Northeastern Urban Containment Boundary Pre-Feasibility Study: Final Report

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EXECUTIVE SUMMARY

A key tenet of sustainable development is the pursuit of a compact urban form. Densification promotes servicing efficiencies, improves the viability of alternative transportation modes, and reduces the urban footprint. This allows more land to be retained in its natural state and/or utilized for parks and recreation. In keeping with leading edge practice, the City of Whitehorse 2010 Official Community Plan (OCP) identified two broad Urban Containment Boundary (UCB) study areas. This report examines the viability of residential development in the northeastern expansion area (NUCB) located north of Long Lake and east of the Yukon River (**Study Area Map #1** next page).

A pre-feasibility study scopes out the future urban land development potential of a defined area. It identifies the natural values present, the general development suitability for different land uses, along with the opportunities, constraints and technical challenges the City of Whitehorse must consider. The report also provides a high level overview to facilitate discussion during the upcoming review of the Official Community Plan on where the City should focus next after Whistle Bend is built-out. This area is one of the options available.

Highlights

- The area is generally suitable for the installation of urban services;
- Key issues include number and location of Yukon River Bridge crossings required; pros and cons of pre-grading on other values present, impacts on wildlife habitat and migration patterns, integration of First Nation land development and conservation interests, desire to create a continuous east riverbank trail and potential impacts on level of use and sustainability of Chadburn Lake Regional Park;
- Approximate on site costs $522M ($968,000/ha) + off-site costs $136M = $658M ($2016);
- Gross area 1,110ha - 213ha unsuitable (19%) = 897ha of which 571ha (63.6%) have no constraints, 140ha (15.7%) may encounter near surface bedrock and 175ha (19.6%) would require pre-grading. Reclaiming the old sewage lagoons adds 10.2ha (1.1%) of land and eliminates lagoon setback requirements;
- Yukon Bureau of Statistics estimates that between 2017 and 2030 Whitehorse will require 2,835 housing units to accommodate 6,237 people;
- Net useable area 538 ha (48.5%) @ 16units/ha = 8,620 units and 18,964 people @2.2 persons/unit which far exceeds demand using a low-density subdivision model;
- This means that if the City increases density in Whistle Bend and encourages infill elsewhere the need for investment in a new area can be postponed for at least 15 years;
- Similarly, increasing density in the NUCB area consumes less land area for the same population/unit yield while reducing minimum recovery cost threshold and providing more flexibility to accommodate other values present; and,
- Minimum recovery cost $76,620/unit at 16 units/ha.

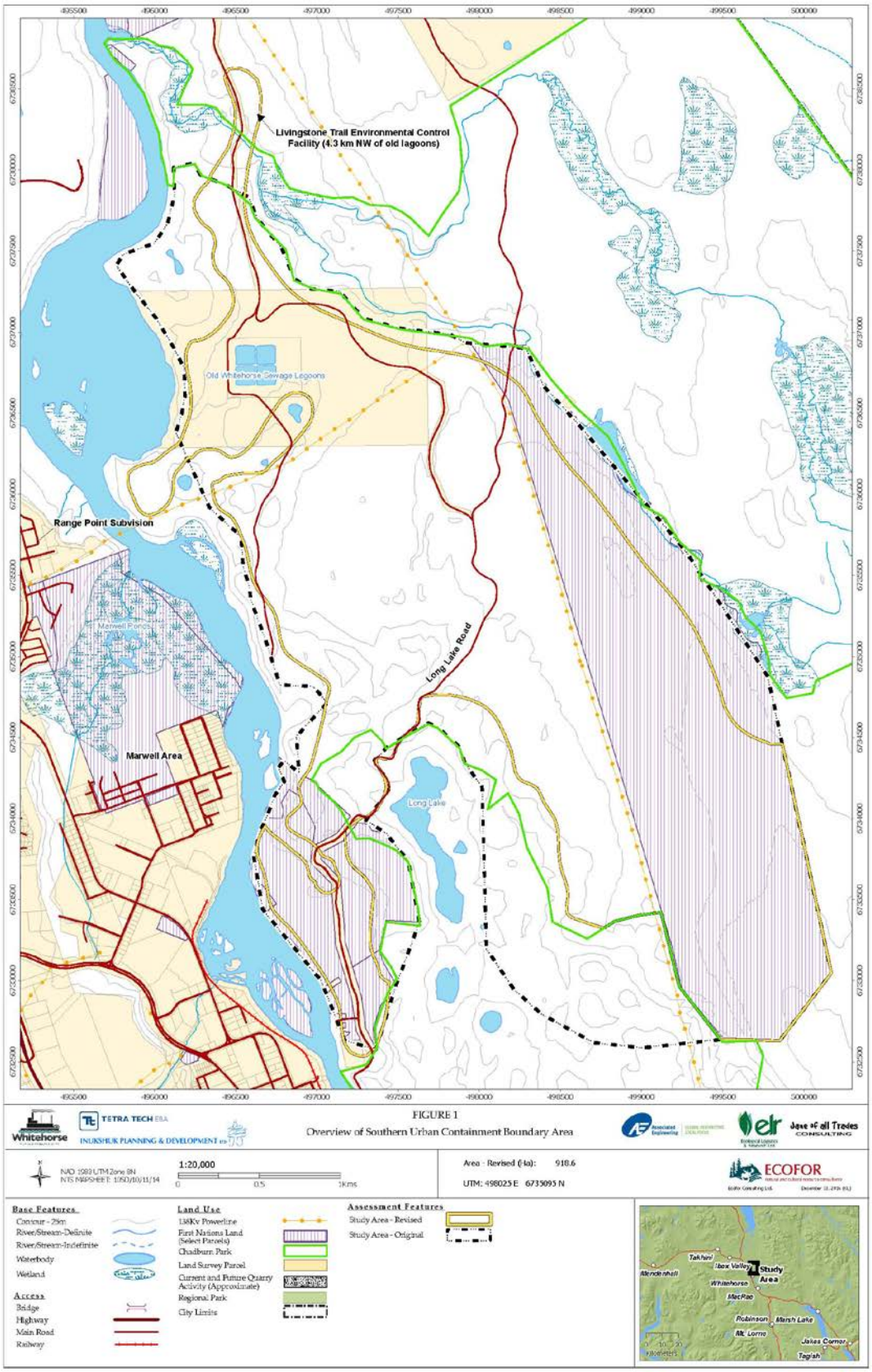

Figure 1: Northeastern Study Area

This is a broad-based pre-feasibility study. The objective was to assess the general suitability for urban development based on discipline-specific investigation and analysis of:

- Geotechnical and terrain considerations;
- Hydrogeological conditions;
- Ecological/environmental values, including fisheries and wildlife considerations;
- Heritage and cultural values present;
- Recreational uses and values;
- Infrastructure and engineering issues, including power, transportation, communications, water distribution, and wastewater collection;
- Servicing constraints and costs; and,
- General stakeholder issues and interests.

The project team drew from previous investigations and supplemented existing data with targeted fieldwork to identify development issues, opportunities, and constraints sufficient to inform a determination of development feasibility at a broad scale.

The NUCB study area is located within city boundaries on the east side of the Yukon River between Chadburn Lake Park and Croucher Creek and the east boundary of KDFN land selection C-116B.

The revised gross area with subsequent boundary adjustments is now 1,111 ha. The Yukon River comprises the western boundary, Croucher Creek the approximate northern and eastern limits, and the southerly limit roughly coincides with the southern end of Long Lake Road.

Land Ownership

The NUCB area is predominantly undeveloped Commissioner's land. There is a sizeable Kwanlin Dün First Nation (KDFN) Type 1 settlement parcel (C-116B) comprising 355 ha between the power line right-of-way and the eastern study area boundary. The Yukon Energy Corporation's (YEC) transmission line and the former Whitehorse sewage lagoons are also found in the study area.

Surficial Geology & Drainage

Surficial geology mapping in the NUCB shows glaciofluvial granular soils or deltaic/aeolian sand over and interbedded with glaciolacustrine silt. There are three distinct sets of terrain features present:

- Steep sided, hummocky and ridged ice-contact glaciofluvial terrain features immediately north and south of Long Lake and extending east to the power line;
- In the northern and westerly portions, rolling to gently rolling terrain that generally slopes towards the Yukon River, with some kame and kettle topography and two low areas near the old sewage lagoon likely associated with a former river meander; and,
- In the eastern portion, two areas identified as likely having shallow bedrock overlain by morainal deposits.

The overall regional groundwater flow direction and discharge is west towards the Yukon River. It is possible that localized, perched aquifers are present.

The complex topography and depositional history in the NUCB means there may be multiple local groundwater discharge areas within and just outside of the study area, including Long Lake, Croucher Creek and the various kettle and pothole lakes.

Environment & Wildlife Considerations

Key environmental considerations for the NUCB are:

- Croucher Creek, sections of the Yukon River, and the wetlands and drainages associated with both waterbodies are areas of significant fish and wildlife value;
- Environmentally sensitive areas include steep, often unstable slopes and hummocky terrain extending west and north of Long Lake, the Croucher Creek drainage and areas adjacent to the Yukon River;
- More than 20 mammal species and an estimated 74 species of birds potentially occur in the NUCB study area. including Woodland Caribou that use the NUCB as part of their winter range;

Highlights

Species listed under the federal *Species at Risk Act* (SARA) known to occur in the NUCB include:

- Woodland Caribou;
- Bank Swallow;
- Wolverine; and,
- Olive Sided Flycatcher.

- Wildlife movement into and within the NUCB is relatively unrestricted due to good habitat connectivity, relatively low levels of human use, and limited infrastructure; and,
- Croucher Creek, sections of the Yukon River and the wetlands and drainages associated with both waterbodies are areas of significant wildlife value.

Culture & Heritage Resource Potential

A GIS analysis identified more than 100 discrete areas of high heritage resource potential totaling 102ha (7.63% of the total study area). Approximately 825ha (62%) of the study area contain areas of old growth forest (>70 years old) which have potential for CMTs as well as a possible added forest fire risk.

Two archaeological sites with Borden numbers have been recorded within the study area, as well as five located just outside of it. While no Historic Period sites are recorded in the Yukon Historic Sites Inventory for the area, the Langholtz Mink Ranch, Ryder Wood Camp #3, and John McGundy Fish Camp are recognized heritage resources.

Trails & Recreation Use

There is a myriad of trails located within the NUCB study area, reflecting the evolution of travel and land use in the area dating back to pre-Contact times. Numerous trails in the area have been designated and adopted by the City, including “out and away” motorized multi-use (MMU) trails along the eastern portion and various singletrack trails designated for non-motorized use in the southern portion.

- Summer use of the City's singletrack trails by mountain bikers, walkers, hikers, and runners is high. Snowmobiling appears to be the most frequent winter recreational activity within the study area;
- The kame and kettle terrain located to the east and north of Long Lake is highly valued by orienteers due to its variable topography and lack of roads and trails. The area has also been used for national-level competitions; and,
- The remainder of the study area receives minor recreational use because of limited access. There is a unique opportunity to incorporate a continuous Yukon River escarpment trail in future planning of this area.

Highlights

- Water distribution and sewage collection is feasible to the NUCB based on desktop review;
- Updates to the 2003 Water Sewer Master Plan are required; and,
- A vehicular bridge is required and a pedestrian bridge is recommended.

Infrastructure & Site Servicing

Servicing the NUCB area at an urban service level is feasible using a combination of new infrastructure and upgrades to the existing infrastructure. Subsurface and hydrogeological conditions are favourable and productive aquifers may be present. Connecting to the existing water distribution network in Riverdale (along with upgrades to the Selkirk pump house and Riverdale Reservoir) would eliminate the need for a second water treatment plant.

Sewage collection would best be achieved through the construction of a new lift station and force main that discharges directly to the Livingston Trail Environmental Control Facility, located several kilometers north of the study area.

- On-site water supply and sewage disposal are both considered feasible within the study area, leaving the country residential servicing option also a possibility though that development form is not consistent with the UCB concept intent;
- A new Yukon River bridge crossing is required. The existing Robert Campbell Bridge serving Riverdale is at capacity. Terrain constraints along Wickstrom Road prevent the widening and upgrading necessary for it to successfully function as a primary arterial route;
- The team revisited two previously investigated crossings in the Marwell area along with a new alternative crossing connecting to the Range Point neighbourhood. Cut slopes will be required on the eastern bank for both Marwell crossing options to achieve target design grades, and the Range Point crossing necessitates the burial or relocation of the YEC transmission line; and,
- Either Marwell bridge crossing will work but each requires further technical analysis to identify a preferred option.

A narrow, active transportation oriented bridge connecting the Long Lake Road with Downtown in the vicinity of Shipyards Park/Ogilvie Street is considered highly desirable. Two options have been identified from a NUCB development perspective. Other locations have been identified further south in the previous Downtown Plan and may emerge through the OCP update.

- The installation of power and communications infrastructure in the NUCB does not pose any significant challenges. A new substation off the YEC transmission line could be installed and both secondary electrical transmission and communications trunk lines could be fed from the existing network on the west side of the Yukon River to the NUCB via the new bridge;
- Deep and shallow utility construction using conventional methods is considered possible throughout most of the area, with some potential for shallow bedrock in the southeast; and,
- The NUCB's distance from existing granular sources is a concern. The team recommends the development of a source within and/or adjacent to the area to minimize haul distance and traffic congestion from trucks needing to travel through Downtown and/or across the Robert Campbell Bridge until the new bridge is completed.

Residential Development Feasibility

The feasibility of residential development in the NUCB must be considered in the broader context of the City's strategic goals, objectives, and policies, other landholder interests, and planning and design principles that support densification to achieve a compact urban form. The inter-relationship between the NUCB and Chadburn Lake Park is also a key consideration.

Changing attitudes around pre-grading as a standard development practice, forest fire risk management, the area's wildlife habitat and migration values, as well as the ability of existing and future Yukon River crossings to address emergency evacuation needs, all raise important planning questions about how future development of the NUCB should proceed.

Feasibility is a subjective term. The context is important because it shaped the study's approach and focus. The project priority is accommodating future urban growth in a compact form. Thus, development suitability looked at access, terrain conditions, proximity to existing services and the expected general planning and engineering requirements to achieve that aim.

Highlights

- Weighing the costs and benefits of various location and value trade-offs is a community and Council responsibility; and,
- This study identifies those trade-offs at a broad scale for consideration in the upcoming OCP review.

KDFN owns a 355 ha land selection (C-116B) on the eastern perimeter of the study area. Much of that property is suitable for development in the distant future. However, given its location, the principal long term planning concern is to ensure service capacity is sized accordingly and development phasing allows for that eventuality. There would be no direct impact on development of the NUCB lands in the short and medium term.

To advance an understanding of potential engineering and financial feasibility, the team revised the study area boundary to facilitate basic quantitative analysis. The general approach to study area revision factored in known and strongly suspected technical constraints, incompatible land uses, and significant environmental, heritage and recreational values that did not obviously compromise the broader objective of optimizing the amount of potentially developable land.

The revised study area incorporates a gross area of 1,111 hectares of which 213ha (19%) are considered unsuitable for development. Of the remaining 898ha, 571ha (63.6%) are developable without any constraints while 140ha have potential near surface bedrock (16%).

One hundred seventy-six hectares (19.6%) may require pre-grading to facilitate an urban service standard. An additional 10.2ha (1.1%) of land can also be made developable by reclaiming the former sewage lagoons.

City staff and their KDFN, TKC and Government of Yukon counterparts participated in a workshop September 14th, 2016. Participants evaluated the ability of the revised NUCB study area to satisfy a suite of development suitability criteria. The results reflected the trade-off central to the prospect of using the NUCB area for residential development. The area is conducive to a compact urban development form promoting active transportation, housing choice and densification.

However, the NUCB's relatively pristine nature and high wildlife values mean there was also discussion that there may be "more to lose" here because of those values compared to other areas that could be developed within Whitehorse.

Using a general industry standard ratio of 60% of gross area for lots, the revised study boundary area has the potential to provide a net developable area of 539 hectares which could house up to 18,964 people or 8,620 housing units at 16 units/ha. Assuming that the conventional 150-200-lot development phase approach is adopted, this amounts to some 43-57 phases of future development.

Highlights

- The Yukon Bureau of Statistics population growth forecast expects Whitehorse to grow by 6,237 people between 2017 and 2030 requiring 2,835 housing units; and,
- Between Whistle Bend, infill redevelopment and modest increases in densification, the need to develop a new area can quite likely be postponed by 10-15 years.

Highlights

- 16 units/ha is a conventional subdivision low-density subdivision. It represents the minimum lot yield to facilitate macro-level cost comparisons assuming full land utilization. Densification changes the ratio between low and high density housing types. Double the density and only half the land is required to generate the same unit yield and population growth.

While some portions of the development can be phased sequentially, the bridge, underground and stormwater management infrastructure may need to be constructed well in advance of the population that will ultimately rely on it when residing there.

These off-site capital costs are significant and their timing, budgeting and funding requirements need to be weighed in conjunction with other City asset management needs and priorities. Working from the available Whistle Bend Phases 1 & 2 development cost data adjusted for the calculated net NUCB development area, the team estimates a total investment of approximately $661M will be required through to build-out.

The onsite costs are estimated at approximately $522M ($968,000/ha)[1]. The offsite costs, including the bridge crossing and new capital investments in upgrades for water and sewer infrastructure, a $2.97M allowance for further studies, a 30% contingency, 15% for engineering, 10% for developer costs, and 5% for permitting are estimated at $139M.

The long-term development horizon and need for multiple iterative phases of subdivision design to incorporate evolving market needs prevents a detailed cost recovery analysis at this point. A straight-forward analysis has been used that distributes development costs in 2016 dollars across all housing units and assumes a conservative, low density housing form (16 units/ha). The 539ha of developable area yields an average per unit cost price of $76,670 to recover on and off-site development costs.

The average 2015 price of Whistle Bend lot sales weighted between single family, duplex and townhouse lots was $103,040 in comparison.

Several more iterations of detailed site investigation and data gathering will be required should residential development in the NUCB be pursued, including:

- Further testing and modelling of groundwater supply and demand and downgradient impacts from old sewage lagoons;
- Additional detailed geotechnical evaluation of both banks of the river crossing options to inform pile design/installation;
- Detailed geophysical evaluation to determine depth to bedrock in the southeast portion and to estimate the volume and quality of granular material available in the area;
- Traffic modelling and updating of the 2006 City-Wide Transportation Master Plan;
- Updating of the City Wide Sewer and Water Master Plan to account for estimated population growth and servicing options for NUCB;
- Completion of more detailed ecosystem mapping, rare plant and wildlife studies, fish and fish habitat assessments, targeted wildlife and plant surveys, and studies aimed at a more complete understanding of Woodland Caribou use and potential residential impacts;
- Further discussion with KDFN and TKC regarding heritage and traditional use and conformance with the *Yukon Archaeological Sites Regulation* in future heritage assessment work and/or in the event of unanticipated heritage resource discoveries; and,
- More detailed trail planning needs to be done at the subdivision concept planning and detailed design stage to ensure construction of new trails coupled with selective decommissioning of old ones occurs as part of the subdivision approval stage and before the arrival of new residents. Particular attention needs to be paid to the area east of Long Lake and along the Yukon River east bank escarpment.

[1] Government of Yukon estimates Phase I & II of Whistle Bend cost approximately $650,000/ha to develop but could not confirm what all was included in that figure or provide an equivalent per unit break down.

The Way Forward

To facilitate the decision-making process that will ultimately determine whether or not to proceed with development in the NUCB and when, the team offers the following process-oriented recommendations:

- Review the results and conclusions of the two pre-feasibility studies for the Southern and Northeastern Urban Containment Boundary areas with the affected partner governments (City/YG/TKC/KDFN) comparing and contrasting the merits of each. Include a review of Whistle Bend build-out projections and density, and include an analysis of infill potential;

- Engage the Government of Yukon and First Nations in the greater Whitehorse area around the development of a regional growth strategy that aligns with sustainability objectives;

- Consider reframing public input during the next OCP review around the following questions:

  - *Which* currently undeveloped areas within the Urban Containment Boundary – all of which hold high ecological, recreational, or other values – may be most suitable for future development, versus *whether* one or both should be developed at all;

  - The fiscal merits of densification including its contribution towards housing affordability are known and the use of urban containment boundaries is generally accepted as a valid "best management" growth management practice. The question for public debate *is where and how densification should be applied* especially if it reduces the city's urban footprint to accommodate other values present and *whether* the presently defined urban containment boundary can be reduced;

- Should the NUCB area be retained as a future residential development option by the City, work with government partners to identify the key conditions precedent upon which a future determination to proceed would be based and address the information gaps outlined in Section **Error! Reference source not found.** accordingly; and,

- Continue and prioritize discussions with the Government of Yukon and First Nation governments around creating an action-oriented, collaborative approach to optimize and integrate the development of First Nation settlement lands within the City of Whitehorse in an efficient and cost effective manner.

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1.0 INTRODUCTION

A key tenet of sustainable development is the pursuit of a compact urban form through densification to promote servicing efficiencies, improve the viability of alternative transportation modes, and reduce the urban footprint. This allows more land to be retained in its natural state and/or utilized for other purposes such as parks and recreation. The City of Whitehorse 2010 Official Community Plan (OCP) introduced the concept of establishing an Urban Containment Boundary (UCB) as a strategy for managing future urban residential growth through densification. Several infill possibilities were identified as well as future expansion areas adjacent to the UCB if needed.

In March 2016, Inukshuk Planning and Development Ltd., in partnership with others, were retained by the City of Whitehorse Planning and Building Services Department to conduct a pre-feasibility study of the Northeastern Urban Containment Boundary area (NUCB). The area extends north from Long Lake and Chadburn Lake Park to Croucher Creek and lies between the Yukon River to the west and the Kwanlin Dün First Nation C-116B to the east (**Figure 1 Executive Summary**). With allowance for a 50-metre buffer around the perimeter, the study area encompasses approximately 1333 hectares.

The objective of the pre-feasibility study is to determine general suitability for urban development based on discipline-specific assessments of servicing feasibility, biophysical characteristics and values, recreational value/usage, heritage values, and land use suitability. This initial determination of technical and economic feasibility will inform the City's public discussion of this areas' future in the upcoming OCP review.

The following report highlights the results of the discipline-specific assessments conducted by the project team. It offers a synthesis of their collective implications for potential future residential development of this area within the broader context of policy, best practice, and City objectives. It provides directions on next steps, discusses information gaps and recommends principles that can be applied to the next stage of development planning. It also outlines the nature, extent and significance of trade-offs likely involved in any future development scenario. It makes a broad determination of development feasibility and outlines next steps for the City and potential partners.

The full discipline assessments are included as appendices to this report.

1.1 Study Scope, Limitations/Assumptions

The scope of the pre-feasibility study included an investigation and analysis of the following:

- Geotechnical and terrain considerations;
- Hydrogeological conditions;
- Ecological/environmental values, including fisheries and wildlife considerations;
- Heritage and cultural values present;
- Recreational uses and values;
- Infrastructure and engineering issues, including transportation, communications, water distribution, and waste water collection;
- Servicing constraints and costs; and,
- Identification of general stakeholder issues and interests.

The analysis is based largely on a review of previously gathered data and information for the NUCB, supplemented by targeted fieldwork and investigation. The objective was to arrive at a high-level identification of issues, opportunities, and constraints sufficient to inform a determination of development feasibility at a broad scale.

The project team endeavored to make the discipline assessments as comprehensive and accurate as possible based on the limitations of the data available. The methods employed provide a relatively coarse resolution of conditions in the study area due to the limited field time available and size of the area. Data gaps were encountered as expected with respect to the heritage, recreation and ecological values present. Without subsurface investigation, there is potential for variability and higher margins of error in the geotechnical and hydrological investigations. In general, the Team drew preliminary conclusions based on the available data and their respective first-hand knowledge of conditions in, and/or, similar areas within the city.

Highlight

- Much of the existing data relevant to infrastructure and servicing feasibility is out of date, limiting the engineering teams' ability to fully scope serviceability at this stage.

Servicing cost is influenced by the level of service standard applied, density, proximity to existing services, and threshold capacity. Initially, two levels of servicing were considered: full urban and partially serviced (e.g. country residential). However, as the study evolved and government partners had the opportunity to weigh in, it became clear that the country residential option was incompatible with the intent of creating UCB's. This does not mean that the option may not be considered in the future at the detailed subdivision design stage to maximize utilization.

For comparison purposes, Whistle Bend actual costs and a density of 16 units/ha were used as the proxy for the purposes of projecting servicing costs and ultimately - potential revenue generation from lot sales. A 5-to-7-year lead time is also assumed to be the minimum required to complete the final design, permitting process, and installation of key off-site infrastructure. Two factors will affect the start date. They are the time to build-out of the last phase of Whistle Bend and the amount of infill or other development that occurs elsewhere throughout the city and the adjacent catchment area.

1.2 Approach and Methodology

The general steps taken in the project team's approach and methodology are summarized below. For more discipline-specific detail, please refer to the report appendices.

1.2.1 Desktop Review

Each discipline team compiled and reviewed previous studies and information pertinent to the study area, including relevant reports and past studies commissioned by the City of Whitehorse and Government of Yukon. This information included the following:

- City of Whitehorse and other studies and information relevant to municipal servicing and transportation;
- City of Whitehorse 2015-2050 Sustainability Plan and 2010 Official Community Plan;

- Geotechnical and hydrological data gathered within and/or adjacent to the study area (Tetra Tech EBA NUCB Feasibility Level Geotechnical Assessment 2014);
- Wildlife, conservation data and ecosystem mapping and data previously collected (NUCB Expansion Area Fish and Wildlife Baseline Conditions and Issues Scoping, EDI 2014);
- Previous heritage resource management research, including archaeological studies, historic records and ethnographic accounts, conducted within the study area and adjacent lands;
- Inventory of physical/environmental attributes that could serve as predictors of human occupation;
- Collection and review of recreational mapping resources for the area, including City of Whitehorse trail data, Chadburn Lake Park Management Plan (June 2016 draft) and other sources; and,
- Miscellaneous secondary research using online and hard copy sources (e.g. Yukon River Corridor Plan Gartner Lee 1999).

1.2.2 Personal Interviews & Discussions

Interviews were held with key informants with expertise and/or interests related to the study area. A project meeting with representatives of the Kwanlin Dün First Nation (KDFN) was held on April 13, 2016, followed by a meeting with Ta'an Kwäch'än Council (TKC) on April 15, 2016. Other interviews were held with the following:

- City of Whitehorse and Yukon Government Land Development staff;
- Selected recreational groups and commercial operators; and,
- Local residents with insight into recreational use and other values present.

1.2.3 Field Investigation

The ecology team undertook field reconnaissance of the NUCB on May 19 and 20, 2016 to review and field-check previously completed ecosystem mapping (AEM 2000) and gain an understanding of the terrain and ecosystem units not available at the resolution of the ecosystem maps (1:20,000). This included visits to known or potentially sensitive areas to investigate any changes since AEM's initial work.

The recreation team carried out fieldwork in the NUCB over several weeks between late May and early June 2016. This included collecting additional trail data and assessing other recreation values present in the landscape.

The geotechnical consultants relied on a review of their records and air photo interpretation supplemented by several brief site inspections of specific areas of concern.

After reviewing the sub-consultant technical reports, the lead planner used a combination of air photo interpretation and two brief aerial reconnaissance flights to get an overview of the area[2].

[2] Both areas are within the airport control zone restricting flight options

This was followed by short site visits to specific east bank bridge crossing locations as well as areas identified by other team members as areas of environmental concern.

1.2.4 GIS Analysis

A GIS-based heritage resource potential analysis was conducted to evaluate lands within the study area and identify specific areas of heritage potential. The results of this analysis were then scrutinized by experienced archaeologists from Ecofor who reviewed the predictions in relation to the hypothesized results. GIS analysis was also used to evaluate the potential for Culturally Modified Trees (CMTs), with the key parameters for this analysis being pine-dominant forests more than 70 years old.

Highlights

- The study area is quite large and notably undeveloped given its limited access despite its relative proximity to downtown Whitehorse.
- The information available for the pre-feasibility study was limited in scale, completeness, age and utility with many gaps as outlined in the following sections. However, it was sufficient to get a "sense" of general development suitability.
- Limited access, particularly the need for a second Yukon River bridge, is a key factor in why the area is largely still in its natural state and why other values present (e.g. wildlife utilization) have been less impacted to date by urbanization pressures.

2.0 DESCRIPTION & ANALYSIS OF STUDY AREA LAND VALUES

The initial study area covered 1333 hectares[3] within the City of Whitehorse, including a 50-metre buffer zone around its perimeter, all of which fall within the traditional territories of the Kwanlin Dün First Nation (KDFN) and Ta'an Kwäch'än Council (TKC). The study area is located within Boreal Cordillera Ecozone and the Yukon Southern Lakes Ecoregion**,** which is characterized by broad valleys and large lakes.

2.1 Land Tenure and Uses

The Northeastern Urban Containment Boundary (NUCB) is bounded by the Yukon River on the west side, Croucher Creek for part of the eastern margin and by the eastern border of the KDFN C-116B land selection. The study area currently features a range of land tenure and uses, including the following:

- KDFN Type 1 settlement parcels C-116B, C-42B and C-143B;
- TKC settlement parcels C-96B/D, C-77B, and C-14B;
- Approximately five private titled residential properties accessed from Long Lake Road and/or spurs;
- Two quartz mining claims just northeast of the Livingston Trail Environmental Control Facility (LTECF) access road at Croucher Creek; and,
- The original City of Whitehorse sewage lagoons.

The remainder of the study area is predominantly undeveloped Commissioner's lands managed by the City of Whitehorse as green space under the broad powers conferred by the *Municipal Act*.

Existing land use and tenure is shown on the overview map. (**See Figure 2**).

Until the bridge to Riverdale was built, almost all urban development was concentrated on the west side of the Yukon River. Aside from a stretch of housing along Wickstrom Road across from downtown, access and use of the NUCB was limited to a main powerline, the initial sewage lagoons and a mining access road that has subsequently been upgraded as far as the new Livingstone sewage treatment facility.

Construction of a second Yukon River bridge would substantially change the potential spillover effects and pressures of urbanization on the other natural values including unimpeded wildlife movement. The majority of past recreational use has been concentrated in the Long Lake area now part of Chadburn Regional Park.

[3] The revised gross study area boundary was later reduced from 1,333 to 1,111 hectares as the study evolved.

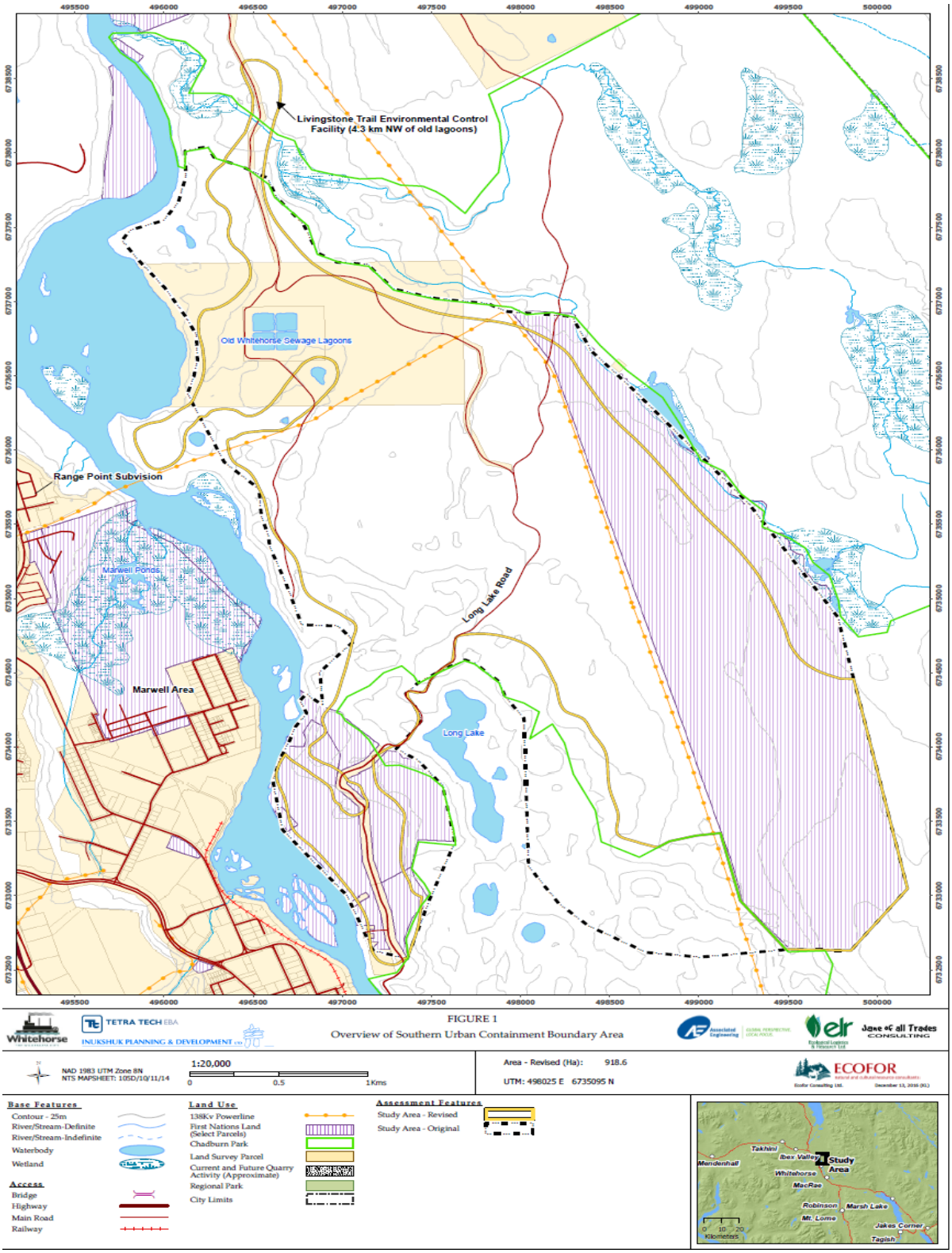

Figure 2: Overview of Northeastern Urban Containment Boundary

2.2 Geotechnical Considerations

Glaciation, deglaciation and the depositional and erosional forces of water and wind have shaped the surficial geology of the Whitehorse Map area resulting in the variable soil conditions encountered throughout the study area. Surficial geology mapping shows glaciofluvial granular soils or deltaic/aeolian sand over and interbedded with glaciolacustrine silt (Bond 2004). Surficial sediments in the NUCB are mapped as glaciofluvial materials from the Judas Creek Soil Complex and a combination of moraine and glaciofluvial materials from the Brooks Brook Soil Complex.

Bedrock mapping shows the area almost entirely covered in quaternary sediments, while the underlying bedrock formations have not been confirmed. Bedrock mapped in the area surrounding the NUCB includes Hancock Member Limestone from the Aksala Formation in the southeastern quadrant, granodiorite from the Whitehorse Plutonic Suite and intermediate to felsic subaerial volcanic rocks from the Skukum group to the east, lower to middle Triassic Laberge Group sedimentary rocks to the south, and Povoas Formation basalt to basaltic andesite flows to the northeast.

Bedrock outcropping have been identified in the southeast portion of the study area but have not yet been mapped in detail. Existing test pits and boreholes in the area have not encountered bedrock; however, topographical and geological mapping indicate that bedrock may outcrop at surface in the southeastern portion of the NUCB. The depth to bedrock is likely variable throughout the area with the bedrock morphology controlling the sedimentary thickness. However, the sediment sequence is likely relatively thick throughout the majority of the site.

Boreholes drilled by Tetra Tech EBA in 2008 in the vicinity of the old City of Whitehorse sewage lagoon were completed at 50.2 and 56.4m below grade in overburden. Bedrock was not encountered upon completion. A water well, located on the southeast boundary of the NUCB, which was deepened to a depth of about 30m below grade, also did not encounter bedrock at completion.

Three distinct sets of terrain features are present in the surficial deposits of the NUCB:

- In the north to northwestern portion, rolling to gently rolling terrain that (in general) slopes towards the Yukon River, with two low areas (both with standing water) to the north and south of the old sewage lagoon likely associated with a former river meander (Area 1a) and kame and kettle topography (Area 1b).
- Steep sided, hummocky and ridged ice-contact glaciofluvial terrain features are evident in the area around Long Lake, extending east to the power line, west to the Yukon River, south to the hospital area and to about one kilometre north of Long Lake (Area 2). The complex topography in this area results in multiple highs and depressions over a relatively small scale.
- In the eastern section of the NUCB, two areas have been identified as likely having shallow bedrock overlain by morainal deposits (Areas 3a and 3b).

The relevant areas of geotechnical concern are shown in **Figure 3.**

Highlights

- Steep, eroding Yukon River east bank
- Complex kame/kettle topography around Long Lake
- Pockets of near surface bedrock may be present

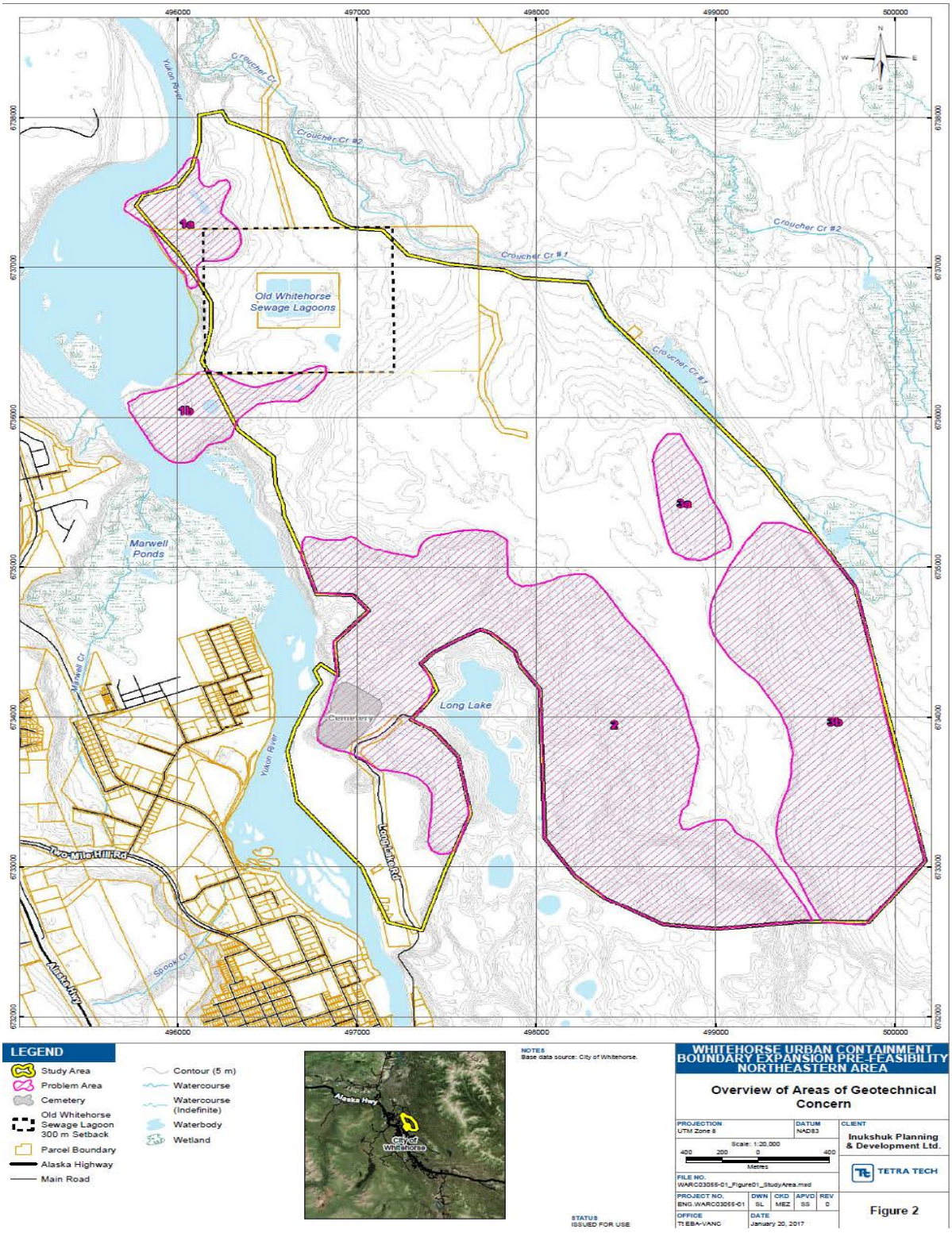

Figure 3: Areas of Geotechnical Concern

2.3 Drainage and Hydrogeology

The composition of the shallow subsurface layer is expected to be variable. Some areas show significant quantities of silt and clay, which may result in localized seasonal perched shallow groundwater. This is based on the geological mapping available, monitoring well data at the old City of Whitehorse sewage lagoon, and the limited geotechnical test pit and shallow borehole data available for the area.

Due to the complex nature of the surficial deposits and the variable topography in the area, it is likely that - if present - localized, perched aquifers will have variable groundwater flow direction depending on the topography and the surface dip (angle and direction) of low permeability layers. Evidence of shallow groundwater is present in Areas 1a and 1b of the study area, and kettle lakes in the vicinity of Long Lake suggest there is some potential for shallow groundwater in Area 2. The likely presence of shallow bedrock in Areas 3a and 3b means these areas have potential for shallow groundwater due to the low permeability bedrock barrier.

Based on general hydrogeological principles, regional groundwater flow direction is expected to mimic topography and flow toward the Yukon River, the major regional discharge location. The depth to the regional groundwater table at the location of the old Whitehorse sewage lagoon was found to be between 33.4 and 44.4m below grade (the discrepancies in depth to the groundwater table observed here due to the difference in elevation of the wells installed). The water table beneath the sewage lagoon was relatively flat and groundwater flow at this location was inferred to flow in a westerly direction towards the Yukon River.

Several pothole lakes can be observed in the Long Lake area with significantly higher elevation than the Yukon River suggesting that shallow groundwater may be present in this area either in the form of perched localized aquifers or as a shallow regional groundwater table.

Within the NUCB, groundwater may migrate towards and discharge in low-lying areas with existing waterbodies (i.e., swamps, ponds, lakes) or to creeks/rivers that are within or close to the study area. At and in the vicinity of groundwater discharge areas, groundwater would be expected to be at or close to the ground surface. Groundwater discharge areas can be used to determine the existing groundwater regime, identify areas where shallow groundwater is likely present and help guide development so that potential problem areas can be identified and either avoided or mitigated.

While the overall regional groundwater flow direction and discharge is likely west toward the Yukon River, complex topography and depositional history in the NUCB means there may be multiple local groundwater discharge areas identified within and just outside of the study area. These include: Long Lake and other small kettle lakes in its vicinity, the pothole lakes in Areas 1a and 1b, and Croucher Creek.

There are several examples where shallow groundwater issues have occurred in the Whitehorse region with substantial associated costs.

Hydrogeological studies of the problem areas have suggested that increased groundwater infiltration due to changes in the surface characteristics and water balance have contributed to higher groundwater elevation in areas that were not previously identified to have shallow groundwater.

Shallow aquifers that are not identified during conceptual and detailed design may become problematic after development if increased groundwater recharge and altered groundwater flow paths result, changing the water balance. Lot grading and surface drainage management can also be contributing factors.

Due to the variable thickness and soil types encountered in this area, variable groundwater flow conditions are expected to occur throughout the study area. Based on the presence of low permeability silty soils that can act to restrict groundwater infiltration, it is expected that shallow groundwater could be found in localized areas throughout the study area with some localized areas having shallower groundwater than others. Groundwater at shallow depths may constrain basement construction in these areas.

Areas 1a, 1b, 2, 3a, and 3b are all potentially problematic for development within the NUCB due to the presence of standing water (1a and 1b), permafrost (1b), possibility of perched localized aquifers or shallow regional groundwater table (2) and shallow bedrock deposits that may act as aquitards[4] and result in shallow groundwater either as regional shallow groundwater or as localized, perched groundwater features (3a and 3b).

Two additional areas were identified as potentially problematic due to anthropogenic activities that could have an impact on groundwater quality in downgradient areas. The former sewage lagoon could cause elevated concentrated concentrations of nitrate, metals or have microbiological contaminants that could pose a health risk to any groundwater users in the vicinity. The site stopped receiving inflow in 2009 and only a small amount of water remains. The cells are lined with plastic to prevent infiltration and test wells drilled to date have shown no contamination. Still, in addition to the required setback of 300 metres for any community water supply from the lagoon, the team suggests avoiding construction of any water supply wells within this setback as well as downgradient (west to northwest) of the lagoons.

The other area of concern is the KDFN cemetery located about 400m west of Long Lake. The Yukon Public Health Drinking Water Regulations require a 120m minimum setback from cemeteries for water wells supplying Large Public Drinking Water Systems. In the absence of applicable regulations in the Yukon for small scale water supply, the team recommends that residential wells not be located closer than this 120m setback or downgradient (west/northwest) without detailed hydrogeological assessment.

Highlights

- Localized, variable groundwater conditions can be expected throughout study area.
- Regional groundwater flow/discharge to Yukon River.
- Avoid well development within 300m of former sewage lagoons and 120m of KDFN cemetery.

[4] Aquitards are rocks with low values of hydraulic conductivity, which allows some movement of water through it, but with rates of flow lower than those of adjacent aquifers.

2.4 Ecology

Previous ecosystem mapping conducted in 2000 by AEM identified fourteen ecosystem types in the NUCB, with the Pine-Bearberry ecosystem covering the largest percentage of the area (approximately 61%) followed by Trembling Aspen – Bearberry (18.8%), White Spruce – Feathermoss (7.9%) and Lodgepole Pine – Lichen (6.4%). Other mapped ecosystem units each cover less than 5% of the area (e.g., urban areas and open water). No significant land cover changes since 2000 were observed by ELR. However, some of the seral class modifiers (time since last fire) identified in the AEM report may need to be revised due to the 16 years that have passed since the original mapping was completed.

Figure 4: Pine-Bearberry (foreground), Aspen-Bearberry Forest (background) within KDFN 116B (ELR)

Croucher Creek (northeastern boundary), sections of the Yukon River (western boundary) and the wetlands and drainages associated with both water bodies are areas of significant wildlife value. The main environmentally sensitive areas within the NUCB are the steep, and often unstable, slopes and hummocky terrain that extend west and north of Long Lake, along with the Croucher Creek boundary and areas adjacent to the Yukon River. Although technically outside the NUCB, environmentally sensitive areas have also been identified around most of Long Lake, with connections to environmentally sensitive areas within the study area.

Figure 5: Steep banks leading down to Croucher Creek (ELR)

Most of the slopes overlooking the Yukon River and portions of the slope along Croucher Creek are very steep and show signs of ongoing erosion in exposed areas.

Figure 6: Looking southeast towards east Yukon River bank (ELR)

In general, the habitat values present within the Yukon River corridor are considered to be under pressure due to the presence of infrastructure along many stretches of the river and modifications to the shore, banks, and bed of the river in those areas (AEM 2003). The primary wildlife and habitat considerations relevant to the NUCB area are shown in **Figure 7** on the following page.

More than 20 mammal species potentially occur in the region including species of conservation concern (e.g., Little Brown Bat, Woodland Caribou), and managed species (e.g., Grizzly Bear, Black Bear, Moose and Canada Lynx). There are also an estimated 74 species of birds. Remote cameras have frequently documented Mule Deer, and to a lesser extent larger mammals including Moose and Woodland Caribou (EDI 2014). While cameras documented only one black bear over a 6-month period, bear scat has been observed at several locations during field surveys.

Government of Yukon 2012 to 2014 human-bear incident data for the Whitehorse and Southern Lakes area does not list any incidents of bear-human encounters in the NUCB (Government of Yukon 2016), although this is likely due to the low number of residences in the area.

Five species of conservation concern potentially occur or are known to occur in the NUCB. These include the Woodland Caribou, Little Brown Bat, Wolverine, Bank Swallow and Olive-Sided Flycatcher. Four Woodland Caribou were detected by remote camera in 2014, approximately 600m northeast of the north end of Long Lake (EDI 2014). The Government of Yukon has documented Woodland Caribou in the area through collar telemetry and helicopter winter surveys[5].

[5] Personal Communication, Bruce Mclean, Government of Yukon, June 6th, 2016

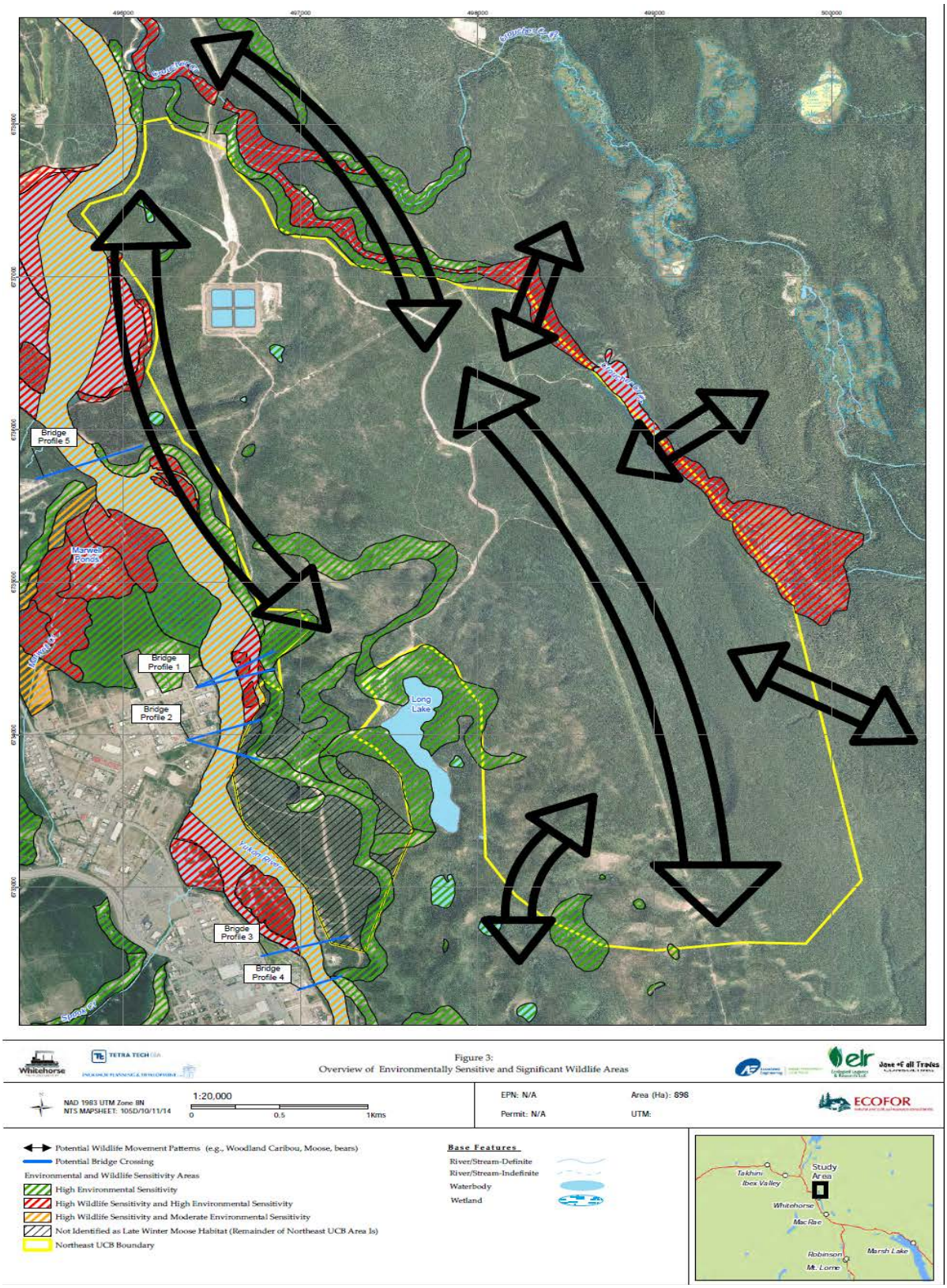

Figure 7: Overview of Environmentally Sensitive and Significant Wildlife Areas

The individual caribou sightings are most likely members of the Carcross Caribou Herd, based on studies and the herd's annual range which overlaps with the NUCB area (Government of Yukon 2015). Wolverine tracks were also observed in the NUCB in February 2014 (EDI 2014).

No fish species were documented in the NUCB[6] and fish presence in the kettle ponds has not been confirmed (EDI 2014). Croucher Creek, Long Lake and the Yukon River are located adjacent to the NUCB area. The Yukon River in the vicinity of the NUCB is host to at least 15 species of fish and is known to provide important but sensitive habitat that is already under significant pressure through urban development.

Chinook Salmon migrate past Whitehorse on the Yukon River. The section of the river between McIntyre Creek and the Whitehorse Rapids Dam is used for spawning and juvenile rearing (AEM 2003). Croucher Creek is known to support several fish species, and is also known to be a non-natal Chinook salmon rearing stream (AEM 2003). This usage has been documented in the lower reaches of the creek, some of which is located within the NUCB. Other species including Arctic Grayling, Longnose Sucker, and Rainbow Trout have been documented in the upper reaches of the creek. Usage by juvenile Chinook salmon and other species gives high value to the habitat of Croucher Creek, in turn making those values susceptible to degradation through development.

The 2003 AEM study raised concerns about the need to limit the number of culverts roads and trails crossing the lower Croucher Creek drainage. Steep, easily erodible slopes are also concerns in this area.

Wildlife movement into and within the NUCB is relatively unrestricted due to good habitat connectivity, the relatively low levels of human use, and limited infrastructure. The existing roads and trails, sewage treatment lagoon, transmission line, and residential areas near the Yukon River are not considered to pose a significant barrier for wildlife movement. North-south wildlife movement corridor connections are very good, partly because of the proximity of the Yukon River and Croucher Creek. East-west movement corridors into and out of the NUCB are currently good, as indicated by the presence of Woodland Caribou in the NUCB in the winter that likely move down from the higher ground to the east used during the summer months.

Highlights

- Five species of conservation concern, 20 species of mammals, 74 bird species potentially occur or are known to occur in study area
- Pine-bearberry ecosystem makes up 61% of NUCB
- Wildlife movement relatively unrestricted due to good habitat connectivity, low level of human use, and limited infrastructure.
- Areas of environmental sensitivity include Croucher Creek drainage (fish), east bank Yukon River (bank stability/wildlife values), Long Lake/Chadburn Regional Park kame/kettle topography (biodiversity/landscape character)
- Habitat values present within the Yukon River corridor are under pressure

[6] Fish are present in the Yukon River and Croucher Creek drainage which are adjacent to but not within the NUCB study area boundary.

2.5 Culture and Heritage

Heritage resources are managed under the provisions of the Yukon First Nations Umbrella Final Agreement (UFA) Chapter 13, *Yukon Historic Resources Act* and the *Archaeological Sites Regulations*. Yukon is responsible for heritage resource management on non-Settlement lands. Archaeological resources are protected under the *Heritage Resources Act*, whether located on public or private land. Protected sites may not be altered without a permit issued by the Minister or designate.

A search of the Yukon Heritage Resource Inventory of archaeological sites with Borden numbers identified two previously recorded sites within the NUCB and five just outside of it. Several Culturally Modified Tree (CMT) sites are known to be in and immediately adjacent to the study area.

No Historic Period sites have been recorded in the Yukon Historic Sites Inventory within the NUCB, but several sites have been recognized in previous City of Whitehorse studies. A map prepared for the City's *Yukon River Corridor Management Plan* (2000) shows two sites, the Langholtz Mink Ranch and Ryder Wood Camp #3, listed as "Historic Wood Camps and Fur Farms" within the study area. The John McGundy Fish Camp is also identified at the mouth of Croucher Creek, in close vicinity to the wood camp. Attempts to uncover further information on these sites to date have been unsuccessful.

The GIS analysis identified more than 100 discrete areas of high heritage resource potential, totaling 101.73 hectares (or 7.63% of the total study area). Moreover, multiple areas of old growth forest (>70 years old) with potential for CMTs were identified (825.26 hectares, or 61.93% of the total study area). The presence of old growth forest, like the presence of topographic features that may have high heritage resource potential and related CMTs does not necessarily preclude development. Rather it serves as a "heads up" for consideration in more detailed design. This also applies to fire smart considerations which should be integrated directly into subdivision design.

The remaining lands are considered to possess low potential for significant heritage resource sites, although the possibility of chance finds of heritage materials is always present.

The eastern bank of the Yukon River is a documented travel corridor historically utilized by both First Nations and later European people. First Nations use includes a trail running between Marsh Lake and Lake Laberge. The exact location of the traditional trail (or trails) through the NUCB study area is not well mapped but its existence has been confirmed through Traditional Land Use Elder interviews.

This trail system likely followed high ground on east side of Yukon River. As such, it is considered likely that segments of First Nations trails cross portions of the proposed NUCB footprint. Given the tendency for early European travel routes to incorporate First Nation routes, it is also likely that some early European use of the escarpment in the area also occurred.

Eleven broad site types were considered in the Heritage Resources Overview Assessment (HROA) for their likelihood to be present within the study area based on extrapolation from previous archaeological studies and known sites in the larger area. These are shown in **Table 1** on the following page.

Table 1: Heritage Resource Site Types and Potential

Site Type	Potential	Comments
Permanent/Long-Term Habitation	Moderate-High	Permanent/long-term habitation tends to be located near significant landscape features that provide optimal places for campsites. Several such landscape features/camping places are present within the study area, primarily along the well-defined terraces above the Yukon River valley and surrounding Long Lake.
Fishing Sites	Low-Moderate	The potential for finding fishing sites along the Yukon River is evaluated as moderate. This site type may also overlap with temporary and long-term habitation sites, while the potential for fishing sites adjacent to Croucher Creek #1 and ponds is evaluated as low to moderate.
Rock Art Sites	Low	The potential for rock art is considered to be low throughout the study area.
Temporary Habitation	High	The probability of finding temporary habitation sites is bolstered by the same factors that create moderate-high potential for longer-term sites, as well as the likelihood of travel corridors passing through the study area.
Culturally Modified Trees CMTs	Low-Moderate	Although CMTs have been previously recorded in the vicinity of the study area, most are quite recent and speak more to current traditional land use patterns than heritage resources.
Quarry Sites	Low-Moderate	Although basalt is present within the study area, it is typically not of knappable quality. There is limited potential for small outcrops of higher quality basalt or other knappable volcanic rocks. Some potential exists for knappable rocks in river and streambeds.
Human Remains	Low	Organic preservation conditions in the area are not considered to be favorable for the preservation of human remains; however, there is a small chance of encountering isolated Historic Period graves.
Historic	High	Intensive use of portions of the study area from the mid-19th century onward is well-documented. Historic Period sites may include settlements, seasonal use sites, fish camps, trails and trapping/mining related sites, etc.
Isolated Finds	High	Several isolated finds have been made within and immediately adjacent to the study area in areas that have been subject to intensive heritage resource survey. As such, it is considered likely that similar sites exist in areas that have not yet been surveyed.
Palaeontology	Low	The potential for encountering palaeontological materials is considered to be low. However, there is some chance of Pleistocene fossils in gravels associated with the Yukon River.

The general areas of concern and archaeological potential are identified in **Figure 8**. Known archaeological sites are obscured in the mapping. Avoid where possible. Archaeological and potential CMT areas are not "no go" zones but rather require pre-development field survey. Sites are managed on a site-by-site basis using avoidance, minimization and/or impact mitigation. The level of investigation required depends on level of disturbance, nature of sites found and chance finds procedures.

Highlights

- East bank Yukon River documented travel corridor
- 100+ sites of high resource potential (7.6% of area) identified through GIS mapping interpretation
- 62% of study area old growth forest so patches of CMTs likely present
- More analysis required at conceptual subdivision planning stage

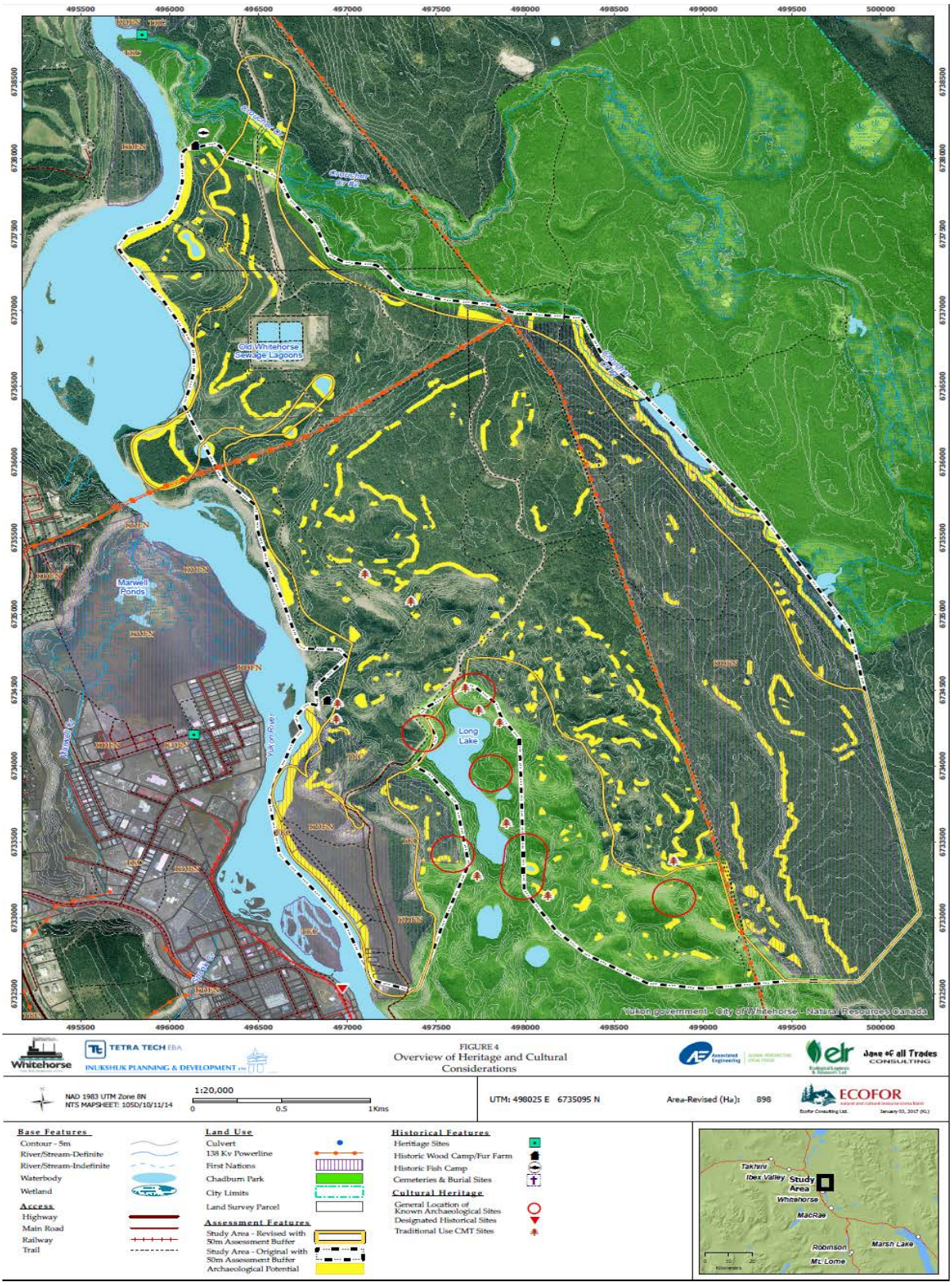

Figure 8: Overview of Heritage and Cultural Considerations

2.6 Recreational Use

The City of Whitehorse's Department of Parks and Community Development bears primary responsibility for neighbourhood-level recreation amenities such as playgrounds, parks, and trails.

Figure 9: A bush road typical of those found in the NUCB

Pursuant to its 2007 Trail Plan, the City of Whitehorse actively manages trails located within municipal boundaries. Neighbourhood-level trail planning identifies highly valued and/or significant trails for formal City adoption. These trails are incorporated into the City's Trails Maintenance Policy and maintained by the City and/or its partners. A Memorandum of Understanding was signed between the City and KDFN) in spring 2015 to allow the City to adopt and manage significant trails located on KDFN lands until future development occurs.

The predominant recreational resource in the NUCB area is trails. There are a myriad of trails located within the study area, ranging from secondary roads (passable by on-road vehicles), to narrower doubletrack[7]/tote roads (passable by off-road vehicles), to narrow singletrack[8] trails (typically 18-36" wide). The complement of local trails reflects the evolution of travel and land use in the area dating back to pre-Contact times, with traces of river escarpment footpaths and various trails and roads associated with early-to-mid 20th century wood camps and more recent wood cutting activity. Numerous trails in the area have been designated and adopted by the City.

[7] A doubletrack trail by definition is wide enough to allow two (or more) users to travel side by side, or pass without one user having to yield the trail to another. Doubletrack trails generally include tote roads, ATV-width trails, etc.

[8] A singletrack trail is so narrow that users must generally travel in single file. A single-use trail is one that is open to only one type of user and may be unidirectional depending on its purpose.

The motorized multi-use (MMU) Fat Tire Fever trail and power line corridor (both of which are essentially roads) and the narrower doubletrack Bypass Trail serve as "out and away" routes from Riverdale and occupy the easterly portion of the NUCB.

The Doghouse trail at the southeast boundary is a MMU designated specifically for dirt bike use to preserve its valued singletrack. There are also several City designated non-motorized trails, located primarily in the southern portions of the NUCB. "Hula Girl" is a singletrack trail that branches off the northern end of the Bypass Trail to avoid steep grades on the power line. "Hilarious" is a singletrack that follows a distinct ridgeline feature before descending into the forest south of Long Lake. To the west of Long Lake, the Hospital Ridge trail climbs from lake level onto the eastern river escarpment ridge that extends south to the Whitehorse General Hospital.

Summer use of the City singletrack trails located in the southern portion of the study area (i.e., Hilarious, Hula Girl, Hospital Ridge) by mountain bikers, walkers, hikers, and runners is high. Winter use is significantly lower on these trails, with the Hospital Ridge trail receiving the most use due to its closer proximity to Downtown and residential areas. Fat Tire Fever is featured in the Yukon Conservation Society's "Hikes and Bikes" guide, but its use by hikers and bikers is low. Events have been hosted on Fat Tire Fever in the past; currently, most commercial and organized trail uses in the NUCB are concentrated on the Hospital Ridge and Hilarious trails.

Snowmobiling is probably one of the most frequent winter recreational uses of the study area, with the Long Lake Road/Livingston Trail, power line and Fat Tire Fever being the most popular. ATV use is believed to be moderate year-round, and summer use of the area by dirt bikers has reportedly decreased since the "Stinky Lake" race circuit north of the NUCB (and roughly east of the Livingston Trail sewage lagoons) was largely abandoned due to the development of an alternate venue for motocross events out of City limits.

The kame and kettle terrain located to the east and north of Long Lake is considered by local orienteers to offer one of Canada's best orienteering areas due to its variable topography and relative absence of roads and trails[9]. The area has been utilized for numerous local meets, as well as western Canadian and national-level competitions in 1998, 2004, and 2015.

The trail network also facilitates other recreation uses such as bird watching where the trails either overlook the Yukon River or pass by ponds, wetlands and forest edges.

The absence of significant recreational values in the western and northern portions of the study area minimizes potential development conflicts. Nonetheless, there is considerable potential for the landscape to support accessible, high quality recreation in the complex kettle-kame topography that wraps around the northern boundary of the Chadburn Lake Park at Long Lake as well as along the adjoining Yukon River escarpment. This potential should be incorporated to the extent possible into the overall land use plan for this area.

The relevant recreational value considerations are shown in **Figure 10** on the following page.

[9] Forest Pearson, personal communication, May 26, 2016

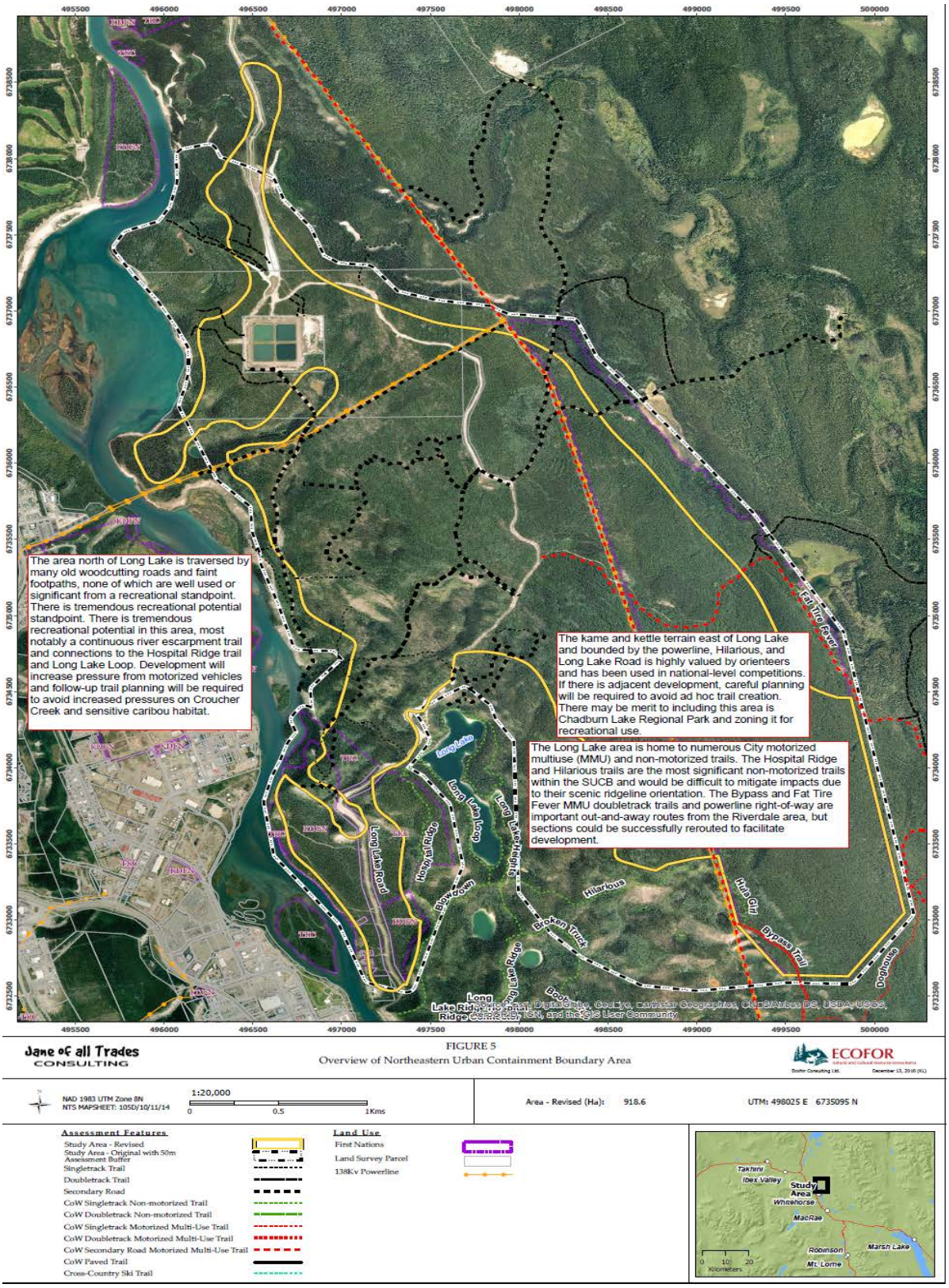

Figure 10: Overview of Recreational Values

The Yukon River escarpment in this area offers tremendous scenic views and wildlife viewing opportunities and the opportunity for a continuous singletrack trail incorporating sections of old footpaths. This would also be part of a long-term goal to create a continuous trail along the east bank of the Yukon River from southern to northern city limits.

The small kettle lakes, while unsuitable for swimming, are important landscape features integral to the area's biodiversity. Their presence also facilitates recreational activities such as bird watching and wildlife viewing.

Highlights

- Trail activities dominant recreation use in southern portion of study area
- Opportunity to create continuous east bank Yukon River trail good
- Trail planning and routing need to be determined and confirmed at subdivision planning stage

The implications of possible road and pedestrian bridge location options on recreational use are discussed elsewhere (**see Section 3.3**).

2.7 Mitigation of Negative Impacts to Land Values

Some impacts are inevitable and irreversible, a consequence of urbanization and the inherent difficult decisions that go with it. This includes the necessity for value trade-offs. The project team has identified a variety of measures to mitigate the impact of concentrating future urban growth within the proposed UCB expansion area.

2.7.1 Ecology

Any residential development and corresponding increase in human population in the area will inevitably remove habitat for year-round resident species use as well as impact transitory and seasonal species use. This places additional pressure on the remaining habitat as well as on individual species use of the area. Displacement of animals, disturbance of fragile and sensitive habitats, an increase in wildlife-vehicle collisions, and increase in human-bear encounters are all possible negative outcomes of potential residential development.

The types of terrain, habitat connectivity, forest cover, and documented occurrence of wildlife in the NUCB indicate that biophysical values will be impacted. Development is technically feasible throughout much of the same area. Thus, balancing the site-specific ecological protection needs will be a challenge. Steep slopes and cliffs associated with the Yukon River would normally be afforded a 30-metre setback from top of bank. The OCP provides for greater setbacks where necessary. Given the ongoing erosion of the river cliffs and proximity of environmentally sensitive and significant wildlife areas along the Yukon River, a larger setback should be considered (e.g., 100-metre minimum). A 30-metre setback from the top of bank for Croucher Creek and other water bodies may be suitable in some sections but a larger setback may be prudent. Should development proceed, then its ultimate form and associated density should be factored into the determination of final setbacks respecting the biophysical values present.

Although a large proportion of the NUCB contains habitat that commonly found in the region, the area facilitates unrestricted north-south wildlife movement, and to a lesser degree east-west via the McIntyre Creek drainage across the river.

This allows a wide variety of wildlife to move relatively unimpeded over long distances. Both Croucher Creek and the Yukon River form significant wildlife movement corridors.

If development were to occur, the associated vegetation clearing would remove habitat for year-round resident species (e.g., Red Squirrel, Gray Jay, Black-capped Chickadees) and transitory and seasonal species (e.g., Woodland Caribou, Moose and migratory birds). An increase in the human population in the area will inevitably result in negative effects on the remaining habitats or individual species currently using the area.

These impacts include displacement of species particularly large mammals, disturbance to fragile and sensitive habitats, potential overfishing in Croucher Creek and the ponds, creation of unofficial trails through sensitive or significant habitats, an increase in wildlife-vehicular collisions, and likely an increase in human-bear incidents.

Various landscape features can be used to help define the natural development boundary from an ecological perspective. These include the transition from higher to lower terrain in the vicinity of the Yukon River and along Croucher Creek, the location of environmentally sensitive areas not associated with water (including appropriate setbacks) and recognizing the connectivity needs to support wildlife movement and minimize displacement. The larger reality is that increasing density within an urban containment boundary still represents a compromise between a smaller urban footprint and the larger negative spatial and cumulative impacts on ecological values associated with urban sprawl.

Mitigation of these impacts will be difficult. From an ecological perspective, only the southwestern portion would be recommended for residential development. A 100m setback from top of bank has been included in the revised boundary for the Yukon River and any associated environmentally sensitive or significant wildlife areas. A 30m setback has been included for kettle ponds and for any environmentally sensitive areas not associated with riparian areas. From an ecological perspective, the recommended northern development area would be reduced from 538.7ha to 320ha with the difference made up by increasing the overall density to offset the useable land set aside to mitigate impacts on the other ecological values present.

2.7.2 Heritage

The following mitigation measures are recommended to minimize negative impacts to heritage values in the study area in the event that development proceeds:

- Completion of Heritage Resource Impact Assessments (HRIAs) for areas with high heritage resource potential prior to any development proceeding within them, while acknowledging the possibility that additional areas of high potential may be discovered during this work that will also require follow-up.
- A pedestrian survey through areas with potential for CMTs (70 years and older) should also be completed prior to any development proceeding, with any finds documented and reported to the local First Nations.
- If any additional heritage resources are observed in association with CMTs, or if any landforms with heritage resource potential (as identified in this report) are identified within them, full HRIA work is recommended due to the tendency of CMTs to be correlated with other site types such as trails.

- Development in low potential areas may be allowed to proceed on the condition that all chance finds of heritage resource materials be reported immediately to the Heritage Resources Unit of the Yukon Department of Tourism and Culture.
- All work at the location of a chance find shall cease until the Heritage Resources Unit is able to assess the finds and issue a response.

Moreover, if any development is planned within 30m of a previously recorded heritage resource site, the potential impact to the site should be reviewed on a case-by-case basis and addressed via a more detailed HRIA. Similarly, all chance finds of heritage resources should also be reviewed on a case-by-case basis to allow for a determination of whether HRIA work should be required prior to any development. If chance finds include human remains, *Guidelines Respecting the Discovery of Human Remains and First Nation Burial Sites in the Yukon* should be followed.

2.7.3 Recreation

Since the adoption of the Trail Plan in 2007, the City has made a concerted effort to rationalize the city-wide trail network to accommodate user needs, minimize conflicts between users and reduce impacts on other environmental values present. Many trails used today evolved out of bush roads, mining exploration and survey cut lines or followed game trails and natural landscape features such as watercourses and escarpments. Many were rerouted or displaced by urbanization rather than effectively incorporated into subdivision plans right at the beginning.

Trails are now an integral part of the City's open space and alternative transportation system. This means their location, routing and purpose needs to be better articulated in subdivision design. Similarly, with ever increasing use and public support, relocation and displacement are not the only mitigation measures that need to be considered to prevent overcrowding and a reduction in the quality of the user experience as the NUCB area is built out.

Connectivity may require new trails allowing for seasonal and year-round use. Determining appropriate setbacks, buffers and even setting aside other areas to compensate for displacement need to be considered at the detailed design stage.

Mitigation measures should focus primarily on the Hospital Ridge and Hilarious trails, both of which occupy scenic and uniquely positioned ridgeline features that are not easily replicated and/or rerouted. A minimum 40m buffer from any development should be applied and measures taken to protect these highly valued singletracks from evolving into doubletracks from motorized incursion.

The kettle lake southwest of the old sewage lagoon should receive a minimum 30-metre buffer. The setback along the Yukon River may vary in width significantly (30-100m) to take into account bank stability, riverbank height, soil composition and susceptibility to slumping and erosion induced by changes in river morphology over time.

Sections of both Hula Girl and the Bypass Trail could potentially be rerouted if necessary; the key is to avoid forcing non-motorized trail users onto the portion of the power line located between the Bypass and Hilarious trails due to its considerable steepness and loose cobbles.

On the motorized trail front, the key mitigation objective should be to maintain connectivity between developed areas and the hinterland, versus the preservation of any specific bush road in the area.

In the event that residential development proceeds, the City may wish to expand its motorized multi-use trail designations in the study area, as local residents will be seeking access to shorter loops from their homes.

The kettle-kame terrain north and east of Long Lake poses a more complex set of considerations for future development. An area around Long Lake, the Croucher Creek drainage, and terrain east of Croucher Creek are identified as conservation zones in the Chadburn Lake Park Plan.

Under the proposed conservation zones only low intensity recreational uses are permitted and the focus is primarily on the protection of the natural landscape and wildlife habitat with minimal human disturbance.

Should residential development proceed in the KDFN C-116B parcel and/or area between the Long Lake Road and power line, those portions of the orienteering area not captured within the park boundaries could provide one of the few viable areas for a near residential trail network. Undisturbed kame kettle topography is ideal for orienteering but it is also attractive to others whose recreational interests and needs imply the creation of a permanent human footprint, however minor.

Managing future trail development both within park boundaries and around their perimeter will be a challenge. It is largely dependent on how the NUCB area is planned and ecological values, spatial needs weighted. Improved access and a residential footprint will inevitably alter the nature, location and intensity of recreational use - both planned and unplanned - in the areas immediately north and northeast of Long Lake.

A compromise may be required between the recreational needs of prospective NUCB residents, the Conservation, Natural Environment, and Cultural Heritage Protection designation of Chadburn Regional Park areas adjacent to the NUCB, and the interests of local orienteers. At the more detailed planning stage it may be prudent to plan and construct a trail network that offers a variety of options and connections to Long Lake but with a minimal footprint. It will be critical to plan, design and construct recreational trails in advance of or alongside residential development in order to avoid ad hoc trail development and future controversy as each phase of development proceeds to build-out.

In addition to mitigation measures, future development should embrace best practices in an effort to support and enhance recreational values and create a high quality of life for area residents. Best practices include the creation of diverse “stacked loop” trail networks, provision of urban recreation features (i.e., playgrounds, skating rinks), incorporation of “on trend” amenities such as natural playgrounds and community gardens, and conformance to best practices of sustainable and user-oriented trail design.

3.0 SERVICING CONSIDERATIONS

The water and sanitary sewer servicing considerations have been based on a desktop review of the existing 2003 City of Whitehorse Sewer and Water Study. This study provided good but dated information on the City's entire water distribution and sewage collection networks. It needs to be updated prior to proceeding with conceptual subdivision design to provide a fuller understanding of servicing options and associated costs. Additional modelling has not been completed for the proposed options discussed within this report. It is noted that since the publication of the 2003 report, the City's water source has migrated from a combined surface and groundwater source to complete groundwater source. The populations values presented within this section are specific to the City's current groundwater supply.

A general overview of the servicing considerations is presented in **Figure 11** on page 29.

3.1 Water Supply and Distribution

Currently Whitehorse's water supply is drawn from multiple wells in the Riverdale aquifer located in the Riverdale subdivision. The existing supply and distribution network is estimated to support approximately 32,000 people based on the current well supply infrastructure. The 2003 City of Whitehorse Sewer and Water Study (Stantec) states that under normal operating conditions all pump stations and transmission/distribution mains should be capable of servicing development north of the Riverdale Reservoir.

This assertion was based on the following findings from the 2003 study:

- The Riverdale Expansion as proposed in the 2003 Water Sewer study (with expected population of 1500 people north of the Riverdale subdivision) can be serviced with the installation of a 300mm supply line from the 350mm Riverdale Reservoir line.
- A secondary feed can be provided by a connection to the Marwell distribution system via a future bridge at the end of Industrial Road. Alternately, water wells can be developed in the Riverdale Expansion Area;
- The Riverdale Reservoir is undersized, but due to the proximity of the Selkirk pump station it is not a significant concern. However, consideration needs to be made for upgrading of Selkirk Pump House to ensure the station meets future maximum day demand. If the vortexing potential is addressed or determined not to be a concern, the reservoir will be adequately sized; and,
- The Riverdale Reservoir is currently (as of 2003) and ultimately under-capacity.

Since 2003, the Selkirk Pump House and associated water supply infrastructure have undergone significant upgrades and modifications; nonetheless, additional capacity and costly upgrades will still be required to service the NUCB area from Riverdale. Making these potential upgrades is technically feasible and expected to be the preferred solution after further detailed study through an updated to the 2003 Water Sewer study. Other connections using a future NUCB bridge would also be feasible as a secondary feed to the area. Full assessment of all options and consideration of the upgrades since 2003 need to be taken into account in the next water and sewer master plan update, all incorporating revised population densities for the NUCB based on the outcome of this study.

Highlights

- Water supply distribution to the NUCB is feasible based on desktop review
- Updates to the 2003 Water & Sewer Study and additional water modelling are required to further water servicing discussion for the NUCB
- Water supply from Riverdale and second bridge crossing of Yukon River
- Expanded or new Riverdale Reservoir required

Water distribution to the NUCB area can be achieved through two primary supply points as mentioned above and looped to provide frost protection and address water quality considerations. A circulation station may be required in the NUCB to ensure proper circulation and would ultimately be determined through water model analysis and final selection of a future crossing point over the Yukon River. Based on the information currently available, there are no significant constraints envisioned in establishing a full water distribution system for the NUCB study area.

With additional population in the NUCB expected, the existing Riverdale Reservoir should be expanded. We see the primary pressure zone for the NUCB being the Riverdale Zone, supplemented by the Valleyview sub-zones, Marwell, and/or Range Road North, depending on the location of a second Yukon River crossing. A need for a dedicated reservoir for the NUCB area is not envisioned; however, this may be considered as a secondary option to expanding the existing Riverdale Reservoir at its present location. Existing residences located within the NUCB study area could be connected to a new water distribution system if allowed for in future subdivision layouts. The incorporation of these lots would not affect the overall planning densities for water consumption.

The presence of a potential bedrock aquifer in the northern and southern portions of the NUCB is inferred from mapping of limestone units of the Mandana Member in this area (GLL 2003). The Mandana Member Limestones may have high fracture connectivity resulting in high hydraulic conductivity and associated yield due to the potential for karst formation.

In the vicinity of Long Lake, potential for productive overburden aquifers is indicated by the mapped presence of the kame and kettle topography left by glacial retreat (GLL 2003). The highly productive Selkirk Aquifer in Riverdale is interpreted to be part of the same deposit which extends from the study area to beyond Chadburn Lake, 10 kilometres to the south. This aquifer may support either individual wells on residential properties or several higher yield community wells that could supply water to a large-scale residential development.

The deep hydrogeological characteristics of the NUCB area north of the inferred and indicated aquifers are unknown. The area is overlain by quaternary sediments (silt/clay and silty sand/sandy silt) of unknown thickness, although they are at least 55ms thick in the area around the old sewage lagoons, where drilling has taken place. A thin (around 5m) sand layer below the water table encountered in these wells may offer a productive aquifer, although the lateral extent of this unit is unknown and its long-term yield may be limited. Nonetheless, there is the potential that a high yielding aquifer/s is located below this depth. Shallow and/or perched aquifers (<15m in depth) may exist within the study region. , they are not expected to be regionally extensive and may not provide long term yields suitable for residential water supply.

Additionally, shallow groundwater is more susceptible to surface source contamination and has the potential to be under the direct influence (GUDI) of surface water sources. Shallow wells are not generally recommended for domestic or commercial water supply.

Groundwater quality information available for the NUCB area includes water chemistry results from the two wells located in the southwest boundary near the Yukon River and from the monitoring wells installed at the old sewage lagoons. While the water from tested wells in both areas met the Guidelines for Canadian Drinking Water Quality (GCDWQ), the water from the southwest wells is considered very hard, and iron, manganese, and arsenic concentrations exceeded the Aesthetic Objective guideline in the GCDWQ. Further testing of water quality should be undertaken in the vicinity of the old sewage lagoons to confirm compliance with the GCDWQ standards prior to formalizing a decision on suitability of water wells in the area.

Groundwater quality likely varies throughout the study area depending on the aquifers available for development. If part of the NUCB area is indeed underlain by the Selkirk Aquifer, then little to no treatment (other than standard disinfection) would be expected based on the quality of water from the City of Whitehorse supply well. Groundwater quality in other areas is expected to vary based on the material encountered. The elevated arsenic, iron and manganese found in the wells near the Yukon River suggest water treatment may be needed to obtain acceptable water quality in parts of the NUCB.

There is also potential that productive wells could be completed in bedrock aquifers in some areas of the NUCB expansion area, although these are unlikely to be target aquifers for large-scale groundwater supply based on the possibility of a productive overburden aquifer. Tetra Tech EBA notes that there has been no drilling done to confirm the existence of karst fracture connectivity in the Mandana limestones.

Although there may be the potential for development of additional groundwater wells to supply a larger development in the NUCB, connecting to the existing water distribution system is recommended. This eliminates the need to develop and maintain a second water treatment plant with possible differing water quality characteristics than the existing distribution system.

The current Riverdale aquifer only has capacity for several thousand more residents at this point in time. With further upgrades, it may be able to be expanded beyond the current design horizon to create additional well capacity.

To install a new water system in the NUCB, designers would first look at the final selected location of the second Yukon River Crossing and model required system upgrades (which are anticipated to primarily involve increasing capacity in the Riverdale Reservoir).

Highlights

- Groundwater quality will vary throughout the study area depending on aquifers present.
- Current Selkirk aquifer wells in Riverdale only have capacity for several thousand more residents at present but may be expandable beyond the current time horizon.
- The boundary and capacity of the Selkirk aquifer to accommodate NUCB withdrawal needs to be determined. It may also extend into the southeast corner of the NUCB area.
- Connecting to the existing water distribution is recommended as the first choice based on information currently available.

3.2 Sewage Collection and Transmission

In general, the City's sanitary sewage is collected and discharged for treatment in the Livingston Trail Environmental Control Facility (LTECF). This facility has an estimated service population of approximately 36,000 in order to allow for future growth. As such, the estimated expansion within the NUCB area would exceed the current design level for the City's existing sanity sewage treatment infrastructure.

The 2003 City of Whitehorse Water and Sewer Report (Stantec) states that it is impractical to service a "north of Riverdale" development via the existing Riverdale system. Instead it suggests the following three alternatives:

1. Construct a new lift station and force main that discharges upstream of the Marwell Lift Station. This would require the Marwell Lift Station and Yukon River crossing force main to be upgraded to accommodate the increase in flow; or,
2. Construct a new lift station and force main connection that discharges to the existing Marwell force main on the east side of the river downstream of the existing sanitary sewer river crossing. This would likely require upgrades to the Marwell force main. A control sequencing mechanism would have to be introduced to ensure the new lift station does not discharge at the same time as the Marwell lift station; or
3. Construct a new lift station and force main that discharges directly to the LTECF.

A fully serviced urban development is feasible within the NUCB so Option 3 is believed to be the most practicable solution at this point pending preparation of a subdivision conceptual layout and engineering design. The second option would be to utilize the existing LTECF force main as per Option 2 above. The selection of either option should be undertaken within the context of an update to the overall Water and Sewer Master Plan for the City. Based on the estimated population density which could be accommodated within the NUCB, the existing LTECF will require expansion to accommodate increased flow volumes.

Highlights

- Connection to the LTECF is feasible
- Updating the 2003 Water & Sewer Study is necessary to provide the data for detailed engineering assessment

Within the NUCB the topography allows for a predominately gravity enabled collection system supported by lift stations to convey the sewerage toward the LTECF.

Existing residences within the NUCB could be connected to a proposed collection system. It is recommended that they are connected via individual low lift pump systems into the gravity collection system so as to avoid having the few existing residences dictate the invert design of the entire NUCB collection system. Specific costs and design considerations would need to be refined and integrated at the conceptual subdivision design stage once the 2003 Water & Sewer Study update is completed.

An overview of servicing considerations is summarized in **Figure 11** on the next page.

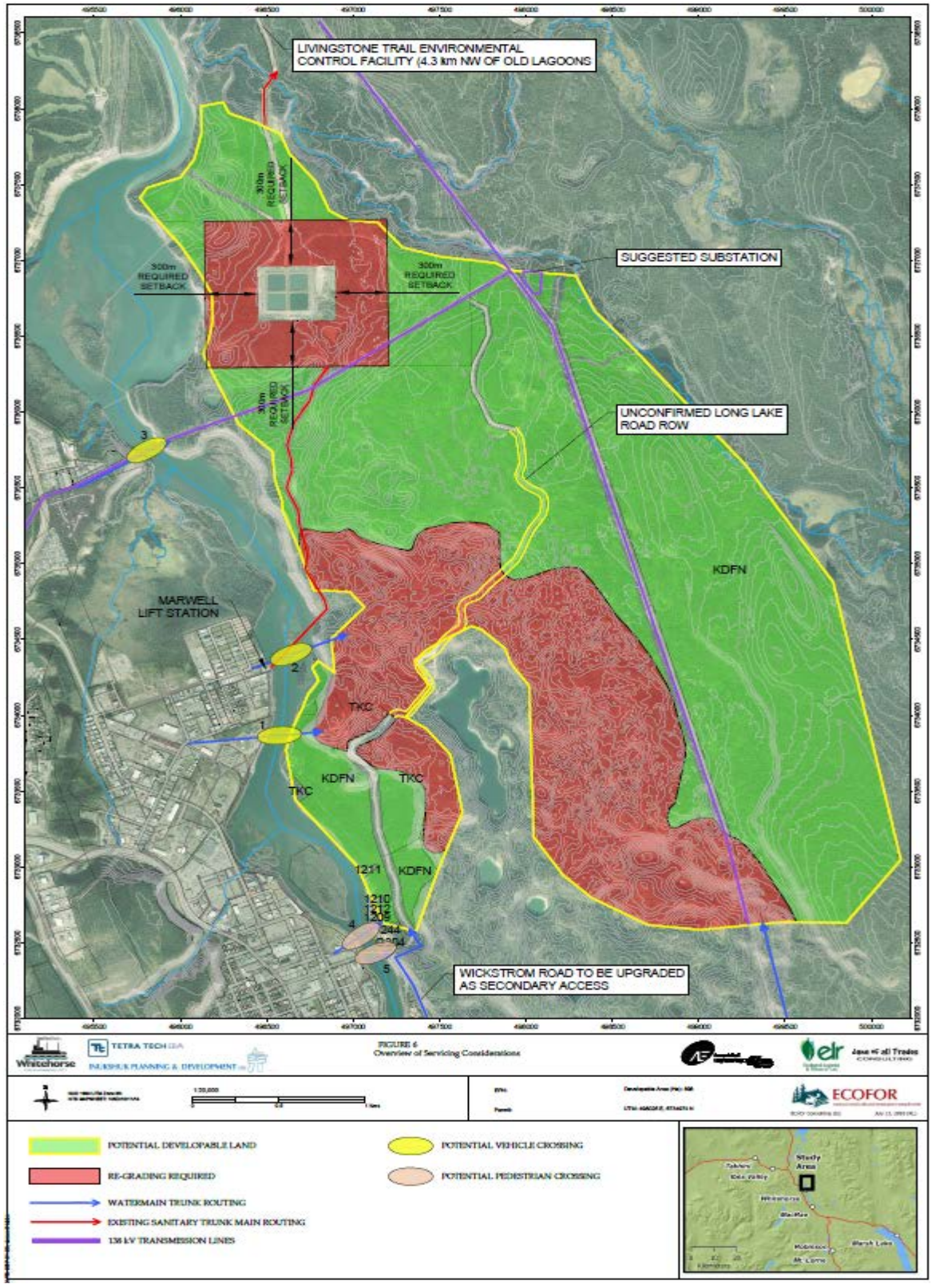

Figure 11: Overview of Servicing Considerations

The majority of the developable portions of the NUCB area are underlain by glaciofluvial sediments, which are typically ideal as an "accepting soil" layer. As such, the potential for successful construction of on-site sewage disposal systems will be relatively high. There has been limited testing of the hydraulic properties of the soils in the NUCB area with the exception of the old Whitehorse sewage lagoon area. Based on the surficial geology mapping showing glaciofluvial granular soils or deltaic/aeolian sand over and interbedded with glaciolacustrine silt, the hydraulic conductivity is expected to be relatively high in the near surface soils. It may vary from site to site depending on the depth to glaciolacustrine silts (which typically have a lower hydraulic conductivity) in the transition area at the north end of the NUCB. As always, individual site assessment and percolation testing will be required for each lot.

There are some problem areas where topography and the potential for shallow groundwater would limit potential for installation and construction of some absorption field options. If site grades are greater than 15%, on-site sewage disposal system construction is not allowed since the potential for down gradient day-lighting increases. Therefore, if a component of country residential development were to be considered at some point in the future, pre-grading[10] will be required throughout the southern kame/kettle portion of the NUCB area to not only relax slopes to acceptable limits, but also to fill in low-lying areas where shallow groundwater may be present.

Since there is the potential that minimal morainal till soil cover exists over shallow bedrock in the southeast corner of the NUCB (Areas 3a and 3b), there may be restrictions on the construction of conventional on-site sewage disposal systems. The use of mechanical plant systems and raised absorption fields may be dictated. More geotechnical testing will be necessary here.

The potential for impacts to groundwater quality from on-site sewage disposal will depend on lot size and density, as well as the connectivity between the shallow overburden aquifer (if present) and the deep bedrock aquifer where residential water wells may be constructed. Bedrock aquifer hydraulic conductivity is dependent on the presence of fractures. This connectivity can be highly variable depending on the fracture geometry and the thickness of the overburden, and is therefore inherently unpredictable.

Nitrate ($N0_3$) sourced from on-site sewage disposal systems has been identified as a chemical of concern that could impact groundwater, particularly in areas where the water supply comes from private water supply wells. Impacts include adverse health effects (Hagerty et al. N.D.) and if discharged into surface water, nitrate can cause excessive plant and algae growth that depletes oxygen levels and can negatively impact early life stage development in aquatic organisms and aquatic life in general (CCME 2009).

If country residential development is included in a portion of the final development plan consideration should be given to lot sizing based on the potential for nitrate impact. A mass balance analytical model can be used to predict contaminant concentrations based on actual (or assumed) hydraulic conductivity, hydraulic gradient and groundwater flow directions.

[10] Pre-grading would also be necessary for conventional installation of underground utilities in the kame/kettle area.

Through the use of an analytical model such as this with an appropriate factor of safety built in, lot sizes can be adjusted to minimize risk of impact to nearby groundwater users. In typical situations where residents are relying on groundwater supply and on-site sewage disposal, a minimum lot size of 1ha should be assumed, at least until further assessment is conducted to refine the sizing based on subsurface conditions.

Nitrate concentrations can be also be reduced through the use of mechanical treatment systems, allowing for an accompanying reduction in lot size – a technique applied to Phase 2 of the Ravens Ridge subdivision. Potential impacts from nitrate loading can also be mitigated through the use of a filtration system if concentrations exceed drinking water guidelines (regular testing of the water by the individual home owners will be necessary). Since groundwater quality will depend on the level of loading, larger lot sizes will reduce the potential for on-site sewage disposal to have negative impacts on the groundwater quality and the Croucher Creek #1 drainage.

Phasing of the sanitary infrastructure would first look at the existing LTECF lagoons and force main capacity once overall expected design population is determined. An assessment of lagoon design capacity and overall force main operation would ultimately inform the decision to utilize the existing LTECF force main or construct a new force main specific to the NUCB area.

At this point, the LTECF capacity will be exceeded before build-out. While lagoon cell capacity can be readily increased, future development should examine further ways to reduce the expected per capita water consumption. Limiting clean water flows will help to increase the effluent concentration for successful treatment processes within the existing lagoons.

3.3 Transportation

The options for accommodating the transportation requirements of potential residential development in the NUCB are somewhat limited due to the location of the study area and terrain constraints.

The current access into the NUCB from the Downtown core is via the Robert Campbell Bridge, Hospital and Wickstrom roads, which transition into the Long Lake Road. This route has limited existing capacity and would require substantial upgrades to accommodate a large-scale development. The 2004 City-Wide Transportation Study (UMA Engineering Ltd.) states the existing Robert Campbell Bridge is near capacity for traffic volumes and recommends an increase in transportation capacity on the east side of the Yukon River to service any new development. Simply put, any development in the NUCB area is contingent on the construction of an additional bridge.

The team envisions three potential access points for the NUCB area: a primary access comprising a new vehicle crossing of the Yukon River; a secondary access via an upgraded Wickstrom Road; and lastly, an active transportation crossing of the Yukon River. The Wickstrom Road access would be upgraded to a two lane, hard surfaced minor collector road intended to provide secondary access and strategically - direct emergency response access to and from the Whitehorse General Hospital.

Vehicle bridges would be designed for both vehicle and active transportation use while an active transportation-focused bridge would convey only non-motorized travel modes such as walking and cycling, etc. (although the design could consider loading for vehicular traffic as an emergency route.

All crossings would allow for utility connections and meet universal accessibility standards. Detailed planning and design will be necessary to confirm site-specific conditions, road alignment and profile, and bridge geometry and associated details.

A high-level review of possible vehicle and active transportation crossing locations was conducted to facilitate a relative comparison of likely bridge requirements for each location and aid in the selection of a preferred crossing location. These options are discussed in the following sections.

As is the case for any bridge crossing, significant upfront work is required prior to the final selection of a location, including overall transportation network planning, site-specific geotechnical and hydrological investigations, and permitting. The concept locations shown herein are intended to facilitate discussion and the consideration of options; further work will be required to make the final determination of a crossing.

Near term upgrades to the transportation network related to the Whistle Bend subdivision will impact transportation planning for the NUCB. In general, the Whistle Bend related upgrades will provide additional transportation capacity for all modes west of the Yukon River while Marwell upgrades coming out of the recently initiated planning study may influence a decision on NUCB future bridge location choice. The impact of the NUCB on these proposed near term upgrades will be dependent on high level decisions required related to the NUCB. Items such as ultimate NUCB size, style and density of development along with timing and bridge crossing location decisions will drive trip generation from the NUCB into and out of the downtown core. Once confirmed, a network wide transportation planning study is recommended.

3.3.1 Marwell Crossing

Two proposed crossing alignments are located in the Marwell Industrial Area and shown in overview in **Figure 11** and in more detail in **Figure 12.** Location #1 is the vicinity of the North of 60 Petro Ltd. property and has had a previous geotechnical suitability study completed for the west embankment by Hoggan Engineering & Testing Ltd in 2002[11].

The geotechnical recommendations stated that this location is a suitable and feasible location for a bridge crossing and that piled foundations would be necessary. We concur and further anticipate that piled foundations will be required for all the potential crossing locations being considered at both pier and abutment supports. The second location is effectively an extension of Tlingit Street, and no previous work has been completed on this option.

[11] Hoggan Engineering & Testing (1980) Ltd: *Geotechnical Suitability Study 2002*

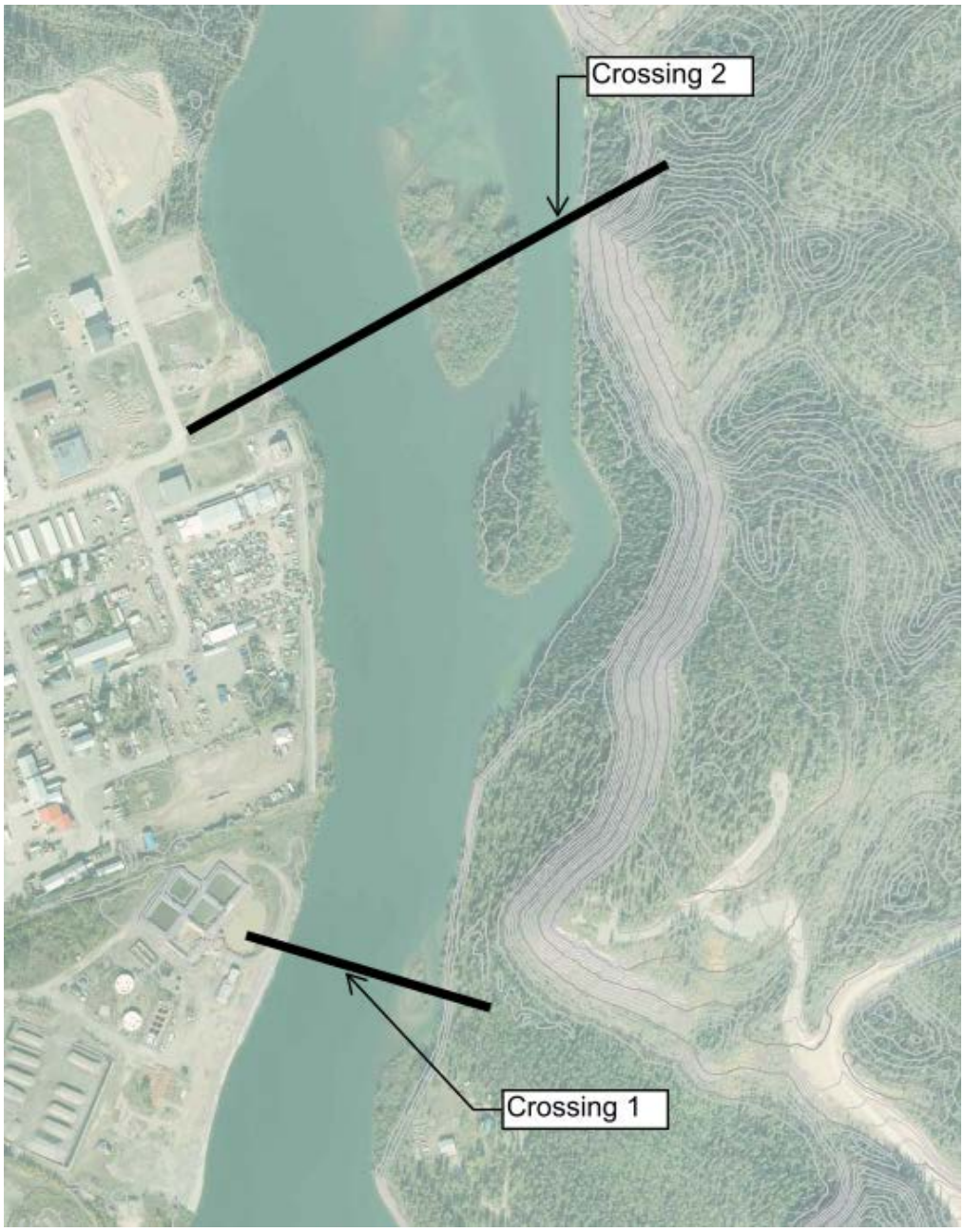

Figure 12: Marwell to NUCB Vehicle Bridge Crossing Locations

As the banks of the potential crossing locations in the Marwell area must overcome significant elevation differences between the east and west banks, the team attempted to locate both crossing concepts to take advantage of existing terrain features and limit longitudinal bridge grades to a maximum of 6%.

The natural elevation difference and span distance for **Crossing #1** is:

- An elevation difference of approximately 47m over a 370m span, resulting in a 12.7% grade.; and
- **Crossing #2** has an elevation difference of approximately 45m over a 400m span, resulting in an 11.3% grade.

Figure 13: Approximate location of Marwell Bridge Crossing 1 looking east (ELR)

To achieve the recommended maximum longitudinal grade of 6% for the crossings, the team adopted the 60-metre typical spans of the existing Robert Campbell Bridge. The resulting bridge layout and eastern cut slopes are approximated as follows:

- **Crossing 1**: Grade = 5%; Bridge Length = 390m; 2 abutments; 6 piers; 62m interior spans; 40m exterior spans; and,
- **Crossing 2**: Grade = 6%; Bridge Length = 420m; 2 abutments; 7 piers; 58m interior spans; 36m exterior spans.

Figure 14: Approximate location of Marwell Bridge Crossing 2 looking east (ELR)

Crossing 2 would require significant upgrades to Tlingit Road, which should be coordinated with the water and sewer trunk main upgrades already required in that road right-of-way. Some property acquisition will be required if there is a need to increase the capacity of Tlingit Road from two to four lanes.

Such improvements would need to be modeled in detail during a city-wide Transportation Master Plan review and should incorporate the direction provided by the Marwell Plan to be undertaken in 2017.

Both alignment profiles can accommodate the passage of a local road in front of the west abutment, and this has been assumed in reviewing the feasibility and layout details of the bridges.

3.3.2 Range Point Crossing

As both Marwell crossing options connect to the southern portion of the NUCB, the team looked at an additional option that would tie in at a more central location within the NUCB. The resulting crossing location, which ties into the Range Point neighbourhood on the western embankment, would have a shorter span in comparison to the Marwell options, allowing for a more cost-effective bridge solution. However, network access to the bridge from the existing road network would require the relocation or burying of the existing 138kv Yukon Energy transmission line immediately north of Crow Street.

This crossing does pose some geotechnical challenges for designers due to the steep and unstable slopes; however, a field visit by engineering team members concluded these challenges are surmountable.

Figure 15: Looking east towards Range Point and Crossing 3 (IPD)

Referring to Figure 16, the conceptual bridge layout for this alignment is approximated as follows:

- **Crossing 3**: Grade = 6%; Bridge Length = 270m; 2 abutments; 4 piers; 64m interior spans; 39m exterior spans.

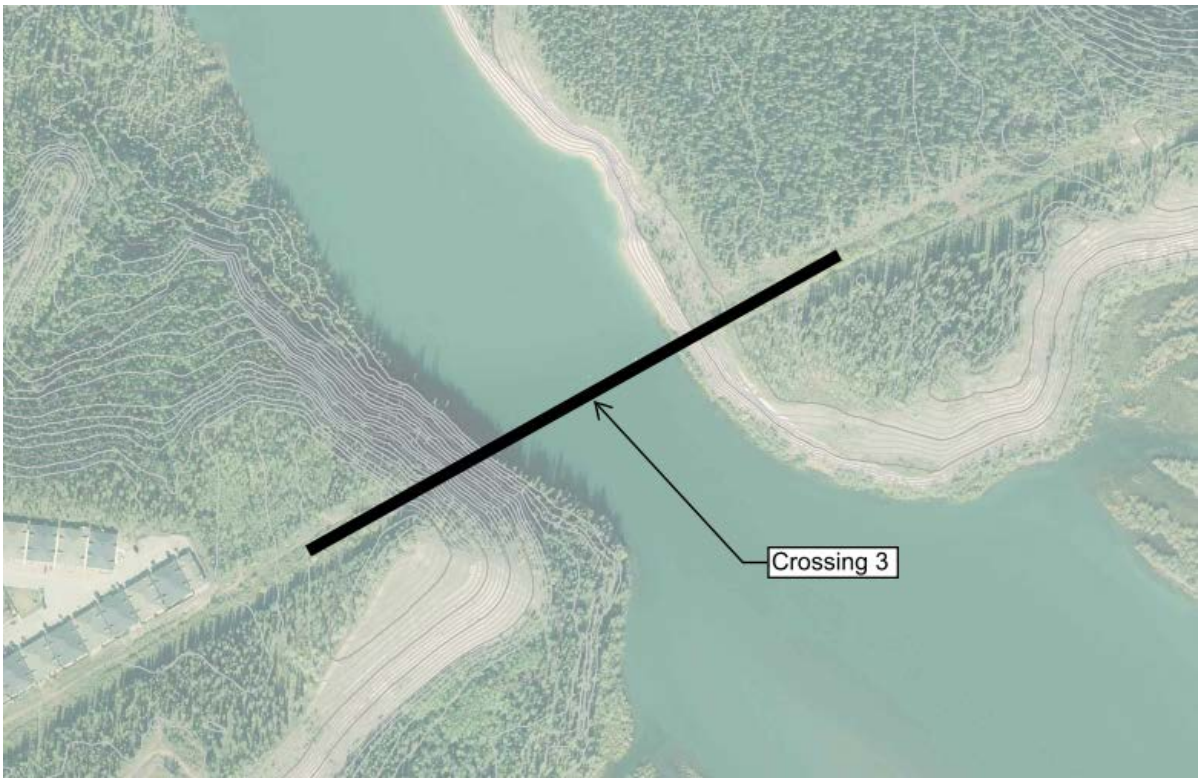

Figure 16: Range Point to NUCB Vehicle Bridge Crossing Option #3

Upgrades to existing infrastructure required to accommodate a bridge crossing at this location would be significant. First, the existing Yukon Energy transmission line would need to be relocated underground to allow for the new road alignment (the conduit could be incorporated into the bridge superstructure). Second, Range Road and the intersection of Range Road and Mountainview Drive would need to be redesigned and upgraded to accommodate the increased traffic. Third, additional lanes would also be required on Copper and Quartz roads to accommodate increased traffic from the NUCB. Lastly, a new intersection may be warranted which would involve a direct route off Crossing #3 to connect to Mountainview Drive while realigning and combining the existing Range Road intersections. This would require property acquisition in the local area to achieve.

3.3.3 Downtown Active Transportation Crossings

Recognizing the importance of active transportation to the City's sustainability agenda, the team investigated the feasibility of an active transportation bridge near the southern end of the NUCB across from Downtown. A location in the vicinity of Ogilvie Street and Shipyards Park is considered ideal as it would link existing City trails in the Long Lake area with the paved commuter trail network situated on the Downtown waterfront. Two conceptual locations are shown in **Figure 17** on the following page.

The shorter crossing lengths and lower embankments inherent to these locations are more favourable to a cost-effective bridge solution than other possible locations. However, based on the configuration of the existing transportation network and private properties on the eastern bank, only a narrow bridge similar to the Rotary Centennial Bridge is likely to be feasible.

Both profiles can accommodate the passage of a local road or path in front of the western abutment and this has been assumed in reviewing the feasibility and layout details of the bridges.

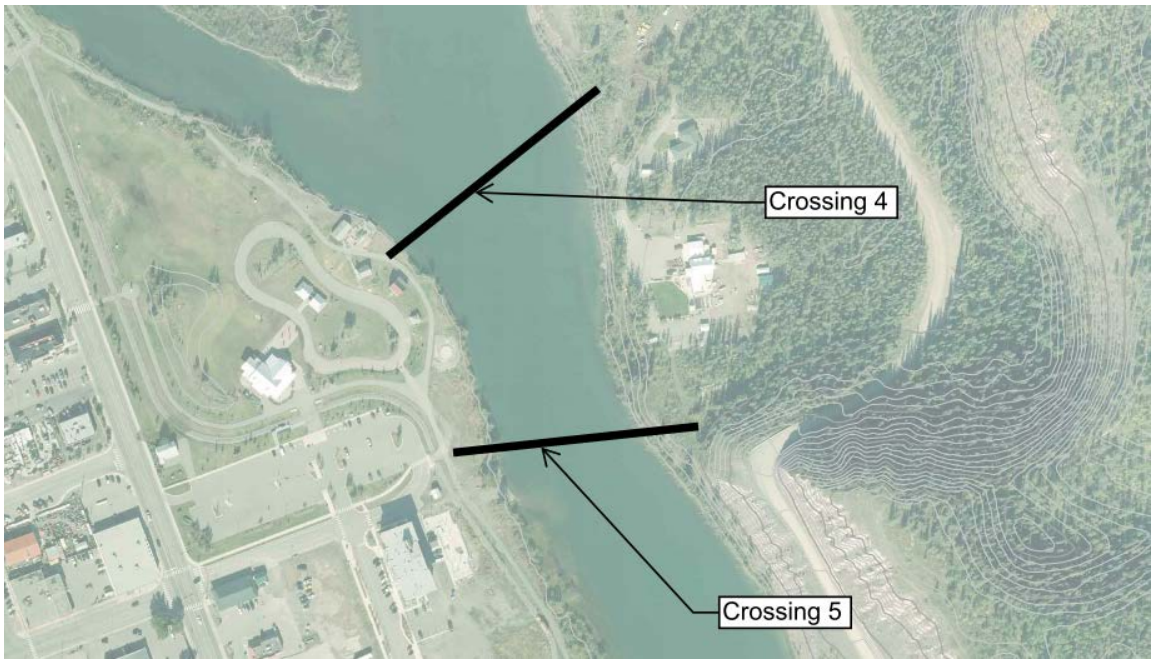

Figure 17: Location of Pedestrian (Active Transportation) Bridge Crossings

Figure 18: Pedestrian Bridge Crossing #4 looking east from Shipyards Park (ELR)

The bridge layout detail for the active transportation (pedestrian) bridge alignment at Crossing #4 is:

- **Crossing 4**: Grade = 1% (min.); Bridge Length = 260m; 2 abutments; 4 piers; 60m interior spans; 40m exterior spans.

Figure 19: Pedestrian Crossing Bridge Crossing #5 looking east near Ogilvie Street (ELR)

The bridge layout detail for the active transportation (pedestrian) bridge option # 5 is:

- **Crossing 5**: Grade = 6%; Bridge Length = 160m; 2 abutments; 2 piers; 70m interior spans; 45m exterior spans. Existing 6m cut slope on eastern embankment is sufficient for this new profile.

Minimal upgrades to existing infrastructure would be required for both pedestrian bridge options. Care would need to be taken in locating the east bank abutment approaches to ensure the routing does not impact private or First Nation settlement land located along the east bank of the Yukon River.

It is also worth noting that either location would still have merit even if the NUCB were not developed in the foreseeable future because they facilitate access to the Long Lake area and Chadburn Lake Regional Park from the downtown.

3.3.4 Recommended Crossings

Within the NUCB an overall loop configuration transportation network is considered highly feasible. The detailed layout is contingent on the selected location of the Yukon River crossing and would ultimately be driven by how the crossing points tie into the overall detailed conceptual master plan for the NUCB, which is not within the scope of this study.

For the purposes of this study, Crossing #1 is assumed to be the preferred vehicle crossing location. While Crossing #1 is relatively short, it does require both Industrial and Quartz roads to be widened to four lanes. Additionally, the City has allowed for future expansion of the water distribution system with stubs located at the Industrial Road and Platinum Road Intersection. This crossing location is noted to have the least requirements for additional infrastructure to support a new major transportation route. In addition, although Crossing #1 overlaps slightly with a significant wildlife area, depending on bridge design, any area of significant wildlife value may not be directly affected. However, indirect affects (e.g., noise levels, displacement) have to be considered. The bridge crossing may interrupt a continuous Yukon River east bank escarpment trail, should one be formalized, and provisions would need to be made for recreational users to safely cross both the bridge itself and accommodate north/south movement along the east side of the river.

Although not recommended at this juncture, we would encourage Crossing #3 remain a possibility and be looked at within the City's next network level transportation modeling exercise. By modelling the possible development and the overall existing network, unrealized benefits may be identified due to this crossing's more central location within the NUCB area.

Crossing #5 is the recommended location for the active transportation connection to the NUCB. This crossing location will likely be more cost-effective due to its shorter length and generally has better access to pedestrian and road networks, being roughly located at the end of Ogilvie Street. Additionally, Crossing #5 has more favourable land availability on the eastern shore of the Yukon River. From an environmental standpoint, the crossing does overlap with an environmentally sensitive area (steep banks susceptible to erosion) although some re-alignment of the crossing may be possible or the crossing could potentially be constructed to span the sensitive area. There are no concerns from a recreational standpoint.

Staging of the proposed Yukon River Crossings would be highly dependent on the nature and type of development ultimately decided on for the NUCB and is discussed further in **Section 5**.

3.3.5 Transit and Active Transportation

With the inclusion of a pedestrian bridge across the Yukon River there is great potential for active transportation linkages to and from the Downtown core into the NUCB and Chadburn Lake Regional Park. The relative proximity of the NUCB allows for similar active transportation commute times to that of the Riverdale, a reasonably successful subdivision from an active transportation perspective.

Currently there is no transit service to the east side of the Yukon River beyond the hospital. Density, subdivision layout (five-minute walking distance), trip origin/destination pairing and frequency are principal level of service standard considerations in operating a viable and efficient transit system.

This is another reason why a looped road network hierarchy is an important design consideration as increased transit usage is one of the City's important sustainability objectives.

Within the NUCB, an overall loop transportation network incorporating active transportation considerations is highly feasible. The detailed layout is contingent on the selected location of the Yukon River crossing and would ultimately be driven by how the crossing points final tie into the overall detailed conceptual master plan for the NUCB which is not within the scope of this study.

Much of the existing road that continues through the NUCB to the LTECF and beyond is un-surveyed and can be rerouted as needed to suit the subsequent master plan layout, with two exceptions. First, any future alignment should maintain the present Croucher Creek crossing point and avoid creating a new one. Second, it should tie into the existing Long Lake Road where it abuts private and First Nation property.

3.4 Power and Communications

The NUCB area has excellent access to power from the YEC 138kv transmission line that runs north-south along the eastern NUCB boundary. It also connects to an east-west line south of the old sewage lagoon and across the Yukon River to the McIntyre Creek wetlands/Yukon College area and beyond.

There are also existing ATCO distribution lines crossing the Yukon River near the Kwanlin Dün Cultural Center.

The primary power distribution source in a new NUCB development would be a new substation off the existing YEC transmission line, with a secondary feed off the existing ATCO system in the Marwell/Range Road area utilizing the second bridge river crossing. The ATCO system would require upgrades to local area feeders to incorporate the additional load into the existing network and accommodate the secondary feed.

Northwestel has limited connectivity in the NUCB area and would require new infrastructure to service it. Local area network upgrades would be required on the western side of the Yukon River to feed main trunk lines across a new bridge.

3.5 Municipal Landfill

The NUCB area is expected to utilize the services of the existing City of Whitehorse Landfill located near the Porter Creek subdivision.

Based on the 2013 City of Whitehorse Landfill Cost Assessment Report (Morrison Hershfield) and discussions with the City of Whitehorse, the team concludes that the current landfill has adequate capacity to accommodate development in the NUCB. The landfill has capacity for additional population growth until approximately 2046 based on the current waste diversion rate of 20%. This equates to a service population of approximately 43,000 people. Should the City of Whitehorse be successful in increasing the diversion rates to 50%, this would further extend the life of the landfill until 2057 and extend the service life up to a population of 51,000 people.

3.6 Underground Utilities Construction

Aside from the potential problem areas identified for the NUCB, deep and shallow utility construction using conventional methods is considered possible throughout most of the area. The majority of the utility trenches will be excavated in glaciofluvial sands and gravels, glaciolacustrine silts (at the north end of the area), or morainal till soils (in the KDFN C-116B area along the eastern portion of the study area). All soil types are considered acceptable for reuse as long as they are not too wet to facilitate compaction. The Class "B" pipe bedding configuration (with 150 mm of bedding under and beside the pipe as well as 300 mm above the pipe) presented in the City of Whitehorse Servicing Standards Manual is considered appropriate.

If underground utilities are constructed near the shallow groundwater areas identified (Areas 1a and 1b), contractors should be prepared to pump water and install bedding stone where seepage zones are encountered. If utility trenches must be blasted into bedrock (Areas 3A and 3B), properly spaced ditch plugs should become part of the deep utilities design to prevent hydraulic short-cuts. Imported bedding sand and stone should conform to the gradation specifications presented in

Table 2.

Table 2: Recommended Pipe Bedding Materials Specifications

Bedding Sand		25 mm Bedding stone	
Particle Size (mm)	% Passing by Mass	Particle Size (mm)	% Passing by Mass
10.000	100	25.000	**100**
5.000	80 – 100	20.000	**70 - 100**
2.000	55 – 100	12.500	**55 – 100**
0.630	25 – 65	10.00	**30 – 80**
0.250	10 – 40	5.000	**0 – 40**
0.080	**2 – 15**	**2.000**	**0 – 10**

3.6.1 Seasonal Frost Analysis

In 1998, Tetra Tech EBA developed a *Geothermal Design Manual* which presented ground temperature data in typical soils found in various subdivisions throughout Whitehorse. Based on data collected in areas of Whitehorse with similar soil conditions, seasonal frost depths for use in design include:

North End of Site

For sand over glaciolacustrine silt, use:

- 2.5m for snow covered areas (lawns, boulevards, etc.);
- 3.0m under paved roadways; and
- 3.5m for the 1:50 year design under paved roadways.

Southern and Central Portions of Site

For glaciofluvial sands and gravels with surficial silts in low-lying areas, use:

- 2.5m for snow covered areas (lawns, boulevards, etc.);
- 3.3m under paved roadways; and
- 3.6m for the 1:50 year design under paved roadways.

Southeast Portion of Site

For areas with silty and sand till soils over bedrock (i.e., predicted for Areas 3a and 3b), use:

- 3.0m for snow covered areas (lawns, boulevards, etc.);
- 3.6m under paved roadways; and
- 5.0m for the 1:50 year design under paved roadways.

3.6.2 Bedrock Considerations

The cost associated with deep and shallow utilities installation in bedrock is an important factor in determining the level of service standard used and density of development needed to recover higher installation costs. There is a direct relationship between the nature and cost of services provided at an urban versus country-residential standard. The principal difference is that some costs (e.g., drilling a water well, installing a septic system) are transferred directly to the property owner in a country residential development, whereas services are incorporated into the price of an urban lot.

The assumption of responsibility for service costs also applies to the subsequent operating costs for either level of service.

The potential to encounter shallow bedrock is believed to be limited to Areas 3a and 3b. To address this issue, ground penetrating radar (GPR) technology and a test-pitting program can be undertaken and the results used to guide a more detailed assessment (focused specifically along the proposed roadway corridors) at the conceptual subdivision planning stage.

While the City's overall objective may be to minimize the footprint of new development and reduce sprawl, applying a lower density of development in one area to compensate for local ground conditions may be justifiable and offset by applying a higher standard in another area when full life cycle costs and other values present are factored in.

3.7 Sand & Gravel Materials Source

The haul distance to the NUCB is dependent on the location of the bridge crossing and its distance from the aggregate source. The main potential existing pit sources are located at McLean Lake and just west of the intersection of the Alaska Highway and North Klondike Highway. In practical terms developing a source within the NUCB is the recommended option.

During site reconnaissance Tetra Tech EBA noted a potential source along the force main leading from the Marwell pump station to the old Whitehorse Lagoon site. The exposure indicates the presence of good quality granular material, but additional geotechnical investigation would be required to properly assess volume, quality, depth and extent.

The timing and material volume requirements for residential development in the NUCB area are currently unknown. Using Whistle Bend as a proxy, we can assume development would be phased and in turn, directly affect aggregate demand. It is also assumed that development of any UCB infill or expansion area will be timed to commence after Whistle Bend has reached build-out, but it would be premature at this time to assume which UCB area would be developed first or furthermore - that all future development would only occur in these two areas.

The City of Whitehorse has developed a granular borrow site in an area along the outfall line that runs from a long-term storage cell at the LTECF down to the discharge point at the Yukon River. A bedrock quarry was also developed during construction of the wastewater treatment facility to supply armour rock along the inside faces of the berms. Borrow areas located outside and downwind of the boundaries of a proposed residential development may be preferable as there would be fewer land use conflicts.

3.8 Level of Service Standards

Generally speaking, two levels of service standard options are possible. The first, full service option assumes paved roads, curbs, gutters and sidewalks with underground utilities consistent with urban City servicing standards applied across the entire developed area.

The second, partial service option would be a modified country residential standard, which by necessity involves larger lots and lower density. In general, roads would be BST surfaced with ditches rather than curbs, gutters and sidewalks.

Property owners would be responsible for provision of their own water supply and sewage disposal systems and power and telephone service would be provided through overhead lines to the property line. Garbage pick-up and disposal would be provided by the City.

It is important to remember that the intent of establishing an Urban Containment Boundary (UCB) is to reduce the urban footprint by increasing density. Increased density consumes less land and distributes the initial capital costs over more users lowering the development cost recovery price point. Increased density also improves affordability if a portion of these cost savings are passed onto consumers in eventual lot sales.

Increased density is also beneficial from an asset management/full life cycle accounting perspective. The added density and compact footprint generates more taxpayers to cover downstream operating and eventual infrastructure replacement costs.

Cost estimates are based on historical Whistle Bend development costs and are considered Class D (+/-30%). Not included are owner costs, off-site infrastructure (i.e., bridge) financing costs, future study costs, GST, cost escalation beyond 2016, land costs, and legal survey costs which will be substantial. (See estimates developed for each in **Section 5.0**).

It is assumed that full cost recovery is a mandatory objective of the public or First Nation government initiating the land development process on their respective lands. It is important to note that no assumptions have been made in the calculations regarding access to infrastructure financial cost sharing programs.

The preliminary estimated development servicing costs discussed in **Section 5.0** have been prepared using Whistle Bend Phase 1 & 2 data as the base case for discussion purposes. The information should be used with caution. Upon further refinement of the developable areas and investigation of site-specific conditions, the initial per hectare costs will change.

The country residential development option may appear to be less expensive because it reflects a lower level of service and infrastructure construction standard (BST versus paved roads). Instead of full municipal services, water supply and sewage disposal become the responsibility of the lot purchaser. This generally means lots need to be larger (minimum 0.5-1.0ha) which the purchaser is prepared to accept because of the perceived benefits (increased privacy and more flexibility in building options) but this option comes at a long-term price for both the lot purchaser and municipality.

Highlights

- Both full and partial service level options are available but only the full service option is consistent with the UCB objective of a reduced footprint through increased density.
- A hybrid option that increases density in one area to offset a lower density in another because of site conditions or other values present should still be evaluated at the conceptual subdivision design stage comparing both the initial capital and subsequent life-cycle costs.
- Full cost recovery is assumed to be the minimum pricing standard.
- Added density and a compact urban form generate more taxpayers to cover downstream operating and eventual infrastructure replacement costs as well as improving affordability.

4.0 PLANNING AND DEVELOPMENT CONSIDERATIONS

While this is a pre-feasibility study, it is important that the broader city-wide growth management goals, objectives and policy context be considered. Many factors will affect the timing, pace, scale and nature of development that occurs. Perspectives may change as new information becomes available from the follow-up investigations recommended as part of this study and as the planning work itself is refined over time. It is likely, for example, that at least one more review of the City's Official Community Plan (OCP) will occur after the 2017 review before development within an Urban Containment Boundary (UCB) infill or expansion area will be required.

4.1 Guiding Legislation and Policy

The *Yukon Municipal Act* requires incorporated municipalities to prepare an OCP and Zoning Bylaw with periodic updates to ensure currency and relevance to changing circumstances. Municipalities have the authority to determine how plans will be implemented through policy and bylaw. The Zoning Bylaw must be consistent with the direction set out in the OCP.

The concept of an UCB was introduced in the 2010 OCP as a growth management tool and a means to promote a compact, more efficient urban form. More recent master plans completed by the City, including the 2015 Strategic Sustainability Plan and 2014 Transportation Demand Management Plan (Boulevard Transportation Group) reinforce the broad direction given by the OCP, focusing on efficient, low-impact transportation, dense and livable urban forms, and wilderness preservation.

The *Umbrella Final Agreement* (UFA) lays out the broad framework for the land management and land use planning inter-governmental relationship for the two First Nations with Settlement lands located within the NUCB, Kwanlin Dün First Nation (KDFN) and Ta'an Kwäch'än Council (TKC). The essence of the UFA is the encouragement of land management coordination and promotion of land use compatibility through joint planning initiatives.

The KDFN and TKC Final and Self-Government Agreements also address land use compatibility and planning coordination. They acknowledge that both First Nations can enact legislation applicable to their own Settlement Lands and enter into local service agreements for the provision and operation of infrastructure. Both agreements also provide for collaborative planning mechanisms.

Settlement Lands are classified as site specific, rural or community lands, and further defined as Category A and B. On Category A lands, a First Nation has surface and subsurface rights. On Category B lands they only have surface rights. Within the City of Whitehorse, KDFN lands are also classified as Type 1, 2 or 3 in accordance with the degree to which self-government powers apply. On Type 1 lands, the First Nation has full self-government powers, whereas Type 2 and 3 lands confer progressively less powers. All KDFN settlement lands located within the Northeastern Urban Containment Boundary are Type 2. TKC lands within city boundaries are category B lands and all are identified as C community land parcels.

Over the past year KDFN has prepared and approved a *Traditional Territory Land Vision,* which sets out a broad framework for planning and land management within the traditional territory.

It is analogous to the City's OCP, with the intent to "ensure a consistent approach to the planning, management and use of settlement land based on the values of the Kwanlin Dün community"[12].

The vision articulates four main land-supported goals:

- *Conserve areas of high ecological value and maintain and improve the health of wildlife populations;*
- *Conserve areas of high heritage value, while maintaining and creating opportunities for Kwanlin Dün citizens' traditional use of the land;*
- *Develop opportunities to support the provision of land for individual citizens and for government needs to provide services to citizens; and*
- *Make lands available to generate revenue for the benefit of the KDFN community*[13].

Within the NUCB, the selected KDFN C-parcels are identified for Commercial/FN Institutional use Revenue generation is a key consideration in C-land parcels while conservation of lands of high ecological value and ensuring land is available for traditional uses and governance needs are also land management objectives. TKC does not currently have an overarching land visioning document at this time or specific plans for the two parcels located within the NUCB but they share similar values in principle.

Development within the NUCB will trigger an assessment under the *Yukon Environmental and Socioeconomic Assessment Act* (YESAA). The Yukon Environmental and Socioeconomic Assessment Board may make recommendations to the authorities having jurisdiction whether a project should proceed (with or without conditions) or not. Every land development project creates impacts, both positive and negative. The identification of potential impacts and mitigation measures at the pre-feasibility stage allows for project adjustments to be made to minimize negative consequences.

4.2 Planning & Design Principles

The 2010 OCP sets out broad goals, objectives, principles and land management policies, connecting them back to the values Whitehorse residents feel are important. Several key OCP themes are particularly relevant to planning for the NUCB area. These include:

- Linking stewardship, environmental protection, sustainability and efficiency;
- Supporting inclusiveness, equity, culture, partnership, integration and accountability; and
- Demonstrating leadership and investment in energy conservation and participatory decision-making while preserving choice for future generations.

These themes and intentions for city growth management can be reflected in the following core principles intended to guide the NUCB residential development planning process. They are:

- ***the neighbourhood as the fundamental building block***

[12] Kwanlin Dün First Nation Traditional Territory Land Vision 2016

[13] IBID

Sustainable neighbourhoods require diversity and system integration so they can adapt to change over time without compromising foundational values such as walkability, access to transit, open space and efficient service delivery.

- ***The "do no harm" precautionary principle***

The intent of this principle is to address the risk of unintended consequences arising from a lack of sufficient information, knowledge and foresight, or holistic thinking about long-term consequences.

- ***Diversity helps maintain environmental integrity and resilience.***

Balancing environment, economy and community needs and values is the challenge. Diversity in urban form and housing type provides lifestyle choice while supporting broad community goals such as inter-generational living, aging in place, inclusiveness, affordability, etc. Ecological diversity respects the functions and roles of natural systems while economic diversity supports sustainable prosperity.

- ***System connectivity has consequential threshold effects on the provision and reliability of hard and soft services.***

The inter-connectivity and inter-dependency systems relationship applies not only from a service delivery standard perspective but is also a consideration in risk management. Without back-up systems there can be serious cumulative consequences. Connectivity is equally important to planning for parks, trails and protected area functionality.

- ***The planning process itself should be holistic, open, transparent, inclusive and participatory***.

This principle cannot be taken for granted though it would appear to be self-evident. Without a balanced presentation of facts, discussion of alternative scenarios and effective debate of values, trade-offs, and the cost/benefits of the choices available (including their consequential impacts for future generations), good decisions are difficult to make.

- ***Life cycle costing and asset management consequences are an integral part of land development planning.***

Full cost accounting considers the initial capital investment, the life cycle operating cost and the eventual replacement cost. It includes the consideration of options and mitigation measures proposed in suggested trade-offs should be spelled out to assist informed decision-making.

- ***A commitment to best practices and leadership acknowledges that circumstances and needs change over time.***

This acknowledges that change is a constant and there are always unforeseen variables that come into play. Technology improves, and new creative solutions can be found by thinking out of the box.

- ***Demand side management acknowledges there are limits to growth and service threshold capacity points that need to be considered in promoting sustainability in practical asset management terms.***

Managing power demand through energy efficient construction, reducing per capita water consumption rates, increasing waste diversion, and promoting public transit to reduce traffic congestion are all tried-and-true practices that enhance liveability while reducing capital and operating system costs.

- ***The crime protection through environmental design (CPED) principle is becoming increasingly popular and expanded to address all forms of safety and risk management.***

Traditionally CPED was applied at a detailed site planning level but it can also be used in subdivision planning in several ways. Specific safety concerns such as wildfire risk and minimizing negative human/wildlife interactions are examples relevant to NUCB planning.

An example of achieving both equity and safety objectives would be the construction of a single sided street along an escarpment with a public trail along the top of the bank. The houses are more valuable because of the view, the public retains access to the trail, and the residences provide informal supervision of the public space.

4.3 Big Picture Planning Context Considerations

The following is a brief discussion of some of the other relevant "big picture" considerations that need to be kept in mind as planning for the NUCB progresses.

4.3.1 Protection of Ecological and "Intangible" Values

The team notes that the largely undeveloped nature of the NUCB is a factor in both the diversity of wildlife use currently present and the quality of habitat available for use on a transitory, seasonal or year-round basis. Urban development will have consequential impacts on both parameters, and those impacts would not just be restricted to the NUCB but would also "spill over" into the surrounding area. For many species, particularly large mammals, the end result is often displacement and/or avoidance, with the associated impact of habitat loss.

Environmentally sensitive lands include tangible landscape features such as steep slopes, wetland areas influenced by groundwater discharge and/or infiltration, unstable and easily erodible soils, rare vegetation, etc.

Other land sensitivities may reflect more intangible values such as proximity to wilderness, noise, preservation of the night sky, protection of in-situ heritage resources, viewscapes, etc. Typical mitigation measures include setbacks and buffers, avoidance, imposition of policies to maintain natural system connectivity, monitoring and adaptive management (e.g., "no net loss" and compensation for displacement). The time to consider these matters and their potential consequences is at the pre-feasibility stage before options are eliminated.

4.3.2 Chadburn Lake Regional Park

The 2010 OCP provides for the development of Chadburn Lake Regional Pak and designates lands abutting the potential park boundaries as greenbelt and/or future planning. At the Zoning Bylaw level similar zoning is applied.

The final park management plan issued in fall 2016 outlines five types of land management areas: Conservation, Cultural Heritage Protection, Intensive Recreation, Natural Environment and Park and Visitor Services. The majority of the park lands bordering on the NUCB area are designated Conservation and Natural Environment.

A few smaller areas along the southern/Long Lake area boundaries are designated Natural Environment and Cultural Heritage Protection. The objectives of these three zones are particularly relevant to planning of the NUCB and the consideration of ecological values outlined previously. The objectives are as follows:

- *Conservation – To protect regionally significant natural ecosystems for their intrinsic value, contribution to biodiversity and long-term public appreciation.*
- *Natural Environment – To provide accessible natural areas where outdoor recreation values are balanced with the preservation of natural, ecological, and scenic values.*
- *Cultural Heritage Protection – To protect and ensure no landscape alterations occur that would have a detrimental impact on culturally significant resources, storied landscapes, and traditional trails.*

The common features of these zones include low intensity and density of recreation use, preservation of undisturbed landscapes and wildlife habitat, an emphasis on balanced interaction and respect for the natural values present, and minimal infrastructure development.

Given these management objectives, the larger questions for discussion in regards to the NUCB are:

- To what extent does the presence of the adjacent park and its zoning objectives address and/or compensate for the level of disturbance created through urbanization of the NUCB lands?
- How should the transition between these two land uses be considered in subsequent planning and municipal zoning for NUCB lands especially if pre-grading is contemplated on the portion of NUCB lands adjacent to the north boundary of the park near Long Lake?

4.3.3 First Nation & Other Private Landowner Interests

While both First Nations have private land interests in the NUCB, KDFN is by far the largest private landowner with three large land selections: C-42B and C-143B bordered by the east bank of the Yukon River and Long Lake Road, and the much larger C-116B located between the YEC transmission line and Croucher Creek. All three parcels are identified for Commercial/FN Institutional use and are Type 1 lands with no taxation restrictions. TKC has two small land parcels (C-14B and C-77B) in the Long Lake area, both of which have 20-year tax exemptions.

The C lands within the City were mainly selected for their revenue generating potential so the First Nation has a vested interest in when and how development proceeds in the NUCB.

There are also two quarry leases on the northeast side of Croucher Creek near the road to the Livingston sewage lagoons in an area of environmental sensitivity from a habitat protection and wildlife movement perspective.

There are also private properties along the Long Lake Road fronting on the east bank of the Yukon River who are likely to be affected by the final location of the road and pedestrian bridges as well as the upgrades required to the Wickstrom and Long Lake roads.

4.3.4 Pre-Grading for Subdivision Development

Where the desired end use is an urban subdivision, pre-grading (such as that undertaken in Whistle Bend) can simplify design, as well as reduce engineering and servicing costs and complexity. Tetra Tech EBA and Associated Engineering both recommend that pre-grading be considered in the kame and kettle topography in Area 2. Pre-grading may also reduce sub-grade granular material volume needs.

While this approach to land development was common practice until the 1970s, it is generally recognized today as a flawed, unnecessarily invasive approach. This is particularly true when modern development standards and full cost accounting principles are measured against current best practices. Trends suggest market preference is moving quickly towards a more sustainable, eco-friendly design approach.

The questions that merit further public discussion and political debate are:

- Whether the practice is appropriate given other values present;
- Whether the cost/benefit of such an approach is as high when landscaping reclamation costs are factored in through full-cost accounting; and,
- Whether such an approach is still publicly acceptable and consistent with the "best practices" land management philosophy set out in the City's present OCP.

4.3.5 Yukon River Bridge Crossing and Emergency Considerations

The prospect of significantly increasing the population residing on the east side of the Yukon River warrants consideration of the current emergency evacuation context. Presently, the Robert Campbell Bridge is the only functioning access in and out of Riverdale. A one-lane emergency road can also be opened up at the Whitehorse Rapids hydroelectric facility. The two greatest potential risks to both Riverdale (and by extension the NUCB) are wildfires and flooding from a catastrophic dam failure. The probability that a significant dam breach would take out the Robert Campbell Bridge and/or sections of Wickstrom Road is reasonably high. A Marwell bridge would likely also be vulnerable[14]. The Range Road Point crossing location further downstream is also another pinch point but the bridge structure can be built higher and possibly spanned completely to reduce the risk.

Investment in another bridge across the Yukon River is a necessary precursor to development in the NUCB area. As it stands, unless another bridge is constructed further north during build-out the current Riverdale situation would simply be recreated in the NUCB with one main crossing.

[14] Marwell is already a pinch point when ice jamming occurs some winters

Emergency measures experts may wish to carefully consider whether a single crossing from the NUCB, particularly for a significant residential population, is a prudent long-term planning strategy or whether two bridge crossings may be necessary before build-out.

4.3.6 Forest Fire Risk Management

While proximity to wilderness has its benefits it also carries with it certain risks – chief among them are wildfires. The prevailing winds in the Yukon River valley in Whitehorse are south to north. There is an emerging consensus among forest fire fighting agencies and wildland managers that wildfire risk is steadily increasing. There are a variety of reasons including climate change. What the wildfire experiences of Kelowna, Slave Lake, and most recently Fort McMurray show, is that the intensity, speed, behaviour and severity of damage associated with wildfires is becoming more unpredictable and extreme.

Whitehorse has had several close calls over the years. It is no longer a question of "if", but rather "when". The literature suggests that while traditional fire smart activities help, they are not enough and are often carried out in an ad hoc manner after a significant event has occurred.

Sixty-two percent of the study area contains old growth coniferous forest. The heritage assessment anticipates patches of culturally modified trees will also likely be present. Since old growth coniferous forest is more vulnerable to wildfire than deciduous dominant forests, it would be prudent to assess both the existing and potential future wildfire risk so the necessary risk abatement programming can be integrated into the eventual subdivision design. Such an assessment was not within the present scope of work but should be considered in the next phase of planning.

4.3.7 Population Growth

In 2016 the Yukon Bureau of Statistics introduced a new population projection methodology. In addition to high, medium and low projections based on standard demographic data sets, the YBS has added a "preferred" projection that adds the outputs of an economic factors model that looks at in-migration as a function of the economic performance of the Yukon.

The following table presents the number of housing units required to house the projected growth in population over different time periods based on an assumed average of 2.2 people per unit. By 2030, more than 2,100 new housing units will be required at a minimum, with over 3,600 units required under a high growth projection. Note housing units do not equate to number of lots required because that is determined by density (e.g. Number of units/hectare).

Scenario	2017 to 2020	2021 to 2025	2026 to 2030	Total by 2030
Low growth	533	793	795	2,121
Medium growth	812	984	984	2,780
High growth	1,192	1,236	1,234	3,662
Preferred projection	762	1,236	836	2,835

Source: Yukon Bureau of Statistics special data request.

5.0 NUCB DEVELOPMENT FEASIBILITY

Feasibility is a highly subjective term. The context is important because it shaped the project approach and focus. In this study the priority was to accommodate future urban growth in a compact form. Thus development suitability looked at access, terrain conditions, proximity to existing services and the expected general planning and engineering requirements to achieve that aim. Weighing the costs and benefits of various trade-offs is a Council responsibility. This study identifies those trade-offs at a broad scale.

In a 21st century context, technical, environmental and engineering feasibility is only one part of the development equation: legal, social, financial and political considerations also figure prominently in determining highest and best land use. Feasibility can also be influenced by factors that can't necessarily be foreseen. The challenge is finding the right balance and flexibility to accommodate today's needs and preferences without unduly compromising future choices.

Geotechnical, hydrogeological, and terrain characteristics can be considered the core constituents of technical feasibility. Social feasibility speaks to the human-ascribed values present in the landscape, such as heritage and recreation. Environmental feasibility occupies a spectrum between the technical and social realms: countless urban developments of the past have proven the technical ease with which wildlife and habitat can be displaced, but modern-day social values around ecological preservation pose barriers to the continuance of such practices. Legal and political feasibility are closely intertwined and provide a bridge between public institutions and social feasibility. Engineering and financial feasibility tend to exhibit an inverse relationship: theoretically speaking, engineering constraints can be overcome with infinite financial resources. The reality is virtually always different.

The key observation is this: the technical, engineering, and financial parameters of feasibility can be evaluated in a relatively neutral, objective way. The evaluation of feasibility according to virtually all other parameters relies on the careful weighing and negotiation of comparatively more value-laden, subjective considerations.

It was not the role of the team to make those determinations. The team has provided a baseline of information from which the potential value conflicts and trade-offs posed by development can be understood and weighed by the public, initially through the OCP review process and ultimately by those charged with making such difficult and complex decisions.

With those roles in mind a preliminary determination of development feasibility was nonetheless explored. The team first revised the study area boundary as a means of revealing trade-offs and facilitating a quantitative assessment of engineering and financial feasibility. The general approach taken was to factor in known and strongly suspected technical constraints, incompatible land uses, and significant environmental, heritage and recreational values that do not obviously compromise the objective of optimizing the amount of potentially developable land. In this sense, the approach prioritizes the fulfillment of the primary purpose behind creating the NUCB concept. The following sections describe the revised study boundary and development assumptions proposed by the team and the degree to which the resulting NUCB concept is likely to satisfy some of the criteria underpinning social, legal, and political feasibility.

The resulting servicing costs and financial feasibility determinations are intended to serve as a "base case" from which the implications of adjustments to the development boundary can be understood at a broad level.

5.1 Description and Boundaries

Based on the results of the discipline-specific assessments and a balance of broader planning considerations, a revised NUCB study area (see Figure 20) was developed by the team for discussion purposes. The revised study boundary assumes the following:

- Approximately 213 hectares of environmentally sensitive areas along the Yukon River escarpment and Croucher Creek watershed are unsuitable for development; and,
- 158.7 hectares within the southeast portion of the study area could be incorporated within the Chadburn Lake Park boundaries to protect some of the more pronounced kame-kettle terrain that would require significant pre-grading and is of high value to local orienteers and/or future NUCB residents.

Within the remaining 897.9ha NUCB study area, additional assumptions are made regarding development feasibility:

- A 9-hectare reserve would be placed on the high escarpment area across from Range Point for a potential bridgehead or park area;
- The KDFN cemetery and surrounding area (11.7ha) is unavailable for development;
- Approximately 572ha (or 64%) of the revised area is highly developable;
- Approximately 140ha (or 16%) of the revised area could have potential near-surface bedrock, which could pose additional costs and complexity;
- A 10.2ha area will become developable after the sewage lagoons are remediated; and,
- Pre-grading may be required within 176 hectares (20%) of the revised study area to optimize subsequent development.

5.2 Stakeholder/Partner Input

Development feasibility is typically evaluated against its ability to satisfy a pre-determined set of criteria. Not all criteria are created equal: some may be considered "musts" whereas others are "nice to haves". A variety of approaches, including criteria weighting, can be applied to ensure those nuances are captured at the evaluation stage. As a starting point, City staff and their Kwanlin Dün First Nation (KDFN), Ta'an Kwäch'än Council (TKC) and Government of Yukon (YG) counterparts were tasked with a criteria-based exercise at a daylong workshop in September 2016. It included the following steps:

1. Reviewing and revising a draft set of development suitability criteria;
2. Ranking the final set of criteria in accordance with priority to decision makers; and,
3. Evaluating the ability of the revised NUCB study area and development assumptions to satisfy each criterion on a 5-point scale (with 1 signifying strong disagreement that the criterion was satisfied and 5 signifying strong agreement).

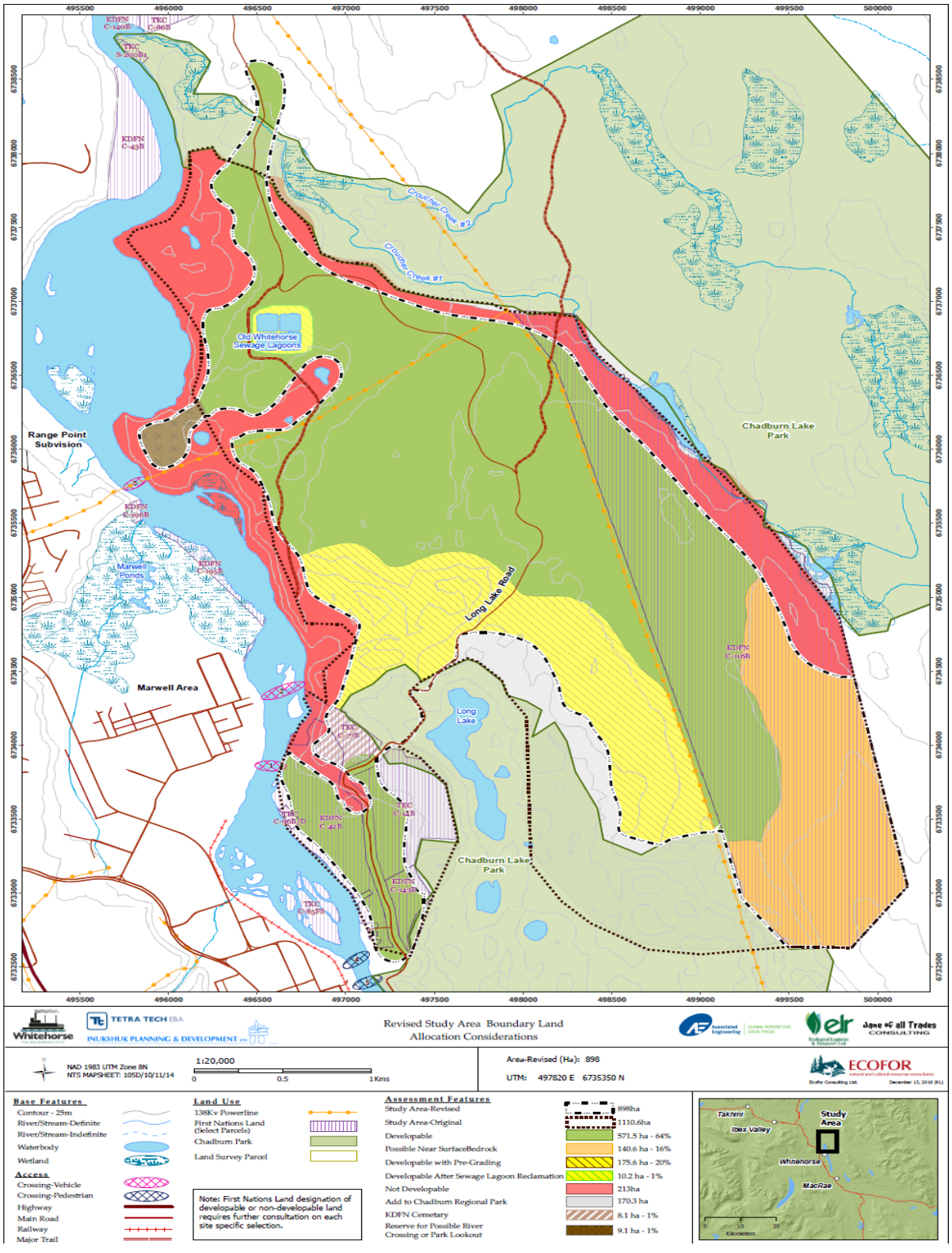

Figure 20: Revised Study Area

For the most part, the NUCB area received average scores in the 2.5-3.5 range against the various criteria and a total aggregate average score of 50.5 out of a possible 85 points. The development suitability criteria and results of workshop participant scoring of the NUCB against those criteria are shown in **Table 3**. The complete workshop results are included as an appendix.

Table 3: Performance of NUCB Revised Boundary against Development Suitability Criteria

Rank	Primary Criteria	Average Score
1	Respect/protect environmentally sensitive areas	2.66
2	Take wildfire risk management into account	2.11
3	Reflect highest and best use of UCB lands	3.56
4	Minimize overall urban development footprint	2.5
5	Integrate private/public lands	3.33
6	Avoid or protect known heritage values present	4
7	Encourage densification and servicing efficiency	2.7
8	Minimize significant landscape alteration to build	3.11
9	Acknowledge need for a range of affordable housing choices	2.66
10	Anticipate and promote multi-modal active transportation choices	3.22
	Secondary Criteria	
11	Acknowledge need for best practices for infrastructure delivery and asset management	3.1
12	Integrate well with existing neighbourhoods	2.44
13	Overcome identified physical constraints	3
14	Maintain existing recreation assets	3.78
15	Address existing level of service standards and infrastructure deficiency threshold limits	3.25
16	Address spill-over effects beyond UCB into adjacent undeveloped areas	1.8
17	Incorporate and reflect direction in City plans and policies	3.3
TOTAL AGGREGATE AVERAGE SCORE		**50.52**
TOTAL POSSIBLE SCORE		**85**

Workshop participant scoring reflected the general consensus that perhaps the greatest advantage of the NUCB is its strong potential to accommodate a very large development (Whistle Bend-size or larger) in relative proximity to the Downtown core. A range of housing options and high density appear highly achievable. However, the additional cost of a bridge crossing, potential impacts to caribou habitat and anticipated "spill-over" effects to sensitive areas adjacent to the NUCB (i.e. Croucher Creek, Swan Lake, and Livingston Trail) were viewed as the most significant disadvantages. One participant observed there was "more to lose" in pursuing urban development in this area, a sentiment shared by others in the room.

There was considerable discussion about the bridge and debate about the best tie-in location for overall City traffic circulation and active transportation. Participants were unanimous that an active transportation connection to Downtown was a pre-requisite to NUCB development. One participant suggested that the bridge could be constructed to accommodate a small alternative development in the southern-most portion of the NUCB first.

5.3 Capacity and Density

Based on the previously outlined assumptions, the gross developable area is 897.8ha. Using an industry standard ratio of 60% of gross area for lot development[15], the revised study boundary area has the potential to provide a net developable area of 539 ha. Based on a unit density of 16 units/ha and a unit population density of 2.2 persons/unit (both parameters provided by the City of Whitehorse as a guideline), the NUCB area could accommodate an estimated population of about 18,964 people and 8,620 housing units.

It should be noted that the 16 unit/hectare lot yield is similar to a conventional Whitehorse low density subdivision and is being used here only as a baseline for illustrative purposes. This is because it is not consistent with the UCB intent to encourage a compact development form.

What it does demonstrate in simplest terms is how raising density by changing the mix of housing provided from low to high density can be used to influence overall project cost and improve affordability. Benefits accrue to both the municipality and the eventual housing unit purchaser. From a subdivision design and servicing perspective allowing added density in area of near surface bedrock becomes a viable option if it offsets the higher cost to develop in that area because of the bedrock presence. Similarly, added density means the same number of people can be accommodated in a smaller footprint leaving more land for other purposes.

Generally speaking, the NUCB area is well suited to an urban type of development and all servicing cost estimates have been developed with the assumption that an urban level of service standard will be desired by the City and its prospective development partners.

5.4 Development Phasing

Traditionally, phased subdivision development has provided a 150 – 200 lot supply[16] to allow development to proceed under market-supported conditions. As such, the proposed developable NUCB area could produce a subdivision development comprising between 40 and 60 phases at 150 – 200 lots per phase. However other threshold considerations may affect both timing and size of each phase. For example, the ability of the water and sewage systems or roadways to accommodate the demands of the new development will likely be exceeded unless their design capacities are increased in concert with planning the new development.

The main considerations for phasing are:

- Market demand and keeping the 150 – 200 lot portions as consistent as is practicable;

[15] The net development ratio can vary significantly depending on the nature of local site conditions and municipal service requirements. It is normally calculated by deducting environmentally sensitive lands, park and school site dedications, roads, sidewalks and utility requirements (e.g. stormwater management requirements) all of which is subsequently recaptured through density and lot pricing.

[16] Lot supply does not equate directly to number of housing units because that depends on the proportion of lots that are developed for single or multi-family use.

- Providing looped water distribution to the development area as part of staged phasing via a master plan for the NUCB area. For example, it may be necessary to construct some portions of water infrastructure in advance to allow for earlier phases to operate efficiently;
- Advanced construction of development wide supporting infrastructure is always a challenge in developing the infrastructure phasing plan because of the implications associated with lower operational utilization levels during the early subdivision buildout period;
- Providing an efficient transportation network within the NUCB with convenient access to the Downtown and Marwell areas. The commitment to support active transportation can be promoted from the outset by early implementation of the pedestrian bridge option in conjunction with the required Yukon River road bridge. The vehicle bridge crossing and NUCB primary road network would be planned to provide necessary access to the proposed development area and overall network wide circulation. The installation of associated infrastructure such as water, sanitary and storm may require additional road construction prior to adjacent lot development. For the purposes of this study, we assume Marwell Crossing #1 would be the preferred location;
- Planning underground infrastructure to efficiently service the phased approach to the entire development while minimizing the amount of infrastructure required beyond the immediate phases with costs amortized over the life of the entire development;
- Considering major onsite sanitary infrastructure development such as pump stations and force mains early in the planning stages by completing a master planning exercise to allow for efficient usage through a long-term development horizon;
- Undertaking storm water management planning, including sustainable options for climate change, early in the next stage of planning assuming the NUCB is accepted as the preferred next subdivision development area through the upcoming OCP review. It will be necessary to plan future storm water features in the NUCB and set aside the land required to accommodate such infrastructure in all phases. The construction of storm water management facilities for the entire development area may be required in initial development phases; and,
- Completing a wildfire risk assessment for the entire study area so risk abatement procedures (e.g. fire-smarting) are incorporated into each development phase from the beginning and integrated into the eventual NUCB area servicing plan and conceptual subdivision design.

Overall, the NUCB is expected to require a number of significant infrastructure upgrades and capital investments to achieve both the necessary access and levels of service required to allow development in the area to proceed.

5.5 Development Costs

Cost estimates for the NUCB are generally based on information provided to the team for the recent Whistle Bend subdivision on a per hectare basis. Quantity measurements for roads, grading, or linear infrastructure have not been undertaken because they need to be based on a conceptual subdivision plan which is premature at this stage. The cost estimates are considered to be Class D estimates appropriate for a pre-feasibility level of detail.

Both onsite and offsite infrastructure costs have been estimated and will need to be updated as additional consultation and design are carried out in the future. Costs are presented in 2016 dollars and additional considerations are highlighted.

5.5.1 Off-Site Costs

Offsite costs have been based on average unit rates for similar infrastructure from recent tender results. The Yukon River bridge crossing costs assume that Crossing 1 (Marwell) and Crossing 5 (active transportation) will be the preferred locations and the necessary transportation network upgrades to Copper Road and Quartz Road would be completed in conjunction with the Whistle Bend subdivision build-out process. Approximately $136 million in offsite development costs are estimated based on these assumptions. Please refer to **Table 4** for estimated offsite development costs.

Table 4: Estimated Off-site Costs Associated with NUCB Development

Infrastructure	Cost Estimate	Notes
Reservoir	$9,500,000	Based on Valleyview estimate
Riverdale Water Connection	$1,320,000	WM to connect Riverdale supply main to boundary
Downtown Water Connection & Improvements	$2,340,000	Connection from Two Mile Booster to Marwell Bridge Crossing, will vary depending on bridge crossing location
2 Mile Hill Booster Upgrades	$750,000	Estimate for new pumps, SCADA
Riverdale Wells	$12,000,000	New pump house and 2 wells.
Primary sanitary collection pump house	$6,500,000	Based on WB sanitary pump house and larger service areas
Sanitary FM to LTECF	$4,000,000	New FM from mid-point of area to lagoons
Upgrades to lagoons	$9,000,000	Assumes two new cells added to existing system
Vehicle bridge	$28,000,000	Based on 350 m length, 16 m width, would depend on final selected location
Pedestrian bridge	$4,680,000	Based on 260 m length, 4 m width
Wickstrom Road upgrades	$2,000,000	From Lewis Blvd to study boundary
Existing city network road upgrades	$4,000,000	Allowance for network upgrades, would depend on final transportation links and study, Assumes Copper and Quartz are upgrades due to WB
Engineering Master Plans	$1,040,000	
NUCB Offsite Subtotal	**$85,130,000**	
Contingency (30%)	$25,539,500	
Engineering (15%)	$12,769,500	
Developer Costs (Land, Legal, Internals) (10%)	$8,513,000	
Permitting (5%)	$4,256,500	
NUCB Offsite Total	**$136,208,500**	

Cost estimates for offsite infrastructure are based on the proposed infrastructure requirements as envisioned within this document. As planning for the proposed development proceeds, boundaries are further defined, and City-wide master plans updated, the specific requirements for offsite infrastructure upgrades and expansion will be refined and associated costs reviewed.

5.5.2 Onsite Costs

Within the proposed developable area, we have assumed a full urban type development consisting of full utility (water, storm, sanitary), shallow utilities (ATCO, Northwestel) and full surface works (full curb/gutter/asphalt surfacing). In addition to this, we have included landscaping for the development areas upon completion. A few of the key cost drivers used in our cost estimate are highlighted below:

- Whistle Bend Phases 1 & 2 onsite development costs - $650,000/ha (Yukon Government)
- Whistle Bend Phase 3 – 7 onsite development costs - $650,832/ha (City, Whistle Bend Phase 3 – 7 Report), with the following considerations:
  - In areas expected to have shallow bedrock, modified construction techniques may be required. Costs have been increased by 30% over the standard Whistle Bend costs.[17]
  - The current area shown within outlining possible near surface bedrock has been based on a desktop study and should be field confirmed prior to the next stage of planning for the NUCB. The findings of such a study may have a significant effect on cost estimates for the NUCB area.
  - The costs of remediation of the former City lagoon area have been incorporated into the per hectare development costs.
- Municipal landfill costs for additional cells have not been incorporated as this is considered an optional cost, rather than a capital cost.
- Soft landscaping costs estimate - $85,000/ha (Whistle Bend Phase 3 – 7 Report[18])
- Shallow utility costs - $75,000/ha (ATCO, NWTel)
- Developer costs – Assumed at 10% of net development costs
- Permitting – Assumed at 5% of net development costs

Based on the key cost drivers outlined above and the calculated net development area, the NUCB total onsite development costs are estimated to be $522 million or $968,000/ha. See **Table 5** for a more detailed breakdown.

[17] This allowance has been based on a high-level comparison of costs within Yellowknife between developments with a low proportion of bedrock and those known to be fully situated in bedrock. The 30% difference allows for alternative construction techniques such as blasting.

[18] Soft landscaping costs will quickly mount if extensive pre-grading is undertaken, eliminating natural treed buffers anticipated in the approved subdivision plan. Landscaping costs do not include fire-smart activities.

Table 5: Estimated On-site Costs Associated with NUCB Development

	Developable	Possible Near Surface Bedrock	Pre-grading Required	Lagoon Reclamation	Non-Developable	Total
Gross area (ha)	571.5	140.6	175.6	10.2	212.7	1,110.6
Net area (ha)	342.9	84.4	105.4	6.1	-	538.7
Development costs ($/ha)	$650,000	$850,000	$650,000	$700,000		
Landscaping ($/ha)	$85,000	$85,000	$85,000	$85,000		
Shallow utilities ($/ha)	$75,000	$75,000	$75,000	$75,000		
Subtotal Costs ($)	**$277,749,000**	**$85,203,600**	**$85,341,600**	**$5,263,200**		**$453,557,400**
Developer Costs (10%)						$45,355,740
Permitting (5%)						$22,677,870
Total Cost						**$521,591,010**
Total Cost ($ per ha)						**$968,168**

Notes on **Table 5**:

- Costs are in 2016 dollars.
- Net development area ratio of 60% of gross area assumed overall target for development
- Per hectare development costs based on Whistle Bend Phases 1 & 2 provided by Government of Yukon.
- Contingency and engineering costs are included in the per hectare estimates.
- Unit and population density provided by the City of Whitehorse.
- Assumption of average unit density of 16 per ha (a low density) gives 8,620 total units.
- Average of 2.2 people per unit gives a total service population of 18,964.
- Total population would exceed current well and lagoon design population of approximately 32,000 and 36,000 respectively (therefore the need for new wells and additional lagoons).

5.5.3 Conceptual Costs and Lot Pricing Implications

Using Class D estimates for the on and off-site costs for development of the NUCB, the team can provide a preliminary estimate for the average lot price per housing unit.

A straightforward analysis that distributes all costs across all units indicates that the average lot price per housing unit will need to be $75,631 to recover all costs, as shown in the table below. Note that this high-level analysis makes the simplifying assumption that all the lots are developed and sold in a short time frame (see assumptions on phasing and inflation below) in order to allow a straight-forward comparison with current land prices.

Table 6: Minimum Lot Price for Development Cost Recovery

Total hectares to be developed	**539**
Total number of units (16 units/ha)	8,620
Total off site costs	$130,339,500
Total on site costs	$521,591,010
Total costs	$651,930,510
Total cost per hectare	$1,210,102
Average lot price per housing unit for cost recovery	**$75,631**

Key issues and assumptions underlying the estimate of the average price include:

- Most of the on-site cost calculations are based on actual costs from the first two phases of Whistle Bend as described in the preceding sections and are considered very robust;
- The off-site costs are based on average unit rates of similar recent infrastructure as described in the preceding sections and are similarly considered robust estimates;
- The numbers used are not based on an overall master plan design for the area due to the very preliminary nature of the study. The final mix of lot size and type may vary significantly around the average price and, if the density is significantly higher - will push the average lot price per housing unit down;
- No allowance is made for any costs associated with phasing the development, e.g., an allowance for the cost of money incurred by the need to build off-site infrastructure in advance of lot sales;
- No allowance was made for the cost of the studies identified in the recommendations other than to increase the contingency allowance from 25 to 30% and,
- No allowance is made for inflation - all dollars are 2016 dollars.

It is important to note that these average lot prices are based on the assumption of a low density family dwelling density figure (e.g. single family/duplex-fourplex unit); in reality, the cost per lot could be substantially lower if a mix of housing densities is employed (for example, multi-family high density development can be in the 40 to 100 unit/ha range).

To put the estimated average lot price per housing unit in the NUCB into broader context, the following table presents the average lot price for Whistle Bend Phases 1 & 2 for single family, townhouse, and duplex lots only.

The average price for each type of lot is from Government of Yukon Lands Branch 2015 sales data and the overall average price is calculated by weighting the total number of each type of lot sold by its 2015 sale price.

Table 7: 2015 Whistle Bend Lot Sales

	Number	Average 2015 selling price	Percentage of total	Weighted cost
Single family lots	185	$119,154	61.1%	$72,751
Duplex (units)	68	$77,778	22.4%	$17,455
Townhouse lots	50	$77,778	16.5%	$12,835
Total	**303**			**$103,040**

Note that there was no separate price provided for townhouse lots at Whistle Bend and we have made the assumption that the price was equal to the per-unit price of a duplex lot for the purpose of this analysis.

The estimated cost per unit in the NUCB, at $75,631, is 27% lower than the $103,040 average sale price[19] for the mix of single family, duplex and townhouse lots sold in Whistle Bend Phases 1 & 2. However, Whistle Bend also has several multi-family developments of different sizes that, if included, would bring the weighted cost down significantly. Similarly, increasing the density in the NUCB area will also lower the average lot price per housing unit.

16 units/ha is a conventional low density subdivision. It represents the minimum lot yield to facilitate macro-level cost comparisons assuming full land utilization. Densification changes the ratio between lower and higher density housing types. Double the above density and only half the land is required to generate the same unit yield and population growth.

Existing Government of Yukon Land Development Policy requires cost recovery as a minimum. As noted above increased density reduces the per unit development cost and such savings above cost recovery could be passed on to the end lot purchaser improving affordability. Assessing the political and socio-economic implications of changing land development policy is beyond the scope of this study.

It is noteworthy that the difference in estimated per unit development cost and average 2015 sale pricing, even at this very preliminary pre-feasibility stage, provides considerable flexibility in slowing and stabilizing pricing improving potential affordability. Similarly, as stated previously, increasing allowable overall unit density per net hectare of land also reduces cost and improves affordability.

[19] YG Community Services was unable to breakdown both their $650,000/ha cost estimate for Whistle Bend Phase 1 & 2 nor confirm whether the sale price represented market price, recovery of actual development cost or some combination of the two.

6.0 CONCLUSION AND RECOMMENDATIONS

The study team concludes that the development in the Northeastern Urban Containment Boundary (NUCB) area is technically and economically feasible.

The recommendations that follow speak to bridging the discipline-specific information gaps and "next steps" from a strategic, process-oriented standpoint. It assumes that the City wishes to reserve the option to pursue some level of development in the NUCB area at some point in the future and continue with the next stage of planning.

6.1 Bridging the Information Gaps

The following is a list of outstanding information gaps that the team recommends be undertaken prior to moving into detailed conceptual subdivision design.

Much of the information will assist the City (and potential development partners) in meeting the requirements of the *Yukon Environmental and Socioeconomic Assessment Act* review process.

6.1.1 Geotechnical and Hydrogeological

The geotechnical and hydrogeological assessments in this study relied on limited existing data at a regional scale. More precision is required for conceptual design given the potential for variability in subsurface conditions. Further consideration of the NUCB for development should be accompanied by:

- Installation of test wells at strategic locations to ensure adequate groundwater supply should on-site water supply wells for urban or a country residential standard of servicing be contemplated. Groundwater wells should not be located within 300 metres of the old City sewage lagoons or less than 120 metres from the KDFN cemetery;
- Calculating the expected water supply demand and groundwater recharge rates for the proposed development along with nitrate loading calculations for onsite sewage disposal (if a country residential component is pursued) when the number of dwellings and development footprint are known;
- Individual percolation testing at each individual lot to inform septic disposal system design if a country residential component is pursued;
- Further investigation of potential downgradient groundwater impacts from the existing, old sewage lagoons, including (at a minimum) review of inputs to the lagoons (volumes, concentrations) and estimated infiltration rates;
- Additional detailed geotechnical evaluation (including drilling of boreholes) of both banks of the river crossing options should be undertaken to inform a more detailed recommendation for an appropriate pile design/installation;
- A more detailed geophysical evaluation to determine depth to bedrock (via ground penetrating radar and accompanying test-pitting) to better delineate the boundaries of areas suited to an urban service standard versus country residential standard should be undertaken during the next stage of planning; and,

- A drilling program should be included to estimate the volume and quality of granular material available at an appropriate location(s) suitable to meet NUCB construction requirements.

6.1.2 Civil Engineering & Site Servicing

From a civil engineering and municipal infrastructure perspective, further consideration of the NUCB for development should be accompanied by:

- An investigation of the impacts of increased traffic volumes from NUCB development on the existing transportation infrastructure at the proposed bridge crossing points including Wickstrom, Industrial, Tlingit, Range and Quartz roads, as well as Mountainview Drive;
- Updating of the City Wide Sewer and Water Master Plan to account for estimated population growth and servicing options for NUCB;
- Updating of the 2006 City-Wide Transportation Master Plan to account for estimated population growth and servicing options for NUCB, factoring in a potential secondary bridge location based on expected densities; and,
- Update to the City's Source Water infrastructure planning to confirm long term water supply in comparison to proposed population growth beyond current predicted levels.

From a development phasing standpoint, the following sequence of steps should be followed:

- Confirmation of the development area boundaries to inform the next feasibility stage of planning, engineering, and design; and,
- Confirmation of the level of service desired by the City and its development partners.

6.1.3 Ecology

If the NUCB area is considered further for development the following data collection or refinement tasks are recommended:

- Completion of ecosystem mapping at a more refined scale of 1:5000 to provide a greater level of land cover detail, update the existing data (e.g., areas of disturbed ground and seral stages) and help guide other targeted surveys (e.g., bat surveys, rare plant and habitat surveys);
- Completion of a bat roost assessment, targeted rare plant and wildlife studies following updating the ecosystem mapping at the same proposed 1: 5,000 scale;
- Completion of targeted wildlife surveys and ecosystem mapping in the KDFN and TKC land parcels since previous studies did not include these properties;
- Collaborative work with the Yukon Department of Environment to better understand and assess the potential residential development impacts on Woodland Caribou use of the area; and,
- Completion of fish and fish habitat assessments with targeted studies at the potential bridge crossings, kettle ponds and mouth of Croucher Creek.

6.1.4 Heritage & Culture

The Team recommends that the appended Heritage Resources Overview Assessment report be submitted to Kwanlin Dün First Nation (KDFN) and Ta'an Kwäch'än Council (TKC) for review and consultation with regard to traditional knowledge/land use.

Should future Heritage Resources Inventory Assessment (HRIA) work be conducted, all heritage resource sites identified, whether new or revisited; should be recorded as per the requirements outlined in the *Yukon Archaeological Sites Regulation* (O.I.C. 2003/73). Once recorded/revisited, specific heritage resource management recommendations should be made for each site that reflects the potential impacts associated with the proposed development that spurred the HRIA.

6.1.5 Recreation

An overall trail development and management strategy should be an integral part of the next stage of subdivision planning. This will ensure the resulting trail network is consistent with city-wide Trail Plan goals and integrated into the subdivision's parks, open space and alternative transportation network. In addition to mitigation measures, future development should embrace best practices in an effort to support and enhance recreational values and create a high quality of life for area residents.

Best practices include the creation of diverse "stacked loop" trail networks, provision of urban recreation features (i.e., playgrounds, skating rinks), incorporation of "on trend" amenities such as natural playgrounds and community gardens, and conformance to best practices of sustainable and user-oriented trail design.

Adding new recreational trails helps mitigate overuse of existing trails and the associated negative impacts on user experience. It can also reduce incursions of motorized users into highly sensitive environmental areas located to the east of the NUCB. "Out and away" areas appropriate for motorized use will need to be identified and developed ahead of subdivision development in conjunction with decommissioning of undesirable routes. A public education campaign and increased bylaw enforcement presence will also need to be coordinated as development occurs. To the extent possible, the development of sustainable, well-designed trails should precede lot sales to avoid the creation of ad hoc trails that subsequently become maintenance and management liabilities for the City.

An early "win" would be a continuous Yukon River escarpment trail with various loops configured off of it to connect with residential areas. A proactive approach is also warranted where the orienteering area east of Long Lake is concerned, with the Yukon Orienteering Association actively consulted on decisions around the location and density of any new trails proposed in this area.

6.2 Making Sense of it All: Process "Next Steps"

With four phases of Whistle Bend remaining to be built out, any sense of immediacy around the decision to proceed or not with urban development in the NUCB may be muted. Nonetheless, the upcoming community discussions around the review of the City's Official Community Plan (OCP) necessitates a thoughtful consideration of how to frame and rationalize the City of Whitehorse's thinking in regards to the NUCB area and its eventual use.

The September 2016 workshop held with City staff and their KDFN, TKC, and YG counterparts failed to yield a strong consensus on whether or not residential development in the NUCB was in the best interests of residents and/or governments.

A general desire did emerge that perhaps the NUCB should be considered a "last resort" because of other values present rather than particular technical issues or cost considerations. It was suggested that the City and its partners may proactively want to consider pursuing development of other vacant and under-utilized lands first – primarily First Nation-owned lands located in closer proximity to already existing subdivisions. Furthermore, there was general agreement from those present that the City should remain committed to the vision of smart growth, higher densification, and sustainability articulated in the 2010 OCP and not default to the less sustainable practices (i.e., country residential) of the past.

As stated previously, it is ultimately Mayor and Council, drawing from the advice of City administration and public feedback during the upcoming OCP review who must weigh the complex and competing values at play in regards to prospective development in the NUCB. In addition to the planning principles and considerations highlighted in **Section 4.0** of this report, the City must not lose sight of the fact that the UCB concept in and of itself is a pro-active measure intended to check urban sprawl and achieve the broader objective of sustainable growth.

That the prospect of actually developing the constituent parts of the UCB, including the NUCB area itself, may conflict with site-specific values is to be expected. The key question moving forward is how the City (and its prospective partners) maintains a principled, coherent, and consistent approach to the question of development in Whitehorse.

6.3 Big Picture Decision-Making Considerations

To the end of establishing and maintaining a coherent approach to the development question, the team offers the following overarching considerations to the City as it approaches the upcoming OCP review and its determination of how to designate future land use in the NUCB:

- The creation of five Regional Parks in the 2010 OCP process effectively alienated 30% of the municipal land area from future residential development. In so doing ecological, heritage, intrinsic wilderness, and recreational values in these areas were given priority where they were understood to be most prevalent on a city-wide basis.
- Public expectations around protected areas tend to be high. Reversing a decision to preserve and protect green space is likely to encounter significantly more opposition than a decision to leave future options open if deemed to be in the public interest. Likewise, a decision to preserve an option for the future does not necessarily equate to a tacit decision to pursue it to the exclusion of other options that may satisfy the public interest to an equal or greater degree when the time for a decision arrives.

- Several recent City of Whitehorse-issued studies[20] pointed to a land shortage as a contributing factor to the significant escalation in housing prices that Whitehorse experienced from the mid-2000s to 2011 and recommended that the City exercise its jurisdiction to prevent future land and/or housing shortages and facilitate housing availability and affordability.
- With staking within municipal boundaries under moratorium, trail planning on the east side of the Yukon River complete and the Chadburn Lake Park Management Plan awaiting final approval, it is reasonable to assume that the NUCB area will remain more or less in its present state for the foreseeable future.
- Current residents may show a general disinclination towards the question of future growth and how to accommodate it. Both planners and public governments have to balance the interests of current residents with those who lack a voice – the residents of the future.
- Accommodating inevitable population growth in the capital region isn't solely the purview of the City of Whitehorse. The continued practice of country residential lot development outside City boundaries undermines sustainability as well as wildlife and habitat protection at a much larger scale.
- Sprawl still exists because the demand is still there but the cumulative effects of such continued accommodation of personal interests comes at an ever increasing environmental and financial cost to future generations.
- At this very preliminary level of investigation, there are many unknowns. The precautionary principle can be taken as a directive to further study and seek to understand complex issues so both public and decision maker(s) are well informed of the options available, associated trade-offs and consequences associated with the choices made.

Highlights

- The Yukon Bureau of Statistics population growth forecast expects Whitehorse to grow by 6,237 people between 2017 and 2030 requiring 2,835 housing units; and,
- Between Whistle Bend, infill redevelopment and modest increases in densification, the need to develop a new area can quite likely be postponed by 10-15 years.

6.4 Summary of Process Steps Going Forward

To move forward the following steps are recommended:

- Engage the Government of Yukon and First Nations in the greater Whitehorse area around the creation of a regional growth strategy that aligns with sustainability objectives;
- Review the results and recommendations of this study with partner governments.
- Assess the results and recommendations of the pre-feasibility studies for the Northeastern and Southern UCB studies with partner governments comparing and contrasting the merits of each against each other along with possible regional growth management strategy implications.

[20] The 2016 City of Whitehorse Resource Development Preparedness Strategy and 2016 Downtown Retail and Entertainment Strategy

- Consider reframing public input during the next OCP review around the question of *which* currently undeveloped areas within the UCB – all of which hold high ecological, recreational, or other values – may be most suitable for future development, versus *whether* one or both should be developed at all.
- Should the NUCB area be retained as a future residential development option by the City, work with government partners to identify the key conditions upon which a future determination to proceed would be based and address the information gaps outlined in **Section 6.1** accordingly.
- Continue and prioritize discussions with the Government of Yukon and First Nation governments around creating an action-oriented, collaborative approach to developing First Nation settlement lands within the City of Whitehorse for residential and commercial development.
- In consultation with First Nation governments, consider assigning priority to process-based actions and objectives designed to achieve the goal of First Nation settlement land development in the upcoming OCP review.

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8.0 TECHNICAL REPORT APPENDICES

The individual working draft background technical reports are available from the City of Whitehorse Planning Department. Components of those reports may differ from this report in terms of figure numbers; area estimates etc. and content edits. The salient features of these reports dealing with geotechnical matters, ecological considerations, recreation values and heritage considerations are summarized herein.

The civil engineering considerations were not written up as a separate report for several reasons. First key city-wide infrastructure reports were out-of-date. Second, the servicing concepts depend on having conceptual plan design options to evaluate. Preparing such concepts was not within the project scope and budget. Fourth, the findings of the other studies related to other values present and geotechnical considerations were needed to provide context for both conceptual plan preparation and servicing assessment.