Appendix 13-C

Invasive Plant Surveys within the Active Footprint of the Crown Mountain Coking Coal Project

Invasive Plant Surveys within the Active Footprint of the Crown Mountain Coking Coal Project

NWP Coal Canada Ltd

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March 30, 2020

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Introduction

Keefer Ecological Services Ltd. (KES) was retained by NWP Coal Canada Ltd. (NWP Coal) to conduct an inventory of invasive plant species occurring within the Crown Mountain Coking Coal Project (Project) area. The Invasive Species Council of British Columbia (ISC BC) defines invasive species as:

Any non-native organism that cause economic or environmental harm and can spread quickly to new areas of BC.

Following habitat loss, invasive species are considered the largest threat to biodiversity globally (Madren, 2011). Non-native plants are the group of invasive organisms that are addressed in this report. Invasive plants can rapidly colonize an area as these plants have been introduced to BC without their natural herbivores, parasites and pathogens from their place of origin (ISC BC, n.d.). Invasive plants can cause numerous impacts, some of which include (BC FLNRO, n.d.; FPB, 2006):

- Disrupting natural ecosystem processes, such as nutrient and hydrological cycles
- Displacing native plant species, reducing biological diversity
- Reducing ecosystem complexity and stability
- Altering soil chemistry, which may prevent the regrowth of native plants
- Increasing soil erosion
- Dominating disturbed habitats for long periods of time, disrupting ecological restoration of native plant communities
- Altering habitat structure for wildlife
- Reducing forage production for wildlife and domestic livestock
- Poisoning wildlife and livestock
- Altering natural fire regimes
- Disrupting forest regeneration

Invasive plants typically require disturbance to establish (Polster, 2003); however, pathways and vectors are needed for invasive plants to colonize a site. Pathways are geographic routing by which invasive plants enter and move, which can be natural (e.g., water currents or air) or human-caused (e.g., roads and railway corridors); and vectors are the means by which invasive plants from a source population follow a pathway to a new destination, such as vehicles and animals (ISC BC, 2012). Mine sites may provide ideal habitat for invasive species to establish because mining creates significant disturbances. As well, mining activities, such as the development of roads and movement of machinery, provide the needed pathways and vectors for invasive plants to colonize a site (Hougen et al., 2012).

The *Health, Safety and Reclamation Code for Mines in British Columbia*, (BC MEM, 2017) details requirements of mining companies related to reclamation and hence, invasive plants, as follows:

- "10.7.1 It is the duty of every owner, agent, and manager to institute and, during the life of the mine, to carry out a program of environmental protection and reclamation, in accordance with the standards described in section 10.7.4 to 10.7.21 of this code."
- "10.7.7 On all lands to be re-vegetated, land shall be re-vegetated to a self-sustaining state using appropriate plant species."
- "10.7.8 On all lands to be re-vegetated, the growth medium shall satisfy land use, capability, and water quality objectives. All surficial soil materials removed for mining purposes shall be saved for use in reclamation programs unless these objectives can be otherwise achieved."

A component of this duty in invasive plant management is to ensure land is reclaimed to an appropriate end land use. Under the BC *Weed Control Act* (SBC, 1996), an occupier must control noxious weeds growing or located on land and premises, and on any other property located on land and premises, occupied by that person. Under the Act, an occupier is defined as: "A person who (a) is in physical possession of land premises or property, or (b) is responsible for, and has control over, the condition of, the activities conducted on and the persons allowed to enter or use, land, premises, or property." A noxious weed is defined under the Act as: "A weed designated by regulation to be a noxious weed and includes the seeds of the noxious weed."

The ISC BC urges mining companies to proactively manage invasive plants to minimize their threats and reduce economic and environmental costs. To initiate the process of invasive plant management within the proposed Crown Mountain Coking Coal Project area, NWP Coal Canada Ltd. retained Keefer Ecological Services Ltd. to conduct invasive plant surveys within the current active footprint (i.e., the 2018 Notice of Work), which includes access roads, drill pads, and proposed rail loadout area. The objective of the survey was to identify the distribution and density of invasive plants along the access roads, drill pads, and loadout and identify priority management actions to initiate invasive plant management within the proposed mine area. The data collected from the survey work will also be used to direct the development of an invasive plant management plan as part of the Environmental Assessment.

Study Area

The Local Study Area (LSA) of the Project spans 12,367 ha and comprises the bulk of the Alexander, West Alexander and Grave Creek watersheds of southeastern British Columbia, north of Crowsnest Highway 3 (Figure 1). The study area encompasses four biogeoclimatic units (MacKillop e*t al.*, 2018), which include dry warm Montane Spruce subzone (MSdw), Kootenay dry cool Engelmann Spruce-Subalpine Fir variant (ESSFdk1), dry cool woodland Engelmann Spruce-Subalpine Fir subzone (ESSFdkw), and dry cool parkland Engelmann-Spruce Subalpine Fir subzone (ESSFdkp).

NWP Coal Canada Ltd

LSA Overview

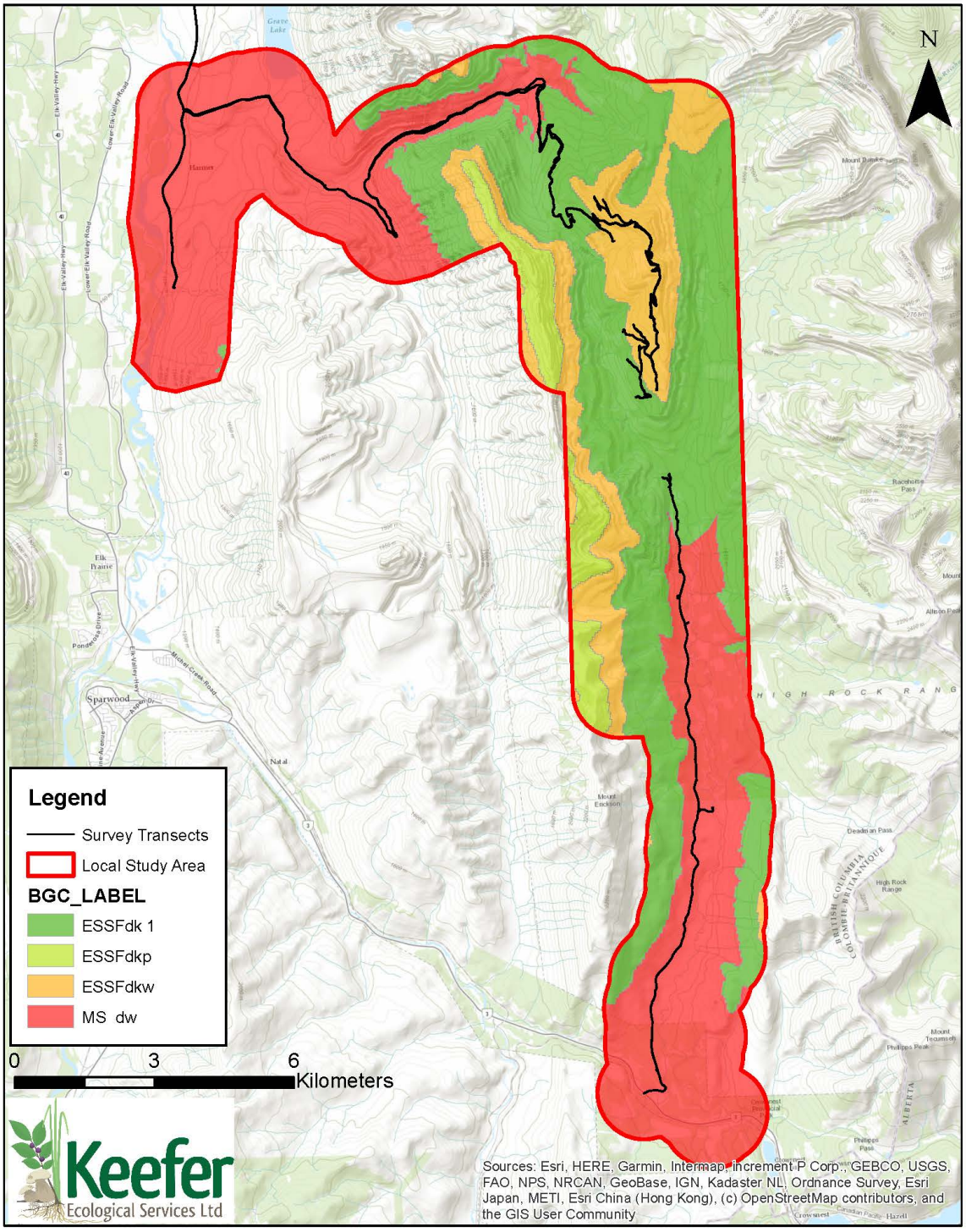


Figure 1. LSA showing biogeoclimatic (BEC) units.

The areas within the LSA that were surveyed and inventoried for invasive plants include all active roads and spurs as vectors for spread (Figure 2). Specifically, this included existing access roads, newly excavated trails, groundwater well sites, geotechnical drilling sites (e.g., test pits and bore holes) and exploration program geology sites (i.e., drill pads). The list of roads, trails and sites surveyed and inventoried is presented in Table 1, below. The list of roads, trails and sites surveyed and inventoried includes all that were constructed and accessible at the time of the surveys (August 29, 30 and 31, 2018).

Table 1: List of access roads, excavated trails, groundwater well sites and drilling sites surveyed and inventoried within the LSA.

Roads and Trails	Groundwater Well Sites	Geotechnical Drilling Sites	Exploration Program Geology Sites
Valley Service Road	-	-	-
Harmer Road	-	-	-
Grave Creek Road	-	-	-
Branch C	-	-	BH18-7 CM18-05 CM18-10 CM18-14 CM18-16 CM18-23 CM18-28 CM18-29
Spur 1	GW12a-BR & OB	TP18-MD6	CM18-06
Spur 2	-	-	CM18-03 CM18-04
Spur 3	-	-	CM18-21
Spur 3.5	-	-	-
Spur 4	-	-	CM13-20 CM18-22
Branch 4	-	-	-
Branch 5	-	-	-
Alexander Road	-	-	-

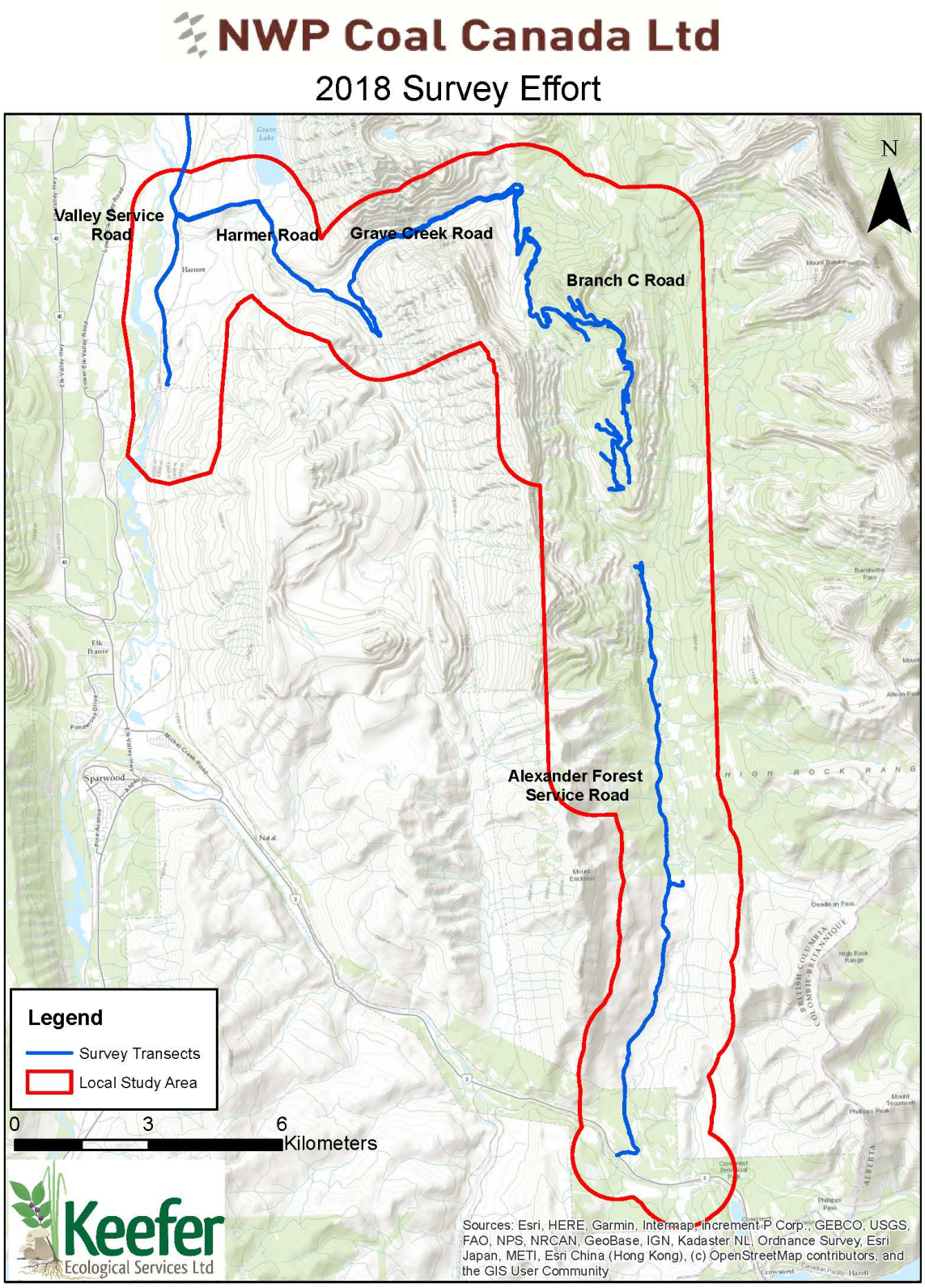


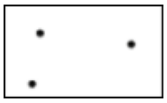
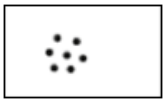
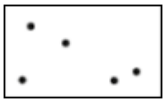
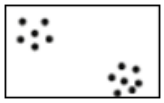
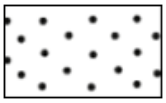
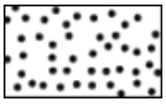
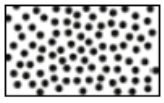
Figure 2. Overview of 2018 survey effort.

Methods

Invasive plant surveys were conducted between August 29-31, 2018. Vehicle traverse was used to survey access roads, groundwater, geotechnical and exploration sites, and the proposed rail loadout area within the active Notice of Work (NOW) footprint (current to the date of survey) of the proposed Crown Mountain Coking Coal Project.

Distribution and density classes (as well as species names) defined under the Invasive Alien Plant Program (IAPP; Government of BC, n.d.) were used to survey invasive plant species in the LSA (Table 2). The provincial IAPP distribution codes were developed to represent spatial distribution of invasive species across the landscape; the site-specific distribution presented herein represents the modal distribution within kilometer markers along the surveyed roads. The distribution and density of invasive plants were documented per kilometer along Grave Creek Road up to Branch C, along Branch C, and along the Alexander Forest Service Road (Figure 2). Distribution and density of invasive plants was also documented per branch and spur road off Branch C. Occurrence was measured to indicate the number of times the invasive plant was identified along an applicable road based on kilometer markers. For example, if a species was found between kilometer markers 90-91 and 97-98 on a road, an occurrence of 2 was given (Table 4). The presence (and not their distribution or density) of invasive plants along Harmer Road, four kilometers of Valley Service Road just south of the Harmer Road and Valley Road intersection, (where the loadout will be located), and a portion of Valley Road between Line Creek Mine Road and the Harmer Road intersection were recorded to document possible invasive plant seed sources (Table 5). These infestations occur on private land and as such, are outside of NWP's jurisdiction which is why the survey effort is different for these roads. Occurrences were located using GPS and mapped locations are provided (Figure 3).

Table 2: Distribution and density codes used by the Invasive Alien Plant Program (Ministry of Forests and Range, 2010) to survey invasive plants.

DISTRIBUTION CODE		
Code	**Reference**	**Description**
1		Rare individual, a single occurrence
2		Few sporadically occurring individuals
3		Single patch or clump of a species
4		Several sporadically occurring individuals
5		A few patches or clumps of a species
6		Several well-spaced patches or clumps of a species
7		Continuous uniform occurrence of well-spaced individuals
8		Continuous occurrence of a species with a few gaps in the distribution
9		Continuous dense occurrence of a species

DENSITY CODE		
Code	**Reference**	**Description**
1	Low	$\leq$ 1 plant/m^2
2	Medium	2-5 plants/ m^2
3	High	6-10 plants/ m^2
4	Dense	> 10 plants/ m^2

Invasive plants identified onsite were those presented under the BC *Weed Control Act*, the BC *Forest and Range Practices Act*, and the Invasive Species Checklist provided by the Electronic Atlas of the Flora of British Columbia (Klinkenberg, 2012). A priority management level was assigned to each invasive plant based on the invasive potential of the species, whether it is a regulated plant provincially, and the extent of infestations throughout the active footprint (Table 3; Appendix B). The species-specific management priorities consider those dictated by the province but have been adapted to be site-specific; thus, the

management priorities presented herein may differ from those found in provincial literature (e.g., Bladder campion (Table 3)). Examples of changes in priority from provincial to site-specific management priorities include species whose occurrence is limited and that are capable of spreading rapidly to recently disturbed sites.

Table 3: Invasive plants identified within the current active footprint of the Crown Mountain Coking Coal Project and site-specific management priorities for these species.

Common Name	Scientific Name	Map Label	BC *Weed Control Act*	Noxious / Nuisance Weed*	Site-Specific Management Priority
Annual sow thistle	*Sonchus oleraceus*	AS	P	Noxious	High
Bladder campion	*Silene vulgaris*	BC	-	Nuisance	High [a]
Blueweed	*Echium vulgare*	BW	R	Noxious	High
Bull thistle	*Cirsium vulgare*	BT	-	Nuisance	High [b]
Canada thistle	*Cirsium arvense*	CT	P	Noxious	High
Common tansy	*Tanacetum vulgare*	TC	R	Noxious	High
Curled dock	*Rumex crispus*	CD	-	Nuisance	Low
Great mullein	*Verbascum thapsis*	MU	-	Nuisance	Low
Hound's-tongue	*Cynoglossum officinale*	HT	P	Noxious	High
Oxeye daisy	*Leucanthemum vulgare*	OD	-	Noxious	Medium
Scentless chamomile	*Matricaria perforata*	SH	P	Noxious	High
Spotted knapweed	*Centaurea maculosa*	SK	P	Noxious	High
Sulphur cinquefoil	*Potentilla recta*	SC	-	Noxious	Medium [c]
Western goat's-beard	*Tragopogon dubius*	WG	-	Nuisance	Low
Yellow hawkweed	*Hieracium spp.*	YH	-	Nuisance	Medium
Yellow toadflax	*Linaria vulgaris*	YT	P	Noxious	High

*Plants identified as noxious and nuisance species based on the Invasive Species Checklist provided by the Electronic Atlas of the Flora of British Columbia (Klinkenberg, 2012).

[a] High management priority for bladder campion due to its limited occurrence within the LSA.

[b] High management priority for bull thistle due to its occurrence throughout the LSA and its ability to colonize recently disturbed areas (Rees et al., 1996).

[c] Medium management priority for sulphur cinquefoil due to its limited occurrence within the LSA, within BC Hydro powerline right of way.

Results

Throughout the current active footprint (NOW exploration development as of August 31, 2018), 16 invasive plant species were identified, six of which are considered provincially noxious (P) and two of which are considered regionally noxious (R) in the East Kootenay under the BC *Weed Control Act;* 10 are identified as invasive under the BC *Forest and Range Practices Act*; and 10 are considered noxious and

six are considered nuisance based on the Invasive Species Checklist provided by the Electronic Atlas of the Flora of British Columbia (Klinkenberg, 2012; Table 3).

The *BC Weed Control Act* identifies provincially and regionally noxious weeds that are the responsibility of land occupiers to control. Provincially noxious weeds are classified as such in all regions of the province, whereas regionally noxious weeds are designated as noxious only within the boundaries of the corresponding regional districts (SBC, 1996). The *Forest and Range Practices Act* (SBC, 2002) identifies specific weed species and prevention methods that land managers are required to implement. The Invasive Species Checklist (Klinkenberg, 2012) summarizes the designations for each weed species (e.g., nuisance, noxious). Careful consideration of each of these designations coupled with the species occurrence within the LSA resulted in the site-specific Management Priority specified in Table 3.

All 16 invasive plant species were identified along Alexander Road (Table 4). Oxeye daisy was the most widely distributed invasive plant, identified at eight of the 13 active footprint areas surveyed, followed by Canada thistle and yellow hawkweed, both of which were identified at seven of the 13 active footprint areas. Only one occurrence each of bladder campion, blueweed, hound's tongue, sulphur cinquefoil, and common tansy were identified during surveys, all of which were located along Alexander Road. Invasive plants were not found along Branch 4, Spur 3.5, and Spur 4 off Branch C (Table 4; Figure 3).

Table 4: Summary of the distribution and density of invasive plants found in the Project area per current active footprint.

Active Footprint Area	Invasive Plant	Distribution	Density	Occurrence [a]
Alexander Rd [b]	annual sow thistle	5	2	7
	bladder campion	4	2	1
	blueweed	1	1	3
	bull thistle	2	2	9
	Canada thistle	6	4	14
	common tansy	4	2	1
	curled dock	5	2	8
	great mullein	5	2	13
	hound's tongue	2	2	1
	oxeye daisy	6	3	14
	scentless chamomile	6	3	12
	spotted knapweed	4	2	5
	sulphur cinquefoil	3	3	1
	yellow hawkweed	6	4	14
	yellow salsify	4	1	11
	yellow toadflax	5	4	5
Branch C [b]	Canada thistle	5	4	9
	curled dock	1	1	1
	oxeye daisy	5	3	9
	scentless chamomile	3	3	2
	yellow hawkweed	5	2	8

Active Footprint Area	Invasive Plant	Distribution	Density	Occurrence [a]
Branch 4 [b] (< 1 km)	-	-	-	-
Branch 5 [b] (< 1 km)	yellow hawkweed	4	2	1
Spur 1 [b] (< 1 km)	bull thistle	1	1	1
	Canada thistle	3	4	1
	great mullein	1	1	1
	oxeye daisy	3	4	1
	yellow hawkweed	4	2	1
Spur 2 [b] (< 1 km)	oxeye daisy	5	2	1
Spur 3 [b] (< 1 km)	yellow hawkweed	4	2	1
Spur 3.5 [b] (< 1 km)	-	-	-	-
Spur 4 [b] (< 1 km)	-	-	-	-
Grave Creek Rd [b]	annual sow thistle	2	1	2
	bull thistle	2	1	2
	Canada thistle	5	4	8
	great mullein	5	2	5
	oxeye daisy	5	3	7
	scentless chamomile	5	2	2
	spotted knapweed	5	2	2
	yellow hawkweed	5	4	5
	yellow salsify	2	1	4
	yellow toadflax	5	4	2

[a] Occurrence indicates the number of occurrences the invasive plant was identified along an applicable road based on kilometer markers. For example, if a plant was found between kilometer markers 90-91 and 97-98 on a road, an occurrence of 2 was given.

[b] Roads in which invasive plant surveys were conducted per kilometer. For detailed results of the distribution and density of invasive plants identified per kilometer, see Appendix A.

Table 5: Summary of the invasive plants documented along roadsides occurring on private land in the Crown Mountain LSA.

Active Footprint Area	Invasive Plant	Distribution	Density	Occurrence [a]
Harmer Rd [c]	annual sow thistle	-	-	-
	bull thistle	-	-	-
	Canada thistle	-	-	-
	curled dock	-	-	-
	great mullein	-	-	-
	oxeye daisy	-	-	-
	scentless chamomile	-	-	-
	yellow hawkweed	-	-	-
	yellow salsify	-	-	-
Valley Service Rd (south of Harmer Rd) [c]	annual sow thistle	-	-	-
	bull thistle	-	-	-
	Canada thistle	-	-	-
	curled dock	-	-	-
	great mullein	-	-	-
	oxeye daisy	-	-	-
	scentless chamomile	-	-	-

Active Footprint Area	Invasive Plant	Distribution	Density	Occurrence [a]
	spotted knapweed	-	-	-
	yellow salsify	-	-	-
	yellow toadflax	-	-	-
Valley Service Rd (north of Harmer Road) [c]	bull thistle	-	-	-
	Canada thistle	-	-	-
	great mullein			
	oxeye daisy			
	scentless chamomile			
	spotted knapweed			
	yellow salsify			
	yellow toadflax			

[c] Roads in which the presence of invasive plants was only documented.

In addition to invasive plant species, several "agronomic" non-native grasses and legumes were noted within the current active footprint area, including six grass species and six legume species (Table 6). It has long been an accepted practice to reseed areas impacted by disturbance from forestry, mining, oil and gas with agronomic species because these seeds are commercially available non-native mixes which have desirable qualities of predictable germination and aggressive growth. Agronomic seeds are readily available and affordable. Previous reclamation practices primarily focused on revegetation and rehabilitation to 'equivalent land capability' with little consideration of ecological function. Where the end land use of a disturbance area is to re-establish a diverse native plant community, the use of agronomic species is no longer acceptable. Agronomic species, like invasive species, often compete with native species for nutrients, water and space. Many are drought, saline/alkali or acid tolerant, rapidly developing and long-lived species (e.g., crested wheatgrass, Canada bluegrass, smooth brome, orchard grass).

Long term monitoring has shown industrial disturbances seeded with non-native species had more bare ground, less litter cover, and lower total vegetation than sites seeded with native species over time (Naeth et al., 1997). Because agronomic non-native species have a superior ability to establish on bare and disturbed sites, they establish quickly and colonize a site resulting in lower species diversity and structure. Native grasslands are comprised of diverse vegetative cover including ground cover like lichen and moss, tall and low grasses and forbs and often trees and shrubs. They are also superior in capturing solar energy, in cycling of organic matter and nutrients, retaining moisture, supporting wildlife habitat values, and in providing the highest potential productivity for the site (Adams et al., 2016).

Smooth brome was the most common agronomic grass found on site, identified at nine of the 10 active footprint areas, followed by common timothy and orchard grass. Red clover was the most common agronomic legume, identified at six of the 10 active footprint areas (Table 6). Many of these non-natives are popular pasture and forage crops.

Agronomic Grass Species

Smooth brome is a perennial grass that grows from an exclusive creeping rhizome. It can form a dense sod which can smother and exclude native species and decrease natural biodiversity. Timothy has the ability to dominate stands, alter native plant communities and form dense monocultures. Seeds are small and readily dispersed by wind. Leaf lifetime on the stem is long and it accumulates a high amount of standing biomass which can form dense thatch cover choking out establishment of other species, altering conifer and deciduous understories and increasing fuel load concerns for fire prevention. Orchard grass has become an aggressive and persistent low growing grass in many places, growing in many soil types, showing drought resiliency and is documented to overrun native grasslands. Seeds are the main reproductive method and are dispersed by stiff winds, birds, animals and humans. Canada bluegrass is well adapted to wet sites but thrives on moderately acidic and droughty soils with poor fertility, including rocky outcrops and mountain tops. It successfully establishes on clay and clay loam soils (e.g., fine textured soils). Seeds are hardy and can be spread long distances by cattle and deer, establishing well in disturbed areas. Crested wheatgrass has a deep fibrous root system and is highly tolerant of grazing, frost, drought, fire and produces large amounts of viable seeds. It forms dense monotypic stands of wooly plant material which is not preferred browse by wildlife or livestock. Some stands of crested wheatgrass have remained as intact monocultures for over 50 years. Quack grass propagates easily by the rhizomes which include short pieces that include a node. Undisturbed plants can develop rapidly by extending clones. As a weed, quack grass is highly competitive and has been documented in impeding crop growth and production and can result in high yield losses in competitive cereal crops.

Agronomic Legume Species

Alfalfa is a long-lived perennial legume which has wide distribution and can become weedy or invasive and displace vegetation if not properly managed. It has the ability to survive winter temperatures as low as -20˚C, produces a hard seed, has nitrogen-fixing symbiosis and is deep rooted and able to tolerate droughty conditions. Tufted vetch can be invasive as it escapes cultivation and can aggressively climb fencing, trees, bushes and other vegetation thus monopolizing on sunlight, space and moisture. It readily produces seeds. Red clover and yellow clover are hardy and resistant to heavy grazing and trampling and show moderate competitiveness. These are common reclamation species which are somewhat acid tolerant but unable to survive in highly alkaline or acidic soil. They can fix atmospheric nitrogen and readily establishes in moist draws, ditches and sites preferring moderately fine to medium textured soils. Seed can be stored for up to 25 years and can establish easily on poorly prepared seedbeds. Yellow and white sweet clover are biennials which develop a deep tap-root system and are capable of growing up to 6 feet tall. These plants die after producing seed but have long-term seed viability (documented up to 80 years) which allow infestations to persist in perpetuity. Sweet clover invades and degrades native grasslands by overtopping and shading native sun-loving plants. It grows abundantly on disturbed lands, roads and abandoned fields. It also responds favorably to fire.

Table 6: Agronomic species identified in the Crown Mountain Coking Coal Project area per current active footprint.

Active Footprint Area	Agronomic Species											
	alfalfa	Canada bluegrass	common Timothy	crested wheatgrass	orchard grass	quackgrass	red clover	smooth brome	tufted vetch	white sweet clover	yellow clover	yellow sweet clover
	Medicago sativa	*Poa compressa*	*Phleum pratense*	*Agropyron cristatum*	*Dactylis glomerata*	*Elymus repens*	*Trifolium pratense*	*Bromus inermis*	*Vicia cracca*	*Melilotus alba*	*Trifolium aureum*	*Melilotus officinalis*
Alexander Rd	x	x	x	x	x	x	x	x	x	x	x	x
Branch C	x	x	x	x	x	x	x	x	x	-	x	-
Branch 4	-	-	-	-	-	-	-	-	-	-	-	-
Branch 5	-	-	x	-	x	-	-	x	-	-	-	-
Spur 1	-	-	x	-	x	-	-	x	-	-	-	-
Spur 2	-	-	x	-	x	-	x	x	-	-	-	-
Spur 3	-	-	x	-	x	-	x	x	-	-	-	-
Spur 3.5	x	-	x	-	x	-	x	x	-	-	-	-
Spur 4	-	-	x	-	x	-	-	x	-	-	-	-
Grave Creek Rd	x	x	x	-	-	x	x	x	x	x	x	x
Harmer Rd	Agronomic grasses and clovers noted along road											
Valley Service Rd (south of Harmer Rd)	Agronomic grasses and clovers noted along road											
Valley Service Rd (north of Harmer Rd)	Agronomic grasses and clovers noted along road											

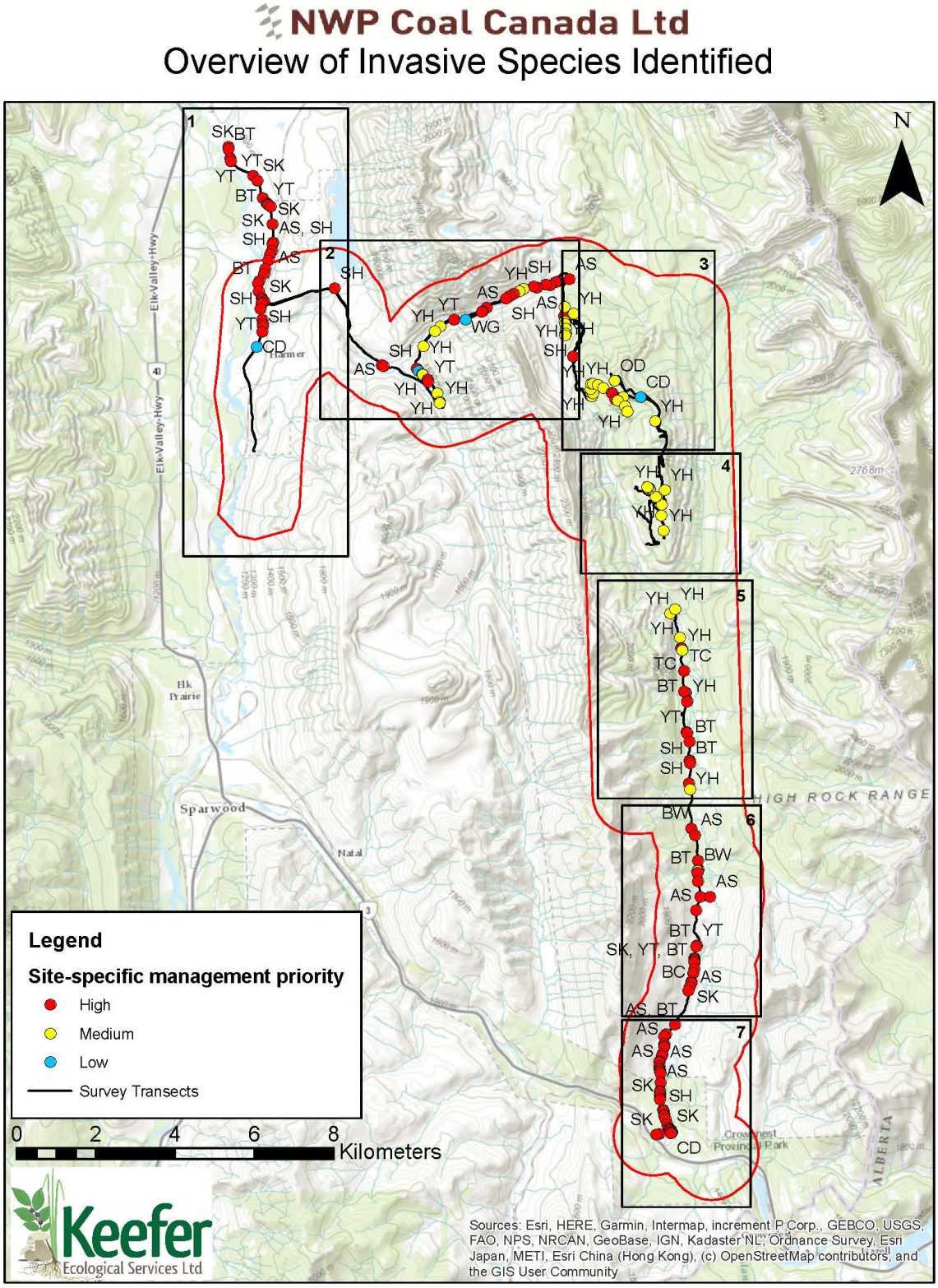


Figure 3. Overview of invasive plant survey results and subset map boundaries (below; refer to Table 3 for species codes).

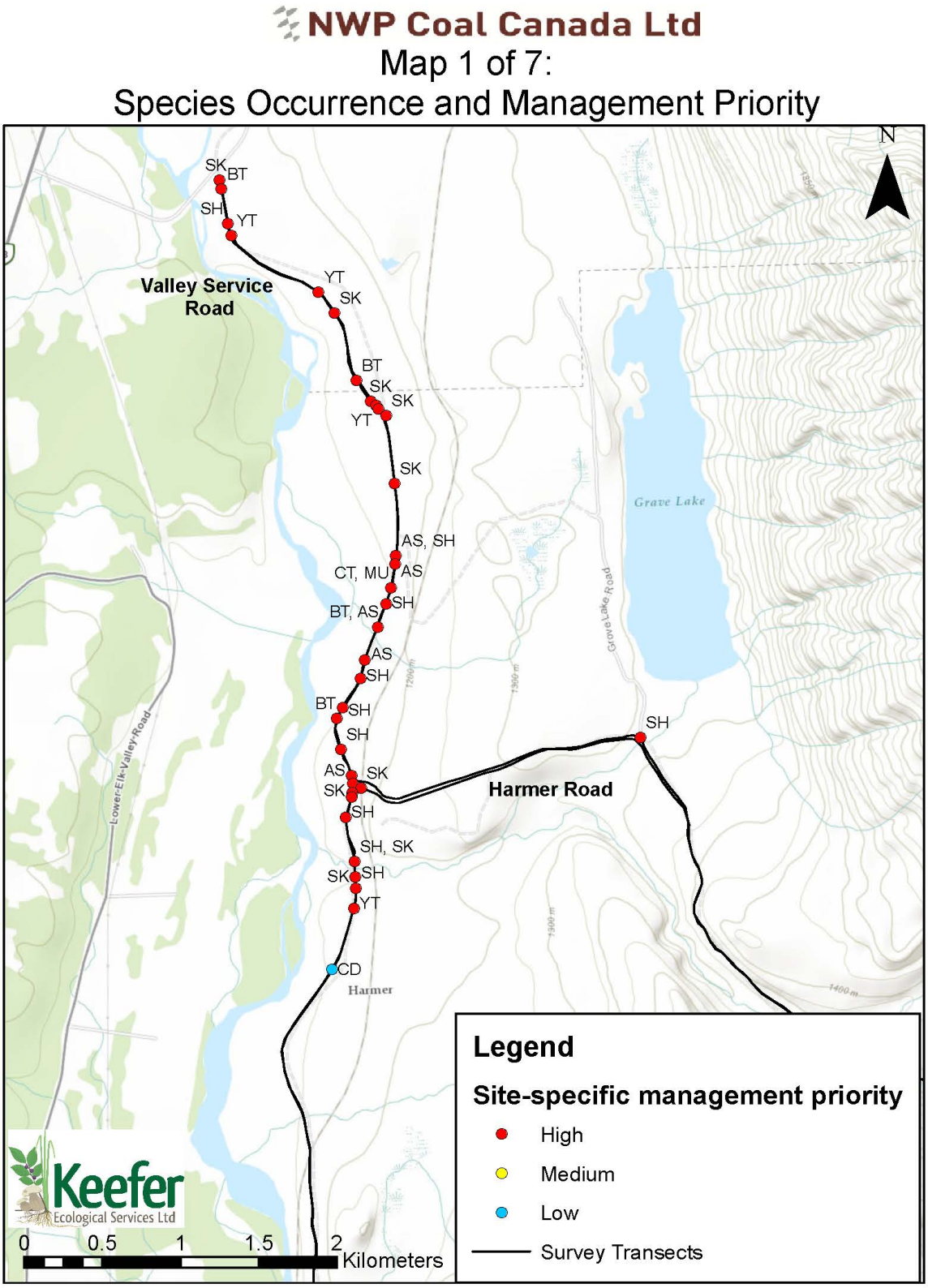


Figure 3a. Map 1 of 7: Valley Service Road and western portion of Harmer Road.

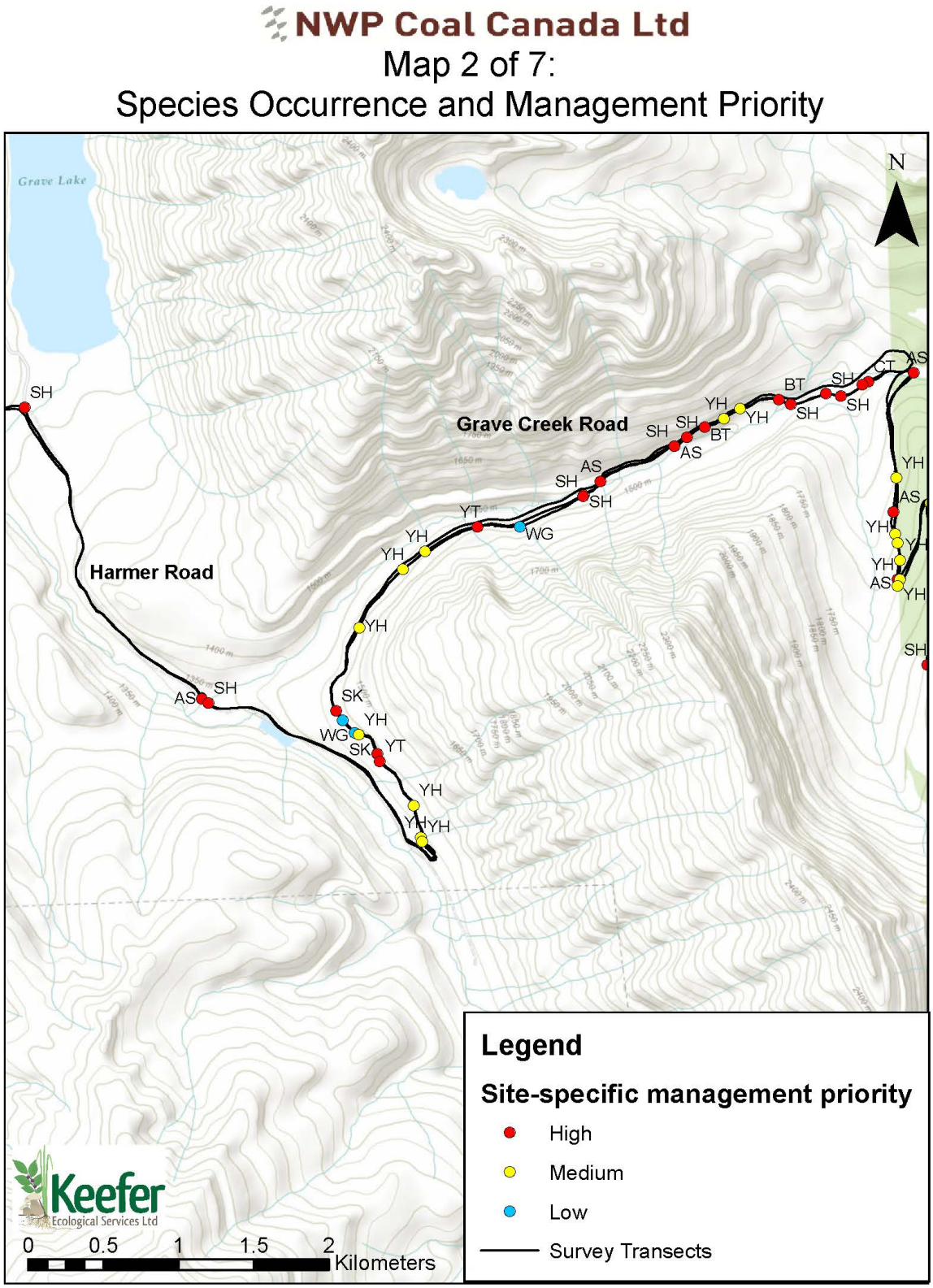


Figure 3b. Map 2 of 7: East portion of Harmer Road and Grave Creek Road to intersection with Branch C.

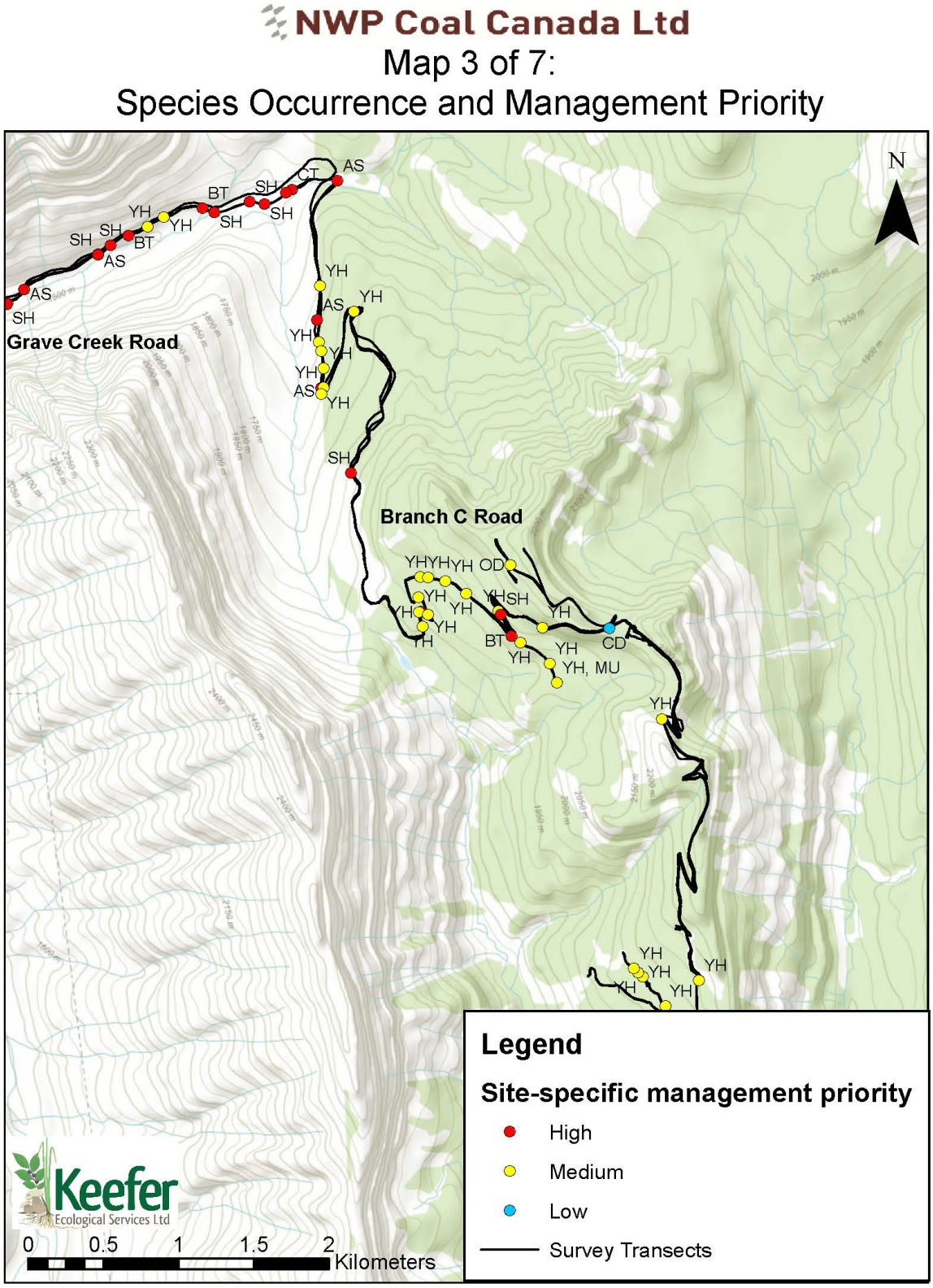


Figure 3c. Map 3 of 7: Northern portion of Branch C from intersection with Grave Creek Road.

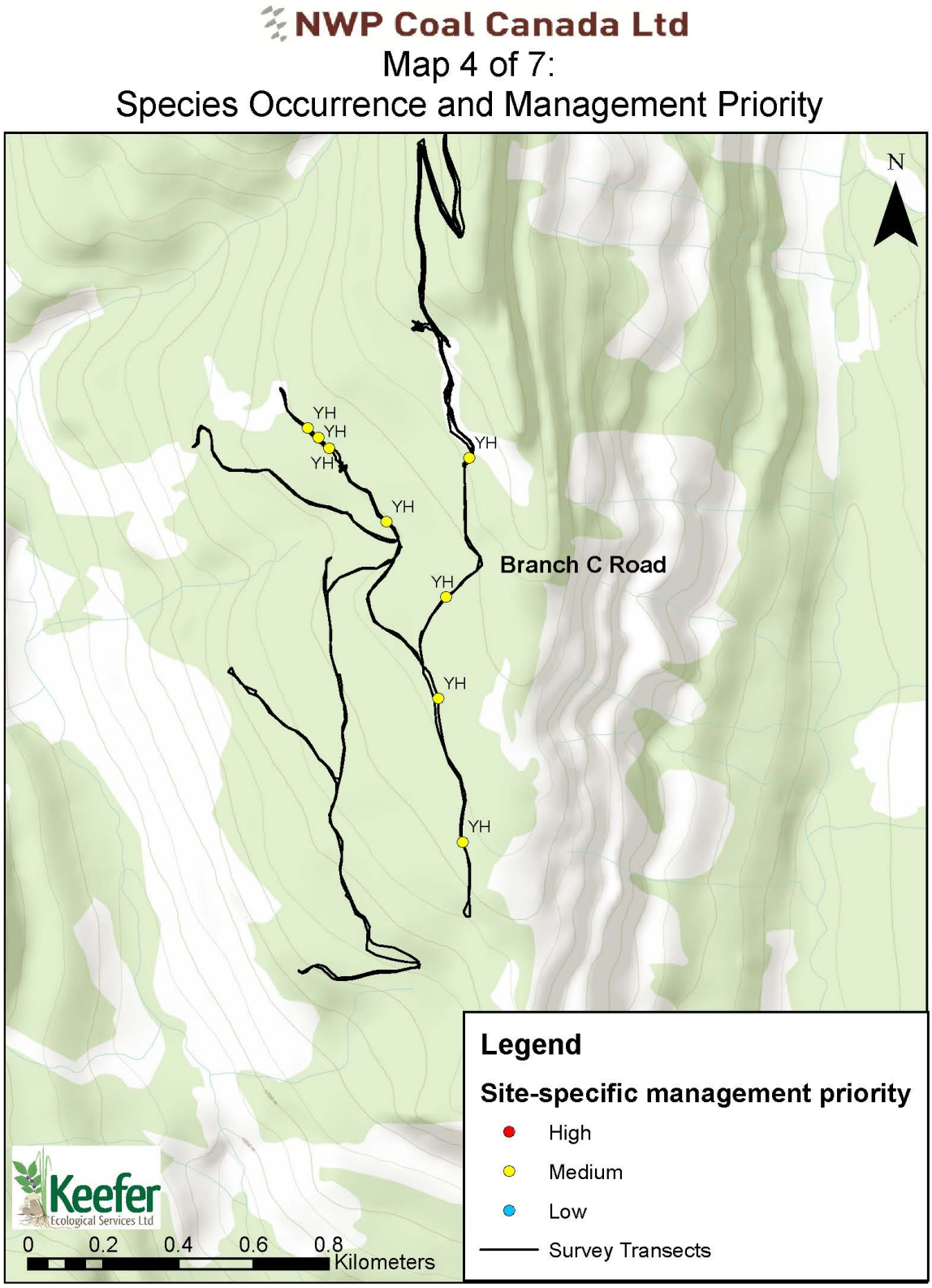


Figure 3d. Map 4 of 7: Southern portion of Branch C.

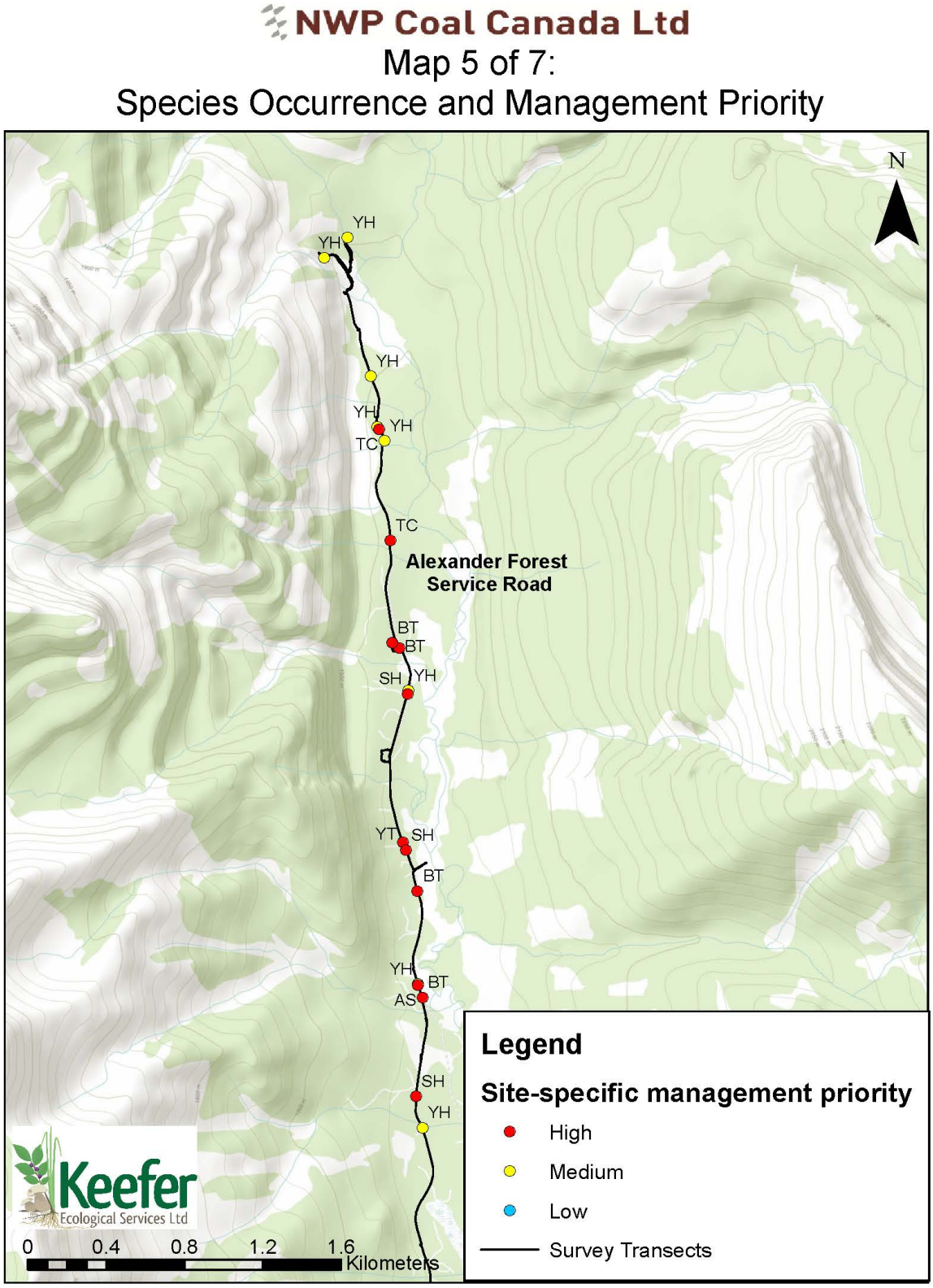


Figure 3e. Map 5 of 7: Northern portion of Alexander Forest Service Road.

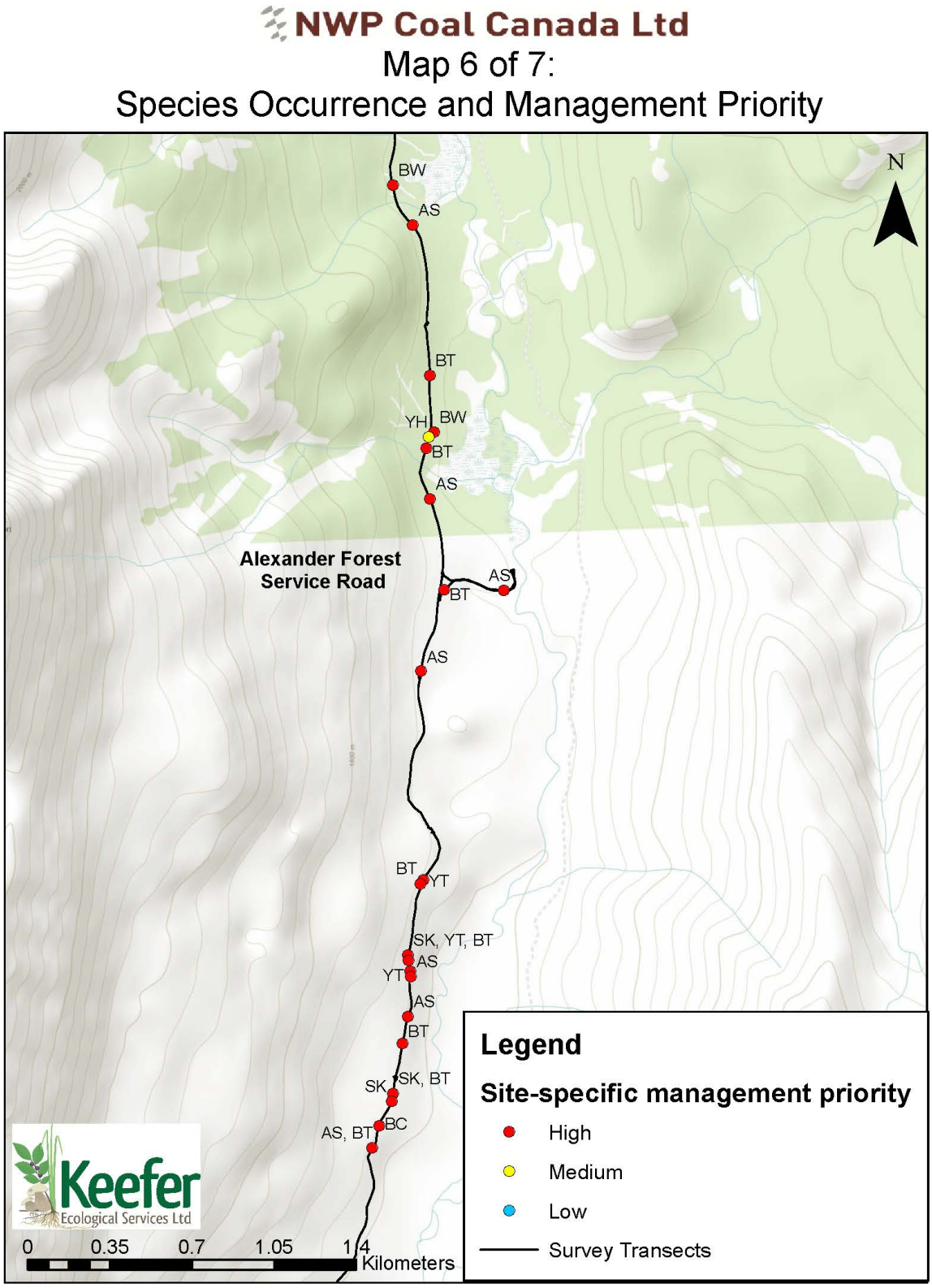


Figure 3f. Map 6 of 7: Middle portion of Alexander Forest Service Road.

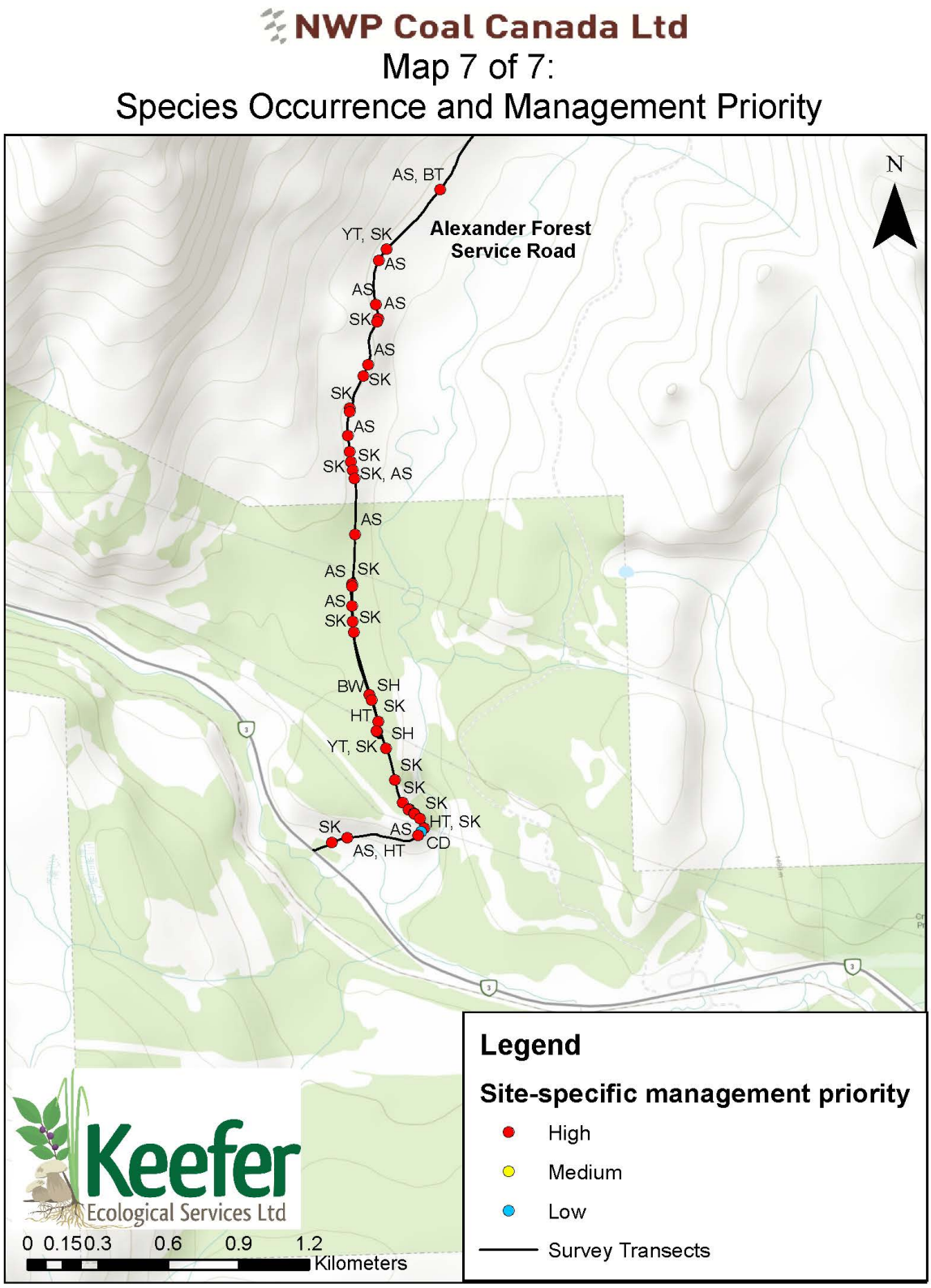


Figure 3g. Map 7 of 7: Lower portion of Alexander Forest Service Road at intersection with Highway 3.

Discussion

Provincial legislation requires a mining company to manage weeds on their property during exploration, development, active and decommissioning mine phases, as land occupiers or owners. Proactive management of invasive plants within the Crown Mountain Coking Coal Project area is imperative to avoid compromising ecosystem function and reducing the threats and costs invasive plants pose to reclamation efforts.

A critical first step to invasive plant management is avoidance of invasive plant establishment. Development within the Project area results in areas with little to no vegetation competition and disturbed soil, creating an ideal site for invasive plants to colonize (Polster, 2003). Within the current footprint, invasive plants were not documented along Branch 4, Spur 3.5 and Spur 4, each of which lead to drill pads (Table 4). These recently disturbed roads are at a high risk of invasive plant colonization as they are located off of Branch C, which has five invasive plant species documented along its length, two of which are considered high management priorities (Table 3). Best management practices that can be taken to avoid invasive plant establishment in freshly disturbed areas include (ISC BC, 2015; Hougen et al., 2012; Polster, 2003):

- **Clean Vehicles, Equipment, and Gear**
  Ensure vehicles, equipment, and gear moving into freshly disturbed areas are free from invasive plant seeds. Seed can become trapped in mud on vehicles, equipment and gear which can later fall off at other locations on the mine site, encouraging the spread of invasive plants. The application of a pressure washer on vehicles and equipment is an effective tool to manage movement of invasive plants. As well, a brush may be used to remove seeds from gear. Washing and brushing should be performed in areas where weed seeds do not pose a problem.

- **Avoid Parking and/or Storing Vehicles, Equipment, and Gear in Infested Areas**
  Ensure vehicles, equipment, and gear are not parked and/or stored in areas infested with invasive plants to avoid attachment of invasive plant parts and seeds onto vehicles, equipment and gear, preventing their spread to new locations. In order to achieve this, infested areas should be clearly identified on the ground and crews should be familiarized with identification features of invasive species.

- **Avoid Contaminated Seed Mixes**
  Reclamation seed mixes may contain invasive plant seeds. To avoid contaminated reclamation seed mixes, purchase seed from a reputable dealer and request a seed analysis certificate for all species included in the seed mix. The seed analysis certificate will specify weed and other crop seeds present in the seed mix, providing information on the purity of the seed. The added cost of a good quality seed mix outweighs the cost that will be required to manage the weeds once established.

- **Avoid Infested Gravel and Soil**
  Invasive plants may be present in gravel and soil brought to site for exploration, development or reclamation purposes. To avoid contaminated gravel and soil, ensure that salvaged soil does not come from roadside areas that were infested by invasive plants or obtain material from a provider that ensures the soil and gravel do not contain invasive plant seeds.

Implementing best management practices will manage possible pathways and vectors needed for invasive plants to colonize a site. Operating staff and contractors on site should be trained on invasive plant identification and best management practices to prevent risks associated with invasive plants. In addition to implementing best management practices, initiating invasive plant treatment efforts within the current footprint is recommended to begin managing infestations throughout the footprint area, reducing their potential impact to disturbance areas created throughout the lifetime of the Project. Appendix B outlines approaches that are recommended to manage the 16 invasive plants identified within the Project area, which includes eradication from roadways, containment, and monitoring.

Management efforts are recommended to initially focus on the treatment of invasive plants identified as high priority, which include annual sow thistle, bladder campion, bull thistle, blueweed, Canada thistle, common tansy, hound's tongue, scentless chamomile, spotted knapweed, and yellow toadflax. Eradication of all high priority species, excluding Canada thistle, from roadways is advised to prevent plant parts and seed from attaching onto vehicles, equipment, and gear that would enable the spread of these species into non-invaded areas. Application of herbicide, or mowing followed by herbicide application are advised to address these weeds (Appendix B). Of the listed high priority species, bladder campion and bull thistle are not regulated under the BC *Weed Control Act*. However, only one small (< 0.01 ha) bladder campion infestation was identified along Alexander Road, and thus treatment is strongly advised to prevent the expansion and spread of this infestation. Further, bull thistle is identified as an invasive plant under the BC *Forest and Range Practices Act* and it is known to become a dominant species for several years in disturbed areas (BC MAFF and OLA, 2002). Bull thistle is not widely distributed throughout the footprint (Table 4; Appendix B) and thus eradication from roadsides is advised to prevent its establishment into freshly disturbed areas. Eradication of Canada thistle, while desirable, is not deemed feasible because the invasive plant is widespread throughout the Project area. However, containment of infestations is advised to prevent the aggressive weed from expanding and becoming established in freshly disturbed areas. Large and small patches are easier to treat and control than evenly distributed plants so early detection and efforts should be focused on patches which might have success in treatment.

A few invasive plants were noted along the powerline crossing Alexander Road, including Canada thistle, great mullein, hound's tongue, oxeye daisy, spotted knapweed, sulphur cinquefoil, yellow salsify, and yellow toadflax. Management of weeds along the powerline is the responsibility of BC Hydro. Coordinating with BC Hydro regarding the management of invasive species along the powerline, particularly Canada thistle, hound's tongue, spotted knapweed, sulphur cinquefoil, and yellow toadflax,

is recommended as the powerline acts as a seed source of invasive plants, increasing the risk of spread of high concern invasive plants throughout the Project area.

Development of an integrated pest management plan that incorporates best management practices and approaches to treat invasive plants onsite will guide management efforts throughout the Project phases from development to reclamation.

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Appendix A

Distribution and density of invasive plants identified within the current active footprint of the Crown Mountain Coking Coal Project. Note only the presence of invasive species was noted along Harmer Rd, Grave Prairie Valley Rd, and Valley Rd.

Date Surveyed	Active Footprint Area	Kilometer Marker	Species	Distribution	Density
29-Aug-18	Branch C	start-90	oxeye daisy	5	4
			Canada thistle	5	4
			yellow hawkweed	2	1
29-Aug-18	Branch C	89-90	Canada thistle	6	4
			oxeye daisy	6	3, 4
			yellow hawkweed	5	3
29-Aug-18	Branch C	90-91	Canada thistle	6	4
			oxeye daisy	5	3, 4
			yellow hawkweed	5	4
29-Aug-18	Branch C	92-93	Canada thistle	5	4
			oxeye daisy	5	2, 3
			scentless chamomile	3	4
29-Aug-18	Branch C	93-94	Canada thistle	5	3
			oxeye daisy	5	2, 3
29-Aug-18	Branch C	94-95	oxeye daisy	5	2, 3
			yellow hawkweed	4, 5	1, 2
			Canada thistle	5	2
29-Aug-18	Branch C	95-96	oxeye daisy	5	2, 3
			Canada thistle	4, 5	1, 2
			yellow hawkweed	4, 5	1, 2
29-Aug-18	Branch C	96-97	yellow hawkweed	2, 5	1, 2
			Canada thistle	4, 5	1, 2
			oxeye daisy	5	2, 3
			scentless chamomile	1	1
29-Aug-18	Branch C	97-98	curled dock	1	1
29-Aug-18	Branch C	98-99	yellow hawkweed	3	2
			Canada thistle	3	2
29-Aug-18	Branch C	99-100	-	-	-
29-Aug-18	Branch C	100-101	-	-	-
29-Aug-18	Branch C	101-102	yellow hawkweed	2, 5	1, 2
29-Aug-18	Branch C	102-103	oxeye daisy	3	2
29-Aug-18	Branch C	103-104	-	-	-
29-Aug-18	Branch C	104-105	-	-	-

Date Surveyed	Active Footprint Area	Kilometer Marker	Species	Distribution	Density
29-Aug-18	Spur 4	< 1 km	-	-	-
29-Aug-18	Spur 3.5	< 1 km	-	-	-
29-Aug-18	Spur 3	< 1 km	yellow hawkweed	2, 5	1, 2
29-Aug-18	Branch 4	< 1 km	-	-	-
29-Aug-18	Branch 5	< 1 km	yellow hawkweed	2, 5	1, 2
29-Aug-18	Spur 2	< 1 km	oxeye daisy	2, 5	1, 2
29-Aug-18	Spur 1	< 1 km	Canada thistle	3	4
			oxeye daisy	3	4
			curled dock	1	1
			yellow hawkweed	2, 5	1, 2
			great mullein	1	1
29-Aug-18	Grave Creek Rd	90-89	oxeye daisy	-	-
			Canada thistle	-	-
29-Aug-18	Grave Creek Rd	89-88	oxeye daisy	5	2
			Canada thistle	5	2, 3
			scentless chamomile	4, 5	1, 2
			curled dock	1	1
29-Aug-18	Grave Creek Rd	88-87	oxeye daisy	4, 5	1, 2
			Canada thistle	5	2
			yellow hawkweed	5	4
			great mullein	5	2
			curled dock	2	1
			annual sow thistle	3	2
29-Aug-18	Grave Creek Rd	87-86	oxeye daisy	5	2, 3
			Canada thistle	5	4
			scentless chamomile	5	2, 3
			yellow salsify	1	1
			great mullein	1	1
29-Aug-18	Grave Creek Rd	86-85	yellow toadflax	3	4
			oxeye daisy	5	2, 3
			yellow hawkweed	5	4
			Canada thistle	3	4
29-Aug-18	Grave Creek Rd	85-84	oxeye daisy	5	2, 3
			yellow hawkweed	5	4
			Canada thistle	5	4
			great mullein	5	2
			spotted knapweed	3	2
			yellow salsify	1	1

Date Surveyed	Active Footprint Area	Kilometer Marker	Species	Distribution	Density
29-Aug-18	Grave Creek Rd	84-83	great mullein	4, 5	1, 2
			yellow salsify	4, 5	1, 2
			Canada thistle	5	3
			oxeye daisy	5	2, 3
			spotted knapweed	3	2
			yellow toadflax	3	3
			yellow hawkweed	5	3
29-Aug-18	Grave Creek Rd	83-end	yellow hawkweed	3	4
			great mullein	5	2
			annual sow thistle	1	1
			yellow salsify	4	1
			Canada thistle	3	4
29-Aug-18	Harmer Rd	-	oxeye daisy	-	-
			great mullein	-	-
			yellow hawkweed	-	-
			annual sow thistle	-	-
			Canada thistle	-	-
			curled dock	-	-
			yellow salsify	-	-
			scentless chamomile	-	-
			curled dock	-	-
29-Aug-18	Grave Prairie Valley Rd (Loadout Area)	-	scentless chamomile	-	-
			yellow salsify	-	-
			spotted knapweed	-	-
			annual sow thistle	-	-
			curled dock	-	-
			Canada thistle	-	-
			great mullein	-	-
			yellow toadflax	-	-
			oxeye daisy	-	-
			curled dock	-	-
30-Aug-18	Alexander Rd	Alex End-Alex Main	Canada thistle	6	4
			oxeye daisy	5	2,3
			curled dock	5	2,3
			scentless chamomile	3	4
			great mullein	2	1
			yellow salsify	2	1

Date Surveyed	Active Footprint Area	Kilometer Marker	Species	Distribution	Density
			yellow hawkweed	5	2, 4
30-Aug-18	Alexander Rd	Alex Main-90	curled dock	4	2
			oxeye daisy	4	2
			Canada thistle	6	3, 4
			yellow hawkweed	5	2
30-Aug-18	Alexander Rd	90-89	curled dock	5	2
			yellow hawkweed	6	4
			oxeye daisy	5	2, 3
			common tansy	2, 5	1, 2
			Canada thistle	5	2, 3
			great mullein	2	1
			yellow salsify	2	1
30-Aug-18	Alexander Rd	89-88	oxeye daisy	8	2, 3
			Canada thistle	8	2, 3
			great mullein	2	1
			curled dock	5	2
			curled dock	2	1
			yellow hawkweed	6	4
			scentless chamomile	1	1
30-Aug-18	Alexander Rd	88-87	Canada thistle	8	4
			curled dock	5	2, 4
			yellow toadflax	3	4
			yellow hawkweed	6	4
			scentless chamomile	2	2
			great mullein	4, 5	1, 2
			oxeye daisy	8	4
			curled dock	2	1
			annual sow thistle	5	2
			yellow salsify	2	1
30-Aug-18	Alexander Rd	87-86	Canada thistle	8	4
			great mullein	5	2
			oxeye daisy	8	3
			yellow salsify	2	1
			curled dock	5	2
			scentless chamomile	5	2, 3
			curled dock	2	1
			yellow hawkweed	8	4

Date Surveyed	Active Footprint Area	Kilometer Marker	Species	Distribution	Density
30-Aug-18	Alexander Rd	86-85	oxeye daisy	8	2
			Canada thistle	8	3, 4
			yellow hawkweed	6	4
			scentless chamomile	6	2, 3
			great mullein	2	1
			curled dock	4, 5	1, 2
			blueweed	1	1
			annual sow thistle	3	2
30-Aug-18	Alexander Rd	85-84	scentless chamomile	6	3
			oxeye daisy	5	2
			yellow hawkweed	8	4
			great mullein	2	1
			yellow salsify	2	1
			Canada thistle	8	4
			curled dock	5	2
			curled dock	2	1
			blueweed	1	1
30-Aug-18	Alexander Rd	84-83 + Dead Man's Pass	Canada thistle	8	4
			great mullein	5	2
			scentless chamomile	9	4
			oxeye daisy	5	2, 3
			yellow salsify	4	1
			yellow hawkweed	6	4
			annual sow thistle	5	2
30-Aug-18	Alexander Rd	83-82	Canada thistle	6	3, 4
			scentless chamomile	8	3, 4
			yellow salsify	4, 5	1, 2
			oxeye daisy	5	2,3
			great mullein	2, 5	1, 2
			yellow toadflax	5	3, 4
			spotted knapweed	1	1
			annual sow thistle	3	2
			yellow hawkweed	5	2, 4
			curled dock	2, 5	1, 2
30-Aug-18	Alexander Rd	82-81	scentless chamomile	6	3, 4
			yellow hawkweed	8	3, 4

Date Surveyed	Active Footprint Area	Kilometer Marker	Species	Distribution	Density
			curled dock	4, 5	1, 2
			oxeye daisy	5	2, 3
			Canada thistle	5	2, 3
			great mullein	5	2
			yellow salsify	4, 5	1, 2
			bladder campion	2	1, 2
			spotted knapweed	2	1
30-Aug-18	Alexander Rd	81-80	oxeye daisy	5	2, 3
			scentless chamomile	6	3, 4
			yellow hawkweed	5	2, 4
			Canada thistle	5	4
			curled dock	4, 5	1, 2
			great mullein	5	2, 3
			yellow salsify	4, 5	1, 2
			yellow toadflax	3	2
			spotted knapweed	2	1
			annual sow thistle	5	2
30-Aug-18	Alexander Rd	80-79	great mullein	4, 5	1, 2
			yellow hawkweed	5	4
			spotted knapweed	5	2, 3
			oxeye daisy	4	2, 3
			scentless chamomile	5	3, 4
			Canada thistle	5	2, 3
			yellow toadflax	5	3, 4
			curled dock	2, 5	1,2
			yellow salsify	5	2, 3
			annual sow thistle	6	3, 4
30-Aug-18	Alexander Rd	79-78-Alex Start	annual sow thistle	5	3, 4
			spotted knapweed	5	3, 4
			Canada thistle	5	3, 4
			oxeye daisy	5	2, 3
			yellow salsify	5	2, 3
			great mullein	5	2, 3
			curled dock	2, 5	1, 2
			blueweed	1	1
			scentless chamomile	5	2, 3
			yellow toadflax	5	4

Date Surveyed	Active Footprint Area	Kilometer Marker	Species	Distribution	Density
			hound's tongue	2, 5	1, 2
			yellow hawkweed	5	4
			sulphur cinquefoil	-	-
31-Aug-18	Valley Rd	-	spotted knapweed	-	-
			curled dock	-	-
			Canada thistle	-	-
			yellow salsify	-	-
			scentless chamomile	-	-
			yellow toadflax	-	-
			great mullein	-	-
			oxeye daisy	-	-

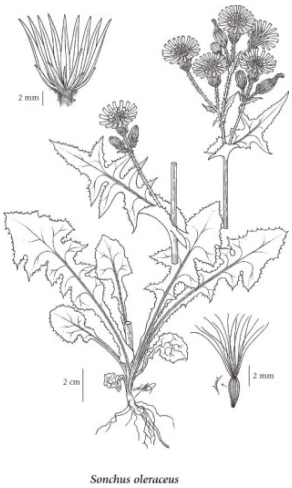
Appendix B

Descriptions of invasive plants identified within the current active footprint of the Crown Mountain Coking Coal Project and recommended treatment approaches based on management priority.

High Management Priority

Annual sow thistle (*Sonchus oleraceus*)

Management Priority: High



Images from E-Flora BC

General Ecology

Annual sow thistle is an annual forb that grows 0.1-1.0 m in height (BC MAFF and OLA, 2002). Flowers are yellow and dandelion-like, leaves are deeply lobed with small, weak teeth along the margins, and stems are erect and branched near the top. Stems are hollow and exude a milky juice when broken. Each plant produces approximately 6,100 lightweight seeds which are primarily dispersed by wind and can remain viable in the soil for several years. Annual sow thistle grows best on fertile, moist soils in full sunlight; however, it grows in a wide range of environments including roadsides, riparian areas, gravel pits, and logged areas (BC MAFF and OLA, 2002).

Management Strategy

Eradication

Annual sow thistle is considered a noxious weed under the BC *Weed Control Act*. Eradicating annual sow thistle from roadsides will aid in preventing the weed from spreading to new disturbances and seed attaching to humans and mobile equipment.

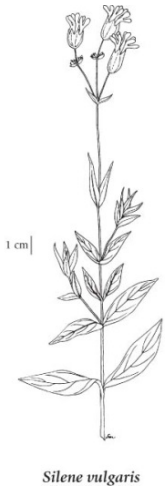
Control Methods

Mechanical: Mowing prior to seed set can prevent seed production; however, mowing must be lower than 20 cm to prevent re-growth. Small infestations can be hand-pulled (BC MAFF and OLA, 2002).

	Chemical: Post-emergence herbicides, such as MCPA, MCPB, 2,4-D, and 2,4-DB can be applied prior to blooming to manage the plant and prevent seed production (BC MAFF and OLA, 2002). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application.
Recommended Treatment	Herbicide application or mowing followed by herbicide application.
On Site Locations	• Grave Creek Rd, between road start to kilometer marker 83 and between kilometer markers 87-88 • Harmer Rd • Grave Prairie Valley Rd (Loadout Area) • Alexander Rd, between road start and kilometer marker 81 and between kilometer markers 82-86 and 87-88
References	BC Ministry of Agriculture, Food and Fisheries (BC MAFF) and Open Learning Agency (OLA). 2012. Guide to Weeds in British Columbia. Burnaby, BC: Open Learning Agency. Accessed November 30, 2018 from https://www.for.gov.bc.ca/hra/plants/weedsbc/GuidetoWeeds.pdf.

Bladder campion (*Silene vulgaris*)

Management Priority: High



Silene vulgaris

Images from E-Flora BC

General Ecology

Bladder campion is a perennial forb that grows approximately 0.6 m tall (Parks, 2007). Flowers have five white petals with the base expanding into a balloon or "bladder" that holds the seed pod. Leaves are waxy, light green to whitish and the plant has a deep tap root. Bladder campion reproduces by seed or vegetative propagation. It prefers to grow on medium to coarse, well-drained soils, commonly found along roadsides, rail lines, right-of-ways, pastures, and gravel pits (Parks, 2007).

Management Strategy

Eradication

Bladder campion is not considered a priority noxious weed under the BC *Weed Control Act*. However, a small infestation of bladder campion was only found at one location along the roadside on Alexander Rd between kilometer markers 81-82. Removing this infestation is advised to prevent its spread.

Control Methods

Mechanical: Repetitive mowing prior to flowering or seed set can effectively control infestations that are established (Parks, 2007).

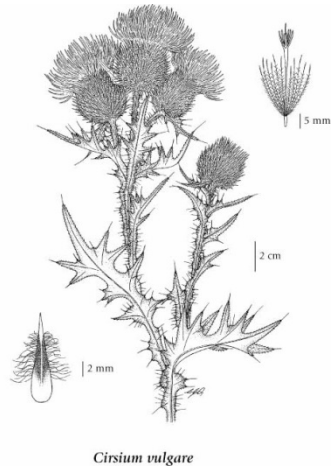
Chemical: Herbicides such as picloram and imazapyr may be applied prior to seed set to manage the plant (Parks, 2007). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application.

Biological: A beetle, *Cassida azurea*, has been released in Canada. The beetle defoliates the upper leaves and consumes the majority of the flower which reduces seed production; however, it does not control the plant (Parks, 2007).

Recommended Treatment	Herbicide application or mowing followed by herbicide application.
On Site Locations	• Alexander Rd, between kilometer markers 81-82
References	Parks, C. 2007. Best Management Practices for Industry: Top Invasive Plant Concerns for Rights-of –Way. Brandon, MB: Leafy Spurge Stakeholders Group. Accessed on November 30, 2018 from https://invasivespeciesmanitoba.com/site/uploads/managementplan/8-%20LeafySpurgeBMPManual2007.pdf.

Bull thistle (*Cirsium vulgare*)

Management Priority: High



Images from E-Flora BC

General Ecology

Bull thistle is a biennial forb that grows from a short, fleshy taproot and ranges from 0.3-2.0 m in height (BC MAFF and OLA, 2002). Stems are erect and branched with leaves that are deeply lobed containing stout spines at the lobes and tips. Flowers are pinkish to dark purple. Bull thistle reproduces by seed, producing up to 4,000 seeds per plant that are highly viable and can germinate quickly under favourable conditions. Seeds are primarily dispersed by wind. Bull thistle grows is dry to moist habitats, including roadsides, pastures, and logged forestland (BC MAFF and OLA, 2002).

Management Strategy

Eradication

Bull thistle is not considered a priority noxious weed under the BC *Weed Control Act*; however, it is listed as an invasive plant under the BC *Forest and Range Practices Act*. Bull thistle can become a dominant species for several years in disturbed areas (BC MAFF and OLA, 2002). It is not widely distributed throughout the active footprint, and thus eradication from roadsides is advised to prevent its colonization into freshly disturbed areas and seed attaching to humans and mobile equipment.

Control Methods

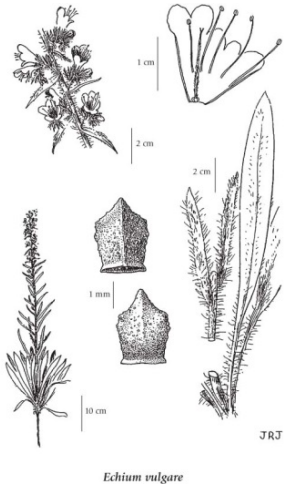
<u>Mechanical:</u> Cutting or mowing top growth or cutting the taproot just below the root crown prior to seed-set will prevent seed production (BC MAFF and OLA, 2002).

<u>Chemical:</u> Herbicides, such as picloram, dicamba, glyphosate, and 2,4-D, can effectively manage bull thistle (BC MAFF and OLA, 2002). Herbicides should be applied when the plant is in its rosette stage or after mowing because bull thistle is more tolerant of herbicides after the flower stalk is produced. Soil

	and/or substrate type and nearness to water sources must be considered prior to herbicide application. Biological: The seedhead fly (*Urophora stylata*) has been released in BC and has reportedly reduced bull thistle seed production by 80% in some areas (BC MAFF and OLA, 2002).
Recommended Treatment	Herbicide application or mowing followed by herbicide application.
On Site Locations	• Alexander Rd between road start to kilometer marker 85 and between kilometer markers 86-89 • Spur 1 off of Branch C • Grave Creek Rd between kilometer markers 87-89 • Harmer Rd • Grave Prairie Valley Rd (Loadout Area) • Valley Rd
References	BC Ministry of Agriculture, Food and Fisheries (BC MAFF) and Open Learning Agency (OLA). 2012. Guide to Weeds in British Columbia. Burnaby, BC: Open Learning Agency. Accessed November 30, 2018 from https://www.for.gov.bc.ca/hra/plants/weedsbc/GuidetoWeeds.pdf.

Blueweed (*Echium vulgare*)

Management Priority: High



Echium vulgare

Images from E-Flora BC

General Ecology

Blueweed is a biennial or short-lived perennial that produces a low growing rosette of hairy leaves in the first year and a flowering bolt in the second year (AISC, 2014). Blueweed grows 30-80 cm tall from a long, stout taproot. Stems and leaves are covered in short, stiff hairs. Leaves are lance shaped and flower petals are bright blue. Blueweed produces up to 2,800 seeds which can remain viable for several years. Seed is generally dropped near the parent plant; however, the seeds are rough and can therefore be transported by sticking to animals and humans. Blueweed can grow in a variety of soil types and pH. It can also grow in nutritionally poor soils and it is found along roadsides, drainage ditches, right-of-ways, pastures, and other disturbed areas (AISC, 2014; ISC BC, 2014).

Management Strategy

Eradication

Blueweed is considered a noxious weed under the BC *Weed Control Act*. Blueweed was only found in three areas along Alexander Rd and only one plant was observed at each of these locations. Eradicating blueweed from the roadside will aid in preventing the weed from spreading to new disturbances and seed attaching to humans and mobile equipment.

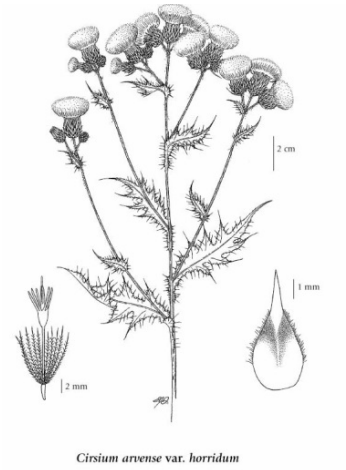
Control Methods

<u>Mechanical:</u> Mowing can deplete root reserves and prevent the production of seed; however, mowing must be repeated because cut stems encourage re-sprouting. Hand-pulling is effective in loose soil. In harder packed soil, cut the stem just below ground level. Wear gloves and long sleeves as blueweed causes itching and rashes (AISC, 2014).

	Chemical: The herbicide 2,4-D can be applied in spring or early autumn for short-term control. Glyphosate may also be applied for short-term control. The herbicide picloram provides long-term, residual control. (ISC BC, 2014). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application.
Recommended Treatment	Herbicide application or hand-pulling.
On Site Locations	• Alexander Rd between road start to kilometer marker 79 and kilometer markers 84-86
References	Alberta Invasive Species Council (AISC). 2014. Blueweed *Echium vulgare* (aka Viper's bugloss). Accessed on November 30, 2018 from https://abinvasives.ca/wp-content/uploads/2017/11/FS-Blueweed.pdf. Invasive Species Council of BC (ISC BC). 2014. Blueweed. *Echium vulgare*. Tips. Accessed on November 30, 2018 from https://bcinvasives.ca/documents/Blueweed_TIPS_Final_08_06_2014.pdf.

Canada thistle (*Cirsium arvense*)

Management Priority: High



Images from E-Flora BC

General Ecology

Canada thistle is a perennial forb that grows 0.5 to 1.5 m tall from a creeping root system (AISC, 2014). Leaves are lance-shaped, dark green, shiny and spiny. Lower leaves are the largest and leaves decrease in size up the stem. Flowers are purple, pink, or white in colour, occurring in clusters of one to several at the end of stems. Canada thistle reproduces through seed and vegetatively through a creeping root that can spread up to 4.5 m horizontally and 6.0 m vertically. Plants are estimated to live approximately 2 years; however, they are replaced by new shoots which results in infestations made up of genetically identical plants. Approximately 1,000 to 1,500 seeds are produced per shoot and seeds may remain dormant for 20 years. Seeds are primarily dispersed by wind, but may also be dispersed by water, animals, and humans. Canada thistle is commonly found along roadsides, cultivated fields and pastures, logged forests, and other disturbed areas (AISC, 2014).

Management Strategy

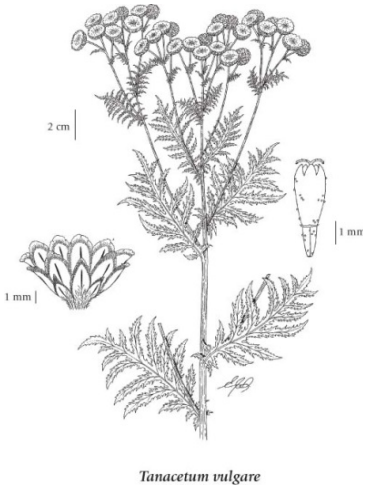
Containment

Canada thistle is listed as a noxious weed under the BC *Weed Control Act*. Canada thistle is abundant throughout the study area and large infestations are present within the study area (e.g., infestation over 2 ha in size adjacent to Alexander Rd). Eradication of Canada thistle is not feasible due to the density and distribution of infestations throughout the study area. However, containment of infestations is imperative to prevent further spread of Canada thistle into disturbed areas as Canada thistle is known as an aggressive plant that forms dense colonies (AISC, 2014). Managing Canada thistle along roadways will aid in preventing its colonization of disturbed areas and attachment of seeds on humans and mobile equipment.

Control Methods	Mechanical: Repeated mowing through the growing season slowly reduces food energy stores in the root system and seed-set; however, this is a long-term management approach (AISC, 2014). Chemical: Several herbicides may be applied in the spring and autumn to control Canada thistle, including 2,4-D, aminopyralid, chlorsulfuron, clopyralid, dicamba, glyphosate hexazinone, metsulfuronmethyl, MCPA, and picloram (AISC, 2014). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application.
Recommended Treatment	Herbicide application or mowing followed by herbicide application along roadways.
On Site Locations	• Alexander Rd from road start to road end • Branch C from road start to kilometer marker 99 • Spur 1 off of Branch C • Grave Creek Rd from road start to kilometer marker 90 • Harmer Rd • Grave Prairie Valley Rd (Loadout Area) • Valley Rd
References	Alberta Invasive Species Council (AISC). 2014. Canada Thistle *Cirsium arvense* (aka Creeping Thistle). Accessed on November 30, 2018 from https://abinvasives.ca/wp-content/uploads/2017/11/FS-CanadaThistle.pdf.

Common tansy (*Tanacetum vulgare*)

Management Priority: High



Images from E-Flora BC

General Ecology

Common tansy is a perennial herb that grows up to 1.8 m tall (ISC BC, 2014). Leaves are 10-20 cm in length, dark green and divided with serrated leaflets. Flowers are yellow disc flowers located at the top of the stems in a flat-topped cluster with 20-200 flower heads per plant. Common tansy reproduces by seed as well as short rhizomes and seeds can remain viable in the soil for 25 years (AISC, 2014; ISC BC, 2014). Common tansy prefers to grow in sunny areas with well-drained soils, commonly invading stream banks, pastures, and roadsides (ISC BC, 2014).

Management Strategy

Eradication

Common tansy is considered noxious in the East Kootenay region under the BC *Weed Control Act* and it is identified as an invasive plant under the BC *Forest and Range Practices Act*. Common tansy was only identified in one area along Alexander Rd. Eradicating common tansy from the roadside will aid in preventing the weed from spreading to new disturbances and seed attaching to humans and mobile equipment.

Control Methods

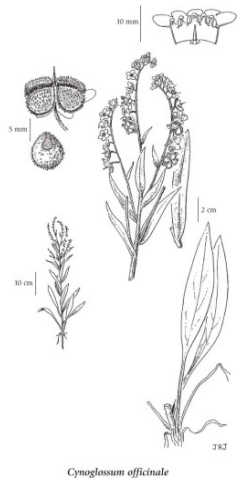
Mechanical: Regular mowing may be applied to reduce seed production; however, mowing must be repeated to be effective as common tansy can regrow from the root stock (AISC, 2014). Hand-pulling may be used to deal with small infestations; however, gloves and other protective clothing should be worn as common tansy can cause skin irritation (ISC BC, 2014).

Chemical: Herbicides, including picloram, picloram/2,4 D, metsulfuron methyl, and aminopyralid, may be applied to common tansy to manage the plant (ISC

	BC, 2014). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application.
Recommended Treatment	Herbicide application or mowing followed by herbicide application.
On Site Locations	• Alexander Rd between kilometer markers 89-90
References	Alberta Invasive species Council (AISC). 2014. Common Tansy *Tanacetum vulgare*. Accessed on December 10, 2018 from https://abinvasives.ca/wp-content/uploads/2017/11/FS-CommonTansy.pdf. Invasive Species Council of British Columbia (ISC BC). 2014. Common Tansy *Tanacetum vulgare*. Accessed on December 10, 2018 from https://bcinvasives.ca/documents/Common_Tansy_TIPS_Final_08_06_2014.pdf.

Hound's tongue (*Cynoglossum officinale*)

Management Priority: High



Images from E-Flora BC

General Ecology

Hound's tongue is a biennial to short-lived perennial plant that grows 0.5-1.2 m tall from a woody taproot (ISC BC, n.d.). Bristly hairs cover all parts of the plant (AISC, 2014). Leaves are rough and wide, growing up to 30 cm in length (ISC BC, n.d.; AISC, 2014). Flowers have 5 petals that are reddish-purple, hanging in small clusters from panicles at the top of the stem (AISC, 2014). Each flower produces four rounded-triangular seeds that are covered with hooked prickles. A mature plant can produce 2,000 to 4,000 seeds which remain viable for 1 to 3 years (ISC BC, n.d.). Seeds disperse by attaching to clothing, livestock, and wildlife, enabling the plant to spread great distances. Hound's tongue prefers to grow on drier, well-drained soils (AISC, 2014). It is found on dry pasture, roadsides, and logged forestland (ISC BC, n.d.).

Management Strategy

Eradication

Hound's tongue is listed as noxious under the BC *Weed Control Act*. Hound's tongue has only been located at one location along Alexander Rd. Eradicating hound's tongue from this area will aid in preventing the weed from spreading to new disturbances and seed attaching to humans and mobile equipment.

Control Methods

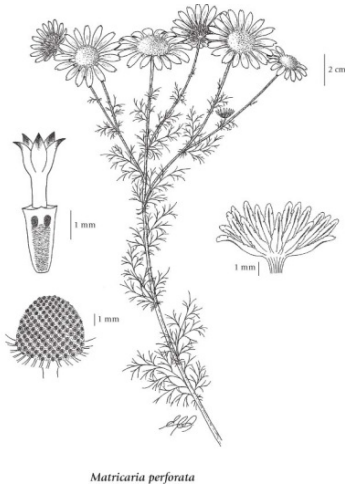
Mechanical: Mowing prior to flowering will prevent the production of seed. Hand-pulling is effective; however, re-sprouting can occur if the root breaks off. Severing the root below ground level should prevent re-sprouting (AISC, 2014).

Chemical: The application of the herbicide picloram applied in the spring, summer, or autumn has shown long-term control and the herbicide dicamba,

	applied in spring or autumn, offers good control. However, spring applications of picloram and dicamba have been found to be more effective than autumn application (BC MAFF and OLA, 2002). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application. Biological: Two control insects, including *Mogulones cruciger* and *Longitarsus quadrigutattus*, have been released and research suggests they impact the plant (AISC, 2014; BC MAFF and OLA, 2002).
Recommended Treatment	Herbicide application or mowing followed by herbicide application.
On Site Locations	• Alexander Rd between road start and kilometer marker 79
References	Alberta Invasive Species Council (AISC). 2014. Hound's Tongue *Cynoglossum officinale*. Accessed on November 30, 2018 from https://abinvasives.ca/wp-content/uploads/2017/11/FS-HoundsTongue.pdf. Invasive Species Council of British Columbia (ISC BC). n.d. Hound's-Tongue. Accessed on November 30, 2018 from https://bcinvasives.ca/invasive-species/identify/invasive-plants/hounds-tongue. BC Ministry of Agriculture, Food and Fisheries (BC MAFF) and Open Learning Agency (OLA). 2012. Guide to Weeds in British Columbia. Burnaby, BC: Open Learning Agency. Accessed November 30, 2018 from https://www.for.gov.bc.ca/hra/plants/weedsbc/GuidetoWeeds.pdf.

Scentless chamomile (*Matricaria perforata*)

Management Priority: High



Images from E-Flora BC

General Ecology

Scentless chamomile is an annual, biennial, or short-lived perennial herb that grows 0.15-1 m in height (ISC BC, 2014). Stems are branches and leaves are finely divided into short, thread-like segments (carrot-like). Flowers are white and daisy-like, 2-3 cm in diameter, occurring singly at the end of each branched stem. Scentless chamomile only reproduces by seed. A single plant can produce up to 1 million seeds that are mature once the flower forms and may remain viable in the soil for up to 15 years. Seeds can disperse by wind, water, on wildlife, and on equipment and vehicles. Scentless chamomile prefers to inhabit areas with high soil moisture, commonly found along ponds, streams, and other areas susceptible to seasonal flooding. However, scentless chamomile is also commonly found in disturbed areas, including roadsides, drainage ditches, fence lines, and dry shorelines (ISC BC, 2014).

Management Strategy

Eradication

Scentless chamomile is considered provincially noxious under the BC *Weed Control Act* and the BC *Forest and Range Practices Act*. Eradicating scentless chamomile from roadsides will aid in preventing the weed from spreading to new disturbances and seed attaching to humans and mobile equipment.

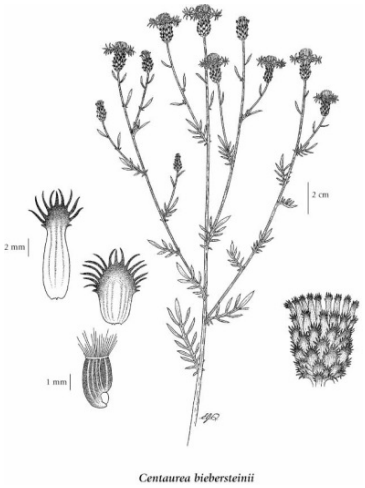
Control Methods

<u>Mechanical:</u> Mowing prior to flower formation can be applied to reduce seed production. Successive mowing must be lower than the previous one because plants will form new flowers below mowing height. Mowing must be done early and often to be effective. Hand-pulling plants prior to flowering may be used to address small infestations (ISC BC, 2014).

	Chemical: Herbicides, including picloram, aminopyralid, metsulfuron methyl, dicamba, 2,4-D, and MCPP, applied early in the season prior to flowering can effectively manage scentless chamomile. Herbicide may also be applied throughout the season as long as plants are green and growing (ISC BC, 2014). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application. Biological: In northeastern BC, a seed-head weevil (*Omphalapion hookeri*), stemboring weevil (*Microplontus endentulus*), and adult gall midge (*Rhopalomyia tripleurospermi*) have been released (ISC BC, 2014).
Recommended Treatment	Herbicide application or mowing followed by herbicide application.
On Site Locations	• Alexander Rd from road start to road end • Branch C between kilometer markers 92-93 and 96-97 • Grave Creek Rd between kilometer markers 86-87 and 88-89 • Harmer Rd • Grave Prairie Valley Rd (Loadout Area) • Valley Rd
References	Invasive Species Council of British Columbia (ISC BC). 2014. Scentless chamomile *Matricaria maritime*. Accessed on December 10, 2018 from https://bcinvasives.ca/documents/Scentless_Chamomile_TIPS_Final_08_06_2014.pdf.

Spotted knapweed (*Centaurea stoebe*)

Management Priority: High



Images from E-Flora BC

General Ecology

Spotted knapweed is a biennial or short-lived perennial that grows 1.5 m in height (ISC BC, 2014). Spotted knapweed forms a rosette in the first year and a flowering bolt in the second year (AISC, 2014). Rosette leaves grow up to 15 cm long and are deeply lobed. Leaves on bolting stems are pinnately divided, becoming smaller towards the top of the shoot (AISC, 2014; ISC BC, 2014). Flowers occur singly at the end of the branches, are pinkish-purple, occasionally creamy white with black tips on the bracts at the flowers base (AISC, 2014). Spotted knapweed reproduces only by seed, producing over 140,000 seeds which may remain viable in the soil for over 8 years (AISC, 2014; ISC BC, 2014). Spotted knapweed can re-sprout from roots and roots exude a chemical which prevents root growth of other plants (AISC, 2014). Spotted knapweed prefers to grow on well-drained, light to coarse textured soils, establishing on grasslands, open forests, roadsides, and right-of-ways (ISC BC, 2014).

Management Strategy

Eradication

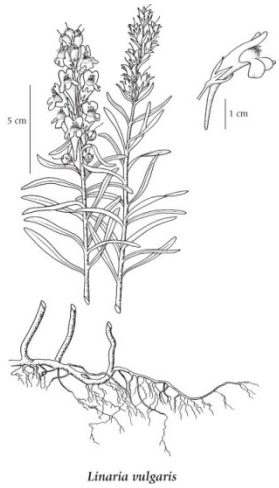
Spotted knapweed is considered provincially noxious under the BC *Weed Control Act* and the BC *Forest and Range Practices Act*. The distribution of spotted knapweed is limited throughout the study area. Eradicating spotted knapweed from roadsides will aid in preventing the weed from spreading to new disturbances and seed attaching to humans and mobile equipment.

Control Methods

	Mechanical: Prior to seed set, plants may be hand-pulled, cut, or mowed to prevent seed production. If hand-pulled, the entire root system should be removed to prevent re-sprouting (ISC BC, 2014). Chemical: Herbicides, including picloram, dicamba, 2,4-D, clopyralid, aminopyralid, and glyphosate, may be applied to manage spotted knapweed (ISC BC, 2014). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application. Biological: Twelve biocontrol agents have been released in BC, including 3 moths, 4 flies, 4 weevils, and a rust (AISC, 2014). Many of the agents are seed-feeders and some are root-miners (AISC, 2014). When used in combination, these agents are found to effectively manage spotted knapweed (ISC BC, 2014).
Recommended Treatment	Herbicide application along roadways.
On Site Locations	• Alexander Rd between road start to kilometer marker 83 • Grave Creek Rd between kilometer markers 83-85 • Grave Prairie Valley Rd (Loadout Area) • Valley Rd
References	Alberta Invasive Species Council (AISC). 2014. Spotted knapweed *Centaurea maculosa*. Accessed on December 10, 2018 from https://abinvasives.ca/wp-content/uploads/2017/11/FS-SpottedKnapweed.pdf. Invasive Species Council of British Columbia (ISC BC). 2014. Knapweeds, Spotted - *Centaurea biebersteinii*, Diffuse - *Centaurea diffusa*. Accessed on December 10, 2018 from https://bcinvasives.ca/documents/Knapweed_TIPS_Final_08_06_2014.pdf.

Yellow toadflax (*Linaria vulgaris*)

Management Priority: High



Images from E-Flora BC

General Ecology

Yellow toadflax is a perennial herb that grows 0.15-1 m tall (AISC, 2014). Mature plants may have 1 to 25 stems. Leaves are soft, narrow, lance-shaped, pale green, and numerous. Leaves can be up to 10 cm in length. Flowers are bright yellow, located in a cluster at the ends of stems. Flowers have a long spur that extends from the base of the flower and flowers can have orange colouring at the throat. Overall, the flower ranges in size from 2 to 3.5 cm in length. Yellow toadflax produces approximately 5,000 seeds per stem which are viable in the soil for up to 10 years; however, germination rates are commonly less than 10%. Yellow toadflax primarily reproduces from its creeping root system, with 2-3 week old seedlings producing creeping roots. Yellow toadflax prefers to grow in sandy-gravelly soils; however, it has adapted to a variety of growing conditions (AISC, 2014).

Management Strategy

Eradication

Yellow toadflax is considered provincially noxious under the BC *Weed Control Act* and the BC *Forest and Range Practices Act*. Yellow toadflax is not widely distributed throughout the study area. Eradicating yellow toadflax from roadsides will aid in preventing the weed from spreading to new disturbances and seed attaching to humans and mobile equipment.

Control Methods

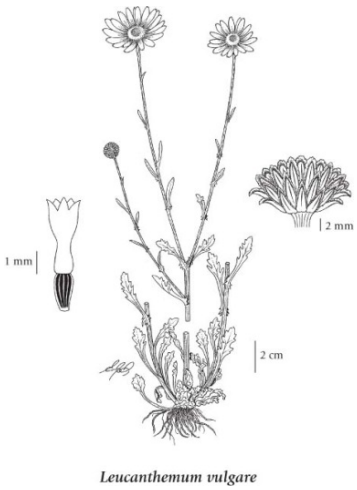
Mechanical: Hand-pulling small infestations in soft soil may be applied. Repeated hand-pulling must be conducted to deplete the seed bank and all root pieces. Mowing prior to seed set can be used to starve the roots (AISC, 2014).

	Chemical: Herbicides, including acetic acid, amitrole, dichlorprop, diuron, glyphosate, hexazinone, imazapyr, MCPA, metsulfuron-methyl, picloram, and tribenuron-methyl and thifensulfuron-methyl (in a product mix), may be applied to manage yellow toadflax (AISC, 2014). Biological: Biocontrol agents have been released to manage common toadflax. Research has indicated the stem mining weevil (*Mecinus janthinus*) has successfully established and provides effective control of yellow toadflax (AISC, 2014).
Recommended Treatment	Herbicide application or mowing followed by herbicide application.
On Site Locations	• Alexander Rd between road start and kilometer marker 81 and between kilometer markers 82-83 and 87-88 • Grave Creek Rd between kilometer markers 83-84 and 85-86 • Grave Prairie Valley Rd (Loadout Area) • Valley Rd
References	Alberta Invasive Species Council (AISC). 2014. Yellow Toadflax *Linaria vulgaris* (Aka Common toadflax, Butter-and-Eggs, Spurred Snapdragon). Accessed on December 11, 2018 from https://abinvasives.ca/wp-content/uploads/2017/11/FS-CommonToadflax.pdf.

Medium Management Priority

Oxeye daisy (*Leucanthemum vulgare*)

Management Priority: Medium



Images from E-Flora BC

General Ecology

Oxeye daisy is a perennial herb that can grow up to 1 m in height (AISC, 2014). Leaves are egg-shaped to spoon-shaped, pinnately lobed or toothed, with leaves decreasing in size as they move up the stem and becoming less lobed and toothed (Klinkenberg, 2017). Flowers occur singly at the end of stems and reach 5 cm in diameter with yellow centers and 20 to 30 white petals (AISC, 2014). Oxeye daisy primarily spreads by seed; however, it can also spread through its shallow, creeping roots. Oxeye daisy can produce over 500 seeds which are viable for 2 to 3 years or longer. Oxeye daisy grows in a variety of habitats, including soils poor in nutrients (AISC, 2014).

Management Strategy

Containment

Oxeye daisy is not considered regionally noxious under the BC *Weed Control Act*; however, it is listed as an invasive plant under the BC *Forest and Range Practices Act*. Oxeye daisy is widespread throughout the study area and is commonly found along roadsides. Eradication of oxeye daisy is not feasible due to its prevalence in the area; however, containment of infestations is imperative to prevent further spread of oxeye daisy as it is considered an aggressive invader (AISC, 2014). Managing oxeye daisy along roadways will aid in preventing its colonization of disturbed areas and attachment of seeds on humans and mobile equipment.

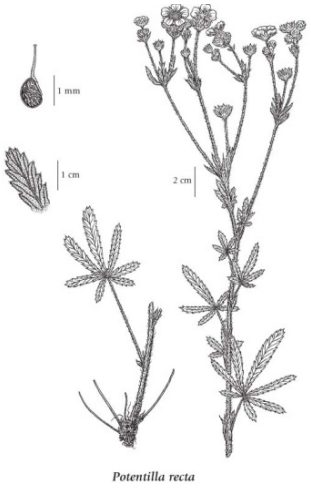
Control Methods

Mechanical: Hand-pulling or digging before seed production is effective; however, removing as much of the roots as possible is critical for this method

	to be successful. Repeated mowing can prevent seed production; however, it can stimulate re-sprouting of stems (AISC, 2014). Chemical: The herbicides picloram, dicamba, 2,4-D, and glyphosate are effective to control oxeye daisy (BC MAFF and OLA, 2002). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application.
Recommended Treatment	Herbicide application along roadways.
On Site Locations	• Alexander Rd from road start to road end • Branch C from road start to kilometer marker 91 and between kilometer markers 92-97 and 102-103 • Spur 1 off of Branch C • Spur 2 off of Branch C • Grave Creek Rd from road start to kilometer marker 90 • Harmer Rd • Grave Creek Prairie Valley Rd (Loadout Area) • Valley Rd
References	Alberta Invasive Species Council (AISC). 2014. Oxeye Daisy (*Leucanthemum vulgare*, *Chrysanthemum leucanthemum*) Accessed on December 7, 2018 from https://abinvasives.ca/wp-content/uploads/2017/11/FS-OxeyeDaisy.pdf. BC Ministry of Agriculture, Food and Fisheries (BC MAFF) and Open Learning Agency (OLA). 2012. Guide to Weeds in British Columbia. Burnaby, BC: Open Learning Agency. Accessed November 30, 2018 from https://www.for.gov.bc.ca/hra/plants/weedsbc/GuidetoWeeds.pdf. Klinkenberg, B. 2017. *Leucanthemum vulgare* Lam. Accessed on December 7, 2018 from http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Leucanthemum%20vulgare.

Sulphur cinquefoil (*Potentilla recta*)

Management Priority: Low



Images from E-Flora BC

General Ecology

Sulphur cinquefoil is a perennial herb that grows 30-70 cm tall from a thick, simple to branched stem-base (AISC, 2014). Hairs cover the entire plant except for the flowers. Leaves are compound with 5-7 leaflets with toothed edges. Flowers are light yellow with 5 heart-shaped petals. Sulphur cinquefoil reproduces by seed, producing over 1,600 seeds per plant, and also reproduces vegetatively by shoots emerging from woody rootstocks (AISC, 2014; ISC BC, 2014). Sulphur cinquefoil is long-lived, surviving up to 20 years. Sulphur cinquefoil grows in various soils and climates; however, it grows best in semi-arid regions (AISC, 2014).

Management Strategy

Monitoring

Sulphur cinquefoil is not considered regionally noxious under the BC *Weed Control Act*; however, it is listed as an invasive plant under the BC *Forest and Range Practices Act*. Sulphur cinquefoil was only located under the powerline passing over Alexander Rd. Monitoring for the potential spread of sulphur cinquefoil into disturbed areas is recommended.

Control Methods

Mechanical: Hand-pulling prior to seed set may be an effective method to control small infestations. Pulling, cutting, or mowing large infestations does not appear to be effective as plants spread vegetatively (ISC BC, 2014).

Chemical: Herbicides, including picloram, 2,4-D, combination of picloram/2,4-D, and aminopyralid, applied in the spring or early summer can effectively manage sulphur cinquefoil (ISC BC, 2014). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application.

Recommended Treatment	Monitoring to identify any spread of sulphur cinquefoil into disturbed areas.
On Site Locations	• Alexander Rd along powerline
References	Alberta Invasive Species Council (AISC). 2014. Sulphur Cinquefoil *Potentilla recta* (Aka Rough-fruited cinquefoil, Erect cinquefoil, sulfur cinquefoil). Accessed on December 7, 2018 from https://abinvasives.ca/wp-content/uploads/2017/11/FS-SulphurCinquefoil.pdf. Invasive Species Council of British Columbia (ISC BC). 2014. Sulphur Cinquefoil *Potentilla recta*. Accessed on December 7, 2018 from https://bcinvasives.ca/documents/Sulphur_Cinquefoil_TIPS_Final_08_06_2014.pdf.

Yellow hawkweed (*Hieracium spp*)

Management Priority: Medium

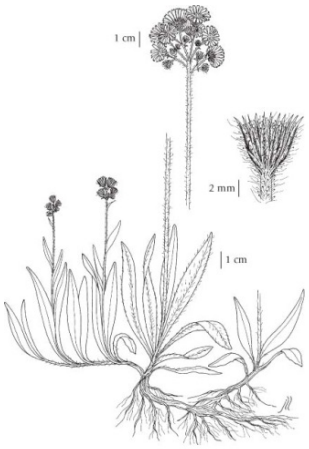


Image from E-Flora BC

Images from ISC BC

General Ecology

There are 14 non-native hawkweeds present in BC, 13 of which have yellow flowers (ISC BC, 2014). Yellow hawkweed stems have short, stiff hairs. Leaves are commonly hairy, found at the base of the stem in a rosette form. Leaves are rare along the stem. Flowers are yellow ray flowers that occur in clusters at the top of each stem. Yellow hawkweed can reproduce through four mechanisms, which include above-ground runners, rhizomes, seed, and buds on the roots; however, established populations primarily expand through above-ground runners. Yellow hawkweed prefers well-drained, coarse-textured soils. It invades natural open areas and disturbed sites, such as roadsides, pastures, and clearings (ISC BC, 2014).

Management Strategy

Containment

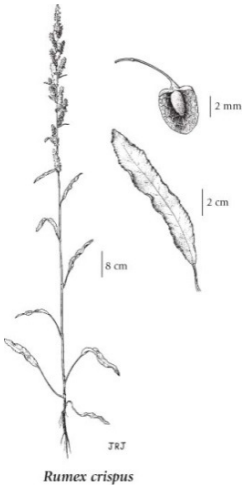
Yellow hawkweed is not regulated under the BC *Weed Control Act* and only meadow hawkweed (*Hieracium pilosella*), one of the 13 non-native yellow hawkweeds in BC, is regulated under the BC *Forest and Range Practices Act*. Despite the lack of regulation concerning yellow hawkweed, it is an aggressive invader that can form dense mats (ISC BC, 2014) and should be managed to prevent its establishment into disturbed areas. Yellow hawkweed is commonly found along roadsides in the study area. Eradication of yellow hawkweed is not feasible due to its prevalence in the area; however, containment of infestations is imperative to prevent further spread of yellow hawkweed. Managing yellow hawkweed along roadways will aid in preventing its colonization of disturbed areas and attachment of seeds on humans and mobile equipment.

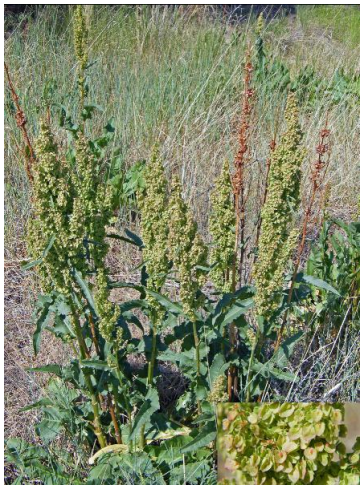
Control Methods	Mechanical: Small infestations may be dug out prior to seed set; however, the entire plant must be removed to prevent re-growth. Mowing will remove seed heads; however, its use is cautioned as it promotes vegetative spread (ISC BC, 2014). Chemical: Herbicides, including clopyralid, picloram, picloram + 2,4-D, aminopyralid, or aminopyralid + 2,4-D, are known to effectively control yellow hawkweed (ISC BC, 2014). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application.
Recommended Treatment	Herbicide application along roadsides.
On Site Locations	• Alexander Rd from road start to road end • Branch C between road start and kilometer marker 91 and between kilometer markers 94-97, 98-99, and 101-102 • Spur 1 off of Branch C • Spur 3 off of Branch C • Branch 5 off of Branch C • Grave Creek Rd between road start and kilometer marker 86 and between kilometer markers 87-88 • Harmer Rd
References	Invasive Species Council of British Columbia (ISC BC). 2014. Hawkweeds (*Hieracium spp.*). Accessed on December 10, 2018 from https://bcinvasives.ca/documents/Hawkweeds_TIPS_Final_08_06_2014.pdf.

Low Management Priority

Curled dock (*Rumex crispus*)

Management Priority: Medium





Images from E-Flora BC

General Ecology

Curled dock is a perennial herb that grows up to 1.6 m from a stout, fleshy taproot that can extend 1.5 m into the soil (BC MAFF and OLA, 2002). A rosette is produced in the first year whereas a flowering stalk is produced in the second year. Basal leaves are 10-30 cm in length and stem leaves become shorter moving up the stem. Leaves have wavy and curled margins. Numerous small flowers are clustered at the end of the stem. Flowers are initially greenish red, then mature to pinkish and finally turn brown. Curled dock reproduces from seed and root fragments. A plant produces 30,000-60,000 seeds. With sufficient light, nearly 90% of seeds will germinate. Seeds buried more than 3 cm will remain dormant; however, seeds are long-lived with approximately half surviving after 50 years. Seed dispersal primarily occurs by wind or water; however, seed pods are rough and can stick to animals and humans. Curled dock grows in moist to mesic sites along roadsides, within ditches, pastures, riparian areas, and disturbed sites (BC MAFF and OLA, 2002).

Management Strategy

Eradication and Monitoring

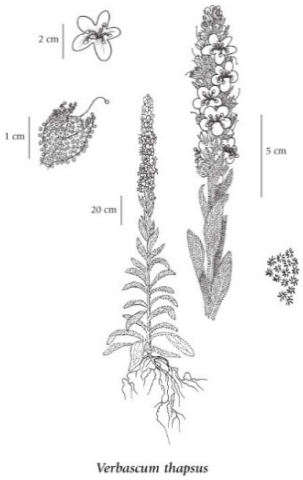
Curled dock is not listed under the BC *Weed Control Act* or BC *Forest and Range Practices Act*. It is considered a nuisance species rather than a weed of high concern. Along Branch C, only one curled dock plant was identified. Eradication of this plant is recommended to prevent its spread. Monitoring curled dock infestations in other areas of the active footprint is recommended to assess increases in distribution and density in disturbed areas.

Control Methods

	Mechanical: Mowing prior to flowering can prevent seed production (BC MAFF and OLA, 2002). Chemical: Application of the herbicides MCPA, dicamba, or 2,4-D amine in the spring when plant seedlings are in the 2-4 leafy stage can be effective. The herbicide glyphosate applied during the full leaf stage can control the plant. New plant seedlings may be suppressed by the herbicides MCPA/MCPB or 2,4-DB (BC MAFF and OLA, 2002). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application.
Recommended Treatment	Application of herbicide on the plant identified along Branch C and monitoring of other infestations to assess increases in distribution and density of curled dock in disturbed areas.
On Site Locations	• Alexander Rd between kilometer marker 84 and road end • Branch C between kilometer markers 97-98 • Harmer Rd • Grave Prairie Valley Rd (Loadout Area)
References	BC Ministry of Agriculture, Food and Fisheries (BC MAFF) and Open Learning Agency (OLA). 2012. Guide to Weeds in British Columbia. Burnaby, BC: Open Learning Agency. Accessed November 30, 2018 from https://www.for.gov.bc.ca/hra/plants/weedsbc/GuidetoWeeds.pdf.

Great mullein (*Verbascum thapsus*)

Management Priority: Low



Images from E-Flora BC

General Ecology

Great mullein is a biennial forb that grows 0.5-2.0 m tall from a taproot (Klinkenberg, 2017). Leaves and inflorescence are densely woolly-hairy. Rosette leaves are grey-green, 5-40 cm in length and upper leaves are smaller, ranging from 10-30 cm in length (AISC, 2014). Flowers are bright yellow, produced in 20-50 cm long spike-like racemes. Great mullein can produce up to 240,000 seeds; however, most seeds fall in close proximity to the parent plant (AISC, 2014). Seeds can remain viable in the soil for over 100 years. Great mullein commonly grows in disturbed areas with well-drained, sandy or gravelly soils, typically found along roadsides, right-of-ways, and waste areas. Great mullein also colonizes meadows, pastures, forestry cut blocks, and recently burned sites (AISC, 2014).

Management Strategy

Monitoring

Great mullein is not listed under the BC *Weed Control Act* or BC *Forest and Range Practices Act*. It is considered a nuisance species rather than a weed of high concern. Monitoring of great mullein is recommended to assess increases in distribution and density in disturbed areas.

Control Methods

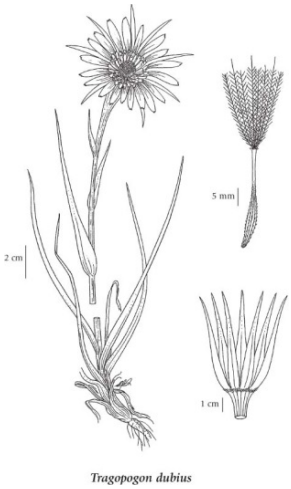
Mechanical: Tillage offers effective control of great mullein. Mowing is not as effective because rosettes will continue to form following cutting (AISC, 2014).

Chemical: The herbicides 2,4-D, bromacil, dichlorprop in a product mix with 2,4-D, hexazinone and imazapyr may be used on great mullein to control the plant (AISC, 2014). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application.

Recommended Treatment	Monitoring to assess increases in distribution and density of great mullein in disturbed areas.
On Site Locations	• Alexander Rd from road start to road end • Spur 1 off of Branch C • Grave Creek Rd from road start to kilometer marker 88 • Harmer Rd • Grave Creek Prairie Valley Rd (Loadout Area) • Valley Rd
References	Alberta Invasive Species Council (AISC). 2014. Common Mullein *Verbascum thapsus* (aka Flannel Plant, Velvet Plant, Lungwort, Feltwort, Jacob's Staff, Torchplant). Accessed on November 30, 2018 from https://abinvasives.ca/wp-content/uploads/2017/11/FS-CommonMullein.pdf. Klinkenberg, B. 2017. *Verbascum thapsus* L. Accessed on November 30, 2018 from http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Verbascum%20thapsus&redblue=Both&lifeform=4.

Yellow salsify (*Tragopogon dubius*)

Management Priority: Low



Images from E-Flora BC

General Ecology

Yellow salsify is a biennial, and occasionally annual, herb that grows 0.3-1 m in height from a taproot (Mangold, 2017). Leaves are grass-like, ranging from 20-50 cm in length, and clasp the stem at the base. Flowers are yellow and dandelion-like, occurring singly on stems with ten or more long, narrow involucral bracts extending beyond the flower. Yellow salsify reproduces by seed, with each flower producing 20 to 120 seeds. Seeds are primarily wind dispersed. Yellow salsify grows in a variety of soil types, from sandy to clay loam. Yellow salsify is commonly found in highly disturbed sites, but may also occur on less disturbed areas, such as grasslands and mesic forests. Various parts of yellow salsify are consumed by wildlife, such as deer and grouse (Mangold, 2017).

Management Strategy

Monitoring

Yellow salsify is not considered a noxious weed under the BC *Weed Control Act* or the BC *Forest and Range Practices Act*. It is considered a nuisance species rather than a weed of high concern. Monitoring for the potential spread of yellow salsify into disturbed areas is recommended.

Control Methods

Mechanical: Hand-pulling prior to seed set may be used to manage small infestations, preventing seed production (Mangold, 2017).

Chemical: Herbicides, including clopyralid + 2,4-D, metsulfuron + chlorsulfuron, picloram, and dicamba, may be used to manage yellow salsify (Mangold, 2017). Soil and/or substrate type and nearness to water sources must be considered prior to herbicide application.

Recommended Treatment	Monitoring to identify any spread of yellow salsify into disturbed areas.
On Site Locations	• Alexander Rd between road start to kilometer marker 85, between kilometer markers 86-88, and between kilometer marker 89 to road end • Grave Creek Rd between road start to kilometer marker 85 and between kilometer markers 86-87 • Harmer Rd • Grave Prairie Valley Rd (Loadout Area) • Valley Rd
References	Mangold, J. 2017. Western Salsify. Montana State University Extension. Accessed on December 10, 2018 from http://msuinvasiveplants.org/documents/publications/extension_publications/Western%20Salsify_revised%202017.pdf.