Prairie Creek Mine All-Season Road: Collared Pika Baseline & Habitat Loss Estimates

PRESENTED TO

Canadian Zinc Corporation

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Tetra Tech Canada Inc.
Box 2244, 201, 4916 - 49 Street
Yellowknife, NT X1A 2P7 CANADA
Tel 867.920.2287 Fax 867.873.3324

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Conformity Table: GNWT ENR Comments*

Item	Requirement	Review Comment Reference	Section of Plan
1.	*Section 8.1.2*: There are nine talus sites between km 15 and 16 that are adjacent to the existing all-season road, which are on territorial public land (Prairie Creek Proposed Phase 1 Road -Collared Pika Habitat Loss Estimates – November 14, 2019). All but one was active in summer 2019. The WMMP indicates that snowplowing activities will be restricted where there is Pika presence within 10 m of the Phase 1 road, but the specific talus sites that this applies to are not identified. Will there be follow-up surveys to determine occupancy in summer 2020 to assess whether they might have been impacted by Phase 1 road operations? Please specify the specific talus sites where snowplowing activities must avoid pika talus habitat. ENR notes that PCA made a similar request in PCA Comment #11 (January 2020).	Attachment 1 Table 2	Specific talus sites where snowplowing restrictions apply are in Section 3.3.1.1 of baseline report and WMMP Mapbook

** Conformity Table per ENR Comments presented in a letter (Further Revisions Required for the Wildlife Management and Monitoring Plan for Phase 1 of the Canadian Zinc's Prairie Creek All-Season Road Project) dated May 5, 2020*

Conformity Table : Parks Canada Comments*

Item	Requirement	Review Comment Reference	Section of Plan
1.	*WMMP, Section 7.4.2, 8.1.2 & WMMP #2 Section 1.0:* CZN to provide one or more figures that illustrate how the road alignment has been adjusted to mitigate impacts to Collared pika, and to show where snowplowing activities will be restricted, based on the pika baseline data. CZN to update environmental alignment sheets to include locations where there are restrictions on snowplowing activities.	#11	Refer to Figure 3 in this baseline report to see ASR re-alignments to date. Specific talus sites where snowplowing restrictions apply are in Section 3.3.1.1 in the baseline report and WMMP Mapbook sheets.
2.	*Technical Memo - Prairie Creek Proposed Phase 1 Road Collared Pika Habitat Loss Estimates, 3.0 Results:* CZN to revise the results section to include a figure (i.e., map) that depicts the following: pika talus sites, the existing alignment, the proposed Phase 1 road alignment, and any areas of direct or indirect pika habitat loss resulting from Phase 1 operations.	#73	Refer to Figures 2a-2m. Note, the existing 1980s road seen on imagery.
3.	*Technical Memo - Prairie Creek Proposed Phase 1 Road Collared Pika Habitat Loss Estimates, Table 1:* CZN to revise Table 1 as follows: replace the 'Total Area of Pika Habitat (ha)' column from Table 1 with two columns - 'Total Area of Talus Patch (ha)' and 'Total Area of Indirect Pika Habitat (ha)'.	#74	Refer to Table 4 in this baseline report

** Conformity Table per Table 14 of Parks Canada "Comments on Management Plans and other Submissions under Water License PC2014L8-0006 and Land Use Permit PC2014F0013" dated December 14, 2020.*

EXECUTIVE SUMMARY

Canadian Zinc Corporation (CZN) submitted a Developers Assessment Report to the Mackenzie Valley Review Board (MVRB) in 2015 for the proposed Prairie Creek Mine all-season road (the Project; EA1415-01; CZN 2015). Parks Canada and Environment and Natural Resources (ENR) recommended that collared pika baseline surveys be conducted. In response, baseline pika surveys were completed in 2016, 2017, and 2019 along the proposed all-season road (ASR) alignment.

The purpose of the collared pika baseline surveys was to evaluate their distribution and relative abundance along the proposed ASR alignment following survey methods developed with Parks Canada and ENR. In 2019, a pre-construction pika monitoring survey, which conformed to the Pioneer Winter Road (PWR) Wildlife Management and Monitoring Plan (WMMP), was also completed at the same time as the pika baseline. Results from both the baseline and pre-construction monitoring events are presented herein.

Results from 2016 and 2017 were initially reported in baseline field reports (Tetra Tech 2016; 2018) and in a technical memo (Tetra Tech 2019). This current report is intended to amalgamate the information presented in the baseline field reports and the technical memo and present additional results and analyses from the 2019 baseline and pre-construction monitoring in a unified report on pikas in relation to the Project.

Suitable pika habitat in the form of talus sites and associated meadow occur from KP 15.0 to 38.1. During the baseline surveys, 45 talus sites within 500 m of the ASR were found to meet, or likely meet, pika habitat criteria. Of these 45 sites, 38 are, or have once been, occupied by pika. Talus sites occur in elevation ranging from 808 m to 1,535 m and are concentrated in three main areas near the ASR: 1) KP 15-17, 2) KP 32-35, and 3) KP 37-38.

Active haypiles were found at 22 of the 38 talus sites ground-surveyed (Figure A). Of the alpine talus sites ground-surveyed, 86% (12 of the 14 surveyed) were active in at least one survey year with 42% (10 of the 24 surveyed) in the timberline/subalpine zone.

Generalized Linear Mixed Models were used to better understand pika haypile abundance and pika probability of occurrence at talus sites in relation to survey year and various geographic factors. Survey year and elevation were found to best explain active haypile abundance. Active haypile abundance was approximately five times higher in 2019 than in 2017 and the number of active haypiles increased with elevation. A similar pattern was found for the analysis of pika probability of occurrence though probability of occurrence was also found to be related to distance from the ASR (i.e., pika probability of occurrence increases with distance away from the ASR).

The PWR pre-construction monitoring survey identified four talus sites and 23 active and 19 inactive haypiles within 25 m of the PWR pre-construction survey area. The surveyors also delineated the area of these four talus sites and the extent of available meadow. Meadow habitat is available at all four talus sites and commonly occurs at the toe of talus slopes, sometimes up along the talus perimeter, and inside the talus itself.

The meadow at CZN-32-PK-4 is regenerating across the former 1980s winter road, and since the PWR follows the existing 1980s road, the PWR will result in a loss of pika meadow (approximately 0.021 ha) at CZN-32-PK-4. This is a direct loss to approximately 25% of the total meadow available at this site and triggers the need for adaptive management. Construction of the PWR, however, avoids direct loss to talus sites (0 ha direct loss).

A road survey crew will be deployed to site in the fall of 2021 to adjust the PWR alignment to avoid the meadow at the CZN-32-PK-4 talus site. A pre-construction monitoring survey is also planned this fall, prior to PWR construction. During the pre-construction survey, metal stakes will be installed along the PWR to delineate the area where the storage and deposit of snow/rock is prohibited on talus sites and meadow for construction and snowplow operators. The approximate locations of these metal stakes are provided in the WMMP's Appendix A Mapbook, which will be updated after the pre-construction monitoring survey with the final locations of the metal stakes.

The ASR alignment is considered final, but small realignments (e.g., by a few metres) to avoid talus sites and available meadow, have yet to be finalized. CZN is designing the ASR alignment to avoid talus sites and meadow to the extent possible. Since 2016, the ASR re-alignments have avoided 15 talus sites near KP 16 and approximately from KP 33 to 38.

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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
ASR	All-season Road
CZN	Canadian Zinc Corp.
ENR	Environment and Natural Resources
GIS	Geographic Information System
GPS	Global Positioning System
PWR	Pioneer Winter Road
WMMP	Wildlife Management and Monitoring Plan

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Canadian Zinc Corporation and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Canadian Zinc Corporation, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in Appendix D or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

Canadian Zinc Corporation (CZN) submitted a Developers Assessment Report to the Mackenzie Valley Review Board (MVRB) in 2015 for the proposed Prairie Creek Mine all-season road (the Project; EA1415-01; CZN 2015). Parks Canada and Environment and Natural Resources (ENR) recommended that collared pika baseline surveys be conducted. In response, baseline pika surveys were completed in 2016, 2017, and 2019 along the proposed all-season road (ASR) alignment where suitable habitat for pika existed. The purpose of the collared pika baseline surveys was to evaluate the occurrence, relative abundance, and distribution of pika along the proposed ASR alignment following survey methods developed with Parks Canada and ENR. An additional pre-construction pika monitoring survey was also completed at the same time as the 2019 pika baseline survey and was based on the Pioneer Winter Road (PWR) Wildlife Management and Monitoring Plan (WMMP).

Results from 2016 and 2017 were initially reported in baseline field reports (Tetra Tech 2016; 2018) and in a technical memo (Tetra Tech 2019). This current report is intended to amalgamate the information presented in the baseline field reports and the technical memo and present additional results and analyses from the 2019 baseline and pre-construction monitoring in a unified report on pikas in relation to the Project.

1.1 Background

Collared pika are listed as Special Concern (Schedule 1) under the *Species at Risk Act* because of anticipated climate-driven changes to habitat and survival (survival related to temperature, moisture, and weather changes).

Baseline and pre-construction monitoring surveys were designed in consideration of the following pika ecology:

- Live in talus (boulder fields), typically above the treeline, and commonly 700 to 1,800 m above sea level (COSEWIC 2011).
- Talus naturally occurs in small, isolated patches, and not all talus may be suitable for pika (COSEWIC 2011).
- Within talus, medium to large sized boulders are preferred by pika and the availability of nearby meadows are essential for suitable habitat (COSEWIC 2011).
- Collared pika defend small territories year round ranging in size from a 15 – 25 m radius area (COSEWIC 2011; Morrison and Hik 2008). Territory availability limits the population size (Morrison and Hik 2008).
- When foraging in meadows, collared pika typically remain within 10 m of the protective cover of the talus (COSEWIC 2011).
- Talus sites more than 30 m apart, or those separated by a significant dispersal barrier such as a river, are considered separate talus sites (Carroll 2016).
- Pikas are born deep inside the talus. In the southwestern Yukon, the date of pika parturition varies from early May to the end of June depending on the year (Franken 2002). Parturition is delayed in years with high snow accumulation and late spring snowmelt (Franken 2002).
- Morrison and Hik (2008) found that juveniles rarely dispersed more than 300 m from their natal talus site and applied a 300 m threshold between talus sites to represent potentially connected habitat (Morrison and Hik 2008). However, dispersals reaching 350 m to 2 km have also been recorded (Franken 2002; COSEWIC 2011).
- Collared pika build at least 1 haypile, within their territory, starting in July each year and continue to build the haypile until snowfall.

- Collared pika re-use the same haypiles each year, and juvenile pika recolonize old haypiles in unoccupied territories (Morrison and Hik 2008).
- Collared pika abundance within talus sites varies considerably both temporally and spatially (COSEWIC 2011). Population fluctuations are known to occur, likely as a result of harsh winters and early springs (COSEWIC 2011). Relatively stable and higher abundances are found on south-facing slopes, whereas east and west-facing slopes cycle between localized extinction and recolonization (Morrison and Hik 2008).
- Pika are both cold and heat intolerant. Moyer-Horner et al. (2016) explain that hyperthermia (i.e., overheating) and death of American pika could occur at moderate (25.5 – 29.4°C) ambient temperatures. Collared pika are assumed to be equally sensitive to overheating. Morrison and Hik (2008) also hypothesized that the pikas in their Yukon study area collapsed by 90% due to warmer winters that resulted in low snow accumulation, increased frequency of freeze-thaw events, winter rains, and late winter snowfall.
- Parks Canada and Moyer-Horner et al. (2016) each suggest that pikas are easy to detect during ground-based surveys. Detection probability is greater than 90%, and thus a single visit during each sample year is appropriate (Owchar 2016).

2.0 METHODS

Baseline collared pika surveys were completed in 2017 and 2019 along the proposed ASR, and another baseline survey was completed in 2016 at select borrow sites. During the 2019 baseline survey, a pika pre-construction monitoring survey was also conducted simultaneously.

Objectives of the baseline programs evolved over time and were:

- In 2016, the objective was to determine pika presence and relative abundance at select borrow sources following British Columbia's pika survey methods (RISC 1998).
- In 2017, the objective was to record pika presence and distribution within 300 m of the ASR from KP 12 – 39 following Parks Canada's pika monitoring methods for repeated presence-absence surveys.
- In 2019, the objectives were to determine pika presence and relative abundance in relation to distance from the ASR at KP 12 – 39 following Parks Canada's recent direction for their pika monitoring designs.

In 2016, a pika field survey was completed July 11 – 17. At this time, the ASR alignment followed that of the existing 1980s winter road and would not directly overlap talus, except at borrow sources. Surveys were completed in proposed borrow sources (and those portions of the ASR alignment inside the borrows) in the Sundog Creek from KP 32 to KP 38.5, as well as at borrow sources 14 (near KP 14) and 16 (near KP 16). Methods followed British Columbia's inventory standards for pika relative abundance along transects (RISC 1998).

Survey methods were later developed in consultation with Parks Canada and ENR prior to each of the 2017 and 2019 field surveys. In 2017, methods followed those undertaken by Parks Canada to monitor pika occupancy in Nahanni National Park Reserve (Carroll 2016) and other parks (e.g., Banff, Lake Louise, Yoho, and Kootenay National Parks; Owchar 2016). In 2019, the methods were modified to follow Parks Canada's recent updates to collect relative abundance indices. Surveys were completed from August 12 – 15, 2017 and August 20 – 26, 2019.

A Tetra Tech biologist and at least one local assistant conducted the surveys each year. In 2017, baseline surveys were supported by a second field crew led by a Parks Canada employee and a local assistant.

2.1 Baseline

Distribution

Prior to the field surveys, potential talus sites within 500 m on either side of the ASR from KP 12 to 39 were pre-identified using orthophotos (dated 2012). Once in the field, a pika habitat assessment was conducted at talus using ground-based and/or aerial reconnaissance surveys. Following expert-based knowledge of pika habitat, talus was considered suitable when the:

1. Talus was at least 30 cm deep, with rock crevices, and little exposed soil

2. Average boulder size ≥30 cm diameter

3. Meadow or vegetation patch within 10 m of the talus

4. Talus patch size was at least 20 m diameter

Talus that met or likely met pika habitat criteria were ground-surveyed for pika and pika sign. Talus that did not meet pika habitat criteria, or those that were unsafe for surveyors (e.g., very steep slopes), were not ground-surveyed.

A crew of two surveyors conducted the ground surveys following the methods outlined below:

- In 2016, surveys were composed of two parts: a passive acoustic/observation survey and transect surveys. Prior to the initiation of the transect surveys, the survey crew performed a 10-minute passive acoustic/observation survey at the edge of each talus site. Each individual pika heard vocalizing and/or sighted was recorded, along with their approximate distance and direction from the observation station. Surveyors attempted to locate pika sign where an individual was heard/seen, including those off transect. The survey crew then searched for pika and pika sign (i.e., haypiles and latrines) along a single, 4 m wide transect within the first 20 m of the talus toe. Features with a high probability of detecting pika sign (e.g., under large overhanging rocks) located off-transect were also searched.

- In 2017, the survey crew searched for pika and pika sign with one person walking along the talus toe and the other walking a parallel transect 10 – 15 m upslope. When a haypile was detected, an additional 15 m radius search was conducted around the haypile to locate additional pika sign which was assumed to occur within a single pika territory (following similar methods previously performed by Parks Canada).

- In 2019, the survey crew searched for pika and pika sign along a 4 m wide toe transect, plus along parallel transects upslope spaced approximately 15 m apart until the talus site ended or it became unsafe to continue surveying. The surveyors also returned to previously identified haypiles in 2016/2017 to confirm if each was active.

While on transect in 2017 and 2019, surveyors also regularly stopped to look and listen for pika.

In all years, all pika and their sign were recorded and georeferenced with a handheld global positioning system (GPS). Pika sign was described as active or inactive (i.e., fresh or old, respectively). For example, haypiles were active (or fresh) when at least one piece of green plant matter was present.

The outside perimeter of each talus site was marked using waypoints and tracklogs on a handheld GPS to calculate the area of talus sites. Relative abundance estimates were calculated for each talus site each year, using the total number of active haypiles detected within the 4 m wide transects (toe and upslopes) and 15 m radius search areas.

Relative Abundance and Occurrence

The data was modelled in two ways: (1) using the number of active haypiles at each talus site and (2) using the presence/absence of pika, as indicated by the presence (> 0) of active haypiles at each talus site. The number of active haypiles is assumed to be an indicator or index of the number of pika present at a site. There is, however, variability in the number of haypiles that an individual pika may build each year, and the number may depend on environmental factors such as summer air temperatures. The analysis of pika presence was used to complement the active haypile analysis and as an alternate assessment of the data to compare patterns. The presence data has lower granularity than the count of active haypiles, however it has the benefit of removing confounding variability in the number of active haypiles as an indicator of pika abundance. We considered this approach to be preferable to attempting to determine the number of pika territories within each talus site because of a number of assumptions involved in determining the shape and size of a pika territory and assigning each active haypile to a territory.

To model the number of active haypiles at talus sites, a Poisson Generalized Linear Mixed Model (GLMM) with log link was used. The following covariates were selected as candidate model variables based on previous studies (e.g., Moyer-Horner et al. 2016; Bruggeman 2010) and our own observations on variation in active haypile counts:

1. Survey year (categorical)
2. Elevation (metres above sea level; scaled with mean = 0; continuous);
3. Slope aspect, in four categories: North (316-45º), East (46-135º), South (136-225º) and West (226-315º)
4. Nearest distance of site to ASR, to establish the baseline or “before condition” for future monitoring (metres, continuous)
5. Talus site area (hectares; continuous)
6. An interaction between survey year and elevation

To incorporate the dependency of observations at the same site in different years, talus site was included as a random effect with random intercept. The full model with all covariates was:

*Active Haypile Count ~ survey year + elevation + aspect + distance to ASR + talus site area + survey year * elevation + (1 | talus site).*

The area surveyed at each talus location in each year was included as an offset to account for variation in survey effort. Models with subsets of the covariates were generated and compared using Akaike’s Information Criterion corrected for small samples (AIC_c). Of the 32 sub models incorporating various combinations of the seven covariates (sub models are listed in Appendix B), the sub model with the lowest AIC_c was selected as the top model and considered the most appropriate to model active haypile counts. The top model was further evaluated using diagnostic plots of residuals generated using the R package *DHARMa* (Hartig 2019). Zero-inflated Poisson and negative binomial GLMMs were also tested and found to estimate similar coefficients though had significant deviations in residuals versus model predictions compared to the Poisson GLMM. All modeling was conducted using the software R (version 4.1.0; R Core Group, 2021). Models were fit using the R package *lme4* (Bates et al., 2015).

The amount of variance explained by the top model (goodness-of-fit) was estimated by a specific formulation of R^2 for mixed-models (Nakagawa and Schielzeth 2013) using the function *r.squaredGLMM* in the R package *MuMIn* (Barton 2020). The R^2 values reported were estimated using the “trigamma method”.

Mean count of active haypiles with 95% confidence intervals (CI) were estimated for each survey year while holding the effect of covariates constant (the marginal mean). Means and confidence intervals were calculated using the R package *emmeans* (version 1.6.2-2; Lenth 2021).

To model the presence of pika at talus sites, the count of active haypiles at each talus site was converted to presence/absence by setting all counts greater than 0 to 1 and using a binomial GLMM with logit link. The same covariates and the same model selection approach (sub models are listed in Appendix C) were used as described above for modelling of the count of active haypiles. The R^2 values reported were estimated using the "delta method". Means were estimated and represent the probability of pika occurrence.

The nearest meteorology station is at the Prairie Creek Mine. Weather data is not available for any individual or group of talus locations. Climate and weather conditions could therefore not be used in models to help explain variability in the pika data. It can however be used to conceptually infer how climate and weather conditions may correlate with annual differences in pika data. The following weather parameters possibly relevant to pika were calculated annually for the years 2015 – 2019:

- Maximum July temperature
- Mean temperature from June to August
- Minimum January temperature
- Mean temperature from December (of the prior year) to February
- Total annual precipitation

2.2 Pre-Construction

Pre-construction monitoring at talus sites within 25 m of the PWR began in August 2019 prior to planned 2019 winter construction (of note, PWR construction did not proceed as planned in 2019). Pre-construction monitoring was completed with the objectives of determining the 1) spatial limit (and area) of talus sites and available meadow within 25 m of PWR construction, and 2) presence of active pika haypiles to inform adaptive management action.

The overall methods of the 2019 pre-construction pika survey were the same as the baseline surveys, with the exception that the 4 m wide transects were positioned along the talus edge nearest to the PWR and spaced at 5 m intervals to a maximum of 25 m from the PWR. Where the talus site was sufficiently large, baseline survey transects continued beyond the pre-construction survey area at approximately 15 m intervals to be consistent with the baseline survey.

3.0 RESULTS

Talus sites are described in Appendix A.

3.1 Baseline

3.1.1 Spatial Distribution of Talus Sites

A talus site is defined as a distinct patch of talus (located at least 30 m from another talus site; Carroll 2016) that meets the criteria of pika habitat irrespective of whether pika or pika sign was detected. Those that are greater than 30 m apart and separated by habitat breaks (e.g., scree, meadow) are classified as distinct talus sites. Talus sites occur within 500 m on either side of the ASR between KP 15.0 and 38.1, with concentrations mainly near 1) KP 15-17, 2) KP 32-35, and 3) KP 37-38 (Table 1; Figure 1).

Based on ground-based surveys, 38[1] talus sites meet pika habitat criteria and range in size from 0.003 to 0.754 hectares (ha) (total 3.401 ha)[2] (Table 1). Seven additional talus sites (total 1.133 ha; Table 1) likely meet pika habitat criteria based on an aerial reconnaissance. Thirty-six sites, pre-identified from orthophotos, do not meet pika habitat.

Talus sites that meet and likely meet pika habitat criteria are located in alpine and timberline/subalpine biogeoclimatic zones (elevation ranges from 808 m to 1,535 m; Table 1). They are most common at the bottom of slopes with northern (49%, n=22) and western (31%; n=14) aspects and fewer on slopes with eastern (13%; n=6) and southern (7%; n=3) exposures (Table 1).

Table 1: Description of Talus Sites

Talus Site Name[1]	ASR Kilometer	Minimum Distance to ASR Centreline (m)	Biogeoclimatic Zone	Elevation (m)[2]	Talus Site Area (ha)	Aspect[3]	Subpopulation
CZN-15-PK-1	15	7	Alpine	1349	0.291	N	1
CZN-15-PK-2	15	0	Alpine	1376	0.155	W	1
CZN-15-PK-3	15	37	Alpine	1435	0.089	W	1
CZN-16-PK-1	16	69	Alpine	1456	0.023	E	1
CZN-16-PK-2	16	187	Alpine	1449	0.017	E	1
CZN-16-PK-3	16	11	Alpine	1468	0.078	S	1
CZN-16-PK-4	16	102	Alpine	1450	0.137	N	1
CZN-16-PK-5	16	65	Alpine	1493	0.151	E	1
CZN-16-PK-6	16	47	Alpine	1502	0.206	N	1
CZN-16-PK-7	16	86	Alpine	1534	0.088	S	1

[1] 41 talus sites were reported in the Collared Pika Habitat Loss Estimates memo (November 2019); however, some talus sites were combined under a single Talus Site Name after confirming that they were within 30 m of each other.

[2] Area of talus sites is 0.2 ha less than the area originally reported in the Collared Pika Habitat Loss Estimates memo since the accuracy of the talus site boundaries were improved from higher resolution GPS and orthophotos.

Table 1: Description of Talus Sites

Talus Site Name[1]	ASR Kilometer	Minimum Distance to ASR Centreline (m)	Biogeoclimatic Zone	Elevation (m)[2]	Talus Site Area (ha)	Aspect[3]	Subpopulation
CZN-17-PK-1	17	53	Alpine	1519	0.011	N	1
CZN-17-PK-2	17	58	Alpine	1487	0.041	W	2
CZN-18-PK-1	18	160	Alpine	1420	0.754	S	3
CZN-24-PK-1	24	206	Alpine	1212	0.174	N	4
CZN-25-PK-1	25	225	Timber./Subalp.	1152	0.170	N	5
CZN-25-PK-2	25	262	Timber./Subalp.	1151	0.093	N	5
CZN-26-PK-1	26	224	Timber./Subalp.	1147	0.041	N	5
CZN-28-PK-1	28	195	Timber./Subalp.	1057	0.093	E	6
CZN-32-PK-1*	32	287	Timber./Subalp.	980	0.116	W	7
CZN-32-PK-2	32	179	Timber./Subalp.	943	0.056	W	7
CZN-32-PK-3	32	140	Timber./Subalp.	930	0.018	W	7
CZN-32-PK-4	32	8	Timber./Subalp.	888	0.044	W	8
CZN-32-PK-5*	32	113	Timber./Subalp.	910	0.223	E	8
CZN-32-PK-6*	32	391	Alpine	1227	0.046	W	9
CZN-32-PK-7	32	17	Timber./Subalp.	889	0.046	W	8
CZN-33-PK-1*	33	474	Timber./Subalp.	1135	0.297	E	10
CZN-33-PK-2	33	29	Timber./Subalp.	871	0.033	W	11
CZN-33-PK-3	33	30	Timber./Subalp.	874	0.040	W	11
CZN-33-PK-4	33	32	Timber./Subalp.	871	0.081	W	11
CZN-34-PK-1	34	29	Timber./Subalp.	859	0.134	N	11
CZN-34-PK-2	34	27	Timber./Subalp.	860	0.006	N	11
CZN-34-PK-3	34	36	Timber./Subalp.	853	0.003	N	11
CZN-34-PK-4	34	27	Timber./Subalp.	857	0.041	N	11
CZN-34-PK-5	34	1	Timber./Subalp.	845	0.007	W	11
CZN-34-PK-6*	34	215	Timber./Subalp.	1037	0.175	N	11
CZN-34-PK-7	34	20	Timber./Subalp.	853	0.003	N	11
CZN-35-PK-1	35	12	Timber./Subalp.	849	0.097	N	11
CZN-35-PK-2*	35	96	Timber./Subalp.	931	0.233	N	11
CZN-35-PK-3*	35	210	Timber./Subalp.	936	0.043	N	12
CZN-37-PK-1	37	47	Timber./Subalp.	825	0.044	N	13

Table 1: Description of Talus Sites

Talus Site Name[1]	ASR Kilometer	Minimum Distance to ASR Centreline (m)	Biogeoclimatic Zone	Elevation (m)[2]	Talus Site Area (ha)	Aspect[3]	Subpopulation
CZN-37-PK-2	37	33	Timber./Subalp.	810	0.010	N	13
CZN-37-PK-3	37	36	Timber./Subalp.	816	0.016	W	13
CZN-37-PK-4	37	36	Timber./Subalp.	829	0.060	N	14
CZN-37-PK-5	37	45	Timber./Subalp.	811	0.008	N	14
CZN-38-PK-1	38	23	Timber./Subalp.	807	0.041	N	14
Total					**4.534**		

1. 41 talus sites were reported in the Collared Pika Habitat Loss Estimates memo (November 2019); however, some talus sites were combined after confirming that they were within 30 m of each other, and possible talus sites were added after the aerial reconnaissance.
2. Elevation at talus site centre
3. North (316-45º), East (46-135º), South (136-225º) and West (226-315º
* Possible talus sites identified by orthophoto and aerial reconnaissance.

Consistent with Morrison and Hik (2008), a conservative 300 m separation threshold between talus sites was applied to estimate the spatial connectedness between habitat patches. It is assumed that pika occupying talus sites within 300 m of each other are a subpopulation, and that there is little dispersal to talus sites farther away. Based on this threshold, most talus sites are well-connected and there are an estimated 14 pika subpopulations (Table 1). Seven talus sites are spatially isolated from others: CZN-17-PK-2, CZN-18-PK-1, CZN-24-PK-1, CZN-28-PK-1, CZN-32-PK-6, CZN-33-PK-1, and CZN-35-PK-3 (Table 1).

3.1.2 Relative Abundance and Occurrence

Active haypiles were found at 22 of the 38 talus sites ground-surveyed in 2017 and 2019 (Figure A). Of the alpine talus sites ground-surveyed, 86% (12 of the 14 surveyed) were active in at least one survey year with 42% (10 of the 24 surveyed) in the timberline/subalpine zone.

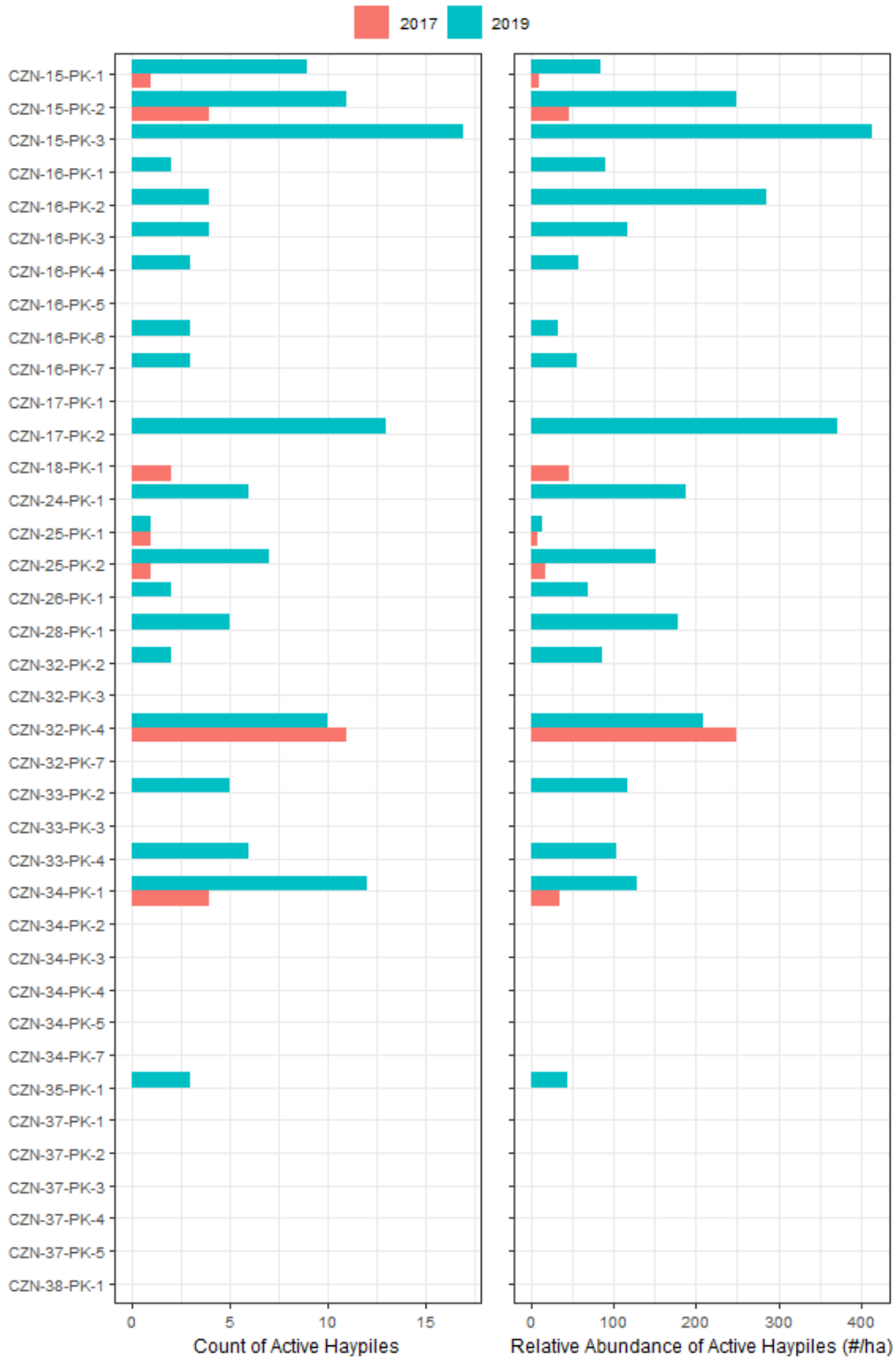

Figure A: Count and Relative Abundance
(count divided by area searched) of active haypiles at each talus site

The model selected to estimate active haypile count (the top model) included the covariates survey year and elevation. Models with the interaction term survey year * elevation were fit but in all cases were found to have significant deviations in residuals versus model predictions and were dropped from consideration due to the potential for unreliable estimates. An interaction between survey year and elevation may exist and should be further examined after additional data has been collected. Model selection results are presented in Appendix B.

Active haypile counts were estimated to be more than five times higher in 2019 than in 2017 (Figure B and Table 2) and the number of actives haypiles increased with increasing elevation (Figure C). The model parameter estimates, and test statistics (presented in Appendix B) indicate there is very high confidence in the effect of survey year and elevation ($p < 0.001$ and $p = 0.01$ respectively).

The conditional R^2 (the proportion of variance explained by both fixed and random effects) is 0.88, indicating that 88% of the variability in the count of active haypiles is explained by survey year, elevation, and the variability between talus sites not accounted for by the fixed effects. When the effect of talus location (the random effect) is removed, the marginal R^2 (the proportion of variation explained by fixed effects only) is 0.33, indicating that 33% of the variability between talus locations is explained by survey year and elevation. The difference between the marginal and conditional R^2 indicates additional factors may help explain variability in counts of active haypiles. As new data is collected, other factors should be explored and considered in future modeling with the objective of improving the precision of count estimates.

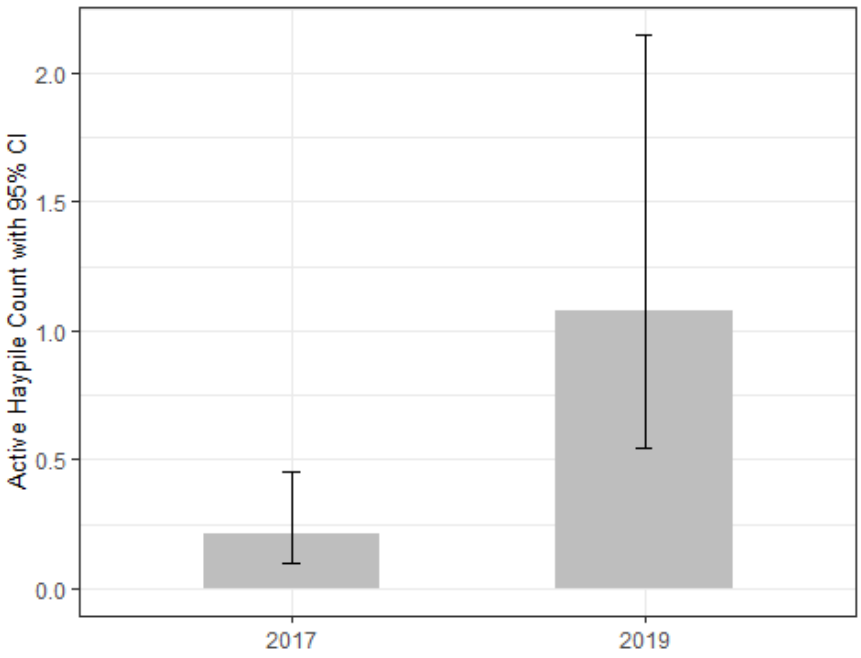

Figure B: Estimated Mean Count of Active Haypiles in 2017 and 2019
(Mean counts are standardized to 0.039 ha survey area)

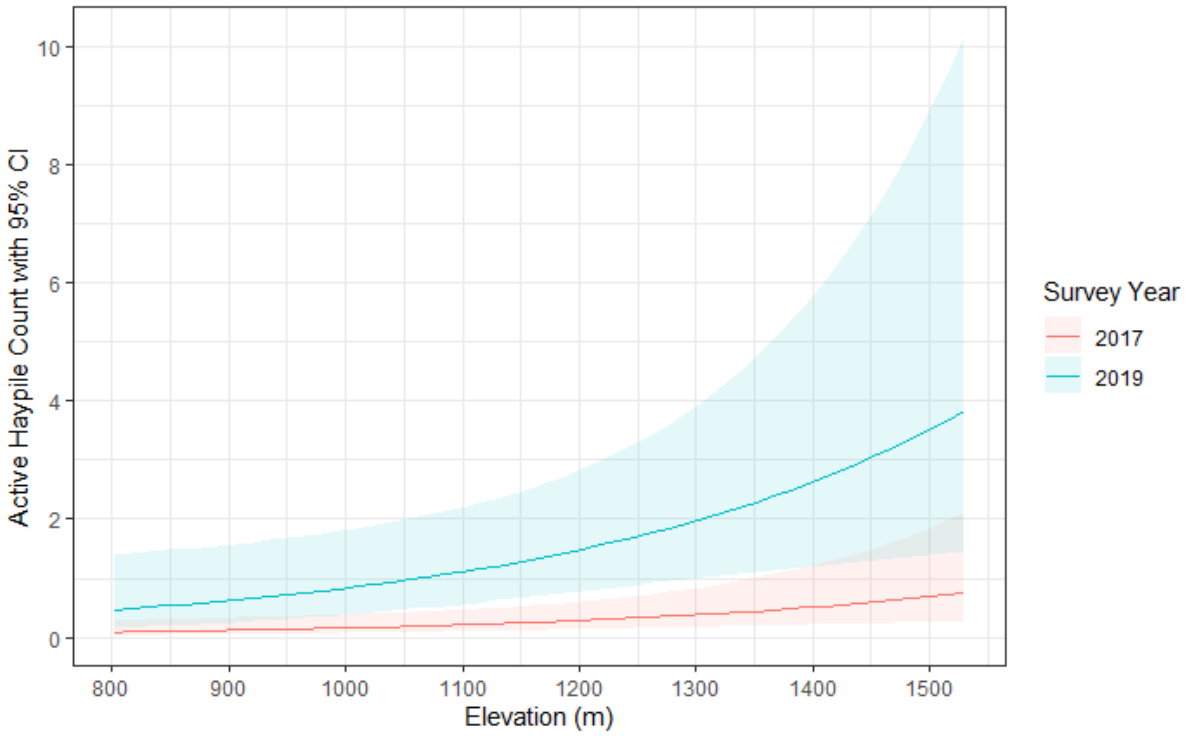

Figure C: Estimated Mean Count of Active Haypiles Across Varying Elevations in 2017 and 2019
(Mean counts are standardized to 0.039 ha survey area)

Table 2: Estimates of the Number (Count) and Density of Active Haypiles in Each Survey Year when the Effect of Elevation is Held Constant

Survey Year	Mean Count[1]	Count SE	Count 95% CI	Mean Density (#/ha)	Density SE	Density 95% CI
2017	0.21	0.083	0.10-0.46	5.3	2.11	2.4-11.6
2019	1.08	0.379	0.54-2.15	27.5	9.64	13.8-54.6

[1] Count is standardized to a 0.039 ha search area, the average area searched across all sites.

The model selected to estimate the presence of pika (the top model) included the covariates survey year, distance to ASR and elevation. Pika probability of occurrence was estimated to be more than five times higher in 2019 than in 2017 (Figure D and Table 3). Pika occurrence was also found to increase with increasing elevation (Figure E) and with distance from ASR (Figure F). The model parameter estimates, and test statistics (presented in Appendix C) indicate there is high confidence in the effect of survey year ($p = 0.016$), moderately-high confidence in the effect of elevation ($p = 0.071$) and moderate confidence in the effect of distance to ASR ($p = 0.162$).

The conditional R^2 is 0.51, indicating that 51% of the variability in the probability of occurrence of pika is explained by survey year, elevation, distance to ASR and the variability between talus sites not accounted for by the fixed effects. When the effect of talus location (the random effect) is removed, the marginal R^2 is 0.34, indicating that 34% of the variability between talus locations is explained by survey year and elevation. The difference between the marginal and conditional R^2 indicates additional factors may help explain variability in pika presence and should be explored and considered in future modeling with the objective of improving the precision of estimates.

The pika occurrence model shows patterns that are similar and consistent with the active haypile abundance model. Distance to ASR was found to help explain pika occurrence (with moderate confidence) though not active haypile abundance. This pattern can be further explored as new data is collected and will become an important element of future analyses after construction of the ASR.

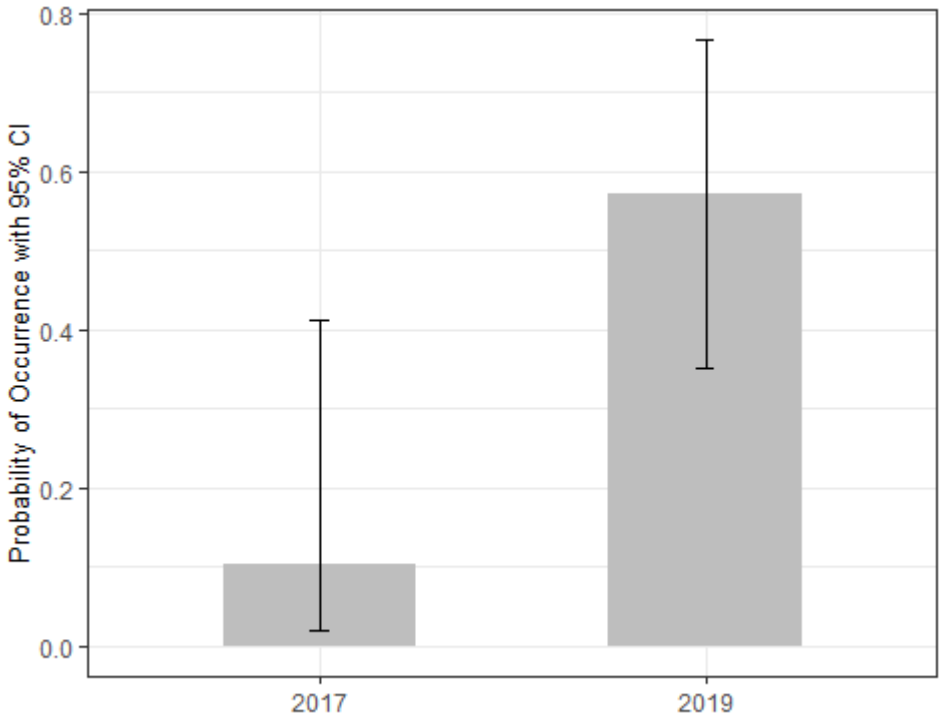

Figure D: Estimated Pika Probability of Occurrence in 2017 and 2019

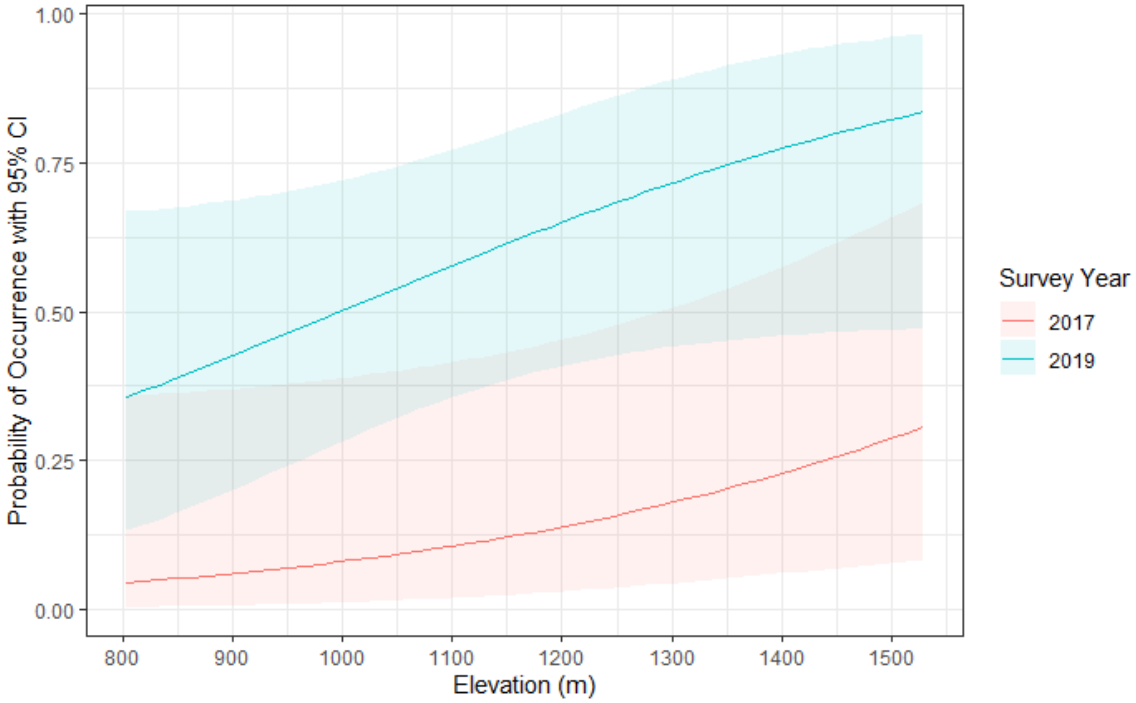

Figure E: Estimated Pika Probability of Occurrence Across Varying Elevations in 2017 and 2019

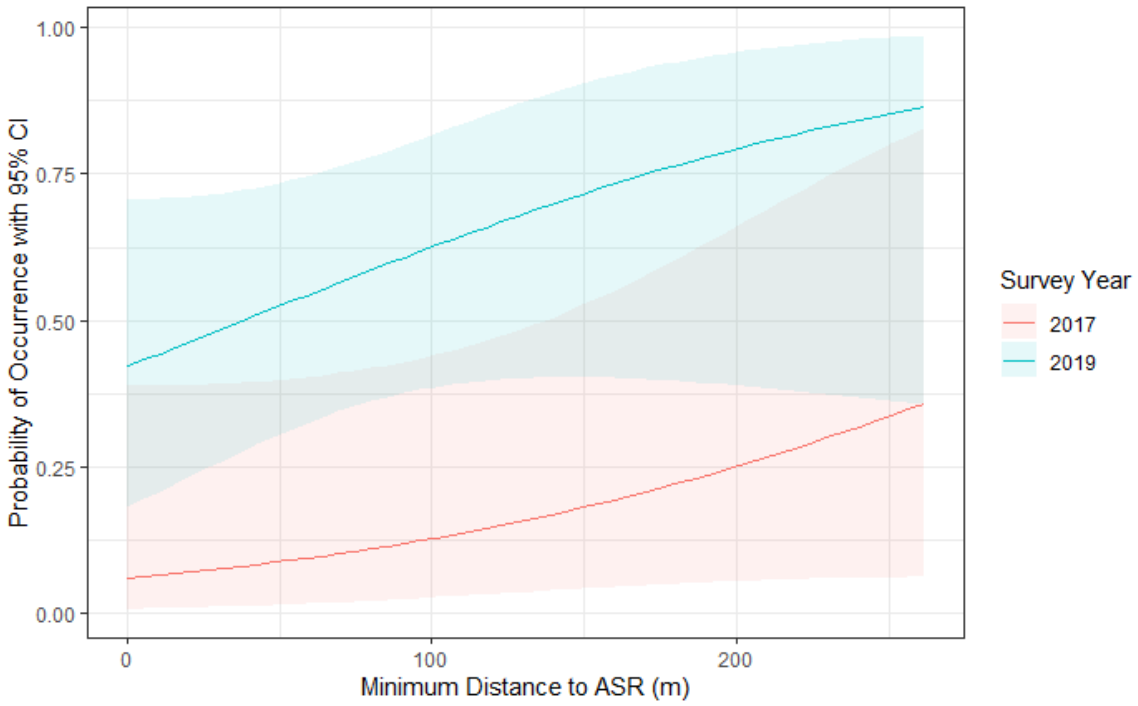

Figure F: Estimated Pika Probability of Occurrence Across Varying Distance to ASR in 2017 and 2019

Table 3: Estimated Pika Occurrence in Each Survey Year when the Effect of Elevation and Distance to ASR is Held Constant

Survey Year	**Mean** Occupancy	**Occupancy** SE	**Occupancy** 95% CI
2017	0.10	0.085	0.02-0.41
2019	0.57	0.113	0.35-0.77

Previous studies of pika have shown a strong influence of climate and weather factors on pika distribution and abundance: pikas have low tolerance to high temperatures in summer, low temperatures in winter, and low snow accumulation (Bruggeman 2010; COSEWIC 2011). It is possible that weather and climate factors contributed to the observed differences between survey years. This relationship could not be statistically explored in this study given the lack of climate and weather data for individual or groups of talus sites. Summaries of several weather parameters (Figure G) indicate that 2017 had higher summer temperatures and lower annual precipitation than in 2019. Winters 2016 and 2017 were also warmer (average winter temperatures) than in 2018 and 2019.

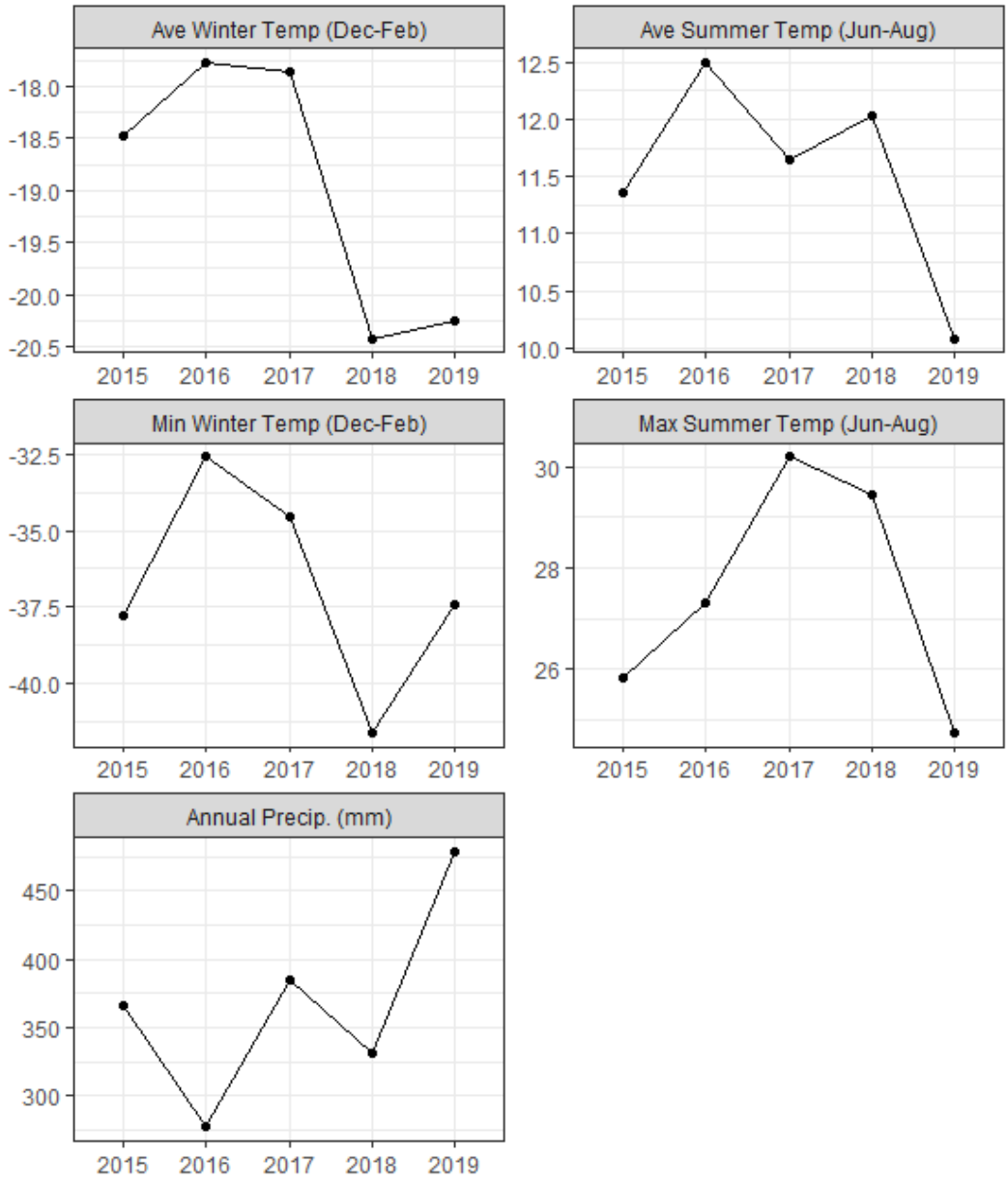

Figure G: Summary of Selected Weather Parameters that may Influence Pika Abundance and Distribution

3.2 Pre-Construction

Four talus sites occur within 25 m of the PWR and were surveyed for pika and pika sign as part of pre-construction monitoring: CZN-15-PK-1 and -2, CZN-16-PK-3 and CZN-32-PK-4 (Table 4). The surveyors also delineated the area of these four talus sites and available meadow which are integrated throughout this report and summarized in Appendix A.

Surveyors detected 42 active and inactive haypiles within 25 m of the PWR alignment. Of the 42 haypiles, 23 were active and 19 inactive (Table 2).

While foraging in meadows, collared pika typically remain within 10 m of the protective cover of the talus. Meadow habitat is available at all four talus sites and often extends across valleys well beyond 10 m from the talus (Photos 1 to 5). Meadows commonly occur at the toe of talus slopes and sometimes up along the talus perimeter and inside the talus itself. The area of meadow inside the talus was not estimated.

Meadow at the eastern portion of CZN-32-PK-4 is influenced by the presence of the existing 1980s road. Here the existing 1980s road is providing meadow habitat as it regenerates to willow and grasses (Photos 1 and 5). Since the PWR follows the existing 1980s road, the PWR results in a loss of pika meadow at CZN-32-PK-4. The PWR avoids the loss of talus sites and meadow at all other sites. Refer to Section 3.3.1 for pika habitat loss estimates resulting from the PWR.

Photo 1: Looking across the eastern edge of CZN-32-PK-4 towards the existing 1980s road immediately downslope of the talus site. Red line approximates the nearest edge of the existing road (2.7 m). Note that the existing road is downslope of the talus but is not shown well on this photo.

Table 4: 2019 Pre-Construction Monitoring Results

Talus Site Name	Minimum Distance to PWR Centreline (m)	Total Area		Within the 25 m Survey Area			Within 10 m of the PWR Footprint[2]
		Talus Site (ha)	Available Meadow[1] (ha)	Talus Site (ha)	Available Meadow (ha)	# of Haypiles (active/inactive) in 2019	# of Haypiles (active/inactive) in 2019
CZN-15-PK-1	7	0.291	0.266	0.134	0.029	3/3	1/0
CZN-15-PK-2	4	0.155	0.112	0.069	0.009	6/5	1/2
CZN-16-PK-3	7	0.078	0.058	0.034	0.001	3/0	0/0
CZN-32-PK-4	6	0.044	0.083	0.044	0.083	11/11	3/2
Total		**0.568**	**0.519**	**0.281**	**0.123**	**23/19**	**5/4**

1. Available meadow is defined as meadow and or open forest habitat within 10 m of each talus site. Although meadow habitat extends well beyond the talus sites, pika commonly use only the first 10 m of meadow.
2. PWR footprint includes the full construction width.

Photo 2: On the existing 1980s winter road looking west across CZN-15-PK-1 to the meadow below in valley (meadow on east perimeter of talus site not shown). West boundary of talus site shown as blue line.

Photo 3: Standing at the toe looking upslope across talus site CZN-15-PK-2 (full extent of toe meadow not shown), the existing 1980s winter road (red line), and the meadow along the eastern perimeter of the talus site.

Photo 4: Looking north across the meadow in the valley, CZN-16-PK-3, and existing 1980s winter road (red line).

Photo 5: Looking downslope across CZN-32-PK-4 towards the meadow to Sundog Creek and the existing 1980s winter road (red line; approx. 12 m from edge of talus in this photo. See Photo 1 showing the existing road as close as 2.7 m to eastern edge of this talus site).

3.3 Habitat Loss Estimates

During the June 2019 technical session for the Phase 1 road [now the PWR], Parks Canada requested a table that:

1. summarizes the total area of available pika habitat

2. provides the total amount of pika habitat that could be affected by the proposed road

3. identifies which pika habitat sites are occupied

Upon review of the habitat loss table, Parks Canada requested a figure and updates to the table to better differentiate between talus and meadow habitat loss.

These updated are provided below for the PWR.

3.3.1 Pioneer Winter Road

Since the PWR follows that of the existing 1980's road at and near the talus sites, the PWR centerline alignment and orthophotos of the existing road were used to prepare the PWR footprint shapefile. The PWR footprint was then overlaid on the pika talus sites using a geographic information system (GIS) to estimate the area of pika habitat loss (Table 5; Figures 2a to 2m). PWR habitat loss estimates will be generally lower from the Phase 1 estimates presented early in the 2019 technical memo since the PWR construction does not require cut and fill.

Yukon Government suggests that winter construction should avoid destroying talus occupied by overwintering pika (Julie Thomas, pers. comm. Yukon Government). CZN also committed to avoiding direct loss to meadow within 10 m of talus sites. Habitat loss calculations, for talus sites and associated meadow, are reported separately in Table 4 in response to Park Canada's request described above.

Construction of the PWR avoids direct loss to talus sites (0 ha direct loss) and currently results in 0.021 ha of temporary loss to available meadow at CZN-32-PK-4 because the 1980s road, which the PWR follows, is regenerating and providing some meadow habitat for pika at this site. Construction of the PWR does not damage the regenerating grasses in the meadow but does delay the snowmelt and spring availability of this portion of meadow to pika. This is a temporary loss to approximately 25% of the total meadow available at CZN-32-PK-4. Refer to Section 3.3.1.1 for adaptive management action below.

Table 5: Collared Pika Habitat Loss from the Pioneer Winter Road

Talus Site Name	Min. Distance to PWR Centreline (m)	Total Area		Activity			Habitat Loss from the Pioneer Winter Road[1]	
		Talus Site (ha)	Meadow[1] (ha)	2019	2017	2016	Direct Loss to Talus Site (ha)	Temporary Loss of Meadow Availability (ha)
CZN-15-PK-1	7	0.291	0.266	Active	Active	NS	0	0
CZN-15-PK-2	4	0.155	0.112	Active	Active	NS	0	0
CZN-15-PK-3	35	0.089	-	Active	Inactive	NS	0	0
CZN-16-PK-1	124	0.023	-	Active	Inactive	NS	0	0
CZN-16-PK-2	210	0.017	-	Active	Inactive	NS	0	0
CZN-16-PK-3	7	0.078	0.058	Active	Inactive	NS	0	0
CZN-16-PK-4	94	0.137	-	Active	Inactive	Inactive	0	0

Table 5: Collared Pika Habitat Loss from the Pioneer Winter Road

Talus Site Name	Min. Distance to PWR Centreline (m)	Total Area		Activity			Habitat Loss from the Pioneer Winter Road[1]	
		Talus Site (ha)	Meadow[1] (ha)	2019	2017	2016	Direct Loss to Talus Site (ha)	Temporary Loss of Meadow Availability (ha)
CZN-16-PK-5	64	0.151	-	Inactive	Inactive	NS	0	0
CZN-16-PK-6	47	0.206	-	Active	Inactive	NS	0	0
CZN-16-PK-7	86	0.088	-	Active	Inactive	NS	0	0
CZN-17-PK-1	53	0.011	-	Inactive	NS	NS	0	0
CZN-17-PK-2	55	0.041	-	Active	Inactive	NS	0	0
CZN-18-PK-1	158	0.754	-	Inactive	Active	NS	0	0
CZN-24-PK-1	206	0.174	-	Active	Inactive	NS	0	0
CZN-25-PK-1	224	0.170	-	Active	Active	NS	0	0
CZN-25-PK-2	267	0.093	-	Active	Active	NS	0	0
CZN-26-PK-1	230	0.041	-	Active	Inactive	NS	0	0
CZN-28-PK-1	203	0.093	-	Active	NS	NS	0	0
CZN-32-PK-1*	277	0.116	-	NS	NS	NS	0	0
CZN-32-PK-2	164	0.056	-	Active	Inactive	NS	0	0
CZN-32-PK-3	124	0.018	-	Inactive	Inactive	NS	0	0
CZN-32-PK-4	6	0.044	0.083	Active	Active	Inactive	0	0.021
CZN-32-PK-5*	117	0.223	-	NS	NS	NS	0	0
CZN-32-PK-6*	408	0.046	-	NS	NS	NS	0	0
CZN-32-PK-7	104	0.046	-	Inactive	Inactive	NS	0	0
CZN-33-PK-1*	425	0.297	-	NS	NS	NS	0	0
CZN-33-PK-2	61	0.033	-	Active	Inactive	NS	0	0
CZN-33-PK-3	51	0.040	-	Inactive	Inactive	NS	0	0
CZN-33-PK-4	73	0.081	-	Active	Inactive	NS	0	0
CZN-34-PK-1	68	0.134	-	Active	Active	Inactive	0	0
CZN-34-PK-2	160	0.006	-	Inactive	Inactive	NS	0	0
CZN-34-PK-3	162	0.003	-	Inactive	Inactive	NS	0	0
CZN-34-PK-4	142	0.041	-	Inactive	Inactive	NS	0	0
CZN-34-PK-5	122	0.007	-	Inactive	Inactive	NS	0	0
CZN-34-PK-6*	321	0.175	-	NS	NS	NS	0	0
CZN-34-PK-7	135	0.003	-	Inactive	Inactive	Inactive	0	0
CZN-35-PK-1	147	0.097	-	Active	Inactive	Inactive	0	0
CZN-35-PK-2*	265	0.233	-	NS	NS	NS	0	0
CZN-35-PK-3*	352	0.043	-	NS	NS	NS	0	0
CZN-37-PK-1	120	0.044	-	Inactive	Inactive	NS	0	0
CZN-37-PK-2	97	0.010	-	Inactive	Inactive	NS	0	0
CZN-37-PK-3	110	0.016	-	Inactive	Inactive	Inactive	0	0
CZN-37-PK-4	61	0.060	-	Inactive	Inactive	NS	0	0
CZN-37-PK-5	83	0.008	-	Inactive	Inactive	Inactive	0	0
CZN-38-PK-1	61	0.041	-	Inactive	Inactive	NS	0	0
Total		**4.534**					**0**	**0.021**

1. Includes the full construction footprint of the PWR.

NS = Not ground surveyed for pika or pika sign

* Talus sites that likely meet pika habitat criteria based on aerial reconnaissance. Not ground-surveyed for pika and pika sign.

3.3.1.1 Adaptive Management

Adaptive management action is required when winter construction results in a direct loss to talus sites and/or available meadow, as determined by the pre-construction survey. The 2019 pre-construction survey resulted in the identification of 0.021 ha of temporary loss to available meadow at CZN-32-PK-4, and thus, does not trigger adaptive management action. Nonetheless, there is opportunity to re-align the PWR further away from the site.

Road survey work is planned in August 2021 to finalize minor road re-alignments to avoid pika meadow at the eastern end of CZN-32-PK-4. The extent of re-alignment will be reported following the road survey work.

A pre-construction monitoring survey is also planned in August 2021. During the field survey, metal stakes (clearly marked with orange paint) will be installed along the PWR to direct construction and snowplow operators where the storage and deposit of snow on talus sites and the surrounding meadow is prohibited.

Criteria to determine where the storage and deposit of snow and rock is prohibited are: 1) where talus sites are downslope of the PWR, and 2) where talus sites and meadows exist at the edge of the existing 1980s road and thus the PWR. Approximate locations of the metal stakes will be between:

- CZN-15-PK-1: KP 14.98 to 15.19
- CZN-15-PK-2: KP 15.27 to 15.4
- CZN-16-PK-3: KP 16.48 to 16.52
- CZN-32-PK-4: KP 32.62 to 32.72

The approximate location of these metal stakes are provided in the WMMP's Appendix A Mapbook, which will be updated after the pre-construction monitoring survey with the final locations of the metal stakes.

3.3.2 All-Season Road

The ASR alignment is considered final, but small realignments (e.g., by a few metres) to avoid talus sites and available meadow, are yet to be finalized. A road survey is planned this fall 2021 where there is potential overlap of the PWR/ASR and talus sites/meadow to finalize the alignments. Pika habitat loss estimates, as result of the ASR construction will be provided at a later date.

3.3.2.1 Adaptive Management

CZN is designing the ASR alignment to avoid talus sites and meadow to the extent possible. Since 2016, the ASR has undergone various re-alignments to avoid 15 talus sites and this work continues. Re-alignments to date are summarized below and shown on Figure 3:

KP 16.1: re-aligned the ASR by approximately 60 m to avoid CZN-16-PK-1 (Figure 3, Inset 1).

KP 16.5: re-aligned the ASR approximately 3 m upslope to further avoid CZN-16-PK-3 (Figure 3, Inset 1).

KP 33.0 to 35.2 and KP 36.8 to 37.4: re-aligned portions of the ASR along this segment to avoid 13 talus sites (Figure 3, Insets 2, 3, and 4). As first reported in the 2016 baseline report (Tetra Tech 2016), CZN directed Allnorth to move the proposed ASR alignment, to the extent possible, off the talus in the vicinity of lower Sundog Creek. As a result, the ASR alignment was moved onto the Sundog Creek floodplain and/or to the floodplain edge, to the extent possible.

4.0 CLOSURE

We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

Prepared by:
Karla Langlois, B.Sc., P.Biol.
Biologist
Environment & Water Practice
Direct Line: 867.675.0254
Karla.Langlois@tetratech.com

Prepared by:
Jeff Matheson, M.Sc., R.P.Bio., P.Biol.
Senior Biologist
Environment & Water Practice
Direct Line: 604.612.6457
Jeff.Matheson@tetratech.com

Reviewed by:
Tania Perzoff, M.Sc., R.P.Bio.
Senior Regulatory Specialist
Environment & Water Practice
Direct Line: 778.945.5717
Tania.Perzoff@tetratech.com

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REFERENCES

Barton, K. 2020. MuMIn: Multi-Model Inference. R package version 1.43.17. https://CRAN.R-project.org/package=MuMIn

Bruggeman, J.E., 2010. Pilot Study on Factors Affecting Pika Populations in the North Cascades Ecosystem. Farmington, Minnesota, 82 pp.

Douglas, B.., M. Maechler, B. Bolker, and S. Walker. 2015. Fitting Linear Mixed-Effects Models Using lme4. Journal of Statistical Software, 67(1), 1-48. doi:10.18637/jss.v067.i01.

Carroll, M. 2016. Condition Monitoring of the Collared Pika (Ochotona collaris), 2015 Field Operations Report Nahanni National Park Reserve. Parks Canada Agency. 19 pp.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2011. COSEWIC Assessment and Status Report on the Collared Pika (*Ochotona collaris*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. 50 pp.

Franken, R.J. 2002. Demography and metapopulation dynamics of collared pikas in the southwestern Yukon. MSc. Thesis, University of Alberta. 149 pp.

Hartig, F. 2021. DHARMa: Residual Diagnostics for Hierarchical (Multi-Level / Mixed) Regression Models. R package version 0.4.3.

Lenth, R. 2021. emmeans: Estimated Marginal Means, aka Least-Squares Means. R package version 1.6.2-2. https://CRAN.R-project.org/package=emmeans

Morrison, S.F. and D.S. Hik. 2008. When? Where? And for how long? Census design considerations for an alpine lagomorph, the Collared Pika (*Ochotona collaris*). Lagomorph Biology: 103-113.

Moyer-Horner, L., E.A. Beever, D.H. Johnson, M. Biel, and J. Belt. 2016. Predictors of current and longer-term patterns of abundance of American pikas (Ochotona princeps) across a leading-edge protected area. PLoSOne 11(11): e0167051. Web access: Predictors of Current and Longer-Term Patterns of Abundance of American Pikas (Ochotona princeps) across a Leading-Edge Protected Area (nih.gov)

Nakagawa, S. and H. Schielzeth. 2013. A general and simple method for obtaining R^2 from Generalized Linear Mixed-effects Models. Methods in Ecology and Evolution 4: 133–142

Owchar, R. 2016. EI Monitoring and Reporting Program, Pika Monitoring Protocol for the Montane Cordillera Bioregion, Version 2. Parks Canada Agency. 24 pp.

R Core Team. 2021. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing. Vienna, Austria. https://www.R-project.org.

Resources Inventory Committee (RISC). 1998. Inventory Methods for Pikas and Sciurids: Pikas, Marmots, Woodchuck, Chipmunks and Squirrels. Web access: https://www.for.gov.bc.ca/hts/risc/pubs/tebiodiv/pisc/index.htm

Tetra Tech Canada Inc. 2016. July 2016 Vegetation and Wildlife Baseline Surveys, Prairie Creek All-Season Road. 130 pp.

Tetra Tech Canada Inc. 2017. 2017 Baseline Wildlife and Vegetation Field Report Proposed Prairie Creek All-Season Access Road. 79 pp.

Tetra Tech Canada Inc. 2019. Prairie Creek Proposed Phase 1 Road, Collared Pika Habitat Loss Estimates. Technical Memo, November 14, 2019.

FIGURES

410000 411000 412000 413000 414000 415000 416000 417000 418000 419000

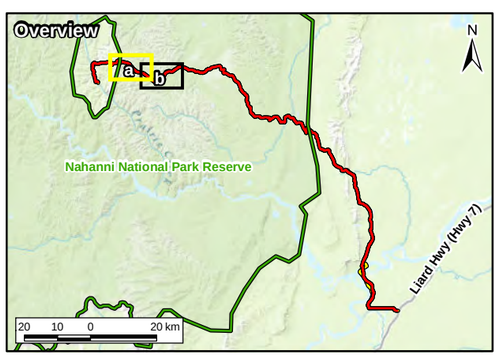
6832000 6831000 6830000 6829000

CZN-16-PK-2
CZN-16-PK-1
KP 16
CZN-16-PK-3
CZN-15-PK-3
CZN-16-PK-7
CZN-15-PK-2
KP 17
KP 18
CZN-17-PK-1
KP 19
CZN-15-PK-1
CZN-17-PK-2
KP 15
CZN-16-PK-6
CZN-18-PK-1
CZN-16-PK-5
KP 20
CZN-16-PK-4
KP 21
Nahanni National Park Reserve
KP 22
KP 23
KP 24
KP 25
CZN-24-PK-1
KP 26
CZN-25-PK-1
CZN-25-PK-2
CZN-26-PK-1

N W E S

LEGEND

- Pika Talus Site
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]
- Nahanni National Park Reserve Boundary
- Watercourse



NOTES
1. Pioneer Winter Road only visible where it differs from the All-Season Road.

Base data sources:
2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.
Nahanni National Park Reserve of Canada.
Imagery from ESRI; Maxar (2018/2019).
Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Overview

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:25,000
500 250 0 500
Metres

FILE NO.
EENW03326-02_Figure01_Overview.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MRV	SL	KL	0

DATE	PROJECT NO.
August 18, 2021	ENW.EENW03326-02

TETRA TECH

Figure 1a

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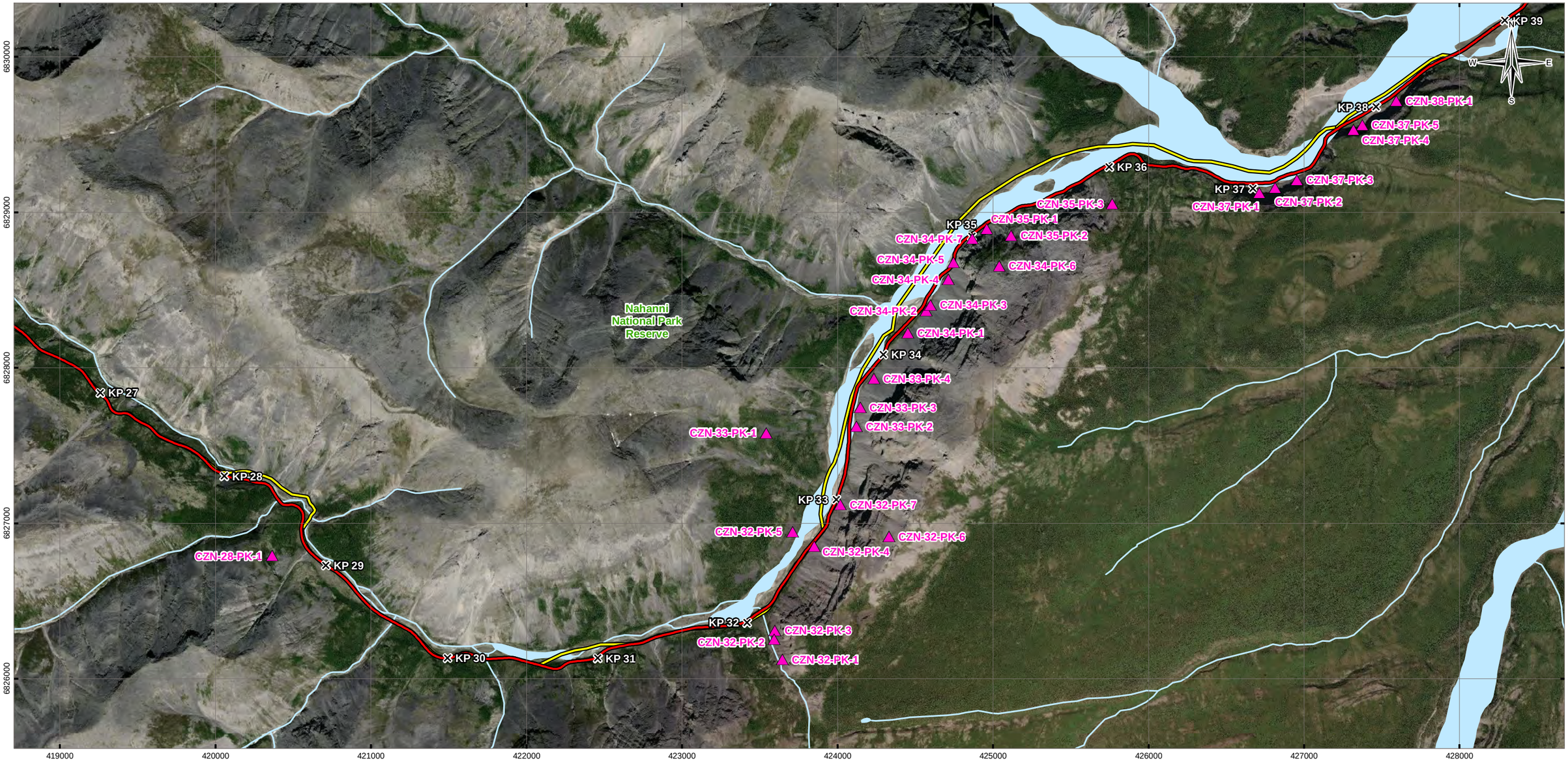

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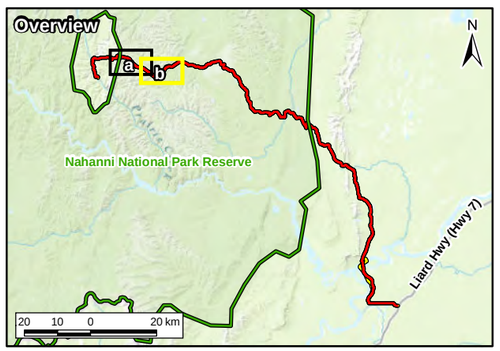
LEGEND

- Pika Talus Site
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]
- Nahanni National Park Reserve Boundary
- Watercourse
- Waterbody



NOTES
1. Pioneer Winter Road only visible where it differs from the All-Season Road.

Base data sources:
2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.
Nahanni National Park Reserve of Canada.
Imagery from ESRI; Maxar (2018/2019).
Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Overview

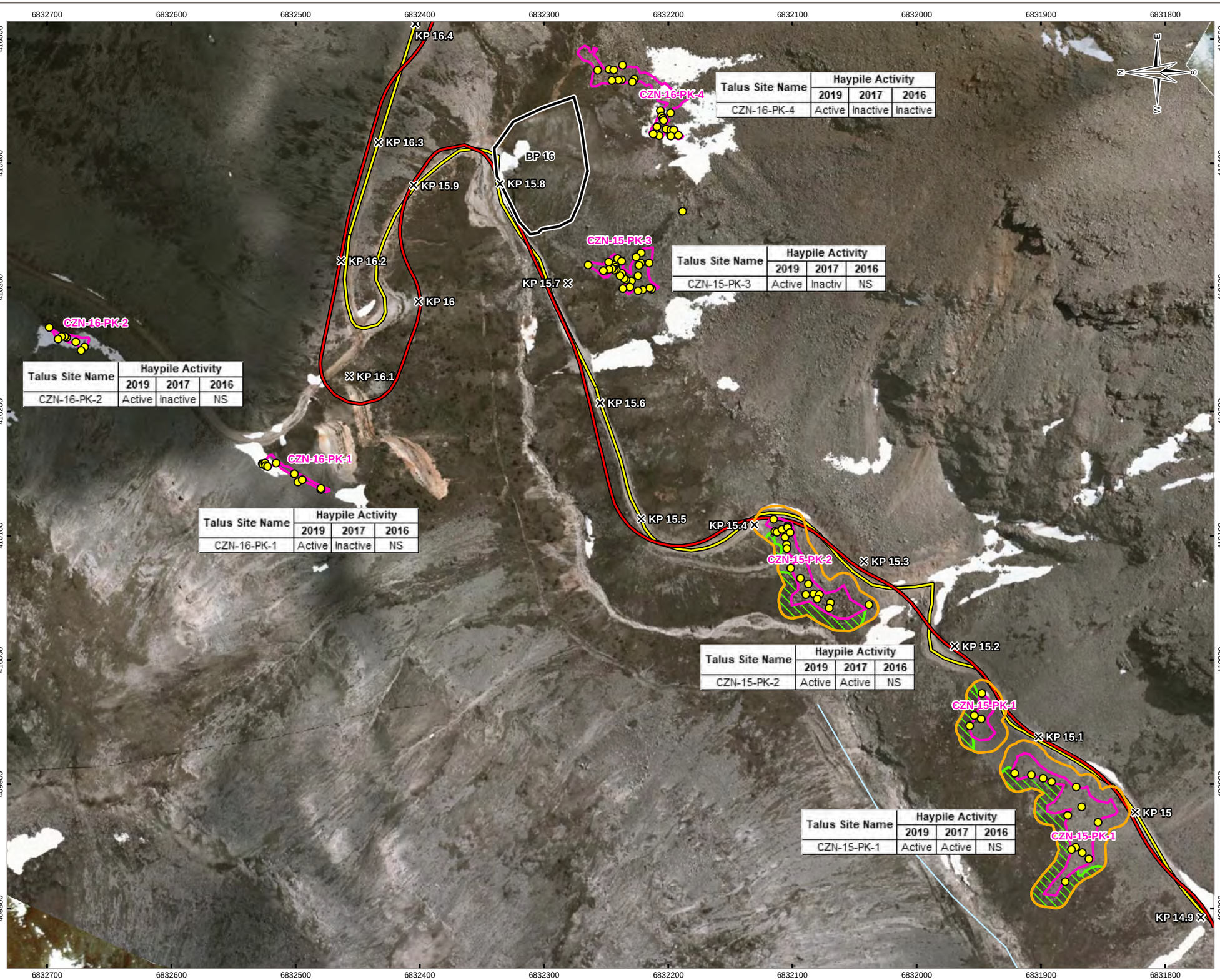
PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:25,000
500 250 0 500
Metres

TETRA TECH

FILE NO.				
EENW03326-02_Figure01_Overview.mxd				
OFFICE	**DWN**	**CKD**	**APVD**	**REV**
Tt-VANC	MRV	SL	KL	0
DATE	**PROJECT NO.**			
August 18, 2021	ENW.EENW03326-02			

Figure 1b

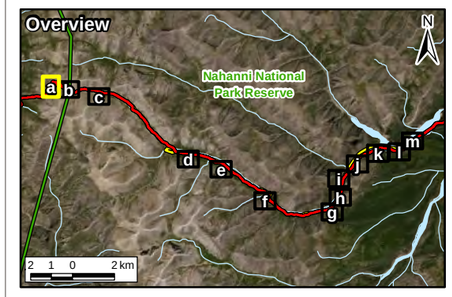


LEGEND

- Haypile
- 10 m Buffer
- Available Meadow
- Pika Talus Site
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]
- Borrow Pit

Base Data

- Watercourse/Waterbody



NOTES

1. Pioneer Winter Road only visible where it differs from the All-Season Road.
NS = Not Surveyed
Base data sources:
2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.
Nahanni National Park Reserve of Canada.
Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.
Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Details

PROJECTION UTM Zone 10	**DATUM** NAD83	**CLIENT** CANADIAN ZINC CORPORATION
Scale: 1:3,000 — 50 25 0 50 — Metres		TETRA TECH
FILE NO. EENW03326-02_Figure02_TalusDetails.mxd		
OFFICE Tt-VANC	**DWN** MRV / **CKD** SL / **APVD** KL / **REV** 0	**Figure 2a**
DATE August 18, 2021	**PROJECT NO.** ENW.EENW03326-02	

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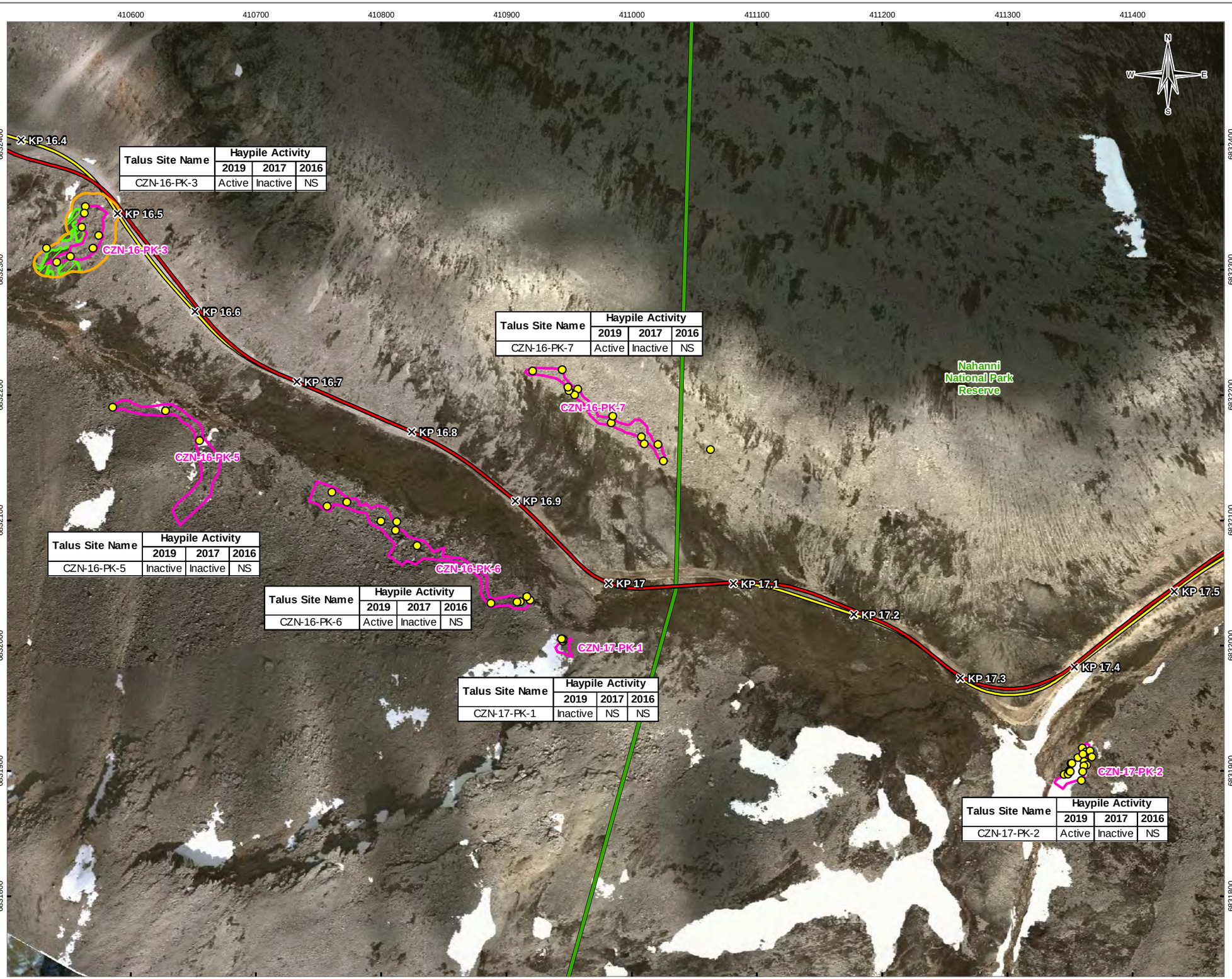


Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-16-PK-3	Active	Inactive	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-16-PK-7	Active	Inactive	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-16-PK-5	Inactive	Inactive	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-16-PK-6	Active	Inactive	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-17-PK-1	Inactive	NS	NS

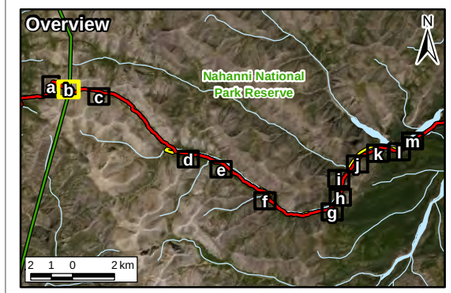
Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-17-PK-2	Active	Inactive	NS

LEGEND

- Haypile
- 10 m Buffer
- Available Meadow
- Pika Talus Site
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]

Base Data

- Watercourse/Waterbody
- Nahanni National Park Reserve Boundary



NOTES
1. Pioneer Winter Road only visible where it differs from the All-Season Road.
NS = Not Surveyed
Base data sources:
2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.
Nahanni National Park Reserve of Canada.
Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.
Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Details

PROJECTION UTM Zone 10	**DATUM** NAD83	**CLIENT** CANADIAN ZINC CORPORATION
Scale: 1:3,000 (50 25 0 50 Metres)		TETRA TECH
FILE NO. EENW03326-02_Figure02_TalusDetails.mxd		
OFFICE Tt-VANC	**DWN** MRV / **CKD** SL / **APVD** KL / **REV** 0	**Figure 2b**
DATE August 18, 2021	**PROJECT NO.** ENW.EENW03326-02	

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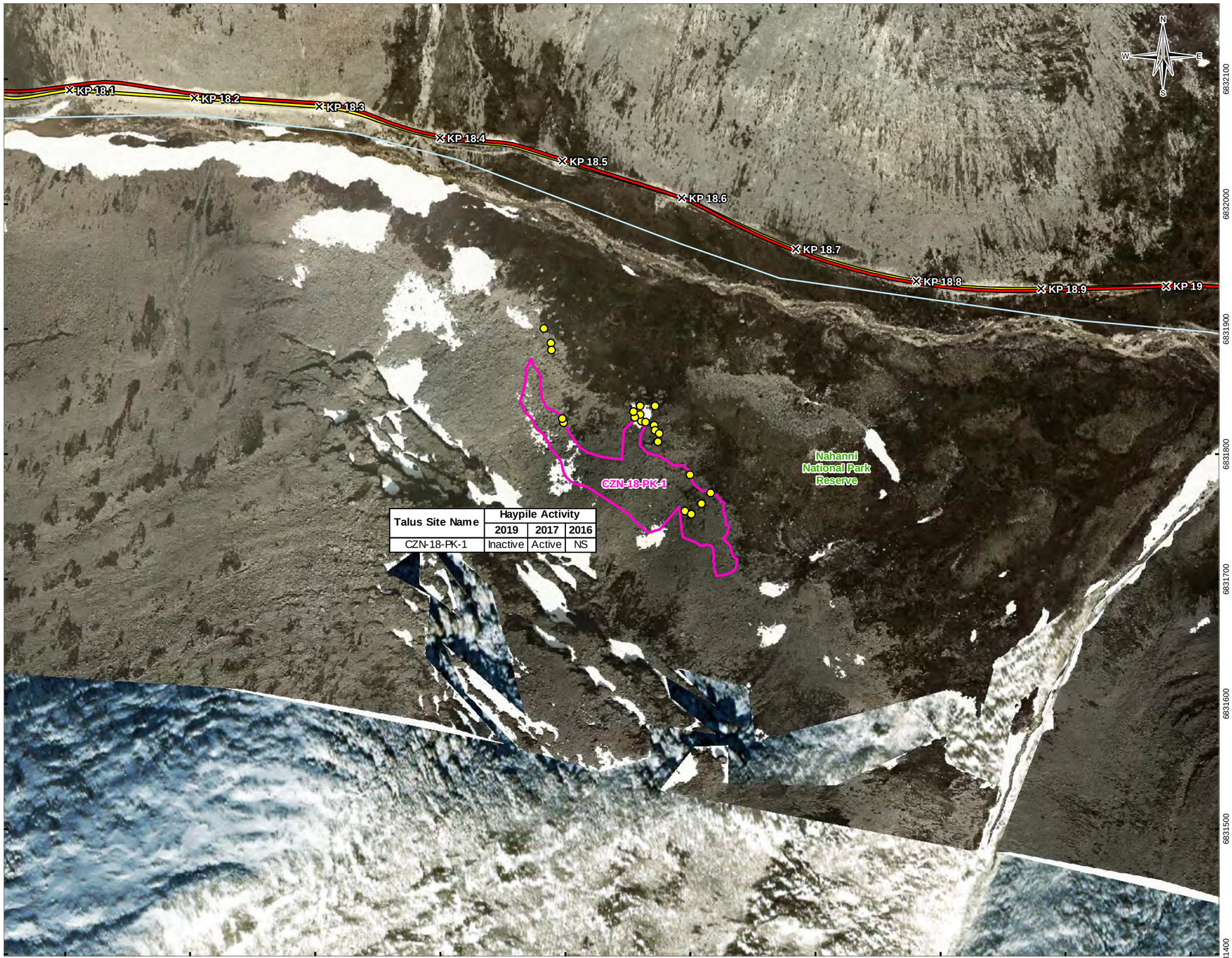


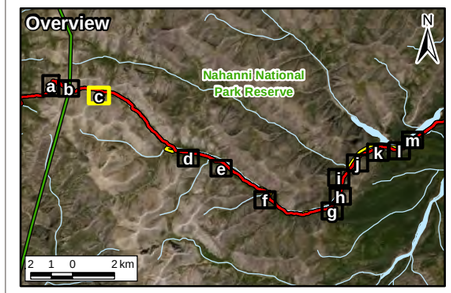
Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-18-PK-1	Inactive	Active	NS

LEGEND

- Haypile
- Pika Talus Site
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]

Base Data

- Watercourse/Waterbody
- Nahanni National Park Reserve Boundary



NOTES
1. Pioneer Winter Road only visible where it differs from the All-Season Road.
NS = Not Surveyed
Base data sources:
2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.
Nahanni National Park Reserve of Canada.
Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.
Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Details

PROJECTION UTM Zone 10	**DATUM** NAD83	**CLIENT** CANADIAN ZINC CORPORATION
Scale: 1:3,000 50 25 0 50 Metres		TETRA TECH
FILE NO. EENW03326-02_Figure02_TalusDetails.mxd		
OFFICE Tt-VANC	**DWN** MRV / **CKD** SL / **APVD** KL / **REV** 0	**Figure 2c**
DATE August 18, 2021	**PROJECT NO.** ENW.EENW03326-02	

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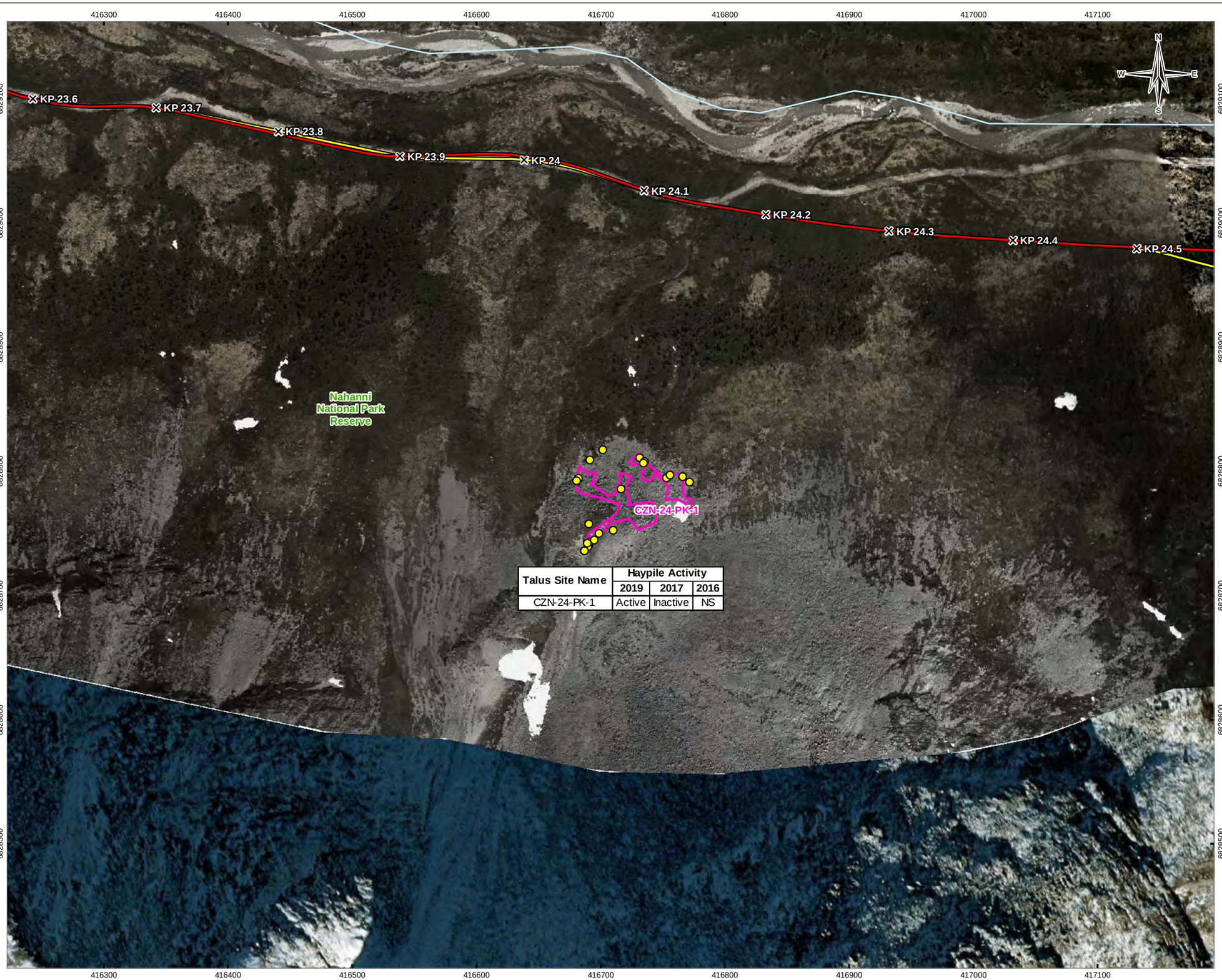


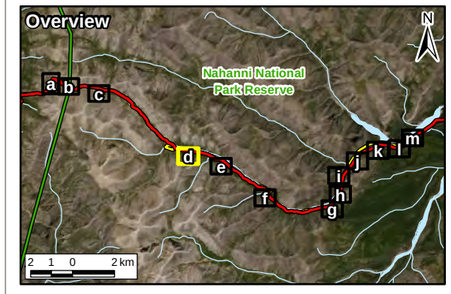
Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-24-PK-1	Active	Inactive	NS

LEGEND

- Haypile
- Pika Talus Site
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]

Base Data

- Watercourse/Waterbody
- Nahanni National Park Reserve Boundary



NOTES

1. Pioneer Winter Road only visible where it differs from the All-Season Road.

NS = Not Surveyed

Base data sources:

2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.

Nahanni National Park Reserve of Canada.

Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.

Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Details

PROJECTION UTM Zone 10	**DATUM** NAD83	**CLIENT** Canadian Zinc Corporation
Scale: 1:3,000 (50 25 0 50 Metres)		
FILE NO. EENW03326-02_Figure02_TalusDetails.mxd		Tetra Tech
OFFICE Tt-VANC	**DWN** MRV / **CKD** SL / **APVD** KL / **REV** 0	**Figure 2d**
DATE August 18, 2021	**PROJECT NO.** ENW.EENW03326-02	

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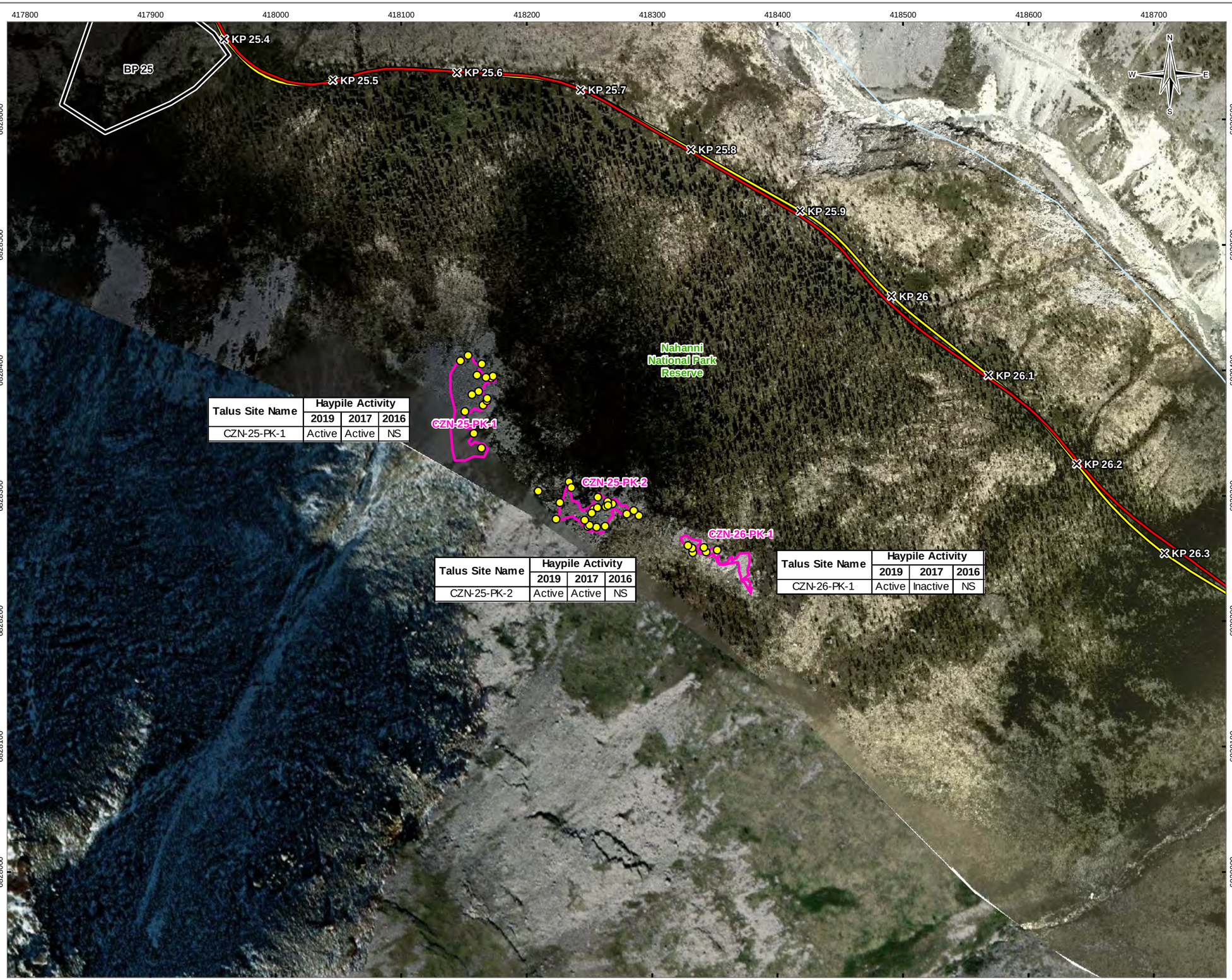

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-25-PK-1	Active	Active	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-25-PK-2	Active	Active	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-26-PK-1	Active	Inactive	NS

LEGEND

- Haypile
- Pika Talus Site
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]
- Borrow Pit

Base Data

- Watercourse/Waterbody
- Nahanni National Park Reserve Boundary

NOTES

1. Pioneer Winter Road only visible where it differs from the All-Season Road.

NS = Not Surveyed

Base data sources:

2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.

Nahanni National Park Reserve of Canada.

Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.

Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Details

PROJECTION UTM Zone 10	**DATUM** NAD83	**CLIENT** CANADIAN ZINC CORPORATION
Scale: 1:3,000 — 50 25 0 50 — Metres		TETRA TECH
FILE NO. EENW03326-02_Figure02_TalusDetails.mxd		

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MRV	SL	KL	0
DATE August 18, 2021	**PROJECT NO.** ENW.EENW03326-02			

Figure 2e

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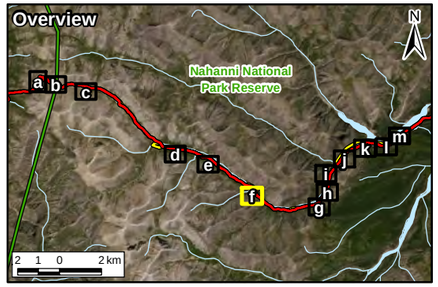
Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-28-PK-1	Active	NS	NS

LEGEND

- Haypile
- Pika Talus Site
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]

Base Data

- Watercourse/Waterbody
- Nahanni National Park Reserve Boundary



NOTES
1. Pioneer Winter Road only visible where it differs from the All-Season Road.
NS = Not Surveyed
Base data sources:
2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.
Nahanni National Park Reserve of Canada.
Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.
Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Details

PROJECTION UTM Zone 10	**DATUM** NAD83	**CLIENT** CANADIAN ZINC CORPORATION
Scale: 1:3,000 — 50 25 0 50 — Metres		TETRA TECH
FILE NO. EENW03326-02_Figure02_TalusDetails.mxd		
OFFICE Tt-VANC	**DWN** MRV / **CKD** SL / **APVD** KL / **REV** 0	**Figure 2f**
DATE August 18, 2021	**PROJECT NO.** ENW.EENW03326-02	

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423200 423300 423400 423500 423600 423700 423800 423900 424000

6826600 6826500 6826400 6826300 6826200 6826100 6826000 6825900

KP 32.3
KP 32.2
KP 32.1
KP 32
KP 31.9
KP 31.8
KP 31.7

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-32-PK-3	Inactive	Inactive	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-32-PK-2	Active	Inactive	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-32-PK-1	NS	NS	NS

CZN-32-PK-3
CZN-32-PK-2
CZN-32-PK-1

Nahanni National Park Reserve

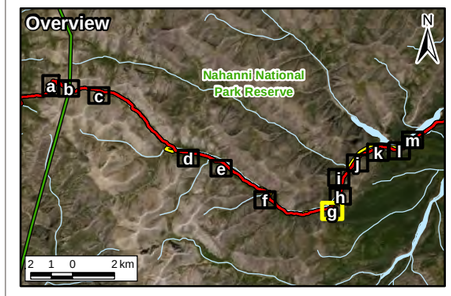
N W E S

LEGEND

- Haypile
- Pika Talus Site
- Possible Pika Talus Site (Aerial Reconnaissance)
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]

Base Data

- Watercourse/Waterbody
- Nahanni National Park Reserve Boundary



NOTES
1. Pioneer Winter Road only visible where it differs from the All-Season Road.
NS = Not Surveyed
Base data sources:
2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.
Nahanni National Park Reserve of Canada.
Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.
Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Details

PROJECTION UTM Zone 10	**DATUM** NAD83	**CLIENT** CANADIAN ZINC CORPORATION
Scale: 1:3,000 50 25 0 50 Metres		TETRA TECH
FILE NO. EENW03326-02_Figure02_TalusDetails.mxd		
OFFICE Tt-VANC	**DWN** MRV / **CKD** SL / **APVD** KL / **REV** 0	**Figure 2g**
DATE August 18, 2021	**PROJECT NO.** ENW.EENW03326-02	

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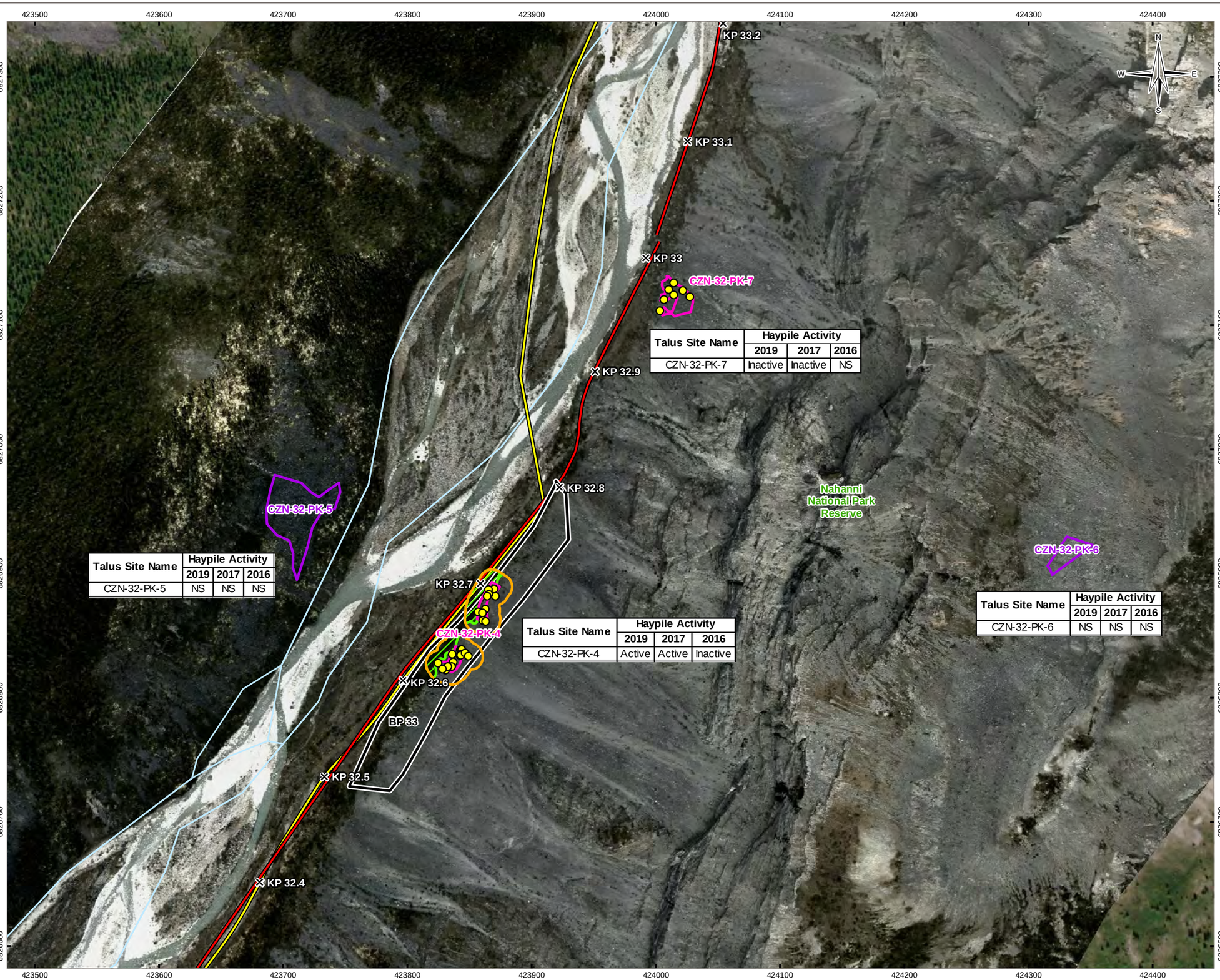

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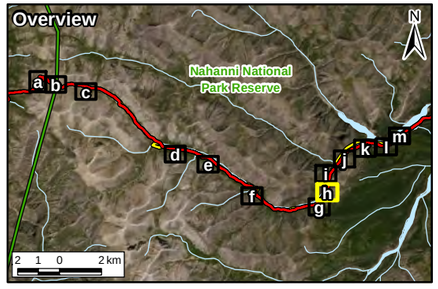
LEGEND

- Haypile
- 10 m Buffer
- Available Meadow
- Pika Talus Site
- Possible Pika Talus Site (Aerial Reconnaissance)
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]
- Borrow Pit

Base Data

- Watercourse/Waterbody
- Nahanni National Park Reserve Boundary



NOTES

1. Pioneer Winter Road only visible where it differs from the All-Season Road.

NS = Not Surveyed

Base data sources:

2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.

Nahanni National Park Reserve of Canada.

Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.

Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Details

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:3,000

50 25 0 50

Metres

TETRA TECH

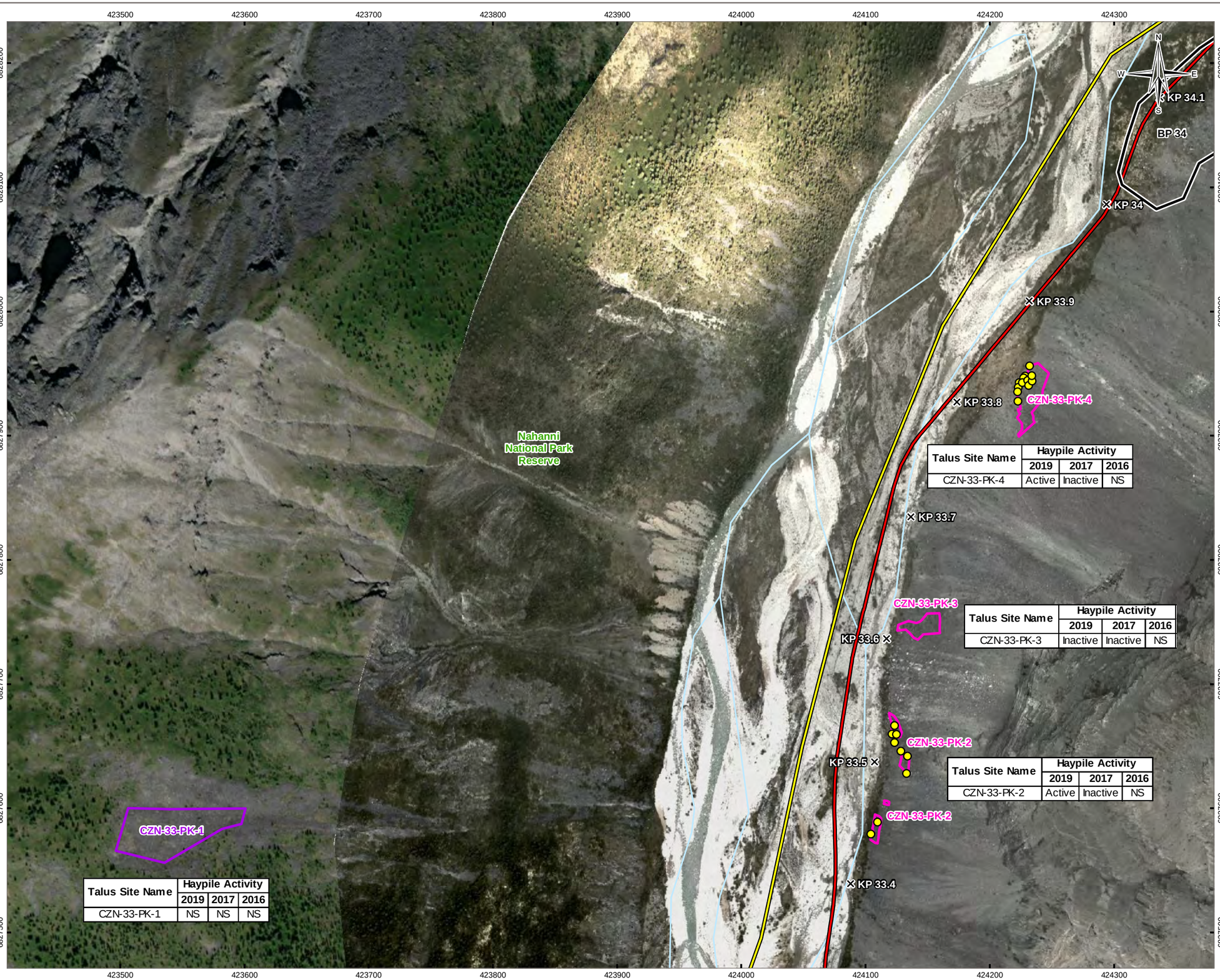
FILE NO.
EENW03326-02_Figure02_TalusDetails.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MRV	SL	KL	0

DATE
August 18, 2021

PROJECT NO.
ENW.EENW03326-02

Figure 2h



Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-33-PK-4	Active	Inactive	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-33-PK-3	Inactive	Inactive	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-33-PK-2	Active	Inactive	NS

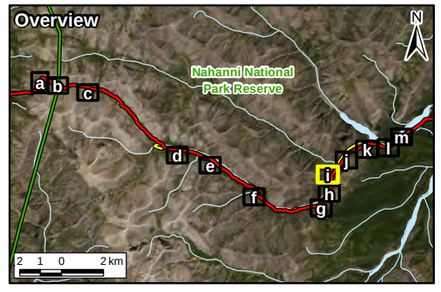
Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-33-PK-1	NS	NS	NS

LEGEND

- Haypile
- Pika Talus Site
- Possible Pika Talus Site (Aerial Reconnaissance)
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]
- Borrow Pit

Base Data

- Watercourse/Waterbody
- Nahanni National Park Reserve Boundary



NOTES

1. Pioneer Winter Road only visible where it differs from the All-Season Road.
NS = Not Surveyed
Base data sources:
2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.
Nahanni National Park Reserve of Canada.
Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.
Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Details

PROJECTION UTM Zone 10	**DATUM** NAD83	**CLIENT** CANADIAN ZINC CORPORATION
Scale: 1:3,000 (50 25 0 50 Metres)		TETRA TECH
FILE NO. EENW03326-02_Figure02_TalusDetails.mxd		
OFFICE Tt-VANC	**DWN** MRV / **CKD** SL / **APVD** KL / **REV** 0	**Figure 2i**
DATE August 18, 2021	**PROJECT NO.** ENW.EENW03326-02	

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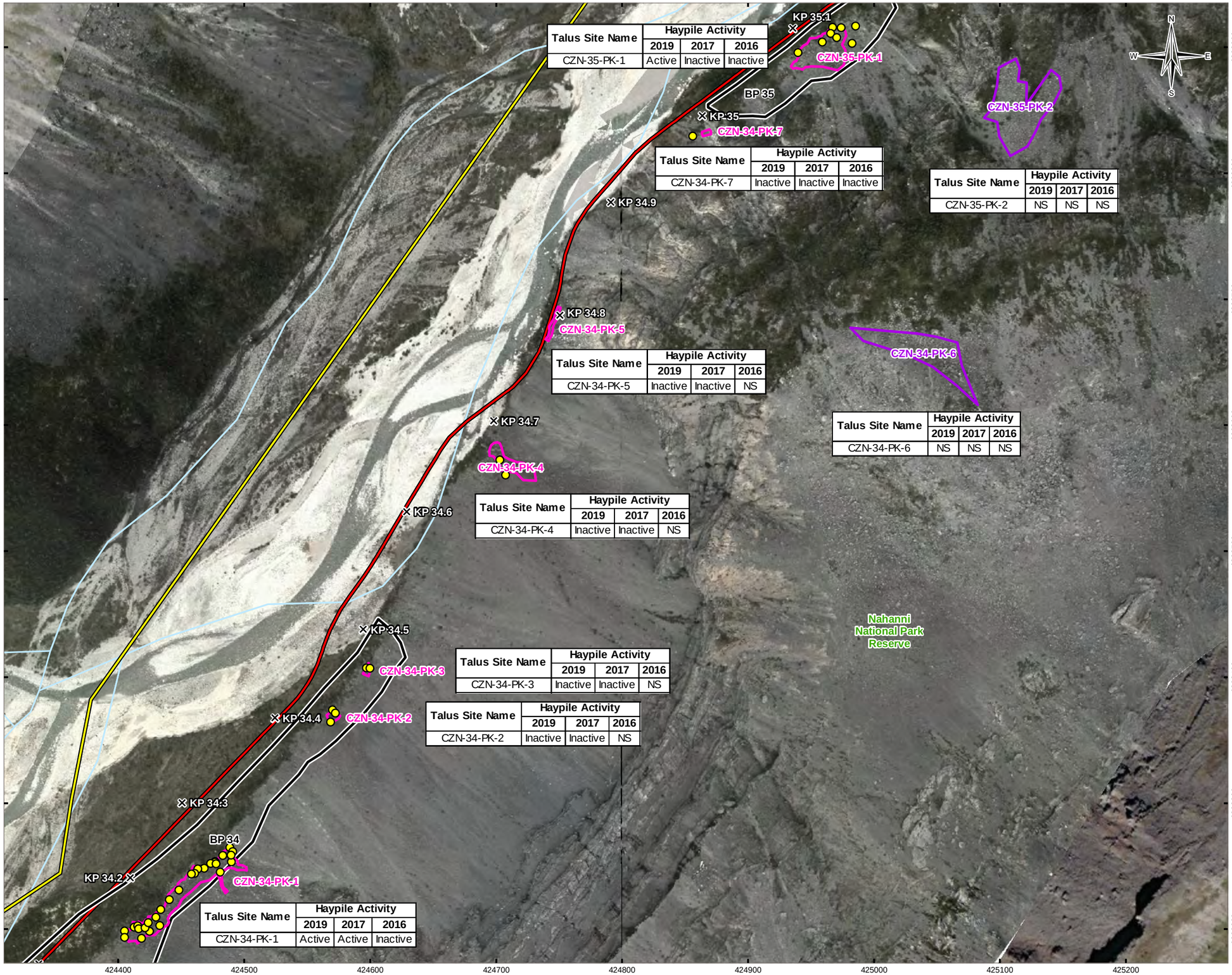


Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-35-PK-1	Active	Inactive	Inactive

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-34-PK-7	Inactive	Inactive	Inactive

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-35-PK-2	NS	NS	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-34-PK-5	Inactive	Inactive	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-34-PK-6	NS	NS	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-34-PK-4	Inactive	Inactive	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-34-PK-3	Inactive	Inactive	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-34-PK-2	Inactive	Inactive	NS

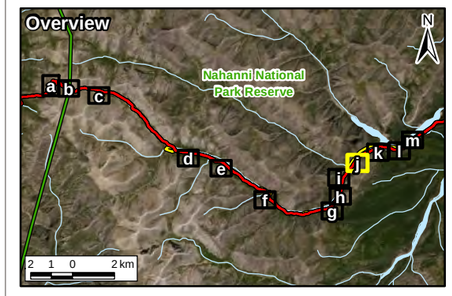
Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-34-PK-1	Active	Active	Inactive

LEGEND

- Haypile
- Pika Talus Site
- Possible Pika Talus Site (Aerial Reconnaissance)
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]
- Borrow Pit

Base Data

- Watercourse/Waterbody
- Nahanni National Park Reserve Boundary



NOTES
1. Pioneer Winter Road only visible where it differs from the All-Season Road.
NS = Not Surveyed
Base data sources:
2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.
Nahanni National Park Reserve of Canada.
Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.
Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Details

PROJECTION UTM Zone 10	**DATUM** NAD83	**CLIENT** Canadian Zinc Corporation
Scale: 1:3,000 (50 25 0 50 Metres)		
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OFFICE Tt-VANC	**DWN** MRV / **CKD** SL / **APVD** KL / **REV** 0	**Figure 2j**
DATE August 18, 2021	**PROJECT NO.** ENW.EENW03326-02	

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425300 425400 425500 425600 425700 425800 425900 426000 426100 426200

6829400 6829300 6829200 6829100 6829000 6828900 6828800 6828700

KP 36.2
KP 36.1
KP 36.3
KP 36.4
KP 36.5
KP 36
KP 35.9
KP 35.8
KP 35.7
KP 35.6
KP 35.5

CZN-35-PK-3

Nahanni National Park Reserve

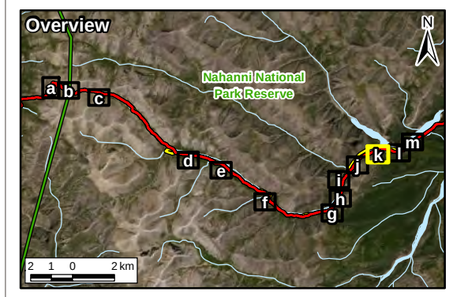
Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-35-PK-3	NS	NS	NS

LEGEND

- Possible Pika Talus Site (Aerial Reconnaissance)
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]

Base Data

- Watercourse/Waterbody
- Nahanni National Park Reserve Boundary



NOTES
1. Pioneer Winter Road only visible where it differs from the All-Season Road.
NS = Not Surveyed
Base data sources:
2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.
Nahanni National Park Reserve of Canada.
Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.
Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Details

PROJECTION UTM Zone 10			**DATUM** NAD83		**CLIENT** CANADIAN ZINC CORPORATION
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DATE August 18, 2021	**PROJECT NO.** ENW.EENW03326-02				

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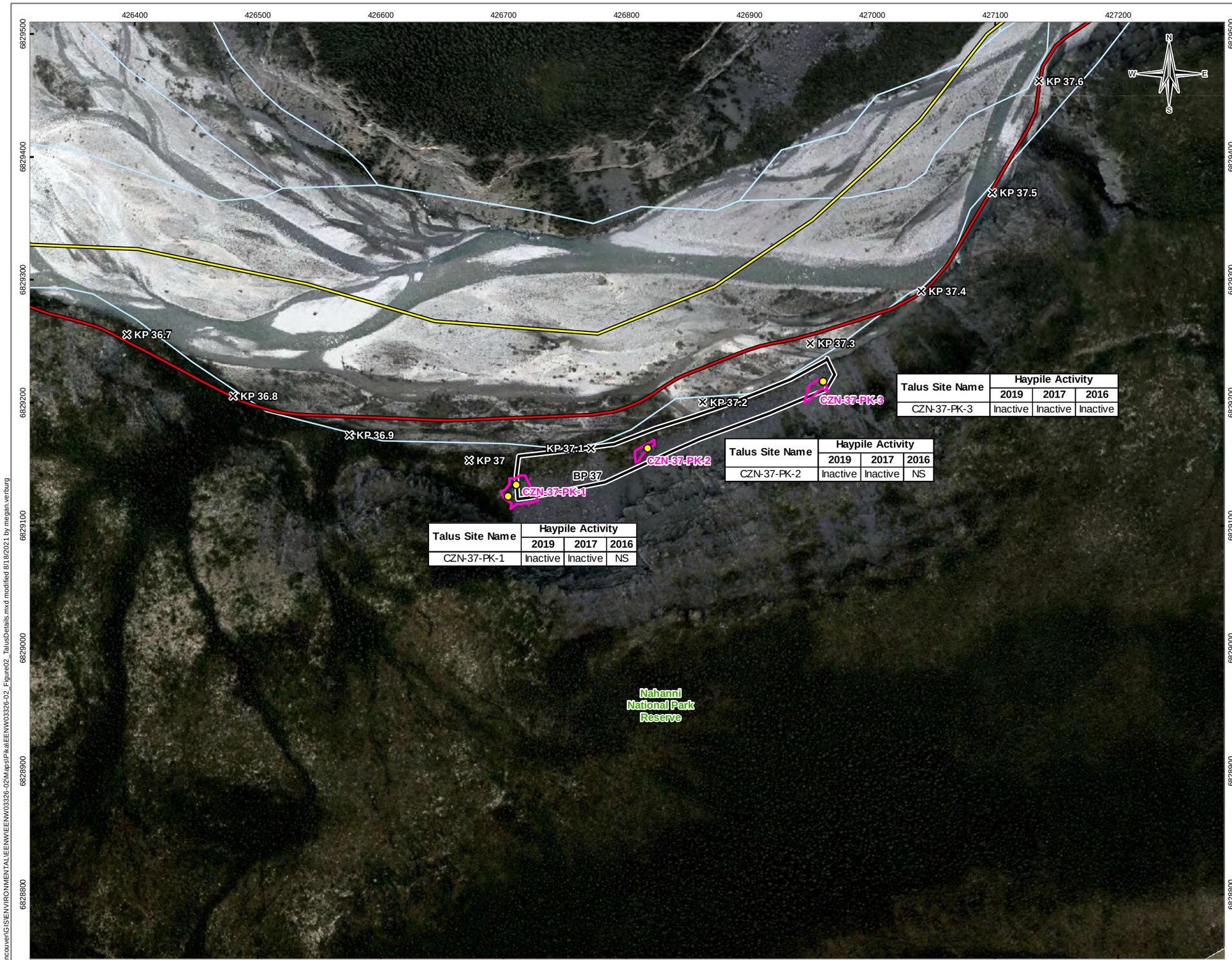


Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-37-PK-3	Inactive	Inactive	Inactive

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-37-PK-2	Inactive	Inactive	NS

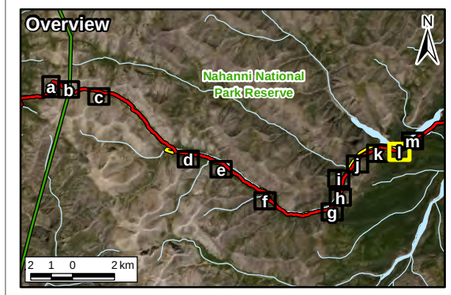
Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-37-PK-1	Inactive	Inactive	NS

LEGEND

- Haypile
- Pika Talus Site
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]
- Borrow Pit

Base Data

- Watercourse/Waterbody
- Nahanni National Park Reserve Boundary



NOTES

1. Pioneer Winter Road only visible where it differs from the All-Season Road.

NS = Not Surveyed

Base data sources:

2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.

Nahanni National Park Reserve of Canada.

Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.

Hydrology from CanVec (1:50,000).

STATUS

ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Details

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:3,000

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Metres

TETRA TECH

FILE NO. EENW03326-02_Figure02_TalusDetails.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MRV	SL	KL	0

DATE August 18, 2021

PROJECT NO. ENW.EENW03326-02

Figure 2l

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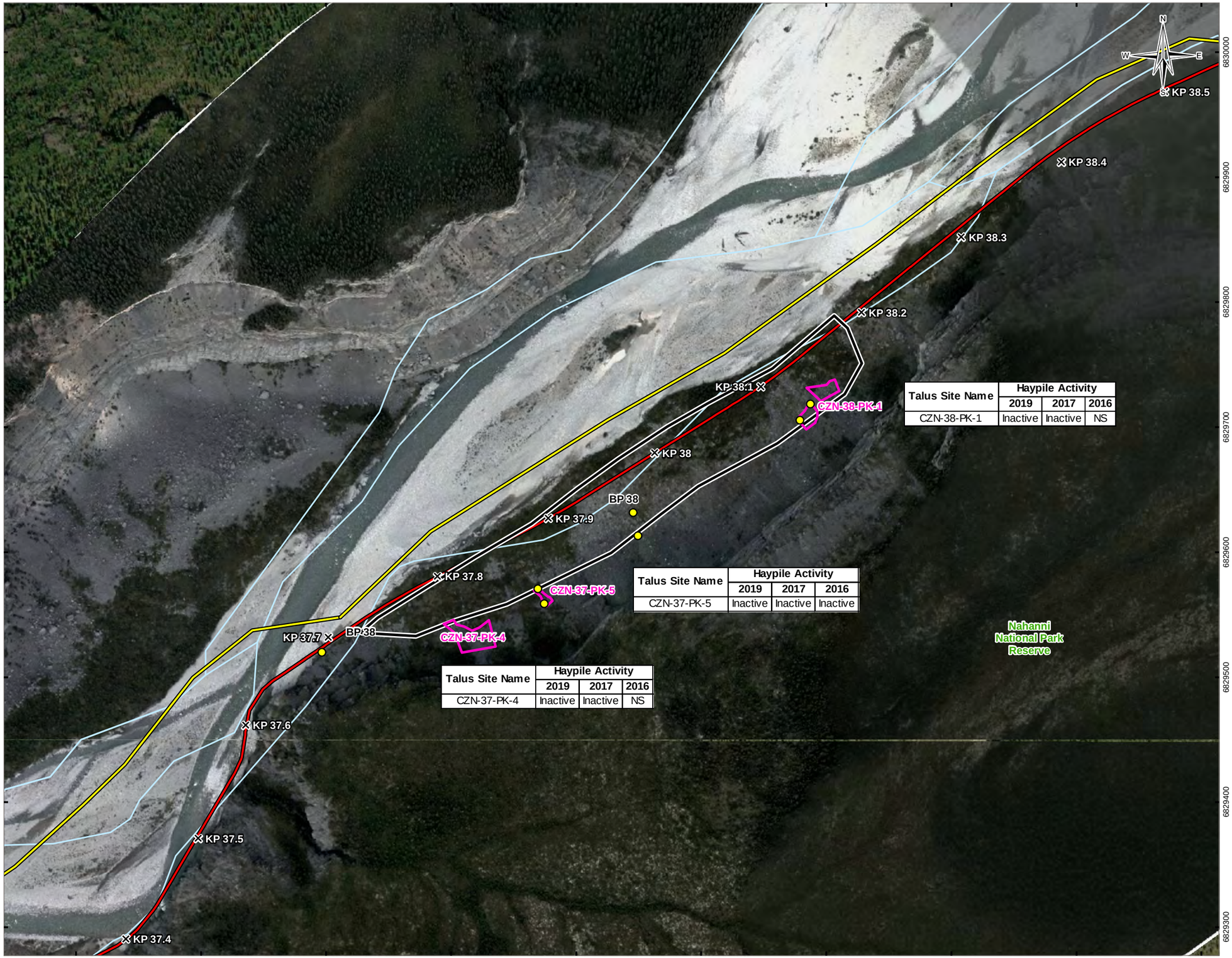


Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-38-PK-1	Inactive	Inactive	NS

Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-37-PK-5	Inactive	Inactive	Inactive

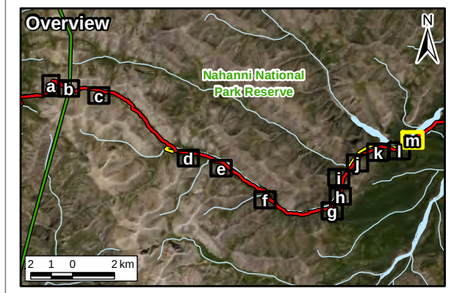
Talus Site Name	Haypile Activity		
	2019	2017	2016
CZN-37-PK-4	Inactive	Inactive	NS

LEGEND

- Haypile
- Pika Talus Site
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Proposed Pioneer Winter Road[1]
- Borrow Pit

Base Data

- Watercourse/Waterbody
- Nahanni National Park Reserve Boundary



NOTES
1. Pioneer Winter Road only visible where it differs from the All-Season Road.
NS = Not Surveyed
Base data sources:
2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.
Nahanni National Park Reserve of Canada.
Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.
Hydrology from CanVec (1:50,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

Talus Site Details

PROJECTION UTM Zone 10	**DATUM** NAD83	**CLIENT** CANADIAN ZINC CORPORATION
Scale: 1:3,000 (50 25 0 50 Metres)		TETRA TECH
FILE NO. EENW03326-02_Figure02_TalusDetails.mxd		
OFFICE Tt-VANC	**DWN** MRV / **CKD** SL / **APVD** KL / **REV** 0	Figure 2m
DATE August 18, 2021	**PROJECT NO.** ENW.EENW03326-02	

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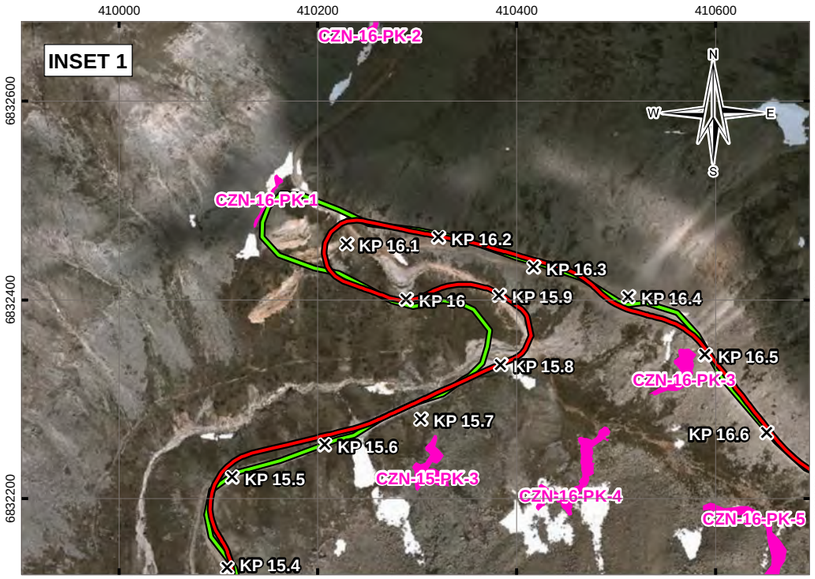
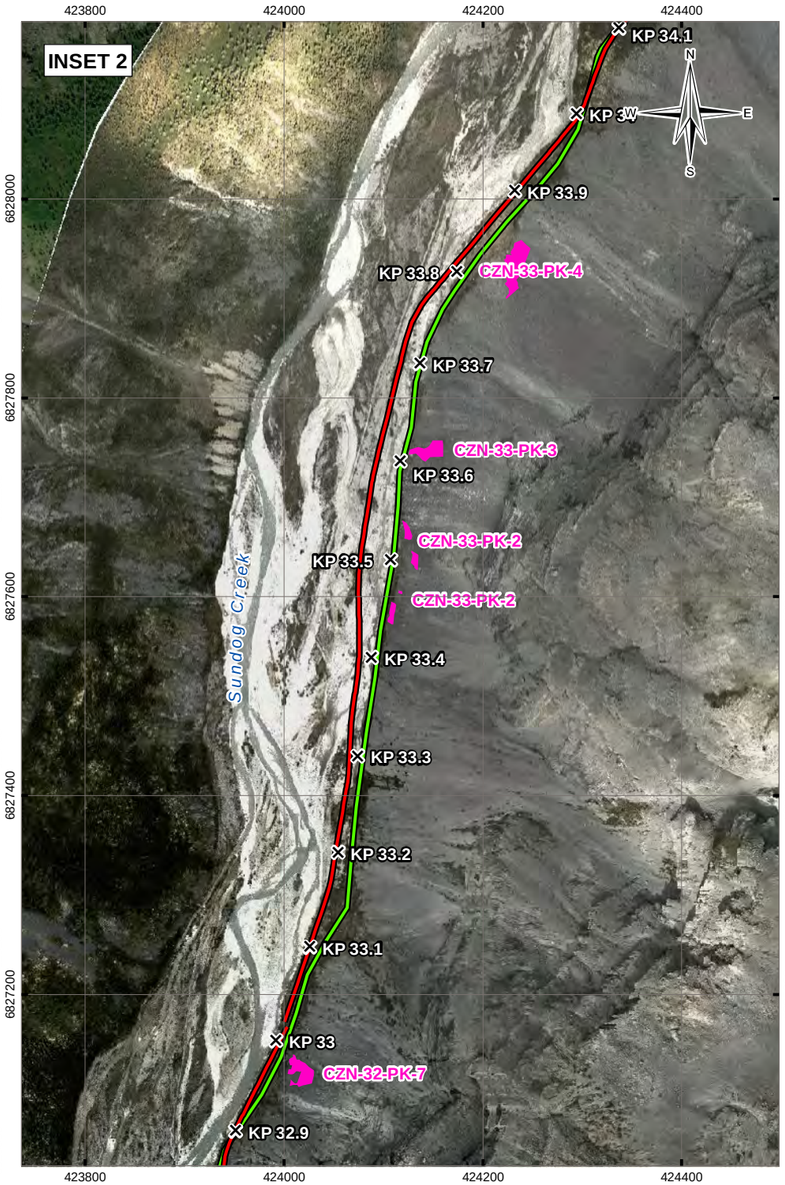
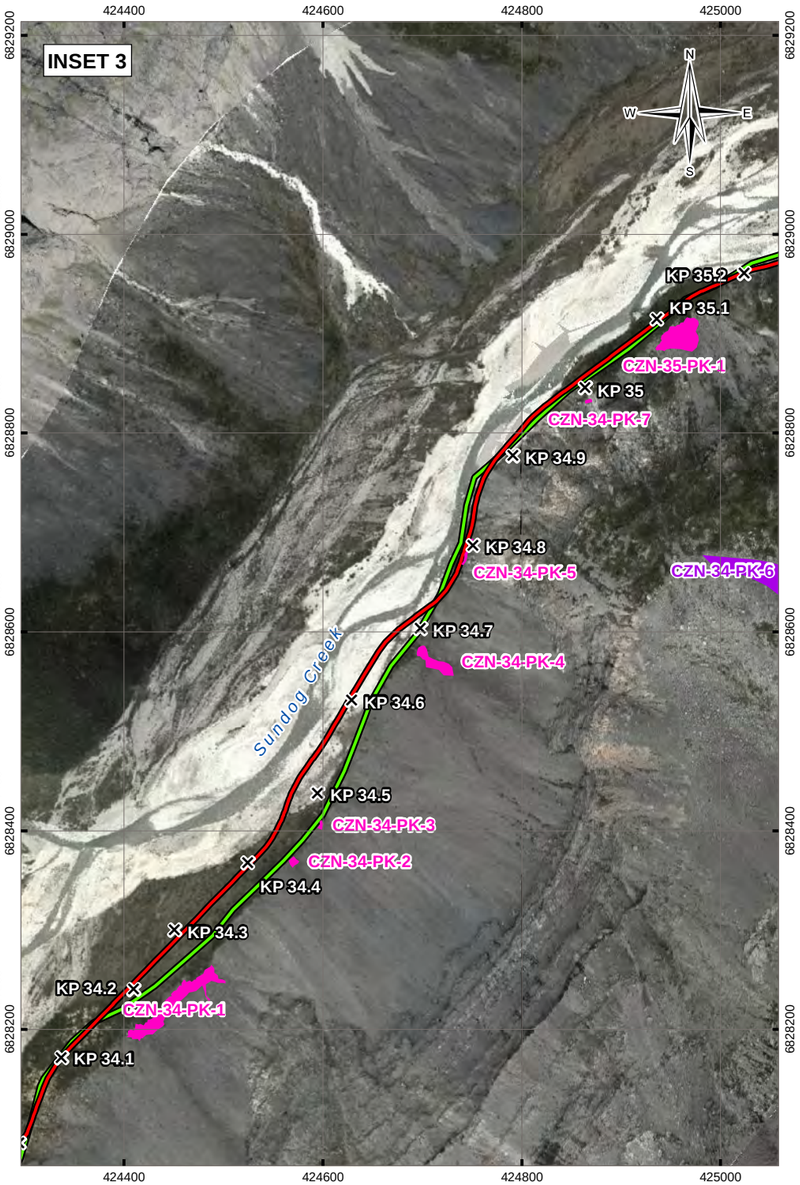
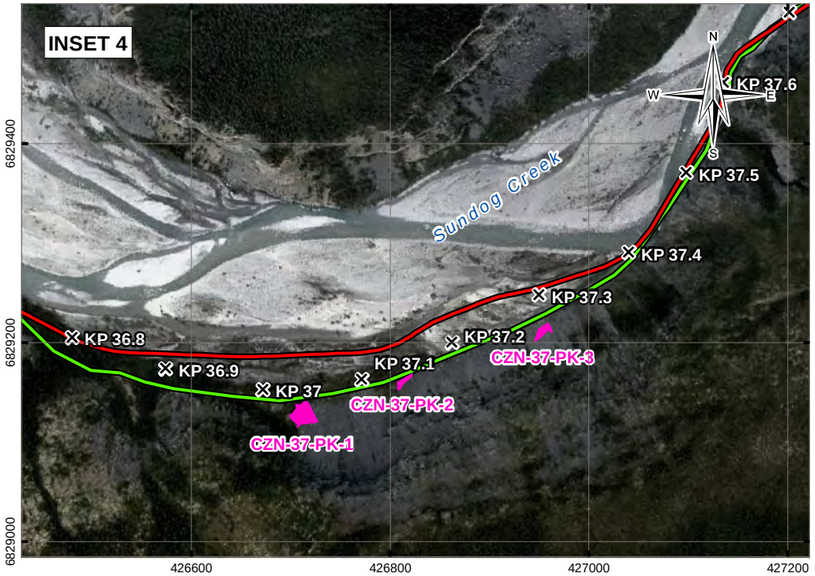


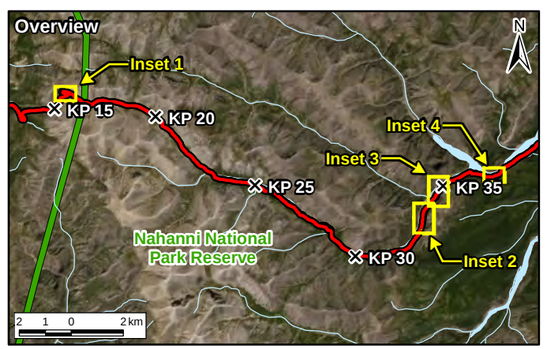






LEGEND

- ✕ All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- Former Proposed All-Season Road Alignment (April 5, 2016)
- Pika Talus Site
- Possible Pika Talus Site (Aerial Reconnaissance)



NOTES
1. Pioneer Winter Road only visible where it differs from the All-Season Road.

Base data sources:
2019 Kilometre Markers and 2021 Winter Road and All-Season Road alignments from AllNorth.
Nahanni National Park Reserve of Canada.
Primary imagery provided by AllNorth, background imagery from ESRI; Maxar.
Hydrology from CanVec (1:250,000).

STATUS
ISSUED FOR USE

PRAIRIE CREEK MINE ALL-SEASON ROAD COLLARED PIKA BASELINE & HABITAT LOSS ESTIMATES

All-Season Road Re-alignments for Collared Pika

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:6,000
100 50 0 100
Metres

TETRA TECH

FILE NO.
EENW03326-02_Figure03_Realignment.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MRV	SL	KL	0

DATE
August 18, 2021

PROJECT NO.
ENW.EENW03326-02

Figure 3

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APPENDIX A

TALUS SITE DESCRIPTIONS

Appendix A: Talus Site Descriptions

Talus Site Name	2019 Talus Site Name	2017 Talus Site Name	ASR KP	Minimum Distance to ASR Centreline (m)	Area (ha)	Elevation at Talus Centre (m)	Biogeoclimatic Zone	Subpopulation	Aspect Category[1]	Average Boulder Size[2]	Meadow Dominant Cover	Extent of Toe Meadow from Talus Edge (estimated in Field)
CZN-15-PK-1	CZN-15-PK-1	15-003	15	7	0.291	1349.32	Alpine	1	N	Small - Medium	Forbs and Bare Ground/Rocks	70 m wide meadow to creek barrier
CZN-15-PK-2	CZN-15-PK-2	15-023	15	0	0.155	1376.41	Alpine	1	W	Large	Forbs and Bare Ground/Rocks	20 m wide meadow to creek barrier
CZN-15-PK-3	CZN-15-PK-3	15-031	15	37	0.089	1435.60	Alpine	1	W	Medium	Forbs and Lichen/Moss	60 m of meadow to existing 1980s road
CZN-16-PK-1	CZN-16-PK-1	16-near 10	16	69	0.023	1456.61	Alpine	1	E	Medium	Forbs and Bare Ground/Rocks	>100 m wide meadow
CZN-16-PK-2	CZN-16-PK-2	16-10-1	16	187	0.017	1449.78	Alpine	1	E	Small	Graminoids and Bare Ground/Rocks	30 m wide meadow in drainage area
CZN-16-PK-3	CZN-16-PK-3	16E of 12-1	16	11	0.078	1469.00	Alpine	1	S	Medium	Forbs and Bare Ground/Rocks	40 m wide meadow for full width of valley
CZN-16-PK-4	CZN-16-PK-4	16-14	16	102	0.137	1450.63	Alpine	1	N	Large	Forbs and Graminoid	40 m wide meadow for full width of valley
CZN-16-PK-5	CZN-16-PK-5	16-4	16	65	0.151	1493.30	Alpine	1	E	Medium	Forbs and Graminoid	30 m wide meadow for full width of valley
CZN-16-PK-6	CZN-16-PK-6	17-14b-14a	16	47	0.206	1502.76	Alpine	1	N	Large	Forbs and Graminoid	40 m wide meadow for full width of valley
CZN-16-PK-7	CZN-17-PK-1	17-15	16	86	0.088	1534.86	Alpine	1	S	Medium	Forbs and Bare Ground/Rocks	70 m wide meadow to exiting 1980s road
CZN-17-PK-1	CZN-17-PK-2	17-3	17	53	0.011	1519.38	Alpine	1	N	Small	Forbs and Bare Ground/Rocks	5 m wide meadow (very limited) to scree
CZN-17-PK-2	CZN-17-PK-3	17-16-1	17	58	0.041	1487.13	Alpine	2	W	Medium	Forb and Bare Ground/Rocks	12 m wide meadow to creek barrier
CZN-18-PK-1	CZN-18-PK-1	19-112	18	160	0.754	1420.75	Alpine	3	S	Small - Medium	Forbs and Lichen/Moss	80 m wide meadow to creek barrier
CZN-24-PK-1	CZN-24-PK-1(3)	24-094	24	206	0.174	1212.36	Alpine	4	N	Medium	Lichen/Moss and Bare Ground/Rocks	>100 m wide meadow/forest
CZN-25-PK-1	CZN-25-PK-1	26-125#2	25	225	0.170	1152.11	Timberline/Subalpine	5	N	Small	Forbs	>100 m wide meadow/forest
CZN-25-PK-2	CZN-25-PK-2	26-125 middle	25	262	0.093	1151.98	Timberline/Subalpine	5	N	Small	Forbs	>100 m wide meadow/forest
CZN-26-PK-1	CZN-25-PK-3	26-155	26	224	0.041	1147.22	Timberline/Subalpine	5	N	Small	Tree/Shrub and Lichen/Moss	>100 m wide meadow/forest
CZN-28-PK-1	CZN-28-PK-1	50-28-501	28	195	0.093	1057.56	Timberline/Subalpine	6	E	Small - Medium	Tree/Shrub and Lichen/Moss	>100 m wide meadow/forest
CZN-32-PK-1	Aerial Reconn. 11	NS	32	287	0.116	980.61	Timberline/Subalpine	7	W	Small	NA	10 m wide meadow to gravel drainage channel
CZN-32-PK-2	CZN-32-PK-2	33-001 (south site)	32	179	0.056	943.18	Timberline/Subalpine	7	W	Small	Forb and Lichen/Moss	30 m wide meadow to gravel drainage channel
CZN-32-PK-3	CZN-32-PK-1	33-001 (north site)	32	140	0.018	930.11	Timberline/Subalpine	7	W	Small	Forb and Lichen/Moss	25 m wide meadow to gravel drainage channel
CZN-32-PK-4	CZN-32-PK-3(2)	32-61A2	32	8	0.044	888.69	Timberline/Subalpine	8	W	Medium	Tree/Shrub and Graminoid	12 m wide meadow to existing 1980s road. Meadow at eastern portion of talus site only 2.7 m wide to existing 1980s road, plus the portion of the existing road that provides some meadow habitat.
CZN-32-PK-5	Aerial Reconn. 13	NS	32	113	0.223	910.75	Timberline/Subalpine	8	E	Medium	NA	35 m wide meadow to Sundog Creek
CZN-32-PK-6	Aerial Reconn. 15	NS	32	391	0.046	1227.53	Alpine	9	W	Small	NA	Very limited meadow available. Meadow begins approx. 20 m from talus.
CZN-32-PK-7	CZN-33-PK-1	33-61B	32	17	0.046	889.93	Timberline/Subalpine	8	W	Medium	Tree/Shrubs and Lichen/Moss	20 m wide meadow to Sundog Creek
CZN-33-PK-1	Aerial Reconn. 17	NS	33	474	0.297	1135.87	Timberline/Subalpine	10	E	Small	NA	>100 m wide meadow/forest
CZN-33-PK-2	CZN-33-PK-3(2)	33-near 61D	33	29	0.033	871.46	Timberline/Subalpine	11	W	Medium	Graminoids and Lichen/Moss	5 m wide meadow to Sundog Creek

Appendix A: Talus Site Descriptions

Talus Site Name	2019 Talus Site Name	2017 Talus Site Name	ASR KP	Minimum Distance to ASR Centreline (m)	Area (ha)	Elevation at Talus Centre (m)	Biogeoclimatic Zone	Subpopulation	Aspect Category[1]	Average Boulder Size[2]	Meadow Dominant Cover	Extent of Toe Meadow from Talus Edge (estimated in Field)
CZN-33-PK-3	CZN-33-PK-3	33-near 61D (2)	33	30	0.040	874.65	Timberline/Subalpine	11	W	Large	Forb and Graminoid	4 m wide meadow to Sundog Creek
CZN-33-PK-4	CZN-33-PK-5	34-61E (before 34)	33	32	0.081	871.43	Timberline/Subalpine	11	W	Medium	Lichen/Moss and Graminoid	25 m wide meadow to Sundog Creek
CZN-34-PK-1	CZN-34-PK-1	34-086/61G	34	29	0.134	859.39	Timberline/Subalpine	11	N	Medium-Large	Forbs and Lichen/Moss	70 m wide meadow to Sundog Creek
CZN-34-PK-2	CZN-34-PK-2	34-080(1)	34	27	0.006	860.09	Timberline/Subalpine	11	N	Medium	Forbs	30 m wide meadow to Sundog Creek
CZN-34-PK-3	CZN-34-PK-3	34-080#2	34	36	0.003	853.80	Timberline/Subalpine	11	N	Small	Forbs and Tree/Shrubs	15 m wide meadow to Sundog Creek
CZN-34-PK-4	CZN-34-PK-4(1)	34-080	34	27	0.041	857.32	Timberline/Subalpine	11	N	Small	Lichen/Moss and Tree/Shrubs	10 m wide meadow to Sundog Creek
CZN-34-PK-5	CZN-34-PK-5	34-077	34	1	0.007	845.99	Timberline/Subalpine	11	W	Medium	Tree/Shrubs and Lichen/Moss	4 m wide meadow to Sundog Creek
CZN-34-PK-6	Aerial Reconn. 19	NS	34	215	0.175	1037.62	Timberline/Subalpine	11	N	Small	NA	>100 m wide meadow/forest
CZN-34-PK-7	CZN-35-PK-1(1)	35-069	34	20	0.003	853.02	Timberline/Subalpine	11	N	Medium	Forb and Bare Ground/Rocks	25 m wide meadow to Sundog Creek
CZN-35-PK-1	CZN-35-PK-2	35-069	35	12	0.097	849.12	Timberline/Subalpine	11	N	Small - Medium	Tree/Shrubs and Lichen/Moss	30 m wide meadow to Sundog Creek
CZN-35-PK-2	Aerial Reconn. 19#2	NS	35	96	0.233	931.91	Timberline/Subalpine	11	N	Small	NA	30 m wide meadow to scree
CZN-35-PK-3	Aerial Reconn. 23	NS	35	210	0.043	936.32	Timberline/Subalpine	12	N	Small	NA	>100 m wide meadow/forest
CZN-37-PK-1	CZN-37-PK-1	37-060	37	47	0.046	825.25	Timberline/Subalpine	13	N	Small - Medium	Tree/Shrubs and Lichen/Moss	20 m wide meadow to Sundog Creek
CZN-37-PK-2	CZN-37-PK-2	37-059	37	33	0.010	810.85	Timberline/Subalpine	13	N	Small - Medium	Lichen/Moss and Forbs	15 m wide meadow to Sundog Creek
CZN-37-PK-3	CZN-37-PK-3	37-057	37	36	0.016	816.61	Timberline/Subalpine	13	W	Small	Tree/Shrubs and Forbs	2 m wide meadow to Sundog Creek
CZN-37-PK-4	CZN-37-PK-5	38-052	37	36	0.060	829.97	Timberline/Subalpine	14	N	Small - Medium	Tree/Shrubs and Lichen/Moss	45 m wide meadow to Sundog Creek
CZN-37-PK-5	CZN-37-PK-6	38-050	37	45	0.008	811.38	Timberline/Subalpine	14	N	Small	Tree/Shrubs and Lichen/Moss	50 m wide meadow to Sundog Creek
CZN-38-PK-1	CZN-38-PK-2(2)	38-045	38	23	0.041	807.59	Timberline/Subalpine	14	N	Medium	Tree/Shrubs and Lichen/Moss	20 m wide meadow to Sundog Creek

1. Aspect: North from 316-45º; East from 46-135º; South from 136-225º; and West from 226-315º.
2. Average Boulder Size: Small from 30-50 cm diameter; medium from 50-100 cm diameter; large >100 cm diameter.

APPENDIX B

ACTIVE HAYPILE ABUNDANCE MODEL RESULTS

Active Haypile Abundance Model Selection Results

Comparison of models using all combinations of candidate covariates. All models had talus location as a random effect. The model with the lowest AIC_c was selected as the top model.

Rank	Total Area	Aspect	Dist to ASR	Elevation	Survey Year	df	logLik	AICc	delta	weight
1				+	+	4	-122.58	253.74	0.000	0.396
2	+			+	+	5	-122.35	255.59	1.854	0.157
3			+	+	+	5	-122.45	255.78	2.043	0.142
4		+		+	+	7	-120.79	257.28	3.548	0.067
5	+		+	+	+	6	-122.26	257.78	4.043	0.052
6	+	+		+	+	8	-120.04	258.30	4.568	0.040
7		+	+	+	+	8	-120.24	258.69	4.954	0.033
8	+				+	4	-125.07	258.73	4.991	0.033
9					+	3	-126.31	258.96	5.226	0.029
10	+	+	+	+	+	9	-119.67	260.15	6.415	0.016
11			+		+	4	-125.96	260.49	6.754	0.014
12	+		+		+	5	-125.07	261.03	7.292	0.010
13	+	+			+	7	-123.51	262.73	8.990	0.004
14		+			+	6	-125.16	263.57	9.837	0.003
15	+	+	+		+	8	-123.17	264.56	10.819	0.002
16		+	+		+	7	-124.51	264.73	10.990	0.002
17				+		3	-159.45	325.24	71.508	0.000
18	+			+		4	-159.24	327.06	73.326	0.000
19			+	+		4	-159.28	327.15	73.412	0.000
20		+		+		6	-157.81	328.86	75.129	0.000
21	+		+	+		5	-159.31	329.49	75.757	0.000
22	+	+		+		7	-157.06	329.81	76.072	0.000
23		+	+	+		7	-157.22	330.13	76.394	0.000
24	+					3	-162.03	330.40	76.668	0.000
25						2	-163.26	330.69	76.951	0.000
26			+			3	-162.64	331.63	77.893	0.000
27	+	+	+	+		8	-156.93	332.07	78.330	0.000
28	+		+			4	-161.89	332.35	78.615	0.000
29	+	+				6	-160.44	334.13	80.391	0.000
30		+				5	-162.10	335.07	81.337	0.000
31		+	+			6	-161.26	335.78	82.043	0.000
32	+	+	+			7	-160.11	335.92	82.182	0.000

Summary of the Top Model for Active Haypile Abundance

Model:

Generalized linear mixed model fit by maximum likelihood (Laplace Approximation) [glmerMod]
Family: poisson (log)
Formula: haypiles_active ~ survey_year + elevation_scaled + (1 | site)
Data: dat_model
Offset: area_surveyed

Model Parameters:

Effect	Group	Term	Estimate	Std. Error	Statistic	P-value
fixed	NA	(Intercept)	-1.54946	0.39567	-3.91606	9.00E-05
fixed	NA	survey_year2019	1.641229	0.223102	7.356421	1.89E-13
fixed	NA	elevation_scaled	0.802626	0.315136	2.546921	0.010868
random	site	sd__(Intercept)	1.501737	NA	NA	NA

APPENDIX C

PIKA OCCURRENCE MODEL RESULTS

Pika Occurrence Model Selection Results

Comparison of models using all combinations of candidate covariates. All models had talus location as a random effect. The model with the lowest AIC_c was selected as the top model.

Rank	Total Area	Aspect	Dist to ASR	Elevation	Survey Year	df	logLik	AICc	delta	weight
1			+	+	+	5	-37.759	86.400	0.000	0.193
2				+	+	4	-39.078	86.736	0.336	0.163
3	+			+	+	5	-37.957	86.795	0.396	0.158
4	+		+	+	+	6	-36.907	87.068	0.668	0.138
5	+		+		+	5	-38.231	87.344	0.945	0.120
6	+				+	4	-39.670	87.920	1.520	0.090
7			+		+	4	-40.105	88.789	2.389	0.058
8					+	3	-42.413	91.169	4.769	0.018
9		+	+	+	+	8	-36.803	91.820	5.421	0.013
10	+	+		+	+	8	-36.947	92.109	5.710	0.011
11	+	+	+	+	+	9	-35.657	92.127	5.727	0.011
12		+		+	+	7	-38.553	92.803	6.403	0.008
13	+	+	+		+	8	-37.628	93.472	7.072	0.006
14	+	+			+	7	-39.261	94.218	7.818	0.004
15		+	+		+	7	-39.669	95.035	8.635	0.003
16			+	+		4	-43.957	96.493	10.093	0.001
17				+		3	-45.209	96.761	10.361	0.001
18	+			+		4	-44.273	97.126	10.726	0.001
19	+		+			4	-44.366	97.311	10.912	0.001
20	+		+	+		5	-43.246	97.374	10.975	0.001
21		+			+	6	-42.104	97.461	11.061	0.001
22	+					3	-45.821	97.985	11.585	0.001
23			+			3	-46.250	98.843	12.443	0.000
24						2	-48.500	101.169	14.769	0.000
25		+	+	+		7	-43.143	101.983	15.583	0.000
26	+	+		+		7	-43.420	102.538	16.138	0.000
27		+		+		6	-44.677	102.607	16.207	0.000
28	+	+	+	+		8	-42.252	102.719	16.320	0.000
29	+	+	+			7	-43.881	103.459	17.059	0.000
30	+	+				6	-45.449	104.152	17.753	0.000
31		+	+			6	-45.933	105.119	18.720	0.000
32		+				5	-48.236	107.355	20.955	0.000

Summary of the Top Model for Pika Occurrence

Model:

Generalized linear mixed model fit by maximum likelihood (Laplace Approximation) [glmerMod]
Family: binomial (logit)
Formula: haypiles_active ~ survey_year + elevation_scaled + (1 | site)
Data: dat_model_binomial

Model Parameters:

Effect	Group	Term	Estimate	Std. Error	Statistic	P-value
fixed	NA	(Intercept)	-2.73986	1.16864	-2.34448	0.019053
fixed	NA	survey_year2019	2.439614	1.017487	2.397686	0.016499
fixed	NA	elevation_scaled	0.84711	0.469312	1.805002	0.071074
fixed	NA	dist_asr_min	0.008293	0.005941	1.395953	0.162729
random	site	sd__(Intercept)	1.249912	NA	NA	NA

APPENDIX D

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LIMITATIONS ON USE OF THIS DOCUMENT

NATURAL SCIENCES

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The ability to rely upon and generalize from environmental baseline data is dependent on data collection activities occurring within biologically relevant survey windows.

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design or scope, in consideration of the level of the environmental baseline information that was reasonably acquired to facilitate completion of the scope.

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