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The Fight Against Botanical Invaders: Summer Internship with the Montana Conservation Corps and the U.S. Forest Service

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ABSTRACT

This paper aims to synthesize and reflect upon my internship with the Montana Conservation Corps, and the U.S. Forest Service during the summer of 2016. The primary responsibilities as an intern under the USFS's Vegetation Manager included eradicating and monitoring invasive weeds within the Hebgen Lake Ranger District, in West Yellowstone, MT. I gained a wealth of knowledge on how invasive plants take control of landscapes throughout Montana specifically. This opportunity provided me with the chance to develop both hands-on and GIS-based conservation efforts. The following chapters review my summer internship by diving deeper into the structural organization of the MCC and USFS, my responsibilities as an intern, and my overall assessment of the internship.

ACADEMIC HISTORY

Name: Bryan Buttigieg   Date: May 2017

Baccalaureate Degree: B.S., Environmental Science and Policy

Marist College (Poughkeepsie, NY)   Date: May 2015

DEDICATION

To Montana.

To the wildlife.

To the mountains.

To fellow corps members.

To Susan Lamont: May retirement be good to you.

ACKNOWLEDGEMENTS

I would like to thank the people that made my summer internship with the Montana Conservation Corps possible. To Anna Greenberg, thank you for coordinating my summer internship with the Montana Conservation Corps and pairing me with the U.S. Forest Service. To fellow corps members, thank you for all of the hard work, adventures, and many laughs. To Susan Lamont, thank you for the wealth of knowledge you have bestowed upon me. To all members of the Hebgen Lake Ranger District, thank you for welcoming me into your family and helping create an unforgettable summer. To Clark Faculty and Sharon Hanna thank you, for guiding me towards my future career as a geo-scientist.

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CHAPTER 1: INTRODUCTION

While pursuing my bachelor's degree of environmental science and policy at Marist College in Poughkeepsie, NY, I was introduced to the world of geographic information science through the few introductory courses my college had to offer. By the end of the term, I was left with a basic understanding of the field and wondered how these theories and tools could be applied to much greater issues of land change, climate change, environmental risk management, and conservation efforts. I felt as if we had just skimmed over the surface of what this field was capable of, and I wanted to dive further into the depths. I was fortunate to have a passionate academic advisor at the time who strongly pushed students to consider pursuing higher education for the benefit of attaining knowledge and being better off in finding employment. Many graduate school programs are heavily research based, and I found Clark University extremely unique in that the GISDE program had research, internship, or portfolio options within the Master's program. I was drawn to Clark for the opportunity of advancing my geospatial education and having the opportunity to utilize my skills within a professional work environment between my two years of study.

In the summer of 2016, I decided to serve with the Montana Conservation Corps and had the honor to be placed at the U.S. Forest Service, in West Yellowstone, Montana. I was placed under the supervision of the Vegetation Manager, Susan Lamont for the purpose of treating and GPS tracking invasive weeds within the Custer-Gallatin National Forest and updating the USFS invasive weed national database. I was excited to work alongside a substantial organization such as the USFS, and conduct both hands-on and GIS conservation efforts. Being provided the luxury of living on the forest service compound allowed me to become both fully engaged with the employees of the ranger district and the natural beauty of Montana because I was within walking distance of the office and the west entrance to Yellowstone National Park. The USFS gave me a chance to showcase my skills and develop lasting relationships in the state of Montana which may help towards future employment.

CHAPTER 2: DESCRIPTION OF ORGANIZATION

The Montana Conservation Corps (MCC) is a non-profit organization aimed to inspire youth and young adults through hands-on conservation service and education efforts. Conservation projects are conducted within local communities, national forest, state and national parks, wildlife refuges, and federally designated wilderness areas [1]. The MCC was modeled off of the Civilian Conservation Corps that was initiated by President Franklin Roosevelt back in 1933 to promote environmental conservation efforts such as planting trees, maintaining roads, and fighting forest fires [2]. The first crew established in the MCC was during the summer of 1991, and the program has continued to expand with the help from sponsors, host-sites, and AmeriCorps over its 25-year lifespan [3]. The MCC currently has four regional offices throughout the state of Montana: 1) Northern Rockies 2) Western Wildlands 3) Central Divide and 4) Greater Yellowstone. Although these offices are located within the state, the service of the MCC is much broader than that. Common positions include those who work out of the Western Wildlands jurisdiction, who may work anywhere from Western Montana to North-Central Idaho, and those working for the Greater Yellowstone office may have the opportunity to work in locations such as Grand Teton National Park and the Jedidiah Smith Wilderness in Wyoming.

The Montana Conservation Corps has a mission:

> “to inspire young people through hands-on conservation service to be leaders, stewards of the land, and engaged citizens who improve their communities, through five core program objectives: 1) an ethic of volunteer service and civic responsibility 2) strengthened communication and team-building skills 3) enhanced competencies to be leaders and contributing team members 4) increased knowledge of the natural environment and 5) an enthusiasm for the benefits of hard work and quality results[4].”

There are various crews which one can apply to within the Montana Conservation Corps ranging from middle schoolers to veterans, based on one’s age and experience. These crews will often be based out of their regional office but go on extended backcountry hitches conducting work whether it be trail maintenance, vegetation management, or fuel reduction projects. A relatively new position within the MCC is that of the Conservation intern and it is structured slightly different from the other crew or corps member positions within the Montana Conservation Corps. They are still an intern working for the MCC, but they are stationed at a host-site location where they are working alongside a partner or sponsored organization. These host-sites often include the U.S. Forest Service, the Bureau of Land Management, Land Trust Organizations or City councils throughout the regional jurisdiction of the MCC. For my Conservation Internship I was stationed with the U.S. Forest Service at the Hebgen Lake Ranger District in West Yellowstone, MT.

Host Site: U.S. Forest Service, Hebgen Lake Ranger District (West Yellowstone, MT)

"The mission of the U.S. Forest Service (USFS) is to sustain the health, diversity, and productivity of the Nation's forest and grasslands to meet the needs of present and future generations [5]." The USFS is divided into four levels: 1) Headquarters 2) Region 3) National forests and grasslands 4) Ranger district in an effort to accomplish the mission it has set forth. Within the most local level of the USFS, the ranger district, there are various positions which help to focus on the construction and maintenance of both hiking and off-highway vehicle trails, campground operation, and management for vegetation, wildfire and wildlife habitat [6]. The effectiveness of accomplishing the mission set out by the USFS is strongly based on the budget of a particular year. Budget will affect all aspects of the USFS management efforts including trails, campground operation, vegetation, wildfires, and wildlife habitat and therefore projects need to be prioritized in some aspect. Trails are often prioritized throughout a season based on which contain the highest volumes of foot, horse, or motorized traffic. Vegetation management, specifically invasive species management is extremely limited in funding and high priority treatment areas include those containing wildlife habitats, recreational areas, and other ecological beneficial areas. When it comes to fire management, firefighters have priority in getting sent out to handle the flames. If a time arises when extra help is needed, anyone who is red card certified is able to go out and assist in fire management. In this case of pulling people from non-fire departments, money is saved from their department budget and redistributed from the fire department's budget.

The USFS utilizes GIS to align with their mission statement in regards to vegetation management, trail construction and maintenance, forest merging, fire management, timber management, etc.

Vegetation management -The USFS inventories locations of noxious invasive weeds. The inventories are based on the species as well as indicating areas where these weeds have been treated through chemical, mechanical, or biological treatment techniques.

Trail Construction and Maintenance - Throughout a season, every time a new trail is constructed or cleared by either the off-highway vehicle (OHV) or recreational trail crews, a map is constantly updated displaying where these trails are. Therefore, the public is notified on which trails are safe and will not be hazardous to their recreational actives whether that be ATV, dirt-biking, hiking, or horseback riding through the trail system. The USFS also establishes Wilderness and Topographic maps expressing elevation through contour lines in both designated wilderness and recreational trail areas.

***Fire Management* –** The USFS looks to analyze the spread of wildfire through past fire histories, and current climatic conditions, as well as the characteristics of a tree stand including crown width/height, species type, and age. The USFS created an active fire mapping program in which they "utilize satellite based imagery and near real-time detection methods to characterize fire conditions in a geospatial context for the continental U.S., Alaska, Hawaii, and Canada [7]."

Timber - Timber stands are mapped out for the purposes of expressing the relative size and composition of stands, to show areas where there is an infection (ex. bark beetle, fungus) and its possible spread, or where there is a potential timber sale in order.

***Forest Merging* –** In a recent effort to save money, National Forests are merging together across the continental United States. Currently major GIS projects for the USFS involve the efforts to merge GIS databases across the forests that are merging. Each National Forest consists of different landscapes and has their own way of coding and labeling attributes within databases. Therefore, it is the GIS coordinators' responsibility for each forest to agree on a method of labeling and categorizing across the forests for any project that they do.

The USFS also creates maps to aid in forest visitation in which information on attractions, facilities, services, and other recreational opportunities are highlighted.

CHAPTER 3: DESCRIPTION OF INTERNSHIP RESPONSIBILITIES

Throughout the summer with the Montana Conservation Corps, I worked closely with the West Zone Vegetation Manger for the Custer-Gallatin National Forest, Susan Lamont. Although I was an intern for the Montana Conservation Corps, my position at the U.S. Forest Service entailed being the Invasive Weeds GPS and Database Coordinator on the Hebgen Lake Ranger District for the Custer Gallatin National Forest. Our primary objective was to aid in the identification and reduction of noxious invasive weeds within the forest. Noxious weeds are introduced from another country, often without their natural competitors or bio-controls. Therefore, the noxious weeds often outcompete the natural vegetation within an area. Wildlife such as bighorn sheep may often confuse noxious weeds for the natural vegetation that they eat causing them to get sick. In a recreational sense, people travel to national forests for the opportunity to enjoy the beauty of a landscape, but the awe of a landscape can be lessened if it is riddled with invasive weeds.

The treatment and eradication of noxious invasive weeds ties directly into the mission of the U.S. Forest Service in "sustaining the health, diversity, and productivity of the Nation's forest and grasslands to meet the needs of present and future generations [8]." The removal of noxious weeds benefits the national forest in the conservation of wildlife habitats, recreational areas, and maintaining ecological stability. Unfortunately, within the Custer-Gallatin National Forest, there are roughly 50,000 acres of invasive weeds and the U.S. Forest Service's budget limits vegetation management to only treating about 2,000-4,000 of those acres per year. Therefore, the areas which received treatment were often areas where the weeds threatened wildlife habitat, natural vegetation, or recreation. Thirty-five eradication sites were determined within twenty-two location maps (Tables 1 & 2, Figure 1) by the West Zone Vegetation Manager, Susan Lamont, prior to the arrival of myself or other MCC crew members. Daily treatment methods were conducted through chemical, mechanical, and biological efforts including herbicide application, pulling, cutting, and releasing of biocontrol insects. Along with a co-intern, I was in charge of supervising a four person

MCC crew and ensured that the work was completed thoroughly and safely. The effectiveness of the treatment needed to be monitored a couple weeks after spraying occurred and the effectiveness was based on a scaled percentage ranking system ranging from 0% where no effect was noticed to 100% where not a single individual survived (Table 6).

In addition to treatment within the field, information about weed location and treatment areas were recorded utilizing a Trimble Nomad GPS. The GPS incorporates ArcPad and an Invasive Species Mobile application which was developed by the U.S. Forest Service. Two main layer shapefiles were recorded within the Invasive Species Mobile application, the inventory and treatment of the noxious weeds. The inventory layer includes attributes pertaining to the type of invasive weed and the percentage of a specific area that was infested while the treatment layer includes attributes such as the type of weeds treated, type of herbicide applied, fund code, type of site, and local weather conditions such as the temperature, wind speed and its direction. The treatment areas could only be recorded into the GPS application in locations where there was already an existing weed inventory, thus eliminating the case of treating an area where no weeds are present.

Field data collection utilizing ArcPad and the specific USFS developed Invasive Species Mobile (ISM) application was a new skill acquired throughout my summer internship with the Montana Conservation Corps. ArcPad has three main toolbars which are: 1) the Main Toolbar 2) the Browse Toolbar and 3) the Editor Toolbar. These toolbars offer similar functions and tools to ArcMap including editing symbology of layers, querying existing data, and sketching new polygons (Table 8). Similarities between ArcPad and ArcMap made it easy for me to adjust to the use of a mobile recording device. With the implementation of the ISM application, an additional ISM Toolbar is added in ArcPad, allowing for data entry specific to invasive species inventory and treatment methods. Once a new inventory or treatment polygon is created, Invasive Species Mobile data entry forms will automatically open. The data entry form consists of drop down options with pre-programmed choices, as well as empty fields to type in information. Besides hand drawing a new inventory or treatment, the GPS can be activated to track one's location and follow the movement of the recorder. For the GPS to determine an accurate location, a fix on at least three satellites needed to be made. To maintain the accuracy of spatial locations, sites could be remeasured if the size of an active weed patch has increased or decreased since previous recordings. Remeasurements were done utilizing the USFS ISM remeasure tool. For a remeasurement, the attribute information will remain the same despite the changing in the shape of the polygon.

All of the GPS data recorded within the field utilizing the Nomad Trimble and ISM application needed to be uploaded to the USFS national database and I was primarily responsible for the accuracy of the spatial and tabular information being entered into GPS device and would have to resolve and debug any errors prior to uploading the data onto the national database and server. The data was therefore uploaded to the local office computer and analyzed using ArcMap to resolve any errors. The shapefiles for both inventory and treatment layers were edited to eliminate cross overs of vertices or slivers that were present. Slivers or crossovers would often occur when using the GPS tracking method of drawing. This is because the satellite would only record a vertice about every 10 seconds or so, and may not place a vertice in every place you have walked. Therefore, it was important to walk slowly on narrow paths or corners if the GPS tracking drawing method was being used. The shapefiles' vertices were also adjusted in a manner that they did not cross over into waterbodies because we did not treat any aquatic invasive species and we did not spray into any waterbodies directly. Any attributes which needed to be further adjusted were edited once the layers were uploaded to the national database. This is because the attribute tables associated with the polygons all contain information linked spatially to internal tables within the national database. Unlike an attribute table in ArcMap, the national database's attribute editor consisted of drop down options with pre-programmed choices, and empty fields to type in information, similar to the data entry form within the ISM Mobile application.

Besides mapping weed locations by species, and individual treatment locations (Figure 2), another part of my GIS project entailed analyzing the amount of herbicides used within each watershed. Back in 2005, the United States Forest Service conducted an Environmental Impact Statement (EIS) on the treatment of noxious and invasive weeds for the Gallatin National Forest and reached a Record of Decision (ROD) in June of 2005. Through much analysis, this ROD provided maximum limits on the amount of pounds of a particular chemical that was allowed into a particular watershed, otherwise known as HUC. These maximum levels (Table 4) were determined because they were considered to maintain safe environments for wildlife, drinking water, agriculture, etc [9]. Therefore, I aggregated chemical treatment records from the national database for 2016 for each watershed to try and analyze if safe levels of herbicides were utilized (Table 5, Figure 3). I found it alarming that maximum levels were crossed for Tordon, one of the stronger herbicides which we were using (Figure 4). I am not too worried about this finding, because it is possible that the maximum allowable levels may need to be updated or re-assessed as it has been 10 years since they were determined, and it may be hard to compare these numbers.

CHAPTER 4: ASSESSMENT OF INTERNSHIP

Although I was technically an employee of a non-profit organization, I benefited exponentially from being able to complete my service with the U.S. Forest Service - Hebgen Lake Ranger District as my host site and immediate supervisors. On a daily basis, I experienced how a federal organization worked as I was involved in morning meetings, and interacted with different people from various departments within the office. Specifically, every Monday we would have a meeting describing the goals and plans of each department for the week and this was a good time to learn the responsibilities of the ranger district on a weekly basis. This experience emphasized and solidified conservation efforts being conducted at small regional levels in the intermountain region to nationwide governmental levels of the U.S. forest and grasslands.

Throughout the course of the internship, invasive weed identification and treatment methods were learned extensively. Each weed would have distinct characteristics such as growth habits, seed dispersal methods, root growth, the flowers, and leaves. This would sometimes be a daunting task because the weeds could look differently in their juvenile stage in the beginning of the summer, compared to their peak stage mid-summer and we needed to do our best to identify the weeds in all phases. As each weed possesses distinct characteristics, there may be specific treatment methods which may work best for different weeds. Some weeds would only be able to be eradicated through chemical methods, while others could be removed through mechanical or biological efforts. Field data collection with ArcPad and Trimble GPS was also a completely new experience for me through my summer internship. Previously, I have only had experience using DNR GPS, where waypoints or spatial locations of a particular object were collected. This was a beneficial experience because it not only added to my skillset, but ArcPad and Trimble data collection is more robust in collecting multiple attributes for a particular object within the field than DNR GPS, where mostly just location data is collected.

Previous knowledge of interpreting satellite imagery through remote sensing courses taken at Clark, and having a spatial mindset was extremely beneficial in determining where the patches of invasive weeds were located. This is because my supervisor provided us with site location maps consisting of 1-meter satellite images, with overlaying polygons indicating pre-existing infestation areas. where weeds were in an area. We often did not have time to travel to these sites for assessment prior to treatment, and interpretation of the satellite images was critical to saving some time. The incorporation of final group projects within coursework at Clark had also prepared me for this internship in the sense that I would be working with a variety of different people from a variety of locations around the United States. Although you may not get along with everyone that you work with, you need to settle your differences to accomplish a common goal at hand. This is an important life skill to develop and bring forward to working experiences and is definitely gained through group project work within the semester.

Upon completion of this internship, it has engrained in my mind that my ideal carrier would involve some type of field work aspect to it. I know that a lot of GIS work is inside, and behind a computer, but I thoroughly enjoyed getting out of the office every day and making a difference through hands-on conservation efforts. I would definitely consider applying to the U.S. Forest Service and even consider living on the forest compound again where I would be steps away from the office, but far away enough where I would have my own space after work. The Hebgen Lake Ranger District in West Yellowstone, was a close knit group, but also a well-oiled machine when it came to the workforce and getting things done and I am honored to have had the opportunity to work with them for a summer season.

CHAPTER 5: CONCLUSION

The summer of 2016, and my internship with the Montana Conservation Corps is a summer that I will never forget. The conservation corps matched me to a host site perfectly based on my skillsets and the USFS's demand for a conservation minded individual with proficiency in GIS. The fieldwork aspect of my internship was extremely beneficial and rewarding. Often it may be difficult to imagine changes across a landscape without actually being there and seeing how different species of flora and fauna interact at different levels of scale. It meant so much to be immersed within the environment where the phenomenon was occurring to understand and see how different invasive weed patches could spread, or take over a particular landscape. This allowed me to better appreciate the conservation efforts at a local hands-on level, and scale them up through the utilization of GIS theories and techniques. The USFS gave me a chance to showcase my skills and develop lasting relationships in the state of Montana which may aid in future employment efforts.

TABLES:

Location (1st Week) June 27	Weeds	Herbicide (spray light mist on plants)	Job Code
Map 1 – Lonesomehurst – 45 ac Contour Road - 9 ac Romset Beach – 2 ac	Orange hawkweed, hoary alyssum, yellow toadflax	Alyssum, hawkweed – Milestone/Metcel/R11 Yellow toadflax – Tordon/24D (just a small area Susan will treat)	NWE
Map 2 – Fisherman Point 2 ac, Rumbaugh SH 4 ac, Rumbaugh CG 7 ac	Hoary alyssum, thistle, knapweed	Milestone/Metcel/R11	NWE
Map 3 - Edwards Peninsula - 30 ac	Orange hawkweed, hoary alyssum, yellow toadflax, Canada thistle, mullein	Yellow toadflax – Tordon/24D/R11 hawkweed – milestone/r-11 alyssum (by road) - Milestone/Metcel/R11	NWE
Map 4 – Horse Butte by lake 0.1 ac, lookout 9 ac, and back side 2 ac	Knapweed, alyssum Yellow toadflax	Milestone/Metcel/R11 (by road); Yellow toadflax – Tordon/24D/R11	NWE
Map 5 – Whiskey bay 4 ac	Knapweed, alyssum, Yellow toadflax	Milestone/Metcel/R11; Yellow toadflax – Tordon/24D/R11	NWE
Map 6A – Ghost village 6 ac	knapweed	Milestone/Metcel/R11 (hill side)	NWE
Map 6B – Refuge Point 7 ac	Knapweed, poison hemlock, houndstongue	Milestone/Metcel/R-11	NWE
Location (2nd Week) July 5	**Weeds**	**Herbicide (spray medium mist on plants)**	
Map 7 – Spillway, VIC 40 ac	knapweed	Milestone/Metcel/R11	NWE
Map 8 – Hilgard 8 ac	Knapweed, thistle, alyssum	Milestone/Metcel/R11	NFRG
Map 9 - Quake lake sign – 1 ac	Knapweed, poison hemlock, houndstongue	Milestone/Metcel/R11	NWE
Map 9 - Boat launch – 16 ac	Knapweed, alyssum, thistle, hounds tongue	Milestone/Metcel/R11	NWE
Map 10A –compound 23 ac	Knapweed, alyssum	Milestone/Metcel/R11	KV
Map 10B old dump 18 ac	Knapweed, alyssum	Milestone/Metcel/R11	KV
Map 10C –mad bluff 17 ac	Knapweed, alyssum	Milestone/Metcel/R11	NFRG
Map 11– Scarp 14 ac	knapweed	Milestone/Metcel/R11	NWE

Table 1. Treated sites for weeks 1-2 of MCC crews (S. Lamont, USFS).

Location (3rd Week) June 27	**Weeds**	**Herbicide (spray plants till wet)**	
Map 13 - Lakeside 33ac	Knapweed, hounds tongue thistle	Milestone/Metcel/R11	NWE
Map 14 – Building Destruction 35 ac	Knapweed, alyssum, St. Johnswort, poison hemlock, oxeye	Milestone/Metcel/R11	NWE
Map 14– Kirkwood trail	Knapweed,	Milestone/Metcel/R11	NFRG
Location (4th Week) July 5	**Weeds**	**Herbicide (spray plants till wet)**	
Map 15 - West Denny -5 ac	knapweed	pull	NFRG
Map 16 – sheep creek,	Knapweed, alyssum	Milestone/Metcel/R11	NFRG
Map 17 - Whits Lake – 10 ac	Yellow toadflax, Canada thistle	roundup	NFRG
Map 18 – Fir ridge 4 ac	Knapweed, yellow toadflax, alyssum	Tordon/24-d/R-11	NFRG
Map 1 & 3 retreat	Orange hawkweed		NWE
Location (5th Week) August 1	**Weeds**	**Herbicide (spray plants till wet)**	
Map 1 & 3 retreat	Orange hawkweed		NWE
Map 19 - Mollys point, Stoddard point 7 ac	yellow toadflax	Tordon/24-d/R-11	NWE
Map 20 - Northflats 15ac	yellow toadflax	Tordon/24-d/R-11	NFRG
Map 21 - Mad Arm – 175 ac	Yellow toadflax, alyssum	Yellow toadflax – tordon/24D/R11 Alyssum (near roads) - metcel/24-d/R11	NWE
Map 22 - Sage	Oxeye, houndstongue	Milestone/Metcel/R11, pull	KV

Table 2. Treated sites for weeks 3-4 of MCC crews (S. Lamont, USFS)

Herbicide	Label Rate	Mix Rate
24-D	32 oz/ac	1 oz/gal water
Metcel / Escort	1 oz/ac	1 gram/gal water
Hi-light dye		1 oz/gal water
Milestone	6 oz / acres	0.25 oz/gal water
R-11		0.5 oz/gal water
Roundup	1.7 % solution	2.2 oz/gal water
Telar	1 oz/ac	1 gram/gal water
Tordon	32 oz/ac	2 oz/gal water (stay 50 feet away from water)

Table 3. Herbicides utilized with their label rate compared to mixture rates (S. Lamont, USFS).

HUC	Watershed Name	Max # of lbs 2,4-D	Max # of lbs metsulfuron methyl	Max # of lbs chlorsulfuron	Max # of lbs aminopyralid	Max # of lbs picloram
W200070202	Upper Madison	50655	18091	30152	12423	90
W200070204	S. Fork Madison	16522	5901	9834	4052	30
W200070205	Denny	45212	16147	26912	11088	81
W200070304	Duck Red Canyon	25662	9165	15275	6293	46
W200070305	Grayling	34522	12329	20549	8466	62

Table 4. Displays the 2005 EIS Report from on how many pounds of a particular chemical are allowed into a particular watershed (HUC).

HUC	Total lbs of 2,4-D	Total lbs of metsulfuron methyl	Total lbs of chlorsulfuron	Total lbs of aminopyralid	Total lbs of picloram
W200070202	152	61.5	16.5	227	108
W200070204	19	0	0	28	2
W200070205	7.6	36	23.25	156	4
W200070301	0	9.6	0	32	0
W200070303	68.4	0	22.5	60	36
W200070304	0	3.6	0.75	12	0
W200070305	760	120	0	0	400
W200070307	3.8	73.5	0	245	32
W200070401	0	3.6	0	12	0
W200070404	570	169.2	0	264	300
W200070701	0	10.2	0	34	0

Table 5. Amount of herbicide sprayed in pounds per HUC for 2016 summer in pounds.

Effectiveness Percentage	Effectiveness Description
0%	No effect
1-5%	Little effect on population
6-25%	Treatment killed less than ¼ of the population
51-75%	Over half of the population killed
76-90%	Treatment killed most of the population
91-99 %	More than 91% population killed
100%	Not a single individual survived

Table 6. Displays the monitoring treatment effectiveness scale for herbicide treatments.

Species Code	Species	Treated Acres
ANTI	Golden chamomile	0.8144
BEIN2	Hoary alyssum	3471.017
BRTE	Cheatgrass	257.9292
CADR	Whitetop	0.0938
CANU4	Nodding plumeless thistle	17.4407
CEBI2	Spotted knapweed	5567.577
CEDI3	Diffuse knapweed	3.614
CHLE80	Oxeye daisy	12.005
CIAR4	Canada thistle	651.569
CIVU	Bull thistle	39.6713
COAR4	Field bindweed	0.6559
COMA2	Posion hemlock	617.6885
CYOF	houndstounge	1086.864
EUES	Leafy spruge	9.9005
HAIU	Orange hawkweed	1037.407
HYPE	Common St. johnswort	9.0806
LIDA	Dalmatian toadflax	606.7515
LIVU2	Butter and eggs	1488.737
PORE5	Sulpher cinquefoil	1.0759
TAVU	Common tansy	6.414
TRIN11	Scentless false mayweeed	0.023
VETH	Common mullein	523.9572

Table 7. Amount of acres of noxious weeds treated by West Yellowstone and Bozeman USFS crews for 2016.

Toolbar	Functions
Main Toolbar	Open & save maps, add layers, edit map symbology, add scale bar, north arrow, setup GPS satellites
Browse Toolbar	Zoom in, zoom out, query
Editor Toolbar	Sketch (freehand polygon, circle, rectangle, or GPS tracking)
Invasive Species Mobile (ISM) Specific Toolbar	Create treatment or inventory layer, remeasure sites.

Table 8. Describes the functions and tools available in ArcPad with the addition of the ISM application.

FIGURES:

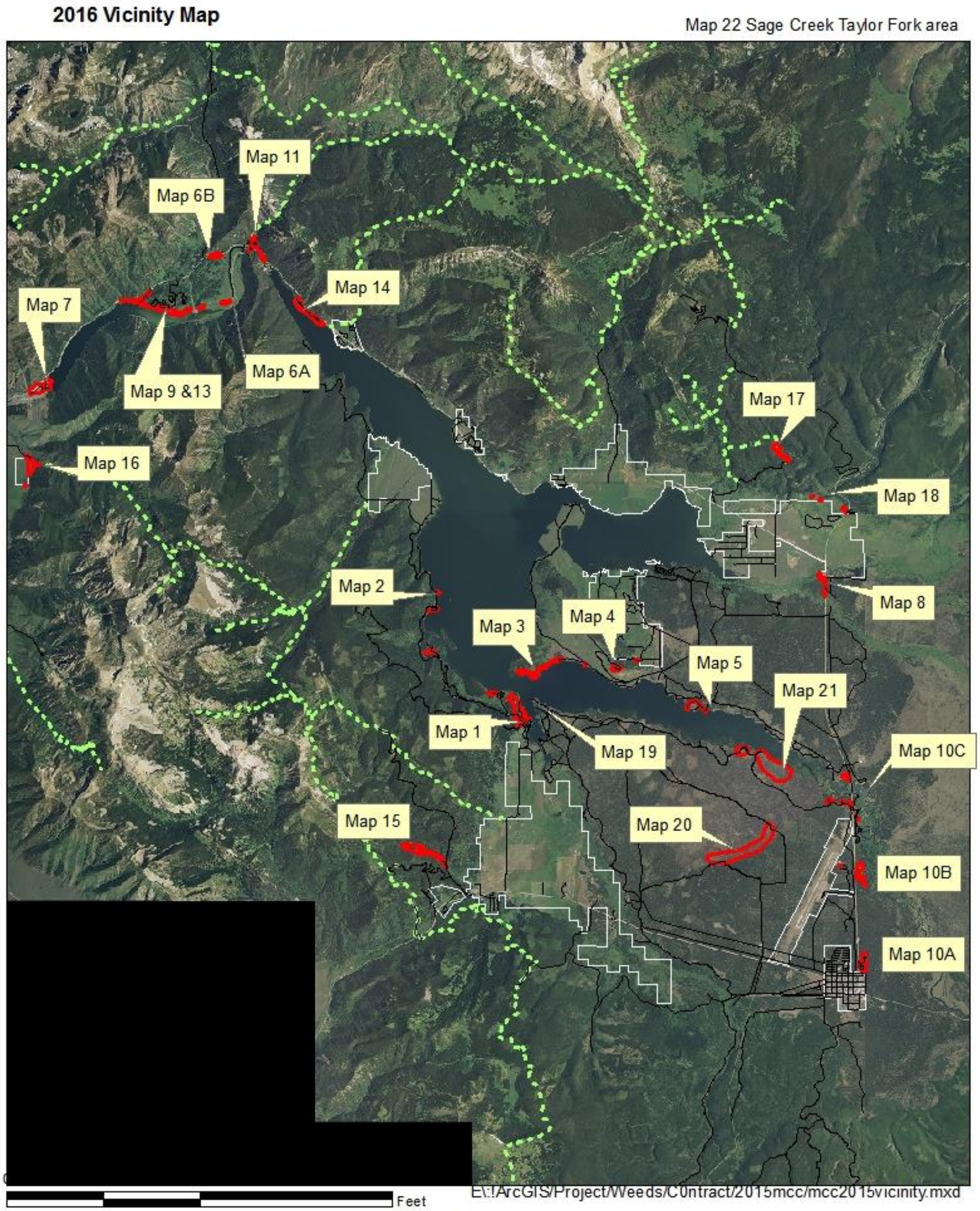

Figure 1. Vicinity map of planned treatment sites (S. Lamont, USFS).

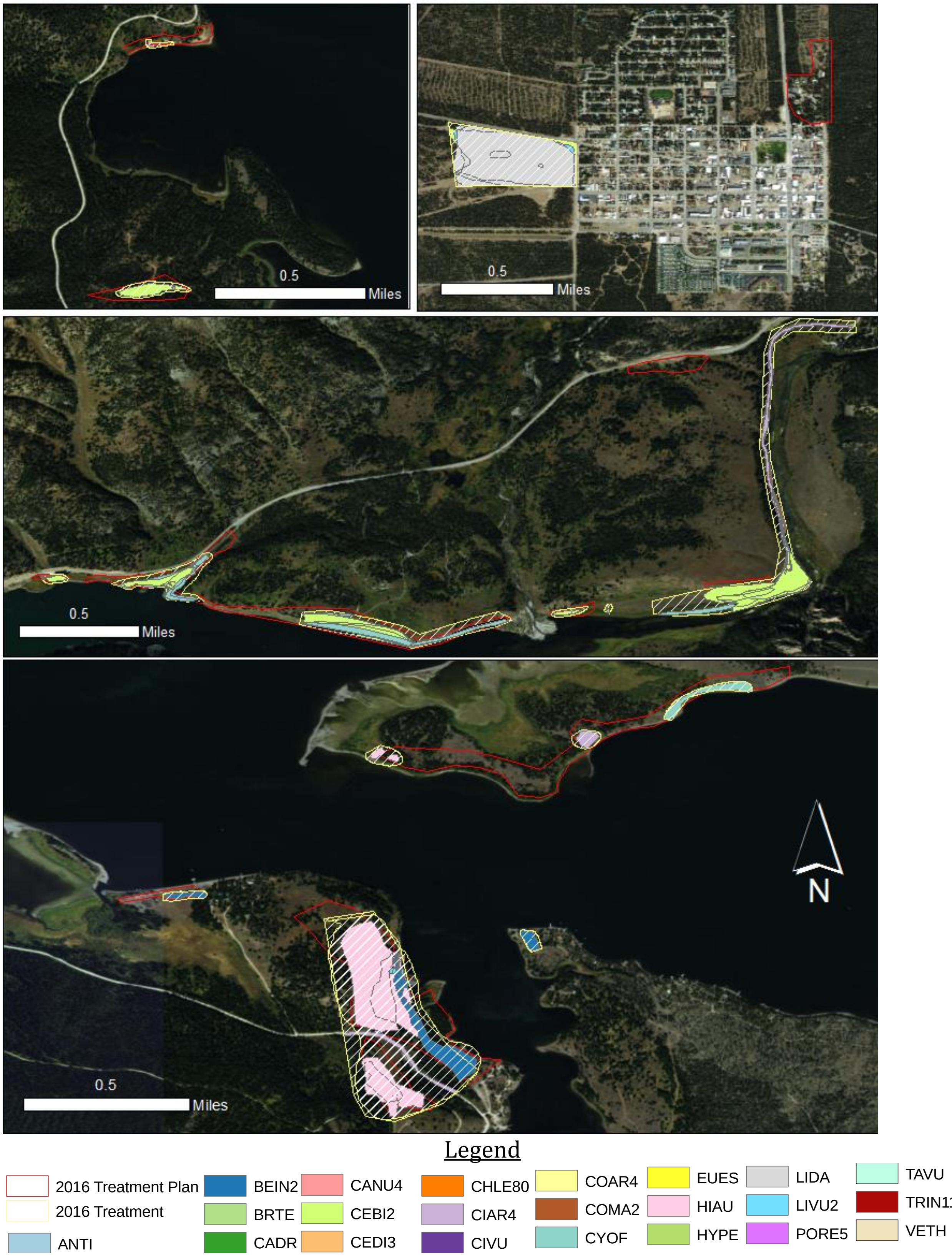

Figure 2. Displays insets of treated sites of Figure 6 (upper left), Figure 14 (upper right), Figures 10 & 12 (middle), and Figures 5 & 7 (bottom).

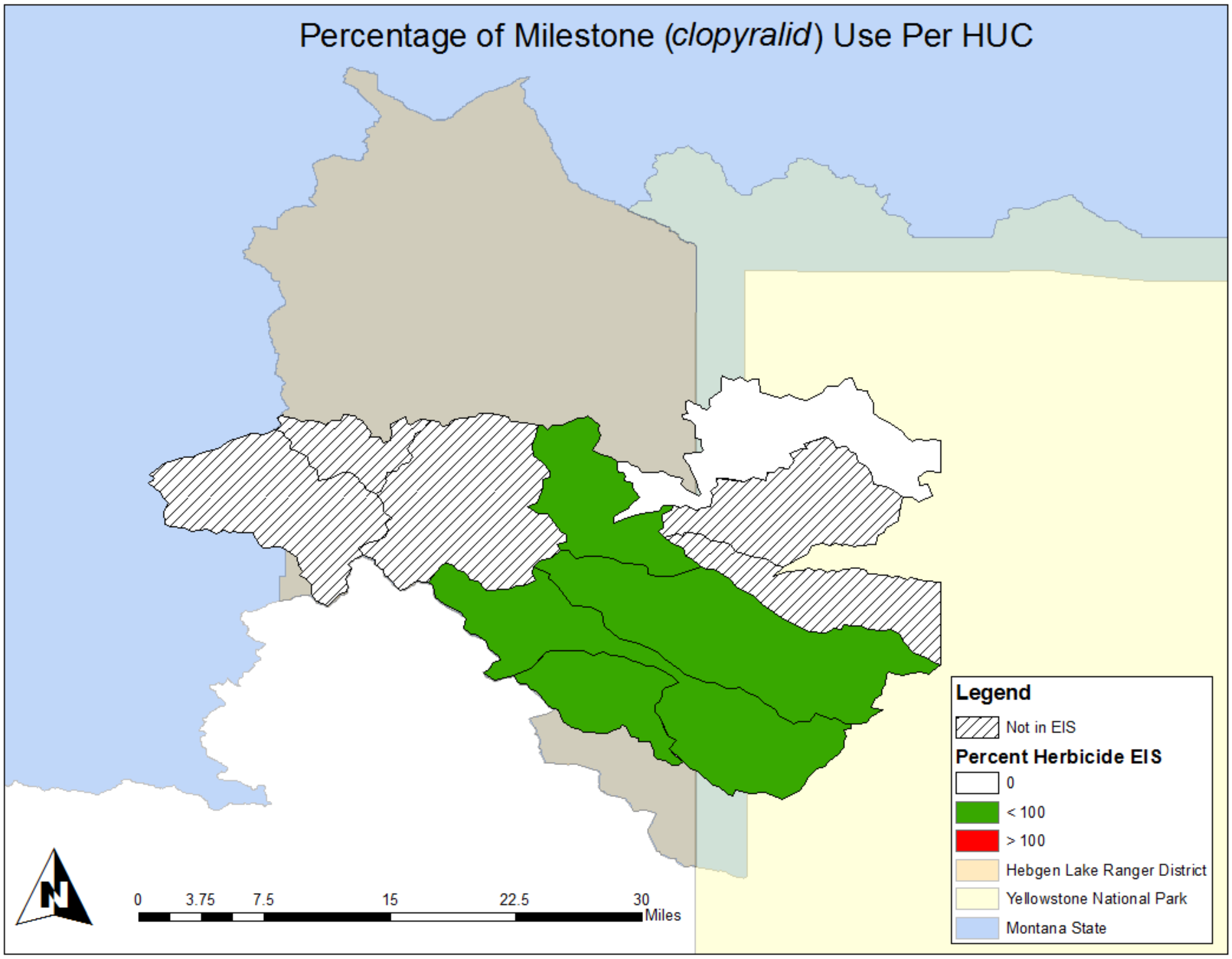

Figure 3. Displays the percentage of allowed herbicide sprayed per watershed (HUC) for Milestone based on the 2005 EIS Report.

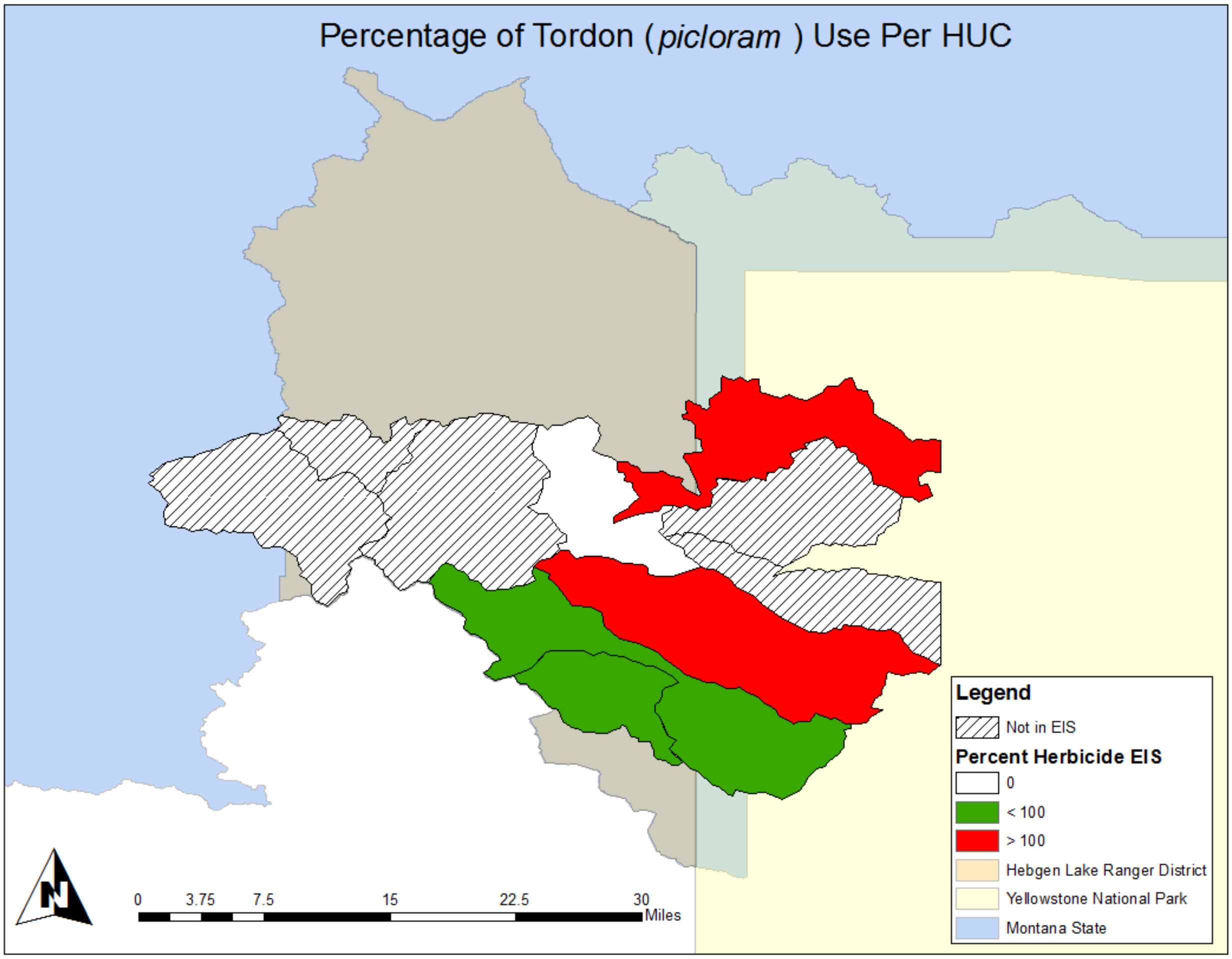

Figure 4. Displays the percentage of allowed herbicide sprayed per watershed (HUC) for Tordon based on the 2005 EIS Report.

REFERENCES

[1] LinkedIn Corporation., 2016. *Montana Conservation Corps* [online]. Source. Available from: https://www.linkedin.com/company/3550662?trk=tyah&trkInfo=clickedVertical%3Acompany%2CclickedEntityId%3A3550662%2Cidx%3A3-3-11%2CtarId%3A1474316932398%2Ctas%3Amontana%20c [Accessed 16 September 2016].

[2] History.com Staff., 2009. *FDR creates Civilian Conservation Corps* [online]. Source. Available from: http://www.history.com/this-day-in-history/fdr-creates-civilian-conservation-corps [Accessed 19 September 2016].

[3] Montana Conservation Corps, 2016. *Montana Conservation Corps History* [online]. Source. Available from: http://mtcorps.org/about/history/ [Accessed 14 September 2016].

[4] Montana Conservation Corps, 2016. *Montana Conservation Corps Mission Statement* [online]. Source. Available from: http://mtcorps.org/about/mission-statement/ [Accessed 14 September 2016].

[5] United States Department of Agriculture, 2016. *U.S. Forest Service What We Believe* [online]. Source. Available from: http://www.fs.fed.us/about-agency/what-we-believe [Accessed 15 September 2016].

[6] United States Department of Agriculture, 2016. *U.S. Forest Service Agency Organization* [online]. Source. Available from: http://www.fs.fed.us/about-agency/organization [Accessed 15 September 2016].

[7] United States Department of Agriculture, 2016. *U.S. Forest Service Maps* [online]. Source. Available from: http://data.fs.usda.gov/geodata/maps/index.php [Accessed 15 September 2016].

[8] United States Department of Agriculture, 2016. *U.S. Forest Service What We Believe* [online]. Source. Available from: http://www.fs.fed.us/about-agency/what-we-believe [Accessed 15 September 2016].

[9] United States Department of Agriculture, 2005. *Record of Decision For the Gallatin National Forest Noxious and Invasive Weed Treatment Project* [print].

APPENDIX

Map 1 - 2016 MCC Lonesomehurst

Figure 5. Planned treatment sites for Lonesomehurst campground, Contour Road, and Romset Beach (S. Lamont, USFS).

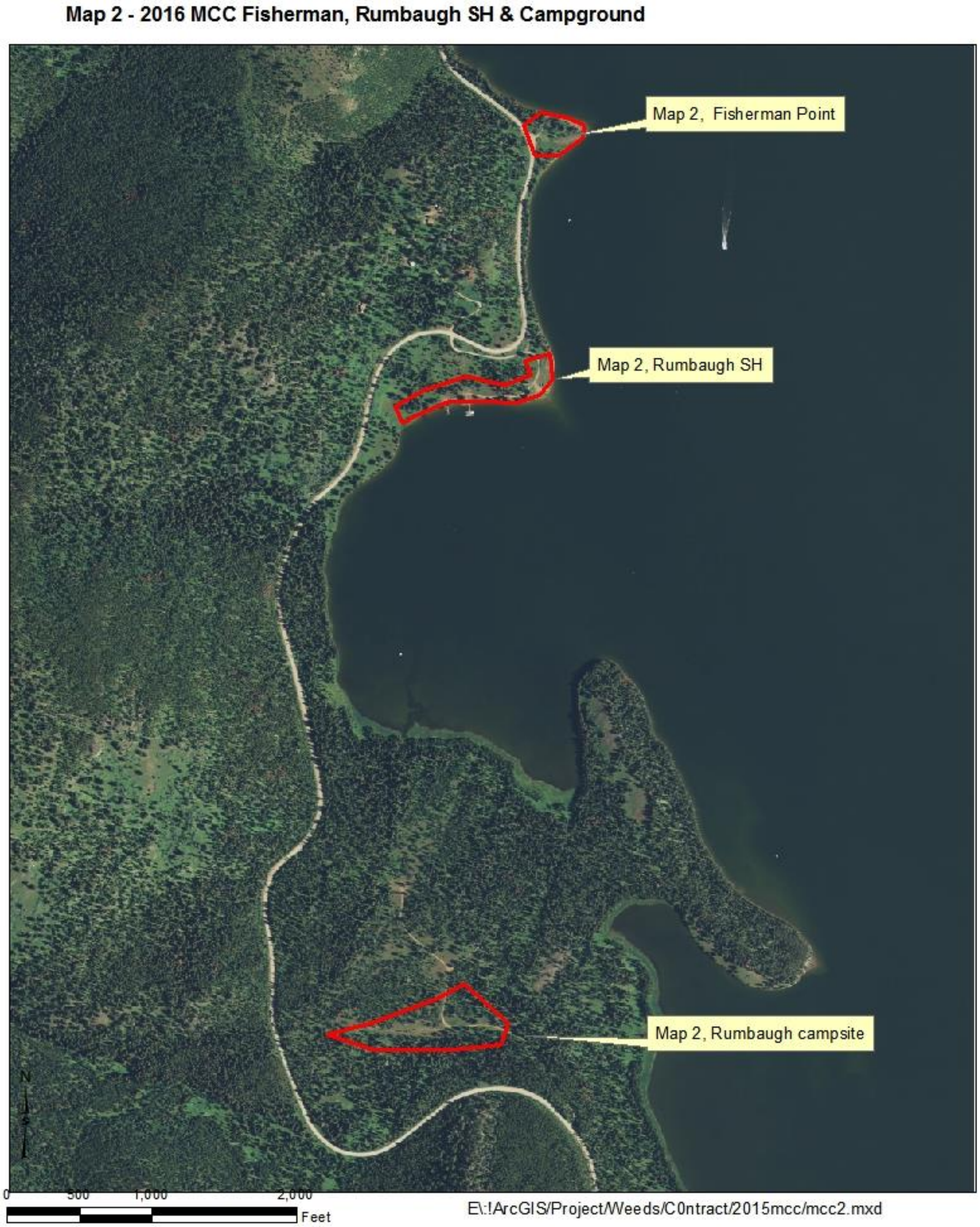

Figure 6. Planned treatment sites for Fisherman's Point, Rumbaugh Shore, and Rumbaugh campsite (S. Lamont, USFS). (S. Lamont, USFS)

Figure 7. Planned treatment site for Edwards Peninsula (S. Lamont, USFS).

Map 4 - 2016 MCC Horse Butte

Figure 8. Planned treatment sites for Horse Butte lookout and lakeside (S. Lamont, USFS).

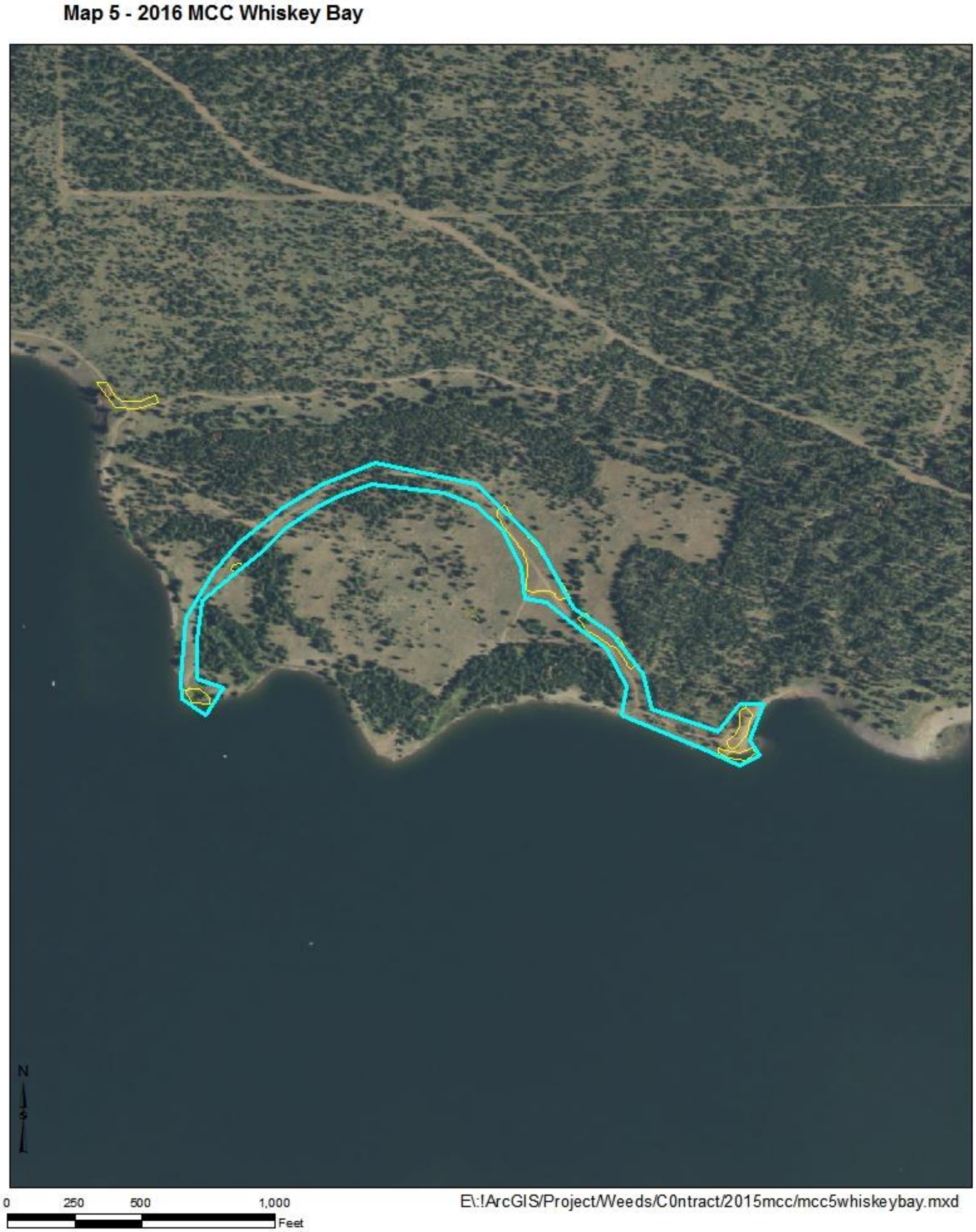

Figure 9. Planned treatment site for Whiskey Bay (S. Lamont, USFS).

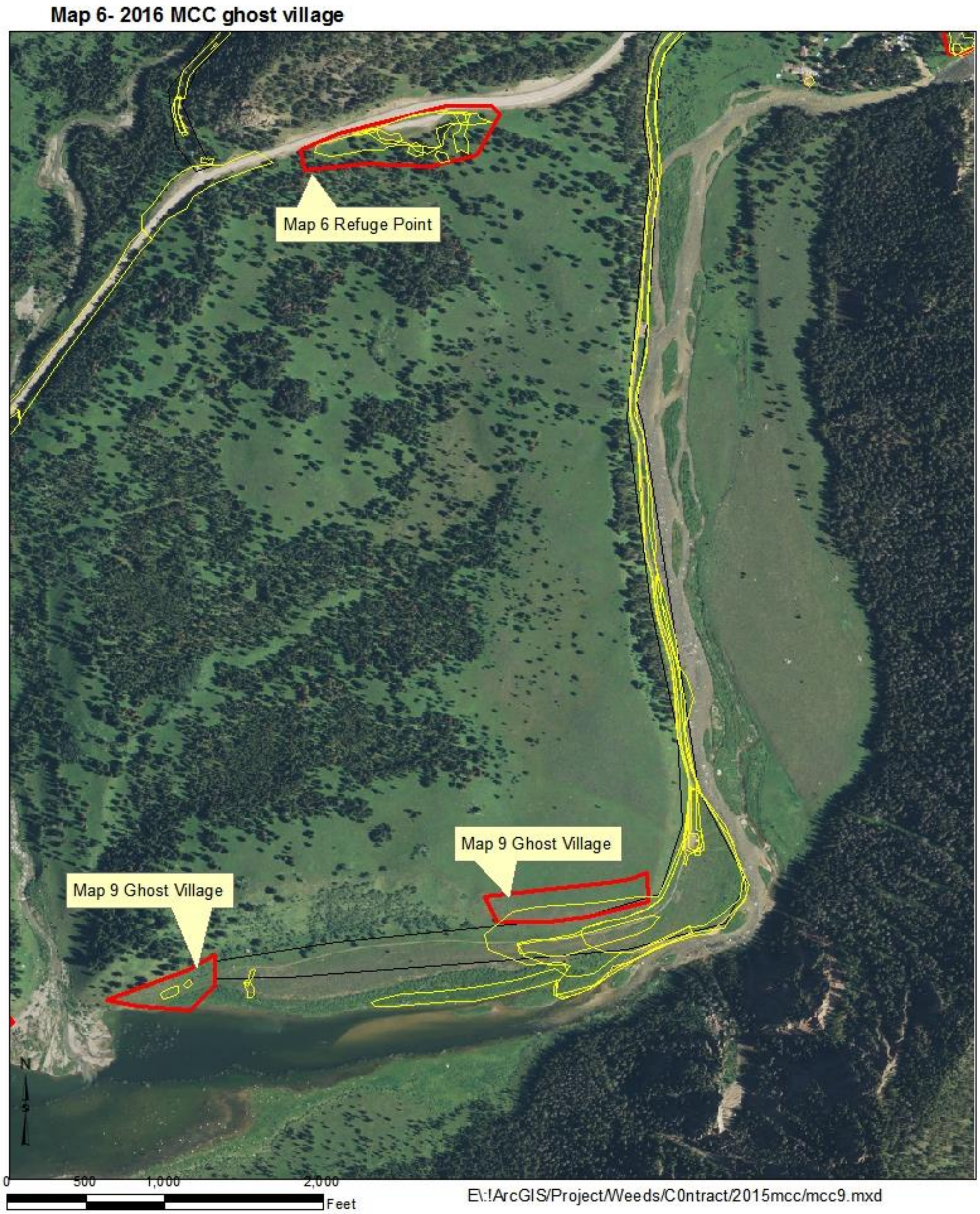

Figure 10. Planned treatment sites for Ghost Village and Refuge Point (S. Lamont, USFS).

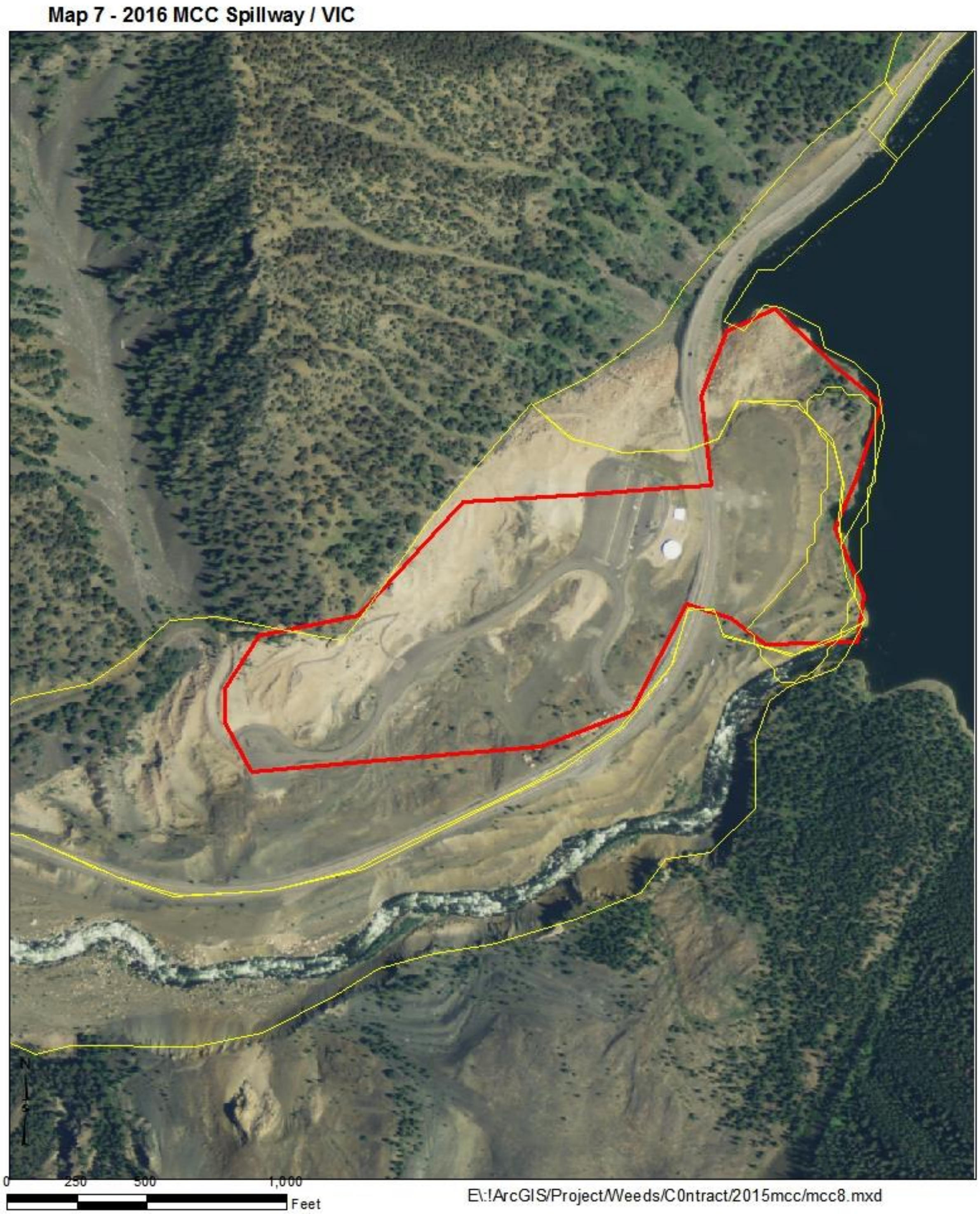

Figure 11. Planned treatment site for Earthquake Lake Visitor Center Spillway (S. Lamont, USFS).

Figure 12. Planned treatment sites for Earthquake Lake boat launch and sign (S. Lamont, USFS).

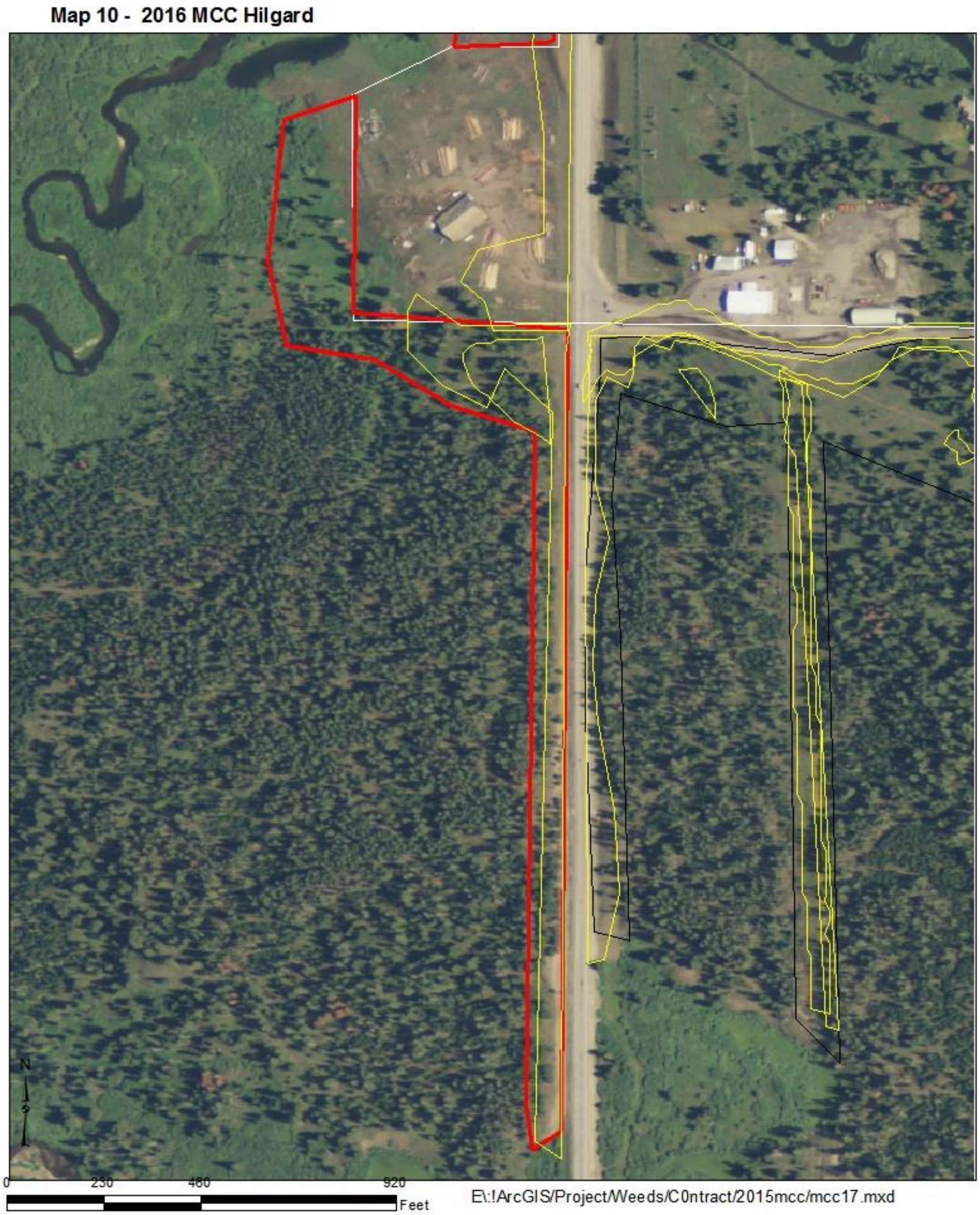

Figure 13. Planned treatment site for Hilgard (S. Lamont, USFS).

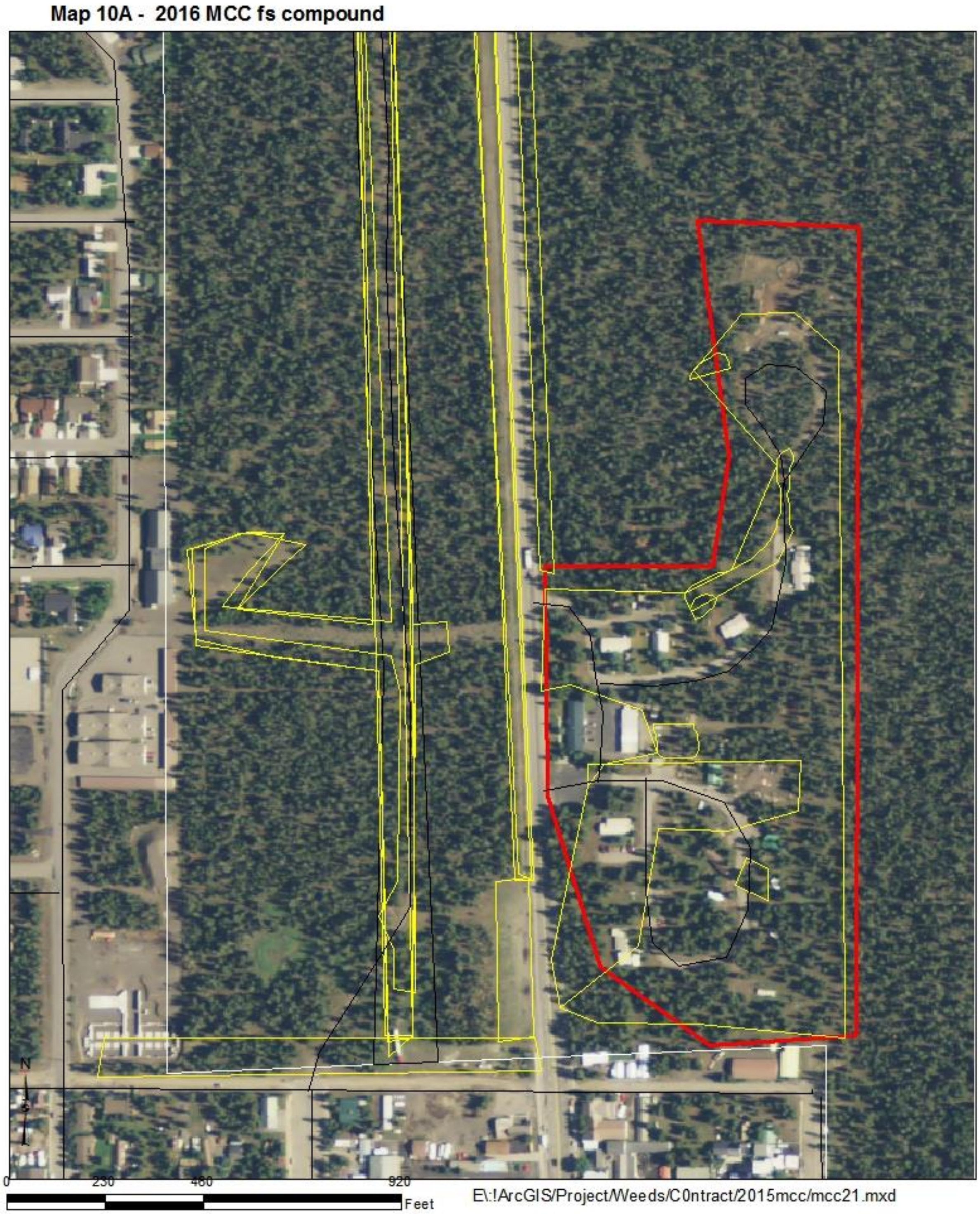

Figure 14. Planned treatment site for the Hebgen Lake Ranger District Compound (S. Lamont, USFS).

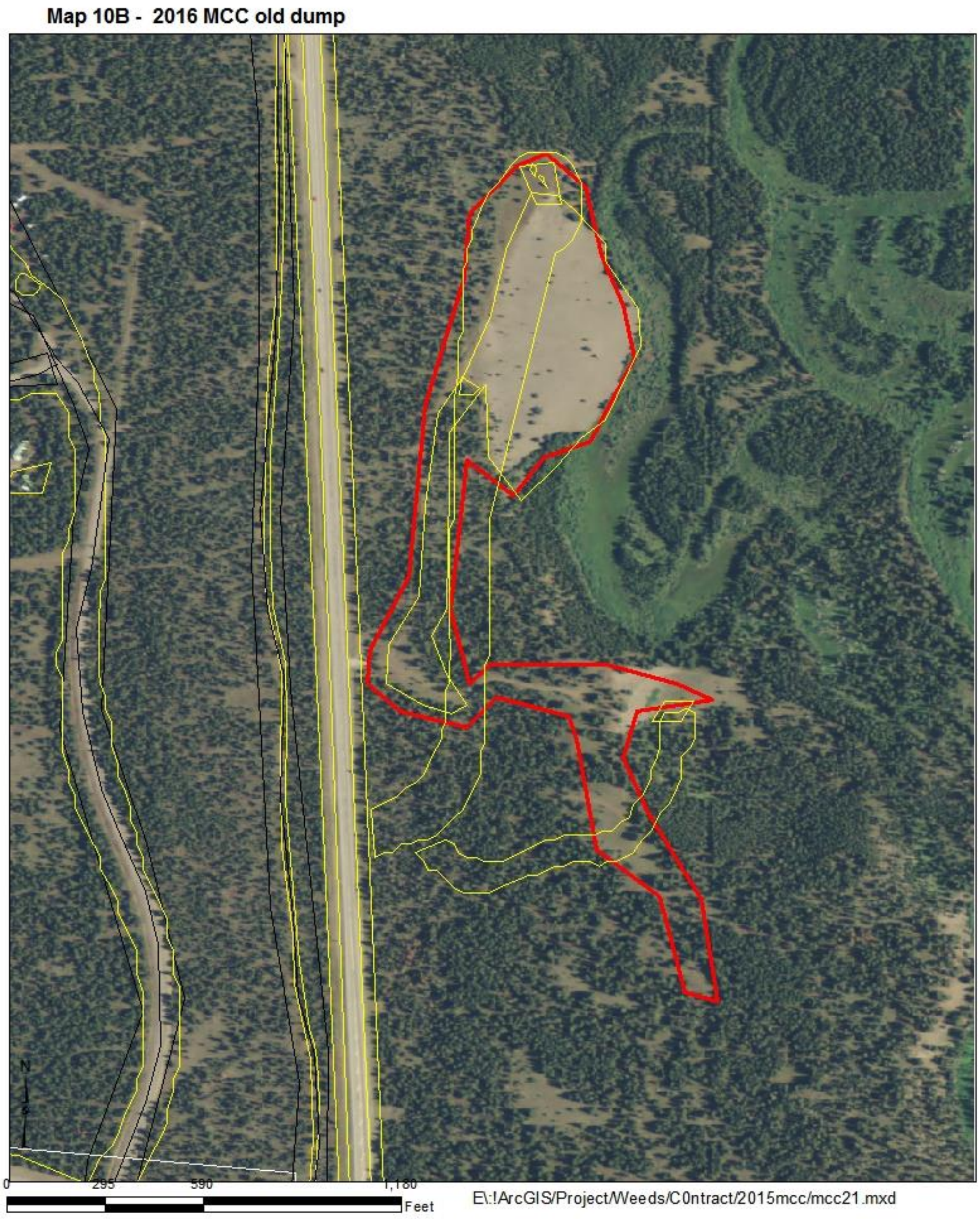

Figure 15. Planned treatment site the Old Dump (S. Lamont, USFS).

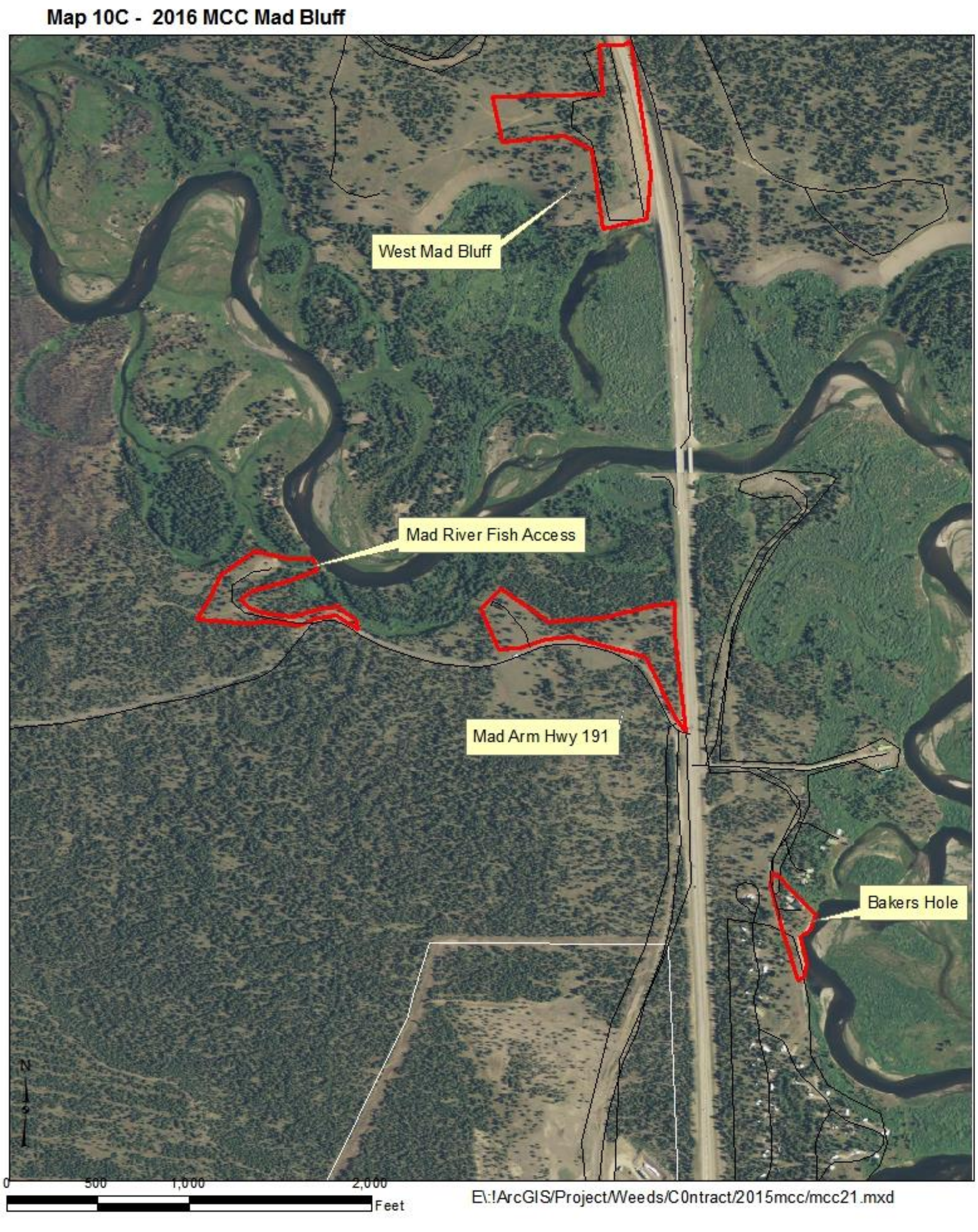

Figure 16. Planned treatment sites for West Mad Bluff, Mad River Fish Access, Mad Arm Highway 191 and Bakers Hole campground (S. Lamont, USFS).

Map 11- 2016 MCC scarp

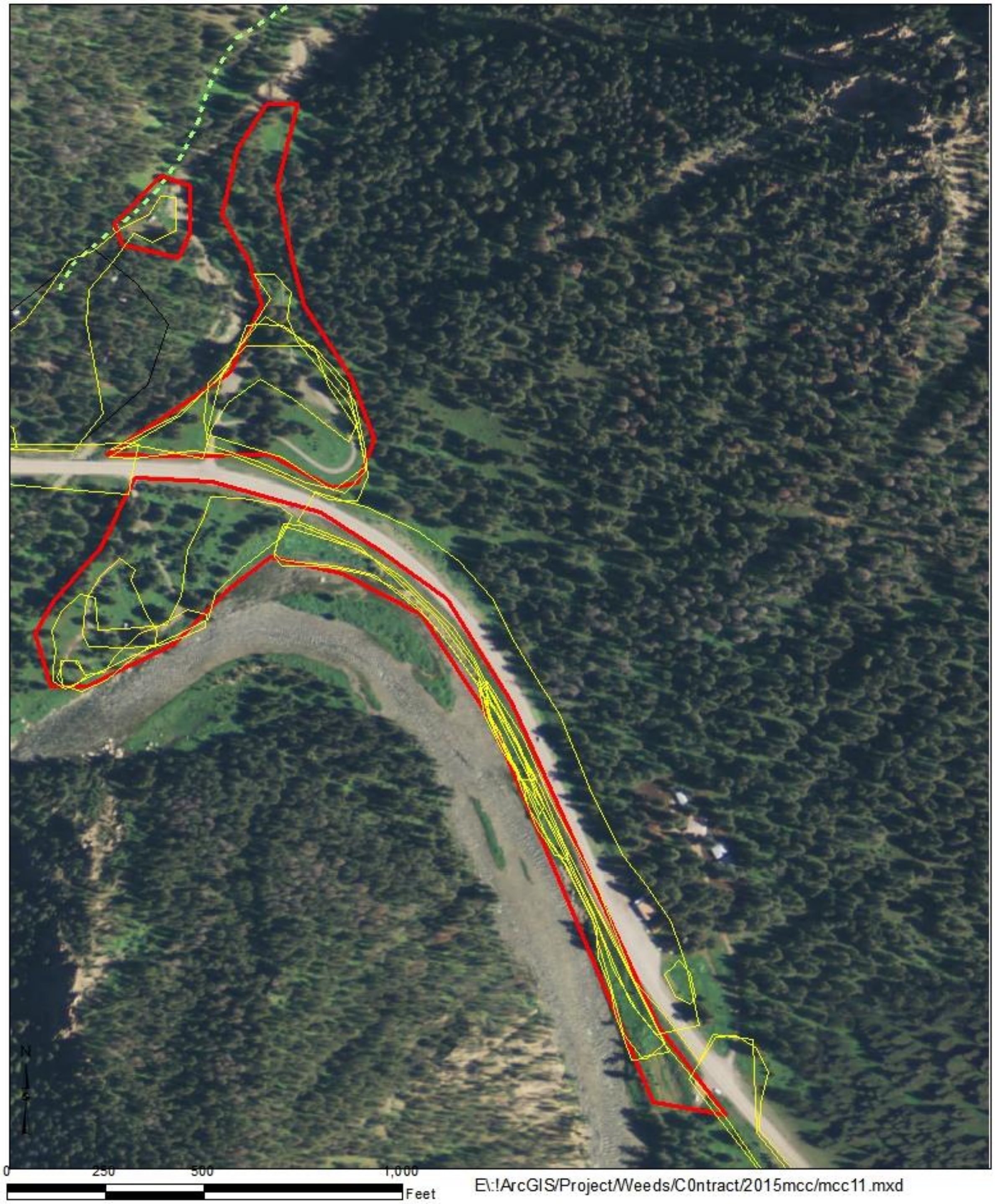

Figure 17. Planned treatment sites for Scarp (S. Lamont, USFS).

Map 13 - 2016 MCC Lake side earthquake

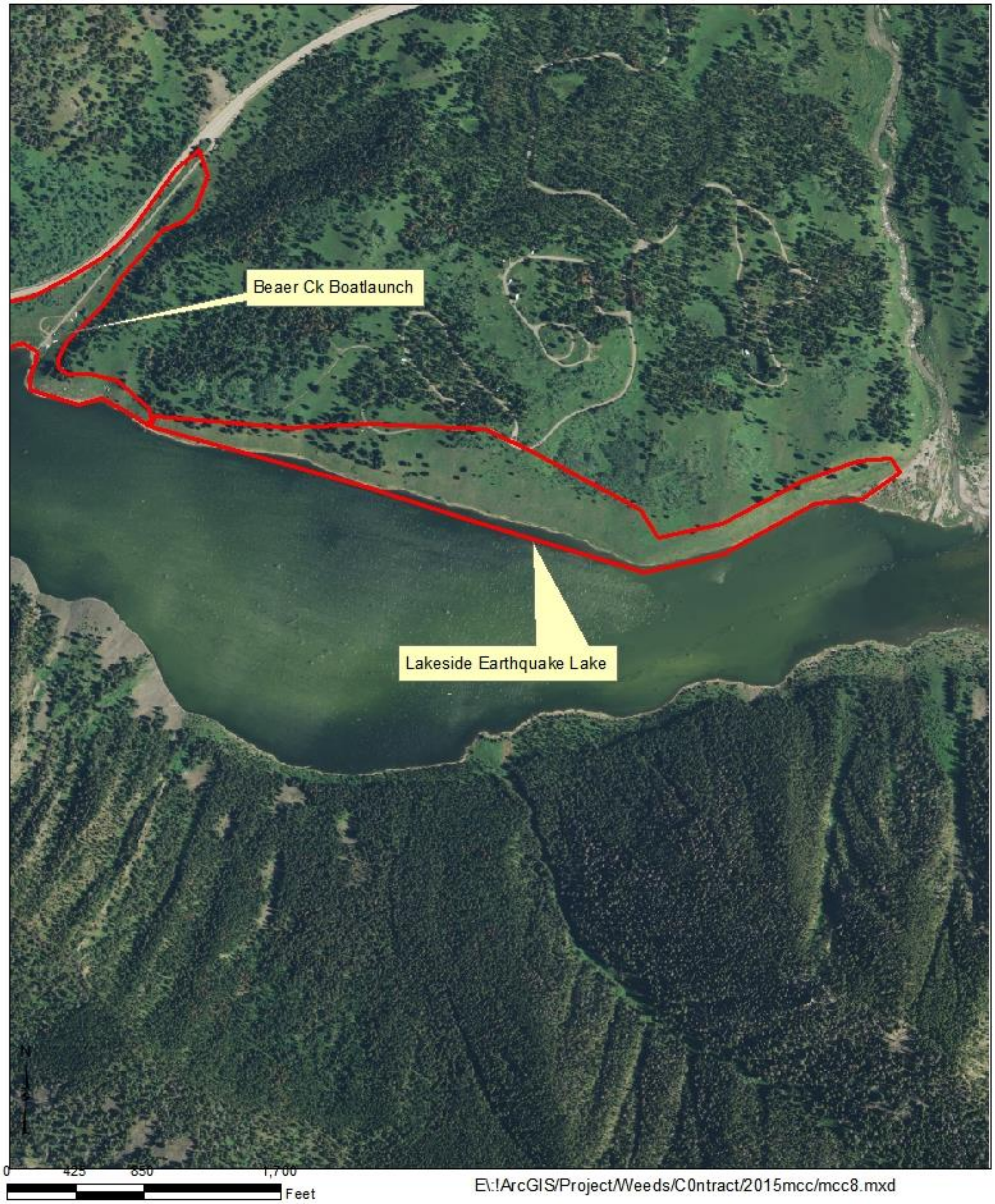

Figure 18. Planned treatment site for Earthquake Lake (S. Lamont, USFS).

Figure 19. Planned treatment site for Building Destruction (S. Lamont, USFS).

Map 15 - 2016 MCC West Denny

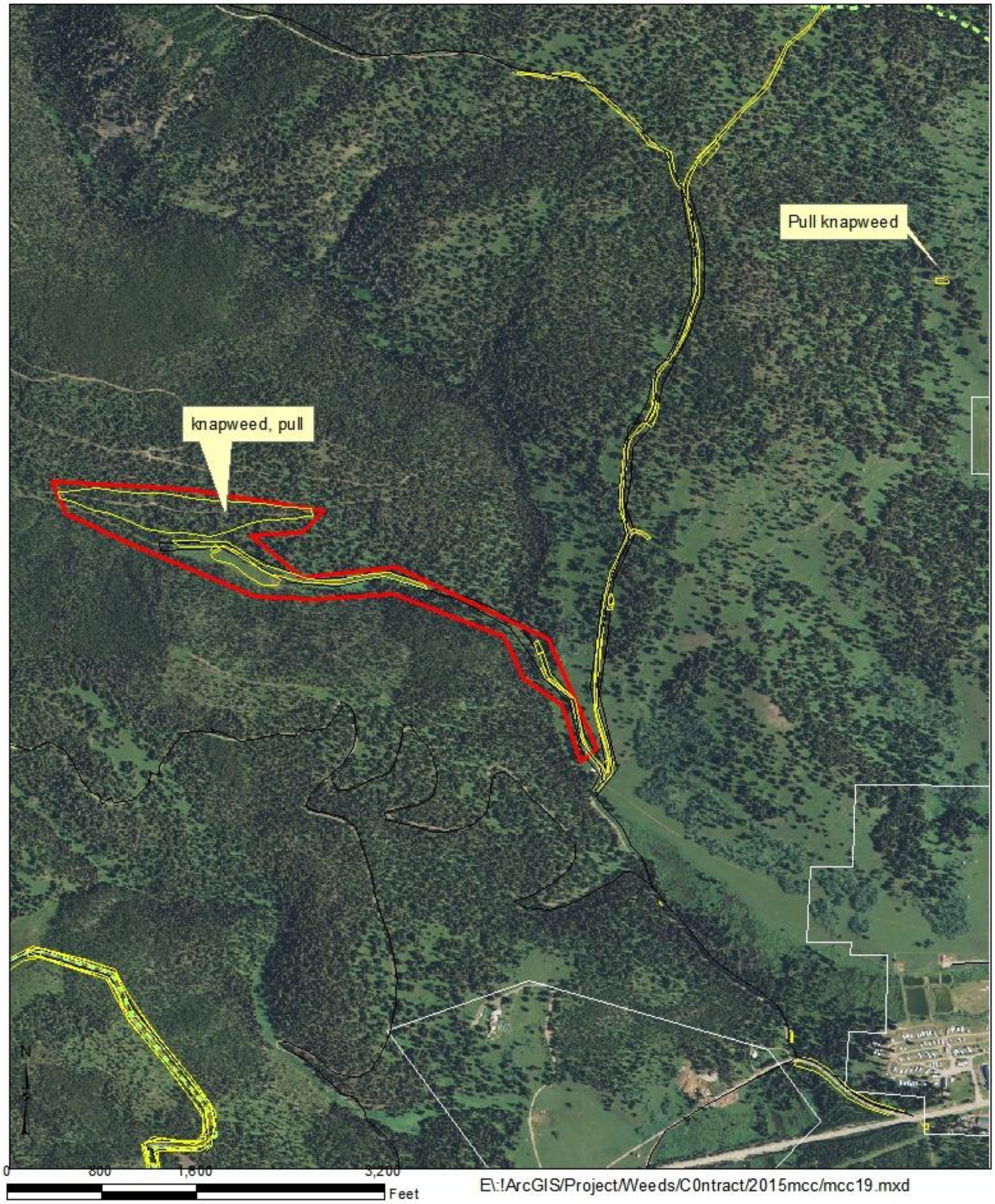

Figure 20. Planned treatment sites for Horse Butte lookout and lakeside (S. Lamont, USFS).

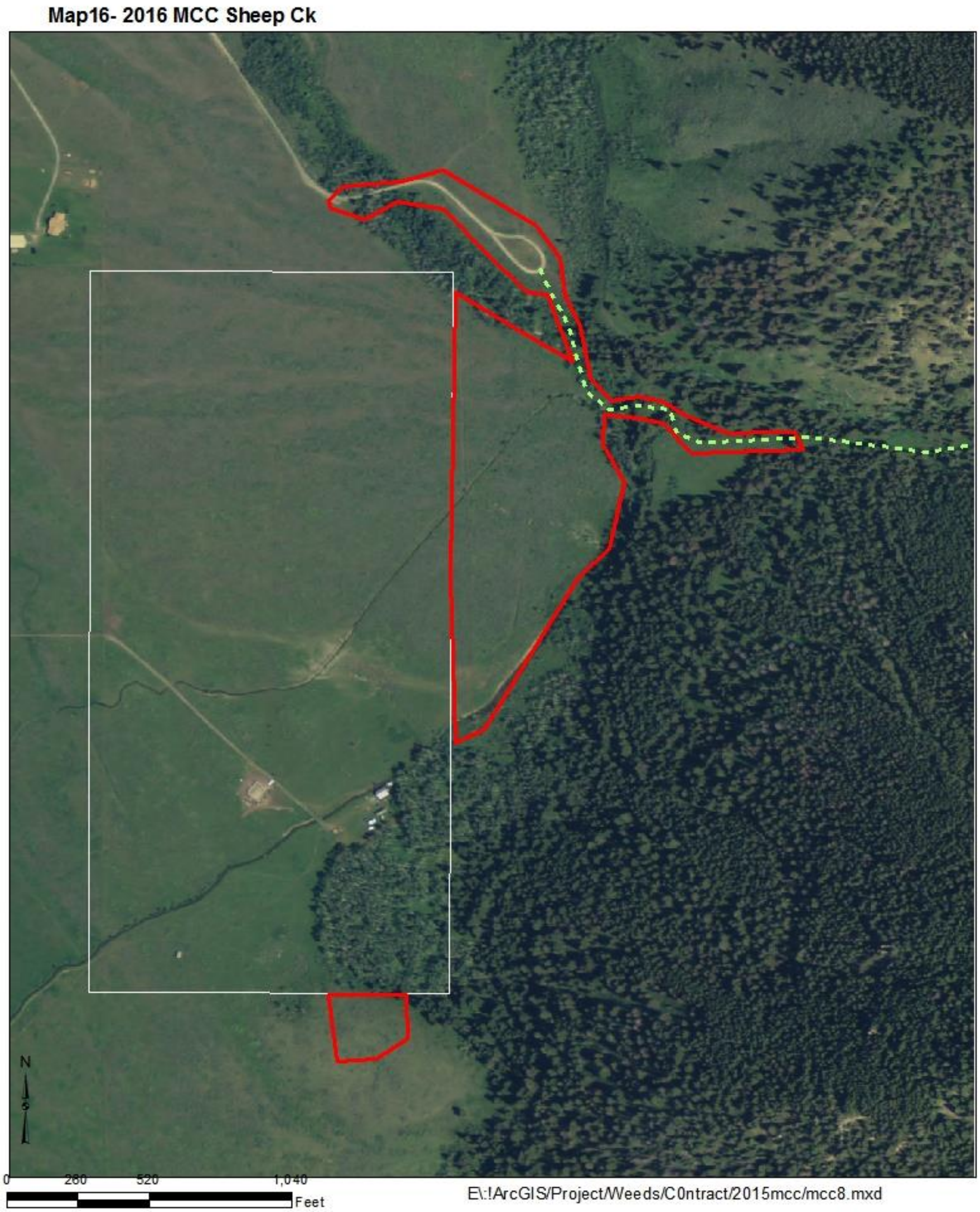

Figure 21. Planned treatment sites for Sheep Creek Trail (S. Lamont, USFS).

Map 17- 2016 MCC Whits Lake

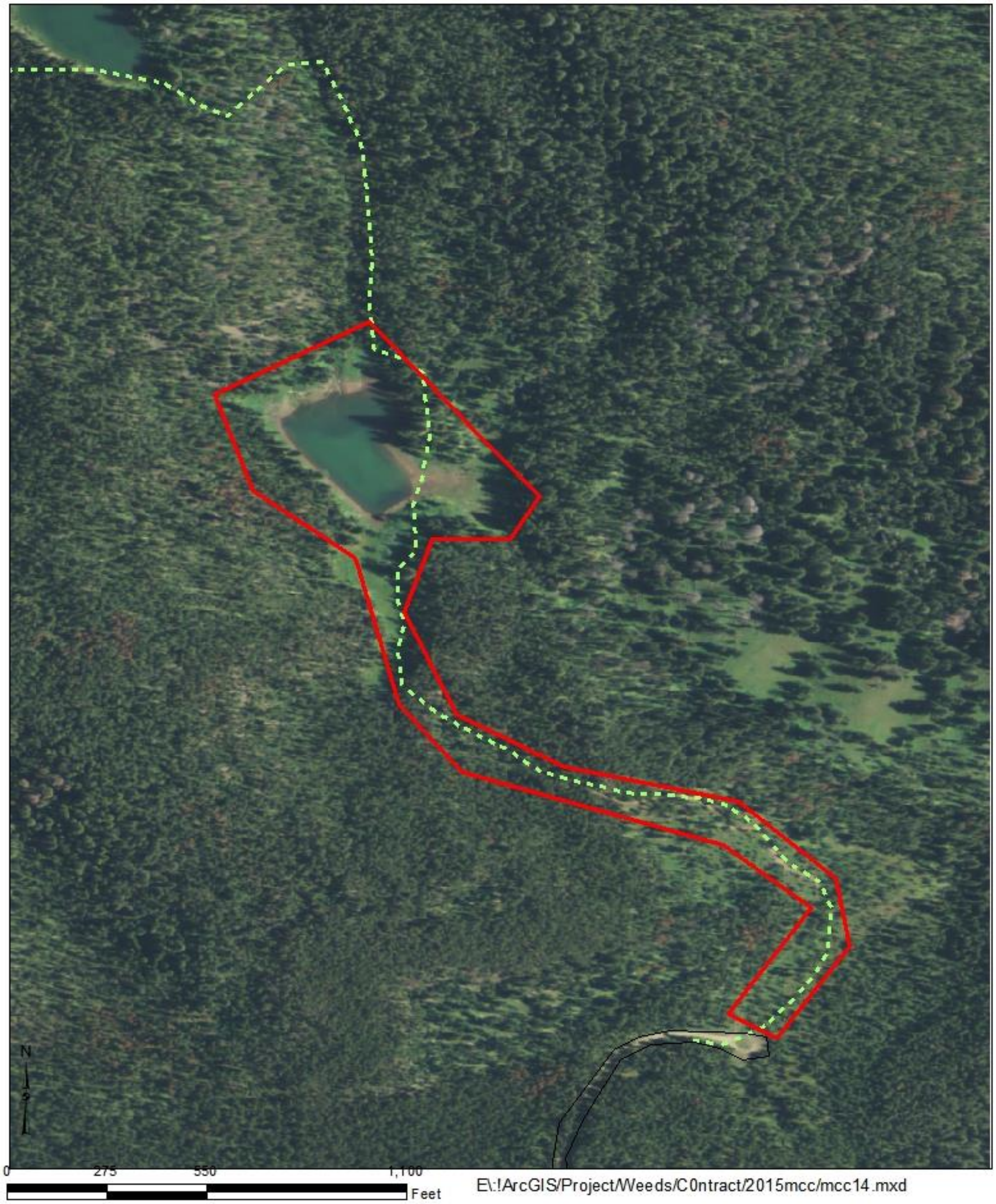

Figure 22. Planned treatment site for Whits Lake (S. Lamont, USFS).

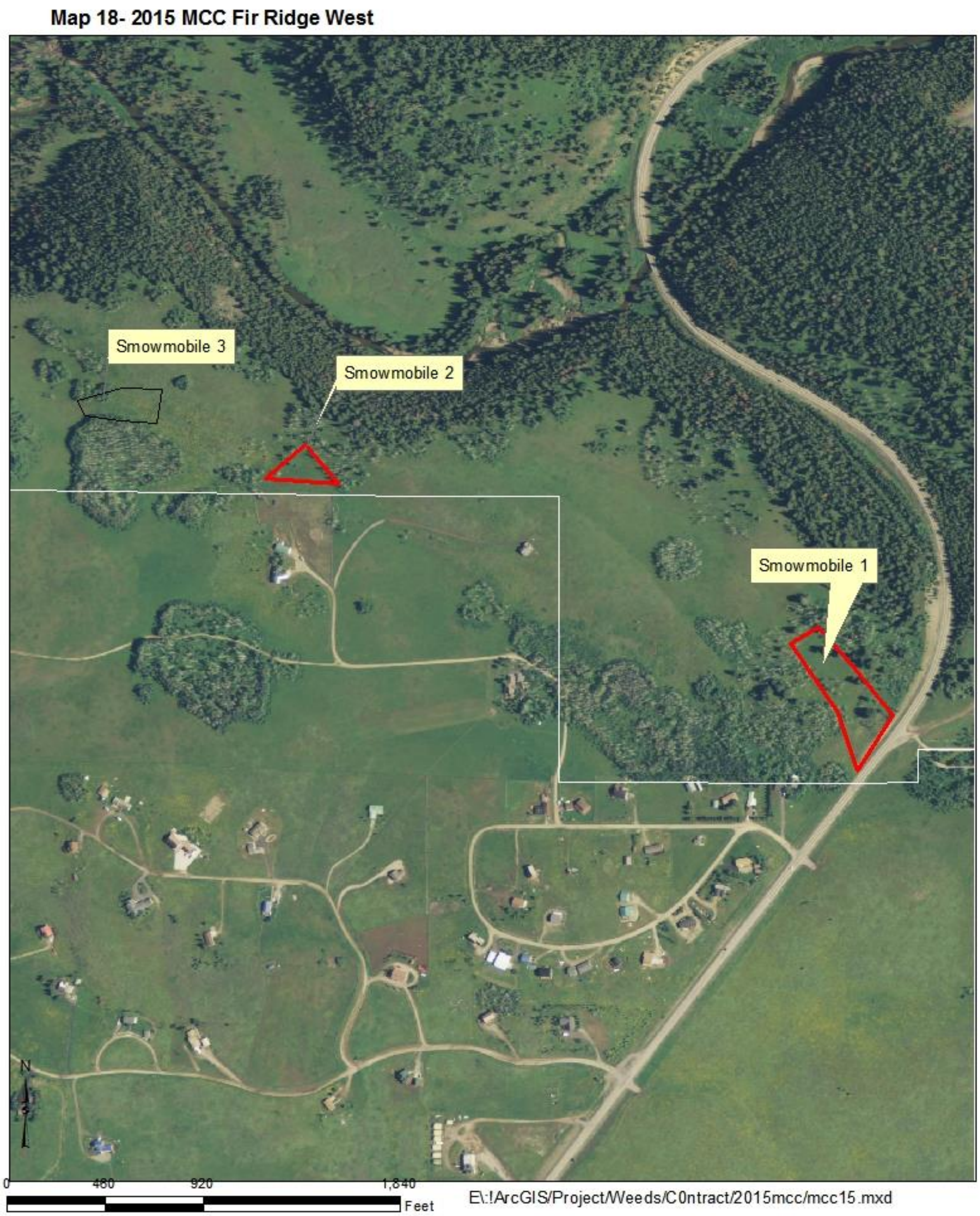

Figure 23. Planned treatment sites for Fir Ridge Trail (S. Lamont, USFS).

Map 19A - 2016 stodders point and mollys point

Figure 24. Planned treatment sites for Molly's and Stoddard Point including areas of biocontrol where pesticide treatment was not conducted (S. Lamont, USFS).

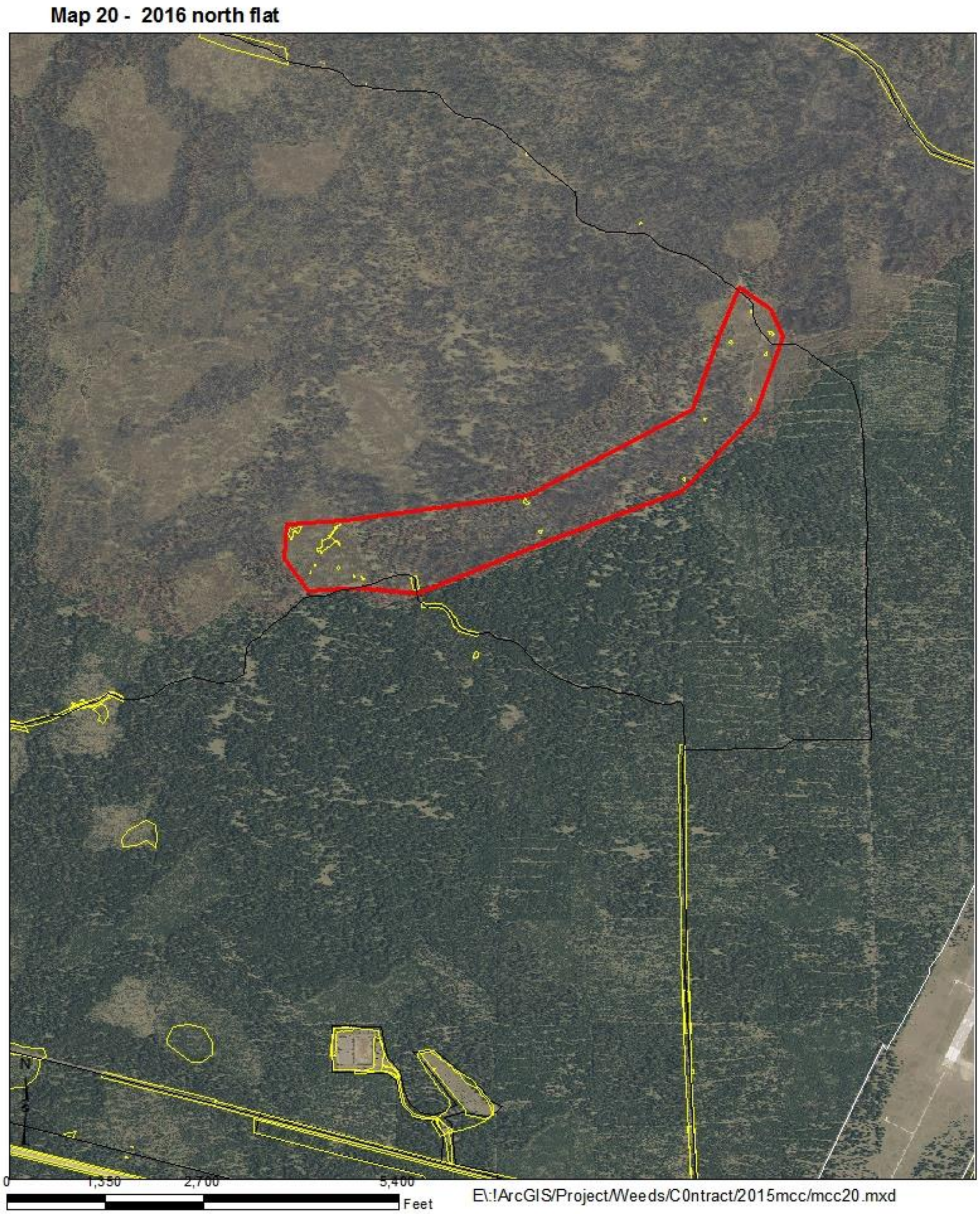

Figure 25. Planned treatment site for North Flats (S. Lamont, USFS).

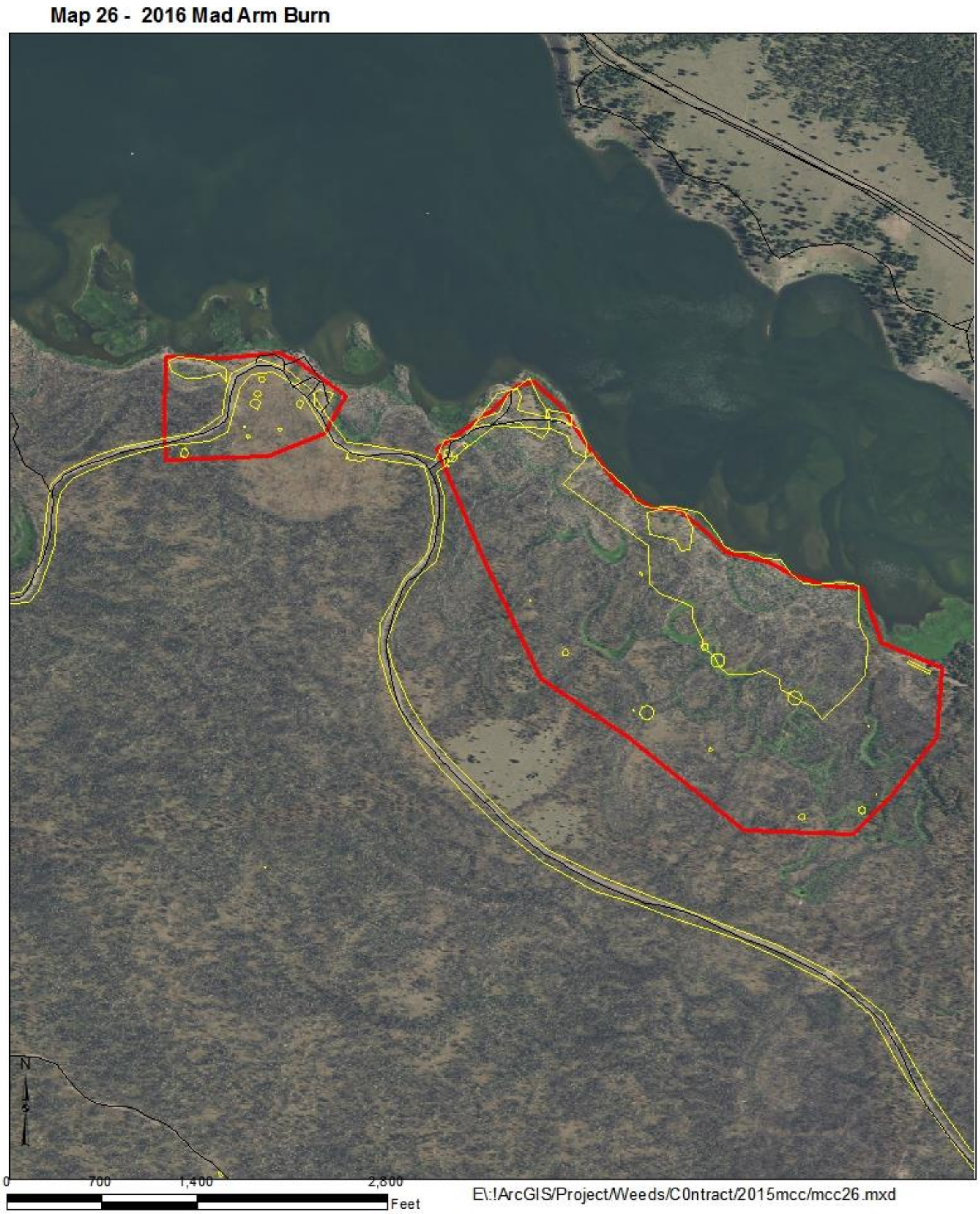

Figure 26. Planned treatment sites for Mad Arm Burned Area (S. Lamont, USFS).

Map 22- 2016 MCC sage

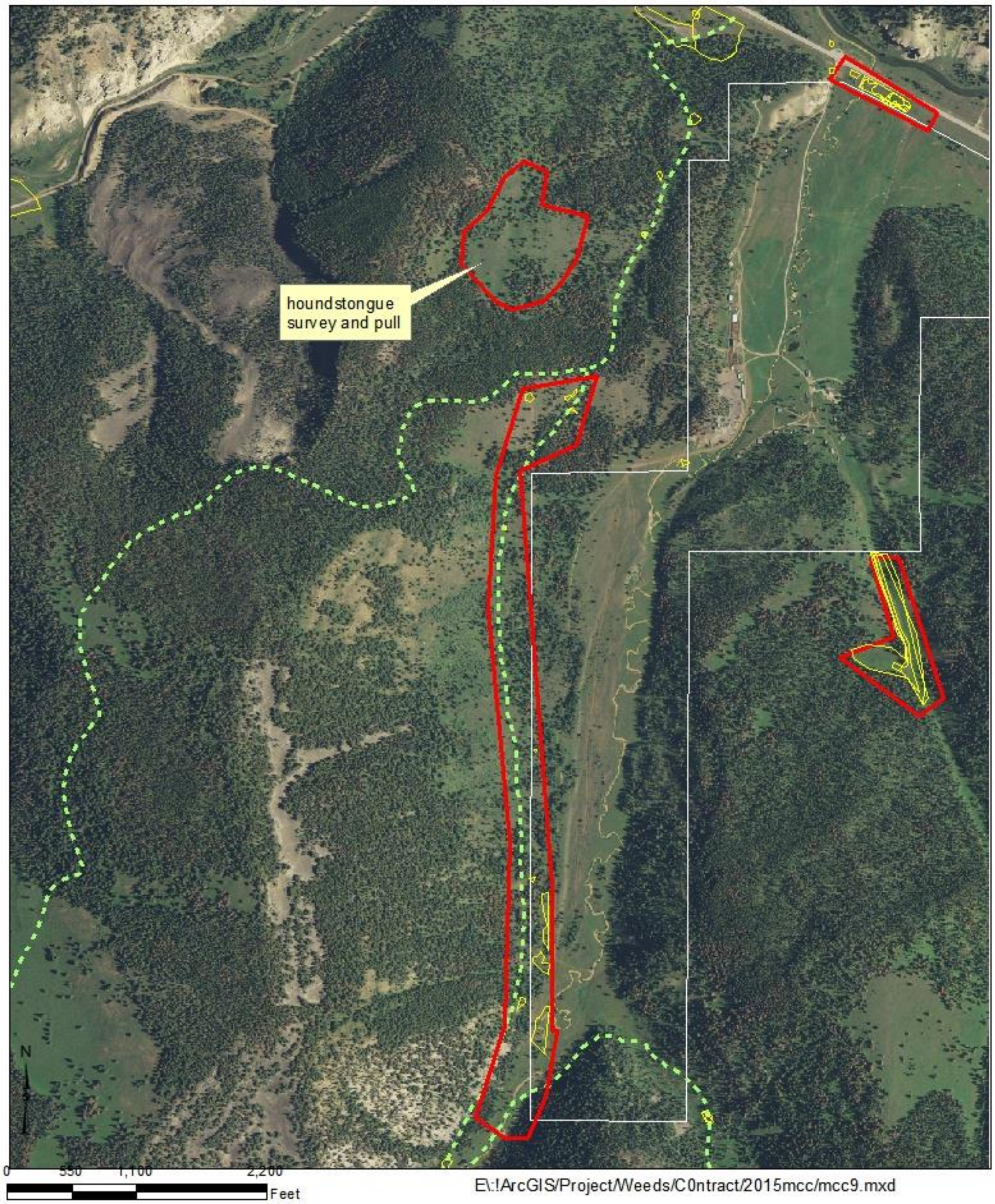

Figure 27. Planned treatment sites for Sage Creek Trailhead (S. Lamont, USFS).

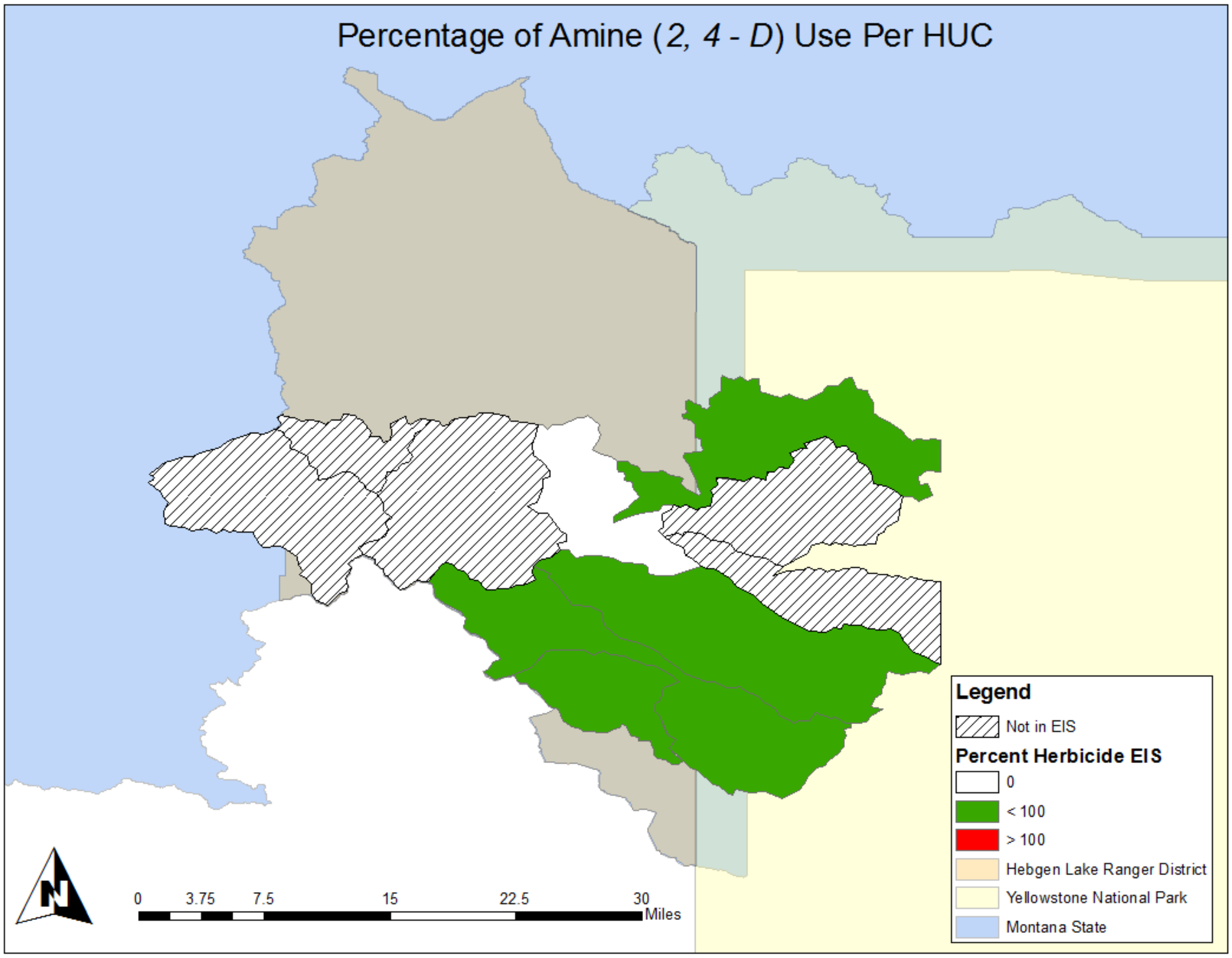

Figure 28. Displays the percentage of allowed herbicide sprayed per watershed (HUC) for Amine based on the 2005 EIS Report.

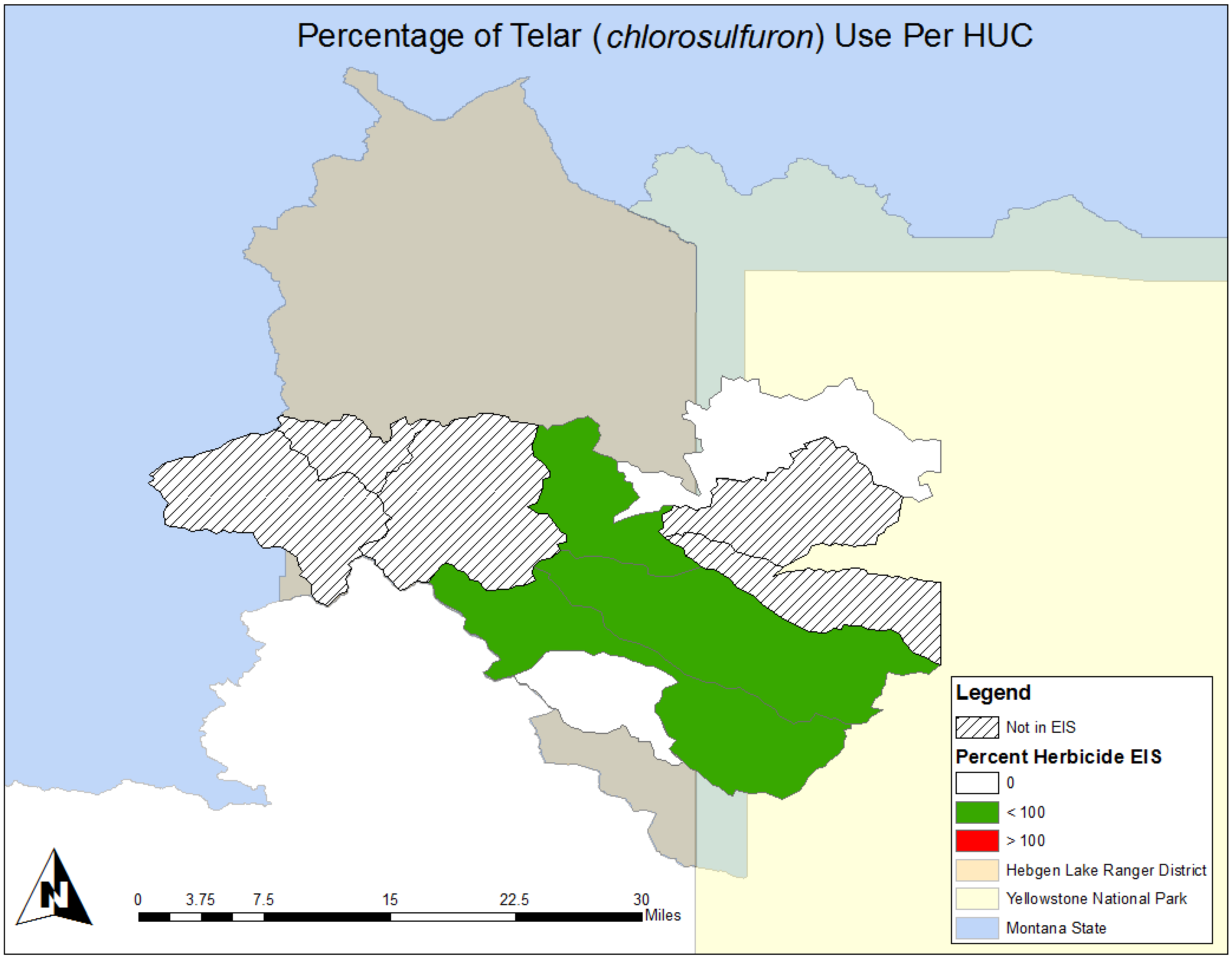

Figure 29. Displays the percentage of allowed herbicide sprayed per watershed (HUC) for Telar based on the 2005 EIS Report.

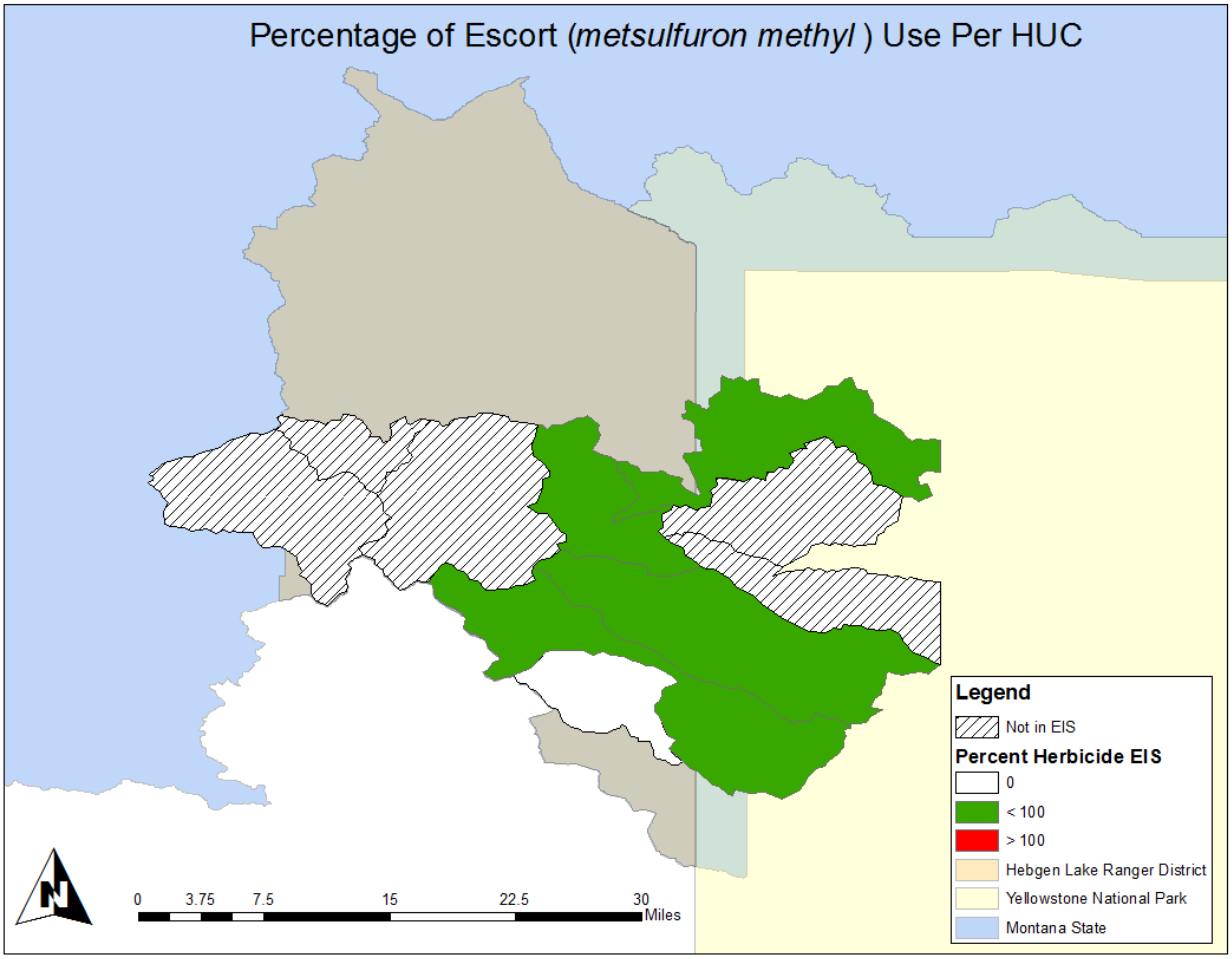

Figure 30. Displays the percentage of allowed herbicide sprayed per watershed (HUC) for Escort based on the 2005 EIS Report.