GRIZZLY BEAR HABITAT MODELS REPORT

KUDZ ZE KAYAH PROJECT

June 2018

Prepared for:

BMC MINERALS (NO. 1) LTD.

DISTRIBUTION LIST

# of copies	Company/Agency name
1	BMC Minerals (No.1) Ltd.

ALEXCO ENVIRONMENTAL GROUP INC. SIGNATURES

Signature REDACTED

Report prepared by: ______________________ 6/5/2018

Lea Pigage, B.Sc. R.P.Bio., PMP
Senior Biologist

Signature REDACTED

Report prepared by: ______________________ 6/5/2018

Marie Ducharme
GIS and Environmental Data Manager

Signature REDACTED

Report reviewed by: ______________________ 6/5/2018

Jenifer Hill, M.Sc., R.P.Bio.
Senior Reviewer

Executive Summary

The Kudz Ze Kayah (KZK) Project is a proposed mine located in the Yukon Territory, approximately 260 km northwest of Watson Lake and 110 km southeast of Ross River, within the Yukon Plateau-North Ecoregion, part of the Canadian Boreal Cordillera Ecozone. Grizzly bears (*Ursus arctos*) inhabit the entire Project area and have been seen during the exploration field seasons.

Following the public comment period of the Project screening, YESAB issued a *Request for Supplemental Information: Information Request No.3* (YESAB, 2018). This report has been prepared in response to R3-9 and R3-10 regarding requests for identification and maps of seasonally important habitats, security and linkage zones. The scope and scale of the requested modelling were further discussed and confirmed with Yukon Government biologists.

To further assess Project effects on grizzly bears, three habitat models were developed to determine the amount of effective grizzly bear habitat in the Project area:

1. Habitat Effectiveness Model;
2. Security Areas Model; and
3. Linkage Zones Model.

These models, together are referred to as a grizzly bear cumulative effects model, and are based on methods developed by United States Department of Agriculture (USDA) Forest Service (1990) and refined by Purves and Doering (1998) and Gibeau et al., (1996).

The Habitat Effectiveness Model assesses habitat quality in relation to human activities to quantify the amount of effective, or usable, habitat in a given area. Overall, the habitat effectiveness for the entire Grizzly Bear Study Area (GBSA) is 96% for all seasons, once the Project is considered. The change in habitat effectiveness for Bear Assessment Unit 5 (BAU 5), where the Project lies, is predicted to be 3% for summer and fall but no change for spring. The change for the entire Grizzly Bear Study Area (GBSA) is is predicted to be 1% for spring and fall but no change for summer.

The Security Areas Model looks at the amount of secure habitat for grizzly bears; this is defined as the habitat available for female grizzly bears to forage in for 24 to 48 hours without getting disturbed by human activity. Within the GBSA, 83% of the study area is considered secure under current conditions and 82% is predicted to be secure with Project development. The majority of the habitat (15% both under baseline conditions and with development) that is not secure is currently unsuitable habitat (i.e. water, rock, and unvegetated areas). Human activity accounts for 2% of unsecure habitat under baseline conditions and 3% is predicted upon Project development.

The Linkage Zones Model identifies areas where bears can safely travel through a landscape affected by anthropogenic activity. When looking at baseline disturbance only, 72% of the entire GBSA is considered to have minimal danger and 27% is considered to have low danger. These percentages remain the same when the proposed KZK Project is considered. Throughout the entire GBSA, there are extensive areas that provide safe travel corridors through the smaller areas of human activity.

Table of Contents

1 INTRODUCTION ... 1

2 ENVIRONMENTAL SETTING ... 3

3 GRIZZLY BEAR HABITAT MODELS ... 5

3.1 STUDY AREA ... 5
3.2 HABITAT EFFECTIVENESS MODEL ... 8
3.2.1 Methods ... 8
3.2.2 Results ... 12
3.3 SECURITY AREAS MODEL ... 17
3.3.1 Methods ... 17
3.3.2 Results ... 18
3.4 LINKAGE ZONES MODEL ... 22
3.4.1 Methods ... 22
3.4.2 Access Route Density ... 22
3.4.3 Proximity to Human Activity ... 23
3.4.4 Presence or Lack of Hiding Cover ... 23
3.4.5 Proximity to Riparian Areas ... 24
3.4.6 Results ... 25

4 DISCUSSION AND CONCLUSION ... 29

5 LIMITATIONS ... 30

6 REFERENCES ... 31

LIST OF TABLES

Table 3-1: Important Grizzly Bear Habitat and Food Sources available in the GBSA 9
Table 3-2: Disturbance Coefficients and Zone of Influence Buffer for Disturbance Features 10
Table 3-3: Habitat Effectiveness for each Bear Assessment Unit 13
Table 3-4: Available Security Habitat with Baseline Disturbance 19
Table 3-5: Available Security Habitat with Baseline and Proposed Project Disturbance 19
Table 3-6: Linkage Zone Results for Baseline Disturbance 26
Table 3-7: Linkage Zone Results for Baseline Disturbance with the Proposed Project Development 26
Table 4-1: Combined Assessment of Habitat Effectiveness, Security Areas and Linkage Zones with Baseline and Proposed Project Disturbance 29

LIST OF FIGURES

Figure 1-1: Location of Kudz Ze Kayah Project Site 2
Figure 3-1: Grizzly Bear Study Area and Bear Assessment Units for Kudz Ze Kayah Project 7
Figure 3-2: Habitat Potential for Grizzly Bears in the GBSA – Spring 14
Figure 3-3: Habitat Potential for Grizzly Bears in the GBSA – Summer 15
Figure 3-4: Habitat Potential for Grizzly Bears in the GBSA – Fall 16
Figure 3-5: Security Areas Model for Baseline Disturbance 20
Figure 3-6: Security Areas Model for Baseline and Proposed Project Disturbance 21
Figure 3-7: Linkage Zones Model for Baseline Disturbance 27
Figure 3-8: Linkage Zones Model for Baseline and Proposed Project Disturbance 28

ACRONYMS

AEG .... Alexco Environmental Group Inc.
BAU .... Bear Assessment Unit
BMC .... BMC Minerals (No. 1) Ltd.
CD .... Cumulative disturbance coefficient
CEA .... Cumulative Effects Assessment
COSEWIC .... Committee on the Status of Endangered Wildlife in Canada
DC .... disturbance component
DEM .... Digital Elevation Model
ESRI .... Environmental Systems Research Institute
GBSA .... Grizzly Bear Study Area
GIS .... Geographic Information System
HE .... Habitat Effectiveness
km^2 .... square kilometres
KZK .... Kudz Ze Kayah
m .... metres
masl .... metres above sea level
NRCan .... Natural Resources Canada
NRN .... National Road Network
PEM .... Predictive Ecosystems Map
PH .... Potential Habitat
RSA .... Regional Study Area
RH .... Realized Habitat
sp. .... species
ZOI .... Zone of Influence
USDA .... United States Department of Agriculture
YESAB .... Yukon Environmental and Socio-economic Assessment Board

GLOSSARY

Bear Assessment Unit (BAU): The study area was delineated into seven bear assessment units to assess the model results. These BAUs are the approximate size of a female grizzly bear's average home range and, where possible, encompasses major drainage basins, including the subordinate drainages.

CanVec: digital cartographic reference product produced by Natural Resources Canada, originating from the latest available geospatial data sources covering Canadian Territory, containing topographic information in vector format complying with international geomatics standards.

Digital Elevation Map (DEM): a digital model or 3D representation of a terrain's surface.

Discontinuous Permafrost Zone: an environment where 30-80% of the ground surface is underlain by permafrost. The areas of discontinuous permafrost increases progressively in size and number from north to south.

Habitat Effectiveness: an analysis of baseline habitat and human activities to determine the actual ability to support grizzly bears.

Expert Opinion: a belief or judgement about a topic given by an expert on the subject.

Game Management Subzone (GMS): a legal boundary delineated by creeks and rivers that defines an area within which big game management objectives can be met through the setting of area specific regulations, and together form the larger Game Management Zones.

Geographic Information System (GIS): a computer system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data.

Grizzly Bear Study Area (GBSA): the study area used for the Grizzly Bear Habitat models which encompasses by Game Management Subzone 10-07 but extends beyond to the height of land to include entire valley systems which is more relevant to bear habitat use.

Linkage Zones: areas of potential movement for bears between larger areas of undisturbed habitat.

Potential Habitat (PH): the potential of an ecosystem unit to provide grizzly bear habitat based solely on the biophysical properties of that landscape.

Predictive Ecosystems Map (PEM): a modelled approach to ecosystem mapping, whereby existing knowledge of ecosystem attributes and relationships are used to predict ecosystem representation in the landscape.

Realized Habitat (RH): the potential of a ecosystem unit to provide grizzly bearhabitat once human disturbance is considred.

Security Areas: areas suitable for individual foraging bouts for adult female grizzlies based on ecological and human factors.

1 INTRODUCTION

The Kudz Ze Kayah (KZK) Project (the Project) is a proposed copper, lead, zinc, gold and silver project located in the northern Pelly Mountains, 110 km south of Ross River and 260 km northwest of Watson Lake in South Central Yukon (Figure 1-1).

Following the public comment period of the Project screening, YESAB issued a *Request for Supplemental Information: Information Request No.3* (YESAB, 2018). This report has been prepared in response to R3-9 and R3-10 regarding requests for identification and maps of seasonally important habitats, security and linkage zones. The scope and scale of the requested modelling were further discussed and confirmed with Yukon Government biologists. This modelling had not been requested during baseline program discussions with Yukon Government biologists nor during the adequacy stage of the review. The Project Proposal included an assessment of grizzly bear habitat loss and impacts on movement from the Project, which were determined not to be significant. There is little land development in the region that would be expected to limit grizzly bear movement, habitat security, or habitat effectiveness.

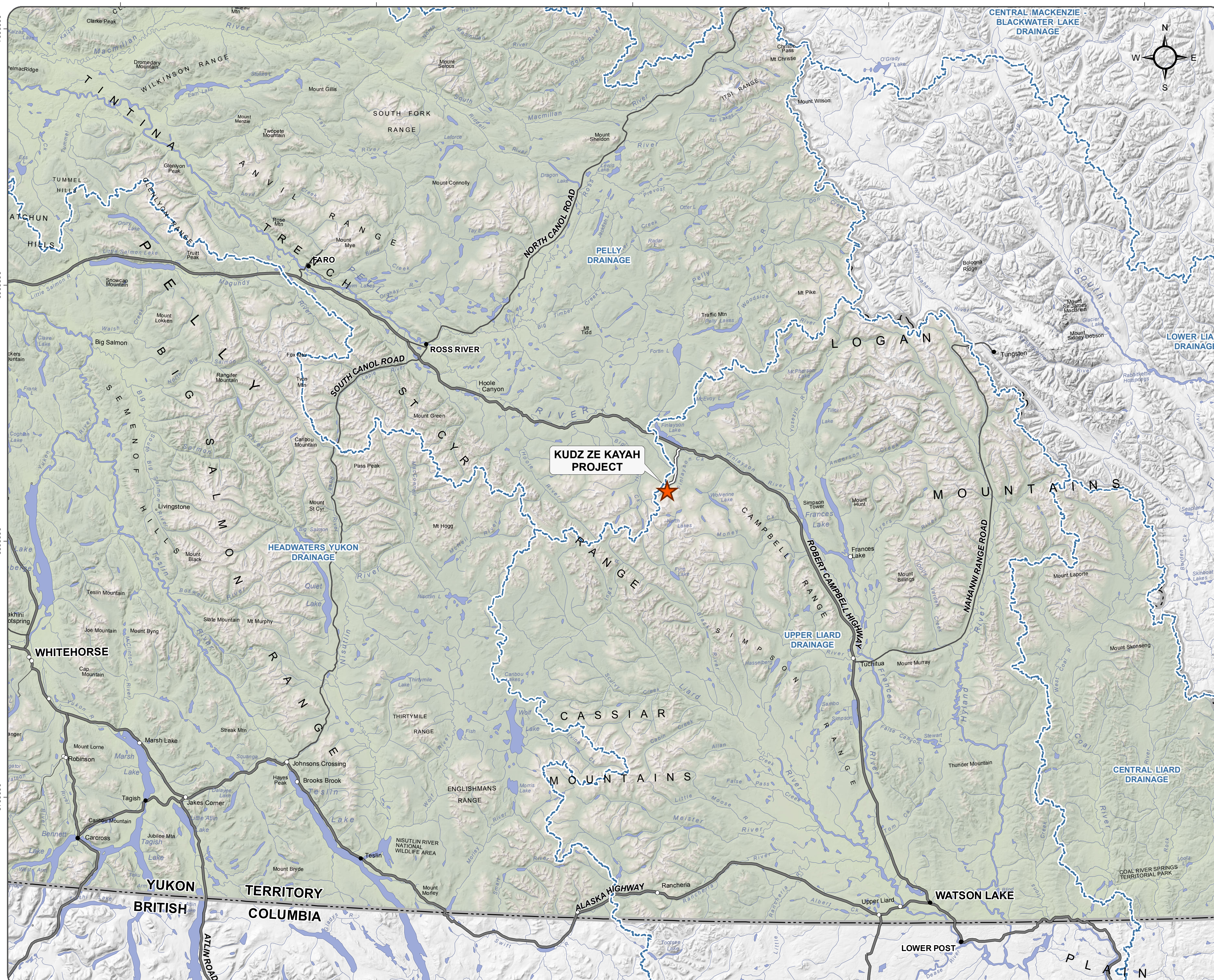
Grizzly bears (*Ursus arctos*) are a species valued for both their cultural, ecological and economic importance. Grizzly bears are listed by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Special Concern because they are highly sensitive to human disturbance; vulnerable to high mortality risk in areas of high human activity and areas with road access; and populations have declined in many parts of its range (COSEWIC, 2012).

In Yukon, grizzly bear populations are considered healthy; however, they are constantly threatened by human activities as they are not well adapted to habitat degradation (Yukon Environment, 2015).

To further assess Project effects on grizzly bears (as requested by YESAB), three habitat models were developed to determine the amount of effective grizzly bear habitat in the Project area:

1. Habitat Effectiveness Model;
2. Security Areas Model; and
3. Linkage Zones Model.

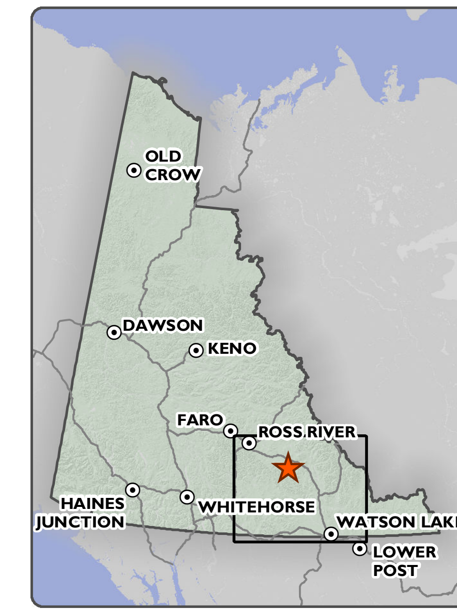
These models, together referred to as a grizzly bear cumulative effects model, are based on methods developed by United States Department of Agriculture (USDA) Forest Service (1990) and refined by Purves and Doering (1998) and Gibeau et al. (1996). The Habitat Effectiveness Model assesses habitat quality in relation to human activities to quantify the amount of effective, or usable, habitat for grizzly bear in a given area. The Security Areas Model looks at the amount of secure habitat grizzly bears, specifically female bears, have available to forage in for 24 to 48 hours without getting disturbed by human activity. The Linkage Zones Model identifies areas where bears can safely travel through a landscape affected by anthropogenic activity.



KUDZ ZE KAYAH PROJECT
GRIZZLY BEAR HABITAT MODELS REPORT

FIGURE 1-1
LOCATION OF KUDZ ZE KAYAH PROJECT SITE

MAY 2018



★ KUDZ ZE KAYAH PROJECT

Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

Canvec compiled by Natural Resources Canada at a scale of 1:10,000 - 1:50,000. Reproduced under license from Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources Canada. All rights reserved.
Drainage areas obtained from National Hydrology Network 2011

Datum: NAD 83; Projection UTM Zone 9N

This drawing has been prepared for the use of Alexco Environmental Group Inc.'s client and may not be used, reproduced or relied upon by third parties, except as agreed by Alexco Environmental Group Inc. and its client, as required by law or for use of governmental reviewing agencies. Alexco Environmental Group Inc. accepts no responsibility, and denies any liability

1:1,500,000 when printed on 11 x 17 inch paper

0 20 40 60 80
Kilometres

D:\Project\AllProjects\Kudz_Ze_Kayah\Maps\01_Overview\03-Intermeditate\Project_Overview_20180523.mxd
(*Last edited by: mducharme; 5/23/2018/15:28 PM*)

2 ENVIRONMENTAL SETTING

The Project is located in the northern foothills of the Pelly Mountains on the Yukon River Plateau near the divide between the Pelly and Liard River drainage systems. The Project is situated in a transitional climatic zone bordering on three different ecoregions: Yukon Plateau-North; Liard Basin to the east; and the higher elevation Pelly Mountains Ecoregion to the south (Yukon Ecoregions Working Group, 2004). The Tote Road is mainly within the Yukon Plateau-North Ecoregion. The proposed mine is just within the northern portion of the Pelly Mountains Ecoregion.

The proposed KZK Project lies within the subalpine and alpine zones, with surrounding topography of rolling hills and steep mountains. Near the proposed mine, a few small lakes and wetlands occupy the valley bottom and some larger lakes are located to the south and east. Elevations in the area range from approximately 1,300 metres above sea level (masl) in the valleys to about 1,900 masl on the peak located above Fault Creek, to the southwest of the proposed Project footprint.

Shrub and herb cover dominate the higher elevations and graduate to predominately boreal forest at lower elevations. Prevalent species at high elevations include scrub birch (*Betula glandulosa*), willows (*Salix sp*.) and various species of lichens and forbs with sub-alpine fir (*Abies lasiocarpa*), and open stands of white spruce (*Picea glauca*). At lower elevations, on gentle to moderate slopes, a mixed forest of white and black spruce (*Picea mariana*) is common. These are mature old forests, as there have been very few fires in the area. The shrub understory is well developed with feathermoss ground cover; in drier conditions lichens and grasses are more abundant.

The riparian systems within the area are of two basic types: slow flowing creek/fen complexes with associated wetlands, or faster flowing creeks confined to deep valleys with definitive floodplains, such as Finlayson Creek. The first type of riparian system contains organic substrates derived from sphagnum mosses and sedges. Acid tolerant plants such as Labrador tea (*Rhododendron groenlandicum*), bog blueberry (*Vaccinium uliginosum*), and cloudberry (*Rubus chamaemorus*) grow in amongst the moss hummocks. The second type of riparian system has a rocky substrate; sediment is composed mostly of gravel, cobbles, and boulders. The vegetation associated with this system are tall willows, balsam popular (*Populus balsamifera*), and white spruce on upper terraces.

Grizzly bears have large home ranges and are found in all habitat types. They den in alpine, subalpine and montaine areas from October to May, with males emerging first and females with cubs emerging later. After emergence, they use habitat that provides much needed forage opportunities including avalanche tracks, south-facing slopes, and forest openings such as meadows, wetlands and other riparian areas. Summer habitat often includes alpine and subalpine areas, riparian areas, open forests that have dense herb and shrub layers, including berry-producing shrubs. During the fall, habitats that have abundant berry crops, roots, insect larvae, grasses and sedges, and areas with ground squirrels and marmots are important. These include open forest with high berry production, riparian areas, and some alpine/subalpine areas (Hamilton, 1989; Riddell, 2005; Miller et al, 1982). The Project area has suitable habitat for all these seasonal uses.

3 GRIZZLY BEAR HABITAT MODELS

The grizzly bear cumulative effects assessment is a tool (separate from the cumulative effects assessment completed in the KZK Project Proposal (BMC, March 2017)) used to assess potential effects of land use activities and the effects of human actions on grizzly bears and their habitat (USDA, 1990; Gibeau, 1998). For the Project, the approach used followed the Geographic Information System (GIS) based application developed by Purves and Doering (1998) and Gibeau et al. (1996). In Yukon, this approach was used to assess the effects of human activities for Ketza River Mine (EBA, 2011), Casino Project (EDI, 2013) and Coffee Gold Mine (EDI, 2016); and this approach has been requested for the Project through communications with YG, including a meeting on May 3, 2018. Purves and Doering's (1998) application is based on models described by Gibeau et al. (1996) and includes three separate elements or model components:

1. Habitat Effectiveness – provides an analysis of existing habitat and human activities to determine the actual ability to support grizzly bears;

2. Security Areas – identifies areas suitable for individual foraging bouts for adult female grizzlies based on ecological and human factors; and,

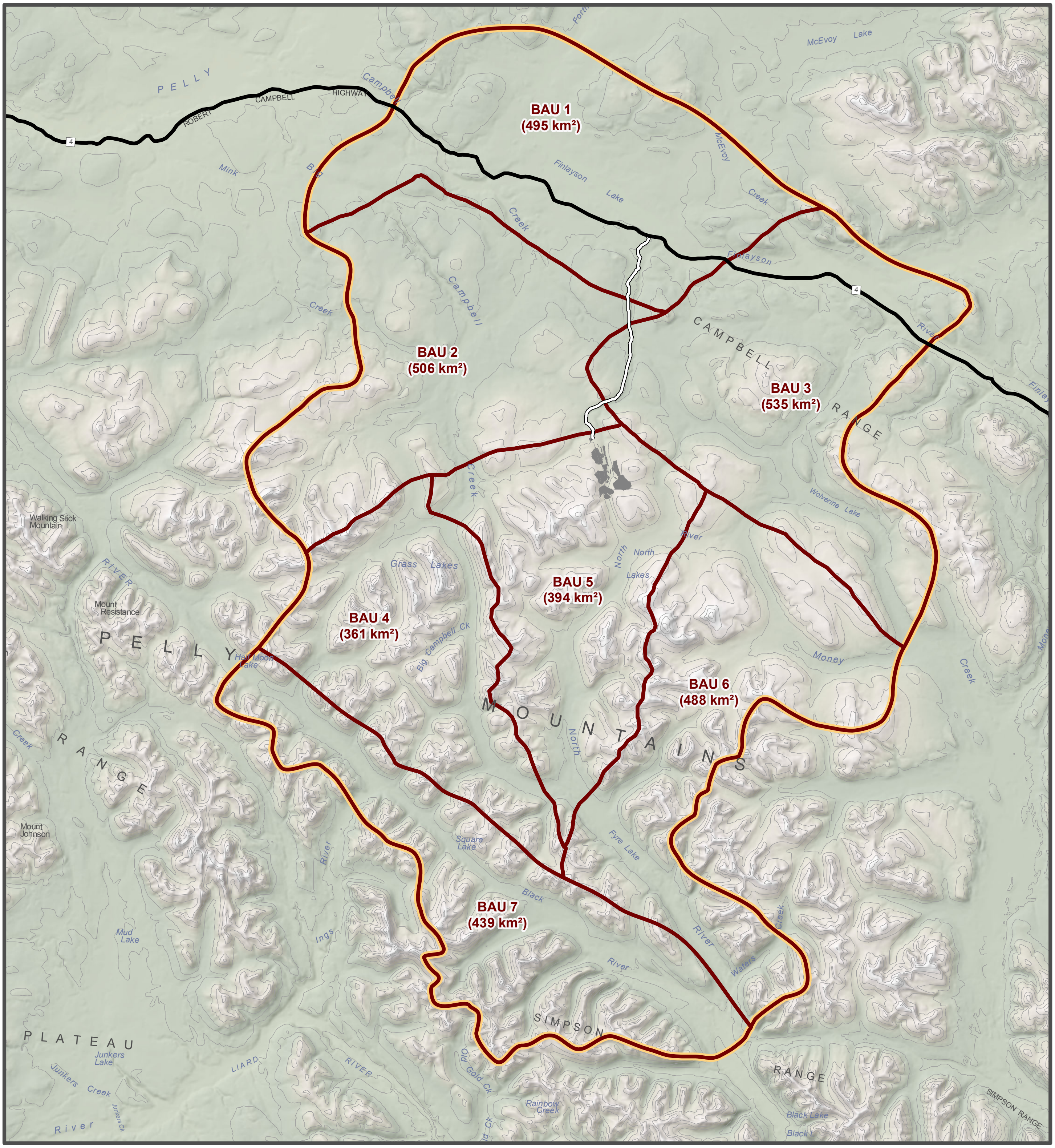
3. Linkage Zones – identifies areas of potential movement for bears between larger areas of undisturbed habitat.

Denning habitat was not assessed in this report since grizzly bear habitat denning analysis was previously completed for the KZK Project Proposal and was provided in the Kudz Ze Kayah Wildlife Baseline Report, Appendix E-8 of the Project Proposal (BMC, 2017).

3.1 STUDY AREA

A Grizzly Bear Study Area (GBSA) was delineated in consultation with Yukon Government biologists and used for the Habitat Effectiveness, Security Areas and Linkage Zone Models included in this report. This study area is based on the Wildlife Regional Study Area (RSA) used for the caribou and moose assessments for the Project which was expanded to capture grizzly bears natural habitat use patterns. The RSA was based on the boundaries for Game Management Subzone (GMS) 10-07. Game Management Zones, and corresponding Subzones, were originally delineated by the Yukon Fish and Wildlife Branch to monitor sheep harvest, thus the boundaries of GMSs typically lie along valley bottoms. Typically bears use habitat within an entire valley system, and although bears do cross over mountain tops, the heights of land often act as natural boundaries for grizzly bears (Boyce et al., 2016). The total area of the GBSA is 3,217 km^2.

The GBSA was divided into seven Bear Assessment Units (BAUs) which range in size from 361 to 535 km^2. Each BAU is the approximate size of a female grizzly bear's average home range and, where possible, encompasses major drainage basins, including the subordinate drainages. BAUs used in this assessment are equivalent to Bear Management Units (BMU) identified in Purves and Doering (1998) and Gibeau et al., (1996), and used in other Grizzly Bear Habitat Models completed for proposed mines in Yukon. In the Mackenzie Mountains, the average size of six female home ranges was 265 km^2 (Miller et al., 1982). Maraj (2007) found that in the Kluane area, the weighted average multi-annual female home range size was 305 km^2.



Grizzly Bear Assessment Unit (BAU)
Grizzly Bear Study Area (GBSA)
Location of Proposed Infrastructure
Robert Campbell Highway
Tote Road/Proposed Access Road

KUDZ ZE KAYAH PROJECT
GRIZZLY BEAR HABITAT MODELS REPORT

FIGURE 3-1

GRIZZLY BEAR STUDY AREA AND BEAR ASSESSMENT UNITS

MAY 2018

Datum: NAD 83; Projection: UTM Zone 9N

AEG

BMC MINERALS

D:\Project\AllProjects\Kudz_Ze_Kayah\Maps\03_Study\Wildlife\Bear\05-Habitat_Suitability\IR3\Figures\StudyArea\GMA_BAU_20180528.mxd

3.2 HABITAT EFFECTIVENESS MODEL

The Habitat Effectiveness (HE) Model relates habitat quality with human activities to determine the amount of effective habitat, which is an area's actual ability to support bears (Purves and Doering, 1998; Gibeau, 1998). The HE model has two inputs: 1) Habitat Component, which assesses the value of each habitat unit within an area and 2) Disturbance Component, which identifies, and rates human activity based on type of disturbance and frequency of use.

3.2.1 Methods

3.2.1.1 Habitat Component

The habitat component of the HE Model uses a qualitative and quantitative approach to assess the spatial and temporal distribution of grizzly bear food in the GBSA. Predictive Ecosystem Mapping (PEM) for the Regional Ecosystems of East-Central Yukon (Grods et al., 2013) was used to assess and rate grizzly bear habitat as Potential Habitat (PH). PH is the potential of an ecosystem unit to provide grizzly bear habitat based solely on the biophysical properties of that landscape. These biophysical properties determine food distribution. Each Broad Ecosystem Unit (BEU) within the GBSA was rated for its habitat value to grizzly bears by season including: spring (mid-March to May); summer (June to mid-August); and fall (mid-August to October). A score of one (1) was considered to be good quality habitat; a score of a half (0.5) was considered to have moderate value to bears; and a score of zero (0) was considered to have no value to bears during a particular season. A summary of important habitat and food sources for grizzly bears, by season, is provided in Table 3-1.

The PEM raster was reclassified for each season using ArcGIS Spatial Analyst tools, assigning a score of 1, 0.5, or 0. The output of the habitat component is the PH.

3.2.1.2 Disturbance Component

The disturbance component assesses human activity in the GBS. Human use features were assessed by activity type and intensity and assigned a disturbance coefficient. Disturbance coefficients are rated on a scale of zero (0) to one (1) based on how grizzly bears would respond to that activity type. A disturbance coefficient of zero implies total displacement and a disturbance coefficient of one implies no displacement (Purves and Doering, 1998). Disturbance types, disturbance coefficients, and zones of influence are provided in Table 3-2. Disturbance coefficients and zones of influence are taken from Purves and Doering (1998) and Gibeau (1998).

Table 3-1: Important Grizzly Bear Habitat and Food Sources available in the GBSA

Season	Important Food Sources	Important Habitat	References
Spring (mid-March to May)	• Overwintered berries • Horsetails, cow parsnip, grasses, roots • Hedysarum • Winter-killed carrion • Hoary marmots and artic ground squirrels • Moose calves (mid-May to mid-June) • Insects (ants, beetles, etc.)	• Snow-free south facing slopes • Avalanche chutes • Alpine and subalpine habitats • Riparian areas with good conditions for forbs and grasses • Winter feeding grounds for ungulates (willow dominated valleys, avalanche chutes)	Gibeau et al, 1996; Green et al., 1997; Hamilton, 1989; McCrory and Herrero, 1983; Miller et al., 1982; Nagy 1990; Riddell, 2005; Simpson, 1990.
Summer (June to mid-August)	• Succulent forbs, grasses, horsetails, sedges • Berries • Moose (mid-May to mid-June) and caribou calves (early June) • Hoary marmots and artic ground squirrels • Insects (ants, beetles, etc.)	• Alpine and subalpine habitats • Avalanche chutes • Fluvial land forms and alluvial fans, riparian areas • Meadows • Steep south-facing slopes with aspen and poplar • Open forests with dense shrub and herbaceous layers, particular those rich with berries • Early seral stage forest with closed canopy and high berry production • Low elevation riparian and wetland habitats	Ash, 1985; Ardea, 2004; Hamilton, 1989; Kansas and Riddell, 1995; Le Franc et al., 1987; Riddell, 2005; Waller and Macce 1997; Yukon Environment, 2015.
Fall (mid-August to October)	• Berries • Succulent forbs, roots, herbaceous plants, grasses and sedges • Hoary marmots and Arctic group squirrels • Insects (ants, beetles, etc.)	• Open forest with high berry production • Early seral stage, with closed canopy and with high berry production • Active floodplains, large burns • Alpine and subalpine habitats • Mid to crest slope position, warm slopes with herbaceous and shrub layers	Hamilton, 1989; Le Franc et al., 1987; Miller et al., 1982; Nietlfeld et al., 1985; Riddell, 2002; Riddell, 2005; Yukon Environment, 2015.

Human activity in the GBSA is limited. Areas of human activity were identified using Google Earth and/or ESRI World Imagery and local knowledge. Most activities are related to the KZK Project, the Wolverine mine, exploration activities at Fyre Lake, the Finlayson airstrip, highway pull-off and a few residences near Finlayson Lake. The baseline disturbances where digitized using satellite or aerial imagery. The footprint of the proposed Project was provided by BMC.

Proposed and baseline disturbances were compiled in separate layers so that their influence on habitat effectiveness could be evaluated separately. Both layers were buffered using the size associated to the zone of influence prescribed by the disturbance type. Each disturbance area was also assigned a disturbance coefficient (Table 3-2). Disturbance coefficients and zones of influence used in this model were based on data collected in the Rockies and used by Gibeau (1998). For motorized activities, a zone of influence (ZOI) of 800 m was applied. For non-motorized activities, a zone of influence of 400 m was applied. The resulting layers where then converted to 25 m rasters to calculate the cumulative disturbance in each BAU.

Table 3-2: Disturbance Coefficients and Zone of Influence Buffer for Disturbance Features

Disturbance Type	Disturbance Description	>100 Disturbance Events/Month	Disturbance Coefficient	Zone of Influence (m)
Access Road	KZK Tote Road	yes	0.16	800
Airstrip	Finlayson Airstrip	no	0.64	800
Clearing	Highway Roadside	no	0.83	400
Limited Use Road	Exploration Roads	no	0.64	800
Limited Use Road	Trails/Roads off the RC HWY	no	0.64	800
Limited Use Road	Wolverine Roads	yes	0.16	800
Local Road	Robert Campbell Highway	yes	0.16	800
Quartz Claim	Fyre Lake	no	0.16	800
Quartz Claim	KZK Camp	yes	0.16	800
Quartz Claim	KZK Exploration/Drill Pads	yes	0.16	800
Quartz Claim	KZK Exploration Areas	yes	0.16	800
Quartz Mining	Wolverine Mine	yes	0.16	800
Residence	Caretakers Residence	yes	0.16	800
Residence	Finlayson Lake Housing	no	0.16	800
Quartz Mining	KZK Mining (proposed)	yes	0.16	800
Quartz Mining	KZK Diversion Ditches (proposed)	no	0.83	400
Quartz Mining	KZK New Ponds (proposed)	no	0.83	400
Clearing	KZK Along Tote Road	no	0.83	400

The cumulative disturbance for a BAU is the product of all the individual overlapping disturbances and is calculated using the following equation (Purves and Doering, 1998):

$CD_p = DC_{pai} * DC_{paj} * DC_{pak} .... DC_{pax}$

Where:

CD_p = cumulative disturbance for the polygon (0.0 <= n <= 1.0)

$DC_{pai} … DC_{pax}$ = disturbance coefficient for each region in which the polygon exists (0.0 <=n<=1.0)

3.2.1.3 Realized Habitat

Potential habitat is combined with the disturbance coefficient to calculate the Realized Habitat (RH) for each polygon. Realized habitat assesses the ability of bears to use habitat within an area once human disturbance is considered. A RH rating of zero (0) is interpreted as having no value to bears and a rating of one (1) is interpreted as having the best possible habitat.

For every polygon, RH was calculated using the following equation (Purves and Doering, 1998):

$RH_p = PH_p * CD_p$

Where:

RH_p = realized habitat for the polygon (0.0 <= RH <= 1.0)

PH_p = potential habitat for the polygon (0.0 <= PH <= 1.0)

CD_p = cumulative disturbance coefficient for the polygon (0.0 <= n <= 1.0)

3.2.1.4 Habitat Effectiveness

Habitat effectiveness is the comparison between the potential habitat and the realized habitat value of an area, once disturbance has been accounted for and reflects an area’s actual ability to support grizzly bears (Gibeau, 1998). Comparison of the habitat and disturbance components produces a table of HE values for each BAU that represent the percentage of habitat for that area by season (Gibeau, 1998). These numeric values are interpreted simply as the percentage of habitat left after accounting for human disturbances (Gibeau, 1998). HE for each BAU is calculated using the following equation:

$$HE_{bmu} = \left[\sum_{p=1}^{Np} \left(RH_p * area_p \right) / \sum_{p=1}^{Np} area_p \right] / \left[\sum_{p=1}^{Np} \left(PH_p * area_p \right) / \sum_{p=1}^{Np} area_p \right]$$

Where:

HE_{bau} = habitat effectiveness for the bear assessment unit (0.0 <= n <= 1.0)

RH_p = realized habitat for the polygon (0.0 <= n <= 1.0)

PH_p = potential habitat for the polygon (0.0 <= n <= 1.0)

$area_p$ = area of the polygon

PH and RH values, as well as HE, are totalled using an area-weighted average for each BAU.

3.2.2 Results

The habitat effectiveness analysis provides a measure of habitat potential for grizzly bears when disturbance is considered and quantifies the extent of the landscape available to bears (Gibeau 1998). Table 3-3: provides a summary of the Habitat Effectiveness Model results for each BAU in the study area by season. Figure 3-2, Figure 3-3 and Figure 3-4 show the PH for spring, summer and fall, respectively, with: 1) baseline disturbance, and 2) baseline disturbance with the proposed Project development.

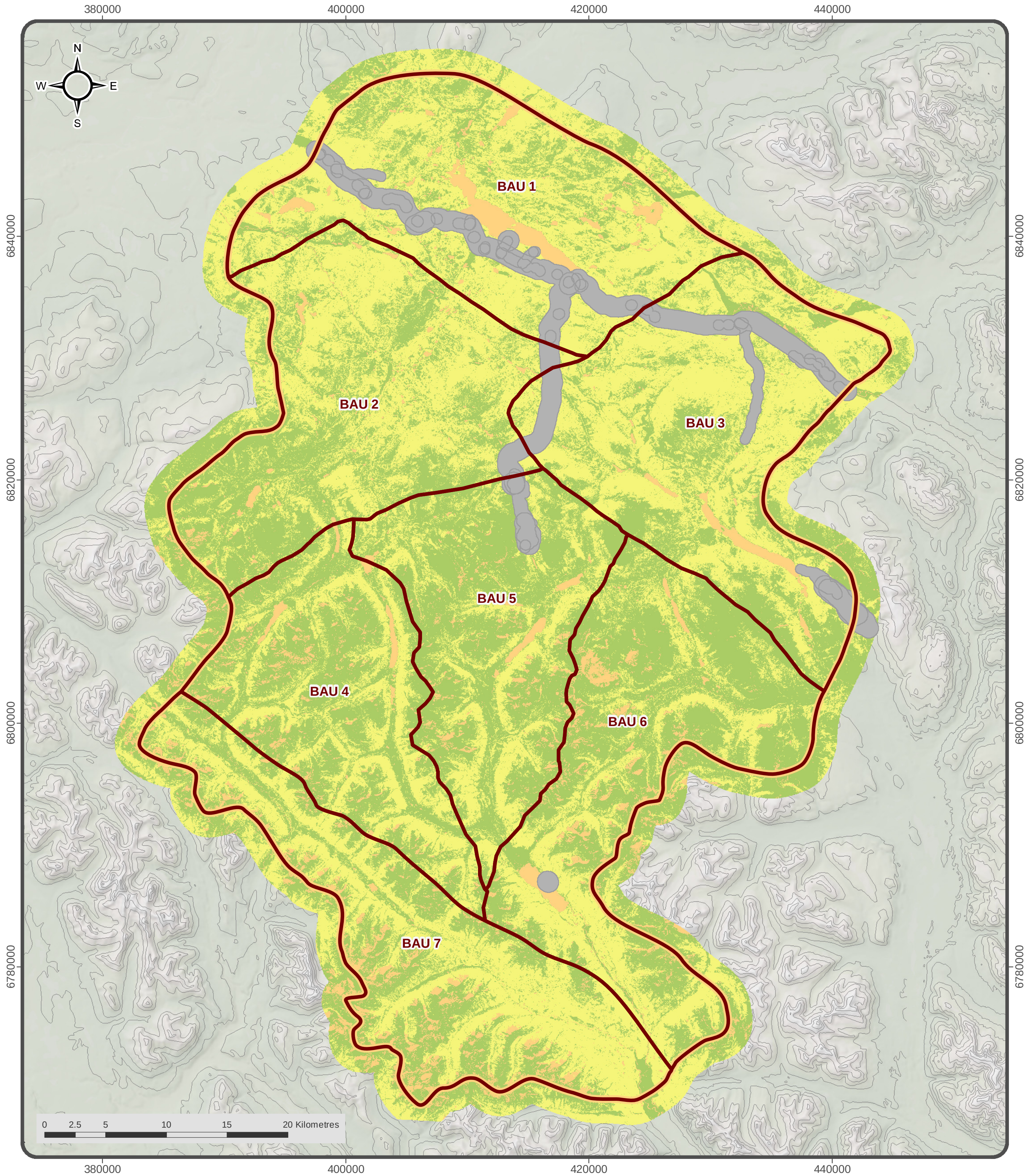
Overall, the habitat effectiveness for the entire GBSA is 96% for all seasons, once the proposed Project is considered. The change in habitat effectiveness for BAU 5, where the Project lies, is 3% for summer and fall but no change for spring. The change for the entire GBSA is 1% for spring and fall but no change for summer.

While high potential habitat is present in all BAUs, BAUs 2, 4, 5 and 6 have a larger percentage of the area with high habitat potential. When just baseline disturbance is considered, these BAUs have between 98 and 100% habitat effectiveness. With both baseline disturbance and the proposed Project, these areas are predicted to have between 95 and 100% habitat effectiveness. Areas with high habitat value are shown in Figure 3-2 to Figure 3-4.

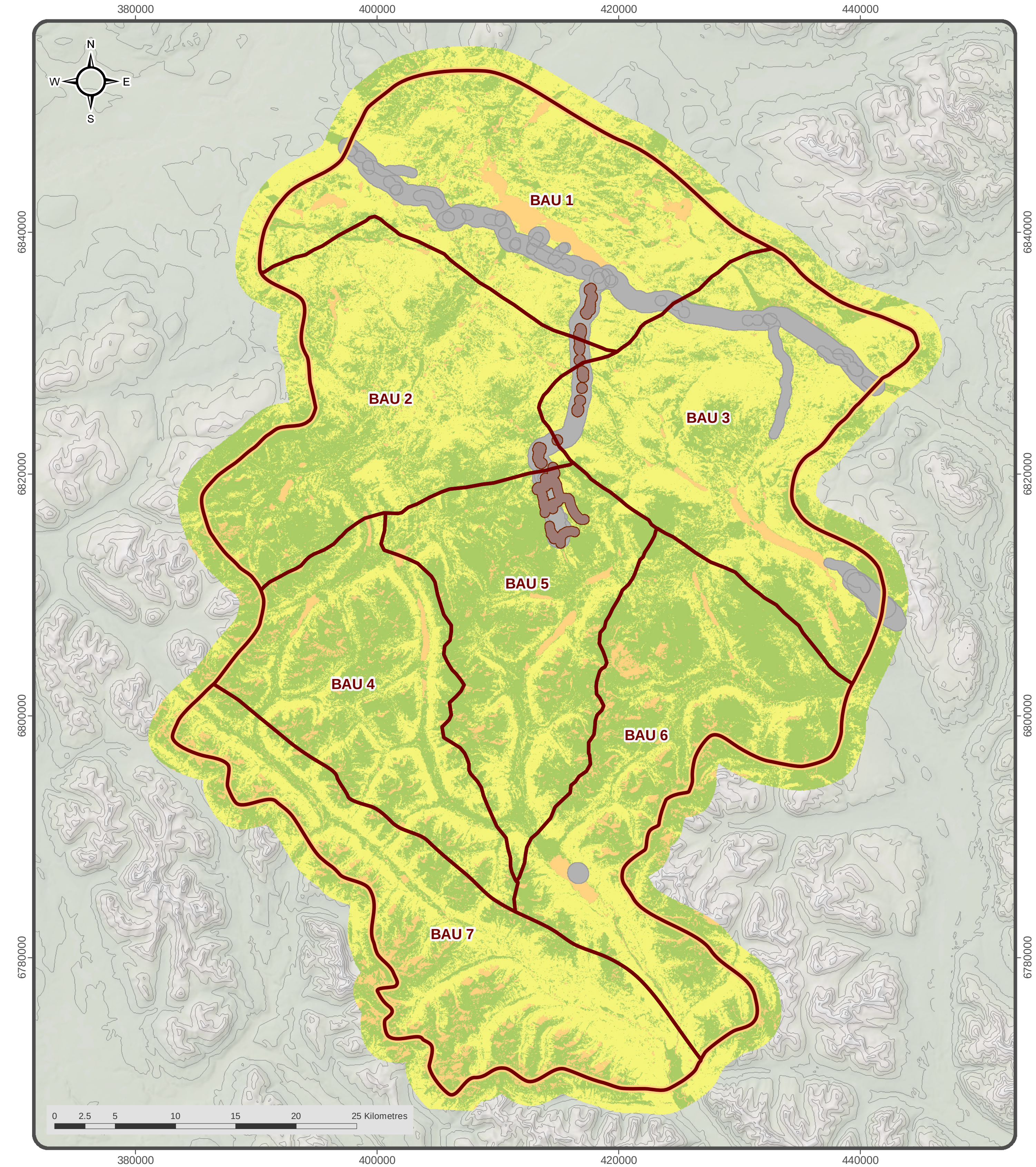
Table 3-3: Habitat Effectiveness for each Bear Assessment Unit

Bear Assessment Unit	BAU Total Size (km^2)	Season	Baseline Habitat Effectiveness (%)	Baseline Habitat Effectiveness with the Proposed Project Development (%)
1	495	Spring	89	89
		Summer	89	89
		Fall	90	90
2	506	Spring	98	98
		Summer	98	98
		Fall	98	98
3	535	Spring	91	91
		Summer	91	91
		Fall	91	91
4	361	Spring	100	100
		Summer	100	100
		Fall	100	100
5	394	Spring	98	98
		Summer	98	95
		Fall	98	95
6	488	Spring	100	100
		Summer	100	100
		Fall	100	100
7	439	Spring	100	100
		Summer	100	100
		Fall	100	100
Total	3,217	Spring	97	96
		Summer	96	96
		Fall	97	96

HABITAT POTENTIAL WITH BASELINE DISTURBANCES



HABITAT POTENTIAL WITH BASELINE AND PROPOSED DISTURBANCES



Datum: NAD 83; Map Projection: UTM Zone 9N

AEG

- Grizzly Bear Assessment Unit (BAU)
- Grizzly Bear Study Area (GBSA)
- Baseline Disturbance (Buffered according to ZOI)
- Proposed Disturbance (Buffered according to ZOI)

Habitat Potential

- Low Potential (196 km²)
- Moderate Potential (1,533 km²)
- High Potential (1,489 km²)

BMC MINERALS

KUDZ ZE KAYAH PROJECT
GRIZZLY BEAR HABITAT MODELS REPORT

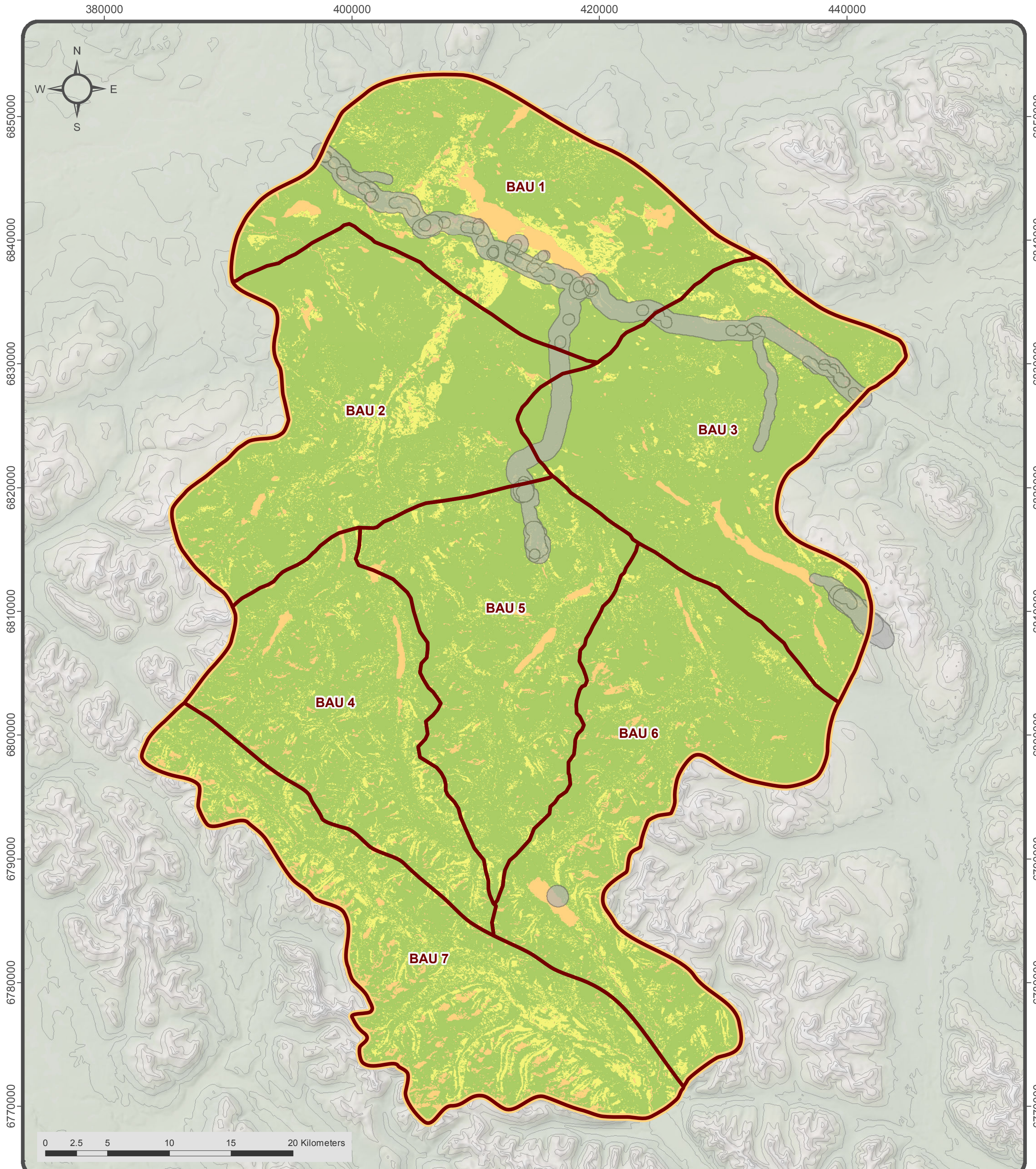
FIGURE 3-2

HABITAT POTENTIAL FOR GRIZZLY BEARS IN THE GBSA: SPRING

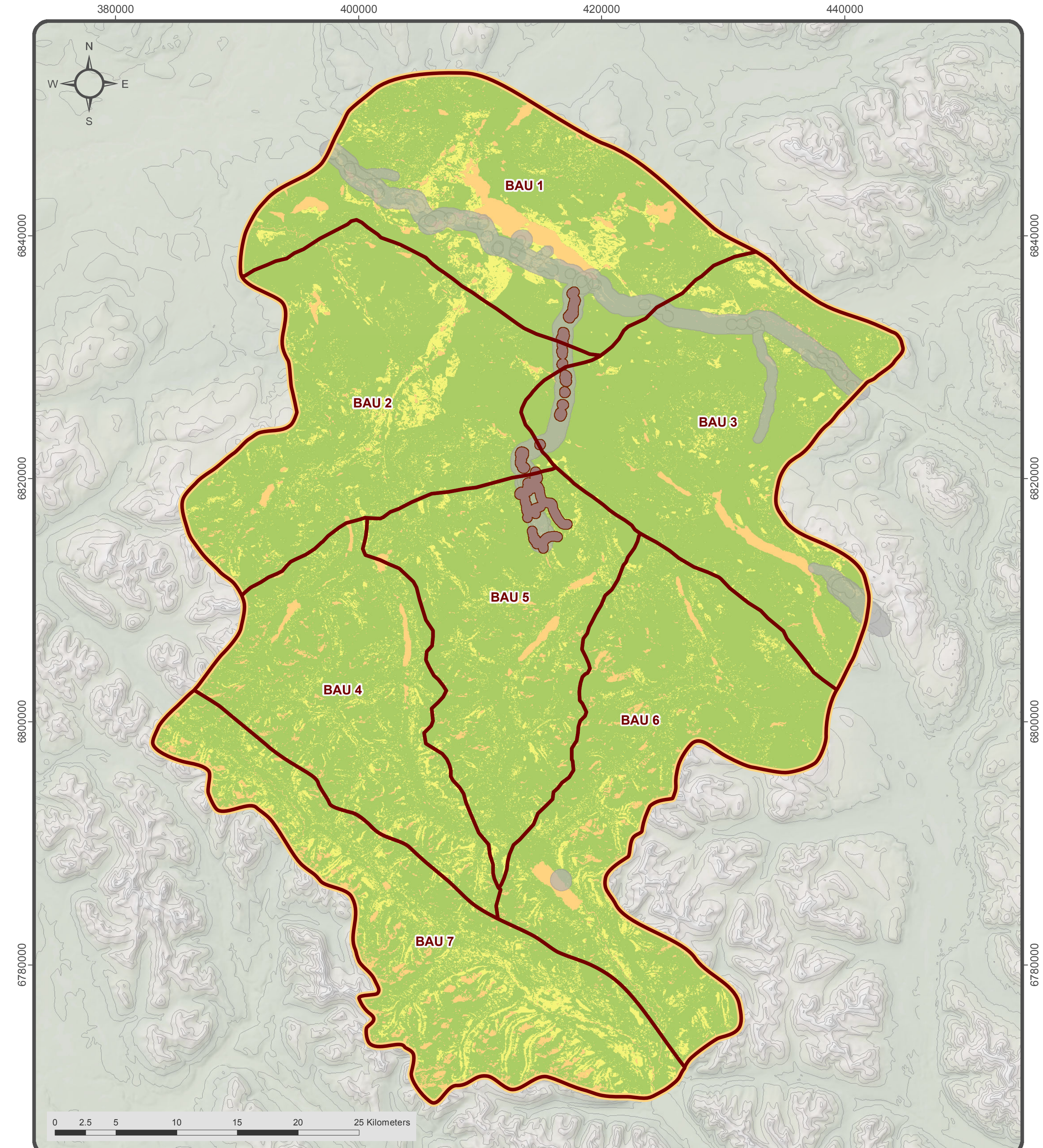
JUNE 2018

D:\Project\AllProjects\Kudz_Ze_Kayah\Maps\03_Study\Wildlife\Bear\05-Habitat_Suitability\IR3\Figures\Effectiveness\Potential_Spring_20180612.mxd

HABITAT POTENTIAL WITH BASELINE DISTURBANCES



HABITAT POTENTIAL WITH BASELINE AND PROPOSED DISTURBANCES



Datum: NAD 83; Map Projection: UTM Zone 9N

AEG

- Grizzly Bear Assessment Unit (BAU)
- Grizzly Bear Study Area (GBSA)
- Baseline Disturbance (Buffered according to ZOI)
- Proposed Disturbance (Buffered according to ZOI)

Habitat Potential

- Low Potential (155 km²)
- Moderate Potential (391 km²)
- High Potential (2,672 km²)

BMC MINERALS

KUDZ ZE KAYAH PROJECT
GRIZZLY BEAR HABITAT MODELS REPORT

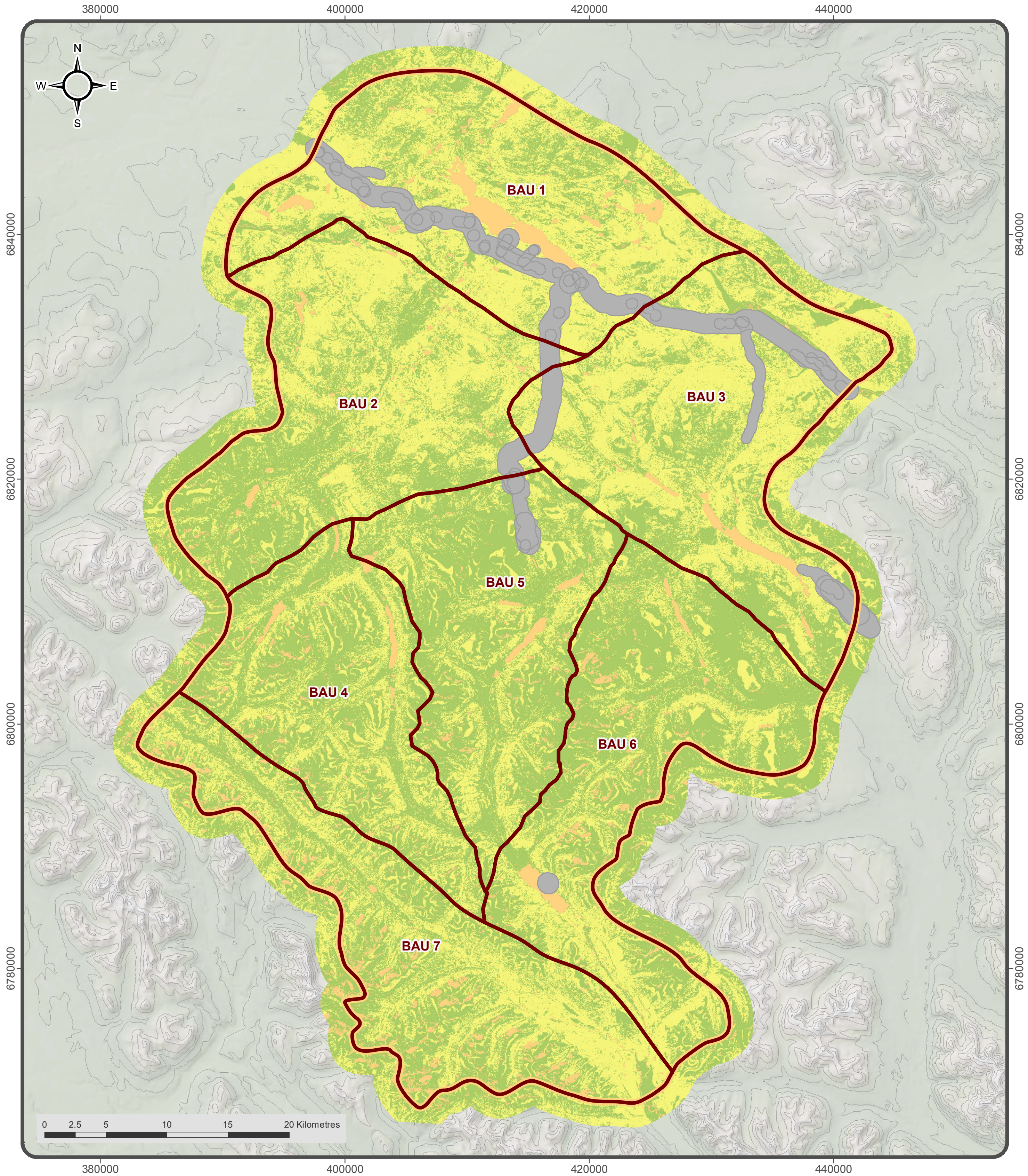
FIGURE 3-3

HABITAT POTENTIAL FOR GRIZZLY BEARS IN THE GBSA: SUMMER

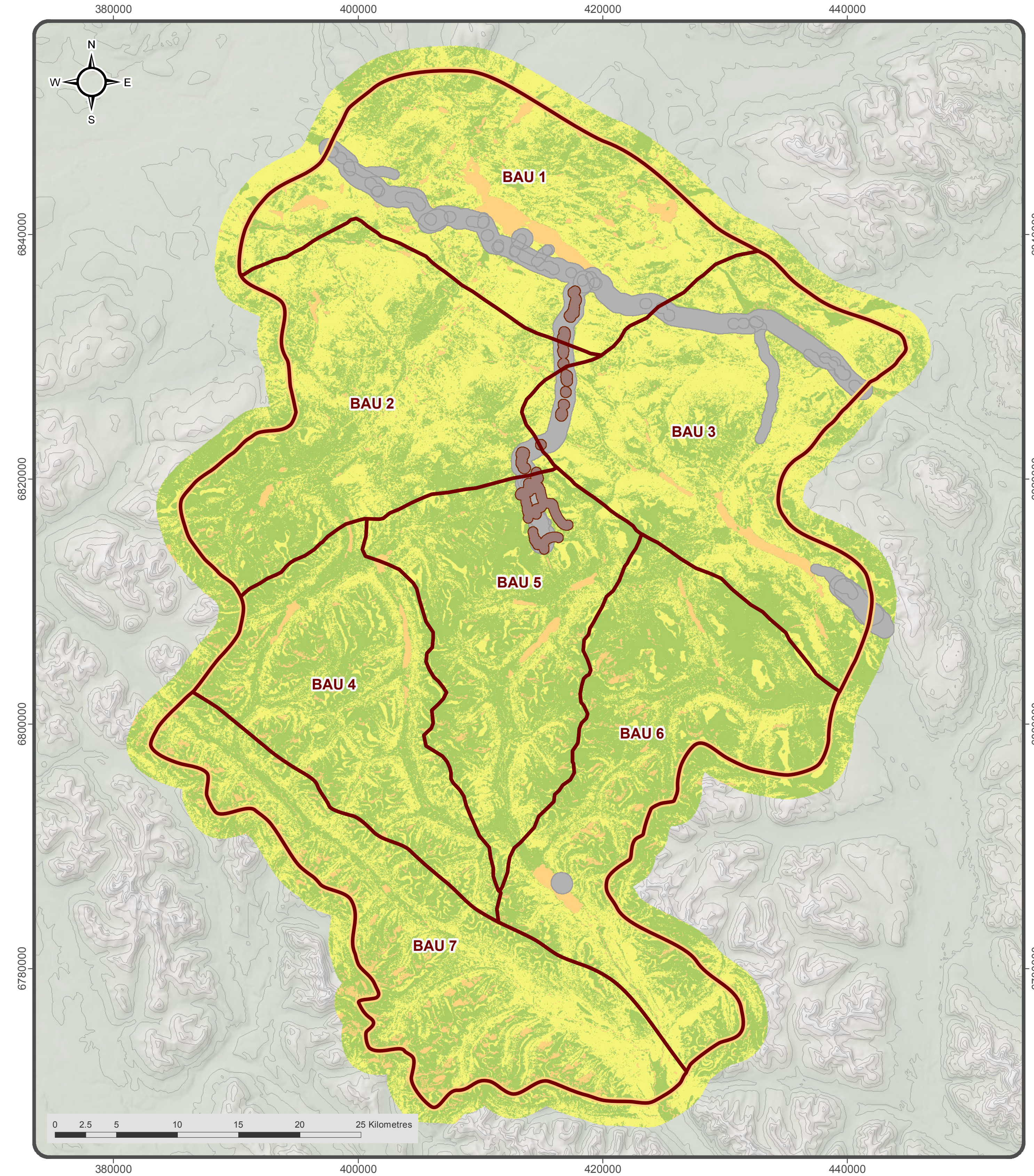
MAY 2018

D:\Project\AllProjects\Kudz_Ze_Kayah\Maps\03_Study\Wildlife\Bear\05-Habitat_Suitability\IR3\Figures\Effectiveness\Potential_Summer_20180523.mxd

HABITAT POTENTIAL WITH BASELINE DISTURBANCES



HABITAT POTENTIAL WITH BASELINE AND PROPOSED DISTURBANCES



Datum: NAD 83; Map Projection: UTM Zone 9N

AEG

- Grizzly Bear Assessment Unit (BAU)
- Grizzly Bear Study Area (GBSA)
- Baseline Disturbance (Buffered according to ZOI)
- Proposed Disturbance (Buffered according to ZOI)

Habitat Potential

- Low Potential (155 km²)
- Moderate Potential (1,455 km²)
- High Potential (1,608 km²)

BMC MINERALS

KUDZ ZE KAYAH PROJECT
GRIZZLY BEAR HABITAT MODELS REPORT

FIGURE 3-4

HABITAT POTENTIAL FOR GRIZZLY BEARS IN THE GBSA: FALL

JUNE 2018

D:\Project\AllProjects\Kudz_Ze_Kayah\Maps\03_Study\Wildlife\Bear\05-Habitat_Suitability\IR3\Figures\Effectiveness\Potential_Fall_20180612.mxd

3.3 SECURITY AREAS MODEL

Grizzly bears are known to use areas longer if they are secure from human disturbance. The habitat effectiveness model does not address the need for habitat security which allows bears to maintain their wary behaviour around humans (Purves and Doering, 1998). To address this, the Security Areas Model was developed to identify areas where a female grizzly can forage for 24 to 48 hours without being disturbed by human activity (Purves and Doering, 1998). Security areas models are run in conjunction with HE models because 1) the HE Model does not account for habitat security, and 2) the HE Model does not address the area between the areas of human activity that are considered too small to provide security for bear (Gibeau et al., 2001). Based on Purves and Doering (1998), secure areas include areas that are:

- Below 1,650 masl elevation (i.e. below alpine) and vegetated;
- Greater than 500 m from human activity, where disturbances occur more than 100 times per month; and
- Contiguous areas greater than 9 km² in size.

3.3.1 Methods

The Security Areas Model follows the methods outline in Purves and Doering (1998) and Gibeau et al. (2001). Three data sets were used to run the security areas model:

Elevation — A digital elevation model (DEM) obtained from Geomatics Yukon, resampled to 25 m to match with the Predictive Ecosystem Mapping (PEM) data , was used for elevation data;

Vegetation cover — The Predictive Ecosystem Mapping (PEM) data from Regional Ecosystems of East-Central Yukon (Grods et al., 2013) was used for vegetation cover; and

Disturbance layers — Human activity areas were delineated as described in Section 3.2.1 (Habitat Effectiveness Model Methods). Only disturbances estimated to occur greater than 100 times per month were included in this model. Trapping and hunting are also activities expected in the area but would likely occur less than 100 times per month so were not included.

To calculate the amount of secure habitat in the GBSA and within each BAU, the following areas were removed:

- Areas >1,650 masl in elevation, which is the subalpine/alpine transition elevation (Grods et al., 2013);
- Unsuitable habitat, which included non-vegetated units (rock, ice, cloud, shadow, exposed land, water);
- Areas within 500 m of human activity where human activity would be greater than 100 disturbance events per month; and
- Areas smaller than 9 km².

All remaining areas were considered to be secure.

3.3.2 Results

The Security Areas Model was run for the baseline disturbance and baseline disturbance with the proposed Project disturbance. A summary of the two models is provided in Table 3-4 and Table 3-5, respectively. Figure 3-5 shows the amount of habitat that is secure and not secure with the baseline disturbance and Figure 3-6 shows the secure and not secure areas with both the baseline disturbance and proposed KZK Project.

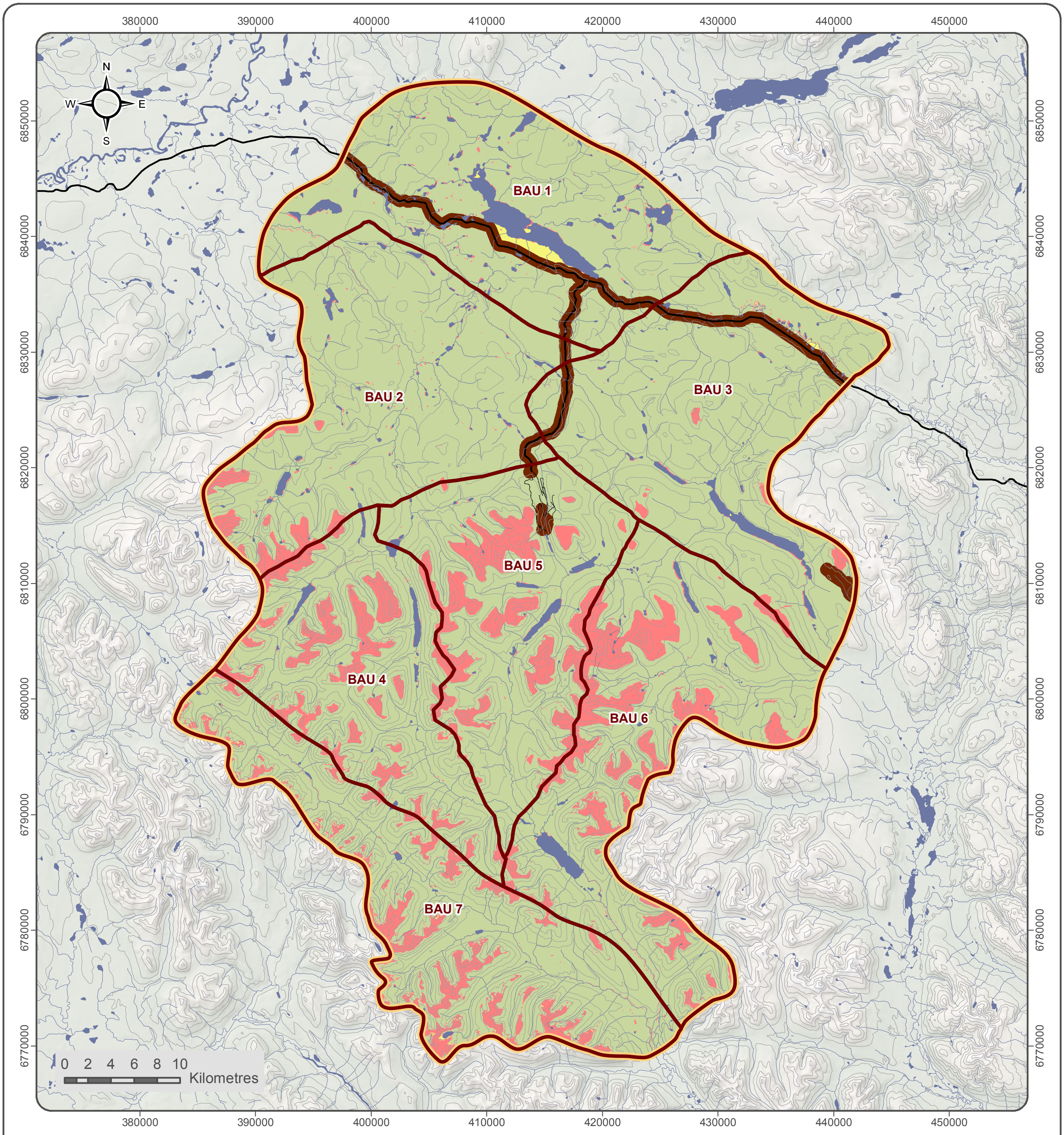
Within the 3,129 km² study area, 2,657 km² (or 83%) of the study area is considered secure in baseline conditions and 2,642 km² (82%) is predicted to be secure with the proposed Project included. The majority of the habitat (15% both under baseline conditions and with the Project) that is not secure is unsuitable habitat such as water, rock, and unvegetated areas. Human activity accounts for 2% of unsecure habitat in baseline conditions and 3% with the proposed Project.

Table 3-4: Available Security Habitat with Baseline Disturbance

Bear Assessment Unit		SECURITY CLASS							
		Secure		Not Secure due to Human Activity		Not Secure due to Size (<9 km²)		Unsuitable Habitat	
BAU	**Size (km²)**	**Area (km²)**	**% of BAU**	**Area (km²)**	**% of BAU**	**Area (km²)**	**% of BAU**	**Area (km²)**	**% of BAU**
1	495	414	84%	38	8%	5.5	1%	37	7%
2	507	467	92%	6	1%	0.03	0%	34	7%
3	535	481	90%	31	6%	0.7	0%	22	4%
4	361	279	77%	0	0%	0.2	0%	82	23%
5	394	295	75%	5	1%	0.1	0%	94	24%
6	488	367	75%	0	0%	0.2	0%	121	25%
7	439	354	81%	0	0%	1.2	0%	84	19%
Total	3,219	2,656	83%	80	2%	8.0	0%	475	15%

Table 3-5: Available Security Habitat with Baseline and Proposed Project Disturbance

Bear Assessment Unit		SECURITY CLASS							
		Secure		Not Secure due to Human Activity (km²)		Not Secure due to Size (<9 km²)		Unsuitable Habitat	
BAU	**Size (km²)**	**Area (km²)**	**% of BAU**	**Area (km²)**	**% of BAU**	**Area (km²)**	**% of BAU**	**Area (km²)**	**% of BAU**
1	495	414	84%	39	8%	5.5	1%	37	7%
2	507	466	92%	6	1%	0.03	0%	34	7%
3	535	480	90%	32	6%	0.7	0%	22	4%
4	361	279	77%	0	0%	0.2	0%	82	23%
5	394	281	71%	19	5%	0.1	0%	94	24%
6	488	367	75%	0	0%	0.2	0%	121	25%
7	439	354	81%	0	0%	1.2	0%	84	19%
Total	3,219	2,642	82%	95	3%	8.0	0%	474	15%



- Grizzly Bear Assessment Unit (BAU)
- Grizzly Bear Study Area (GBSA)
- Secure (2,656 km²)
- Suitable but Smaller than 9 km² (8 km²)
- Unsuitable (475 km²)
- Baseline Disturbances (80 km²)

KUDZ ZE KAYAH PROJECT
GRIZZLY BEAR HABITAT MODELS REPORT

FIGURE 3-5

GRIZZLY BEAR SECURITY AREAS FOR BASELINE DISTURBANCES

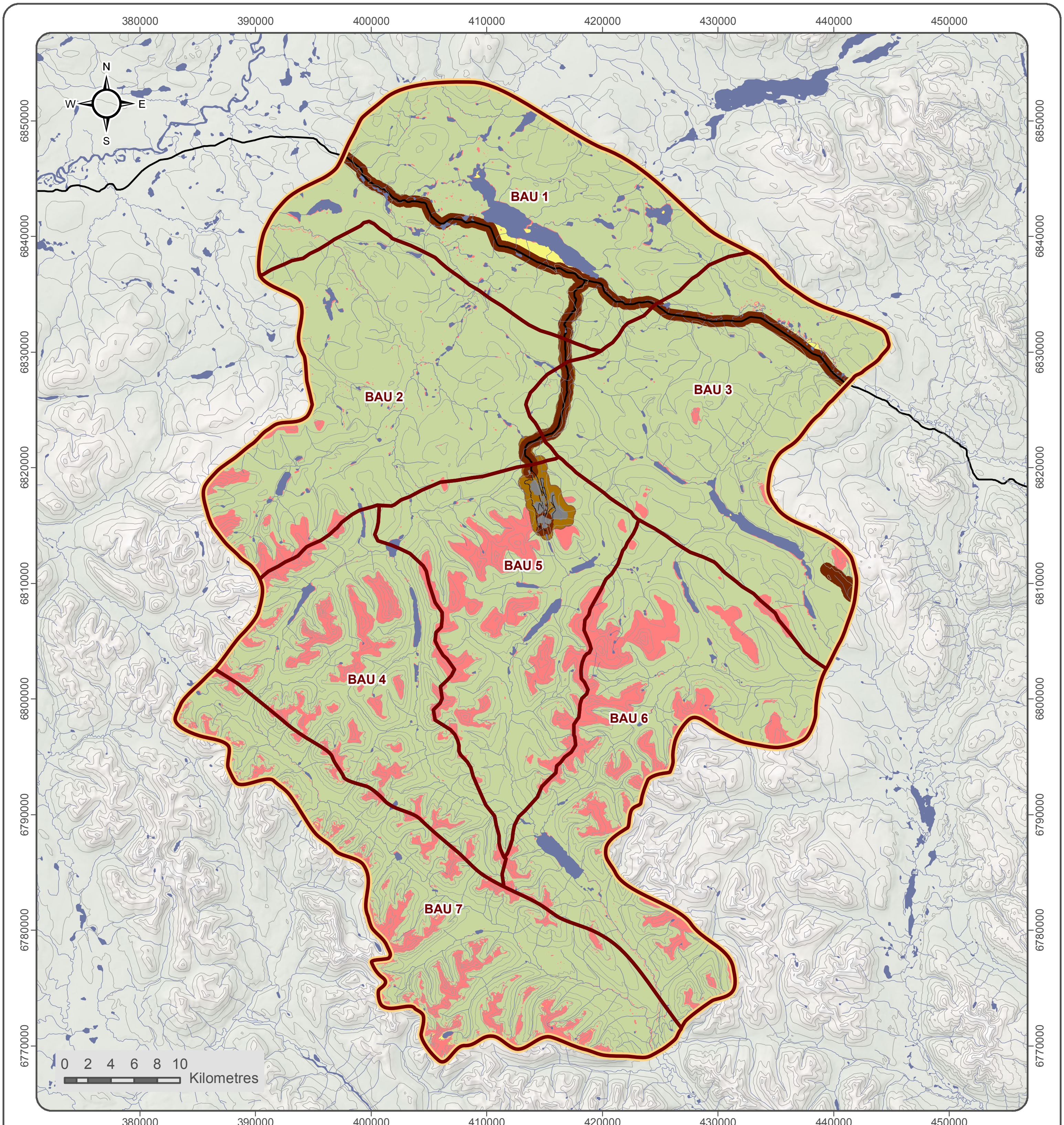
MAY 2018

Datum: NAD 83; Projection: UTM Zone 9N

AEG

BMC MINERALS

D:\Project\AllProjects\Kudz_Ze_Kayah\Maps\03_Study\Wildlife\Bear\05-Habitat_Suitability\IR3\Figures\Security\SecurityModel_Existing_20180523.mxd



Grizzly Bear Assessment Unit (BAU)
Grizzly Bear Study Area (GBSA)
Location of Proposed Infrastructure
Secure (2,642 km²)
Suitable but Smaller than 9 km² (8 km²)
Unsuitable (474 km²)
Proposed Disturbances (15.5 km²)
Baseline Disturbances (80 km²)

KUDZ ZE KAYAH PROJECT
GRIZZLY BEAR HABITAT MODELS REPORT

FIGURE 3-6
GRIZZLY BEAR SECURITY AREAS FOR BASELINE AND PROPOSED PROJECT DISTURBANCES

MAY 2018

Datum: NAD 83; Projection: UTM Zone 9N

AEG

BMC MINERALS

D:\Project\AllProjects\Kudz_Ze_Kayah\Maps\03_Study\Wildlife\Bear\05-Habitat_Suitability\IR3\Figures\Security\SecurityModel_Proposed_20180523.mxd

3.4 LINKAGE ZONES MODEL

Linkage zones are areas where wildlife can travel around anthropogenic disturbance (Purves and Doering, 1998). Linkage zones provide foraging habitat, connectivity between home ranges and avenues of dispersal (Riddell, 2005). They are important for maintaining genetic diversity in fragmented landscapes (Riddell, 2005; Ruediger, 2000). In areas with human activity, grizzly bears usually stay close to hiding cover (i.e. shrubs and thicker forest) during daylight hours (Blanchard, 1978; Schallenberger and Jonkel, 1980; Aune and Kasworm, 1989). However, in areas with little human activity, they seem unaffected by cover conditions (McLellan and Mace, 1985; McLellan and Shackleton, 1989; and McLellan, 1990 in Servheen, 2001).

The Linkage Zones Model assesses the availability of movement corridors in valley bottom settings by identifying and quantifying areas of potential carnivore crossing and use in mountainous environments. The output of this model is a scored map with four danger score classes (high, moderate, low and minimal) resulting from human influence. The areas with a low or minimal danger score are potential movement areas, or linkage zones, for bears and other wildlife.

3.4.1 Methods

The Linkage Zones Model for the Project followed the methods used in Purves and Doering (1998). The data layers used in this model are:

- Access route density;
- Proximity to human activity;
- Presence or lack of hiding cover; and
- Proximity to riparian areas.

The sum of the four layers provides a combined danger score; areas with high danger scores have greater levels of human activity and are therefore more dangerous to grizzly bears.

3.4.2 Access Route Density

For access route density, several data sources were used to depict access features. The main source was the National road network (NRN) provided by Natural Resources Canada as part of the CanVec dataset, at a scale of 1:50,000. The NRN can include omissions and roads that are no longer in use; therefore, the road network layer was compared to both Google Earth and ESRI World Imagery. Secondary roads and trails included in the GBSA were compared to the imagery and removed from the analysis, if no longer in use. Any features not part of the NRN, such as access routes to mines, residences and secondary roads branching off from the Robert Campbell highway were digitized and added to the dataset.

Features were merged into one file. A spatial analysis was then performed to obtain a density of access in units of km/km² using ArcGIS Spatial Analyst Tool: *Density*, which calculates a magnitude-per-unit area from a polyline feature that falls within a chosen radius. The radius was set to 900 m to approximate 2.56 km² as outlined in Purves and Doering (1998). The final step was to give the output density raster a score per the following criteria using the scoring by Purves and Doering (1998) and Gibeau et al (1996):

0 km/km²	Score of 2
0 - 0.625 km/km²	Score of 3
0.625 - 1.250 km/km²	Score of 4
>1.250 km/km²	Score of 5

3.4.3 Proximity to Human Activity

Baseline and human disturbances in the GBSA were identified using Google Earth and/or ESRI World Imagery and local knowledge. These disturbances were then delineated (where required) and categorized by intensity (<100 disturbance events/month or >100 disturbance events/month). Disturbances with <100 disturbance events per month were buffered by a 120 m buffer. Disturbances with >100 disturbance events per month, including the Robert Campbell Highway, the Wolverine mine and associated roads, as well as the KZK Tote Road and exploration areas, were buffered by a 240 m buffer. Buffer distances used those outlined in Purves and Doering (1998) and Servheen et al. (2001). The disturbance with its buffer is referred to as the human influence zone. These zones of influence reflect disturbance of a bear's movement through the landscape and are smaller than the zones of influence for habitat effectiveness which reflect a bear's available food sources.

All disturbances, with their respective buffers, were merged into one file and the ArcGIS Spatial Analyst Tool: *Euclidian Distance* was applied to the buffered feature dataset. A raster file was then created that contained distances from each feature. The resulting raster was then scored according to Purves and Doering (1998) as follows:

> 200 m from the influence zone:	Score of 2
Between 100 and 200 m of the influence zone:	Score of 4
Within 100 m of the influence zone:	Score of 5
Within influence zone:	Score of 6

3.4.4 Presence or Lack of Hiding Cover

Areas within 50 m of hiding cover are considered to be safer for bears than areas greater than 50 m away from cover (Servheen and Sandstrom, 1993). The PEM data from Regional Ecosystems of East-Central Yukon (Grods et al., 2013) were used to classify broad ecosystem units as hiding cover or non-hiding cover based on the vegetation characteristics described in Holland and Coen (1982). Hiding cover was then given a score, based on the methods used in Purves and Doering (1998):

Areas with hiding cover:	Score of 2
Areas within 50 m of cover:	Score of 3

Areas >50 m from cover Score of 5

3.4.5 Proximity to Riparian Areas

For the linkage zones analysis, riparian areas typically provide greater foraging potential and more opportunity for bear movement. Riparian areas are those ecosites with dominantly wet terrain identified using the PEM data from Regional Ecosystems of East-Central Yukon (Grods et al., 2013). Habitat within 50 m of either side of the stream or around the edge of a lake was also classified as riparian assuming these areas provide the same attributes as riparian areas. However, the area of water was not included for lakes.

Riparian areas were also identified from the wetlands layer from the hydrographic features of the CanVec dataset obtained from NRCan.

Additionally, the ArcGIS Spatial Analyst Hydrology Tool was used on the digital elevation model (DEM) obtained from Geomatics Yukon to identify the streams with sufficient regular annual flow to support riparian areas. Once a flow accumulation raster was produced, the resulting raster was compared to recent high resolution aerial imagery within the study area to confirm the streams support riparian areas. The results from this process is similar to the watercourse CanVec dataset, but does not include high elevation ephemeral drainages and is considered a more conservative data source than the more general CanVec hydrology watercourse layer.

The PEM riparian, CanVec wetlands, and the watercourse resulting from the DEM analysis were merged into a unique layer and converted to a 25 m resolution raster and then reclassified as Riparian or Non-Riparian and given a score:

Riparian area, which includes a 50 m buffer around the riparian zone:	Score of 1
Non-riparian area, which includes all areas outside of riparian areas:	Score of 2

3.4.6 Linkage Zones Model Summation

Finally, the scores for each of the four layers used in the linkage zones analysis (access density, distance to disturbances, proximity to cover, and proximity to riparian areas) were summed to provide a single combined danger score ranging from seven to 18, categorized as follows (Purves and Doering, 1998):

Minimal Danger:	Score of 7 to 10
Low Danger:	Score of 11 to 12
Moderate Danger:	Score of 13 to 14
High Danger:	Score of 15 to 18

3.4.7 Results

The Linkage Zones Model was run for the baseline disturbance and the baseline disturbance with the proposed Project development. The model classified the study area into four categories: minimal, low, moderate, and high danger. Areas with a high danger score were those with high human disturbance; minimal danger scores were those areas with little to no human disturbance.

Table 3-6 and Table 3-7 provide a summary of the Linkage Zones Model for the baseline disturbance and for the baseline disturbance plus the proposed Project, respectively. Figure 3-7 and Figure 3-8 show model results for the baseline disturbance and the baseline disturbance plus the proposed Project, respectively.

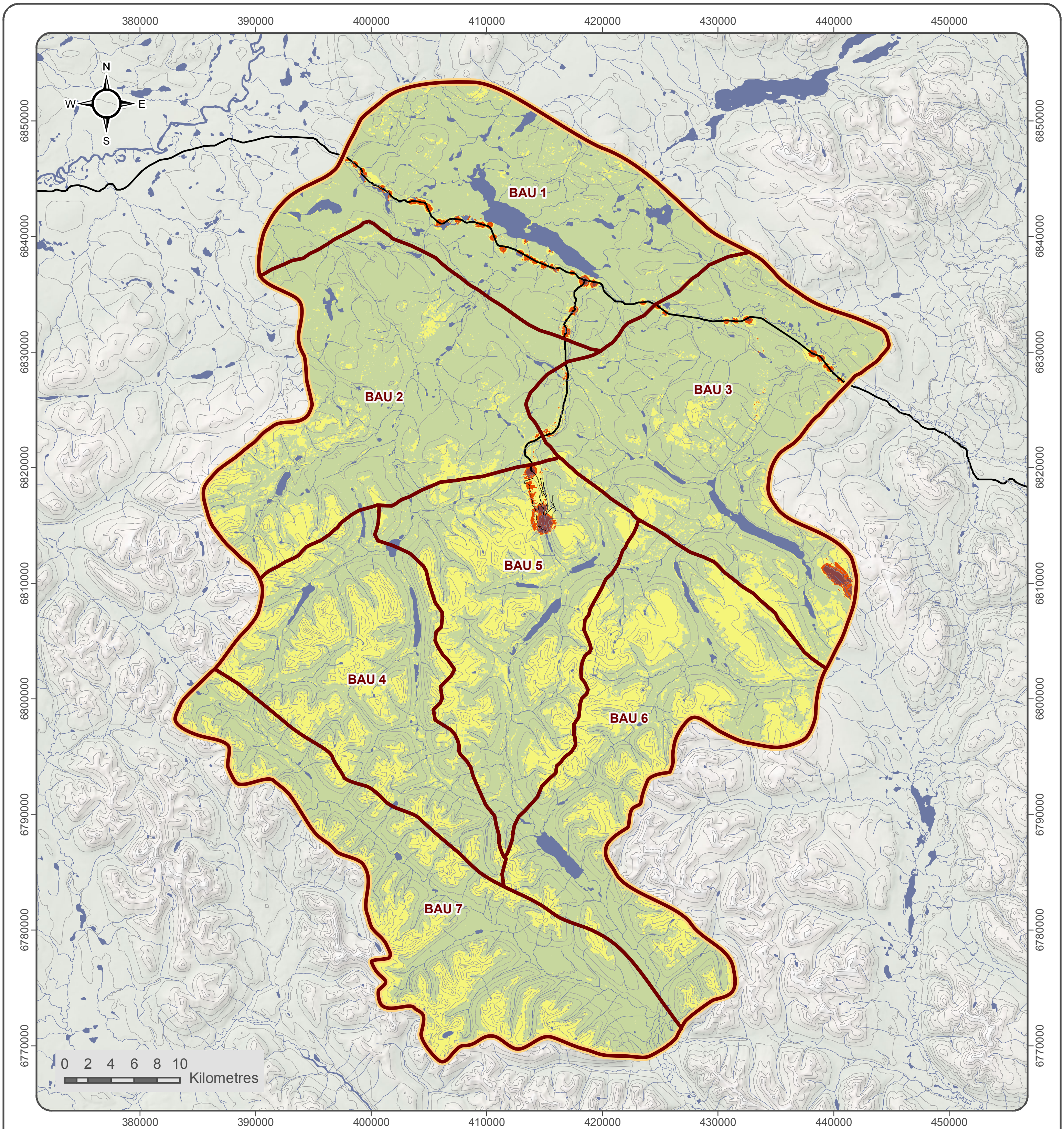
When looking at baseline disturbance only, 72% of the entire GBSA is considered to have minimal danger and 27% is considered to have low danger. These percentages remain the same when the proposed Project is considered. The Project lies within BAU 5 and the amount of area rated as high danger changes from 2 km^2 to 10 km^2 when the proposed Project is considered. Other areas with moderate and high danger ratings occur along the Tote Road, the Robert Campbell Highway and at the Wolverine Mine site. There are extensive areas throughout the GBSA that provide safe travel corridors between the smaller areas of human activity.

Table 3-6: Linkage Zone Results for Baseline Disturbance

Bear Assessment Unit		DANGER CATEGORIES							
		Minimal Danger		Low Danger		Moderate Danger		High Danger	
BAU	Size (km²)	Area (km²)	% of BAU	Area (km²)	% of BAU	Area (km²)	% of BAU	Area (km²)	% of BAU
1	495	436	88%	49	10%	8	2%	2	0%
2	507	423	83%	83	16%	0	0%	0	0%
3	535	447	84%	79	15%	5	1%	3	1%
4	361	220	61%	141	39%	0	0%	0	0%
5	394	220	56%	168	43%	3	1%	2	1%
6	488	281	57%	207	42%	0	0%	0	0%
7	439	299	68%	140	32%	0	0%	0	0%
Total	3,217	2,325	72%	867	27%	18	1%	7	0%

Table 3-7: Linkage Zone Results for Baseline Disturbance with the Proposed Project Development

Bear Assessment Unit		DANGER CATEGORIES							
		Minimal Danger		Low Danger		Moderate Danger		High Danger	
BAU	Size (km²)	Area (km²)	% of BAU	Area (km²)	% of BAU	Area (km²)	% of BAU	Area (km²)	% of BAU
1	495	435	88%	49	10%	9	2%	2	0%
2	507	421	83%	83	16%	2	0%	0	0%
3	535	446	83%	79	15%	6	1%	3	1%
4	361	220	61%	141	39%	0	0%	0	0%
5	394	214	54%	164	42%	5	1%	10	3%
6	488	281	57%	207	42%	0	0%	0	0%
7	439	299	68%	140	32%	0	0%	0	0%
Total	3,217	2,315	72%	863	27%	23	1%	16	0%



Grizzly Bear Assessment Unit (BAU)

Grizzly Bear Study Area (GBSA)

Danger Categories

Minimal Danger (2,325 km²)

Low Danger (867 km²)

Moderate Danger (18 km²)

High Danger (7 km²)

KUDZ ZE KAYAH PROJECT
GRIZZLY BEAR HABITAT MODELS REPORT

FIGURE 3-7

LINKAGE ZONES MODEL FOR BASELINE DISTURBANCES

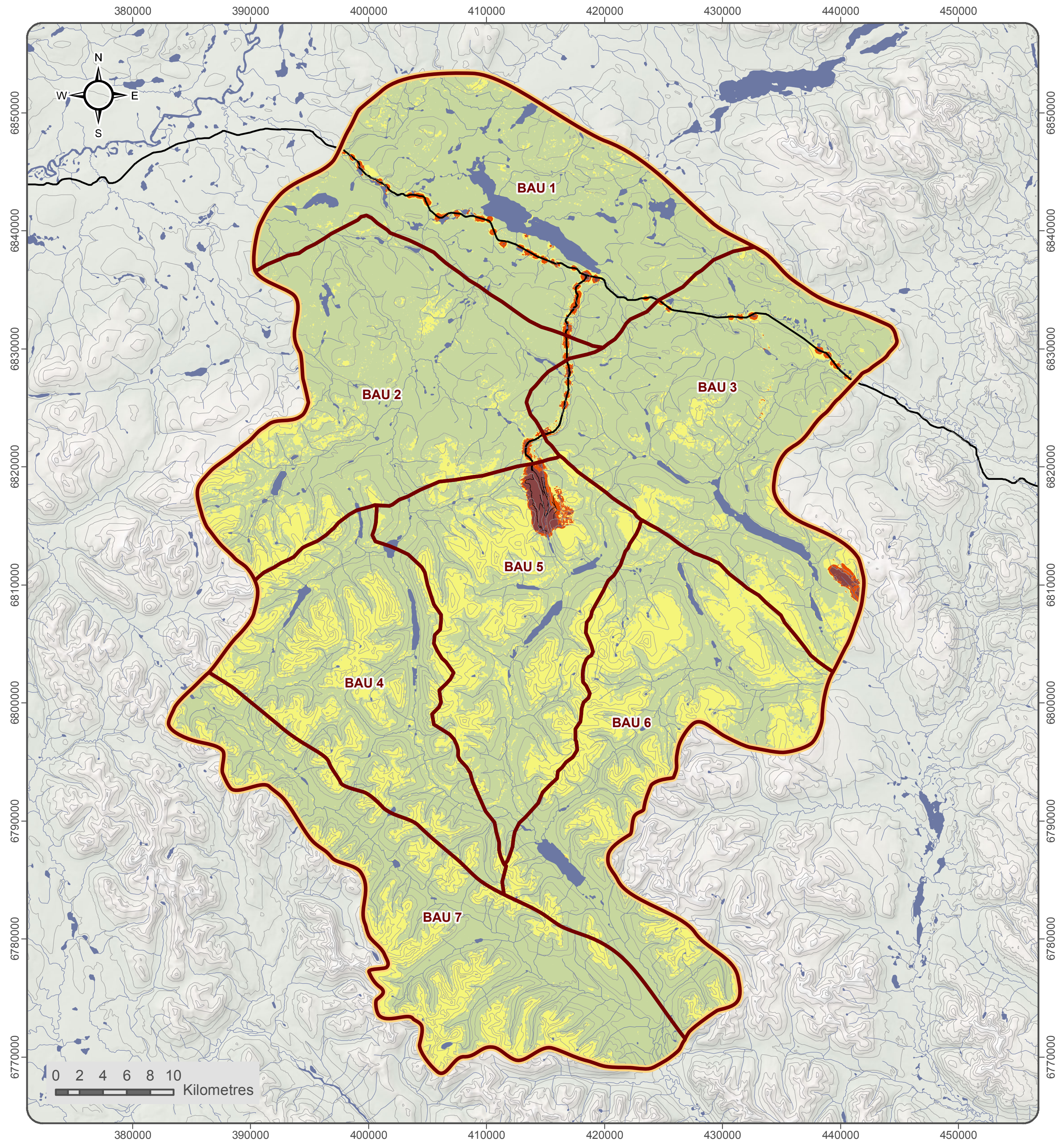
MAY 2018

Datum: NAD 83; Projection: UTM Zone 9N

AEG

BMC MINERALS

D:\Project\AllProjects\Kudz_Ze_Kayah\Maps\03_Study\Wildlife\Bear\05-Habitat_Suitability\IR3\Figures\Linkage\LinkageModel_Existing_20180523.mxd



Grizzly Bear Assessment Unit (BAU)
Grizzly Bear Study Area (GBSA)

Danger Categories

- Minimal Danger (2,315 km²)
- Low Danger (863 km²)
- Moderate Danger (23 km²)
- High Danger (16 km²)

KUDZ ZE KAYAH PROJECT
GRIZZLY BEAR HABITAT MODELS REPORT

FIGURE 3-8

LINKAGE ZONES MODEL FOR BASELINE AND PROPOSED PROJECT DISTURBANCES

MAY 2018

Datum: NAD 83; Projection: UTM Zone 9N

AEG

BMC MINERALS

D:\Project\AllProjects\Kudz_Ze_Kayah\Maps\03_Study\Wildlife\Bear\05-Habitat_Suitability\IR3\Figures\Linkage\LinkageModel_Proposed_20180523.mxd

4 DISCUSSION AND CONCLUSION

Results of the Habitat Effectiveness, Security Areas and Linkage Zone models for the GBSA were reviewed together to assess the effects of the Project on grizzly bear habitat in a Grizzly Bear Study Area (GBSA). This study area and the modeling methods were discussed and agreed upon with Yukon Government biologists. Table 4-1 summarizes the results for each BAU.

Overall, 96% of the GBSA is predicted to be effective habitat for grizzly bears during all season. The BAU with the least amount of effective habitat is BAU 1 which has 89% habitat effectiveness. Finlayson Lake and the Robert Campbell Highway are located in this BAU.

Of the 3,217 km² study area, 82% is considered to be secure with the majority of the area being unsuitable habitat (15%). BAU 5 where the Project lies is predicted to have the least amount of secure habitat (71%). However, unsuitable habitat represents 24% of the total area with 5% being not secure as a result of human activity.

For the Linkage Zones analysis, 72% of the total area is predicted to have minimal danger, with another 27% predicted to have low danger. BAU 5 has the lowest amount of minimal danger area (54%) with 42% being classified as low danger, 1% being moderate danger and 3% predicted to have high danger.

Within the overall GBSA and within each individual BAU, there are extensive areas of high quality habitat in which it is considered safe for bears to forage undisturbed, and to travel through without being affected by human activities.

Table 4-1: Combined Assessment of Habitat Effectiveness, Security Areas and Linkage Zones with Baseline and Proposed Project Disturbance

Bear Assessment Unit		Habitat Effectiveness (%) of BAU			Secure Areas		Linkage Zones (Minimal Danger)	
BAU	Size (km²)	Spring	Summer	Fall	Area (km²)	% of BAU	Area (km²)	% of BAU
1	495	89	89	90	414	84%	435	88%
2	507	98	98	98	466	92%	421	83%
3	535	91	91	91	480	90%	446	83%
4	361	100	100	100	279	77%	220	61%
5	394	98	95	95	281	71%	214	54%
6	488	100	100	100	367	75%	281	57%
7	439	100	100	100	354	81%	299	68%
Total	3,219	96	96	96	2,642	82%	2,315	72%

5 LIMITATIONS

The grizzly bear habitat models used existing available datasets. A number of limitations and assumptions were made to complete these models, including:

- The HE model is a knowledge-based model that incorporates quantitative data with expert opinion. The model reflects some biases related to expert opinion.
- All models use baseline disturbance, if available. There are no other known proposed projects in the GBSA at the time of this writing.
- Disturbance layers reasonably represent the spatial extent of human activity.
- Surface disturbance layers represent the spatial extent of human activity in the area.
- Surface disturbance classifications reasonably represent human activity associated with each disturbance feature.
- Assumptions were made on human use intensity for each human activity feature identified.
- Assumptions were made on the effects of human activity on bears.
- Disturbance coefficients and zone of influence buffers used by Purves and Doering (1998) and Gibeau (1998) are a good representation of actual habitat displacement and degradation in Yukon.
- Potential habitat and realized habitat is rated relative to the availability within the GBSA.
- Disturbance activity levels represent actual human activity associated with each disturbance feature.
- These models quantify information about available habitat and baseline and proposed human activity and do not speak to the viability of the local grizzly bear population. Reducing bear mortality, including kills as a defense of life or property, is one of the most important factors for having healthy bear populations.
- The modelling was solely a desktop study.
- As with all habitat-based models, these models attempt to simulate the effects of a highly complex environment in which the effects of social, environmental, and individual variations on habitat use are not well understood.

6 REFERENCES

Ardea Biological Consulting (Ardea). 2004. Grizzly Bear Spring, Summer, and Fall – Habitat Suitability Models. Morice and Lakes Forest Districts IFPA. Prepared for: Morice and Lakes IFPA. March 2004

Ash, M. 1985. Grizzly bear habitat component descriptions - Whitefish Range, Flathead and Kootenai National Forests. Manuscript report.

Aune, K., and W. F. Kasworm. 1989. East Front grizzly bear study; final report. Montana Department Fish, Wildlife and Parks. Helena, Montana.

Blanchard, B. M. 1978. Grizzly bear distribution in relation to habitat areas and recreational use: Cabin Creek- Hilgard Mountains. M.S. Thesis. Montana State University, Bozeman, Montana.

BMC, Minerals Inc. (BMC). 2017. Kudz Ze Kayah Project, Project Proposal. March 2017. Submitted to the Yukon Environmental and Socio-economic Assessment Board.

Boyce, M.S., A.E. Derocher, and D.R. Garshelis, 2016. Scientific Review of Grizzly Bear Harvest Management System in British Columbia. Prepared for Ministry of Forests, Lands and Natural Resource Operations.

Canadian Forest Service, 2006. EOSD Land Cover Classification v 1.0. Canadian Forest Service, Pacific Forestry Centre, Victoria, British Columbia.

COSEWIC. 2012. COSEWIC assessment and status report on the Grizzly Bear Ursus arctos in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiv + 84 pp.

EBA. 2011. Grizzly bear cumulative effects assessment models Ketza River Project. Prepared for Yukon Nevada Gold Corp. August 2011.

EDI Environmental Dynamics Inc. 2013. Casino Project: Wildlife Baseline Report. Prepared for Casino Mining Corporation, Vancouver, BC by EDI, Whitehorse, YT. 18 October 2013.

EDI Environmental Dynamics Inc. 2016. Coffee Gold Project: Grizzly Bear Habitat Model Report. Prepared for Kaminak Gold Corporation, Vancouver, BC by EDI Whitehorse, YT. September 8, 2016.

Geo-Engineering, 2000. Kudz Ze Kayah project: environmental baseline and geotechnical evaluation report. Report for Indian and Northern Affairs Canada Waste Management Program by Geo-Engineering Vancouver, BC: Geo-Engineering Ltd (MST) Lst. P. 52

Gibeau, M. L. 1998. Grizzly bear habitat effectiveness model for Banff, Yoho and Kootenay National Parks, Canada. Ursus 10:235-241.

Gibeau, M.L., S.Herrero, J.L.Kansas and B.Benn.1996. Grizzly bear population and habitat status in Banff National Park: A Report to the Banff-Bow Valley Task Force. Eastern Slopes Grizzly Bear Project, University of Calgary, Alberta. Available at: http://www.canadianrockies.net/grizzly/pophab_banff96.html

Gibeau, M.L., S. Herrero, B.N. McLellan, and J.G. Woods. 2001. Managing for Grizzly Bear Security Areas in Banff National Park and the Central Canadian Rocky Mountains.

Green, G.I, D.J. Mattson, and J.M. Peek. 1997. Spring feeding on ungulate carcasses by grizzly bears in Yellowstone National Park. J. Wildl. Manage. 61(4):1040-1055.

Grods, J., S.R. Francis, J.C. Meikle, K. McKenna and S. Lapointe. 2013. Regional Ecosystems of East-Central Yukon, Part 1: Ecosystem descriptions. Report prepared for Energy, Mines and Resources, Government of Yukon by Makonis Consulting Ltd. and Associates, West Kelowna, BC.

Hamilton, T. 1989. Assessment of Grizzly Bear Ecology in the Ospika Drainage as it Relates to Proposed Timber Harvest. B.C. Ministry of Environment, Mackenzie, B. C.

Holland, W.D., and G.M. Coen. 1982. Ecological land classification of Banff and Jasper National Parks. Alberta Institute of Pedology Publication no. SS-82-44. Edmonton. 540 pp.

Kansas, J.L. and R.N. Riddell. 1995. Grizzly bear habitat model for the four contiguous mountain national parks: Second Iteration. Report for Canadian Parks Service, Calgary, Alberta. 109pp.

LeFranc, Jr., M.N., M.B. Moss, K.A. Patnode and W.C. Sugg III. (editors), 1987. Grizzly bear compendium. Interagency Grizzly Bear Committee, Bozeman, Mont. 540pp.

Maraj, R., 2007. Evaluating the ecological consequences of human land-use on grizzly bears in southwest Yukon, Canada. Thesis submitted to the Faculty of Environmental Design University of Calgary, Calgary, AB.

McCrory, W. and S. Herrero. 1983. The Capability and Use of Grizzly Bear Habitats in the Kananskis and Spray Lakes Valleys and Areas from Canmore to Mount Allan. 1982. BIOS Environmental Research and Planning Associated. Calgary, Alberta. 20pp.

McLellan, B. N., and R. D. Mace. 1985. Behavior of grizzly bears in response to roads, seismic activity, and people. Preliminary Report; Canadian Border Grizzly Project, Cranbrook, B.C.

McLellan, B.N., and D.M. Shackleton. 1988. Grizzly bears and resource-extraction industries: effects of roads on behaviour, habitat use and demography. Journal of Applied Ecology 25:451-460.

McLellan, B. N. 1990. Relationships between human industrial activity and grizzly bears. International Conference on Bear Research and Management 8:57-64.

Miller, S.J., N. Barichello, and D. Tait. 1982. The Grizzly Bears of the Mackenzie Mountains, Northwest Territories.

Nagy, J. A. 1990. Biology and Management of Grizzly Bear on the Yukon North Slope. Yukon Fish and Wildlife Branch, Whitehorse, Yukon.

Nietfeld, M., J. Wilk, K. Woolnough, and B. Hoskin. 1985. Wildlife Habitat Requirement Summaries for Selected Wildlife Species in Alberta. Wildlife Resource Inventory Unit. Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division. Edmonton, Alberta.

Purves, H. and C. Doering. 1998. Grizzly Bear Habitat Effectiveness: Assessing Cumulative Effects of Human Use in Jasper National Park.

Riddell, R. 2002. Cariboo Mountains Provincial Park and Surrounding Areas Grizzly Bear Habitat Study and Lower Mitchell River Ecosystem Ecological Assessment. Final Report. Prepared for: BC Ministry of Environment, Lands and Parks, BC Parks Division, Cariboo District, Williams Lake. Prepared by: Wildlands Ecological Consulting Ltd., Red Deer, Alberta.

Riddell, R.N. 2005. Critical Grizzly Bear Habitat Mapping: Mackay Landscape Unit, British Columbia. Prepared for MWLAP. February 2005.

Ruediger, B. 2000. Report to the Interagency Grizzly Bear working group on wildlife habitat linkages. Draft Report. USDA Forest Service, Northern Region, Missoula, MT.

Schallenberger, A., and C. Jonkel. 1980. Rocky Mountain east front grizzly studies, 1979. Border Grizzly Project Special Rep. No.39. Univ. of Montain, School of Forestry, Missoula. 207 pp.

Servheen, C. and P. Sandstrom. 1993. Human activities and linkage zones for grizzly bears in the SwanClear Valleys, Montana. U.S. Fish and Wildlife Service, Missoula, MT. 28pp.

Servheen C, Waller JS and Sandstrom P. 2001. Identification and management of linkage zones for grizzly bears between the large blocks of public land in the Northern Rocky Mountains. IN: Proceedings of the 2001 International Conference on Ecology and Transportation, Eds. Irwin CL, Garrett P, McDermott KP. Center for Transportation and the Environment, North Carolina State University, Raleigh, NC: pp. 161-179.

Simpson, K. 1990. Seasonal habitat use by grizzly bears in the Babine River drainage. Unpublished report for Min. of Env. Smithers, BC. 29pp.

Smith, C.A.S., Meikle, J.C., and C.F. Roots. 2004. Eoregions of the Yukon Territory, Biophysical Properties of the Yukon Landscapes. Agriculture and Agri-Food Canada, PARC Technical Bulletin 04-01, Summerland, British Columbia.

Stenhouse, G., J. Dugas, J. Boulanger, D. Hobson, and H. Purves. 2003. Grizzly Bear Cumulative Effects Assessment Model Review for the Regional Carnivore Management Group. Hinton, AB: Foothills Model Forest Grizzly Bear Project.

USDA Forest Service. 1990. CEM—A model for assessing effects on grizzly bears. U.S. Department of Agriculture, Forest Service, Missoula, Montana. 24pp.

Waller J.S. and R.D. Mace. 1997. Grizzly bear habitat selection in the Swan Mountains, Montana. J. Wildl. Manage. 61(4):1032-1039.

YESAB, 2018. Request for Supplemental Information: Information Request No.3. Project Assessment 2017-0083, BMC Minerals Inc., Kudz Ze Kayah Project. April 9, 2018. 18pp.

Yukon Ecoregions Working Group (YEWG). 2004. Yukon Coastal Plain. In: Ecoregions of the Yukon Territory: Biophysical properties of Yukon landscapes, C.A.S. Smith, J.C. Meikle and C.F. Roots (eds.), Agriculture and Agri-Food Canada, PARC Technical Bulletin No. 04-01, Summerland, British Columbia, p. 63–72.

Yukon Environment. 2015. Full Mammal Description: Grizzly Bear Ursus arctos. Available at: http://www.env.gov.yk.ca/animals-habitat/mammals/documents/20GrizzlyBear_Sep-2015.pdf [accessed May 3, 2018].