Two-Hearted River Forest Reserve
CFA Forest Management Plan

Prepared for
State of Michigan Commercial Forest Reserve Program
by
Compass Land Consultants
and
The Nature Conservancy

March 2020

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Signatures of Plan Writers *Date*

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Table of Contents

Statement of Purpose

This forest management plan has been developed to guide the management activities of the Two-Hearted River Forest Reserve (THRFR) property in accordance with the State of Michigan Commercial Forest Reserve requirements and the objectives of the landowner, The Nature Conservancy. This plan has been written to guide activities on the property for at least the next 10 years and should be reviewed and revised if needed at least every 10 years. This plan is one component of the comprehensive property management for this property which will include a Forest Stewardship Council-approved management plan, and written policies regarding various aspects of the property management.

The Nature Conservancy (the Conservancy) is an international, private, nonprofit organization whose mission is to conserve the lands and waters on which all life depends. To achieve this mission, the Conservancy uses a science-based, non-confrontational and market-based approach.

With the acquisition of the Two Hearted River Forest Reserve, the Conservancy in Michigan is making the commitment to 'working forest lands' as a critical conservation strategy in land management philosophy. The Conservancy manages similar forest lands across the country, including Minnesota, Pennsylvania, Maryland, Virginia, Vermont, New York State, Ohio, Kentucky and Maine. The Conservancy has over 623,500 acres in a group FSC certificate.

The goal in the Conservancy's efforts regarding this property is to reach a balance of sustaining jobs, timber management, and timber revenue along with enhancing the quality of water resources, climate resilience, and improving diversity of forest communities and wildlife resources.

Forest Management Goals

The following are overarching goals that will drive the management activities on the property:

1. Maintain, restore, and enhance the biological diversity, climate resilience, carbon storage, disease defense, water quality, and ecological integrity of the Two-Hearted River watershed and the broader landscape context through long-term, sustainable, forest management practices.

2. Meet the requirements of Michigan's Commercial Forest Act and Forest Stewardship Council Certification, as well as The Nature Conservancy's organizational objectives in all aspects of land management.

3. Reinvest revenue generated from sustainable production of forest products into the Reserve, as well as fund additional conservation work in the Two-Hearted River Watershed and Michigan.

4. Foster the sharing of lessons learned and future forest management innovation by establishing the property as an education and research center for ecologically-based land management.

5. Create and maintain positive, viable collaborations with other landowners to achieve individual and common objectives across the landscape.

6. Contribute to the local economy through forest jobs, forest products, and compatible outdoor recreation opportunities.

Forest Management Principles

An important component of achieving the management goals on this property involves adhering to the following set of management principles when conducting any management activities. The principles are grouped by categories. Specific objectives for the various forest types on the property are presented in the "Forest Cover Type Description and Objectives" section of this plan.

Protecting soil & water resources

- Ensure that all activities meet or exceed Best Management Practices, state (EGLE), county (Soil/Sedimentation) and Natural River regulations and permitting requirements.

- Assess potential impacts of all management activities on soil & water resources before conducting those activities.

- Ensure that roads do not degrade water quality of wetlands and/or streams or modify sheet flows of water.

- Use the existing road network rather than constructing new roads and close or improve roads that are found to have negative impacts on water resources.

- Improve existing road stream crossings to meet or exceed BMPs, state (EGLE), and county (Soil/Sedimentation) regulations.

Forest characteristics

- Promote levels of standing and down coarse woody debris that are necessary for regeneration for a variety of tree species.

- Promote age and structural diversity across the forested landscape that are appropriate for a variety of tree species.

- Promote species composition of forests that are appropriate for the site characteristics.

- Where economically possible, silviculture should attempt to mimic the natural disturbance patterns of the landscape (such as windthrow, disease, and fire).

- Improve climate resilience through various harvest and regeneration techniques and underplanting of climate resilient species.

- Improve carbon sequestration and storage by emphasizing regeneration and recruitment of long-lived species, and lengthen rotations to accomplish additional carbon storage.

Protection of wildlife and natural communities

- Consult Michigan Natural Features Inventory data before conducting any activity in areas identified as Element occurrences (rare species or exemplary natural communities).

- Assess proposed harvest sites for rare species and other wildlife considerations (vernal pools, bear dens, raptor nests, etc.) before conducting harvests.

- Minimize negative impacts of harvests on wildlife, understory vegetation, and soils by limiting all harvest activities to frozen ground conditions or dry summer months when possible.

Research

- Partner with academic institutions and other public and private forest land managers to incorporate practical, forest management-related research questions into harvests on the property.

Property management

- Identify all property boundaries before beginning any management activity, consulting with the adjacent landowner to ensure accuracy of the boundary line.

- Develop or adopt a system of documentation to track all management activities on the property.

- Support local economy directly by hiring local loggers, selling wood products to local merchants; and indirectly by allowing access for canoeing, fishing, and hunting.

- Encourage use of the property for forest ecology research.

- Be a responsible landowner in the community by developing good working relationships with adjacent landowners, recreational enthusiasts, and community organizations.

General Property Description and History

Location

The property known as the Two-Hearted River Forest Reserve is a total of 24,244 acres of land in northern Luce County in Michigan's Upper Peninsula. The property is made up of a patchwork of parcels located in the following 8 townships:

T47N-R10W	T48N-R10W	T49N-R09W
T47N-R11W	T48N-R11W	T49N-R10W
T48N-R09W	T48N-R12W	T49N-R11W
		T49N-R12W

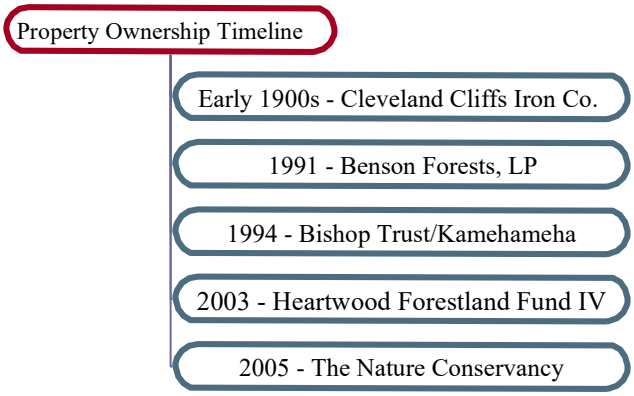
For management purposes the property is divided into four separate compartments. The compartment boundaries are based primarily on access and major roads and river channels. The entire property and the four compartments are shown on the map in **Exhibit A.**

The entire ownership, aside from the following exceptions, is enrolled in Michigan's Commercial Forest program.
Parcels not enrolled (refer to the detailed maps in **Exhibit B**):

- 80-acre parcel in T48N-R10W, Section 25.
- 10-acre parcel in T48N-R10W, Section 2.
- 40 acre parcel in T48N-R12W, Section 4 (this parcel is a former recreational lease, with an old cabin – slated for demolition Summer of 2020).

History

The Nature Conservancy purchased the property in 2005 from the Heartwood Forestland Fund IV (HFF IV), as part of a larger conservation deal which also involved the purchase of a conservation easement over approximately 240,000 acres of HFF IV's ownership in the Upper Peninsula of Michigan. Prior to this transaction, the property had a long history of industrial ownership. The property was likely to have first been heavily logged, along with much of the region, in the late 1800s. The first trees to be harvested were the large white pines, with the rest of the forest soon to follow. In the early 1900s Cleveland Cliffs Iron Company (CCI) purchased the property, as part of a much larger timber ownership base across the region.



The primary focus of CCI's early ownership was mineral resources, and the surface resources were used primarily to support the below-ground activities by supplying raw materials for building, energy, and processing in and around the mining and milling operations. During the latter part of CCI's tenure, the wood processing operations became a more significant part of their business and were separated into the Cliffs Forest Products subsidiary (Cliffs FP).

The property was acquired by Benson Forests, LP (Benson), from Cliffs FP in 1991. Benson was responsible for compiling the current ownership configuration. In October of 1994, this tract was acquired by the Bernice Pauahi Bishop Trust (Bishop Trust). The Bishop Trust managed the property, known as 'The Bishop Tract' as an investment for their educational endowment funds benefiting Hawaii's Kamehameha Schools (KS). Shelter Bay Forests, Inc. was contracted to manage the lands locally for KS. In May of 2003, HFF IV purchased the Bishop Tract. (Hagan and Fehringer, 2005, HFF IV's Easement 4 FSC Management Plan).

In 2019, a land-swap between the State of Michigan and The Nature Conservancy was finalized. This land-swap helped to "block-up" some of the more fractured pieces of the Reserve by adding scattered pieces of State land to large blocks of Reserve lands, and vice-versa. In total, roughly 3,700 acres changed hands. A map that details result of the land-swap can be found in **Exhibit C**.

Physical Setting

The property is located almost entirely within the watershed of the Two Hearted River (see map in **Exhibit D**). It comprises 18% of the 132,500-acre watershed, making it the second largest tract of single ownership within the watershed. The single largest landowner in the watershed is the Michigan Department of Natural Resources which owns 48% of the watershed. The Two Hearted River is fed by several tributaries – East Branch, West Branch, North Branch, South Branch, Dawson Creek, and Widgeon Creek.

The entire Two Hearted River Forest Reserve is situated within two Regional Landscape Ecosystems (RLE), as described by Albert, 1995. The relatively level lowland areas located in the headwaters region of the Two Hearted River are associated with the Seney Sand Lake Plain RLE. This broad ecosystem covers over one million acres in the central

and eastern Upper Peninsula. A smaller portion of the property is located within the Grand Marais Sandy End Moraine and Outwash RLE. This ecosystem is commonly associated with sandy ridges of end moraines and pitted outwash areas.

As illustrated in **Exhibit D**, the surficial geology of the property is nearly 50% peat and muck, 35% lacustrine sand and gravel, and 15% end moraines of coarse-textured till. Bands of sedimentary bedrock underlie the property, but it is covered by dozens of feet of glacial drift and is not near the surface at any point within the property.

There is relatively little topographic relief on the property. Elevations range from 688 feet along the Two-Hearted River to 980 feet on the ridges of the northwest portion of the property. However, small changes in elevation reflect dramatic changes in soils and vegetation. The low-lying areas are characterized by peat and muck, poorly drained soils that support swamp conifers and scattered non-forested wetlands. Narrow sandy ridges within the lowland sites are typically very well-drained sandy soils that support white and red pine, or occasionally jack pine. Broader expanses of upland soils are typically well-drained loamy sands dominated by northern hardwood forests. The low gradients of the landscape make the natural flow of water susceptible to modification by road construction. A relatively minor road construction project could have significant impacts on the hydrology of the site, negatively impacting the adjacent wetland communities.

For Luce County, average annual precipitation is about 31 inches. Annual snowfall is 108 inches due in large part to lake effect snow from Lake Superior. The average growing season is 120 days and temperature extremes in recent decades range from 103°F to - 32°F.(1950-1980 data from Michigan State climatologist office, http://climate.geo.msu.edu/).

Existing Infrastructure

The property is undeveloped and several miles away from the nearest population center of Newberry, Michigan. The existing infrastructure on the property includes a network of roads, several large road-stream crossings (bridges, box culvert), and one old cabin on a former recreational lease that is slated to be demolished in the summer of 2020.

Roads

The various parcels that comprise the property are accessible by an existing road network. This network includes county roads as well as forest roads such as the 'CCI' or 'Burma' road, and smaller two-tracks and skid trails established by previous owners. There are also a number of two-track roads that provide access to adjacent private lands. Table 1 summarizes the roads on the property. The road system is shown in the series of detailed property maps in **Exhibit B**.

There are many road-stream crossings throughout this road network. These crossings primarily consist of culverts – both box and circular, and two bridges. The Water Quality section of this document discusses these crossings in more detail.

There are only a few gates on the property, each of which is associated with private landowners who use the gates to control motorized access to their inholdings.

Table 1. Road network summary

Road type	Description	Total Length (miles)
*Paved (County road)	Small portion of CR407	1.8
*Gravel – maintained (County road)	Portions of CR414, 418, 420	4.0
Woods roads	Either old haul roads or camp access roads; many have ditching, and/or culverts, and most are accessible to high clearance vehicles	28.4
Old skid trails	Current condition variable &/or unknown; length is significantly underestimated.	36.2
	Total of all road types	70.4

*Public roads that pass through the property over public right-of-ways.

Leases

The Nature Conservancy inherited two recreational leases when they purchased this property. One lease (T48N-R11W Section 9) was terminated shortly after the land sale, and the cabin on the lease was removed in 2010. The other lease (T48N-R12W Section 4) was terminated as well, but the cabin remains. Plans are in place to remove this cabin in the spring of 2020 –

as soon as conditions allow.

Sand and Gravel Pits

The landowner is not actively extracting any sand or gravel from the property. The landowner is aware of only one open sand pit on the property. This pit is less than 2 acres in size and is located in T48N-R10W Section 17, along CR407 (see map in **Exhibit B**). It is likely that there are minor, abandoned borrow pits on the property that were used by previous owners.

Natural Disturbance & Past Conditions

Natural Disturbance

Prior to the large-scale harvesting of the forests in this region in the late 1800s, the primary sources of natural disturbance were windthrow, fire, insect damage, and beaver activity. Fire and insect infestations were probably more common on the drier pine sites while small patches of windthrow were likely common within the hardwood, mixed hardwood conifer, and lowland conifer forests (Price 1994).

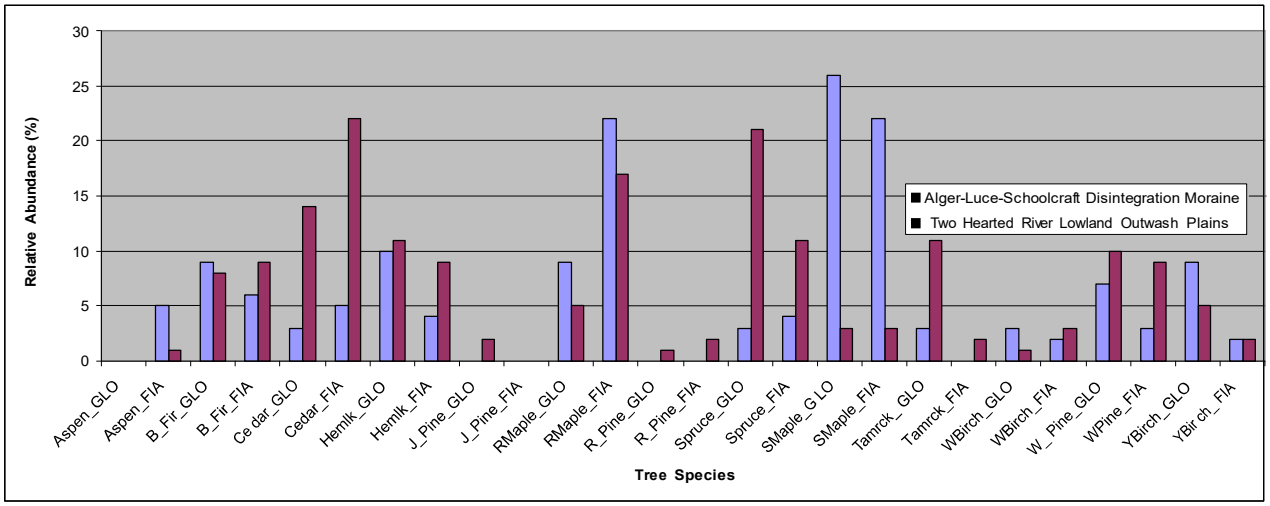
These disturbance regimes have a shaping effect on the successional pathways and distribution of successional classes on the landscape. In general, for the ecological systems that experienced frequent natural stand-altering disturbances such as jack pine forests, there would have been a greater proportion of early stage successional classes. Conversely, in ecological systems with relatively rare stand-altering disturbances late successional classes would have been most prevalent. For example, it is estimated that roughly 80% of the pre- settlement northern hardwood/hemlock forests would have been in a late successional class (LANDFIRE 2005).

Past Conditions

Our understanding of the historical forests suggests that the forests in the region today differ significantly from the forests prior to when widespread timber harvesting began in the late 1800s. Based on an analysis of Government Land Office (GLO) line tree data across this property, and based on GLO vegetation maps (Comer et. al 1995) there do not appear to be dramatic patterns of forest conversion on the property from one forest type to another over the past 150 years. Rather, the changes appear to be related to the structural and compositional diversity of the forests.

Figure 1 displays a comparison of historic GLO data and contemporary Forest Inventory and Analysis (FIA) data from the two primary Land Type Associations (LTAs) covered by this property. The Alger-Luce-Schoolcraft Disintegration Moraine LTA represents many of the uplands on the property, while the Two Hearted River Lowland Outwash Plain covers the lowland conifer areas. It should be noted that this analysis has some inherent weaknesses, such as the difference in scale (FIA data are relatively small circular plots; GLO data are from long lines) and difference in data recording (FIA records every species; GLO data often has biases such as leaving out short-lived species and not distinguishing between similar species). So, while the data are neither precise enough, nor reliable enough to justify managing a specific stand to try to match the exact numbers shown for the GLO data, this analysis does demonstrate a few trends to take into consideration with our management objectives. Note that aspen was not even present in the GLO data, while it is a significant component of the primary upland LTA type found on this property. This suggests that more early successional forests existed today, compared with the 1850's. The increase in white cedar over time may be tied to the corresponding decrease in tamarack and spruce (species not defined) in the Two Hearted LTA. Red maple also shows a marked increase while yellow birch, white pine, and hemlock all show declines.

Figure 1. Comparison of GLO data (1840-1850s) with FIA data (1990s) for two Land Type Associations found on the property. Tree species relative abundances are presented. Spruce species (black and white) are lumped together. (Data source: Mark McKay, MI DNR).



Climate Change Stressors

The forests of the Northern Great Lakes region have been significantly altered since the pre-European settlement era. Extensive logging and large, severe, slash-fueled fires during the settlement era (late 19th-early 20thcenturies) led to dramatic changes in forest ecosystems. Both forest composition and landscape structure have become dramatically more homogeneous. Dominance shifted from late-successional or mid-seral conifer and hardwood species to early successional hardwood species.

This regional shift towards homogeneity in composition and spatial pattern likely will make forests more vulnerable to the suite of emerging stressors including climate change, invasive species, pests and pathogens, atmospheric deposition, and continued demand for forest products.

Recent work suggests that many characteristic northern forest species (paper birch, balsam fir, Picea spp., jack pine, red pine) may decline significantly over the next 50 to 100 years even under moderate greenhouse gas emissions scenarios (Scheller and Mladenoff 2005, 2008). Climate change may lead to increased mortality due to fire, insect outbreaks, drought stress, and wind storms. In addition, high deer populations and non-native earthworms may limit tree growth and establishment. Hemlock wooly adelgid (HWA) is an exotic organism that causes high levels of mortality in eastern hemlock. HWA currently occurs in a relatively small area of the natural range of hemlock in eastern North America. HWA spreads at a rate of 20-30 km/year and can survive in extreme cold in its native Japan. However, recent studies indicate HWA mortality increases at higher latitudes in eastern North America. Cold winter temperatures in the northern Lake States could slow or limit the spread of HWA to northern Michigan, though the projected climate warming in the coming decades would create a greater frequency conditions favorable for survival and spread of HWA. Emerald ash borer (EAB) and Beech Bark Disease (BBD) already pose a significant threat to the Upper Peninsula of Michigan. While BBD is well established, it is widely believed that it is only a matter of time before EAB populations become well established in the Upper Peninsula and projected temperature increases could lead to increased growth, survival and dispersal of EAB populations and corresponding increased damage to preferred host species (white ash, black ash and green ash).

CO2 levels may allow for increased productivity over the short term and may offset some impacts of a warming climate over longer time spans (Frelich and Reich 2009). Increased CO2 can increase water-use efficiency under warmer temperatures and increase establishment and growth. Nitrogen deposition likely will lead to some increased productivity, particularly on sites that are nitrogen limited.

While CO2 fertilization and nitrogen deposition may offset some of the negative impacts, the suite of climate change related stressors will challenge and limit the capacity for forests to provide key ecosystem services such as water quality, biological diversity, wood fiber, carbon storage, recreation and spiritual values.

Soils

Although there are 28 different soil map units represented on the property, 10 of these soils together comprise 86% of the property. These 10 soils are shown in Figure 2 along with the percentage of the property that they represent according to the Luce County Soil Survey. Soil maps of the entire property can be found in **Exhibit E**. One of the most important factors regarding the soils in relation to forest management is the prevalence of poorly drained soils. As shown in Figure 3, most of the soils on the property are too poorly drained to be suitable for haul road construction. Only 10% of the soils are considered well suited to the construction of haul roads, and 30% are moderately suited.

Soil Symbol	Soil Name	Acreage	Percent of Property
36	Carbondale, Lupton, and Tawas Soils	7,890	33%
94	Tawas-Spot-Finch Complex	2,248	9%
179	Wallace Sand	2,152	9%
175	Wallace-Spot Complex	2,132	9%
61	Paquin Sand	1,582	7%
89	Spot-Finch Complex	1,417	6%
176	Paquin-Spot Complex	1,275	5%
37	Dawson, Greenwood, and Loxley Soils	884	4%
102	Spot-Dawson Peats	837	3%
173	Paquin-Finch Sands	546	2%
		20,963	**86%**

Figure 2. The 10 most common soil map units on the property with % of total area shown for each soil map unit. Based on the Luce County Soil Survey.

Due to the limitations of the poorly drained soils, any harvesting activity in these wetland soils will be limited to frozen ground conditions. To meet our objective of maintaining the natural hydrology of the wetlands across this property, prior to harvesting in these locations there must be a careful evaluation of the potential impacts of the winter activities on the hydrology of the site.

To protect both soils and aquatic resources, riparian management zones adjacent to streams and wetlands will be established prior to harvests, within which there will be no activities that result in the exposure of bare mineral soil.

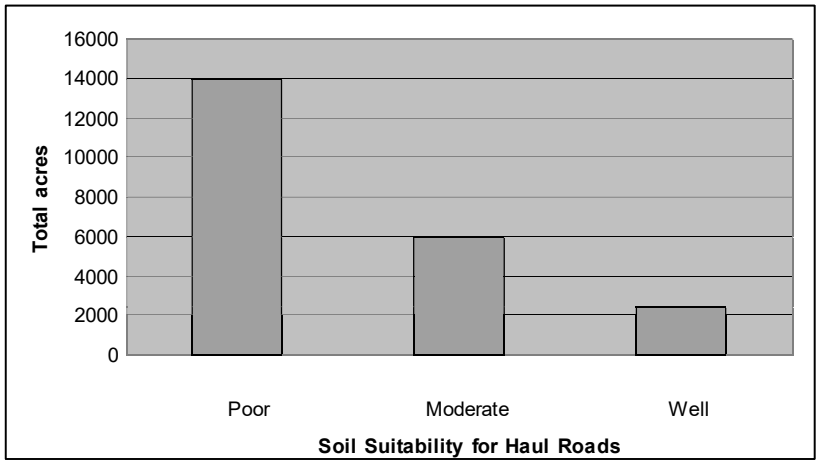


Figure 3. Summary of the total area of soils within the property classified by their suitability for haul roads, as defined by the Luce County Soil Survey.

Public Use of the Property

The property is open to non-motorized public access for hunting, fishing, hiking, birdwatching, and nature study. As stipulated by the Commercial Forest Reserve Act, public access on foot for hunting and fishing is allowed. In addition, the Conservancy desires that the general public be able to access and enjoy this property for any low-impact activity, so hiking and general nature study on the property are welcome. Camping is not allowed on the property, except in the case of Conservancy-approved research or inventory work on the property. Use of snowmobiles on the property is allowed on designated trails (see maps in **Exhibit B**). The use of ORVs off of existing, improved roads is prohibited except in the case of Conservancy-approved research or property management activities. The Conservancy is in the process of developing more detailed policies regarding hunting blinds, baiting, and motorized vehicle use.

American Indian Considerations

There is one federally acknowledged tribal government in the vicinity of the property. The Sault Ste. Marie Tribe of Chippewa Indians has a seven-county service area in the eastern Upper Peninsula including Luce County. At the time of writing this plan no formal contact has been made with the Sault Ste. Marie Tribe, however, it is the intention of TNC to share the final and accepted management plan with the Sault Tribe for comment.

Relevant Laws

In 2007, the State of Michigan and five Michigan Indian Tribes (including the Sault Ste. Marie Tribe) signed the 2007 Inland Consent Decree (Michigan Department of Natural Resources 2009). This agreement affects the vast majority of the property which is enrolled in the Commercial Forest Program. The agreement allows tribal use of Commercial Forest lands for hunting and fishing for personal consumption, outside of the standard seasons and regulations of the Michigan DNR. TNC recognizes and respects the rights that this agreement provides to the tribal members and will not interfere with their ability to exercise those rights on this property. As of 2020 there is very little evidence of tribal use any time of year on the Two-Hearted River Forest Reserve.

The Native American Graves Protection and Repatriation Act (NAGPRA) is a Federal law passed in 1990. NAGPRA requires that TNC report any burial sites that are found on the property to the local tribal contacts.

Contact information:

Sault Ste. Marie Tribe of Chippewa Indians

Environmental Department Services

206 Greenough

Sault Ste. Marie, MI 49783

Phone: 906-632-5575

Compliance with Michigan's Commercial Forest Program

This management plan has been prepared to satisfy the requirements of Michigan's Commercial Forest Program. Under the CFP, all landowners are required to:

- Manage the property for commercial timber production;
- Have a written forest management plan;
- Certify that the forest management plan is in effect; and
- Allow public access (foot only) for hunting and fishing

The law prohibits other activities on the land such as agriculture, grazing and industrial, residential, resort or commercial activities.

Landowner permission to hunt or fish is not required. Although commercial forest landowners must allow access for the purposes of hunting and fishing, landowners retain their private property rights. Access to CF land, by motor vehicle or for activities other than hunting and fishing, is at the discretion of the landowner.

In addition to the above requirements TNC will be responsible for adhering to the following procedures pertaining to the management of this property:

1. **Cutting notification**. Prior to any timber harvest, the form "Notification prior to cutting, harvesting, or removal of forest products from CF land" will be submitted to the DNR. The completed form should be accompanied by a detailed map that the DNR forester can use to visit and evaluate the site. This form should be submitted well in advance of the proposed harvest.

2. **Sand/Gravel extraction**. If sand or gravel is to be extracted from the property, the form "Application to remove sand and/or gravel from CF land" will be submitted to the DNR. No sand or gravel pit may exceed 5 acres in size.

3. **Management plan updates/revisions**. The current plan covers a 10 year period. At the end of this period an updated management plan will be submitted to the DNR. If any changes are proposed for the management of the property before the end of this 10 year period, an amendment to the current plan will be submitted to the DNR.

4. **Sale/transfer of land**. If any portion of this property is sold or transferred to a new owner, the form "Notification of ownership change" will be submitted to the DNR within 30 days of the transfer of title.

Compliance with Forest Stewardship Council Certification

This management plan has been prepared to satisfy the requirements of third-party certification as specified by the Forest Stewardship Council. To achieve FSC Forest Management certification, TNC must contract with an FSC-accredited Certification Body or join a Forest Management Group certificate. In either case, the forest is audited to FSC's Forest Management standards (FSC U.S.).

In the United States, the FSC US Forest Management Standard (v1.0) was formally recommended by the FSC-US Board on May 25, 2010 and approved by FSC International on July 8, 2010. This National Standard pertains to forest management in the continental 48 states of the United States (FSC U.S.).

In order to maintain FSC Forest Management certification a landowner must demonstrate a commitment to the 10 principals and 57 Criteria that apply to FSC-certified forests around the world. A description of the 10 principals follows and a full version of the FSC U.S. Forest Management Standard v1.0 can be found at https://us.fsc.org/forest-management-certification.225.htm.

- **PRINCIPLE #1: Compliance with laws and FSC Principals** - Forest management shall respect all applicable laws of the country in which they occur, and international treaties and agreements to which the country is a signatory, and comply with all FSC Principles and Criteria.
- **PRINCIPLE #2: Tenure and Use Rights and Responsibilities** - Long-term tenure and use rights to the land and forest resources shall be clearly defined, documented and legally established.
- **PRINCIPLE #3: Indigenous Peoples' Rights** - The legal and customary rights of indigenous peoples to own, use and manage their lands, territories, and resources shall be recognized and respected.
- **PRINCIPLE #4: Community Relations and Worker's Rights** - Forest management operations shall maintain or enhance the long-term social and economic well-being of forest workers and local communities.
- **PRINCIPLE #5: Benefits from the Forest** - Forest management operations shall encourage the efficient use of the forest's multiple products and services to ensure economic viability and a wide range of environmental and social benefits.
- **PRINCIPLE #6: Environmental Impact** - Forest management shall conserve biological diversity and its associated values, water resources, soils, and unique and fragile ecosystems and landscapes, and, by so doing, maintain the ecological functions and the integrity of the forest.
- **PRINCIPLE #7: Management Plan** - A management plan — appropriate to the scale and intensity of the operations — shall be written, implemented, and kept up to date. The long-term objectives of management, and the means of achieving them, shall be clearly stated.
- **PRINCIPLE #8: Monitoring and Assessment** - Monitoring shall be conducted — appropriate to the scale and intensity of forest management — to assess the condition of the forest, yields of forest products, chain of custody, management activities and their social and environmental impacts.

- **PRINCIPLE # 9: Maintenance of High Conservation Value Forests** - Management activities in high conservation value forests shall maintain or enhance the attributes which define such forests. Decisions regarding high conservation value forests shall always be considered in the context of a precautionary approach.
- **PRINCIPLE # 10: Plantations** - Plantations shall be planned and managed in accordance with Principles and Criteria 1-9, and Principle 10 and its Criteria. While plantations can provide an array of social and economic benefits, and can contribute to satisfying the world's needs for forest products, they should complement the management of, reduce pressures on, and promote the restoration and conservation of natural forests.

Timber Resources

Inventory Data:

Upon purchase of the property from the Heartwood Forestland Fund IV in the spring of 2005, The Conservancy received a GIS dataset of the stand data for the property. However, the stocking data included in this data layer had not been updated for roughly 10 years, and the stand boundaries were not accurate. This information was not adequate for management purposes, so it has been necessary to generate a new forest cover assessment of the property, with updated stocking data, and revised stand boundaries.

In 2006 the Conservancy contracted with Cold Spring Forestry (CSF) to conduct a timber cruise of the property. CSF began by generating an initial cover type map for the entire property based on aerial photo interpretation. This cover type map uses six broad cover type classes.

During the summer of 2006, CSF conducted a timber inventory across roughly 15% of the property (3,648 acres), giving priority to the upland sites. Standard timber inventory data was collected, along with Kotar habitat types (Burger & Kotar 2003). In March 2007, CSF collected field data focusing on the lowland conifer forest type that comprises the majority of the property. Since 2007, nearly 55% of the total productive forestland on the property has been re-inventoried using Key Ecological Attribute (KEA) inventory. Over the next several years, annual timber inventory will occur on stands with harvest potential, remaining non-inventoried stands, and additional lowland conifer stands.

In 2013, 117 permanent continuous forest inventory (CFI) plots were established across the property. These plots were established to determine the total timber volume of the property, and to monitor change on the Reserve over time. These plots collected data on a 1/10 acre plot (merchantable trees, snags, CWD), and a 1/100 acre plot (regeneration). The plots are due for remeasurement in the summer of 2020. In addition, 26 plots were lost to the land-swap with the State of Michigan. These plots will need to be replaced within their respective strata.

The data collected from these CFI plots, was then used to generate strata-level data across the property. A summary of this data, by strata, is described in the section below, and can be found in report format in **Exhibit F**.

Forest Cover Type Summary

Based on the inventory work since 2007, the property has been delineated into hundreds of stands that are grouped into several cover types/strata. Table 2 presents a summary of the cover types across the entire property. It is clear that the dominant cover type is the lowland softwood type that is found on the abundant poorly drained soils throughout the property. Hardwood and hemlock/hardwood make up another 33% of the property, with a very minor acreage of upland softwood found on a few of the drier sites.

Table 2. Cover Type/Strata Summary (based inventory work since 2007 by CLC)

	Compartment #					
General cover type*	**1**	**2**	**3**	**4**	**Total acres**	**% of total**
Lowland Softwood	1,655	5,245	3,735	2,270	12,905	53%
Hardwood	1,092	1,386	1,297	1,378	5,153	21%
Hemlock/Hardwood	349	519	1,124	835	2,827	12%
Non-Forested/Non-Productive	186	529	577	812	2,105	9%
Upland Softwood			94	554	648	3%
Open Water	28	357	66	155	606	2%
Grand Total	**3,311**	**8,037**	**6,892**	**6,004**	**24,244**	**100%**

*Note: Stand classifications in Table 3 split some of these cover types into multiple categories. Lowland Softwood is split into SC & SH & CW; Hardwood is split into NH & NM & A; Hemlock/Hardwood is split into HH & FS; Upland Softwood is split into PW & PR & NX; and Non-Forested/Non-Productive is split into LB & M & SX & W.

**Note: The acreages and cover types in the above table do reflect the current ownership – even with the 2019 land swap with the State of Michigan. Any land obtained in the swap, was typed remotely and often just merged with adjacent stands from the original foot-print.

Based on the inventory data and forester observations, initial cover types were further refined. Refer to the key in Table 3 for detailed descriptions of these cover types. The maps in **Exhibit B** display the stand boundaries for the entire property along with the general cover type codes found below.

Table 3. Detailed cover type descriptions.

CODE	NAME	DESCRIPTION
NH	Northern Hardwoods	Shade tolerant species, typically found on upland sites and dominated by sugar maple with beech, basswood, yellow birch, and red maple occurring as associated species.
NM	Mid-Tolerant Hardwoods	Moderately shade tolerant species, typically occurring on transitional, more mesic sites and are dominated by red maple with black cherry, birch species and an increase in softwoods such as balsam fir, hemlock and spruce.
HH	Hemlock-Hardwoods	These stands are dominated by hemlock with hardwood species occurring as an interspersed, secondary component.
A	Aspen	A stand comprised of over 60% aspen.
NX	Mixed Pine	Forest cover dominated by red, jack and/or white pine – with an understory of balsam fir and mixed hardwood species.
FS	Fir-Spruce	Upland sites dominated by balsam fir and white spruce with red maple and birch species typically occurring as an associated component.
SC	Swamp Conifer	Mixed lowland forest cover dominated by conifers such as black spruce, cedar, tamarack and balsam fir.
SH	Swamp Hardwoods	Typically dominated by black ash with associated species such as yellow birch, red maple and swamp conifers.
CW	Northern White Cedar	Lowland stands dominated by cedar (≥60%) with a secondary component of mixed lowland hardwood and softwood species.
M	Marsh	Wetlands dominated by grass/sedge complexes.
W	Water	Open water – may be subject to seasonal fluctuation.
SX	Non-Productive Swamp Conifer	Lowland marsh and bog community which typically has swamp conifer forest cover that is not capable of growing into a merchantable size class due to high water table and poor nutrient capacity.
LB	Lowland Brush	Lowland stands which are dominated by shrub species such as alder and willow.
PR	Red Pine	Upland pine stand dominated by an overstory of red pine.
PW	White Pine	Upland pine stand dominated by an overstory of white pine.

In addition to providing volume and species data, the CFI plots established in 2013 are also able to determine Key Ecological Attributes (KEA), by strata. The goal in collecting KEA data was that by measuring numerous ecological metrics that the data could be evaluated and developed to help guide management activities on the Reserve. In addition to "traditional" forest inventory metrics, a summary of KEA data and descriptions can be found in Table 4 below. A sample of both "traditional" stand data and KEA data collected for the property can be found in **Exhibit F**.

Table 4 – KEA data

KEA	Metric	Description
KEA 1	Total Stocking	Function of basal area and trees per acre, expressed in percentage of "available" stocking
KEA 2	Acceptable Growing Stock	Similar to KEA 1 with "acceptable" stems per USFS guidelines
KEA 3	Tree Species Diversity (Richness)	Total number of overstory tree species in a given stand
KEA 4	Tree Species Evenness (Richness Distribution)	The relative abundance of all species found in the stand
KEA 5	Large Live Trees	Measure of trees greater than 19" DBH per acre
KEA 6	Large Snags	Measure of standing snags greater than 10" DBH per acre
KEA 7	Large Coarse Woody Debris	Measure of a downed woody debris greater than 13" diameter expressed in ft^3 per acre
KEA 8	Established Regeneration	Total number of seedlings/saplings greater than 1" DBH per acre
KEA 9	Desirable Seedlings	Total percentage of established regeneration determined "desirable"*

* "Desirability" determined on a case-by-case basis per landowner's goals

Lowland softwood (includes SC, SH, and CW cover types)

Over half of the Two-Hearted River Forest Reserve falls into this classification (53%). Within this classification, swamp conifer (SC) is the most common cover type (91%), followed by pure northern white cedar stands (CW, 8%), and then swamp hardwood (SH) which accounts for 1%.

Northern white cedar is the most common species within this classification. Cedar can occur in pure stands as well as a large component of mixed stands. Where cedar occurs in pure stands it is often densely stocked and of small diameter. More frequently cedar occurs in mixed stands with black spruce, tamarack, balsam fir, and black ash. These stands also can contain a significant component of white pine. Slight elevation changes yield red maple, yellow birch and hemlock in small patches. These species are generally poor formed and suppressed due to the high water table throughout the growing season. As these stands transition to the hardwood/hemlock type the spruce and fir percentage increase with larger average diameters and improved quality. These stands have very little recent harvesting activity with the only cutting taking place in these transitional areas of the stands. As a rule, access to these stands is poor with very few established roads and poor soil conditions.

For the entire lowland softwood strata, stocking averages out at 136 sq. ft. to the acre. 78% of this stocking is comprised of poletimber sized trees, while the remaining 22% is made up of sawtimber sized trees. Total volumes average out at 1.75 MBF to the acre of sawtimber, and 29 cords to the acre of pulpwood. White cedar is the most dominant species in this strata (39%), followed by hemlock (17%), red maple (15%), white pine (6%), and balsam fir (4%). The remaining 19% of the total stocking is comprised of a diverse group of species – mainly other common lowland conifer species (black spruce, tamarack, white spruce, and black ash).

The importance of these stands in relation to protection of the health and quality of the Two Hearted river watershed is the primary consideration with respect to management. Young cedar stands generally support healthy populations of small mammals (especially hare) and the predators that depend on them. These stands form the headwaters of the Two Hearted River and serve as an integral part of the transition from upland to the waterway. Any management activities within these cover types will have to consider the greater landscape and impacts on the watershed as a whole. Where possible management activities will only take place under frozen conditions in an effort to minimize impact. Management objectives and activities should mimic natural disturbance patterns, but at the same time they should be carefully designed in order to prevent unwanted and excessive blowdown. Extensive field work will have to take place in the summer months to verify that any proposed activity will not have a detrimental impact on seasonal waterways, unique features, and adjacent wetlands.

Based on models of natural disturbances and estimates of the natural range of various age classes of this forest type, the broad objective across the landscape is to maintain roughly 40% of the 11,372 acres of productive swamp conifer stands in the 55 to 115 year age class and another 50% of the acreage older than 115 years. The inventory data gathered to date

suggest that the current conditions on the property are not dramatically different from this scenario.

Hardwood (includes NH, NM, and A cover types)

Roughly 21% of the Reserve falls into the hardwood classification. Of this classification, the majority is made up of the northern hardwood (NH) cover type (92%), followed by mid-tolerant hardwood (NM) at 7%, and then a small component of aspen (A) at 1%.

Given the industrial history of this land base, the NH cover type was the ultimate goal of land managers for many years. Past harvesting practices encouraged the growth of sugar maple and removal of red maple, beech, and hemlock when possible as market conditions existed. Diameter distribution in these stands tends to follow the Arbogast model with higher numbers of stems occurring in the smaller size classes, with fewer high-quality stems in the larger size classes. These stands were typically selectively harvested every 10-12 years with the goal of producing high grade sawtimber and pulpwood.

For the entire hardwood strata, stocking averages out at 103 sq. ft. to the acre. 61% of this stocking is comprised of poletimber sized trees, while the remaining 39% is comprised of sawtimber sized trees. Total volumes average out at 2.8 MBF to the acre of sawtimber, and 22 cords to the acre of pulpwood. Sugar maple is the most dominant species in the hardwood strata (31%), followed by red maple (28%), and beech (16%). Another 20% of the total stocking in this stand is comprised of softwood species, in the following order: cedar, hemlock, white pine, white spruce, balsam fir, tamarack, and black spruce. The remaining 5% of the total stocking is made up of other hardwood species (yellow birch, black cherry, white birch, and ironwood).

General management objectives for this stand type are threefold. First, any harvesting activity will promote species diversity. Generally, these stands are in the Acer-Tsuga-Fagus-Dryopteris (ATFD) habitat type (Burger and Kotar 2003). These stands are predominately maple with hemlock, yellow birch, and beech as secondary species. White pine would have been a component of this type as well, generally associated with the super-canopy. Small canopy gaps are also a goal of management in this type. Long term management of these stands has eliminated canopy gaps. Restoration of these gaps is an important component, creating species diversity and a multi-layered canopy, including super-canopy white pine. Finally, an increase in average diameters is desired and encouragement of saw-log production will be necessary to create a more mixed forest condition.

Another common stand/cover type found within this cover type is the “beech-maple cover type”, which was also a result of years of management and timber market conditions. During the 1970’s and early 1980’s these stands were “mined” for valuable yellow birch and sugar maple. During that period conditions were such that only high value veneer and sawlogs were harvested. This process termed “high-grading” was carried out by logging contractors with little management oversight. The result was that stands were left with an unusually high percentage of “less desirable” species and quality. That legacy has resulted in today’s stands with a high percentage of beech and poor formed maple. These stands have prolific regeneration and are highly variable with respect to diameter distribution. Beech bark disease (BBD) is present in virtually all of this stand type and significant (greater than 75%) beech mortality has occurred.

The overall management objective of restoring more diverse forest characteristics remains the focus of planning in these stands. The age class objective will be to achieve 90% of the northern hardwood forest cover in a greater mix than present. The management recommendations will vary greatly from stand to stand however. The nature of these stands today is highly variable, therefore silvicultural considerations will reflect current conditions. Generally, species diversity, promotion of non-maple/beech species, creation of canopy gaps, and the formation of coarse woody debris will be the goal of management planning.

Hemlock/Hardwood (includes HH and FS cover types)

Nearly 12% of the Reserve is encompassed by the hemlock/hardwood strata. For the entire hemlock/hardwood strata, total stocking averages out at 123 sq. ft. to the acre. 67% of this stocking is comprised of poletimber sized trees, while the remaining 33% is made of up sawtimber sized trees. Total volumes average out at 2.94 MBF to the acre, and 25 cords to the acre. Red maple is actually the most prevalent species in this strata, making up 31% of the total stocking. Hemlock accounts for 28% of the total stocking, followed by white cedar (8%), white pine (8%), yellow birch (5%), sugar maple (4%), and beech (4%). The remaining 12% of the total stocking is comprised of white birch, black spruce, balsam fir, white spruce, and aspen.

Generally, these stands have a higher percentage of red maple and hemlock which has resulted in less industrial pressure over time. These stands are typically situated in transition areas between upland and lowland as well as in isolated pockets in maple/beech uplands. Soils in this type tend to be silt/loams or loamy sands, and have a higher water holding capacity which has also limited logging access over time. In recent years these stands have held a higher percentage of yellow birch but most were lost during the 1970's and 1980's as markets were very good for birch veneer.

Given that this stand type is most often associated with the ATFD habitat type, management activities will preserve and promote those characteristics. Promotion of hemlock, yellow birch, and white pine regeneration will be of high priority in these stands. Creation of canopy gaps and small patches will be employed in this type to mimic windthrow and create disturbance necessary for regeneration of these species. Creation of "pit and mound" topography associated with uprooted stems will be employed as well to create both mineral seedbeds as well as "nurse" logs. This can be accomplished by carefully selecting individual trees that will be pushed over (rather than cut and harvested) during the harvest operation – in effect mimicking a small blowdown. Employing low impact management practices in these stands is of high priority. Given the high seasonal water table often associated with these soils, management activity should take place during frozen periods or dry summer months when appropriate. Summer operations will allow for the potential use of soil scarification and the creation of 'tip-ups' to encourage species and structural diversity. The objective for this forest type is to achieve roughly 80% of this forest cover in a greater diversity of age classes.

Upland Conifer (includes NX, PR, and PW cover types)

A very small percentage (3%) of the THRFR occurs in this classification. These stands are generally dominated by red pine with white pine occurring as a co-dominant species. This stand type is located on sand ridges associated with old lake beds and outwash plains. These stands are of natural seed origin and generally occur in small patches and fragments across the ownership. The few stands within this strata found on the Reserve are very different in species composition, stand structure, and stocking levels. As a result, the broad strata data obtained through the CFI plots does not represent the actual stand metrics on the ground. Several of the stands within this strata also fall on the footprint obtained in the land-swap, and will need to be inventoried at a greater detail this summer – prior to making a concrete cover-typing decision. However, the inventory data for this strata can be found in Exhibit H.

This stand type is managed extensively in the region. Thinning regimes are employed to manage these types until ultimately stands are clear-cut and the cycle begins again. The LANDFIRE models predict that there would naturally be roughly 40% of this forest type in older stands. These older saw-log stands appear to be dramatically underrepresented across the regional landscape. Therefore, management of these stands on THRFR ownership will promote stands of a diversity of ages and promote larger average diameters. If necessary, small gaps may be employed to create disturbance necessary for natural regeneration of red and white pine. Prescribed fire may also be considered as a management tool to promote regeneration. Historic GLO data for the property will also be analyzed to determine if there are existing stands of another cover type that have been converted from red/white pine. Such stands will be considered for potential restoration to this upland conifer cover type.

Non-productive lowland (includes LB, M, SX, and W cover types)

The remaining 11% of the THRFR is classified as non-productive lowland and open water. Generally, the non-productive lands are open bog and fen. The Michigan Natural Features Inventory (MNFI) has identified these areas as unique features and they contain a wide variety of rare and unique plants (refer to Table 6). These areas will be managed to maintain their natural processes and will not be subject to timber management.

Silviculture by Forest Type

Based on the management goals and principles listed at the start of this plan, and the more detailed objectives defined for the broad forest types found on the property, general silvicultural treatments have been developed for each stand type. What follows are "broad brush" approaches to the silvics for these stand types. Management decisions are best made on a stand by stand basis, but the silvicultural treatments that follow will serve as the general approach across the property as a whole.

Prior to implementing any treatments that differ significantly from the treatments below, the Conservancy will submit an amended management plan to the DNR.

Lowland Mixed Conifer – Due to the great importance of these forests to the protection of the Two Hearted River watershed, the sensitive wetland soils, and the potential for excessive windthrow, any harvests in these stands will concentrate near transitional areas and will likely be part of an adjacent upland harvest. Any harvests will also be designed to answer important management questions that have application to other landowners in the region. One possibility is to closely examine how well these stands regenerate with various harvest strategies, especially given the impacts of deer herbivory.

To achieve the management goals for lowland conifers, and depending upon the site-specific conditions and research questions being addressed, the following treatments may be applied to individual stands.

Treatment 1

Some stands will have deferred harvest. No harvesting will take place during the period of this management plan, but information about natural regeneration and/or other stand data will be gathered.

Treatment 2

Conduct small, irregular patterned patch openings (1/2 to 2 acres) oriented to optimize seed dispersal and reduce the likelihood of windthrow (perpendicular to prevailing winds). This treatment attempts to harvest in a manner that mimics windthrow, the typical natural disturbance found in this forest type, without resulting in a condition that makes the adjacent stands excessively prone to windthrow. This treatment will only be considered when the important hydrological function of this forest type will not be disturbed.

Note: Traditional industrial management that might include strip clearcuts 50 to 150 feet in width in cedar dominated stands is not likely to be considered as a treatment option due to the potential impact of this type of harvesting on the important hydrological function of these forests.

Slash disposal (mechanical removal or fire) may be required during harvest operations in this covertype in order to provide ample sunlight on the seed bed for regeneration.

Northern Hardwoods – Given that these stands have highly variable species composition, they are best managed on a stand by stand (case by case) basis. The ultimate goal is to increase species and structural diversity as well as promote saw-log development. The most effective method to achieve this condition silviculturally employs a combination of techniques. To do this with a rapid response is not well documented, however, there is some recent research into this topic (Keeton 2006). Two general treatment options will be considered for use. One research goal will be to reveal any differences in these treatments as they affect development of greater species diversity in forest characteristics. Underplanting of site-appropriate species may be considered in areas with major BBD mortality. Soil scarification in limited areas may also be considered to encourage establishment of tree species that require exposed mineral soil for germination, such as yellow birch and white pine.

Treatment 1

This option focuses on stand level management prescriptions utilizing single tree selection to improve stand health and promote saw log production. Much of the initial harvesting will be in the smaller diameter classes (TSI) promoting a residual stand of larger diameter hardwood stems. Species diversity will be encouraged by maintaining non-maple species. Regeneration of non-maple species will be promoted by creating canopy gaps, retaining nurse logs, and potentially incorporating some level of soil disturbance for seed establishment of these species. Potential BBD resistant stems will be retained in all cases as well as scattered infected beech for wildlife purposes and establishment of coarse wood debris. The first harvest rotations will remove approximately 30% of the stocking and will be maintained at 10 to 15-year intervals.

Treatment 2

This option will concentrate on northern hardwood stands that occur on poorer quality soils, have had heavy beech mortality, and have overall site conditions more geared toward mid-tolerant species. Stands that fit this description on the ownership have been slowly self-thinning ever since beech bark disease passed through, and will typically maintain a static stocking level for 20 years or longer. In these stands, silviculture will focus on promoting regeneration, and the recruitment of mid-tolerant species. Stands will be thinned to 50-60 sq. ft. in an attempt to create larger gaps in the canopy that mid-tolerant species could take advantage of. All upland softwood will be retained, and opportunities to establish yellow birch and white pine seed trees will be sought out. Underplanting of white pine may be considered in these stands as well. The use of expanding-gap silviculture may be utilized in these stands as well – to

create conditions that mimic natural disturbance while creating opportunities for the recruitment of mid-tolerant species.

Hemlock/Hardwood - These stands generally have a higher water table and a silt or loam component to their soils. All silvicultural options for this cover type must account for seasonal operation restrictions to minimize overall impact. Again, management will be conducted in order to answer specific questions about which methods are most effective at achieving goals of enhancing and maintaining KEAs. Soil scarification in limited areas may be considered to encourage establishment of tree species that require exposed mineral soil for germination, such as yellow birch and white pine. For this stand type two treatment options are proposed.

Treatment 1

The focus of this will be very similar to Treatment 1 of the northern hardwood prescription; stand level management prescriptions utilizing single tree selection will be employed. The management will focus on improving stand health. Other goals will be to promote stand diversity with hemlock, yellow birch and red maple being primary components of the stand. Canopy gaps will be established to promote hemlock, yellow birch, and white pine regeneration when needed.

Treatment 2

The management for this option will utilize single tree selection focusing on thinning the hardwood poletimber component of this hemlock-hardwood type. This option preserves the softwood component while promoting growth of hardwoods and improving overall forest health. The softwood management will be limited to the harvesting of the poorest quality stems, some of these trees will be left as a source of coarse woody debris to provide potential seed beds for hemlock and yellow birch regeneration.

Upland Conifer – These stands represent only a small portion of the THRFR (±3%). This stand will need to be managed to ensure that adequate natural regeneration is taking place. These stands will be re- evaluated in 10 years to assess regeneration rates. Thinning, small patch cuts, or prescribed fire may be used in these stands to encourage natural regeneration.

Ecological Management Considerations

Water Quality

Protection of water quality across this property is a priority for all management activities. The Two-Hearted River has been designated by the State of Michigan as a Natural River due to its high quality. All management activities on the property will be conducted in a manner to protect the water quality, scenic beauty, and ecological health of this river system. Specific guidelines for management activities near the river can be found in the Two Hearted River Natural River Plan (Michigan DNR 2002).

There is evidence that selective harvesting in northern hardwoods may impact aquatic habitats and their invertebrate populations (Huckins and Burgess 2004), so special attention will be given to this issue when designing harvest plans for specific stands. At a minimum, Michigan BMP's will be strictly adhered to throughout all management activities.

Since 2007, TNC has improved 27 sites that either were experiencing sedimentation or connectivity issues within the Two-Hearted River Watershed. Many of these projects involved removing and replacing undersized or poorly suited crossing structures that were installed by previous land owners. Several bridges, and numerous culverts were installed which improved the infrastructure of the property, and greatly reduced sedimentation into the Two-Hearted River Watershed. These appropriately installed crossing structures also improved connectivity issues on 35 miles of river. In addition, several eroded banks were stabilized, further decreasing sedimentation. These sites are identified on the detailed property maps in **Exhibit B**.

Conservation of Biological Diversity

The conservation of the biological diversity of the property is central to the organizational mission of the Conservancy and a management goal of this property. All management activities on the property will be carefully evaluated to determine the potential impacts on biodiversity. Although it may not be feasible in every circumstance, our goal is to conduct an assessment of rare plants, natural communities, and wildlife habitats before any given parcel is harvested.

Rare species and natural communities

The Conservancy has reviewed the database of rare species and exemplary natural communities that is maintained by MNFI. There are several occurrences in this database that are known to occur on or immediately adjacent to the property (Table 6 below). The occurrences on the property are mapped in **Exhibit G**. There are likely to be additional occurrences of rare plant and animal species on the property that are not included in Table 6 because the property has not been thoroughly inventoried.

The Conservancy will continue to work closely with MNFI ecologists to determine the level of management activities that would be acceptable to conduct in and near the exemplary natural communities. No management actions will take place without the guidance of MNFI. The Conservancy will also work with MNFI biologists, private consultants, and academic groups to obtain a more thorough inventory of the rare species and natural communities on the property.

Table 6. Element occurrences documented to occur on or immediately adjacent to the Reserve (based on Michigan Natural Features Inventory Data, 2015).

Type	Common Name	Scientific Name
Plants		
	English sundew	Drosera anglica
	Northern appressed clubmoss	Lycopodiella subappressa
Wetland (Plant) Communities		
	Bog	
	Hardwood-Conifer Swamp	
	Intermittent Wetland	
	Rich Conifer Swamp	
	Patterned Fen	
	Muskeg	
Upland (Plant) Communities		
	Dry-Mesic Northern Forest	
	Dry Northern Forest	
	Mesic Northern Forest	

Many of the element occurrences are associated with open wetlands. These features will be protected by the design of adequate buffer areas when harvesting adjacent uplands, and by avoiding the construction of roads or skid trails of any type in or adjacent to these unique habitats.

Wildlife Habitat

In addition to the element occurrences on the property, habitat needs of more common wildlife species will be considered during specific harvest operations. The TNC Director of Forestry/Wildlife Biologist will review and approve the stand prescriptions based upon habitat requisites for both game and non-game wildlife species, as well as cover type and age class distributions within the Reserve and the surrounding area. Prior to harvest, existing locations of habitat features such as vernal pools, large snags, cavity trees, and raptor nests will be documented and these locations will be incorporated into the site planning. Buffer areas will be identified around vernal pools and raptor nests. At a minimum, existing management guidelines for species such as Bald Eagle, Red-shouldered Hawk and Northern Goshawk will be followed. Potential cavity trees and large mast-producing trees will be retained. Because of the impacts from Beech Bark Disease, additional efforts will be carried out to bolster both hard and soft mast production through regeneration/underplanting of species such as Northern red oak, Black cherry and disease resistant American beech. Shade tolerance rank and Kotar habitat type of tree species and soils in the area will inform such decisions.

One goal of harvest activities will be to increase the abundance of many habitat features, including snags, coarse woody debris, cavity trees and under-represented conifer species. The target goals for these features will be established based on best available silvicultural

and biological knowledge (ie. Keddy and Drummond, 1996). The specific silvicultural techniques used to achieve these goals will be a key subject of research questions linked to harvest activities. Existing research on this topic has tested some methods in northern hardwood forests in New England (Keeton, 2006; Bryan, 2003).

Habitat for wide-ranging species that are known to occur within the Two Hearted River watershed, such as red crossbills, pine marten, wolves, moose, and black bear, will be provided by maintaining continuous forest cover across the property through the use of small patch or selective tree harvesting, and by avoiding even-aged management in most areas. Bio-diversity is of utmost importance to TNC, from the perspective of climate resilience, wildlife habitat, and invasive species/disease defense. The larger landscape context of individual stands will also be considered when planning harvests to ensure that adequate canopy cover is maintained, while prompting some early successional habitat for important game species that are in decline, such as American woodcock.

The property supports a wide variety of migratory birds, many of which breed and raise young in spring and early summer. Limiting harvests to dry summer months (June – September) or frozen-ground winter months will prevent direct negative impacts on the reproductive success of these birds.

Fire Management

Wildfire is a natural form of disturbance in the landscape of the Upper Peninsula. Although not common in hardwood dominated forests of the Upper Peninsula, wildfires do occur in pine-dominated forests as well as in peatlands and lowland conifers during periods of drought. As a natural part of the ecological processes that shape the landscape, fire is not considered to be a threat to the conservation values of this property. However, given the property interests of neighboring landowners and individuals, as well as the legal mandate of the DNR to suppress wildfires, the Conservancy recognizes the reality that wildfires may need to be confined or controlled by the DNR.

The Sleeper Lake Fire of 2007, and the Duck Lake Fire of 2012 both impacted small portions of the property. Both of the areas impacted were isolated blocks on the far eastern edge of the property (see **Exhibit H**). The block impacted by the Sleeper Lake Fire was mainly marshland, dissected by narrow pine ridges. The block impacted by the Duck Lake Fire was primarily covered by a mix pine stand, however, a salvage harvest was conducted prior to the Conservancy receiving the property from the State of Michigan in the 2019 land swap.

As more inventory work is conducted on the property, the use of prescribed fire may be considered if areas are identified that require fire to maintain the health of the ecosystem. For example, site preparation may include prescribed fire to clear the seedbed, reduce potential pathogens and reduce competition during germination and seedling establishment.

To help inform our understanding of the fire dynamics, the ecological systems and other natural disturbances on the property, the Conservancy is working with other organizations.

Invasive Species & Forest Pests & Pathogens

The property currently has few known problems with invasive plant species. However, harvesting activities and ATV use present the risk of spreading invasive plant species into the forest. Dense populations of species such as garlic mustard or glossy buckthorn can prevent natural regeneration of native forest tree, shrub, and herbaceous species. If any re-seeding is required to stabilize slopes or roadways, only weed-free, native seed mixes will be used. If gravel is required for road improvements or road-stream crossing projects, the gravel must be obtained from a source that is known to be free of invasive plant seeds. A monitoring program will be established to detect the presence of terrestrial and aquatic invasive plants in high risk areas, including areas near homes or camps, recent harvest sites, sites with recent road work, and public rights-of-way, such as powerline corridors.

Beech bark disease is a significant management issue on the property. This disease has caused significant mortality among mature beech in stands across the property. A significant loss of basal area has been documented across the property and stands are actively "self-thinning" as a result. This has delayed our first entry in many stands we intended to harvest as part of our initial plan. Salvaging beech is no longer an option, our primary goal now will be to identify trees that are resistant to the disease and report these trees to the Michigan DNR Forest Health Monitoring group. In stands that we do harvest, some diseased beech may also be retained as snag trees, providing wildlife habitat. In stands which sustain a large percentage of canopy loss due to BBD, underplanting white pine seedlings will be considered. Planting of red oak seedlings is planned for the spring of 2020, with the objective of supplementing the source of hard-mast that beech once provided on the property.

Other exotic insects that could cause significant mortality on the property include the emerald ash borer (EAB) and hemlock woolly adelgid (HWA). Both of these species could cause significant tree mortality on the property, especially the hemlock wooly adelgid. HWA infestations have been found in Michigan. As of February 2020, the furthest north infestation of HWA was located in the southeast corner of Mason County, in Western Michigan. EAB is present in the Upper Peninsula, and has been officially documented in all but three of the western-most counties. This insect has not been documented on the Reserve, but is likely present.

Excessive deer browse is a well-documented forest management issue. Excessive browse of preferred species such as northern white cedar and eastern hemlock can prevent adequate regeneration of these species. Due to the high snowfall amounts in this region, deer typically do not concentrate in this area during winter months, therefore the effects of deer browse are expected to be less severe than in other part of the state. However, due to the potential negative impacts on regeneration, deer browse as well as moose browse must be considered when designing any harvest on this property. Techniques for regenerating deer-preferred tree species may also be a topic of research on the property.

Herbicide use

Widespread application of herbicides, such as for post-harvest treatment or pest control, is not desired by the landowner. The local use of herbicides to control non-native plant species will be determined on a case by case basis by the landowner. Use of herbicides will only be considered if can be applied with minimal negative impacts on native flora and fauna and aquatic habitats.

High Conservation Value Forests and Representative Sample Areas

High Conservation Value Forests (HCVF)

An initial assessment of the Two-Hearted River Forest Reserve has been conducted by Compass Land Consultants as part of the preparation of this management plan based on initial observations and timber inventories. Using the FSC-US HCVF Assessment Template, no HCVFs have been identified on the property. This initial assessment is in no way to be considered final. As the Nature Conservancy and the land manager continues routine assessment and monitoring of the property, further reviews Natural Heritage program data, and input is received from regional experts the HCVF assessment may change. A summary of the initial assessment is presented below.

***Criteria 1**: Forest areas containing globally, regionally or nationally significant concentrations of biodiversity (e.g., endemism, endangered species, refugia)*

Initial assessments of rare, threatened, and endangered (RTE) species yielded 2 species on the property. None of the populations of these 2 species is considered to exist in any significant or exemplary population when compared in the ecoregion.

***Criteria 2**: Forest areas containing globally, regionally or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance.*

The size of the Two-Hearted River Forest Reserve (24,244 acres) largely eliminates the possibility of having large landscape level forests when considered in the ecoregional context.

***Criteria 3**: Forest areas that are in or contain rare, threatened or endangered ecosystems.*

No examples of rare ecosystems with type 1 old-growth conditions exist on the SEVEN LAKES.

***Criteria 4**: Forest areas that provide basic services of nature in critical situations (e.g., watershed protection, erosion control)*

Although lowland conifer forests may meet the criteria of watershed protection, the lowland conifer forests on the Two-Hearted River Forest Reserve do not rise to the threshold described in 4.1 – 4.4 in the assessment guidance.

Criteria 5*: Forest areas fundamental to meeting basic needs of local communities (e.g., subsistence, health)*

None identified. While the forest is important to the local community for timber products and recreation, the forest does not provide basic human needs as defined by this Attribute.

Criteria 6*: Forest areas critical to local communities´ traditional cultural identity (areas of cultural, ecological, economic or religious significance identified in cooperation with such local communities)*.

None identified. The health of the forested landscape as a whole across the region is of course critical to the local culture. However, the particular forest in question is not more valuable to the culture than other forests.

Harvest Plan

Overview

Management under ownership of the Conservancy will be focused primarily on increase in species diversity in upland hardwood stands that have been intensively managed for many decades. This period of management may take decades to achieve its goals. Over time, as the forests are gradually shifted to higher age and species diversity, the focus of management is expected to shift from restoration to the sustainable management of a saw-log and veneer forest product in a manner that derives economic benefit while protecting the ecological integrity and unique features of these forests.

3-Year Harvest Summary

The summary acres of planned harvest areas shown for the three-year period in Table 7 were derived from forest inventories conducted over the last five years. Based on inventory data, professional foresters made recommendations for each stand for the next year of entry. Past the next three years, harvest plans will be based on continued inventory – some of which will occur on some of the first stands harvested on the Reserve, which are fast approaching their target rotation age(s).

The detailed stand maps which display the specific harvest areas summarized in Table 7 are not included in this plan, but they are available upon request.

Harvest Year	Compartment	Stand ID(s)	Approximate Acres
2020-2021	3	300155, 300170, 3000174, 300185, 300203	160
2021-2022	2	200080, 200079	105
2021-2022	4	400339, 400347	158
2022-2023	1	100055, 100062	396
TOTAL			**819**

Table 7. Tentative 3-year harvest plan by Compartment. Total stand acres shown.

Annual Allowable Cut

To calculate annual allowable cut (AAC), only northern hardwood and hemlock forest types were included in the calculation since those are the areas where harvesting is expected to occur for the term of this plan. Table 8 below demonstrates that the proposed annual harvest of 273 acres per year averaged over the 3-year span of this management plan only represents 36% of the annual growth for the hardwood and hemlock hardwood strata.

Table 8. Calculation of Annual Allowable Cut

Description	Value
Total cordwood in Hardwood and Hemlock/Hardwood Strata	240,198
Total acres in Hardwood and Hemlock/Hardwood Strata	7,980
Average cordwood volume per acre	30.1
Average AAC at 2.5% growth rate (cords)	6,005
Projected 3-year annual harvest at 8 cords per acre	2,184
Projected percentage of AAC	36%

*2.5% growth is based on FIA data for all Michigan forest types as reported in the following USFS reports: Michigan's Forest Resources 2004 - Resource Bulletin NC-255, and Michigan's Forest Resources 2007 - Research Note NRS-28

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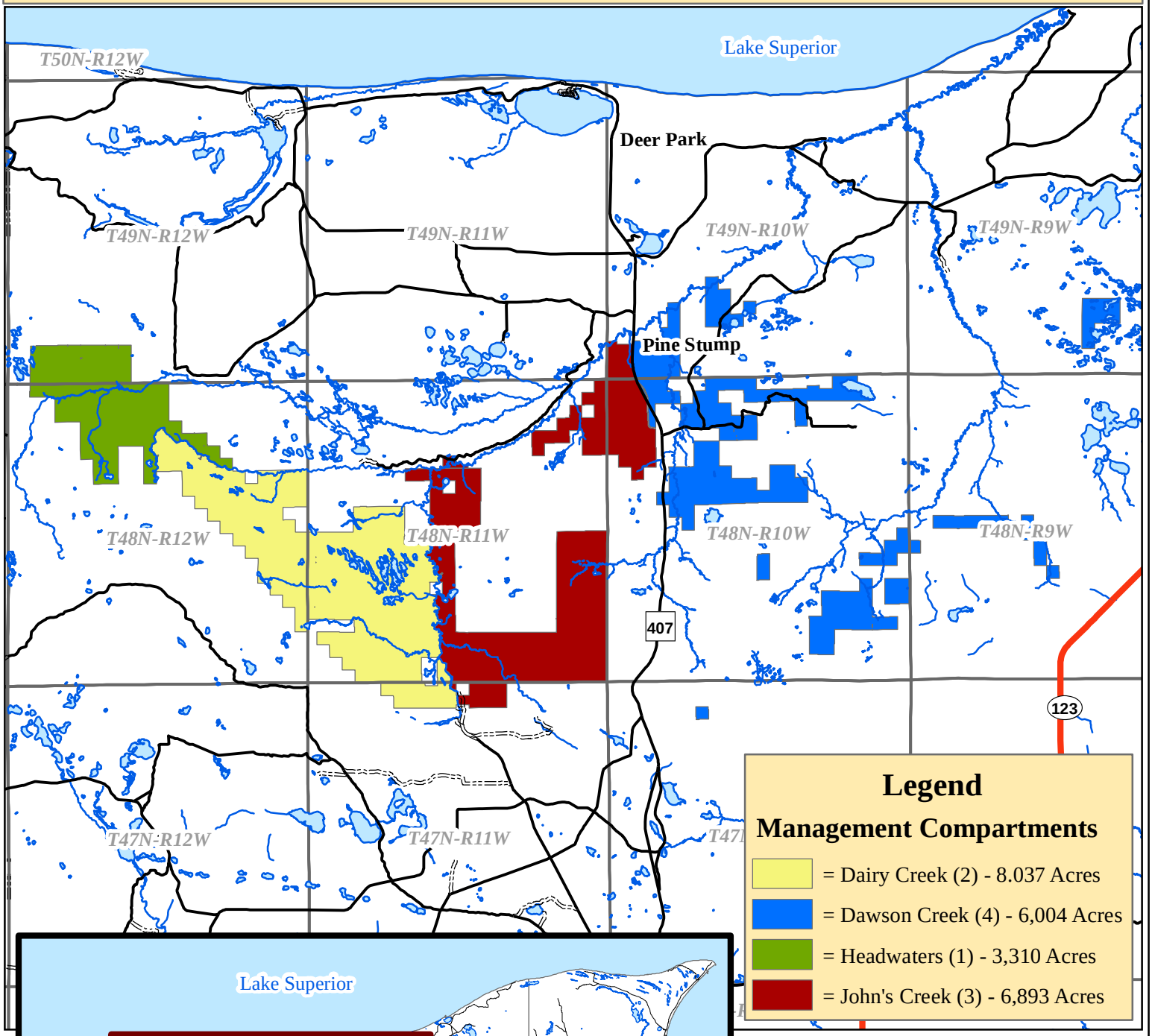
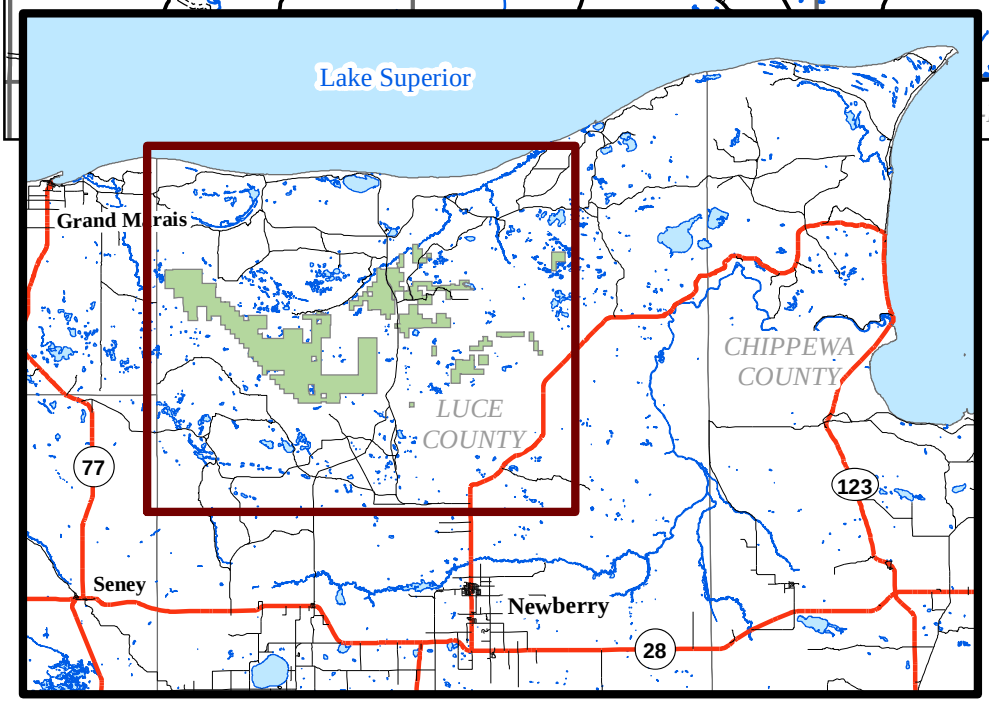
Exhibit A: Overview/Location Map

Two-Hearted River Forest Reserve





0 1 2 4 Miles

NORTH

Scale = 1:180,000
March 2020

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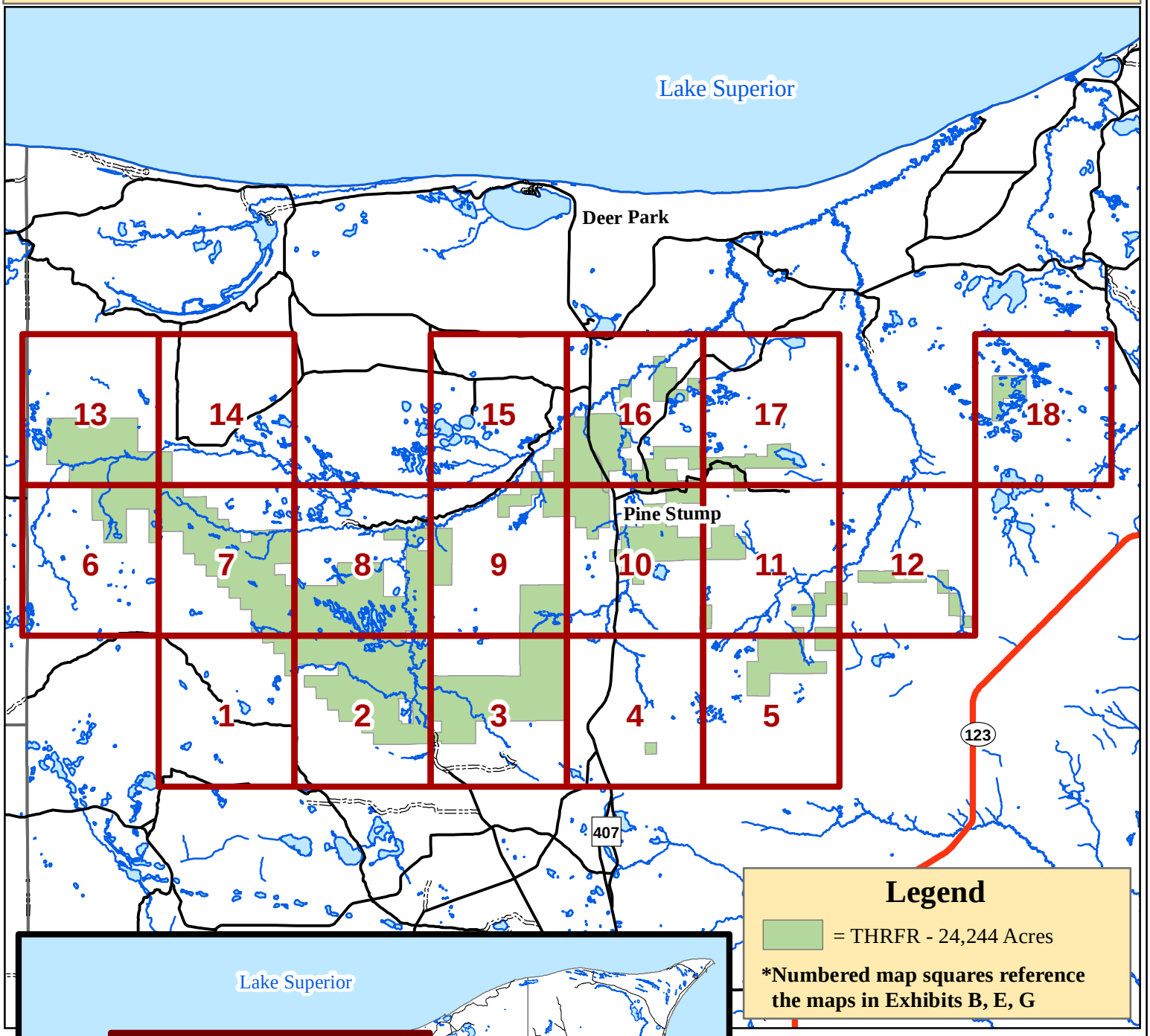
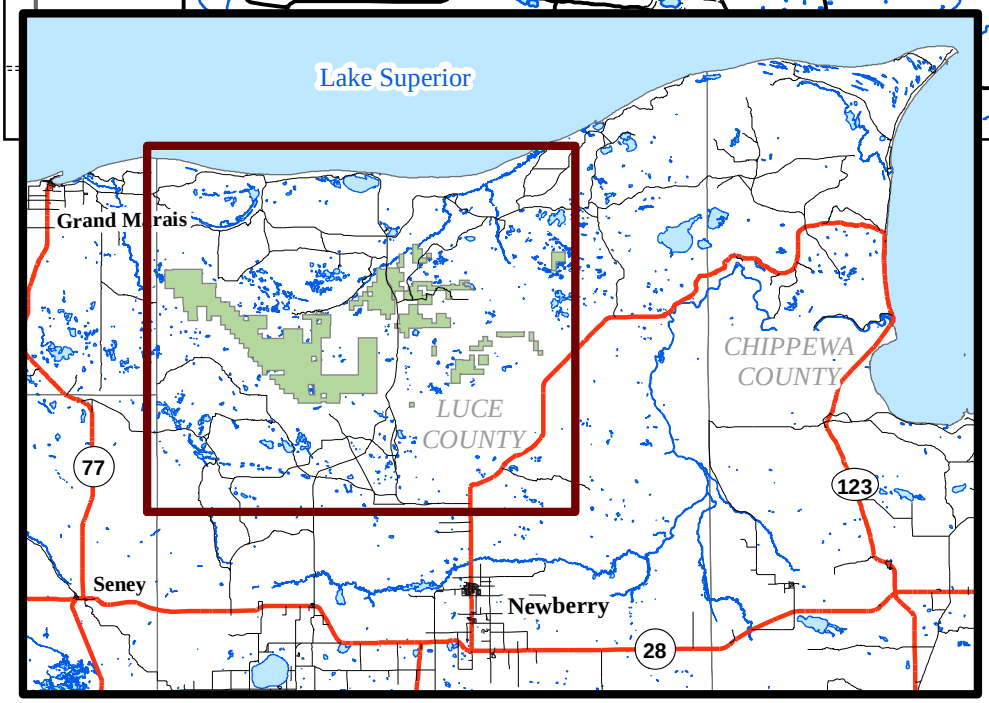
Exhibit A: Map Index

Two-Hearted River Forest Reserve





Legend

= THRFR - 24,244 Acres

***Numbered map squares reference the maps in Exhibits B, E, G**

0 1 2 4 Miles

NORTH

Scale = 1:180,000
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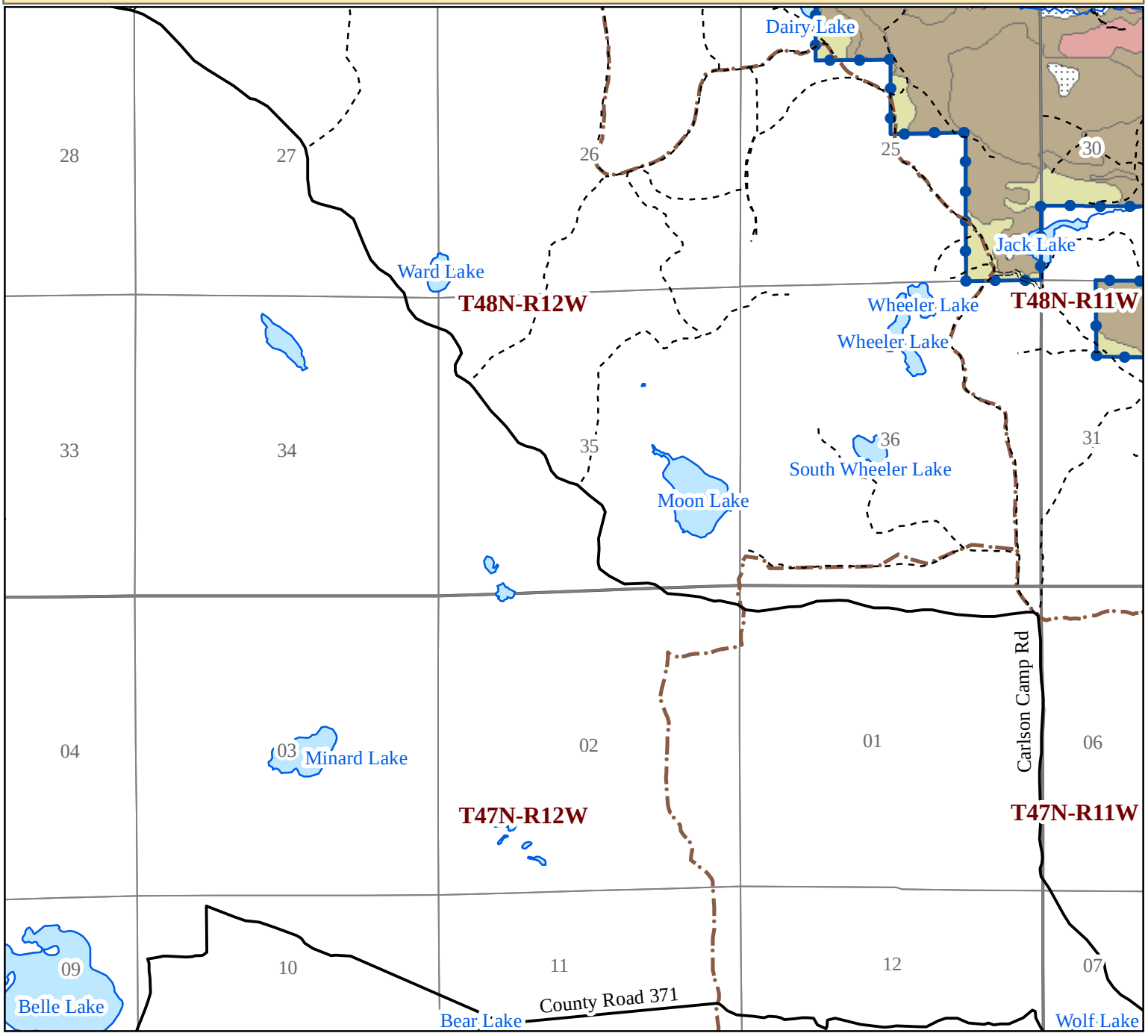
Exhibit B: Property Map 1

Luce County: T48N-R12W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = TNC Preserves
- = Reserve Lands not in CF
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Water Quality Improvement (Since 2007)

THRFR Cover Types

- = Aspen
- = Northern White Cedar
- = Fir-Spruce
- = Hemlock-Hardwoods
- = Non-Forested/Non-Productive
- = Northern Hardwood
- = Mid-Tolerant Hardwood
- = Mixed Pine
- = Red Pine
- = White Pine
- = Swamp Conifer
- = Swamp Hardwood

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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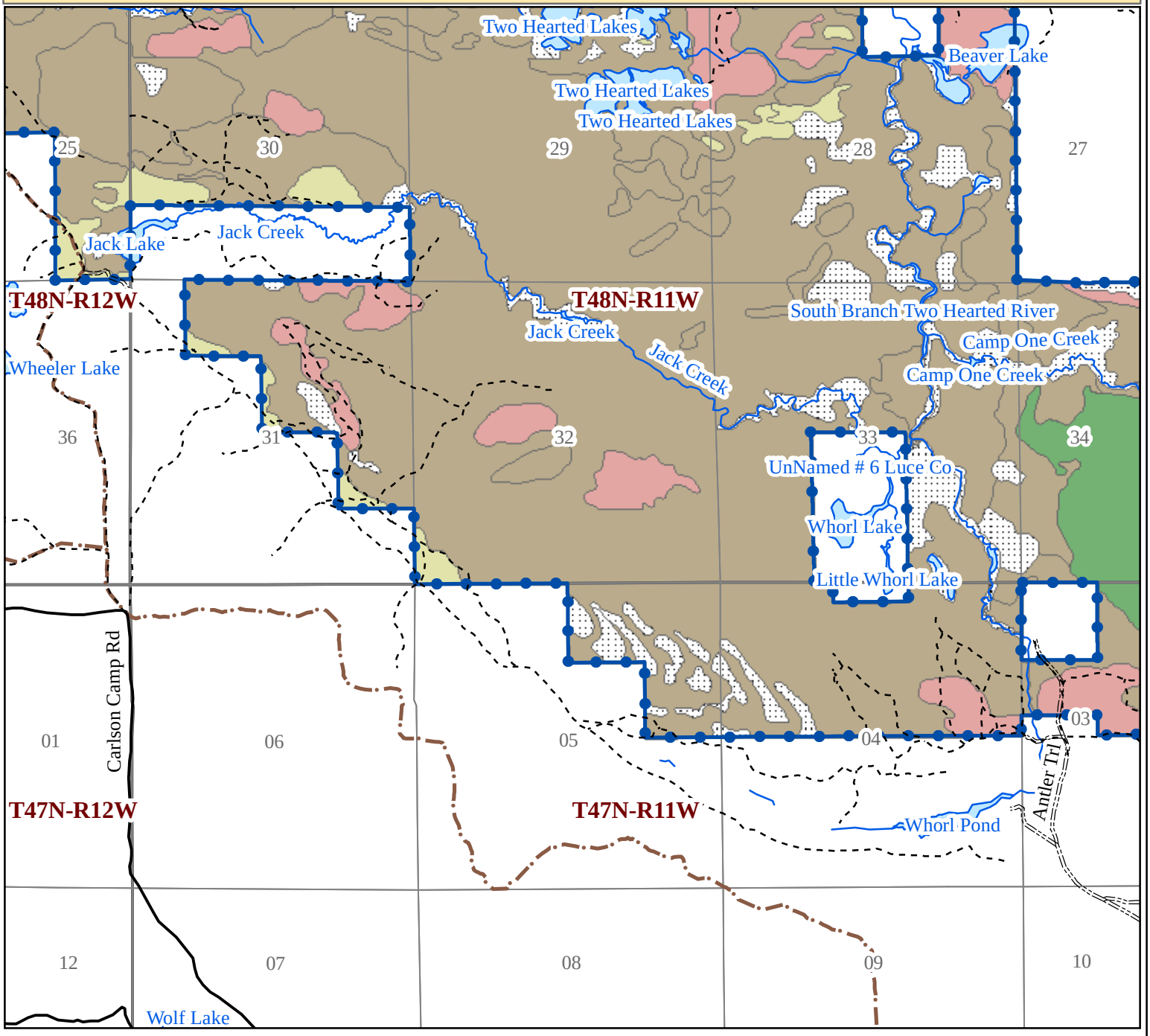
Exhibit B: Property Map 2

Luce County: T47N-R11W



Legend

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- = Red Pine
- = White Pine
- = Swamp Conifer
- = Swamp Hardwood

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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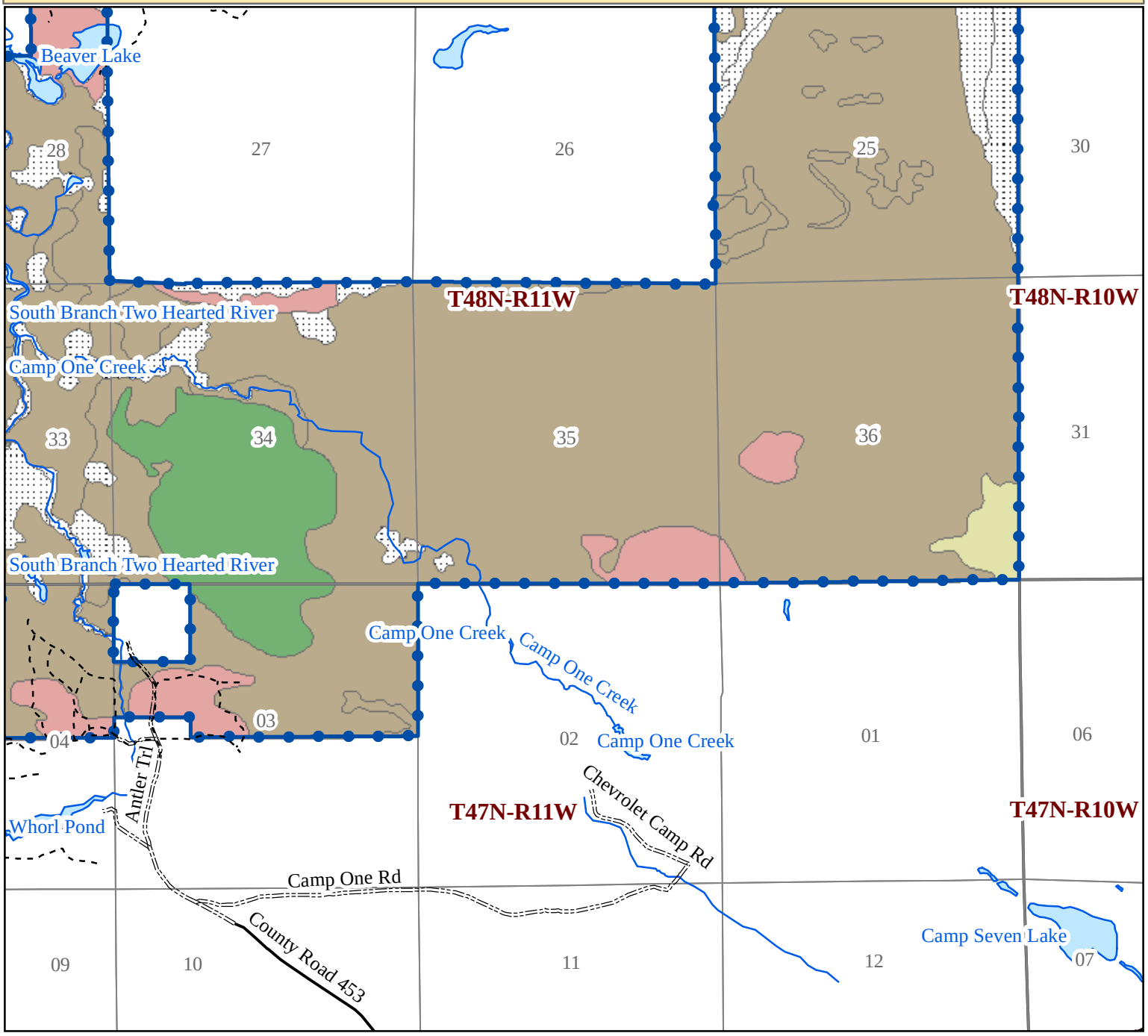
Exhibit B: Property Map 3

Luce County: T48N-R11W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = TNC Preserves
- = Reserve Lands not in CF
- = County Road
- = Secondary Road
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- = Designated Snowmobile Trail
- = Water Quality Improvement (Since 2007)

THRFR Cover Types

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- = White Pine
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- = Swamp Hardwood

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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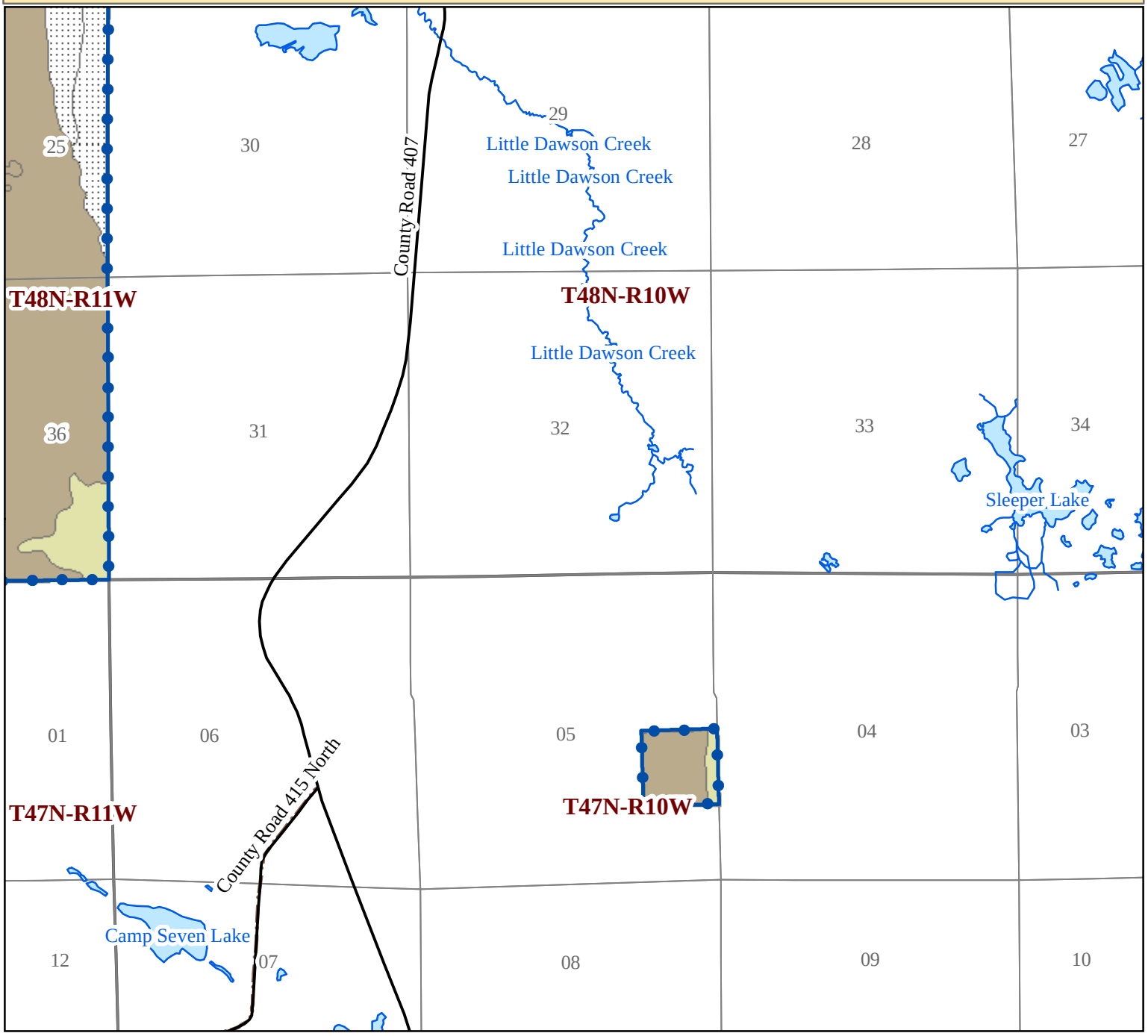
Exhibit B: Property Map 4

Luce County: T47N-R10W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = TNC Preserves
- = Reserve Lands not in CF
- = County Road
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THRFR Cover Types

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- = Non-Forested/Non-Productive
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NORTH

Scale = 1:30,000
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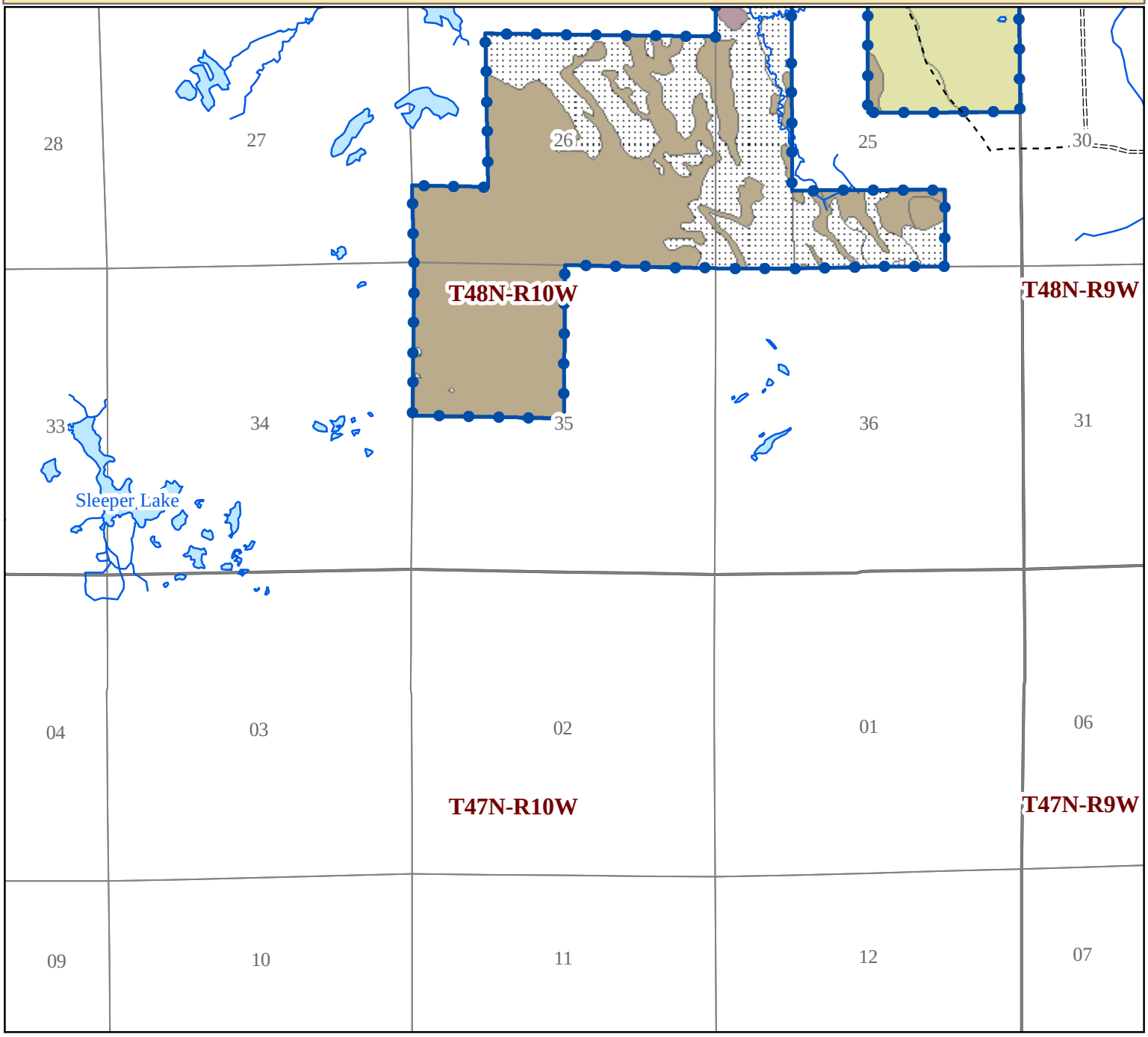
Exhibit B: Property Map 5

Luce County: T48N-R10W



Legend

= Two-Hearted Forest Reserve Property Boundary

= TNC Preserves

= Reserve Lands not in CF

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Water Quality Improvement (Since 2007)

THRFR Cover Types

= Aspen
= Northern White Cedar
= Fir-Spruce
= Hemlock-Hardwoods
= Non-Forested/Non-Productive
= Northern Hardwood
= Mid-Tolerant Hardwood
= Mixed Pine
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= White Pine
= Swamp Conifer
= Swamp Hardwood

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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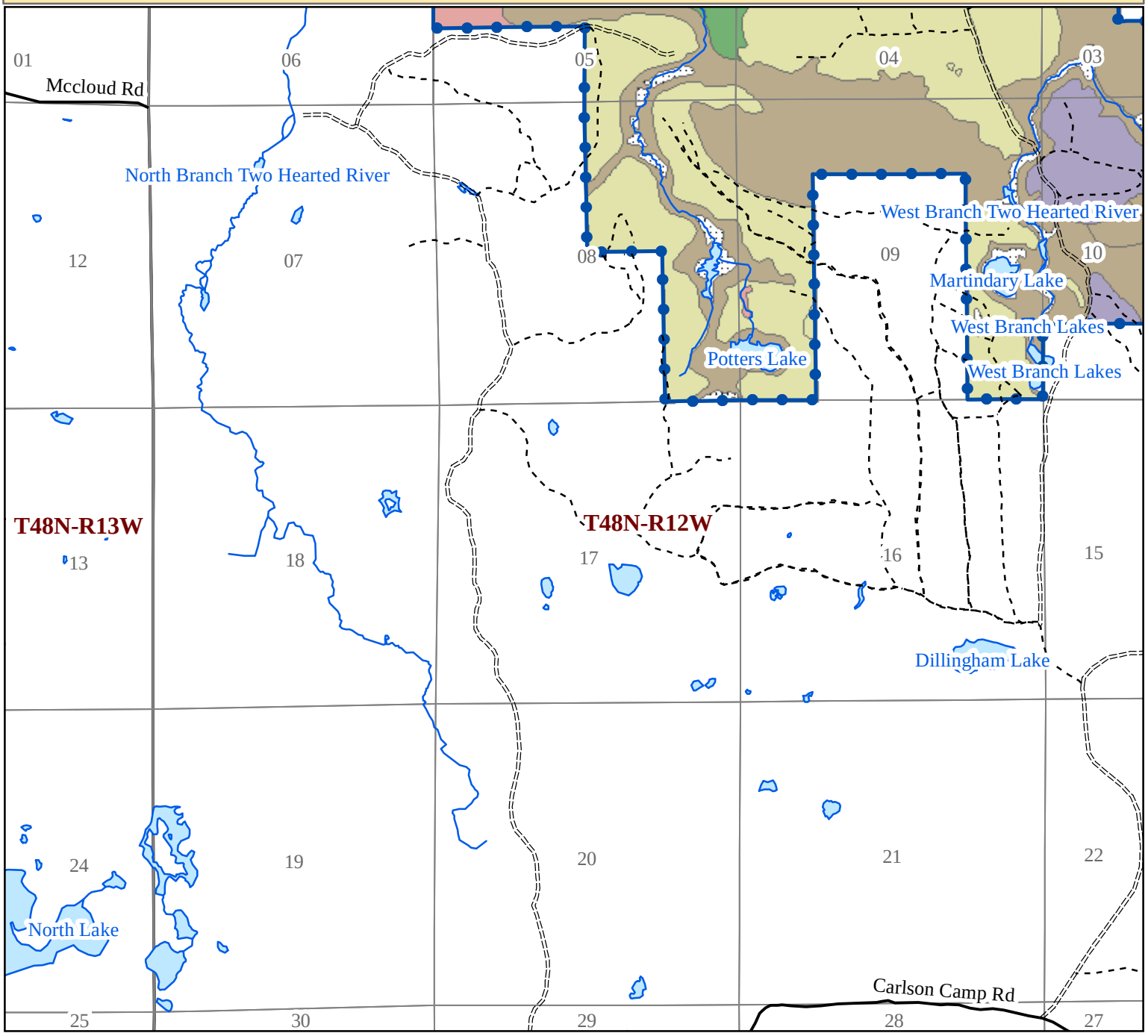
Exhibit B: Property Map 6

Luce County: T48N-R12W



Legend

- = Two-Hearted Forest Reserve Property Boundary
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NORTH

Scale = 1:30,000
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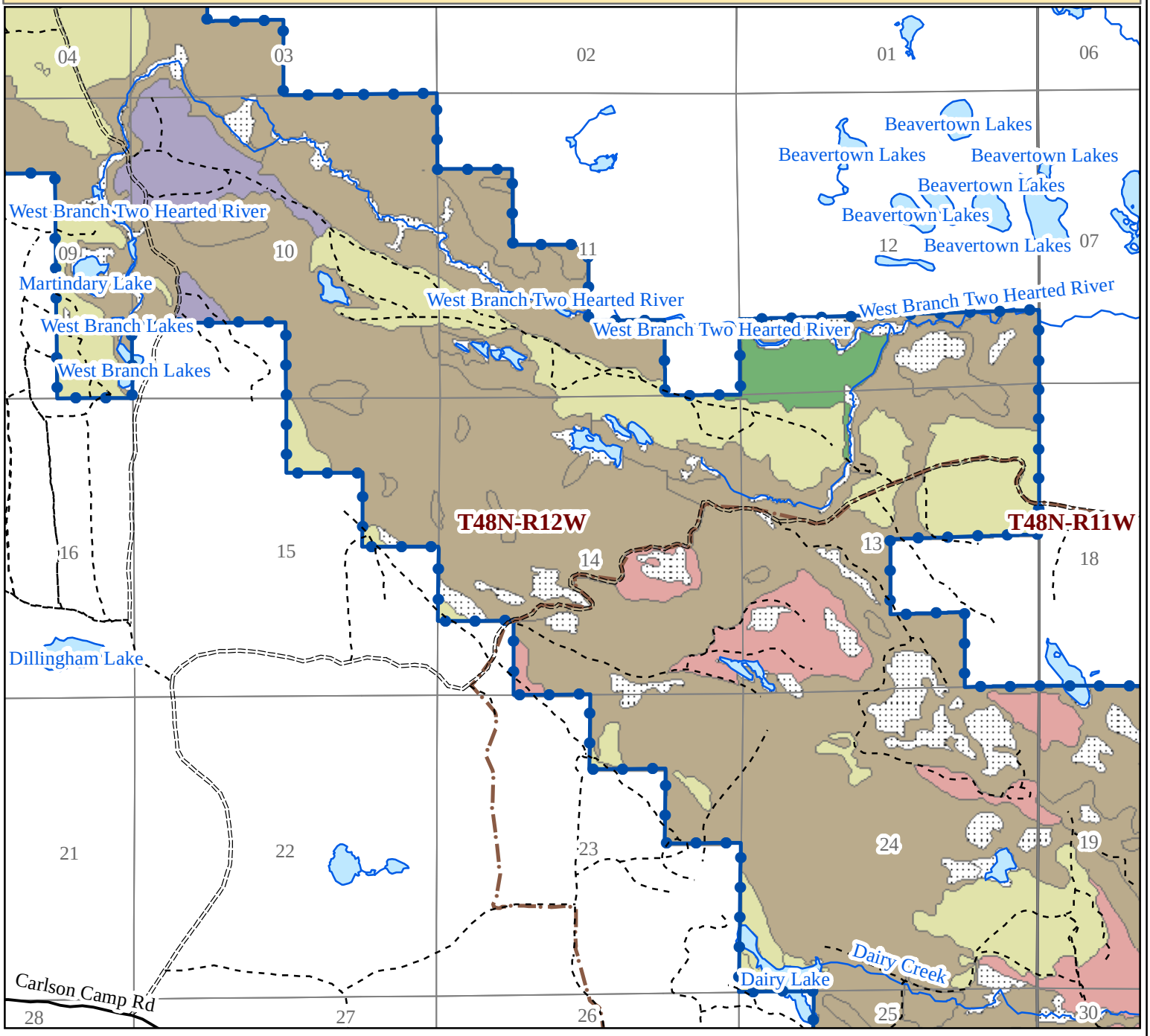
Exhibit B: Property Map 7

Luce County: T48N-R12W



Legend

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0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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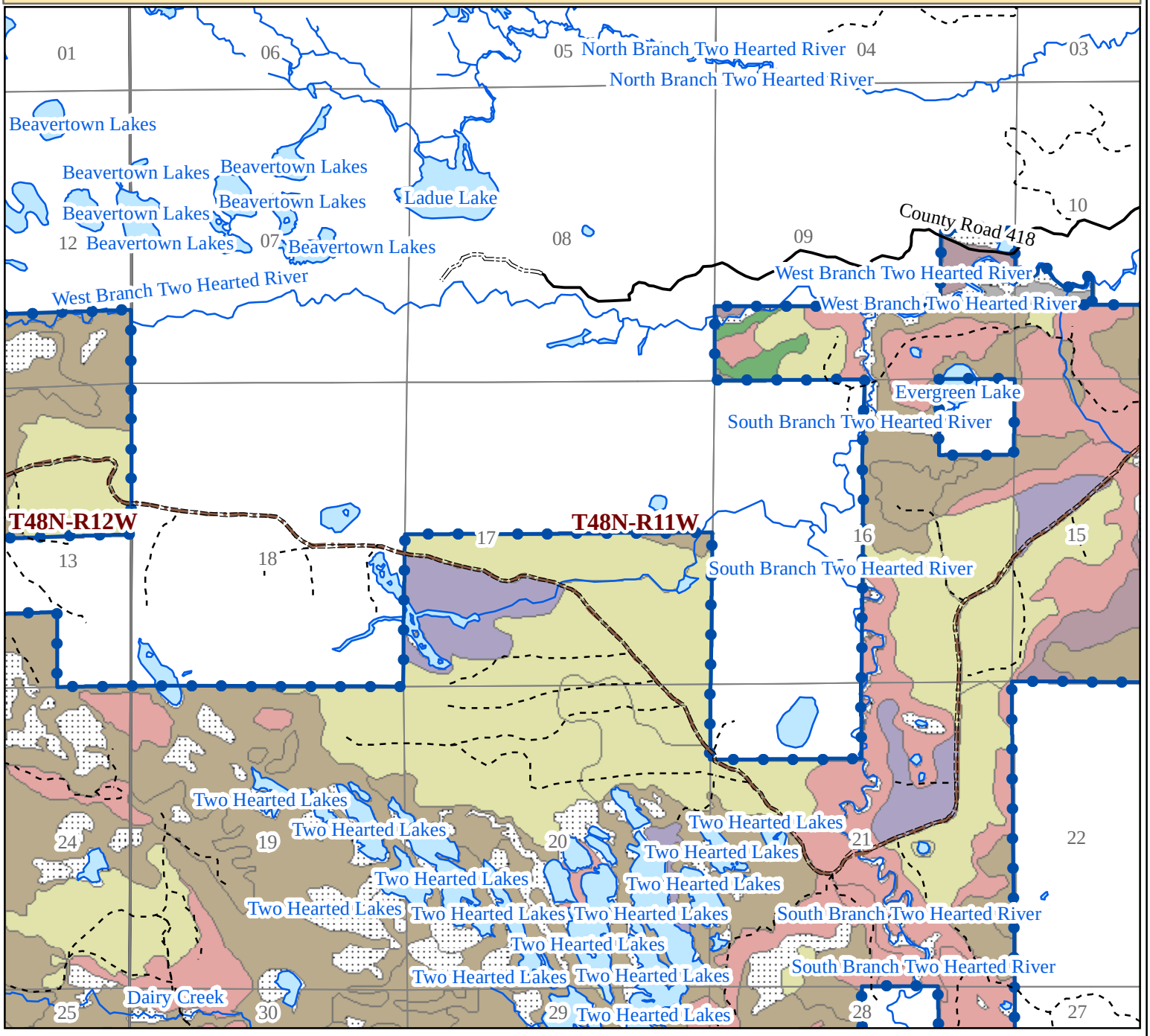
Exhibit B: Property Map 8

Luce County: T48N-R11W



Legend

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0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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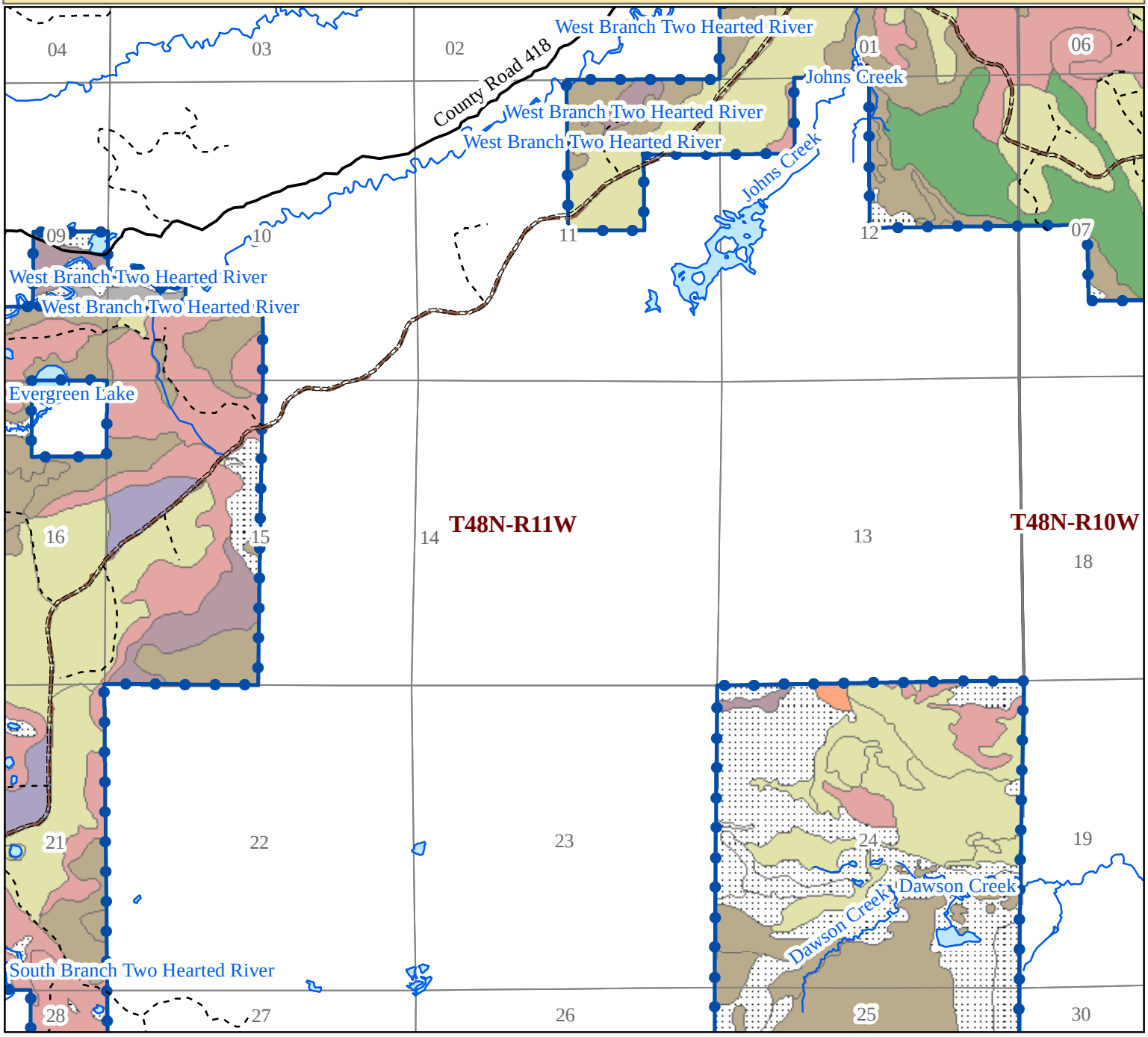
Exhibit B: Property Map 9

Luce County: T48N-R11W



Legend

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0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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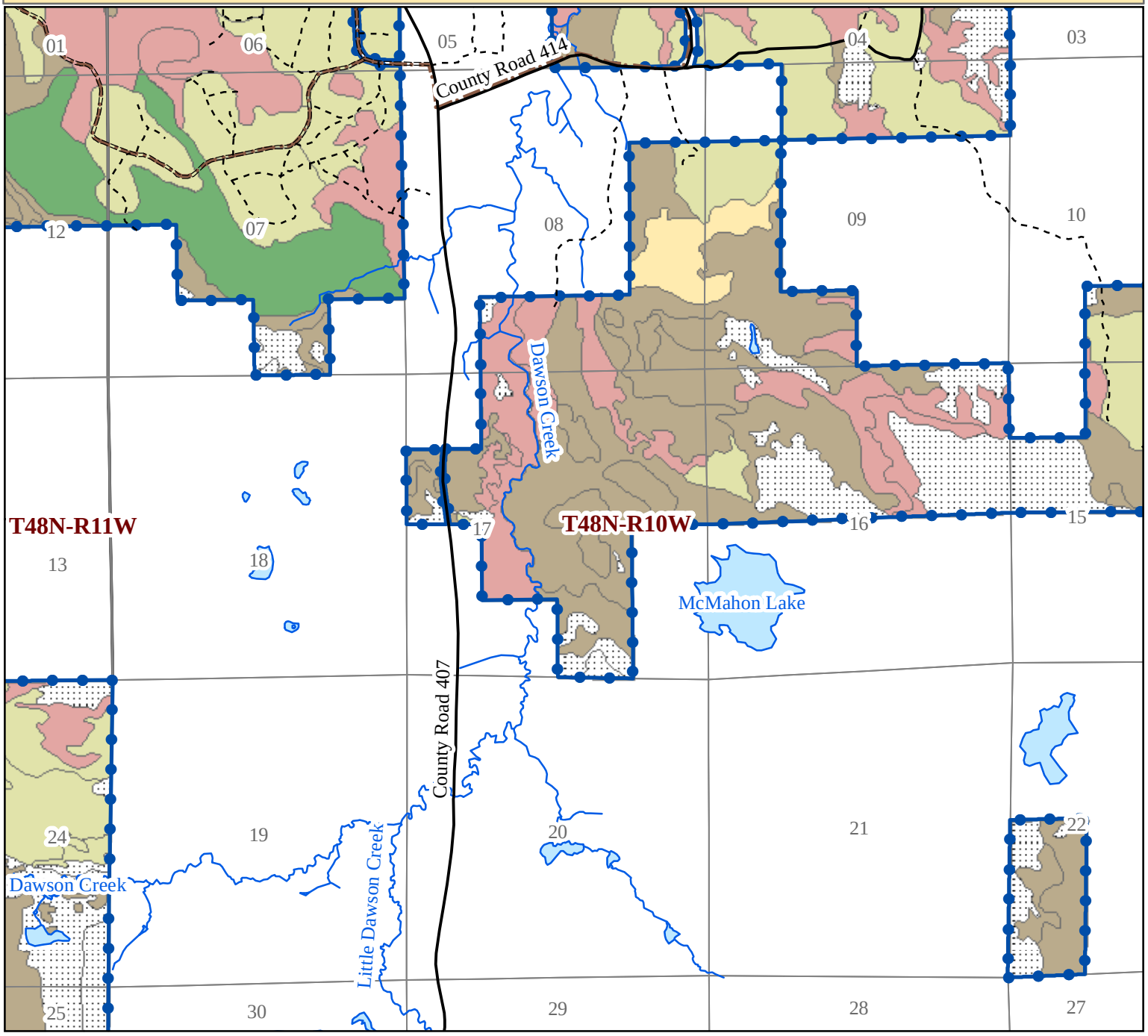
Exhibit B: Property Map 10

Luce County: T48N-R10W



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0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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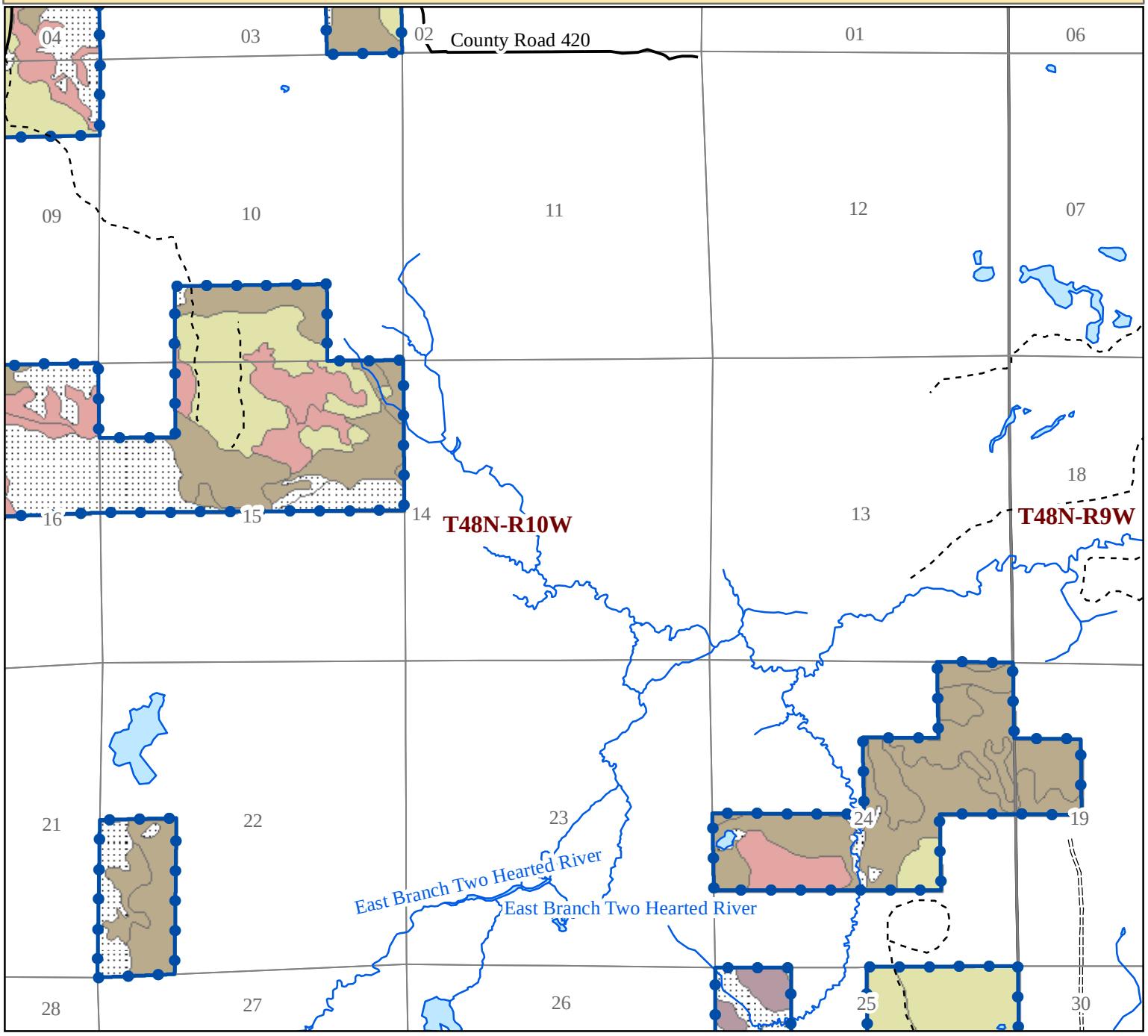
Exhibit B: Property Map 11

Luce County: T48N-R10W



Legend

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0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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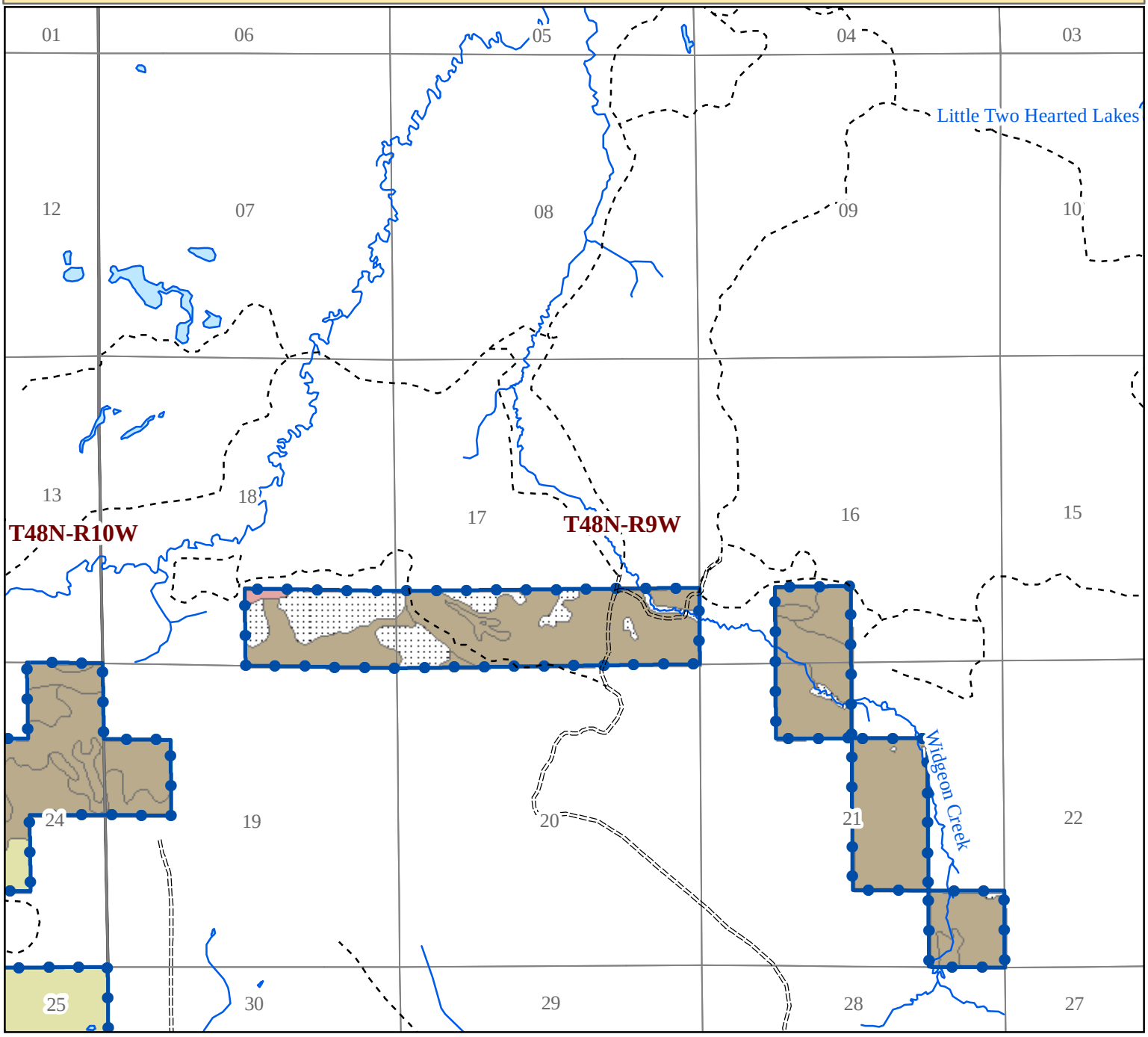
Exhibit B: Property Map 12

Luce County: T48N-R9W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = TNC Preserves
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- = County Road
- = Secondary Road
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0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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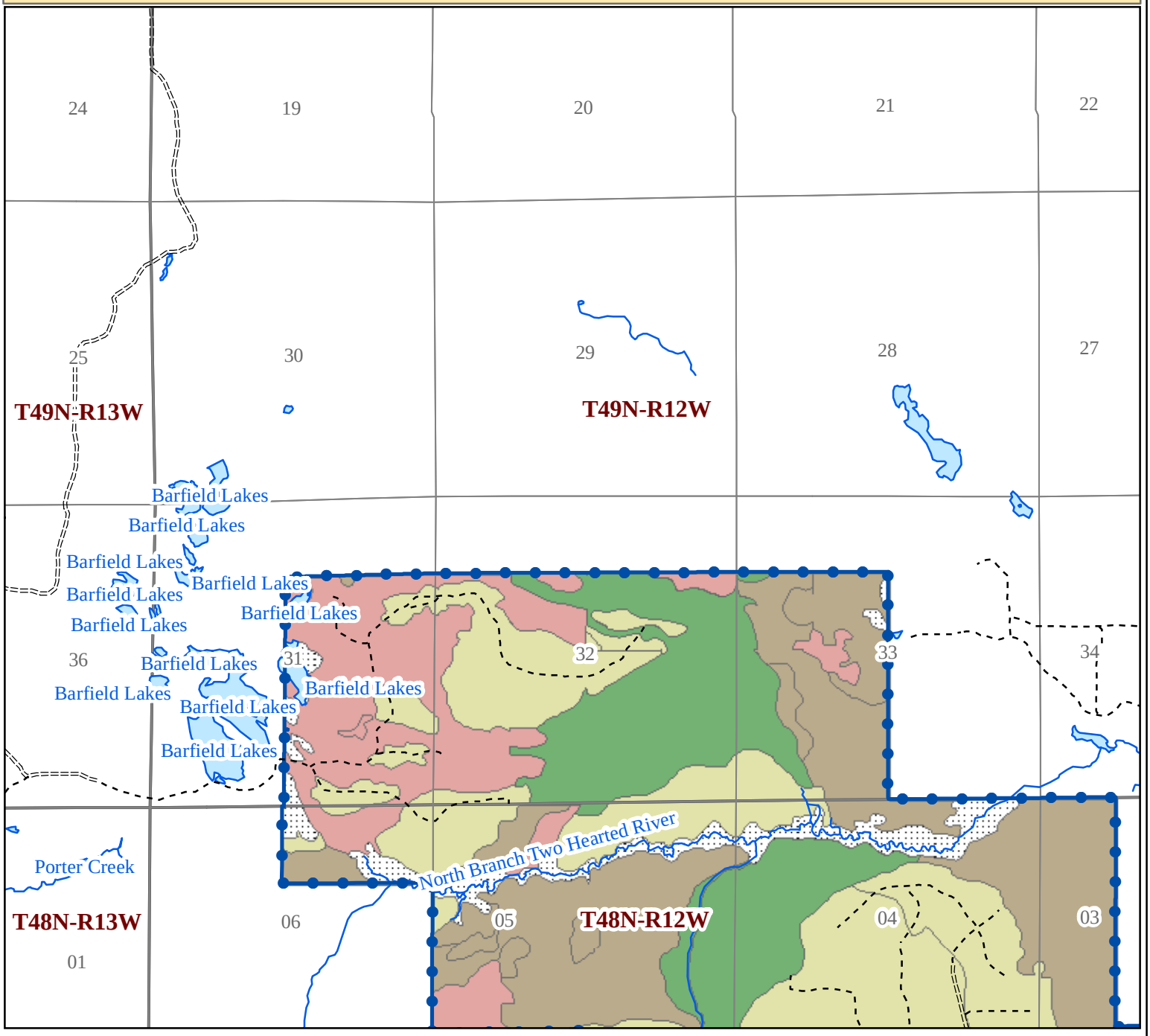
Exhibit B: Property Map 13

Luce County: T49N-R12W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = TNC Preserves
- = Reserve Lands not in CF
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THRFR Cover Types

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0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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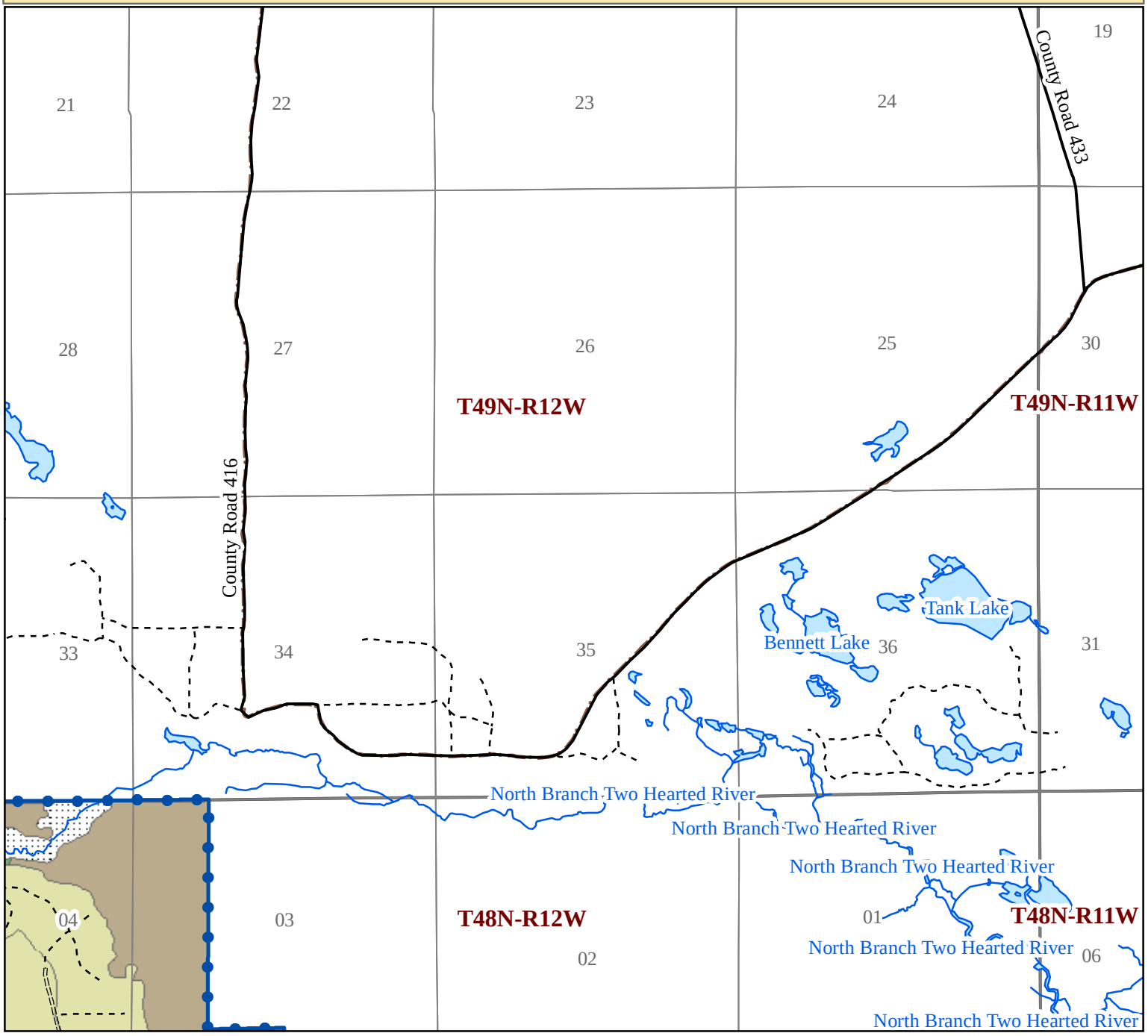
Exhibit B: Property Map 14

Luce County: T49N-R12W



Legend

- = Two-Hearted Forest Reserve Property Boundary
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0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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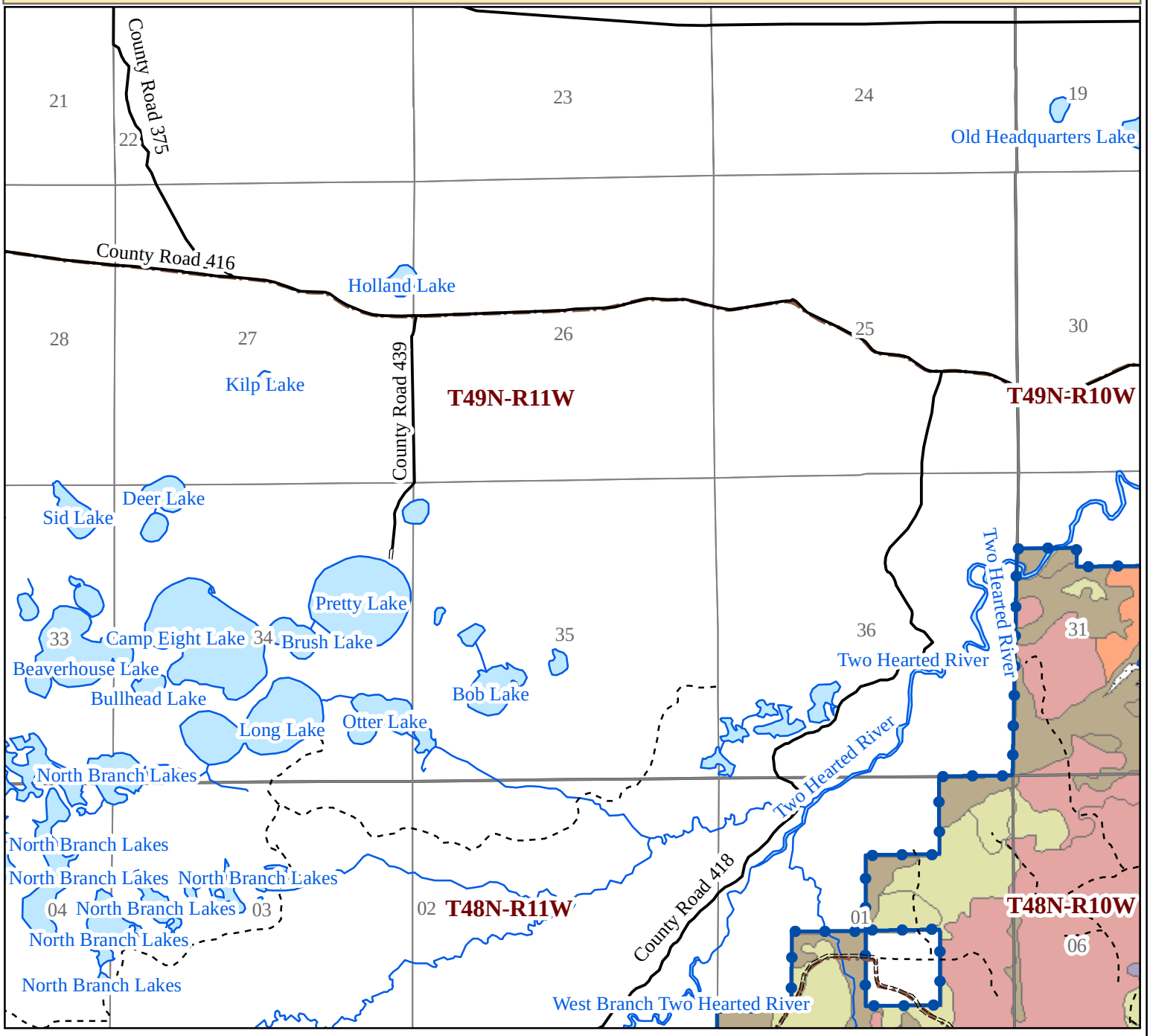
Exhibit B: Property Map 15

Luce County: T48N-R11W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = TNC Preserves
- = Reserve Lands not in CF
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Water Quality Improvement (Since 2007)

THRFR Cover Types

- = Aspen
- = Northern White Cedar
- = Fir-Spruce
- = Hemlock-Hardwoods
- = Non-Forested/Non-Productive
- = Northern Hardwood
- = Mid-Tolerant Hardwood
- = Mixed Pine
- = Red Pine
- = White Pine
- = Swamp Conifer
- = Swamp Hardwood

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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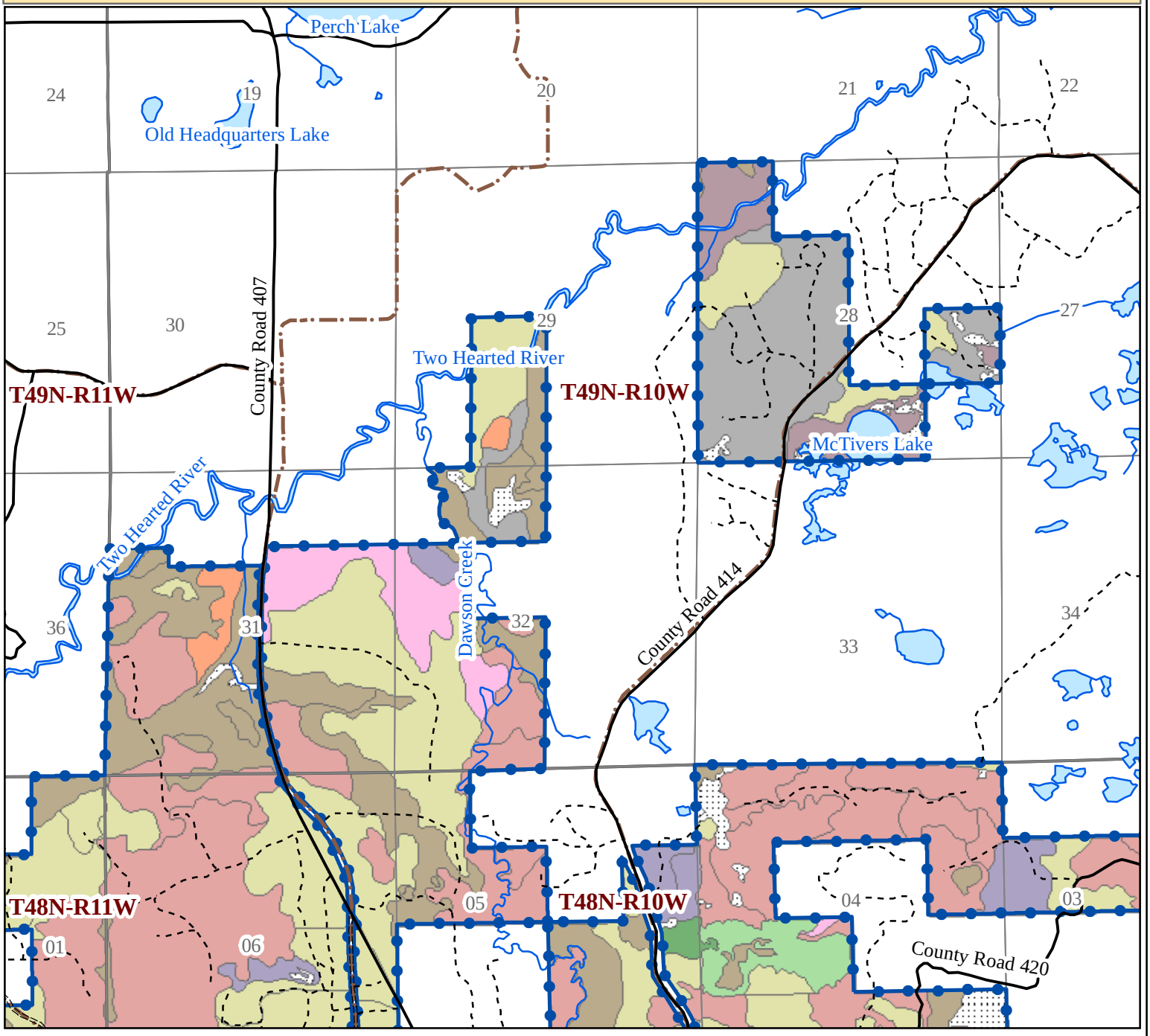
Exhibit B: Property Map 16

Luce County: T49N-R10W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = TNC Preserves
- = Reserve Lands not in CF
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Water Quality Improvement (Since 2007)

THRFR Cover Types

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- = Fir-Spruce
- = Hemlock-Hardwoods
- = Non-Forested/Non-Productive
- = Northern Hardwood
- = Mid-Tolerant Hardwood
- = Mixed Pine
- = Red Pine
- = White Pine
- = Swamp Conifer
- = Swamp Hardwood

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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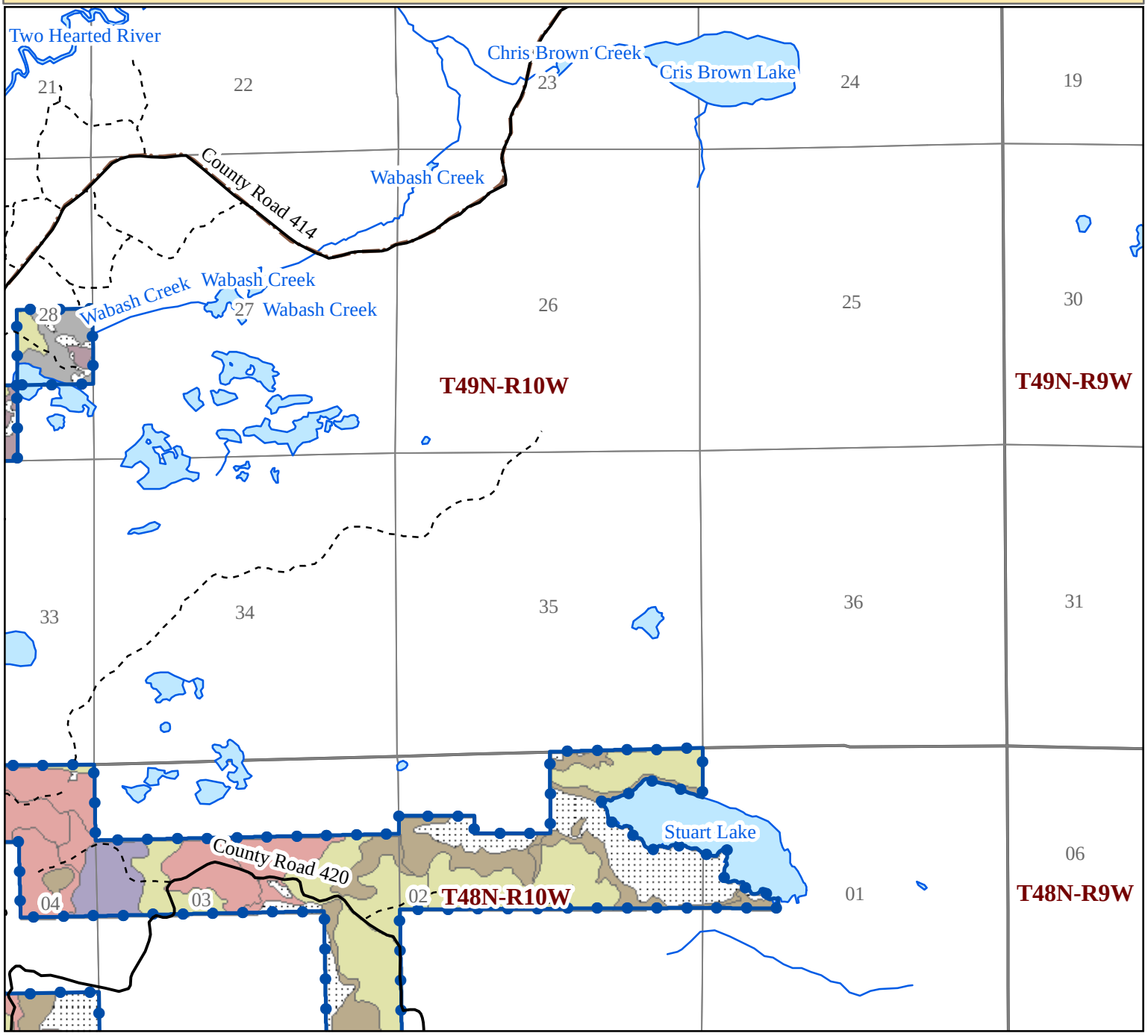
Exhibit B: Property Map 17

Luce County: T48N-R10W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = TNC Preserves
- = Reserve Lands not in CF
- = County Road
- = Secondary Road
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- = Designated Snowmobile Trail
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THRFR Cover Types

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- = Northern White Cedar
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- = Hemlock-Hardwoods
- = Non-Forested/Non-Productive
- = Northern Hardwood
- = Mid-Tolerant Hardwood
- = Mixed Pine
- = Red Pine
- = White Pine
- = Swamp Conifer
- = Swamp Hardwood

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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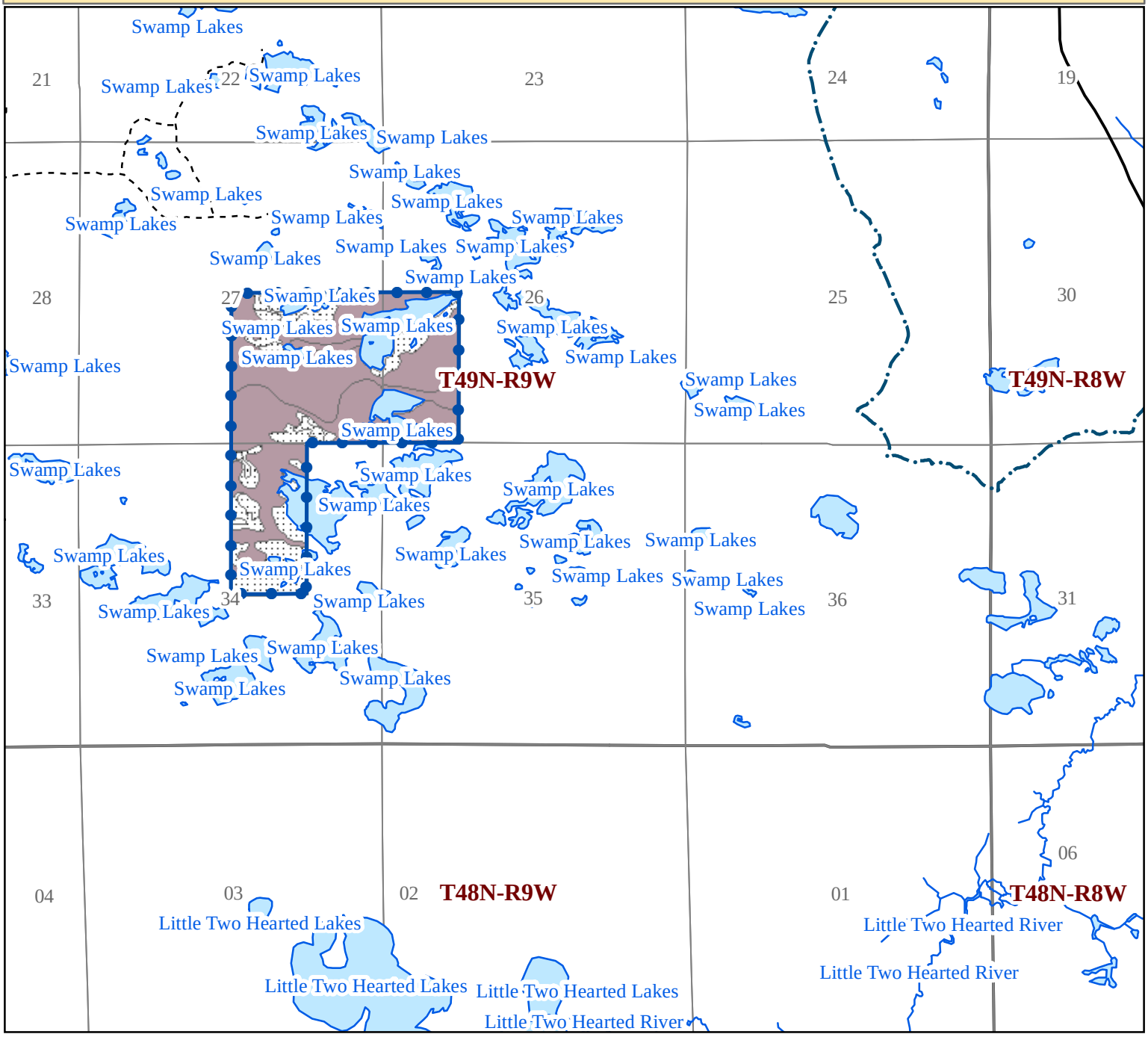
Exhibit B: Property Map 18

Luce County: T49N-R9W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = TNC Preserves
- = Reserve Lands not in CF
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Water Quality Improvement (Since 2007)

THRFR Cover Types

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- = Northern Hardwood
- = Mid-Tolerant Hardwood
- = Mixed Pine
- = Red Pine
- = White Pine
- = Swamp Conifer
- = Swamp Hardwood

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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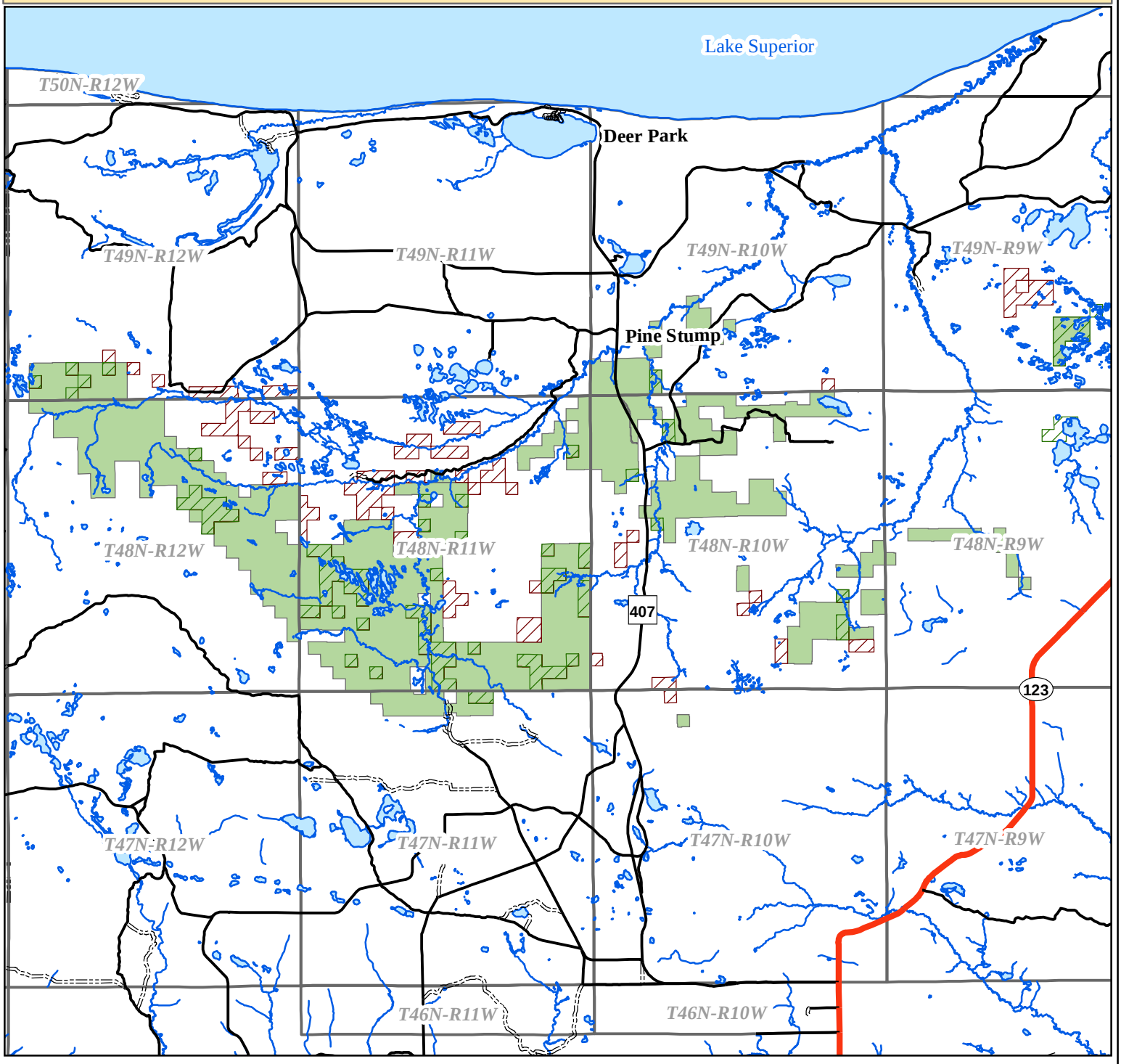
Exhibit C: 2019 DNR/TNC Land Swap

Two-Hearted River Forest Reserve



Legend

= Current THRFR Footprint
Approximately 24,244 Acres

= Former TNC Lands - Granted to DNR
Approximately 3,728 Acres

= Former DNR Lands - Granted to TNC
Approximately 3,716 Acres

0 1 2 4 Miles

NORTH

Scale = 1:180,000
March 2020

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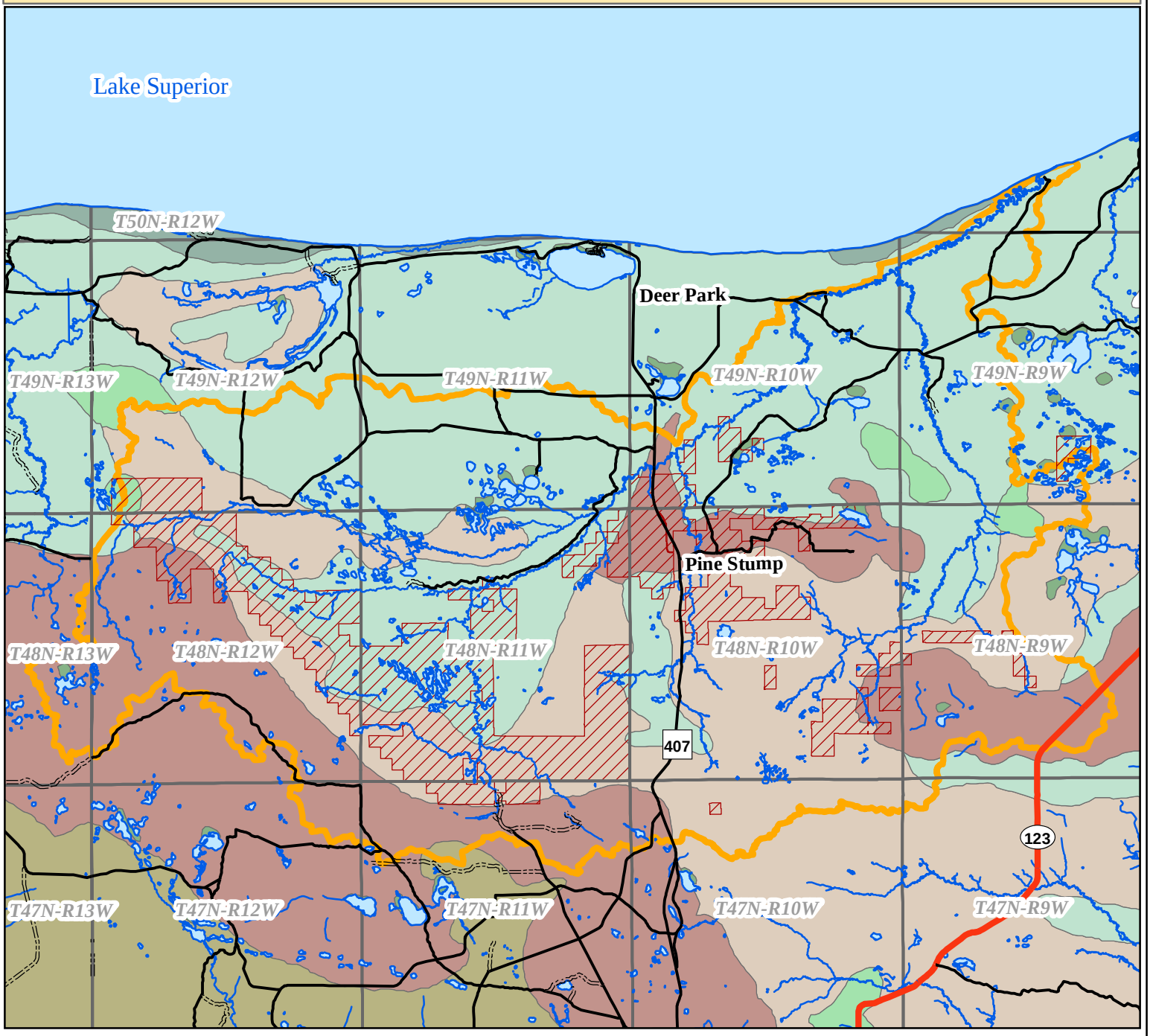
Exhibit D: Surficial Geology & Watershed Map



Legend

- = THRFR Property Boundary
- = Two-Hearted River Watershed
- = Coarse-textured glacial till
- = End moraines of coarse-textured till
- = Glacial outwash sand and gravel and postglacial alluvium
- = Lacustrine clay and silt
- = Lacustrine sand and gravel
- = Peat and muck

0 1 2 4 Miles

NORTH

Scale = 1:200,000
March 2020

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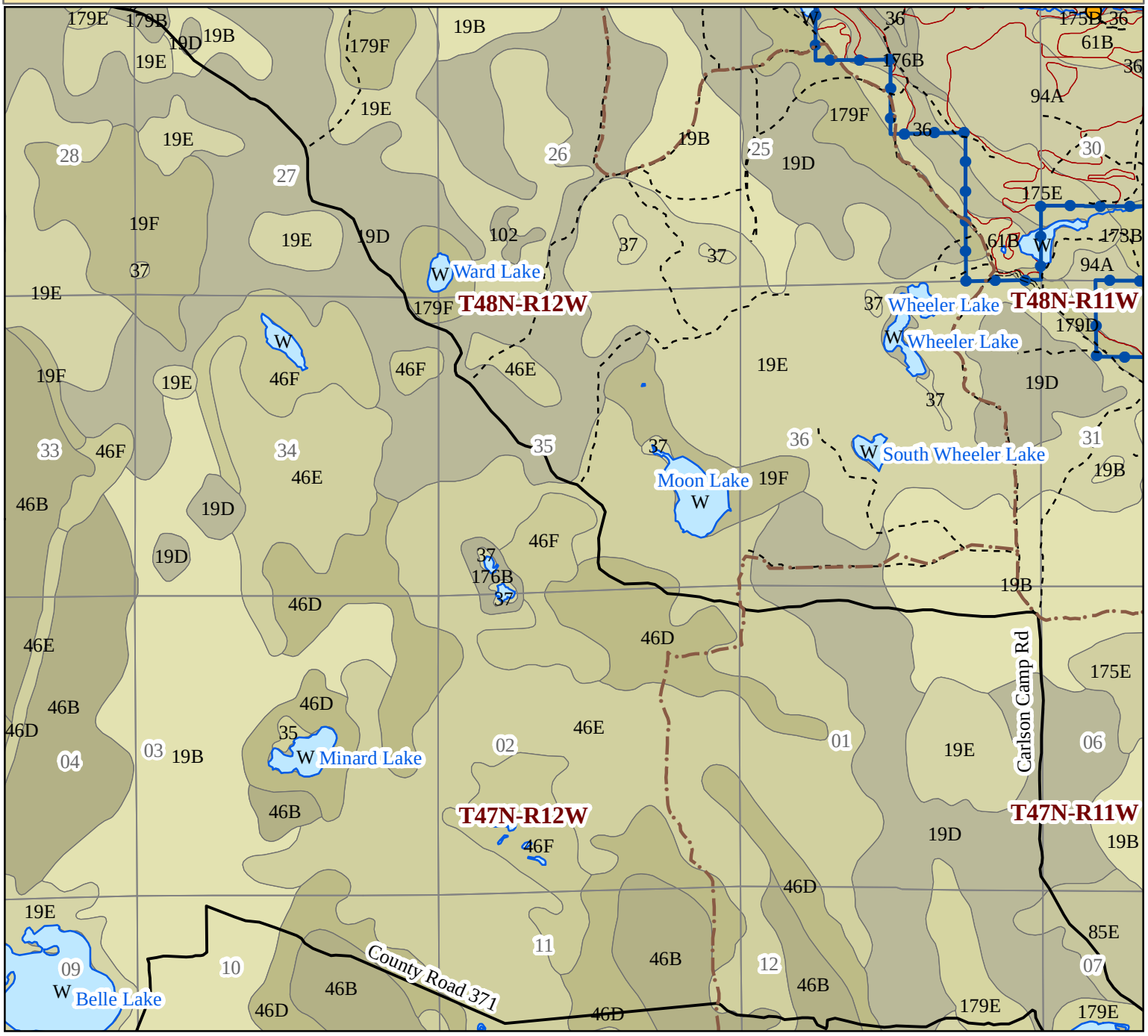
Exhibit E - Soils of the Two-Hearted River Forest Reserve
Soil Codes/Descriptions

MUSYM Code	Soil Name	Acreage	Percent
36	Carbondale, Lupton, and Tawas Soils	7,890	33%
94	Tawas-Spot-Finch Complex	2,248	9%
179	Wallace Sand	2,152	9%
175	Wallace-Spot Complex	2,132	9%
61	Paquin Sand	1,582	7%
89	Spot-Finch Complex	1,417	6%
176	Paquin-Spot Complex	1,275	5%
37	Dawson, Greenwood, and Loxley Soils	884	4%
102	Spot-Dawson Peats	837	3%
173	Paquin-Finch Sands	546	2%
W	Water	348	1%
206	Deerton Loamy Sands	346	1%
190	Bodi Silt Loam	304	1%
212	Markey Muck Peat	301	1%
90	Rousseau-Spot Complex	281	1%
75	Dillingham-Kalkaska Complex	262	1%
19	Kalkaska Sand	258	1%
110	Au Gres-Dawson-Rubicon Complex	251	1%
35	Histosol and Aquents, ponded	211	1%
201	Croswell-Deford Complex (flooded)	154	1%
45	Rubicon-Spot Complex	137	1%
91	Rousseau Fine Sand	119	0%
109	Rousseau-Dawson Complex	103	0%
189	Bodi-Chesbrough Silt Loams	85	0%
186	Sporley Silt Loam	59	0%
174	Croswell-Spot Complex	36	0%
18	Rubicon Sand	21	0%
22	Spot Peat	5	0%
286	Fence Silt Loam	0	0%
		24,244	**100%**

Slope Code	General Descriptions
A	0-3% Slopes
B	0-6% Slopes
C	0-10% Slopes
D	6-15% Slopes
E	15-35% Slopes
F	35-60% Slopes

Exhibit E: Soils Map - 1

Luce County: T48N-R12W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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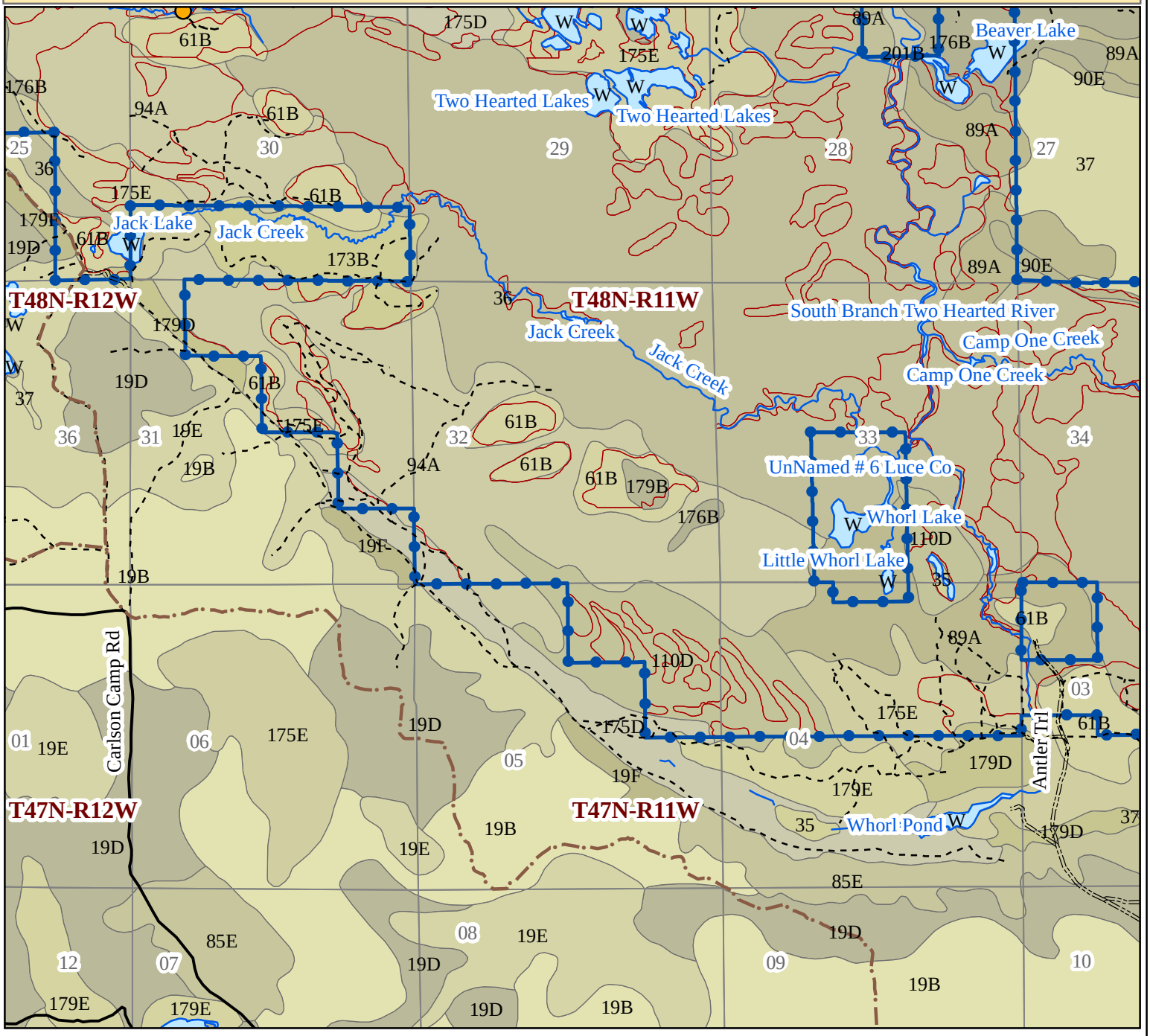
Exhibit E: Soils Map - 2

Luce County: T47N-R11W



Legend

= Two-Hearted Forest Reserve Property Boundary

= Stand Boundaries

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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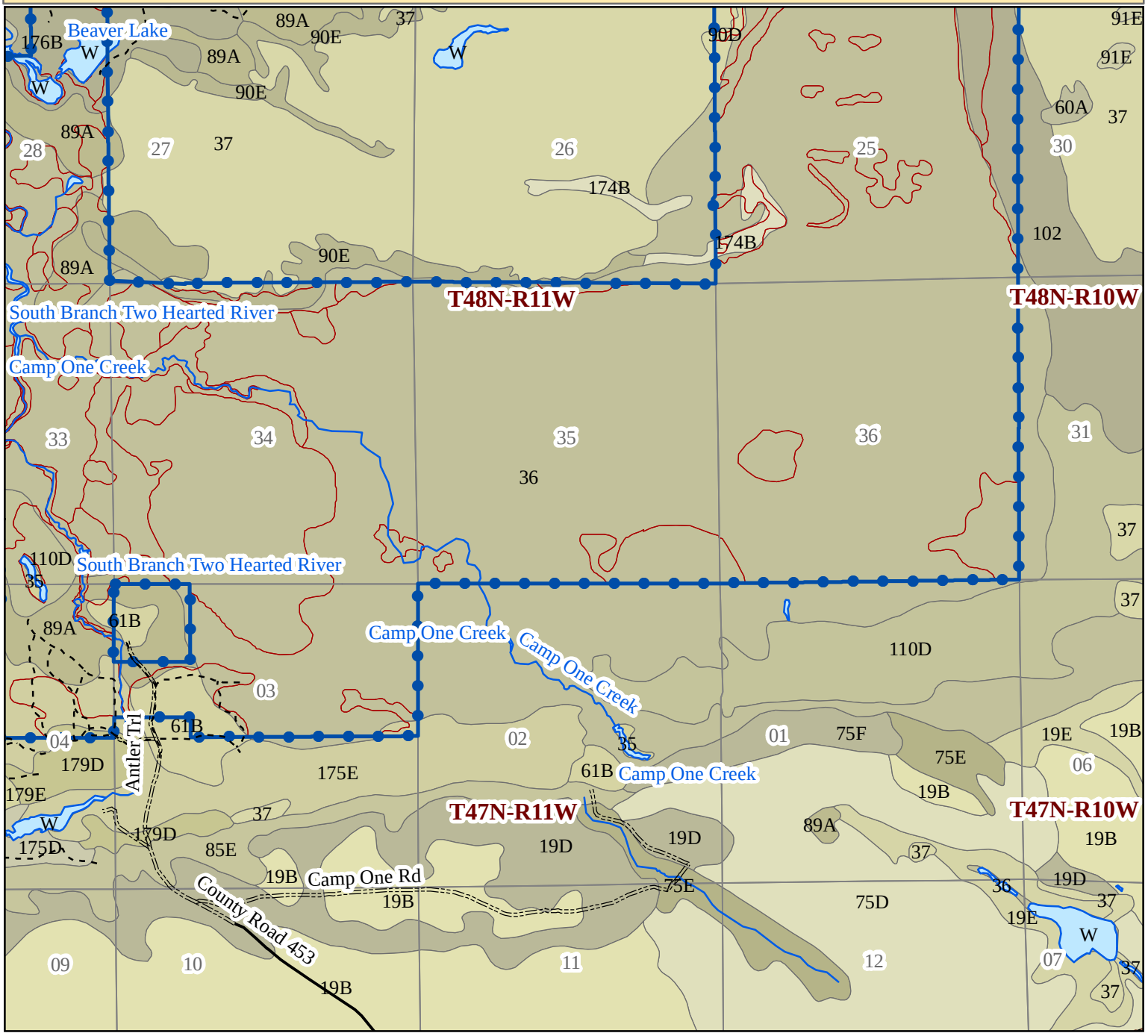
Exhibit E: Soils Map - 3

Luce County: T48N-R11W



Legend

= Two-Hearted Forest Reserve Property Boundary

= Stand Boundaries

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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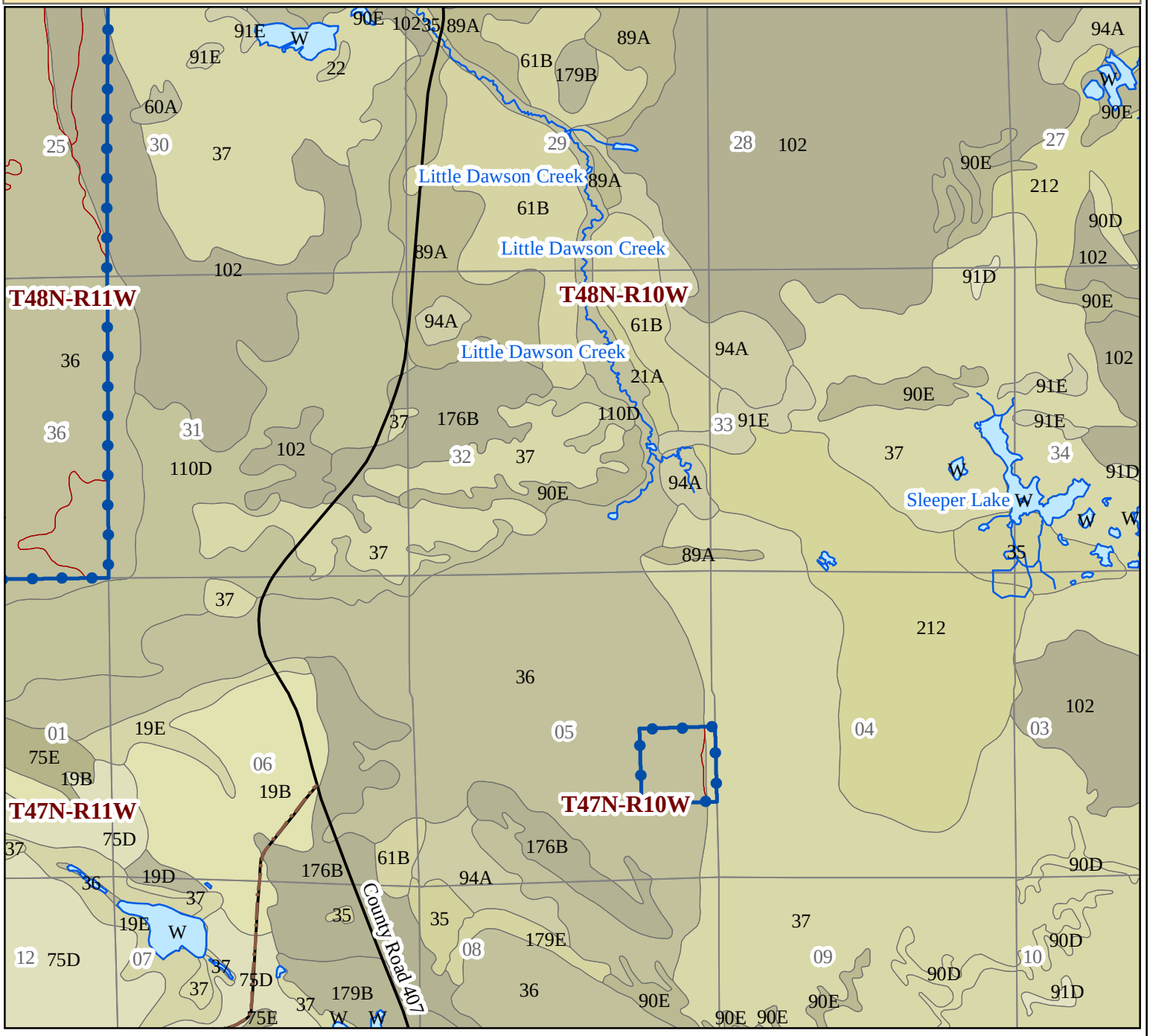
Exhibit E: Soils Map - 4

Luce County: T47N-R10W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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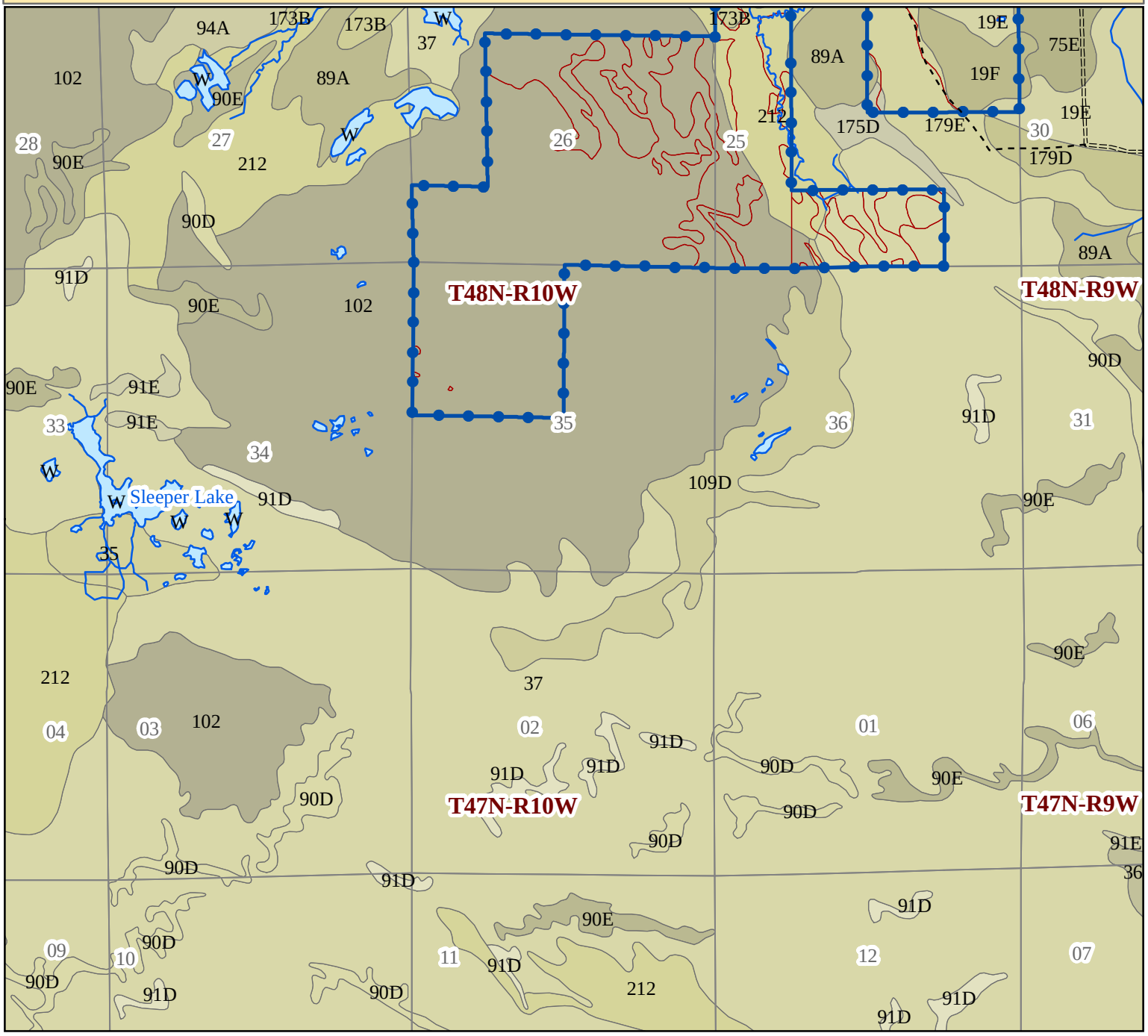
Exhibit E: Soils Map - 5

Luce County: T48N-R10W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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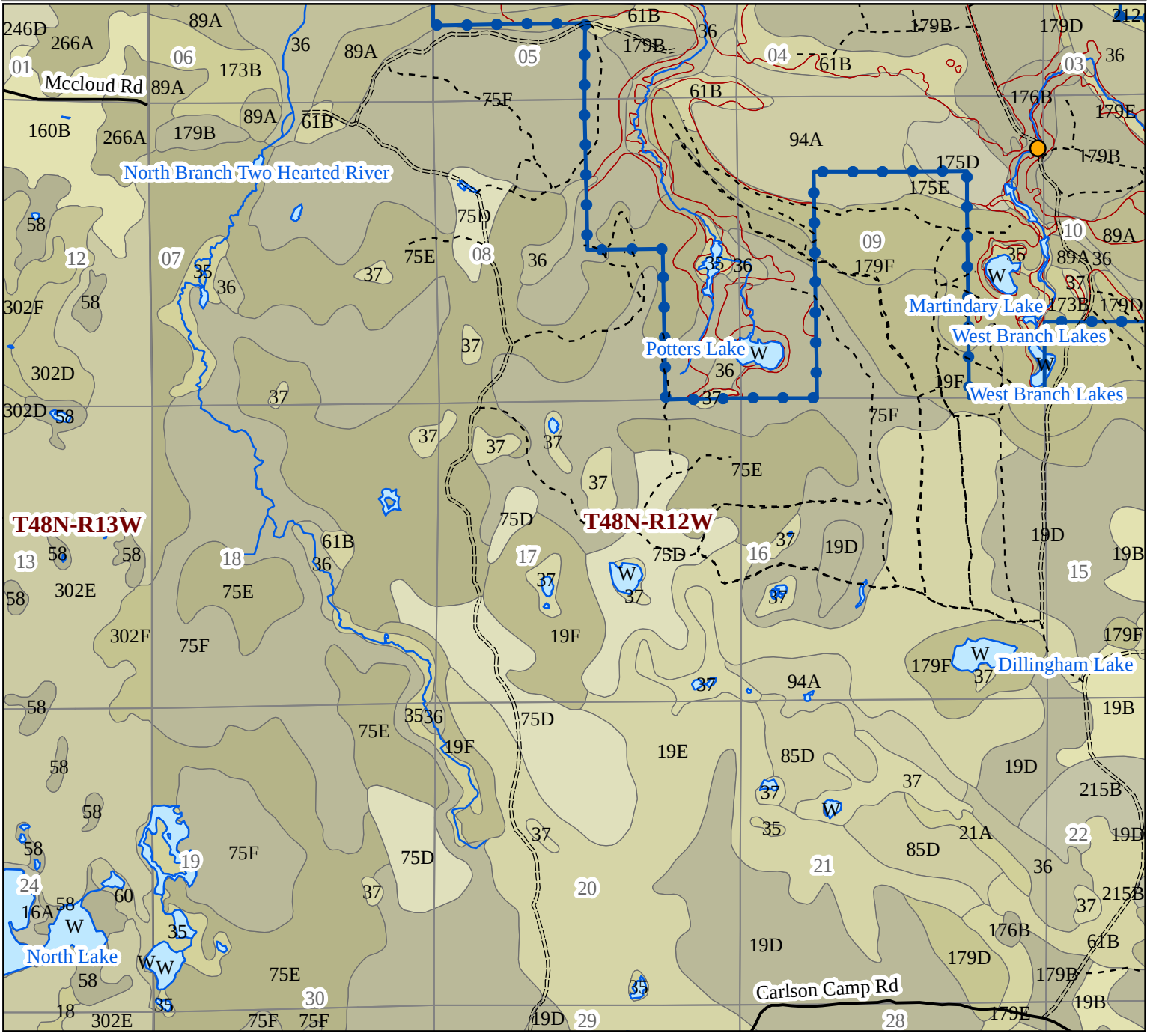
Exhibit E: Soils Map - 6

Luce County: T48N-R12W



Legend

= Two-Hearted Forest Reserve Property Boundary

= Stand Boundaries

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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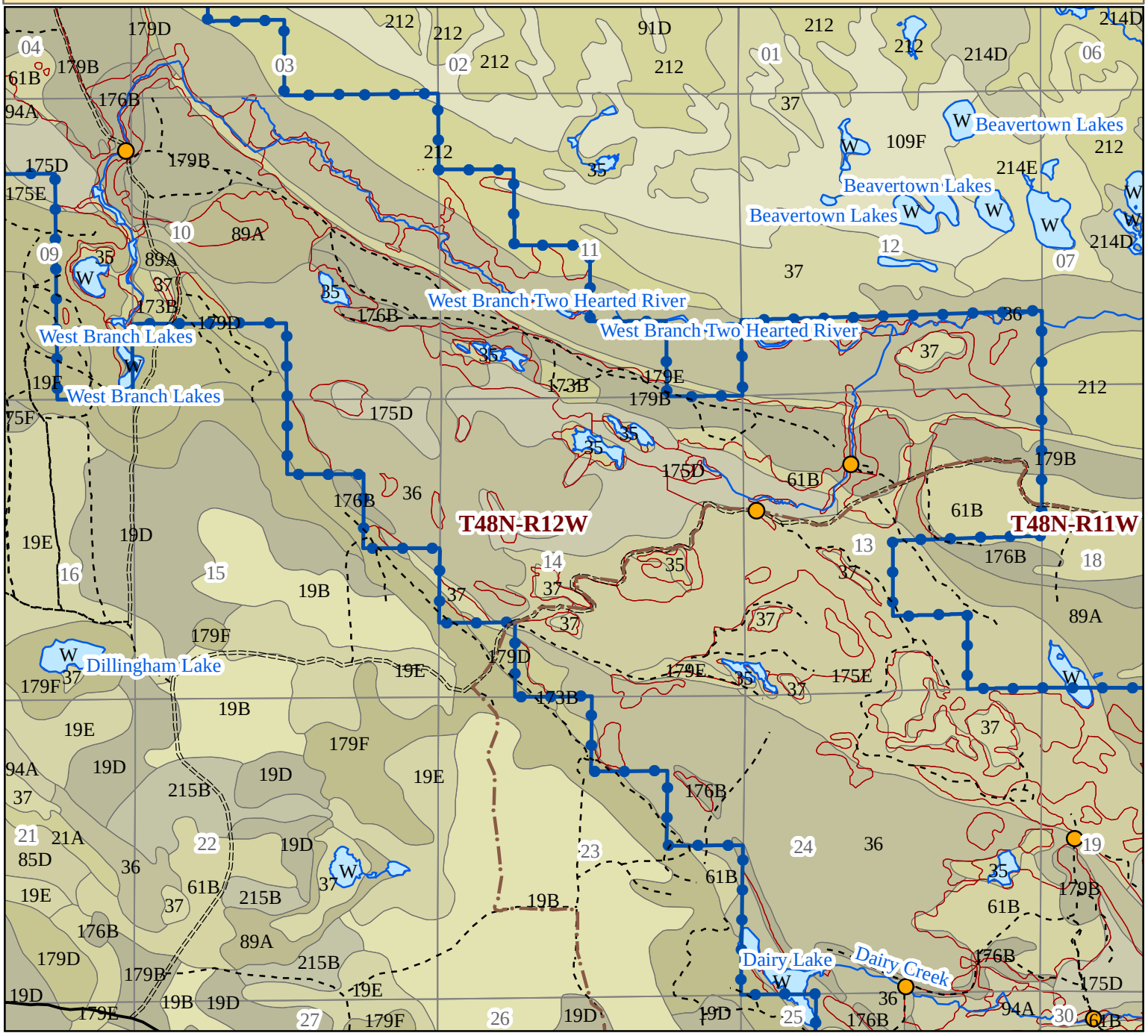
Exhibit E: Soils Map - 7

Luce County: T48N-R12W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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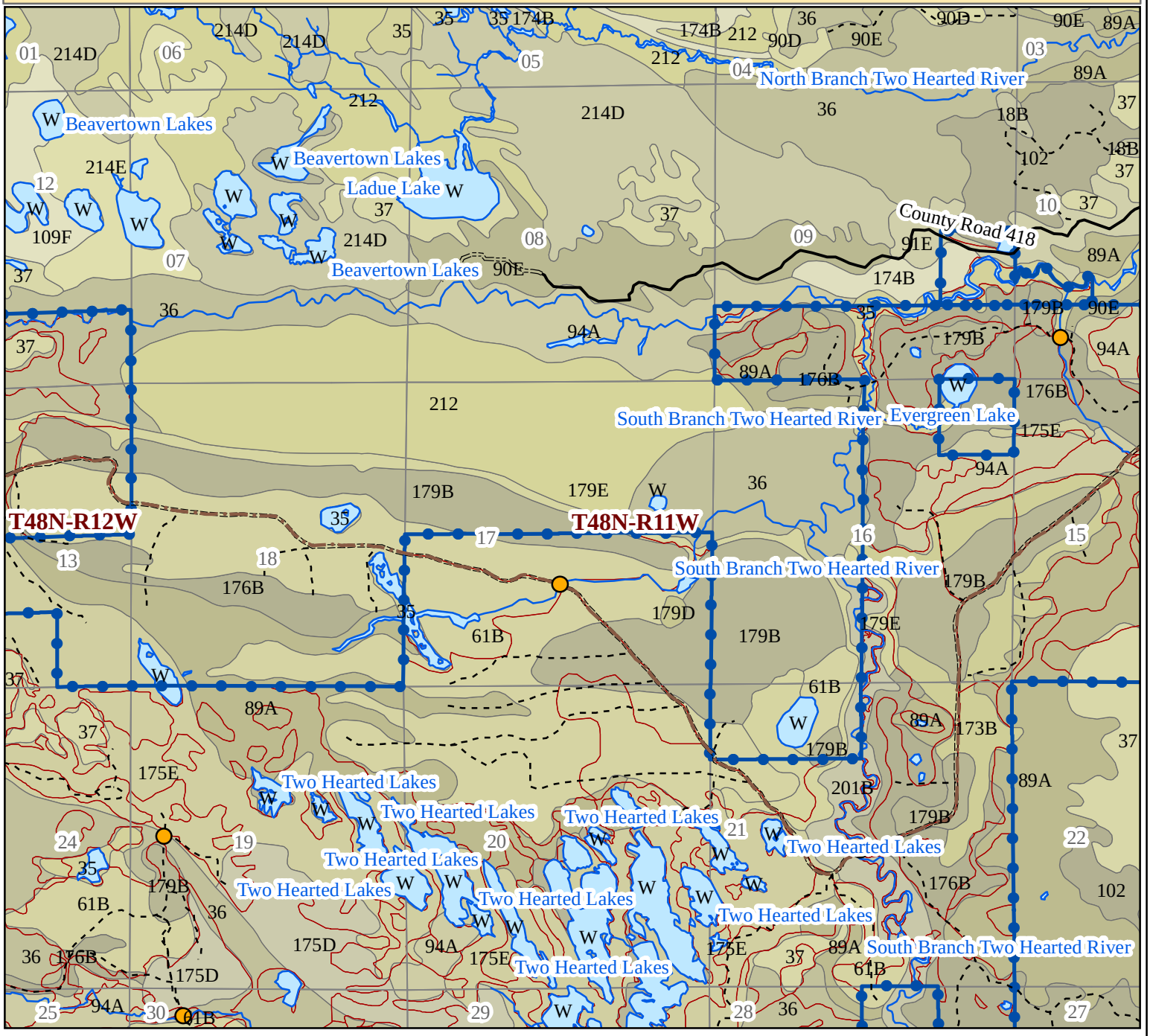
Exhibit E: Soils Map - 8

Luce County: T48N-R11W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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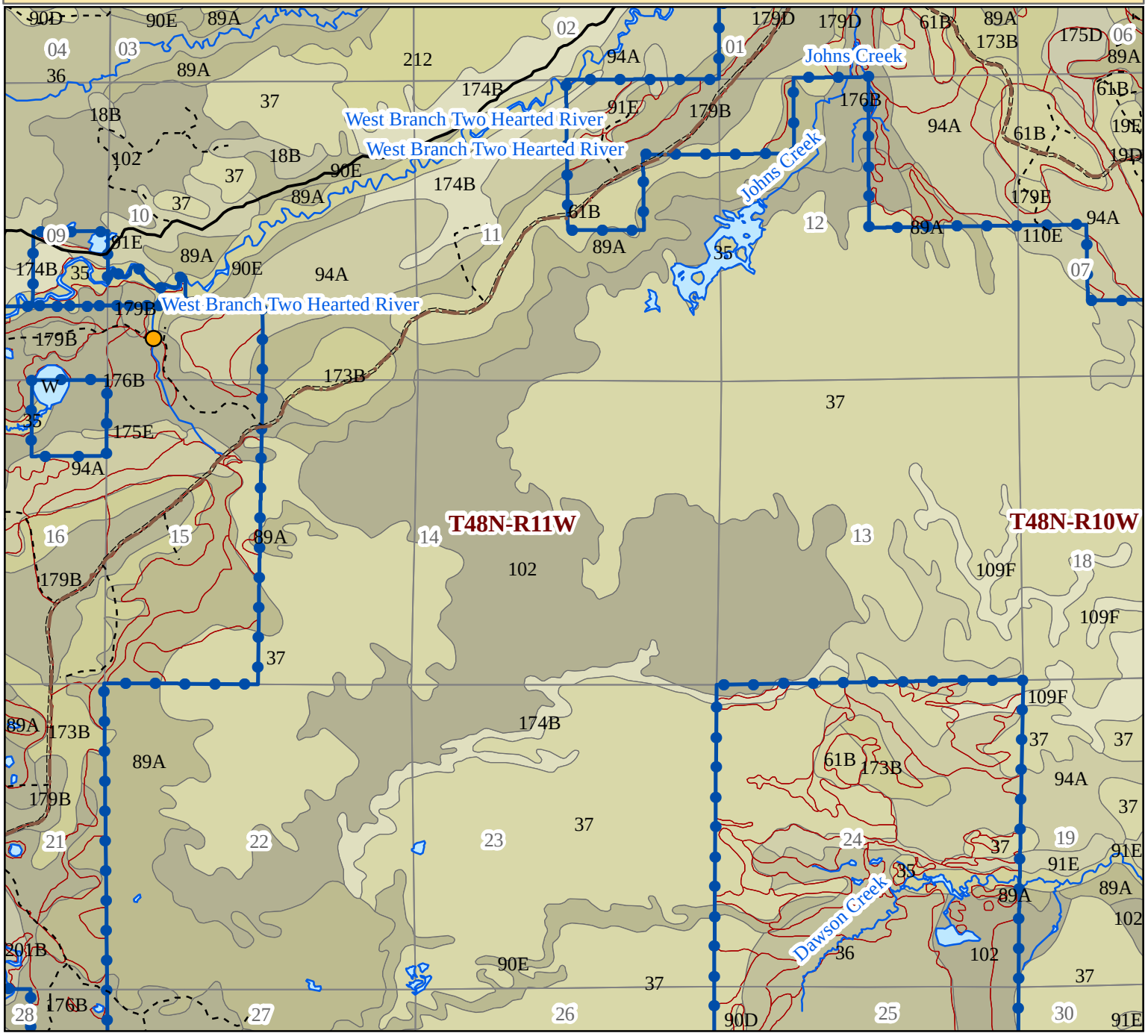
Exhibit E: Soils Map - 9

Luce County: T48N-R11W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
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- = Secondary Road
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- = Designated Snowmobile Trail
- = Road-Stream Crossing

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0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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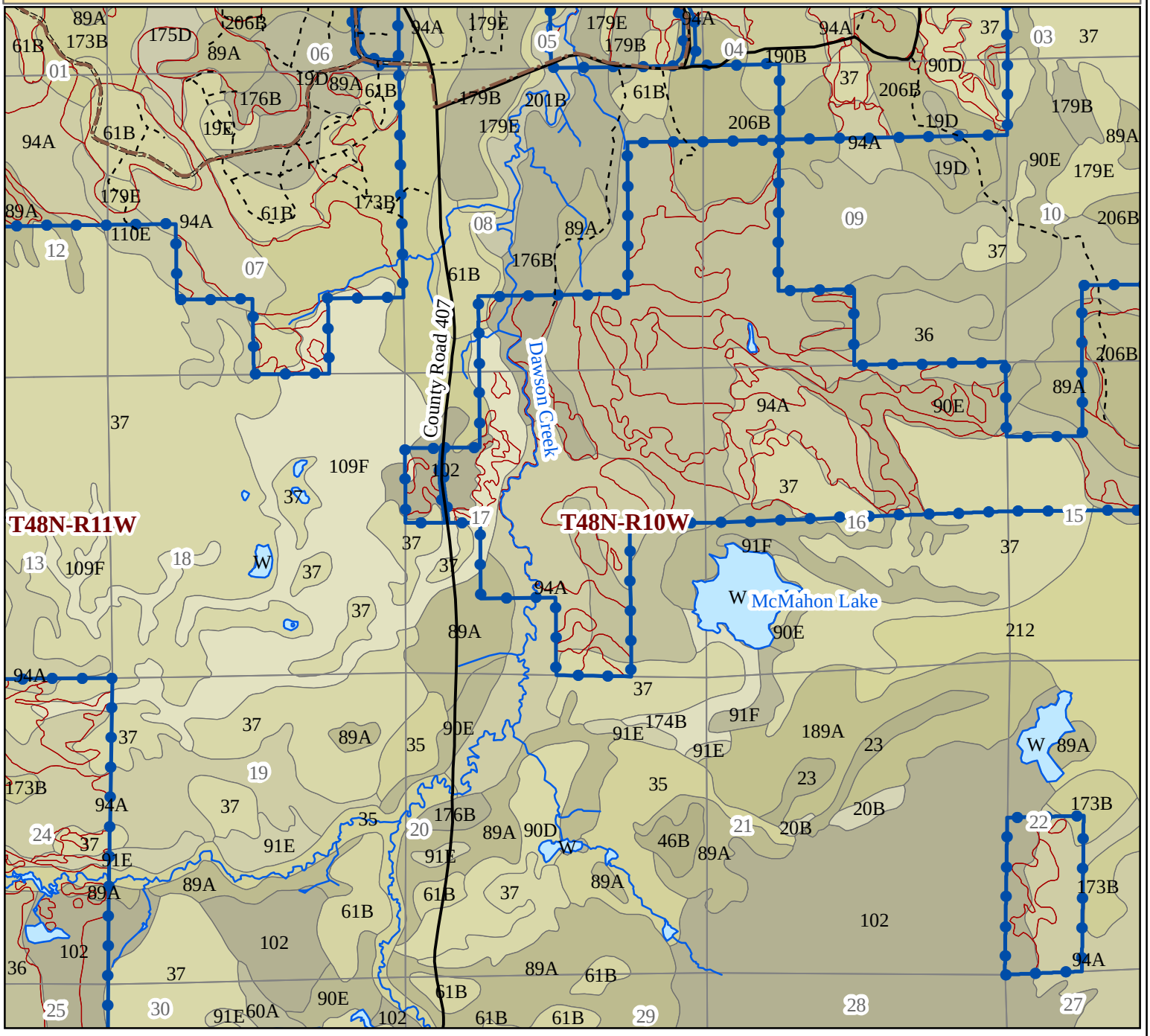
Exhibit E: Soils Map - 10

Luce County: T48N-R10W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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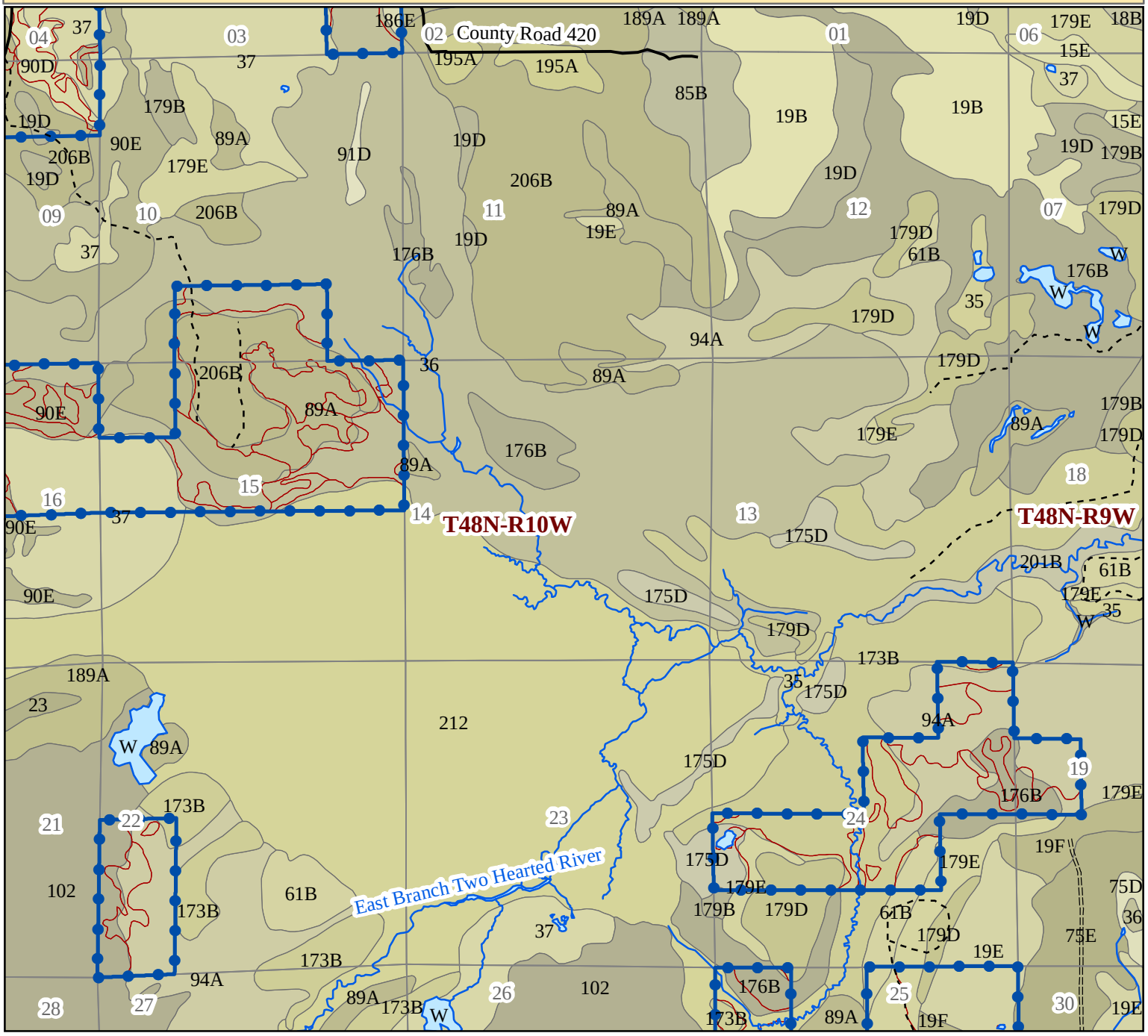
Exhibit E: Soils Map - 11

Luce County: T48N-R10W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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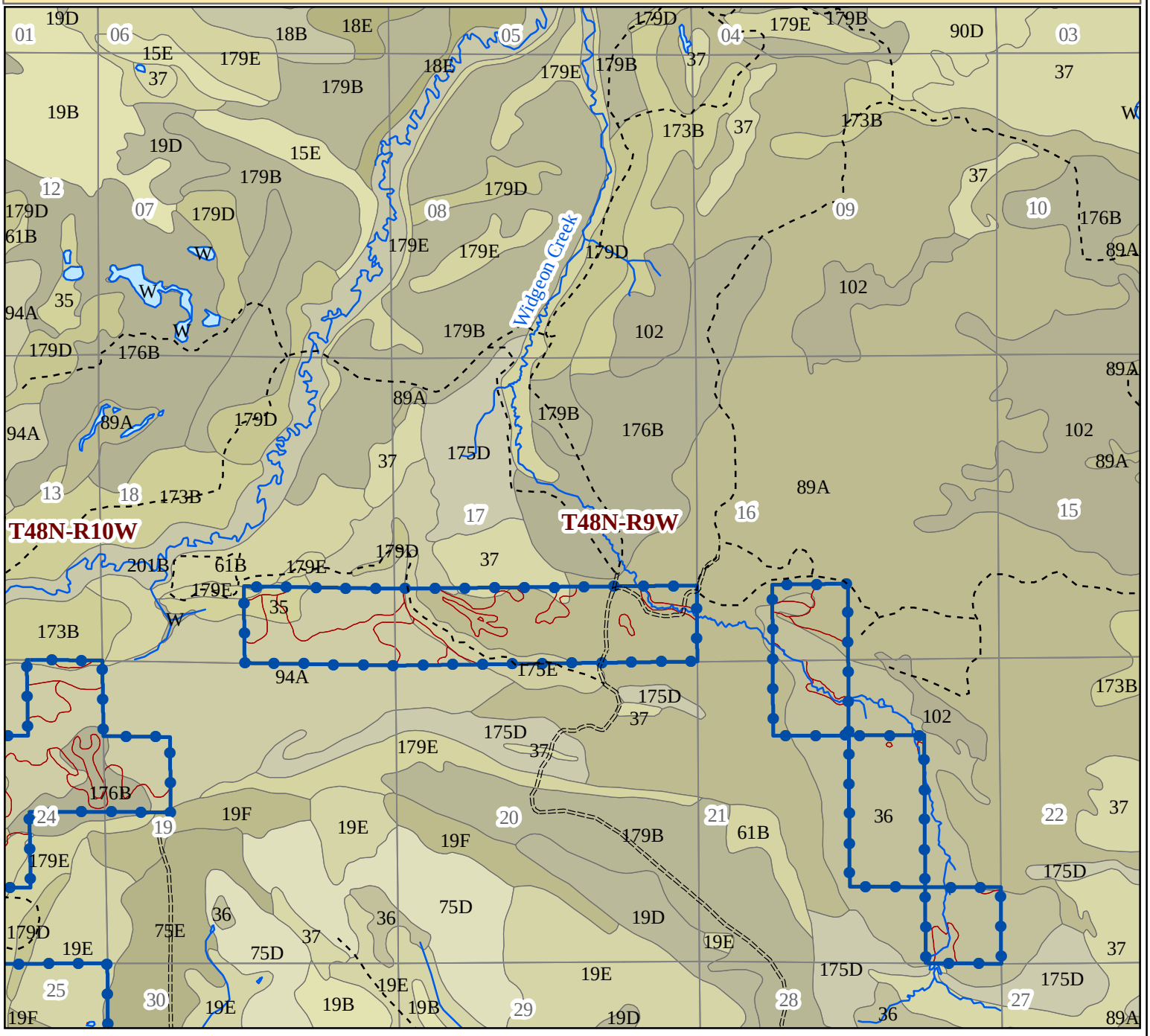
Exhibit E: Soils Map - 12

Luce County: T48N-R9W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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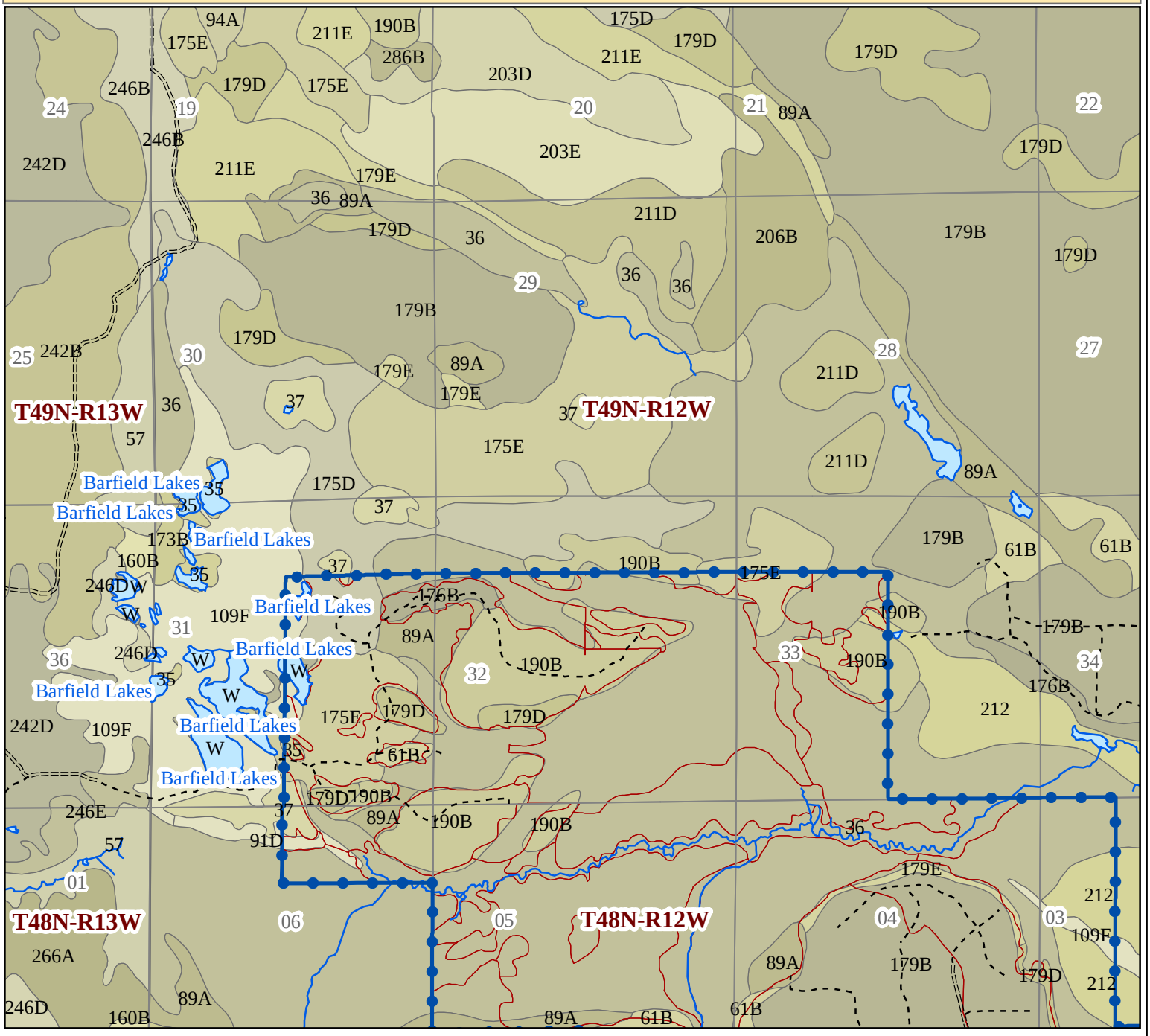
Exhibit E: Soils Map - 13

Luce County: T49N-R12W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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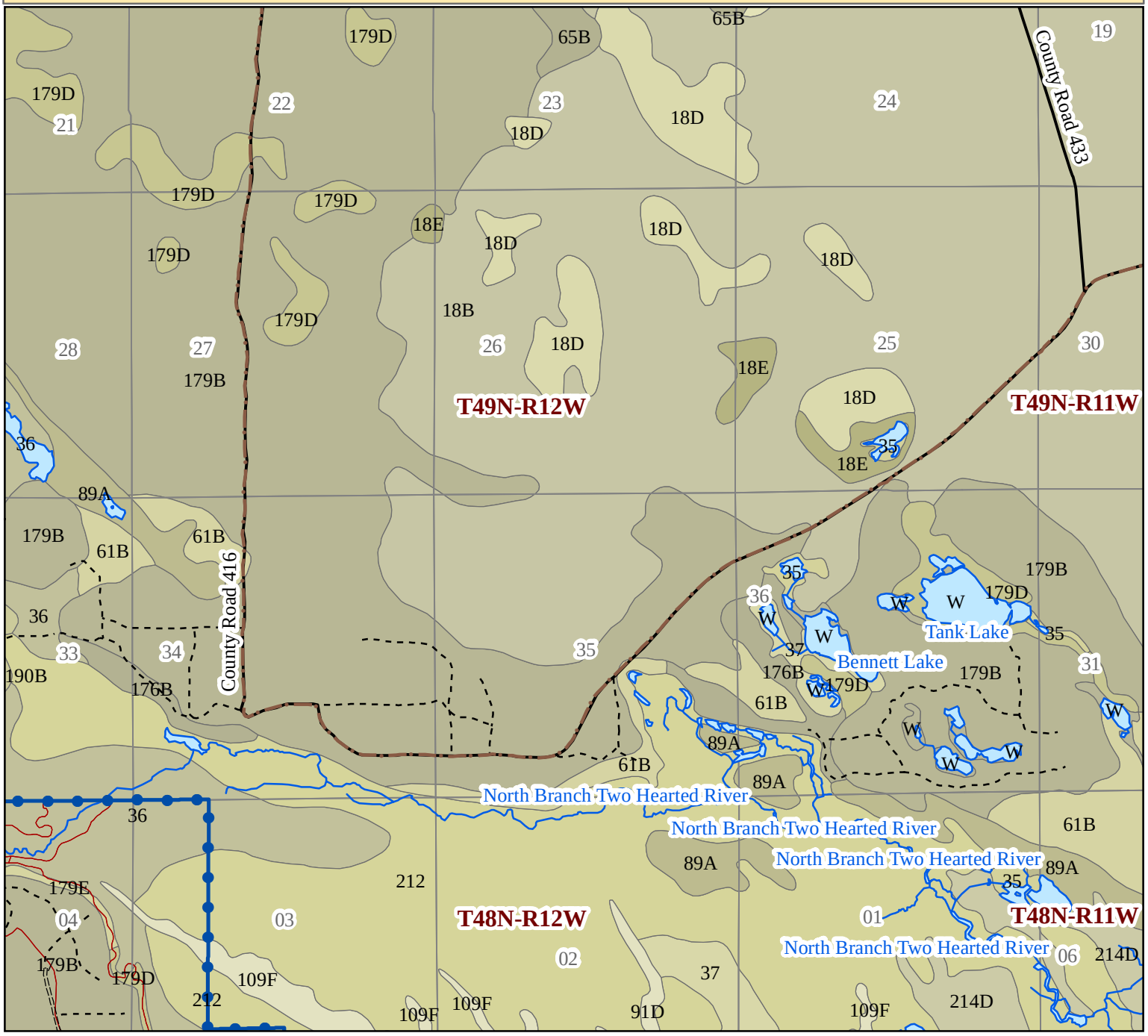
Exhibit E: Soils Map - 14

Luce County: T49N-R12W



Legend

= Two-Hearted Forest Reserve Property Boundary

= Stand Boundaries

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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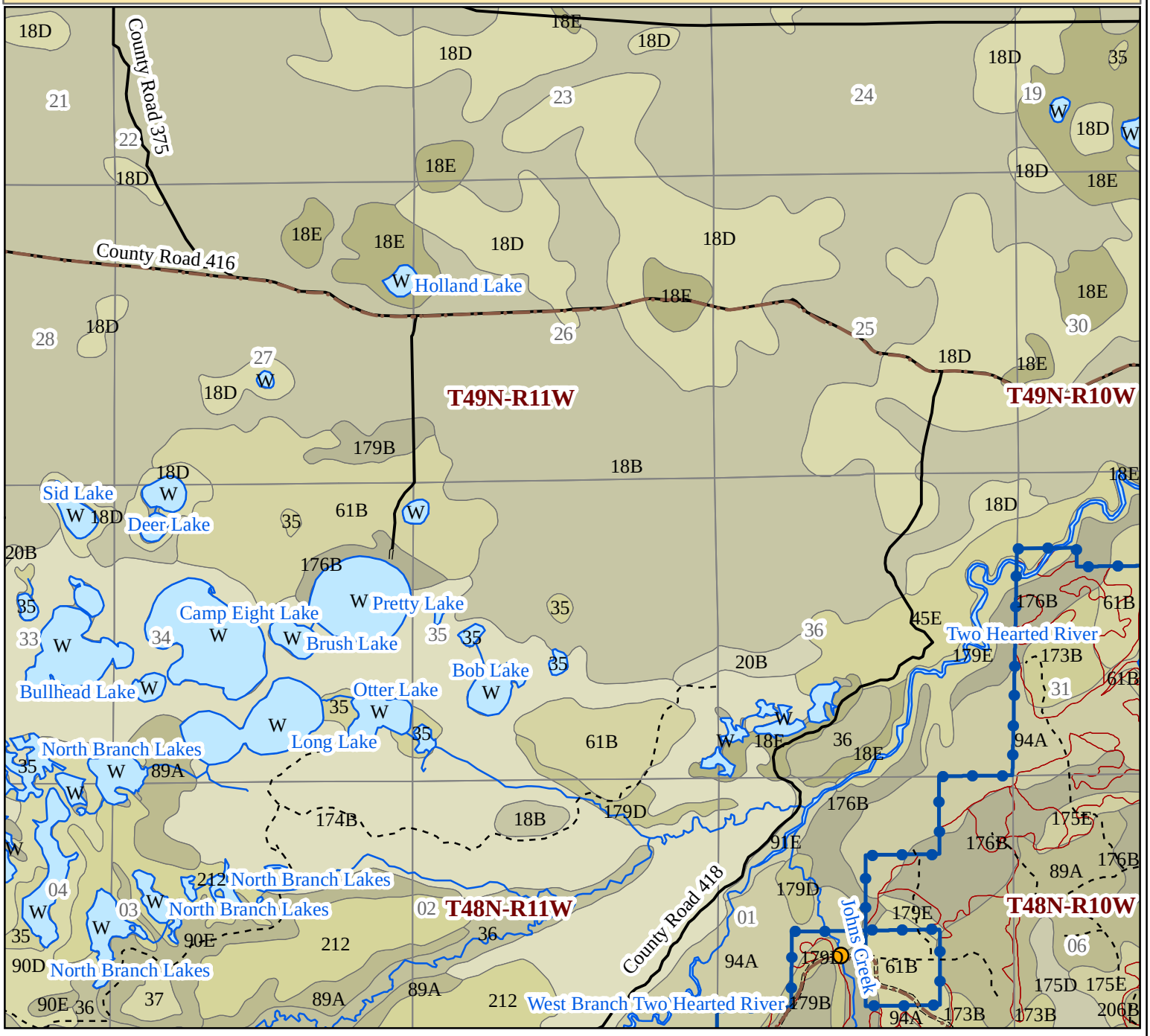
Exhibit E: Soils Map - 15

Luce County: T48N-R11W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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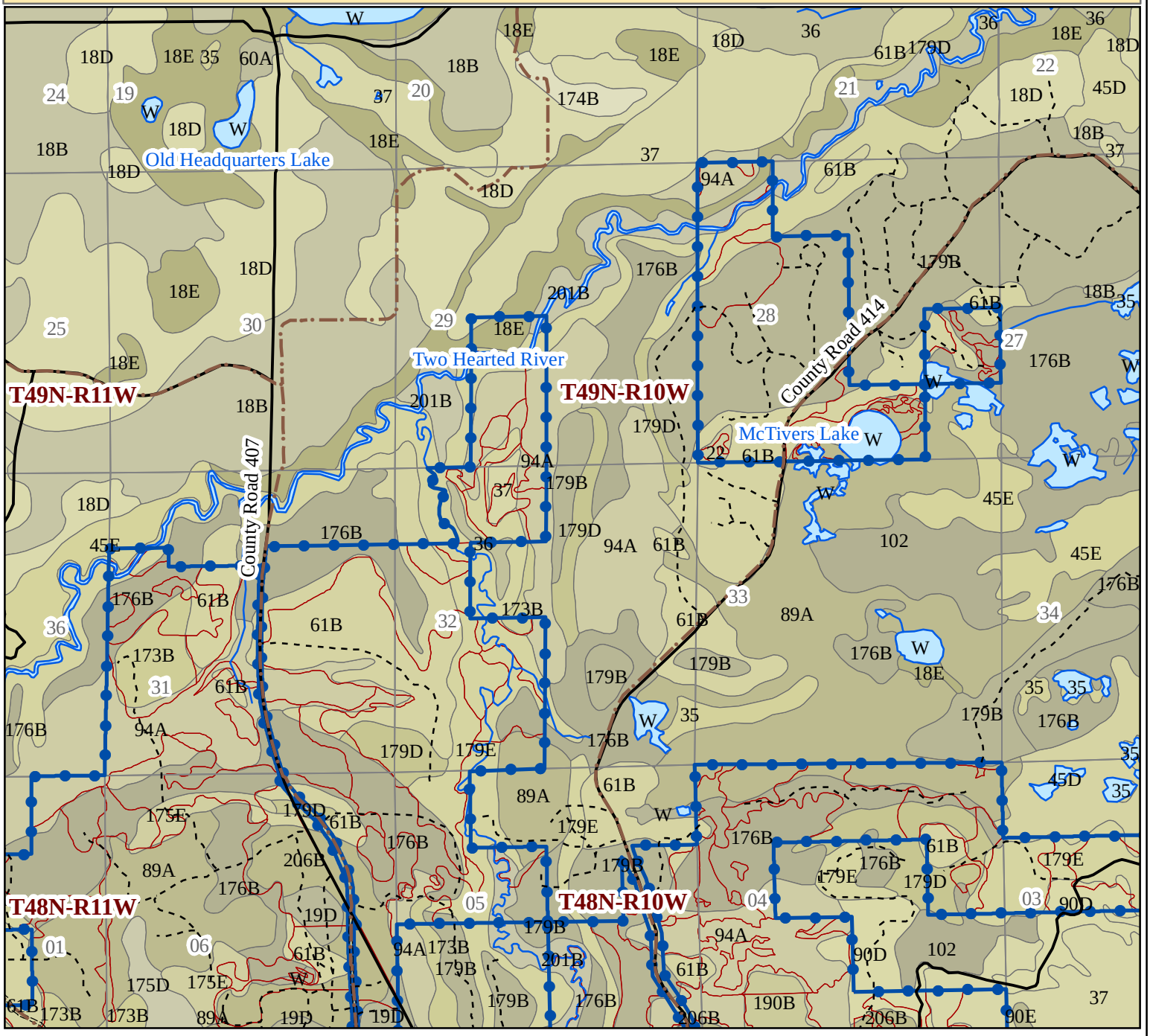
Exhibit E: Soils Map - 16

Luce County: T49N-R10W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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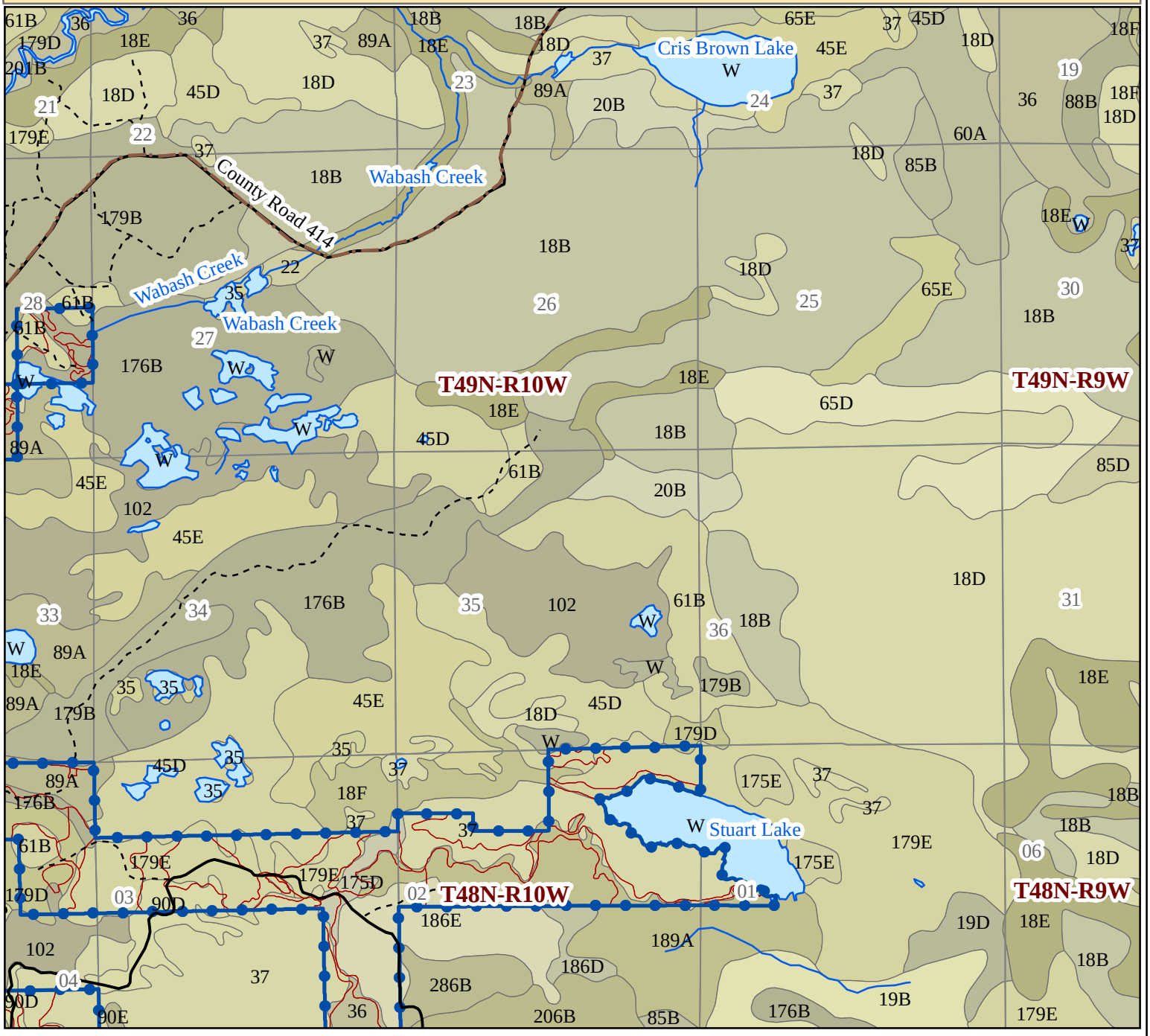
Exhibit E: Soils Map - 17

Luce County: T48N-R10W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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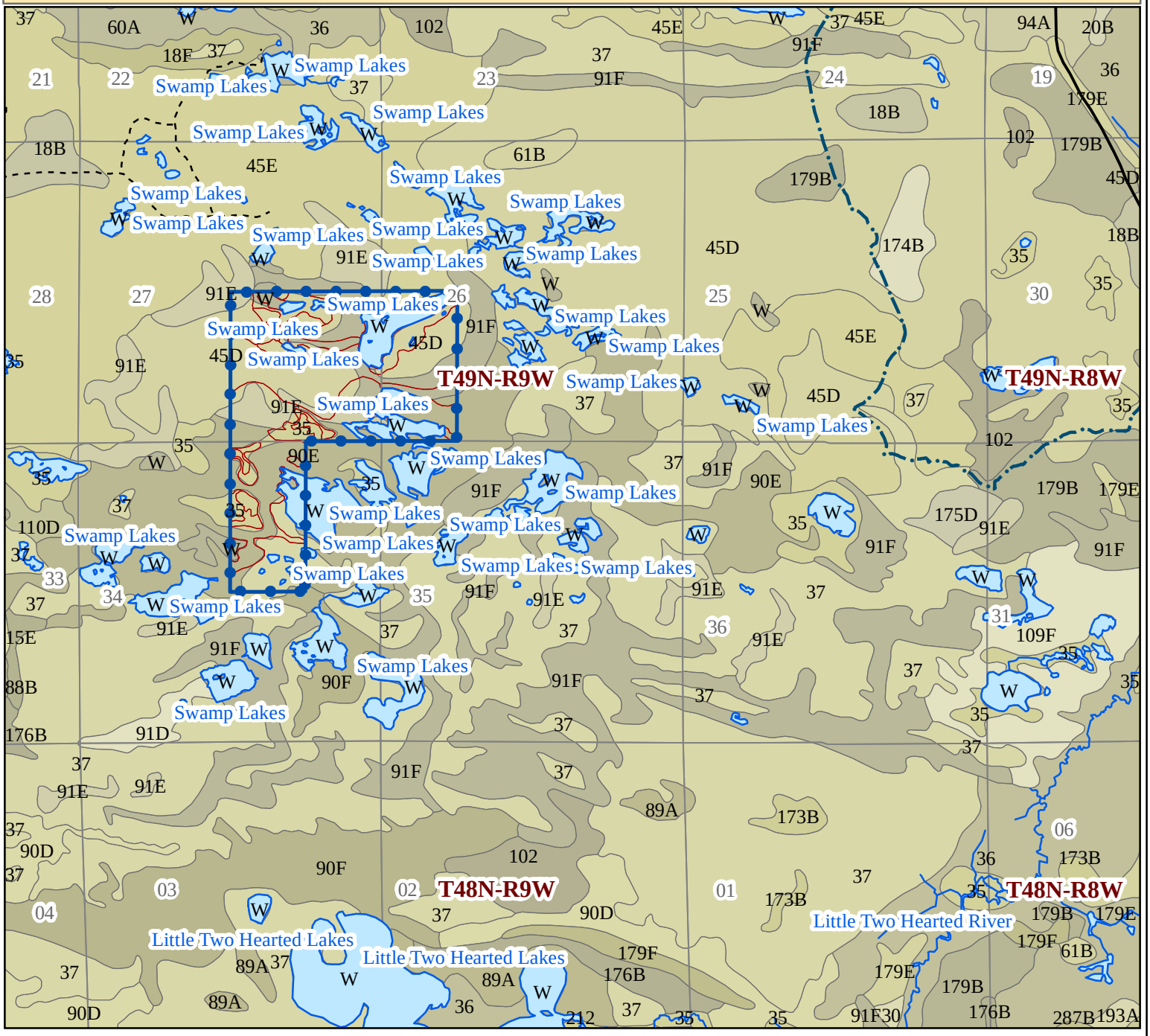
Exhibit E: Soils Map - 18

Luce County: T49N-R9W



Legend

= Two-Hearted Forest Reserve Property Boundary

= Stand Boundaries

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Road-Stream Crossing

***Labeled MUSYM Soil Codes on property can be referenced in the table at the beginning of Exhibit F.**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

The Nature Conservancy
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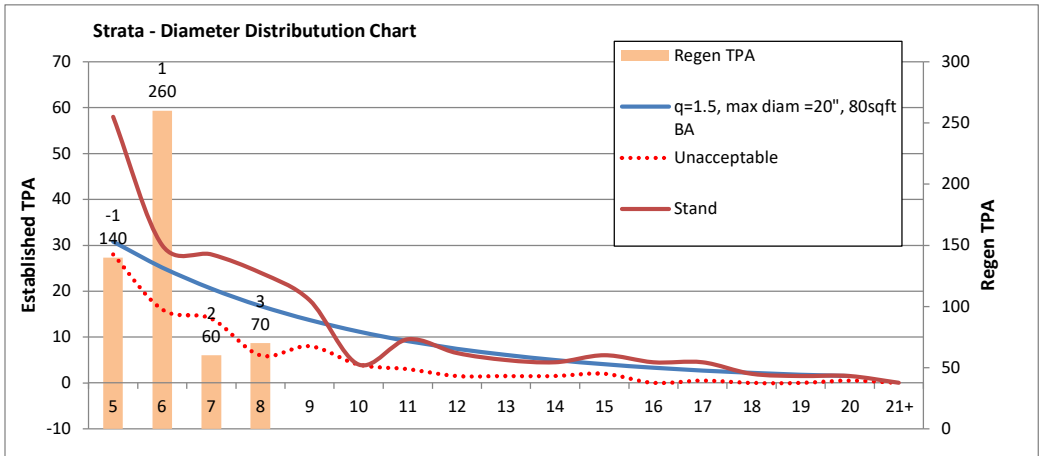
COMPASS™
LAND CONSULTANTS, INC.

Strata	LowlandSoftwood

	Values								
Species Group	BA/Ac	BA Poles	BA Saw	BF/Acre	Cds./ Acre	Non Grow Cords	Stems/ Acre	Regen	Regen TPA
Pine	10	3	7	626	2	0	11	Conifer	861
Hardwood	32	27	5	250	7	0	94	Pine	26
Conifer	94	76	18	872	20	0	230	Hardwood	484
Aspen	0	0	0	6	0	0	0	0	0
unknown	0	0	0	0	0	0	0	**Grand Total**	**1,371**
0	0	0	0	0	0	0	0		
Grand Total	**136**	**106**	**30**	**1,755**	**29**	**0**	**336**		

Regeneration - Trees/Acre by Species and Size Class

	Values								Stand TPA	Size Class							
Species	BA/Ac	BA Poles	BA Saw	BF/Acre	Cds./ Acre	Unaccpt Cords	Stems/ Acre	Avg DBH		-1	0	1	2	3	4	5	Grand Total
White Cedar	53	41	12	480	10	0	120	11	Black Spruce	13	--	16	10	3	--	--	42
Hemlock	23	19	4	268	6	0	30	14	White Pine	16	--	--	3	3	3	--	26
Red Maple	20	18	2	120	4	0	60	9	Yellow Birch	--	--	--	3	10	--	--	13
White Pine	9	3	6	588	2	0	9	15	Balsam Fir	61	--	52	77	35	29	--	255
Balsam Fir	6	6	0	19	1	0	39	7	White Cedar	174	--	65	55	39	19	3	355
Paper Birch	5	4	1	56	1	0	17	10	Hemlock	71	--	55	23	13	6	--	168
Yellow Birch	5	3	2	75	1	0	8	12	Sugar Maple	--	--	--	3	--	--	--	3
Black Spruce	4	4	1	34	1	0	16	9	Red Maple	90	--	29	42	3	13	--	177
Tamarack	4	4	0	0	1	0	17	7	White Spruce	3	--	--	3	--	--	--	6
White Spruce	4	3	1	72	1	0	9	10	Paper Birch	--	--	--	3	10	6	--	19
Black Ash	1	1	0	0	0	0	7	6	Tamarack	6	--	3	6	13	6	--	35
Beech	1	1	0	0	0	0	1	12	Black Ash	39	--	58	61	13	13	--	184
Quaking Aspen	0	0	0	6	0	0	0	15	Elm	--	--	10	3	--	3	--	16
Jack Pine	0	0	0	0	0	0	2	6	Beech	13	--	39	16	3	--	--	71
Red Pine	0	0	0	38	0	0	0	20	nullpt	--	0	--	--	--	--	--	0
Sugar Maple	0	0	0	0	0	0	1	5	**Grand Total**	**487**	**0**	**326**	**310**	**145**	**100**	**3**	**1,371**
nullpt	0	0	0	0	0	0	0	9									
unknown	0	0	0	0	0	0	0	15									
Grand Total	**136**	**106**	**30**	**1,755**	**29**	**0**	**336**	**11**									

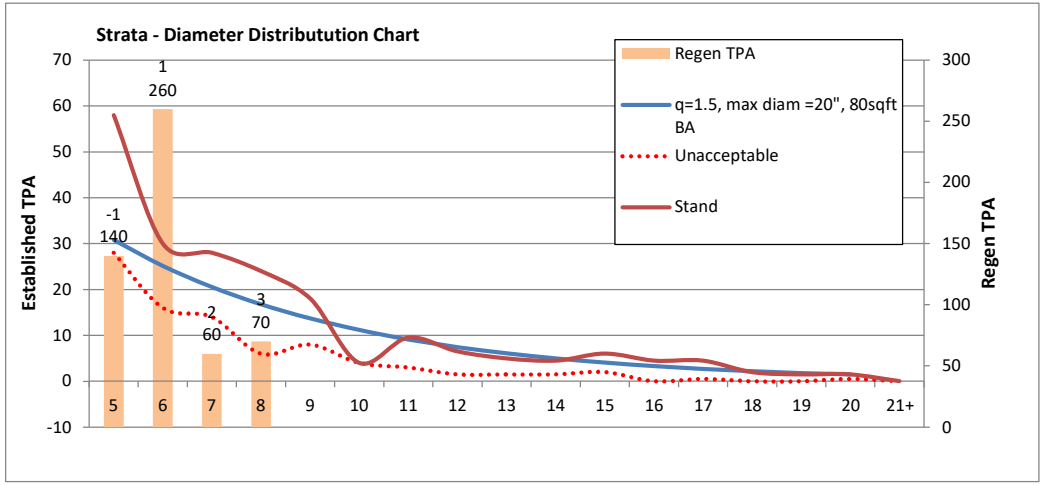


Strata	Hardwood

	Values								
Species Group	BA/Ac	BA Poles	BA Saw	BF/Acre	Cds./ Acre	Non Grow Cords	Stems/ Acre	Regen	Regen TPA
Pine	4	1	3	183	1	0	3	Conifer	117
Hardwood	83	51	31	2,212	18	0	178	Pine	2
Conifer	17	11	6	405	3	0	42	Hardwood	1,241
Grand Total	**103**	**63**	**40**	**2,800**	**22**	**0**	**223**	0	0
								Grand Total	**1,361**

Regeneration - Trees/Acre by Species and Size Class

	Values								Stand TPA	Size Class							
Species	BA/Ac	BA Poles	BA Saw	BF/Acre	Cds./ Acre	Unaccpt Cords	Stems/ Acre	Avg DBH		-1	0	1	2	3	4	5	Grand Total
Sugar Maple	32	16	16	1,077	7	0	61	11	Black Spruce	11	--	2	2	--	2	2	20
Red Maple	29	17	12	914	6	0	60	11	White Pine	--	--	2	--	--	--	--	2
Beech	17	16	1	85	4	0	48	11	Yellow Birch	--	--	2	--	--	--	--	2
White Cedar	6	4	2	184	1	0	15	11	Ironwood	--	--	--	9	9	--	--	17
Hemlock	5	3	2	129	1	0	6	14	Balsam Fir	13	--	26	17	2	--	--	59
White Pine	4	1	3	183	1	0	3	17	White Cedar	--	--	13	7	7	--	2	28
Yellow Birch	3	2	1	121	1	0	5	13	Hemlock	--	--	--	--	2	2	2	7
White Spruce	3	2	1	63	0	0	10	8	Sugar Maple	152	--	98	54	7	7	--	317
Balsam Fir	1	1	0	0	0	0	7	8	Red Maple	85	--	85	61	15	11	7	263
Tamarack	1	0	0	29	0	0	1	13	White Spruce	--	--	2	--	--	2	--	4
Black Spruce	1	1	0	0	0	0	2	8	Black Ash	--	--	4	2	--	--	--	7
Paper Birch	0	0	0	15	0	0	1	12	Beech	189	--	311	83	37	15	--	635
Ironwood	0	0	0	0	0	0	2	5	nullpt	--	0	--	--	--	--	--	0
Black Cherry	0	0	0	0	0	0	0	8	**Grand Total**	**450**	**0**	**546**	**235**	**78**	**39**	**13**	**1,361**
Misc Hardwood	0	0	0	0	0	0	1	5									
Grand Total	**103**	**63**	**40**	**2,800**	**22**	**0**	**223**	**11**									

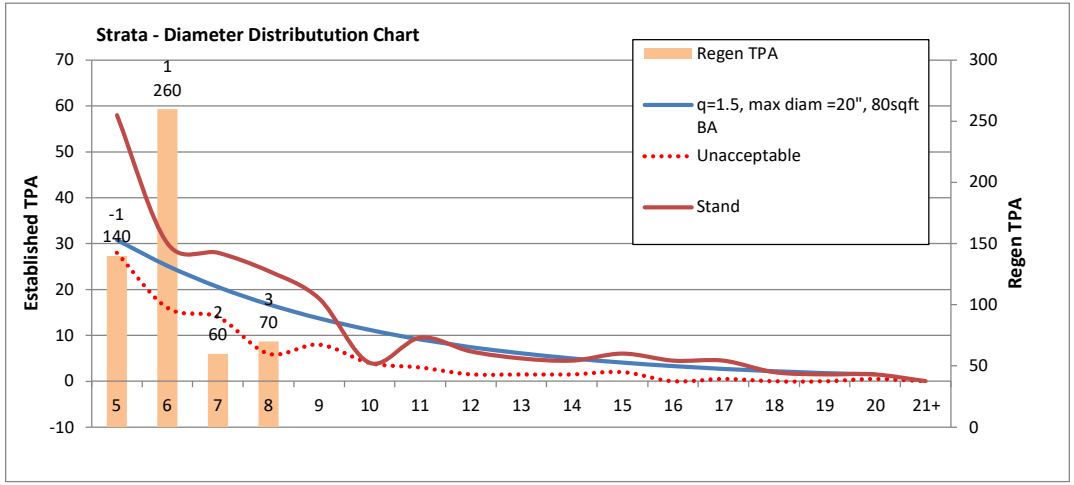


Strata	Hemlock/Hardwood

	Values								
Species Group	BA/Ac	BA Poles	BA Saw	BF/Acre	Cds./ Acre	Non Grow Cords	Stems/ Acre	Regen	Regen TPA
Pine	10	2	8	800	2	0	8	Conifer	453
Hardwood	58	40	17	1,195	12	0	148	Pine	20
Conifer	55	40	15	943	11	0	127	Hardwood	737
Aspen	0	0	0	0	0	0	0	0	0
unknown	0	0	0	0	0	0	1	**Grand Total**	**1,210**
0	0	0	0	0	0	0	0		
Grand Total	**123**	**83**	**40**	**2,939**	**25**	**0**	**283**		

Regeneration - Trees/Acre by Species and Size Class

	Values								Stand TPA	Size Class							
Species	BA/Ac	BA Poles	BA Saw	BF/Acre	Cds./ Acre	Unaccpt Cords	Stems/ Acre	Avg DBH		-1	0	1	2	3	4	5	Grand Total
Red Maple	38	27	11	703	8	0	94	10	Black Spruce	7	--	--	3	3	--	--	13
Hemlock	35	23	12	719	7	0	65	12	White Pine	20	--	--	--	--	--	--	20
White Cedar	10	9	2	72	2	0	23	11	Yellow Birch	7	--	3	3	3	--	3	20
White Pine	10	2	7	769	2	0	8	17	Ironwood	3	--	--	3	--	--	--	7
Yellow Birch	6	3	3	223	1	0	13	12	Balsam Fir	40	--	57	30	10	7	--	143
Sugar Maple	5	3	2	142	1	0	13	11	White Cedar	7	--	3	7	7	7	--	30
Beech	5	5	0	18	1	0	19	9	Hemlock	130	--	20	33	23	27	--	233
Paper Birch	4	2	2	110	1	0	10	11	Sugar Maple	120	--	10	17	10	--	--	157
Black Spruce	4	3	0	10	1	0	14	7	Red Maple	243	--	20	47	23	20	--	353
Balsam Fir	4	3	1	52	1	0	18	8	White Spruce	23	--	--	7	--	3	--	33
White Spruce	3	2	1	91	1	0	6	11	Paper Birch	3	--	3	--	--	--	--	7
Bigtooth Aspen	0	0	0	0	0	0	0	22	Beech	63	--	43	40	30	17	--	193
Red Pine	0	0	0	32	0	0	0	19	nullpt	--	0	--	--	--	--	--	0
Jack Pine	0	0	0	0	0	0	0	14	**Grand Total**	**667**	**0**	**160**	**190**	**110**	**80**	**3**	**1,210**
unknown	0	0	0	0	0	0	1	5									
nullpt	0	0	0	0	0	0	0	12									
Grand Total	**123**	**83**	**40**	**2,939**	**25**	**0**	**283**	**11**									

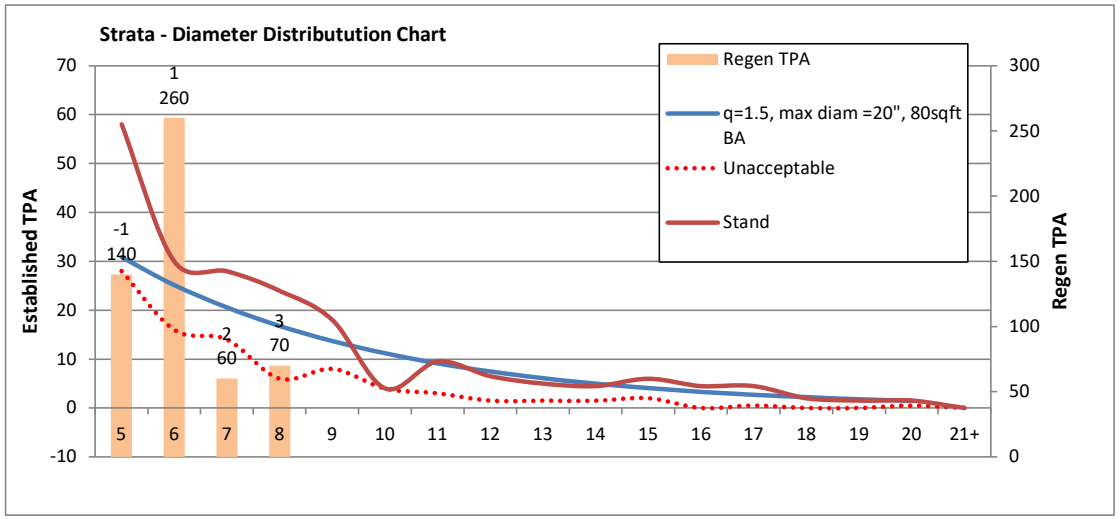


Strata	Upland Softwood

	Values								
Species Group	BA/Ac	BA Poles	BA Saw	BF/Acre	Cds./ Acre	Non Grow Cords	Stems/ Acre	Regen	Regen TPA
Pine	48	6	42	4,446	6	0	49	Conifer	240
Hardwood	24	20	4	252	5	0	64	Pine	120
Conifer	27	20	7	465	4	0	99	Hardwood	190
Aspen	7	2	4	278	1	0	8	**Grand Total**	**550**
Grand Total	**105**	**48**	**57**	**5,441**	**16**	**0**	**220**		

Regeneration - Trees/Acre by Species and Size Class

	Values								Stand TPA	Size Class					
Species	BA/Ac	BA Poles	BA Saw	BF/Acre	Cds./ Acre	Unaccpt Cords	Stems/ Acre	Avg DBH		-1	1	2	3	4	Grand Total
White Pine	37	5	33	3,449	4	0	36	16	Black Spruce	--	20	10	10	--	40
Red Maple	21	18	3	206	4	0	55	9	White Pine	--	40	--	20	--	60
White Spruce	13	12	1	92	2	0	62	7	Balsam Fir	20	70	10	10	10	120
Red Pine	9	0	9	997	1	0	11	13	Hemlock	10	20	--	--	--	30
Hemlock	7	2	5	310	1	0	12	13	Red Maple	10	--	20	20	10	60
Bigtooth Aspen	7	2	4	278	1	0	8	15	White Spruce	20	10	10	--	--	40
Balsam Fir	5	5	1	45	1	0	25	7	Black Cherry	20	--	--	--	--	20
Jack Pine	1	1	0	0	0	0	2	11	Tamarack	--	10	--	--	--	10
Paper Birch	1	0	1	47	0	0	5	10	Beech	60	40	10	--	--	110
Sugar Maple	1	1	0	0	0	0	2	9	Red Pine	--	50	--	10	--	60
White Cedar	1	1	0	0	0	0	1	15	**Grand Total**	**140**	**260**	**60**	**70**	**20**	**550**
Yellow Birch	1	1	0	0	0	0	3	9							
Black Spruce	0	0	0	19	0	0	1	11							
Grand Total	**105**	**48**	**57**	**5,441**	**16**	**0**	**220**	**11**							



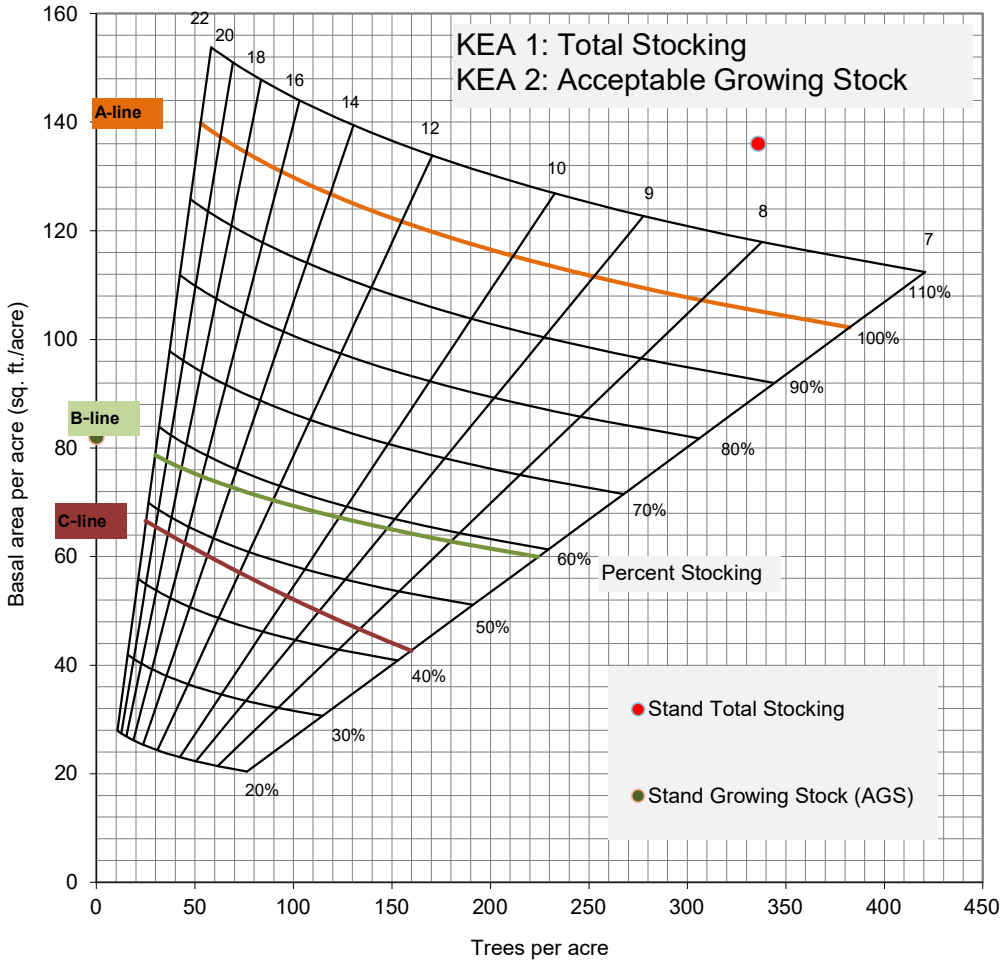
Strata

Lowland Softwood	LowlandSoftwood

Row Labels	Values Stand BA	Stand TPA	TPA Acceptable	TPA unacceptable
Pine	9.6	11	0	1
Hardwood	31.8	94	0	29
Conifer	94.3	230	0	79
Aspen	0.4	0	0	0
unknown	0.0	0	0	0
0	0.0	0	0	0
Grand Total	**136.1**	**336**	**0**	**110**

- Fair 41-60%
- Good 61-79%
- Very Good 80-100%

- Fair 41-53%
- Good 54-69%
- Very Good > 70%



KEA 3: Tree Species Diversity (Richness)

Indicator: Average number of tree species per stand (stems > 5" dbh)

- Poor <3
- Fair 3-6
- Good 7-9
- Very Good >10

Stand Richness	**17.00**

KEA 4: Tree Species Evenness (Richness Distribution)

Indicator: Distribution of tree species diversity across forest stand (stems > 5" dbh)

- Poor 0-0.6
- Fair 0.61-0.7
- Good 0.71-0.8
- Very Good > 0.81

0-0.6
0.61-0.7
0.71-0.8
>0.81

$$J' = \frac{H'}{H'_{\max}}$$

Stand Evenness	0.72

KEA 5: Large Live Trees

Indicator: Average number of live trees per acre (by stand)

>16" dbh

- Poor <= 3
- Fair 4-8
- Good 9-16
- Very Good >17

>19" dbh

- Poor <=3
- Fair 3-5
- Good 6-12
- Very Good >13

TPA >= 16" DBH	17.9

TPA >= 19" DBH	6.3

KEA 6: Large Snags

Indicator: Average number of snags per acre (by stand) >10" dbh

- Poor 0-2
- Fair 3-5
- Good 6-8
- Very Good >9

TPA Large Snags	11.3

KEA 7: Large Coarse Woody Debris

Indicator: Cu.ft. volume per acre; all pieces >13" diameter (large end) and 5' min. length

- Poor <100
- Fair 101-500
- Good 501-999
- Very Good >1000

CWD Ft^3	227.6

Regeneration

KEA 8: Established Regeneration

Indicator: total number all established seedlings per acre 1"-4.5"

- Poor 0-100
- Fair 101-250
- Good 251-400
- Very Good >400

Seedlings/Acre	416.1

KEA 9: Desirable Established Seedlings

Indicator: Ratio of total established seedlings to total desired established seedlings per acre.

- Poor <25%
- Fair 26-54%
- Good 55-74%
- Very Good >75%

Desireable Seedl./Acre	14.0%

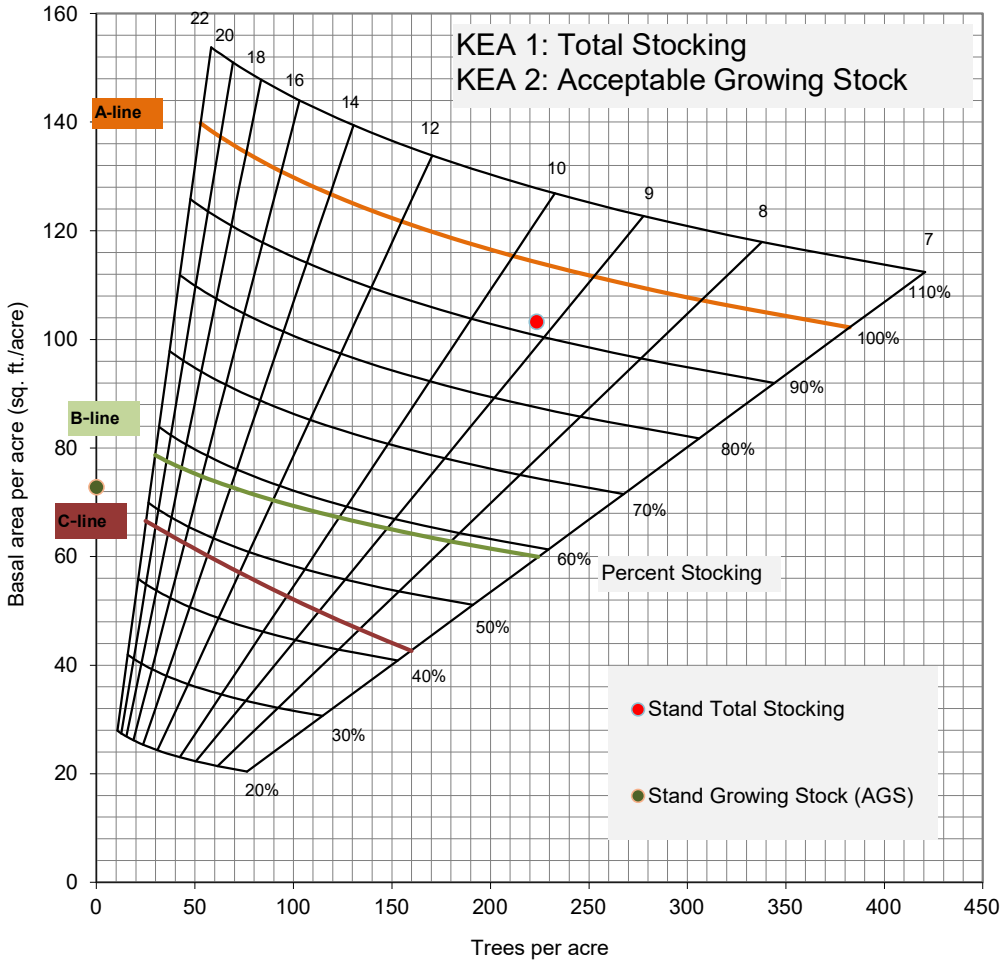
Strata

Hardwood	Hardwood

Row Labels	Values Stand BA	Stand TPA	TPA Acceptable	TPA unacceptable
Pine	3.8	3	0	0
Hardwood	82.5	178	0	51
Conifer	16.9	42	0	11
Grand Total	**103.3**	**223**	**0**	**63**

- Fair 41-60%
- Good 61-79%
- Very Good 80-100%

- Fair 41-53%
- Good 54-69%
- Very Good > 70%



KEA 3: Tree Species Diversity (Richness)

Indicator: Average number of tree species per stand (stems > 5" dbh)

- Poor <3
- Fair 3-6
- Good 7-9
- Very Good >10

Stand Richness	**15.00**

KEA 4: Tree Species Evenness (Richness Distribution)

Indicator: Distribution of tree species diversity across forest stand (stems > 5" dbh)

- Poor 0-0.6
- Fair 0.61-0.7
- Good 0.71-0.8
- Very Good > 0.81

0-0.6
0.61-0.7
0.71-0.8
>0.81

$$J' = \frac{H'}{H'_{\max}}$$

Stand Evenness	0.70

KEA 5: Large Live Trees

Indicator: Average number of live trees per acre (by stand)

>16" dbh

- Poor <= 3
- Fair 4-8
- Good 9-16
- Very Good >17

>19" dbh

- Poor <=3
- Fair 3-5
- Good 6-12
- Very Good >13

TPA >= 16" DBH	13.7

TPA >= 19" DBH	5.0

KEA 6: Large Snags

Indicator: Average number of snags per acre (by stand) >10" dbh

- Poor 0-2
- Fair 3-5
- Good 6-8
- Very Good >9

TPA Large Snags	5.4

KEA 7: Large Coarse Woody Debris

Indicator: Cu.ft. volume per acre; all pieces >13" diameter (large end) and 5' min. length

- Poor <100
- Fair 101-500
- Good 501-999
- Very Good >1000

CWD Ft^3	125.9

Regeneration

KEA 8: Established Regeneration

Indicator: total number all established seedlings per acre 1"-4.5"

- Poor 0-100
- Fair 101-250
- Good 251-400
- Very Good >400

Seedlings/Acre	265.2

KEA 9: Desirable Established Seedlings

Indicator: Ratio of total established seedlings to total desired established seedlings per acre.

- Poor <25%
- Fair 26-54%
- Good 55-74%
- Very Good >75%

Desireable Seedl./Acre	18.9%

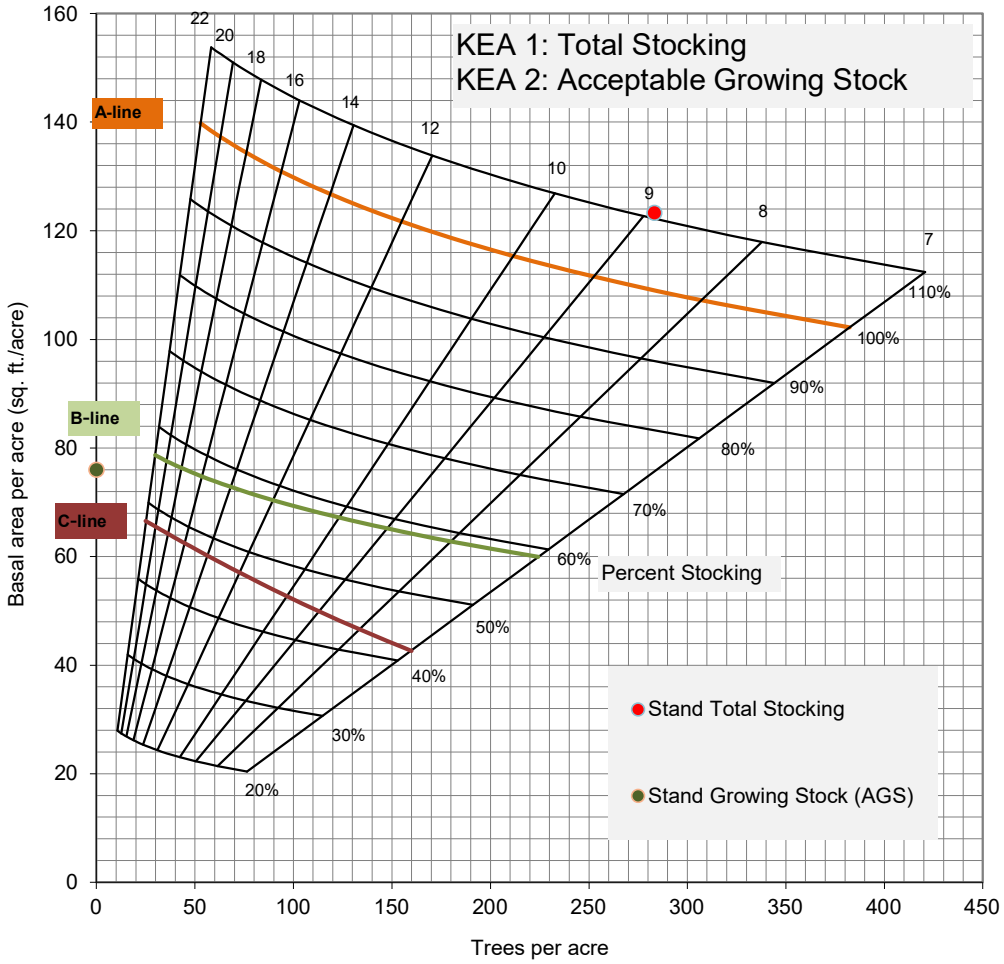
Strata

Hemlock/Hardwood	Hemlock

Row Labels	Values Stand BA	Stand TPA	TPA Acceptable	TPA unacceptable
Pine	10.1	8	0	1
Hardwood	57.7	148	0	54
Conifer	55.0	127	0	42
Aspen	0.4	0	0	0
unknown	0.1	1	0	1
0	0.0	0	0	0
Grand Total	**123.3**	**283**	**0**	**98**

- Fair 41-60%
- Good 61-79%
- Very Good 80-100%

- Fair 41-53%
- Good 54-69%
- Very Good > 70%



KEA 3: Tree Species Diversity (Richness)

Indicator: Average number of tree species per stand (stems > 5" dbh)

- Poor <3
- Fair 3-6
- Good 7-9
- Very Good >10

Stand Richness	**15.00**

KEA 4: Tree Species Evenness (Richness Distribution)

Indicator: Distribution of tree species diversity across forest stand (stems > 5" dbh)

- Poor 0-0.6
- Fair 0.61-0.7
- Good 0.71-0.8
- Very Good > 0.81

0-0.6
0.61-0.7
0.71-0.8
>0.81

$$J' = \frac{H'}{H'_{\max}}$$

Stand Evenness	0.74

KEA 5: Large Live Trees

Indicator: Average number of live trees per acre (by stand)

>16" dbh

- Poor <= 3
- Fair 4-8
- Good 9-16
- Very Good >17

>19" dbh

- Poor <=3
- Fair 3-5
- Good 6-12
- Very Good >13

TPA >= 16" DBH	18.7

TPA >= 19" DBH	6.8

KEA 6: Large Snags

Indicator: Average number of snags per acre (by stand) >10" dbh

- Poor 0-2
- Fair 3-5
- Good 6-8
- Very Good >9

TPA Large Snags	7.2

KEA 7: Large Coarse Woody Debris

Indicator: Cu.ft. volume per acre; all pieces >13" diameter (large end) and 5' min. length

- Poor <100
- Fair 101-500
- Good 501-999
- Very Good >1000

CWD Ft^3	232.5

Regeneration

KEA 8: Established Regeneration

Indicator: total number all established seedlings per acre 1"-4.5"

- Poor 0-100
- Fair 101-250
- Good 251-400
- Very Good >400

Seedlings/Acre	286.7

KEA 9: Desirable Established Seedlings

Indicator: Ratio of total established seedlings to total desired established seedlings per acre.

- Poor <25%
- Fair 26-54%
- Good 55-74%
- Very Good >75%

Desireable Seedl./Acre	30.2%

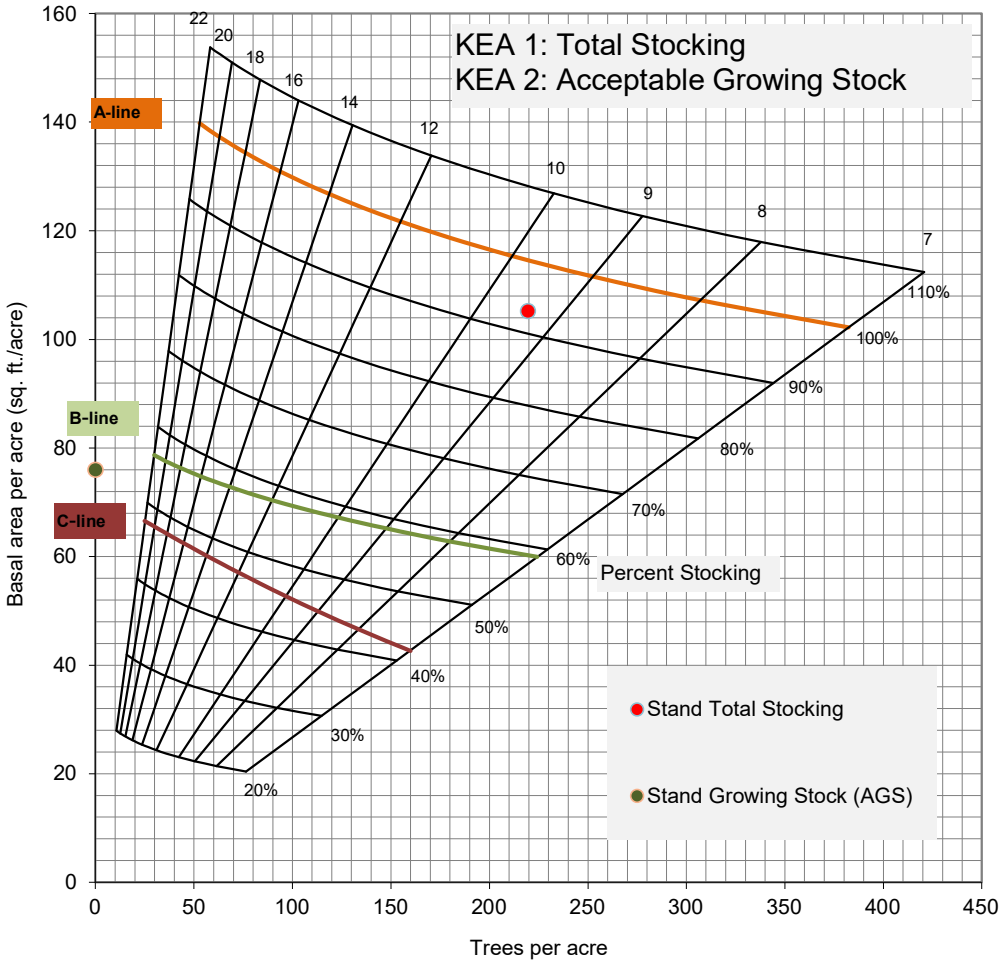
Strata

Upland Softwood	UplandSoftwood

Row Labels	Values Stand BA	Stand TPA	TPA Acceptable	TPA unacceptable
Pine	48.3	49	0	2
Hardwood	23.7	64	0	34
Conifer	26.6	99	0	47
Aspen	6.6	8	0	5
Grand Total	**105.2**	**220**	**0**	**87**

- Fair 41-60%
- Good 61-79%
- Very Good 80-100%

- Fair 41-53%
- Good 54-69%
- Very Good > 70%



KEA 3: Tree Species Diversity (Richness)

Indicator: Average number of tree species per stand (stems > 5" dbh)

- Poor <3
- Fair 3-6
- Good 7-9
- Very Good >10

Stand Richness	**13.00**

KEA 4: Tree Species Evenness (Richness Distribution)

Indicator: Distribution of tree species diversity across forest stand (stems > 5" dbh)

- Poor 0-0.6
- Fair 0.61-0.7
- Good 0.71-0.8
- Very Good > 0.81

0-0.6
0.61-0.7
0.71-0.8
>0.81

$$J' = \frac{H'}{H'_{\max}}$$

Stand Evenness	0.75

KEA 5: Large Live Trees

Indicator: Average number of live trees per acre (by stand)

>16" dbh

- Poor <= 3
- Fair 4-8
- Good 9-16
- Very Good >17

>19" dbh

- Poor <=3
- Fair 3-5
- Good 6-12
- Very Good >13

TPA >= 16" DBH	19.0

TPA >= 19" DBH	7.5

KEA 6: Large Snags

Indicator: Average number of snags per acre (by stand) >10" dbh

- Poor 0-2
- Fair 3-5
- Good 6-8
- Very Good >9

TPA Large Snags	2.0

KEA 7: Large Coarse Woody Debris

Indicator: Cu.ft. volume per acre; all pieces >13" diameter (large end) and 5' min. length

- Poor <100
- Fair 101-500
- Good 501-999
- Very Good >1000

CWD Ft^3	389.0

Regeneration

KEA 8: Established Regeneration

Indicator: total number all established seedlings per acre 1"-4.5"

- Poor 0-100
- Fair 101-250
- Good 251-400
- Very Good >400

Seedlings/Acre	110.0

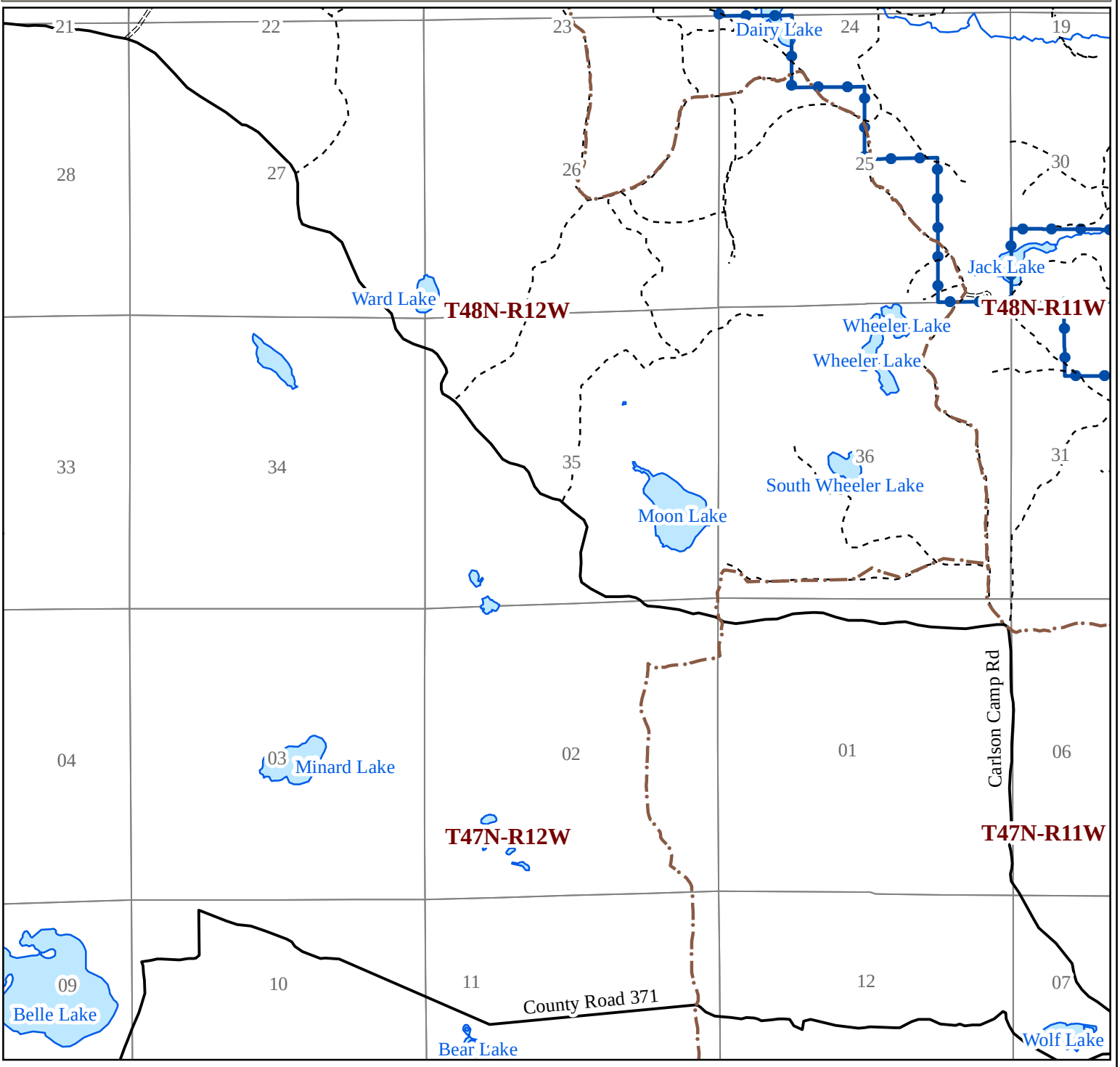
KEA 9: Desirable Established Seedlings

Indicator: Ratio of total established seedlings to total desired established seedlings per acre.

- Poor <25%
- Fair 26-54%
- Good 55-74%
- Very Good >75%

Desireable Seedl./Acre	18.2%

Exhibit G - MNFI (2015) Occurences - 1 — Luce County: T48N-R12W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences
These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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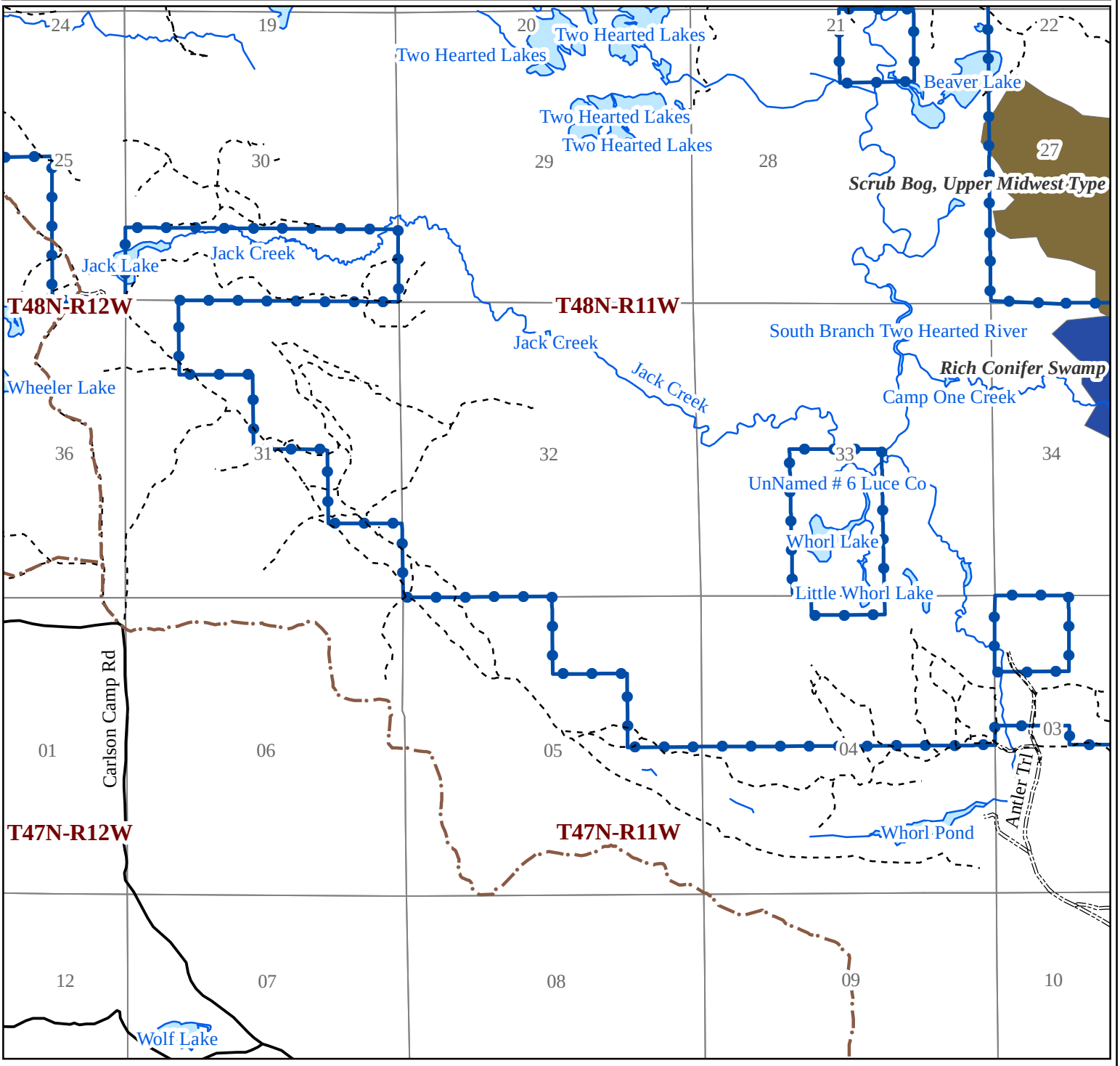
Exhibit G - MNFI (2015) Occurences - 2 Luce County: T47N-R11W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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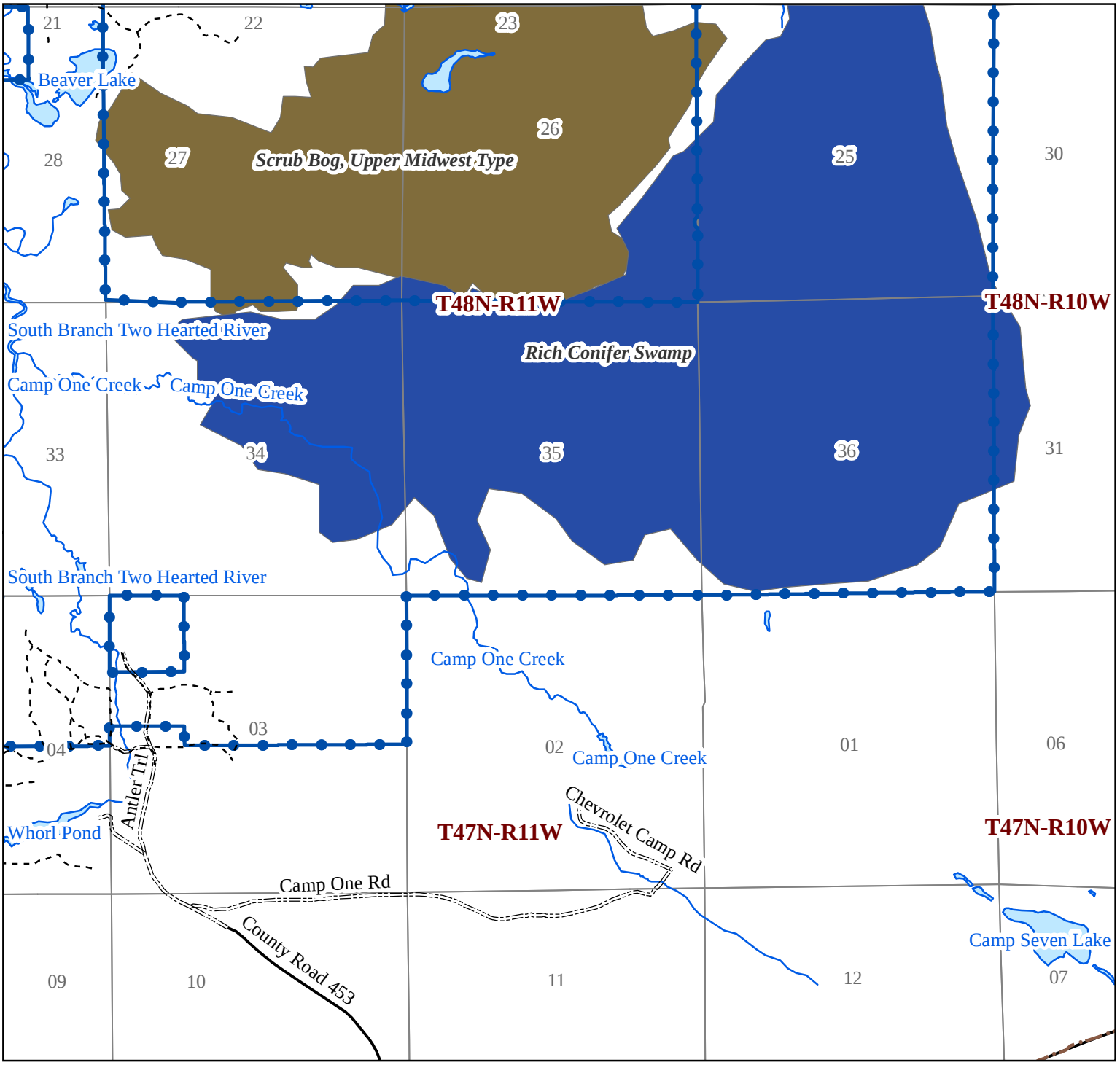
Exhibit G - MNFI (2015) Occurences - 3

Luce County: T48N-R11W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= **Colored Polygons = MNFI Occurences These are described in a table within the actual management plan (page 29)**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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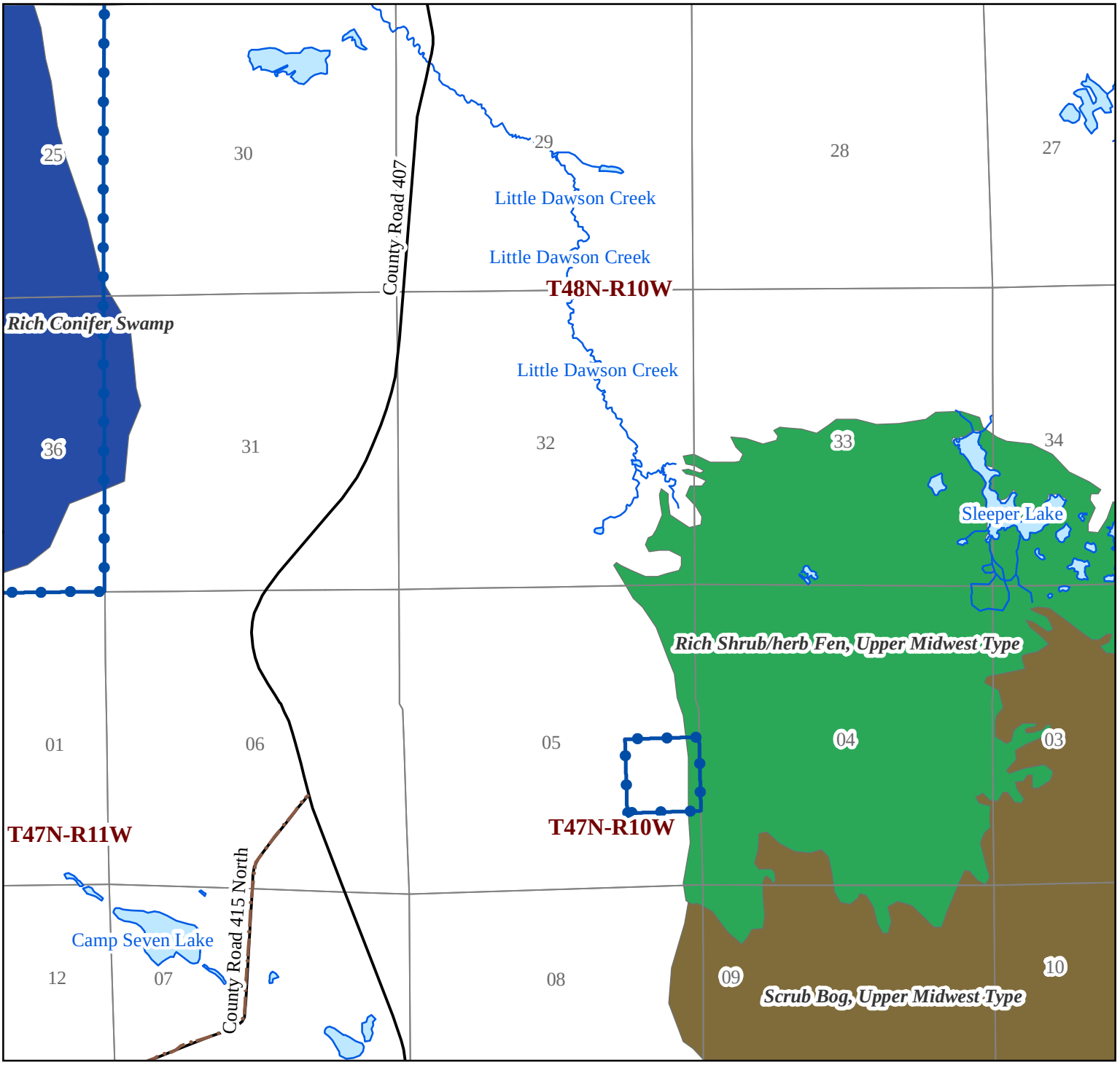
Exhibit G - MNFI (2015) Occurences - 4

Luce County: T47N-R10W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences
These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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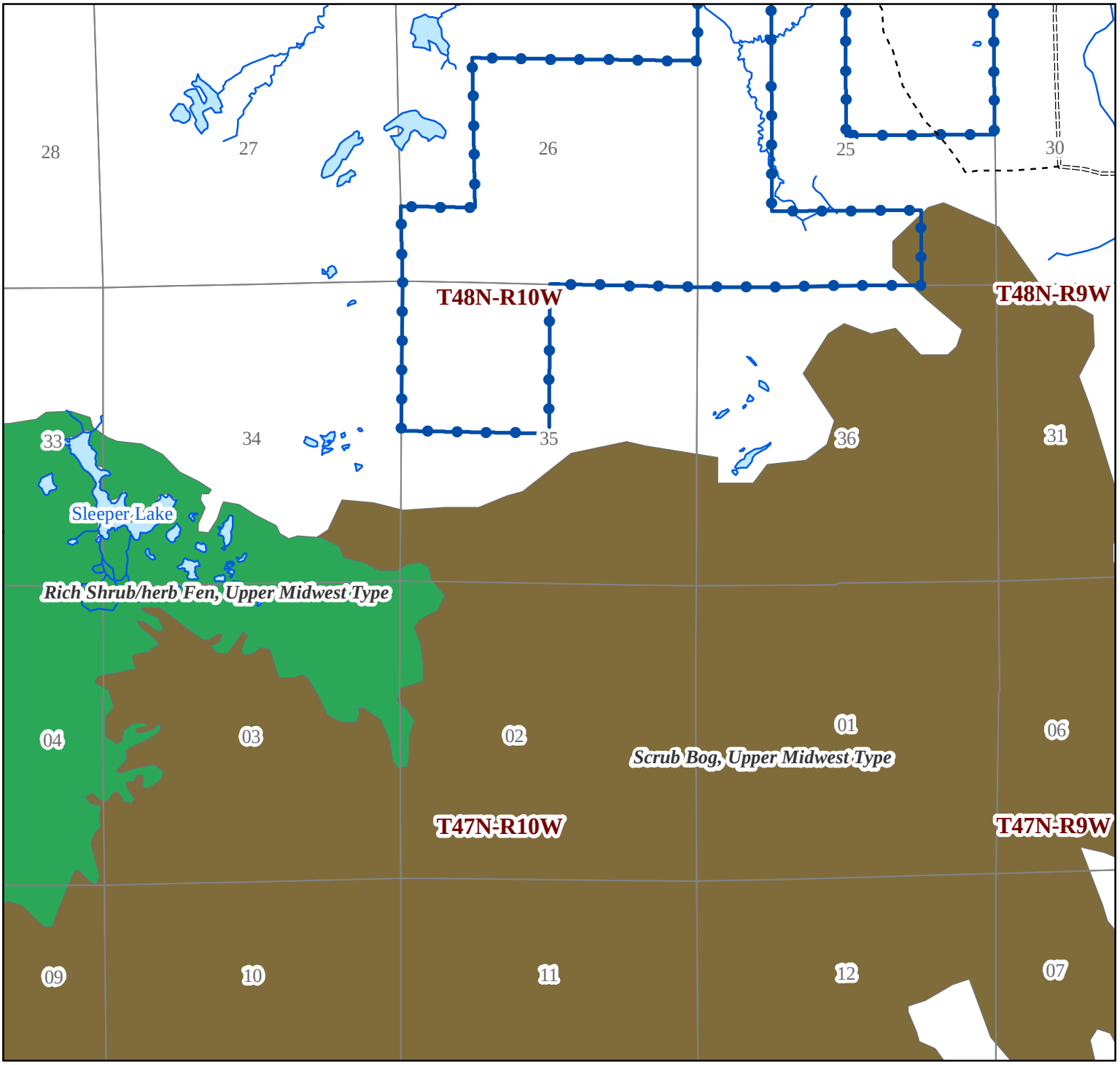
Exhibit G - MNFI (2015) Occurences - 5

Luce County: T48N-R10W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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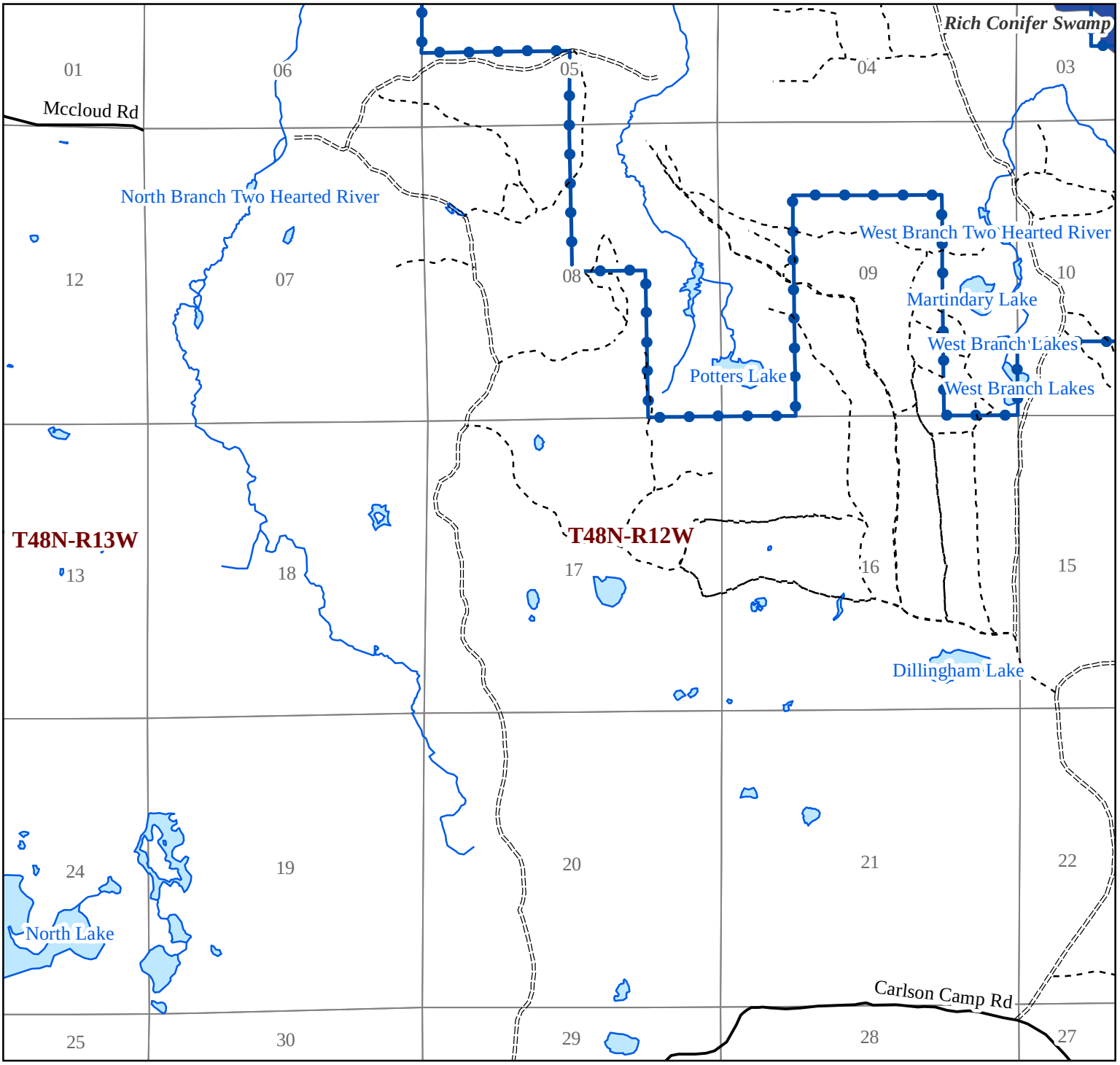
Exhibit G - MNFI (2015) Occurences - 6

Luce County: T48N-R12W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences
These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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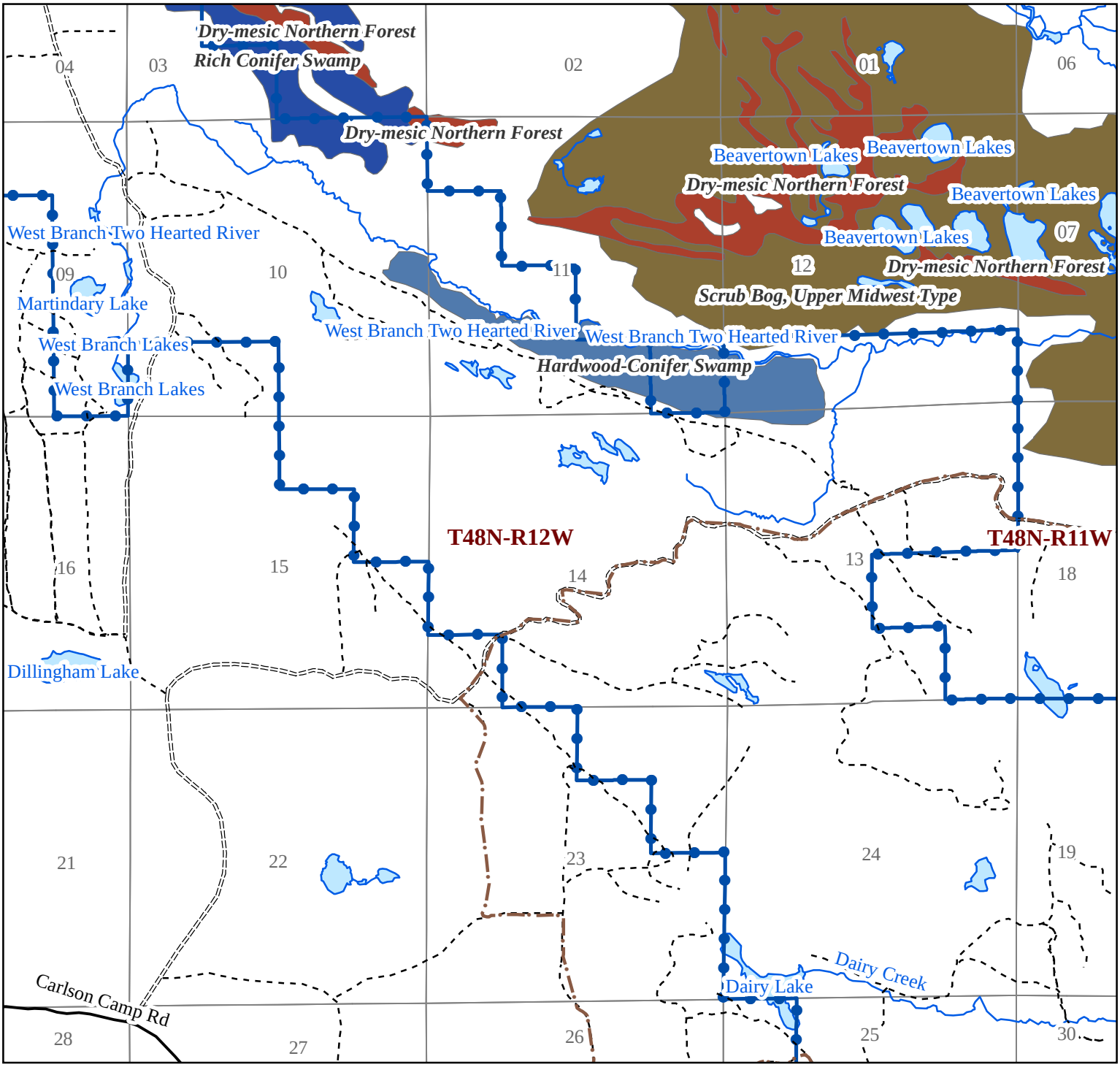
Exhibit G - MNFI (2015) Occurences - 7

Luce County: T48N-R12W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences
These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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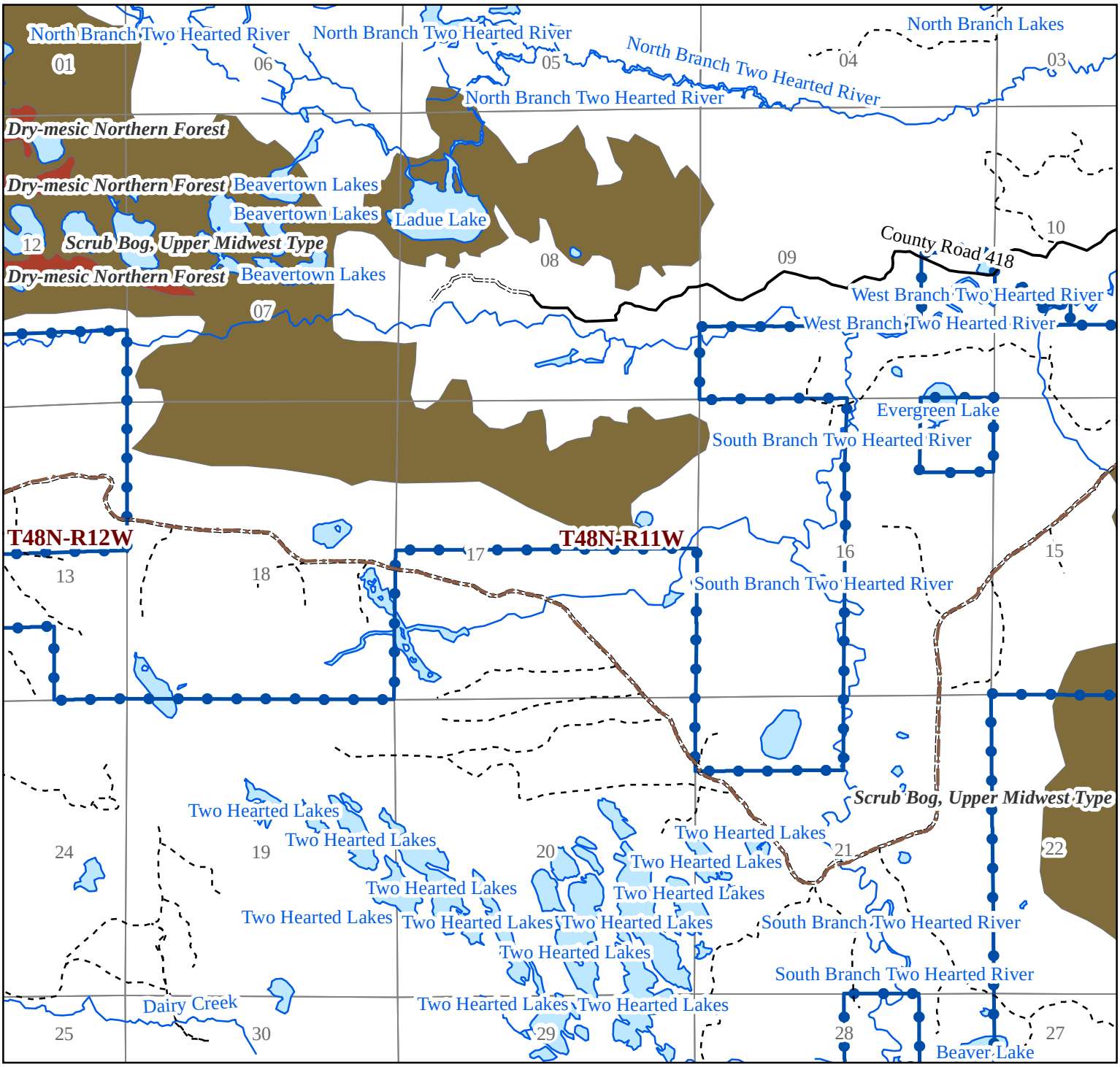
Exhibit G - MNFI (2015) Occurences - 8 — Luce County: T48N-R11W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- **= Colored Polygons = MNFI Occurences These are described in a table within the actual management plan (page 29)**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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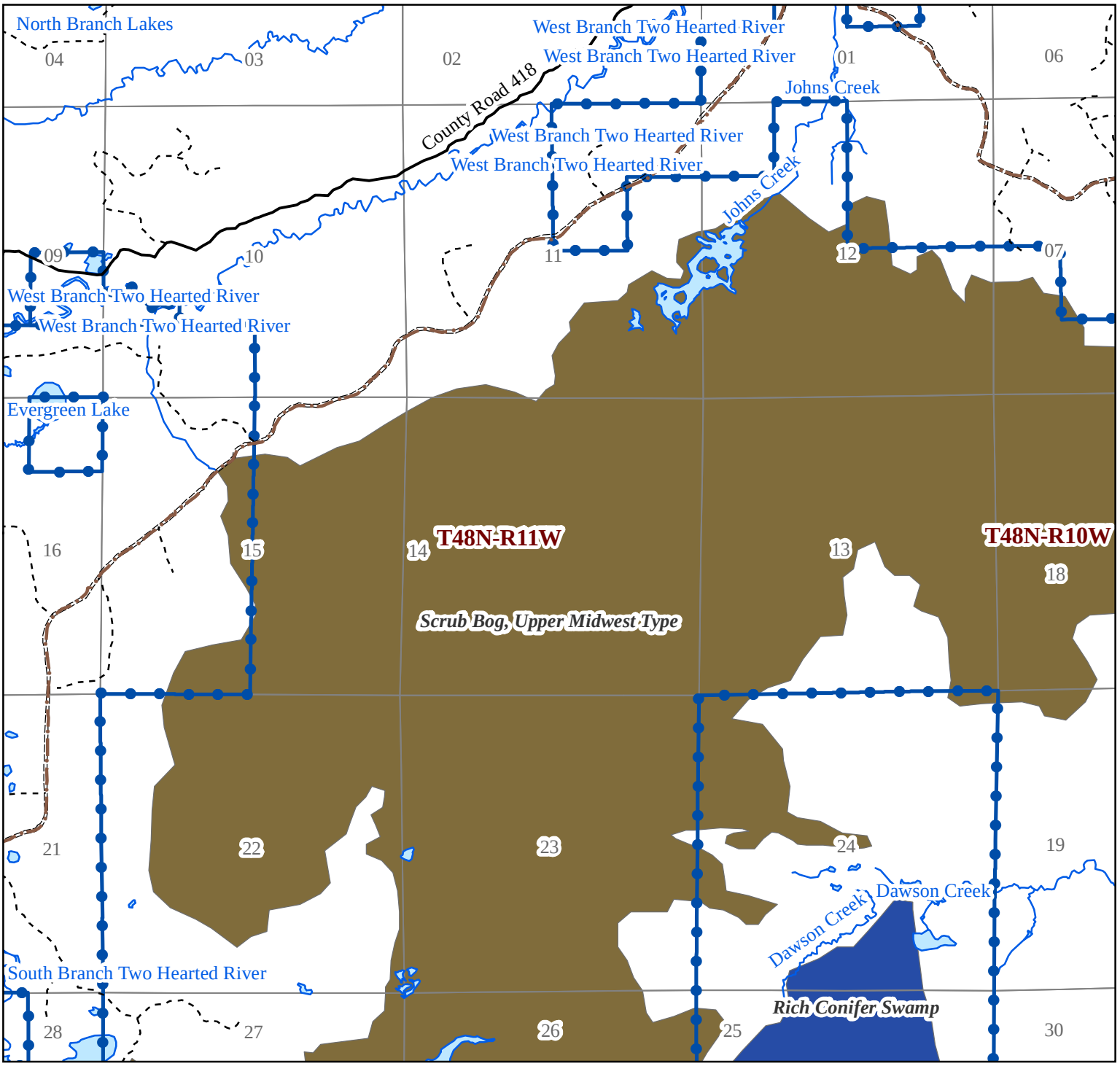
Exhibit G - MNFI (2015) Occurences - 9

Luce County: T48N-R11W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences
These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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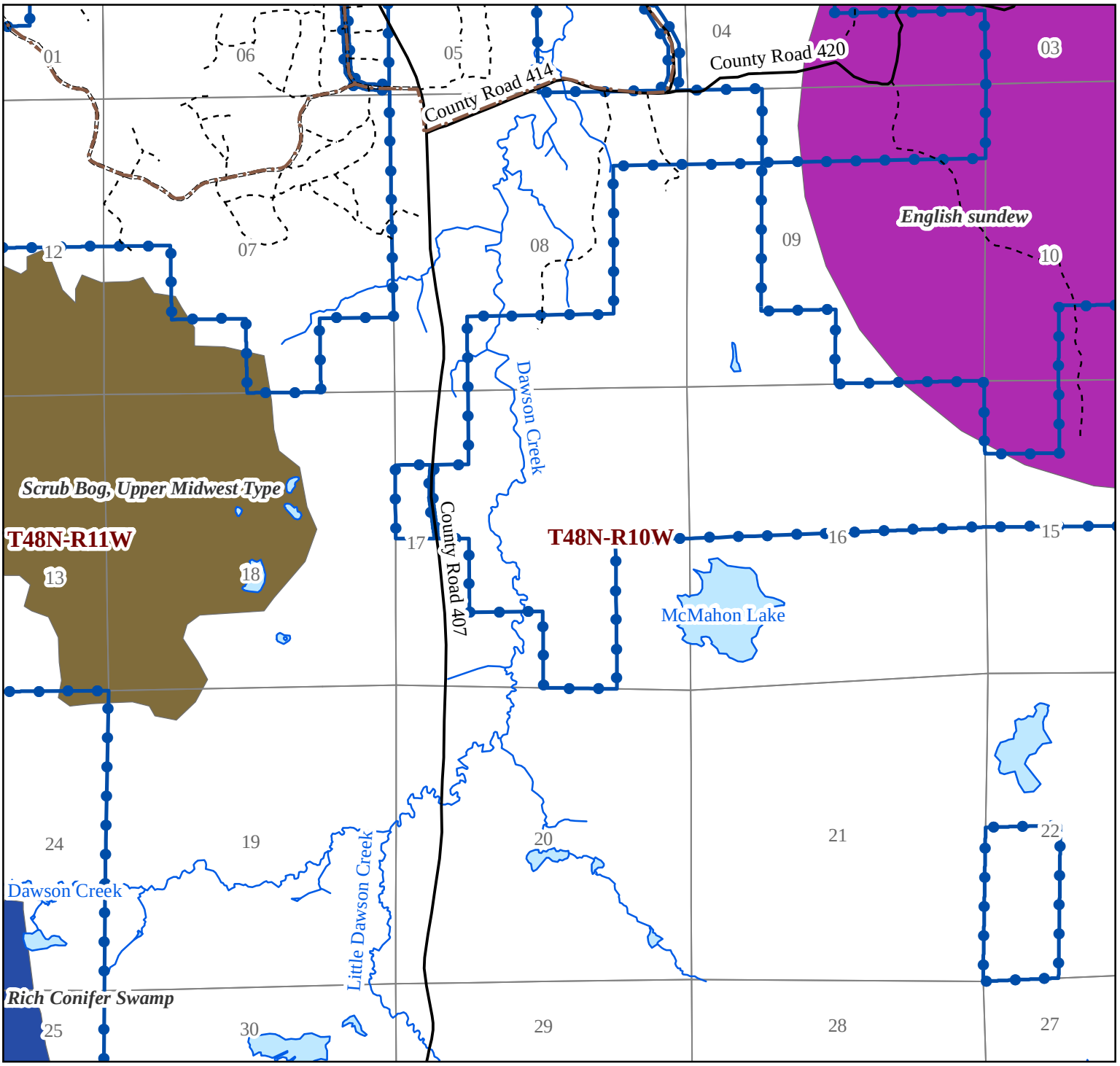
Exhibit G - MNFI (2015) Occurences - 10 Luce County: T48N-R10W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences
These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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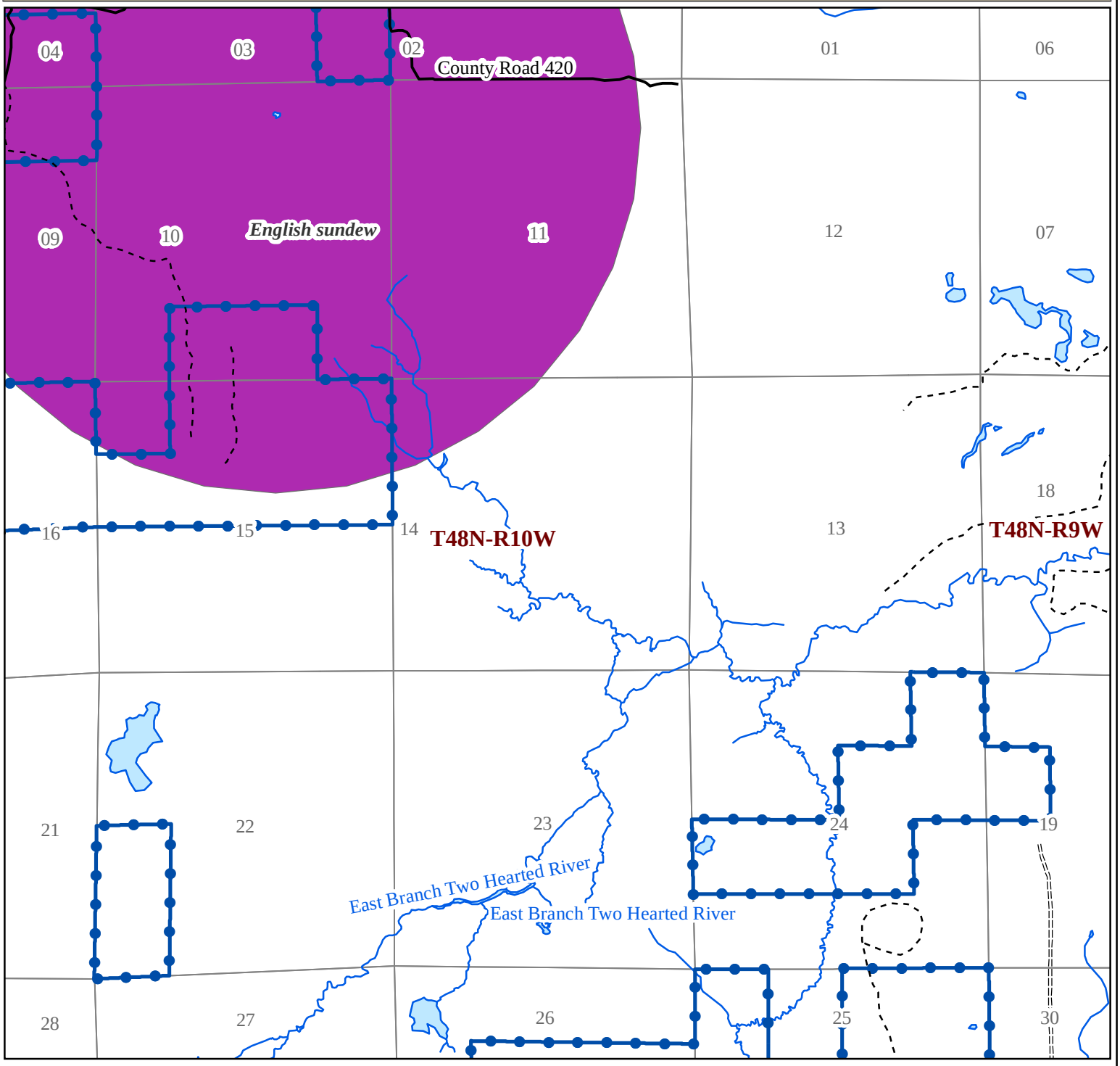
Exhibit G - MNFI (2015) Occurences - 11 — Luce County: T48N-R10W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = **Colored Polygons = MNFI Occurences These are described in a table within the actual management plan (page 29)**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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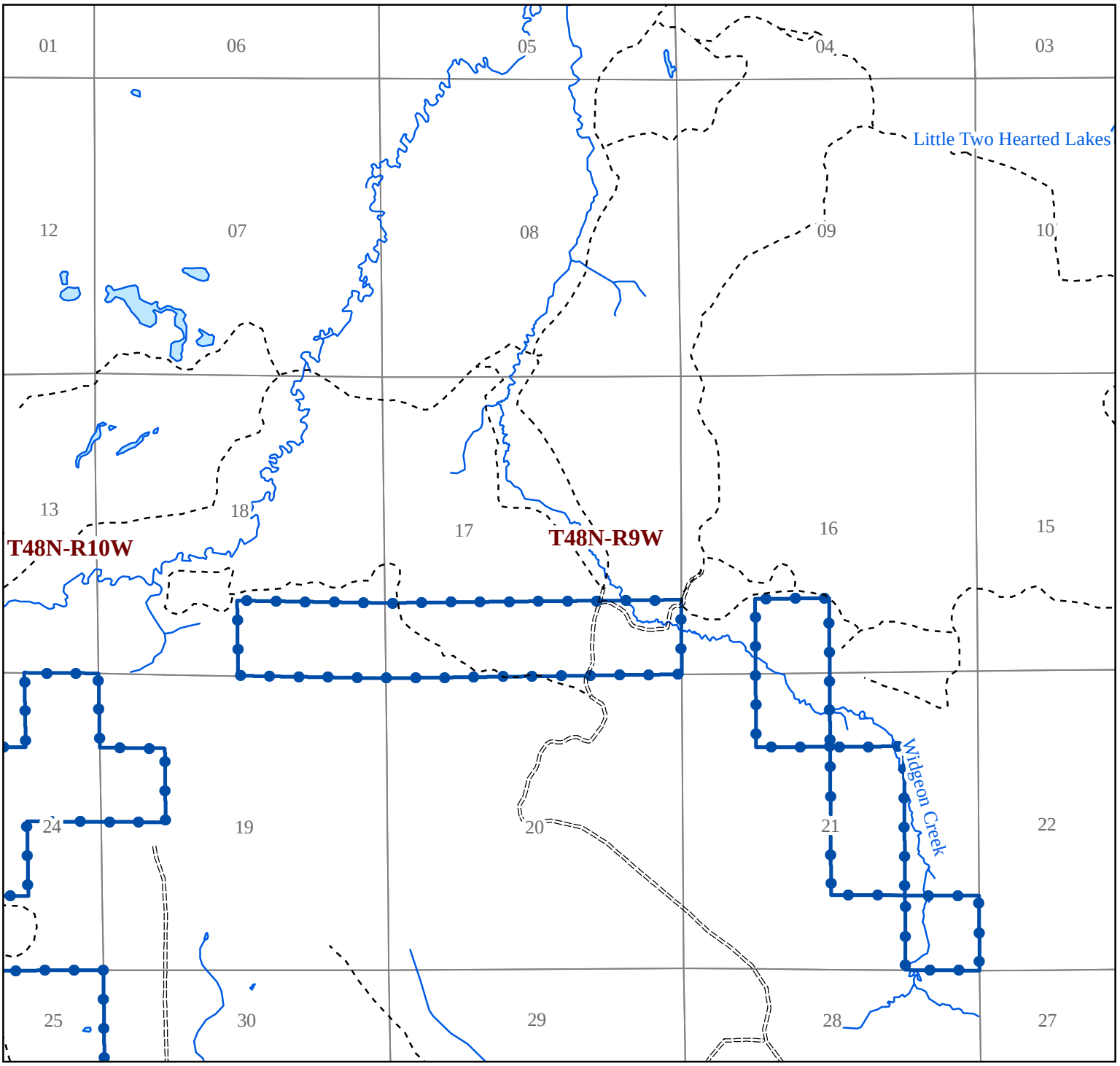
Exhibit G - MNFI (2015) Occurences - 12 Luce County: T48N-R9W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences
These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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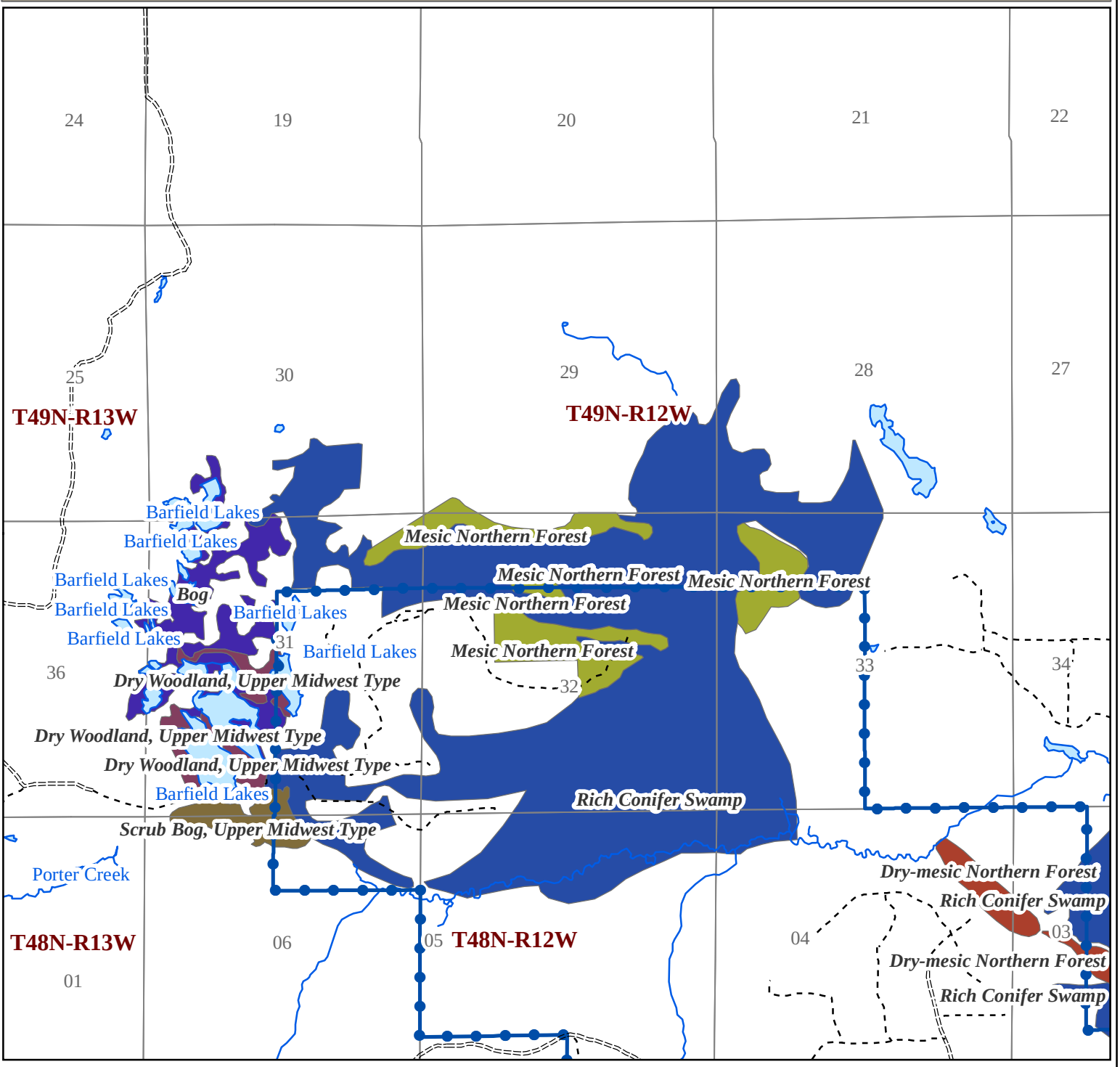
Exhibit G - MNFI (2015) Occurences - 13 Luce County: T49N-R12W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
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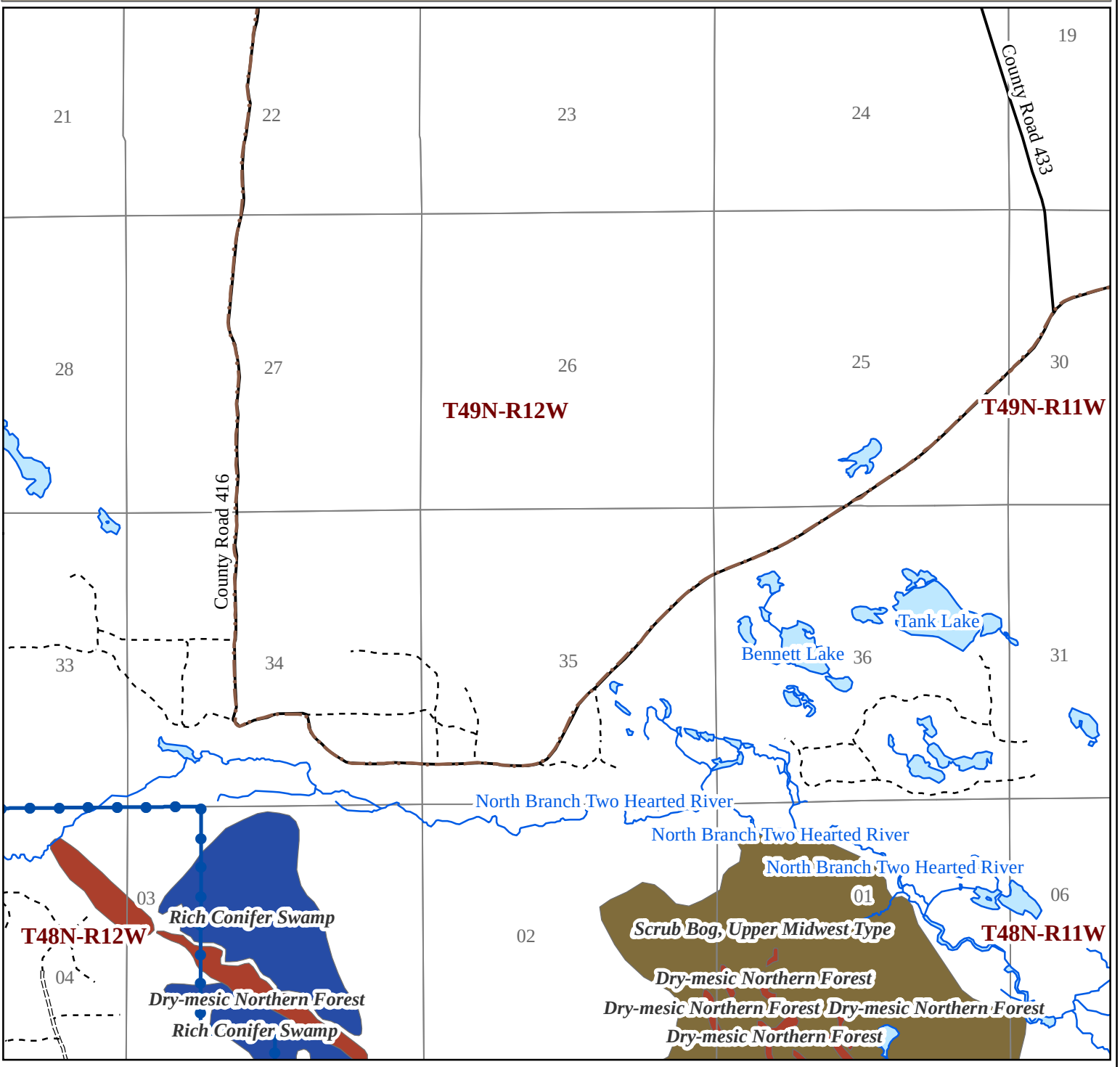
Exhibit G - MNFI (2015) Occurences - 14 Luce County: T49N-R12W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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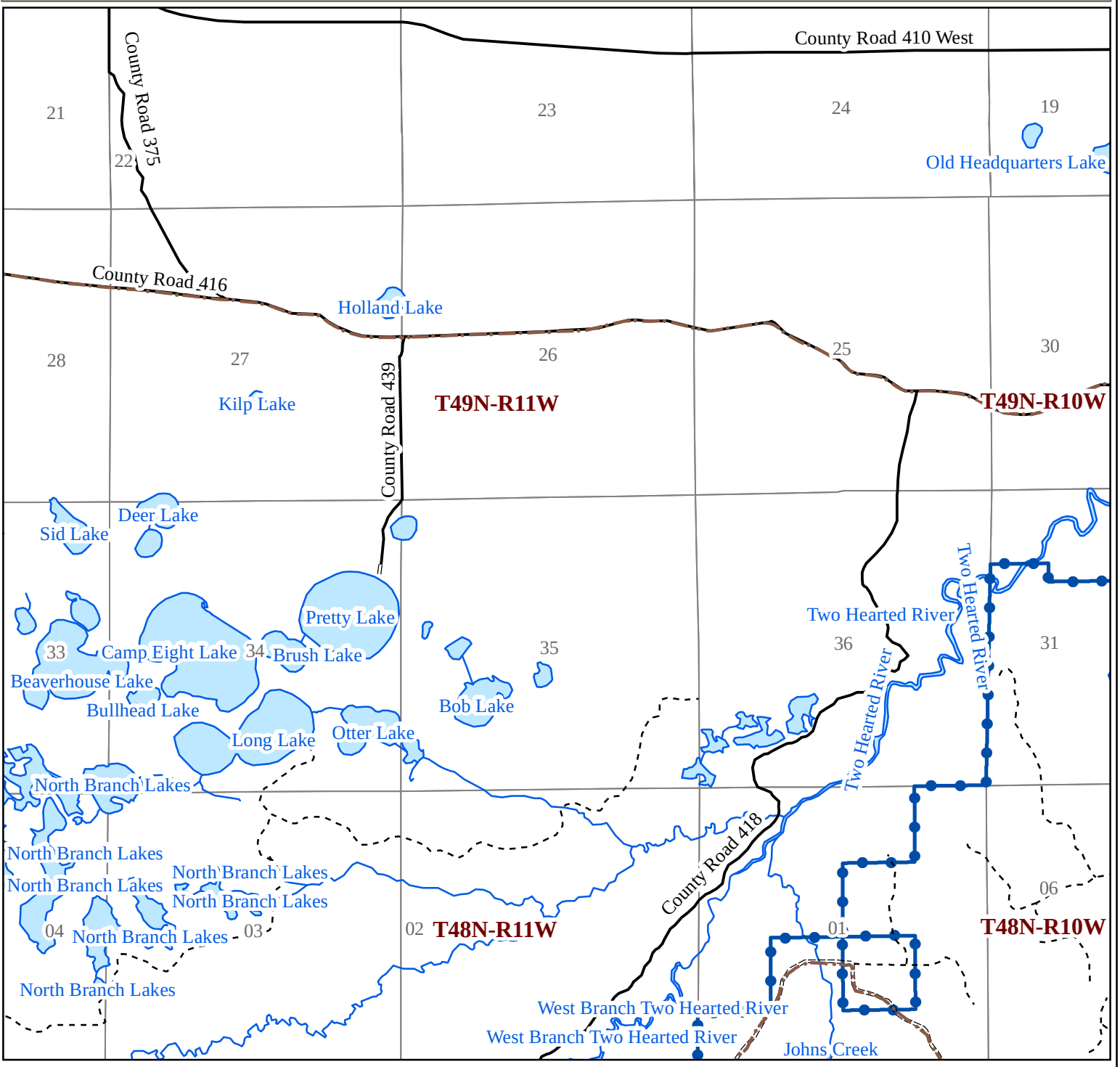
Exhibit G - MNFI (2015) Occurences - 15 Luce County: T48N-R11W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences
These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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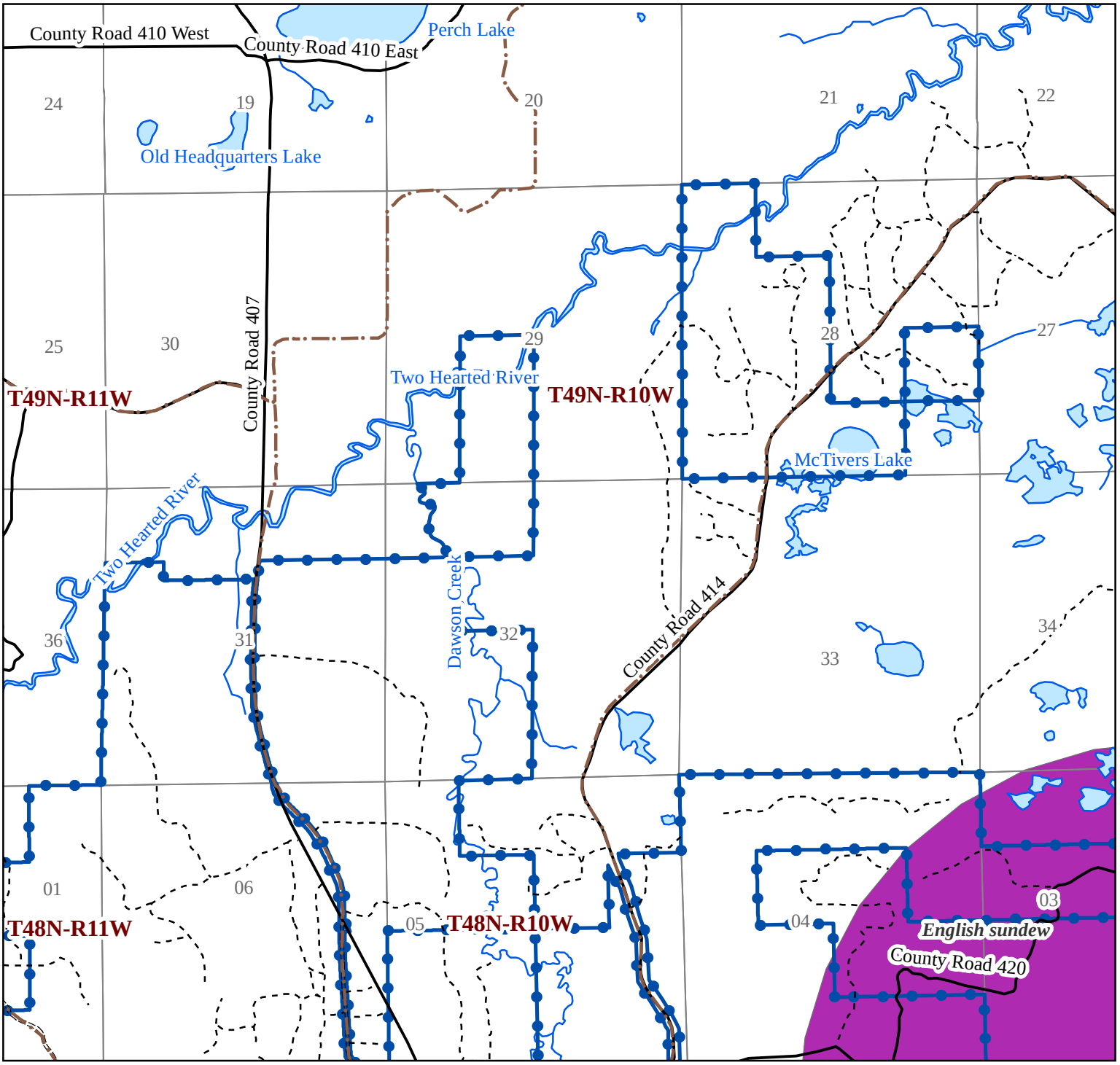
Exhibit G - MNFI (2015) Occurences - 16

Luce County: T49N-R10W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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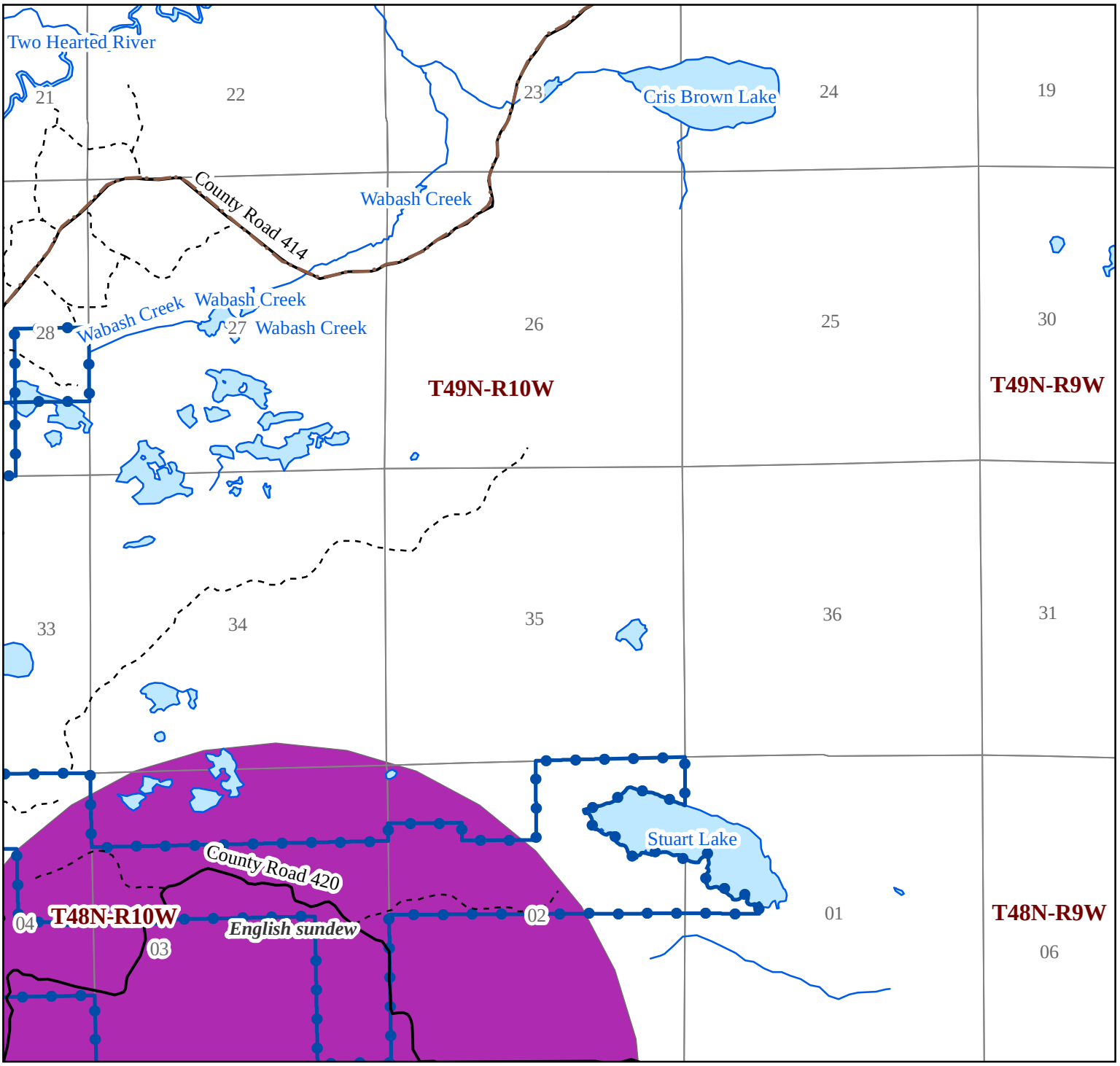
Exhibit G - MNFI (2015) Occurences - 17

Luce County: T48N-R10W



Legend

= Two-Hearted Forest Reserve Property Boundary

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Colored Polygons = MNFI Occurences
These are described in a table within the actual management plan (page 29)

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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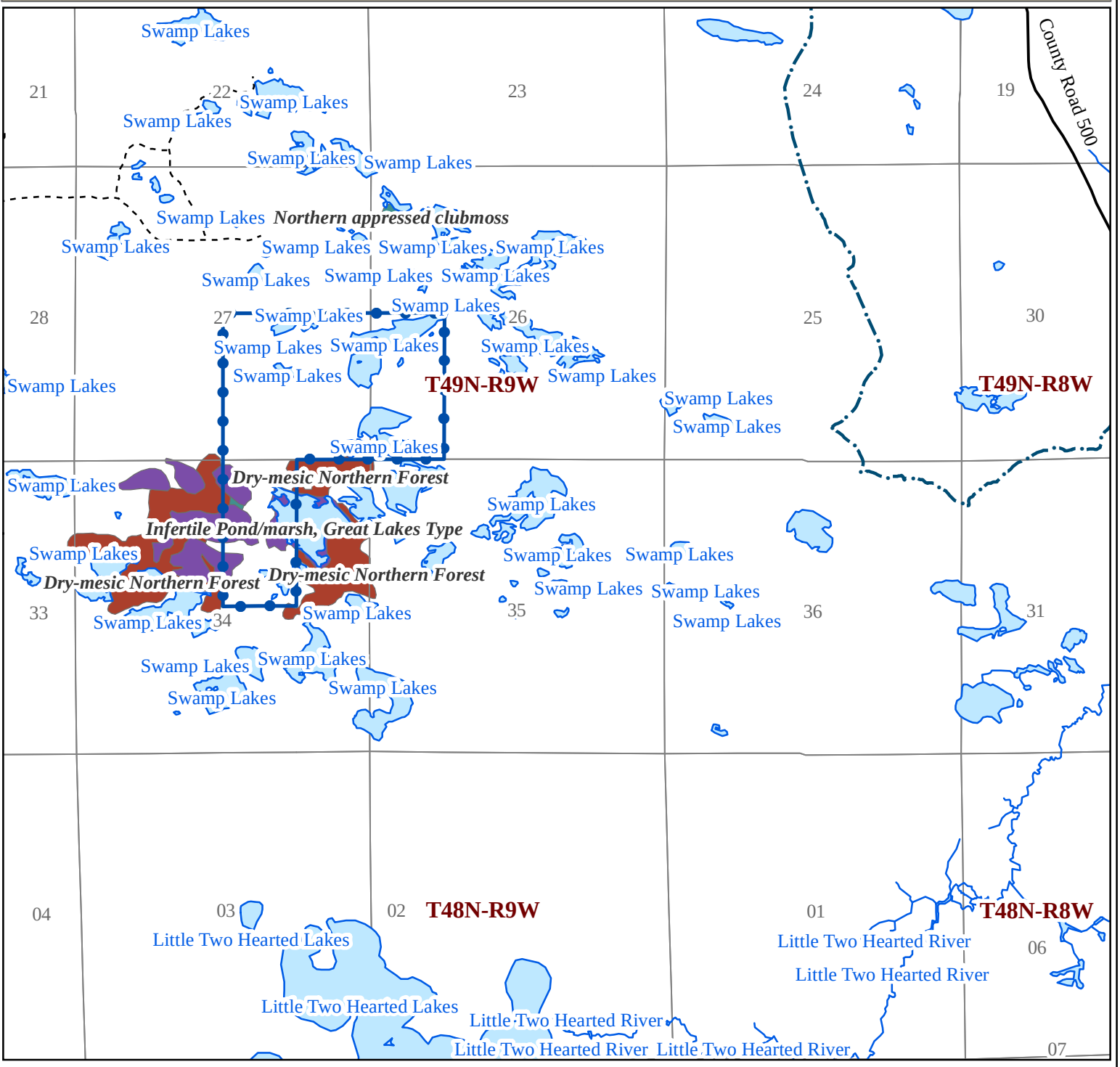
Exhibit G - MNFI (2015) Occurences - 18 Luce County: T49N-R9W



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = **Colored Polygons = MNFI Occurences These are described in a table within the actual management plan (page 29)**

0 1,000 2,000 4,000 Feet

NORTH

Scale = 1:30,000
March 2020

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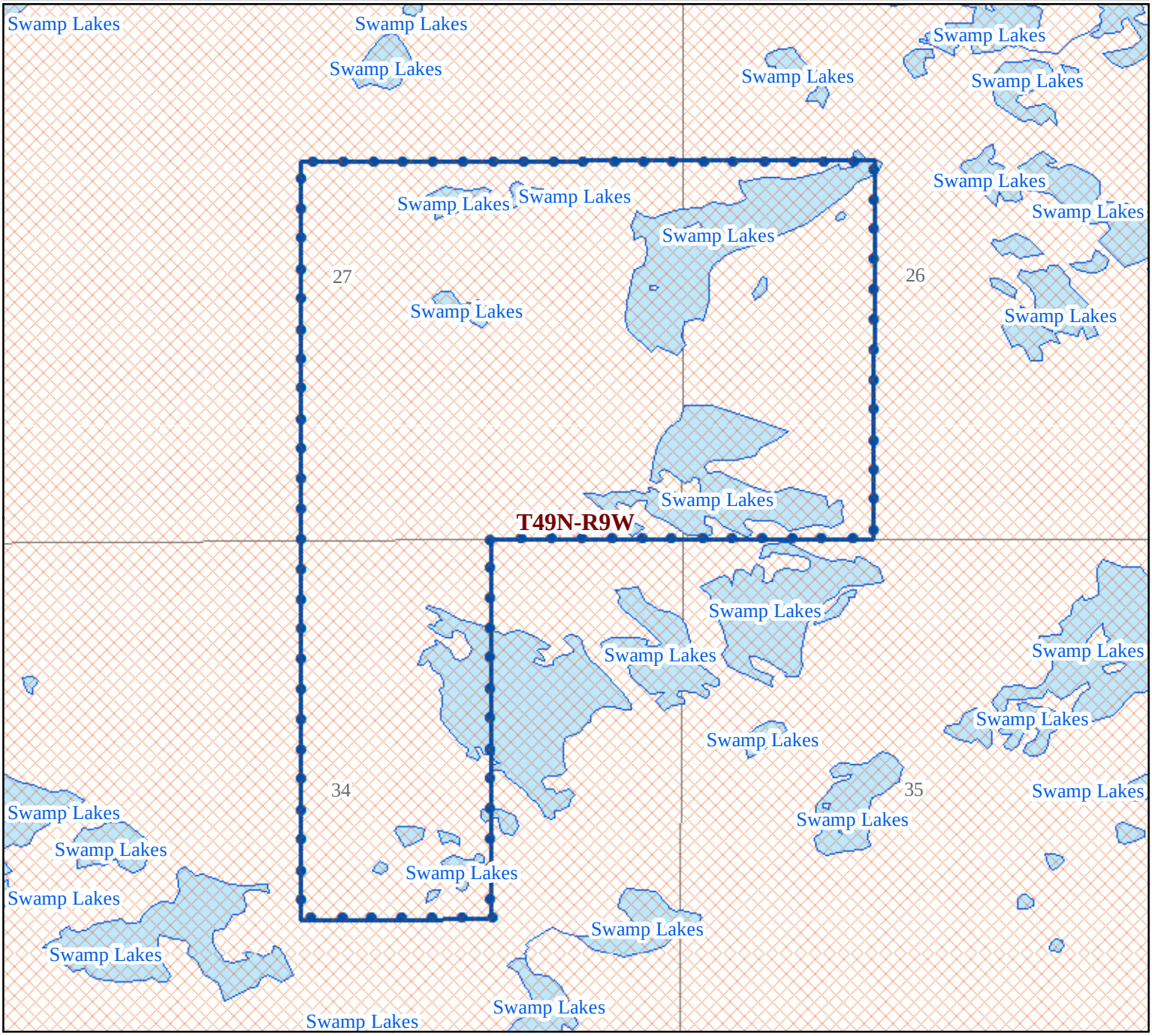
Exhibit H - Property Impacted By Recent Fire Activity

Duck Lake Fire - Located in Sections 26, 27, 34 T49N-R9W, Luce County, MI



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing
- = Area burned in 2012 Duck Lake Fire
- = Approximate Fire Edge

0 375 750 1,500 Feet

NORTH

Scale = 1:12,000
March 2020

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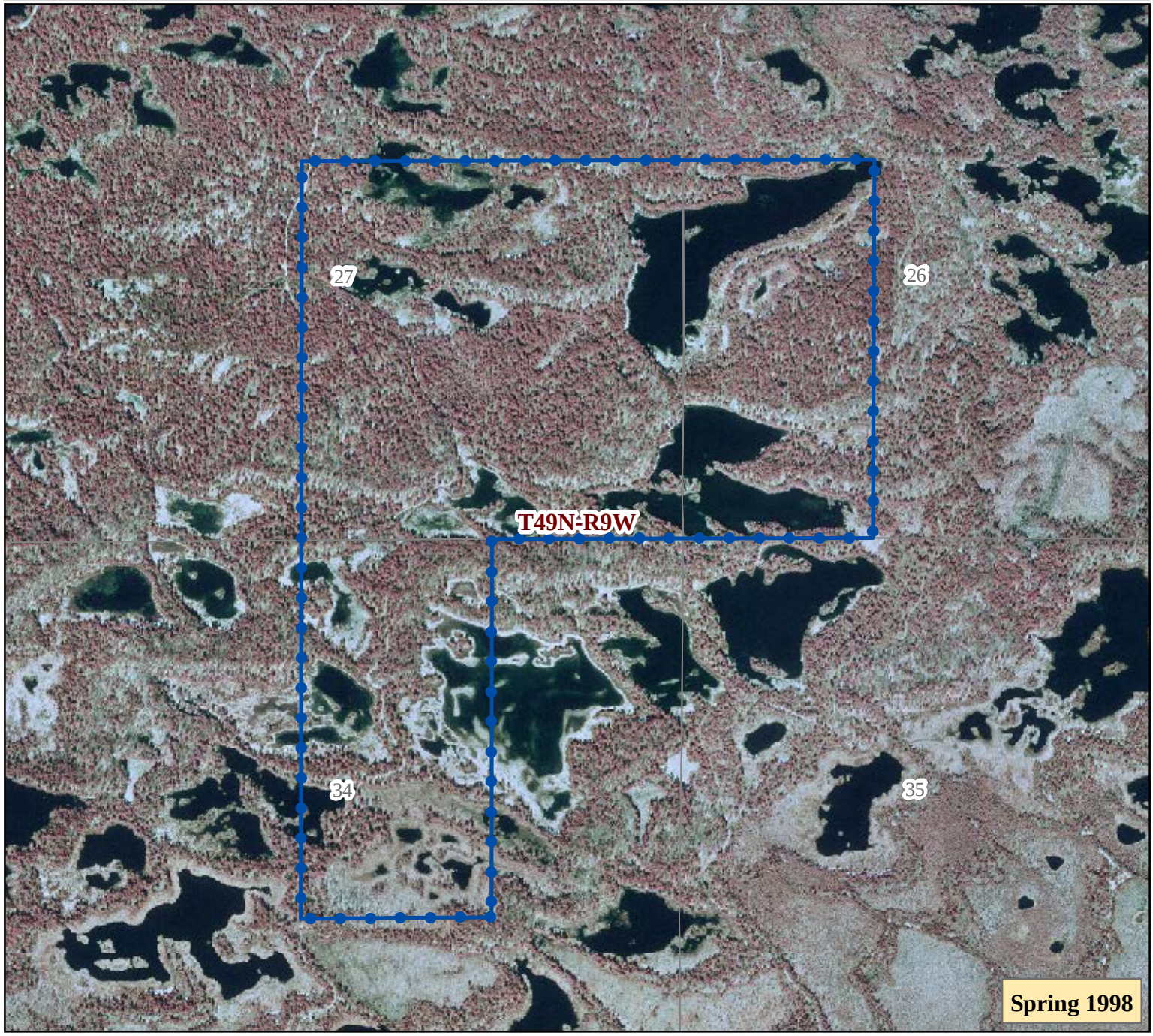
Exhibit H - Property Impacted By Recent Fire Activity
Duck Lake Fire - Located in Sections 26, 27, 34 T49N-R9W, Luce County, MI



Legend

= Two-Hearted Forest Reserve Property Boundary

= Stand Boundaries

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Road-Stream Crossing

= Area burned in 2012 Duck Lake Fire

= Approximate Fire Edge

0 375 750 1,500 Feet

NORTH

Scale = 1:12,000
March 2020

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Exhibit H - Property Impacted By Recent Fire Activity
Duck Lake Fire - Located in Sections 26, 27, 34 T49N-R9W, Luce County, MI

Legend

= Two-Hearted Forest Reserve Property Boundary

= Stand Boundaries

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Road-Stream Crossing

= Area burned in 2012 Duck Lake Fire

= Approximate Fire Edge

0 375 750 1,500 Feet

NORTH

Scale = 1:12,000
March 2020

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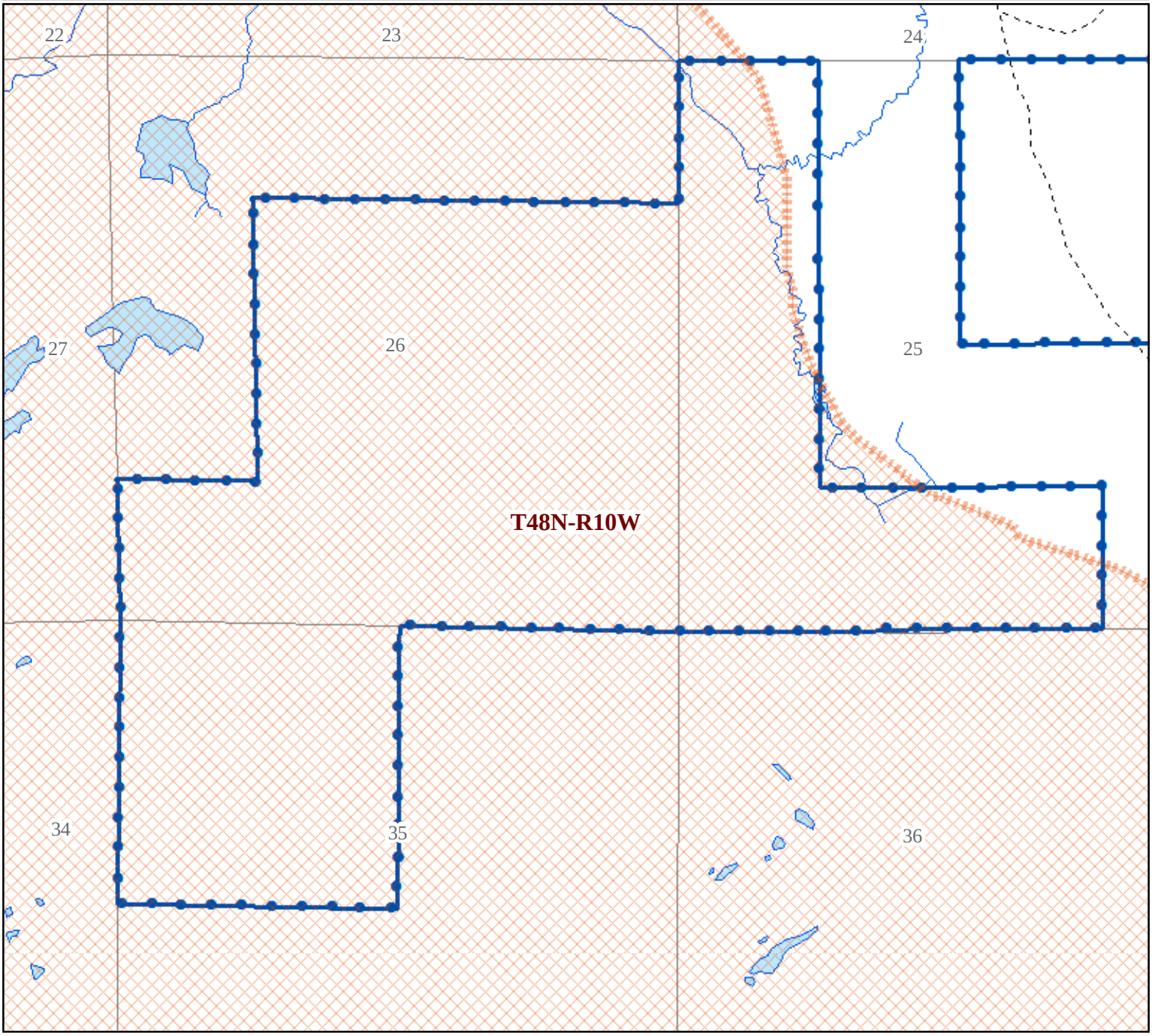
Exhibit G - Property Impacted By Recent Fire Activity

Sleeper Lake Fire - Located in Sections 25, 26, 27, T48N-R10W, Luce County, MI



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing
- = Area burned in 2007 Sleeper Lake Fire
- = Approximate Fire Edge

0 500 1,000 2,000 Feet

NORTH

Scale = 1:16,000
March 2020

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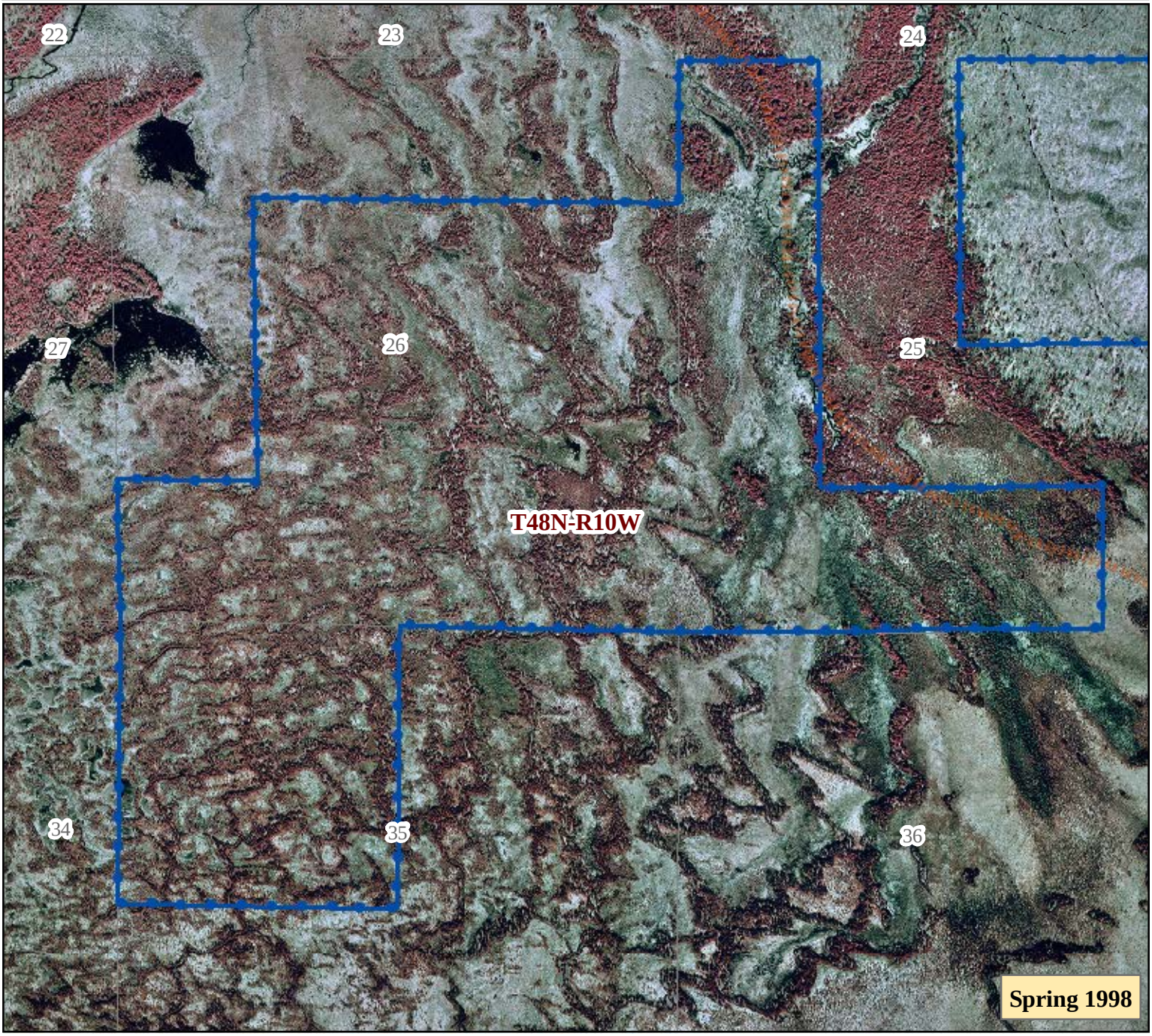
Exhibit G - Property Impacted By Recent Fire Activity

Sleeper Lake Fire - Located in Sections 25, 26, 27, T48N-R10W, Luce County, MI



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing
- = Area burned in 2007 Sleeper Lake Fire
- = Approximate Fire Edge

0 500 1,000 2,000 Feet

NORTH

Scale = 1:16,000
March 2020

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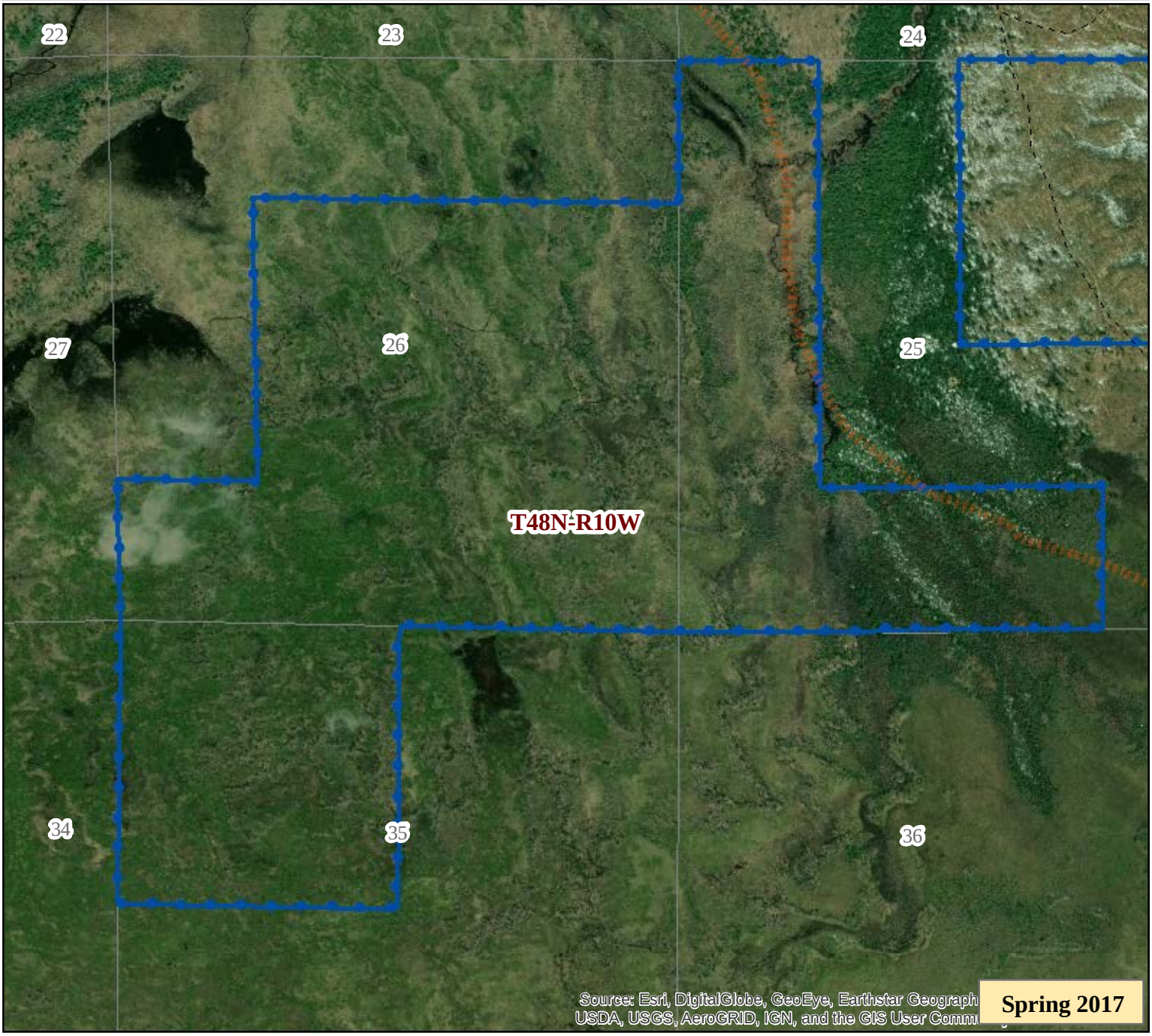
Exhibit G - Property Impacted By Recent Fire Activity
Sleeper Lake Fire - Located in Sections 25, 26, 27, T48N-R10W, Luce County, MI



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing
- = Area burned in 2007 Sleeper Lake Fire
- = Approximate Fire Edge

0 500 1,000 2,000 Feet

NORTH

Scale = 1:16,000
March 2020

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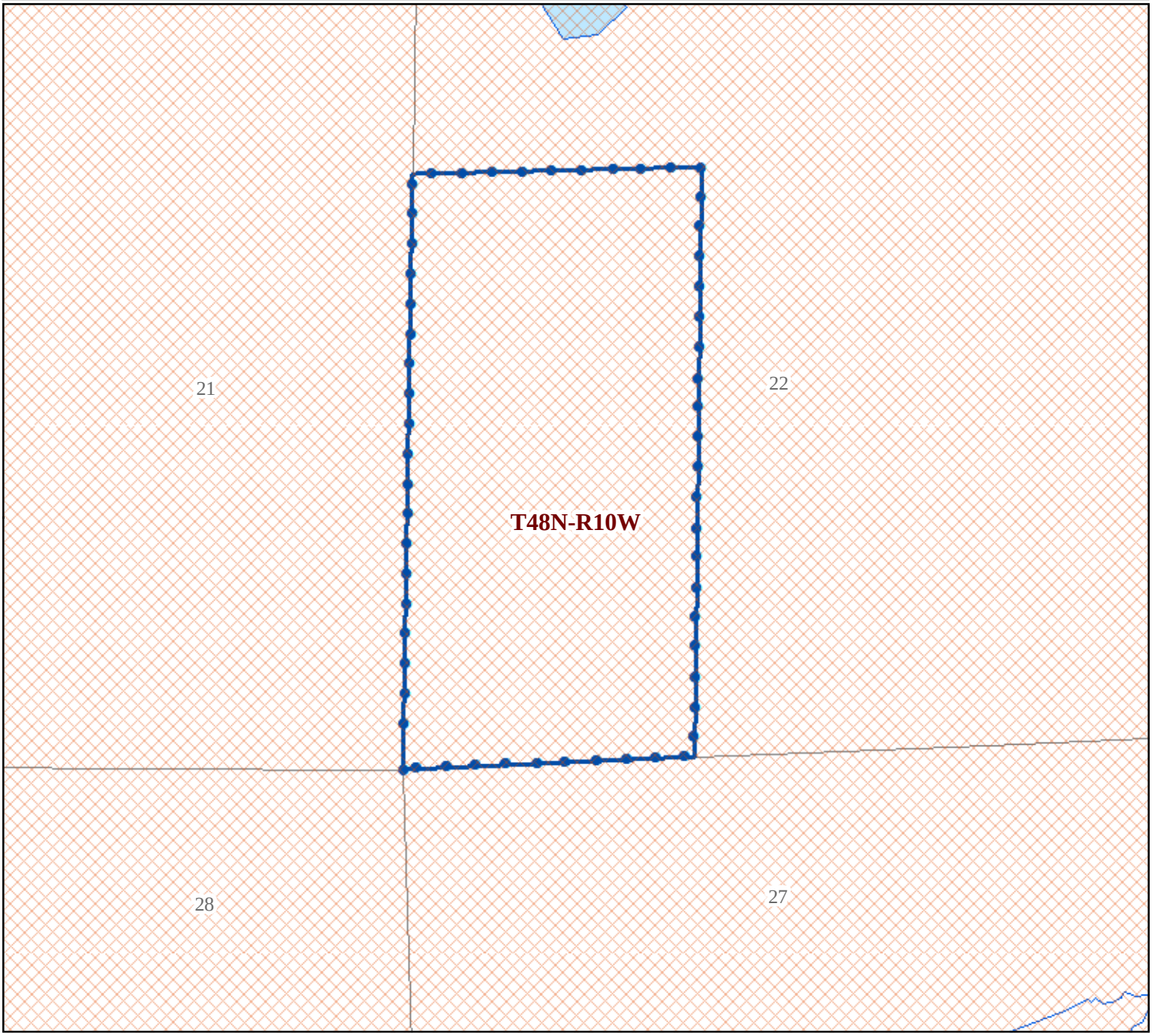
Exhibit G - Property Impacted By Recent Fire Activity
Sleeper Lake Fire - Located in Section 22, T48N-R10W, Luce County, MI



Legend

= Two-Hearted Forest Reserve Property Boundary

= Stand Boundaries

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Road-Stream Crossing

= Area burned in 2007 Sleeper Lake Fire

= Approximate Fire Edge

0 250 500 1,000 Feet

NORTH

Scale = 1:8,000
March 2020

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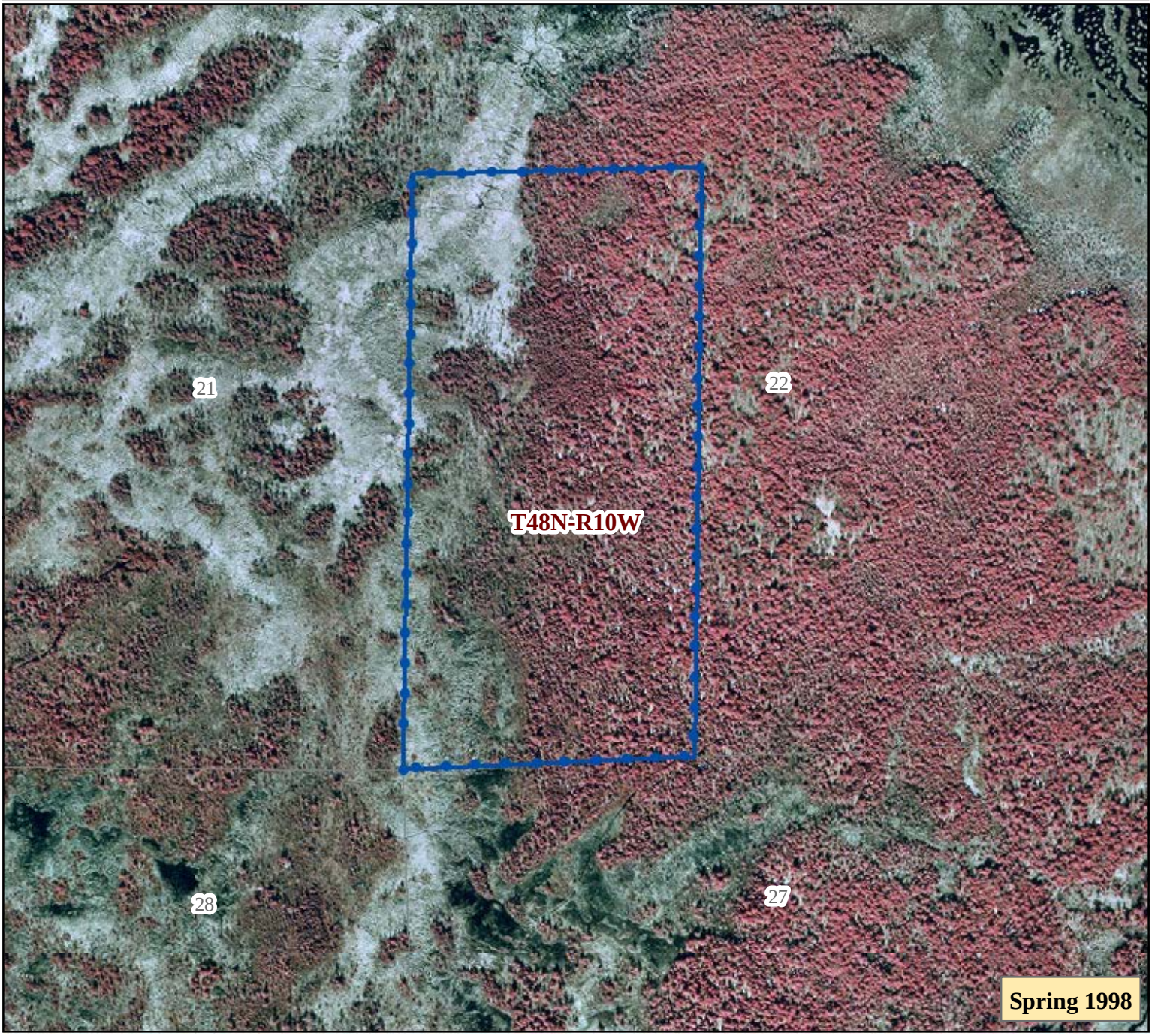
Exhibit G - Property Impacted By Recent Fire Activity

Sleeper Lake Fire - Located in Section 22, T48N-R10W, Luce County, MI



Legend

- = Two-Hearted Forest Reserve Property Boundary
- = Stand Boundaries
- = County Road
- = Secondary Road
- = Skid Trail/Unimproved Road
- = Designated Snowmobile Trail
- = Road-Stream Crossing
- = Area burned in 2007 Sleeper Lake Fire
- = Approximate Fire Edge

0 250 500 1,000 Feet

NORTH

Scale = 1:8,000
March 2020

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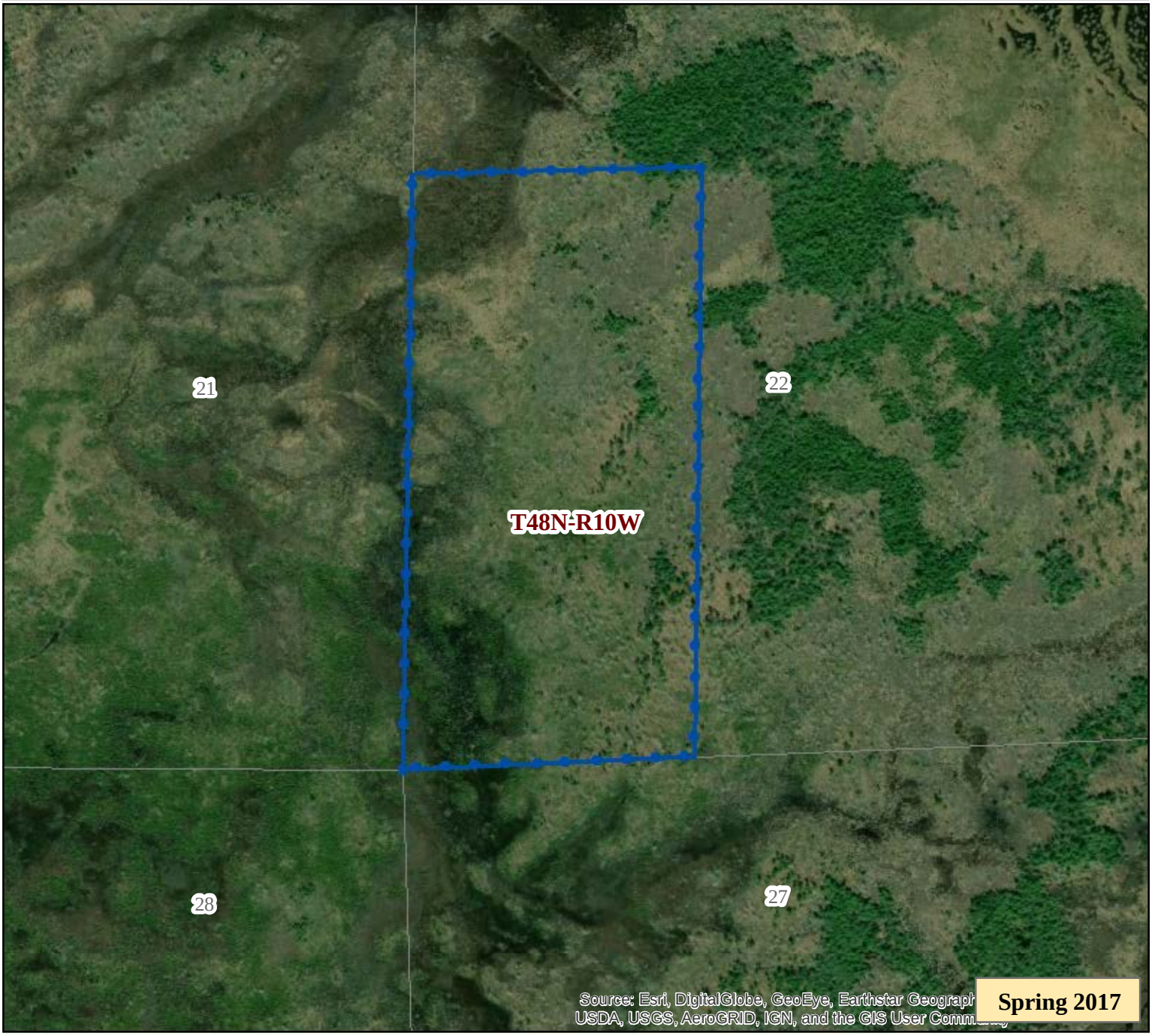
Exhibit G - Property Impacted By Recent Fire Activity
Sleeper Lake Fire - Located in Section 22, T48N-R10W, Luce County, MI



Legend

= Two-Hearted Forest Reserve Property Boundary

= Stand Boundaries

= County Road

= Secondary Road

= Skid Trail/Unimproved Road

= Designated Snowmobile Trail

= Road-Stream Crossing

= Area burned in 2007 Sleeper Lake Fire

= Approximate Fire Edge

0 250 500 1,000 Feet

NORTH

Scale = 1:8,000
March 2020

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