COMMITTEE-OF-THE-WHOLE INFORMATION ITEM

CITY OF Leduc

MEETING DATE: May 14, 2018

SUBMITTED BY: Ken Woitt, Director, Planning & Economic Development

PREPARED BY: Sylvain Losier, Manager, Current Planning & Development

REPORT TITLE: Telford/Saunders Lake Wildlife Corridor Study

REPORT SUMMARY

This report provides the context in which the City of Leduc, Leduc County, and Stantec have partnered with the University of Alberta. This partnership was established for the purpose of enabling a planning studio that would study the Telford / Saunders Lake Wildlife Corridor.

BACKGROUND

PREVIOUS COUNCIL/COMMITTEE ACTION:

The Telford / Saunders Lake Wildlife Corridor has never been an agenda item before City Council or Committee of the Whole until now. However, during the latest Intermunicipal Development Plan (IDP) amendment process (2016-2017), the need to study the linkage through one (1) or more corridor(s) materialized. Through public engagement for the IDP amendment, members of both municipalities clearly identified the need to ensure the linkage between the two lakes for recreational purposes as well as for the protection of a wildlife corridor. The amended IDP currently contains the following policy:

Natural Habitat and Wildlife Corridors

4.6.2.18 The County and City shall jointly examine solutions for protecting and maintaining natural habitat connectivity between Saunders and Telford Lakes in order to support the natural movement of wildlife. The wildlife corridor shall be explored in more detail during the development of related studies, ASPs, outline plans and subdivision plans as well as during the detail designing of the Spine Road between 65th Avenue and Rollyview Road.

KEY ISSUES:

In 2017, the City of Leduc initiated the East Telford Lake Area Structure Plan (ETLASP). This plan area, containing the lands for seven (7) quarter sections, covers the entire east-end of the City of Leduc where Telford Lake's outlet is located. This outlet is a natural connection between the two lakes.

For the purpose of preparing the ASP, the services of Stantec were retained. Furthermore, City Administration has engaged the County's Administration by inviting them to the open houses. County Administration will also be receiving in the next few weeks an official referral as well as another invitation to another open house before the plan goes to Council for first reading.

In order to align with the IDP, the ASP must contain a policy framework that moves forward the wildlife and recreational corridor analysis. This is where the University of Alberta (UoA) links to the ETLASP and the corridor(s) study. Through discussion between both municipal administrations and Stantec, as well as between Mr. Ken Woitt and PhD Sandeep Agrawal, Professor & Inaugural Director, Urban and Regional Planning Programs, this opportunity to conduct a planning studio became reality.

The studio in question was conducted by four (4) planning students recently graduated from UoA (April 2018) under the guidance of UoA Urban and Regional Planning Professors and representatives from both municipalities and Stantec. The studio was conducted from January to April 2018. The deliverables to this studio are as follow:

1. An interim report and presentation including the following:
   - A background discussion on recreational linkages opportunities between the two lakes;
   - A summary of best practice for wildlife corridors; and
   - A summary of criteria that would need to be evaluated in the choosing of a location and the preferred type of infrastructure for a wildlife corridor.

2. A final report and presentation including the following:
   - Final versions of the material included in the interim report;
   - SWOT analysis around the integration of a wildlife corridor into the land use concept for the area;
   - Recommendation towards keeping separate or combining the wildlife corridor with the recreational linkage; and
   - Option(s) on potential location for the wildlife corridor location

It is important to note that this planning studio did not include detailed designing or detailed costing. These elements will be crucial in making a decision on the location of the recreational and wildlife corridor(s) in the future. Therefore, future work will be required by the City of Leduc and Leduc County prior to selecting and implementing the Telford and Saunders Lake linkage strategy.

ATTACHMENTS:
1. Interim report
2. Final report

RECOMMENDATION

This report is currently for information. In addition, Administration would recommend that CoW direct Administration to introduce the corridor study as a topic for future discussions with the IDP Committee.

Others Who Have Reviewed this Report

P. Benedetto, City Manager / M. Pieters, General Manager, Infrastructure & Planning

Leduc Wildlife Corridor Study

Interim Report

February 26th 2018

Brent Dragon, Hamza Farooqui, Sonak Patel, Nathan Stelfox

Prepared for the City of Leduc, the Leduc County, and Stantec Consulting Ltd.

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Fig. 1 (Title Page) View from the top of the Leduc Waste Management Waste Facility

1. Executive Summary

There is potential for a wildlife corridor and trail network between Telford Lake and Saunders Lake in the City of Leduc and Leduc County. These two lakes are home to a rich biodiversity of wildlife but also provide many recreational opportunities to the residents of both municipalities. Public and private stakeholders have demonstrated interest in the development of a corridor between the lakes, and wish to see the natural environment preserved. A variety of literature exists on the best practices for wildlife corridors, trail networks, and how they can be incorporated together. While it is possible for both to coexist in the same area, measures must be taken to ensure minimal impact to wildlife, but also to ensure the safety of trail users.

The City of Leduc has engaged Stantec Consulting to prepare an Area Structure Plan (ASP) for the East Telford Lake Region. The findings of this study will motivate the design in the East Telford Lake ASP and statutory plan completed by Leduc County when they choose to develop west of Saunders Lake. The public engagement for the ASP identified the wildlife corridor and trail network as priorities for the development of the area.

Through a literature review, it was determined that the corridor should be as wide and short as possible to provide wildlife the most connectivity between the two environmentally significant areas. The corridor should have relatively even topography, as slopes greater than 25° will deter wildlife. In addition, the corridor needs to have as little impact from human activity and development as possible. This means reducing the proximity of development to the corridor and transections of the corridor.

Where human activity is necessary, reduce impacts such as effective wildlife crossings, and trail standards for any recreation. The trail network needs to avoid any environmentally sensitive areas and only border one side of the corridor. The trail system should also have a different road crossing, if one is required, than the wildlife corridor as to reduce any stress on wildlife. Most measures centre around putting the wildlife and natural landscape as the first priority, with recreational infrastructure second.

The wildlife corridor is consistent with the approved Intermunicipal Development Plan (IDP) between the City and County and the From Refuse and Refuge Waste Management Plan. Studies completed by both the City and County will be used to inform the location and design. The proposed corridor and trail design will be compliant with any federal and provincial regulations.

Fig. 2 Wildlife Corridor Area of Interest and Edmonton Metropolitan Region Board

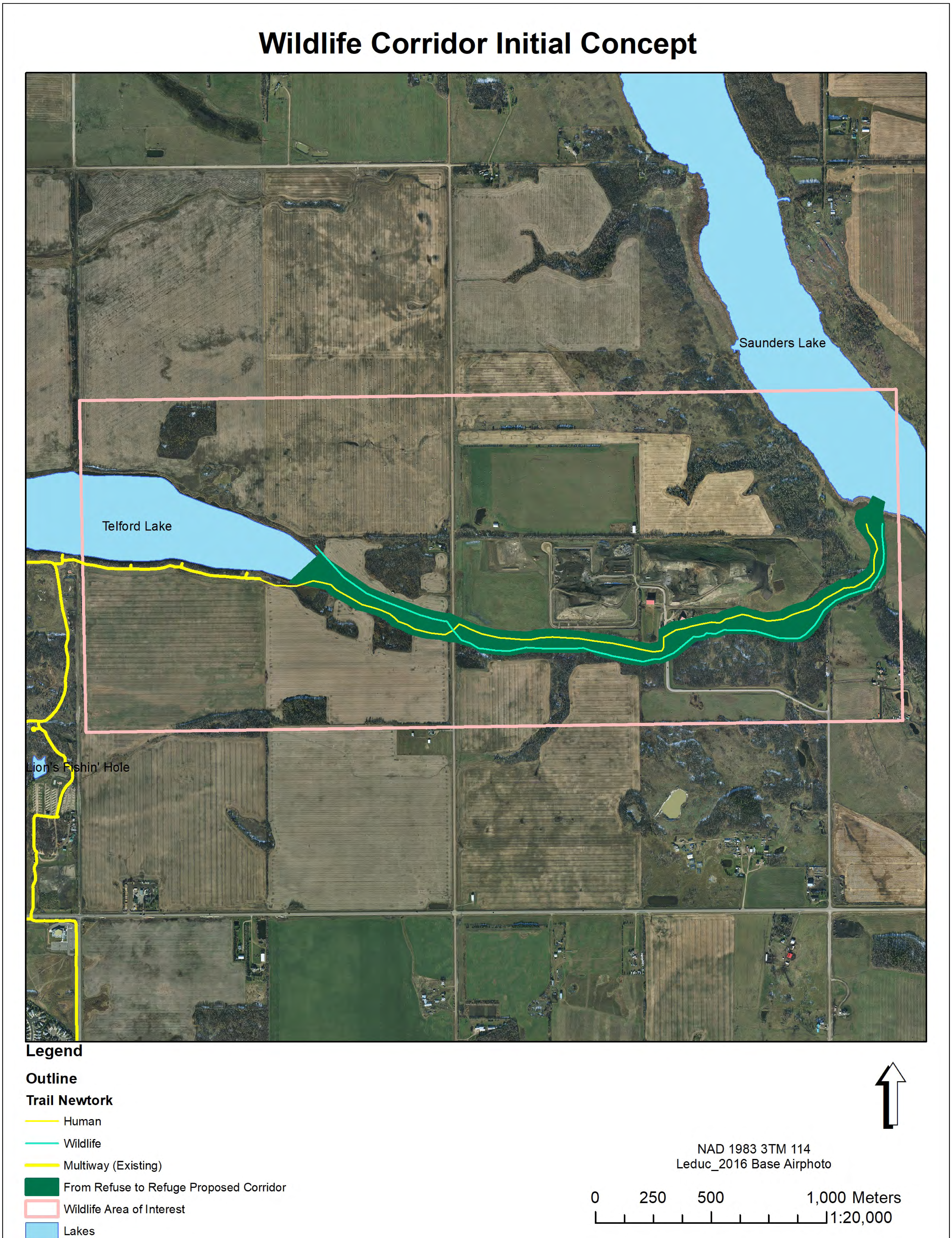


Fig. 3 Wildlife Corridor Initial Concept

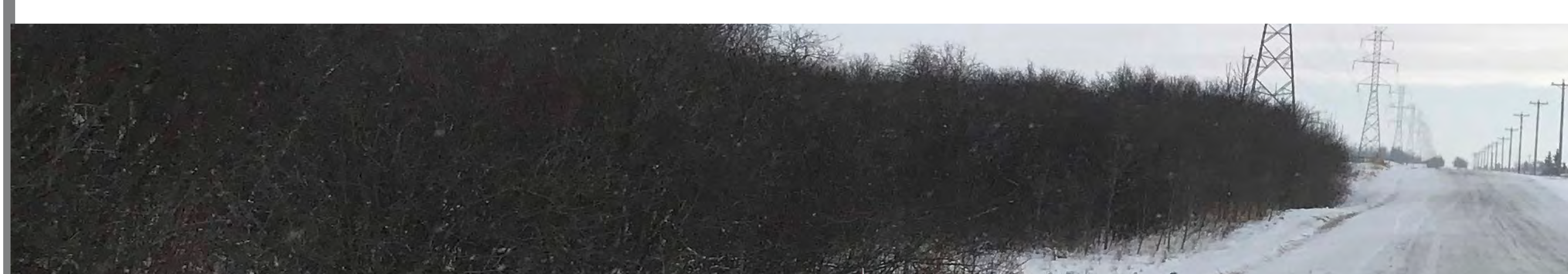
Several environmentally significant areas (ESAs) in the study area have been identified, which span the entirety of the wildlife corridor. The studies determine the area to be of high ecological significance with high connectivity between Telford Lake and Saunders Lake. As several ESAs exist in close proximity to the proposed wildlife corridor, there should be connectivity between these areas and the corridor. Opportunity exists to connect Telford Lake with Saunders Lake and other surrounding natural environments. There is a mix of mammals, amphibians, birds and plant species within the study area, 306 species in fact, that need to be considered in the development of the corridor. Several of the species identified are protected under provincial and federal legislation and must have special consideration as such.

At this point in the project, the best practices for wildlife corridors and trail networks have been identified through a literature review. There is possibility to combine the best practices of each to have a shared space for trail users and wildlife that will have minimal impacts on wildlife and the natural environment. Further to this, any best practices that can be applied to the Leduc Wildlife Corridor have been identified and will be further explained in the final report. From the best practices, a criteria was created of design and planning elements for combining trail networks with wildlife corridors that must be followed for the success of the corridor. The relevant policy and plans in effect for the study area have been examined to see how they are applicable to the wildlife corridor. As the wildlife corridor study will be used to support the creation of corridor through policy and plans, it is vital that the study incorporate existing plans. Lastly, the biophysical environment was assessed to determine the ecological vitality of the area and species that exist in it. It was determined that the study area has high biodiversity and connectivity for the species that exist in it. From the best practices, existing policy and plans, and the biophysical assessment, it is possible to begin determining the best location for the wildlife corridor. Based on information collected and assessed within the interim report, an initial concept for the wildlife corridor location and general connectivity design was created.

2. Background

The City of Leduc and Leduc County are located just south of the City of Edmonton in Alberta. The City of Leduc is much smaller than the County of Leduc and actually exists within the County borders, but is home to almost 60,000 residents, while the more rural Leduc County has a population of 14,000 (Statistics Canada, 2016). Both municipalities are growing in population and development, but wish to retain the rural environmental aspects of their communties that their residents value. These two muncipalities house two large water bodies, Telford Lake and Saunders Lake which are roughly 2.5km away from each other. The lakes are used by each municipality on the water for boating, but also off the water for trail systems. These lakes are provincial water bodies and as such, are protected under provincial legislation. The lakes and surrounding area define the study area for the purpose of this report, and will provide potential locations for a wildlife corridor between the lakes. Development in the study area is predominantly low density residential, industrial, agriculture, and some commercial. Due to the rural aspect of the landscape, there is a large amount of wildlife activity in the area and this must be considered as development furthers in the area.

Telford Lake and Saunders Lake are both important ecological areas in Leduc County and the City of Leduc, providing both natural and recreational opportunities. As many of these areas are environmentally significant, there is a variety of mammal, bird, amphibian, and plant species that exist around and between the two lakes. The City of Leduc and Leduc County Intermunicipal Development Plan acknowledges

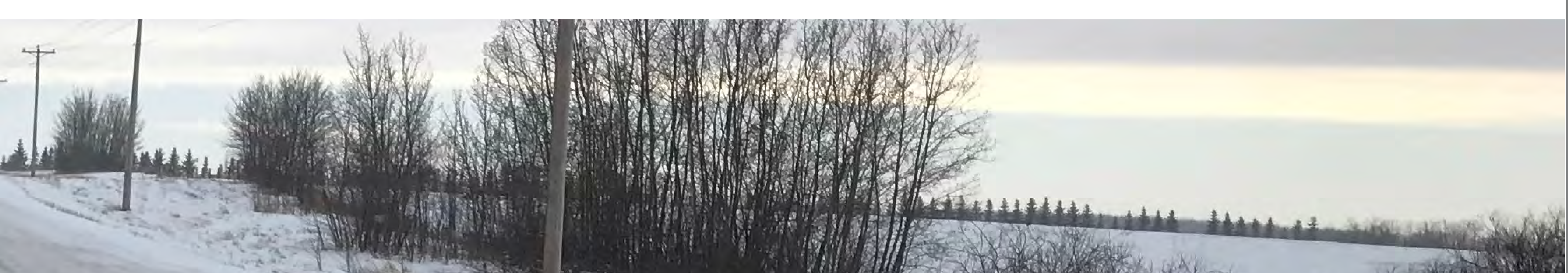


the potential for a wildlife corridor between the two lakes that would provide connectivity for wildlife and people. As Telford Lake is in the City of Leduc and Saunders Lakes is in Leduc County, the wildlife corridor requires cooperation and support from both municipalities to ensure the success of the linkage. With industrial development pressure in the area, it is important that the corridor be clearly defined and dedicated as to ensure it's preservation and protection. The lakes are also large recreation hubs for the two municipalities, providing public and private lakeside amenities. Public consultation for the East Telford Lake ASP also found a strong public interest in a connection between the two lakes for wildlife and a connecting trail system between Saunders and Telford Lake. The City of Leduc multiway trail network that currently exists provides a good connection possibility for the wildlife corridor trail, and should be connected to if possible. As each municipality creates area structure plans within the study area, the specifics of the wildlife corridor and trail system between Telford and Saunders Lakes must be consistent between plans, hence the need for the wildlife corridor study.

To the east of Range Road 245 is the Leduc Waste Management Facility that supports most of the surrounding area. The facility is managed by the Leduc and District Regional Waste Management Authority which determines how the facility will be reclaimed when it reaches capacity. The Leduc Waste Management Facility is currently in the process of decommissioning part of their landfill, and beginning a new deposit to the northwest of the current site. The decommissioned site will be reclaimed for environmental and recreational purposes as per the From Refuse to Refuge document. The plan encourages the development of the wildlife corridor and plans a trail network that connects the two lakes with the proposed recreational trails on the reclaimed landfill site. As this large site borders the potential location for the wildlife corridor, the reclamation plan will need to be incorporated into the Wildlife Corridor Study. Any development within the Leduc Waste Management Facility needs to support wildlife connectivity, and should not hinder the safe passage of wildlife and people within the corridor.

With increased development in the City of Leduc and Leduc County, the Nisku Spine Road is currently being built to support the influx of traffic. This six-lane highway will cut through the centre of the wildlife corridor along the current Range Road 245, resulting in no possible location for the wildlife corridor that avoids the highway. As a large highway is certainly not conducive to a successful wildlife corridor, mitigative measures will need to be taken to ensure that connectivity across the roadway is still possible. This could include an underpass or overpass, or an at-grade crossing. In addition to wildlife connectivity, the safe passage of trail users across the highway must also be considered. The Telford Lake Area Structure Plan (ASP) open house feedback found that residents are also keen to see that the wildlife crossing for the Nisku Spine Road be well designed and effective to limit the impact the roadway will have on wildlife in the area.

The existing context of the study area must be considered when planning and designing the wildlife corridor and trail system. The City of Leduc and Leduc County are both interested in the creation of this corridor, but there is also public interest. In addition to the public and the government, the Leduc Waste Management Facility has interest in preserving and protecting the natural habitat between the two lakes. These are the main stakeholders for this project, and should be consulted with through the process of planning and creating the corridor. Lastly, there is a variety of policy and plans in place which affect the development. Each one must be considered and applied to the design and planning when applicable.



Wildlife Corridor Area of Interest and Intermunicipal Development Plan Area

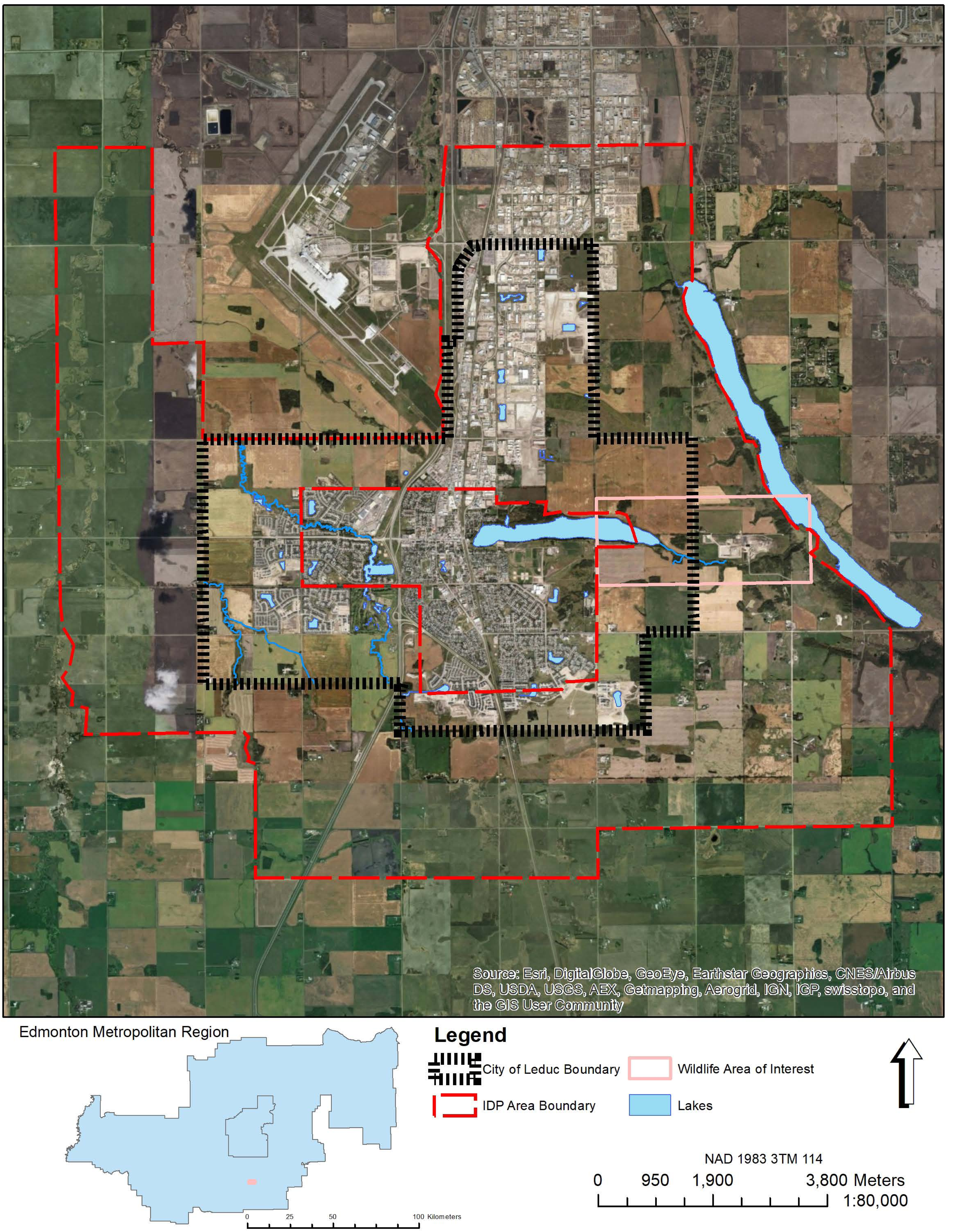


Fig. 4 Wildlife Corridor Area of Interest and Intermunicipal Development Plan Area

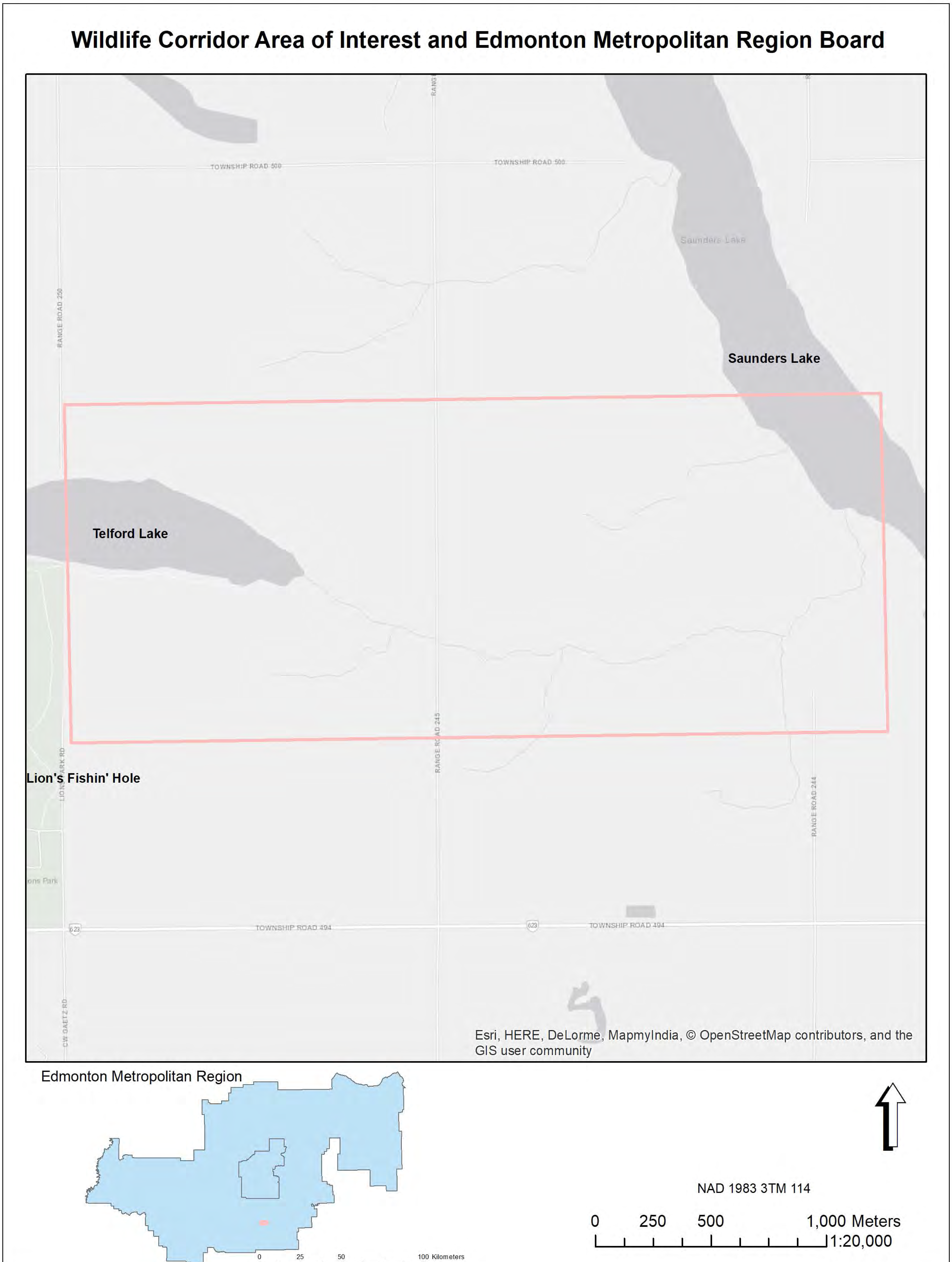


Fig. 5 Leduc Wildlife Corridor Area of Interest

3. Best Practices Summary

3.1 Wildlife Corridor

As human activity encroaches on natural habitats, wildlife populations become increasingly vulnerable. Hazards that emerge from the conflict of human and wildlife use include habitat fragmentation, habitat loss and alienation, and sensory disturbances (Bond, 2003, Bow Corridor Ecosystem Advisory Group, 2012 & Beier et al., 2008). Wildlife corridors are tools that help preserve land for wildlife travel between habitat patches (Bow Corridor Ecosystem Advisory Group, 2012), reducing the negative effect of fragmentation due to human activity (Bond, 2003).

Wildlife corridors are defined as areas of land designed and managed to maintain connectivity between habitat patches (Bow Corridor Ecosystem Advisory, 2012). The goal of a wildlife corridor is to facilitate the safe and effective movement of wildlife in areas where there may be conflict with human activity (Bow Corridor Ecosystem Advisory Group, 2012).

Wildlife crossing structures are infrastructure elements that are designed and incorporated into physical barriers to increase the permeability for wildlife (Chisholm et al., 2010). Crossing structures can be integrated with wildlife corridors to allow wildlife to bypass infrastructure that would, without a crossing, fragment the habitat. Crossing structures can be incorporated into new projects or retrofitted to meet changing demands.

Bond (2003) defines six step methodology for the establishment of wildlife corridors:

1. Identify the habitats the corridor is designed to connect,
2. Select target species for the design of the corridor,
3. Evaluate the relevant needs of each target species,
4. Evaluate how the area will accommodate movement by each target species,
5. Draw the corridor on the map, and
6. Design a monitoring program.

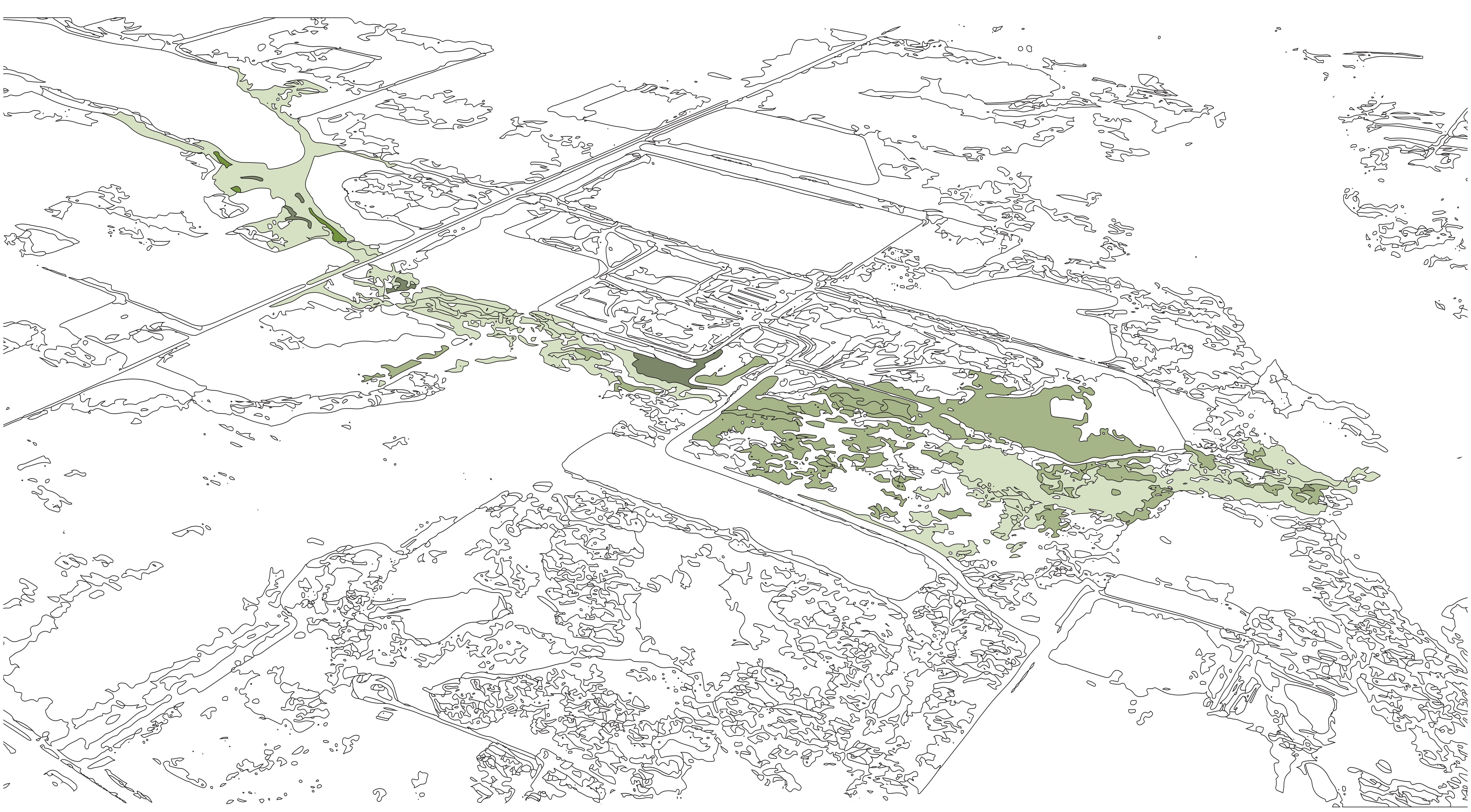


Fig. 6 Potential Wildlife Corridor Natural Area within the Study Area

This closely aligns with the methodology established by Mimet et al. (2016):

1. Define virtual species groups
    1.1 Conduct land-cover mapping,
    1.2 Construct graphs for modelling ecological networks,
    1.3 Prioritizing wildlife crossing locations depending on gain,
    1.4 Combining results in a multispecies analysis,
2. Use information to discover what species are in the area and their habitat,
3. Create a map of land cover type,
4. Identify habitat patches and the least cost distance between sites. Assign different values to cost factors: land cover, fences, etc., and
5. Locate where the crossing is best situated.

These methodologies identified by Bond (2003) and Mimet et al. (2016) are further supported by Chisholm et al. (2010) in the Decision Tree outlined in the City of Edmonton's Wildlife Passage Engineering Design Guidelines. While the information is presented in a slightly different series, the overall concepts are retained. Chisholm et al. (2010) also place a larger emphasis on wildlife crossing structures within a wildlife corridor.

Corridor Location

Corridors should be located to match known movements of animals as closely as possible, to ensure the corridor has the greatest chance of being used by target species (Golden & Associates, 2017). Shorter routes are typically more effective than longer stretches (Golden & Associates, 2017), but corridors can be better located when accounting for least-cost pathways (Mimet et al., 2016). Using this model, barriers such as unfavourable land cover and fences, are attributed cost values. Potential pathways are then evaluated based on the cost to the species, where the least cost pathway is most likely to be used (Mimet et al., 2016).

Corridor Design

Wildlife corridors should be as wide as possible. While corridor designs need to match the species being designed for, the minimum is recommended to be approximately 300 m wide (Bond, 2003). Golder & Associates (2017) states that the Natural Resource Conservation Board requires a width of 350 m, which is also the suggested minimum in the Bow Corridor Ecosystem Advisory Group (2012) report.

The width of the corridor is dependent on the following variables: target species and length. It was identified that larger species will require wider corridors to facilitate movement. Certain species, such coyotes, are minimally affected by human disturbance, relative to species such as bears, elk, wolverines, and wolves, which show greater avoidance for human activity. Additionally, the longer a corridor is, the wider it should be to maintain effectiveness (Bow Corridor Ecosystem Advisory Group, 2012).

Minimize Conflicting Land Use

Adjacent uses to the wildlife corridor should be allocated and regulated as to minimize potential conflicts with the wildlife in the corridor. Many human activities have adverse impacts on natural ecosystems. The following summarises considerations for minimizing conflicts between the wildlife and human development along the corridor.

Developments should not project into the corridor, as this creates pockets that trap wildlife and increases the perimeter of the corridor, which in turn increases the number of harmful edge effects (Bond, 2003 and Bow Corridor Ecosystem Advisory Group, 2012). Corridors should be intersected as little as possible by human developments. When necessary, linear projects, like roads, telephone lines, and pipelines should be bundled together to intersect at a single location, creating a minimal barrier.

The Bow Corridor Ecosystem Advisory Group (2012) recommends a buffer space between a wildlife corridor and the active area of the adjacent development. A 20 m buffer is recommended by residential development and a 40 m buffer is recommended for local commercial activities (Bow Corridor Ecosystem Advisory Group, 2012).

Human lighting has a significant effect on disturbing wildlife species and altering their natural patterns. Artificial lighting disturbs the navigation of nocturnal animals and has been found to negatively impact reptiles (Beier et al., 2008). Strict regulations should be implemented to prevent light pollution in the corridor (Bond, 2003 & Bow Corridor Ecosystem Advisory Group. 2012).

Where necessary, fencing can be implemented to direct fauna to specific locations. Wildlife fencing should be at least 1.8 m in height (Bond, 2003). A 2.5 m page wire fence and walkthrough spin gates are recommended for wildlife corridors (Golder & Associates, 2017). In Florida, the construction of a barrier wall directing wildlife to crossing structures resulted in a roadkill reduction of 93.5% (Beier et al., 2008). One sided ramps can be constructed, to allow wildlife that has become trapped outside the wildlife corridor to easily transition into the wildlife corridor.

Wildlife Crossings

Where wildlife corridors interact with roadways, wildlife crossings can increase the permeability of the road, maintaining connectivity between either side of the habitat bisected by the roadway. Wildlife crossings provide a safe way for animals to get across roads, minimizing the dangers of wildlife on roadways. Chisholm et al. (2010) provides supporting evidence for the environmental and socio-economic benefits of wildlife corridors and crossings structures. Roadways have a number of direct adverse effects, including increased rates of wildlife mortality, habitat loss, habitat fragmentation, and reduced connectivity (Beier et al., 2008). In Canada, an estimated 45,000 vehicle and large animal collisions occur annually, resulting in human and animal death and injury, and millions in property damage (Clevenger & Huijser, 2011). Habitat connectivity loss is a threat to the survival of local species, causing isolated populations to lose genetic diversity (Beier et al., 2008 & Clevenger & Huijser, 2011). Indirectly, roads generate noise and vibration that can interfere with the ability of some reptiles, birds, and mammals to communicate, avoid predators, and detect prey (Beier et al., 2008). Roads also have a demonstrated ability to spread exotic plant life. Studies have shown that the vehicles can deposit from 300 to 800 exotic seeds per sq m per year (Beier et al., 2008). Exotic species can challenge the growth of local flora. Additionally, roads increase erosion rates and pollute the surrounding air and water. Like adjacent development, highway lighting can interfere with wildlife activity (Beier et al., 2008).

One Way Ramps allow wildlife who manage to get outside of the corridor to safely and easily return to the wildlife corridor.

Fig. 7 One Way Ramp Illustration

Design elements are a critical part in construction of effective wildlife crossings, as they can determine how used the crossings are. Additionally, different species will require different types of crossings (Beier et al., 2008). Single species mitigation methods are ineffective, as they fail to account for ecosystem relationships (Clevenger & Waltho, 2000). Chisholm et al. (2010) also supports corridors designed for multiple species and further indicates that connections should be made to larger habitat areas. There is evidence that some mammals will avoid two lane roads with volumes of 100 vehicles per day (Beier et al., 2008). Any larger road may warrant the need for a wildlife crossing. Roads that are six lanes and have greater than 10,000 vehicles per day are a complete barrier to wildlife movement (Chisholm et al., 2010). The level to which species are capable of crossing roads will largely depend on their individual characteristics. Chisholm et al., (2010) suggest categorizing species into 11 ecological design groups (EDGs). Species within an EDG share similar traits that translate into characteristics important to the design of the wildlife corridor.

While the physical size of the species will dictate crossing structure size, behaviour characteristics must also be considered. To accommodate larger animals, larger undercrossings need to be created. A structure of 3.7 m width by 3.7 m height is recommended for larger animals (Bond, 2003). For deer, Chisholm et al. (2010) suggest an optimal passage dimension for culverts should be 2.4 m tall by 6 m wide or 3.1 m in both height and width. A study on white tailed deer activity in Pennsylvania found the average size of an open crossing structure to be 4.6 m wide by 2.4 m tall (Beier et al., 2008). A study in Florida on culvert design and effectiveness suggests that a minimum width of 2.7 m and height of 3 m should be allocated for a passage rate of 75% (Smith, 2003). In the Clevenger and Huijser (2011) handbook, large mammal underpasses have recommended dimensions of 12 m wide by 4.5 m tall.

Possibly a more accurate design metric is the openness ratio, defined as (height)(width)/length (Beier et al., 2008). This value measures how open or constrictive a crossing structure appears to be. Using this metric, the longer a crossing must be, the wider the width should be to offset the tunnel effect (Smith, 2003). Within the Wildlife Passage document (Chisholm et al., 2010), optimal passage dimensions are determined by EDG using the structure. Clevenger and Huijser (2011) provide a breakdown of suitability of structure type for specific species. Box culverts will likely be the most successful for large terrestrial mammals and the openness ratio should be a minimum of 1.5 (Chisholm et al., 2010). Given wide roads, two short crossing structures are prefered to one continuous structure (Chisholm et al., 2010).

When considering wildlife passages that contain water, culverts should span 1.2 times the high water mark and bridges should incorporate 10 m of bank vegetation on both sides (Chisholm et al. 2010). Other components of wet culverts include water depth, upstream, and downstream impact on the hydrological system.

Culvert design metrics that should sustain a 90% crossing rate across species were found to be (Smith, 2003):

- A 3.7 m right of way separating the entrance from the adjacent area
- The presence of herbaceous vegetation, similar to the adjacent habitats
- Traffic volumes of 250 or fewer vehicles per day
- There was a precipitous drop off in species use when traffic volume exceeds 6,000 vehicles per day
- Rectangular shapes were preferred
- Smaller mammals and herpetofauna preferred a height of ≤ 1.5 m
- Larger carnivores and ungulates preferred 3 m minimum hieght
- A length of 11 m or less
- Minimum width of 3 m
- Natural dirt substrate floor

Fig. 8 Underground Wildlife Crossing Illustration

Within the Wildlife Passage (Chisholm et al., 2010) document corridors should be built to accommodate the largest EDGs and incorporate design elements for smaller EDGs (Chisholm et al., 2010). Some suggestions include incorporating stumps or other low vegetation for small terrestrial species. Dry passage can be incorporated into water corridor passages. Shelter crevices can be added for bats (Chisholm et al. 2010). A small tube or berm should be placed parallel to the large culvert box to allow for the movement of small animals. This tube should be built such that the downstream end is lower than the upstream end, preventing the tube from being clogged (Bond, 2003). Culverts have found to be effective for small animals.

Human integration with wildlife crossings should be limited (Beier et al., 2008 & Clevenger & Waltho, 2000). However, in urban environments this may not be feasible due to pressures on natural landscapes (Chisholm et al., 2010). When wildlife and humans must use the same crossing, human activity should be limited during times when wildlife activity is greatest. Some other design principles include limiting domesticated and livestock animals. Physical separation between human trails and wildlife trails should exist within the corridor and visibility between the two should be limited. Shared use of underpasses should only be attempted when the passage is wide and short in length (Chisholm et al. 2010). At the convergence of a wildlife corridor with a human trail or road, measures can be taken to ensure that wildlife access can be limited through fencing, texas gates, or elevation separation.

The base of the culvert should be a natural substrate above cobbled concrete. The natural substrate should match the materials found in the wildlife corridor (Bond, 2003, Smith, 2003, Beier et al, 2008, Clevenger & Huijser, 2011, & Chisholm et al., 2010). Culverts can take many forms and each has unique benefits for wildlife movement. Common culvert designs include closed bottom culverts, open bottom culverts, box culverts, and amphibian tunnels (Chisholm et al., 2010).

Entrances and exits should maintain as much vegetative cover as possible, without physically or visually blocking the crossing (Bond, 2003, Smith, 2003, and Beier et al., 2008). This provides the necessary cover for prey animals to move effectively through the crossing. Where possible, vegetation should be encouraged in the underpass as well. Rows of branches and stumps in the undercrossing can greatly increase connectivity for smaller species (Beier et al., 2008). The use of low forage value vegetation and no mow zones can reduce large EDGs from lingering while providing cover for smaller EDGs (Chisholm et al., 2010).

In addition to the creation of wildlife crossing infrastructure, methods should be implemented to prevent attempted crossings on the roadway. Raising the road is a significant deterrent for wildlife crossing (Mimet et al., 2016). Clevenger et al. (2003) found that vertebrates were 93% less susceptible to roadkill on sections of road raised on embankments, compared to roads at grade. Wildlife crossing safety can also be improved by reducing the speed limit. In the Wildlife Passage document, road barrier effects increase with increased travel speed, vehicles per day, and road right of way widths (Chisholm et al., 2010). In some instances, speed limit reductions are viable options for improving connectivity. At speeds greater than 50 km/h, nearly 2/3rds of crossing attempts are met with mortality. With a 5 km/h reduction in speed, mortality decreases by 32% (Chisholm et al., 2010). Signage and reflectors are most useful for larger wildlife and when traffic volumes and speeds are low.

To minimize their environmental impact, roadways should also minimize noise and traffic, and implementing strict design regulations on road lighting. To minimize the noise disturbance in the crossing structure, noise attenuation barriers should be implemented in high traffic volume roads (Clevenger & Huijser, 2011).

Fig. 9 Texas Gate Illustration

Texas Gates, also known as cattle guards, are useful for limiting the movement of animals onto roadways while allowing vehicles to pass.

Location of Wildlife Crossings

Wildlife crossings should be located as close to natural pathways as possible. Roadkill data, track beds, road surveys, camera detection, and local knowledge can indicate where species are choosing to cross. Topographic features may indicate where wildlife is moving; ridgelines and riparian areas are conducive to wildlife movement (Clevenger & Huijser, 2011).

Management and Enforcement

Conflict with wildlife is likely when the project is:

- built within 250 m of a natural area
- bisecting uplands and wetlands
- bisecting a wetland or natural linear features
- to have high traffic volumes and speeds (Chisholm et al., 2010)

Human development and activity must occur in a manner that preserves the role of the corridor to facilitate wildlife movement. Effective mitigation is dependent on the EDGs that will be in the area. Mitigation tools include signage, fencing, altered lighting, altered sightlines, public education, speed reductions, wildlife crosswalks, diversionary methods, roadkill removal, vegetation management, noise barriers, curb improvements, culverts, and bridges (Chisholm et al., 2010). Mechanisms such as a 10 - 20 m buffer of mowed, flat land along every corridor edge that abuts human development acts as an effective fire break (Bond, 2003).

Domestic pets should be banned from the corridor and adjacent areas, as they act as subsidized predators. Subsidized predators are animals that act as predators but receive an unnatural advantage due to human activities. Wildlife that attack domestic pets are often relocated (Beier et al, 2008 & Bond, 2003). Humans should not attempt to feed any of the wildlife, with the exception of bird feeders (Bond, 2003).

An education program can reach out to adjacent landowners and users, educating them on the importance of wildlife corridor preservation (Bond, 2003). Recreation users of wildlife corridors should also be educated on how to minimize negative human-wildlife interaction (Beier et al., 2008). Land owners should be discouraged from killing nuisance species and the use of pesticide, herbicide, and rodenticide should be restricted within a reasonable distance (Beier et al., 2008). It is also important that adjacent users prevent wildlife from accessing rubbish bins, as this may give suburban natural predators like raccoons, foxes, and crows advantages over other wildlife (Beier et al., 2008).

Human use of wildlife corridors and crossings should be discouraged as much as possible, as it may scare animals away (Beier et al., 2008 and Clevenger & Waltho, 2000). Where trails do interface with wildlife corridors, the system should be designed to minimize conflicts as much as possible; people should be encouraged to stay on trails, dogs should be kept on leashes, and humans should not interact with wildlife. In the Florida study, use of culverts decreased significantly with the presence of humans (Smith, 2003).

Planning

Wildlife corridors should be incorporated into regional and local plans to ensure they remain viable and regulations are enforceable. If necessary, wildlife corridors can combine goals of habitat protection and recreation (Beier et al., 2008).

Regulatory System

Wildlife corridors can trigger policy and legislation from all three tiers of government (Chisholm et al. 2010). Some of the key federal documents include the Migratory Birds Conservation Act, Fisheries Act, and the Species at Risk Act. The key provincial documents include the Alberta Wildlife Act, Environmental Protection and Enhancement Act, Water Act, and the Wetland Classification System.

Maintenance

Maintenance and operations are vital to the long term success of the wildlife corridor. The use of low forage value vegetation and no mow zones can reduce presence of large EDGs while providing cover for smaller EDGs. Some critical measures are to conduct regular inspections of culverts for blockages and substrate condition. It is also important to make sure that fences be checked and maintained (Clevenger & Huijser, 2011).

Monitoring of the wildlife corridor and the health of populations that use it is key to ensuring the effectiveness of the corridor and determining if there are concerns or areas of improvement (Clevenger & Huijser, 2011).

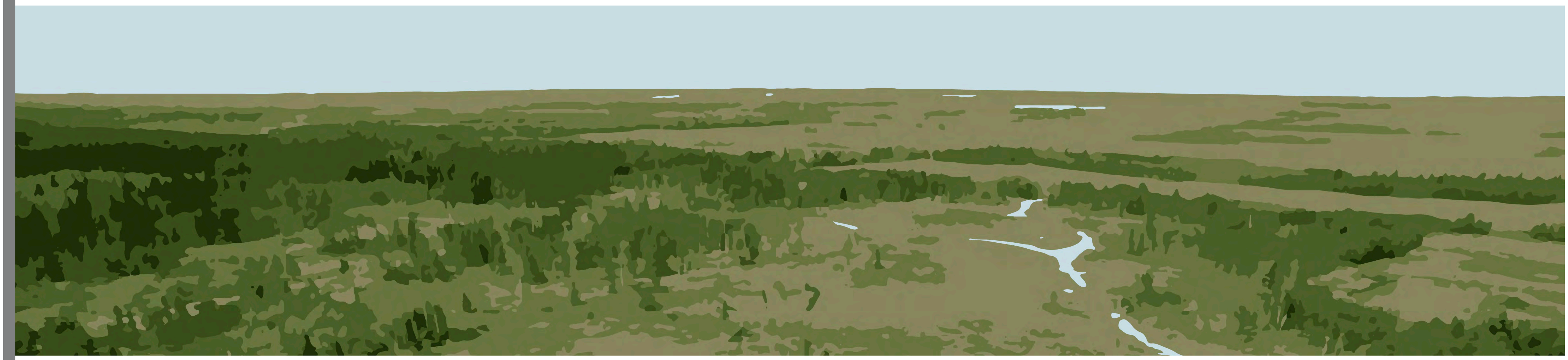
Summary

Wildlife corridors are established as an effective tool to maintain connectivity in areas where human development fractures natural landscapes. Corridors help minimize the significant adverse direct and indirect effects of habitat fragmentation. To ensure the wildlife corridors are as effective as possible, there are a number of location and design elements that must be considered. Corridors should be as wide as possible, with 350 m being considered the minimum necessary width. The location of a corridor should attempt to match known movements of wildlife as closely as possible. Corridors should create the path that represents the least-cost to species.

Adjacent human uses should be located and regulated to minimize conflicts with the corridor. Fencing and buffers can minimize adverse interactions.

Wildlife Corridors can be bisected by human infrastructure, typically roads or highways. At these locations, it often becomes necessary to create wildlife crossings. Common best practices include having natural substrates at the base of crossing, having local vegetation near the entrances. Other characteristics, like culvert dimensions, vary signifcantly by the species being considered.

To ensure the ongoing effectiveness of wildlife corridors, it is important that ongoing maintenance and monitoring occur. Wildlife Corridors and crossings should be reflected in the local and regional plans.



3.2 Trails

To better plan the recreational trail system, background research was conducted to establish best practices for creating a trail that is well designed for users but also conscious of the natural environment. There is a large amount of literature on recreational activities in the natural environment, but the recreation opportunity spectrum (ROS) is the most popular model to help planners with trail design in North America (Buist, 1982). Buist (1982) analyzes the conditions trail users find most favorable for outdoor recreation in a natural setting through the ROS. While some people may prefer a highly accessible trail network that is in an urban setting, others prefer an informal trail system that is remote and isolated in the wilderness. The ROS considers several factors such as remoteness, size of area, evidence of humans, user density, and managerial noticeability to determine the classification of the environment (Buist, 1982). These characteristics define the user experience, and a user survey can help determine which characteristics users value in the subject area. By mapping areas with these characteristics, it's possible to plan the best location for a trail depending on the traits the planner wishes the trail to have. For example, a highly isolated and low managerial noticeability area would not be the best location for a trail with high accessibility, traffic, and infrastructure to support it, rather a semi-urbanized location would be a better fit for this kind of trail. Once the characteristic of the environment is determined, an appropriate activity for the environment can be determined. Depending on the degree of these factors, the environment is classified into a primitive, semi-primitive non-motorized, semi-primitive motorized, roaded natural, rural, or urban landscape (Buist, 1982).

An area such as the Leduc Wildlife Corridor would be classified as roaded natural, being predominantly natural with some evidence of sights and sounds of human activity. There is a relatively low density of users, and the infrastructure to support the trail is minimal and is cohesive with the natural environment (Buist, 1982). In a roaded natural environment, there is opportunity for both active and motorized forms of recreation.

Many of the municipalities around and near the City of Leduc and Leduc County provide their own standards and guidelines for ensuring a well-connected, well-utilized, accessible, and enjoyable trail system. These policy documents discuss ideas surrounding connectivity with other trails, amenities, and road systems. Standards for trail width, material, slope, and signage are important to take note of. In order to design this trail system, reviewing and analyzing the best practices used by these nearby municipalities with similar environmental conditions is necessary. As well, the City of Leduc's own policy and standards should not be ignored. The multiway that exists today is a phenomenal example of a well-connected, well-utilized, robust trail system. Designing a trail system that is coherent and connected to the existing multiway in some capacity is a welcome consideration as it will be familiar to residents.

In addition, the multiway system was a feature discussed in the Telford Lake Master Plan (2010), specifically as a trail that circulates the lake . This development could potentially connect with the Telford Lake-Saunders Lake trail in coherence and design in some capacity. As outlined in the City of Leduc Parks, Open Space, and Trails Master Plan (2012), three conceptual elements are necessary for the multiway:

1. Access,
2. Safety, including proper signage and maintenance, and
3. Continuity and connectivity with the larger system.

In addition, three types of multiway designs exist:

1. Primary,
2. Secondary, and
3. Nature Trails.

What should be noted about these trail types is their use, location, and design features. Primary and secondary trails are normally located in more well-used, arterial areas with the primary trails being asphalt-paved and 3 m wide, and the secondary trails being either asphalt or concrete-paved and 1.8 m wide. Nature trails are "gravel pathways" that see less foot traffic and are designed for passive recreation (City of Leduc, 2012). With the future trail being located within the rural, wildlife corridor environment between Telford Lake and Saunders Lake, the nature trail design may be a potential option for development.

In addition to the City of Leduc's multiway system, many other municipalities present their own standards and guidelines for good trail design. These benchmarks should be observed and considered to design the most accessible, well-connected, and well-used trail system. As seen previously, classifying the different trail type designs was a common practice among municipalities. For midcountry or backcountry environments, the Parkland County Parks, Recreation and Culture Master Plan (2017) recommends the double-track, single-track, and multi-use trail types. These trails range in width from 0.5 -1.5 m to 2.5 - 4 m if motorized vehicles are permitted. Natural surface or crushed gravel would be commonly used as surfacing material. Slopes can reach heights in ranges up to 30% depending on what uses are permitted. Strathcona County's Trail Strategy (2012) provides similar classifications for trail systems. There are three levels of trail development that range in accessibility with (1) being the most accessible and (3) being the least:

1. Developed,
2. Semi-developed, and
3. Undeveloped.

Frequency of use also aids in determining which trail type to use. For midcountry and backcountry experiences, such as those between Telford Lake and Saunders Lake, trails will generally be less frequented. In this case, surfacing recommendations would range from smooth compacted surfacing to turf or bare earth. In addition, cleared widths for the trails should range from 2 - 3 m, depending on permitted uses. Finally, slopes could range from 10%-30% depending on permitted uses. Beaumont's Open Space and Trails Master Plan (2015) also provides three different classifications for multi-use trails. Similar trends from previous documents are seen with the additional consideration of including lighting and winter snow clearing depending on trail type. When designing the trail system to connect Telford Lake and Saunders Lake, assessing the surrounding context and determining the types of uses, level of accessibility, and expected frequency of use is important. Utilizing these classification systems will help in better designing the trail to be accessible, well-utilized, and enjoyable.

As seen through the recreational opportunity spectrum (ROS), a variety of environments can be identified in an area, and corresponding trail types are assigned to each. Multi-use trails are designed to accommodate pedestrians, cyclists, in-line skaters, and/or horseback riders. The type of user will determine the design and technical specifications of the trail. For example, a paved pathway that is 2.4 m wide is required if accommodating wheelchair access, while a dirt pathway with 3 m of height clearance would be required for equestrian use (Searns, 2001). Searns (2001) also notes that a dirt/gravel pathway is sufficient if disabled persons are not accommodated for, and will have less impact on the surrounding natural environment. Accessible trails also need to include resting locations every 60 - 90 m for users to get off the trail and rest. These locations are great spots for educational signage on the natural environment and the trail itself, such as preservation methods or the history of the location. If equestrian use is permitted on the trail, there must also be signage to indicate if active users or horseback riders have the right of way (Searns, 2001). In addition to proper trail design and maintenance, trails require adequate promotion and public interest. Trail networks provide a connection for urban, suburban, and rural communities to travel by active transportation to other communities or natural features (Schasberger, 2009). Often rural and suburban communities lack access to infrastructure for active transportation and the presence of a trail network can provide this. Schasberger (2009), found rural communities have a strong interest in preserving the natural landscape, but also desire a defined trail network that would allow them to get out and experience the landscape. In addition, Schasberger (2009) found that these trail networks in rural communities had increased usership when there was promotion and raised awareness of the trail network.

Undeveloped	Semi-Developed	Developed
Material: Turf or bare earth **Width:** 1-1.5m with cleared width of 2m **Slope:** 10% preferred, 30% max. **Accessibility:** Low-Mid	**Material:** Smooth compacted surfacing **Width:** 2.7-3.3 m **Slope:** 5-10% preferred, 20-30% max. **Accessibility:** Mid	**Material:** Aphalt or concrete surfacing **Width:** 3-3.5m **Slope:** 5% preferred, 10% max. **Accessibility:** High with easy access for service and emergency vehicles

Fig. 10 Trail Classification Illustration

Best practices from surrounding municipalities show that including signage and wayfinding is crucial for coherence, safety, and the enjoyment of users. The Devon River Valley Trails Master Plan (2015) indicates three different types of wayfinding:

1. General Signage,
2. Kiosk/Trail Network Signage, and
3. Trailhead Signage.

The first type would provide ecological and environmental information, they are designed to be interesting and attractive, as well as instill pride in the community. Kiosk/trail network signage are placed at the entrances of trails and provide basic safety, trail etiquette, and important location information. Trailhead signage are placed at major access points to orient users. Signage and wayfinding was also mentioned in the City of Leduc Parks, Open Space, and Trails Master Plan (2012), Strathcona County Trails Strategy (2012), and the Parkland County Parks, Recreation, and Culture Master Plan (2017). Parkland County (2017) also includes the "Universal Trail Assessment Process" (UTAP) on trailhead signage which details info on trail grade, cross slope, trail width, surfacing material, and trail length. Generally, trail signage and wayfinding should be simple, easy to read, and as clear as possible. In this way, trail users are able to easily identify and interpret the information presented.

Various trailhead amenities and considerations can also be included when designing trail systems. These enhance the comfort, enjoyment, and attraction to the trails for visitors. Most documents mention basic amenities such as benches, waste disposal, water fountains, and washrooms (City of Edmonton, 2006; City of Leduc et al, 2012; Strathcona County, 2012). Other amenities that could be included are art installations, ornamental plant materials, bicycle parking/racks, lighting, parking at trail entrances, and guard rails. The Edmonton Urban Parks Management Plan (2006) and Strathcona County Trails Strategy (2012) also mention accommodating linear drainage features or drainage works into the trail system. In addition, Parkland County mentions providing water access where possible. When connecting Telford Lake and Saunders Lake, providing access to water features should be incorporated in some way to maximize the recreation potential of both areas (Parkland County, 2017).

Trails in natural environments should have the least amount of impact on the surrounding environment as possible. This includes the wildlife, vegetation, and physical quality of the landscape. To ensure this, trails must have proper water drainage design to limit the amount of erosion and informal trail widening that occurs. The goal is to keep the water run-off system as close to pre trail conditions (Searns, 2001). This can be done through an open system using swales (open flow beside trail) or sheet flows (even water dispersion over whole trail) which are the most natural and cost effective ways to handle drainage on the trail. A closed system involves underground pipes and culverts to redirect water off the trail, which is more expensive, but more effective at transporting water. The other option is a combined system which uses an open system to collect water, directing it to a closed system which carries the water to a larger water body. A drainage system, whether open or closed, will help reduce running water, wet soils, and rutted trails which are the greatest contributors to excessive trail widening (Leung, 1999). If equestrian use is considered for the multi-use trail, limited use during the wet months should be considered to reduce trail widening and erosion (Leung, 1999).

Best practices have shown that they are many interrelated elements that contribute to the design safe, enjoyable, and well-used trails. Evaluation methods such as the ROS can aid in designing trails through the establishment of specific criteria. Not only can this tool aid in detailed design but also in assessing optimal locations for the placement of trails and their route. As well, as seen in the planning documents of many surrounding nearby municipalities, classify trails into different tiers based on their location, rate of use, and types of uses permitted can aid in deciding the optimal design of the trail. The City of Leduc currently uses their multiway system, and as this proposed trail is connecting Telford Lake in Leduc with Saunders Lake, ensuring coherence to some degree is important for visitors to be familiar with the system. The importance of signage to orient users, identify important locations and information, and present attractive ecological and environmental information should also be stressed. It is also beneficial if the signage is clear, noticeable, and easy to read, in this way it can be more useful to users of the trail. Amenities like benches, washrooms, and water fountains, increase the comfort and enjoyment for visitors, although the types of amenities to be included on the trailway should be addressed on a case-by-case basis. Finally, to ensure that the trail has the least impact on the environment, different types of water drainage designs can be utilized, as well on a case-by-case basis. Considering these multiple elements during the design of the trail connecting Telford Lake to Saunders Lake will aid in making the trail enjoyable, well-connected, and well-utilized.

3.3 Trail and Wildlife Corridor Integration

Trails must consider the natural environment in which they exist. Trail networks have a zone of influence surrounding them in which the natural environment, and the animals that live in it, will feel the effects of the trail and its users. Buchanan et al. (1998) explains that the size of the zone of influence depends on the characteristics of the trail such as the trail width and traffic, but also on the sensitivity of the local wildlife. In addition, any trail heads or parking lots will have the largest zone of influence with the highest density of users in these areas. Searns (2001) mentions that trails often have a 3 - 6 m swath of land that has vegetation removal and obvious impact of humans, however the actual influence of trail users goes far past this. When choosing locations for the trail, look for areas that are already disturbed (Buchanan et al., 1998). This will prevent new habitats from being disturbed, and offer the potential to incorporate the restoration of the disturbed habitat into the planning and design of the trail (Buchanan et al.,1998). An example of this would be aligning the trail with existing edges, such as a fence or roadway. This prevents new edges from being created which act as barriers to ecological flows. Buchanan et al. (1998) mentions considering sensitive wildlife and environments, and to try and avoid these areas at all costs. Habitat fragmentation is extremely detrimental to biodiversity, and trail edges should be routed around habitats rather than through them. This also means that habitat crossings in the forms of boardwalks or bridges are discouraged. Additionally, any riparian areas (small ponds, creeks, or wetlands) should not be bordered on all sides, but only along one edge as to keep one side open for animals to access the area without a barrier. Trails should be as narrow as possible and screened from any sensitive areas by either vegetation or topography to reduce any stress on animals. Animals respond to predictability of trail users and are less stressed if they know how trail users will act. This means staying on the trail, and not allowing dogs off leash if they are permitted. All of these recommendations from in Planning Trails with Wildlife in Mind (Buchanan et al., 1998) prioritize the natural environment before the experience of the trail user. While both can coexist, the trail is essentially there because of the natural environment and so that must be protected.

There are several effects that trails have on the surrounding zone of influence which increase with the traffic on the trail. These effects include muddiness, trail extension and widening, vegetation damage, litter, and fire rings (Lynn and Brown, 2003). Its these effects of greater trail use that actually degrade the user experience and make the trail less enjoyable. Lynn and Brown (2003) examined how trail users reacted to these effects and found that litter was the most objectified, followed closely by vegetation impact, and trail erosion. Muddiness had little effect on users experience as they considered it a naturally occurring event, rather than something caused by trail users. However, all impacts from traffic on the trail had negative effects on trail users, worsening their experience. Lynn and Brown (2003) suggests signage that makes it clear to trail users their impacts on the trail and how they can reduce these impacts to make their experience more enjoyable. Searns (2001) also recommends trail signage to discourage trail users from forming informal pathways which leads to unnecessary trail widening. In addition, trail signage can be placed at any trail vistas where trail users are viewing the natural landscape and wildlife. Viewing vistas prevent people from forming their own trails to view wildlife, and offer opportunities for educational signage.

Looking to preserve the natural areas, and the trails within them, in the Greater Toronto Area, the City of Toronto created the 2013 Natural Environment Trail Strategy (NETS). The NETS (2013) looks to protect the natural environment, while providing recreational activities within these areas. From this, the strategy identified four principles to follow when planning a recreational trail system within a natural area; environmental protection, equitable access, parks and trails as city infrastructure, and community engagement. The NETS (2013) identifies several environmental impacts from poorly designed trails such as erosion, trail widening, vegetation trampling, soil compaction, and trail proliferation. Buchanan et al. (1998) and Lynn and Brown (2003) also identified these impacts, but the NETS has different methods and strategies for minimizing them. NETS has a strong emphasis on public knowledge and educating trail users as to how they can reduce their impacts. This includes wayfinding signage that encourages proper trail etiquette (e.g. staying on the path), and information on species in the area, especially sensitive ones (City of Toronto, 2013). Introducing trail users to the area and educating them about the habitat helps create a sense of ownership and stewardship of the land. Fostering this community pride in the natural environment and its trail network gives it a sense of place.

Wayfinding can also include health benefits of trail based activities, the impacts of littering, natural/cultural history of the natural area, and any important species in the area (City of Toronto, 2013). Additionally, the NETS stresses the importance of identifying environmentally sensitive areas and how trails should be planned around them. Environmentally sensitive areas need to be carefully planned around and considered when locating trails as to have the least amount of impact as possible. These areas should not be transversed with boardwalks or bridges and trails should "direct intensive activities away from sensitive natural areas while providing passive recreation opportunities and promoting ecological awareness" (City of Toronto, 2013, p.23). In addition, any parking lots or trail heads should be planned as far away from environmentally sensitive areas as possible, as high use areas have larger impacts on wildlife (Searns, 2001). Where conflict exists between a sensitive area and recreational purposes, the environmental area should prevail and have precedence over the leisure of trail users.

In instances of conflict between trails and natural features, there are a number of measures that must be implemented and enforced to ensure that trail networks do not threaten the viability of the wildlife corridor. There is evidence that human presence limits the usage of crossing structures (Smith, 2003 and Clevenger & Waltho, 2000). If human use must be incorporated into wildlife crossings, the crossing should be sufficiently wide and there should be a clear delineation between human and natural pathways (Beier et al., 2008). Trail users should be educated on the importance of staying on trails, banning domestic pets or enforcing an on-leash policy, and not feeding wildlife (Bond, 2003). Additionally, use at night may interfere with nocturnal animal navigation (Beier et al., 2008). Lighting does not reduce wildlife collisions and degrades habitat quality with significant impacts on migratory birds (Chisholm et al., 2010). In cases where lighting is mandatory the use of downward lighting with appropriate shields can mitigate some of the negative impacts. These policies and practices can be reinforced with signage along the path.

3.4 Infrastructure Options

3.4.1 Natural Features

To best accommodate the movement of wildlife, wildlife corridors should attempt to match the known pathways. Potential pathways should be evaluated based on preferable land cover and barriers to movement. Corridors should follow pathways that provide adequate tree and vegetation cover. Certain animals will use trees and vegetation to avoid predators, and bird species will use trees as nesting grounds. Corridors will often follow water bodies, as they are necessary components of wildlife habitats. Where additional vegetation needs to be planted, flora species chosen should reflect native species, for the benefit of both local flora and fauna. Typically, shorter routes are more effective than longer paths. The slope of corridors should not exceed 25 degrees. To minimize the adverse interaction between wildlife corridors and adjacent development, 10 - 40 m no mow zones should be implemented in which no development should occur. No mow zones provide a habitat for some species and transition development to a natural area.

When creating a wildlife crossing, certain natural features can help encourage greater use. Culverts and crossings should be floored with natural substrates that are similar to the adjacent area. Local herbaceous vegetation should be planted around the entrances, providing cover for prey species. However, this vegetation should not encumber visibility or accessibility of the entrance and exit. If possible, brush should be placed inside the culvert to provide cover to smaller animals. The culvert should also have adequate drainage elements to ensure that the culvert does not flood during high precipitation events. The wildlife crossing should, as much as possible, feel like a natural extension of the adjacent habitat to encourage wildlife to use the crossing.

3.4.2 Anthropogenic Features

In order to maintain the safety, coherence, and enjoyment of trail connections, especially in rural areas, proper considerations relating to the design of the trail, amenity provision, and adherence to surrounding context need to be taken. Generally, trails should be well-connected to existing infrastructure including areas for vehicle access, existing trail systems, as well as recreational and natural amenities. The following anthropogenic infrastructure features should be implemented in some way to the trail system that connects Telford Lake and Saunders Lake.

From the best practices research conducted, a hierarchy of trail design options were available depending on factors such as trail usability, accessibility, intended use, location, and terrain. Generally, three types of trail design exist in most municipalities: Developed, Semi-Developed, and Undeveloped. For the rural, rarely touched environment connecting Telford Lake and Saunders Lake, trail design within the Semi-Developed and Undeveloped categories would suffice. As such, there are a few different options to consider for the trail design. The first consideration would be the surfacing material of the trail. Less developed trails are suitable for more rural and natural areas as their surfacing material has less environmental impact and is less imposing on surrounding features. For the Telford Lake - Saunders Lake situation, this is recommended, especially when considering a wildlife crossing being located nearby. As such, surfacing material like turf or bare-earth should be initially considered with smooth compacted surfacing such as compacted gravel as a secondary option if the intent is to increase accessibility.

The next consideration would be trail width. As an Undeveloped to Semi-Developed trail, trail width should be between 1.5 - 3m with an additional 0.5m of cleared width to allow for the comfortable movement of two to three able-bodied persons if they were to walk side-by-side. Along with width, cleared height should be between 2.5 - 3m depending on the allowed uses of the trail. Larger uses such as equestrian and motorized uses would need more height clearance. Finally, slope changes should also be taken into account. With the area between Telford Lake and Saunders Lake varying in topography, accessibility for trails may become an issue. More developed trails tend to have lower slope changes, since the Telford-Saunders trail would be less developed, sharper slope changes may be allowed. Slopes are able to be 10%-30% in steepness. It is important to note that these design considerations are strongly dependant on the target users of the trail. Ensuring the comfortable access of all users and types of uses should be at the forefront of the decision-making process and will weigh heavily on what the trail will end up eventually being.

Along with the physical design of the trail, certain infrastructure features within the trail system can increase its safety, comfort, and enjoyment. For the Telford Lake to Saunders Lake trail connection, recommended safety provisions and amenities include: benches, waste disposal, toilets, drainage, parking, signage, and various accessibility infrastructure. Benches can be included at different intervals depending on the terrain and level of use. For the Telford-Saunders connection, longer intervals would be recommended. Benches can aid in providing rest areas as well as lookout areas to important natural features in the surrounding environment. Recycling and waste disposal in rural areas face a higher maintenance burden than those in urban areas (Strathcona County, 2012). Therefore, containers should only be provided at the most heavily utilized locations, preferably near benches. Toilets for the Telford-Saunders trail should be located at trailheads and preferably near parking. Parking, in addition, should be able to accommodate various different modes including equestrian access, trailers, and bicycles. To ensure the least amount of impact on the surrounding environment, trails must have proper water drainage design to limit the amount of erosion and trail widening that occurs. This can be done through an open system using swales (open flow beside trail) or sheet flows (water disperses evening over whole trail). An open system is the most natural and cost effective method of handling drainage on the trail. A closed system involves underground pipes and culverts to redirect water off the trail, which is more expensive, but more effective at transporting water. The other option is a combined system which uses an open system to collect water, directing it to a closed system which carries the water to a larger water body. If equestrian use is considered for the multi-use trail, limited use during the wet months should be considered to reduce trail widening and erosion. Accessibility can be addressed through the type of surfacing, width, and slopes of the trail system, however various amenities like steps, guardrails, and handrails can increase the comfort and enjoyment of the trail. For Telford-Saunders, the level of accessibility desired should be discussed. Based on its location and intended purpose, recommendations would be minimal additional accessibility infrastructure.

Signage is perhaps one of the most important features of the trails. Best practices from surrounding municipalities show that including signage and wayfinding is crucial for coherence, safety, and the enjoyment of users. Types of wayfinding can include general signage, kiosk/trail network signage, and trailhead signage. General signage would provide ecological and environmental information, they are designed to be interesting and attractive, as well as instill pride in the community. Kiosk/trail network signage are placed at the entrances of trails and provide basic safety, trail etiquette, and important location information. Trailhead signage are placed at major access points to orient users. Signage and wayfinding can also include the "Universal Trail Assessment Process" (UTAP) which details info on trail grade, cross slope, trail width, surfacing material, and trail length. Generally, trail signage and wayfinding should be simple, easy to read, and as clear as possible. In this way, trail users are able to easily identify and interpret the information presented. Based on the alignment, function, and design of the Nisku Spine Road, the trail sytem connecting Telford Lake and Saunders Lake could be at grade when crossing the 6-lane arterial.

The wildlife crossing structure that would best accommodate the wildlife in the area is a large culvert. This culvert should be designed considering the following criteria:

- a minimum height of 3 m,
- have natural vegetation around the entrance and exit,
- provide a smaller tube, approximately 1.5 metres in diameter, to accommodate smaller animals,
- provide brush and cover in the culvert,
- be floored with a natural substrate similar to the surrounding area,
- be as wide as possible. In the Range Road 245 and 250 Functional Planning Study, the ultimate cross-section of the Spine Road will be 35.2 m wide, not including ditches. Given this significant length, to maintain an openness ratio of 1.0, the structure should be 11.7 metres wide, assuming it is 3 metres high, and
- if possible, consider reducing the number of lanes for the stretch of the wildlife corridor. This would reduce the length of the culvert, increasing the openness.

4. Wildlife Corridor Criteria

There is potential for a wildlife corridor and trail network between Telford and Saunders Lake, however the incorporation of the two must be considered. From the literature review, several criteria have been identified that must be met for successful connectivity of trail users and wildlife that does not hinder either. The criteria acknowledges that the wildlife corridor has precedence in all instances, and the preservation and protection of the natural landscape and the wildlife are the first priority above trail users. With this in mind, there is still room for both to successfully exist in the area without conflict.

- Trail networks and wildlife corridors should be as separated as possible to reduce stress on wildlife and the environment, as well as ensuring the safety of trail users. This can achieved by creating a visual barrier between any environmentally sensitive areas and the trail by either topography or vegetation. In addition, the trail should intersect the wildlife corridor as little as possible, and certainly not in any sensitive or riparian areas. This includes any boardwalks or bridges.
- Existing disturbed areas should be utilized. Rather than disturbing new areas with the construction of a trail, it should be located along existing edges in the area that are already impacted. Existing edges can include fences, telephone poles, roads, or informal trails that are already frequented by human activity.
- The trail should not border both sides of the wildlife corridor as this will reduce permeability of wildlife in and out of the corridor. This also includes any water bodies (wetlands, creeks, ponds, etc) which should not be circled by trail on all sides. Rather, a trail system should run along the edge of the corridor and only along one side. As environmentally sensitive and riparian areas are areas for high wildlife traffic, it is important that they remain easily reached and animals don’t feel pressure from human activity when visiting them.
- Assume the trail will have a zone of influence about 3-6m wide in which the environment and animals will be impacted by the trail and its users. Within this swath there will be 0.5-2m of vegetation cleared on either side of the trail for wildlife and trail user safety. Environmentally sensitive or riparian areas should not be within this zone, and the trail should have a sufficient border between them.
- Dogs can only be permitted within the wildlife corridor if they are on-leash and properly controlled. Dogs are highly unpredictable and can be stressful to wildlife. This can be reinforced with educational signage along the trail that explains trail etiquette.
- Signage along the trail should also discourage trail users from creating their own pathways which is harmful to the environment. New pathways are commonly formed when the formal trail is in an undesirable state, usually too muddy. This can be reduced with proper drainage mechanisms along the trail, either a closed, open, or combination system to direct water off the path.
- Lighting should be limited along the trail as it can be detrimental to migratory birds and other wildlife. Any necessary lighting should be located at the trail heads where there is the largest amount of human activity, and the farthest from the wildlife corridor. Any lights should be designed to mitigate effects on wildlife.
- The trail should be gravel as this will have less environmental impacts than an asphalt trail, while still providing some accessibility to trail users. Any areas where an asphalt trail is required should be near urbanized areas, or the trail heads, but not near environmentally sensitive areas.
- The slope of the trail and wildlife corridor should not be greater than 25 degrees as this will prevent wildlife from using the corridor, and will be inaccessible to trail users.
- If equestrian use is permitted on the trail, there needs to be 3m of height clearance to allow horseback riders to safely clear any tree branches.

- Waste bins need to be located at high traffic areas such as the trail heads and include mitigating measures to prevent wildlife from accessing rubbish.
- If multiple linear man-made features are present in the area, they should be bundled together as to reduce their impact. This includes putting fences, pipelines, and telephone wires together along the same pathway when possible.
- Wildlife corridors should be as short and wide as possible, so the most direct path between the two lakes that allows for the most amount of land to be dedicated as environmental reserve towards the wildlife corridor would be optimal.
- A wildlife crossing will be required to allow for connectivity across the proposed Nisku Spine Road. Depending on the design of the wildlife crossing, it should be kept separate from an human crossings for the spine road. Crossing six lanes of traffic at, above, or below grade is already stressful for wildlife, and the added pressure of trail users is unnecessary. This means that there should be visual barriers between the human and wildlife crossings of the Nisku Spine Road which can be achieved by having each crossing at different grades.
- The existing land use plans in the area need to be considered when planning the location of the corridor and trail network as to ensure the network in cohesive with other plans. There is a proposed trail network in the Leduc Landfill Refuse to Refuge Plan, and the East Telford Lake ASP that must be taken into consideration when trying to connect the wildlife corridor trail with these trail networks.
- The Nisku Spine Road should be elevated above grade and fenced on either side to discourage wildlife from crossing at the road. One way ramps should be constructed on the road side of the fence, allowing wildlife to get back into the corridor should they get past the fence. The fence should extend north and south of the corridor to prevent wildlife from going around the fence to try and cross the road. The fencing should move wildlife to the wildlife crossing structure, which will be the only permeable location along the road.

5. Policy Review

City of Leduc and Leduc County Intermunicipal Development Plan

In accordance with section 631 of the MGA, the City of Leduc and Leduc County jointly approved an intermunicipal development plan (IDP) to guide development until 2044. The plan identifies five sustainability pillars, one of which is environmental stewardship. This pillar states that Leduc County and the City of Leduc will protect, sustain, and enhance the natural environment.

Specific details on the establishment of a wildlife corridor and trail network are provided in section 4.6.2. Environment and Open Space Policies. Specific policies identified are:

- Cooperation between the municipalities, other orders of government, and local groups.
- Subdivision of lands within the 100 year floodplain shall not be permitted unless flood-proofing measures are taken.
- The location and network of trails shall be delineated at the ASP level.
- At the Area Structure Plan, land use designation, or subdivision stage, Environmental Impact Assessments addressing natural areas or Environment Site Assessments addressing contamination shall be completed.
- Lands identified as sensitive may be designated as Environmental Reserve in accordance with the MGA.
- Developers must identify and attempt to preserve tree stands.
- Both the City of Leduc and Leduc County shall jointly prepare environmental inventories and management plans for the Saunders Lake watershed and other creek and ravine systems.

Section 4.6.2.18. Deals specifically with the establishment of a wildlife corridor, stating: *"The County and City shall jointly examine solutions for protecting and maintaining natural habitat connectivity between Saunders and Telford Lakes in order to support the natural movement of wildlife. The wildlife corridor shall be explored in more detail during the development of related studies, ASPs, outline plans and subdivision plans as well as during the detail designing of the Spine Road between 65th Avenue and Rollyview Road"*

Area B: Saunders/Telford Lake Business: North of Telford Lake:

Provideforhighqualitybusiness,lightindustrialandofficedeveopment with complimentary commerical uses along the northeast side of the City of Leduc and northwest of Saunders Lake. Land uses within the Saunders/Telford Lake Business Policy Area B will take advantage of opportunities related to nearby regional assets, ensuring a distinctive development typology through higher design and architectural standards than policy area F. These land uses include, but are not limited to:

- agribusiness research and development, engineering and production,
- oil and gas R&D, engineering and advanced manufacturing,
- information,communications,Technology(ICT),manufacturing,R&D and Sales Warehousing, distribution, and transportation logistics,
- advanced education, training, research, and certification centres,
- general business and office uses,
- complimentary commercial, retail, and dining.

The County and City shall jointly examine feasible solutions for increasing recreational connectivity access to and between Saunders and Telford Lakes in order to support low-impact recreational uses. Elements such as interconnected trail systems and recreational access points will be explored in more detail during the development of related studies, ASPs, and subdivision plans.

Area G: South of Telford Lake:

Provide for commercial, office, business, and light industrial development in the southeast sector of the IDP, respecting the surrounding uses. Uses will have minimal impact on the surroundings. Given the significant costs associated with extending sewage to the area, development is not expected for the 35 year Capital Region Growth Plan timeline.

Area I: Open Space and Greenways:

Purpose is to establish the foundations for a regional system of public open spaces, trails, and natural areas to benefit future generations within the Leduc area. County and City will work together with local community groups and both provincial and federal jurisdictions to ensure appropriate protection and management of public open

As amended by City of Leduc Bylaw No. 933-2016 Approved August 21, 2017 (Office Consolidation)
and
Leduc County Bylaw No. 24-16 Approved July 11, 2017 (Office Consolidation)

FIGURE 10: INTERMUNICIPAL DEVELOPMENT PLAN POLICY AREAS

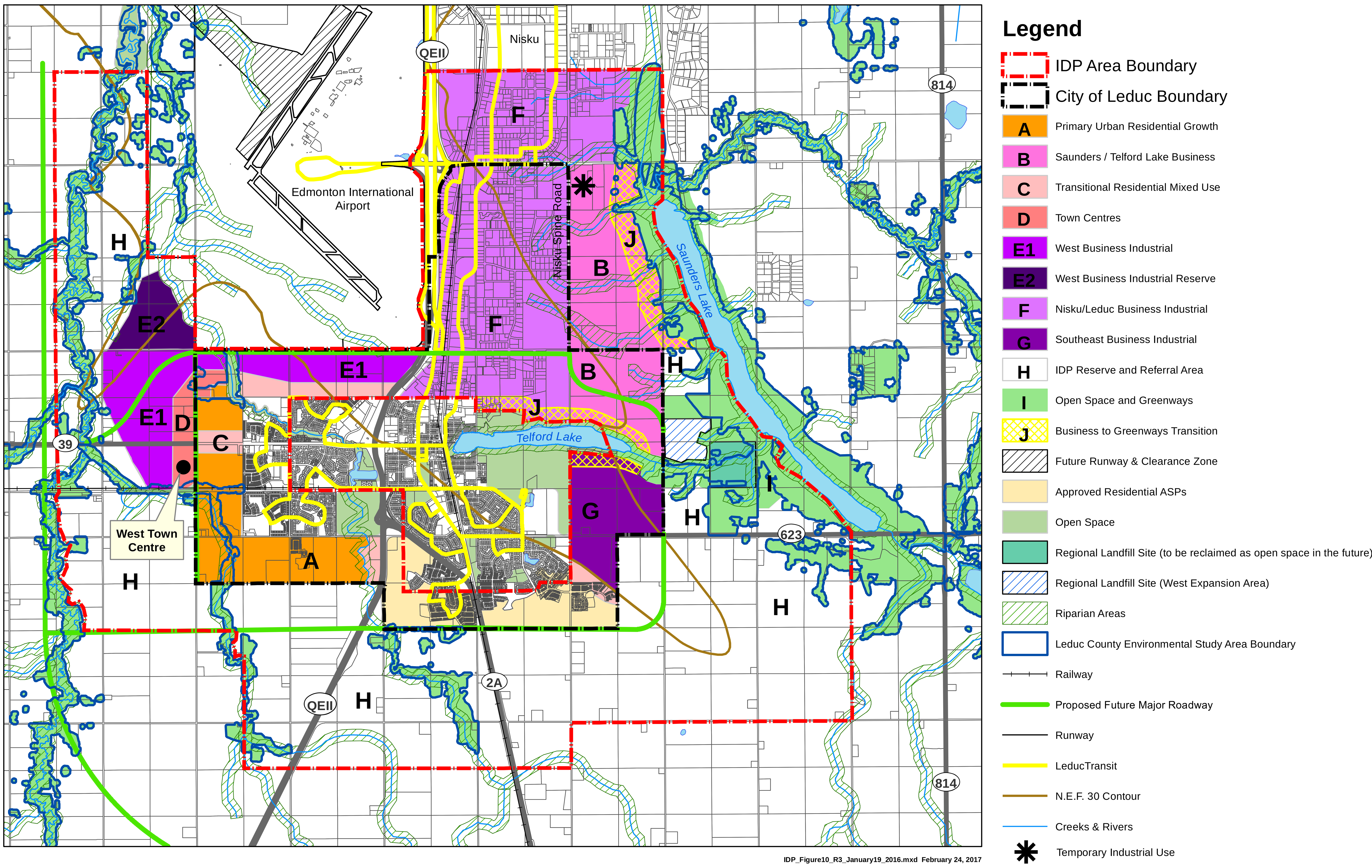


Fig. 11 Leduc County and City of Leduc Intermunicipal Development Plan Policy Plan Areas (2017)

spaces, trails, and natural areas. Work with groups to acquire privately owned land or public access to private land. Public Open Space, trails, and natural areas within the area shall protect and enhance natural features, such as ravines, natural vegetation, habitat, soil, groundwater, and surface water. Planning shall occur at the ASP level.

Area J: Business to Greenways Transition:

Occur at areas abutting the greenspace. Purpose is to ensure that Saunders Lake, Telford Lake and surrounding natural areas. Buffer of low impact business development to transition the greenway to business industrial. Allow for better access to recreation.

Development in the transitional area must minimize the human impacts on wildlife and recreational users. Minimize off site light air and water pollution.

Area H: IDP Reserve and Referral Area:

General purpose is to address lands outside the growth scenario, for future considerations. Intended not to be subdivided until contiguous development and full servicing has been developed in the Growth Scenario areas. County and City shall jointly demonstrate environmental stewardship over this parcel. Areas abutting the natural space are labelled as Area J and provide for a transition from business development to greenways.

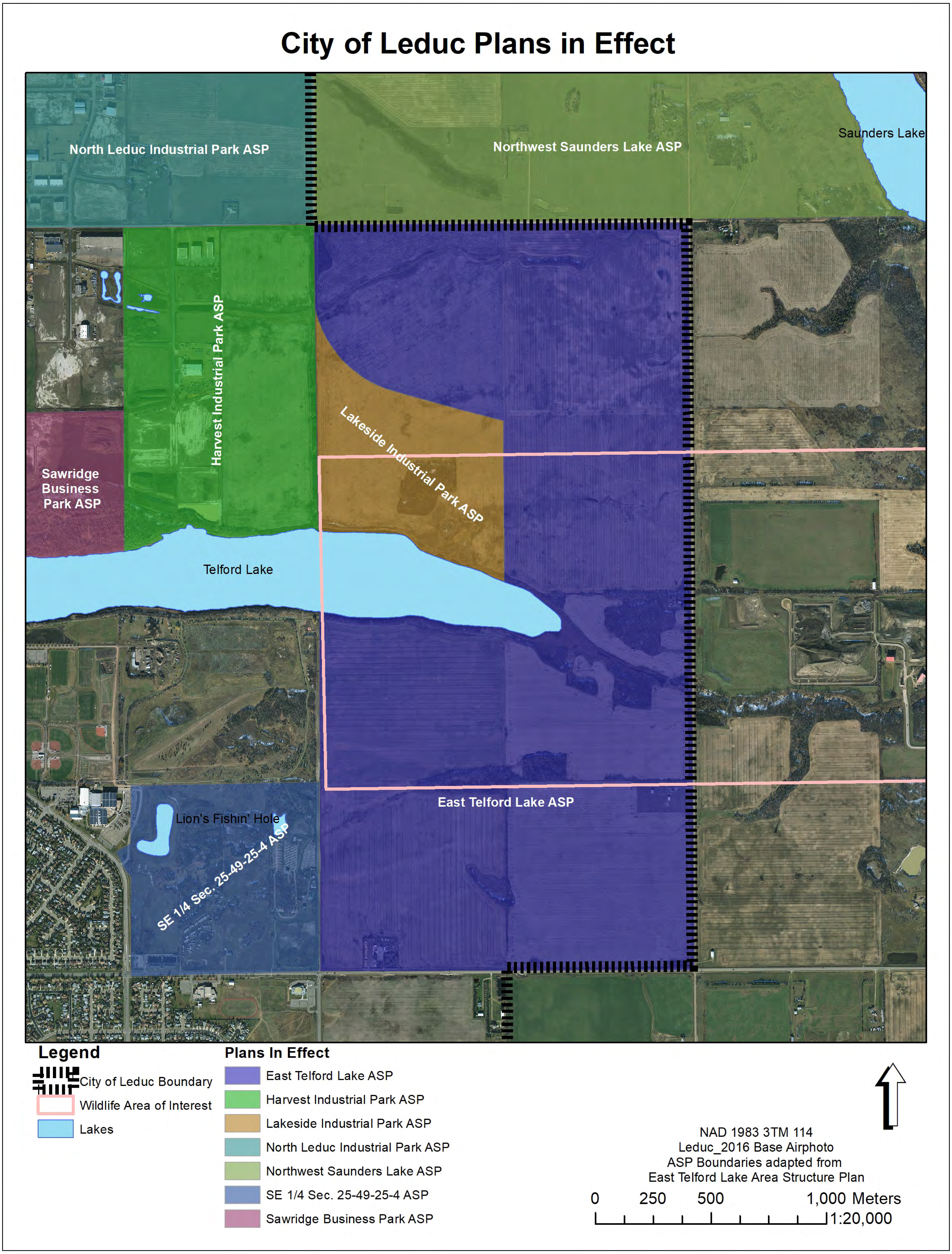


Fig. 12 City of Leduc Plans in Effect

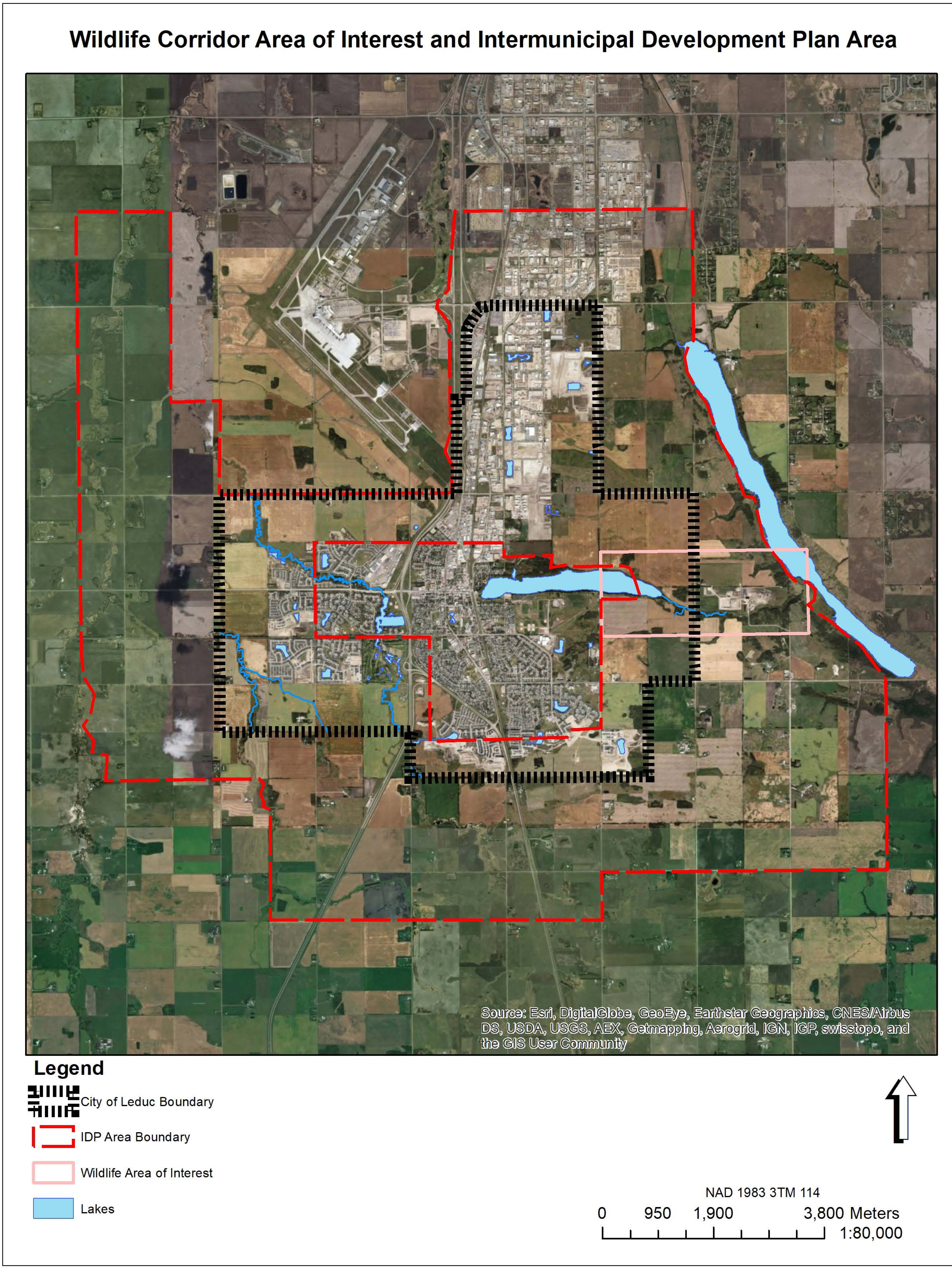


Fig. 13 Wildlife Corridor Area of Interest and Intermunicipal Development Plan Area

Aerotropolis Viability Study

The Aerotropolis Viability study is a comprehensive plan and feasibility study for the development of an Aerotropolis around the Edmonton International Airport. The report provides strategic direction for development on the east side of Telford Lake. This area is envisioned to be a hub for transportation, logistics, and agri-business, as well as ICT and life sciences. A Lakefront Corporate Park is envisioned as wrapping around Telford Lake.

East Telford Lake ASP (Draft)

The East Telford Lake ASP is being drafted for the purpose of guiding development in the east of Telford Lake. The ASP area covers 430 ha. This area is envisioned as accommodating light industrial, office, and other business and employment uses, in accordance with the the IDP and aerotropolis document. The ASP document acknowledges the role of Telford Lake and the surrounding riparian areas to accommodate wildlife and as an opportunity for recreation opportunities. Currently, in the ASP area, the dominant use is agriculture. There are three residences in the area. The ASP recommends a 10 m ER buffer around bed and shore or where slopes exceeds 25%. A 50 m MR buffer was applied outside the ER to allow for the construction of a multiway and provide setback between development and the lake.

Lakeside Industrial ASP

The Lakeside Industrial ASP establishes a framework for the development of lands north of Telford Lake. In accordance with the IDP and City of Leduc MDP, the area is intended to have primarily light industrial uses and some business commercial uses. The ASP does identify a 60 m ER/MR open space buffer along the lake shore, which will eventually accommodate the Telford Lake Multiway. The area does contain a 4.1 ha aspen-balsam woodland. This area will not be retained in the development. Additionally the wetlands to the southeast will also not be retained, but may need to be reconstructed pending approval by the Province under the Water Act.

City of Leduc MDP

The City of Leduc MDP provides information and guidelines regarding natural areas, and active and healthy communities. It should be noted that the City of Leduc is currently working on an updated MDP, at this time the project team does not have access to the document and will be referencing the current MDP.

The City shall conserve and protect natural areas for the purposes of protecting wildlife habitat and corridors, supporting natural systems, and providing recreational opportunities by:
Retaining and protecting natural areas.
Providing buffer areas around sensitive natural areas in order to minimize the impacts of development on natural features.
Providing low impact public access to natural area that can sustain human uses with minimal impact to the overall health of ecosystems
Developing public open spaces with environmentally sensitive best. practices such as bio-swales, which will enhance and integrate natural systems.

Protecting the environmental integrity of Telford Lake and surrounding natural areas through complementary land use development and compatible site and building designs.

Planning and managing natural areas in accordance with FireSmart principles and practices to reduce the hazards and risks of wildfire, particularly where natural.

The City shall promote the creation of an active and healthy community that reflects the needs of residents by:

- Developing outdoor public spaces for year round use, with appropriate plantings and park design.
- Developing the Multiway system as a complete network that promotes walkability and links residential subdivisions, recreation and cultural destinations, hubs of commerce, and high activity areas.
- Consulting with key regional stakeholders, including Leduc County and the school boards, in the planning, development, and potential sharing of costs for open space, cultural, and recreational facilities.
- Including meaningful public participation in planning for recreation, culture, and open space programs and facilities.

Leduc County Municipal Development Plan

The purpose of the Leduc County MDP is to effectively manage subdivision and development of land in the County for the benefit of its present and future residents and their quality of life. Notable additions to the MDP include considerations for Recreation Development and Community Services as well as Environmental Protection guidelines.

Recreation Development and Community Services

To protect and conserve those areas of the County with the greatest scenic and recreational value.

To provide parks and recreation programs for County residents in conjunction with those programs offered by adjacent municipalities. Public access including trails to significant recreation areas shall be protected and enhanced by reserve dedication, easements or other rights of way, and purchase and maintenance of land areas suited for public use.

Environmental Protection

The County will encourage the creation and maintenance of wildlife habitat on private and municipal lands by:

- exploring the possible use of incentive programs for landowners to maintain wildlife habitat, and
- incorporating consideration of wildlife habitat into the planning and design of outdoor recreation systems.

The County encourages landowners to maintain tree cover and natural vegetation in environmentally sensitive areas and on land with steep or unstable slopes.

East Telford Lake ASP Public Open House Summary Report

Following an open house held for the East Telford Lake ASP in June 28, 2017, Stantec Consulting Ltd. produced the East Telford Lake Area Structure Plan Public Open House Comments Summary document. This report details the public feedback received during this open house. The following comments were made during the open house that relate to the creation of the wildlife corridor and trail network:

- Wildlife common and crossing. Want underpass for Spine Road
- Preserve existing woodlots north and south of lake and connect to trail network to enhance recreation and wildlife corridor
- Want connection / trails to Saunders Lake. Try to make them function together
- Connect each trail around Saunders Lake
- Create a re-wilded area at the east end of Telford Lake, isolated from adjacent development and laid out to maximize wildlife connectivity and opportunities for wildlife viewing
- Wildlife crossings should be of a size and design to allow wildlife (including deer and moose) to use without fear of entrapment
- Natural woodlots north and south of Telford Lake should be conserved and a recreational trail system should connect them to the broader network of paths.
- Engineer wildlife crossing features to allow corridor without M.V.A.'s
- Wildlife corridor/passage best practices should be used in the design of wildlife crossings

The Summary Report emphasises the value of providing wildlife and human connectivity and the importance of this environmental importance of this region to the adjacent communities.

Edmonton Metropolitan Region Growth Plan

The latest Edmonton Metropolitan Region Growth Plan came into effect on October 26, 2017 and encompasses both the City of Leduc and Leduc County. One of the seven Guiding Principles identified in the document reads as: "Protect natural living systems and environmental assets". Within this principle, the document identified the objectives of conserving and restoring natural living systems through an ecological network approach and minimizing and mitigating the impacts of regional growth on natural living systems. As member municipalities, the City of Leduc and Leduc County must reflect the values of the Regional Growth Plan in their statutory documents.

Assessment of Citizen Science Initiatives for Wildlife Management City of Leduc

This document gives a quick summary of what can be done to eliminate wildlife-human conflict through the manipulation of habitat, by-law establishment and enforcement, and sometimes wildlife removal. It should be noted that this document is coming from an urban area management perspective.

Canada Geese

- Reduction of turf grass areas with 40m of lakes and ponds
- Reduction or elimination of fertilizer application to lawns within close proximity to water bodies
- Replacement of succulent, low-mowed lawns with taller, less palatable, rough grasses such as ryes and/or wildflowers and shrubbery
- Provide educational signage and conversational opportunities to modify public involvement in feeding the geese, and reducing aggressive contact incidents

Coyotes

- Liaison with provincial fish and wildlife to ensure problem animals and dens are removed as assessments indicate immediate action
- Ensure natural areas and parks have adequate connectivity, and create wildlife underpasses/overpasses where connections need to be made

Striped Skunk

- Skunk denning can be controlled by reducing available sites through occlusion of the ground interface around outbuildings, steps, and other structures
- Tight control of garbage control bylaws can reduce anthropomorphic food sources

Urban Gulls

- Increase bylaw enforcement of garbage regulations and control access to composting
- Clean up public venues during and immediately after major outdoor events
- Reduce short mowed lawn areas in parks, wherever possible
- Employ best practices at landfills

Rock Doves (Pigeons)

- Once squabs are fledged, occlude re-entry into nesting areas or eliminate site
- Tough bylaw enforcement of feeding activities at the street and park levels, along with preventative educational programming, control of garbage and access to compost
- Promote predator habitats in and around the downtown area and any identified hotspots, through the placement of raptor "hack boxes"
- Educate residents and discourage the feeding of pigeons

Telford Lake Master Plan

The focus of the Telford Lake Master Plan is to develop a comprehensive plan and strategy for the long term development and management of Telford Lake and the lands that surround it.

Two of the of the five key objectives of the Master Plan include:

- Environmental Protection: The Master Plan must provide for protection of the quality of the Telford Lake environment by protecting water quality, habitat, and vegetation for wildlife and visitors.
- Multiway and Trails: The Master Plan will clearly illustrate the extension and development of a multiway (multi-use trail with trail amenities) around Telford Lake and define a strategy for its long term implementation as the most important recreational amenity on Telford Lake. The Master Plan must also define a network of trails that is integrated with the City of Leduc trail network, provides a variety of surfaces and experiences to meet the needs of a variety of users, and provides links to existing and proposed facilities.

4.3 North and South Shores
Purpose: the protection of the shoreline of North and South Telford Lake and the development of the Telford Lake Trail
Recommended program features:

- Maintain and protect lake fringe vegetation
- Telford Lake Trail (TLT) - the provision of a 3m wide, asphalt multi-use trail (multiway) around the lake.

4.4 East End
Purpose: the protection of the shoreline and the development of the Telford Lake Trail.

Recommended program features:

- maintain and protect lake fringe vegetation
- TLT - the provision of a 3m wide, asphalt, multiway around the lake
- Boardwalk and Bird Blind - Use a boardwalk in the marsh areas and to cross the creek feeding into Saunders Lake. A bird blind would be developed as a key interpretive feature for bird, wildlife, and waterfowl watching. This feature will also frame views down the length of the lake
- Provide opportunities to develop a future trail that will link Telford Lake into a future regional system and Saunders Lake.

Range Roads 245 and 250 Functional Planning Study

This document details the preliminary planning work completed on extending the Nisku Spine Road (9th Street) south to Highway 623 (Rollyview Road). This 7.5 km extension would give industrial developments east of the City of Leduc access to a major industrial roadway that connects with the International Airport, Nisku Business Park, and the City of Leduc. Currently, Range Roads 245 and 250, as well as Township Road 500, which connects the two, are two-lane, low-volume roads. The Spine Road will be designed with the following criteria:

- Posted Speed: 80 km/h
- 6 lanes at final stage
- Lane width 3.7 m
- Access by signalised intersection
- Intersections spaced at 800 m minimum

Including the median and ditches, the road will have an ultimate width of 60 m. Not including the ditches, the width of the road will be 35.2 m. Development is intended to be staged, starting as a two lane roadway before being extended to 6 lanes. The intersection spacing of 800 m is intended to preserve the posted speed of 80 km/h. The study does evaluate potential bridge sites at the wildlife corridor. The suggested action would be to increase the culvert to 1.2 m diameter. The report does acknowledge the potential damage the road may have on wildlife in the area and suggests the use of wildlife warning signs.

East Telford Lake Desktop Phase 1 Environmental Site Assessment

The CIty of Leduc retained Stantec Consulting Ltd. to complete a Phase 1 Environmental Site Assessment in 2017 for the area in the East Telford Lake ASP. The intention of this report is to locate areas of concern that may trigger potential further assessment. This report indicated a historic oil well on the southeast area of the site, two historical test holes, and a mixed-use commercial residential property with equipment storage in the southwest of the site as potential areas of concern. Further investigation is to occur in the Phase 1 Environmental Site Assessment.

Fisheries Act

The Fisheries Act (1985) was intended to provide for the sustainability and ongoing productivity of commercial, recreational, and Aboriginal fisheries. This Act gives the Minister of Fisheries and Oceans the ability to grant fishing licenses, regulate fishing activities, and to control the quantity of fish harvested. The Minister of Fisheries and Oceans may place specific prohibitions on certain techniques and equipment for fishing uses. The Minister of Fisheries and Oceans also has the ability to, if necessary to ensure the free passage of fish or prevent harm to fish, request owner or individual who creates or manages an obstruction or threat to remove the threat or take other action to return the free movement or safety to the fish. The Act specifically states that no work may be undertaken or deleterious substance released into fish habitat that causes serious harm to fish that are part of a commercial, recreational, or Aboriginal fisheries, without presenting the Minister of Fisheries and Oceans plans, specifications, studies, procedures, schedules, analyses, samples, evaluations, and other information that would allow the Minister of Fisheries and Oceans to determine the significance of the impacts.

Alberta Wetland Policy

The Alberta Wetland Policy aims to provide safe and secure drinking water, healthy aquatic ecosystems, and reliable, quality water supplies for a sustainable economy. This will be achieved by enabling flexible water management, building effective tools, knowledge and capacity, and encouraging wetland conservation and voluntary stewardship. Any development in the wildlife corridor around wetlands should be avoided first, and use mitigative measures if required. The wetland should retain full function as it was prior to any development. To keep the wetland intact, trail users should be educated on the importance of the wetland ecosystem they are in, and be encouraged to have a sense of stewardship of the public land, to conserve and protect it.

Species at Risk Act

The Species at Risk Act (SARA, 2002) was created for the purpose of preventing the loss of wildlife species in Canada. The SARA protects species listed in schedule 1 from being killed, harmed, or collected in addition to protecting the residence of such species. This applies to public lands. With respect to private lands prohibitions only apply to aquatic and migratory bird species. The migratory bird species must also be listed in the Migratory Bird Convention Act (1994). If an order is applied to an area other species may be protected by the SARA even on private land. The protection of critical habitat is a key goal of SARA and strongly encourages voluntary actions and stewardship measures. For non-aquatic species provincial laws will provide protection for critical habitat.

Alberta Wildlife Act

The Alberta Wildlife Act (2000) outlines that it is prohibited to knowingly disturb or destroy nesting or dens of species during specific times of the year, except when done with license or authorization. Outlined in schedule 6 of the Act is a list of species at risk to which specific legal rules apply. They are treated, with a few exceptions, as non-game animals.

Environmental Protection and Enhancement Act

The Environmental Protection and Enhancement Act (2000) is focused around environmental pollution and the reduction and mitigation of harm to the environment. Specific focus is given to industrial contaminants, hazardous waste, pesticides, and other like substances. This Act also includes the environmental assessment provisions.

Alberta Land Stewardship Act

The Alberta Land Stewardship Act (ALSA) provides the basis for the creation of regional plans in Alberta. These regional plans reflect provincial economic, environmental, and social objectives. Municipal legislation must align with items stated in regional plans. Leduc City and County fall within the North Saskatchewan Plan, which is currently under development. ALSA also provides a number of conservation tools for municipalities to use. These include conservation easements, which allow the land owner to put aside a portion of land for the purpose of conservation and protection, conservation directives, and transfer of development credit schemes.

Public Lands Act

This Act prohibits activity in, around, or over a navigable water without approval. However, due to changes made in 2012, this act only applies to water bodies listed in the schedule attached to the legislation, which does not contain either Telford or Saunders Lake.

Alberta Water Act

The Water Act (1999) applies to any permanent or intermittent water body that is supporting an aquatic or terrestrial environment. The Act requires that any development which impacts a water body through infilling, cumulative effects, erosion protection, removal of vegetation within the shore line, draining, or realigning requires a permit from the Provincial Government. If the proposed wildlife corridor and trail network alter or impact either Telford or Saunders Lake in any way, a permit will need to be applied for.

Migratory Birds Convention Act

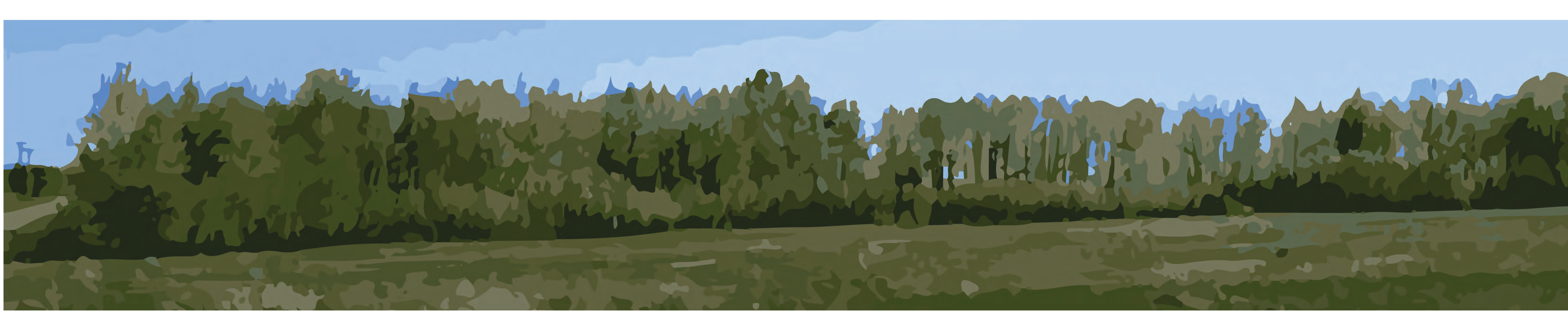
The Migratory Birds Convention Act (1994) applies to all of Canada and serves to conserve and protect migratory birds and their nests. The Act includes a number of prohibitions to protect migratory birds including depositing harmful substances in migratory bird habitats, harming, moving, or disturbing any nests or eggs, and these acts are punishable by law. With a number of migratory bird species in the area, any bird nests will need to be preserved in the creation of the wildlife corridor and recreational trail.

6. Biophysical Report

The City of Leduc and Leduc County have both recently conducted Environmentally Significant Area Studies. These studies examine the ecological significance of natural areas and identifies areas that preserve biodiversity and support natural processes. Within the Leduc Wildlife Corridor area, there are several environmentally significant areas (ESA). In the City of Leduc Environmentally Significant Areas Study (Fiera, 2017), five ESAs have been identified to be in proximity to the wildlife corridor area. On the County's portion of the Wildlife Corridor, Saunders Lake and the streams that flow into it are identified as an ESA in the Leduc County Environmentally Significant Areas Study (Fiera, 2015). While the two reports have different methods together they address the entirety of the wildlife corridor area.

The City of Leduc ESA study evaluates ESAs based on three key features: ecological significance, habitat connectivity, and habitat condition and scores these three components out of 100. Details regarding the methods used can be found in the City of Leduc Environmentally Significant Areas Study (Fiera, 2017). Telford Lake (labelled as ESA #1) has a high ecological significance (89%) while, habitat connectivity and habitat condition are both moderate at 59% and 61% respectively. The study found the area to support 114 plant types (2 of which are considered provincially rare), 33 birds (5 of which are considered provincially sensitive), 6 mammal species, and 1 amphibian species. The study notes that Telford Lake and Saunders Lake are linked by ecological networks and hydrological cycles. The 4.3 ha tree stand (labelled as ESA #7) identified just north of Telford Lake is largely comprised of deciduous trees and wetland. This tree stand is considered moderately significant (56%) with moderate connectivity (61%) and high habitat condition (77%). The study found that this area provides a habitat for a number of bird species and there was evidence of deer and moose activity in the area. This feature falls within the Lakeside Industrial Area Structure Plan area, which does not provide for the conservation of this ESA. The third feature is a 7.1 ha forest stand located on the north side of the Telford Lake outlet (labelled as ESA #8). This forest stand is dominated by deciduous trees in a wetland complex. This ESA ranks moderate for natural area significance and habitat connectivity at 57% and 59% respectively. The tree stand ranks high on habitat condition at 88%.

Additionally, the study found two ESAs approximately 500 metres south of Telford Lake. The first is a 49.5 ha ESA (labelled as ESA #2) which has an ecological significance score of 74%, a connectivity score of 54%, and habitat condition score of 52%. This area contains grasslands, forest, and wetlands, providing for a range of habitats. Located directly east of this ESA is a 7.3 ha swamp wetland (labelled as ESA #5). The study found this wetland to have a significance of 59%, a connectivity score of 67%, and a high habitat condition score of 85%. This ESA is hydrologically connected to the the stream that flows between Telford and Saunders Lake via an ephemeral stream network. This ESA acts as a stepping stone habitat for a number of mammals and waterfowl. If possible, the wildlife corridor should consider connecting to these ESAs to facilitate greater connectivity for larger wildlife populations.



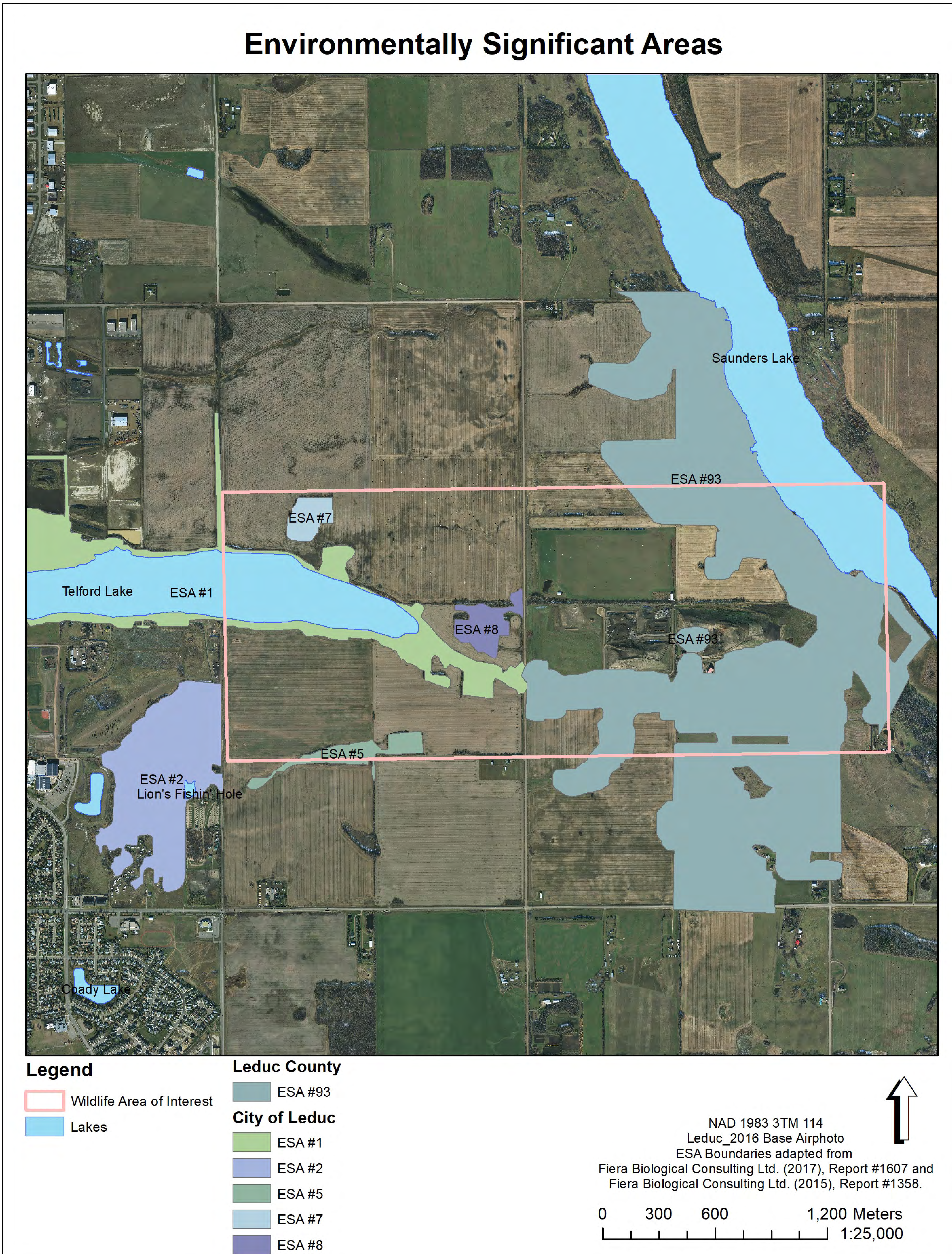


Fig. 14 Environmentally Significant Areas

City of Leduc Plans in Effect and Environmentally Significant Areas

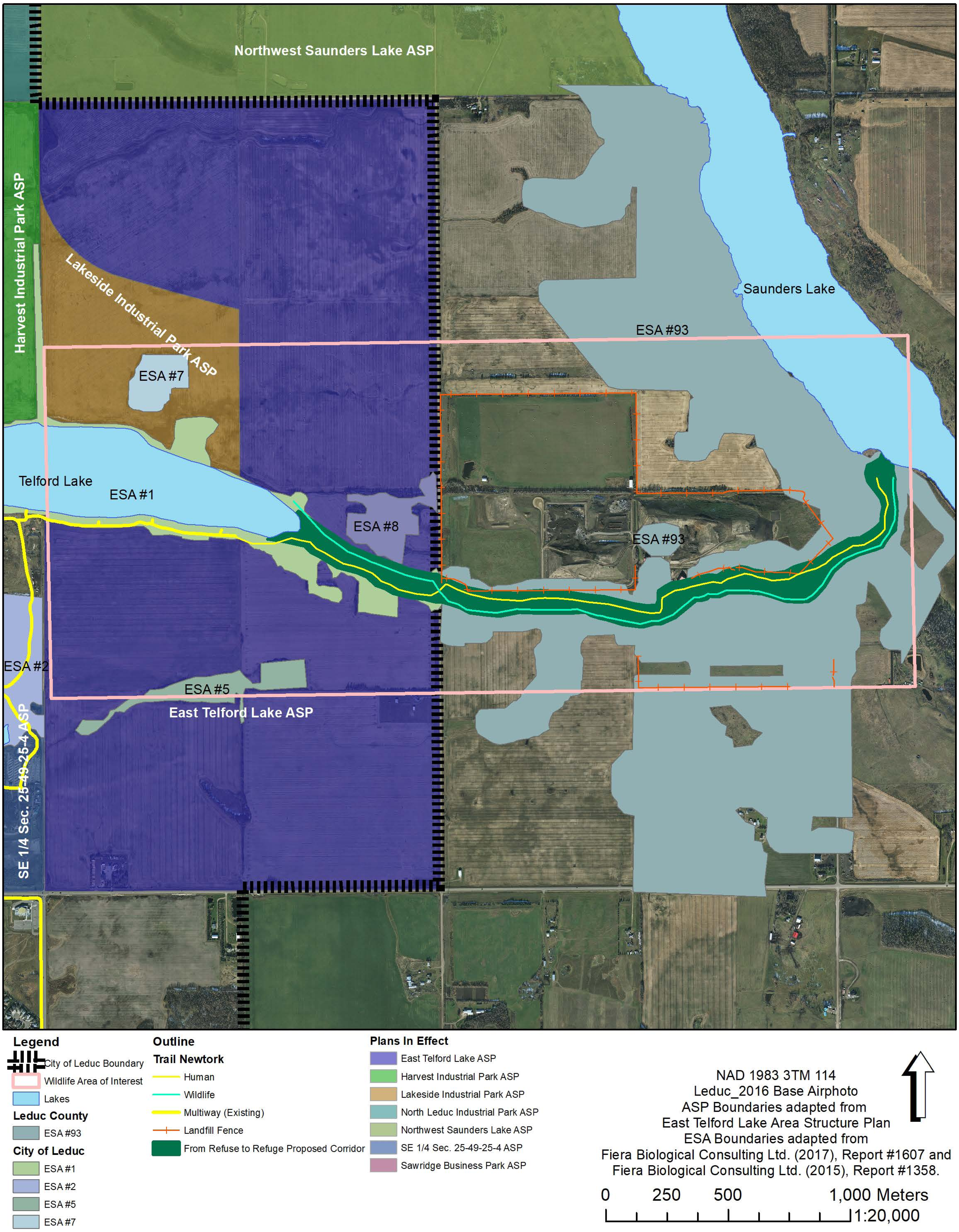


Fig. 15 Wildlife Corridor and Environmentally Significant Area

According to the Leduc County ESA study Saunders Lake and the proposed corridor towards Telford Lake is a mixed environmentally significant area (Fiera, 2015). Saunders Lake is comprised of upland (48.1%), aquatic (36.7%), and riparian (18.7%). Within this report mixed ESAs are identified as important local and regional habitats as such areas can support a diverse assemblage of species (Fiera, 2015). The majority of Saunders Lake is at high risk (89.4%) of disturbance. The Fiera (2015) report identifies disturbance risk to human activity based on adjacent land use and future development based on 20 year projections. Important management considerations for the Leduc Wildlife Corridor are identified in section 8.4 of the report and summarized below. Provide connectivity by maintaining or restoring naturalized corridors. Reduce linear disturbances where possible and where such features cannot be avoided wildlife passages should be considered.

Species List

A total of 306 species have been identified through a desktop review of existing plans, reports, and web resources. The reports used to create our inventory include Queen Elizabeth II and 65th Avenue (Leduc) Functional Planning Study (Vertex Professional Services Ltd., 2015), Landfill from Refuse to Refuge (n.d., 2004), City of Leduc Environmentally Significant Areas Study (Fiera, 2017), Biophysical Assessment in Support of the Gaetz Industrial Area Structure Plan (Spencer Environmental Management Services LTD., 2014). These species were then compared to policy and legislation for wildlife conservation and protection including the; Species at Risk Act (2002), Migratory Birds Convention Act (1994), Fisheries Act (1985), Complete Alberta Wild Species Status List (Alberta Environment and Parks, 2015), and the Alberta Wildlife Act (2000). Of these three (3) species are listed in the Species at Risk Act schedule 1. They are the common nighthawk (Chordeiles minor), Barn Swallow (Riparia riparia), and little brown bat (Myotis lucifugus). An additional 83 species have been identified in other policy and legislation documents, of these 71 are identified as "secure" or "may be at risk" in the Alberta Species at Risk Act. The remaining 220 species have not been identified as listed in any policy or legislation. Refer to table 1 for fish, table 2 for mammals, table 3 for birds, table 4 for vegetation, and table 5 for amphibians and reptiles.

7. Conclusion

The potential wildlife corridor between Telford Lake and Saunders Lake has the ecological connectivity and biodiversity richness to support the corridor, but the impact of human influence on the corridor is an issue. From the best practices summary, a wildlife corridor and trail network can be incorporated but must follow design criteria, as identified in 3.3 Trail and Wildlife Corridor Integration, if it is to be successful for both trail users and wildlife connectivity and safety. This criteria, based on the best practices summary, should be treated as a checklist for the planning of the corridor, ensuring that all components have been incorporated. The preservation of the natural environment and protection of wildlife are the first priority of this wildlife corridor study, followed by the trail network for human use.

The trail network and wildlife corridor are supported in municipal policy and plans that call for connections between the two lakes and the preservation of the natural environment that exists there. The existing trail plans for Saunders Lake, Telford Lake, and the Waste Management Facility will be connected to the proposed trail network placement within the wildlife corridor to make the trail accessible. Provincial and Federal policies have restrictions, enforced by law, on development and actions in regards to this area as to protect the natural environment. These will be incorporated into the design and planning of the corridor, including the disposal of waste, construction effects, and more, on wetlands, water bodies, wildlife, and migratory birds.

All species that exist within the study area have been identified in the biophysical assessment, and the ecological value of the enivronment has been determined to be sufficient. Various infrastructure options, both natural and anthropogenetic, have been researched to better support the connectivity of wildlife and people through the corridor. Several of the infrastructure options, especially road crossings, are applicable to the Leduc Wildlife Corridor and will be considered in the design of the corridor.

Based on the biophysical assessment of the area, the best practices summary, and the review of relevant policy, the initial concept for the location of the wildlife corridor has been drafted. This initial concept follows best practices and aligns with the existing plans in the area, but is still high level and provides only the location of the corridor. The corridor is the most direct linkage between the two lakes, and has sufficient existing green space to allow for the corridor. This is the same corridor location as the one identified in the Waste Management Facility Refuse to Refuge Plan, but larger. The possibility to connect with other ESAs in the study area will be assessed, as more connectivity will result in a more successful corridor. From the best practices summary and supporting infrastructure research, the exact style and dimensions of the Nisku Spine Road crossing can be designed for the final report. As well, the plan and design of the trail network can be created using this background research. Now that the location of the corridor has been identified, the exact design of the corridor can be developed. The next steps for the final report will include site specific designations on the combination of the trail network with the wildlife corridor, trail linkages with other trail networks, and a complete SWOT analysis of the corridor. A formal recommendation of the location, design, and planning of the trail network and wildlife corridor will be provided in the final report.

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9. Appendix

Table 1. Fish

Latin Name	Common Name	Comments
Culaea inconstans	Stockleback	Alberta Species at Risk Act: Secure
Pimephales promelas	Flathead minnow	Alberta Species at Risk Act: Secure
Weissia controversa	green-cushioned weissia moss	

Table 2. Mammals

Latin Name	Common Name	Comments
Alces alces	Moose	Alberta Species at Risk Act: Secure
Canis latrans	Coyote	Alberta Species at Risk Act: Secure
Castor canadensis	Canada beaver	Alberta Species at Risk Act: Secure
Erethizon dorsatum	Porcupine	Alberta Species at Risk Act: Secure
Glaucomys sabrinus	Northern flying squirrel	Alberta Species at Risk Act: Secure
Lepus americanus	Snowshoe hare	Alberta Species at Risk Act: Secure
Mephitis mephitis	Striped skunk	Alberta Species at Risk Act: Secure
Microtus pennsylvanicus	Meadow vole	Alberta Species at Risk Act: Secure
Mustela frenata	Long-tailed weasel	Alberta Species at Risk Act: May be at Risk
Mustela vison	American mink	
Myotis lucifugus	Little brown bat	SARA: Schedule 1 SARA Status: Endangered COSWIC Status: Endangered Alberta Species at Risk Act: May be at Risk
Odocoileus virginianus	White-tailed deer	Alberta Species at Risk Act: Secure
Ondatra zibethicus	Muskrat	Alberta Species at Risk Act: Secure
Peromyscus maniculatus	Deer mouse	Alberta Species at Risk Act: Secure
Procyon lotor	Raccoon	Alberta Species at Risk Act: Secure
Tamiasciurus hudsonicus	Red squirrel	Alberta Species at Risk Act: Secure
Thomomys talpoides	Northern pocket gopher	Alberta Species at Risk Act: Secure
Urocitellus richardsonii	Ground Squirrel	
Vulpes vulpes	Red fox	Alberta Species at Risk Act: Secure

Table 3. Birds

Latin Name	Common Name	Comments
Accipiter cooperii	Cooper's hawk	COSWIC Status: Not at Risk Alberta Species at Risk Act: Secure
Aegolius acadicus	Northern saw-whet owl	Alberta Species at Risk Act: Secure
Anas platyrhynchos	Mallard	Alberta Species at Risk Act: Secure
Archilochus colubris	Ruby-throated hummingbird	Alberta Species at Risk Act: Secure
Aythya affinis	kesser scaup	Alberta Species at Risk Act: Secure
Bombycilla cedrorum	Cedar waxwing	Alberta Species at Risk Act: Secure
Bonasa umbellus	Ruffed grouse	Alberta Species at Risk Act: Secure
Branta canadensis	Canada Geese	Alberta Species at Risk Act: Secure
Bubo virginianus	Great horned owl	Alberta Species at Risk Act: Secure
Bucephala clangula	Common goldeneye	Alberta Species at Risk Act: Secure
Buteo jamaicensis	Red-tailed hawk	COSWIC Status: Not at Risk Alberta Species at Risk Act: Secure
Carduelis pinus	Pine siskin	
Carduelis tristis	American goldfinch	
Charadrius vociferus	Killdeer	Alberta Species at Risk Act: Secure
Chlidonias niger	Black tern	COSWIC Status: Not at Risk Alberta Species at Risk Act: Secure
Chordeiles minor	Common nighthawk	SARA: Schedule 1 SARA Status: Threatened COSWIC Status: Threatened Migratory Birds Convention Status Alberta Species at Risk Act: Sensitive
Circus cyaneus	Northern harrier	COSWIC Status: Not at Risk Alberta Species at Risk Act: Secure

Table. 3 Birds (continued)

Columba livia	Rock dove	Alberta Species at Risk Act: Exotic/Alien
Common redpoll	Carduelis flammea	
Contopus sordidulus	Western wood-pewee	Alberta Species at Risk Act: May be at Risk
Corvus brachyrhynchos	American crow	Alberta Species at Risk Act: Secure
Corvus corax	Common raven	Alberta Species at Risk Act: Secure
Cyanocitta cristata	Blue Jay	Alberta Species at Risk Act: Secure
Dendroica coronata	Yellow-rumped warbler	Alberta Species at Risk Act: Secure
Dendroica petechia	Yellow warbler	Alberta Species at Risk Act: Secure
Dryocopus pileatus	Pileated woodpecker	Alberta Species at Risk Act: Sensitive
Dumetella carolinensis	Gray catbird	Alberta Species at Risk Act: Secure
Empidonax alnorum	Alder flycatcher	Alberta Species at Risk Act: Sensitive
Empidonax minimus	Least flycatcher	Alberta Species at Risk Act: Sensitive
Euphagus cyanocephalus	Brewer's blackbird	Alberta Species at Risk Act: Secure
Falco rusticolus	gyrfalcon	COSWIC Status Not at Risk Alberta Species at Risk Act: Secure
Falco sparverius	American kestrel	Alberta Species at Risk Act: Sensitive
Gallinago gallinago	Common snipe	
Icterus galbula	Baltimore oriole	Alberta Species at Risk Act: Sensitive
Junco hyemalis	Dark-eyed junco	Alberta Species at Risk Act: Secure
Larus californicus	California gull	Alberta Species at Risk Act: Secure
Larus delawarensis	Ring-billed gull	Alberta Species at Risk Act: Secure
Loxia leucoptera	White-winged crossbill	Alberta Species at Risk Act: Secure
Melospiza lincolnii	Lincoln's sparrow	Alberta Species at Risk Act: Secure
Melospiza melodia	Song sparrow	Alberta Species at Risk Act: Secure
Mniotilta varia	Black-and-white warbler	Alberta Species at Risk Act: Secure
Molothrus aters	Brown-headed cowbird	
Oporornis philadelphia	Mourning warbler	Alberta Species at Risk Act: Secure
Parus atricapillus	Black-capped chickadee	
Parus hudsonicus	Boreal chickadee	
Passerculus sandwichensis	Savannah sparrow	Alberta Species at Risk Act: Secure
Pica pica	Black-billed magpie	
Picoides pubescens	Downy woodpecker	Alberta Species at Risk Act: Secure
Picoides villosus	Hairy woodpecker	Alberta Species at Risk Act: Secure
Pooecetes gramineus	Vesper sparrow	Alberta Species at Risk Act: Secure
Progne subis	Purple martin	Alberta Species at Risk Act: Sensitive
Regulus calendula	Ruby-crowned kinglet	Alberta Species at Risk Act: Secure
Regulus satrapa	Golden-crowned kinglet	Alberta Species at Risk Act: Secure
Riparia riparia	Barn swallow	SARA: Schedule 1 SARA Status: Threatened COSWIC Status: Threatened Migratory Birds Convention Status Alberta Species at Risk Act: Sensitive
Sayornis phoebe	Eastern phoebe	Alberta Species at Risk Act Sensitive
Seiurus aurocapillus	Ovenbird	
Sialia currucoides	Mountain bluebird	Alberta Species at Risk Act: Secure
Sitta canadensis	Red-breasted nuthatch	Alberta Species at Risk Act: Secure
Sitta carolinensis	White-breasted nuthatch	Alberta Species at Risk Act: Secure
Sphyrapicus varius	Yellow-bellied sapsucker	Alberta Species at Risk Act: Secure
Spizella pallida	Clay-coloured sparrow	Alberta Species at Risk Act: Secure
Spizella passerina	Chipping sparrow	Alberta Species at Risk Act: Secure
Sturnella neglecta	Western meadowlark	Alberta Species at Risk Act: Secure
Sturnus vulgaris	European starling	Alberta Species at Risk Act: Exotic/Alien
Tachycineta bicolor	Tree swallow	Alberta Species at Risk Act: Secure
Troglodytes aedon	House wren	Alberta Species at Risk Act: Secure
Turdus migratorius	American robin	Alberta Species at Risk Act: Secure
Tyrannus tyrannus	Eastern kingbird	Alberta Species at Risk Act: Sensitive
Vermivora peregrina	Tennessee warbler	Alberta Species at Risk Act: Secure
Vireo gilvus	Warbling vireo	Alberta Species at Risk Act: Secure
Vireo olivaceus	Red-eyed vireo	Alberta Species at Risk Act: Secure
Vireo solitarius	Solitary vireo	Alberta Species at Risk Act: Secure
Zenaida macroura	Mourning dove	Alberta Species at Risk Act: Secure
Zonotrichia albicollis	White-throated sparrow	Alberta Species at Risk Act: Secure

Table. 4 Vegetation

Latin Name	Common Name	Comments
Aloina rigida	aloe-like rigid screw moss	
Achillea millefolium	Common yarrow	
Achillea sibirica	Many-flowered yarrow	
Actaea rubra	Red/White baneberry	
Agrimonia striata	Agrimony	
Agropyron trachycaulum var subsecundum	Slender wheat grass	
Agrostis hyemalis	tickle grass	
Alopecurus aequalis	Short-awned foxtail	
Amelanchier alnifolia	Saskatoon	
Anemone canadensis	Canada anemone	
Anemone multifida	Cut-leaved anemone	
Anemone riparia	Tall anemone	
Antennaria neglecta	Broad-leaved everlasting	
Apocynum androsaemifolium	Spreading dogbane	
Arabis lyrata	Lyre-leaved rock cress	
Aralia nudicaulis	Wild sarsaparilla	
Artemisia dracunculus	Dragonwort	
Artemisia ludoviciana	Prairie sagewort	
Asclepias ovalifolia	Low milkweed	
Aster ciliolatus	Lindley's aster	
Aster conspicuus	Showy aster	
Aster ericoides	Tufted white prairie aster	
Aster hesperius	western willow aster	
Aster laevis	Smooth aster	
Aster puniceus	Purple-stemmed aster	
Aster sibiricus	Arctic aster	
Astragalus dasyglottis	Purple milk vetch	
Athyrium filix-femina	Lady fern	
Beckmannia syzigachne	Slough grass	
Betula papyrifera	Paper birch	
Bidens cernua	Nodding beggarticks	
Brassica napus	Canola	
Bromus ciliatus	Fringed brome	
Bromus inermis ssp inermis	Awnless brome	
Bromus inermis ssp pumpellianus	Northern brome	
Calamagrostis canadensis	Bluejoint	
Callitriche verne	Vernal water-starwort	
Campanula rotundifolia	Harebell	
Carex aquatilis	Water sedge	
Carex atherodes	Awned sedge	
Carex disperma	Two-seeded sedge	
Carex houghtoniana	Sand sedge	
Carex lanuginosa	Woolly sedge	
Carex peckii	Peck's sedge	
Carex praegracilis	Graceful sedge	
Carex praticola	Meadow sedge	
Carex sartwellii	Sartwell's sedge	
Carex siccata	Hay sedge	
Carex sprengellii	Sprengel's sedge	
Carex utriculata	Small bottle sedge	
Cerastium nutans	Long-stalked mouse-ear chickweed	
Cicuta maculata	Water-hemlock	
Cirsium arvense	Canada thistle	
Coeloglossum viride	Bracted green orchid	
Comandra umbellata	Bastard toadflax	
Cornus canadensis	Bunchberry	
Cornus stolonifera	Red-osier dogwood	
Corylus cornuta	Beaked hazelnut	
Cotoneaster	Cotoneaster (domestic)	
Crataegus chrysocarpa	Round-leaved hawthorn	Rare*
Crataegus rotundifolia	Round-leaved hawthorn	
Cyperaceae spp.	sedges	
Cypripedium calceolus	Yellow lady's slipper	
Disporum trachycarpum	Fairybells	
Dracocephalum parviflorum	American dragonhead	
Dryopteris carthusiana	Narrow spinulose shield fern	
Elaeagnus commutata	Silverberry (wolfwillow)	
Eleocharis palustris	Creeping spike-rush	
Epilobium angustifolium	Common fireweed	
Epilobium ciliatum ssp glandulosum	Northern willowherb	
Equisetum sylvaticum	Woodland horsetail	
Erigeron caespitosus	Tufted fleabane	
Erigeron glabellus	Smooth fleabane	
Erigeron philadelphicus	Philadelphia fleabane	
Erysimum cheiranthoides	Wormseed mustard	
Fragaria virginiana	Wild strawberry	
Gaillardia aristata	Brown-eyed Susan	
Galeopsis tetrahit	Hemp-nettle	
Galium boreale	Northern bedstraw	
Galium triflorum	Sweet-scented bedstraw	
Geranium richardsonii	Wild white geranium	
Geum aleppicum	Yellow avens	
Geum macrophyllum	Large-leaved yellow avens	
Glyceria elata	tall mannagrass	
Glyceria grandis	Common tall manna grass	
Glycyrrhiza lepidota	Wild licorice	
Hedysarum alpinum	Alpine hedysarum	
Heracleum lanatum	Cow parsnip	
Heuchera richardsonii	Richardson's alumroot	
Hieracium umbellatum	Narrow-leaved hawkweed	
Hierochloe odorata	Sweet grass	
Hordeum jubatum	foxtail barley	
Impatiens capensis	Spotted jewelweed	
Juncus balticus	Wire rush	

Table. 4 Vegetation (continued)

Koeleria macrantha	June grass	
Lactuca pulchella	Common blue lettuce	
Lathyrus ochroleucus	Cream-coloured vetchling	
Lathyrus venosus	Purple peavine	
Lemna minor	Common duckweed	
Linnaea borealis	Twinflower	
Lonicera dioica	Twining honeysuckle	
Lonicera involucrata	Bracted honeysuckle	
Lysimachia ciliata	Fringed loosestrife	
Maianthemum canadense	Wild lily-of-the-valley	
Matricaria perforata	Scentless chamomile	
Matricaria perforate	chamomile	
Mentha arvensis	Wild mint	
Mertensia paniculata	Tall lungwort	
Mitella nuda	Bishop's-cap	
Moehringia latiflora	Blunt-leaved sandwort	
Monarda fistulosa	Wild bergamot	
Monotropa uniflora	Indian Pipe	Rare*
Orthilia secunda	One-sided wintergreen	
Oryzopsis asperifolia	White-grained mountain rice grass	
Pedicularis labradorica	Labrador lousewort	
Penstemon procerus	Slender blue beardtongue	
Petasites frigidus var. sagittatus	Arrow-leaved coltsfoot	
Petasites palmatus	Palmate-leaved coltsfoot	
Petasites sagittatus	Arrow-leaved coltsfoot	
Phalaris arundinacea	Reed canary grass	
Phleum pratense	Timothy	
Picea glauca	White spruce	
Plantago major	Common plantain	
Poa compressa	Canada bluegrass	
Poa interior	Inland bluegrass	
Poa nemoralis	wood bluegrass	
Poa palustris	Fowl bluegrass	
Poa pratensis	Kentucky bluegrass	
Polygonum lapathifolium	Pale persicaria	
Polygonum viviparum	Bistort	
Populus balsamifera	Balsam poplar	
Populus tremuloides	Aspen	
Potentilla anserina	Silverweed	
Potentilla gracilis	Graceful cinquefoil	
Potentilla norvegica	Rough cinquefoil	
Potentilla palustris	Marsh cinquefoil	
Potentilla pensylvanica	Prairie cinquefoil	
Prunella vulgaris	Heal-all	
Prunus pensylvanica	Pin cherry	
Prunus virginiana	Choke cherry	
Pyrola asarifolia	Pink wintergreen	
Ranunculus abortivus	Small-flowered buttercup	
Ranunculus cardiophyllus	Heart-leaved buttercup	
Ranunculus cymbalaria	Shore buttercup	
Ranunculus gmelinii	Tellow water crowfoot	

Ranunculus cardiophyllus	Heart-leaved buttercup	
Ranunculus cymbalaria	Shore buttercup	
Ranunculus gmelinii	Tellow water crowfoot	

Ranunculus reptans	Creeping spearwort	
Ranunculus sceleratus	Celery-leaved buttercup	
Ribes hudsonianum	Northern black currant	
Ribes oxyacanthoides	Northern gooseberry	
Ribes triste	Wild red currant	
Ricciocarpos natans	Liverwort	Rare*
Rorippa palustris	Marsh yellow cress	
Rosa acicularis	Prickly rose	
Rubus idaeus	Wild red raspberry	
Rubus pubescens	Dewberry	
Rumex crispus	Curled dock	
Rumex occidentalis	Western dock	
Rumex spp.	dock	
Rumex triangulivalvus	Narrow-leaved dock	
Salix arbusculoides	Little tree willow	
Salix bebbiana	Beaked willow	
Salix exigua	Sandbar willow	
Salix lucida ssp. lasiandra	Shining willow	
Salix maccalliana	Velvet-fruited willow	
Salix petiolaris	Basket willow	
Salix planifolia	Flat-leaved willow	
Salix pseudomonticola	False mountain willow	
Salix spp.	willows	
Sanicula marilandica	Snakeroot	
Schizachne purpurascens	Purple oat grass	
Scirpus lacustris	Common great bulrush	
Scutellaria galericulata	marsh skullcap	
Senecio congestus	Marsh ragwort	
Shepherdia canadensis	Canada buffaloberry	
Silene noctiflora	Night-flowering cachfly	
Silene pratensis	white cockle	
Sium suave	water parsnip	
Smilacina stellata	Star-flowered Solomon's-seal	
Solidago canadensis	Canada goldenrod	
Solidago nemoralis	Showy goldenrod	
Solidago rigida	Stiff goldenrod	
Sonchus arvensis	Perennial sow-thistle	
Sorbus sp.	Mountain ash (domestic)	
Sparganium eurycarpum	Giant bur-reed	
Spiraea alba	Narrow-leaved meadowsweet	
Stachys palustris	Marsh hedge-nettle	
Stellaria crassifolia	Fleshy stitchwort	
Stellaria longifolia	Long-leaved chickweed	
Symphoricarpos albus	Snowberry	
Symphoricarpos occidentalis	Buckbrush	
Symphyotrichum ericoides	tufted white prairie aster	
Tanacetum vulgare	Common tansy	
Taraxacum officinale	Common dandelion	
Thalictrum dasycarpum	Tall meadow rue	
Thalictrum venulosum	Veiny meadow rue	
Thermopsis rhombifolia	Golden bean	
Tragopogon dubius	Goat's-beard	

Table. 4 Vegetation (continued)

Trifolium hybridum	Alsike clover	
Triticum spp	Wheat	
Typha latifolia	Common cattail	
Urtica dioica	Common nettle	
Veronica americana	American brooklime	
Viburnum edule	Low-bush cranberry	
Viburnum opulus	High-bush cranberry	
Vicia americana	Wild vetch	
Viola canadensis	Western Canada violet	
Zizia aptera	Heart-leaved Alexanders	

Table 5. Amphibians

Latin Name	**Common Name**	**Comments**
Pseudacris triseriata	Boreal (striped) chorus frog	COSWIC Status: Not at Risk
Rana sylvatica	Wood frog	
Thamnophis sirtalis	Red-sided garter snake	Alberta Species at Risk Act: Sensitive

*Identified in The City of Leduc Environmentally Significant Areas Study (Feira, 2017) as rare. These species did not flag in our comparison to conservation species lists used in this report.

Leduc Wildlife Corridor Study

Final Report

April 2018

Brent Dragon, Hamza Farooqui, Sonak Patel, Nathan Stelfox

Prepared for the City of Leduc, Leduc County, and Stantec Consulting Ltd.

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Fig. 1 (Title Page) View from the top of the Leduc Waste Management Facility

Executive Summary

Purpose

The City of Leduc and Leduc County have engaged the project team to evaluate the feasibility of creating a wildlife corridor and trail system between the east shore of Telford Lake and the west shore of Saunders Lake. Provided in this report is a summary of wildlife corridors and trail systems best practices, and justifies the positives and negatives of establishing the corridor in the East Telford Lake ASP and Leduc County statutory plans. A number of options for pedestrian crossing locations, pedestrian crossing infrastructure, and wildlife crossing infrastructure are identified and examined. The study provides recommended options for each of these, but the City and County may choose alternative options depending on their preference.

The wildlife corridor will connect areas of demonstrated biophysical diversity and environmental significance. The open space allocated for the wildlife corridor also has the potential to be a recreational use, allowing hikers to travel from Telford Lake to Saunders Lake. From consultation events for both the City of Leduc / Leduc County Intermunicipal Development Plan (IDP) and the East Telford Lake Area Structure Plan (ASP), the public has expressed an interest in maintaining wildlife and pedestrian connectivity between the lakes.

Context

The City of Leduc and Leduc County are located in central Alberta just south of the City of Edmonton. As part of the IDP, the development of a wildlife corridor between Telford Lake and Saunders Lake was identified. This study uses recent documents produced for City of Leduc and Leduc County to identify the biophysical conditions around the wildlife area of interest. The regional landscape is an area of moderate species intactness and moderate to low species richness.

Trail and Wildlife Corridor Combination Criteria

We conducted a literature review on best practices of trail systems within natural areas, and this criteria was taken from those best practices. The criteria includes various elements such as limiting human footprint on the wildlife corridor by restricting how much the trail bisects the corridor, only allowing pets on-leash on the trail, using wildlife safe waste disposal, and aligning trails with existing disturbed areas. All of the criteria gives priority to the wildlife corridor and the flora and fauna within it before the recreational trail and the active users.

Geographic Information System Analysis

Using ArcMap 10.5.1, several land use components were digitized from ASPs, Environmentally Significant Areas (ESA), and other non-statutory sources and used to determine barriers to movement and the least cost pathway for wildlife. Examples of barriers include the landfill fence, the Nisku Spine Road, water features, and steep slope. The Cost Path tool was used to identify the location of the proposed trails and wildlife corridor.

Proposed Location Options

The location of the wildlife corridor is best suited along the unnamed stream between Telford Lake and Saunders Lake as it is the shortest distance between the ESAs, connects with multiple existing natural areas, and has high species intactness and richness. In addition, this is the least developable land due to the existence of the natural stream within the proposed corridor.

Once the wildlife corridor boundaries had been determined, the trail network was assessed. Three trail route options were created from this GIS work, each one with a different crossing of the Nisku Spine Road. These include one at-grade crossing north of the corridor, a southern at-grade crossing, and one above or below grade crossing, adjacent to the stream, between the two proposed intersections. The southern trail route is the most favorable as it has the most ecological connectivity, it is safe for trail users crossing the Nisku Spine Road, and has feasible land dedication for the wildlife corridor.

Proposed Design Options

We considered a number of design options to promote the creation of an effective wildlife corridor and trail system. Signage and amenities are to be located to facilitate effective use.

Trail signage should be located to educate users on trail etiquette, and can be educational to foster an understanding of the historical and ecological value of the area.

At-grade crossings were determined to be the most feasible for pedestrians, and the design of the Nisku Spine Road should consider traffic calming measures such as reducing the speed or number of lanes to facilitate the ease of crossing. An underpass was determined to be the best option, depending on cost and probability of adoption by animals. The proposed design recommends a gradual slope increase to the Nisku Spine Road to allow for an open boxed culvert to be built at-grade with minimal impact to the existing stream course. The culvert must be sufficiently wide and tall enough to encourage use. The minimum culvert dimensions are 3 m tall by 11.7 m wide, with a length equal to the width of the road (35.2m).

Acquisition

The report also offers a number of options for the acquisition of land for the establishment of the corridor and the trail system. Tools are provided in the Municipal Government Act (MGA) and Alberta Land Stewardship Act (ALSA). Dedication tools include municipal reserve, environmental reserve, environmental reserve easement, and conservation reserves. Tools described in ALSA include conservation easements, conservations directives, conservation offsets, and transfer of development credits.

Dynamic Elements

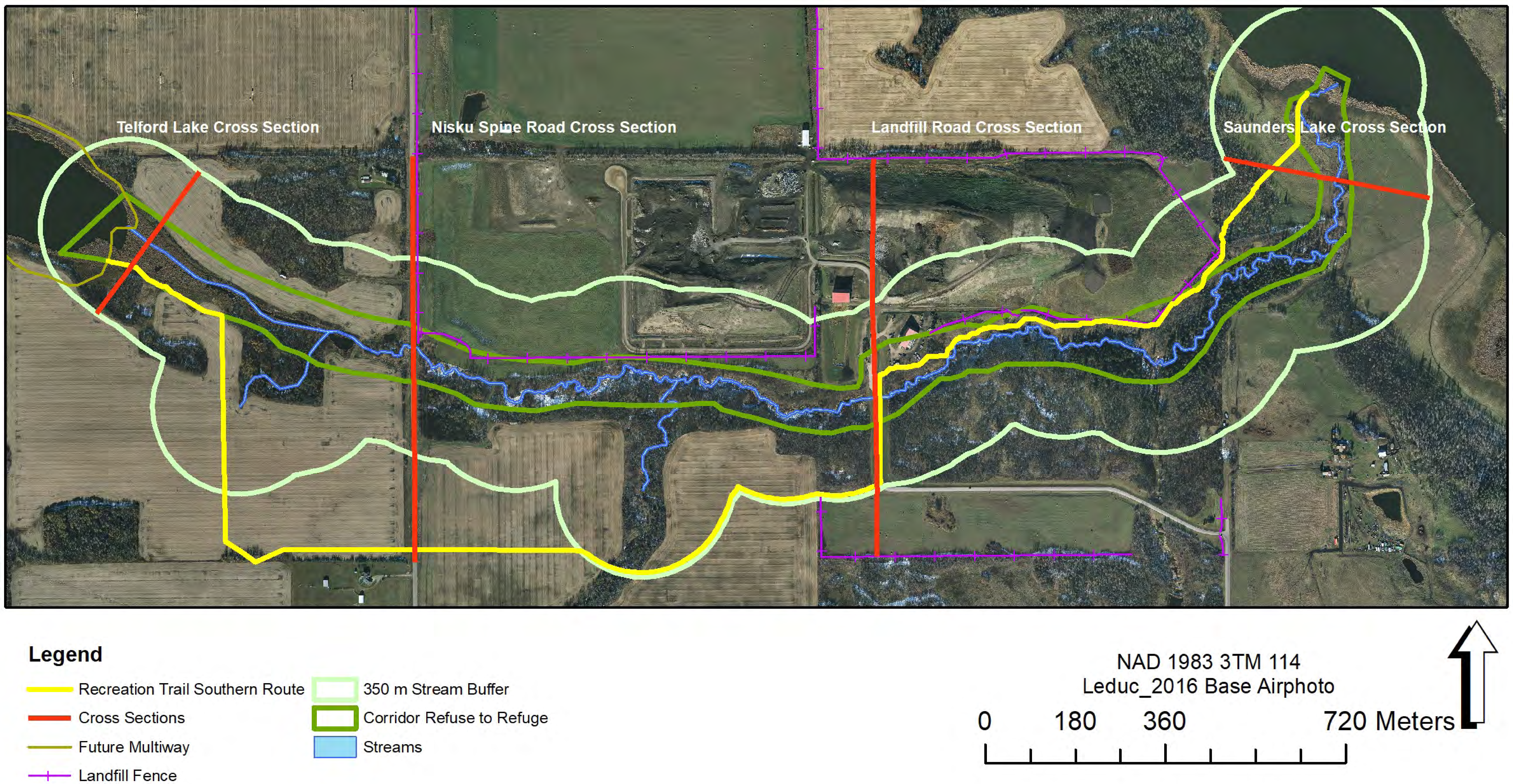
Established plans exist for the development of the Nisku Spine Road and the reclamation of the landfill. The dynamic development of these projects have been considered in the phasing of the wildlife corridor development. A wildlife crossing structure will be required once the Nisku Spine Road becomes four lanes, or reaches a traffic volume that is restrictive to wildlife movement.

The location of the trail system is intended to utilise the reclaimed landfill as a recreational site. As the land is reclaimed, the trail system is anticipated to expand to utilise this land as viewpoints, trails, and other low-impact recreational activities.

It is important that the City of Leduc and Leduc County monitor the effectiveness and use of the wildlife corridor and the trail network to identify opportunities to enhance the wildlife corridor and recreational trail.

The map on the following page shows the wildlife corridor location and preferred southern trail route option.

Wildlife Corridor and Preferred Recreational Trail Option



1. Introduction

1.1 Project Purpose

This study examines the feasibility of creating a wildlife corridor and trail network. Considering policy and biophysical context, this study also provides a number of options and considerations for developing the corridor that best meets the objectives of the two municipalities.

There is potential for a wildlife corridor and trail network between Telford Lake and Saunders Lake in the City of Leduc and Leduc County. These two lakes are home to a rich biodiversity of wildlife but also provide many recreational opportunities to the residents of both municipalities. Public and private stakeholders have demonstrated interest in the development of a corridor between the lakes, and wish to see the natural environment preserved. A variety of literature exists on the best practices for wildlife corridors, trail networks, and how they can be incorporated together. While it is possible for both to coexist in the same area, measures must be taken to ensure minimal impacts to wildlife, but also ensure the safety of trail users.

The City of Leduc has engaged Stantec Consulting Ltd. to prepare an Area Structure Plan (ASP) for the East Telford Lake region. The findings of this study will motivate the design in the East Telford Lake ASP and future statutory plans that guide development west of Saunders Lake. Please see Figure 3 for plans in effect and land owners. The public engagement for the ASP identified the wildlife corridor and trail network as priorities for the development of the area.

1.2 Report Sections

This report is broken down into 14 sections. Each section is intended to build the narrative and provide the reader with the necessary information to make an informed decision on establishing a wildlife corridor and recreational trail between Telford Lake and Saunders Lake.

The report begins with a description of the context of the study area. The biophysical context presents the environmental conditions and evaluates species within and around the area of interest. We also considered the geographic and policy context. An overview of existing and proposed infrastructure within the wildlife area of interest is used to influence the report recommendations. To determine the features necessary to create the most effective wildlife corridor and trail systems, academic research, planning and engineering guidelines, and case studies from across North America were consulted to determine best practices for design.

A SWOT analysis justifies the creation of the wildlife corridor and trail system by examining the strengths, weaknesses, opportunities, and threats associated with establishing and maintaining the corridor and recreational trail. From the best practices summary, SWOT analysis, and assessing the geographic information of the area, three trail route options were determined.

Several design elements were considered which include trail design amenities, pedestrian crossing infrastructure, wildlife crossing infrastructure, and using a green cemetery as a connection between environmentally sensitive areas.

Established criteria from the best practices summary determines what characteristics the trail and wildlife corridor must have if they are to coexist with each other. This criteria came from the best practices summary, which was determined from background research and literature review on the incorporation of trail networks within natural areas. The implementation and phasing section, Section 11, describes how the wildlife corridor and trail design will account for the dynamic development of the Nisku Spine Road and the Landfill Reclamation Plan (2004). Several tools are presented on how lands within the wildlife area of interest can be dedicated for the purpose of conservation, recreation, and wildlife movement.

1.3 Methodology

Using the Terms of Reference (see Appendix C), a methodology was devised to capture the project objectives. The graphic on the following page (Fig. 2) illustrates this process.

Project Phase 1 - Research

In this phase, we collected policy and biophysical information using documents provided by the clients and documents publicly available. We also collected best practice research through a literature review of academic papers, case studies, and engineering documents. Documents consulted include the City of Leduc / Leduc County Intermunicipal Development Plan (IDP), Municipal Development Plans (MDP), Environmentally Significant Area (ESA) studies, and online resources.

Based on the high-level policy review, biophysical study, and best practices research, preferred infrastructure for the wildlife corridor and trails are identified in the report. We determined preferred infrastructure by evaluating the physical context of the area and the expected level of use (of both wildlife and recreational users).

Project Phase 2 - Location Options

Our next step was to determine location options for the wildlife corridor and trail. This involved a SWOT Analysis of incorporating the proposed development of the wildlife corridor and trail into the land use policies of the project area. The SWOT Analysis looked at the strengths, weaknesses, opportunities, and threats of creating a wildlife corridor and trail connecting Telford Lake and Saunders Lake. This analysis is aids in determining preferred location and design criteria that expands strengths, minimizes weaknesses, capitalises on opportunities, and mitigates threats. With the SWOT analysis and evaluation of the physical and policy conditions of the area, we identified potential location options using Geographic Information Systems (GIS) tools. We established criteria based on best practices research and the literature review as well as general preliminary feasibility evaluations of the location options.

Project Phase 3 - Design Considerations

The final phase of the project involved determining the detailed design components of both the wildlife corridor and the trail network. In terms of the wildlife corridor, design considerations concern the wildlife crossing structure rather than the corridor itself as the corridor is intended to be a naturalized space with as little human intervention as possible. The trail network on the other hand, as an anthropogenic feature, needed more attention for features such as seating, signage, and drainage.

This study examines the feasibility of integrating the wildlife corridor and trail network. This decision affected the alignment of the wildlife corridor and trail as well as the crossing structures for both. Design considerations were guided by an understanding of how the two features will interact.

Design options considered in this section include trail amenities, wildlife crossing structures, pedestrian crossing structures, and incorporating the proposed green cemetery with the wildlife corridor.

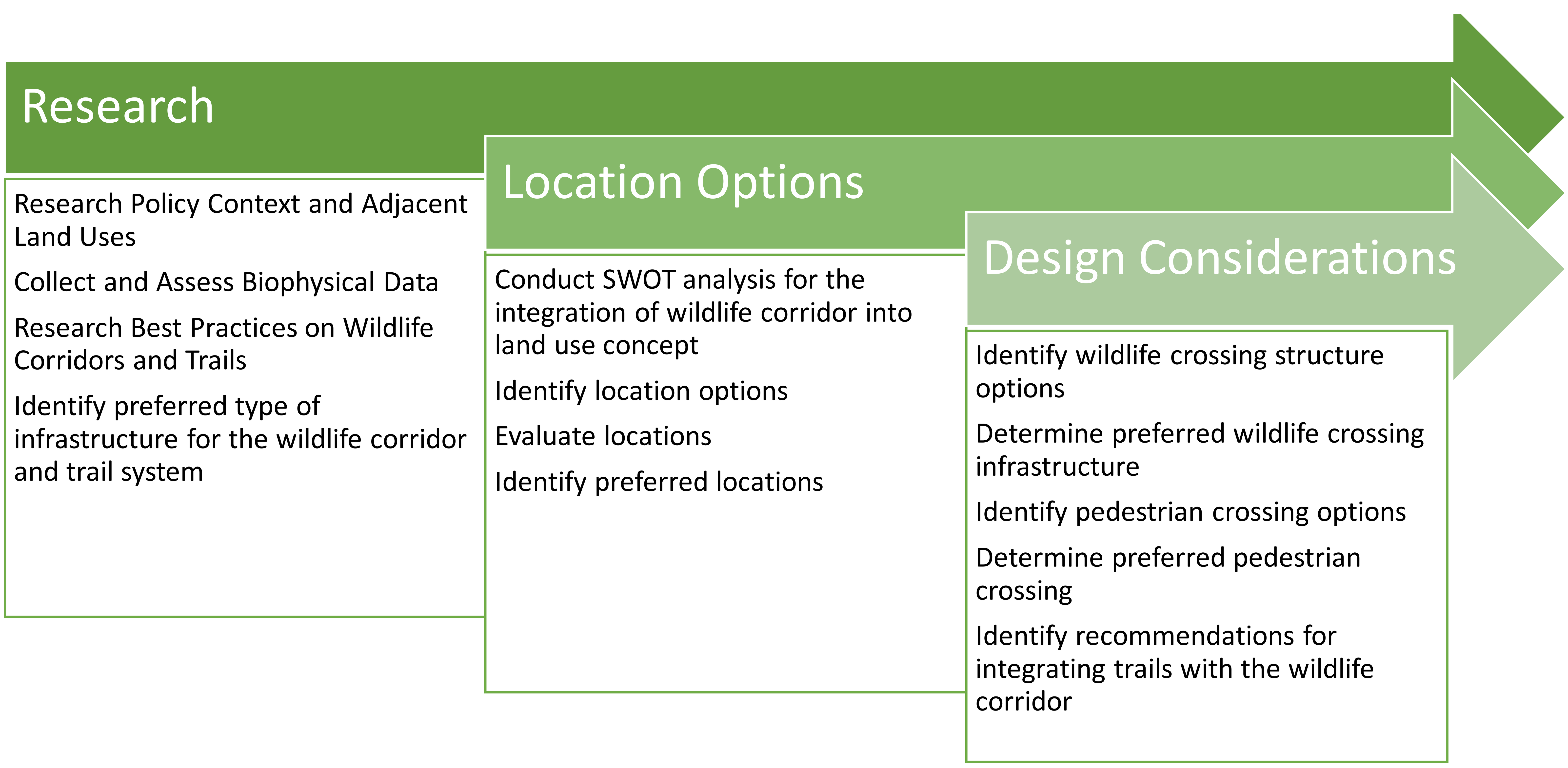


Fig. 2 Methodology Illustrations

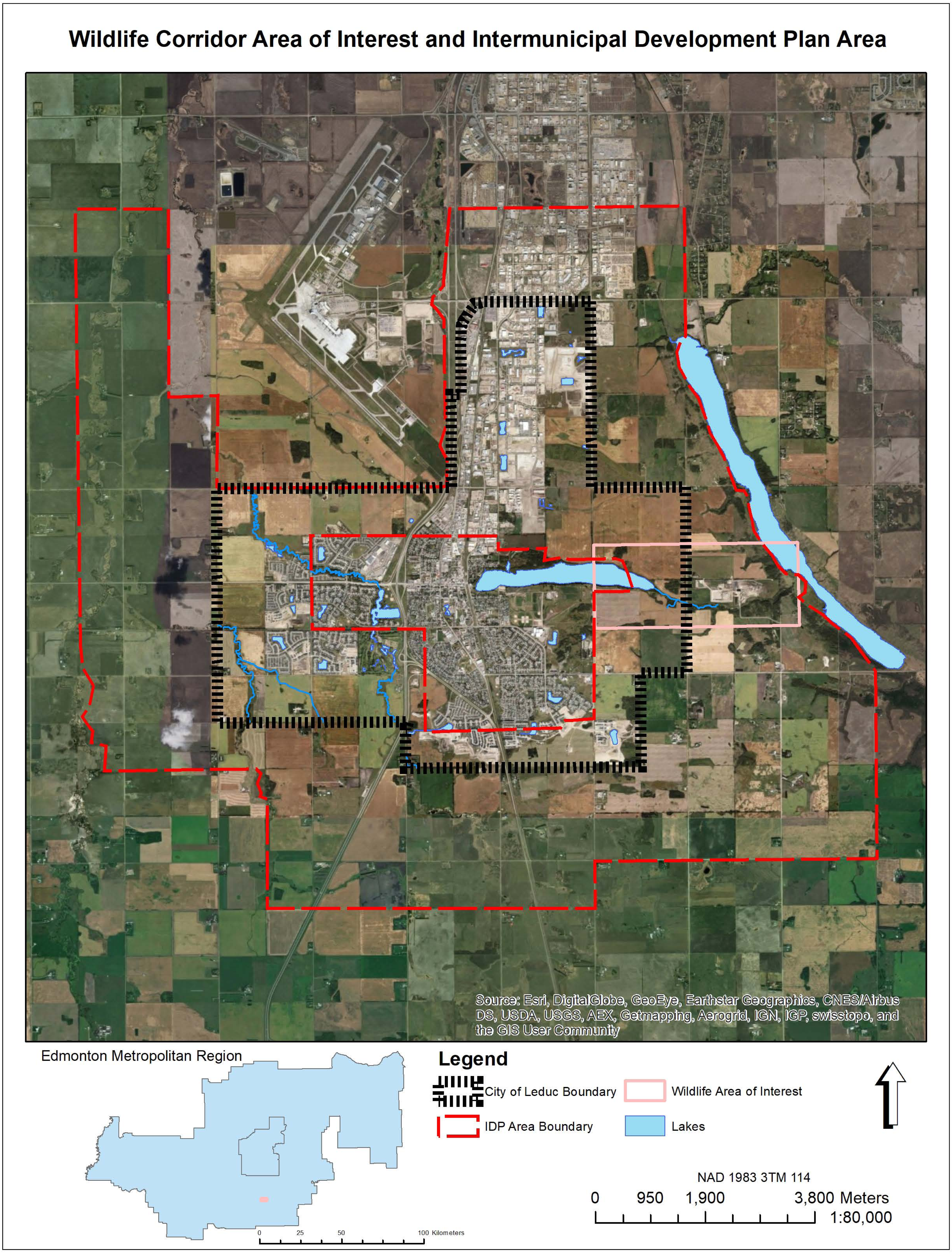


Fig. 3 Wildlife Corridor Area of Interest and Intermunicipal Development Plan Area

1.4 Geography

This section defines the geographical context of the Leduc Wildlife Corridor Study in relation to the local and regional system. A review of two wildlife indicators (species richness and species intactness) and existing recreational trail networks present the foundation for this review. The analysis identified that the wildlife corridor will function in the larger geographic context. The proposed recreation trail has opportunities to connect to existing trail networks. Leduc County level data provides the scale of the regional context. This section ends with a review of existing and proposed land uses at the ASP level. This establishes the corridors context and compatibility with future development.

The location of the wildlife area of interest is in central Alberta, located in the eastern edge of the IDP area (Fig 3). The City of Leduc is completely contained within Leduc County. Leduc County is about 100 km east to west and about 35 km north to south. The County covers a geographic area around 2,700 km^2 (Fig.11). The City of Leduc is significantly smaller in size at 7 km east to west and 8 km north to south covering a geographic area of about 43 km^2. The wildlife area of interest is 3.5 km east to west and 1.5 km north to south and covers a geographic area of 5.3 km^2 (Fig. 3).

The area of interest for the Leduc Wildlife Corridor has been identified to reflect the goals outlined in the Terms of Reference (Appendix C). The wildlife area of interest captures a part of Telford Lake and Saunders Lake. The elevation and slope of the area of interest is noted in Appendix D and was created using the City of Leduc LiDAR 2012 data. Elevation has a gradual decline of 20 m from Telford Lake to Saunders Lake. Slopes are generally small with the exception of the landfill and the stream which have slopes as high as 70 degrees.

According to the Alberta Biodiversity Monitoring Institute (ABMI), Leduc County and the City of Leduc are moderate in species intactness and moderate to low in species richness (Fig.11). Water features are high with respect to intactness but are low in species richness. Species intactness displays the condition of the landscape relative to an equivalent region with zero human footprint. Species richness shows the relative abundance of species expected in each pixel. The scale of these ABMI criteria is one kilometre by one kilometre pixels (ABMI, 2014a & ABMI, 2014b). These criteria show the importance of preserving natural features and maintaining connections where possible across the landscape. For a view of ABMI data at the Provincial, North Saskatchewan Watershed, Edmonton Metropolitan Region, and wildlife area of interest refer to Figure 44, 45 in Appendix D. Additional information was taken from ESA studies that were conducted for the City of Leduc and Leduc County (Fig. 4, 6).

There are three recreational trails that could connect to the proposed recreational trail with minimal effort. They are the River Valley Alliance (RVA), the Waskahegan Trail, and the Great Trail. The RVA connects Devon to Fort Saskatchewan along the North Saskatchewan River (River Valley Alliance, nd). The Waskahegan Trail is a 300 km route that uses public and private lands to connect several municipalities and Elk Island National Park (Skirrow & Waskahegan Trail Association, 2001). The Great Trail is a cross Canada Trail that already connects with the Leduc Multi-Way (Trans Canada Trail, 2018). Further information on each of these trails is available through the cited materials.

Within the area of interest there is a mixture of private and public lands, some of which do not have plans in effect (Fig. 5). The East Telford Lake ASP will be the most impactful plan to the wildlife area of interest on the City of Leduc Lands. The lands of the Leduc Regional Landfill will be the most impactful to the area of interest in Leduc County. Lands within the area of interest in Leduc County have not been identified in any ASP.

The City of Leduc owned parcel in the East Telford Lake ASP and the County of Leduc and Provincial lands present the opportunity for municipalities to have significant influence over the long term development of the wildlife corridor.

The work outlined in this document should be used when the development of an ASP for the land east of the Nisku Spine Road is initiated to support the dedication of lands for the implementation of the proposed Leduc Wildlife Corridor.

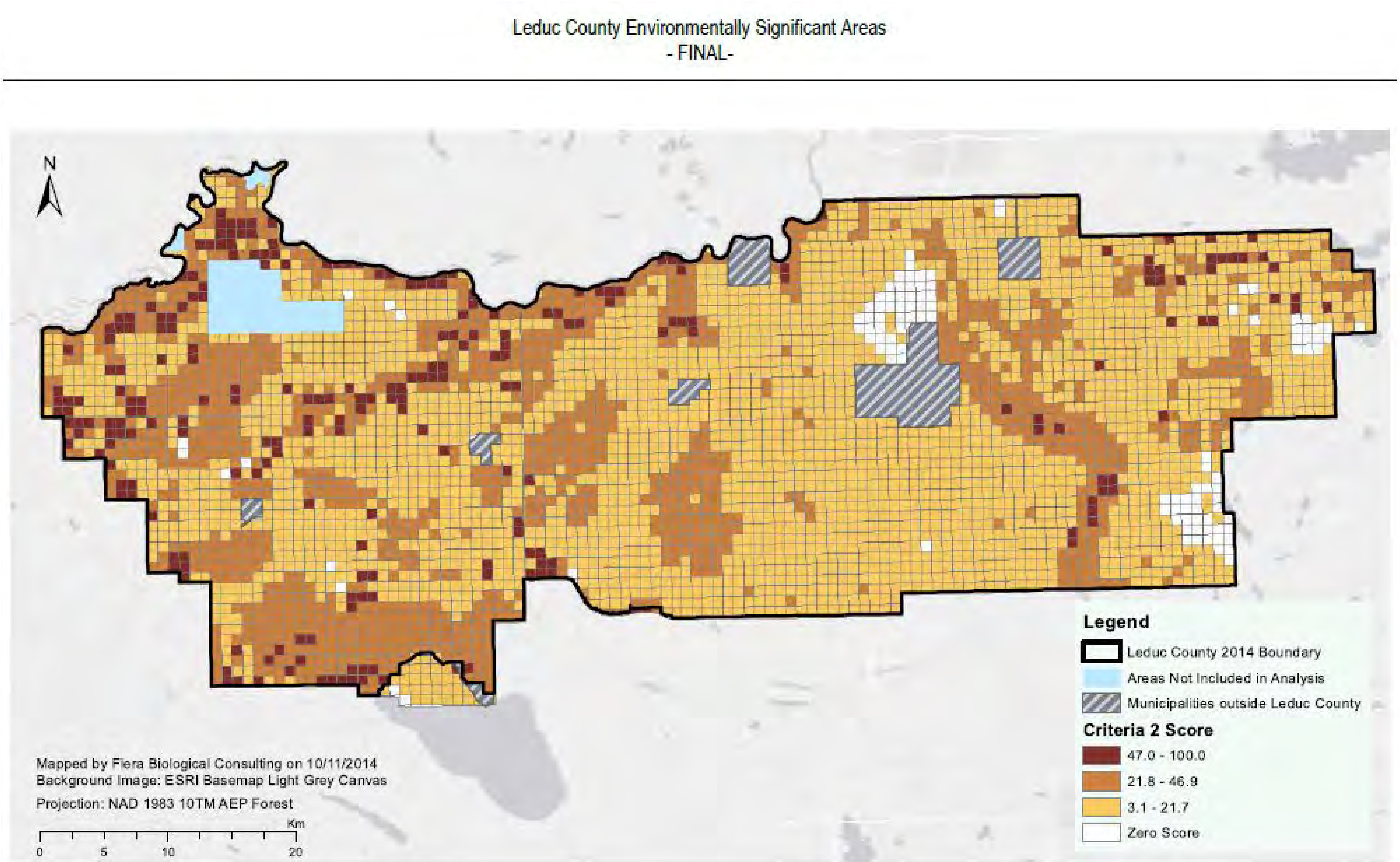


Fig. 4 Leduc County Environmentally Significant Areas

Plans in Effect, Land Ownership, and Environmentally Significant Areas

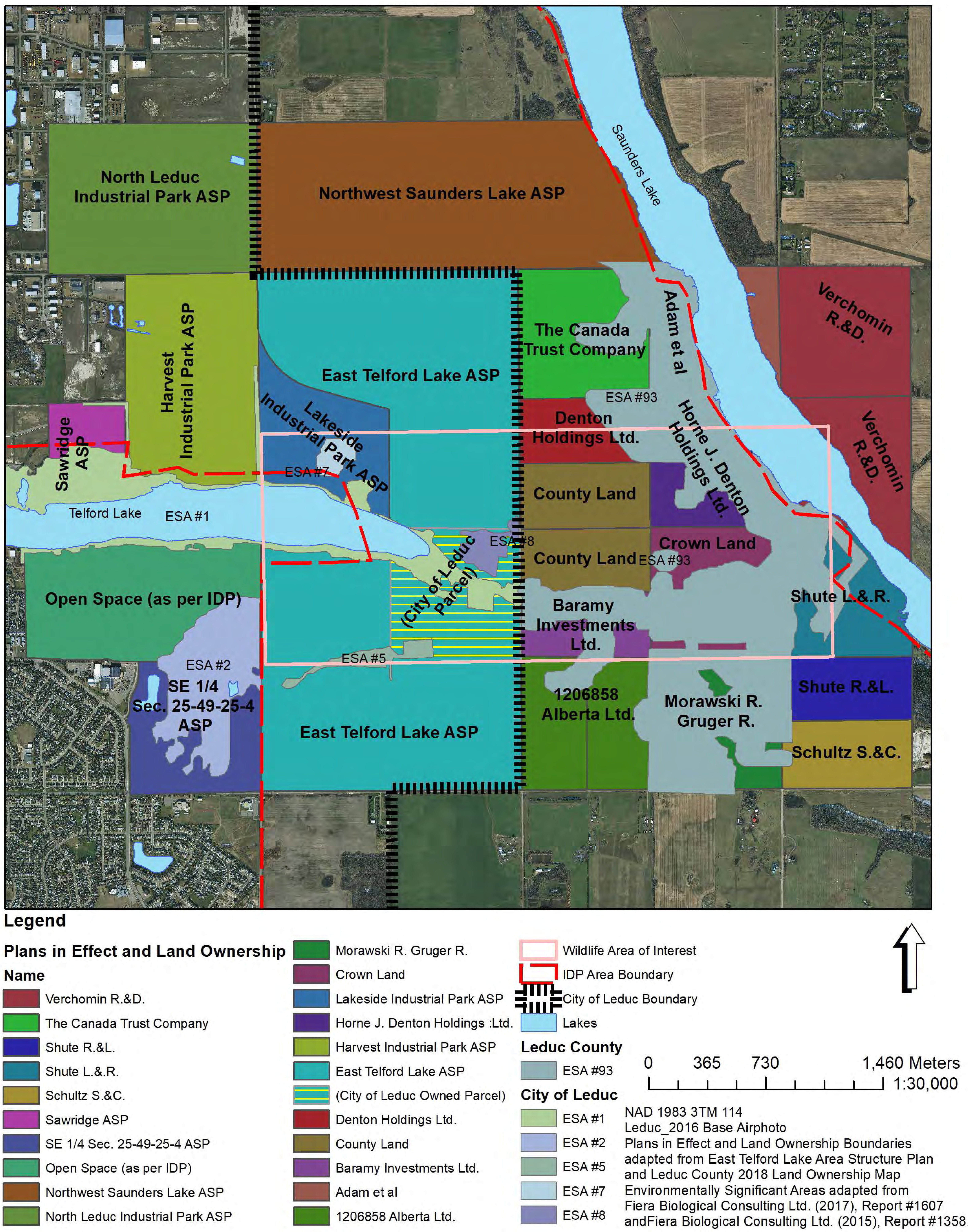
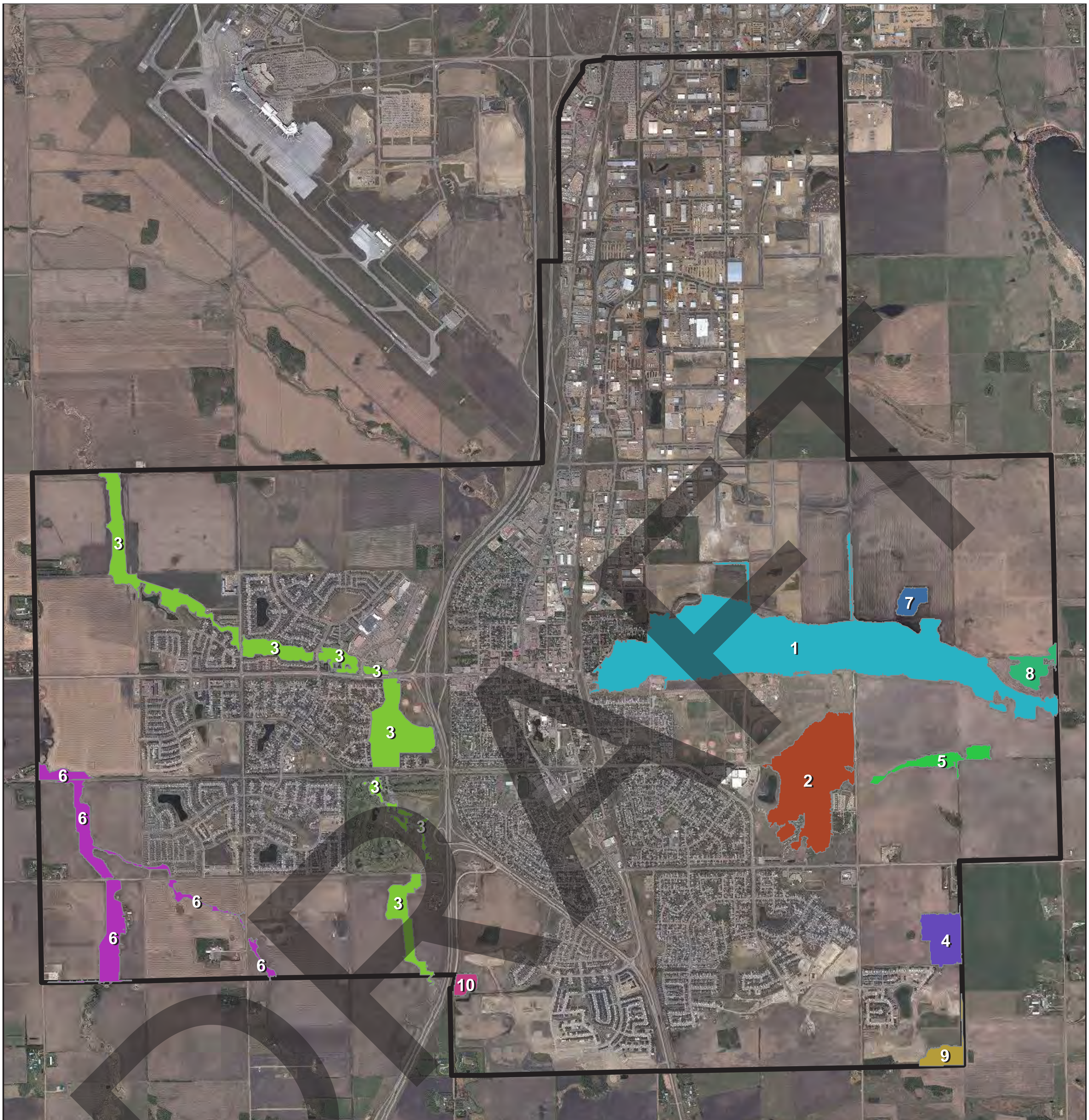


Fig. 5 Plans In Effect, Land Ownership, and Environmentally Significant Areas



Environmentally Significant Areas

Environmentally Significant Area

City of Leduc

DRAFT

Fig. 6 Environmentally Significant Areas identified in the City of Leduc (City of Leduc Environmentally Significant Areas Study, 2017)

1.5 Policy Context

This section of the report describes relevant legislation and adjacent land uses for the creation of a wildlife corridor in this area. The following chart (Fig. 7) depicts all relevant policies explored by all orders of government. A description of each of these is provided in Appendix B.

The provincial and federal documents establish priorities and guidelines for conservation. Municipal goals for conservation are detailed in the City of Leduc / Leduc County IDP as well as the MDPs for both the City and Leduc County. The IDP specifically establishes the goal of examining the possibility for creating a wildlife corridor to maintain the habitat connectivity between Telford Lake and Saunders Lake.

Municipal tools for conservation are described in the Municipal Government Act (MGA). In accordance with Section 664(1), a subdivision authority may require that dedication of land as environmental reserve (ER) if it consists of a natural drainage course, ravine, gully, swamp, or coulee, is subject to flooding, or abuts a water body. ER dedications are intended to preserve natural aspects, prevent environmental damage, or to provide public access to the water body. Additionally, the MGA creates a new designation for conservation: conservation reserve, which is intended to protect environmentally significant lands. Similar to eminent domain, this tool allows the Municipality to claim lands for conservation in exchange for market value compensation to the landowner. Further tools for land acquistion are discussed in Section 10.

Municipal		Provincial	Federal
Statutory: • City of Leduc / Leduc County IDP • East Telford Lake ASP (Draft) • City of Leduc MDP • Leduc County MDP • Telford Lake Master Plan • Lakeside Industrial ASP	Non-Statutory • Aerotropolis Viability Study • East Telford Lake Desktop Phase 1 • Environmental Site Assessment • East Telford Lake ASP Public Open House Summary Report • Assessment of Citizen Science Initiatives for Wildlife Management City of Leduc • Range Roads 245 and 250 Functional Planning Study • Edmonton Metropolitan Region Growth Plan • Leduc County Environmentally Significant Area Study • City of Leduc Environmentally Significant Area Study	• Alberta Wildlife Act • Environmental Protection and Enhancement Act • Alberta Water Act • Alberta Wetland Policy • Alberta Land Stewardship Act • Public Lands Act • Municipal Government Act	• Species at Risk Act • Migratory Bird Convention Act • Fisheries Act • Navigation Protection Act

Fig. 7 Relevant Policy List

1.5.1 Adjacent Land Uses

At the municipal order, statutory plans guide development in the project area. The IDP describes the adjacent land uses, based on recommendations from the Aerotropolis Viability Study (MXD Development Strategists, Stantec Consulting Ltd., 2015). The area adjacent to the lakes and the stream is described as Open Spaces and Greenways, which allows for naturalised areas and trails.

In the City of Leduc, north of the corridor area, lands will eventually provide high quality business and light industrial activity. South of the corridor, the IDP allocates land for commercial, office, business, and light industrial. In the adjacent areas to the greenway, the IDP provides for a transitional space from business to natural space. This space ensures that the business development has a minimal impact on the corridor. These land uses are further established in the Draft East Telford Lake ASP, which also describes the creation of a cemetery south of the corridor area. As this area will be relatively naturalised, it presents an opportunity to be connected to the trail network.

In Leduc County, the areas adjacent to the greenways, outlined in the IDP, does not anticipate development within the document timeframe. Figure 8 shows the land use plan provided in the IDP.

As amended by City of Leduc Bylaw No. 933-2016 Approved August 21, 2017 (Office Consolidation)
and
Leduc County Bylaw No. 24-16 Approved July 11, 2017 (Office Consolidation)

FIGURE 10: INTERMUNICIPAL DEVELOPMENT PLAN POLICY AREAS

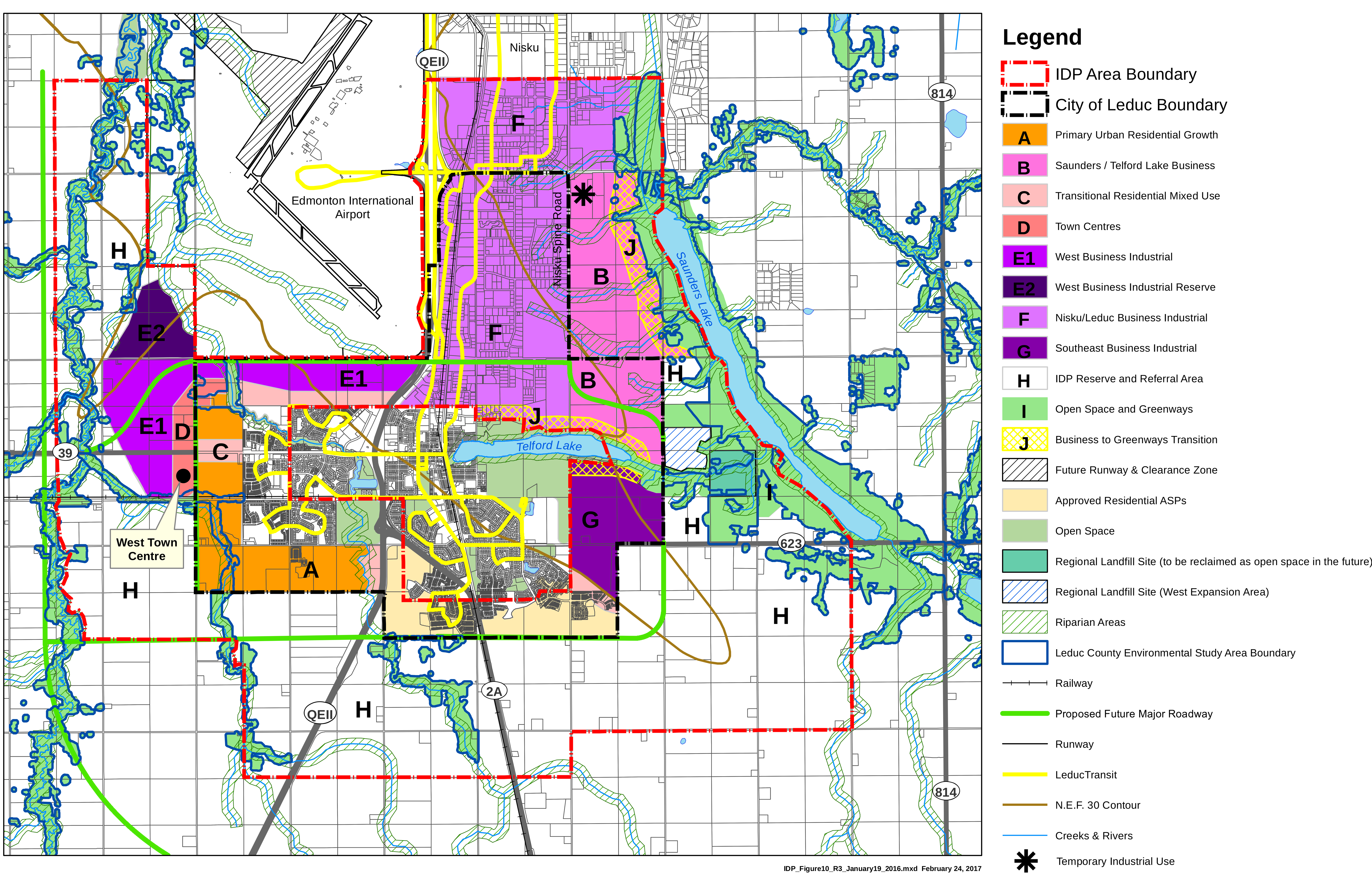


Fig. 8 Intermunicipal Development Plan Areas

2. Biophysical Context

The objective of the biophysical section is to determine the environmental conditions within and adjacent to the project area. This involved a desktop review of environmental conditions and species identified in reports produced for the City of Leduc and Leduc County. Ultimately this will determine areas of understand of importance within the biophysical context.

Fiera Biological Consulting recently conducted Environmentally Significant Area Studies for the City of Leduc (Fiera, 2017) and Leduc County (Fiera, 2015). These studies examine the ecological significance of natural areas and identify areas that preserve biodiversity and support natural processes. Detailed methods are outlined in each report. Fiera (2017) identifies five ESAs that are within the City of Leduc and within or adjacent to the project area (Fig. 6). In Leduc County, Fiera (2015) identifies Saunders Lake and the unnamed stream as a single ESA (Fig. 4). While the two reports have different methods together they address the entirety of the wildlife corridor area (Fig. 10).

A review of the five ESAs from the City of Leduc Environmentally Significant Area Study (Firea, 2017) is presented. The study evaluates ESAs based on three key features: ecological significance, habitat connectivity, and habitat condition, and scores these components out of 100. Ecological networks and hydrological cycles link Telford Lake and Saunders Lake. Figure 10 outlines each ESA in relation to the wildlife corridor area of interest.

Telford Lake (labelled as ESA #1) has a high ecological significance (89%) while habitat connectivity and habitat condition are both moderate at 59% and 61% respectively. The study found the area to support 114 plant types (two of which the province considers as rare), 33 birds (five of which the province considers sensitive), six mammal species, and one amphibian species.

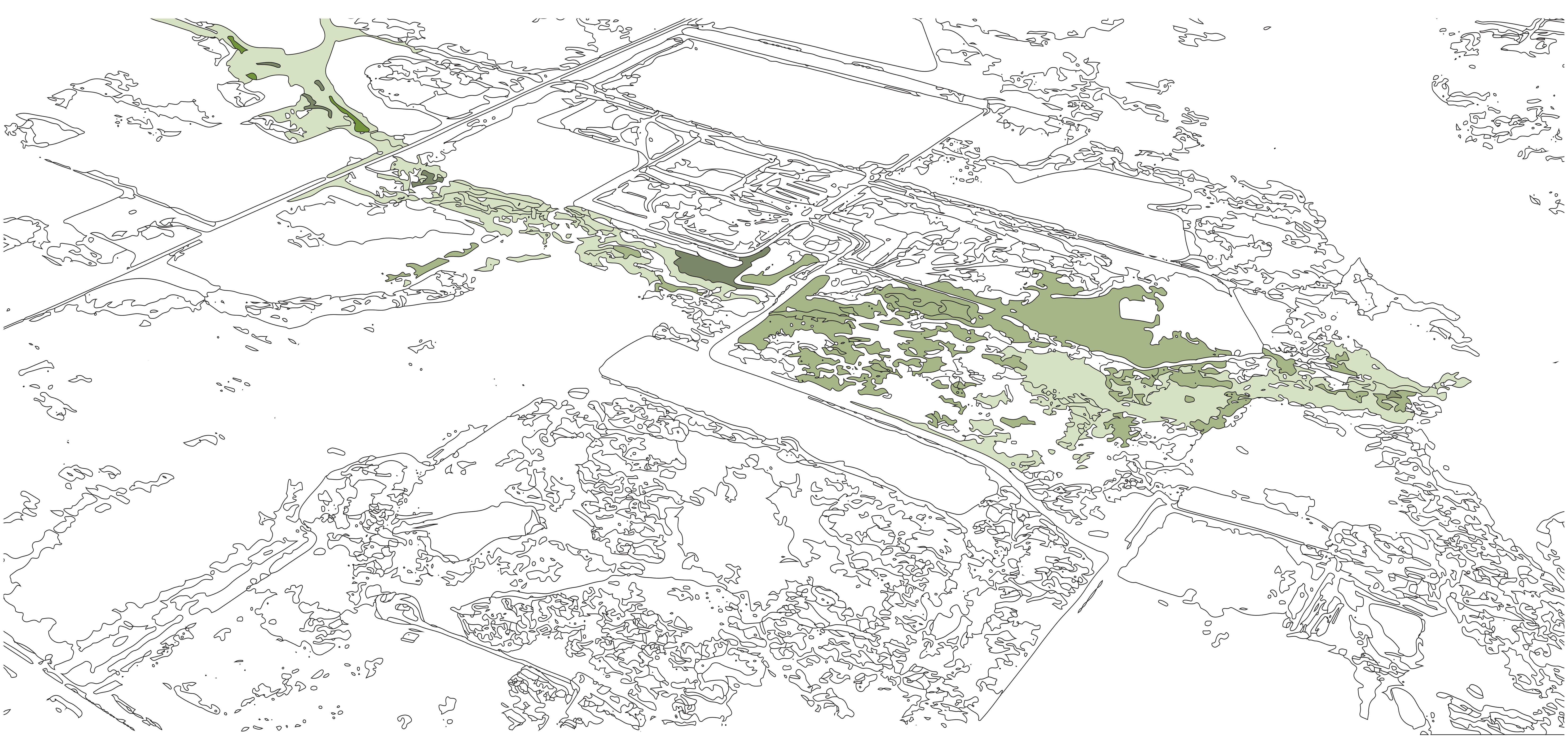


Fig. 9 Potential Wildlife Corridor Natural Area within the Study Area

The 4.3 ha tree stand (labelled as ESA #7) identified just north of Telford Lake is largely comprised of deciduous trees and wetland. This tree stand is moderately significant (56%) with moderate connectivity (61%) and high habitat condition (77%). The study found that this area provides a habitat for a number of bird species and there was evidence of deer and moose activity in this area. This feature falls within the Lakeside Industrial ASP, which does not provide for the conservation of this ESA.

The third ESA is a 7.1 ha forest stand located on the north side of Telford Lake (labelled as ESA #8). This forest stand is dominated by deciduous trees in a wetland complex. This ESA ranks moderate for an ecological significance and habitat connectivity at 57% and 59% respectively. The tree stand ranks high on habitat condition at 88%.

The remaining two ESAs are approximately 500 metres south of Telford Lake. The first is 49.5 ha (labelled as ESA #2) which has an ecological significance score of 74%, a connectivity score of 54%, and habitat condition score of 52%. This area contains grasslands, forest, and wetlands, providing for a range of species. Located directly east of this ESA is a 7.3 ha swamp/wetland (labelled as ESA #5). The study found this wetland to have an ecological significance score of 59%, a connectivity score of 67%, and a high habitat condition score of 85%.

ESA #5 is hydrologically connected to the the stream that flows between Telford Lake and Saunders Lake via an ephemeral stream network. This ESA acts as a stepping stone habitat for a number of mammals and waterfowl. If possible, the wildlife corridor could consider connecting to these ESAs to facilitate greater connectivity for larger wildlife populations.

According to the Leduc County ESA study, Saunders Lake and the proposed corridor towards Telford Lake is a mixed environmentally significant area (Fiera, 2015). The composition of Saunders Lake is upland (48.1%), aquatic (36.7%), and and riparian (18.7%). The report identifies mixed ESAs as important local and regional habitats as such areas can support a diverse assemblage of species (Fiera, 2015). The majority of Saunders Lake is at high risk (89.4%) of disturbance. The Fiera (2015) report identifies disturbance risk due to human activity based on a 20 year projection of future development and adjacent land use. Section 7 of this report identifies important management considerations for the Leduc Wildlife Corridor which is summarized as follows: provide connectivity by maintaining or restoring naturalized corridors and reduce linear disturbances where possible and where such features are unavoidable, wildlife passages should be considered.

This report identifies 306 species though a desktop review of existing plans, reports, and web resources. The reports used to create our inventory include: the Queen Elizabeth II and 65th Avenue (Leduc) Functional Planning Study (Vertex Professional Services Ltd., 2015), Landfill from Refuse to Refuge (2004), City of Leduc Environmentally Significant Areas Study (Fiera, 2017), and Biophysical Assessment in Support of the Gaetz Industrial Area Structure Plan (Spencer Environmental Management Services Ltd., 2014). These species were then compared to policy and legislation for wildlife conservation and protection including: the Species at Risk Act (2002), Migratory Birds Convention Act (1994), Fisheries Act (1985), Complete Alberta Wild Species Status List (Alberta Environment and Parks, 2015), and the Alberta Wildlife Act (2000). Of these, three species are listed in the Species at Risk Act Schedule 1. They are the common nighthawk *(Chordeiles minor*), barn swallow (*Riparia riparia*), and little brown bat (*Myotis lucifugus*).

The reports mentioned above identify 83 species which are identified in the Alberta Species at Risk Act. Of these 71 are identified as "secure" or "may be at risk" (SARA, 2002). Refer to Appendix A, Table 1 for fish, Table 2 for mammals, Table 3 for birds, Table 4 for vegetation, and Table 5 for amphibians and reptiles. A formal biophysical studies would still be required to ensure conditions have not changed dramatically between desktop studies and future development.

Environmentally Significant Areas

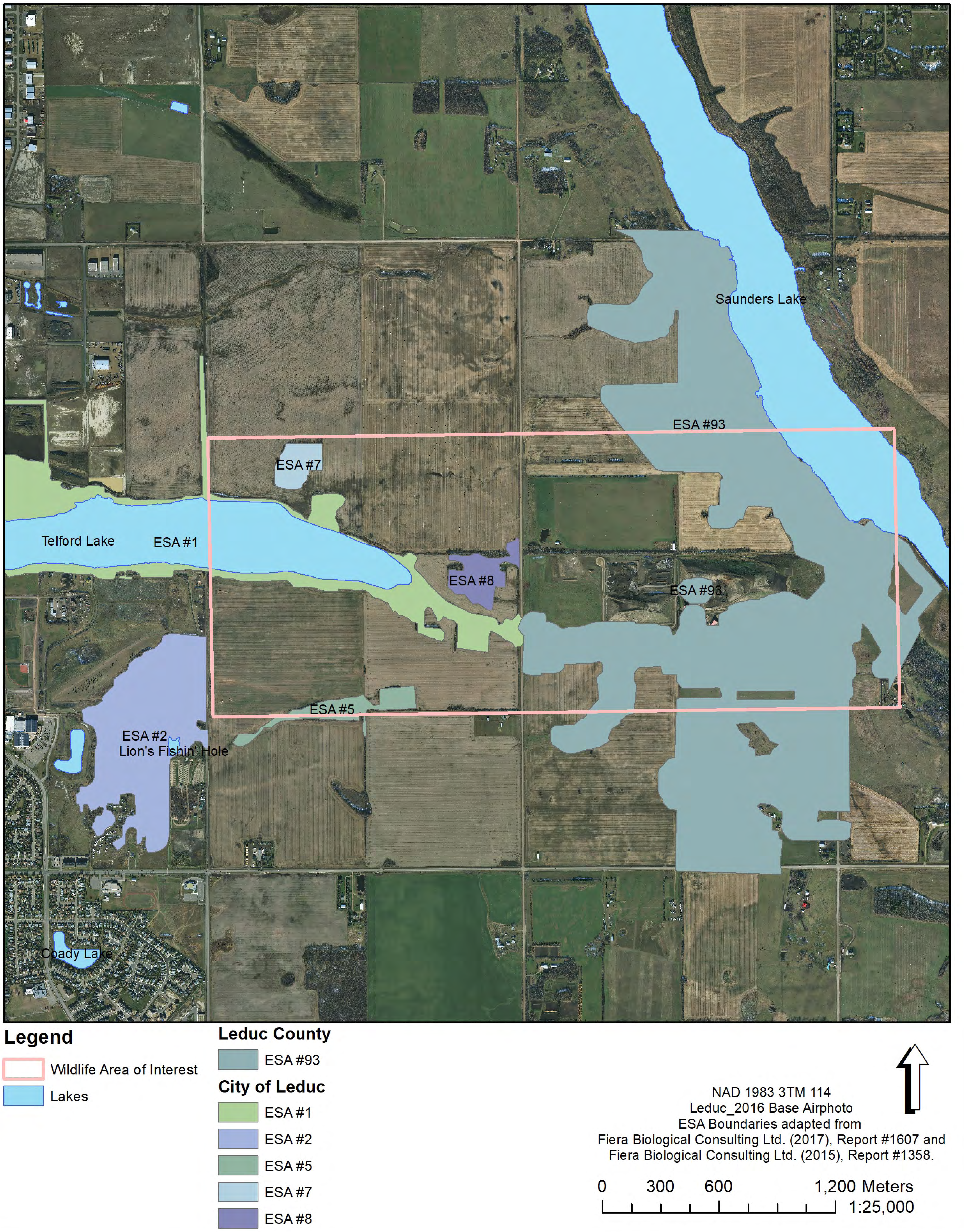


Fig. 10 Environmentally Significant Areas

Alberta Biodiversity Monitoring Institute
All Species Intactness and All Species Richness

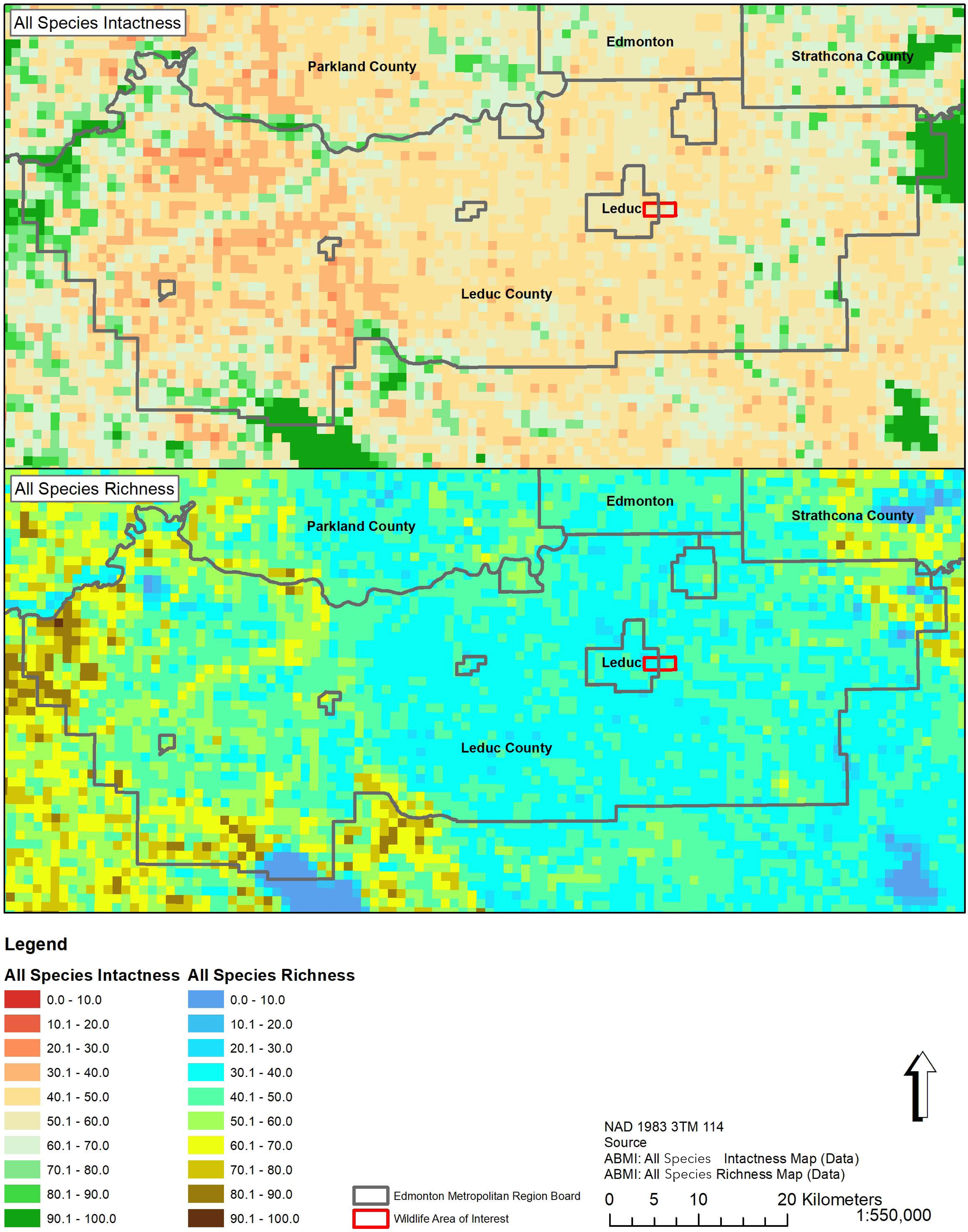


Fig. 11 Alberta Biodiversity Monitoring Institute (refer to Appendix D for more information)

3. Best Practices and Design Considerations

We conducted a best practices study tp assess the current standards for developing wildlife corridors and trails. Several academic and professional documents pointed to best practices regarding the locations, detailed design, management, and maintenance of wildlife corridors, wildlife crossings, and trails. The information gathered in this section aided in informing the final design of the wildlife corridor and trail network connecting Telford Lake and Saunders Lake.

3.1 Wildlife Corridor

Wildlife corridors are defned as areas of land designed and managed to maintain connectivity between habitat patches (Bow Corridor Ecosystem Advisory, 2012). The goal of a wildlife corridor is to facilitate the safe and effective movement of wildlife in areas where there may be confict with human activity (Bow Corridor Ecosystem Advisory Group, 2012).

Wildlife crossing structures are infrastructure elements that are designed and incorporated into physical barriers to increase the permeability for wildlife (Chisholm et al., 2010). Crossing structures can be integrated with wildlife corridors to allow wildlife to bypass infrastructure that would, without a crossing, fragment the habitat.

This section will include best practices research for wildlife corridors, specifically, how to best determine corridor location, corridor design, interactions with surrounding land use, crossing design, management and enforcement, and maintenance.

Corridor Location

Shorter routes are typically more effective than longer stretches (Golden & Associates, 2017), but corridors can be better located when accounting for least-cost pathways (Mimet et al., 2016). Using this model, barriers such as unfavourable land cover and fences are attributed cost values (Mimet et al., 2016). Corridors should also account for elevation changes; slopes exceeding 25 degrees can be problematic (Golden and Associates, 2017).

One Way Ramps allow wildlife who manage to get outside of the corridor to safely and easily return to the wildlife corridor.

Fig. 12 One Way Ramp Illustration

Corridor Design

Wildlife corridors should be as wide as possible, the recommended minimum width is approximately 300 m (Bond, 2003). Golder & Associates (2017) states that the Natural Resource Conservation Board requires a width of 350 m, which is also the suggested minimum in the Bow Corridor Ecosystem Advisory Group (2012) report. Larger species will require wider corridors. As well, the longer a corridor is, the wider it should be to maintain effectiveness. In addition, certain species, such as coyotes, are minimally affected by human disturbance, relative to species such as bears, elk, wolverines, and wolves, which show greater avoidance for human activity (Bow Corridor Ecosystem Advisory Group, 2012).

Minimizing Conflicting Land Use

Developments projecting into the corridor creates pockets that trap wildlife and increases the perimeter of the corridor, which in turn increases the number of harmful edge effects (Bond, 2003 and Bow Corridor Ecosystem Advisory Group, 2012). Artificial human lighting disturbs the navigation of nocturnal animals (Beier et al., 2008). Strict regulations can help prevent light pollution in the corridor (Bond, 2003 & Bow Corridor Ecosystem Advisory Group. 2012). The Bow Corridor Ecosystem Advisory Group (2012) also mentions a 20 m buffer from residential development and a 40 m buffer from commercial development.

Fencing can be implemented to direct fauna to specific locations. Wildlife fencing between 1.8 m-2.5 m in height were preferred by literature review (Bond, 2003 and Golder & Associates, 2017). In Florida, the construction of a barrier wall directing wildlife to crossing structures resulted in a roadkill reduction of 93.5% (Beier et al., 2008). One sided ramps can be constructed (Fig. 12), to easily transition trapped wildlife back into the wildlife corridor.

Wildlife Crossing Design

Wildlife crossings provide a safe way for animals to get across roads, minimizing the dangers of wildlife on roadways. Roadways have a number of direct adverse effects, including increased rates of wildlife mortality, habitat loss, habitat fragmentation, and reduced connectivity (Beier et al., 2008). In Canada, an estimated 45,000 vehicle and large animal collisions occur annually (Clevenger & Huijser, 2011). Habitat connectivity loss is a threat to the survival of local species, causing isolated populations to lose genetic diversity (Beier et al., 2008 & Clevenger & Huijser, 2011). Indirectly, roads generate noise and vibration that can interfere with the ability of some animals to communicate, avoid predators, and detect prey (Beier et al., 2008). Roads also have the ability to spread exotic plant life (Beier et al., 2008). Additionally, roads increase erosion rates and pollute the surrounding air and water. Highway lighting can also interfere with wildlife activity (Beier et al., 2008).

Different species will require different types of crossings (Beier et al., 2008). There is evidence that some mammals will avoid two lane roads with volumes of 100 vehicles per day (Beier et al., 2008). Roads that are six lanes with greater than 10,000 vehicles per day are a complete barrier to wildlife movement (Chisholm et al., 2010). The level to which species are capable of crossing roads will largely depend on their individual characteristics. Chisholm et al., (2010) suggest categorizing species into 11 ecological design groups (EDGs) and basing the crossing design on the EDGs utilizing it.

Larger undercrossings can accomodate larger animals. A structure of 3.7 m width by 3.7 m height is recommended for larger animals (Bond, 2003). A study in Florida on culvert design and effectiveness suggests that a minimum width of 2.7 m and height of 3 m should be allocated for a passage rate of 75% (Smith, 2003). In the Clevenger and Huijser (2011) handbook, large mammal underpasses have recommended dimensions of 12 m wide by 4.5 m tall. A more accurate design metric may be the Openness Ratio, defined as (height)(width)/length (Beier et al., 2008). This value measures how open or constrictive a crossing structure appears to be. Using this metric, the longer a crossing must be, the wider the width should be to offset the tunnel effect (Smith, 2003). Clevenger and Huijser (2011) provide a breakdown of suitability of structure type for specific species. Box culverts (Fig. 13) will likely be the most successful for large terrestrial mammals and the openness ratio should be a minimum of 1.5 (Chisholm et al., 2010). Given wide roads, two short crossing structures are preferred to one continuous structure (Chisholm et al., 2010).

Culverts have been found to be effective for small animals. The base of the culvert could be a natural substrate above cobbled concrete. The natural substrate would match the materials found in the wildlife corridor (Bond, 2003, Smith, 2003, Beier et al, 2008, Clevenger & Huijser, 2011, & Chisholm et al., 2010). Culverts can take many forms and each has unique benefits for wildlife movement. Common culvert designs include closed bottom culverts, open bottom culverts, box culverts, and amphibian tunnels (Chisholm et al., 2010). Entrances and exits should maintain as much vegetative cover as possible, without physically or visually blocking the crossing (Bond, 2003, Smith, 2003, and Beier et al., 2008). This provides the necessary cover for prey animals to move effectively through the crossing. Where possible, vegetation should be encouraged in the underpass as well. Rows of branches and stumps in the undercrossing can greatly increase connectivity for smaller species (Beier et al., 2008). The use of low forage value vegetation and no mow zones can reduce large EDGs from lingering while providing cover for smaller EDGs (Chisholm et al., 2010). In addition to the creation of wildlife crossing infrastructure, methods should be implemented to prevent attempted crossings on the roadway. Raising the road is a significant deterrent for wildlife crossing (Mimet et al., 2016). Wildlife crossing safety can also be improved by

Fig. 13 Underground Wildlife Crossing Illustration

reducing the speed limit. In the Wildlife Passage document, road barrier effects increase with increased travel speed, vehicles per day, and road right of way widths (Chisholm et al., 2010). In some instances, speed limit reductions are viable options for improving connectivity. At speeds greater than 50 km/h, nearly 2/3rds of crossing attempts are met with mortality. With a 5 km/h reduction in speed, mortality decreases by 32% (Chisholm et al., 2010). Signage and reflectors are most useful for larger wildlife and when traffic volumes and speeds are low.

To minimize their environmental impact, roadways should also reduce noise and traffic. To minimizethe noise disturbance in the crossing structure, noise attenuation barriers can be implemented in high traffic volume roads (Clevenger & Huijser, 2011).

Location of Wildlife Crossings

Wildlife crossings should be located as close to natural pathways as possible. Topographic features may indicate where wildlife is moving; ridgelines and riparian areas are conducive to wildlife movement (Clevenger & Huijser, 2011).

Management and Enforcement

Conflict with wildlife is likely when the project is:

- built within 250 m of a natural area,
- bisecting uplands and wetlands,
- bisecting a wetland or natural linear features,
- to have high traffic volumes and speeds (Chisholm et al., 2010).

Human development and activity must occur in a manner that preserves the role of the corridor to facilitate wildlife movement. Effective mitigation is dependent on the EDGs that will be in the area. Mitigation tools include signage, fencing, altered lighting, altered sightlines, public education, speed reductions, wildlife crosswalks, diversionary methods, roadkill removal, vegetation management, noise barriers, curb improvements, culverts, and bridges (Chisholm et al., 2010). Mechanisms such as a 10 - 20 m buffer of mowed, flat land along every corridor edge that abuts human development acts as an effective fire break (Bond, 2003).

Domestic pets act as subsidized predators to wildlife in the corridor. Subsidized predators are animals that act as predators but receive an unnatural advantage due to human activities. Wildlife that attack domestic pets are often relocated (Beier et al, 2008 & Bond, 2003). Humans should not attempt to feed any of the wildlife, with the exception of bird feeders (Bond, 2003). An education program can reach out to adjacent landowners and users, educating them on the importance of wildlife corridor preservation (Bond, 2003). Recreation users of natural area pathways can also be educated on how to minimize negative human-wildlife interaction (Beier et al., 2008). Land owners can be discouraged from killing nuisance species by restricted the use of pesticide, herbicide, and rodenticide within a reasonable distance (Beier et al., 2008). It is also important that adjacent users prevent wildlife from accessing waste disposal, as this may give suburban natural predators like raccoons, foxes, and crows advantages over other wildlife (Beier et al., 2008).

Human use of wildlife corridors and crossings may scare animals away (Beier et al., 2008 and Clevenger & Waltho, 2000). Where trails do interface with wildlife corridors, people can be encouraged to stay on trails, dogs can be kept on leashes, and humans can be discouraged from interacting with wildlife. In the Florida study, use of culverts decreased significantly with the presence of humans (Smith, 2003).

Maintenance

Maintenance and operations are vital to the long term success of the wildlife corridor. Some critical measures are to conduct regular inspections of culverts for blockages and substrate condition. It is also important to make sure that fences be checked and maintained (Clevenger & Huijser, 2011).

Monitoring of the wildlife corridor and the health of populations that use it is key to ensuring the effectiveness of the corridor and determining if there are concerns or areas for improvement (Clevenger & Huijser, 2011).

3.2 Recreational Trail

This section will include best practices research for trails, specifically, on using the Recreational Opportunity System, comparing design standards from other municipalities, signage and wayfinding, trail amenity provision, and water drainage design.

Buist (1982) analyzes the conditions trail users find most favorable for outdoor recreation in a natural setting through the Recreational Opportunity Spectrum (ROS). The ROS considers several factors such as remoteness, size of area, evidence of humans, user density, and managerial notice ability to determine the classification of the environment (Buist, 1982). By mapping areas with these characteristics, it is possible to plan the best location for a trail depending on the traits desired. Once the characteristic of the environment is determined, an appropriate activity for the environment can be determined. Depending on the degree of these factors, the environment is classified into a primitive, semi-primitive non-motorized, semi-primitive motorized, roaded natural, rural, or urban landscape (Buist, 1982).

The Leduc Wildlife Corridor area would be classified as roaded natural, being predominantly natural with some evidence of sights and sounds of human activity. In a roaded natural environment, there is opportunity for both active and motorized forms of recreation.

Many of the municipalities near the project area were examined for their trail design practices. The City of Leduc multiway is a phenomenal example of a well-connected trail system. The multiway was a feature discussed in the Telford Lake Master Plan (2010) as a trail that circulates the lake. As such, designing the trail system so that is connected to the existing multiway is a welcome consideration. As outlined in the City of Leduc Parks, Open Space, and Trails Master Plan (2012), three conceptual elements are necessary for the multiway: access, safety, and continuity. In addition, three types of multiway designs exist: Primary, Secondary, and Nature Trails. Primary and secondary trails are normally located in more frequented areas with primary trails being asphalt-paved and 3 m wide, and secondary trails being mainly concrete-paved and 1.8 m wide. Nature trails are "gravel pathways" that see less foot traffic and are designed for passive recreation (City of Leduc, 2012).

A tiered trail design classification system was a popular method for determining trail design. For midcountry or backcountry environments, such as those between Telford Lake and Saunders Lake, the Parkland County Parks, Recreation and Culture Master Plan (2017) recommends the single-track, double-track, or multi-use trail types. These trails range in width from 0.5 m - 1.5 m to 2.5 m - 4 m if motorized vehicles are permitted. Natural surface or crushed gravel would be commonly used as surfacing material. Slopes can reach heights in ranges up to 16.7 degrees depending on what uses are permitted. Beaumont's Open Space and Trails Master Plan (2015) and Strathcona County's Trail Strategy (2012) provides similar classifications for trail systems. Generally, three levels of trail development exist: developed, semi-developed, and undeveloped (Fig. 14). Developed trails are the most accessible and undeveloped trails are the least accessible. For less-frequented areas, trails should have surfacing types ranging from bare earth, to gravel, to smooth compacted surfacing. Cleared widths for the trails should range from 2 m - 3 m depending on permitted uses. Slope changes should range from 5.7 - 16.7 degrees depending on permitted uses.

As seen through the ROS, corresponding trail types are assigned to different environment types. Multi-use trails are designed to accommodate pedestrians, cyclists, in-line skaters, and/or horseback riders. The type of user will determine the design and technical specification of the trail. For example, a paved pathway that is 2.4 m wide is required if accommodating wheelchair access (Searns, 2001). Searns (2001) also notes that a dirt/gravel pathway may be sufficient and will have less impact on the surrounding natural environment. Accessible trails also need to include resting locations every 60 m -90 m. These locations are optimal for educational signage such as preservation methods or the history of the location.

The inclusion of signage and wayfinding can increase the safety and enjoyment of users. The Devon River Valley Trails Master Plan (2015) indicates three types of wayfinding: General Signage, Trail Network Signage, and Trailhead Signage. General Signage would provide ecological and environmental information and are designed to be interesting and attractive as well as instill pride in the community. Trail Network Signage is placed at the entrances of trails and provides basic safety, trail etiquette, and important location information. Trailhead Signage are placed at major access points to orient users. Signage and wayfinding was also mentioned in the City of Leduc Parks, Open Space, and Trails Master Plan (2012), Strathcona County Trails Strategy (2012), and the Parkland County Parks, Recreation, and Culture Master Plan (2017). Parkland County (2017) also includes the "Universal Trail Assessment Process" (UTAP) on trailhead signage which details info on trail grade, cross slope, trail width, surfacing material, and trail length. Wayfinding should be simple, clear, and easy to read.

Various other amenities can enhance the comfort and enjoyment of trails. Basic amenities can include seating, waste disposal, and washrooms (City of Edmonton, 2006; City of Leduc et al, 2012; Strathcona County, 2012). Other amenities could include bicycle parking/racks, vehicle parking, lighting, and guard rails. The Edmonton Urban Parks Management Plan (2006) and Strathcona County Trails Strategy (2012) also mention accommodating linear drainage features into the trail system. Seating can be included at different intervals depending on the terrain and level of use. Recycling and waste disposal in rural areas face a higher maintenance burden than those in urban areas (Strathcona County, 2012). Containers can be provided at the most heavily utilized locations, preferably near seating. Washrooms can be located at trailheads and near parking. Parking, in addition, could accommodate different modes like trailers and bicycles.

Proper water drainage design can limit erosion and trail widening (Searns, 2001). This can be done through an open system using swales (open flow beside trail) or sheet flows (even water dispersion over whole trail), which are the most natural and cost effective ways to handle drainage on the trail. A closed system involves underground pipes and culverts to redirect water off the trail, which is more expensive, but more effective at transporting water. The other option is a combined system which uses an open system to collect water, directing it to a closed system which carries the water to a larger water body. Drainage systems help reduce running water, wet soils, and rutted trails which are the greatest contributors to excessive trail widening (Leung, 1999).

A summary of the best practices can be found in the next section.

Undeveloped	Semi-Developed	Developed
Material: Turf or bare earth **Width:** 1-1.5m with cleared width of 2m **Slope:** 10% preferred, 30% max. **Accessibility:** Low-Mid	**Material:** Smooth compacted surfacing **Width:** 2.7-3.3 m **Slope:** 5-10% preferred, 20-30% max. **Accessibility:** Mid	**Material:** Aphalt or concrete surfacing **Width:** 3-3.5m **Slope:** 5% preferred, 10% max. **Accessibility:** High with easy access for service and emergency vehicles

Fig. 14 Trail Classification Illustration

4. Criteria for Combining the Trail System with the Wildlife Corridor

An active use trail system can be integrated within the wildlife corridor. The trail design and its users should respect the natural environment it is in, and have the smallest impact on the ecosystem as possible. Based on the best practices established in the section prior, we developed a number of recommendations for the creation of the wildlife corridor, trail network, and the integration of the two. These criteria are interpretations of how established best practices can be implemented in the design of the wildlife corridor and trail network in the Telford Lake to Saunders Lake area.

Trail networks and wildlife corridors should be as separated as possible to reduce stress on wildlife and the environment, as well as ensuring the safety of trail users. This can be achieved by creating a visual barrier between any environmentally sensitive areas and the trail by either topography or vegetation. In addition, the trail should intersect the wildlife corridor as little as possible, and certainly not in any sensitive or riparian areas. This includes any boardwalks or bridges.

Existing disturbed areas should be utilized. Rather than disturbing new areas, the trail should be located along existing edges in the area that are already impacted. Existing edges can include fences, telephone lines, roads, or informal trails that are already frequented by human activity.

The trail should not border both sides of the wildlife corridor as this will reduce permeability of wildlife in and out of the corridor. This also includes any water bodies (wetlands, creeks, ponds, etc) which should not be circled by the trail on all sides. Rather, a trail system should run along the edge of the corridor and only along one side.

As environmentally sensitive and riparian areas are areas for high wildlife traffic, it is important that they remain easily reached and animals do not feel pressure from human activity when visiting them.

It is assumed the trail will have a zone of influence about 3 m - 6 m wide in which the environment and animals will be impacted by the trail and its users. Within this swath there will be 0.5 m - 2 m of vegetation cleared on either side of the trail for wildlife and trail user safety. Environmentally sensitive or riparian areas should not be within this zone, and the trail should have a sufficient border between them.

Dogs can only be permitted within the wildlife corridor if they are on-leash and properly controlled. Dogs are highly unpredictable and can be stressful to wildlife. This can be reinforced with educational signage along the trail that explains trail etiquette.

Signage along the trail should also discourage trail users from creating their own pathways which is harmful to the environment. New pathways are commonly formed when the formal trail is in an undesirable state, usually too muddy. This can be reduced with proper drainage mechanisms along the trail, either a closed, open, or combination system to direct water off the path.

Lighting can be detrimental to migratory birds and other wildlife and should be limited where possible. Any necessary lighting should be located at the trail heads where there is the largest amount of human activity, and the farthest from the wildlife corridor. Any lights should be designed to mitigate effects on wildlife.

A gravel trail has less environmental impacts than an asphalt trail, while still providing some accessibility to trail users. Any areas where an asphalt trail is required should be near urbanized areas, or the trail heads, but not near environmentally sensitive areas.

The slope of the trail and wildlife corridor should not be greater than 25 degrees as this will prevent wildlife from using the corridor and will be inaccessible to trail users.

If equestrian use is permitted on the trail, there needs to be 3 m of height clearance to allow horseback riders to safely clear any tree branches.

Waste bins need to be located at high traffic areas such as the trail heads and include mitigating measures to prevent wildlife from accessing refuse.

If multiple linear man-made features are present in the area, they should be bundled together as to reduce their impact. This includes putting fences, pipelines, and telephone lines together along the same pathway when possible.

Wildlife corridors should be as short and wide as possible, so the most direct path between the two lakes that allows for the most amount of land to be dedicated towards the wildlife corridor would be optimal.

A wildlife crossing will be required to allow for connectivity across the proposed Nisku Spine Road. Depending on the design of the wildlife crossing, it should be kept separate from human crossings at the Nisku Spine Road. Crossing six lanes of traffic at, above, or below grade is already stressful for wildlife, and the added pressure of trail users is unnecessary. The Wildlife crossing infrastructure and the recreational trail should be grade or geographically separated to ensure adoption by wildlife and safety for trail users.

The existing land use plans in the area need to be considered when planning the location of the corridor and trail network as to ensure the network is cohesive with other plans. There is a proposed trail network in the Leduc Landfill Refuse to Refuge Plan. This plan and the East Telford Lake ASP that must be taken into consideration.

In the case of the Refuse to Refuge plan for the Leduc Landfill *it is recommended that the proposed trail network not be developed in the existing naturalized forested area* that exists between the landfill cell and landfill road (Appendix D, Fig. 48)

The Nisku Spine Road should be elevated above grade and fenced on either side to discourage wildlife from crossing the road. One way ramps should be constructed on the road side of the fence, allowing wildlife to get back into the corridor should they get past the fence. The fence should extend north and south of the corridor to prevent wildlife from going around the fence to try and cross the Nisku Spine Road. The fencing should move wildlife to the wildlife crossing structure, which will be the only permeable location along the road.

5. SWOT Analysis for Wildlife and Trail System

We conducted a SWOT analysis for the incorporation of the wildlife corridor and trail network into the land use plans in the area. A SWOT analysis defines the strengths and weaknesses of the project, defined as characteristics of the project that generate benefits or harm respectively. The SWOT analysis also characterises opportunities, which are external elements that may enhance the value of the wildlife corridor, and threats, which are external elements that may challenge the feasibility of the corridor.

The purpose of this section is to examine the positives and negatives of establishing a wildlife corridor and trail network in the project area. This analysis considers the biophysical context of the area, adjacent land uses, research, and public consultation described in prior chapters. The intention of this chapter is to assist the City of Leduc and Leduc County in their decision to establish the corridor and define the opportunities the corridor can capitalise on and the threats that should be mitigated.

Strengths

There is significant public interest in preserving the wildlife use of Telford Lake and Saunders Lake and protecting the wildlife movement between the two bodies. Based on engagement conducted for the statutory plans for the area, there is a significant public demand in preserving the natural characteristics in the area. Following an open house held for the East Telford Lake ASP, there were several comments describing the desire to design this area to preserve natural functions, provide for wildlife connectivity, and create a trail network. Public stakeholders were also consulted for the preparation of the City of Leduc and Leduc County Joint Sustainable Growth Study, which assisted in the preparation of the IDP. This document also identifies environmental stewardship as a sustainability pillar for the region. Therefore, the establishment and maintenance of the wildlife corridor aligns with public interest and meets demand for a naturalized recreational area.

The Wildlife Corridor demonstrates environmental stewardship, a key pillar in both City and County legislation. The adoption of a Wildlife Corridor aligns with the municipal goals of stewardship in the City of Leduc / Leduc County IDP, as well as the City of Leduc and Leduc County MDPs. Wildlife corridors serve important ecological functions, in preserving connectivity as human development expands. Human development, particularly roads, have significant adverse effects on local populations, in the form of pollution, direct interactions, and loss of habitat. Fragmented natural habitats suffer from a lack of genetic diversity, making them susceptible to local extinction. Wildlife corridors are a critical tool for the co-existence of natural wildlife and human development, preserving valuable natural species and processes for future generations of both municipalities.

The area between Telford Lake and Saunders Lake is considered of high ecological significance, supporting the need for a naturalized wildlife corridor.

The trail integration creates a recreational space that can support physical and mental health activities. Creating a wildlife corridor would generate a benefit for the residents of both municipalities, by creating an attractive space that can be used for recreational activity. Trails provide a space that encourages active transportation and enhances the physical and mental health of users. Based on the comments made by the public during the open house, the public has a role as a conservator, responsible for ensuring the security and viability of the natural species in the area.

Signage can be used to instill pride in the area and encourage conservation. A recreational trail network exposes users to natural amenities between Telford Lake and Saunders Lake, instilling interest and pride in the area while also educating users at the same time. Signage can divulge relevant facts about the history and heritage of the area, increasing the pride and attachment to place for both the City of Leduc and Leduc County. Signage can also inform trail users about wildlife and floral species that can be found in the area. This will help educate trail users, as well as generate public buy-in for conserving this space. Educating trail users on the remarkable wildlife in the corridor will hopefully foster an interest in conservation in the area. Heritage and environmental knowledge can be furthered by naming specific trails after elements of the Leduc area history.

The presence of a recreational amenity could increase the utility and value of adjacent properties. Natural areas provide significant benefits to the users of the space. Thus, the adjacent properties may experience an increase in value due of their proximity to this natural space. Employees and residents of parcels in the area have the ability to use the recreational space, and receive benefits of cleaner air and more attractive aesthetics. Adjacent employment areas may be able to charge higher rents and attract employees due to the benefits of locating beside the wildlife corridor and trail network.

The corridor promotes wildlife watching at both Telford Lake and Saunders Lake. Currently, both Telford Lake and Saunders Lake are used by local residents for wildlife watching, including bird watching. The Wildlife Corridor retains and enhances this activity, by ensuring that wildlife can continue to use this space, and that the public can access more areas along the trail and see wildlife without adversely interacting with them. Wildlife watching may create additional demand for use of the trail system and existing parks. Promoting wildlife watching can also aid in educating residents on the various natural flora and fauna in the area as well as promote the conservation of these areas.

Weaknesses

The presence of the Nisku Spine Road will be a significant barrier to the effective movement of wildlife. To support the adjacent development of industrial land and provide a route for the industrial facilities to the north, the Nisku Spine Road is required to bisect the corridor. The Nisku Spine Road presents threats of exotic plant life, increased erosion rates, pollution, lighting, and negative noise effects. These threats may potentially interfere with wildlife activity and the effectiveness of the wildlife corridor. As established, in the research and best practices for wildlife corridors, the presence of any human infrastructure is a barrier to the movement of wildlife, especially a significant six highway. The highway also presents a challenge to the movement of humans as well, who will require an intersection to travel between the lakes. This highway needs to permeable to both human and wildlife movement, and measures need to be taken to avoid the adverse impacts of this highway on the adjacent areas.

The Wildlife Corridor land has an opportunity cost, otherwise having been used for other developments. As with any development, there is an opportunity cost associated with allocating a specific use to a piece of land. Opportunity cost is the next best use that could have been located in the wildlife corridor land. In this project, the site could have been otherwise used to accommodate additional industrial and commercial development. This development would have generated employment and provided additional property tax revenue to the municipalities, which are not possible when the land is dedicated for conservation. However, wildlife corridors do generate their own benefits, detailed in the "Strengths" section.

Opportunities

The Wildlife Corridor has the opportunity to connect with other Environmental Significant Areas in the Telford Lake Area. There are a number of ESAs identified in proximity to the two lakes. The proposed corridor integrates three of these into the corridor. However, there is the opportunity to incorporate other ESAs into the corridor, to enhance the ecological value of the each of the ESAs and the corridor as a whole. The ESAs south of Telford Lake can be tied into the corridor via a naturalized space in the cemetery, such as a green cemetery area that supports wildlife movement. Connected habitat patches are much more ecologically valuable if they are connected, as this combats genetic isolation and supports a greater number of species.

The trail network has the potential to utilise the reclaimed landfill site for recreational opportunities. In the proposed wildlife corridor and trail system location, the trail does pass directly south of the landfill. The Refuse to Refuge document states the reclaimed landfill can act as recreational space. As the landfill authority reclaims the current site, this hill can be incorporated into the trail network as a short hike and possible viewing platform. As the future sites fill and are remediated, they can also be incorporated into the trail network. These spaces can function with significant recreational opportunities, such as sledding, hiking, wildlife viewing, and stargazing. Use of this space as a recreational area would be greatly enhanced by providing a pedestrian connection to Telford Lake and Saunders Lake.

The corridor adjacent to the cemetery can provide connections to other places in the City and the County. The recreational trail will run beside the cemetery. This allows for active transportation connections to important nodes in both the City of Leduc and Leduc County. More active transportation options increases the usability of the multiway and trail network, connecting users to different areas of the city through different means than just the private automobile. This also increases the recreational potential of both Telford Lake and Saunders Lake as visitors have more options for travelling to the recreational nodes. As well, animals from the corridor can access the more naturalized cemetery area rather than other more developed areas.

The trail network will connect to Saunders Lake, providing an opportunity to maximize the recreational potential of the area. Saunders Lake has large potential for increasing its use as a recreational amenity within Leduc County. Having a trail network that connects City of Leduc residents to Saunders Lake will increase traffic to the waterbody and catalyze further recreational developments in the area. This can increase the interest, attractiveness, conservation, and use of Saunders Lake as more attention is paid to its safety, sustainability, and use. The trail terminus at Saunders Lake can be the start of new trails or a boardwalk around Saunders Lake. Recreational activities like boating, swimming, and fishing may be implemented as more connections are created to the lake with the further development of its surroundings in the future.

The Wildlife Corridor has the potential to tie into the recreational multiway network at William Lede Park, the proposed Telford Lake trail, and serve as a catalyst to encourage the future development of recreational infrastructure in the Saunders Lake area. The trail adjacent to the corridor can add to the existing recreational infrastructure at Telford Lake, creating a robust, branching trail network that promotes greater use of each trail in the network. William Lede Park can transition to a more comprehensive recreational area, acting as a start of a casual trail around Telford Lake and/or a longer pathway to Saunders Lake.

Threats

The wildfire corridor will impose development constraints on the adjacent properties in the forms of lighting, noise, and waste controls. Adjacent developments to the corridor will have additional constraints placed on them to ensure they do not interfere with natural processes in the corridor. These include having an unbroken wildlife fence adjacent to the corridor, maintaining a no-mow zone buffer (which may provide habitat to rodents and other animals considered pests), preventing light and noise pollution from interfering with the corridor (which would likely entail a setback from the edge of the parcel abutting the corridor), and preventing animal access to human garbage and food. These additional restrictive policies may discourage tenants who do not wish to have these additional responsibilities. A lower demand may force these parcels to sell or lease at a reduced cost.

The presence of the Leduc Landfill may challenge the position of the corridor. The Landfill Administration has expressed interest in developing fencing in the corridor space, which will be a significant deterrent to the movement of wildlife. Within the project area, the landfill site has physical and design elements which will affect the effectiveness of the corridor. The Landfill site may result in light, noise, and physical pollution entering the corridor. Additionally, the landfill administration has indicated they need to fence portions of their parcel. Any fencing in the corridor presents a barrier to the movement of wildlife and people.

Future industrial development in the surrounding area may extend and impose over the wildlife corridor, threatening its integrity as a purely naturalized space connecting the two lakes. The effectiveness of the corridor is contingent on maintaining a sufficient width and ensuring the connectivity remains between the two areas. If, in any single point, this connectivity is challenged, the effectiveness and ecological viability of the corridor as a whole becomes threatened. It is recommended the City of Leduc and Leduc County assume this holistic approach to conservation, rather than preserve certain areas at the expense of others.

There is a possibility that trail users may veer off the trail, disturbing the naturalized area of the wildlife corridor. Off-trail users can significantly threaten the effectiveness and use of the wildlife corridor. The presence of humans significantly alters wildlife behaviour and challenges the role of the corridor as a safe space for wildlife activity. Additionally, the presence of humans is considered a significant contributor to the non-use of wildlife crossing structures. Combining the wildlife corridor with the trail system will require sensitive attention to the interactions between the anthropogenic and natural space. The trail should enter the corridor as minimally as possible and signage elements need to educate and warn users about the risk of going off-trail. Off-trail users may also create informal trails, further reducing the effectiveness of the corridor.

SWOT Analysis for Wildlife and Trail System Summary Table

Strengths	• There is significant public interest in preserving the wildlife use of Telford Lake and Saunders Lake and protecting the wildlife movement between the two bodies. • The wildlife corridor demonstrates environmental stewardship, a key pillar in both City and County legislation. • The corridor promotes wildlife watching at both Telford Lake and Saunders Lake. • The trail integration creates a recreational space that can support physical and mental health activities. • Signage can be used to instill pride in the area and encourage conservation. • The presence of a recreational amenity could increase the utility and value of adjacent properties.
Weaknesses	• The presence of the Nisku Spine Road will be a significant barrier to the effective movement of wildlife. • The wildlife corridor land has an opportunity cost.
Opportunities	• The wildlife corridor has the opportunity to connect with other Environmental Significant Areas in the Telford Lake Area. • The trail network has the potential to utilise the reclaimed landfill site for recreational opportunities. • The corridor adjacent to the cemetery can provide connections to other places in the City and the County. The recreational trail will run beside the cemetery. • The trail network will connect to Saunders Lake, providing an opportunity to maximize the recreational potential of the area. • The wildlife corridor has the potential to tie into the recreational multiway network at William Lede Park, the proposed Telford Lake trail, and serve as a catalyst to encourage the future development of recreational infrastructure in the Saunders Lake area.
Threats	• The wildfire corridor will impose development constraints on the adjacent properties in the forms of lighting, noise, and garbage controls. • The presence of the Leduc Landfill may challenge the position of the corridor. The Landfill Administration has expressed interest in developing fencing in the corridor space, which will be a significant deterrent to the movement of wildlife. • Future industrial development in the surrounding area may extend and impose over the wildlife corridor, threatening its integrity as a purely naturalized space connecting the two lakes. • There is a possibility that trail users may veer off the trail, disturbing the naturalized area of the wildlife corridor.

Fig. 15 Summarized SWOT Analysis

6. Guiding Principles

As our research and understanding of best practices for wildlife corridors and recreational trail networks was completed, we developed five guiding principles from the literature review that direct our design of the wildlife corridor and trail network connecting Telford Lake and Saunders Lake. These guiding principles are listed as follows.

Maintain a linear development edge with adjacent parcels to avoid entrapment of wildlife

Entrapment of wildlife comes of high concern when a wildlife corridor is adjacent to human development. As the purpose of this corridor is to allow the safe movement of wildlife between Telford Lake and Saunders Lake, human development should not encroach and impose onto the corridor. This means ensuring that developments are linear to the corridor alignment so that pockets that trap wildlife are not created and the corridor perimeters are not increased. This in turn decreases the number of harmful edge effects (Bond, 2003 and Bow Corridor Ecosystem Advisory Group, 2012).

Design recreational uses to have minimal impact on wildlife and flora in the corridor as feasible

Whichever anthropogenic/recreational uses are planned for the area, it is important that they have the most minimum impact on the naturalized corridor. The objective of the corridor requires a naturalized space, this is in contrast to the anthropogenic uses planned for the space. Trails and trail amenities will be designed to ensure the least amount of impact as possible to maintain the integrity of the corridor.

Prioritize wildlife connectivity above all other uses

The scope of this project involves not only designing a wildlife corridor for the safe movement of the various species in the area but also to provide recreational and active transportation opportunities between Telford Lake and Saunders Lake for residents. As a result, perceived challenges arise when combining natural and anthropogenic uses. In order to design a connection that respects both uses and ensures harmony and safety between the two, we must prioritise wildlife connectivity. This is because the safe connectivity of wildlife was identified as a primary objective by the community, as well, humans are flexible when it comes to this infrastructure whereas wildlife is not. Special attention must be paid to the form and functionality of this corridor in order for it to be successful. Prioritizing wildlife connectivity will allow us to ensure that wildlife is moving properly and that residents are able to travel safely as well.

Ensure minimal intersection of any anthropogenic feature with the wildlife corridor

It has been identified in background research as well as the Terms of Reference (Appendix C) that several anthropogenic features and activity is planned in the areas adjacent to the wildlife corridor. Examples of this include the current landfill, the Nisku Spine Road, which will bisect the wildlife corridor, and future industrial development. As noted before, it is important that these developments intrude as little as possible onto the wildlife corridor in order to ensure the safe movement of wildlife.

Maintain limited development within a 350 metre buffer of the wildlife corridor

As indicated in our best practices research, a 350 m buffer surrounding the wildlife corridor is preferred. It is important to have an adequate buffer to limit the amount of human development intruding onto the space. This will allow comfortable access for the various species traversing the corridor.

7. Wildlife Corridor Location

The wildlife corridor location and the methods used to create it are described in the following section. The location follows the stream connecting Telford Lake and Saunders Lake. GIS was used to identify the boundary (Fig. 17).

The wildlife corridor location follows a buffer around the stream connecting the two lakes. This location is the most feasible for a number of reasons: it is the shortest route, it contains the stream, there is evidence animals use this space, and on the western side of the Nisku Spine Road, it is entirely within the City owned parcel. Any alternative location was deemed not feasible and will have minimal effectiveness. Thus this report only presents one wildlife corridor.

Using the City of Leduc 2012 LiDAR data, elevation and slope of the area of interest were determined (Appendix D). The stream course was then digitized using the slope information which allowed the streams banks to be identified with ease. A 175 m buffered was used to create the 350 m Leduc Wildlife Corridor boundary. This boundary is represented on all trail routes (in light

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green) and is titled as "350 m Stream Buffer" (Fig. 16). The corridor outlined in the From Refuse to Refuge Landfill Plan (2008) was also digitized to provide reference to existing plans. A significant challenge of the Refuse to Refuge corridor is that, should development abut the corridor, wildlife would be extremely limited in movement due to the meandering nature of the stream.

While the wildlife corridor buffer overlaps the Landfill fence the majority of the corridor remains unimpeded. With the exception of the proposed recreational trail in Section 8, anthropogenic features should not encroach into the corridor as this would be detrimental to the corridor's effectiveness. As remediation of the Leduc Regional Landfill occurs existing infrastructure such as the landfill fence should be removed to improve the natural environment of the wildlife corridor.

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Wildlife Corridor Overview with ESAs

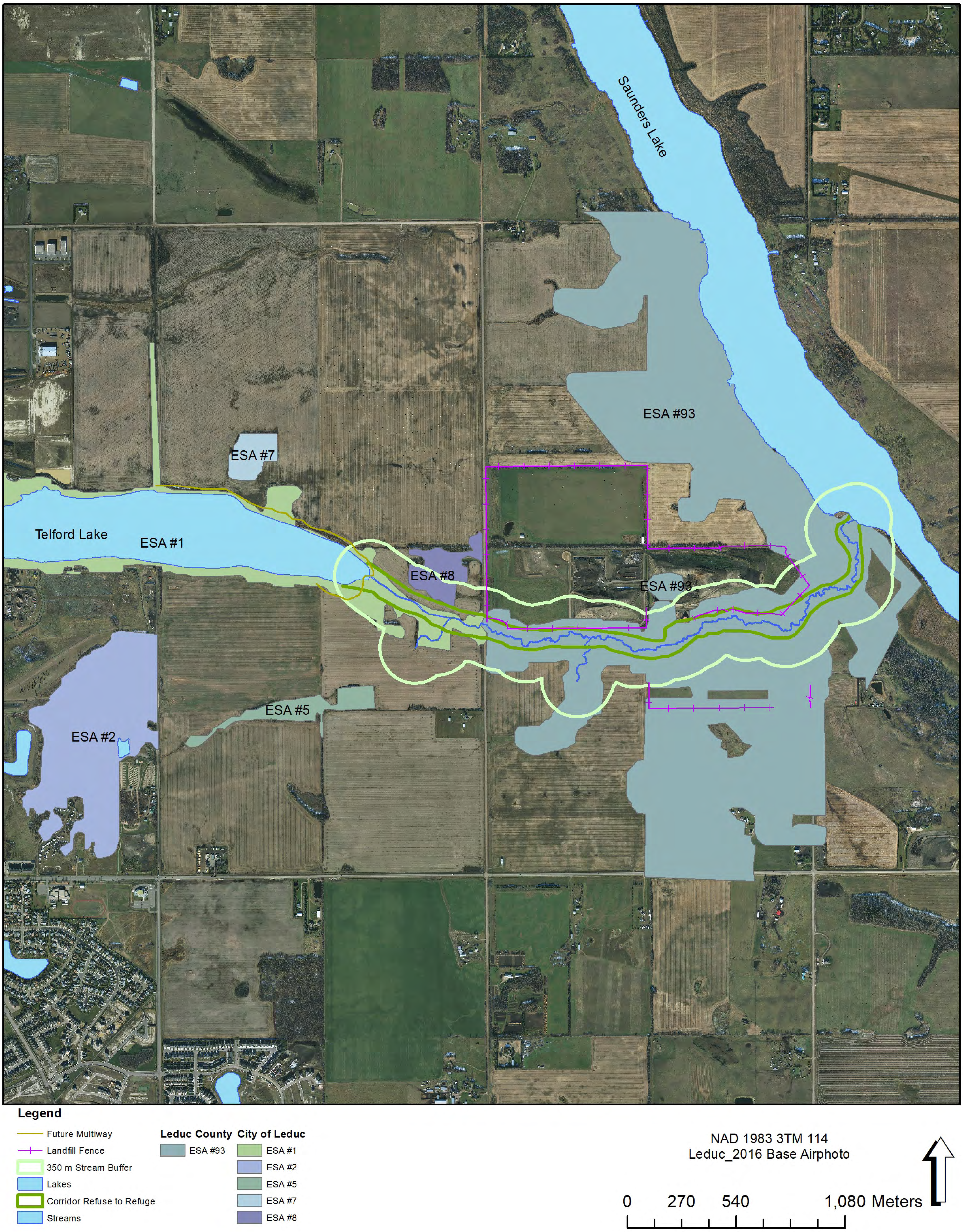


Fig.16 Recreation Trail Constant Features Overview

Wildlife Corridor Close-up with ESAs

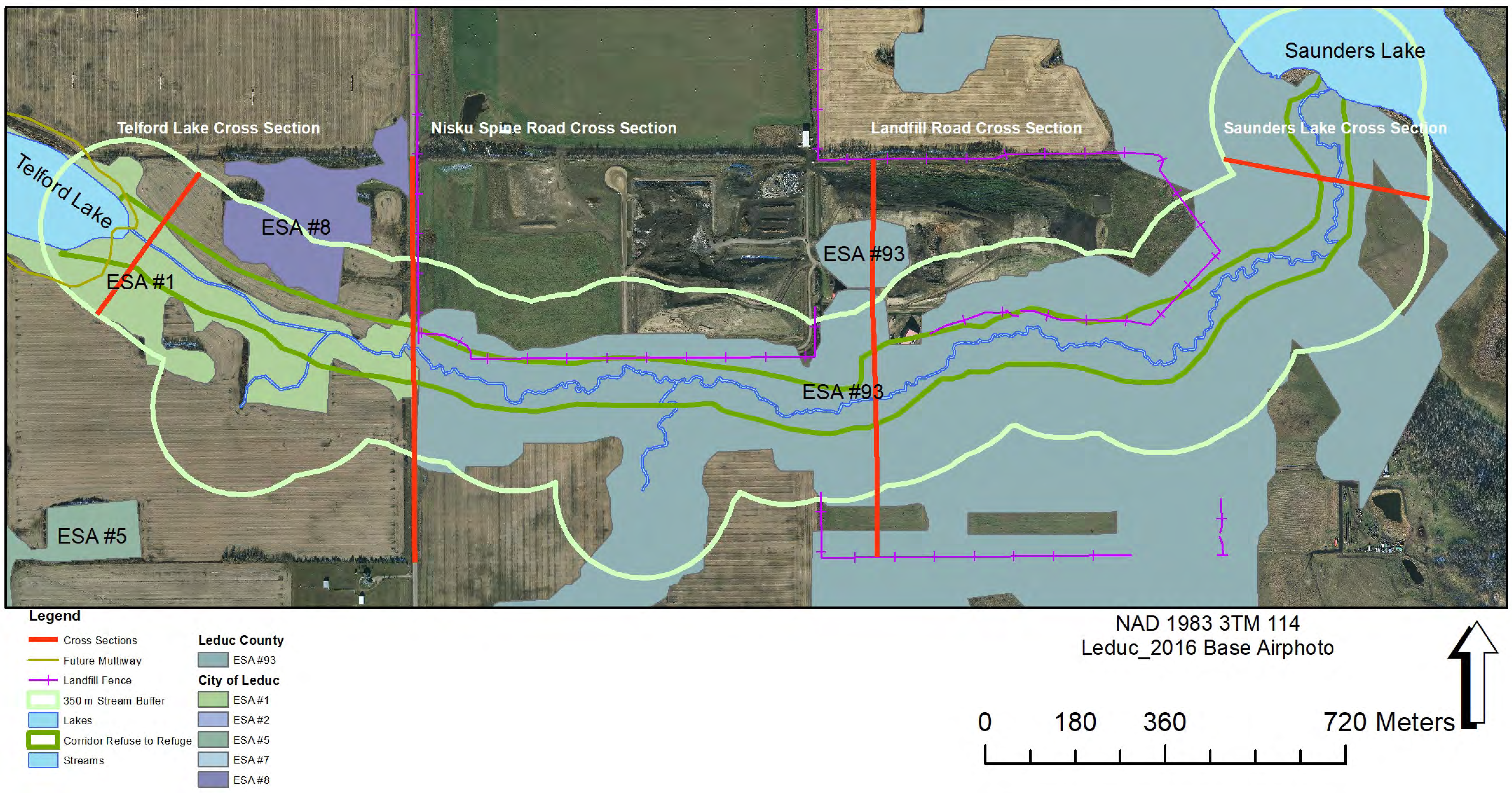


Fig.17 Recreation Trail Constant Features (ESAs included) Close Up

Wildlife Corridor Close-up without ESAs

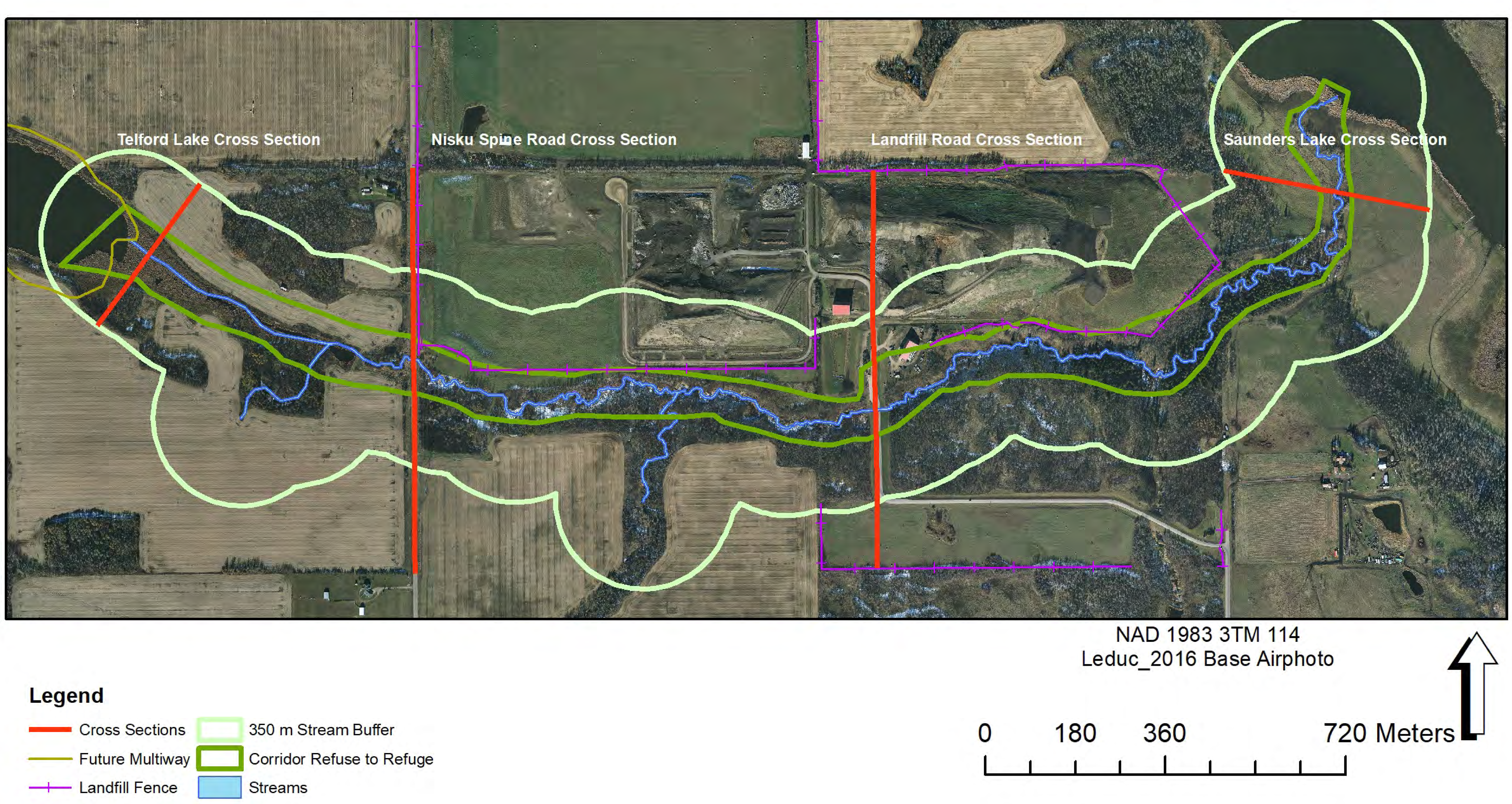


Fig.18 Recreation Trail Constant Features (no ESAs) Close Up

Wildlife Corridor Constant Features

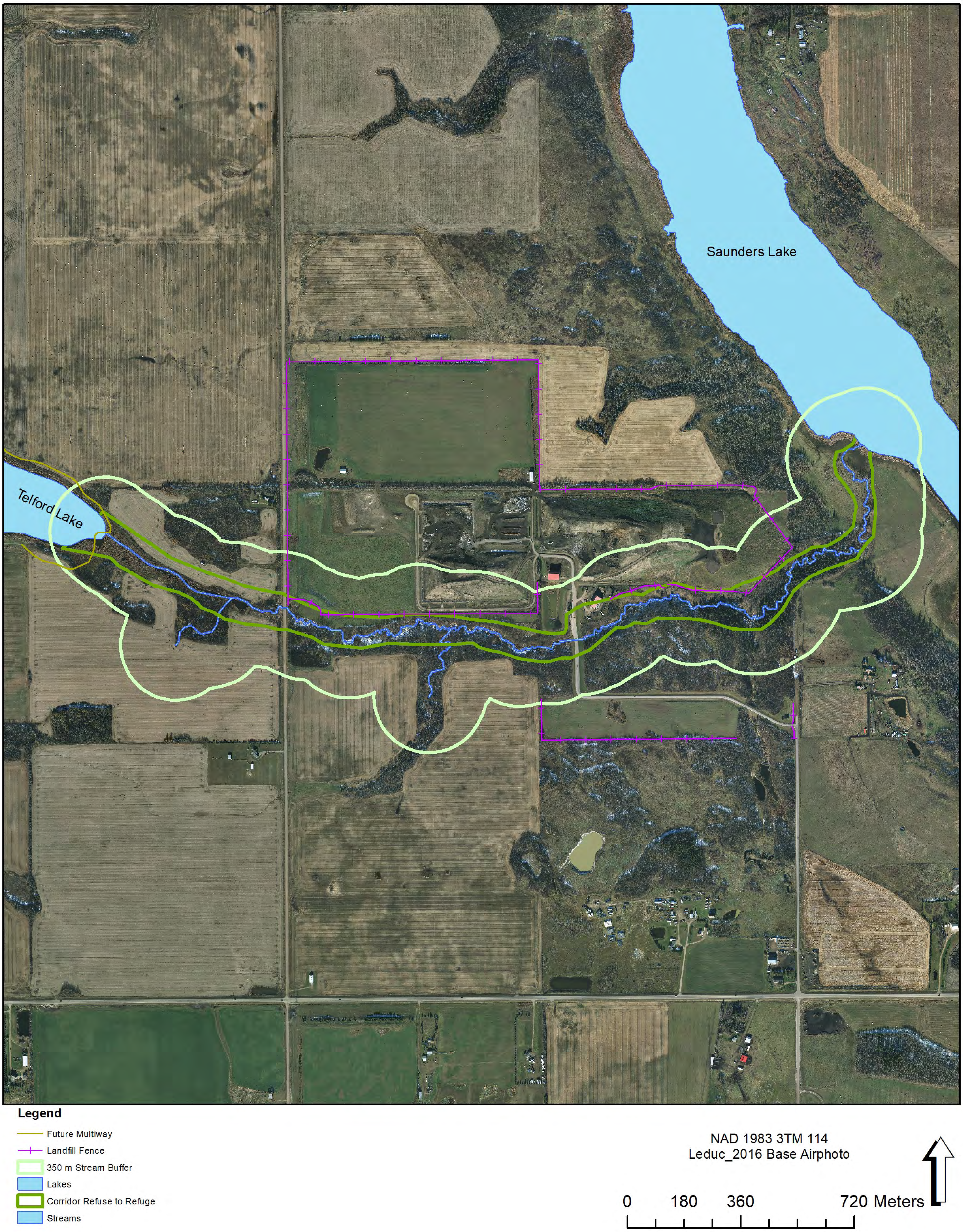


Fig. 19 Recreation Trail Constant Features

8. Potential Recreational Trail Routes

Three different trail route options have been proposed which provide the general layout and route of the recreational trail within the wildlife corridor. These three trail routes were determined using GIS methods that will be discussed later in this section. The trail routes provide the City of Leduc and Leduc County with multiple options for the location of the recreational trail route. As per the Terms of Reference (Appendix C), several options for recreational trails are outlined in this section; the northern route, central route, and southern route. All three different trails options begin at Telford Lake and end at Saunders Lake, but differ in where they cross the Nisku Spine Road. The following three options are illustrated in this section, with the benefits and drawbacks of each one.

From the literature review, and the best practices developed, the pedestrian crossing should be at a distance from the animal crossing, as to reduce putting additional stress on the wildlife. Due to this, two of the trail locations, the northern trail route and the southern trail route, have trail crossings at a different location than the wildlife crossing. The central trail route, proposes to have the trail cross the Nisku Spine Road adjacent to the wildlife corridor crossing as this the most direct and shortest route for trail users. Each trail route has strengths and weaknesses, which will be discussed in this portion of the report.

A summary SWOT table of the trail options is provided in Figure 35.

The following is a brief overview of the methods that were used in creating the proposed trails. ArcMap 10.5.1 was used to create an inventory of land uses within the area of interest. Several land use components were digitized from ASPs, ESAs, and other non-statutory plan documents. Each land use was then converted to a raster dataset of one meter pixels where they were reclassified and assigned weights. The weights were determined qualitatively to reflect the local context. In general, barriers to movement for the recreational trail included areas of high ecological importance and were given high weights. As such, these components have high costs to travel. Examples of barriers include but are not limited to the Landfill fence, the Nisku Spine Road, and water features. Land use features were then combined with slope data using the Weighted Sum Tool. Slope was determined from City of Leduc LiDAR data 2012 where land use features were weighted equally with slope. Finally the Cost Path Tool was used to identify the location of the proposed trail. Trails were then adjusted in small cases to reflect surface conditions such as vegetation. For each of the three trails which differ at the Nisku Spine Road, manual alterations were conducted to reflect the 800 m interchange restriction.

The recommendations also propose not developing the recreational trails outlined in the Refuse to Refuge document that are proposed in the current naturalized areas (Appendix D, Fig. 49)

8.1 Northern Trail Option

The Northern Trail option proposes to have the active use trail cross the Nisku Spine Road 380 m north of the proposed wildlife crossing (Fig. 20). This option keeps the recreational trail at a distance from the wildlife crossing, following recommendations developed from the best practices summary. As illustrated on Figure 20, the trail will start at the Telford Lake multi-use trail to the north of the wildlife corridor to provide connectivity to the proposed land-use plans in the City of Leduc, and continue to the north of the wildlife corridor until it terminates at Saunders Lake. By crossing the Nisku Spine Road to the north of the wildlife corridor, the trail will have to run adjacent to the roadway for roughly 380 m (Fig. 22), between the Nisku Spine Road and the fence of the Leduc Landfill to reconnect with the wildlife corridor. While this is not optimal conditions for trail users, it does prioritize wildlife over trail users.

This trail route is only located along the northern side of the wildlife corridor, providing full permeability of wildlife in and out of the corridor along the southern edge.

Figure 20 shows the proposed trail (in red) against the wildlife corridor, Nisku Spine Road, and the Landfill Road. A number of cross-sections are provided in Figures 21 and 24. Figure 22 shows the proposed trail (in yellow) overlaid across the aerial photo for the project site. Figure 23 shows the proposed trail overlaid across the proposed land uses, as provided in the East Telford Lake ASP and the Refuse to Refuge document. Figure 23 shows how the trail will interact with current and future land uses.

Wildlife Corridor and Recreational Trail - Northern Route

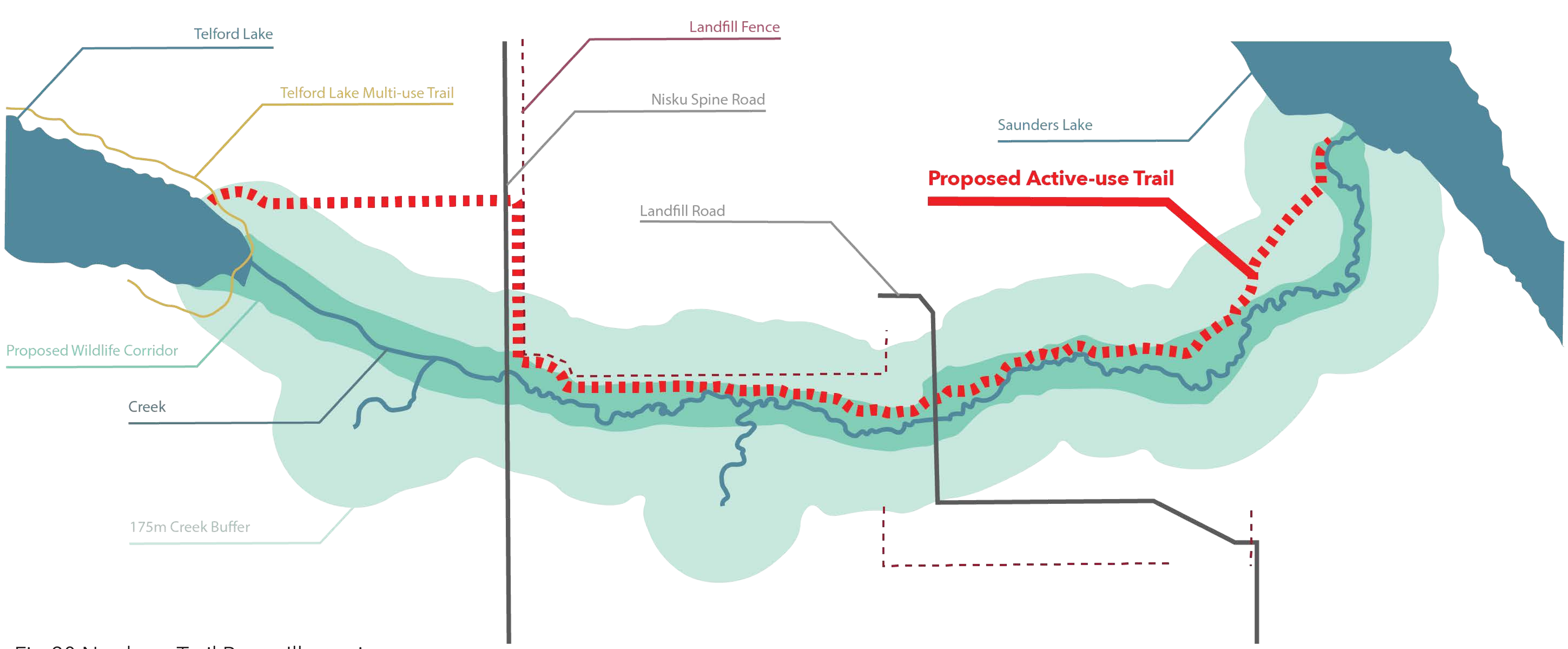


Fig.20 Northern Trail Route Illustration

Wildlife Corridor and Recreational Trail Cross Sections- Northern Route

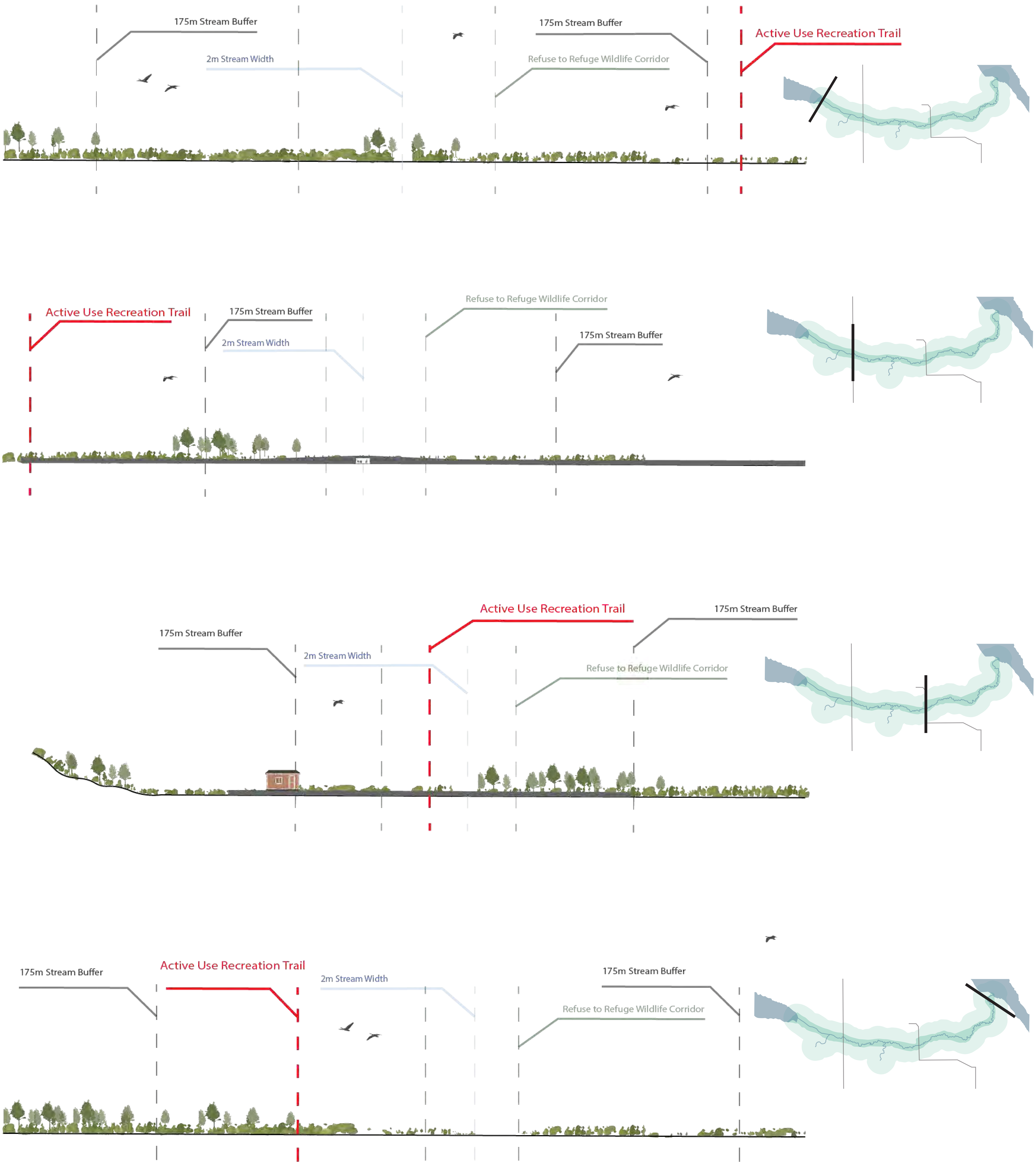


Fig.21 Saunders Lake Cross Section (facing West)

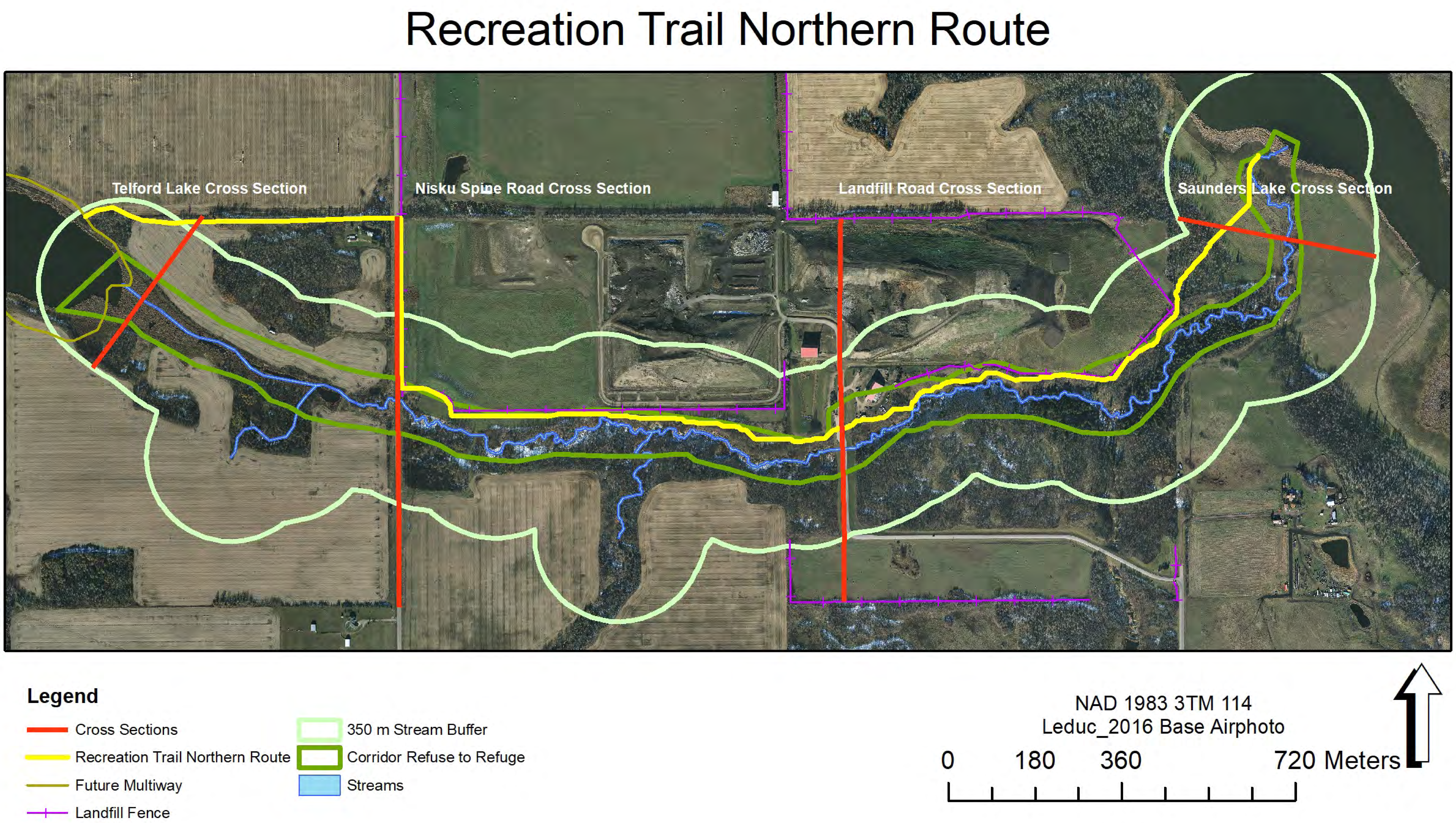


Fig.22 Recreation Trail Northern Route

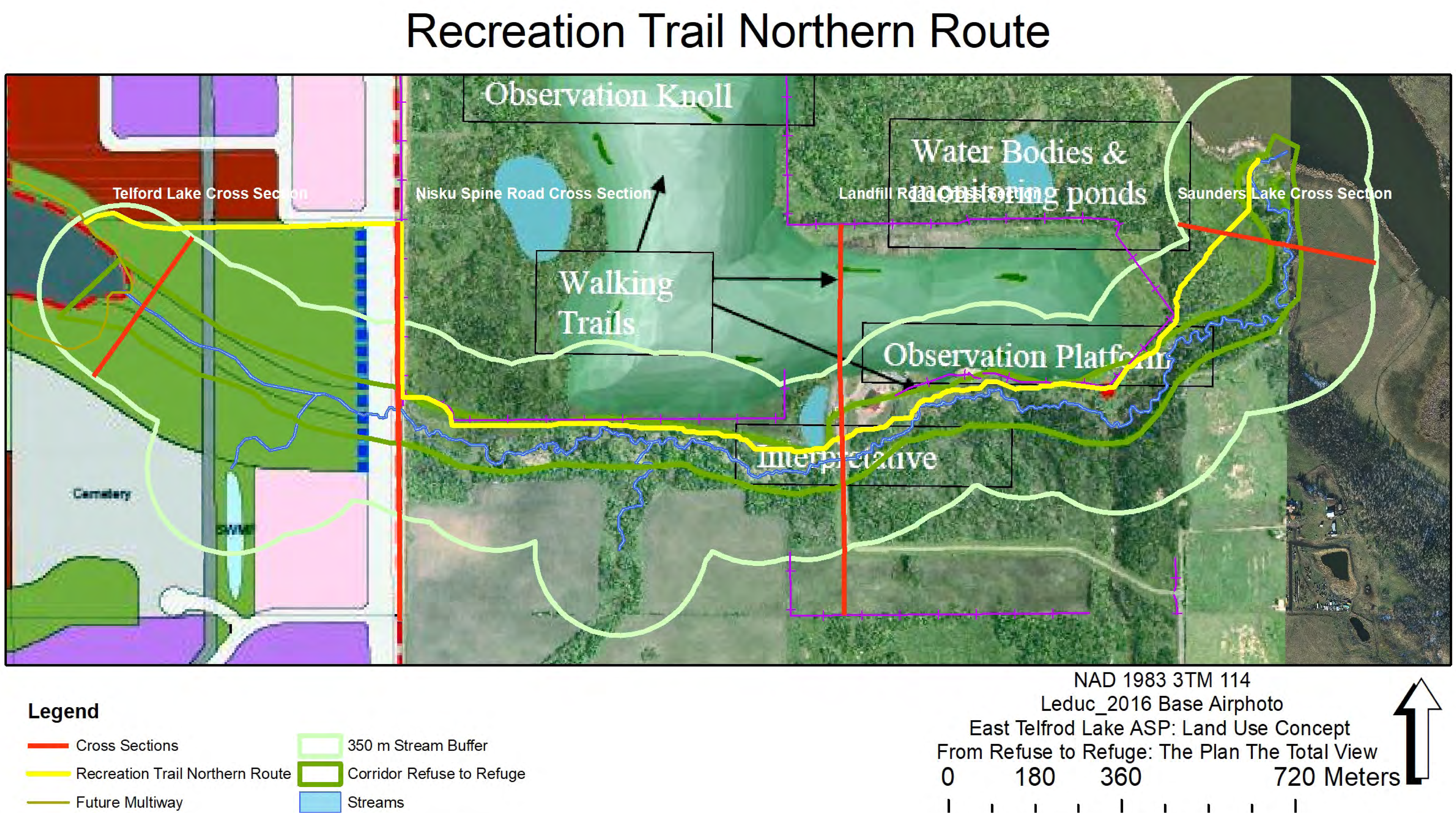


Fig.23 Recreation Trail Northern Route

Northern Recreation Trail Overview of Cross Sections

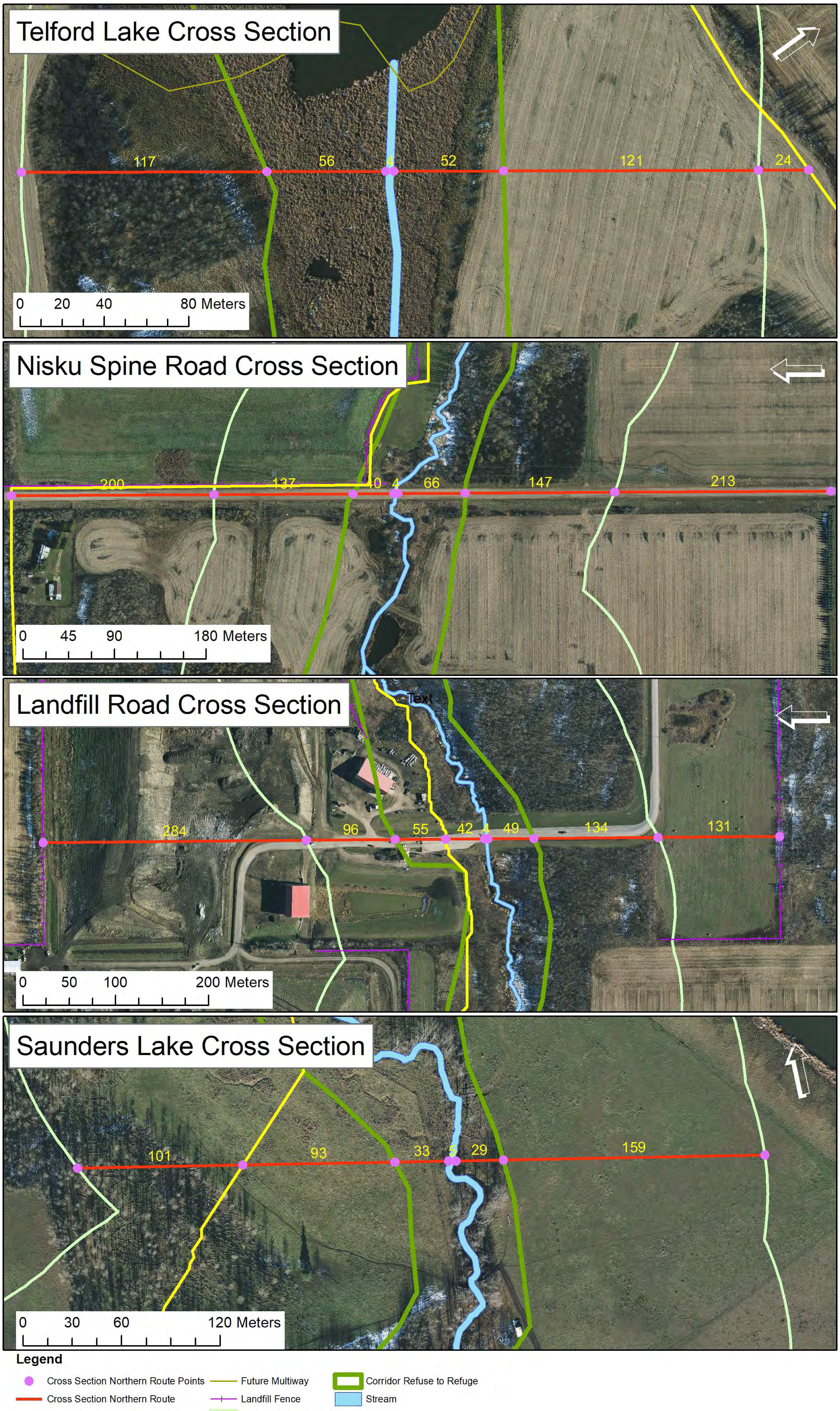


Fig.24 Northern Recreation Trail Overview of Cross-Sections

8.2 Central Trail Option

The central trail route connects with the Telford Lake multi-use trail, starting on the southern side of the wildlife corridor and running adjacent to it until the Nisku Spine Road. The trail crosses the roadway at the same point as the wildlife crossing, however this is within 800 m of the proposed turnoff for the City of Leduc proposed cemetery, and therefore there cannot be an at-grade intersection as per the Range Road 245 and 250 Functional Planning Study (McElhanney Consulting Services Ltd., 2010). This trail route also has the closest pedestrian and wildlife crossing of the three routes, which is not recommended based off of the best practises, as it raises stress for wildlife.

Figure 25 shows the proposed trail (in red) against the wildlife corridor, Nisku Spine Road, and the Landfill Road. A number of cross-sections are provided in Figures 26 and 29. Figure 27 shows the proposed trail (in yellow) overlaid across the aerial photo for the project site. Figure 28 shows the proposed trail overlaid across the proposed land uses, as provided in the East Telford Lake ASP and the Refuse to Refuge document. Figure 28 shows how the trail will interact with current and future land uses.

Wildlife Corridor and Recreational Trail - Central Route

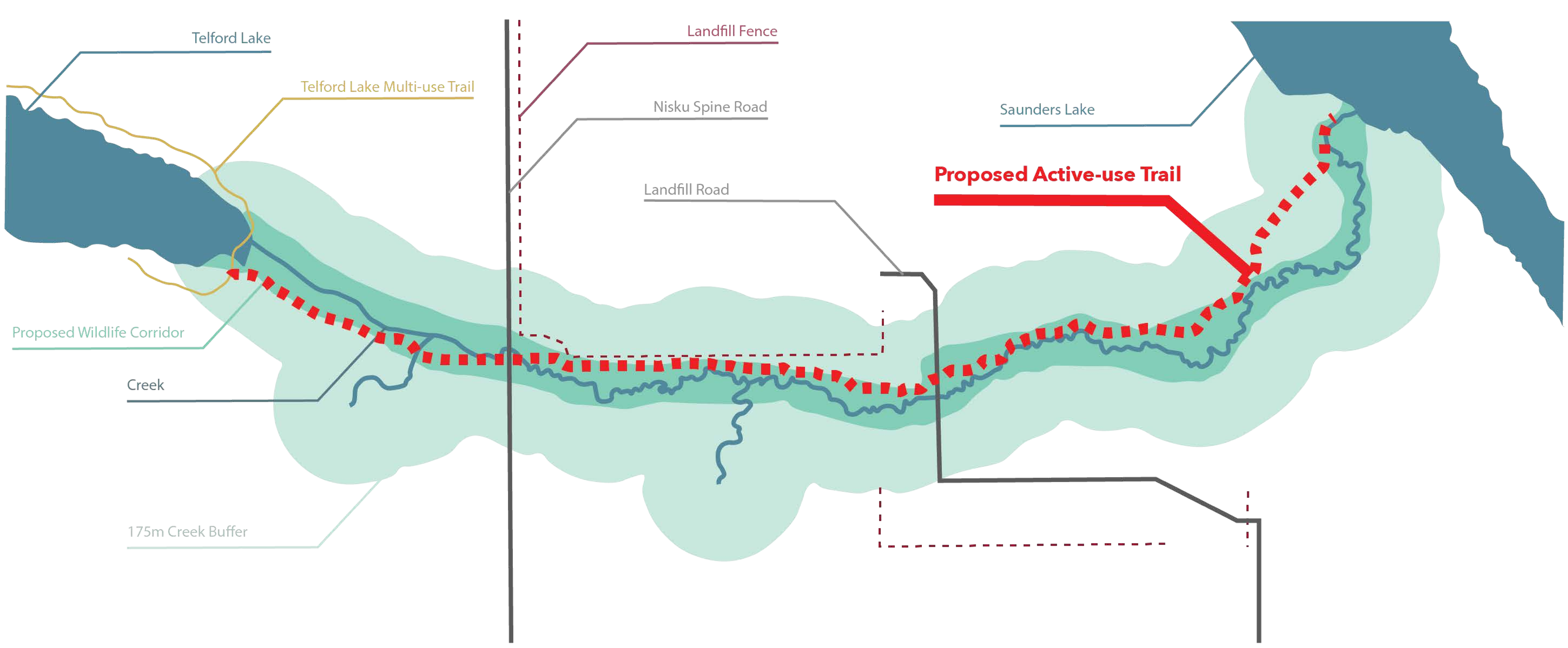


Fig.25 Central Trail Route Illustration

Wildlife Corridor and Recreational Trail Cross Sections- Central Route

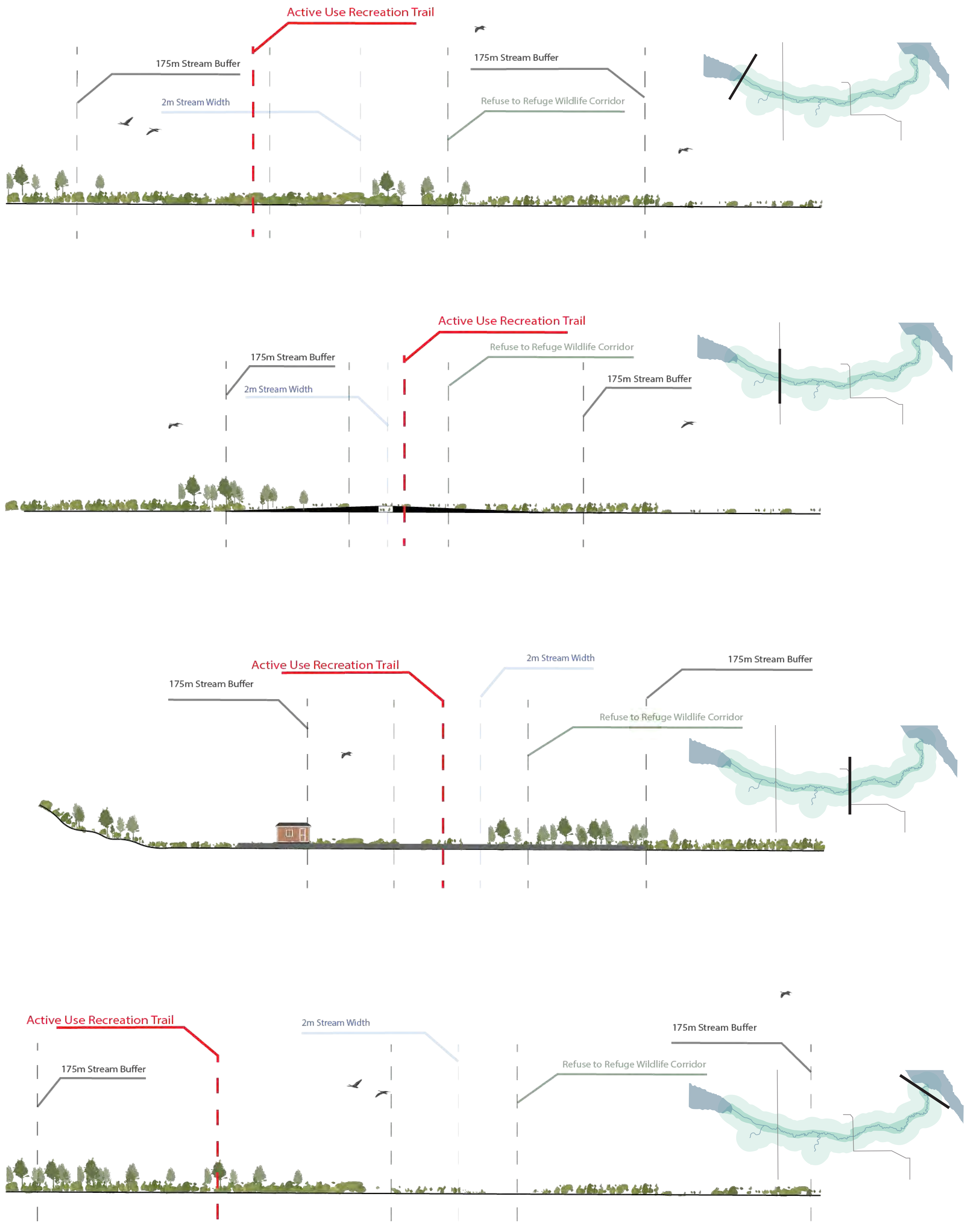


Fig.26 Saunders Lake Cross Section (facing West)

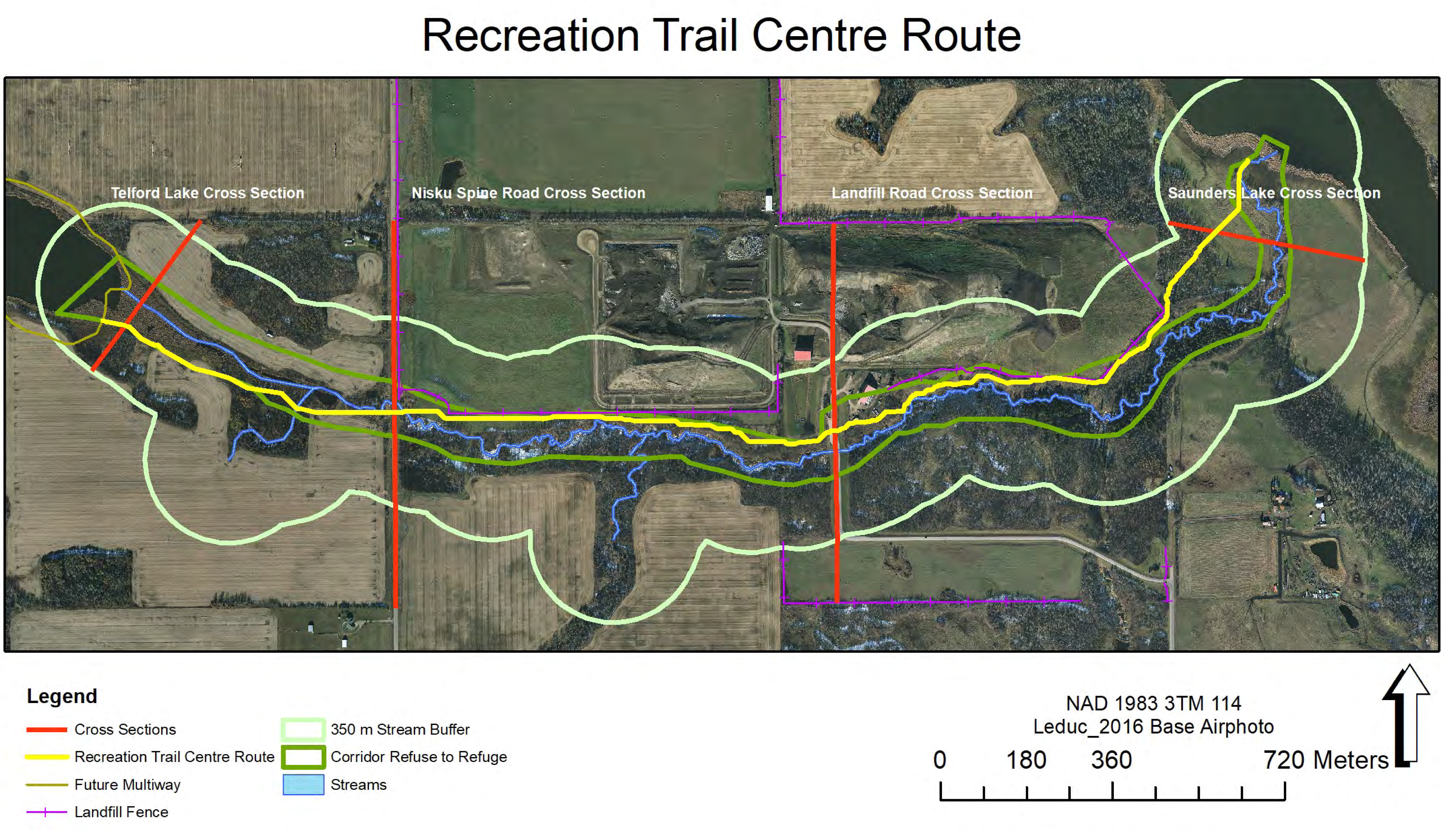


Fig.27 Recreation Trail Centre Route

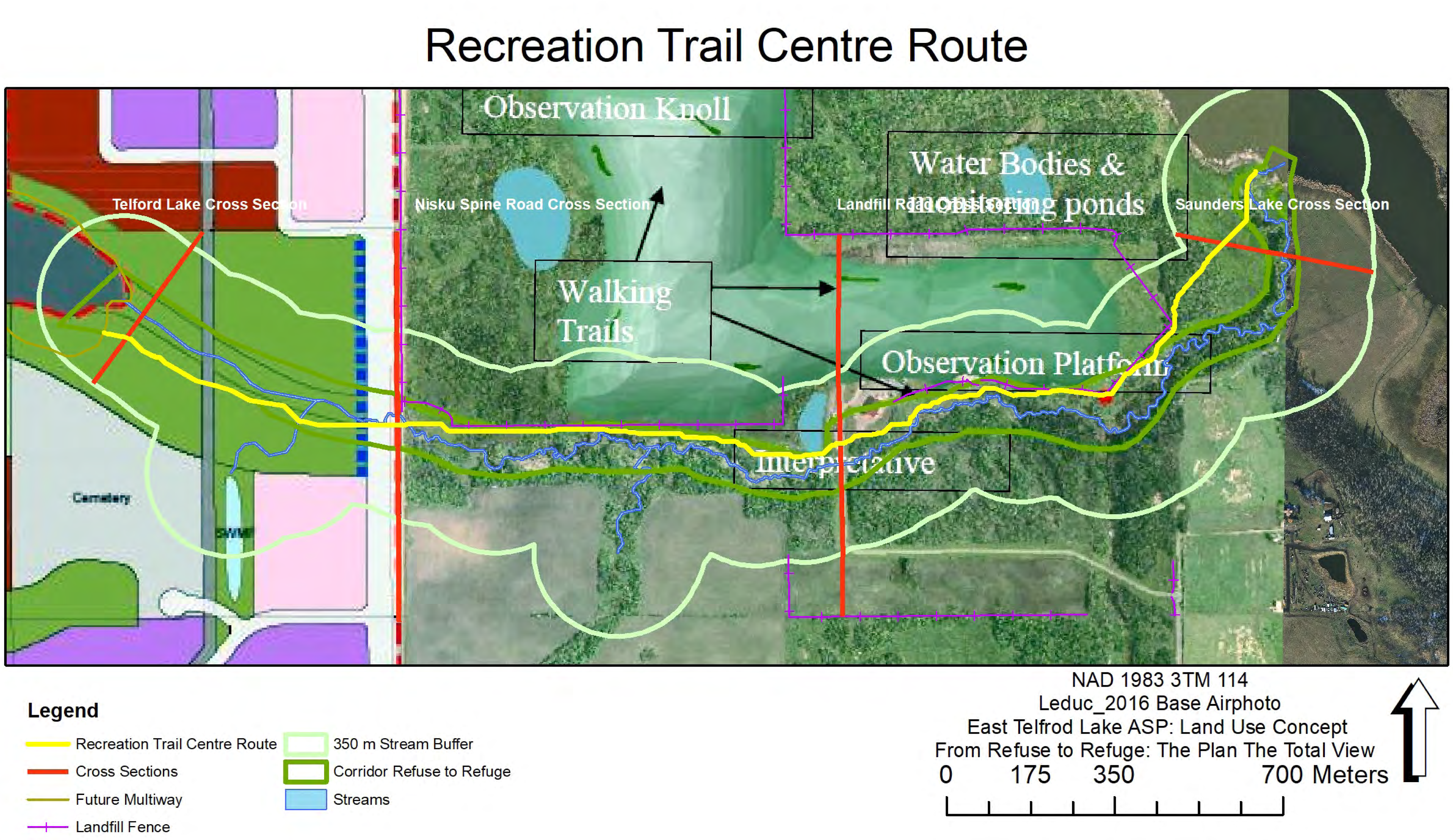


Fig.28 Recreation Trail Centre Route

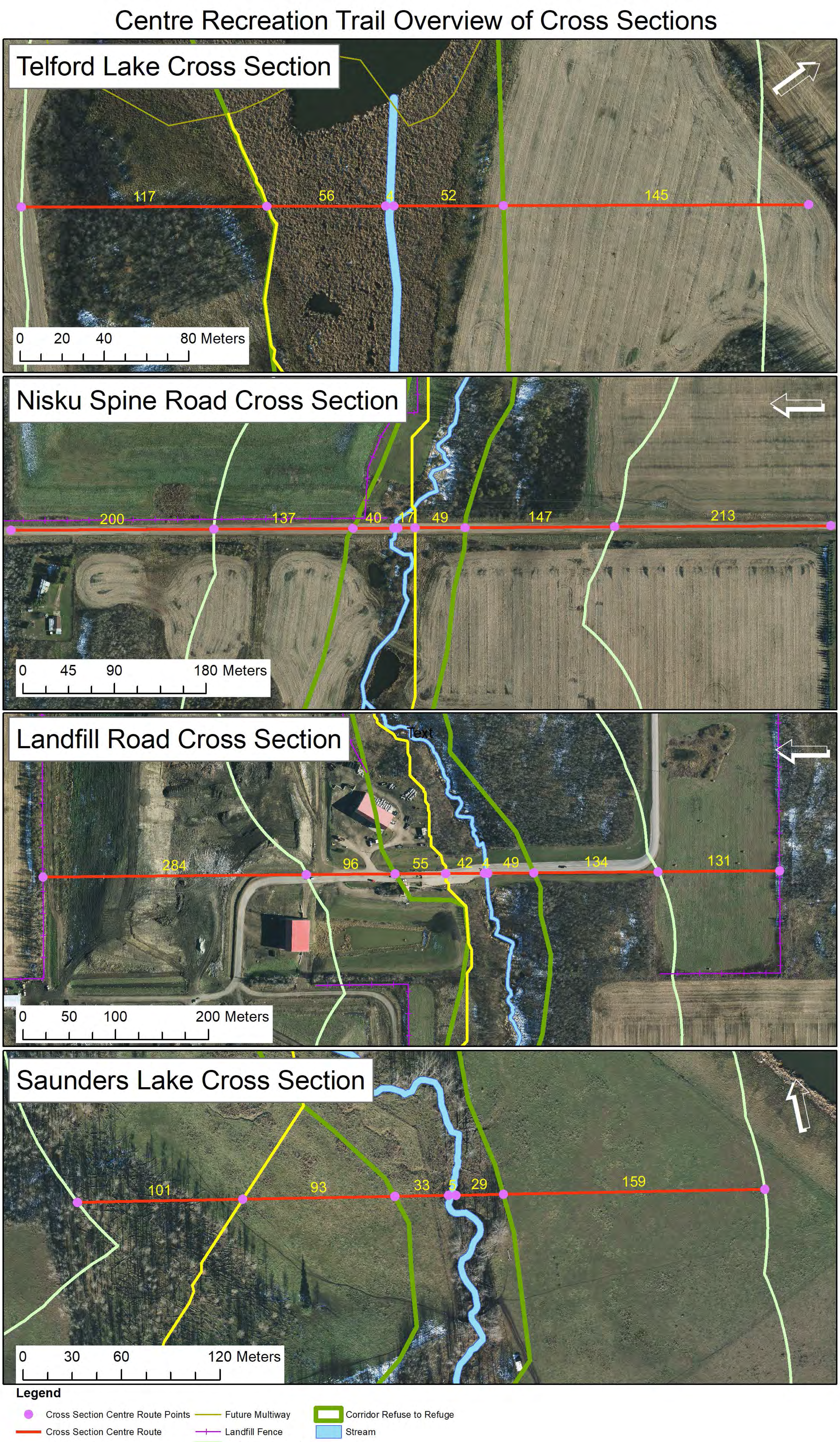


Fig.29 Central Recreation Trail Overview of Cross-Sections

8.3 Southern Trail Option

The southern trail option will start at the Telford Lake multi-use trail, same as the centre trail route, but will connect to the trail system on the south side of the wildlife corridor. From the multi-use trail, the recreational trail will connect with the proposed City of Leduc cemetery to the south of Telford Lake (Fig. 33). This trail route can have the pedestrian crossing of the Nisku Spine Road at the same location as the vehicle turnoff for the City of Leduc Cemetery (Fig. 33), combining the two crossings. Following the Nisku Spine Road crossing, the trail will continue along the eastern edge of the road, crossing the wildlife corridor, and then continue along the northern edge of the wildlife corridor, following the same pathway as the northern route. The lands located south of the stream and east of the Nisku Spine Road were not identified to be part of any ASP or other land use planning document (Fig. 5). This presents an opportunity to locate the recreational trail in a way that supports wildlife movement and is conducive to recreational uses. This option attempts to connect further south by connecting to the southern portion of the Leduc County ESA #93. As these lands become considered for incorporation into future land use plans the trail should be considered. The southern option has some strengths in connecting the City of Leduc Cemetery into the recreational trail system.

Figure 30 shows the proposed trail (in red) against the wildlife corridor, Nisku Spine Road, and the Landfill Road. A number of cross-sections are provided in Figures 31 and 34. Figure 32 shows the proposed trail (in yellow) overlaid across the aerial photo for the project site. Figure 33 shows the proposed trail overlaid across the proposed land uses, as provided in the East Telford Lake ASP and the Refuse to Refuge document. Figure 33 shows how the trail will interact with current and future land uses.

Wildlife Corridor and Recreational Trail - Southern Route

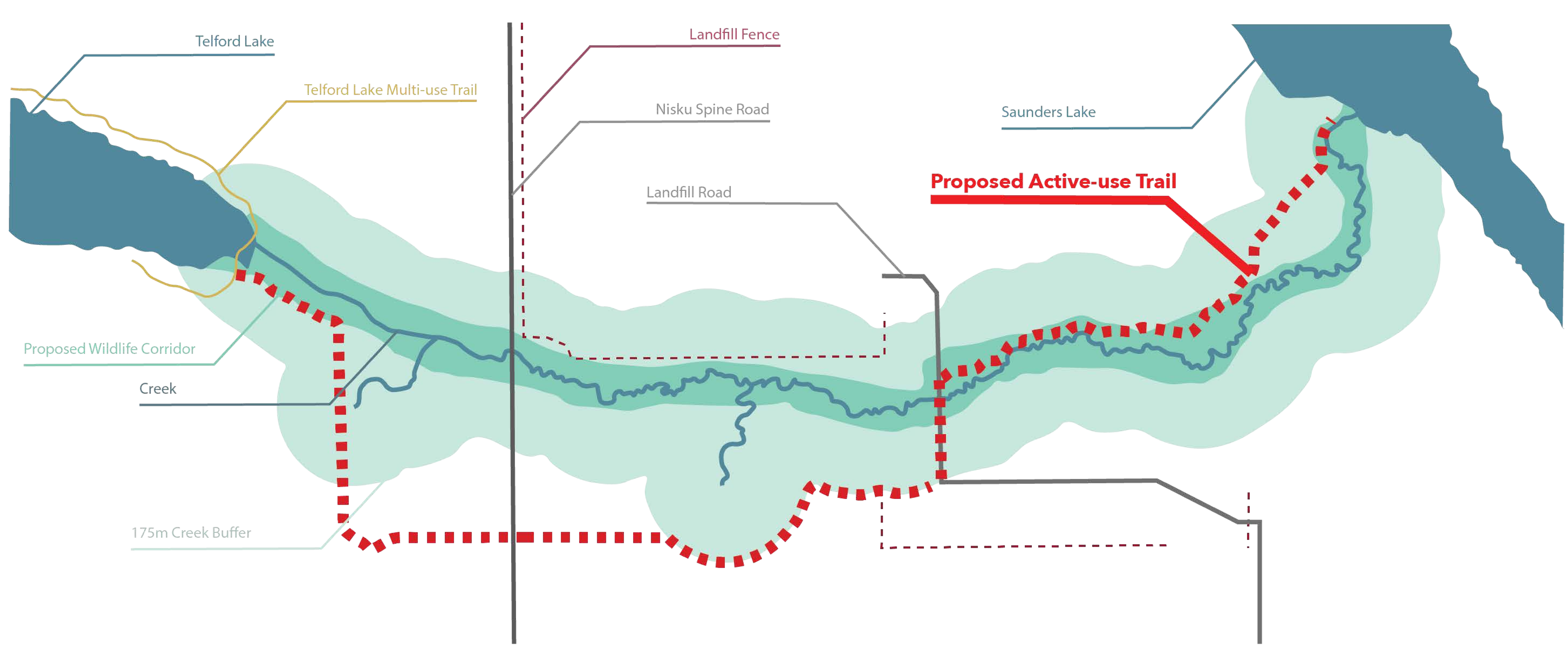


Fig.30 Southern Trail Route Illustration

Wildlife Corridor and Recreational Trail Cross Sections- Southern Route

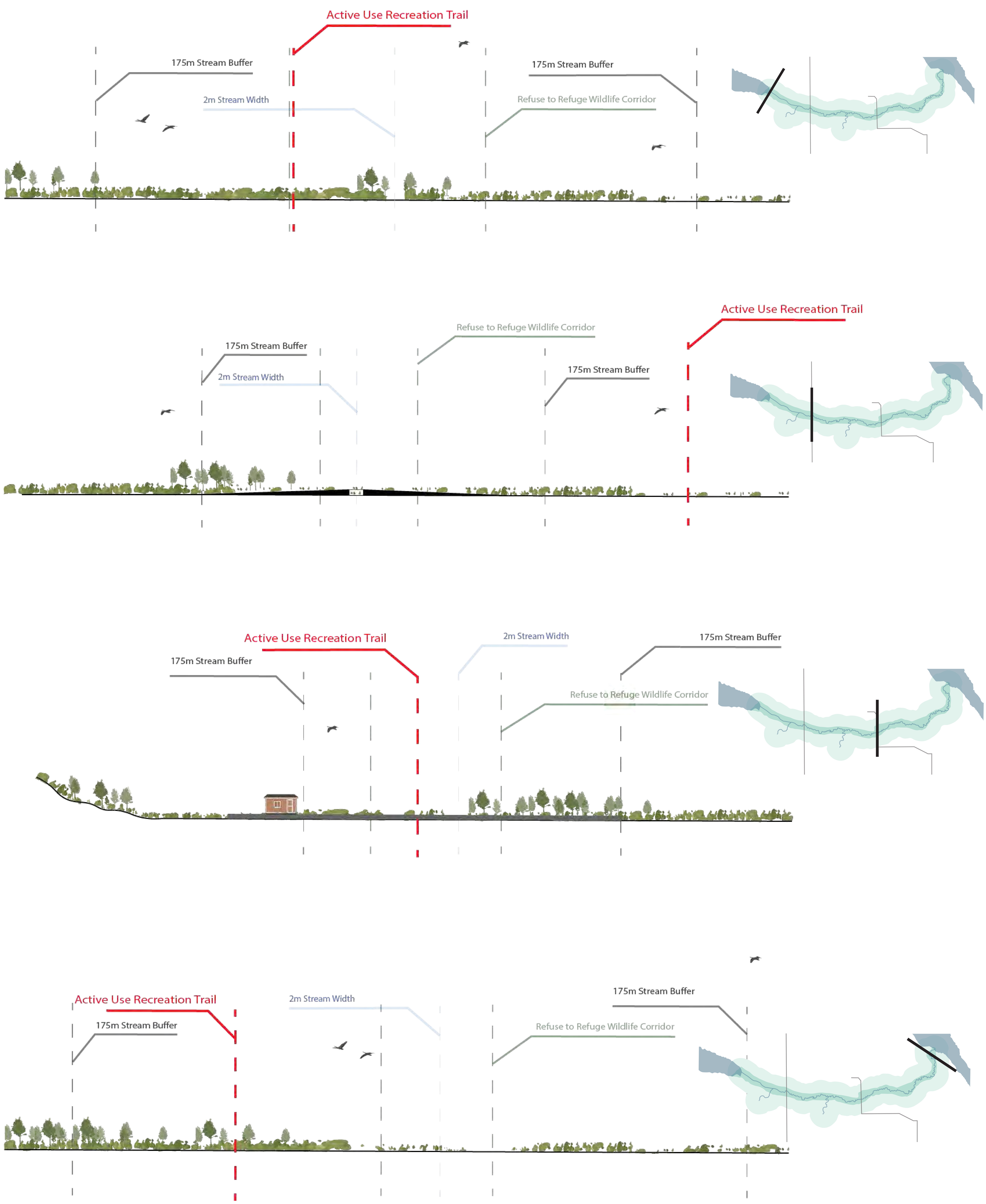


Fig.31 Saunders Lake Cross Section (facing West)

Recreation Trail Southern Route

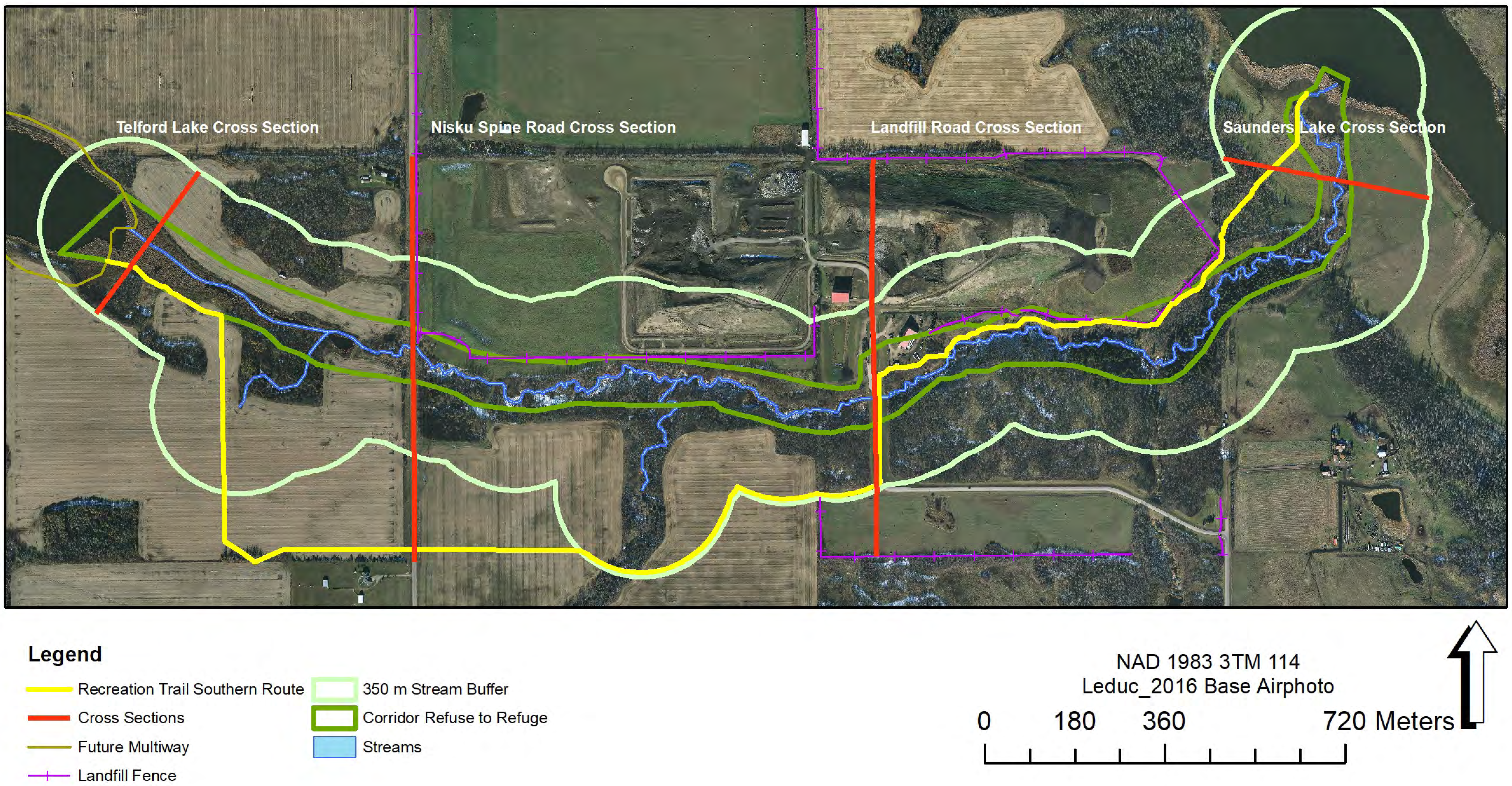


Fig.32 Recreation Trail Southern Route

Recreation Trail Southern Route

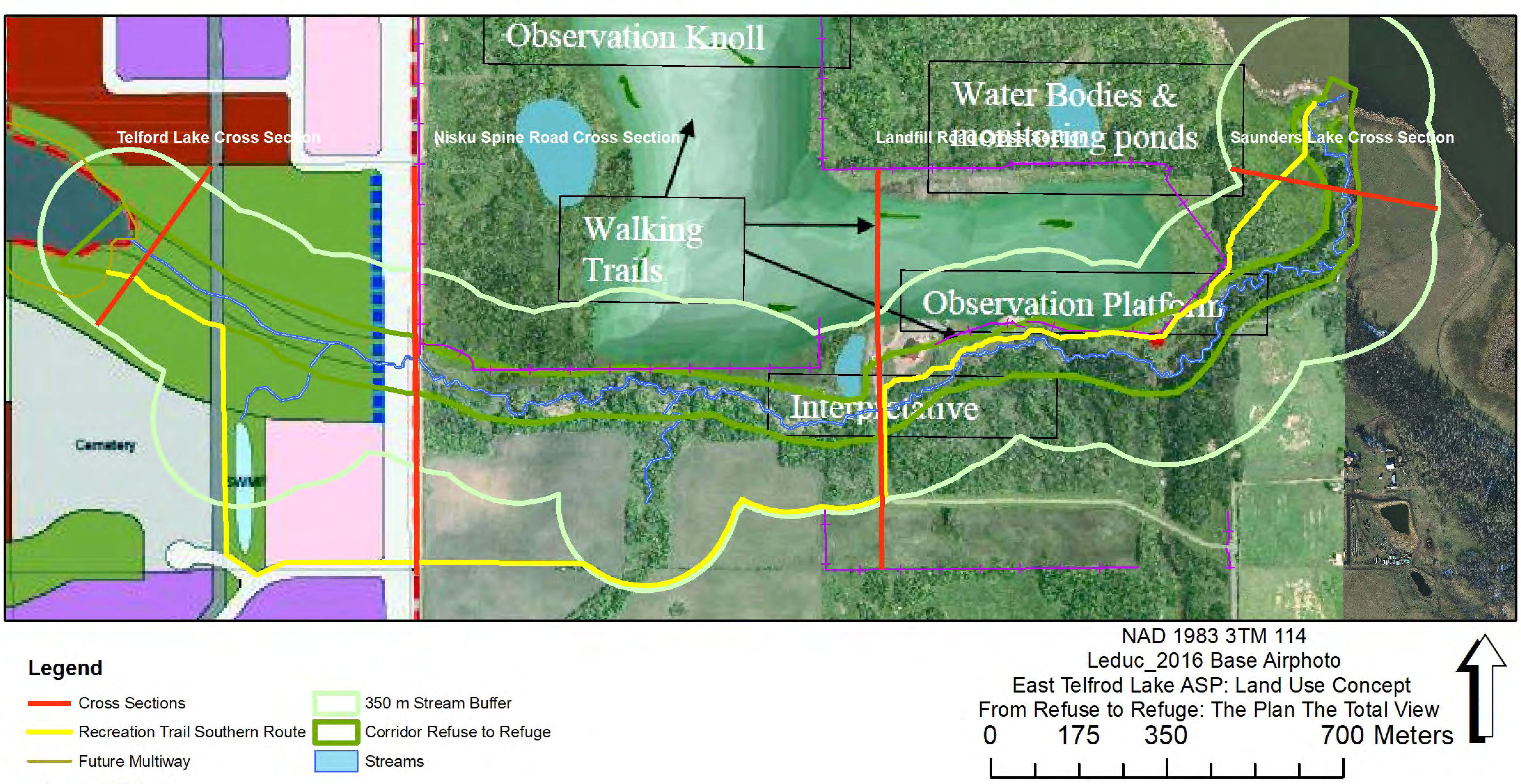


Fig.33 Recreation Trail Southern Route

Southern Recreation Trail Overview of Cross Sections

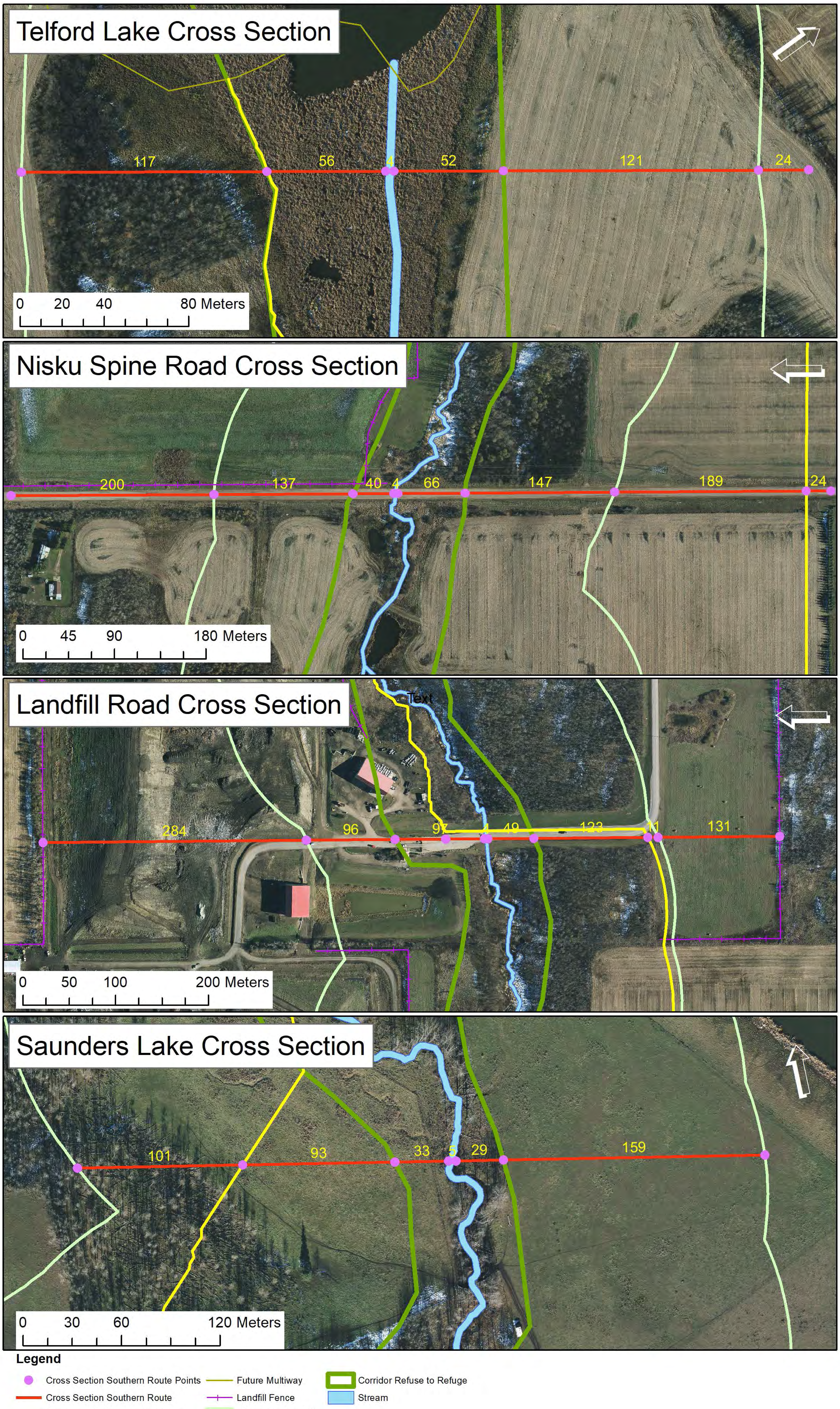


Fig. 34 Southern Recreation Trail Overview of Cross-Sections

	North	South	Stream
Strengths	• Crosses the Nisku Spine Road at a future intersection • Maintains the entire recreational trail on the north side of the stream • Makes use of city owned lands	• Crosses the Nisku Spine Road at a future intersection • Makes use of future land uses on City Lands such as the Cemetery and Stormwater Management pond	• Provides the shortest route between Telford Lake and Saunders Lake
Weaknesses	• Undesirable location of a 380 m section of trail between the Nisku Spine Road and the Landfill fence.	• No guarantee that lands would be dedicated along the southern route	• Recreational trail requires a grade separation from the Nisku Spine Road • An additional culvert would be required for the recreational trail or the Wildlife Culvert would have to be significantly wider
Opportunities	• Integrate the trail into portions of the landfill that are decommissioned or not yet operational	• May allow for future connection to ESA#2 and ESA #5 • May influence the development of a ASP on the South County lands ○ Could see several trail connections that incorporate the south intersection and future roads	
Threats	• The perception of safety may limit recreational use especially along the section running parallel to the Nisku Spine Road	• The perception of safety may limit recreational use especially if the route runs parallel to the Nisku Spine Road	• The perception of safety may limit users from utilizing a underground culvert

Fig.35 SWOT Analysis for Potential Trail Locations

9. Design Options

From the best practices and literature review, several design elements have been identified that should be included within the wildlife corridor and trail network to better facilicate the movement of both people and animals through the corridor. These design elements include the type and location of trail signage, trail drainage, the pedestrian and wildlife crossings of the Nisku Spine Road and using the green cemetery as a connection.

9.1 Trail Signage

Types of signage and wayfinding for trails can include General Signage, trail network signage, and trailhead signage as was discussed in Section 3 of this report. General Signage would provide ecological and environmental information; they are designed to be interesting and attractive, as well as instill pride in the community. Trail Network Signage is placed at any entrances of trails and provide basic safety, trail etiquette, and important location information. Trailhead Signage is placed at major access points to orient users. Wayfinding should be simple, clear, and easy to read.

Crossing signage will be placed where the trail intersects with roads. Notable locations include the Nisku Spine Road and the Landfill Road south of the Leduc Landfill (Fig. 37). This trailhead signage is intended to inform and alert motorists and pedestrians of the crossing, ensuring safety for all users. The following icons are examples of elements that may be incorporated on signage (page 54 and 55). Figure 36 provides an example of trail signage with these icons.

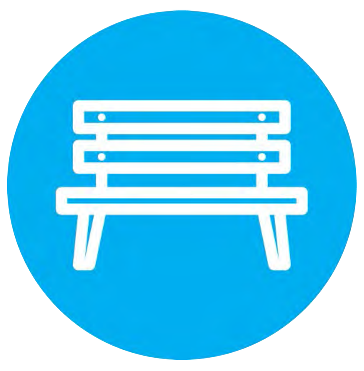
Fig.36 Trail Signage Illustration

Users of the trail must stay on the trail path at all times. Trail network signage at the entry/exit points will indicate as such. Trail network signage will continue orienting users at interim points.

Waste disposal will be placed at interim points on the trail beside seating. Trail network signage at the entry/exit points will indicate the locations of waste disposal on the trail network.

Pets are required to remain on-leash throughout the trail network. This will ensure no adverse effects to wildlife from domestic pets arise. Trailhead signage at the entry/exit points of the trail will indicate as such.

Seating will be provided at interim points throughout the trail network to provide rest and lookout areas for visitors. Trail network signage will indicate the location of benches.



As the design of the trail primarily seeks to have the least amount of impact on the naturalized environment, additional accessibility infrastructure will be limited. Trail Head Signage will notify visitors of these conditions at entry/exit points.

Washrooms will be provided at parking areas. Trail network signage may indicate the location of washrooms.

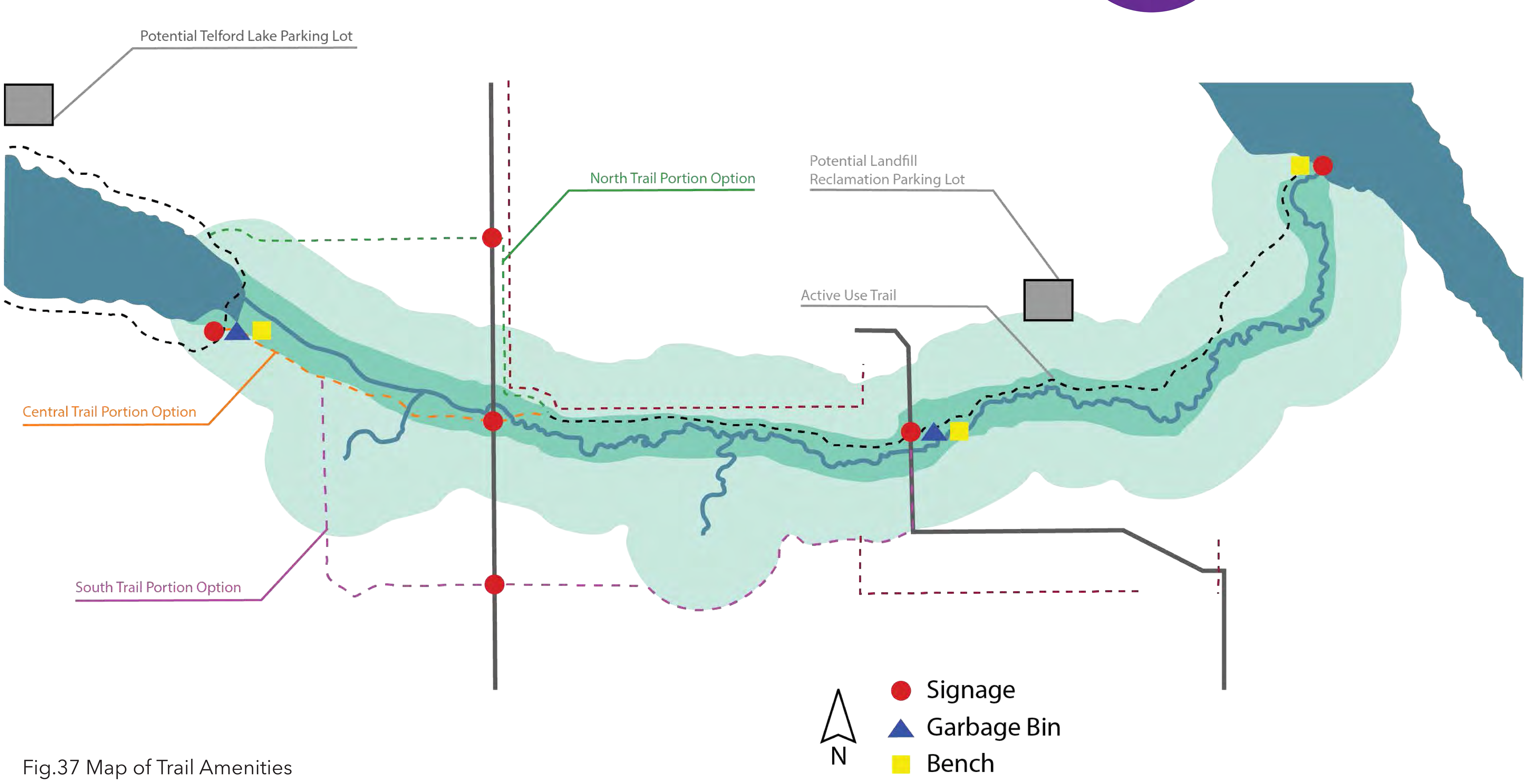


Fig.37 Map of Trail Amenities

History signage will inform users of the various aspects that contribute to the historical significance of the area. General signage will be placed at interim points throughout the trail, preferably near benches and waste disposal.

Environmental context signage will inform users of the various environmentally significant aspects of the area (e.g. significant species). General signage will be placed at interim points throughout the trail, preferably near benches and waste disposal.

9.2 Trail Drainage

Drainage for the trail system will be designed to ensure the least amount of impact possible on the surrounding environment. This will be done through an open system which involves swales and sheet flows. The trail surfacing will be designed to direct water flow to the edges of the trail into the swales on the periphery. This naturalized system of drainage will ensure minimum impact on the surrounding environment. This is illustrated in Figure 38 below, which shows the trail sloping down on either side from the centre, as to direct water to the edges of the trail, and into the swales. Please note this figure is purely illustrative and meant to be a visual aid.

Fig.38 Illustration of Trail Drainage

9.3 Pedestrian Crossing

To ensure the effectiveness of the trail system, there needs to be an effective pedestrian crossing for the Nisku Spine Road. It is important that the pedestrian crossing be separate from the wildlife crossing. The presence of humans is a significant deterrent to the usage of the crossing by wildlife. Trail users should not attempt to cross the highway except at designated places. Fencing along the length of the road will prevent animals from being able to cross the highway at-grade and will also serve to prevent jaywalking attempts. Signage is also a tool that can be used to prevent undesired crossing attempts.

A number of pedestrian crossing structures were assessed to determine which would be most appropriate for the Nisku Spine Road:

At-Grade Intersection

In this option, pedestrians will cross the Spine Road using an intersection with a traffic light. In the Range Road 245 ad 250 Functional Planning Study (McElhanney Consulting Services Ltd., 2010), the Spine Road is intended to have a minimum intersection separation of 800 m. Intended intersections are to be 800 m north of Rollyview Road and a further 800 m north of that. An at grade pedestrian crossing would have to locate at one of these two intersections. See Section 8 for intersection locations.

At-grade intersections do present a number of challenges: the highway is to be 35.2 m wide, not including ditches. Therefore any pedestrian crossing time will have to be long enough to allow pedestrians to cross safely. A potential design option is to provide a pedestrian rest area in the median. A traffic warning light could be located north of the project site, along the curve of the road, indicating when the light was red and vehicles need to slow down and stop. The City of Leduc and Leduc County could also consider reducing the number of lanes at the intersection, reducing the speed near this intersection, or adding a median rest point.

Pedestrian Underpass

An underpass would consist of a tunnel beneath the highway that travels perpendicular to the direction of the highway. The most significant benefit of an underground pedestrian tunnel is that pedestrians do not interact with traffic, preventing a pedestrian collisions. This also means that the crossing could locate anywhere in the road, as opposed to just at intersections. However, an underground crossing would be more expensive than an at-grade crossing. Additionally, there is a significant security concern around an underground crossing. This tunnel would have to be 35.2 m long at least to span the ultimate width of the highway, with only two access points and limited lighting. This tunnel has the potential to become unsafe and therefore unlikely to be used. If an underpass is considered, it is recommended that the tunnel be fairly wide, so as to not feel constrictive, and be very well lit.

Pedestrian Overpass

A pedestrian overpass would have the same benefits as an underpass; it would prevent adverse interactions between pedestrians and automobiles. However, an overpass would have less of a security concern, as it would be visible to traffic below and be brighter due to natural lighting. The concern remains around the cost of the overpass, which would have to be at least 5 m high and span the 60 m width of the highway, including the ditches. Additionally, an overpass exposes users to wind and weather conditions and may become icy in winter, reducing the ease of use for some users. Pedestrian crossings have been shown to be effective at reducing crashes (Federal Highway Administration, 2003).

The different types of crossing structures have their respective strengths and weaknesses. An at-grade crossing is the most economical, but does present the possibility of an accident between pedestrians and automobiles if either user fails to follow protocol. Underpasses eliminate the possibility of pedestrian collisions, but are more expensive and are a security concern. Similarly, an overpass reduces the possibility of a collision but is more expensive. Literature reviewed found that pedestrian overpasses can be effective in reducing collisions, providing that it is more convenient and faster than at-grade crossings (Aborjaradeh, 2013 and Federal Highway Administration, 2003).

It is recommended that the at-grade pedestrian crossing be used for the trail system. Because a pedestrian intersection cannot be established between the two planned traffic intersections, an overpass is the preferred option for the Central Trail Route (Section 8.2). Use of the crossing should be monitored, and if the highway is a significant barrier to the use of the trail, an overpass or underpass should be considered. Recreational users should be consulted prior to the decision to add an overpass or underpass being made.

9.4Wildlife Crossing

Due to the width and traffic volume of the Nisku Spine Road, the highway presents a near impenetrable barrier to wildlife movement as was discussed in the best practices summary. A crossing structure is necessary to maintain the connectivity between the lakes and prevent collisions between automobiles and wildlife. Based on best practices and research, the most appropriate crossing structure would be a box culvert.

At-grade and overpass crossing structures were assessed but considered infeasible. At-grade crossing methods are ineffective on wide roads with a high design speed, like the Nisku Spine Road. While not recommended, an at-grade crossing structure should incorporate the following design measures to be effective. An at-grade structure would require a significant reduction in speed to lower the chance of collisions and number of fatal crashes. If possible, at the crossing structure, lanes should be reduced so the crossing is of less width. Reducing the number of lanes would also have the benefit of reducing speed.

Wildlife crossing signs can help warn drivers to be aware of upcoming threats. However, even with these measures in place, the effectiveness of an at-grade structure will be severely limited and is not recommended.

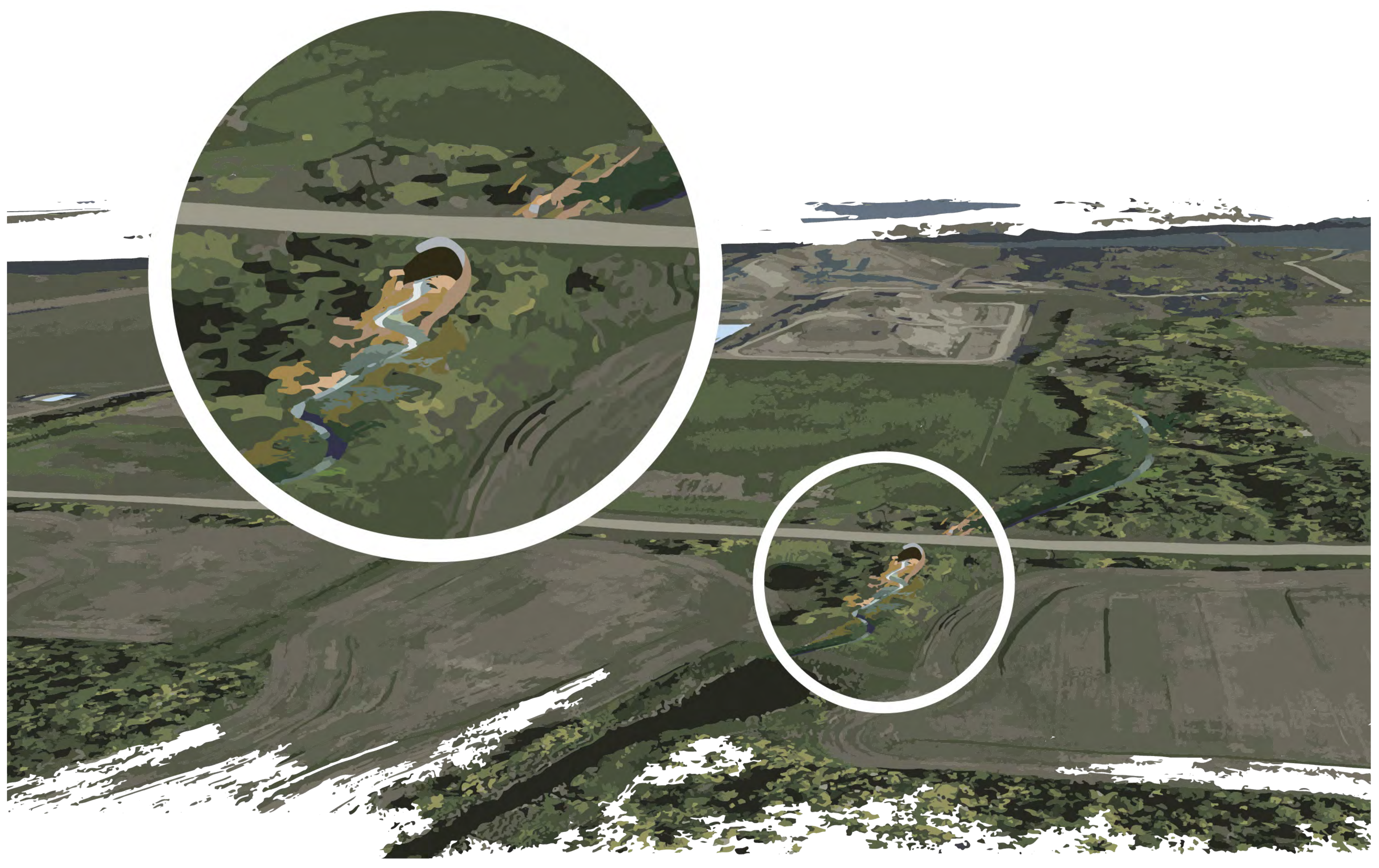


Fig.39 Wildlife Crossing Close-up

An overpass structure for wildlife was also considered, but also comes with significant challenges, mostly in economic feasibility. Because of the industrial nature of the Nisku Spine Road, it is anticipated that tractor trailer units will likely be using this road. As these vehicles can reach heights of 4.1 m. Anticipating a height of 5 m for the overpass, the structure would have to be sufficiently long. Species are unwilling to travel a slope of 25 degrees or more, so we used an estimate of 20 degrees to calculate the length of the ramp required. Because of this, the structure would require a ramp of approximately 14 m on each side, in addition to the 35.2 m width of the road, which does not include the width of the ditches. The overpass would also have to be wide enough to accomodate species, who are unwilling to travel across thin paths that can trap prey. Evink (2002) found that overpasses at least 60 m wide are more effective than narrower overpasses of less than 50 m. Another study gave a minimum width of 50 m for overpasses encouraging large mammals (Wieren & Worm, 2001). Research on the effectiveness of overpasses versus underpasses is inconclusive, with some studies indicating, given a choice between an overpass and underpass, ungulates, which are animals with hooves such as deer or moose, prefer to use overpasses (Corlatti, Hacklander, & Frey-Roos, 2009 and Simpson et al., 2016). However, other papers indicate deer prefer to use underpasses (Corlatti, Hacklander, & Frey-Roos, 2009). The cost of constructing a overpass at least 63 m long and 60 m wide would be significant. A ground level culvert that allows the stream to pass the road would still be necessary.

A wildlife underpass, or a culvert, would be considered the preferred wildlife crossing structure, as it is more economical and effective than at-grade or overpass options. However, this culvert needs to be properly designed to be most effective. A critical design metric is that of openness, measured as the width multiplied by the height over the length of the culvert. This value measures how open a culvert feels, as animals may be unwilling to use a culvert that feels constrictive and trapping.

The proposed culvert is to have minimum dimensions of 3 m in height by 11.7 m in width. The minimum design is intended to maintain a minimum openness value of 1.0, however, wider culverts would more effective. The minimum standard of 1.0 for openness was based on a study conducted in Florida (Smith, 2003) which found that an openness value of 0.86 resulted in a 90% crossing rate of a variety of species. Chisholm et al., 2010 recommend a minimum openness value of 1.5, which, given a height of 3 m, would require a width of 17.6 m. A taller culvert has been shown to result in greater adoption by ungulates, with a 90% passage rate occurring at 3.7 m (Smith, 2003). Depending on the feasibility and economics of the project, the dimensions may vary, but width should not be less than 11.7 m and height should not be less than 3 m. A small tube should be placed beside the culvert for smaller animals. It may also be more effective to raise the grade of the Nisku Spine Road relative to the surrounding area for the stretch of the wildlife corridor. This increases the effectiveness of the culvert, as it maintains the integrity of the stream bed. An elevated road would also greatly discourage wildlife crossing at-grade over the highway. Figure 40 shows the required dimensions for raising the Nisku Spine Road at a slope of 1.7 degrees, as recommended in State of South Dakota, Department of Transportation (n.d.). Figure 41 shows the minimum dimensions of the wildlife culvert.

Because of the enhanced effectiveness and economic feasibility, this crossing structure is considered to be preferred. Regardless of the type of crossing, some infrastructure elements should be considered ubiquitous. All along the roadway, fencing should be unbroken except where the crossing is intended to be.

9.5 Green Cemetery Connection

The East Telford Lake ASP Draft contemplates the establishment of a cemetery south of the proposed corridor location. From discussions with the City of Leduc, one possible component of the cemetery is a green cemetery component. Green burial is becoming increasingly popular in Canada, as an environmentally sustainable method of burial. Green cemeteries are highly naturalized areas, with minimal anthropogenic infrastructure. This greenspace can be located to maximize the effectiveness of the wildlife corridor by connecting the ESA south of the K9 dog park. As mentioned above, the corridor increases in effectiveness with each ESA incorporated, enhancing the ecological viability of each habitat connected. It is recommended that the most naturalized spaces, green cemetery areas, and stormwater pond be located to create a connection between the ESA and the wildlife corridor. If this area remains relatively undisrupted by human infrastructure, wildlife will be able to travel between habitats.

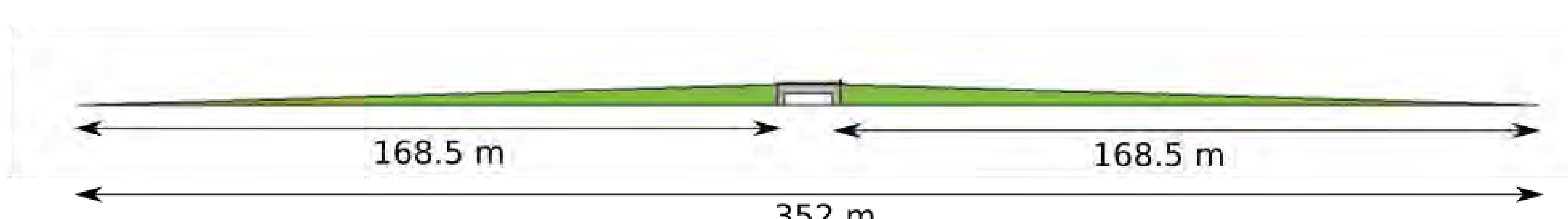


Fig.40 Wildlife Crossing Overview

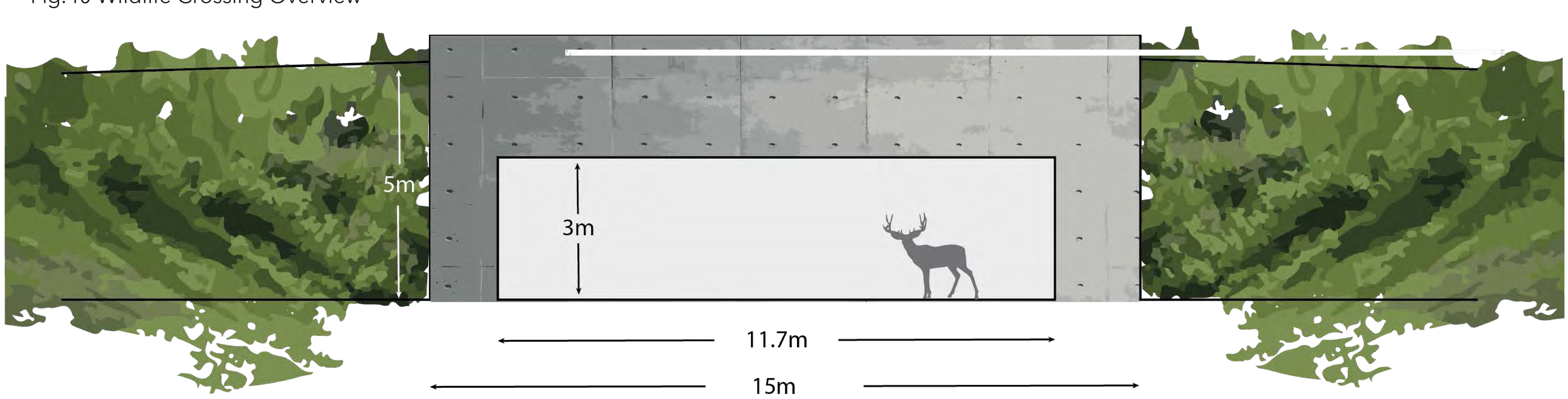


Fig.41 Wildlife Crossing Close-up

	At-Grade Crossing	Overpass	Underpass
Strengths	• Least costly of the three options	• No potential for collisions between pedestrians and vehicles • Safer than underpasses	• No potential for collisions between pedestrians and vehicles
Weaknesses	• Potential for collisions between vehicles and pedestrians if crossing is used incorrectly (Failing to stop at a red light or jaywalking) • Crossing the highway may be a barrier for some users	• More costly than at-grade crossings • Stairs may be a barrier to bicycle and equestrian users • Further limitation to disabled users	• More costly that at-grade crossings • Security concerns around a low-traffic, enclosed, long tunnel • May be susceptible to flooding if drainage is not appropriate • Stairs may be a barrier to bicycle and equestrian users
Opportunitie	• Traffic calming measures can reduce the potential of collisions • Uses existing intersection locations	• May reduce the travel times for hikers and vehicles	• May reduce the travel times for hikers and vehicles
Threats	• Traffic calming measures reduce the effectiveness of the Nisku Spine Road as an industrial transportation corridor	• May not be adopted by all users • Will have to be built at a significant height or it will be a barrier to large vehicles	• May discourage wildlife from using the wildlife crossing structure if the pedestrian underpass is near the wildlife underpass

Fig.42 SWOT Analysis for Pedestrian Crossing Infrastructure

	At-Grade Crossing	Wildlife Overpass	Wildlife Underpass
Strengths	• Least costly • Traffic calming measures can reduce the chance of collisions	• No chance of collisions between vehicles and wildlife	• No chance of collisions between wildlife and traffic
Weaknesses	• Width of the road is a significant barrier to connectivity • Result in collisions between vehicles and animals	• More expensive than at-grade crossings • Needs to be very wide and tall • May not be adopted by all species	• Second most expensive option • Needs to be sufficiently wide to encourage wildlife usage • May flood if there is lots of precipitation and in appropriate drainage
Opportunities	• Traffic calming measures can reduce the number of automobile and wildlife interactions	• Can locate at existing locations where wildlife have been crossing Range Road 245	• Can raise the Nisku Spine Road if economically feasible, reducing the impact of the highway on the adjacent environment • Can follow the stream connecting the two-lakes
Threats	• Traffic calming measures will slow traffic, reducing the effectiveness of the Nisku Spine Road		• Species may not be willing to use a long tunnel, increasing fragmentation

Fig.43 SWOT Analysis of Wildlife Crossing Structures

10. Land Acquisition

Here we will discuss some methods and tools available to the City of Leduc and Leduc County to ensure that the Leduc Wildlife Corridor to receive land dedication. The feasibility of the corridor is contingent on the allocation of sufficient land for the free movement of both wildlife and people.

The MGA outlines many of the tools that the can be used by a municipality to obtain reserve lands. Municipal reserve (MR), environmental reserve (ER), environmental reserve easement (ERE), and conservation reserve (CR). Other tools include direct land purchase.

Under the MGA, the subdivision authority is granted to take up to 10% of lands subject to the subdivision as municipal reserve, school reserve, or municipal school reserve.

Section 664(1) of the MGA outlines specific land features that can be dedicated as ER. With respect to the wildlife corridor, some lands would fall under the criteria of ER. An alternative to an ER could be an ERE. This may require specific collaboration with the landowners. Within the Leduc County area of the wildlife corridor, the area of land that abuts the landfill may be sufficient as the owners of the lands directly north of the stream are the County of Leduc and the Provincial Government. The private lands on the south may require ER dedication.

Coming into effect with the 2018 MGA amendments, CR is a dedication tool that can be used by the municipalities to allocate lands that are environmentally significant for the purpose of conservation. CR must be purchased from the land owner and the dedication cannot be removed nor can the land be sold. The Alberta Land Stewardship Act provides additional tools for conservation, including conservation easements, conservation directives, conservation offsets, and transfer of development credits.

Conservation Easements

This describes a voluntary agreement between a qualified conservation authority and a landowner. Qualified conservation authorities include the Government of Alberta, a local government, or a registered organisation. Under the conservation easement, the landowner retains land ownership but must preserve agricultural, ecological, and cultural values. The easement prevents certain types of development and is tied to the land.

An example of a conservation easement in effect can be seen approximately 10 km from the community of Hay Lakes, where conservation agency Ducks Unlimited Canada purchased, restored, and placed a conservation easement on 14 wetlands used as waterfowl habitat (Ducks Unlimited Canada, 2016).

Conservation Directives

A conservation directive must be established in a regional plan and identifies land for conservation. Land within a directive area can continue to use land in manners allowed for in the directive.

Conservation Offsets

An offset allows developers to support conservation efforts on other lands to offset the adverse impacts of their own development.

Transfer of Development Credits

This tool allows municipalities to transfer development off of land they wish to conserve for environmental or recreational purpose onto other lands. Transfer development credits must be approved by the provincial government or provided for in a regional plan.

11. Implementation and Phasing

This report assumes projects that have been approved by either municipality will occur as specified in their respective plan. This chapter of the report describes how the project may have to adapt to dynamic developments in the project area. The Nisku Spine Road and the Leduc Landfill site will both be changing and will thus have significant impact on the trail network and wildlife corridor.

The buildout of the Nisku Spine Road is anticipated to go from two to four lanes and ultimately to six lanes. If the traffic flow at two lanes is relatively low, the wildlife crossing can be at-grade, provided that there is warning signs and lighting and the speed can be reduced. However, once the project moves to four lanes, movement becomes significantly impeded, requiring an underground structure. When the Nisku Spine Road is being built to four lanes, we recommend the wildlife culvert be installed.

The Leduc Landfill site is currently in the process of having one cell reclaimed. This reclaimed hill will tie into the recreation system in Leduc County. Switchbacks will allow travellers to climb the hill, where they will be treated to an elevated view of Saunders Lake. At the top, they can sit and enjoy the view and bird watch. As the remaining cell is filled and reclaimed, this area will be added to the recreational trail, allowing hikers to walk along the ridge formed by the reclaimed landfill site. However, it is noted that the trails south of the Leduc Landfill site should not be constructed, as they will interfere with the wildlife movement and use of the corridor (Appendix D). As parts of the landfill are reclaimed, they can added to the recreational trail system. It is paramount that the municipalities continue to monitor the trail and corridor for effectiveness and use, and to identify areas of potential improvement.

12. Conclusion

There is sufficient support for the creation of the wildlife corridor and trail network. Key strengths of this proposal include the creation of an attractive recreational system and supporting the significant wildlife that use this space. The trail system will also act as a catalyst for new recreational functions at the trail terminus at Saunders Lake. This wildlife corridor proposal demonstrates environmental stewardship and preserves natural functions for current and future users to enjoy.

However, the project is not without its challenges. The most significant of these being the Nisku Spine Road, which bisects the corridor and presents an almost complete barrier to the movement of wildlife and pedestrians. Other challenges include the presence of the Leduc Landfill.

Despite the challenges, this report finds that a wildlife corridor and trail network is feasible in this location. It presents a number of location and design options that should be incorporated in order to create a wildlife corridor that most effectively meets the goals of facilitating wildlife movement and recreational use.

From the best practices summary, several criteria were established to ensure the recreational trail does not interfere with the wildlife corridor. The design elements, trail location, and wildlife corridor location have incorporated this criteria to ensure that wildlife and the quality of the natural area are given priority over recreational users.

The location of the wildlife corridor was determined from implementing best practices for wildlife corridors in the study area between Telford Lake and Saunders Lake. The proposed location meets a number of best practices as it is the shortest distance between the two ESAs and follows existing linear natural features such as the unnamed stream. This area has the biodiversity and species intactness to support the feasibility of a wildlife corridor. A below-grade wildlife crossing of the Nisku Spine Road at the unnamed stream will provide permeability of the highway for wildlife. This feature's location has been determined as the most suitable site.

Several trail routes have been developed throughout the wildlife corridor to facilitate the movement of recreational users between Telford Lake and Saunders Lake. All three trail routes follow the same path between the Landfill Road and Saunders Lake, but differ in their crossings of the Nisku Spine Road. The northern recreational trail route follows the northern edge of the wildlife corridor, crossing the Nisku Spine Road at-grade, north of the wildlife crossing. However this route does not connect trail users with other open spaces such as the Leduc Cemetery and recreational users are forced to travel along the Nisku Spine Road for a short distance. The second option is a central recreational trail route that follows the wildlife corridor and has a below-grade pedestrian crossing of the Nisku Spine Road beside the wildlife crossing. This route is the shortest distance between the lakes, however it is the least favourable due to the close proximity of the wildlife and recreational users crossings. The third, and our recommended trail route, follows the southern extent of the wildlife corridor. This route connects with the Leduc Cemetery, other ESAs, and allows active users to cross the Nisku Spine Road at the controlled intersection for the Leduc Cemetery. Our official recommendation is the southern trail route as it prioritizes the quality of the wildlife corridor, and the species within it, while providing safe, feasible, and attractive recreational options.

Options for wildlife crossing structures were also evaluated in the forms of an at-grade crossing, an overpass, or an underpass. Due to probability of adoption reasons, a culvert under the Nisku Spine Road was considered the most feasible. A strategy to promote greater wildlife use would be to build the Nisku Spine Road at an elevated grade for a stretch along the corridor, allowing the under-the-road wildlife box culvert to be at ground level, with the highway running above it. Raising the highway has the benefits of maintaining the stream integrity at the culvert and discouraging wildlife from crossing at-grade over the highway.

In summary, this wildlife corridor and recreational trail would be an excellent opportunity for the City of Leduc and Leduc County to preserve and enhance the natural functions of the area and provide recreational opportunities for current and future users.

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14. Appendix

14.1 Appendix A

Table 1. Fish

Latin Name	Common Name	Comments
Culaea inconstans	Stockleback	Alberta Species at Risk Act: Secure
Pimephales promelas	Flathead minnow	Alberta Species at Risk Act: Secure
Weissia controversa	green-cushioned weissia moss	

Table 2. Mammals

Latin Name	Common Name	Comments
Alces alces	Moose	Alberta Species at Risk Act: Secure
Canis latrans	Coyote	Alberta Species at Risk Act: Secure
Castor canadensis	Canada beaver	Alberta Species at Risk Act: Secure
Erethizon dorsatum	Porcupine	Alberta Species at Risk Act: Secure
Glaucomys sabrinus	Northern flying squirrel	Alberta Species at Risk Act: Secure
Lepus americanus	Snowshoe hare	Alberta Species at Risk Act: Secure
Mephitis mephitis	Striped skunk	Alberta Species at Risk Act: Secure
Microtus pennsylvanicus	Meadow vole	Alberta Species at Risk Act: Secure
Mustela frenata	Long-tailed weasel	Alberta Species at Risk Act: May be at Risk
Mustela vison	American mink	
Myotis lucifugus	Little brown bat	SARA: Schedule 1 SARA Status: Endangered COSWIC Status: Endangered Alberta Species at Risk Act: May be at Risk
Odocoileus virginianus	White-tailed deer	Alberta Species at Risk Act: Secure
Ondatra zibethicus	Muskrat	Alberta Species at Risk Act: Secure
Peromyscus maniculatus	Deer mouse	Alberta Species at Risk Act: Secure
Procyon lotor	Raccoon	Alberta Species at Risk Act: Secure
Tamiasciurus hudsonicus	Red squirrel	Alberta Species at Risk Act: Secure
Thomomys talpoides	Northern pocket gopher	Alberta Species at Risk Act: Secure
Urocitellus richardsonii	Ground Squirrel	
Vulpes vulpes	Red fox	Alberta Species at Risk Act: Secure

Table 3. Birds

Latin Name	Common Name	Comments
Accipiter cooperii	Cooper's hawk	COSWIC Status: Not at Risk Alberta Species at Risk Act: Secure
Aegolius acadicus	Northern saw-whet owl	Alberta Species at Risk Act: Secure
Anas platyrhynchos	Mallard	Alberta Species at Risk Act: Secure
Archilochus colubris	Ruby-throated hummingbird	Alberta Species at Risk Act: Secure
Aythya affinis	kesser scaup	Alberta Species at Risk Act: Secure
Bombycilla cedrorum	Cedar waxwing	Alberta Species at Risk Act: Secure
Bonasa umbellus	Ruffed grouse	Alberta Species at Risk Act: Secure
Branta canadensis	Canada Geese	Alberta Species at Risk Act: Secure
Bubo virginianus	Great horned owl	Alberta Species at Risk Act: Secure
Bucephala clangula	Common goldeneye	Alberta Species at Risk Act: Secure
Buteo jamaicensis	Red-tailed hawk	COSWIC Status: Not at Risk Alberta Species at Risk Act: Secure
Carduelis pinus	Pine siskin	
Carduelis tristis	American goldfinch	
Charadrius vociferus	Killdeer	Alberta Species at Risk Act: Secure
Chlidonias niger	Black tern	COSWIC Status: Not at Risk Alberta Species at Risk Act: Secure
Chordeiles minor	Common nighthawk	SARA: Schedule 1 SARA Status: Threatened COSWIC Status: Threatened Migratory Birds Convention Status Alberta Species at Risk Act: Sensitive
Circus cyaneus	Northern harrier	COSWIC Status: Not at Risk Alberta Species at Risk Act: Secure

Table. 3 Birds (continued)

Columba livia	Rock dove	Alberta Species at Risk Act: Exotic/Alien
Common redpoll	Carduelis flammea	
Contopus sordidulus	Western wood-pewee	Alberta Species at Risk Act: May be at Risk
Corvus brachyrhynchos	American crow	Alberta Species at Risk Act: Secure
Corvus corax	Common raven	Alberta Species at Risk Act: Secure
Cyanocitta cristata	Blue Jay	Alberta Species at Risk Act: Secure
Dendroica coronata	Yellow-rumped warbler	Alberta Species at Risk Act: Secure
Dendroica petechia	Yellow warbler	Alberta Species at Risk Act: Secure
Dryocopus pileatus	Pileated woodpecker	Alberta Species at Risk Act: Sensitive
Dumetella carolinensis	Gray catbird	Alberta Species at Risk Act: Secure
Empidonax alnorum	Alder flycatcher	Alberta Species at Risk Act: Sensitive
Empidonax minimus	Least flycatcher	Alberta Species at Risk Act: Sensitive
Euphagus cyanocephalus	Brewer's blackbird	Alberta Species at Risk Act: Secure
Falco rusticolus	gyrfalcon	COSWIC Status Not at Risk Alberta Species at Risk Act: Secure
Falco sparverius	American kestrel	Alberta Species at Risk Act: Sensitive
Gallinago gallinago	Common snipe	
Icterus galbula	Baltimore oriole	Alberta Species at Risk Act: Sensitive
Junco hyemalis	Dark-eyed junco	Alberta Species at Risk Act: Secure
Larus californicus	California gull	Alberta Species at Risk Act: Secure
Larus delawarensis	Ring-billed gull	Alberta Species at Risk Act: Secure
Loxia leucoptera	White-winged crossbill	Alberta Species at Risk Act: Secure
Melospiza lincolnii	Lincoln's sparrow	Alberta Species at Risk Act: Secure
Melospiza melodia	Song sparrow	Alberta Species at Risk Act: Secure
Mniotilta varia	Black-and-white warbler	Alberta Species at Risk Act: Secure
Molothrus aters	Brown-headed cowbird	
Oporornis philadelphia	Mourning warbler	Alberta Species at Risk Act: Secure
Parus atricapillus	Black-capped chickadee	
Parus hudsonicus	Boreal chickadee	
Passerculus sandwichensis	Savannah sparrow	Alberta Species at Risk Act: Secure
Pica pica	Black-billed magpie	
Picoides pubescens	Downy woodpecker	Alberta Species at Risk Act: Secure
Picoides villosus	Hairy woodpecker	Alberta Species at Risk Act: Secure
Pooecetes gramineus	Vesper sparrow	Alberta Species at Risk Act: Secure
Progne subis	Purple martin	Alberta Species at Risk Act: Sensitive
Regulus calendula	Ruby-crowned kinglet	Alberta Species at Risk Act: Secure
Regulus satrapa	Golden-crowned kinglet	Alberta Species at Risk Act: Secure
Riparia riparia	Barn swallow	SARA: Schedule 1 SARA Status: Threatened COSWIC Status: Threatened Migratory Birds Convention Status Alberta Species at Risk Act: Sensitive
Sayornis phoebe	Eastern phoebe	Alberta Species at Risk Act Sensitive
Seiurus aurocapillus	Ovenbird	
Sialia currucoides	Mountain bluebird	Alberta Species at Risk Act: Secure
Sitta canadensis	Red-breasted nuthatch	Alberta Species at Risk Act: Secure
Sitta carolinensis	White-breasted nuthatch	Alberta Species at Risk Act: Secure
Sphyrapicus varius	Yellow-bellied sapsucker	Alberta Species at Risk Act: Secure
Spizella pallida	Clay-coloured sparrow	Alberta Species at Risk Act: Secure
Spizella passerina	Chipping sparrow	Alberta Species at Risk Act: Secure
Sturnella neglecta	Western meadowlark	Alberta Species at Risk Act: Secure
Sturnus vulgaris	European starling	Alberta Species at Risk Act: Exotic/Alien
Tachycineta bicolor	Tree swallow	Alberta Species at Risk Act: Secure
Troglodytes aedon	House wren	Alberta Species at Risk Act: Secure
Turdus migratorius	American robin	Alberta Species at Risk Act: Secure
Tyrannus tyrannus	Eastern kingbird	Alberta Species at Risk Act: Sensitive
Vermivora peregrina	Tennessee warbler	Alberta Species at Risk Act: Secure
Vireo gilvus	Warbling vireo	Alberta Species at Risk Act: Secure
Vireo olivaceus	Red-eyed vireo	Alberta Species at Risk Act: Secure
Vireo solitarius	Solitary vireo	Alberta Species at Risk Act: Secure
Zenaida macroura	Mourning dove	Alberta Species at Risk Act: Secure
Zonotrichia albicollis	White-throated sparrow	Alberta Species at Risk Act: Secure

Table. 4 Vegetation

Latin Name	Common Name	Comments
Aloina rigida	aloe-like rigid screw moss	
Achillea millefolium	Common yarrow	
Achillea sibirica	Many-flowered yarrow	
Actaea rubra	Red/White baneberry	
Agrimonia striata	Agrimony	
Agropyron trachycaulum var subsecundum	Slender wheat grass	
Agrostis hyemalis	tickle grass	
Alopecurus aequalis	Short-awned foxtail	
Amelanchier alnifolia	Saskatoon	
Anemone canadensis	Canada anemone	
Anemone multifida	Cut-leaved anemone	
Anemone riparia	Tall anemone	
Antennaria neglecta	Broad-leaved everlasting	
Apocynum androsaemifolium	Spreading dogbane	
Arabis lyrata	Lyre-leaved rock cress	
Aralia nudicaulis	Wild sarsaparilla	
Artemisia dracunculus	Dragonwort	
Artemisia ludoviciana	Prairie sagewort	
Asclepias ovalifolia	Low milkweed	
Aster ciliolatus	Lindley's aster	
Aster conspicuus	Showy aster	
Aster ericoides	Tufted white prairie aster	
Aster hesperius	western willow aster	
Aster laevis	Smooth aster	
Aster puniceus	Purple-stemmed aster	
Aster sibiricus	Arctic aster	
Astragalus dasyglottis	Purple milk vetch	
Athyrium filix-femina	Lady fern	
Beckmannia syzigachne	Slough grass	
Betula papyrifera	Paper birch	
Bidens cernua	Nodding beggarticks	
Brassica napus	Canola	
Bromus ciliatus	Fringed brome	
Bromus inermis ssp inermis	Awnless brome	
Bromus inermis ssp pumpellianus	Northern brome	
Calamagrostis canadensis	Bluejoint	
Callitriche verne	Vernal water-starwort	
Campanula rotundifolia	Harebell	
Carex aquatilis	Water sedge	
Carex atherodes	Awned sedge	
Carex disperma	Two-seeded sedge	
Carex houghtoniana	Sand sedge	
Carex lanuginosa	Woolly sedge	
Carex peckii	Peck's sedge	
Carex praegracilis	Graceful sedge	
Carex praticola	Meadow sedge	
Carex sartwellii	Sartwell's sedge	
Carex siccata	Hay sedge	
Carex sprengellii	Sprengel's sedge	
Carex utriculata	Small bottle sedge	
Cerastium nutans	Long-stalked mouse-ear chickweed	
Cicuta maculata	Water-hemlock	
Cirsium arvense	Canada thistle	
Coeloglossum viride	Bracted green orchid	
Comandra umbellata	Bastard toadflax	
Cornus canadensis	Bunchberry	
Cornus stolonifera	Red-osier dogwood	
Corylus cornuta	Beaked hazelnut	
Cotoneaster	Cotoneaster (domestic)	
Crataegus chrysocarpa	Round-leaved hawthorn	Rare*
Crataegus rotundifolia	Round-leaved hawthorn	
Cyperaceae spp.	sedges	
Cypripedium calceolus	Yellow lady's slipper	
Disporum trachycarpum	Fairybells	
Dracocephalum parviflorum	American dragonhead	
Dryopteris carthusiana	Narrow spinulose shield fern	
Elaeagnus commutata	Silverberry (wolfwillow)	
Eleocharis palustris	Creeping spike-rush	
Epilobium angustifolium	Common fireweed	
Epilobium ciliatum ssp glandulosum	Northern willowherb	
Equisetum sylvaticum	Woodland horsetail	
Erigeron caespitosus	Tufted fleabane	
Erigeron glabellus	Smooth fleabane	
Erigeron philadelphicus	Philadelphia fleabane	
Erysimum cheiranthoides	Wormseed mustard	
Fragaria virginiana	Wild strawberry	
Gaillardia aristata	Brown-eyed Susan	
Galeopsis tetrahit	Hemp-nettle	
Galium boreale	Northern bedstraw	
Galium triflorum	Sweet-scented bedstraw	
Geranium richardsonii	Wild white geranium	
Geum aleppicum	Yellow avens	
Geum macrophyllum	Large-leaved yellow avens	
Glyceria elata	tall mannagrass	
Glyceria grandis	Common tall manna grass	
Glycyrrhiza lepidota	Wild licorice	
Hedysarum alpinum	Alpine hedysarum	
Heracleum lanatum	Cow parsnip	
Heuchera richardsonii	Richardson's alumroot	
Hieracium umbellatum	Narrow-leaved hawkweed	
Hierochloe odorata	Sweet grass	
Hordeum jubatum	foxtail barley	
Impatiens capensis	Spotted jewelweed	
Juncus balticus	Wire rush	

Table. 4 Vegetation (continued)

Koeleria macrantha	June grass	
Lactuca pulchella	Common blue lettuce	
Lathyrus ochroleucus	Cream-coloured vetchling	
Lathyrus venosus	Purple peavine	
Lemna minor	Common duckweed	
Linnaea borealis	Twinflower	
Lonicera dioica	Twining honeysuckle	
Lonicera involucrata	Bracted honeysuckle	
Lysimachia ciliata	Fringed loosestrife	
Maianthemum canadense	Wild lily-of-the-valley	
Matricaria perforata	Scentless chamomile	
Matricaria perforate	chamomile	
Mentha arvensis	Wild mint	
Mertensia paniculata	Tall lungwort	
Mitella nuda	Bishop's-cap	
Moehringia latiflora	Blunt-leaved sandwort	
Monarda fistulosa	Wild bergamot	
Monotropa uniflora	Indian Pipe	Rare*
Orthilia secunda	One-sided wintergreen	
Oryzopsis asperifolia	White-grained mountain rice grass	
Pedicularis labradorica	Labrador lousewort	
Penstemon procerus	Slender blue beardtongue	
Petasites frigidus var. sagittatus	Arrow-leaved coltsfoot	
Petasites palmatus	Palmate-leaved coltsfoot	
Petasites sagittatus	Arrow-leaved coltsfoot	
Phalaris arundinacea	Reed canary grass	
Phleum pratense	Timothy	
Picea glauca	White spruce	
Plantago major	Common plantain	
Poa compressa	Canada bluegrass	
Poa interior	Inland bluegrass	
Poa nemoralis	wood bluegrass	
Poa palustris	Fowl bluegrass	
Poa pratensis	Kentucky bluegrass	
Polygonum lapathifolium	Pale persicaria	
Polygonum viviparum	Bistort	
Populus balsamifera	Balsam poplar	
Populus tremuloides	Aspen	
Potentilla anserina	Silverweed	
Potentilla gracilis	Graceful cinquefoil	
Potentilla norvegica	Rough cinquefoil	
Potentilla palustris	Marsh cinquefoil	
Potentilla pensylvanica	Prairie cinquefoil	
Prunella vulgaris	Heal-all	
Prunus pensylvanica	Pin cherry	
Prunus virginiana	Choke cherry	
Pyrola asarifolia	Pink wintergreen	
Ranunculus abortivus	Small-flowered buttercup	
Ranunculus cardiophyllus	Heart-leaved buttercup	
Ranunculus cymbalaria	Shore buttercup	
Ranunculus gmelinii	Tellow water crowfoot	

Ranunculus cardiophyllus	Heart-leaved buttercup	
Ranunculus cymbalaria	Shore buttercup	
Ranunculus gmelinii	Tellow water crowfoot	
Ranunculus reptans	Creeping spearwort	
Ranunculus sceleratus	Celery-leaved buttercup	
Ribes hudsonianum	Northern black currant	
Ribes oxyacanthoides	Northern gooseberry	
Ribes triste	Wild red currant	
Ricciocarpos natans	Liverwort	Rare*
Rorippa palustris	Marsh yellow cress	
Rosa acicularis	Prickly rose	
Rubus idaeus	Wild red raspberry	
Rubus pubescens	Dewberry	
Rumex crispus	Curled dock	
Rumex occidentalis	Western dock	
Rumex spp.	dock	
Rumex triangulivalvus	Narrow-leaved dock	
Salix arbusculoides	Little tree willow	
Salix bebbiana	Beaked willow	
Salix exigua	Sandbar willow	
Salix lucida ssp. lasiandra	Shining willow	
Salix maccalliana	Velvet-fruited willow	
Salix petiolaris	Basket willow	
Salix planifolia	Flat-leaved willow	
Salix pseudomonticola	False mountain willow	
Salix spp.	willows	
Sanicula marilandica	Snakeroot	
Schizachne purpurascens	Purple oat grass	
Scirpus lacustris	Common great bulrush	
Scutellaria galericulata	marsh skullcap	
Senecio congestus	Marsh ragwort	
Shepherdia canadensis	Canada buffaloberry	
Silene noctiflora	Night-flowering cachfly	
Silene pratensis	white cockle	
Sium suave	water parsnip	
Smilacina stellata	Star-flowered Solomon's-seal	
Solidago canadensis	Canada goldenrod	
Solidago nemoralis	Showy goldenrod	
Solidago rigida	Stiff goldenrod	
Sonchus arvensis	Perennial sow-thistle	
Sorbus sp.	Mountain ash (domestic)	
Sparganium eurycarpum	Giant bur-reed	
Spiraea alba	Narrow-leaved meadowsweet	
Stachys palustris	Marsh hedge-nettle	
Stellaria crassifolia	Fleshy stitchwort	
Stellaria longifolia	Long-leaved chickweed	
Symphoricarpos albus	Snowberry	
Symphoricarpos occidentalis	Buckbrush	
Symphyotrichum ericoides	tufted white prairie aster	
Tanacetum vulgare	Common tansy	
Taraxacum officinale	Common dandelion	
Thalictrum dasycarpum	Tall meadow rue	
Thalictrum venulosum	Veiny meadow rue	
Thermopsis rhombifolia	Golden bean	
Tragopogon dubius	Goat's-beard	

Table. 4 Vegetation (continued)

Trifolium hybridum	Alsike clover	
Triticum spp	Wheat	
Typha latifolia	Common cattail	
Urtica dioica	Common nettle	
Veronica americana	American brooklime	
Viburnum edule	Low-bush cranberry	
Viburnum opulus	High-bush cranberry	
Vicia americana	Wild vetch	
Viola canadensis	Western Canada violet	
Zizia aptera	Heart-leaved Alexanders	

Table 5. Amphibians

Latin Name	Common Name	Comments
Pseudacris triseriata	Boreal (striped) chorus frog	COSWIC Status: Not at Risk
Rana sylvatica	Wood frog	
Thamnophis sirtalis	Red-sided garter snake	Alberta Species at Risk Act: Sensitive

*Identified in The City of Leduc Environmentally Significant Areas Study (Feira, 2017) as rare. These species did not flag in our comparison to conservation species lists used in this report.

14.2 Appendix B

City of Leduc and Leduc County Intermunicipal Development Plan

In accordance with section 631 of the MGA, the City of Leduc and Leduc County jointly approved an intermunicipal development plan (IDP) to guide development until 2044. The plan identifies five sustainability pillars, one of which is environmental stewardship. This pillar states that Leduc County and the City of Leduc will protect, sustain, and enhance the natural environment.

Specific details on the establishment of a wildlife corridor and trail network are provided in section 4.6.2. Environment and Open Space Policies. Specific policies identified are:

- Cooperation between the municipalities, other orders of government, and local groups.
- Subdivision of lands within the 100 year floodplain shall not be permitted unless flood-proofing measures are taken.
- The location and network of trails shall be delineated at the ASP level.
- At the Area Structure Plan, land use designation, or subdivision stage, Environmental Impact Assessments addressing natural areas or Environment Site Assessments addressing contamination shall be completed.
- Lands identified as sensitive may be designated as Environmental Reserve in accordance with the MGA.
- Developers must identify and attempt to preserve tree stands.
- Both the City of Leduc and Leduc County shall jointly prepare environmental inventories and management plans for the Saunders Lake watershed and other creek and ravine systems.

Section 4.6.2.18. Deals specifically with the establishment of a wildlife corridor, stating: *"The County and City shall jointly examine solutions for protecting and maintaining natural habitat connectivity between Saunders and Telford Lakes in order to support the natural movement of wildlife. The wildlife corridor shall be explored in more detail during the development of related studies, ASPs, outline plans and subdivision plans as well as during the detail designing of the Spine Road between 65th Avenue and Rollyview Road"*

Area B: Saunders/Telford Lake Business: North of Telford Lake:

Provide for high quality business, light industrial and office deveopment with complimentary commerical uses along the northeast side of the City of Leduc and northwest of Saunders Lake. Land uses within the Saunders/Telford Lake Business Policy Area B will take advantage of opportunities related to nearby regional assets, ensuring a distinctive development typology through higher design and architectural standards than policy Area F. These land uses include, but are not limited to:

- agribusiness research and development, engineering and production,
- oil and gas R&D, engineering and advanced manufacturing,
- information, communications, Technology (ICT), manufacturing, R&D and Sales Warehousing, distribution, and transportation logistics,
- advanced education, training, research, and certification centres,
- general business and office uses,
- complimentary commercial, retail, and dining.

The County and City shall jointly examine feasible solutions for increasing recreational connectivity access to and between Saunders and Telford Lakes in order to support low-impact recreational uses. Elements such as interconnected trail systems and recreational access points will be explored in more detail during the development of related studies, ASPs, and subdivision plans.

Area G: South of Telford Lake:

Provide for commercial, office, business, and light industrial development in the southeast sector of the IDP, respecting the surrounding uses. Uses will have minimal impact on the surroundings. Given the significant costs associated with extending sewage to the area, development is not expected for the 35 year Capital Region Growth Plan timeline.

Area H: IDP Reserve and Referral Area:

General purpose is to address lands outside the growth scenario, for future considerations. Intended not to be subdivided until contiguous development and full servicing has been developed in the Growth Scenario areas. County and City shall jointly demonstrate environmental stewardship over this parcel. Areas abutting the natural space are labelled as Area J and provide for a transition from business development to greenways.

As amended by City of Leduc Bylaw No. 933-2016 Approved August 21, 2017 (Office Consolidation)
and
Leduc County Bylaw No. 24-16 Approved July 11, 2017 (Office Consolidation)

FIGURE 10: INTERMUNICIPAL DEVELOPMENT PLAN POLICY AREAS

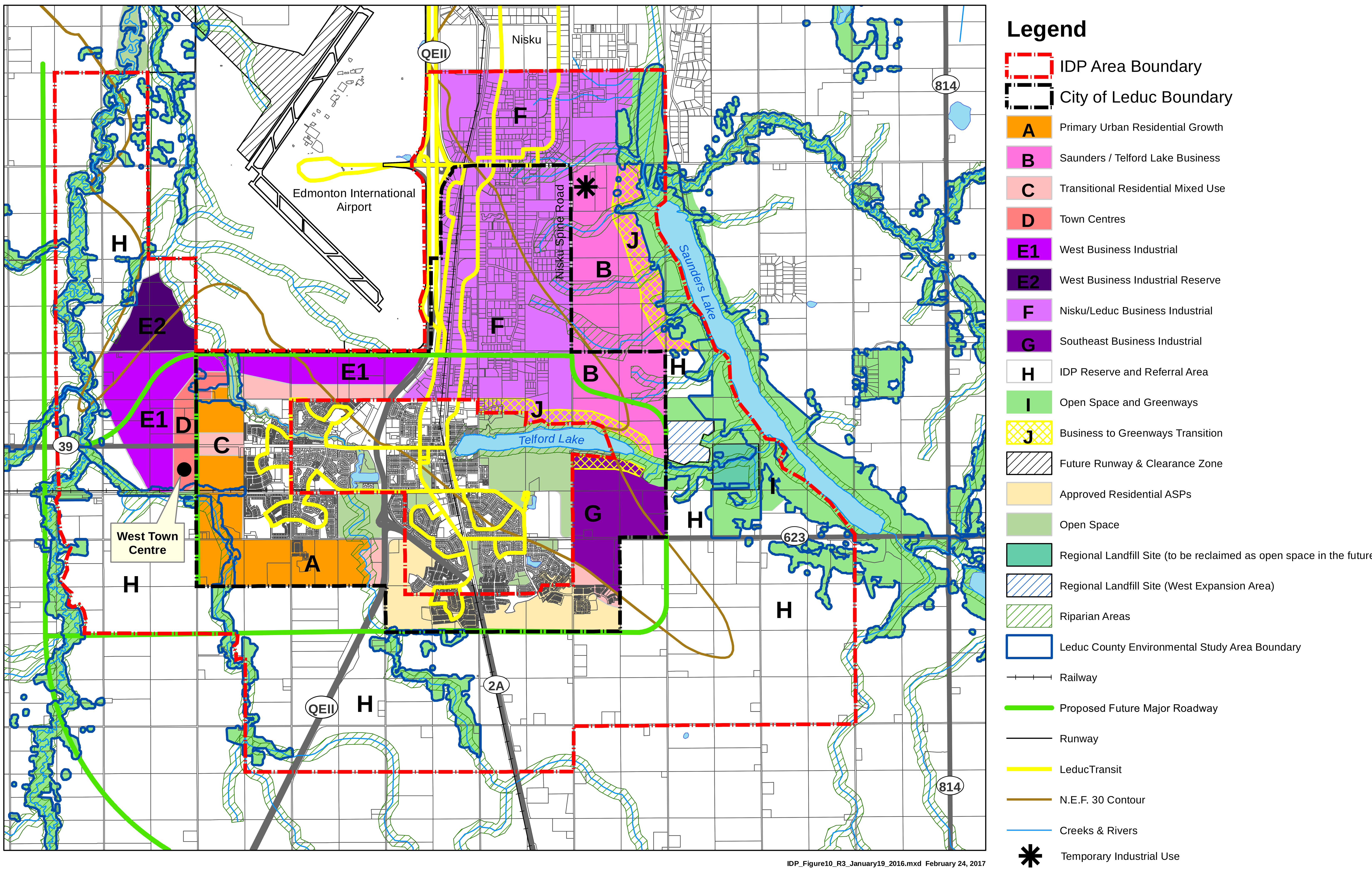

Fig. 15 Leduc County and City of Leduc Intermunicipal Development Plan Policy Plan Areas (2017)

Area I: Open Space and Greenways:

Purpose is to establish the foundations for a regional system of public open spaces, trails, and natural areas to benefit future generations within the Leduc area. County and City will work together with local community groups and both provincial and federal jurisdictions to ensure appropriate protection and management of public open spaces, trails, and natural areas. Work with groups to acquire privately owned land or public access to private land. Public Open Space, trails, and natural areas within the area shall protect and enhance natural features, such as ravines, natural vegetation, habitat, soil, groundwater, and surface water. Planning shall occur at the ASP level.

Area J: Business to Greenways Transition:

Occur at areas abutting the greenspace. Their purpose is to ensure that Telford Lake, Saunders Lake and surrounding natural areas are protected. Buffer of low impact business development to transition the greenway to business industrial. Allow for better access to recreation. Development in the transitional area must minimize the human impacts on wildlife and recreational users. Minimize off site light air and water pollution.

Aerotropolis Viability Study

The Aerotropolis Viability study is a comprehensive plan and feasibility study for the development of an Aerotropolis around the Edmonton International Airport. The report provides strategic direction for development on the east side of Telford Lake. This area is envisioned to be a hub for transportation, logistics, and agri-business, as well as ICT and life sciences. A Lakefront Corporate Park is envisioned as wrapping around Telford Lake.

East Telford Lake ASP (Draft)

The East Telford Lake ASP is being drafted for the purpose of guiding development in the east of Telford Lake. The ASP area covers 430 ha. This area is envisioned as accommodating light industrial, office, and other business and employment uses, in accordance with the the IDP and aerotropolis document. The ASP document acknowledges the role of Telford Lake and the surrounding riparian areas to accommodate wildlife and as an opportunity for recreation opportunities. Currently, in the ASP area, the dominant use is agriculture. There are three residences in the area. The ASP recommends a 10 m ER buffer around bed and shore or where slopes exceeds 25%. A 50 m MR buffer was applied outside the ER to allow for the construction of a multiway and provide setback between development and the lake.

Lakeside Industrial ASP

The Lakeside Industrial ASP establishes a framework for the development of lands north of Telford Lake. In accordance with the IDP and City of Leduc MDP, the area is intended to have primarily light industrial uses and some business commercial uses. The ASP does identify a 60 m ER/MR open space buffer along the lake shore, which will eventually accommodate the Telford Lake Multiway. The area does contain a 4.1 ha aspen-balsam woodland. This area will not be retained in the development. Additionally the wetlands to the southeast will also not be retained, but may need to be reconstructed pending approval by the Province under the Water Act.

City of Leduc MDP

The City of Leduc MDP provides information and guidelines regarding natural areas, and active and healthy communities. It should be noted that the City of Leduc is currently working on an updated MDP, at this time the project team does not have access to the document and will be referencing the current MDP.

The City shall conserve and protect natural areas for the purposes of protecting wildlife habitat and corridors, supporting natural systems, and providing recreational opportunities by:
Retaining and protecting natural areas.
Providing buffer areas around sensitive natural areas in order to minimize the impacts of development on natural features.
Providing low impact public access to natural area that can sustain human uses with minimal impact to the overall health of ecosystems
Developing public open spaces with environmentally sensitive best. practices such as bio-swales, which will enhance and integrate natural systems.

Protecting the environmental integrity of Telford Lake and surrounding natural areas through complementary land use development and compatible site and building designs.

Planning and managing natural areas in accordance with FireSmart principles and practices to reduce the hazards and risks of wildfire, particularly where natural.

The City shall promote the creation of an active and healthy community that reflects the needs of residents by:

- Developing outdoor public spaces for year round use, with appropriate plantings and park design.
- Developing the Multiway system as a complete network that promotes walkability and links residential subdivisions, recreation and cultural destinations, hubs of commerce, and high activity areas.
- Consulting with key regional stakeholders, including Leduc County and the school boards, in the planning, development, and potential sharing of costs for open space, cultural, and recreational facilities.
- Including meaningful public participation in planning for recreation, culture, and open space programs and facilities.

Leduc County Municipal Development Plan

The purpose of the Leduc County MDP is to effectively manage subdivision and development of land in the County for the benefit of its present and future residents and their quality of life. Notable additions to the MDP include considerations for Recreation Development and Community Services as well as Environmental Protection guidelines.

Recreation Development and Community Services

To protect and conserve those areas of the County with the greatest scenic and recreational value.

To provide parks and recreation programs for County residents in conjunction with those programs offered by adjacent municipalities. Public access including trails to significant recreation areas shall be protected and enhanced by reserve dedication, easements or other rights of way, and purchase and maintenance of land areas suited for public use.

Environmental Protection

The County will encourage the creation and maintenance of wildlife habitat on private and municipal lands by:

- exploring the possible use of incentive programs for landowners to maintain wildlife habitat, and
- incorporating consideration of wildlife habitat into the planning and design of outdoor recreation systems.

The County encourages landowners to maintain tree cover and natural vegetation in environmentally sensitive areas and on land with steep or unstable slopes.

East Telford Lake ASP Public Open House Summary Report

Following an open house held for the East Telford Lake ASP in June 28, 2017, Stantec Consulting Ltd. produced the East Telford Lake Area Structure Plan Public Open House Comments Summary document. This report details the public feedback received during this open house. The following comments were made during the open house that relate to the creation of the wildlife corridor and trail network:

- Wildlife common and crossing. Want underpass for Spine Road
- Preserve existing woodlots north and south of lake and connect to trail network to enhance recreation and wildlife corridor
- Want connection / trails to Saunders Lake. Try to make them function together
- Connect each trail around Saunders Lake
- Create a re-wilded area at the east end of Telford Lake, isolated from adjacent development and laid out to maximize wildlife connectivity and opportunities for wildlife viewing
- Wildlife crossings should be of a size and design to allow wildlife (including deer and moose) to use without fear of entrapment
- Natural woodlots north and south of Telford Lake should be conserved and a recreational trail system should connect them to the broader network of paths.
- Engineer wildlife crossing features to allow corridor without M.V.A.'s
- Wildlife corridor/passage best practices should be used in the design of wildlife crossings

The Summary Report emphasises the value of providing wildlife and human connectivity and the importance of this environmental importance of this region to the adjacent communities.

Edmonton Metropolitan Region Growth Plan

The latest Edmonton Metropolitan Region Growth Plan came into effect on October 26, 2017 and encompasses both the City of Leduc and Leduc County. One of the seven Guiding Principles identified in the document reads as: "Protect natural living systems and environmental assets". Within this principle, the document identified the objectives of conserving and restoring natural living systems through an ecological network approach and minimizing and mitigating the impacts of regional growth on natural living systems. As member municipalities, the City of Leduc and Leduc County must reflect the values of the Regional Growth Plan in their statutory documents.

Assessment of Citizen Science Initiatives for Wildlife Management City of Leduc

This document gives a quick summary of what can be done to eliminate wildlife-human conflict through the manipulation of habitat, by-law establishment and enforcement, and sometimes wildlife removal. It should be noted that this document is coming from an urban area management perspective.

Canada Geese

- Reduction of turf grass areas with 40m of lakes and ponds
- Reduction or elimination of fertilizer application to lawns within close proximity to water bodies
- Replacement of succulent, low-mowed lawns with taller, less palatable, rough grasses such as ryes and/or wildflowers and shrubbery
- Provide educational signage and conversational opportunities to modify public involvement in feeding the geese, and reducing aggressive contact incidents

Coyotes

- Liaison with provincial fish and wildlife to ensure problem animals and dens are removed as assessments indicate immediate action
- Ensure natural areas and parks have adequate connectivity, and create wildlife underpasses/overpasses where connections need to be made

Striped Skunk

- Skunk denning can be controlled by reducing available sites through occlusion of the ground interface around outbuildings, steps, and other structures
- Tight control of garbage control bylaws can reduce anthropomorphic food sources

Urban Gulls

- Increase bylaw enforcement of garbage regulations and control access to composting
- Clean up public venues during and immediately after major outdoor events
- Reduce short mowed lawn areas in parks, wherever possible
- Employ best practices at landfills

Rock Doves (Pigeons)

- Once squabs are fledged, occlude re-entry into nesting areas or eliminate site
- Tough bylaw enforcement of feeding activities at the street and park levels, along with preventative educational programming, control of garbage and access to compost
- Promote predator habitats in and around the downtown area and any identified hotspots, through the placement of raptor "hack boxes"
- Educate residents and discourage the feeding of pigeons

Telford Lake Master Plan

The focus of the Telford Lake Master Plan is to develop a comprehensive plan and strategy for the long term development and management of Telford Lake and the lands that surround it.

Two of the of the five key objectives of the Master Plan include:

- Environmental Protection: The Master Plan must provide for protection of the quality of the Telford Lake environment by protecting water quality, habitat, and vegetation for wildlife and visitors.
- Multiway and Trails: The Master Plan will clearly illustrate the extension and development of a multiway (multi-use trail with trail amenities) around Telford Lake and define a strategy for its long term implementation as the most important recreational amenity on Telford Lake. The Master Plan must also define a network of trails that is integrated with the City of Leduc trail network, provides a variety of surfaces and experiences to meet the needs of a variety of users, and provides links to existing and proposed facilities.

4.3 North and South Shores

Purpose: the protection of the shoreline of North and South Telford Lake and the development of the Telford Lake Trail

Recommended program features:

- Maintain and protect lake fringe vegetation
- Telford Lake Trail (TLT) - the provision of a 3m wide, asphalt multi-use trail (multiway) around the lake.

4.4 East End

Purpose: the protection of the shoreline and the development of the Telford Lake Trail.

Recommended program features:

- maintain and protect lake fringe vegetation
- TLT - the provision of a 3m wide, asphalt, multiway around the lake
- Boardwalk and Bird Blind - Use a boardwalk in the marsh areas and to cross the creek feeding into Saunders Lake. A bird blind would be developed as a key interpretive feature for bird, wildlife, and waterfowl watching. This feature will also frame views down the length of the lake
- Provide opportunities to develop a future trail that will link Telford Lake into a future regional system with Saunders Lake.

Range Roads 245 and 250 Functional Planning Study

This document details the preliminary planning work completed on extending the Nisku Spine Road (9th Street) south to Highway 623 (Rollyview Road). This 7.5 km extension would give industrial developments east of the City of Leduc access to a major industrial roadway that connects with the International Airport, Nisku Business Park, and the City of Leduc. Currently, Range Roads 245 and 250, as well as Township Road 500, which connects the two, are two-lane, low-volume roads. The Spine Road will be designed with the following criteria:

- Posted Speed: 80 km/h
- 6 lanes at final stage
- Lane width 3.7 m
- Access by signalized intersection
- Intersections spaced at 800 m minimum

Including the median and ditches, the road will have an ultimate width of 60 m. Not including the ditches, the width of the road will be 35.2 m. Development is intended to be staged, starting as a two lane roadway before being extended to 6 lanes. The intersection spacing of 800 m is intended to preserve the posted speed of 80 km/h. The study does evaluate potential bridge sites at the wildlife corridor. The suggested action would be to increase the culvert to 1.2 m diameter. The report does acknowledge the potential damage the road may have on wildlife in the area and suggests the use of wildlife warning signs.

East Telford Lake Desktop Phase 1 Environmental Site Assessment

The CIty of Leduc retained Stantec Consulting Ltd. to complete a Phase 1 Environmental Site Assessment in 2017 for the area in the East Telford Lake ASP. The intention of this report is to locate areas of concern that may trigger potential further assessment. This report indicated a historic oil well on the southeast area of the site, two historical test holes, and a mixed-use commercial residential property with equipment storage in the southwest of the site as potential areas of concern. Further investigation is to occur in the Phase 1 Environmental Site Assessment.

Fisheries Act

The Fisheries Act (1985) was intended to provide for the sustainability and ongoing productivity of commercial, recreational, and Aboriginal fisheries. This Act gives the Minister of Fisheries and Oceans the ability to grant fishing licenses, regulate fishing activities, and to control the quantity of fish harvested. The Minister of Fisheries and Oceans may place specific prohibitions on certain techniques and equipment for fishing uses. The Minister of Fisheries and Oceans also has the ability to, if necessary to ensure the free passage of fish or prevent harm to fish, request owner or individual who creates or manages an obstruction or threat to remove the threat or take other action to return the free movement or safety to the fish. The Act specifically states that no work may be undertaken or deleterious substance released into fish habitat that causes serious harm to fish that are part of a commercial, recreational, or Aboriginal fisheries, without presenting the Minister of Fisheries and Oceans plans, specifications, studies, procedures, schedules, analyses, samples, evaluations, and other information that would allow the Minister of Fisheries and Oceans to determine the significance of the impacts.

Alberta Wetland Policy

The Alberta Wetland Policy aims to provide safe and secure drinking water, healthy aquatic ecosystems, and reliable, quality water supplies for a sustainable economy. This will be achieved by enabling flexible water management, building effective tools, knowledge and capacity, and encouraging wetland conservation and voluntary stewardship. Any development in the wildlife corridor around wetlands should be avoided first, and use mitigative measures if required. The wetland should retain full function as it was prior to any development. To keep the wetland intact, trail users should be educated on the importance of the wetland ecosystem they are in, and be encouraged to have a sense of stewardship of the public land, to conserve and protect it.

Species at Risk Act

The Species at Risk Act (SARA, 2002) was created for the purpose of preventing the loss of wildlife species in Canada. The SARA protects species listed in schedule 1 from being killed, harmed, or collected in addition to protecting the residence of such species. This applies to public lands. With respect to private lands prohibitions only apply to aquatic and migratory bird species. The migratory bird species must also be listed in the Migratory Bird Convention Act (1994). If an order is applied to an area other species may be protected by the SARA even on private land. The protection of critical habitat is a key goal of SARA and strongly encourages voluntary actions and stewardship measures. For non-aquatic species provincial laws will provide protection for critical habitat.

Alberta Wildlife Act

The Alberta Wildlife Act (2000) outlines that it is prohibited to knowingly disturb or destroy nesting or dens of species during specific times of the year, except when done with license or authorization. Outlined in schedule 6 of the Act is a list of species at risk to which specific legal rules apply. They are treated, with a few exceptions, as non-game animals.

Environmental Protection and Enhancement Act

The Environmental Protection and Enhancement Act (2000) is focused around environmental pollution and the reduction and mitigation of harm to the environment. Specific focus is given to industrial contaminants, hazardous waste, pesticides, and other like substances. This Act also includes the environmental assessment provisions.

Migratory Birds Convention Act

The Migratory Birds Convention Act (1994) applies to all of Canada and serves to conserve and protect migratory birds and their nests. The Act includes a number of prohibitions to protect migratory birds including depositing harmful substances in migratory bird habitats, harming, moving, or disturbing any nests or eggs, and these acts are punishable by law. With a number of migratory bird species in the area, any bird nests will need to be preserved in the creation of the wildlife corridor and recreational trail.

Alberta Land Stewardship Act

The Alberta Land Stewardship Act (ALSA) provides the basis for the creation of regional plans in Alberta. These regional plans reflect provincial economic, environmental, and social objectives. Municipal legislation must align with items stated in regional plans. Leduc City and County fall within the North Saskatchewan Plan, which is currently under development. ALSA also provides a number of conservation tools for municipalities to use. These include conservation easements, which allow the land owner to put aside a portion of land for the purpose of conservation and protection, conservation directives, and transfer of development credit schemes.

Public Lands Act

This Act prohibits activity in, around, or over a navigable water without approval. However, due to changes made in 2012, this act only applies to water bodies listed in the schedule attached to the legislation, which does not contain either Telford or Saunders Lake.

Alberta Water Act

The Water Act (1999) applies to any permanent or intermittent water body that is supporting an aquatic or terrestrial environment. The Act requires that any development which impacts a water body through infilling, cumulative effects, erosion protection, removal of vegetation within the shore line, draining, or realigning requires a permit from the Provincial Government. If the proposed wildlife corridor and trail network alter or impact either Telford or Saunders Lake in any way, a permit will need to be applied for.

Terms of Reference

Telford Lake to Saunders Lake Wildlife Corridor Report

Project Sponsors: City of Leduc/Leduc County, Planning & Development
Term: Winter 2018 Semester

1.1 Purpose

Through the Aerotropolis Viability Study project, the City of Leduc and Leduc County concluded that the lands located around the east side of Telford Lake and the lands west of Saunders Lake contain a great deal of potential for non-residential growth. Due to their proximity to the Edmonton International Airport (EIA), the Queen Elizabeth II Highway (QEII), and the Leduc-Nisku Business Park, the presence of a qualified workforce in many industrial sectors, access to nearby rail, and other competitive advantages, these lands could definitively support clusters associated with advance manufacturing, logistic & distribution, and agri-businesses.

In order to prepare the planning framework for the area, the City of Leduc in partnership with Leduc County, amended in 2017 the City of Leduc – Leduc County Intermunicipal Development Plan (IDP). The area that was once considered for mixed-use developments (within the city boundary) and residential (within County boundary), is now designated for non-residential growth. Each municipality is responsible of their own Area Structure Plan (ASP) within their jurisdiction. Leduc County has approved the Northwest Saunders Lake ASP and the City of Leduc is working on the East Telford Lake ASP.

Throughout the engagement process for the IDP amendment, the stakeholders and the community recognized the importance of ensuring a high level of connectivity between Telford Lake and Saunders Lake. The connectivity would enable to capture and maintain the recreational potential associated with the two lakes as well as to ensure the safe and continuous movement of the wildlife present in the area and protection of natural habitat.

Even though the vast majority of the properties are currently being farmed, there are a few areas that contains the necessary natural features to support certain species and provide opportunities for their various functions either on a permanent or temporary basis. It will be vital to maintain a wildlife corridor as the area between the two lakes develop and the Nisku Spine Road gets built (major industrial arterial – ultimate of 6 lanes divided).

1.2 Scope

The Project will:

- Research trends in recreational linkage through a trail system, preferably in an environment to become urbanized and with the presence of significant water bodies (significance to the community, not in terms of size necessarily);
- Research trends in identifying, evaluating, and defining wildlife corridor, the potential appropriate structures or methods to ensure safe and efficient movement of the fauna and the various mode of transportation, as well as mechanisms to support the maintenance and preservation of natural habitat to ensure biodiversity which is often lost in urban areas due to fragmentation of the natural landscape;
- Conduct a SWOT analysis associated with the integration of a wildlife corridor into the land use concept of the Telford Lake ASP and the potential impact within Leduc County
- Evaluate the options of combining or separating the wildlife corridor from the recreational trail system; and

- Develop a report outlining recommendations for the wildlife corridor between the lakes.

1.3 Assumptions

The project will assume:

- Recommendations will regard the land use objectives and policies from the IDP.
- Long term vision will be sought
- The City of Leduc and their consultant, Leduc County, and the owners within the study area are not obligated to consider the outcomes.

1.4 Deliverables

The interim report and presentation should include the following:

- A background discussion on recreational linkages opportunities between the two lakes;
- A summary of best practice for wildlife corridors; and
- A summary of criteria that would need to be evaluated in the choosing of a location and the preferred type of infrastructure for a wildlife corridor.

The final report and presentation should include the following:

- Final versions of the material included in the interim report;
- SWOT analysis around the integration of a wildlife corridor into the land use concept for the area;
- Recommendation towards keeping separate or combining the wildlife corridor with the recreational linkage; and
- Option(s) on potential location for the wildlife corridor location

1.5 Project Governance

Working Group – Role is to complete work identified in the project scope and deliverables.

- U of A Planning students
- City of Leduc and Leduc County liaison (1 staff from each P&D, with some support from GIS if needed)

Steering Group – Role is to review and help direct the project as needed/required as well as facilitate the necessary connections for the working group between interested parties.

- Sandeep Agrawal, Planning Program, U of A
- Sylvain Losier, P&D, City of Leduc
- Jordan Evans, P&D, Leduc County
- 1 representative from Stantec Consulting (individual TBD), consultant for the East Telford Lake ASP

1.6 Required Resources

• Staff time from municipalities and consultant	Staff time commitment
• Technical Support (printing, spatial data, mapping support)	Staff time commitment and Printing costs ($500)

1.7 Risks and Mitigation

Risk	Mitigation
Time commitment by members of the Stakeholders	Offer to hold meetings during non working hours, at lunch or after work. May require catering budget.
Owners or public reactions	Clarity around any publicity that it is a student project, with help offered by various professional bodies.

14.4 Appendix D

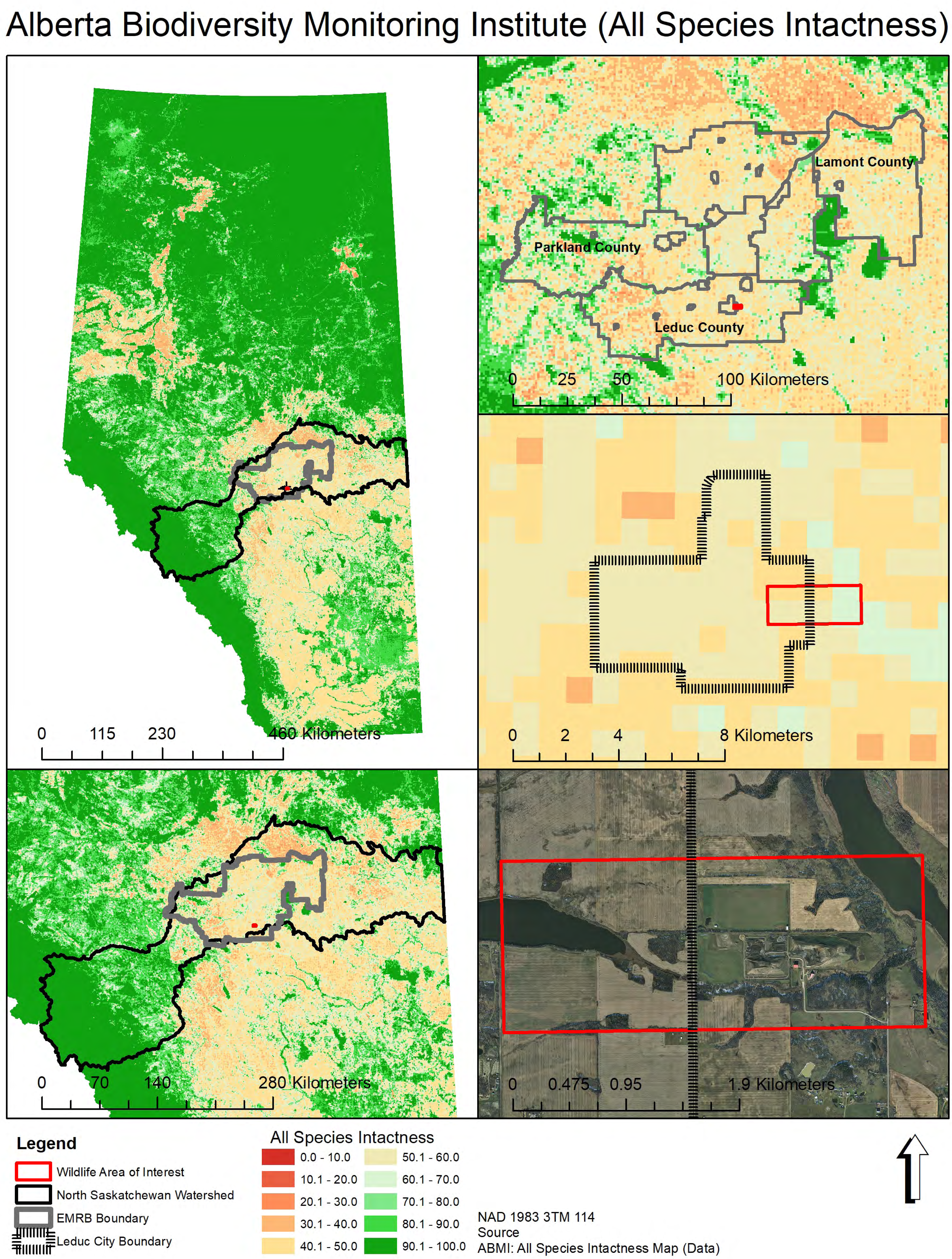

Fig. 44 Alberta Biodiversity Monitoring Institute (All Species Intactness

Alberta Biodiversity Monitoring Institute (Species Richness)

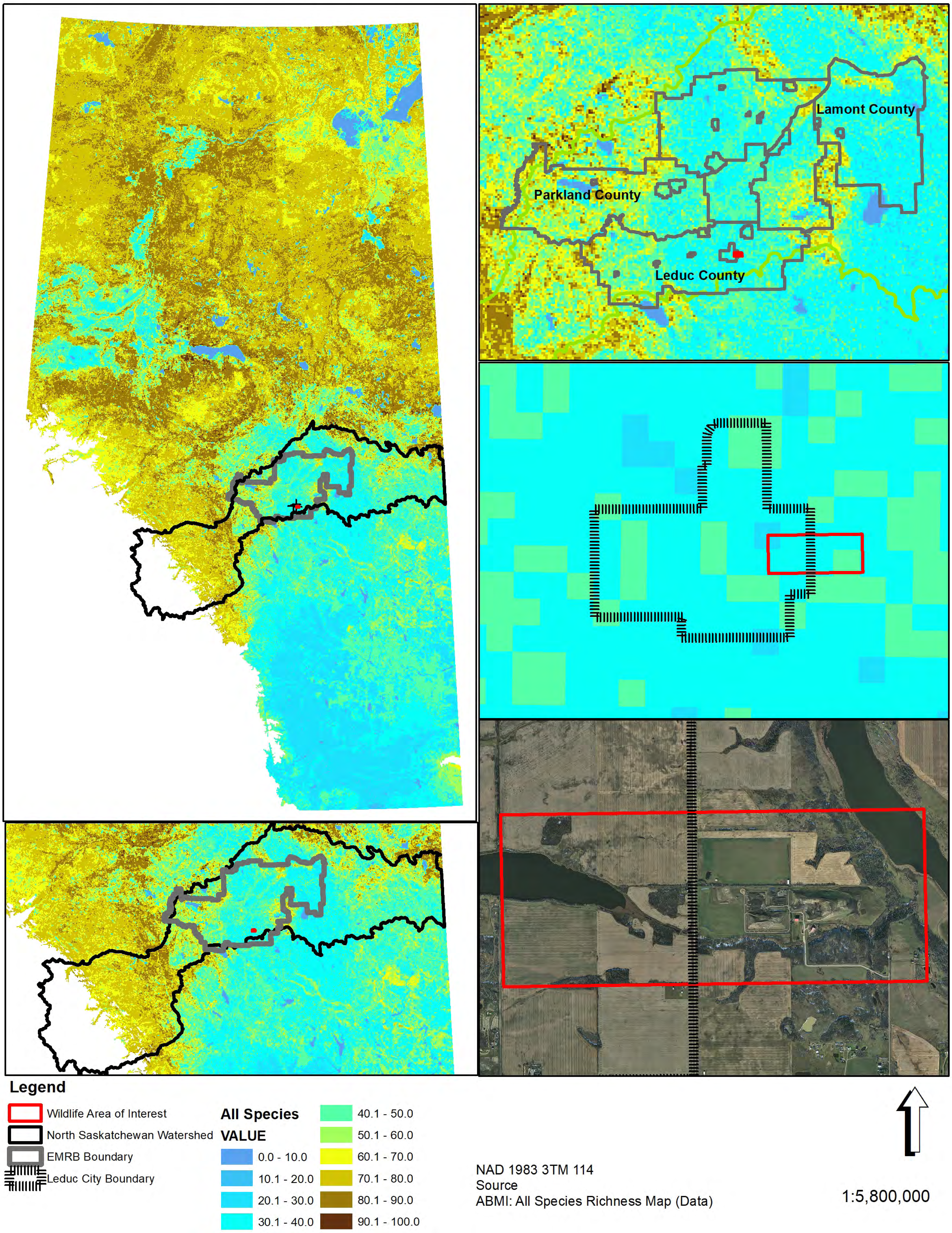

Fig. 45 Alberta Biodiversity Monitoring Institute (Species Richness)

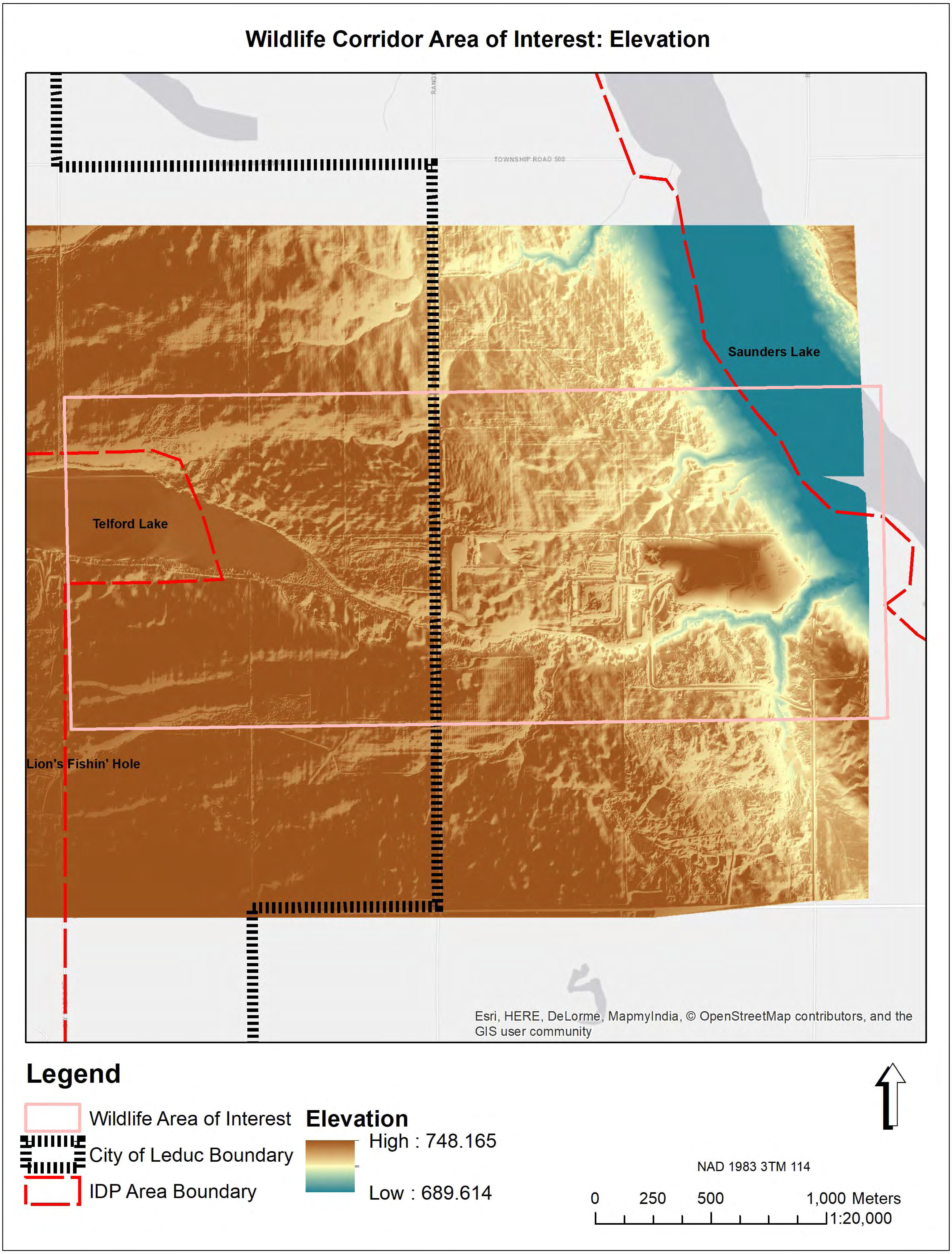

Fig. 46 Wildlife Corridor Area of Interest: Elevation

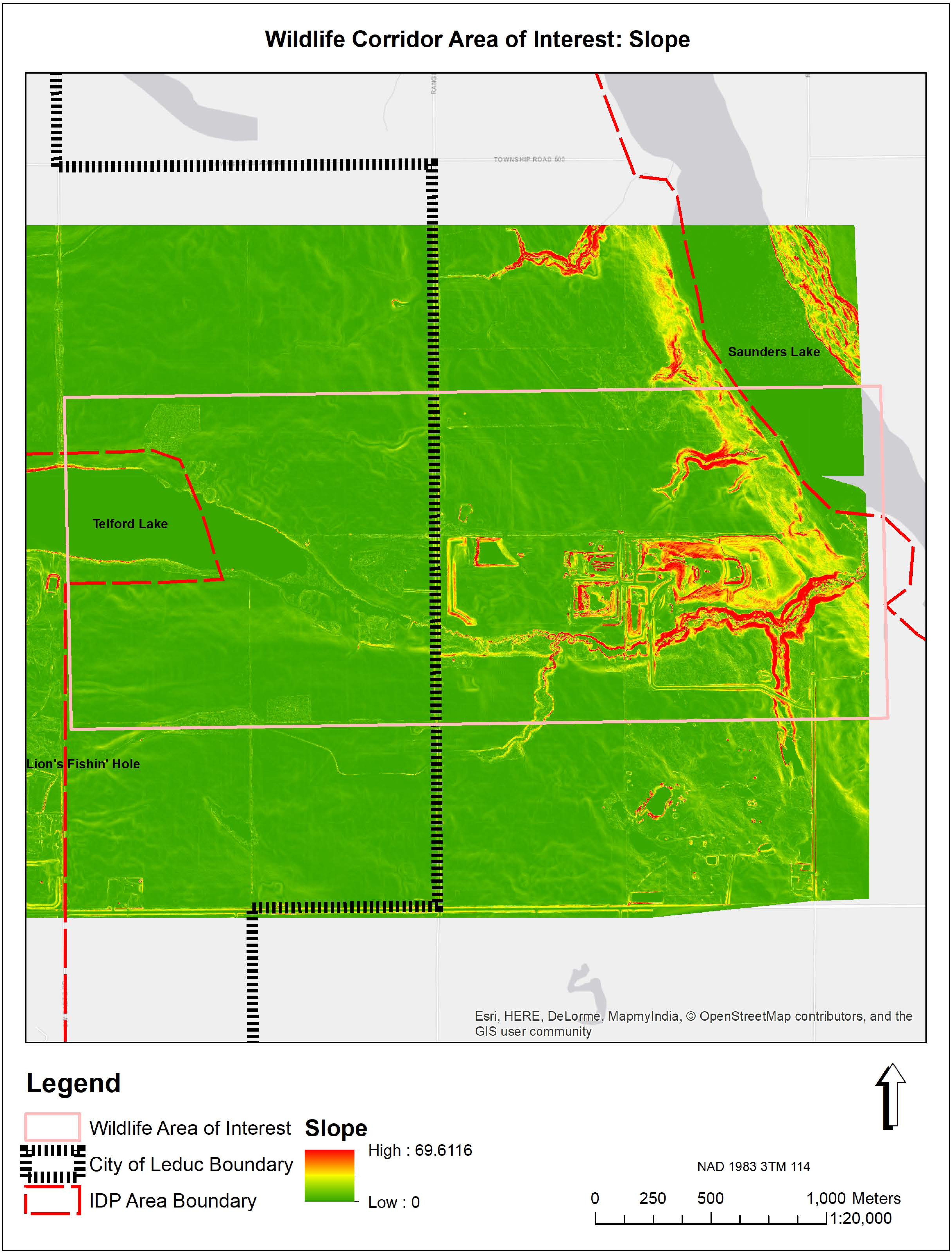

Fig. 47 Wildlife Corridor Area of InterestL Slope

area not to be developed

- Surfaces would be asphalt in the high use urban centre and transition from hard surface to a loose fill organic type covering. All material utilized will be conducive to wheeled devices i.e. wheel chairs, strollers and walkers.

Fig. 48 Refuse to Refuge Plan, Recreational Pathways