Score: 36/100

Overall ESA Rank: 87/120

Area ESA Rank: 4/ 5

Legend

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
Low Risk Area
Other ESAs

Location of ESA Area

Km

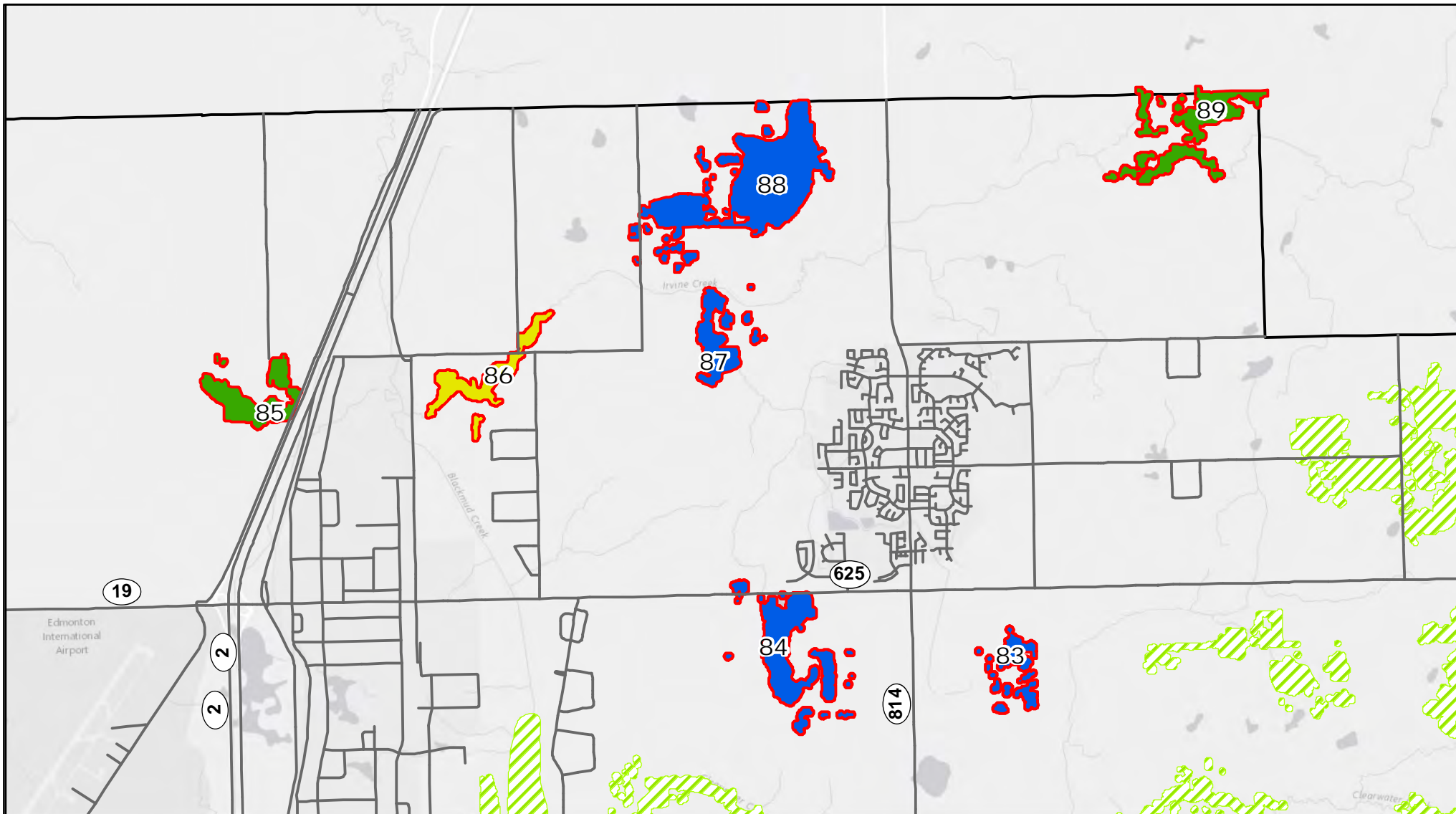0   0.125   0.25   0.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
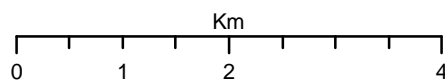Provided by Leduc County
Basemap:ESRI Light Grey Canvas

8-48-25-4

9-48-25-4

5-48-25-4

4-48-25-4

A-74

ESA Number: 75

South Whitemud Creek Area

ESA Type: Mixed
- Upland : 65.6%
- Aquatic : 25.8%
- Riparian : 16.8%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 613

ESA Score: 46.9/100

Overall ESA Rank: 49/120

Area ESA Rank: 1/ 5

Legend

▭ Highlighted ESA
── Streams and Rivers
▭ Wetlands and Lakes
── Roads
▮ High Risk Area
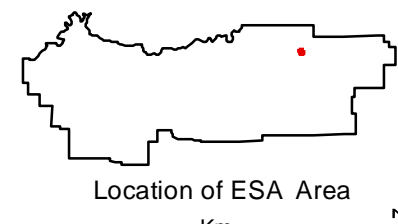▮ Medium Risk Area
▮ Low Risk Area
▨ Other ESAs

Location of ESA Area

Km

0   0.4   0.8   1.6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-75

ESA Number: 76

South Whitemud Creek Area

ESA Type: Mixed
- Upland : 61.3%
- Aquatic : 29.7%
- Riparian : 19.9%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 229

ESA Score: 39.6/100

Overall ESA Rank: 74/120

Area ESA Rank: 3/ 5

Legend

- ▭ Highlighted ESA
- ── Streams and Rivers
- ▭ Wetlands and Lakes
- ── Roads
- ▭ High Risk Area
- ▭ Medium Risk Area
- ▭ Low Risk Area
- ▨ Other ESAs
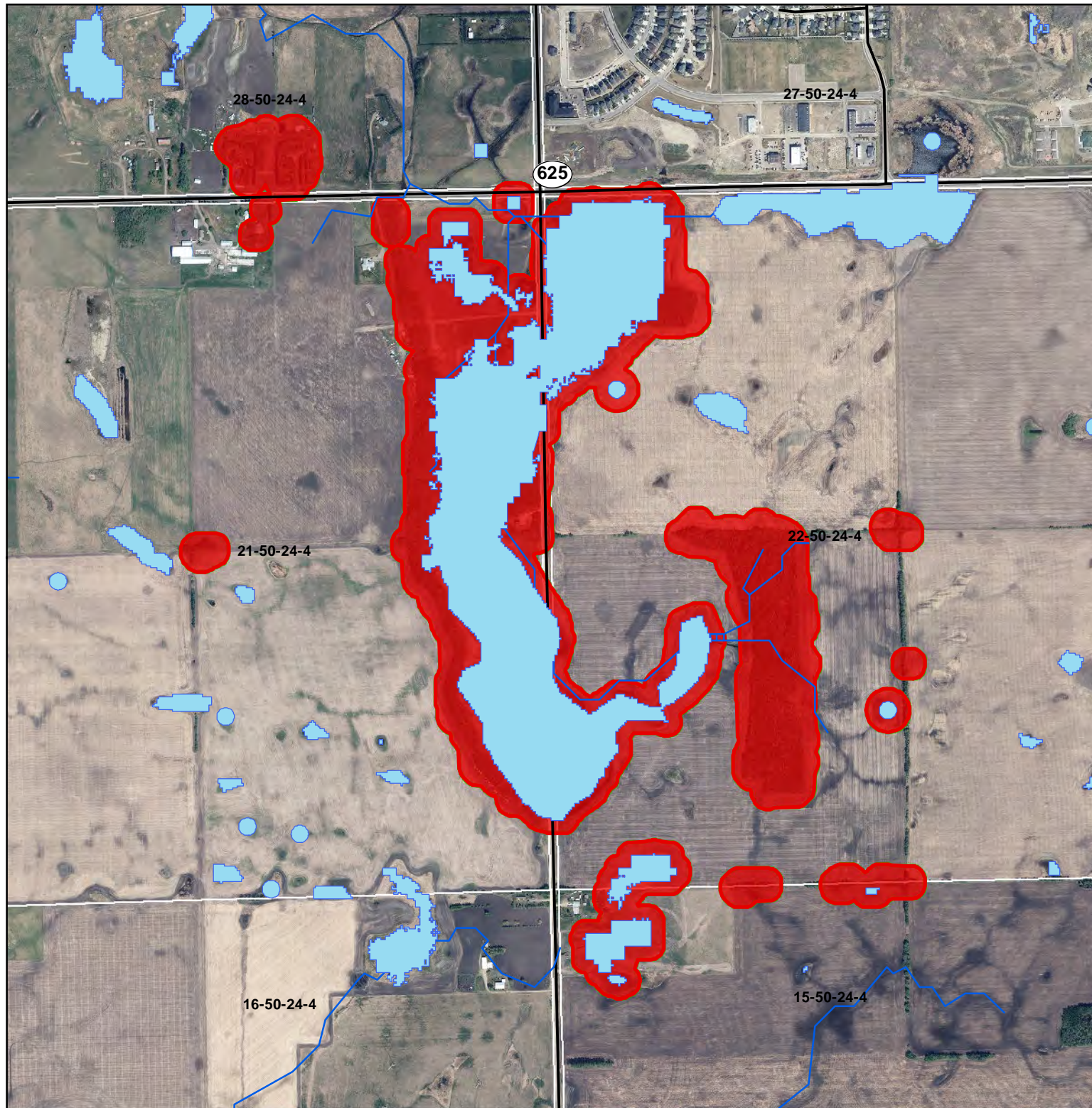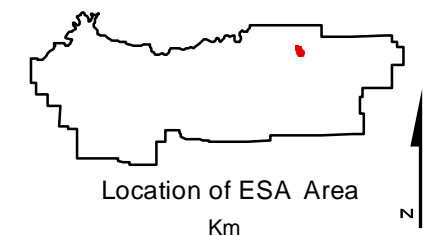
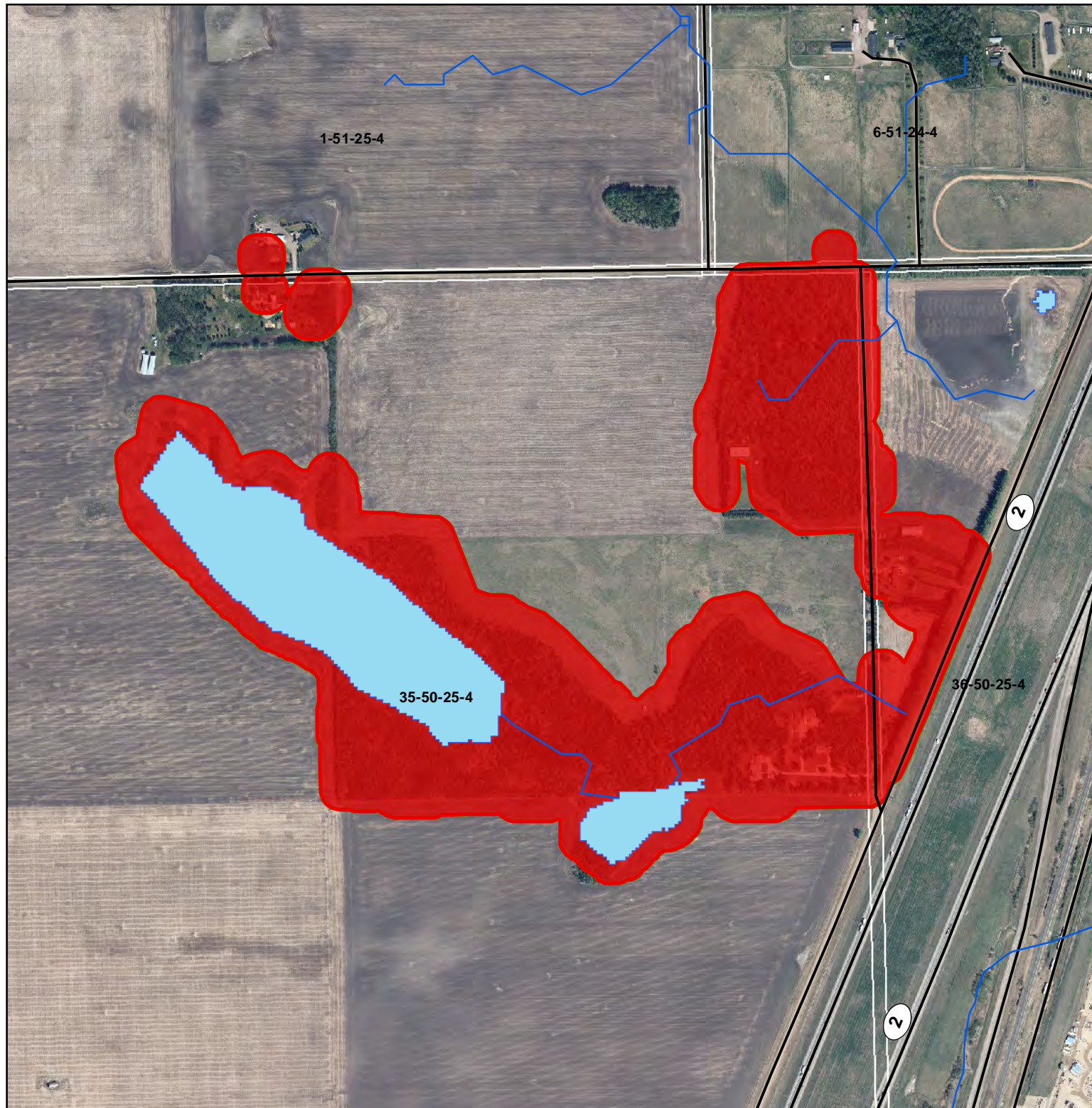Location of ESA Area

Km

0   0.25   0.5   1

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

27-48-25-4   26-48-25-4   25-48-25-4
22-48-25-4   23-48-25-4   24-48-25-4
15-48-25-4   14-48-25-4   13-48-25-4

A-76

ESA Index Map of
Northwest Coal Area

N

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

Major Roads

Highlighted ESA Area

Other ESA Areas

Leduc County 2014 Boundary

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas
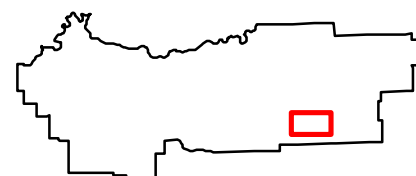
Location of ESA Area
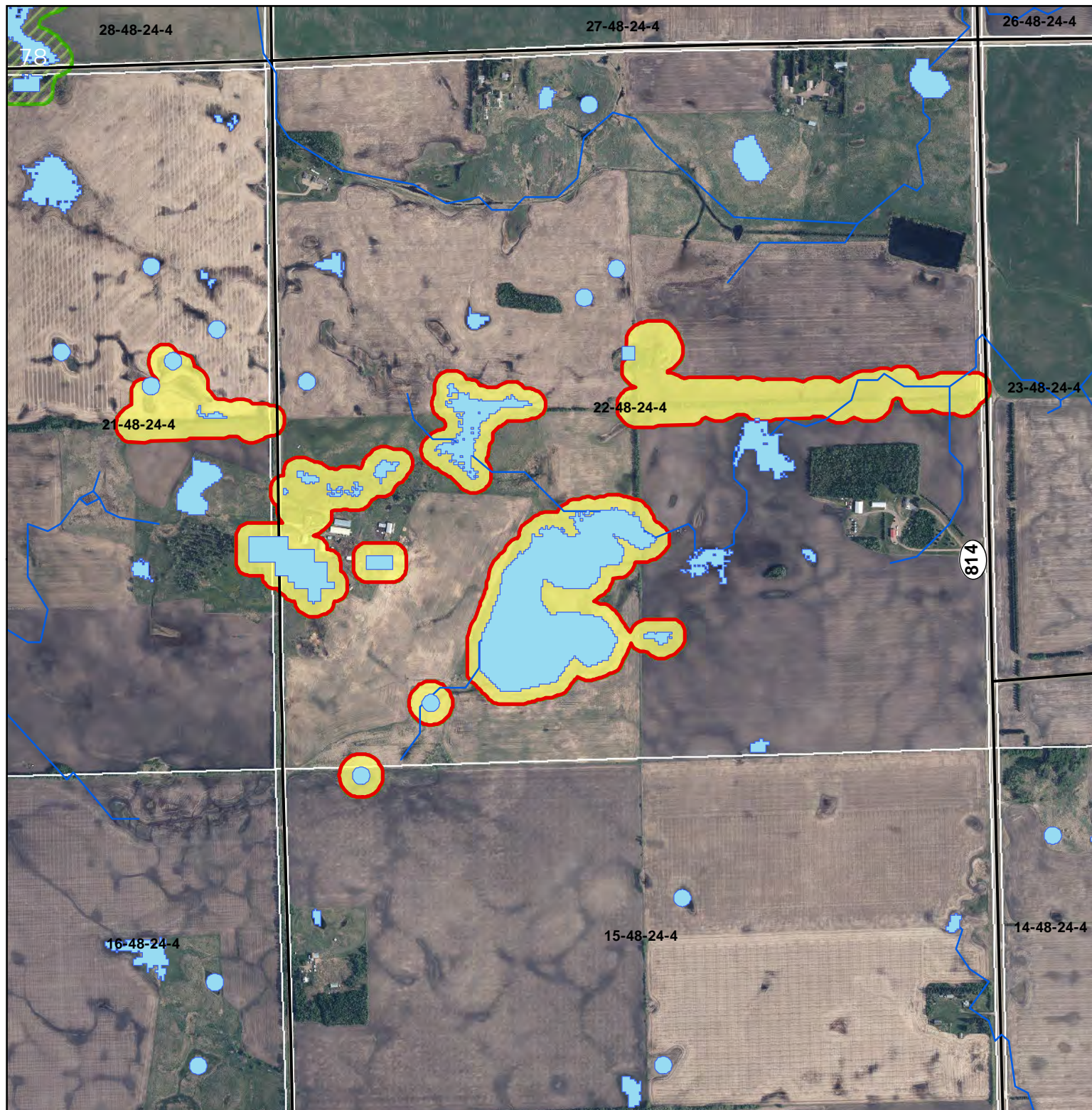
ESA Number: 77

Northwest Coal Area

ESA Type: Aquatic
- Upland : 22.1%
- Aquatic : 72.1%
- Riparian : 20.4%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
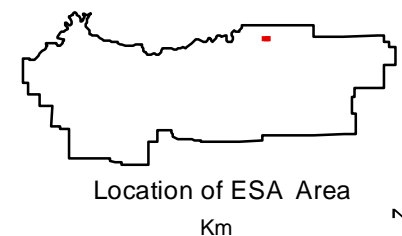- Low : 0%

ESA Area (ha): 44

ESA Score: 30.6/100

Overall ESA Rank: 119/120

Area ESA Rank: 6/ 6

Legend

▭ Highlighted ESA
— Streams and Rivers
▬ Wetlands and Lakes
— Roads
▬ High Risk Area
▬ Medium Risk Area
▬ Low Risk Area
▨ Other ESAs

Location of ESA Area
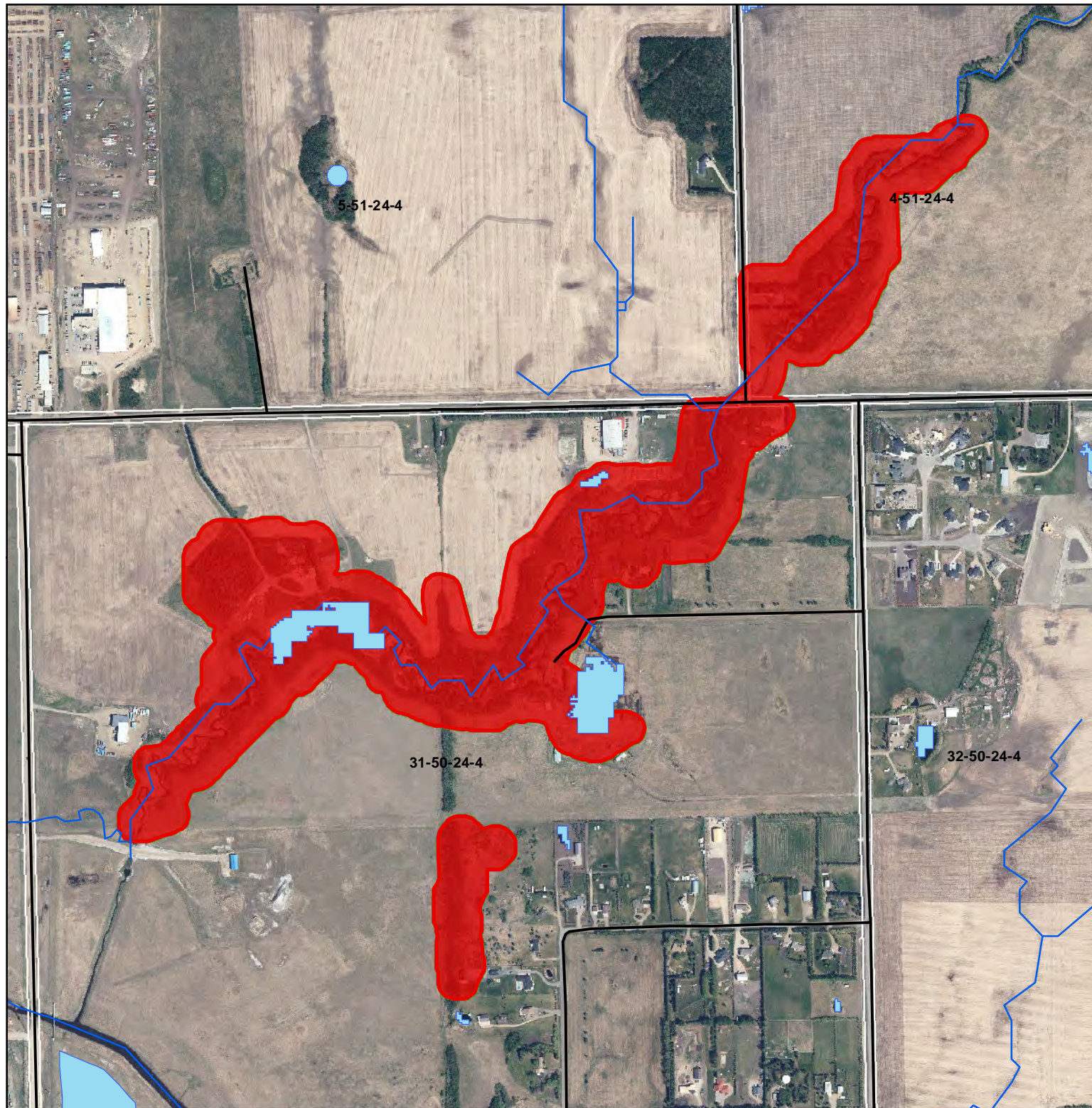
Km

0   0.15   0.3   0.6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-77

ESA Number: 78

Northwest Coal Area

ESA Type: Aquatic
- Upland : 25.2%
- Aquatic : 74.8%
- Riparian : 11.8%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
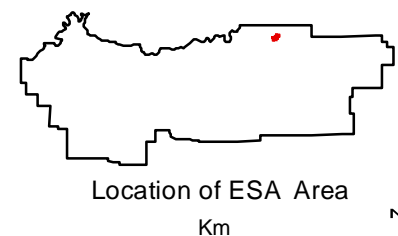- Low : 0%

ESA Area (ha): 51

ESA Score: 36.3/100

Overall ESA Rank: 84/120

Area ESA Rank: 2/ 6

Legend

⬛ Highlighted ESA
— Streams and Rivers
⬛ Wetlands and Lakes
— Roads
⬛ High Risk Area
⬛ Medium Risk Area
⬛ Low Risk Area
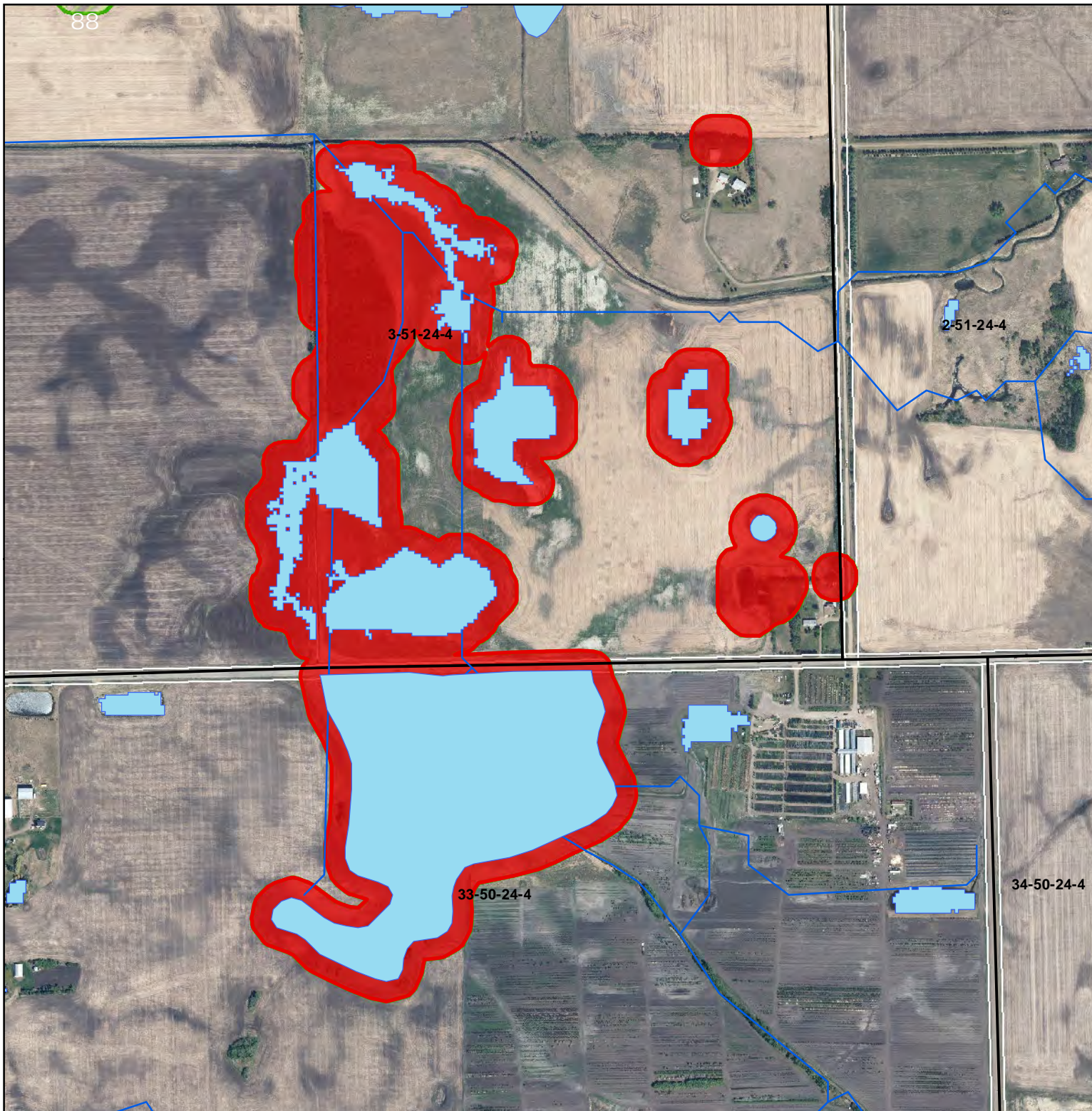▨ Other ESAs

Location of ESA Area

Km

0   0.075   0.15   0.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

28-48-24-4

21-48-24-4

A-78

ESA Number: 79

Northwest Coal Area

ESA Type: Aquatic
- Upland : 0.1%
- Aquatic : 99.9%
- Riparian : 25%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
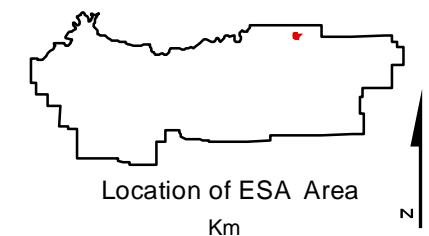- Low : 0%

ESA Area (ha): 43

ESA Score: 35.1/100

Overall ESA Rank: 88/120

Area ESA Rank: 3/ 6

Legend

▭ Highlighted ESA
— Streams and Rivers
▭ Wetlands and Lakes
— Roads
▮ High Risk Area
▮ Medium Risk Area
▮ Low Risk Area
▨ Other ESAs

Location of ESA Area
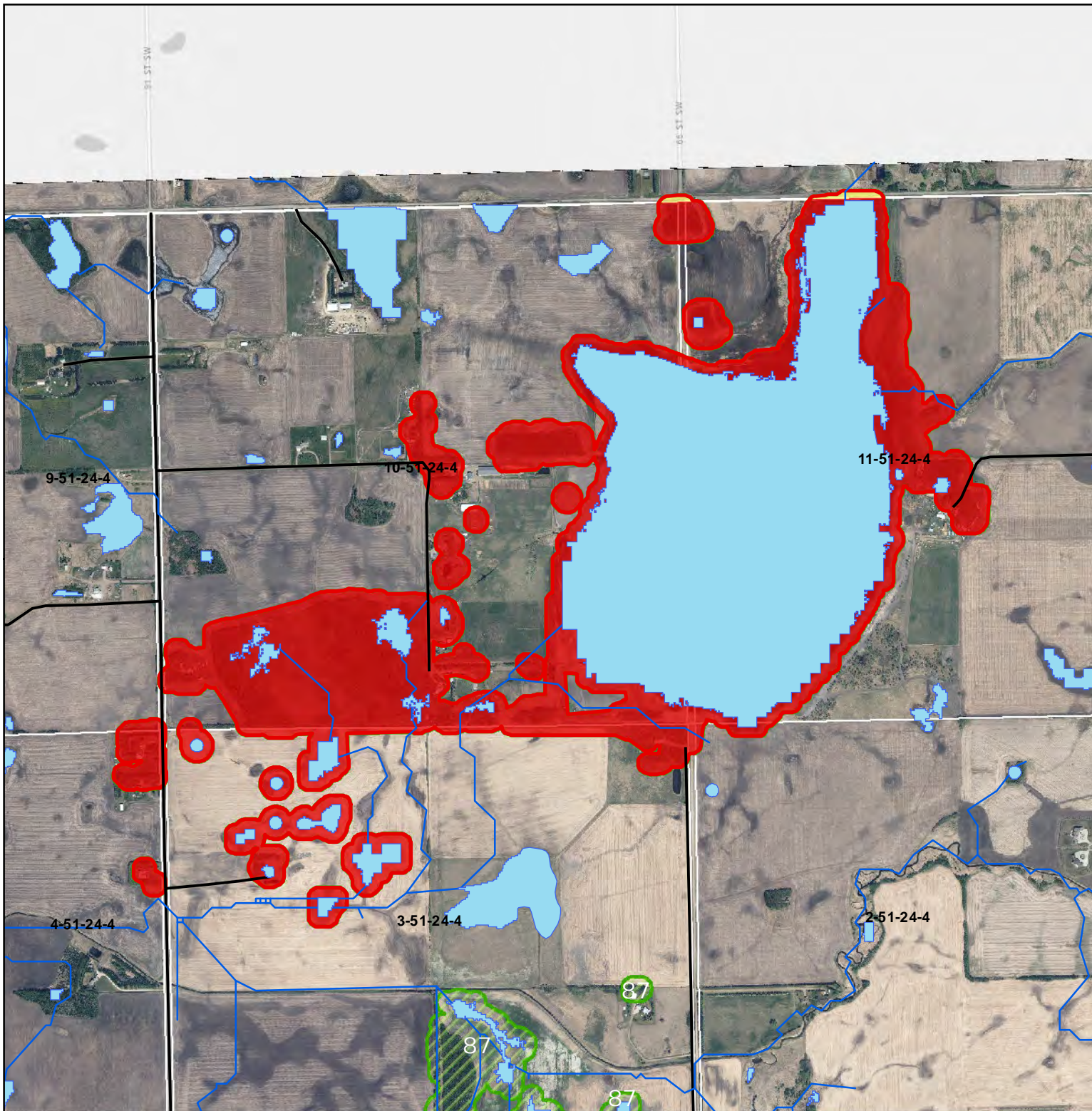
Km

0   0.075   0.15   0.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-79

ESA Number: 80

Northwest Coal Area

ESA Type: Mixed
- Upland : 53.1%
- Aquatic : 42.4%
- Riparian : 13.7%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 56

ESA Score: 32.7/100

Overall ESA Rank: 106/120

Area ESA Rank: 4/ 6

Legend

▭	Highlighted ESA
—	Streams and Rivers
▮	Wetlands and Lakes
—	Roads
▮	High Risk Area
▮	Medium Risk Area
▮	Low Risk Area
▨	Other ESAs

Location of ESA Area

Km

0   0.075   0.15   0.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

31-48-24-4

32-48-24-4

29-48-24-4

30-48-24-4

ESA Number: 81

Northwest Coal Area

ESA Type: Aquatic
- Upland : 19.9%
- Aquatic : 78.3%
- Riparian : 23.4%

Disturbance Risk: Medium
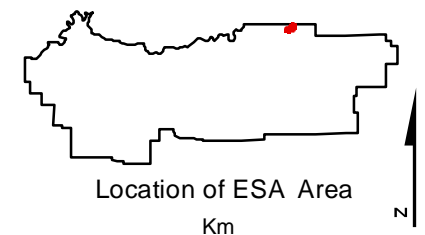- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 44

ESA Score: 31.7/100

Overall ESA Rank: 110/120

Area ESA Rank: 5/ 6

Legend

▭	Highlighted ESA
—	Streams and Rivers
▨	Wetlands and Lakes
—	Roads
▨	High Risk Area
▨	Medium Risk Area
▨	Low Risk Area
▨	Other ESAs

Location of ESA Area
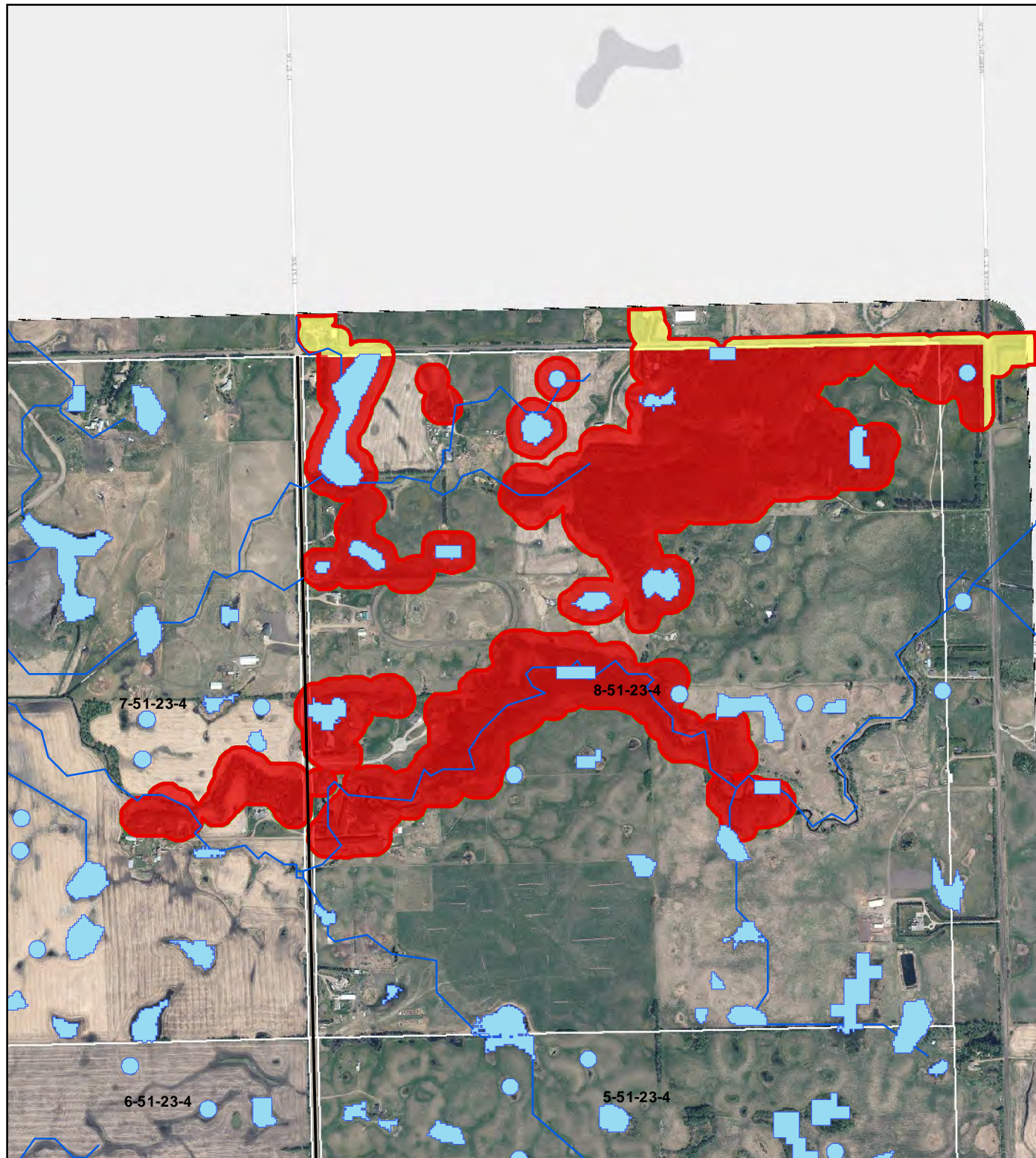
Km

0   0.1   0.2   0.3   0.4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-81

ESA Number: 82

Northwest Coal Area

ESA Type: Aquatic
- Upland : 31.8%
- Aquatic : 57.6%
- Riparian : 28.9%

Disturbance Risk: Medium
- High : 0%
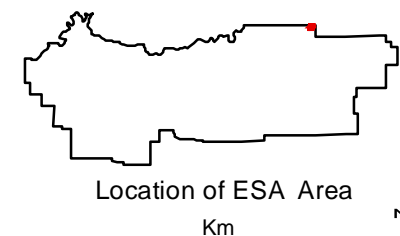- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 66

ESA Score: 42.9/100

Overall ESA Rank: 63/120

Area ESA Rank: 1/ 6

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area

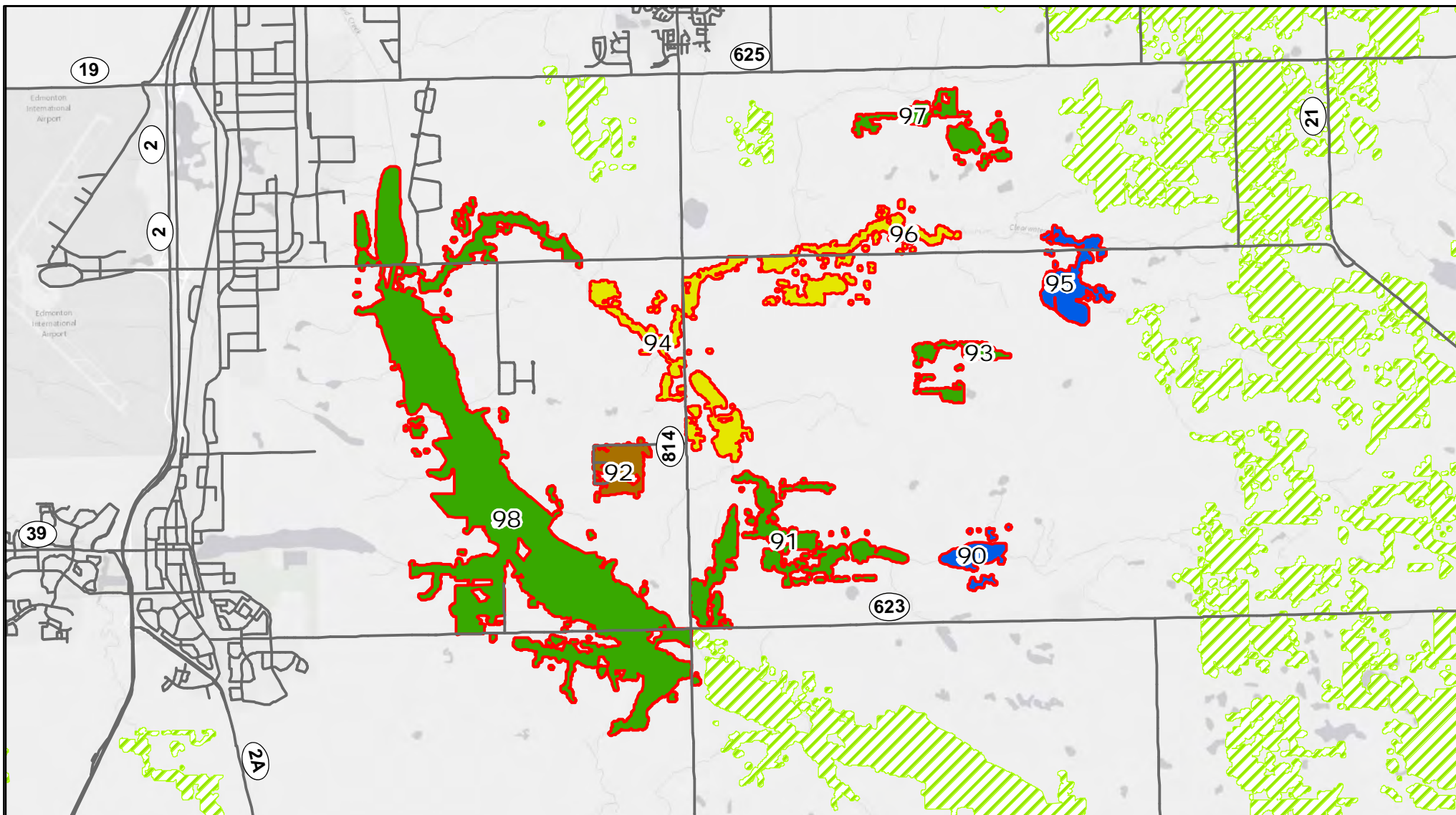Km

0   0.1   0.2   0.3   0.4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
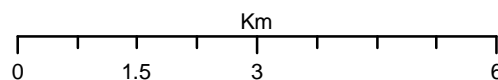Basemap:ESRI Light Grey Canvas

A-82

ESA Index Map of
Irvine/ Blackmud Creek Area

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

— Major Roads

▭ Highlighted ESA Area

▨ Other ESA Areas

▭ Leduc County 2014 Boundary

Km

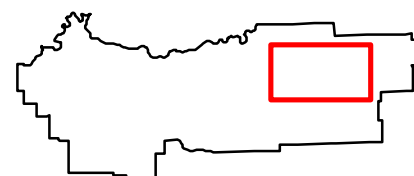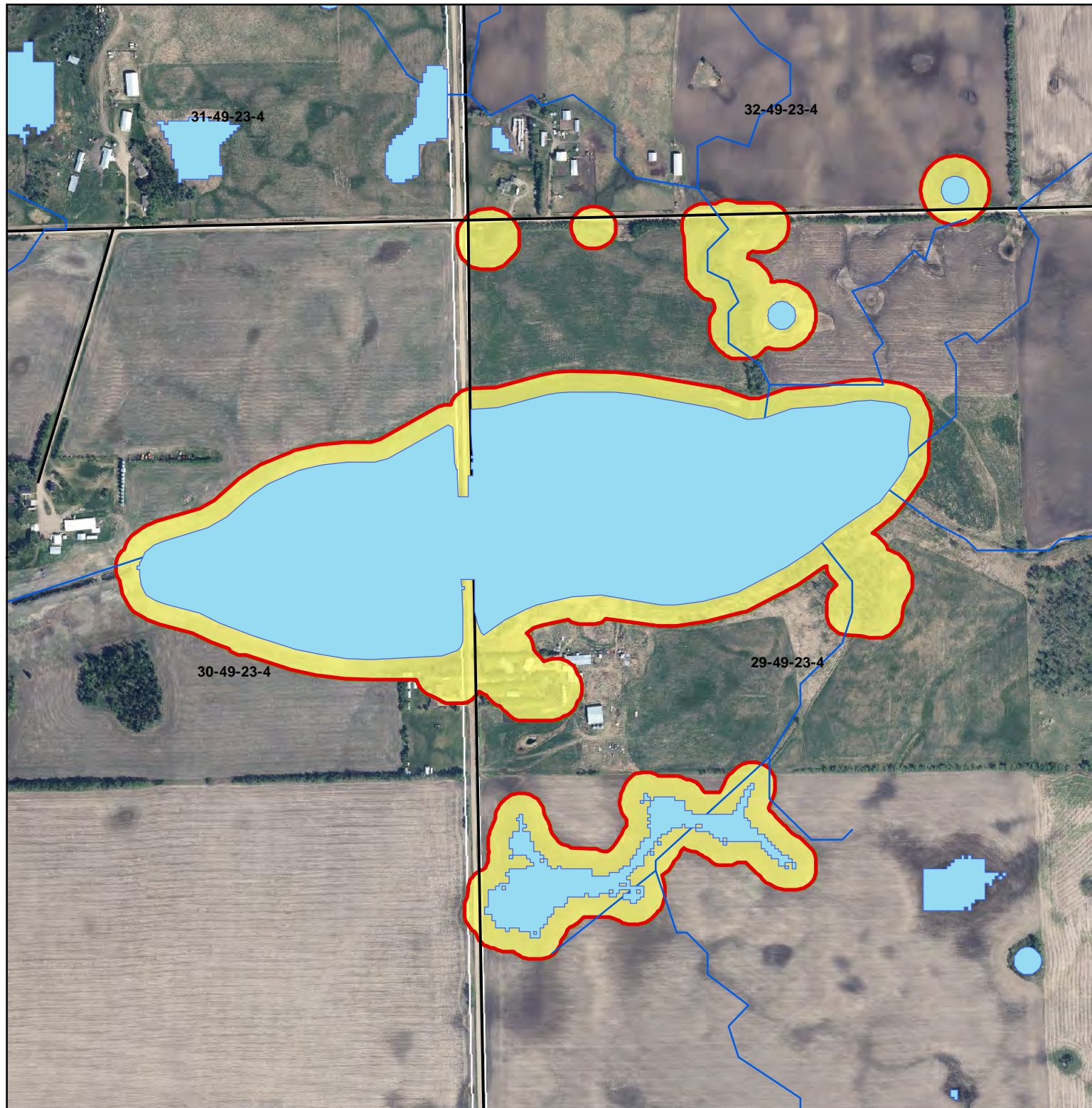0   1   2   4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area

ESA Number: 83

Irvine/ Blackmud Creek Area

ESA Type: Aquatic
- Upland : 22%
- Aquatic : 77.4%
- Riparian : 17.8%

  Disturbance Risk: High
- High : 99.9%
- Moderate : 0%
- Low : 0%

ESA Area (ha): 36

ESA Score: 30.8/100

Overall ESA Rank: 118/120

Area ESA Rank: 7/ 7

Legend

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
Low Risk Area
Other ESAs

Location of ESA Area

Km

0   0.075   0.15   0.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

23-50-24-4

24-50-24-4

14-50-24-4

13-50-24-4

A-83

ESA Number: 84

Irvine/ Blackmud Creek Area

ESA Type: Aquatic
- Upland : 29.5%
- Aquatic : 66.1%
- Riparian : 15.9%

Disturbance Risk: High
- High : 99.9%
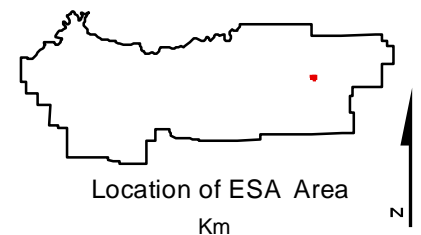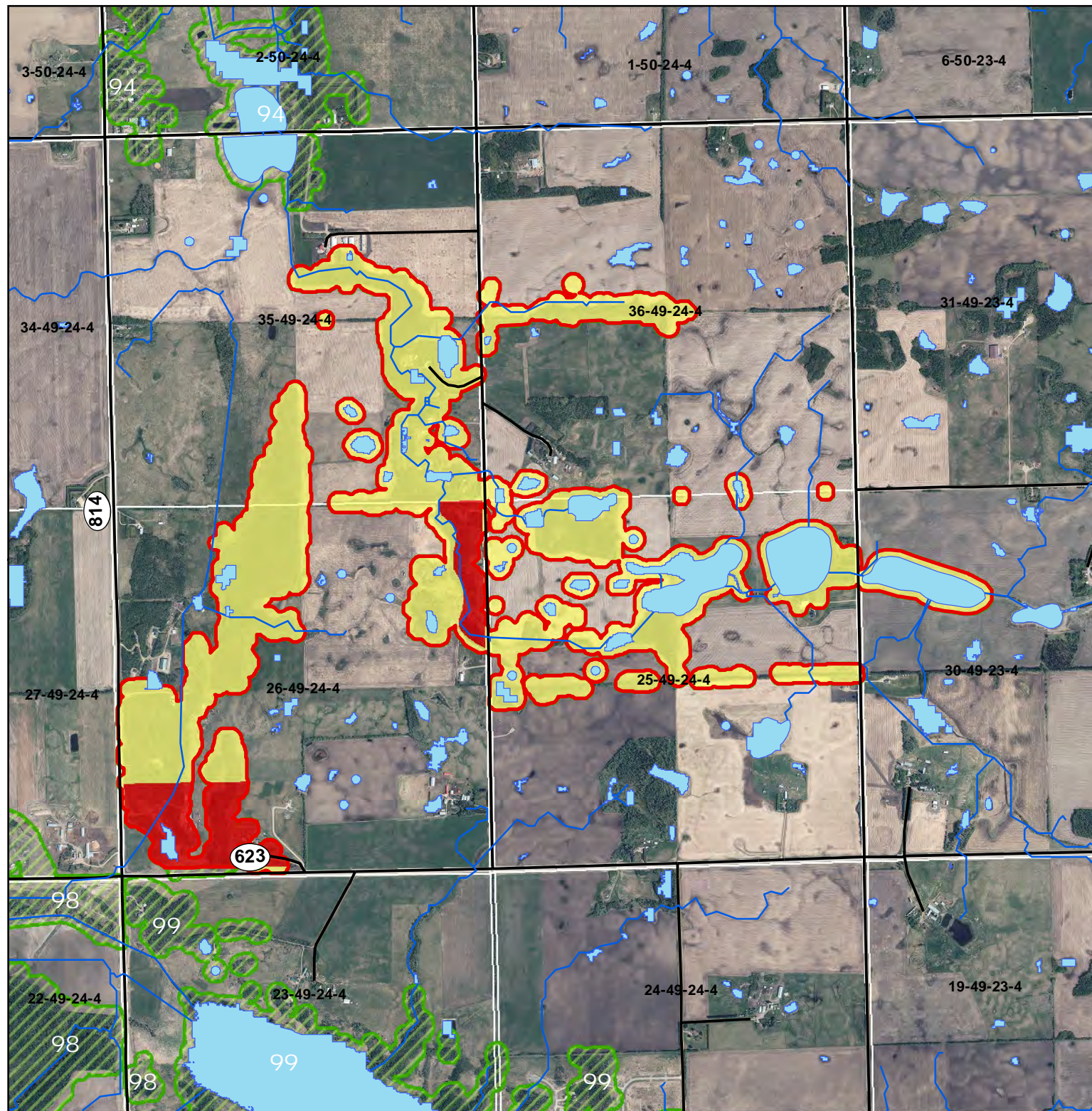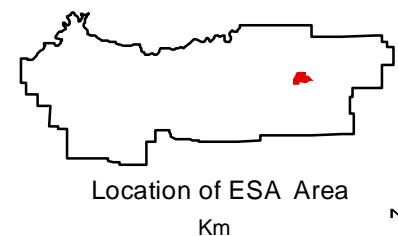- Moderate : 0%
- Low : 0%

ESA Area (ha): 96

ESA Score: 34.3/100

Overall ESA Rank: 96/120

Area ESA Rank: 4/ 7

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area

Km
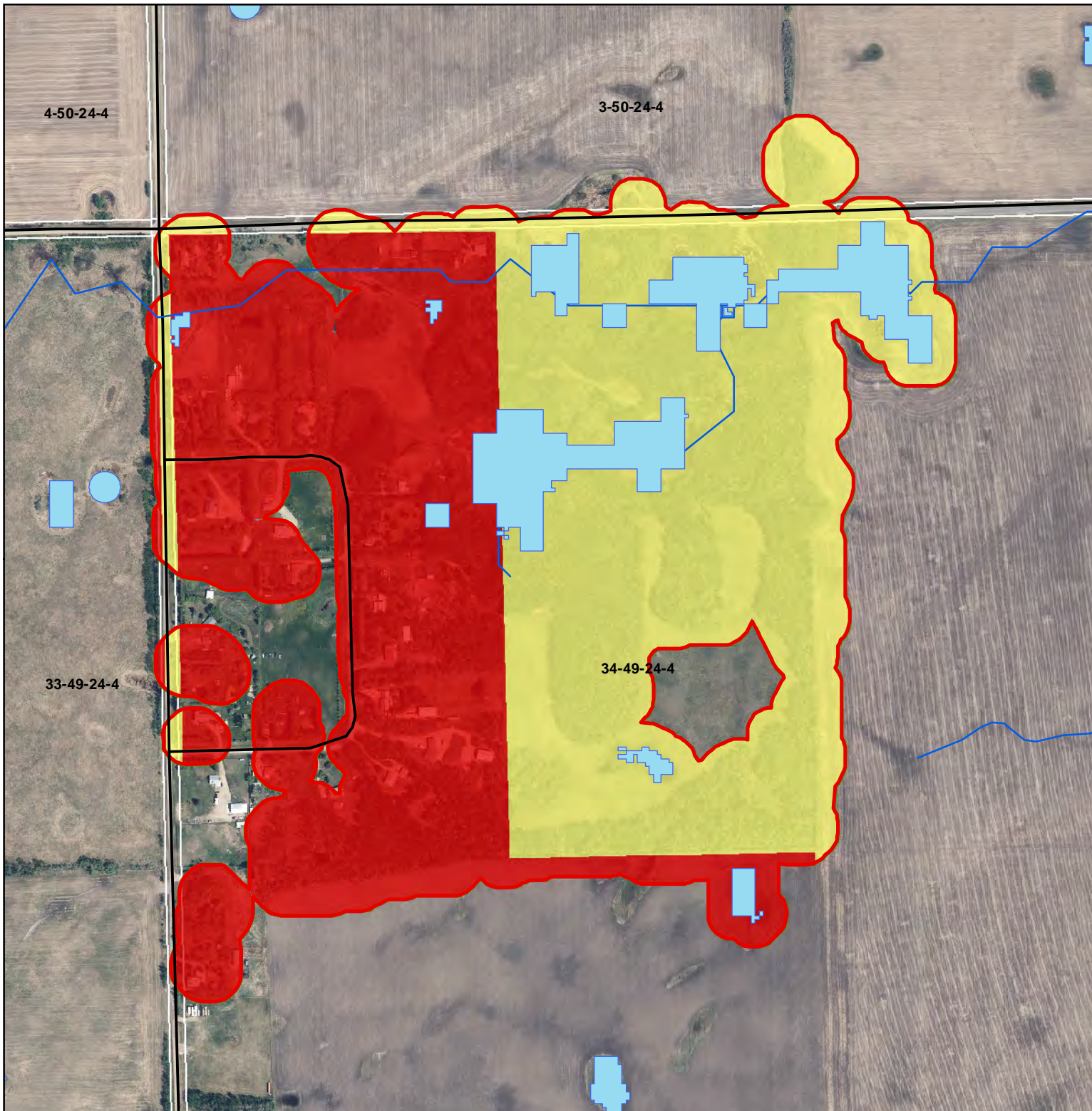
0   0.15   0.3   0.6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-84

ESA Number: 85

Irvine/ Blackmud Creek Area

ESA Type: Mixed
- Upland : 58.2%
- Aquatic : 32%
- Riparian : 18.3%

Disturbance Risk: High
- High : 99.9%
- Moderate : 0%
- Low : 0%

ESA Area (ha): 54

ESA Score: 36/100

Overall ESA Rank: 86/120

Area ESA Rank: 3/ 7

Legend

☐ Highlighted ESA
— Streams and Rivers
☐ Wetlands and Lakes
— Roads
☐ High Risk Area
☐ Medium Risk Area
☐ Low Risk Area
▨ Other ESAs

Location of ESA Area

Km

0   0.1   0.2   0.3   0.4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-85

ESA Number: 86

Irvine/ Blackmud Creek Area

ESA Type: Riparian
- Upland : 43.4%
- Aquatic : 11.2%
- Riparian : 52.3%

Disturbance Risk: High
- High : 99.9%
- Moderate : 0%
- Low : 0%
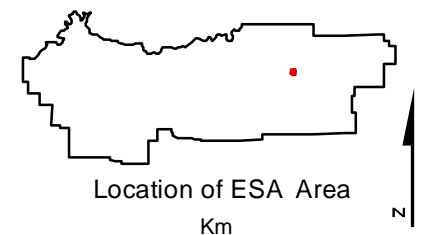
ESA Area (ha): 51

ESA Score: 33.3/100

Overall ESA Rank: 102/120

Area ESA Rank: 5/ 7

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▬ Wetlands and Lakes
- — Roads
- ▬ High Risk Area
- ▬ Medium Risk Area
- ▬ Low Risk Area
- ▨ Other ESAs
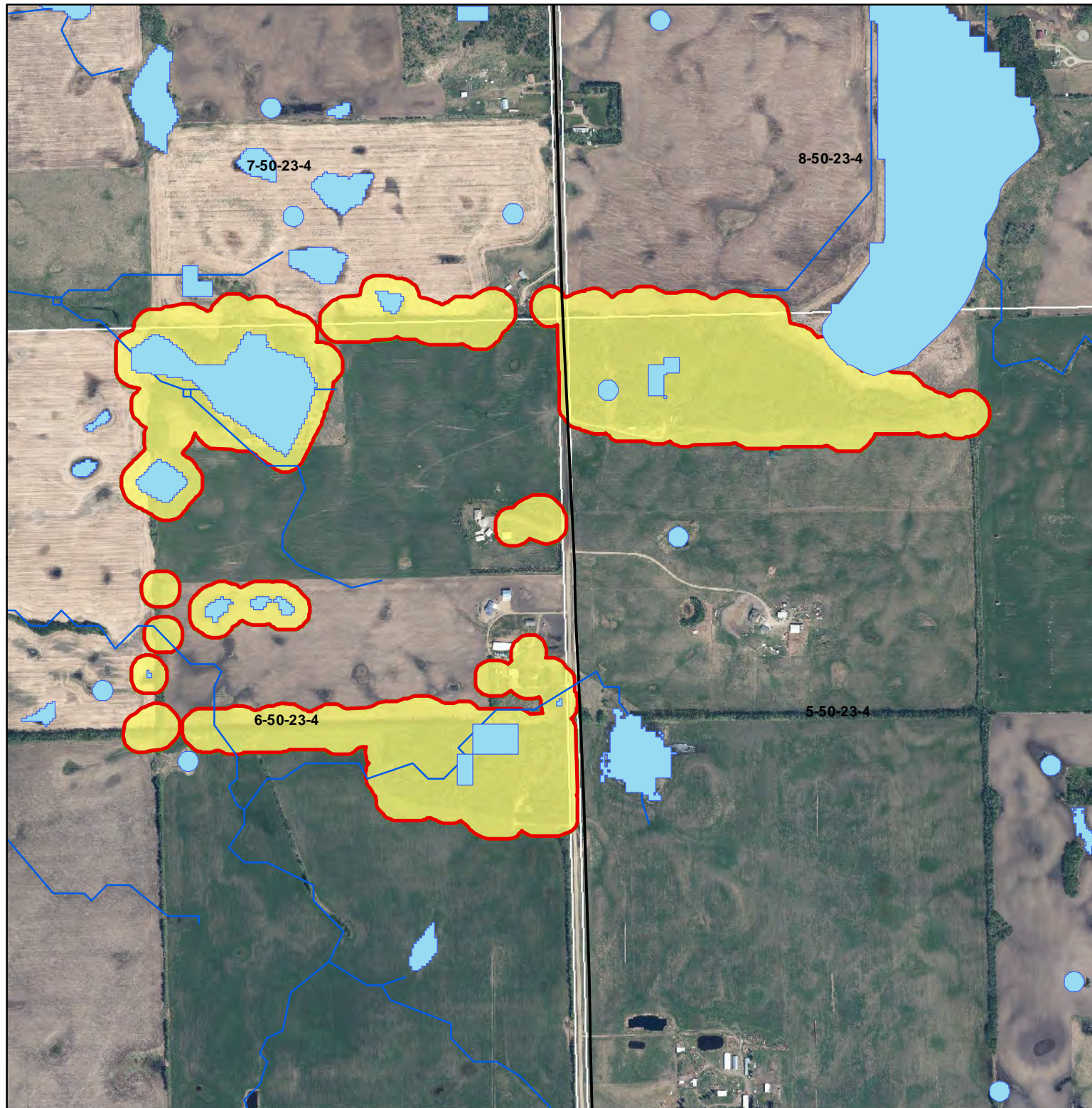
Location of ESA Area

Km

0   0.125   0.25   0.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

5-51-24-4

4-51-24-4

31-50-24-4

32-50-24-4

ESA Number: 87

Irvine/ Blackmud Creek Area

ESA Type: Aquatic
- Upland : 7.1%
- Aquatic : 84.4%
- Riparian : 34.8%

  Disturbance Risk: High
- High : 99.9%
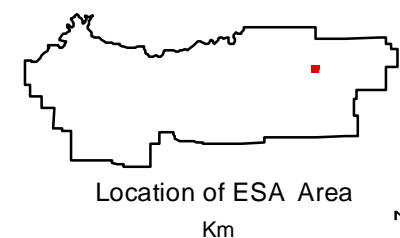- Moderate : 0%
- Low : 0%

ESA Area (ha): 48

ESA Score: 36.4/100

Overall ESA Rank: 83/120

Area ESA Rank: 2/ 7

Legend

▭ Highlighted ESA
— Streams and Rivers
▭ Wetlands and Lakes
— Roads
▭ High Risk Area
▭ Medium Risk Area
▭ Low Risk Area
▨ Other ESAs

Location of ESA Area
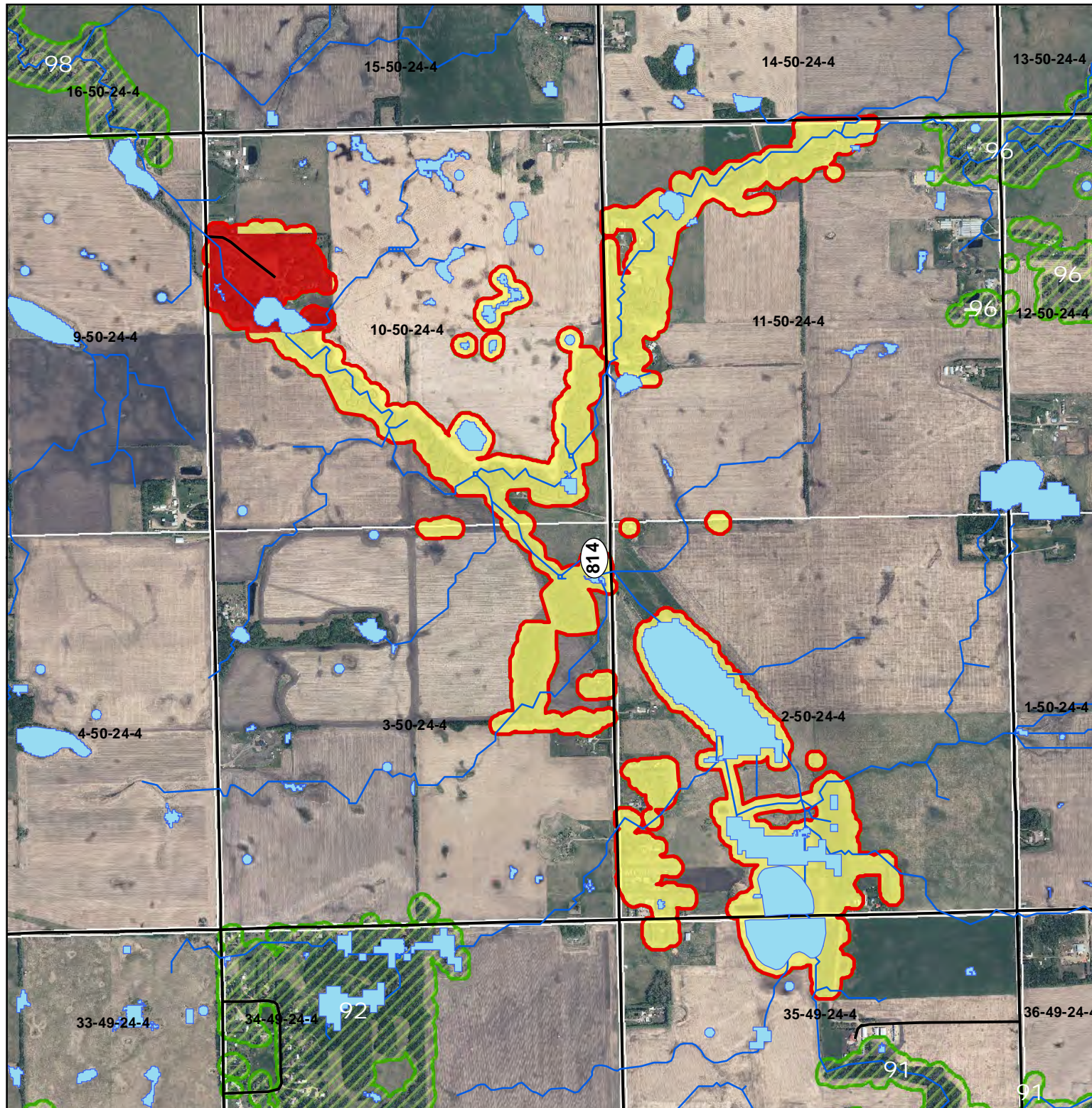
Km

0   0.1   0.2   0.3   0.4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

ESA Number: 88

Irvine/ Blackmud Creek Area

ESA Type: Aquatic
- Upland : 26.6%
- Aquatic : 69.8%
- Riparian : 8.3%

   Disturbance Risk: High
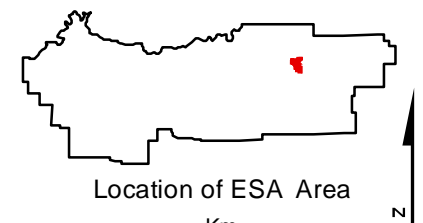- High : 99.7%
- Moderate : 0.3%
- Low : 0%

ESA Area (ha): 203

ESA Score: 36.5/100

Overall ESA Rank: 81/120
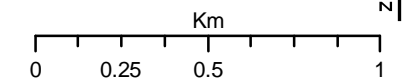
Area ESA Rank: 1/ 7

Legend

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
Low Risk Area
Other ESAs

Location of ESA Area

Km

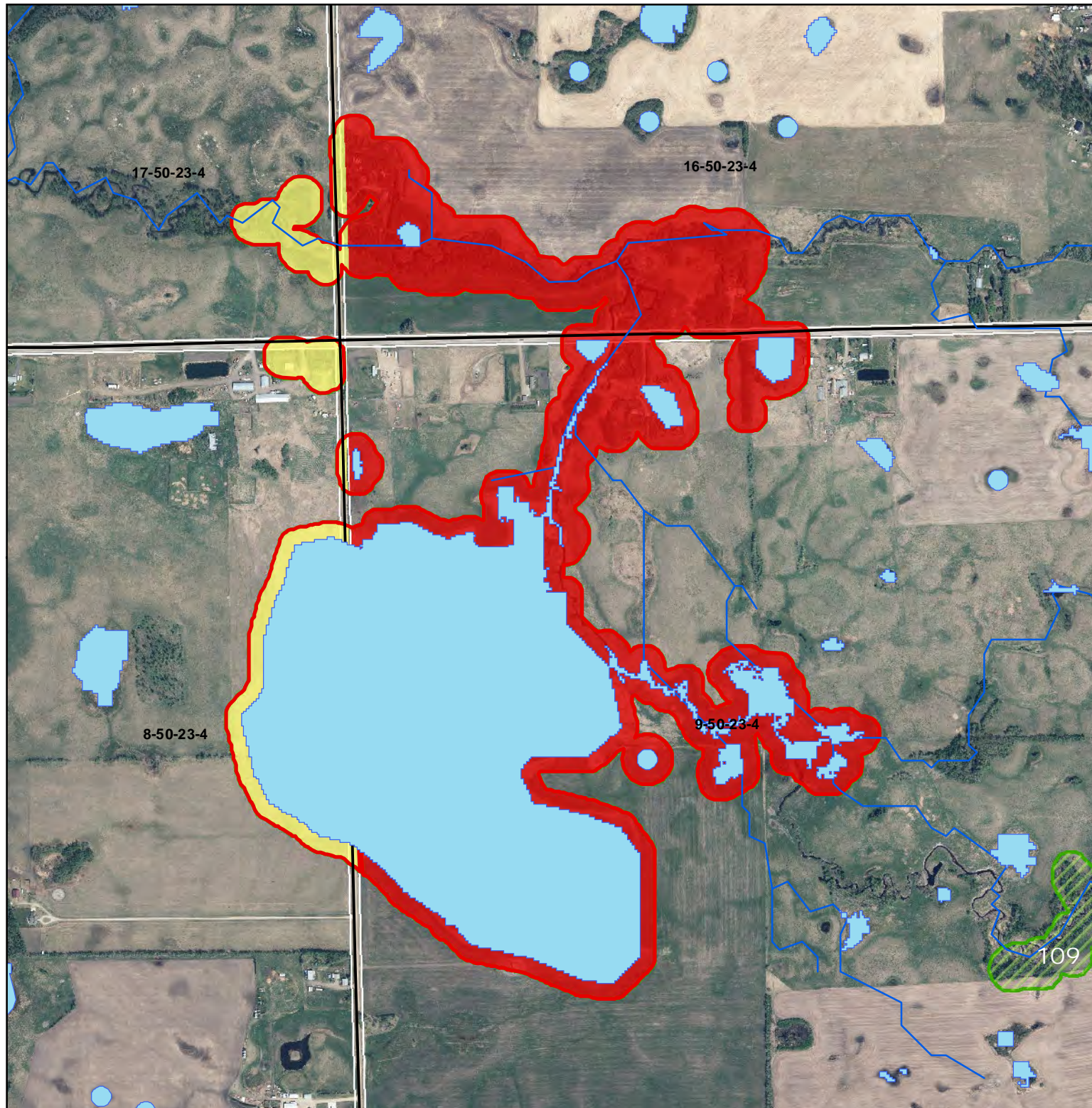0   0.2   0.4   0.8

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

9-51-24-4   10-51-24-4   11-51-24-4

4-51-24-4   3-51-24-4   2-51-24-4

87

87

87

ESA Number: 89

Irvine/ Blackmud Creek Area

ESA Type: Mixed
- Upland : 58.2%
- Aquatic : 26.9%
- Riparian : 23.1%

Disturbance Risk: High
- High : 93.7%
- Moderate : 6.2%
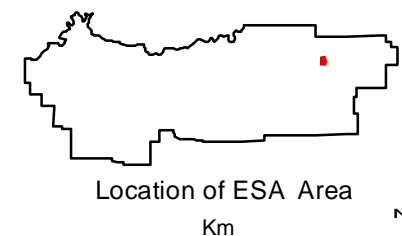- Low : 0%

ESA Area (ha): 85

ESA Score: 32.7/100

Overall ESA Rank: 106/120

Area ESA Rank: 6/ 7

Legend

- ▭ Highlighted ESA
- ── Streams and Rivers
- ▬ Wetlands and Lakes
- ▬ Roads
- ▬ High Risk Area
- ▬ Medium Risk Area
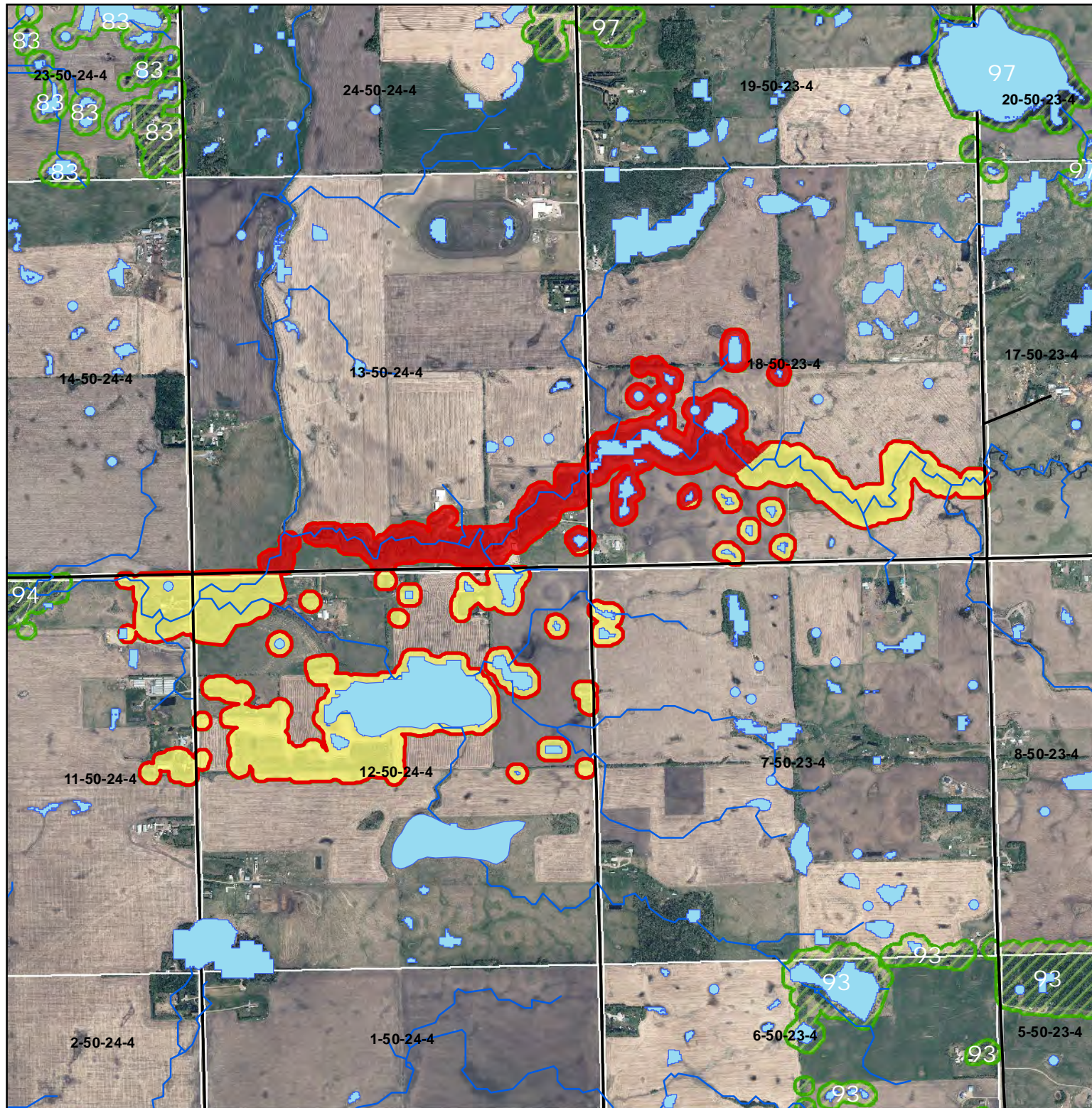- ▬ Low Risk Area
- ▨ Other ESAs

Location of ESA Area

Km

0   0.15   0.3   0.6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

7-51-23-4

8-51-23-4

6-51-23-4

5-51-23-4

ESA Index Map of
Saunders Lake Area

Legend

Individual ESA Type

Aquatic
Mixed
Riparian
Upland

Major Roads
Highlighted ESA Area
Other ESA Areas
Leduc County 2014 Boundary

Km
0   1.5   3   6

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014
Basemap: ESRI Light Grey Canvas

Location of ESA Area

ESA Number: 90

Saunders Lake Area

ESA Type: Aquatic
- Upland : 8.2%
- Aquatic : 87.4%
- Riparian : 17.1%

Disturbance Risk: Medium
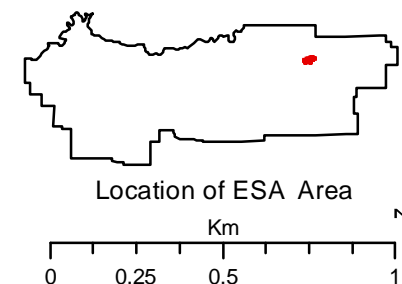- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 50

ESA Score: 34.6/100

Overall ESA Rank: 93/120

Area ESA Rank: 7/ 9

Legend

Highlighted ESA
Streams and Rivers
Wetlands and Lakes
Roads
High Risk Area
Medium Risk Area
Low Risk Area
Other ESAs

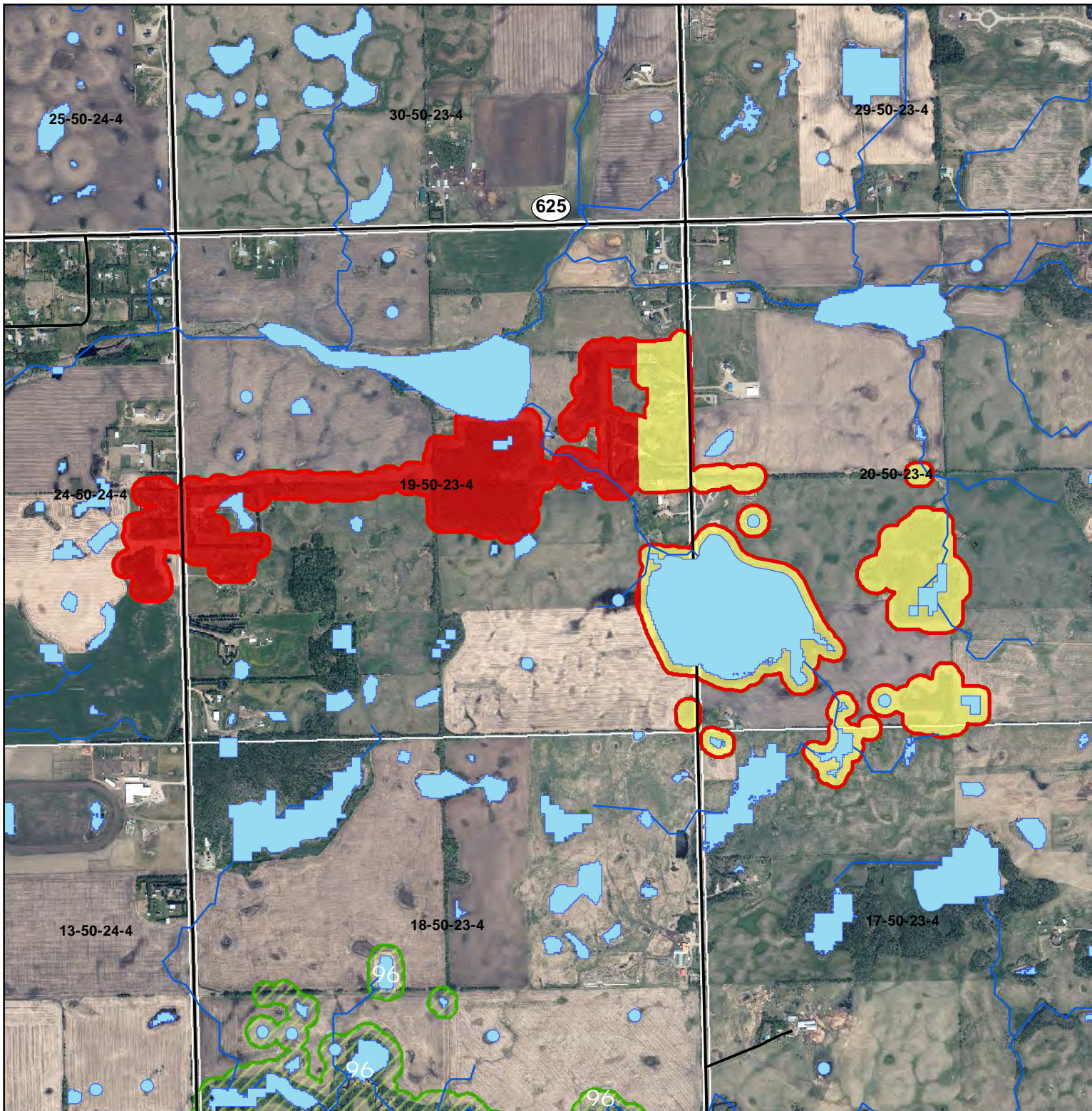Location of ESA Area

Km

0   0.075 0.15   0.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

31-49-23-4
32-49-23-4
30-49-23-4
29-49-23-4

A-90

ESA Number: 91

Saunders Lake Area

ESA Type: Mixed
- Upland : 51.3%
- Aquatic : 31.4%
- Riparian : 25%

Disturbance Risk: Medium
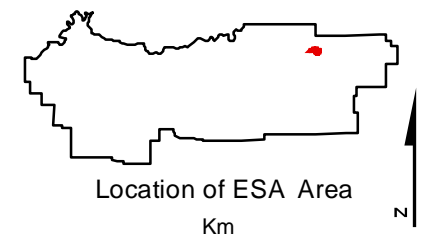- High : 10.1%
- Moderate : 89.7%
- Low : 0%

ESA Area (ha): 242

ESA Score: 34.6/100

Overall ESA Rank: 91/120

Area ESA Rank: 6/ 9

Legend

▭ Highlighted ESA
—— Streams and Rivers
▨ Wetlands and Lakes
—— Roads
▨ High Risk Area
▨ Medium Risk Area
▨ Low Risk Area
▨ Other ESAs

Location of ESA Area
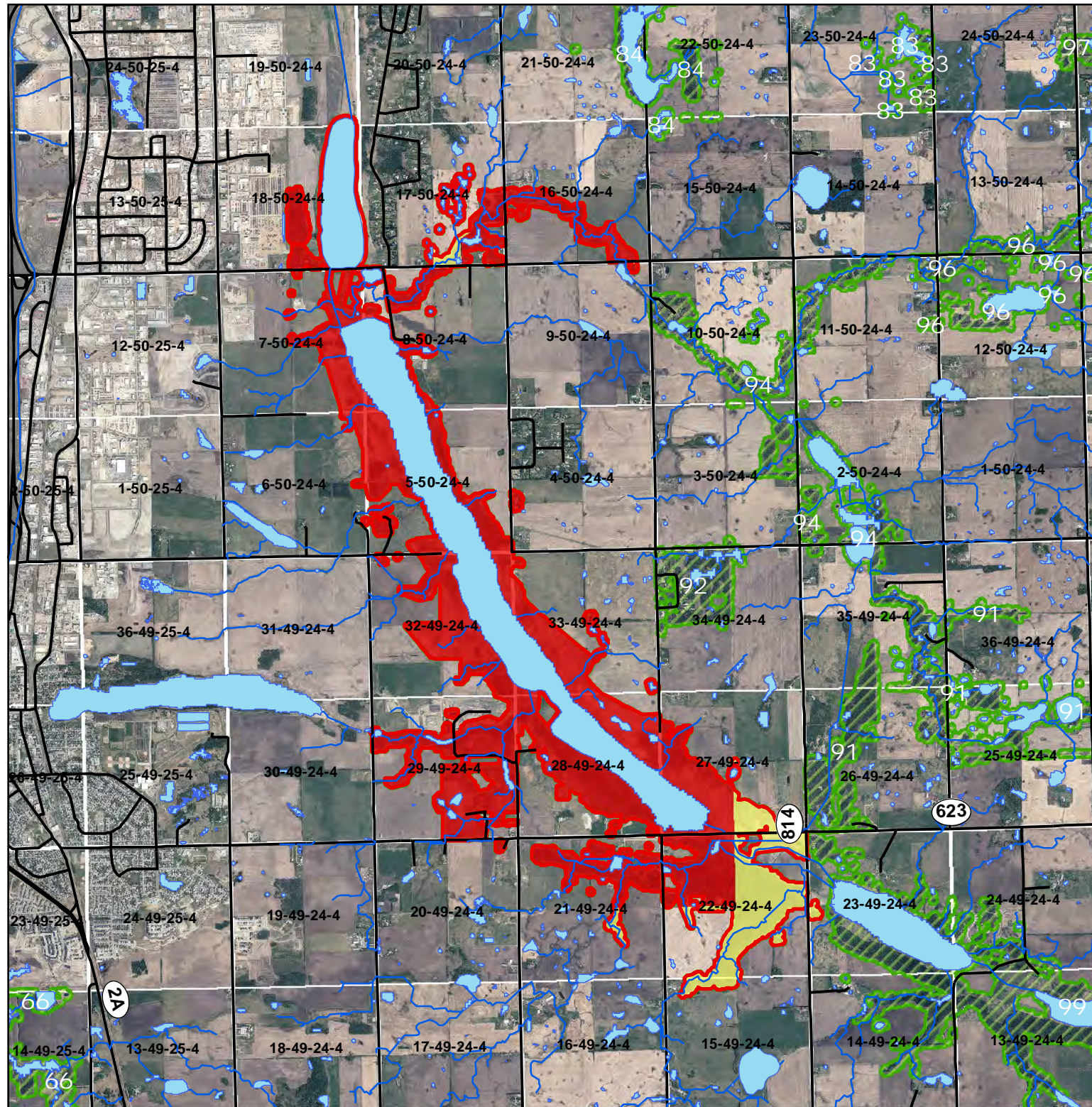
Km

0   0.275   0.55   1.1

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-91

ESA Number: 92

Saunders Lake Area

ESA Type: Upland
- Upland : 71.2%
- Aquatic : 24.8%
- Riparian : 13.2%

Disturbance Risk: Medium
- High : 45.9%
- Moderate : 54.1%
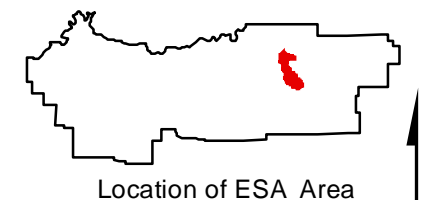- Low : 0%

ESA Area (ha): 73

ESA Score: 42.7/100
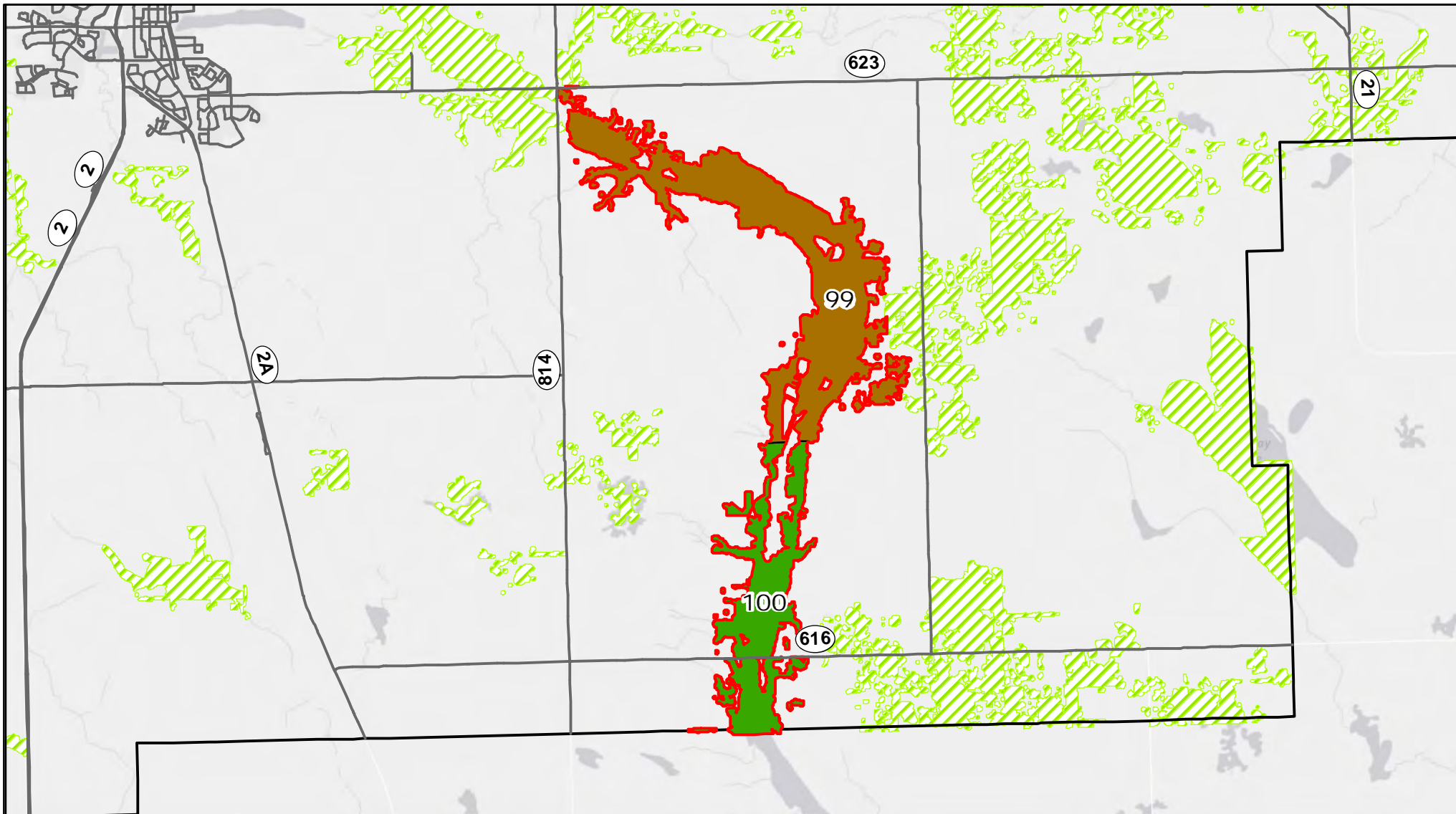
Overall ESA Rank: 65/120

Area ESA Rank: 2/ 9

Legend

▭ Highlighted ESA

── Streams and Rivers

▭ Wetlands and Lakes

── Roads

▮ High Risk Area

▮ Medium Risk Area

▮ Low Risk Area

▨ Other ESAs

Location of ESA Area

Km

0   0.075   0.15   0.3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
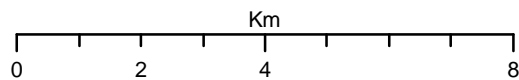Provided by Leduc County
Basemap:ESRI Light Grey Canvas

ESA Number: 93

Saunders Lake Area

ESA Type: Mixed
- Upland : 61.2%
- Aquatic : 33.8%
- Riparian : 14.1%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 56

ESA Score: 31.8/100

Overall ESA Rank: 109/120

Area ESA Rank: 9/ 9

Legend

⬜ Highlighted ESA
— Streams and Rivers
🟦 Wetlands and Lakes
— Roads
🟥 High Risk Area
🟨 Medium Risk Area
🟩 Low Risk Area
▨ Other ESAs

Location of ESA Area

Km

0   0.125   0.25   0.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-93

ESA Number: 94

Saunders Lake Area

ESA Type: Riparian
- Upland : 38.8%
- Aquatic : 34.4%
- Riparian : 43%

Disturbance Risk: Medium
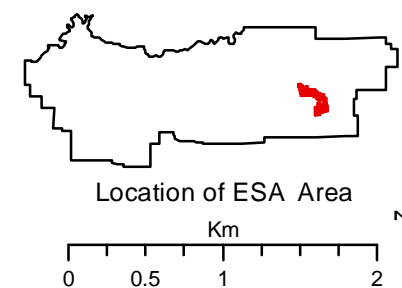- High : 9.3%
- Moderate : 90.5%
- Low : 0%

ESA Area (ha): 190

ESA Score: 36.7/100

Overall ESA Rank: 79/120

Area ESA Rank: 5/ 9

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▮ Wetlands and Lakes
- — Roads
- ▮ High Risk Area
- ▮ Medium Risk Area
- ▮ Low Risk Area
- ▨ Other ESAs

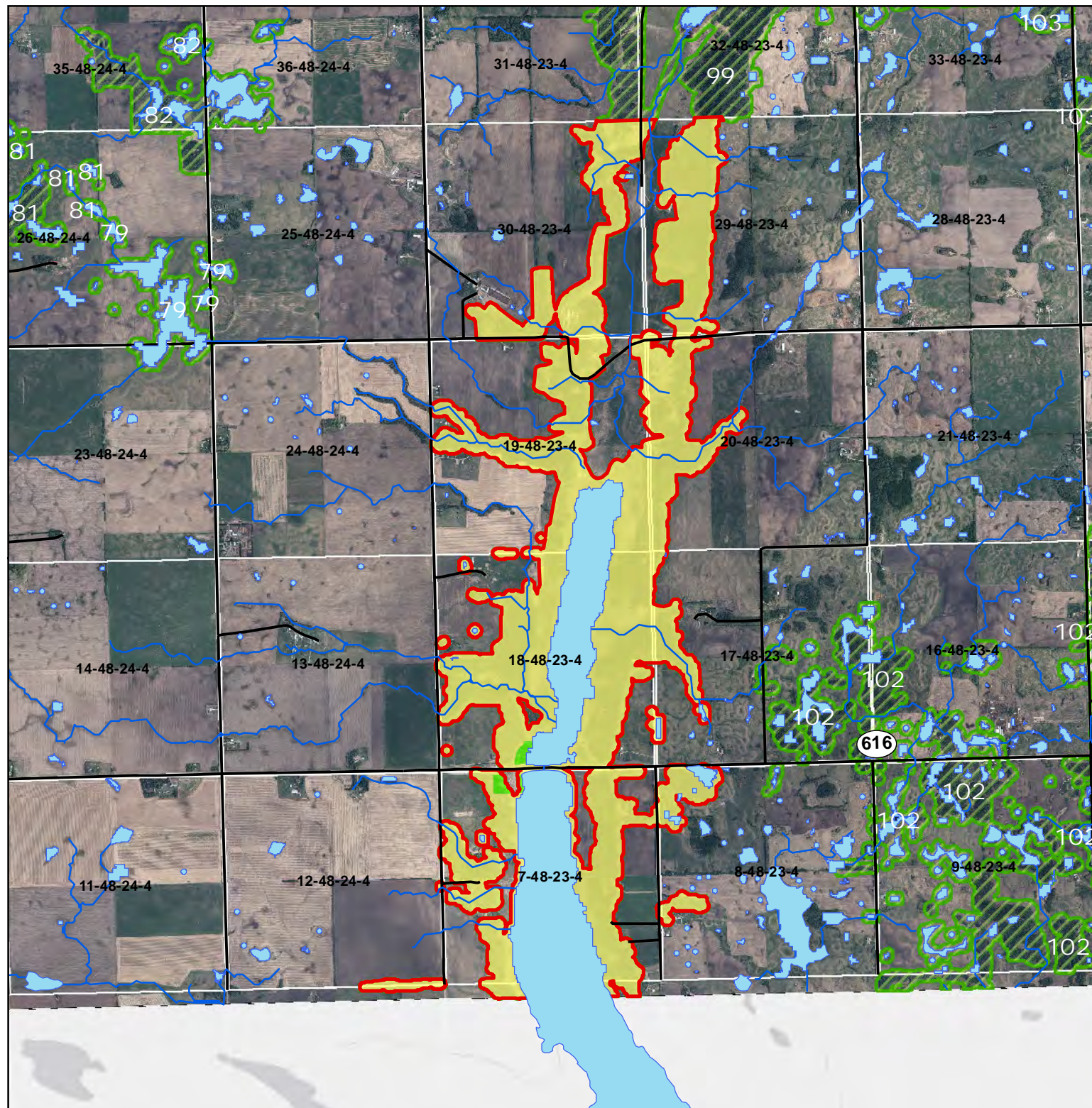Location of ESA Area

Km

0   0.25   0.5   1

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-94

ESA Number: 95

Saunders Lake Area

ESA Type: Aquatic
- Upland : 11.5%
- Aquatic : 76.8%
- Riparian : 22.4%

  Disturbance Risk: High
- High : 82.4%
- Moderate : 17.4%
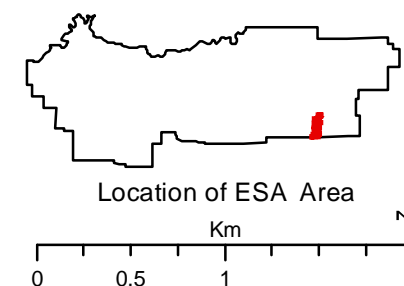- Low : 0%

ESA Area (ha): 100

ESA Score: 42.2/100

Overall ESA Rank: 66/120

Area ESA Rank: 3/ 9

Legend

▭ Highlighted ESA
— Streams and Rivers
▢ Wetlands and Lakes
— Roads
▮ High Risk Area
▮ Medium Risk Area
▮ Low Risk Area
▨ Other ESAs

Location of ESA Area
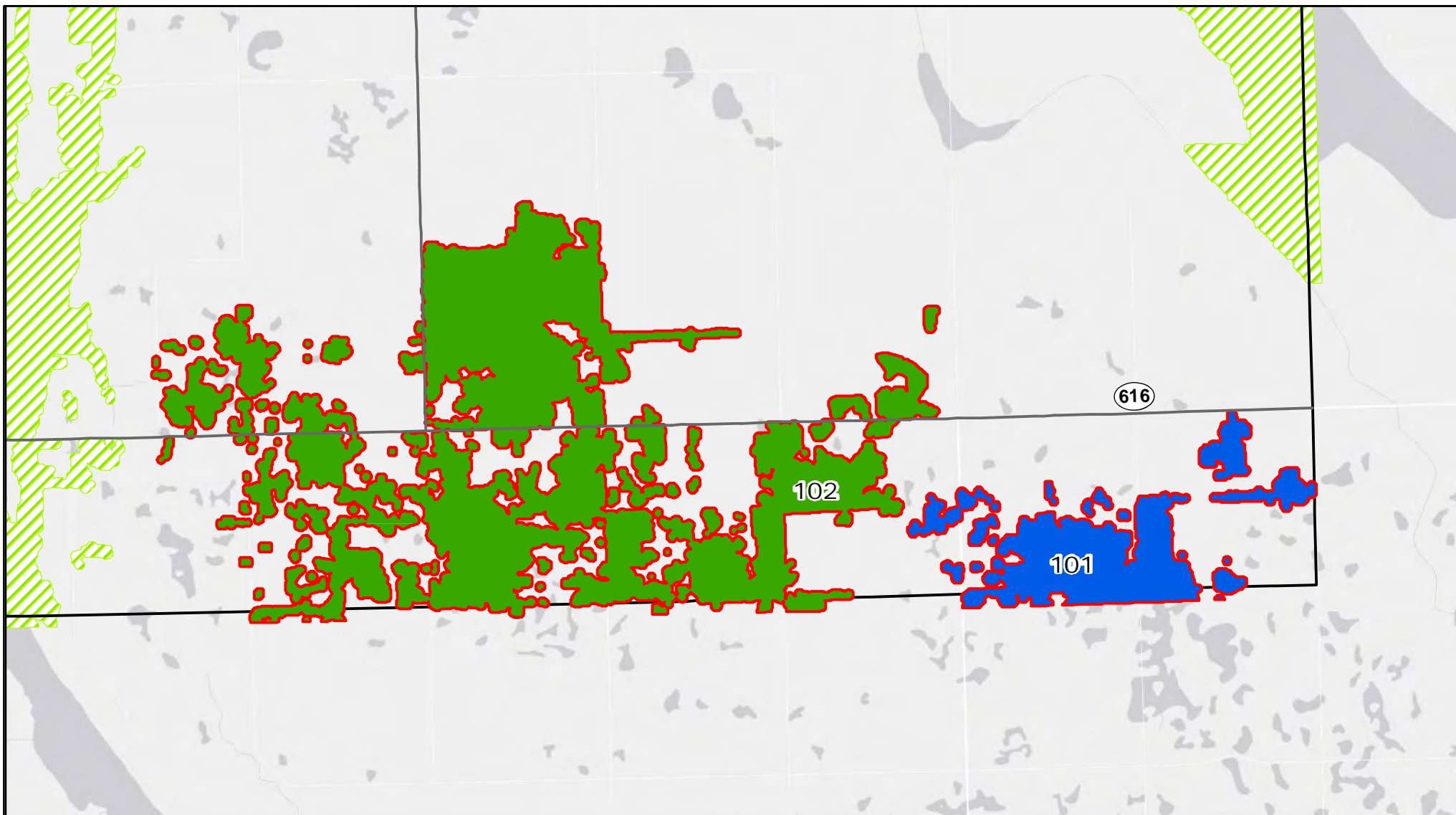
Km

0   0.125   0.25   0.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-95

ESA Number: 96

Saunders Lake Area

ESA Type: Riparian
- Upland : 29%
- Aquatic : 40.3%
- Riparian : 40.2%

Disturbance Risk: Medium
- High : 32.8%
- Moderate : 67.1%
- Low : 0%

ESA Area (ha): 141

ESA Score: 38.2/100

Overall ESA Rank: 77/120

Area ESA Rank: 4/ 9

Legend

▭ Highlighted ESA
— Streams and Rivers
▮ Wetlands and Lakes
— Roads
▮ High Risk Area
▮ Medium Risk Area
▮ Low Risk Area
▨ Other ESAs

Location of ESA Area

Km

0   0.25   0.5   1

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
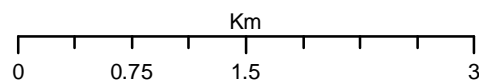Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-96

ESA Number: 97

Saunders Lake Area

ESA Type: Mixed
- Upland : 57.6%
- Aquatic : 38.8%
- Riparian : 10.2%

Disturbance Risk: Medium
- High : 42.2%
- Moderate : 57.7%
- Low : 0%

ESA Area (ha): 96

ESA Score: 34/100

Overall ESA Rank: 98/120

Area ESA Rank: 8/ 9

Legend

▭	Highlighted ESA
—	Streams and Rivers
▇	Wetlands and Lakes
—	Roads
▇	High Risk Area
▇	Medium Risk Area
▇	Low Risk Area
▨	Other ESAs

Location of ESA Area

Km

0   0.2   0.4   0.8

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-97

ESA Number: 98

Saunders Lake Area

ESA Type: Mixed
- Upland : 48.1%
- Aquatic : 36.7%
- Riparian : 18.7%

   Disturbance Risk: High
- High : 89.4%
- Moderate : 10.5%
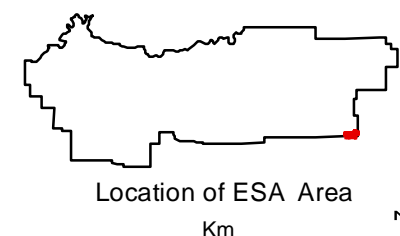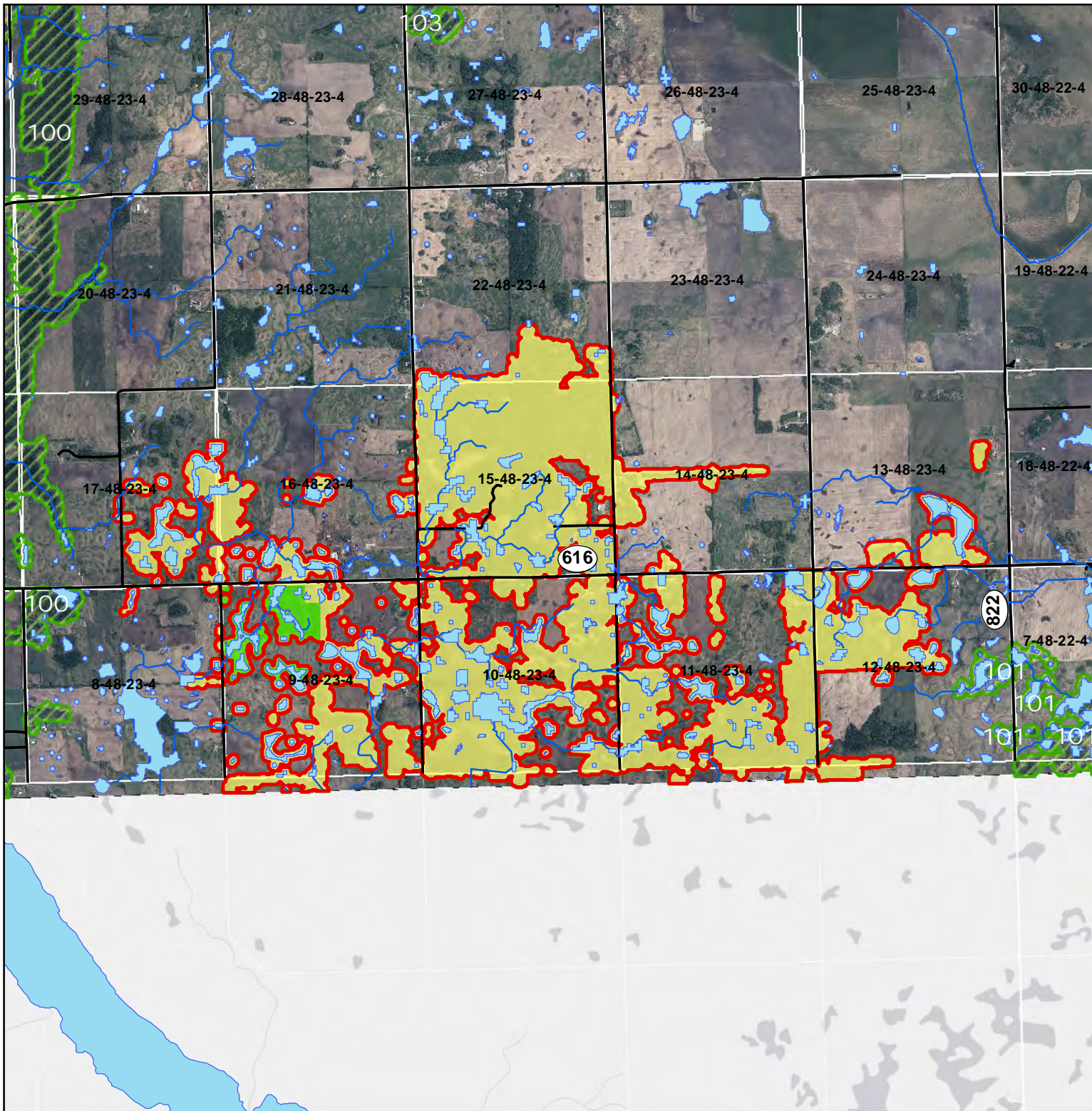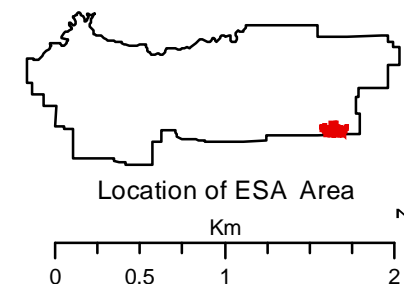- Low : 0%

ESA Area (ha): 1339

ESA Score: 60.5/100

Overall ESA Rank: 23/120

Area ESA Rank: 1/ 9

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area
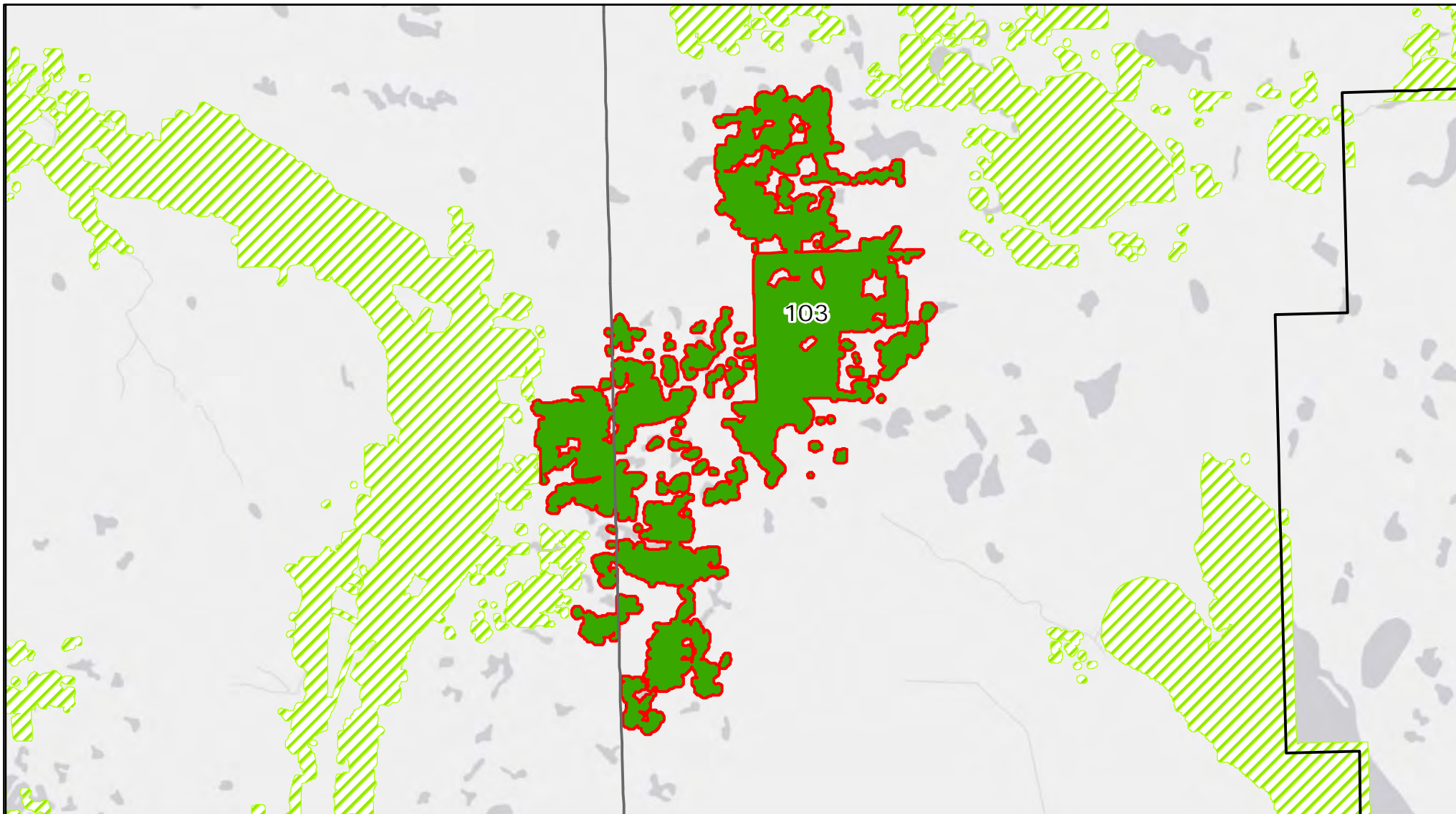
Km

0   0.75   1.5   3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
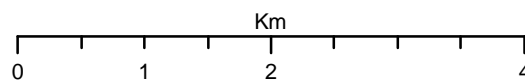Basemap:ESRI Light Grey Canvas

A-98

ESA Index Map of
Coal Lake Area

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

Major Roads

Highlighted ESA Area

Other ESA Areas

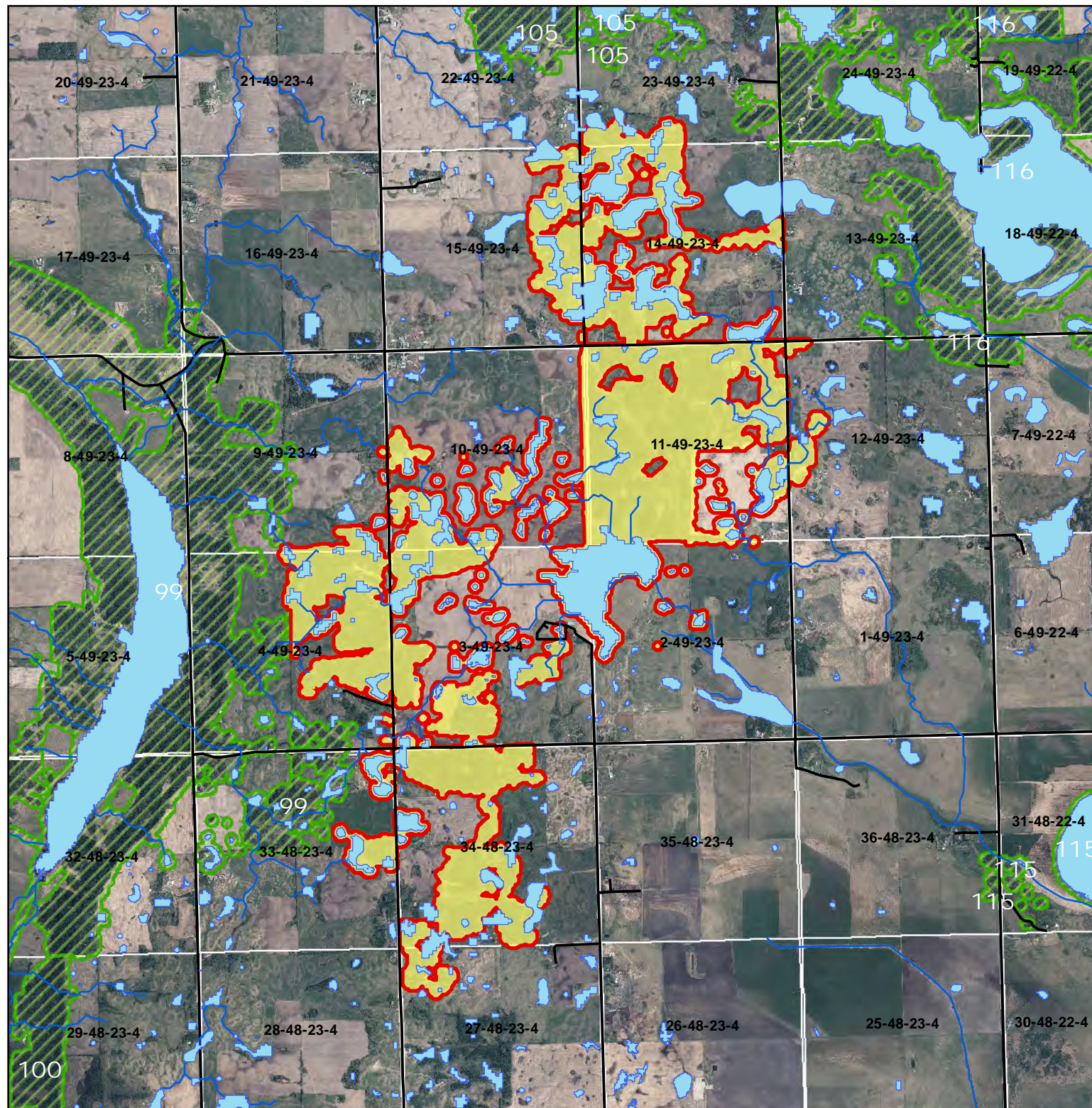Leduc County 2014 Boundary

Km
0   2   4   8

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas
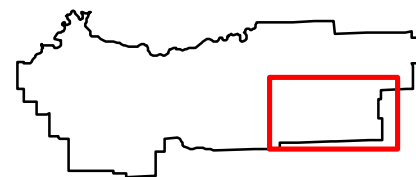
Location of ESA Area
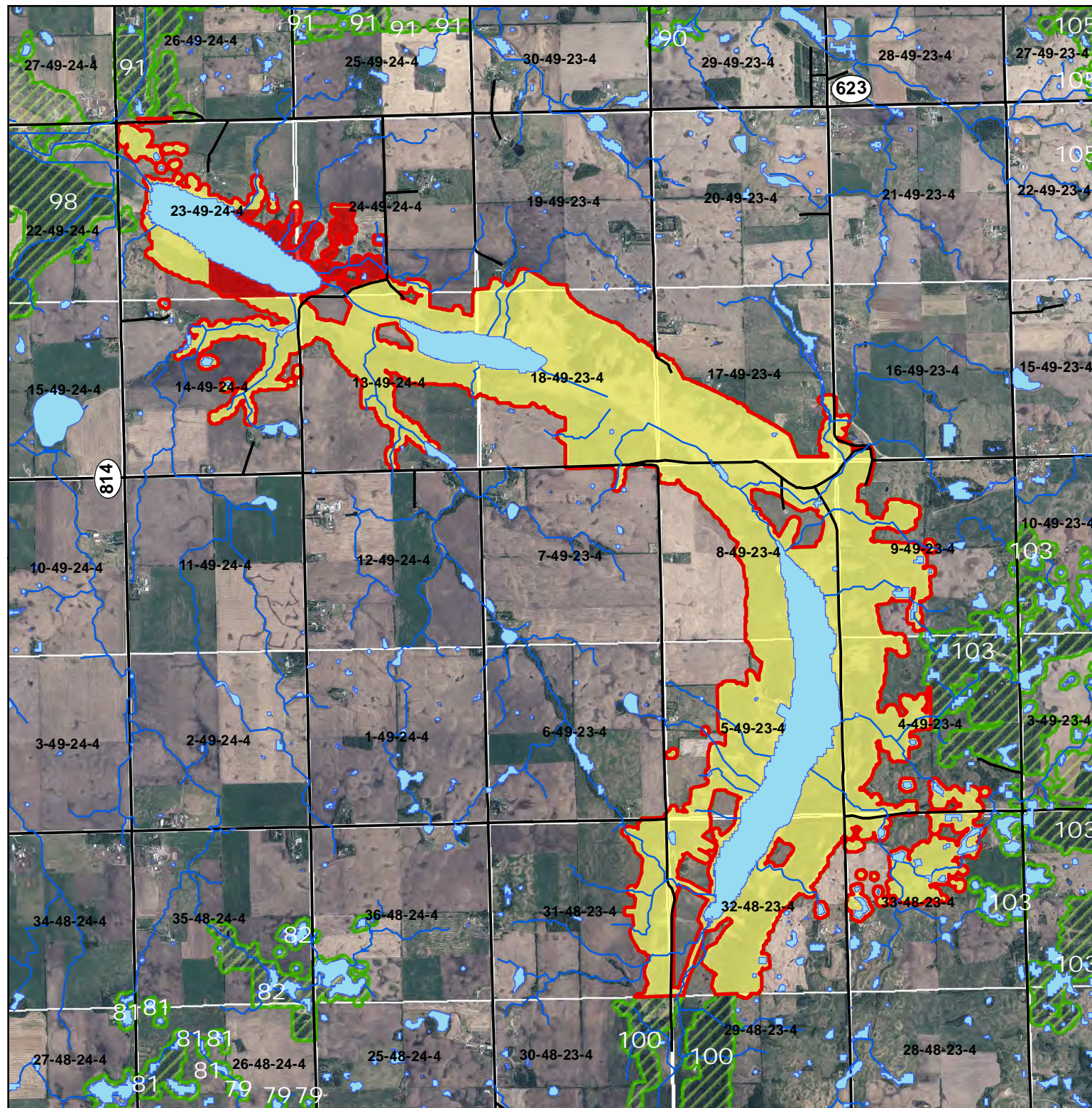
ESA Number: 99

Coal Lake Area

ESA Type: Upland
- Upland : 65%
- Aquatic : 23.8%
- Riparian : 14.2%

Disturbance Risk: Medium
- High : 3.9%
- Moderate : 96.1%
- Low : 0%

ESA Area (ha): 1423

ESA Score: 65.2/100

Overall ESA Rank: 15/120

Area ESA Rank: 1/ 2

Legend

Highlighted ESA

Streams and Rivers

Wetlands and Lakes

Roads

High Risk Area

Medium Risk Area

Low Risk Area

Other ESAs

Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-99

ESA Number: 100

Coal Lake Area

ESA Type: Mixed
- Upland : 62%
- Aquatic : 27.5%
- Riparian : 11.2%

Disturbance Risk: Medium
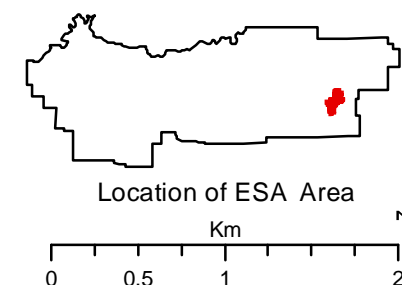- High : 0%
- Moderate : 99.4%
- Low : 0.6%

ESA Area (ha): 697

ESA Score: 56.3/100

Overall ESA Rank: 32/120

Area ESA Rank: 2/ 2

Legend

- ▭ Highlighted ESA
- ── Streams and Rivers
- ▬ Wetlands and Lakes
- ── Roads
- ▬ High Risk Area
- ▬ Medium Risk Area
- ▬ Low Risk Area
- ▨ Other ESAs

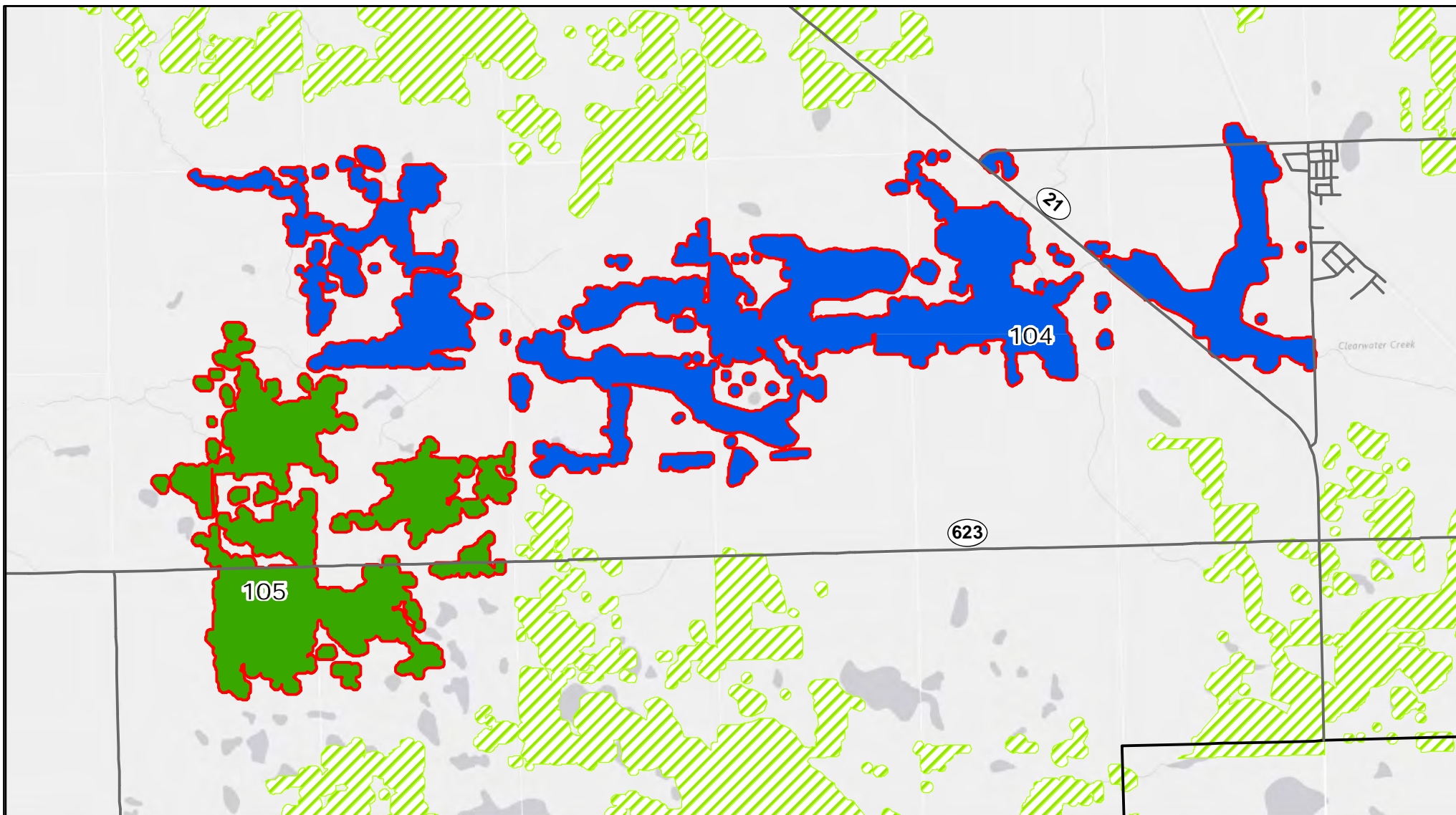Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
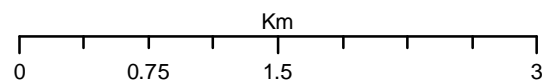Basemap:ESRI Light Grey Canvas

A-100

ESA Index Map of
North Labyrinth Area

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

Major Roads

Highlighted ESA Area

Other ESA Areas

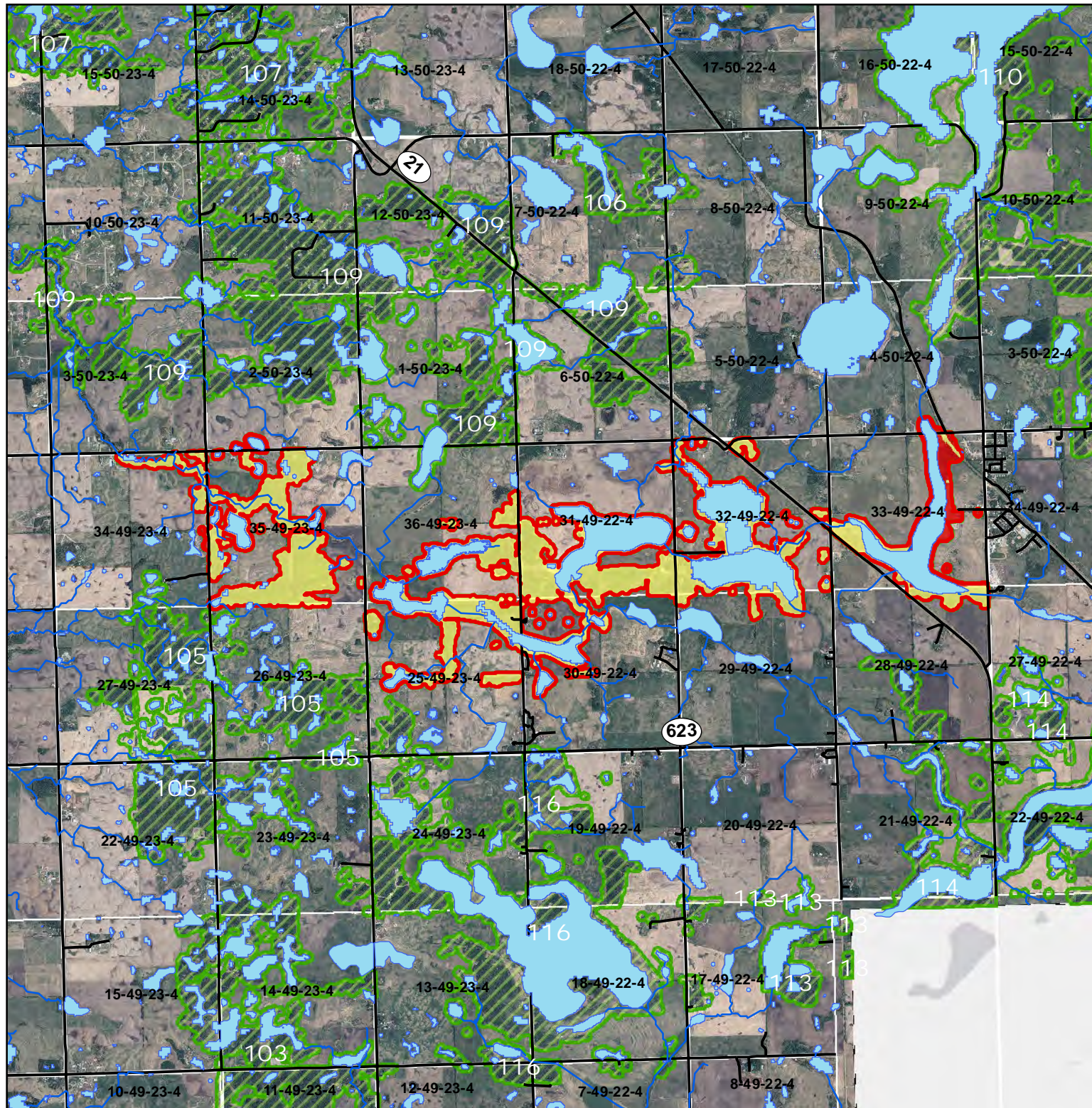Leduc County 2014 Boundary

Km

0   0.75   1.5   3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area
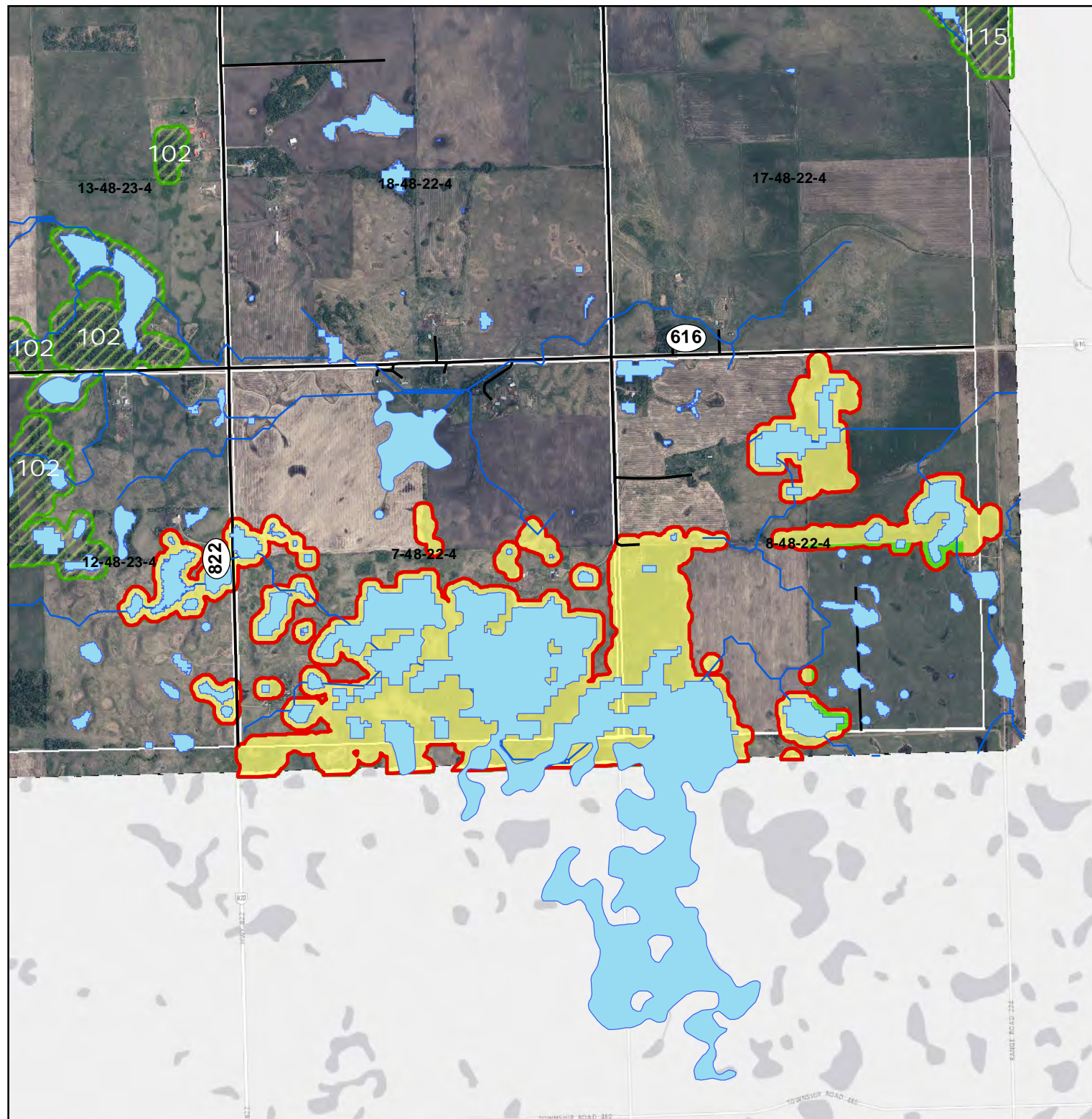
ESA Number: 101

North Labyrinth Area

ESA Type: Aquatic
- Upland : 22.9%
- Aquatic : 75.8%
- Riparian : 13.8%

Disturbance Risk: Medium
- High : 0%
- Moderate : 97.8%
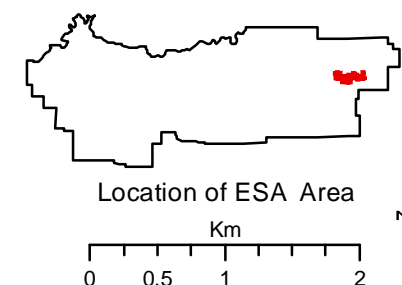- Low : 2.1%

ESA Area (ha): 210

ESA Score: 43.6/100

Overall ESA Rank: 62/120

Area ESA Rank: 2/ 2

Legend

▭ Highlighted ESA
— Streams and Rivers
▬ Wetlands and Lakes
— Roads
▬ High Risk Area
▬ Medium Risk Area
▬ Low Risk Area
▨ Other ESAs

Location of ESA Area
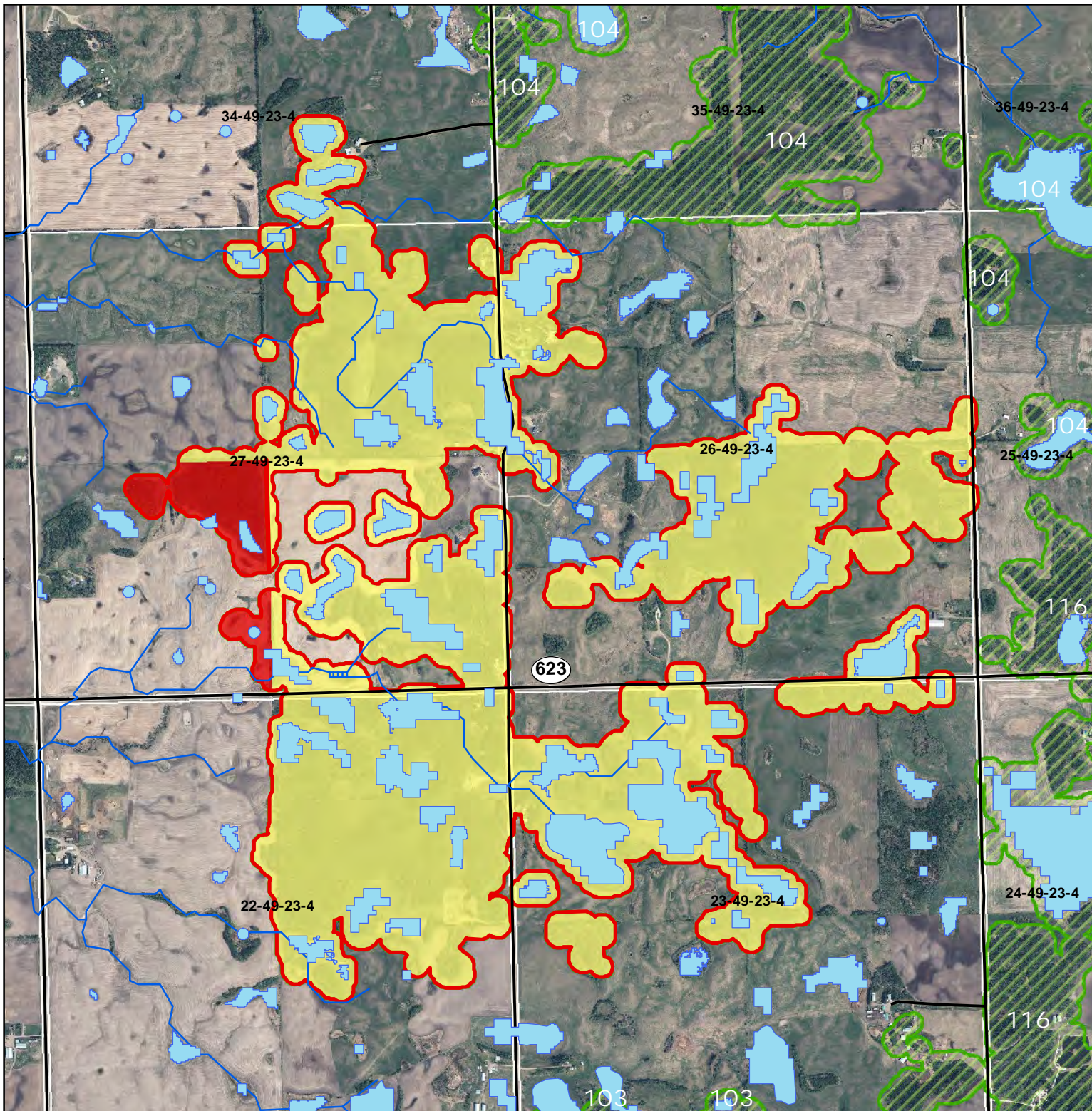
Km

0   0.275   0.55   1.1

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-101

ESA Number: 102

North Labyrinth Area

ESA Type: Mixed
- Upland : 55.6%
- Aquatic : 39%
- Riparian : 14.2%

Disturbance Risk: Medium
- High : 0%
- Moderate : 96.2%
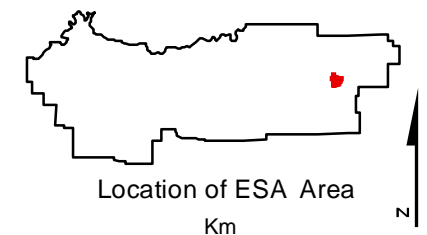- Low : 3.7%

ESA Area (ha): 1020

ESA Score: 56.9/100

Overall ESA Rank: 29/120

Area ESA Rank: 1/ 2

Legend

⬜ Highlighted ESA
— Streams and Rivers
⬜ Wetlands and Lakes
— Roads
⬜ High Risk Area
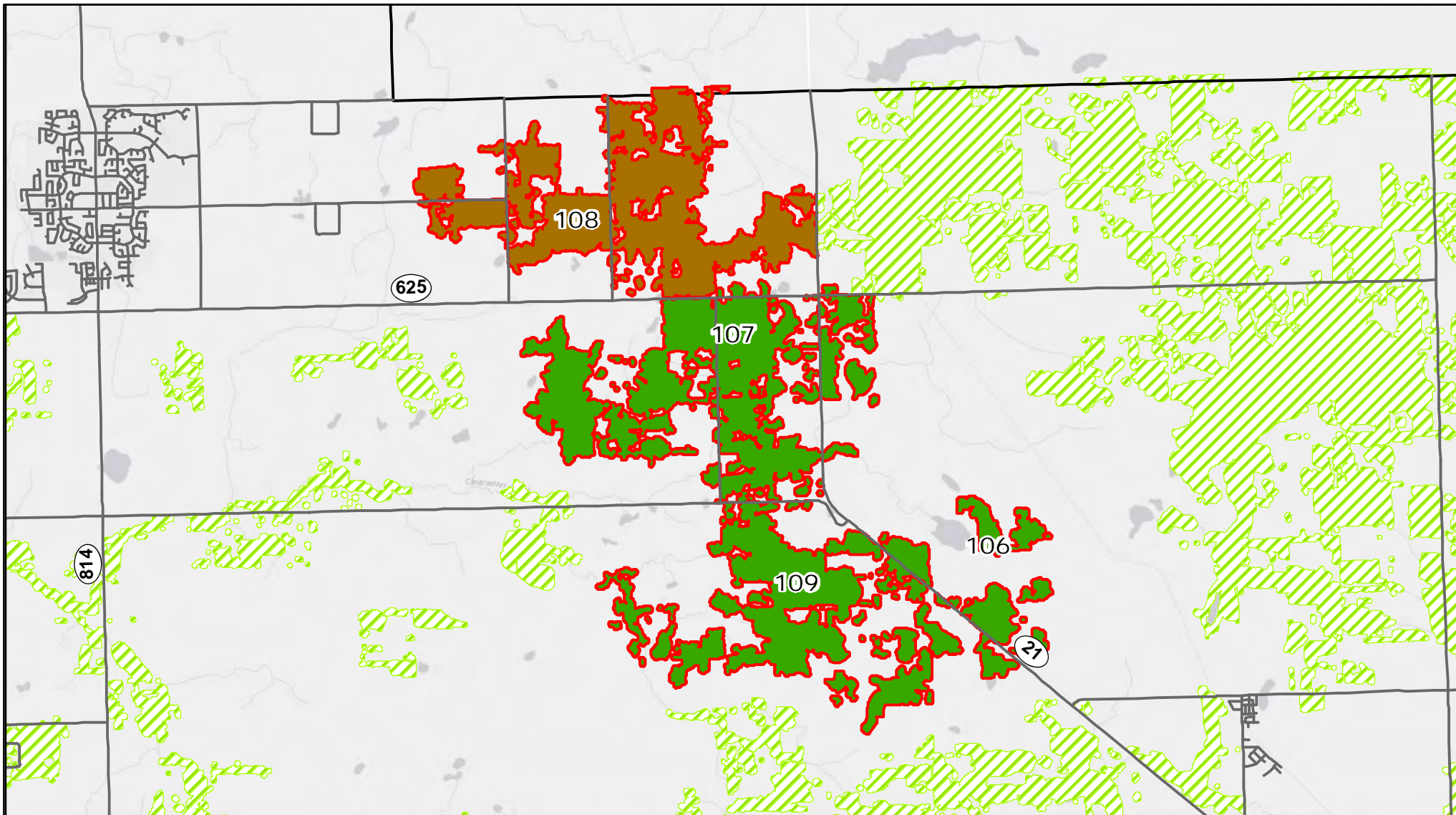⬜ Medium Risk Area
⬜ Low Risk Area
▨ Other ESAs

Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
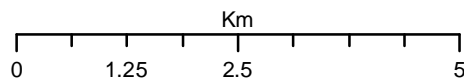Basemap:ESRI Light Grey Canvas

A-102

ESA Index Map of Northwest Hay Area

103

Legend

Individual ESA Type

- Major Roads
- Aquatic
- Mixed
- Riparian
- Upland
- Highlighted ESA Area
- Other ESA Areas
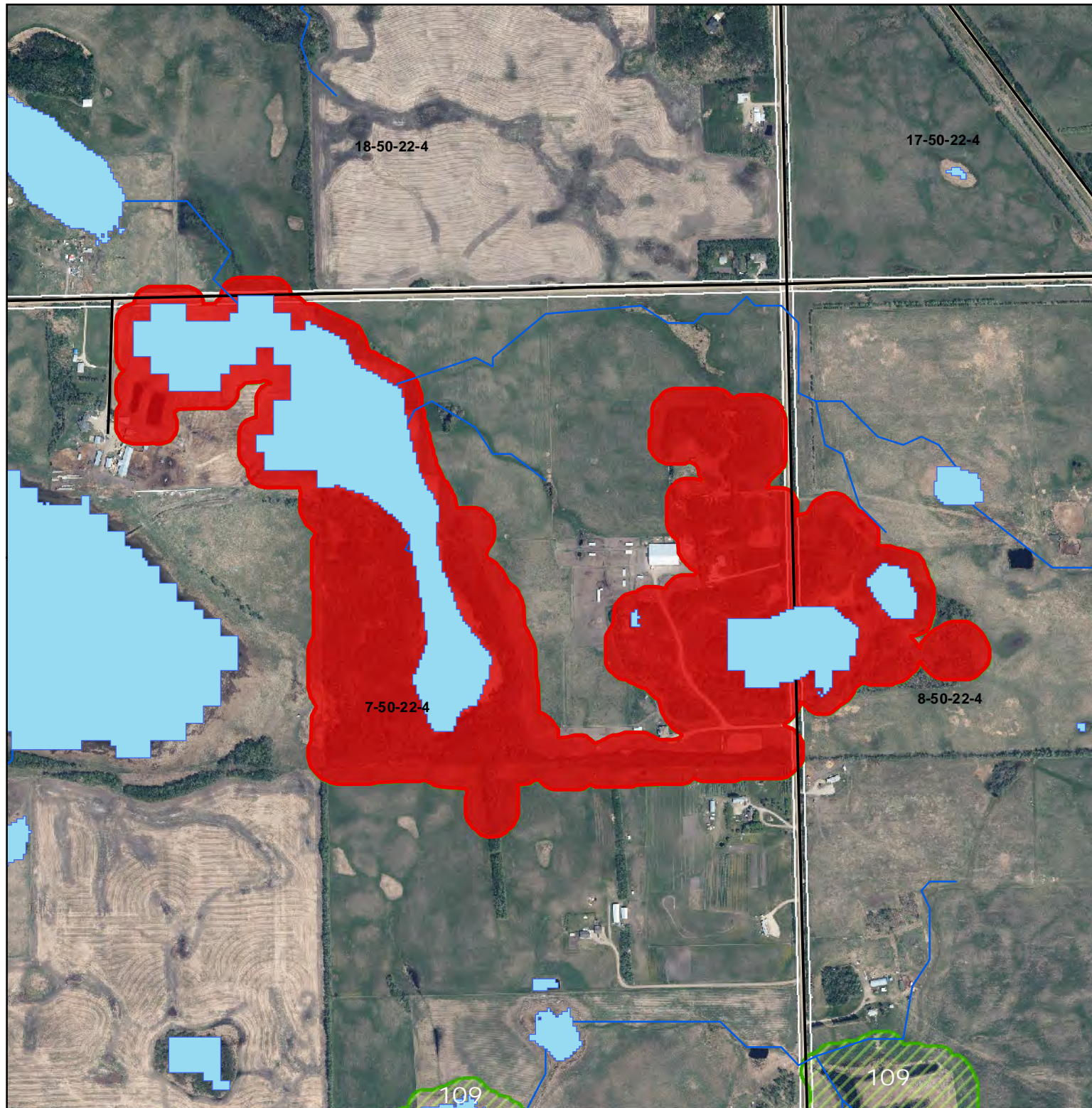- Leduc County 2014 Boundary

Km
0   1   2   4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area

ESA Number: 103

Northwest Hay Area

ESA Type: Mixed
- Upland : 52.9%
- Aquatic : 43.9%
- Riparian : 10.6%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
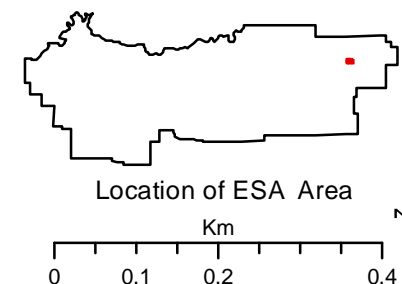- Low : 0%

ESA Area (ha): 883

ESA Score: 54.3/100

Overall ESA Rank: 36/120

Area ESA Rank: 1/ 1

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area
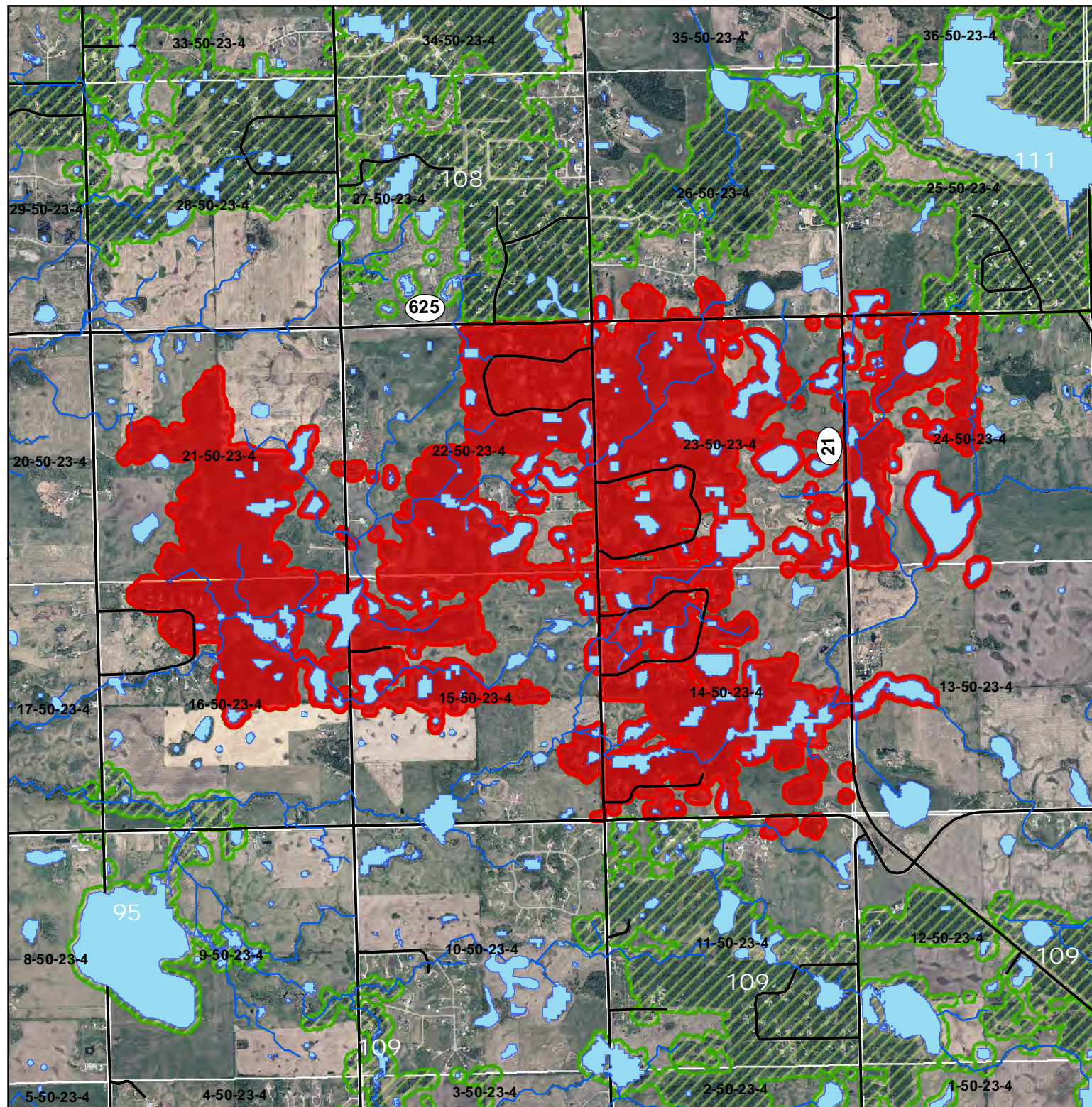
Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-103

ESA Index Map of
New Sarepta Area

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

— Major Roads

Highlighted ESA Area

Other ESA Areas

Leduc County 2014 Boundary

Km

0   0.75   1.5   3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area

ESA Number: 104

New Sarepta Area

ESA Type: Aquatic
- Upland : 40.4%
- Aquatic : 51.6%
- Riparian : 21.4%

Disturbance Risk: Medium
- High : 9%
- Moderate : 90.9%
- Low : 0%

ESA Area (ha): 649

ESA Score: 44.9/100

Overall ESA Rank: 59/120

Area ESA Rank: 1/ 2

Legend

▭	Highlighted ESA
—	Streams and Rivers
▬	Wetlands and Lakes
—	Roads
▬	High Risk Area
▬	Medium Risk Area
▬	Low Risk Area
▨	Other ESAs

Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-104

ESA Number: 105

New Sarepta Area

ESA Type: Mixed
- Upland : 48%
- Aquatic : 47.8%
- Riparian : 9.4%

Disturbance Risk: Medium
- High : 4%
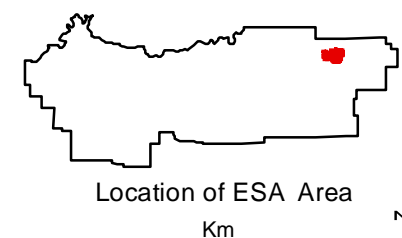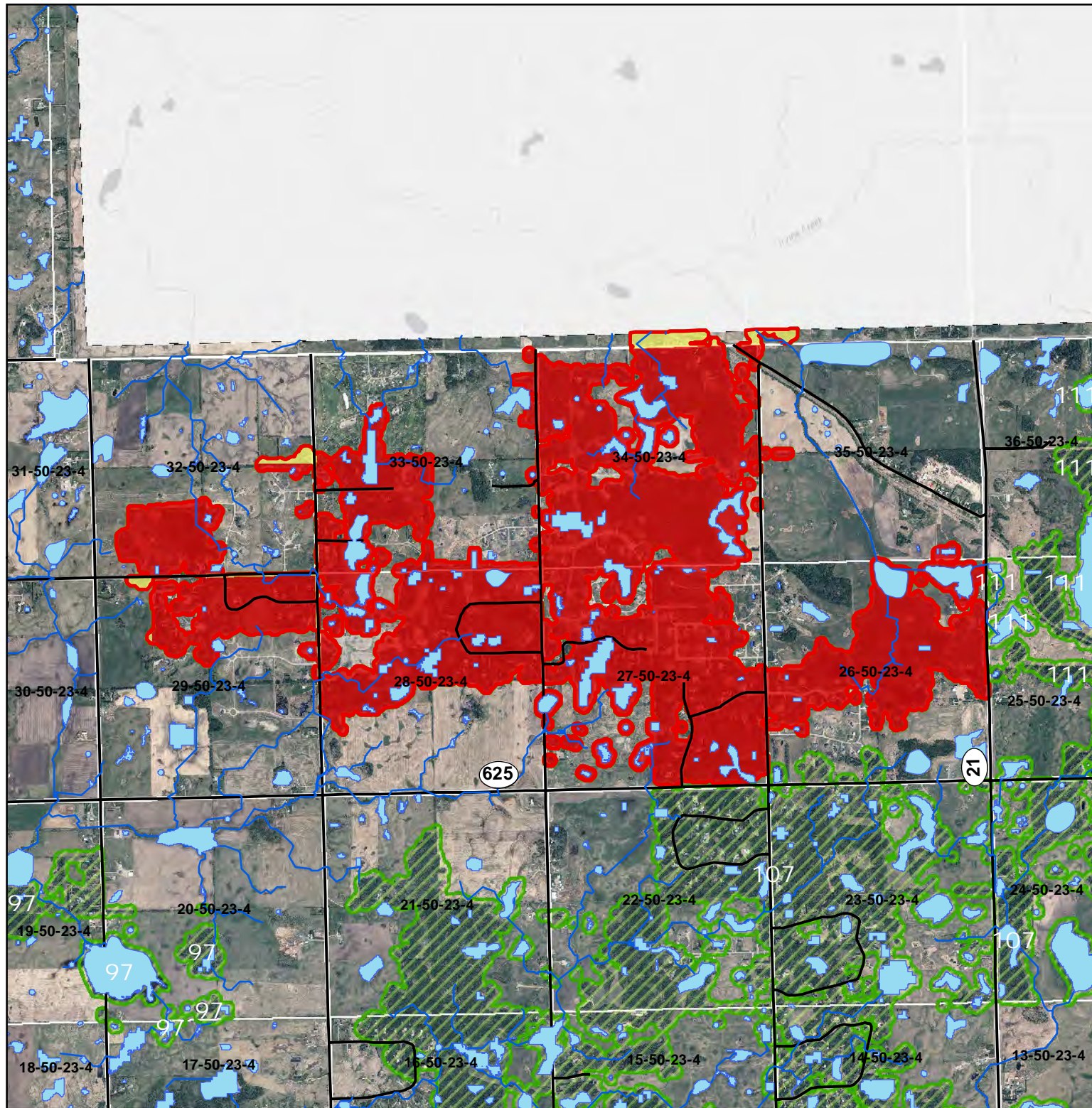- Moderate : 95.9%
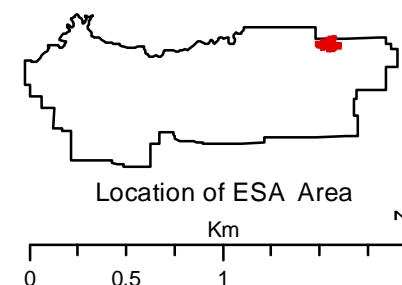- Low : 0%

ESA Area (ha): 341

ESA Score: 41.8/100

Overall ESA Rank: 67/120

Area ESA Rank: 2/ 2

Legend

□ Highlighted ESA
— Streams and Rivers
■ Wetlands and Lakes
— Roads
■ High Risk Area
■ Medium Risk Area
■ Low Risk Area
▨ Other ESAs

Location of ESA Area
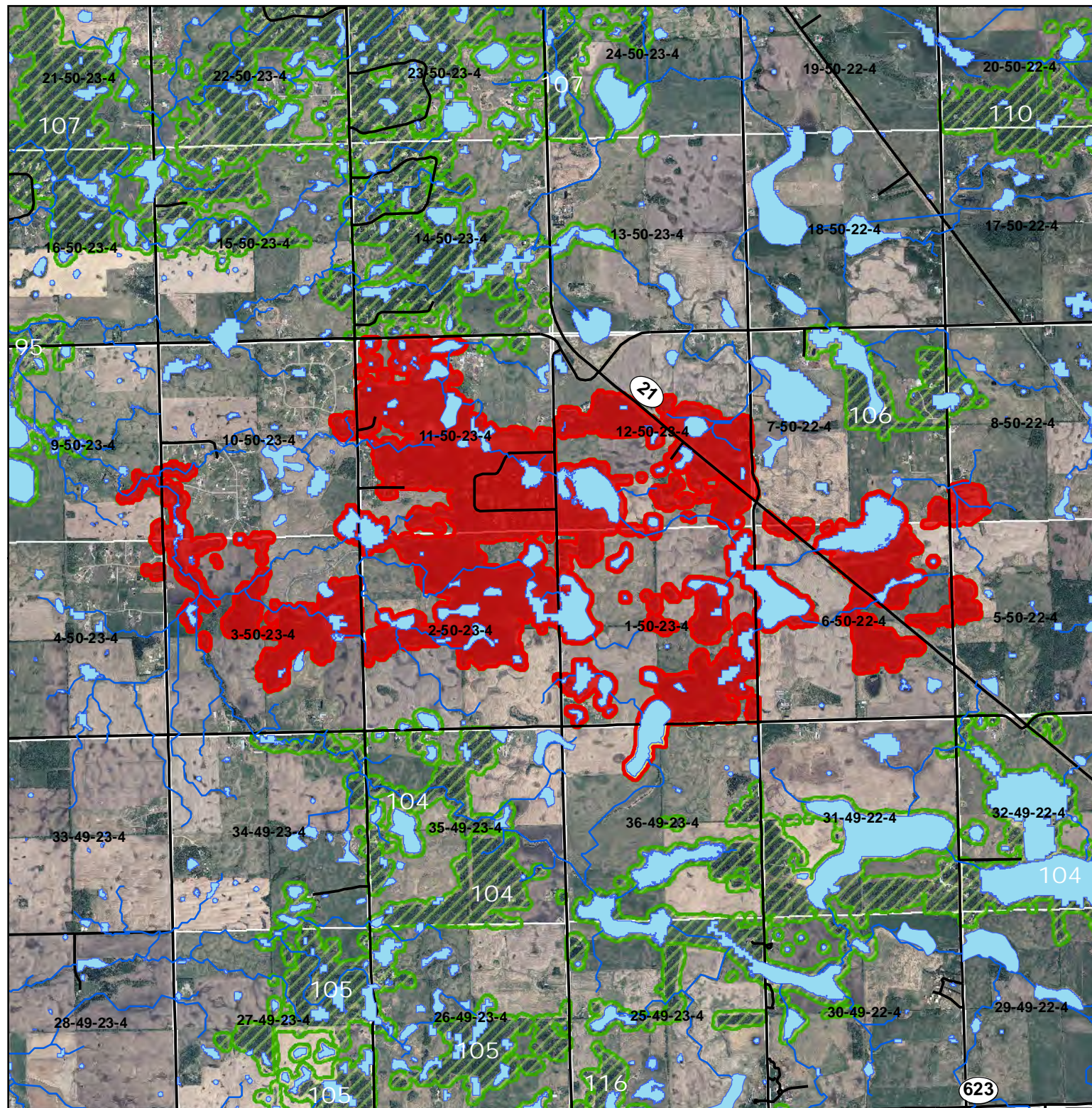
Km
0   0.225   0.45   0.9

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-105

ESA Index Map of Eagle Rock Area

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

Major Roads

Highlighted ESA Area

Other ESA Areas

Leduc County 2014 Boundary

Km

0   1.25   2.5   5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area

N

ESA Number: 106

Eagle Rock Area

ESA Type: Mixed
- Upland : 53.3%
- Aquatic : 46.3%
- Riparian : 10%

  Disturbance Risk: High
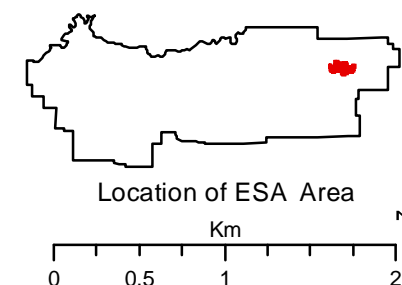- High : 99.9%
- Moderate : 0%
- Low : 0%

ESA Area (ha): 58

ESA Score: 40.6/100

Overall ESA Rank: 70/120

Area ESA Rank: 4/ 4

Legend

▭ Highlighted ESA
── Streams and Rivers
▧ Wetlands and Lakes
── Roads
▧ High Risk Area
▧ Medium Risk Area
▧ Low Risk Area
▨ Other ESAs
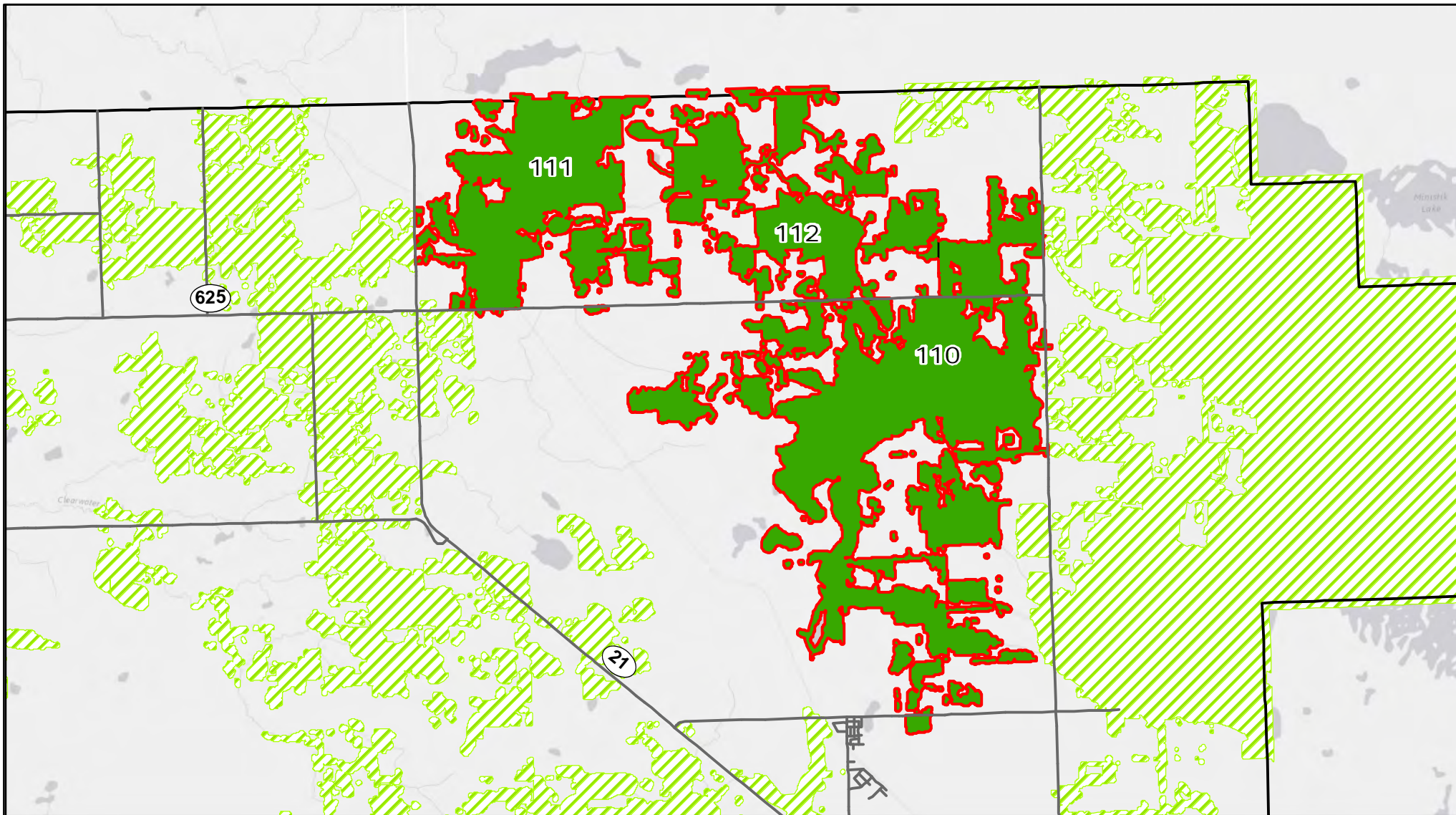
Location of ESA Area

Km

0   0.1   0.2   0.4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
25/11/2014
Background Image: 2013 Air Photo
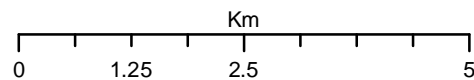Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-106

ESA Number: 107

Eagle Rock Area

ESA Type: Mixed
- Upland : 59.4%
- Aquatic : 32.9%
- Riparian : 15.2%

Disturbance Risk: High
- High : 99.9%
- Moderate : 0%
- Low : 0%

ESA Area (ha): 887

ESA Score: 60.9/100

Overall ESA Rank: 22/120

Area ESA Rank: 1/ 4

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▮ Wetlands and Lakes
- — Roads
- ▮ High Risk Area
- ▮ Medium Risk Area
- ▮ Low Risk Area
- ▨ Other ESAs

Location of ESA Area

Km

0   0.425   0.85   1.7

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-107

ESA Number: 108

Eagle Rock Area

ESA Type: Upland
- Upland : 73.9%
- Aquatic : 21.9%
- Riparian : 6.3%

   Disturbance Risk: High
- High : 97.6%
- Moderate : 2.3%
- Low : 0%

ESA Area (ha): 830

ESA Score: 44/100

Overall ESA Rank: 61/120

Area ESA Rank: 3/ 4

Legend

▭	Highlighted ESA
—	Streams and Rivers
▬	Wetlands and Lakes
—	Roads
▬	High Risk Area
▬	Medium Risk Area
▬	Low Risk Area
▨	Other ESAs

Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-108

ESA Number: 109

Eagle Rock Area

ESA Type: Mixed
- Upland : 59.7%
- Aquatic : 33%
- Riparian : 14.1%

Disturbance Risk: High
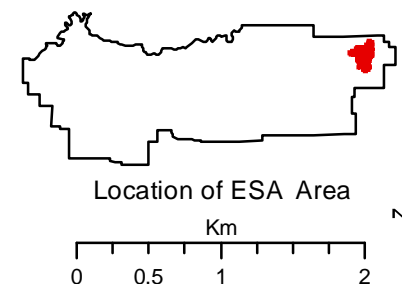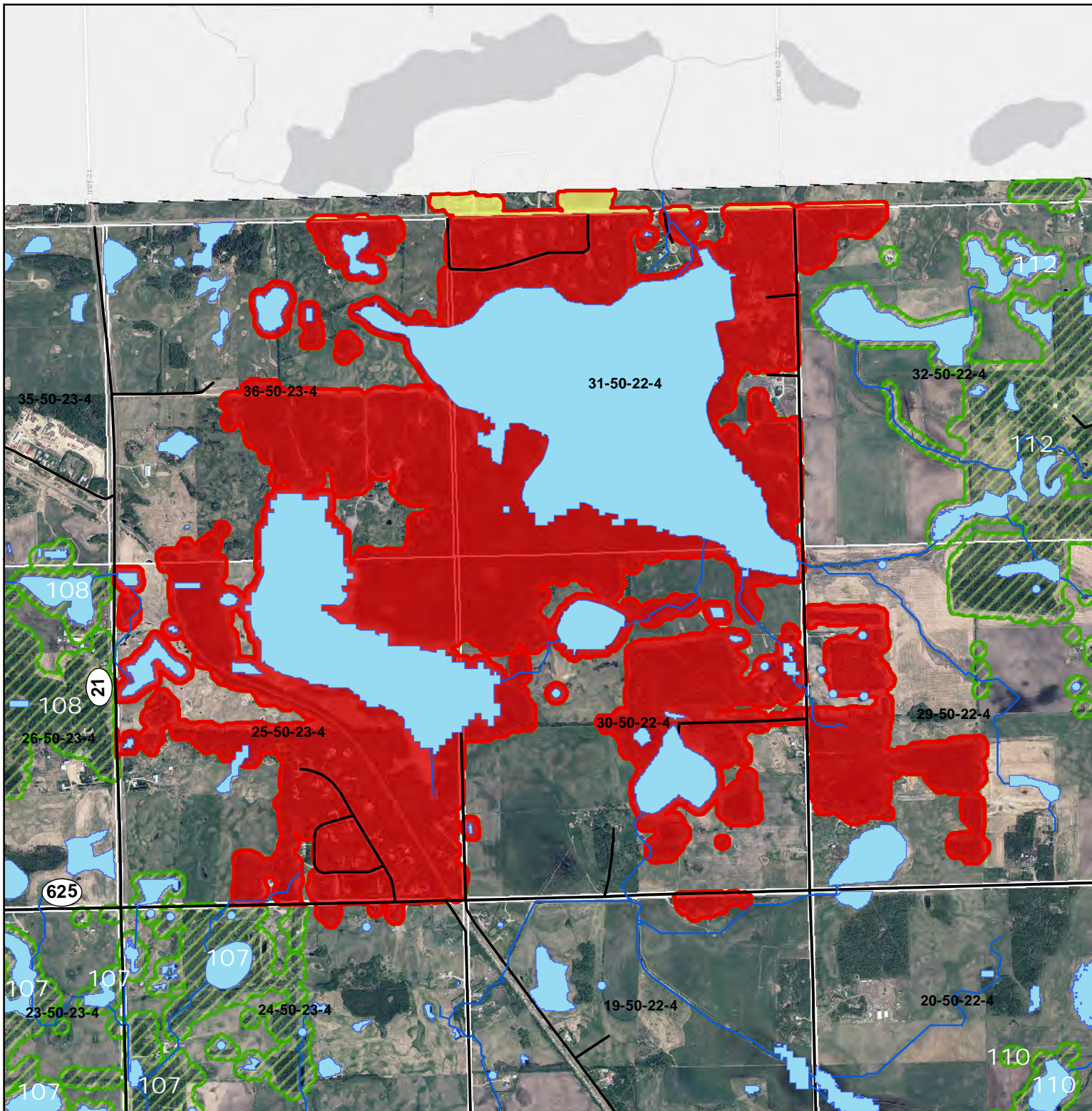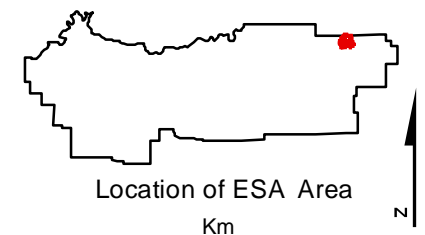- High : 98.5%
- Moderate : 1.4%
- Low : 0%

ESA Area (ha): 780

ESA Score: 54.4/100

Overall ESA Rank: 35/120

Area ESA Rank: 2/ 4

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▢ Wetlands and Lakes
- — Roads
- ▮ High Risk Area
- ▮ Medium Risk Area
- ▮ Low Risk Area
- ▨ Other ESAs

Location of ESA Area
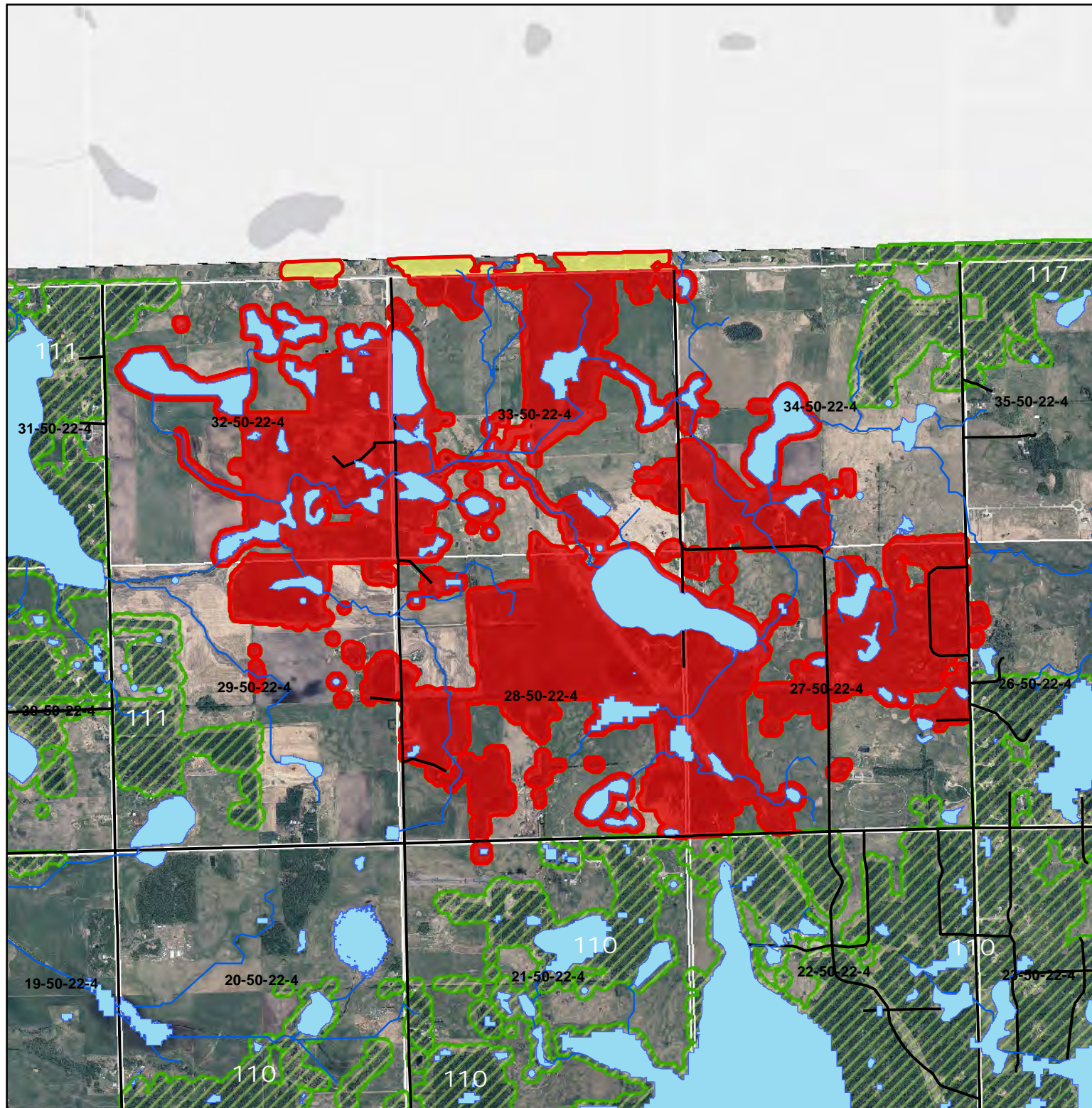
Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-109

ESA Index Map of
Looking Back Lake Area

Legend

Individual ESA Type

Major Roads

Aquatic

Mixed

Riparian

Upland

Highlighted ESA Area

Other ESA Areas

Leduc County 2014 Boundary

Km

0   1.25   2.5   5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area
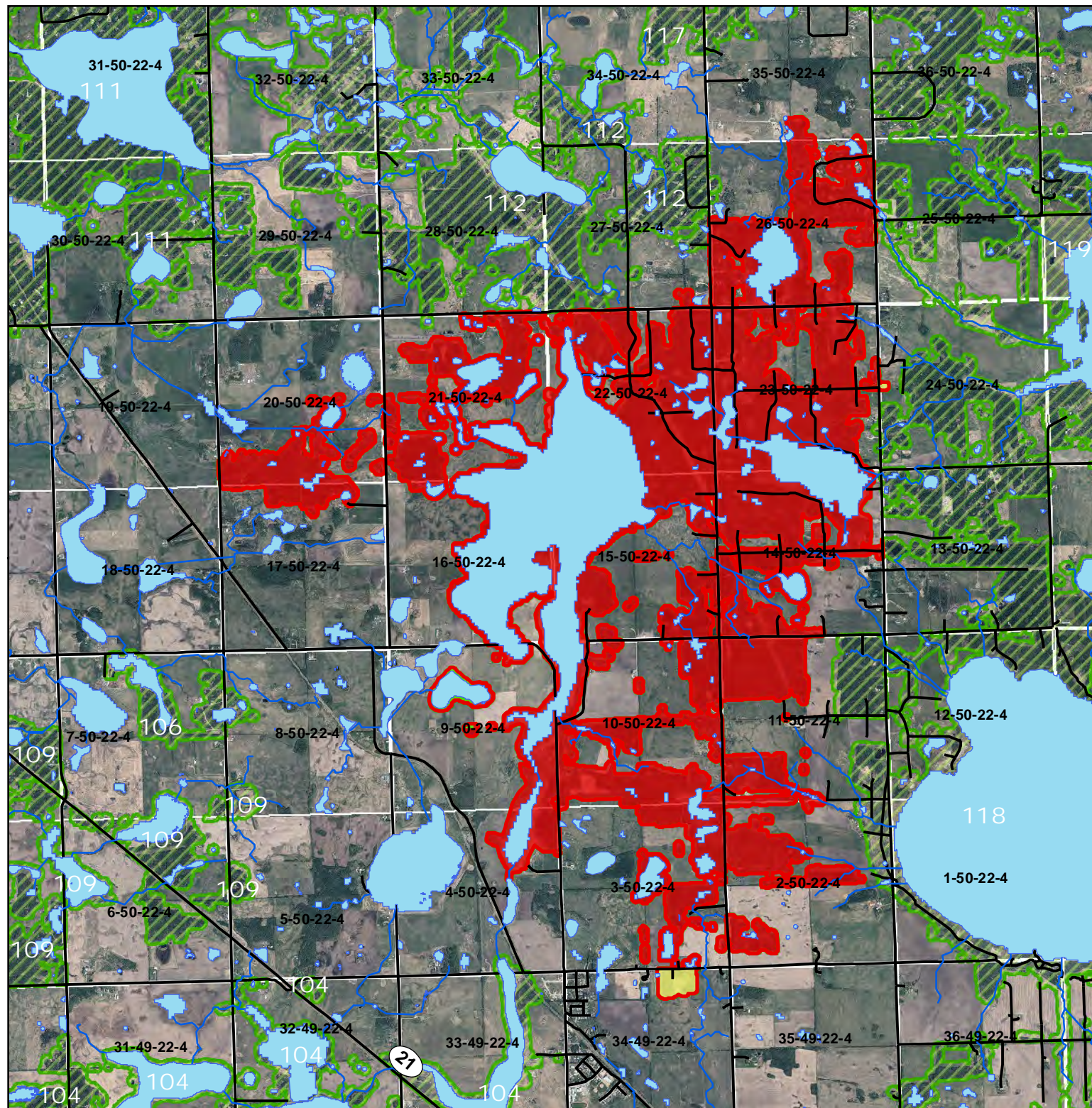
ESA Number: 110

Looking Back Lake Area

ESA Type: Mixed
- Upland : 58%
- Aquatic : 39.5%
- Riparian : 5.7%

  Disturbance Risk: High
- High : 98.4%
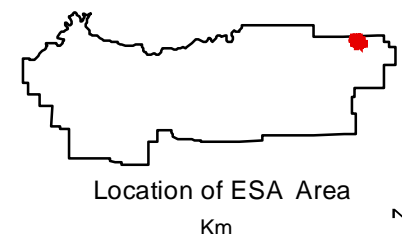- Moderate : 0.8%
- Low : 0.7%

ESA Area (ha): 1765

ESA Score: 55.9/100

Overall ESA Rank: 33/120

Area ESA Rank: 1/ 3

Legend

Highlighted ESA

Streams and Rivers

Wetlands and Lakes

Roads

High Risk Area

Medium Risk Area

Low Risk Area

Other ESAs
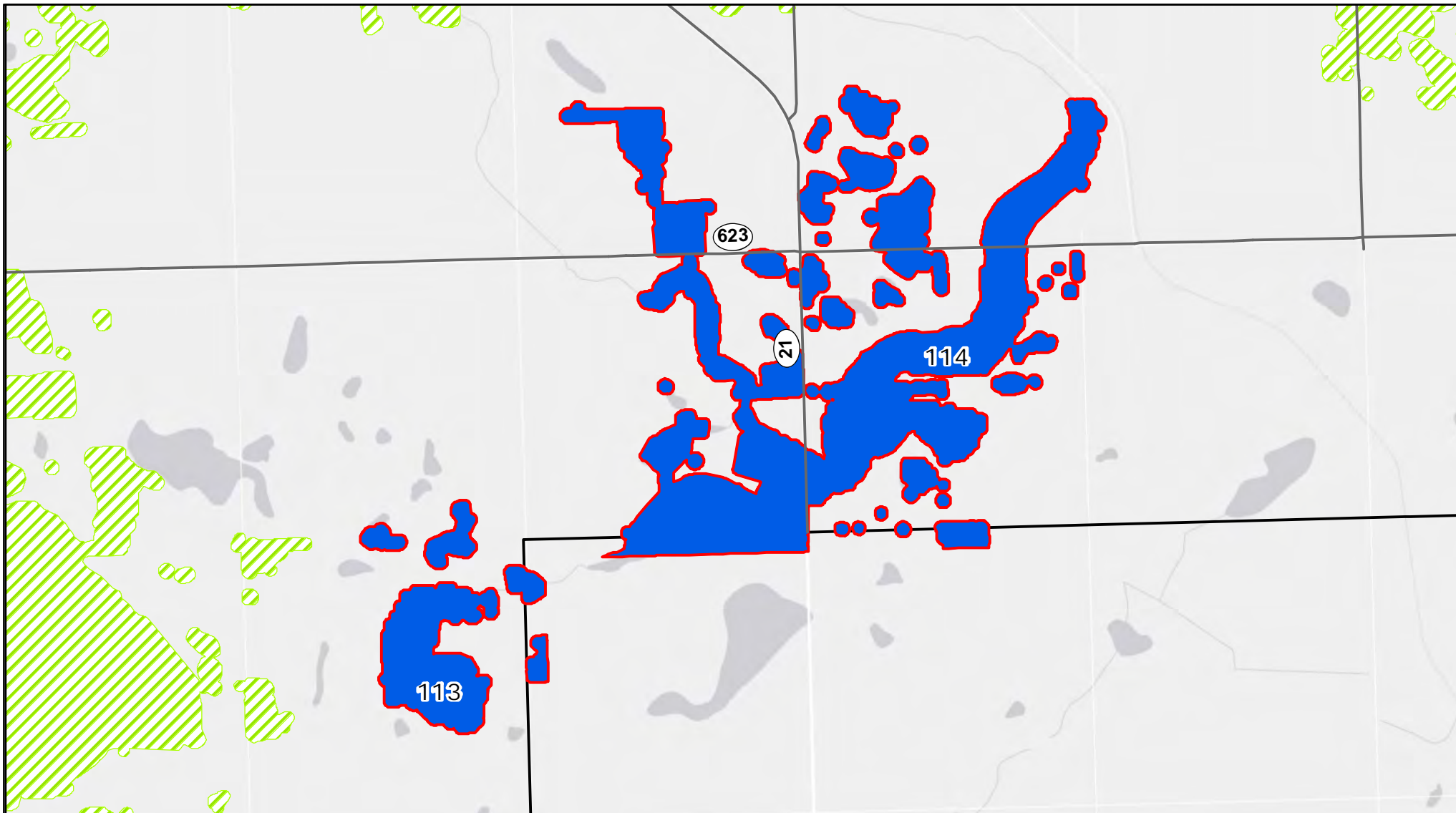
Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
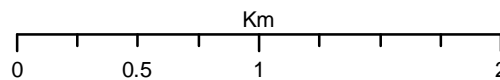Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-110

ESA Number: 111

Looking Back Lake Area

ESA Type: Mixed
- Upland : 57.9%
- Aquatic : 40.5%
- Riparian : 3.3%

Disturbance Risk: High
- High : 98.7%
- Moderate : 1.2%
- Low : 0%

ESA Area (ha): 734

ESA Score: 45.6/100

Overall ESA Rank: 56/120

Area ESA Rank: 3/ 3

Legend

- ▭ Highlighted ESA
- — Streams and Rivers
- ▬ Wetlands and Lakes
- — Roads
- ▬ High Risk Area
- ▬ Medium Risk Area
- ▬ Low Risk Area
- ▨ Other ESAs

Location of ESA Area

Km

0   0.3   0.6   1.2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

ESA Number: 112

Looking Back Lake Area

ESA Type: Mixed
- Upland : 61.1%
- Aquatic : 31.3%
- Riparian : 15.6%

　Disturbance Risk: High
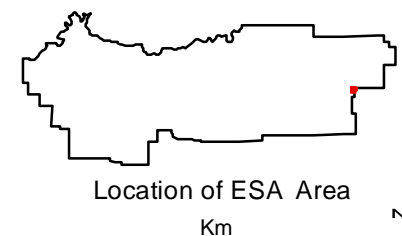- High : 97.5%
- Moderate : 2.3%
- Low : 0%

ESA Area (ha): 674

ESA Score: 55/100

Overall ESA Rank: 34/120

Area ESA Rank: 2/ 3

Legend

Highlighted ESA

Streams and Rivers

Wetlands and Lakes

Roads

High Risk Area

Medium Risk Area

Low Risk Area

Other ESAs
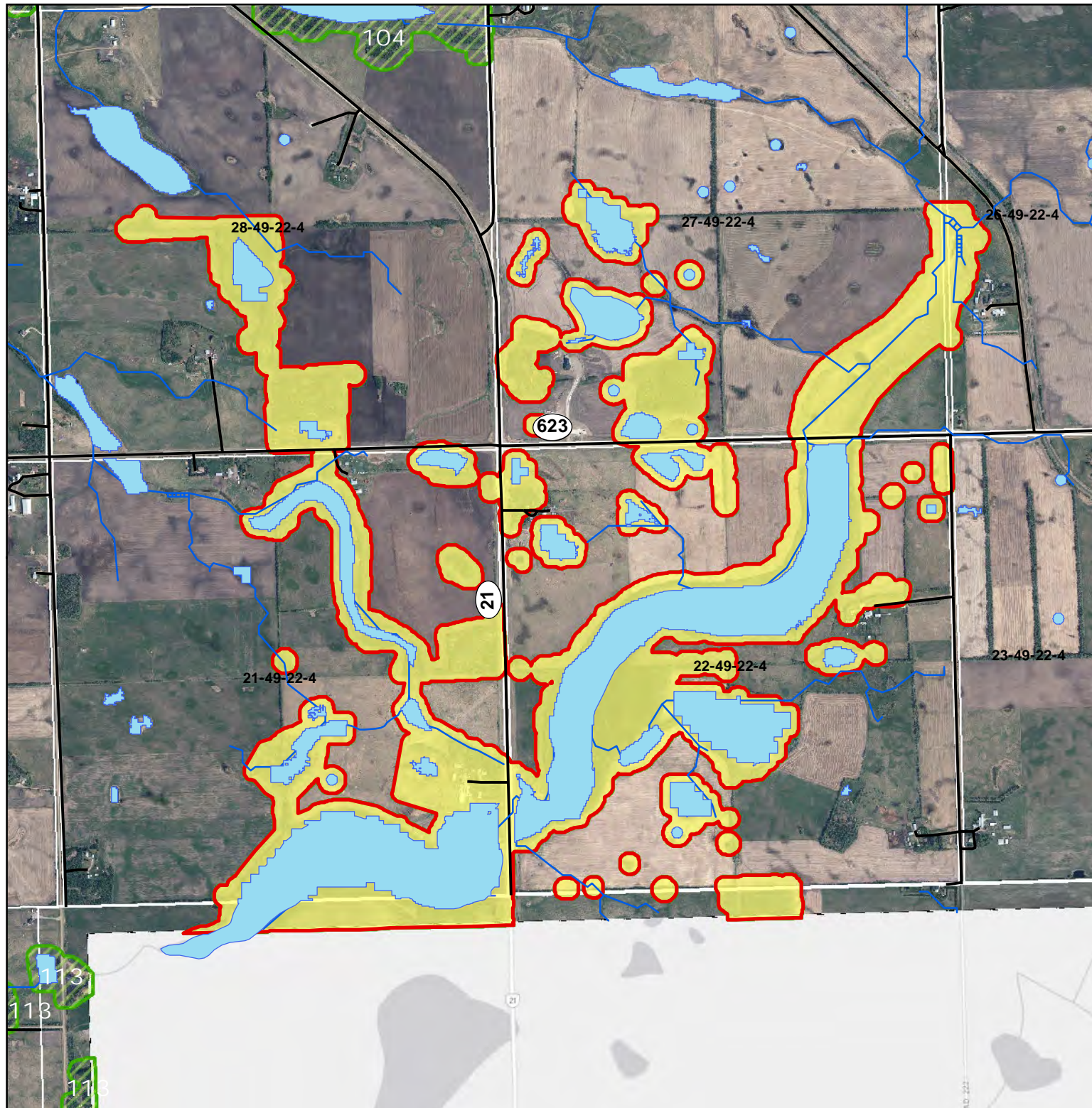
Location of ESA Area

Km

0　0.375　0.75　　1.5

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

ESA Index Map of
South Sarepta Area

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

— Major Roads
▢ Highlighted ESA Area
▨ Other ESA Areas
▢ Leduc County 2014 Boundary

Km
0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area

ESA Number: 113

South Sarepta Area

ESA Type: Aquatic
- Upland : 29.6%
- Aquatic : 68.3%
- Riparian : 12.2%

Disturbance Risk: Medium
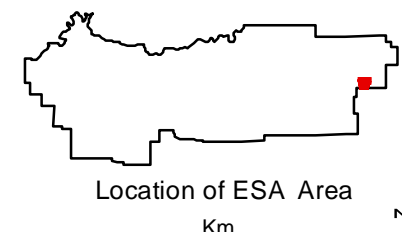- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 56

ESA Score: 31.6/100

Overall ESA Rank: 111/120

Area ESA Rank: 2/ 2

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area
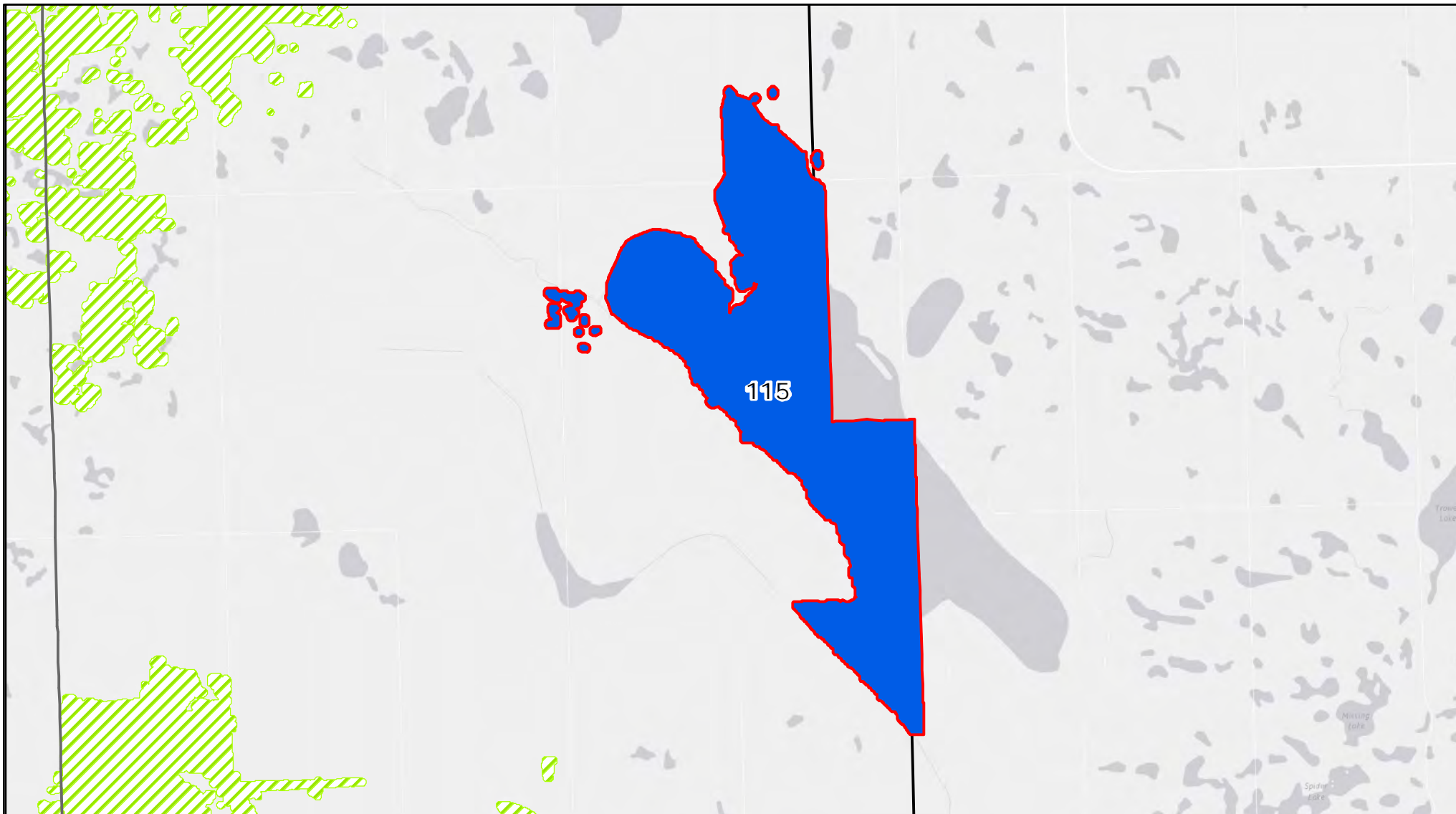
Km

0   0.1   0.2   0.3   0.4

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
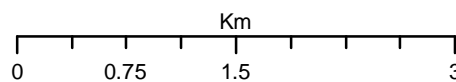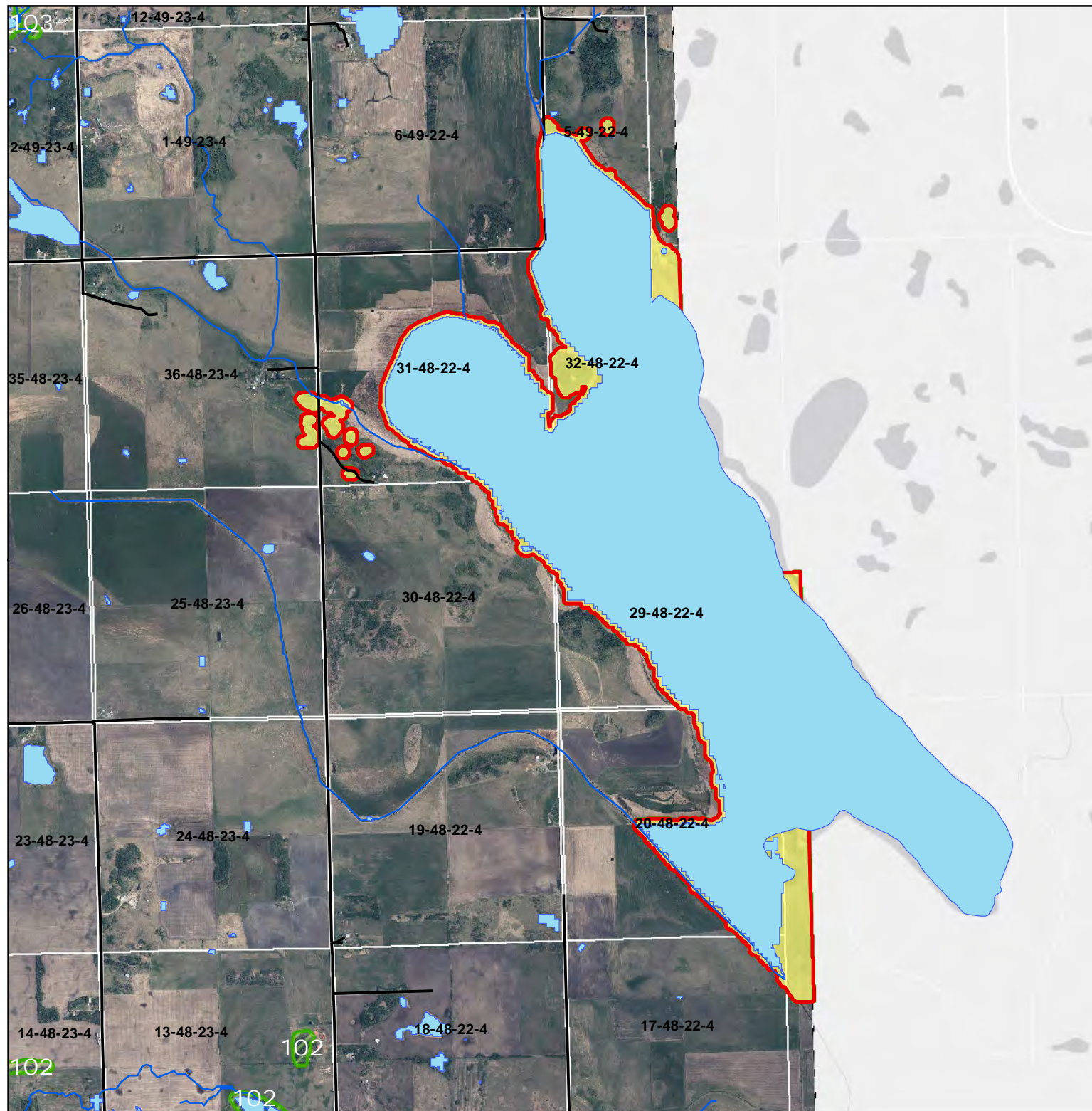Basemap:ESRI Light Grey Canvas

20-49-22-4

21-49-22-4

17-49-22-4

ESA Number: 114

South Sarepta Area

ESA Type: Aquatic
- Upland : 35.3%
- Aquatic : 56.3%
- Riparian : 22.2%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 289

ESA Score: 44.9/100

Overall ESA Rank: 58/120

Area ESA Rank: 1/ 2

Legend

▭	Highlighted ESA
—	Streams and Rivers
▬	Wetlands and Lakes
—	Roads
▬	High Risk Area
▬	Medium Risk Area
▬	Low Risk Area
▨	Other ESAs

Location of ESA Area
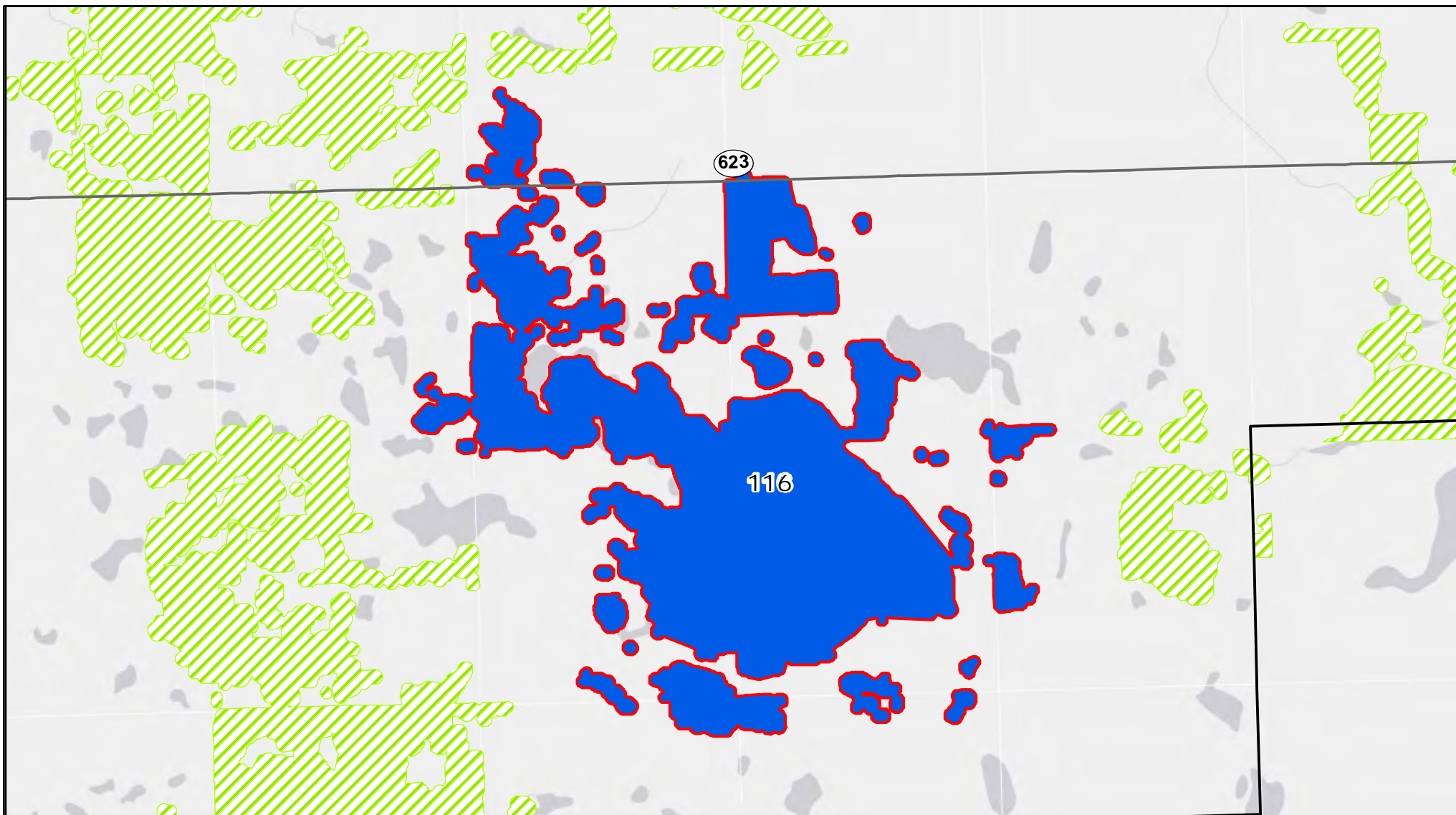
Km

0   0.225   0.45   0.9

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-114

ESA Index Map of
Big Hay Lake Area

115

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

— Major Roads

☐ Highlighted ESA Area

▨ Other ESA Areas
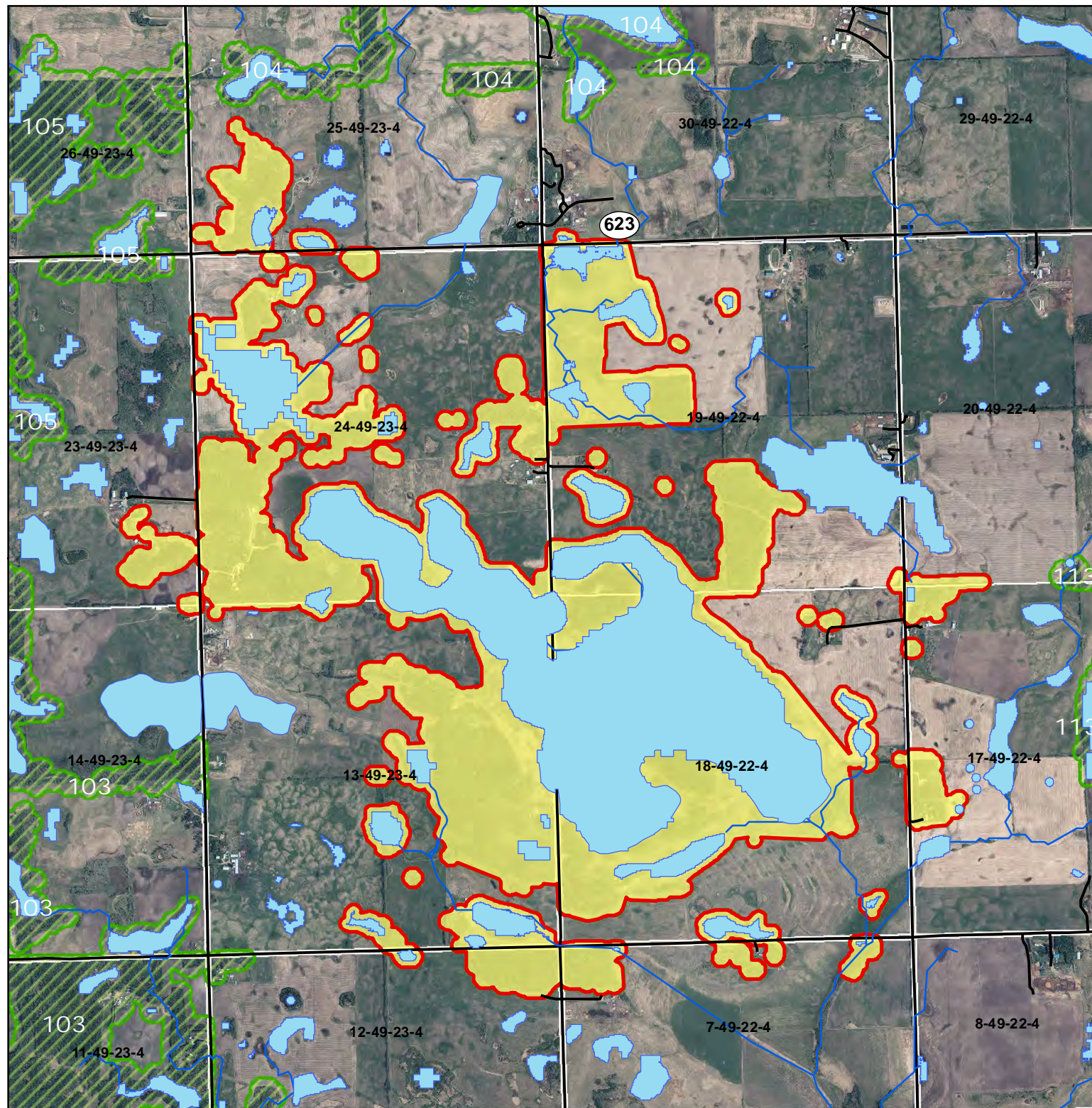
☐ Leduc County 2014 Boundary

Km

0   0.75   1.5   3

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area

N

ESA Number: 115

Big Hay Lake Area

ESA Type: Aquatic
- Upland : 7%
- Aquatic : 92.7%
- Riparian : 4.8%

Disturbance Risk: Medium
- High : 0%
- Moderate : 100%
- Low : 0%

ESA Area (ha): 671
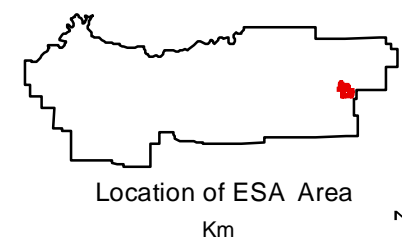
ESA Score: 41.2/100

Overall ESA Rank: 68/120

Area ESA Rank: 1/ 1

Legend

▭ Highlighted ESA
— Streams and Rivers
▭ Wetlands and Lakes
— Roads
▭ High Risk Area
▭ Medium Risk Area
▭ Low Risk Area
▨ Other ESAs
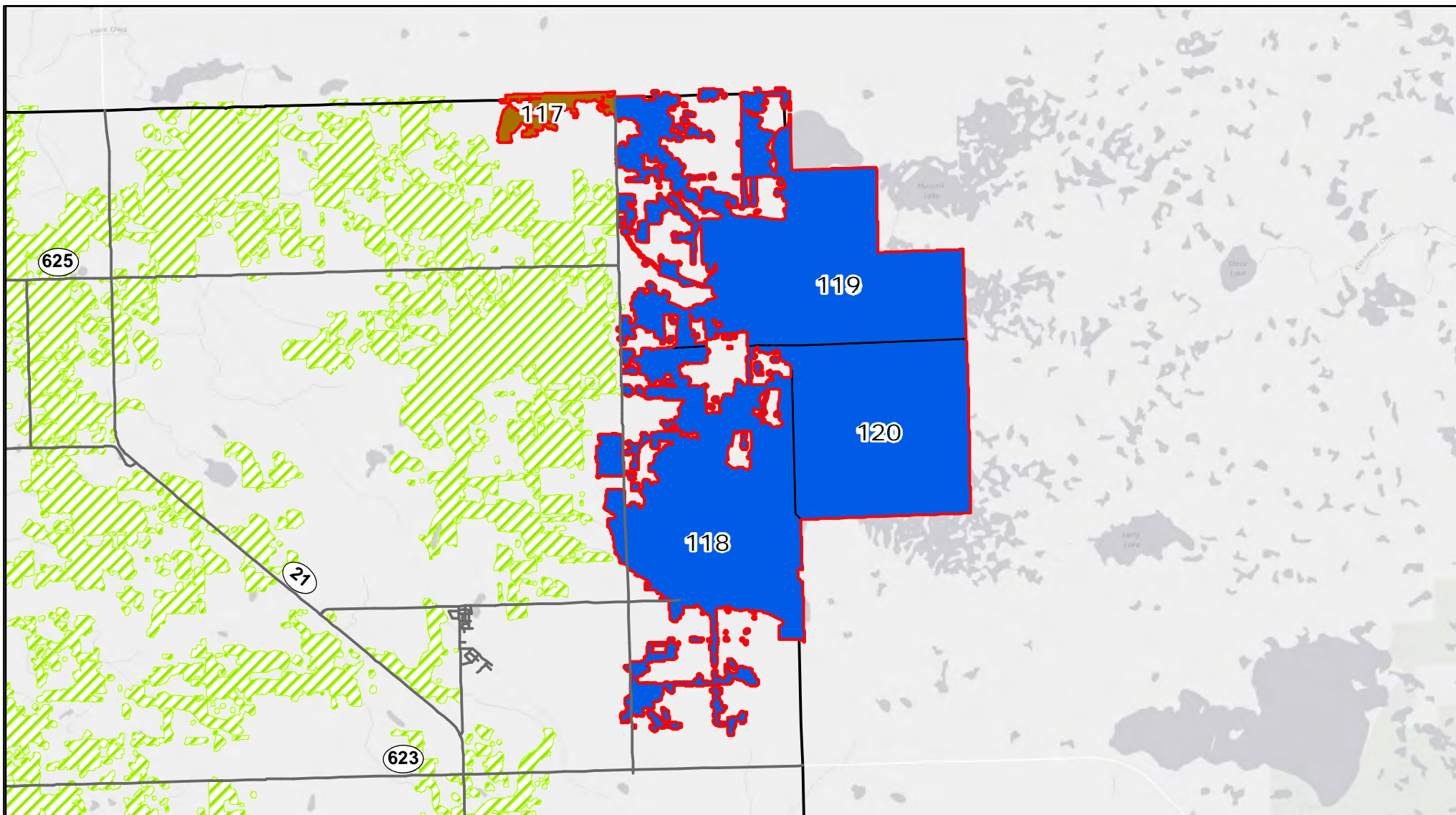
Location of ESA Area
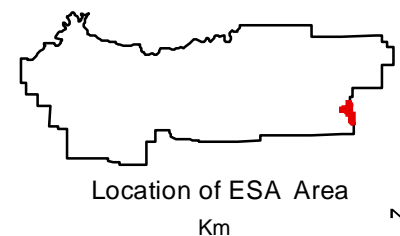
Km
0   0.45   0.9   1.8

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-115

ESA Index Map of
Southwest Sarepta Area

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

— Major Roads

Highlighted ESA Area

Other ESA Areas

Leduc County 2014 Boundary

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
04/11/2014
Basemap: ESRI Light Grey Canvas

Location of ESA Area

623

116

N
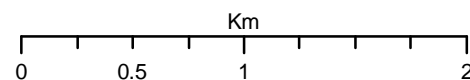
ESA Number: 116

Southwest Sarepta Area

ESA Type: Aquatic
- Upland : 45%
- Aquatic : 52.3%
- Riparian : 6.4%

Disturbance Risk: Medium
- High : 0%
- Moderate : 99.9%
- Low : 0%

ESA Area (ha): 549

ESA Score: 45.5/100

Overall ESA Rank: 57/120

Area ESA Rank: 1/ 1

Legend

- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

Location of ESA Area

Km

0   0.3   0.6   1.2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
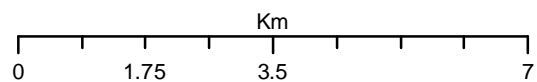Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-116

ESA Index Map of Joseph Lake Area

117

119

120

118

Legend

Individual ESA Type

- Aquatic
- Mixed
- Riparian
- Upland

- Major Roads
- Highlighted ESA Area
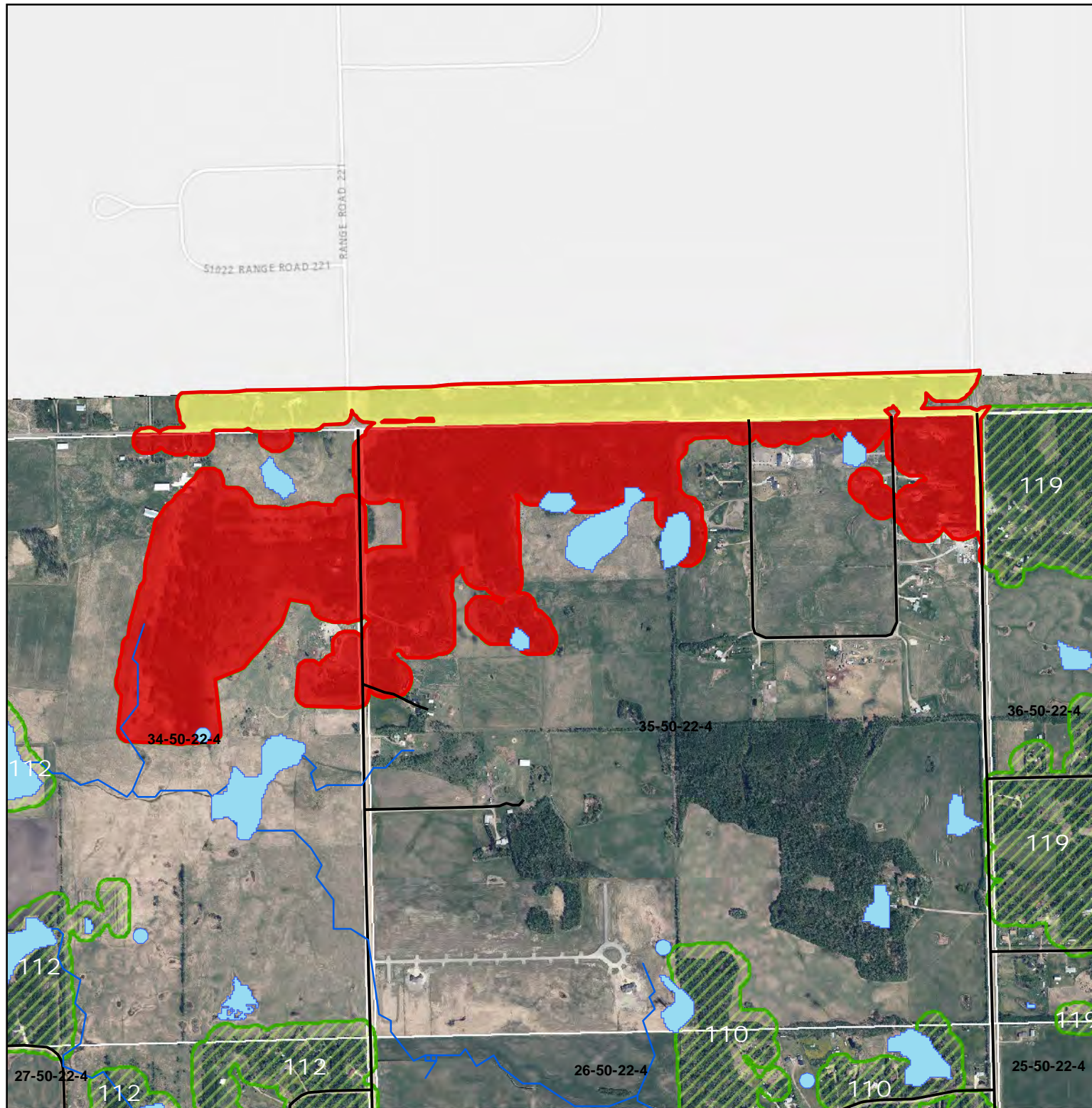- Other ESA Areas
- Leduc County 2014 Boundary

Km

0   1.75   3.5   7

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 04/11/2014

Basemap: ESRI Light Grey Canvas

Location of ESA Area

ESA Number: 117

Joseph Lake Area
ESA Type: Upland
- Upland : 92.7%
- Aquatic : 5.3%
- Riparian : 2%

 Disturbance Risk: High
- High : 77%
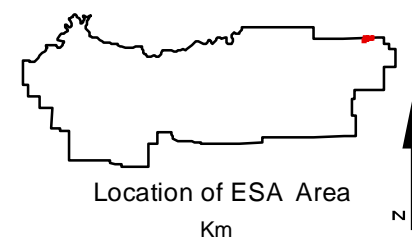- Moderate : 23%
- Low : 0%

ESA Area (ha): 100

ESA Score: 33.1/100

Overall ESA Rank: 103/120

Area ESA Rank: 4/ 4

Legend
- Highlighted ESA
- Streams and Rivers
- Wetlands and Lakes
- Roads
- High Risk Area
- Medium Risk Area
- Low Risk Area
- Other ESAs

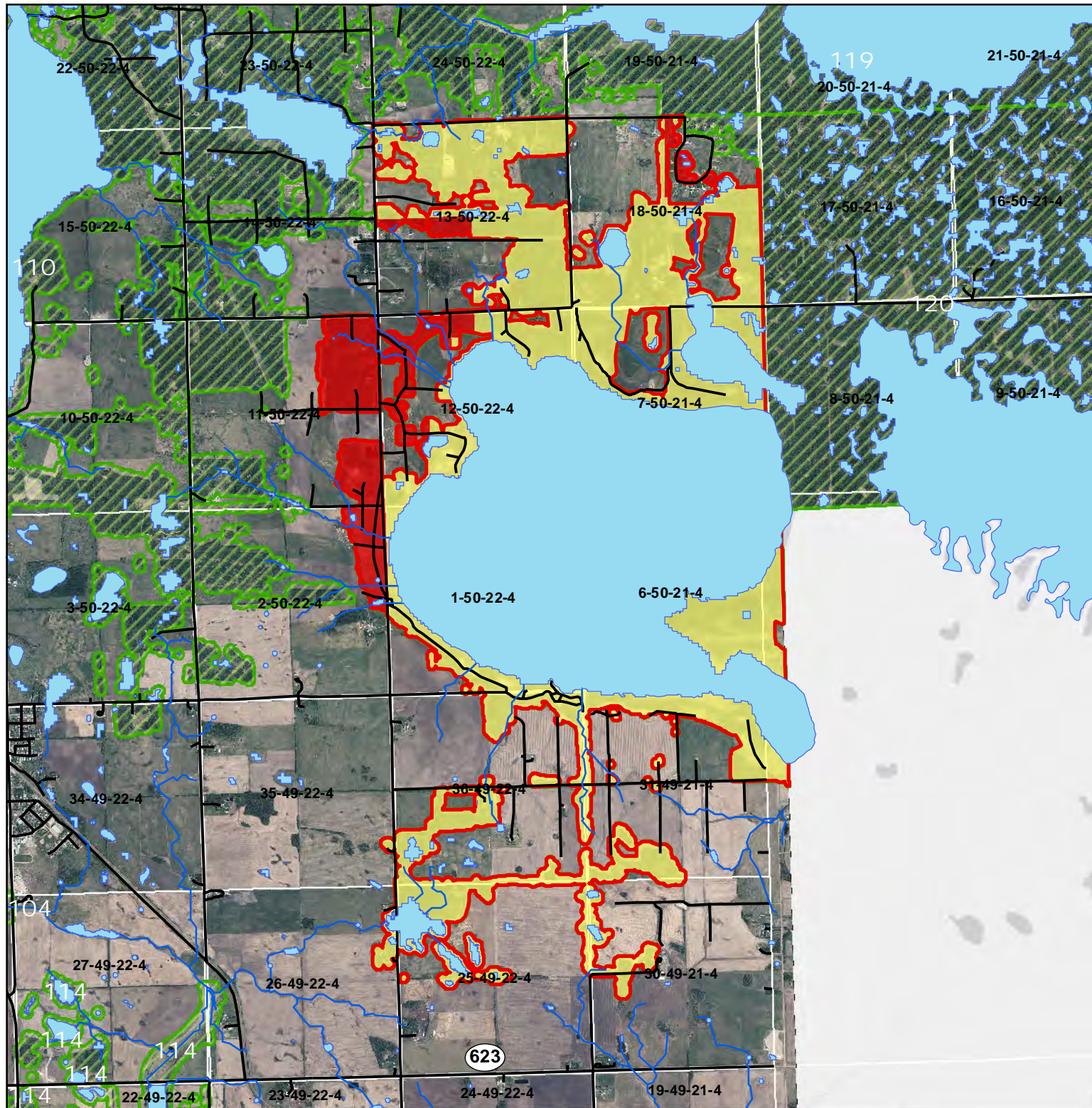Location of ESA Area

Km

0   0.175   0.35   0.7

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

ESA Number: 118

Joseph Lake Area

ESA Type: Aquatic
- Upland : 39.7%
- Aquatic : 57%
- Riparian : 4.4%

Disturbance Risk: Medium
- High : 8.2%
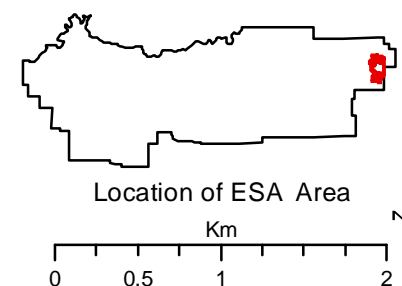- Moderate : 91.8%
- Low : 0%

ESA Area (ha): 1583

ESA Score: 61.3/100

Overall ESA Rank: 21/120

Area ESA Rank: 1/ 4

Legend

▭ Highlighted ESA
— Streams and Rivers
▬ Wetlands and Lakes
— Roads
▇ High Risk Area
▇ Medium Risk Area
▇ Low Risk Area
▨ Other ESAs
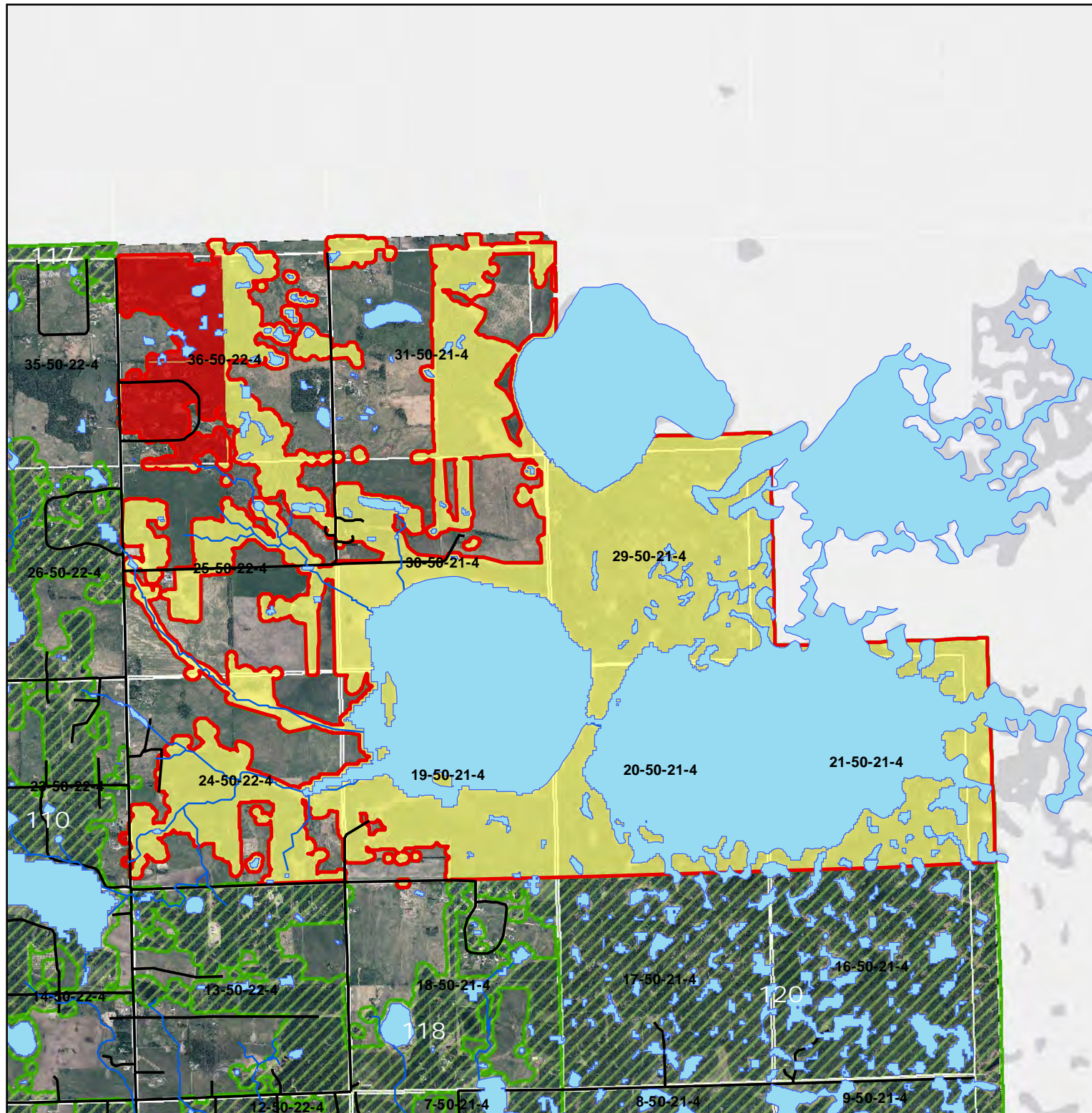
Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on
25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-118

ESA Number: 119

Joseph Lake Area
ESA Type: Aquatic
- Upland : 45.6%
- Aquatic : 51.6%
- Riparian : 3.6%

Disturbance Risk: Medium
- High : 5.4%
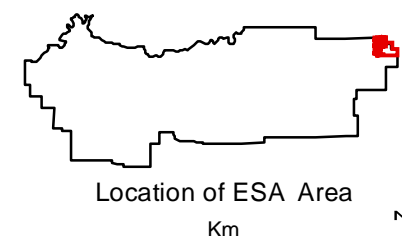- Moderate : 94.6%
- Low : 0%

ESA Area (ha): 1827

ESA Score: 57.8/100

Overall ESA Rank: 28/120

Area ESA Rank: 3/ 4

Legend

- ☐ Highlighted ESA
- —— Streams and Rivers
- ☐ Wetlands and Lakes
- —— Roads
- ☐ High Risk Area
- ☐ Medium Risk Area
- ☐ Low Risk Area
- ☐ Other ESAs

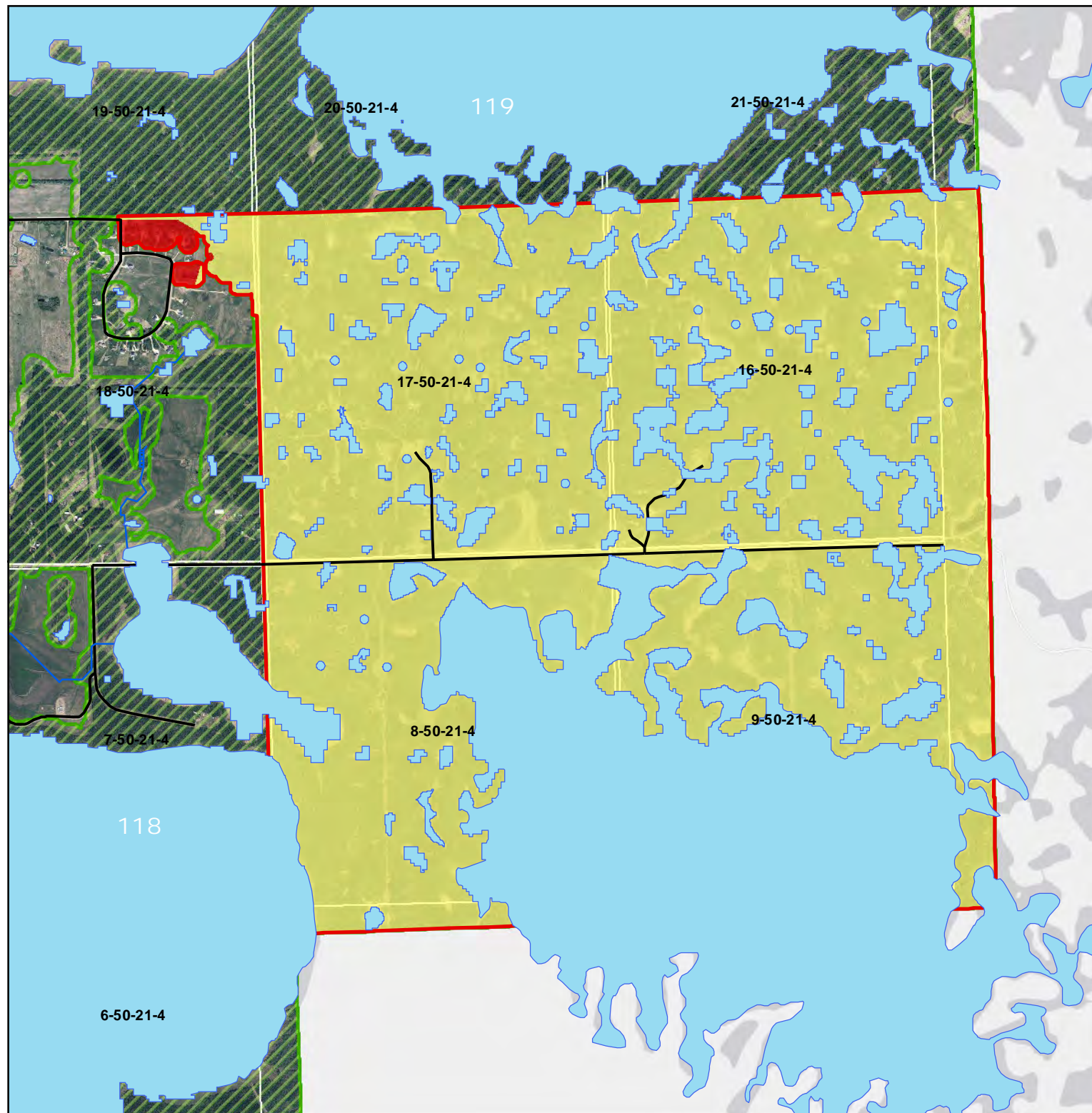Location of ESA Area

Km

0   0.5   1   2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

A-119

ESA Number: 120

Joseph Lake Area

ESA Type: Aquatic
- Upland : 42.5%
- Aquatic : 57.5%
- Riparian : 0%

Disturbance Risk: Medium
- High : 0.5%
- Moderate : 99.5%
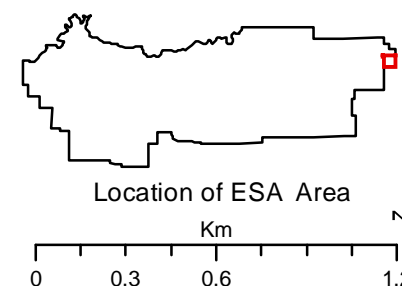- Low : 0%

ESA Area (ha): 1140

ESA Score: 57.8/100

Overall ESA Rank: 28/120

Area ESA Rank: 2/ 4

Legend

- ▢ Highlighted ESA
- — Streams and Rivers
- ▣ Wetlands and Lakes
- — Roads
- ▣ High Risk Area
- ▣ Medium Risk Area
- ▣ Low Risk Area
- ▨ Other ESAs

Location of ESA Area

Km

0   0.3   0.6   1.2

Projection: NAD 1983 10TM AEP Forest

Mapped by Fiera Biological Consulting on 25/11/2014
Background Image: 2013 Air Photo
Provided by Leduc County
Basemap:ESRI Light Grey Canvas

19-50-21-4
20-50-21-4
119
21-50-21-4
18-50-21-4
17-50-21-4
16-50-21-4
7-50-21-4
8-50-21-4
9-50-21-4
118
6-50-21-4

A-120