Appendix A

Site Visit Summaries

30 June 2015 FINAL DRAFT

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Introduction

Each of the selected State Lands was visited during the 2014 field season by the Project Team, accompanied by various members of the Steering Committee and State Lands Stewardship staff, as summarized in Table 1. Interviews with staff were conducted during the site visit; findings are detailed in the following sections, along with site photographs and location maps.

Table 1. Schedule of site visits to selected State Lands, 2014

Management Unit	Town	Date
Camp Plymouth State Park	Plymouth	June 5, October 20
Tinmouth Channel Wildlife Management Area	Tinmouth	June 18
Coolidge State Forest West – *Killington Resort*	Killington	July 31
Coolidge State Forest West - *CCC Rd, Old Plymouth Rd*	Plymouth, Shrewsbury	September 8
Coolidge State Forest East – *Curtis Hollow, Quarry Road*	Woodstock, Plymouth	September 29
Les Newell Wildlife Management Area *Stony Brook Road*	Stockbridge	December 1

Camp Plymouth State Park

Site Visit Date: 5 June 2014

Personnel: Ethan Phelps, VFPR Parks Regional Manager
Tim Morton, VFPR Stewardship Forester
Marie Caduto, VDEC Watershed Management Division
David Brynn, Vermont Family Forests
Kristen Underwood, South Mountain R & CS

Geographic Setting

Camp Plymouth State Park is located in Plymouth, Vermont, on the eastern shore of Echo Lake in the upper Black River watershed. Approximately 45 acres on the west side of Scout Camp Road are improved with parking areas, pavilions, camp buildings, and recreational facilities (Figure 1). The Park also includes 250 acres on the east side of Scout Camp Road, including 4 cabins adjacent to the road, and a road and trail access network on forested lands for recreation and timber harvest [1].

Hydrologic / Geomorphic Setting

Buffalo Brook flows through the State Park crossing under the Scout Camp Road just south of the entrance to the Park. The State Park is located along the lowest reach of Buffalo Brook (M41T6.01). This tributary drains a forested, mountainous catchment approximately 5.7 square miles in area and empties into Echo Lake, the second in a series of four instream lakes on the Black River [2, 3] (Figure 2). The Buffalo Brook watershed spans the towns of Plymouth and Reading; lands are in both public and private ownership. The State of Vermont, Department of Forests, Parks & Recreation (VFPR) owns and manages the Camp Plymouth State Park at the southwest extent of the watershed. The Vermont Fish & Wildlife Department (VFW) owns additional lands in the watershed which are part of the Arthur Davis Wildlife Management Area. A private party (Clifford) holds timber management rights on the lands owned by VFW. Soils of the Tunbridge-Lyman complex and the Berkshire-Tunbridge complex are particularly prevalent in the watershed, reflecting the shallow bedrock and the glacial-till origins of soil parent material [1, 5, 6].

Built Infrastructure

Infrastructure at Camp Plymouth State Park including 4 cabins east of Scout Camp Road, and several buildings including pavilions, camp buildings, lean-tos, parking lots and access roads on the west side of Scout Camp Road (Figure 1). A network of forest access road and trails exists on the east side of the road, providing access to state park and Arthur Davis WMA lands upslope of the park.

Tropical Storm Irene

On 28-29 August 2011, rainfall from Tropical Storm Irene caused widespread flooding in the State of Vermont. Impacts were particularly devastating in central and southern Vermont in areas with significant pre-storm soil moisture levels from rainfall that had fallen in earlier weeks. Between 6.6 and 7.8 inches of rainfall were recorded for the storm at stations maintained by the National Weather Service in Ludlow. Flooding along the upper Black River caused several washouts along Route 100 between Ludlow and Bridgewater Corners. Homes were lost to flooding in Plymouth [6].

Camp Plymouth State Park at the mouth of Buffalo Brook sustained substantial damages during Tropical Storm Irene (Figure 3). More than 35,000 yards of silt, sand and gravel were excavated from the park in the months following the flood [4]. Dredging of silt from the beach area in Echo Lake also occurred following TS Irene.

Echo Lake was highly turbid in the weeks following TS Irene (Figure 4). Water clarity issues persisted for months, in part due to channel activities associated with road and other infrastructure repairs in upstream reaches of the Black River [6].

Major Findings from Site Visit

Areas viewed during the site visit included the State Park facilities on both sides of Scout Camp Road, the flood deposits and delta formed by Buffalo Brook out into Echo Lake, and select trails (C1 and C3) in the lower Buffalo Brook watershed uphill of the Park (Figure 5; see attached Site Photographs).

- The Park sustained significant damages in early floods of 1973, late 1970s, early 1980s, as well as TS Irene (Aug 2011) [7].
- During TS Irene, Echo Lake rose 11 feet, with at least 3 feet of water in the concession stand and water reaching the gate house (photo 1). Septic tanks were submerged and silted in. Silt was later dredged from the beach.
- Trees & debris jammed the Scout Camp Road bridge (photo 5). The bridge span is undersized (46% of the bankfull width) and has a sharp approach angle [5]. Buffalo Brook jumped its banks and breached a 1970s-era berm to flow between cabins and down the camp entry road (photos 3 & 4). Park roads were scoured up to 2 to 3 feet (Figure 3). Grass-turfed areas fared much better and had minimal erosion. The Park incurred approximately $250,000 in damage; some expenses were reimbursed by FEMA, but the majority of expenses were paid for from the capital budget [7].
- Select trails east of Scout Camp Road were accessed on 5 June 2014 (Figure 5). Trail C3 (and C2) represent new skid trails that were installed post-Irene to access patch cut sites further to the northeast on VFPR lands (Figure 5). This new skid trail was installed to avoid using an existing narrower trail that runs close to the Buffalo Brook [8].
- Several segments of the new trail exceed 10% gradient and traverse very steep slopes (photos 6, 8).

The Project Team decided to focus on Camp Plymouth State Park as a demonstration site for application of recommended flood resiliency measures, including monitoring for conformance to the AMPs, and mapping of hydrologic resource zones. An additional site visit was conducted on 20 October 2014 to collect additional field data (see Appendix B).

References:

[1] VTANR, 2004, Camp Plymouth State Park: Long Range Management Plan.

[2] VTANR, 2015, Vermont Natural Resources Atlas, accessed at: http://anrmaps.vermont.gov/websites/anra/

[3] VTANR, 2015, Stream Geomorphic Assessment Data Management System accessed at: https://anrweb.vt.gov/DEC/SGA/projects.aspx

[4] Saylor, Chris, 2012, Vermont State Parks after Irene, 8/22/12, Vermont Public Radio, available at: http://www.vpr.net/episode/54251/slayton-vermont-state-parks-after-irene/

[5] South Mountain Research & Consulting, 2010. Phase 2 Stream Geomorphic Assessment: Black River Watershed, Rutland & Windsor Counties, Vermont - Addendum 1: Patch Brook & Buffalo Brook Tributaries, Towns of Plymouth, Reading, Mount Holly, Ludlow

[6] South Mountain Research & Consulting, 2014. Alternatives Analysis: Buffalo Brook Watershed, Tributary to upper Black River, Plymouth, Windsor County, Vermont. Prepared for Lake Rescue Association.

[7] Phelps, Ethan, 5 June 2014, personal communication.

[8] Morton, Tim, 5 June 2014, personal communication.

Figure 1. Camp Plymouth State Park, located along Scout Camp Road at the eastern shore of Echo Lake, Plymouth, VT.

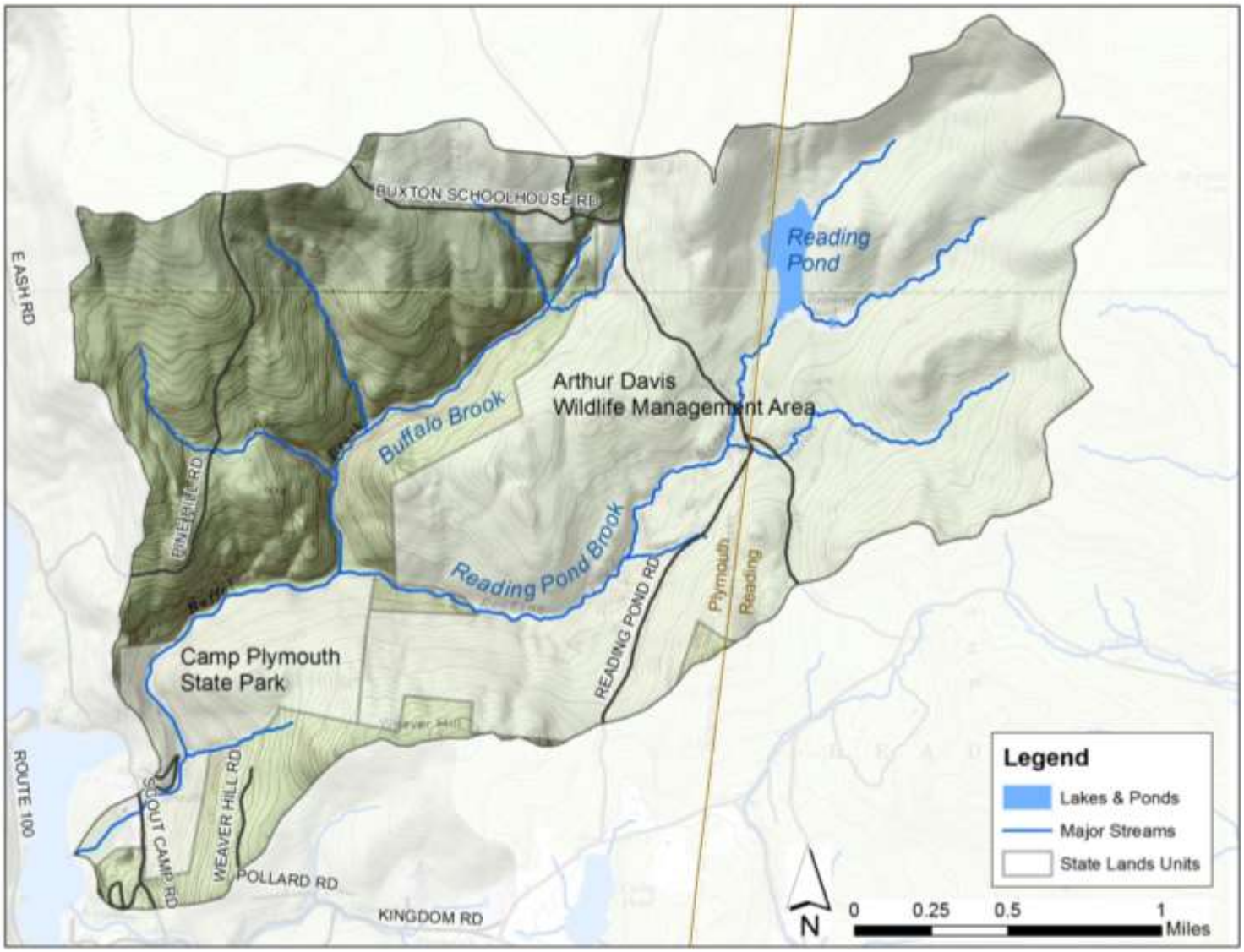


Figure 2. Buffalo Brook watershed draining to Echo Lake at Camp Plymouth State Park.

Figure 3. Camp Plymouth State Park in the hours and days following TS Irene. Photo credits: Chris Saylor. Source: Vermont State Parks after Irene, 8/22/12, Vermont Public Radio http://www.vpr.net/episode/54251/slayton-vermont-state-parks-after-irene/

Washed Away – The Sculpin By Pete Corradino , 9/6/11, Audubon Guides, http://blog.audubonguides.com/tag/hurricane-irene/

Figure 4. Aerial view of Echo Lake just south of Camp Plymouth State Park,
in the vicinity of the Kingdom Brook confluence, view to the southeast, 12 September 2011.
Photo credit: www.mansfieldheliflight.com

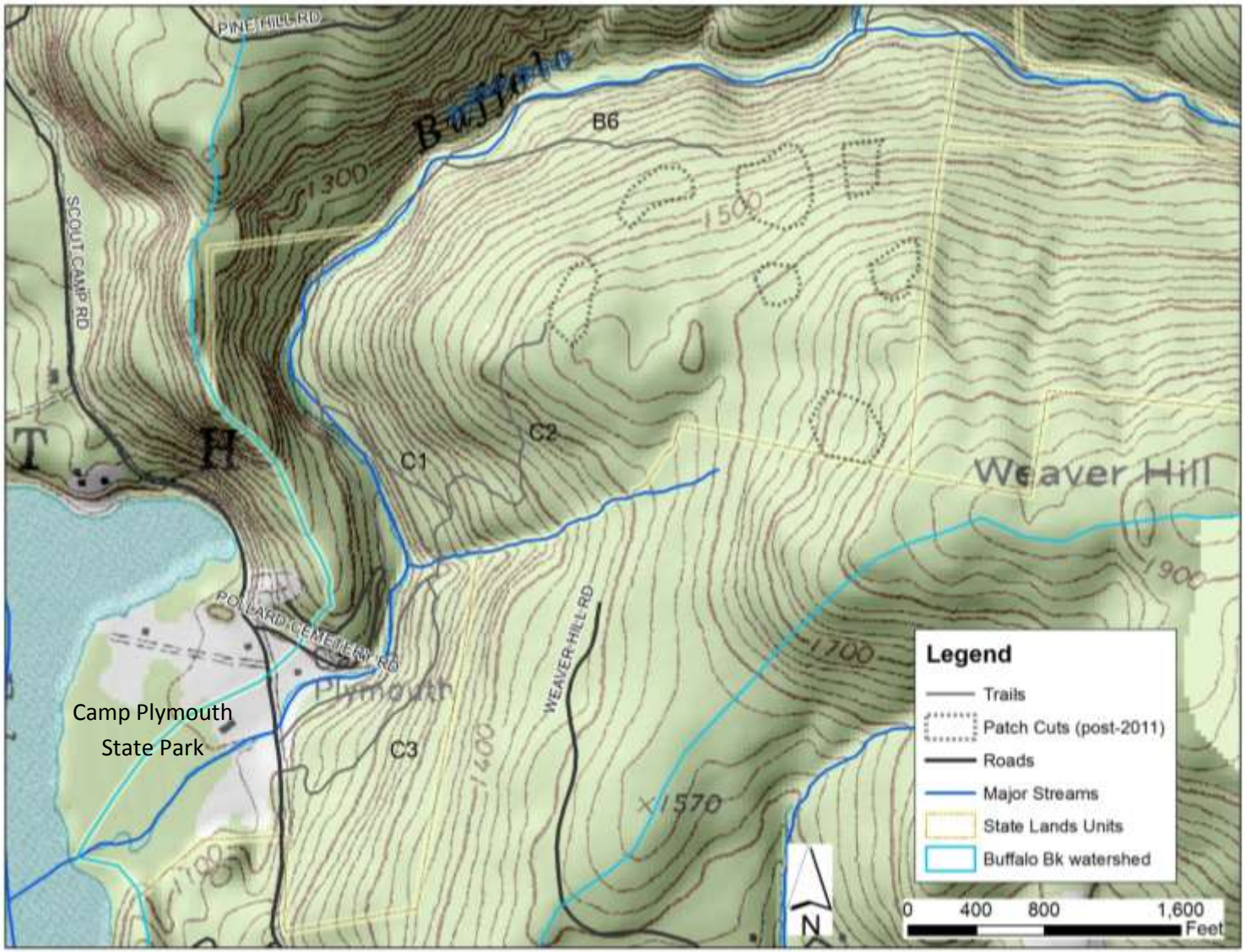


Figure 5. Site visit on 5 June 2014 focused on facilities at the State Park along Scout Camp Road and logging roads, C1 and C3

Camp Plymouth State Park, Buffalo Brook watershed, Plymouth, VT – 6/5/2014

1. View to west from Scout Camp Rd, past Park entrance.

2. View of Buffalo Brook confluence with Echo Lake (delta)

3. View downstream in Buffalo Bk adjacent to Park cabins.

4. View upstream from cabins; post-Irene streambank armor.

Camp Plymouth State Park, Buffalo Brook watershed, Plymouth, VT – 6/5/2014

5. Right-bank abutment of Scout Camp Rd (2009)

6. View uphill from trail junction to C2; 25% road gradient.

7. Incision and widening of stream channel observed downslope from C2 forest road crossing.

8. Forest road installed across >35% slopes, to access patch cuts. Steepness of hillsides and use of skidders necessitated wide road cuts. Steepness of road grade (>10%) required frequent water bars.

Tinmouth Channel Wildlife Management Area -

Site Visit Date: 18 June 2014

Personnel: Lisa Thornton, VFPR Stewardship Forester
John Lones, VFPR Forester
Shannon Pytlik, VDEC Rivers Program
Marie Caduto, VDEC Watershed Management Division
David Brynn, Vermont Family Forests
Kristen Underwood, South Mountain R & CS

Figure 1. View to south into Tinmouth Channel WMA along Clarendon River from North End Rd.

Geographic Setting

Tinmouth Channel Wildlife Management Area (WMA) is located in Tinmouth, Rutland County, Vermont, accessed from VT State Route 140. Three separate lots comprising 1,260 acres are bisected by the Clarendon River (Figure 1) which flows from south to north through a wide valley between Tinmouth Mountains to the west and Clark Mountain to the east (Figure 2) .

The major feature of the WMA is Tinmouth Channel, the channel-contiguous wetland along the Clarendon River. For a brief time in the late 1700s, the area was impounded behind an earthen dam to support operations of an iron forge [1]. Tinmouth Channel is designated as a Class 1 wetland, one of three in the State of Vermont. This designation ensures enhanced protections for wetland ecosystem services including flood attenuation and groundwater and surface water protection.

Hydrologic / Geomorphic Setting

The Tinmouth WMA is drained by the Clarendon River and its tributaries. The three lots of the Tinmouth WMA are bisected by the Clarendon River (reaches R20T1.13 through R20T1.15 [2]). At the North End Road culvert crossing, the Clarendon River has a 16.4 square mile upstream drainage area dominated by forest cover (67%) with lesser percentages of crop (11%) and urban (8%) land uses [3]. The Clarendon River joins the Otter Creek at Center Rutland approximately 12 miles to the north, which drains ultimately to Lake Champlain.

Slopes within the three lots of the Tinmouth WMA are gentle to moderate (less than 15%). Soils are dominated by Hydrologic Soil Group D and hydric soils (Figure 3).

Built Infrastructure

Onsite infrastructure includes parking lots and kiosks off N End Rd and the forest access network (forest roads, skid paths, forwarder paths, and logging landings),. The town of TInmouth maintains roads and stream crossings immediately adjacent to the WMA on North End Rd, Channel Road, and N East Rd. The state of Vermont maintains Route 140 and its crossing of the Clarendon River and its tributaries.

Tropical Storm Irene

On 28-29 August 2011, rainfall from Tropical Storm Irene caused widespread flooding in the State of Vermont. Impacts were particularly devastating in central and southern Vermont in areas with significant pre-storm soil moisture levels from rainfall that had fallen in earlier weeks. Between 5 and 6 inches of rainfall were recorded for the storm at stations maintained by the National Weather Service in neighboring towns. No major losses or damages were reported for Tinmouth WMA by Stewardship staff. It is likely that this wetland served to attenuate flood waters offering protection to downstream communities.

Major Findings from Site Visit

Areas viewed during the site visit included upland forest areas accessed via forest roads from two parking areas along the western and northern boundaries of the largest WMA parcel off N End Rd (see waypoints on Figure 1, and attached Site Photographs).

- Although many of the State Lands management units are located in headwater settings on steep lands, Tinmouth WMA provides an example of a lowland, wetland setting. While slowing and disconnecting runoff is the primary strategy on steeper lands with regard to enhancing flood resilience, support of floodwater attenuation functions is the primary goal in lowland settings such as Tinmouth WMA.
- Primary management goals in the Tinmouth WMA are for wildlife habitat (e.g., support Deer Wintering Areas, create browse) according to the LRMP.
- Private land along the eastern boundary limits access for active timber management.
- Timber sales occurred at this WMA in the winter months of 2013.
- Short segments of the forest access road and logging landing accessed from the western boundary parking area are positioned within required setbacks from a perennial stream (e.g., Photo 4). The group discussed the cost/benefit of moving road segments (and cutting new paths to replace out-of-compliance sections) to comply with AMPs versus maintaining legacy road layouts for short segments that do not meet AMPs.
- Exemplary practices were observed including coarse woody debris corduroy at stream crossings. This site prompted a discussion of the value of river corridors (per VANR guidance) over simple setbacks defined in AMPs.
- Several areas of the WMA are not actively managed (particularly along the eastern boundaries where permission would be required to cross private lands) and therefore function as "ecological reserve" areas.
- Management of hydrologically sensitive areas is accomplished in practice, typically through operational guidelines of a given timber sale or as spelled out in an annual work plan, rather than specifically called out in the Long Range Management Plan.
- Water resource assessments are more commonly being incorporated in the Long Range Management Plan in recent years. Basin planners from VDEC are being included in some of the State Lands Stewardship Teams (but not in all districts) and are involved in Annual Work Plan meetings.
- AMP compliance is typically overseen by VFPR staff. There is no measurement of compliance through monitoring programs. Rather, this is a complaint driven program. A logging contractor is contractually obligated to follow the AMPs. VFPR staff evaluate compliance in a qualitative way through regular inspections of a logging operation and provide guidance through operational requirements specified in the timber sale – (e.g., stream crossing requirements, flag road layout).
- Funding opportunities within VFPR for hydrologic restoration or road decommissioning are significantly limited. In recent years, the Department received approximately $100,000 state-wide to work on roads – the District including Tinmouth WMA received approximately $7,000.

References:

[1] VTANR, 2012, Tinmouth Channel Wildlife Management Area: Long Range Management Plan.

[2] VTANR, 2015, Vermont Natural Resources Atlas, accessed at:
http://anrmaps.vermont.gov/websites/anra/

[3] VTANR, 2015, Stream Geomorphic Assessment Data Management System accessed at:
https://anrweb.vt.gov/DEC/SGA/projects.aspx

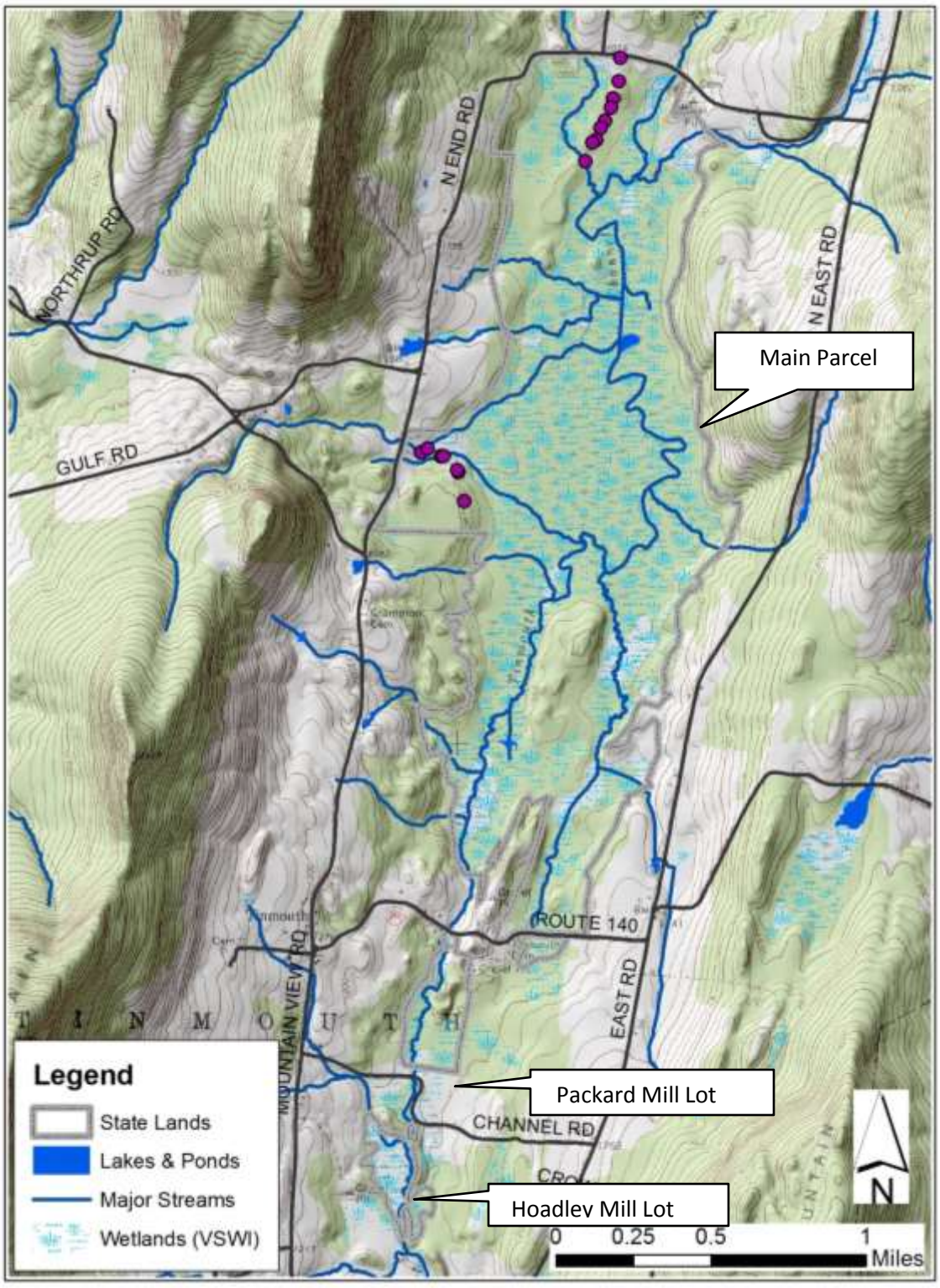


Figure 2. Location map, Tinmouth Channel Wildlife Management Area, Tinmouth, Vermont

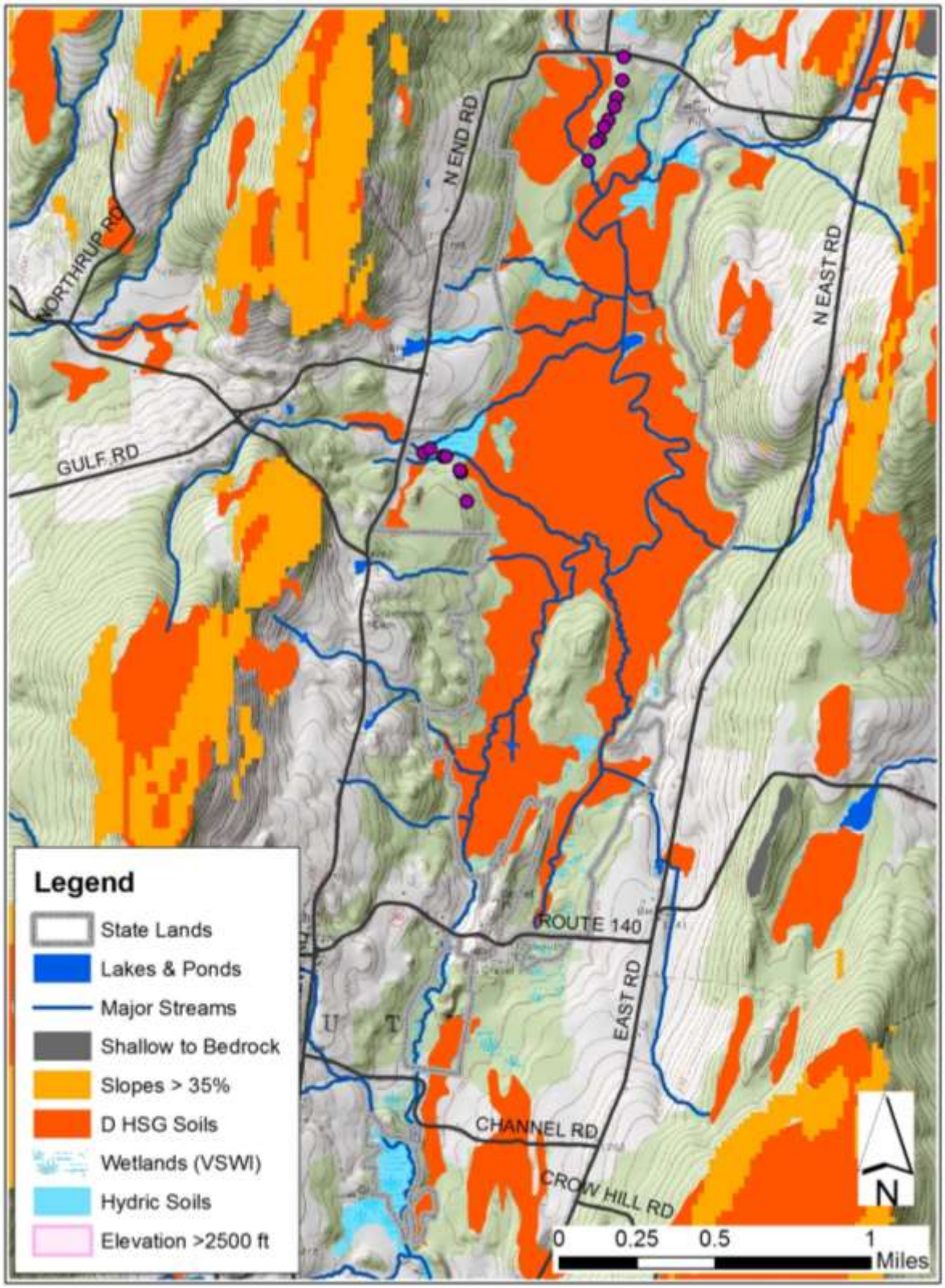


Figure 3. Elements comprising the Hydrologic Reserve zone at Tinmouth Channel WMA.

Tinmouth Channel WMA, Tinmouth, VT – 6/18/2014

1. View to east to log landing last worked in 2013; accessed from western-boundary parking area off N End Rd.

2. Stream crossing stabilized with coarse woody debris.

3. Logging access road through forested uplands used for recreation and hunting.

4. Log landing situated within 30 feet of perennial stream.

Tinmouth Channel WMA, Tinmouth, VT – 6/18/2014

5. Exemplary stream crossing practice.

6. Road approach to stream crossing in photo 5.

7. View to south into former log landing; from northern-boundary parking access off N End Rd.

Coolidge State Forest West -

Killington Resort

Site Visit Date: 31 July 2014

Personnel: Jeff Temple, Director Mountain Operations, Killington Resort
Tait Germon, Patrol Director, Killington Resort
Ethan Phelps, VFPR Parks Regional Manager
Nate McKeen, VFPR Forestry District Manager
Marie Caduto, VDEC Watershed Management Division
Kristen Underwood, South Mountain R & CS

Geographic Setting

Killington Resort leases approximately 1,676 acres of land [1] in the Coolidge State Forest encompassing slopes of Bear Mountain, Killington Peak, Snowden Peak and Rams Head Peak in Killington, Vermont (Figure 1). The resort operates year-round, offering skiing, snowboarding, mountain biking, hiking, golf, and other activities.

Hydrologic / Geomorphic Setting

Leased State Lands of the Killington Resort are positioned on the uppermost reach (T6.08) of the Roaring Brook which drains to the Ottauquechee River [2]. This upper reach has a drainage area of 1.1 square mile and an average slope of 8.3%. The catchment is mostly forested (80%), but contains significant area cleared for ski trails (14.3%) and some development (1.9 %) (Figure 2) [3]. Nearly the entire leased-land area is above 2,500 feet in elevation, and dominated by HSG D and C soils and steep slopes (>35%) (see Figure 3).

Built Infrastructure

Built infrastructure on leased lands within the Killington Resort includes buildings (e.g., Peak Lodge, lift operation buildings), ski lifts and other ancillary structures including a board walk connecting the Peak Lodge to the top of Canyon Quad lift. The area also includes an extensive network of gravel maintenance roads and ski trails, which are utilized year-round.

Tropical Storm Irene

Killington Resort sustained $6.2 Million damage during TS Irene (28-29 August 2011). Insurance covered buildings, but not trail damages [4]. Floodwaters of the Roaring Brook undermined the foundation of the Superstar Pub, an addition to the K-1 Lodge which had been built over the brook (see Photo 1). At this location the Roaring Brook is a second-order stream with an upstream drainage area of only 0.67 square mile. Based on peak flow measured at the nearby Kent Brook gage, the peak flow in Roaring Brook at this location during TS Irene would have been approximately 575 cubic feet per second. At a gradient of 8%, this discharge would have been sufficient to generate bed shear stresses well in excess of 20 pounds per square foot. The pub was rebuilt, but as a separate structure located to the east of the

Brook (photo 3). Further downstream, Roaring Brook caused significant damage in the vicinity of the Route 4 corridor (photo 2).

Major Findings from Site Visit

Areas viewed during the site visit included the K-1 lodge, the Gondola lift and Peak lodge, access roads along the Canyon Quad ski lift, and the board walk connecting the Peak Lodge to the top of the Canyon Quad lift (see attached Site Photographs). The Project Team was accompanied by Tait Germon, Patrol Director. A meeting with Tait and the Director of Operations, Jeff Temple, preceded the field visits.

- VFPR noted there has been great improvement in water quality of Roaring Brook since the 1970s. The resort is undertaking a water quality remediation plan for impaired water segments on the Roaring Brook, including culvert replacements.
- VFPR is a co-applicant on Act 250 permits submitted by the resort for construction or development activities within the boundaries of the Coolidge State Forest. Improved coordination between VDEC Stormwater staff, resort staff and VFPR staff would streamline oversight and ensure greater consistency in methods and guidance.
- Existing trail maintenance guidance could be improved to incorporate flood resiliency planning [5, 6, 7]
- Ski areas on State Lands operate under long-term lease agreements; the current lease agreement for Killington was established in 1960 and extends to 2060 [8]. Killington Resort submits an annual work plan for resort operations/ maintenance to occur on leased State Lands. There is opportunity for State Lands Stewardship Teams to comment on and guide activities to improve flood resiliency.
- There is opportunity to collaborate amongst ski areas which lease State Lands (e.g., Burke Mtn) to implement pilot projects in glade management to improve flood resiliency (e.g., look at alternative harvesting mechanisms and approaches to retain/ detain stormwater runoff in glades; implement improved trail drainage; optimize road network placement; implement signage in high-visibility areas to educate the public re: flood resiliency measures).
- Improved flood resilience on leased State Lands in ski resorts will improve bottom line of resort operations, by reducing or avoided damages sustained during future flood events.

References:

[1] VTANR, 2008, Coolidge State Forest – West of Rt 100: Long Range Management Plan.

[2] VTANR, 2015, Vermont Natural Resources Atlas, accessed at:
http://anrmaps.vermont.gov/websites/anra/

[3] VTANR, 2015, Stream Geomorphic Assessment Data Management System accessed at:
https://anrweb.vt.gov/DEC/SGA/projects.aspx

[4] Temple, Jeff, 2014, personal interview, Director Mountain Operations, Killington Resort

[5] UVM Agricultural Experiment Station, c.1973, Guide to Vermont Ski Trail Construction and Management, Pamphlet 39.

[6] VDEC, 2000, Guidelines for the Design and Construction of Ski Lifts and Trails in Class A Watersheds in Vermont.

[7] Hastings, Blaine, 2014, hydrologist with VDEC Watershed Management Program, personal communication.

[8] Office of the Vermont State Auditor, 2015, State Land Leases Boost Ski Industry but are Dated and Inconsistent: Report to the Vermont Legislature and the Agency of Natural Resources. Non-audit report 15-01.

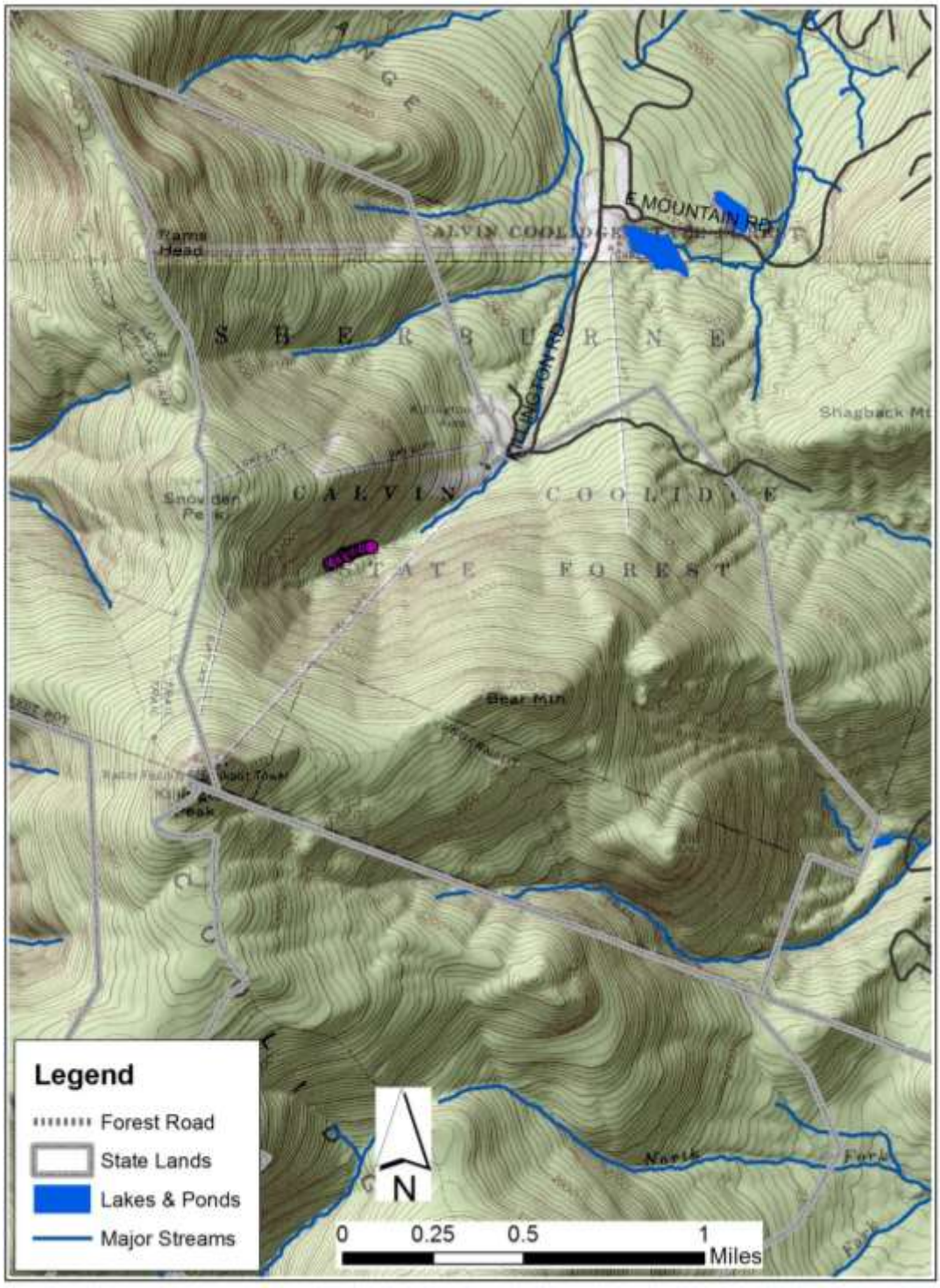


Figure 1. Site Location Map – topographic map,
Killington Resort, Coolidge State Forest West, Killington, VT.

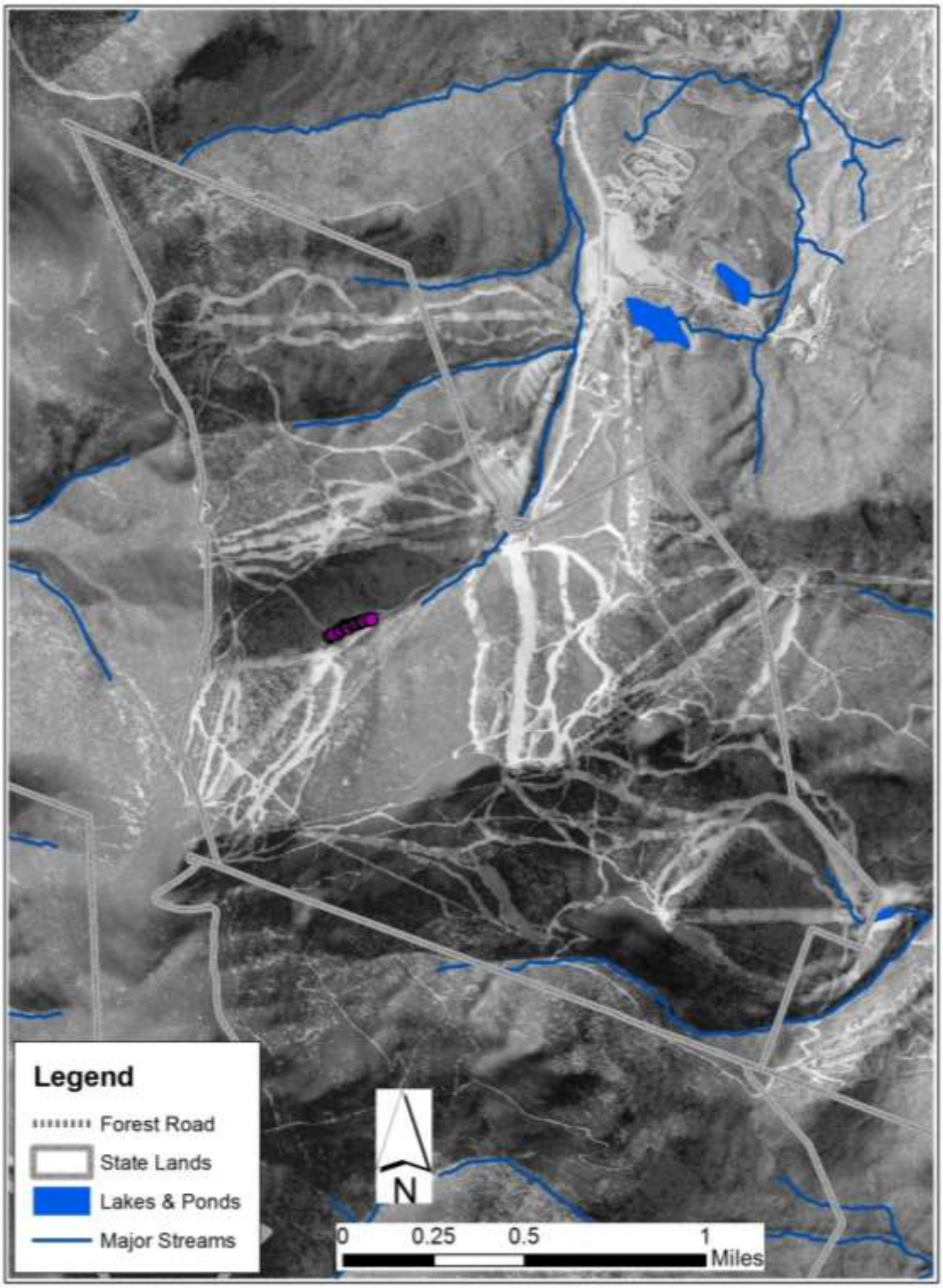


Figure 2. Site Location Map – orthophoto base map,
Killington Resort, Coolidge State Forest West, Killington, VT.

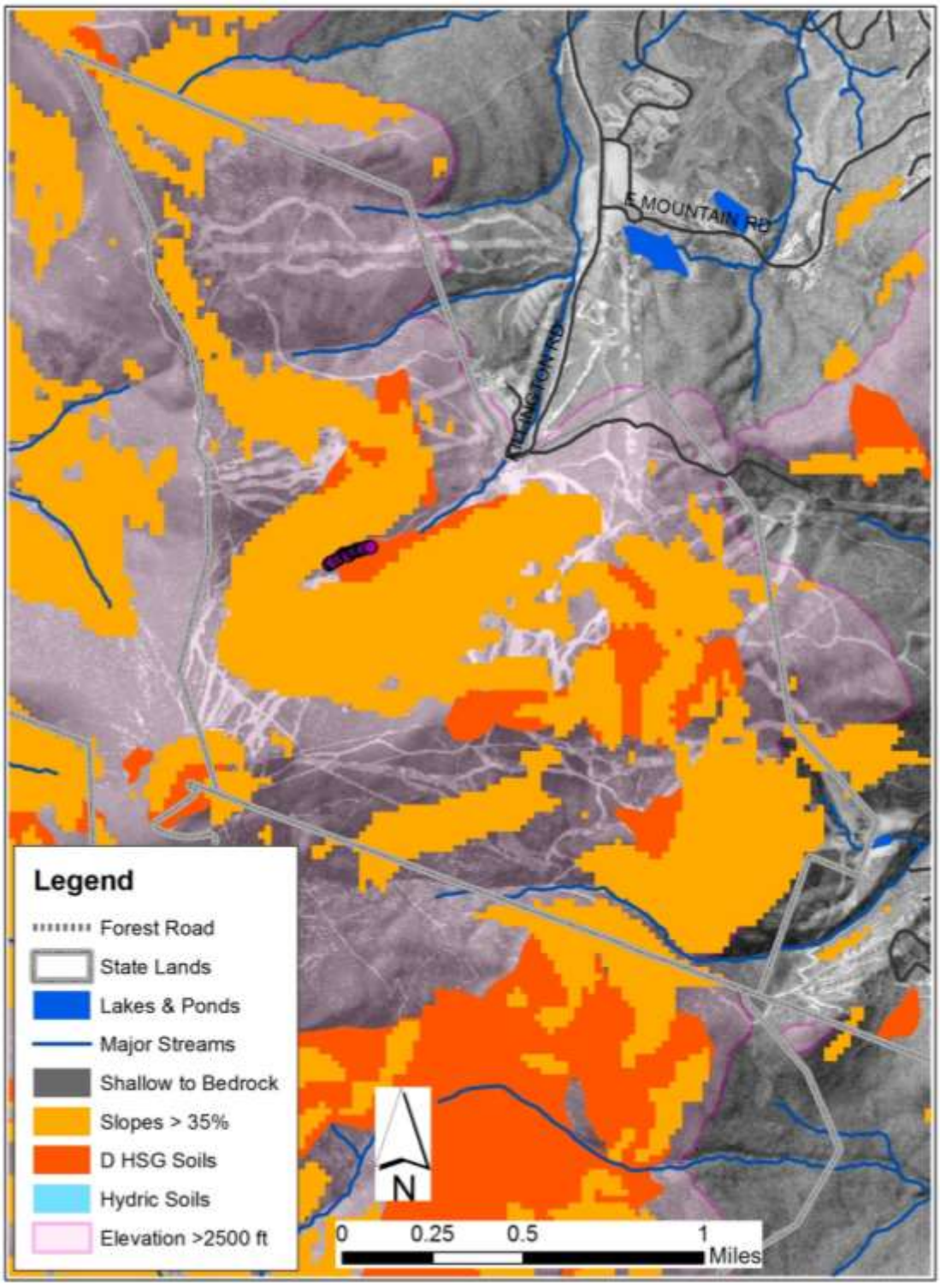


Figure 3. Elements comprising the Hydrologic Reserve zone at Killington Resort, Coolidge State Forest West.

Photo 1. Partial collapse of K-1 base lodge, Superstar Pub addition, at Killington Resort – August 31, 2011. Building foundation and access road undermined by floodwaters from the Roaring Branch. Photo Credit: Lars Gange and Mansfield Heliflight

Photo 2. Damages sustained to the Route 4 corridor further downstream on Roaring Brook during Tropical Storm Irene (August 28, 2011); (photo obtained from draft Town of Killington, Vermont, Local Hazard Mitigation Plan).

Killington Resort, Coolidge State Forest West, Killington, VT – 7/31/2014

2. View downstream in restored reach of Roaring Branch adjacent to pub rebuilt farther to the east.

3. View of Roaring Branch from Gondola lift to Peak Lodge.

4. Boardwalk connecting Peak Lodge to top of Canyon Quad lift. Opportunity for signage/ education/outreach re: glade management.

5. View downstream along maintenance roads to bottom of Canyon Quad lift.

Killington Resort, Coolidge State Forest West, Killington, VT – 7/31/2014

6. View uphill from access road to Canyon Quad lift.

7. One of several water bars on maintenance road, draining to rock-lined detention areas, before discharging to Roaring Brook.

8. View to side slope into Big Dipper glades.

Coolidge State Forest West -

CCC Road, Old Plymouth Rd

Site Visit Date: 8 September 2014

Personnel: Nate McKeen, VFPR Forestry District Manager
Lisa Thornton, State Lands Stewardship Forester
John Lones, VFPR Forester
Shannon Pytlik, VDEC Rivers Program
Marie Caduto, VDEC Watershed Management Division
David Brynn, Vermont Family Forests
Kristen Underwood, South Mountain R & CS

Geographic Setting

Calvin Coolidge State Forest - West is composed of approximately 16,801 acres of forested highlands west of Route 100, exclusive of the abutting Plymsbury Wildlife Management Area (1,859 acres) and the nearby Tiny Pond WMA (739 acres) which are contained in the same management unit as the Coolidge State Forest West [1] (see Figure 1). Coolidge SF West is located in the towns of Killington, Mendon, Shrewsbury and Plymouth.

Two sites were visited with State Lands staff on 8 September 2014: repaired portions of the CCC Road (Shrewsbury Rd SFH) connecting Plymouth to North Shrewsbury (Figures 1 & 2); and two trail heads off the north and south sides of Old Shrewsbury Road near North Shrewsbury providing access to the Plymsbury WMA (Figures 1 & 4). A separate visit was made to leased State Lands on the Killington Resort on 31 July 2014 (see separate entry in this Appendix).

Hydrologic / Geomorphic Setting

CCSF-West is located within the Southern Green Mountain biogeophysical province. The CCC Road and Old Plymouth Road field sites are located in headwaters areas, drained by first-order streams. The small streams crossed by the CCC Road in Plymouth drain toward Woodward Reservoir. On the Old Plymouth Road, the eastern most site providing access to Plymsbury WMA lands south of the road is in the headwaters of Great Roaring Brook (a tributary to the upper Black River). The westernmost site providing access to Plymsbury WMA lands north of the road drains to headwaters of the Cold River, tributary to the Otter Creek [2, 3]. Both the Cold River and Great Roaring Brook were associated with severe flooding during Tropical Storm Irene that resulted in substantial damages to infrastructure.

Portions of the CCSF-West lands near the sites visited are above 2,500 feet in elevation, and underlain by HSG D soils on steep slopes (>35%) (see Figures 3 & 5).

Built Infrastructure

Built infrastructure represented in areas visited on 8 September 2014 consisted primarily of a network of forest access roads and trails that provide access to State Lands for recreation and timber harvest. The CCC Road is owned by VFPR, and is popular with local commuters during non-Winter months as a more direct connection between Plymouth and Shrewsbury.

Tropical Storm Irene

TS Irene resulted in extensive damages to the CCC Road and Old Plymouth Road. Segments of the CCC Road were washed out, timber cribbing was exposed and undermined, and culverts were displaced (see attached photos). The road was closed for 2 years, and reopened in the Spring of 2014. Road repairs were supported by FEMA funds, which reportedly amounted to approximately $250,000.

Major Findings from Site Visit

CCC Road

- The Shrewsbury Road SFH was constructed in the 1930s by Civilian Conservation Corps; hence, it is known locally as the "CCC Road".
- The switchbacks on the eastern (Plymouth) end of the road traverse hillslopes which are locally up to 55% in gradient. Portions of the CCC Road are 15% grade.
- The road receives approximately 65 cars per week, according to recent estimates.
- The Road is closed and gated during the winter months, and becomes popular for snowmobiles as part of the VAST network of trails.
- In recent years, VFPR receives approximately $100,000 annually, Statewide, for road maintenance activities. The Southwest District manages 30 miles of roads and received $7,000 last year and $11,000 this year for their road budget.
- The cost to repair the CCC Road – approximately $250,000 – is 2.5 times the entire Statewide operating budget for road maintenance. FEMA funding made road repair possible.
- There was discussion about abandoning the road, given the high cost-to-benefit ratio. However, VFPR responded to a vocal sector of the public who exerted pressure to re-open the road for commuting and for recreational access.
- Due to safety concerns, given the steep gradient and limited line of sight, one particular segment was replaced as a single-lane road with appropriate signage.
- The road accesses 12,000 acres of timberland (mostly from Shrewsbury end of the road).
- Alternative routes connect Plymouth and Shrewsbury. The CCC Road is not necessary, and in fact is closed to vehicular traffic for half the year.
- Downsizing the easternmost end of this road to a trail with sufficient broad-based dips would continue to accommodate hiking, birding, hunting, mountain biking, horse riding and other non-motorized recreational uses while significantly decreasing maintenance costs, decreasing flood hazards and water quality impacts. Timber harvest areas could continue to be accessed from the Shrewsbury end of the road.

Old Plymouth Road

- Road access from Fisher Lot was repaired following washouts during Irene.
- Wet areas on forest access from southern parking area were stabilized with log corduroy sourced from the log landing. Small settling pond was used to accept runoff from water bar – disconnecting runoff to stream crossing.
- Timber harvest occurred in winter months three winters ago. Early successional patches were installed for wildlife management (deer, grouse, birds).

General

- During the cost-benefit accounting, the Long Range Management Plans and annual work plans should more explicitly include costs associated with water quality impacts and flooding impacts when considering whether to maintain or decommission road segments. Planning should include options to abandon or downsize road segments in unsuitable settings (e.g. too steep) and identify cost thresholds above which road segments will not be replaced following damages sustained in a future flood event.
- The group discussed the possibility of including deductions in timber harvest contracts to support road maintenance and/or decommissioning. At present, up to 10% of timber revenues may be diverted to upgrade roads/trails to improve AMP compliance.
- The group discussed the importance of assessing road conditions and infrastructure status prior to acquiring new lands. If the true costs associated with decommissioning/ upgrading/ or maintaining infrastructure is tallied before acquisition, there is greater potential for raising adequate endowments to support this work – through increased emphasis on private/public partnerships.
- The group discussed potential means of raising additional revenues to fund road/trail network maintenance/ decommissioning, including:

    - Partnering with towns/ watershed groups to apply for VDEC Ecosystem Restoration Grants (precedent exists, e.g. Lake Rescue Association and road/trail work upstream of Camp Plymouth State Park)
    - Partnering with towns for BetterBack Roads grants
    - Partnering with US Forest Service in watersheds occupied by GMNF – even if project sites on State Lands are located outside the boundaries of the GMNF (precedents exist)
    - Land & Facilities Trust Fund

- More loaner skidder bridges could be made available for logging contractors. Forwarders could be incentivsed in contracts or made available on shared basis – perhaps funded through Working Lands Enterprise.
- Methods for assessing compliance with and enforcement of AMPs were discussed. The State Lands teams do not currently perform quantitative measures of AMP compliance (e.g., tally the number of drainage structures including broad-based dips or water bars per trail segment and

compare to recommendations in the AMPs). The notion of Optimal Conservation Practices for roads, trails, riparian buffers, stream crossings, etc. and protocol for monitoring was discussed in light of climate change.

- There is potential for citizens to be engaged in assessment of post-harvest AMP compliance (precedent exists in Addison County watersheds, funded by ERP grants, involving residents and watershed group members; included instruction in installation of broad-based dips and water bars for technology transfer to private landowners).
- When State Lands staff inspect logging jobs, there is currently no practical recourse for fining smaller infractions of AMPs. Minimum fines are $10,000. Enforcement of AMP compliance could be better enabled if incremental ticketing amounts (e.g., $250 or $1,000) were available.
- Buffer guidance has been somewhat unique to each State Lands district; State Lands Team is working to standardize this guidance statewide and incorporate river corridors rather than default setbacks.

References:

[1] VTANR, 2008, Coolidge State Forest – West of Rt 100: Long Range Management Plan.

[2] VTANR, 2015, Vermont Natural Resources Atlas, accessed at: http://anrmaps.vermont.gov/websites/anra/

[3] VTANR, 2015, Stream Geomorphic Assessment Data Management System accessed at: https://anrweb.vt.gov/DEC/SGA/projects.aspx

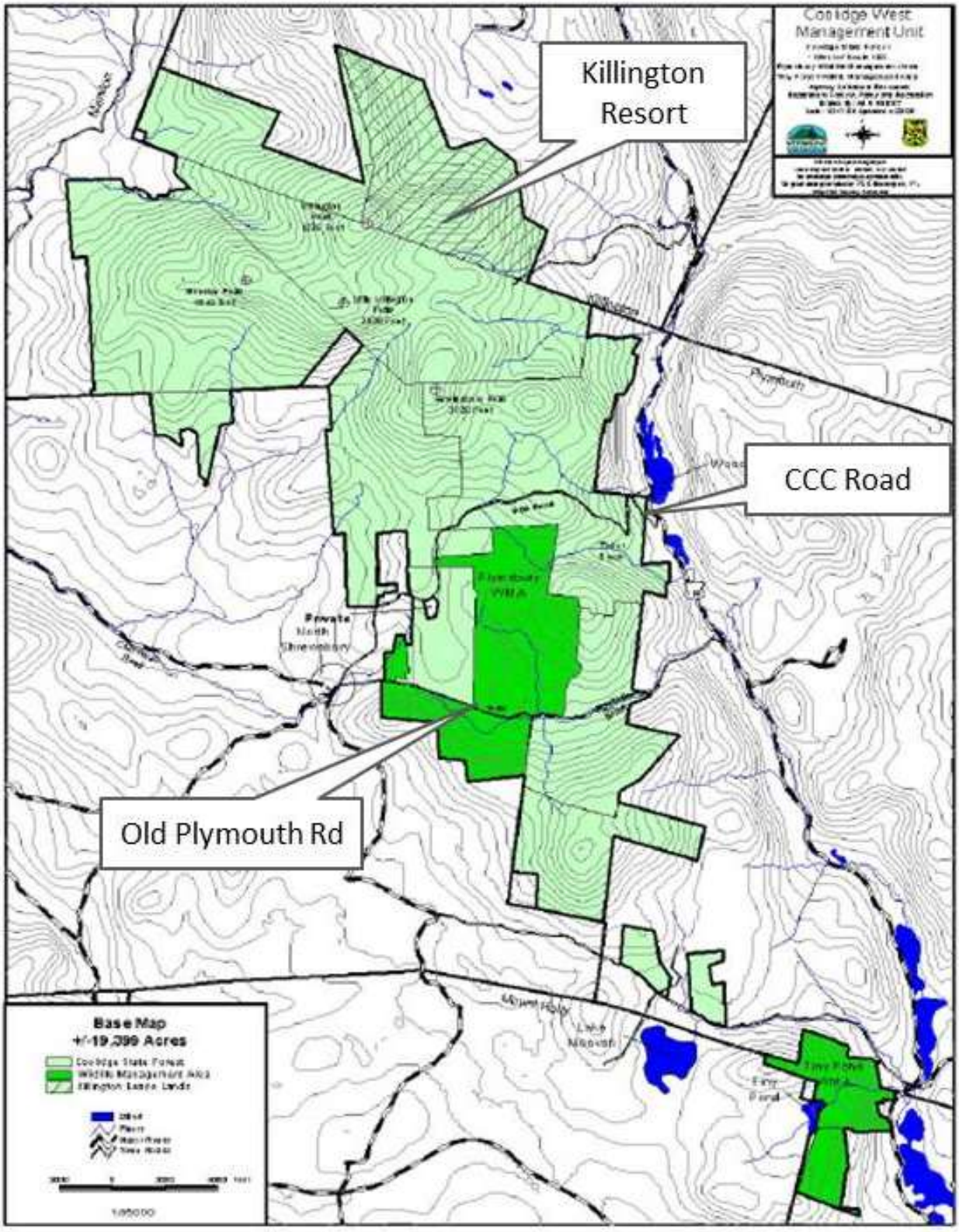


Figure 1. Extent of Calvin Coolidge State Forest – West (excerpted from Long Range Management Plan)

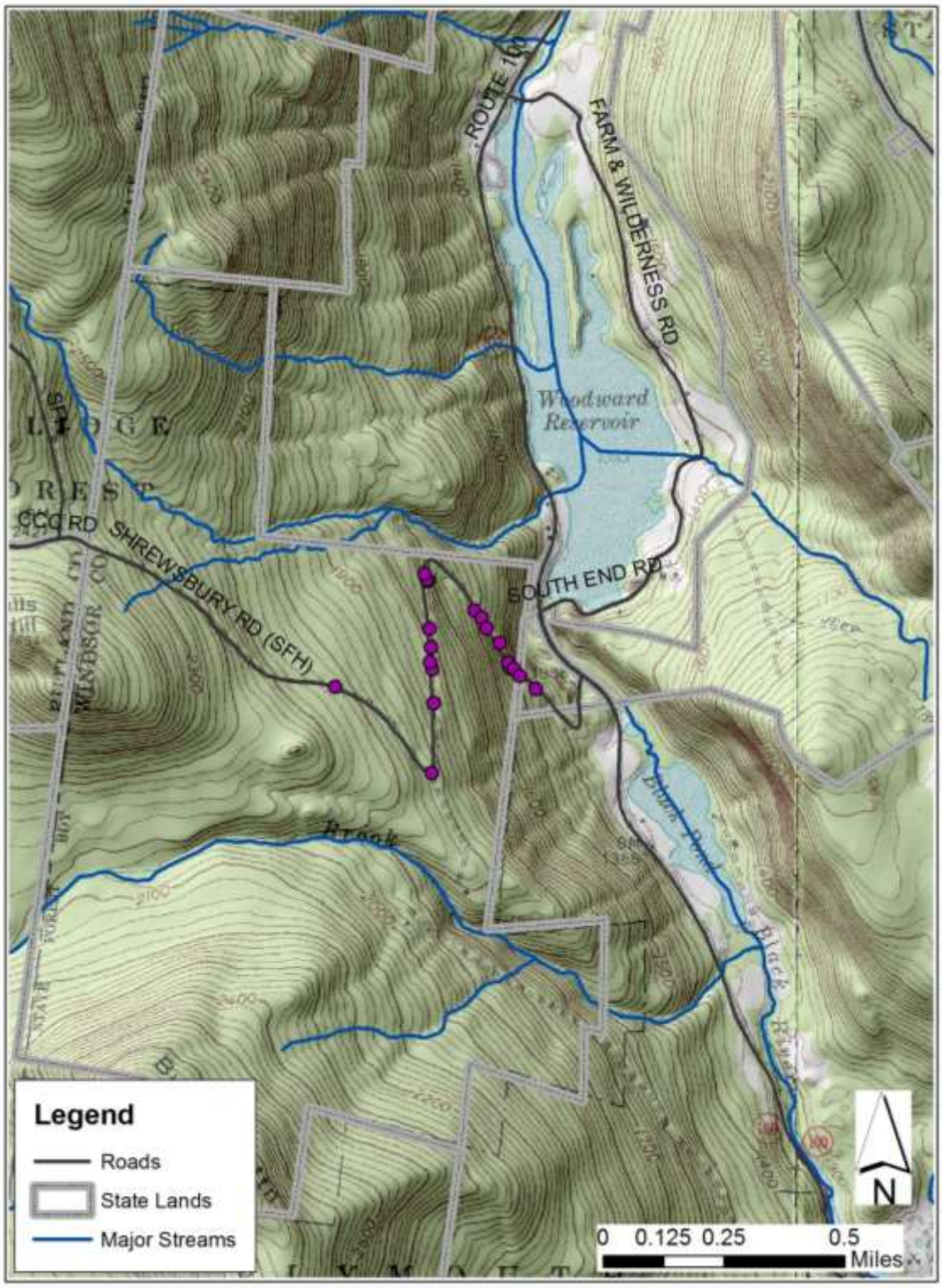


Figure 2. Site Location Map – CCC Road
Calvin Coolidge State Forest – West, Plymouth, Vermont

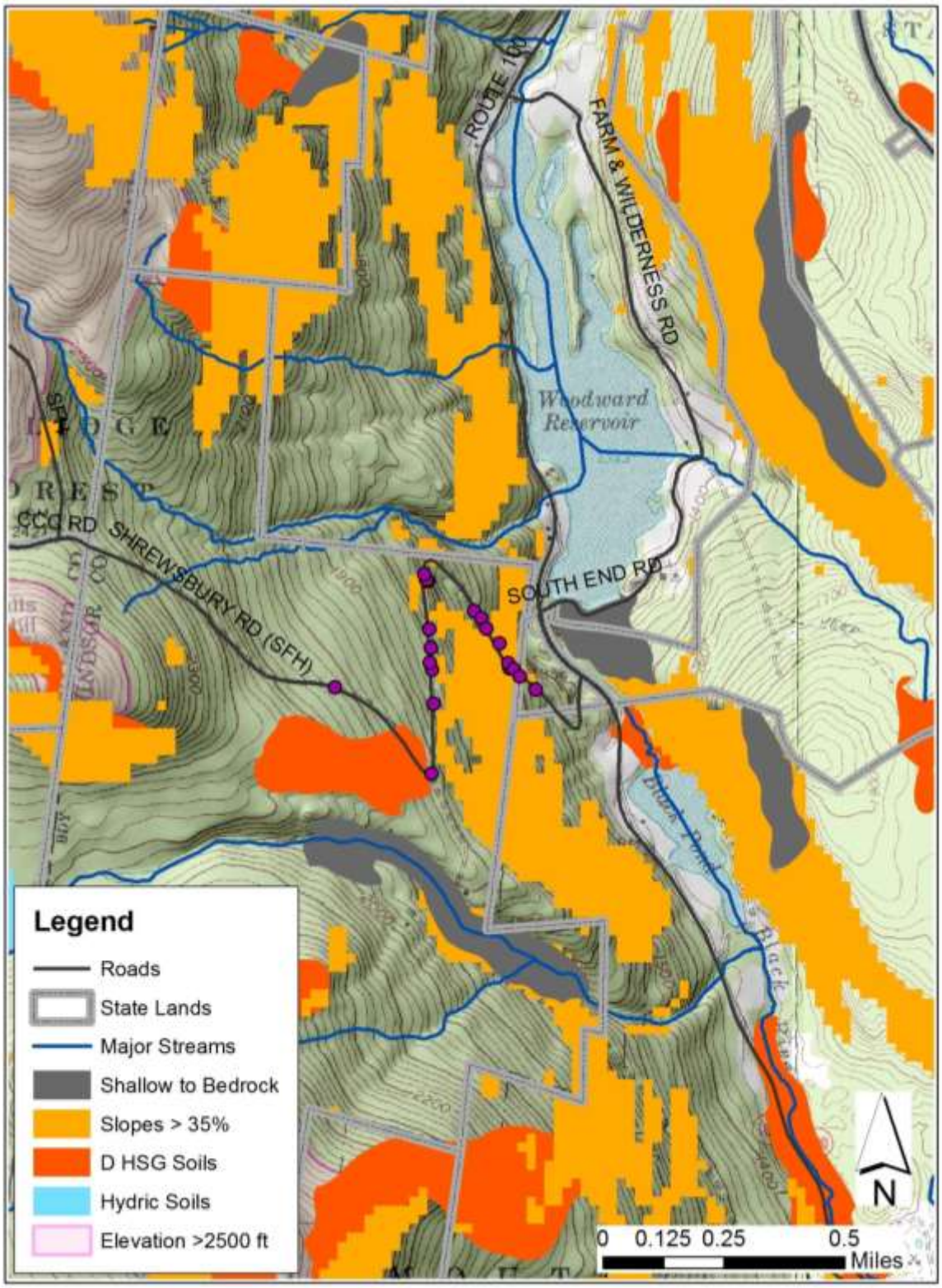


Figure 3. Elements comprising the Hydrologic Reserve zone at the CCC Road site, Calvin Coolidge State Forest – West, Plymouth, Vermont.

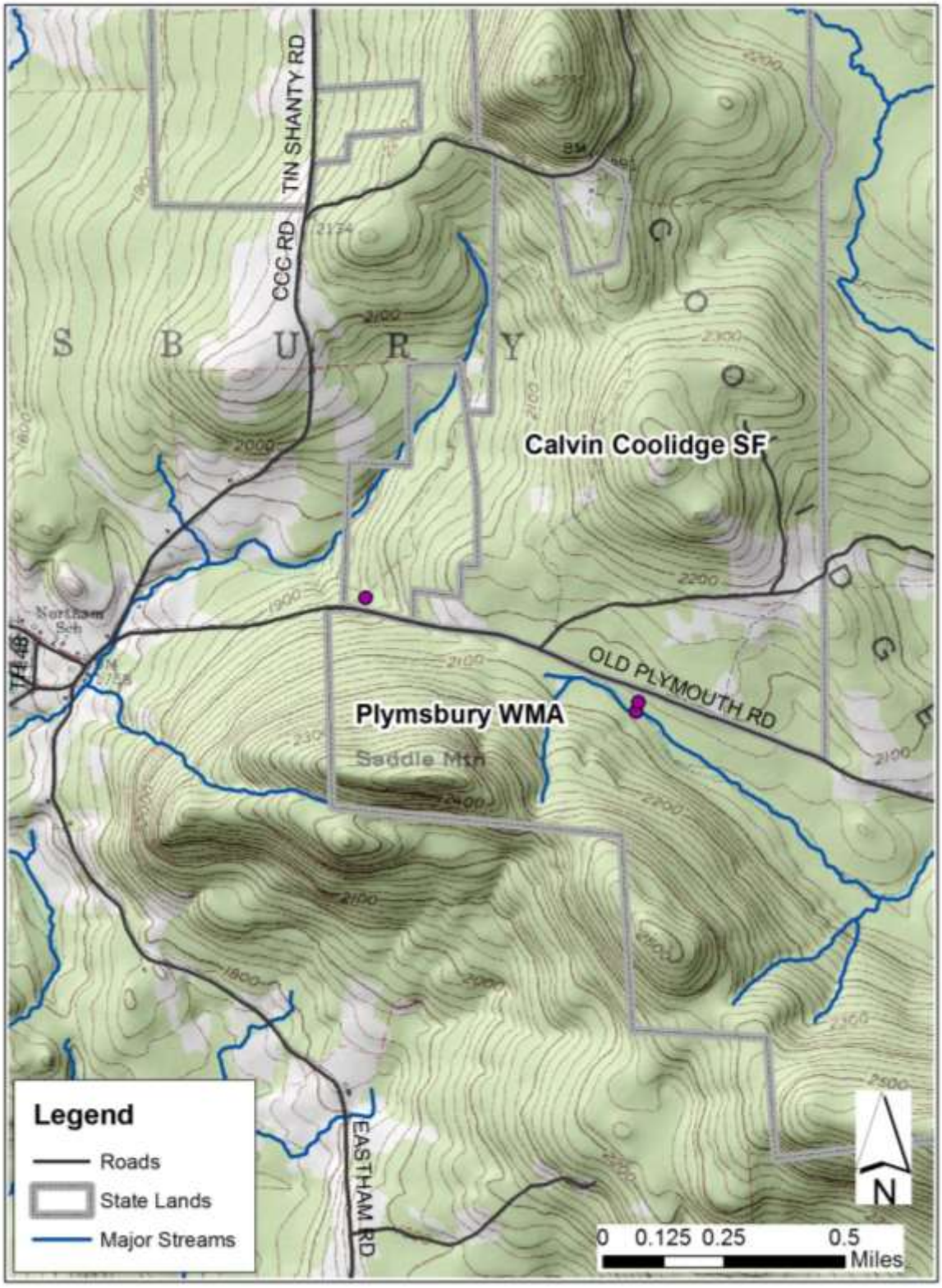


Figure 4. Site Location Map – Old Plymouth Road sites
Calvin Coolidge State Forest – West, Shrewsbury, Vermont.

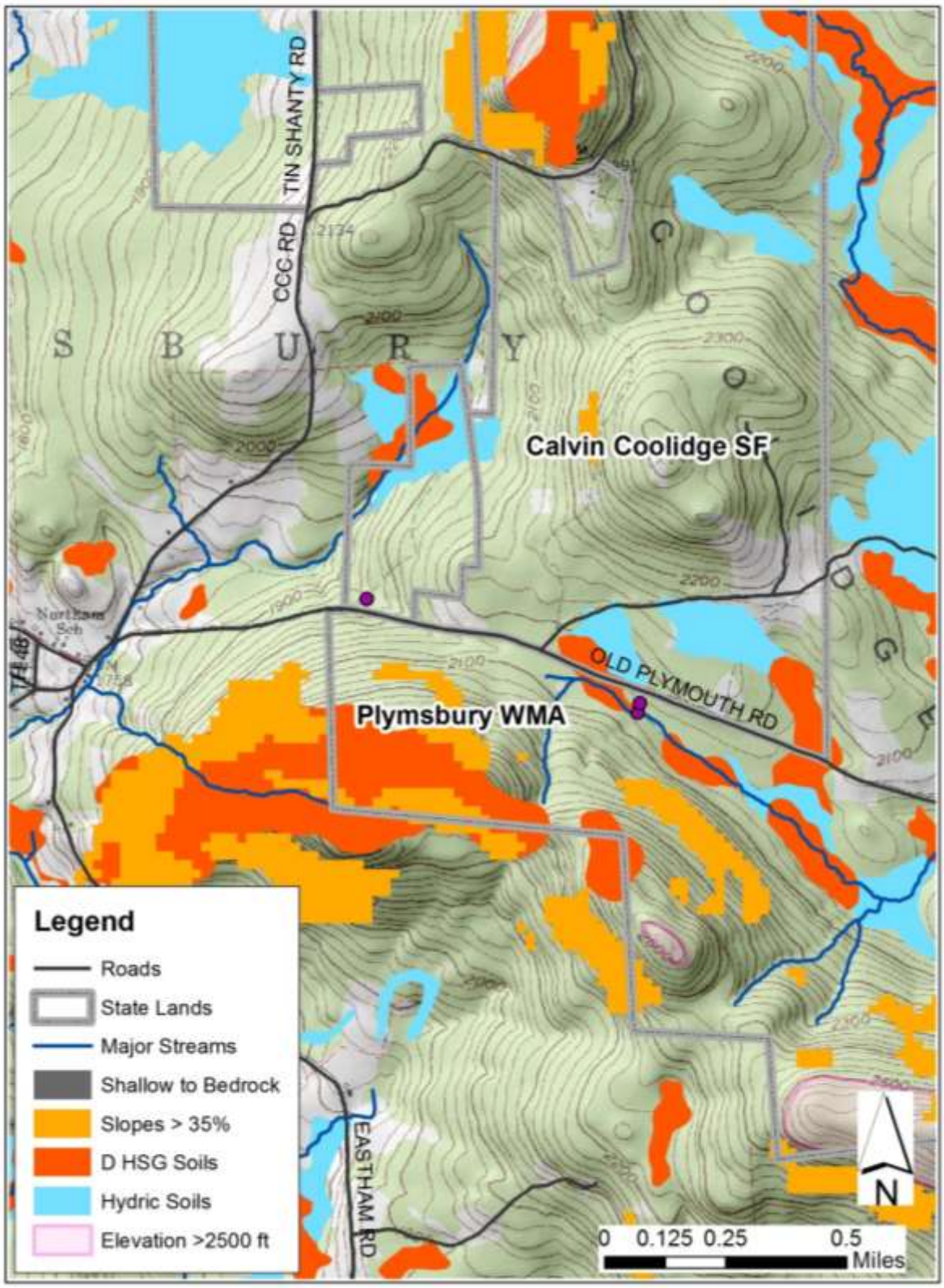


Figure 5. Elements comprising the Hydrologic Reserve zone at the Old Plymouth Road sites, Calvin Coolidge State Forest – West, Shrewsbury, Vermont.

Calvin Coolidge State Forest, West of Rt 100, Plymouth & Shrewsbury, VT – 9/8/2014

1. One-lane segment of CCC Road and stream crossing replaced after TS Irene on >25 % hillslopes through Northern Hardwood Seepage Forest.

2. View downhill, same culvert site as photo 1.

3. Erosion of road sediment from culvert header into tributary draining to Woodward Reservoir; site uphill from photo 1.

Calvin Coolidge State Forest, West of Rt 100, Plymouth & Shrewsbury, VT – 9/8/2014

4. View from south parking area along Old Plymouth Rd into Plymsbury WMA.

5. View into Plymsbury WMA from access area on north side Old Plymouth Road. Repaired following TS Irene.

Damages to CCC Road, Tropical Storm Irene, Plymouth, VT

Source: Town of Shrewsbury

Coolidge State Forest East -

Site Visit Date: 29 September 2014

Personnel: Tim Morton, State Lands Stewardship Forester
David Brynn, Vermont Family Forests
Kristen Underwood, South Mountain R & CS

Geographic Setting

Calvin Coolidge State Forest - East is composed of several thousand acres of forested highlands east of Route 100, in the towns of Woodstock, Bridgewater, Plymouth, and Reading. There is no digitally-accessible Long Range Management Plan for Coolidge State Forest East.

Two sites were visited with State Lands staff on 29 September 2014: (1) a forest road and trail network off Curtis Hollow Road in Woodstock and (2) a box culvert site and recent forest sale on Quarry Road in Plymouth (see Figure 1).

Hydrologic / Geomorphic Setting

CCSF-East is located within the Southern Green Mountain bio-geophysical province. The Curtis Hollow site is drained by Curtis Hollow Brook, a tributary to the Ottauquechee River (Figure 2). The forest access road crosses Curtis Hollow Brook in reach M21S1.02, where the brook is a third-order stream with an upstream drainage are of 1.77 square miles [2, 3]. Lands along the ridge tops at this site are underlain by soils of HSG D on slopes exceeding 35% (Figure 3).

The Quarry Road sites are located in headwaters areas, drained by first-order streams, tributaries to Pinney Hollow Brook which joins Broad Brook and eventually flows to the Ottauquechee River at Bridgewater Corners (Figure 4). Very limited regions of the Quarry Road area on CCSF lands are underlain by soils of HSG D on slopes exceeding 35% (Figure 5).

Built Infrastructure

Built infrastructure represented in areas visited on 29 September 2014 consisted primarily of a network of forest access roads and trails that provide access to State Lands for recreation and timber harvest. At least two year-round residences and four camps on abutting lands are accessed from the Quarry Road.

Tropical Storm Irene

TS Irene caused damage to the forest highway bridge over Curtis Hollow Brook (Figure 5). The left-bank bridge abutment was replaced with design help from VDEC Facilities Engineering and funding from FEMA with local match provided by VFPR capital funds [1].

TS Irene resulted in damages to Quarry Road. Segments of the road were washed out. Debris plugged a box culvert, resulting in a small unnamed tributary overtopping and washing out the road. This stream drains a 250 acre watershed. This stream crossing and the road were constructed during the 1930s by the Civilian Conservation Corps [1].

Major Findings from Site Visit

Curtis Hollow

- Team viewed a recent bridge repair site (Figure 5), examples of culvert in need of removal pending funding, and culverts that have been decommissioned (Figure 4).
- Team viewed a recent patch cut site that was accomplished using forwarders. Saw timber was cut to length, and tops were left in place to some degree. This is a technique that is good for flood resiliency (roughness elements help to detain stormwater flow) but that can invite criticism from hunters using the property.
- Discussed that FOREX system does not include evaluation of road access networks (e.g., for compliance with AMPs, for percent aerial coverage)
- Team viewed the North American Maple Plot – an example of ecological reserve area. This area was last logged in the late 1970s.

Quarry Road / Pinney Hollow

- Team viewed the box culvert crossing of Quarry Road over the unnamed tributary to Pinney Hollow Road (Figure 6, photos 1 & 2). Discussion of possible remedial strategies including raising the stream bed, design to overtop the road in a future major flood, etc.
- Team viewed a recent timber sale off Quarry Road (Figure 8, photos 3 &4). Tight switchbacks on the access road meant that chippers and larger harvesting machinery could not access the site. Patch cuts were accomplished using forwarders. This represents an Optimal Conservation Practice that builds flood resiliency on these State Lands – exemplary practices.

General

- It is helpful to have hydrological restoration and conservation formalized as a management goal.
- There is a recognition that underused roads on unsuitable lands (steep slopes, HSG D soils) should ideally be downsized and decommissioned. However, funding to accomplish this is very limited and insufficient at this time.
- There is a mechanism within timber sale contracts to pay for some property improvements. There could be a deduction in the timber sale contract for stream restoration, for example. However, there is a general rule of thumb not to exceed approximately 10% of the revenues of the sale.
- Training in hydrologic restoration techniques and other practices including disconnecting ditches from streams would be helpful.

References

[1] Morton, Tim, 29 September 2014, personal communication.

[2] VTANR, 2015, Vermont Natural Resources Atlas, accessed at:
http://anrmaps.vermont.gov/websites/anra/

[3] VTANR, 2015, Stream Geomorphic Assessment Data Management System accessed at:
https://anrweb.vt.gov/DEC/SGA/projects.aspx

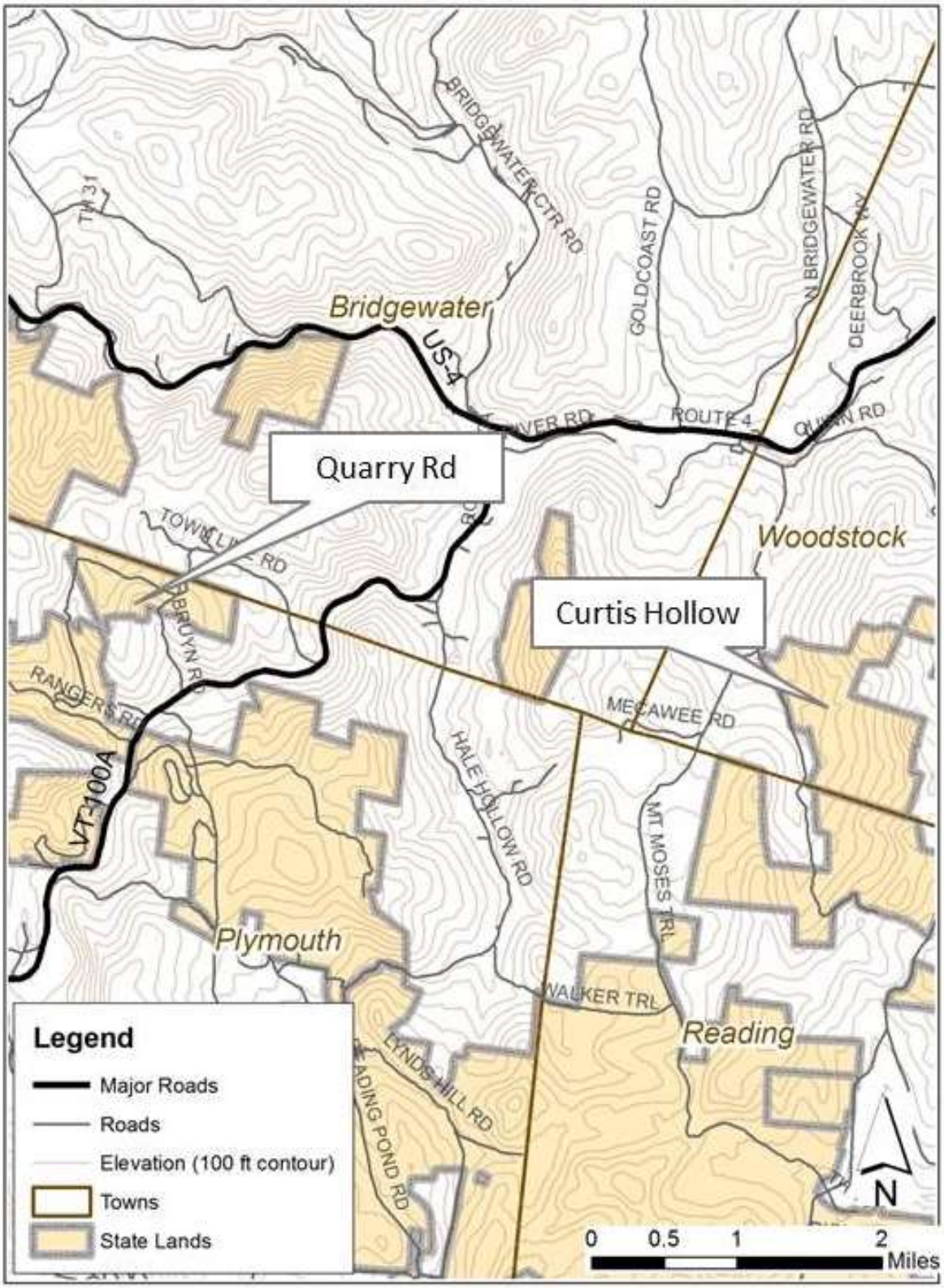


Figure 1. Location of Calvin Coolidge SF – East sites visited on 29 September 2014.

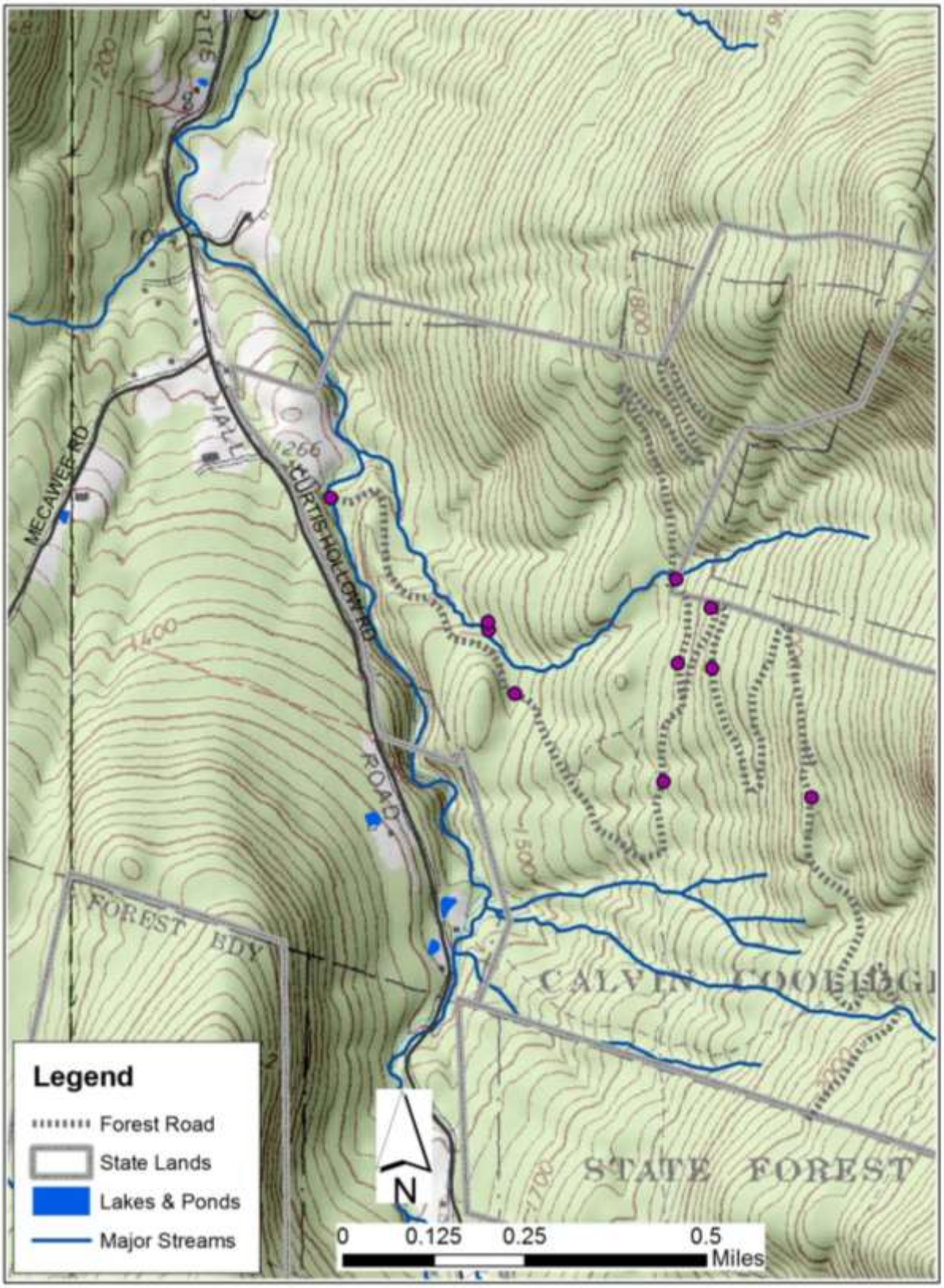


Figure 2. Site Location Map – Curtis Hollow area, Calvin Coolidge SF – East, Woodstock, VT

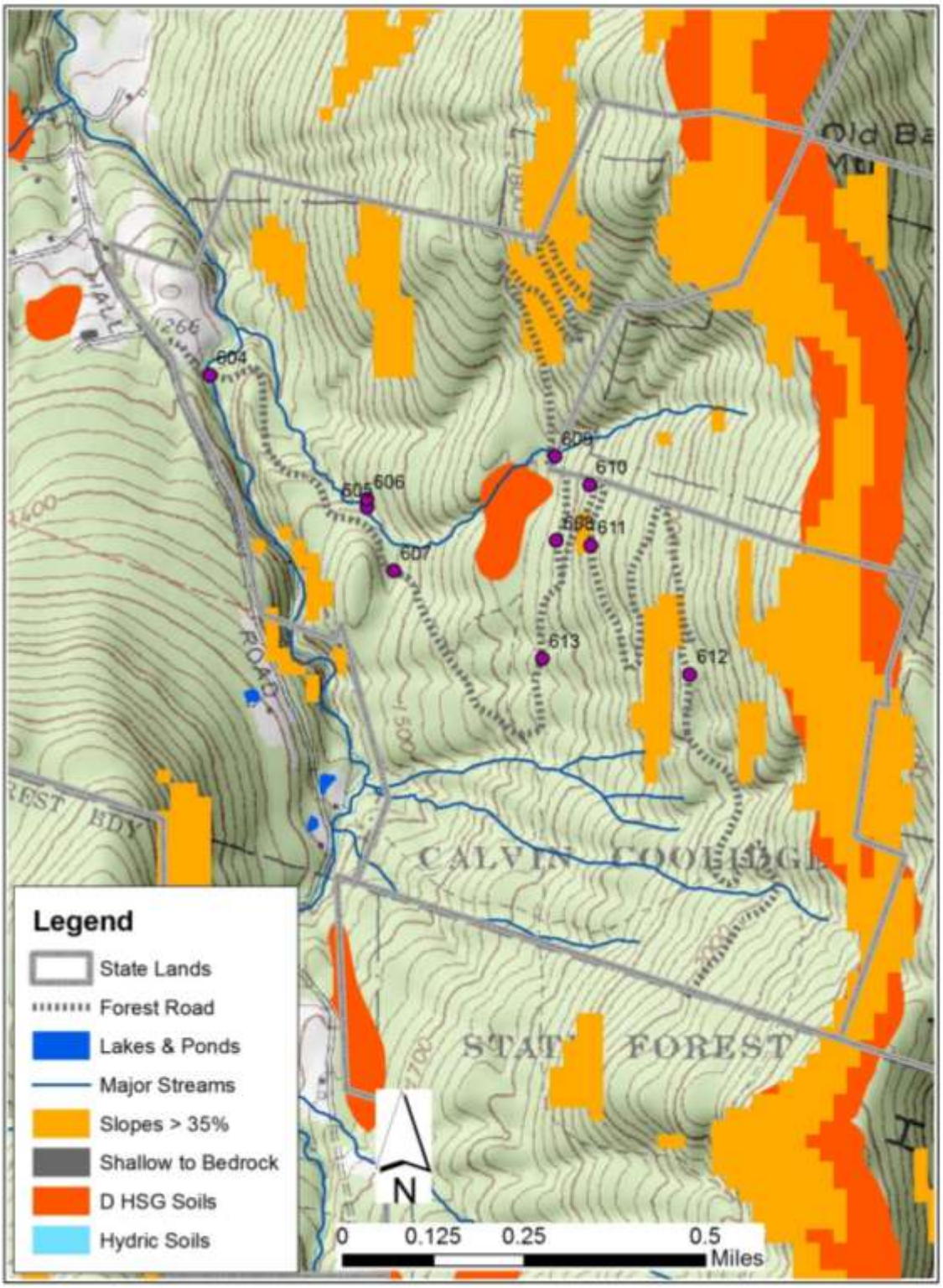


Figure 3. Elements comprising the Hydrologic Reserve zone at the Curtis Hollow site, Calvin Coolidge State Forest – East, Woodstock, Vermont

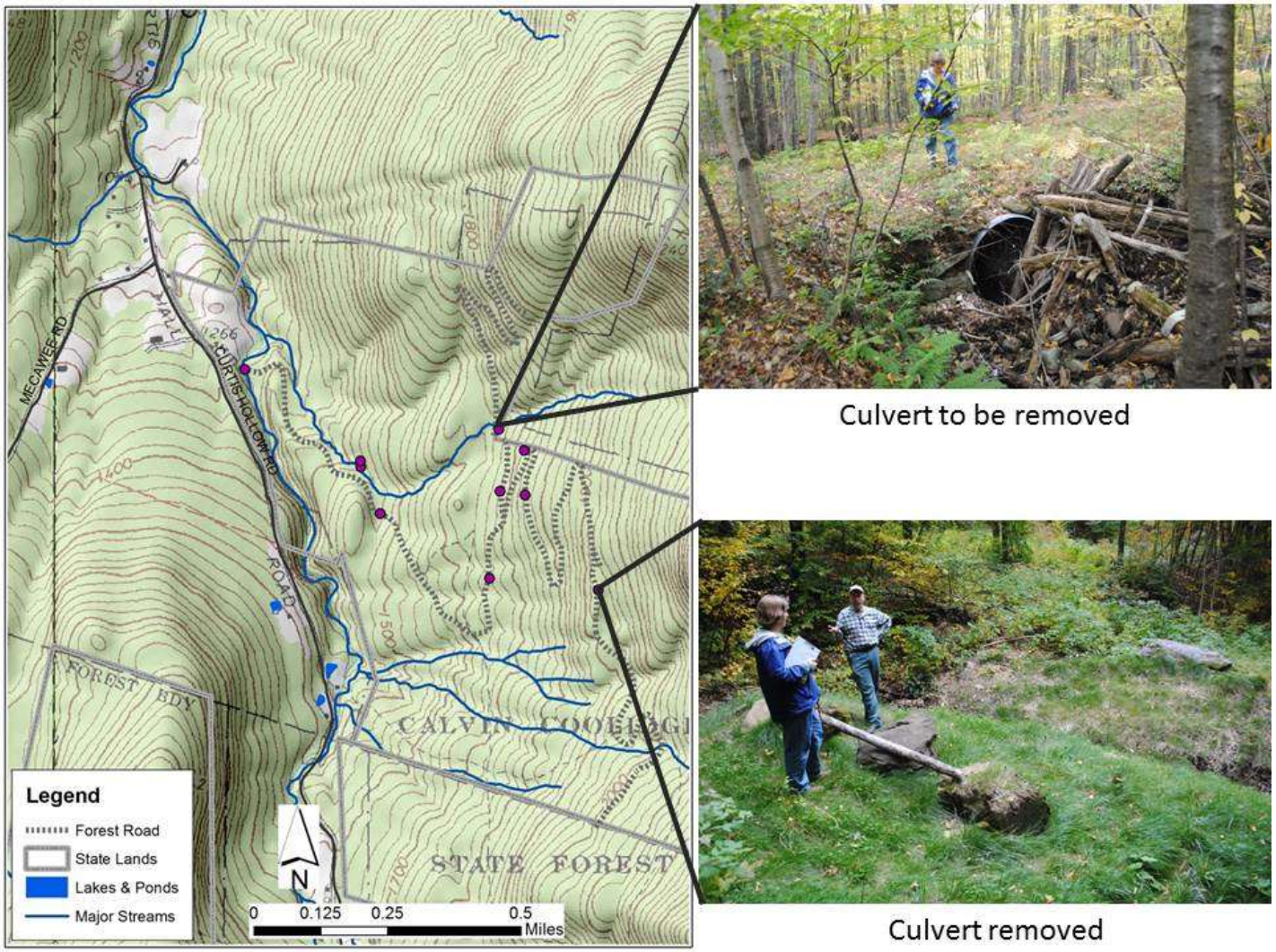


Figure 4. Location of culvert sites, Curtis Hollow area, Calvin Coolidge SF – East.

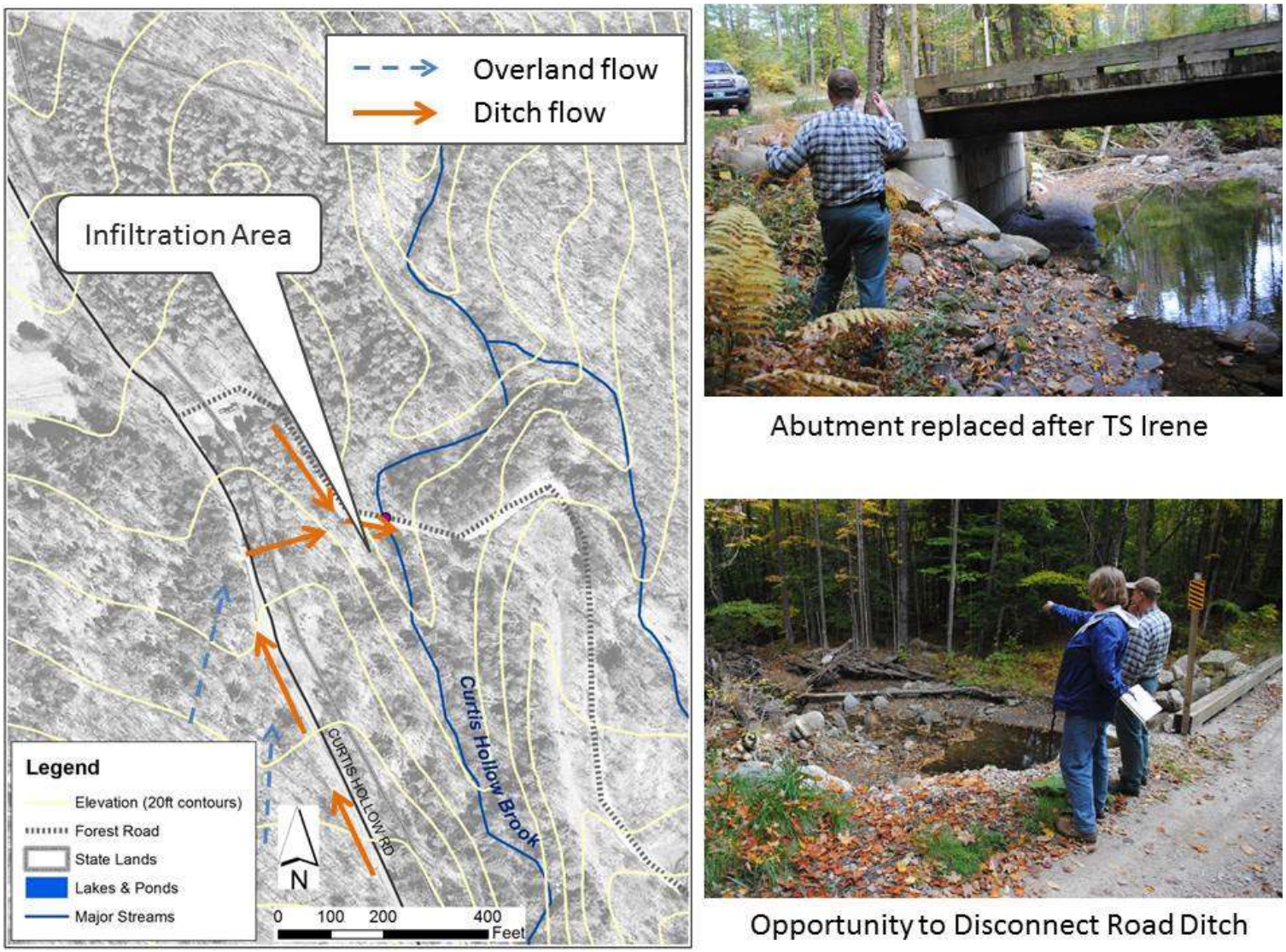


Figure 5. Location of stream crossing of Curtis Hollow Brook, and opportunity to disconnect road ditch drainage.

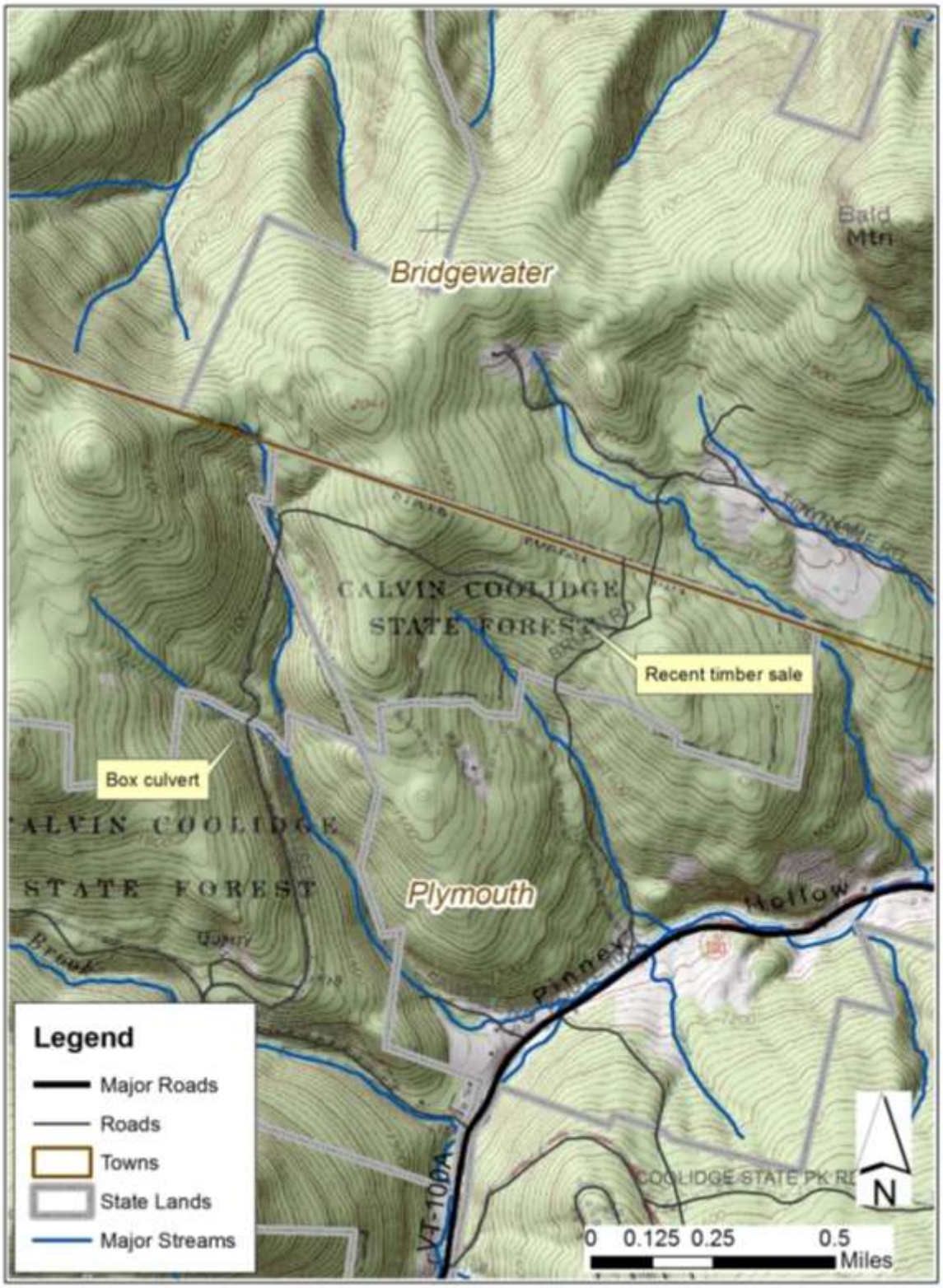


Figure 6. Site Location Map – Quarry Road area, Calvin Coolidge SF – East, Plymouth, VT.

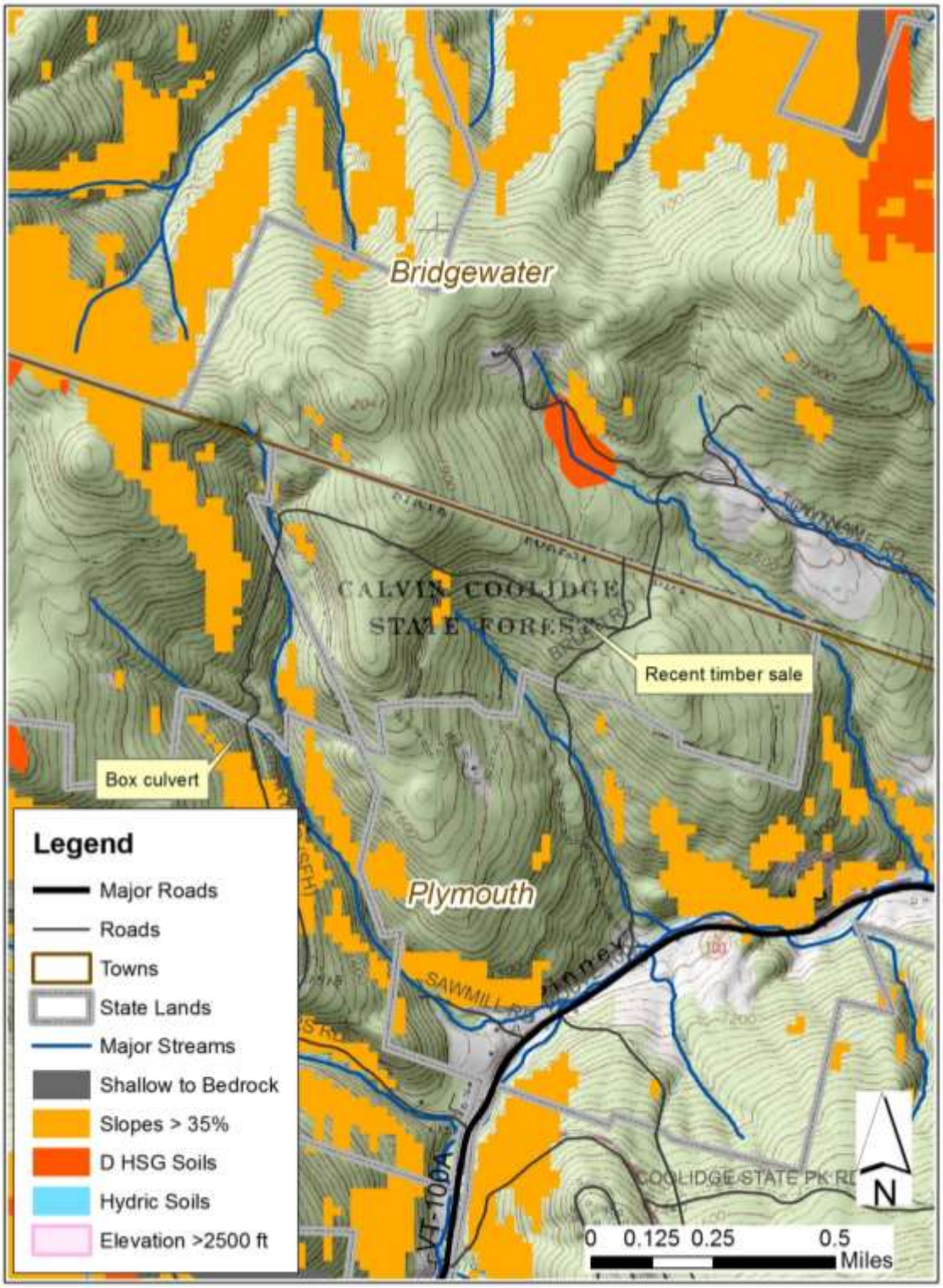


Figure 7. Elements comprising the Hydrologic Reserve zone at the Quarry Road area, Calvin Coolidge State Forest – East, Plymouth, Vermont

Figure 8. Patch cuts implemented using forwarders in 2011 – 2012 at Quarry Road site.

Calvin Coolidge SF – East, Quarry Road / Pinney Hollow area, Plymouth, VT – 9/29/2014

1. View downstream to box culvert crossing of Quarry Road over unnamed tributary to Pinney Hollow Brook.

2. View downstream through box culvert.

Calvin Coolidge SF – East, Quarry Road / Pinney Hollow area, Plymouth, VT – 9/29/2014

3. Forwarding path used to access harvest areas in 2011-2012.

4. Softwood release using forwarder.

Les Newell Wildlife Management Area

Site Visit Date: 1 December 2014

Personnel: David Brynn, Vermont Family Forests
Kristen Underwood, South Mountain R & CS

Geographic Setting

Les Newell Wildlife Management Area is composed of approximately 7,988 acres of forested highlands located in Stockbridge, Barnard, Bridgewater and Killington in the White River watershed (see Figure 1). There is no Long Range Management Plan for Les Newell WMA.

Hydrologic / Geomorphic Setting

Les Newell WMA parcels are located within the Southern and Northern Green Mountain bio-geophysical provinces. The valley along Stony Brook Road is drained by Stony Brook – a 23-square-mile tributary of the White River [1, 2]. Few, sparsely-located pockets of land on Les Newell WMA are underlain by soils of HSG D on slopes exceeding 35%. At the sites visited (Figure 2), the upstream drainage area of Stony Brook is less than 10 square miles and mostly forested.

Built Infrastructure

Built infrastructure represented in areas visited on 1 September 2014 consisted primarily of a network of forest access roads and trails that provide access to State Lands for recreation, hunting, and timber harvest. Bridge and culvert structures are located on Stony Brook and its tributaries.

Tropical Storm Irene

TS Irene caused extensive damages to Stony Brook Road, bridge and culvert crossings and select buildings along the Stony Brook and upstream and downstream segments of the White River in Stockbridge and surrounding communities [3, 4]. Historic and post-Irene channel dredging and management has led to channel instability along the Stony Brook [3].

Major Findings from Site Visit

- Project Team visited a few discrete locations at publically-identified trail heads for the Les Newell WMA. General locations were advised by Tim Morton [4]. State Lands staff members were not able to accompany the Team on these site visits.
- Anecdotally, these areas receive heavy ATV use that results in erosion and impacts to forest roads/trails.
- Legacy trail systems are used for forest harvest access (by A. Johnson Lumber Co. which owns the timber management rights) and for recreational access including hiking, hunting, horse-backriding, mountain biking, and snowmobiling.

- Substantial lengths of these legacy trails are located within 25 feet of streams.
- Insufficient spacing of water bars or broad-based dips has led to stormwater runoff channeled down road beds.
- Road runoff and road-ditch runoff is channeled directly to streams, where room is available to divert this runoff to adjacent side slopes and infiltrate stormwater to subsurface soils.

- It is notable that Les Newell WMA does not have an established Long Range Management Plan. While timber management rights are held by a private party (A. Johnson Lumber Co.), the lands are owned by the State of Vermont. VDEC and VFW are trustees of the water and wildlife resources on these lands. Private operators are responsible to comply with AMPs. VANR has a vested interest to enforce AMPs on lands that it owns and to articulate the management goals for these lands with regard to ecosystem services (flood resiliency, habitat, etc), as well as non-wood products, recreation and tourism.

References:

[1] VTANR, 2015, Vermont Natural Resources Atlas, accessed at: http://anrmaps.vermont.gov/websites/anra/

[2] VTANR, 2015, Stream Geomorphic Assessment Data Management System accessed at: https://anrweb.vt.gov/DEC/SGA/projects.aspx

[3] Ryan, Jim, VDEC Watershed Management Division, email communications.

[4] Morton, Tim, email communications

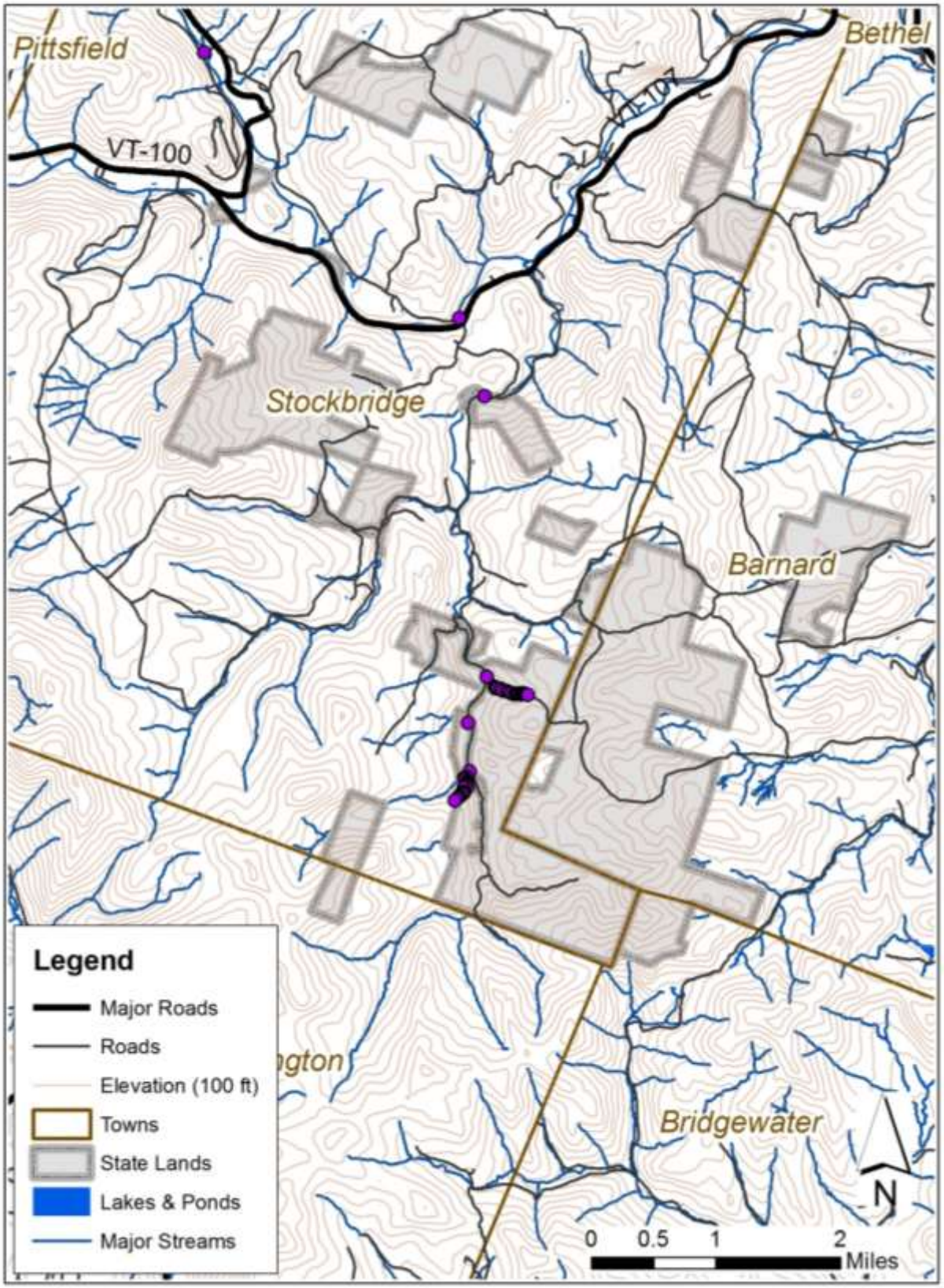


Figure 1. Location map of parcels comprising Les Newell Wildlife Management Area.

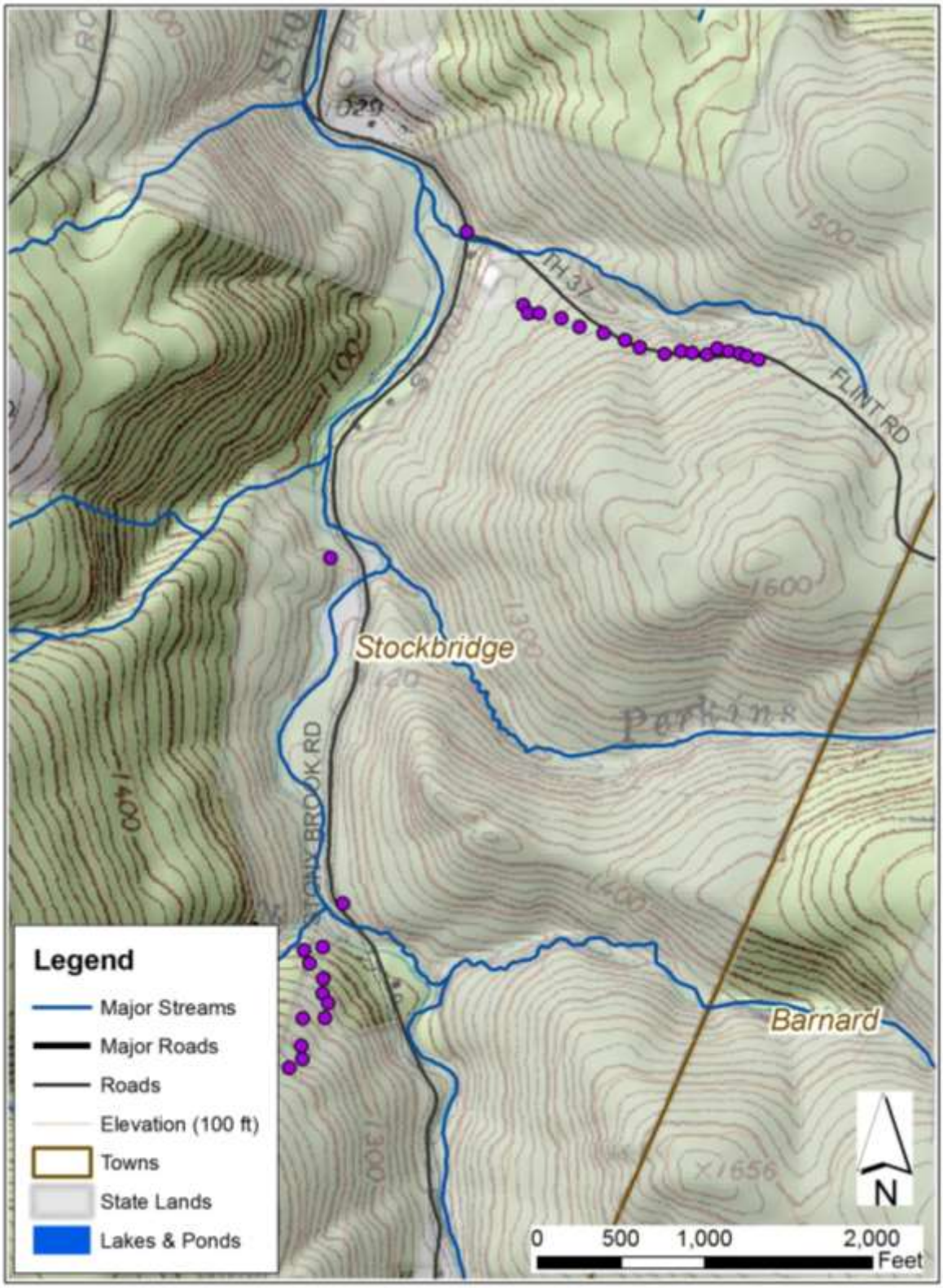


Figure 2. Location Map of sites accessed in Les Newell WMA, 1 December 2014.

Les Newell Wildlife Management Area, White River watershed, Stockbridge, VT – 12/1/2014

1. Southernmost site accessed.

2. Snowmobile trail leading southwest from Stony Brook Rd

3. Steep-gradient road (10 to 40%), with occasional broad-based dips; dugway segment channels water downhill.

4. View upstream in tributary to Stony Brook exhibiting significant widening, incision.

Les Newell Wildlife Management Area, White River watershed, Stockbridge, VT – 12/1/2014

5. Northern trailhead accessed off Stony Bk Rd (see Figure 2).

6. View uphill on narrow forest road that is channeling runoff; dugway banks are 5 ft high in sections.

7. View downhill from photo 6; road drainage runs off to nearby stream

8. Road ditch directs runoff to the stream at the bridge crossing.

Appendix B

Camp Plymouth State Park - Pilot Study

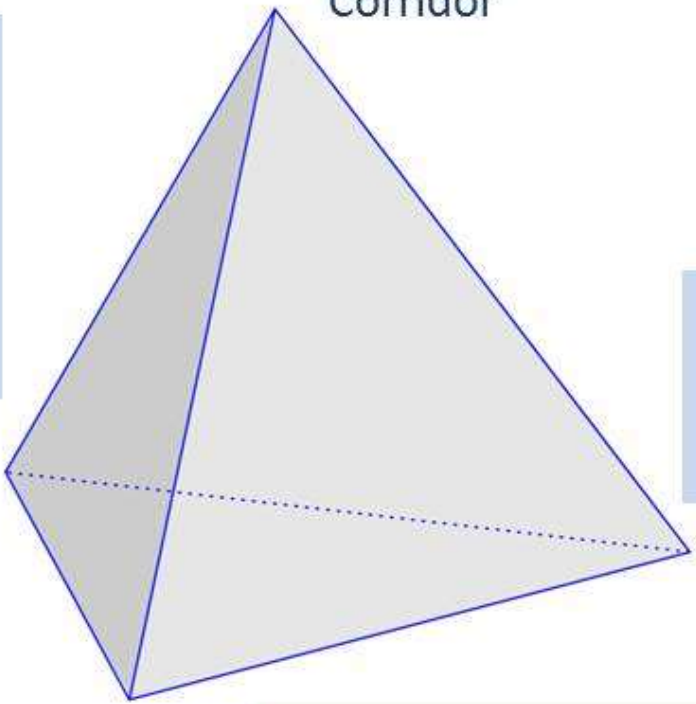
30 June 2015 FINAL DRAFT

Mapping Approach - Hydrologic Resources

River Corridor

- > 2,500 feet Elevation
- > 35 % slopes
- Shallow-to-bedrock soils
- Very Poorly-drained soils (Hydrologic Soil Group D)
- Hydric soils

Hydrologic Reserve



- ≤ 15 % slopes
- Well - drained soils (HSG A, B)

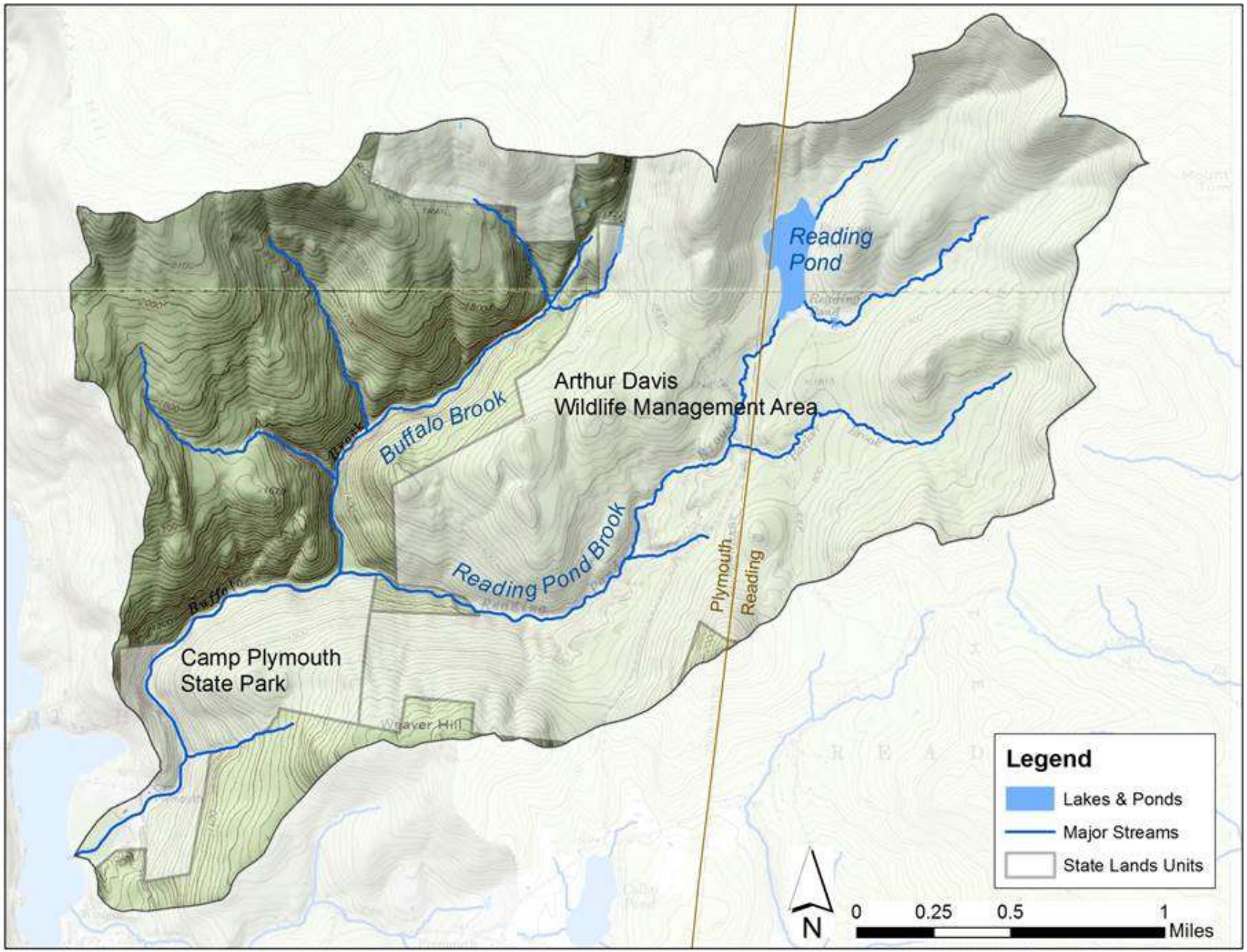
Other Lands

Hydrologic Conservation

- > 15 % slopes
- Poorly-drained soils (Hydrologic Soil Group C)

Camp Plymouth SP

Buffalo Brook watershed
Plymouth, Vermont


Reading
Pond
Arthur Davis
Wildlife Management Area
Buffalo Brook
Reading Pond Brook
Plymouth
Reading
Camp Plymouth
State Park
Weaver Hill
Legend
Lakes & Ponds
Major Streams
State Lands Units
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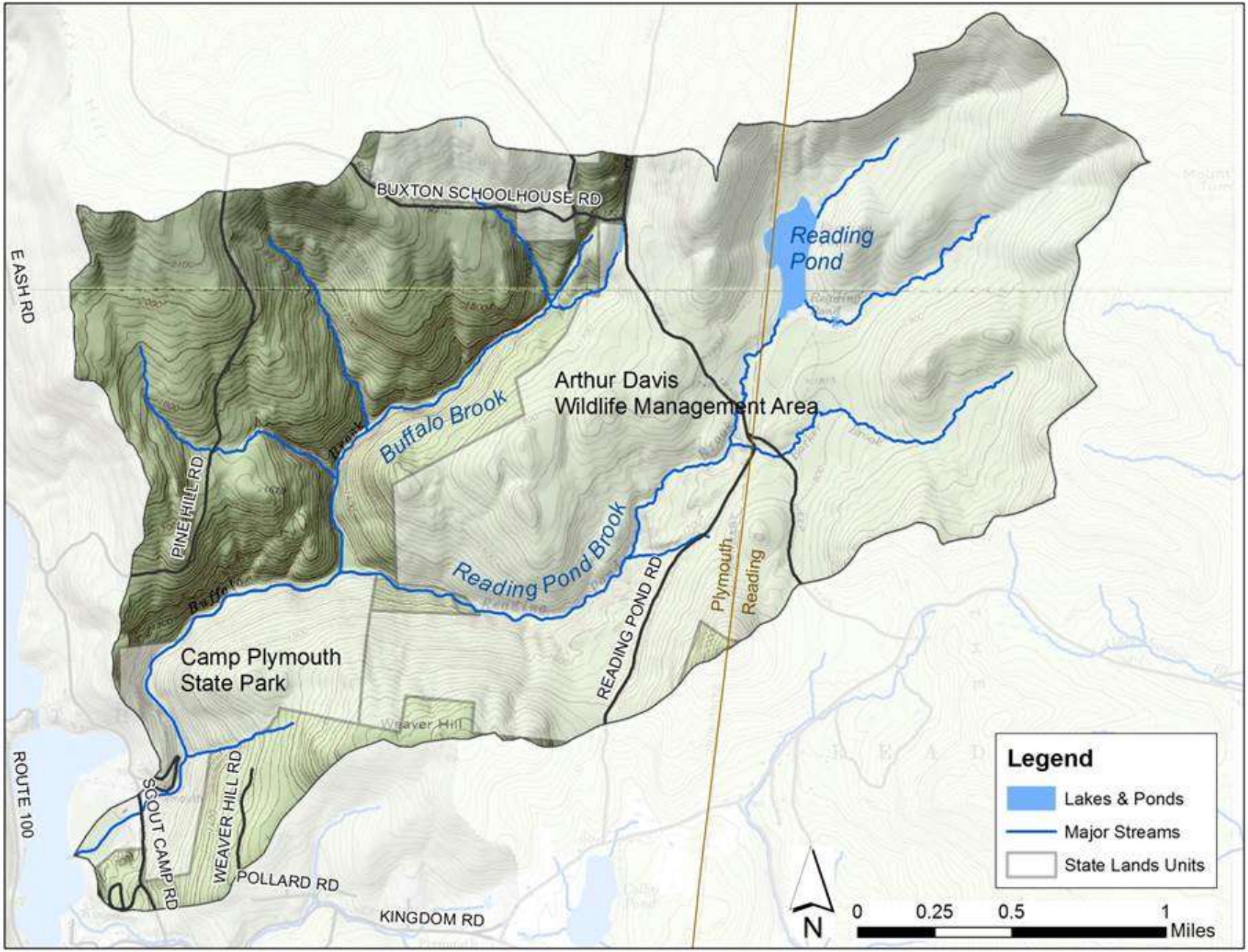
BUXTON SCHOOLHOUSE RD
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Arthur Davis Wildlife Management Area
Buffalo Brook
PINE HILL RD
Reading Pond Brook
READING POND RD
Plymouth
Reading
Camp Plymouth State Park
Weaver Hill
ROUTE 100
SCOUT CAMP RD
WEAVER HILL RD
POLLARD RD
KINGDOM RD
Legend
Lakes & Ponds
Major Streams
State Lands Units
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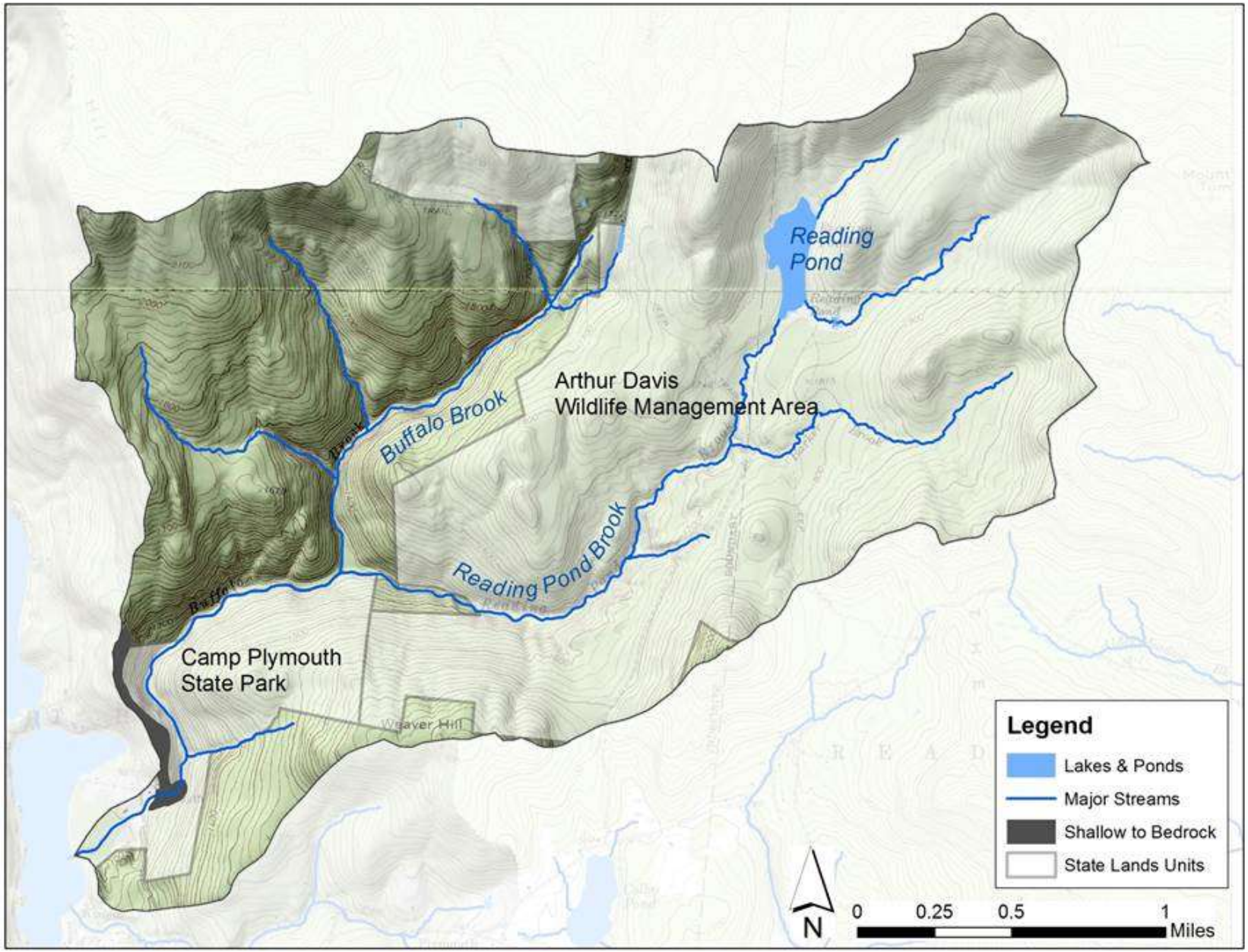
Hydrologic Reserve

(layers comprising)


Reading Pond
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Reading Pond Brook
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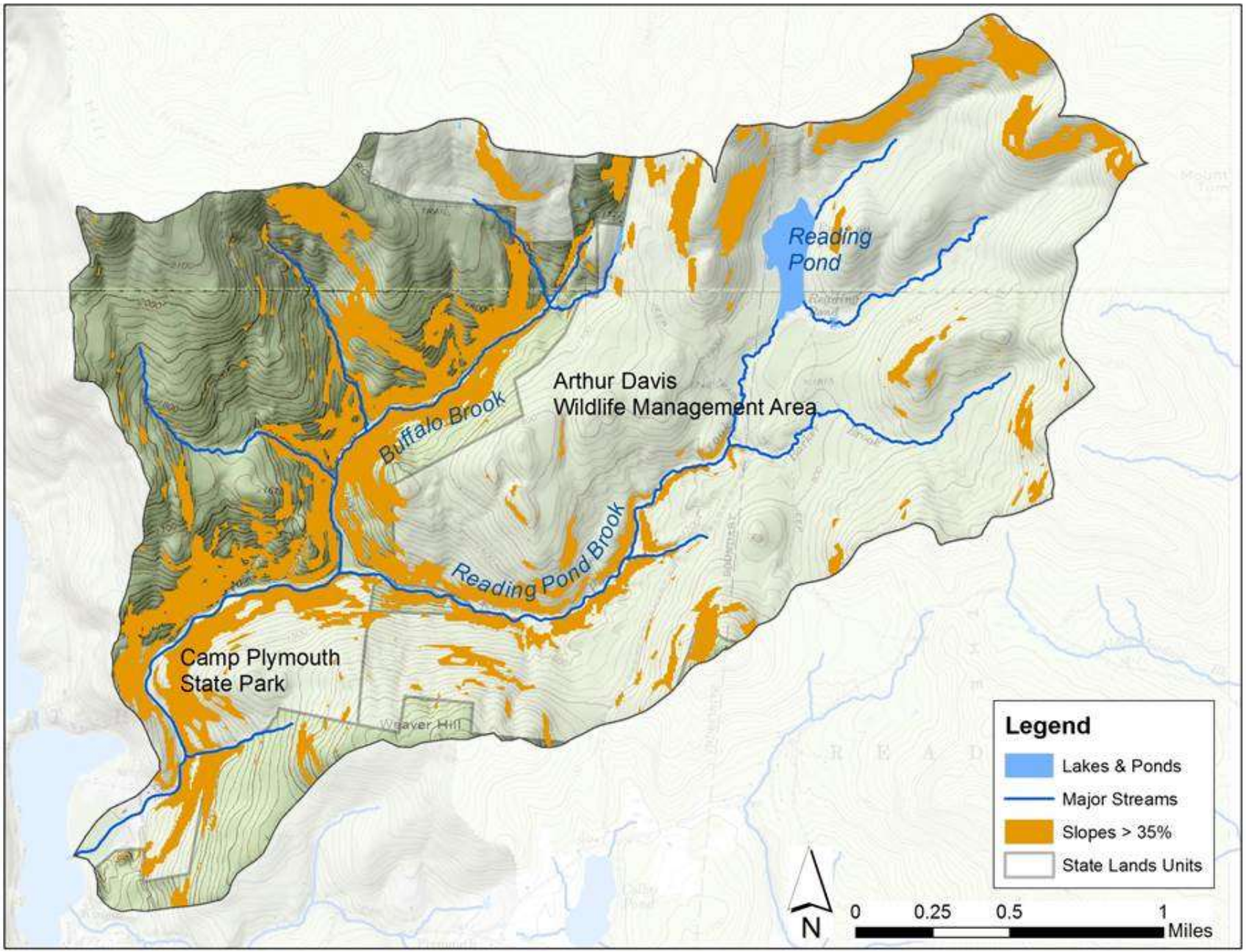
Reading
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State Park
Weaver Hill
Legend
Lakes & Ponds
Major Streams
Slopes > 35%
State Lands Units
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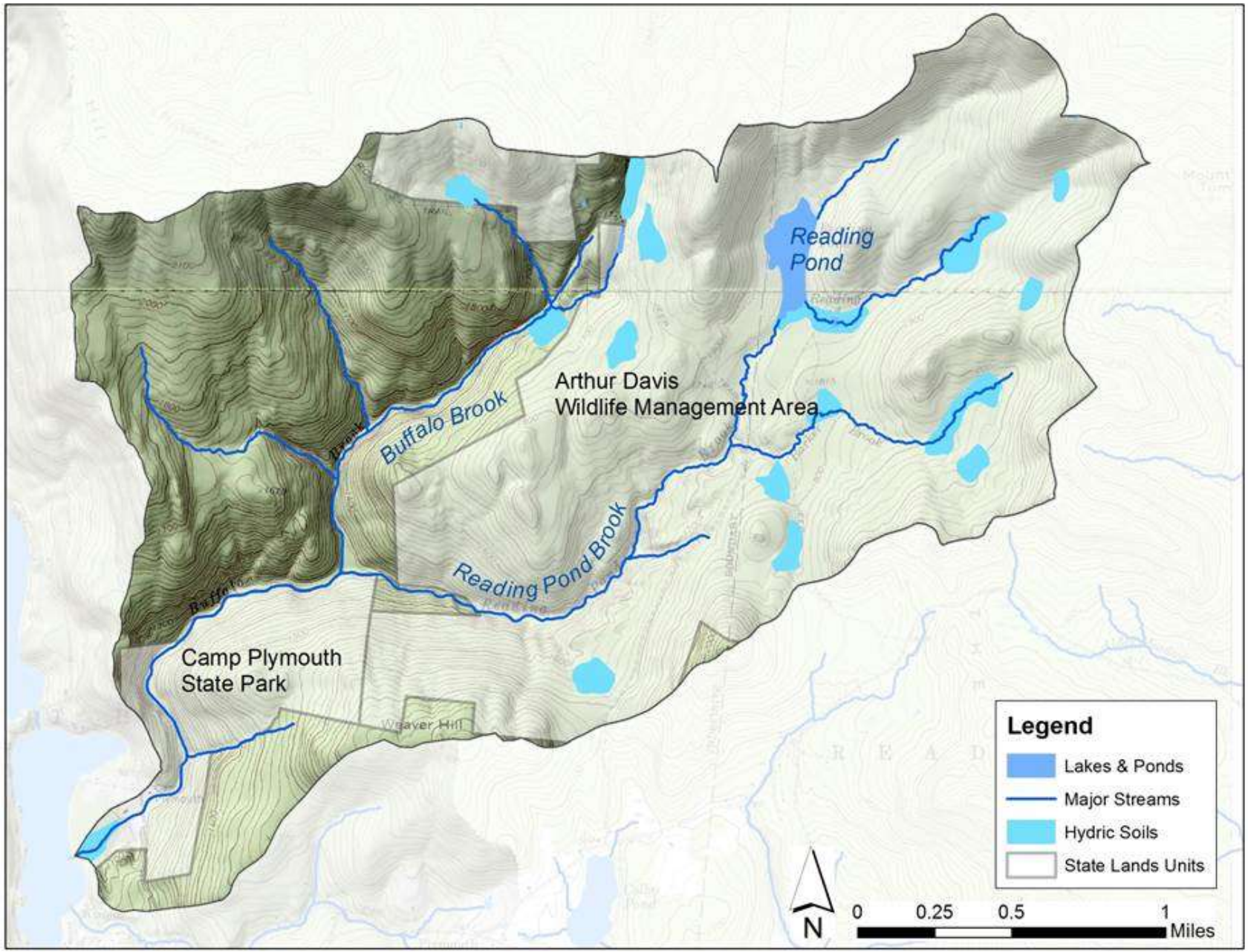
Reading Pond
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Buffalo Brook
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Major Streams
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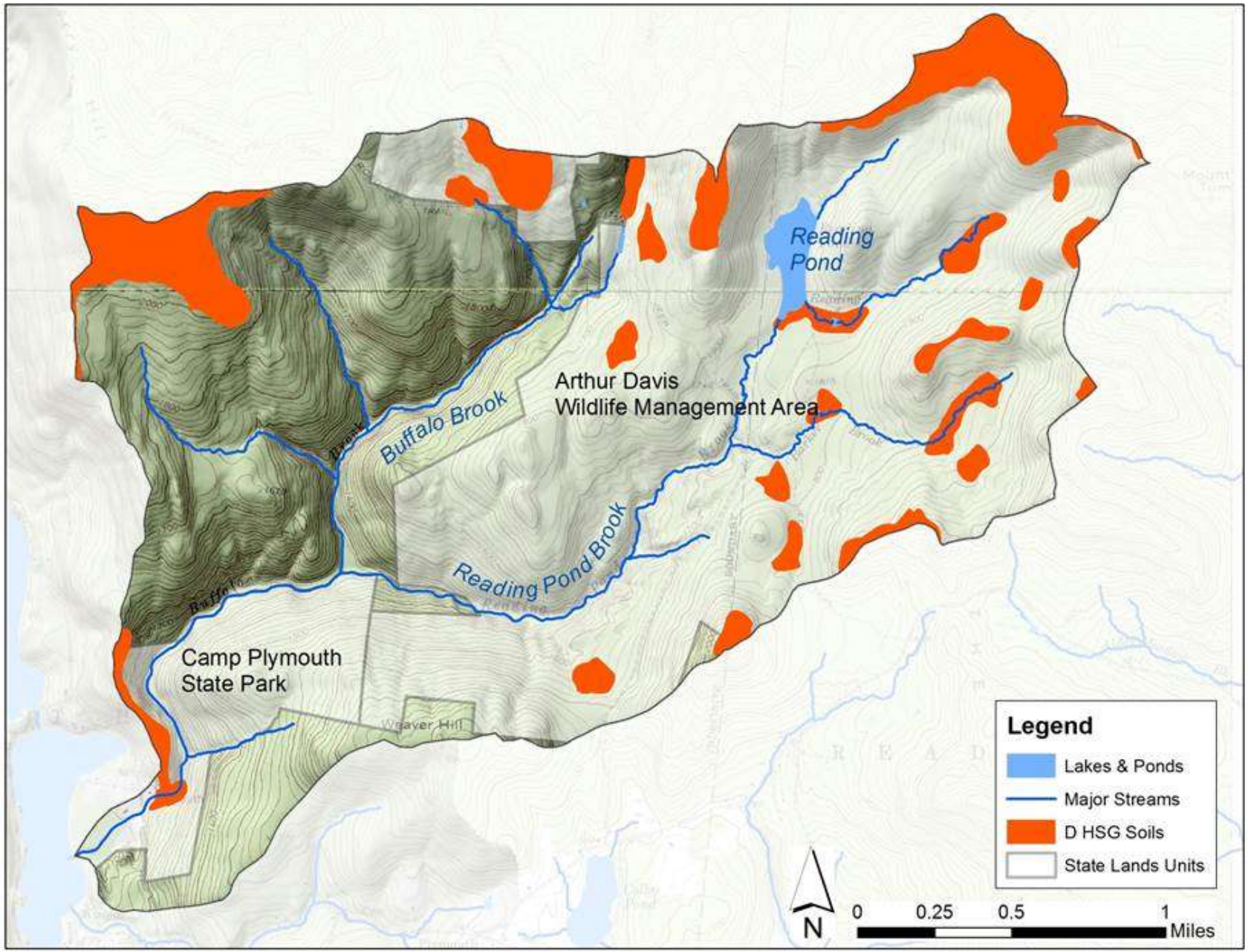
Reading Pond
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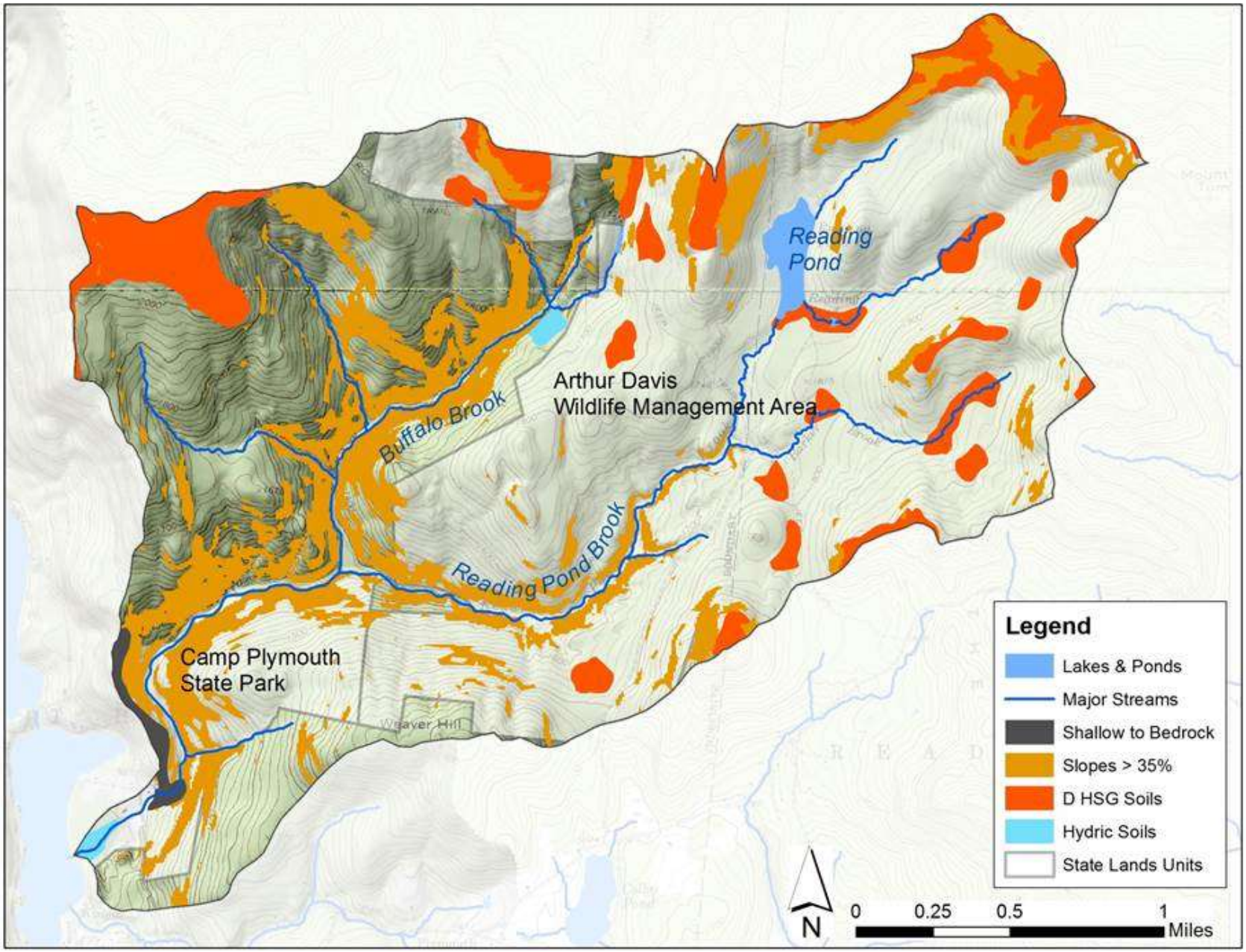
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Lakes & Ponds
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Shallow to Bedrock
Slopes > 35%
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State Lands Units
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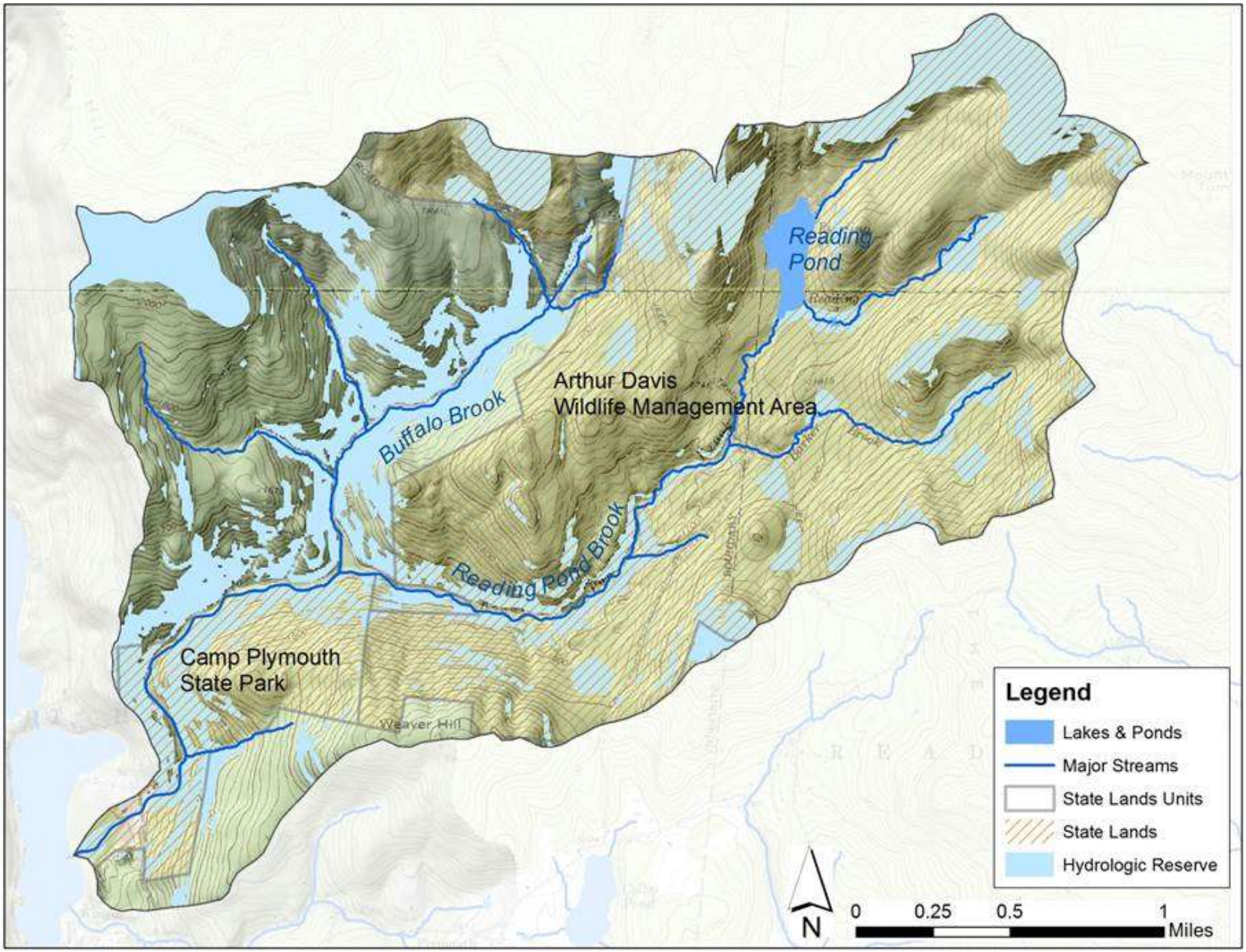
Reading Pond
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Buffalo Brook
Reading Pond Brook
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Weaver Hill
Legend
Lakes & Ponds
Major Streams
State Lands Units
State Lands
Hydrologic Reserve
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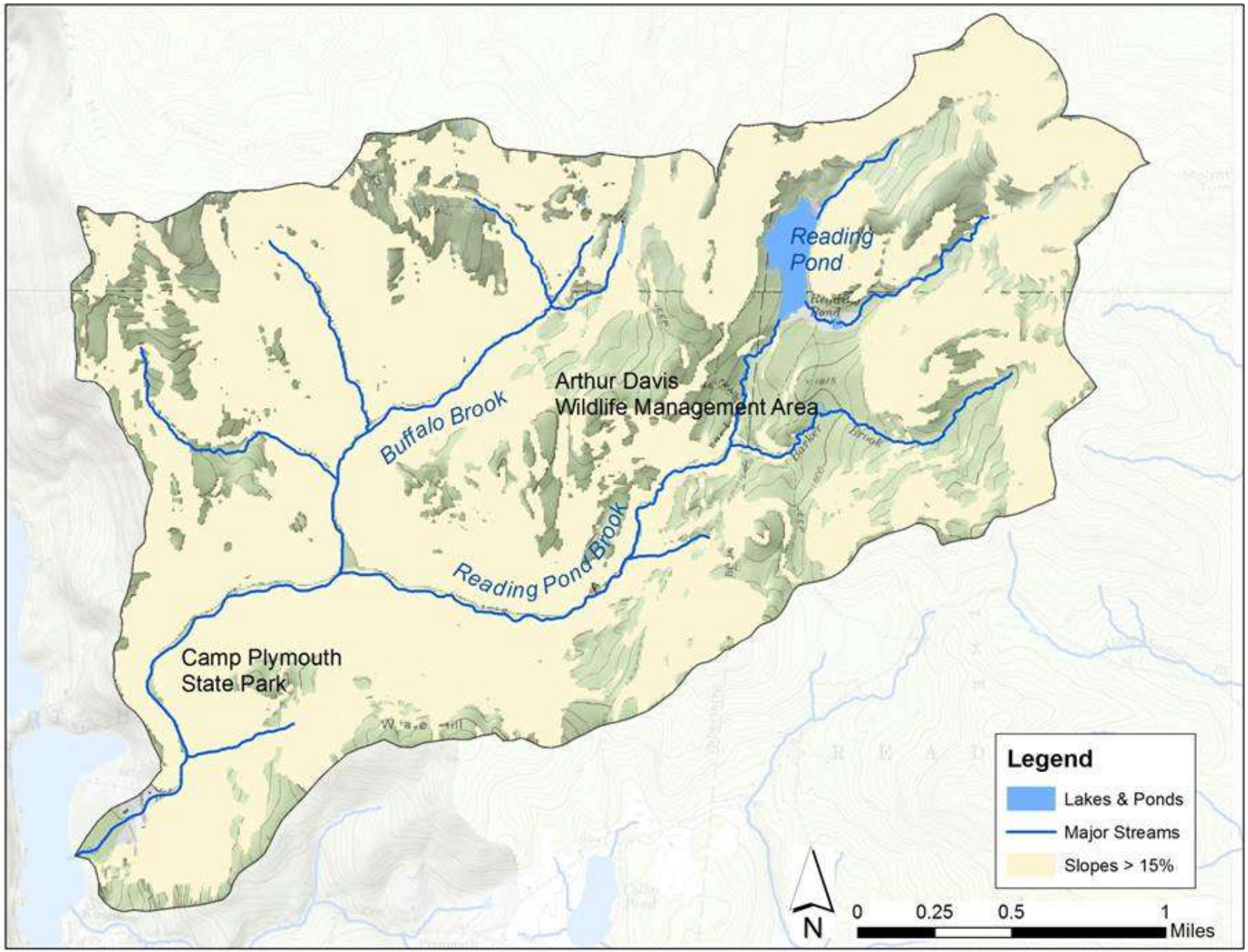
Hydrologic Conservation

(layers comprising)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Buffalo Brook
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Major Streams
Slopes > 15%
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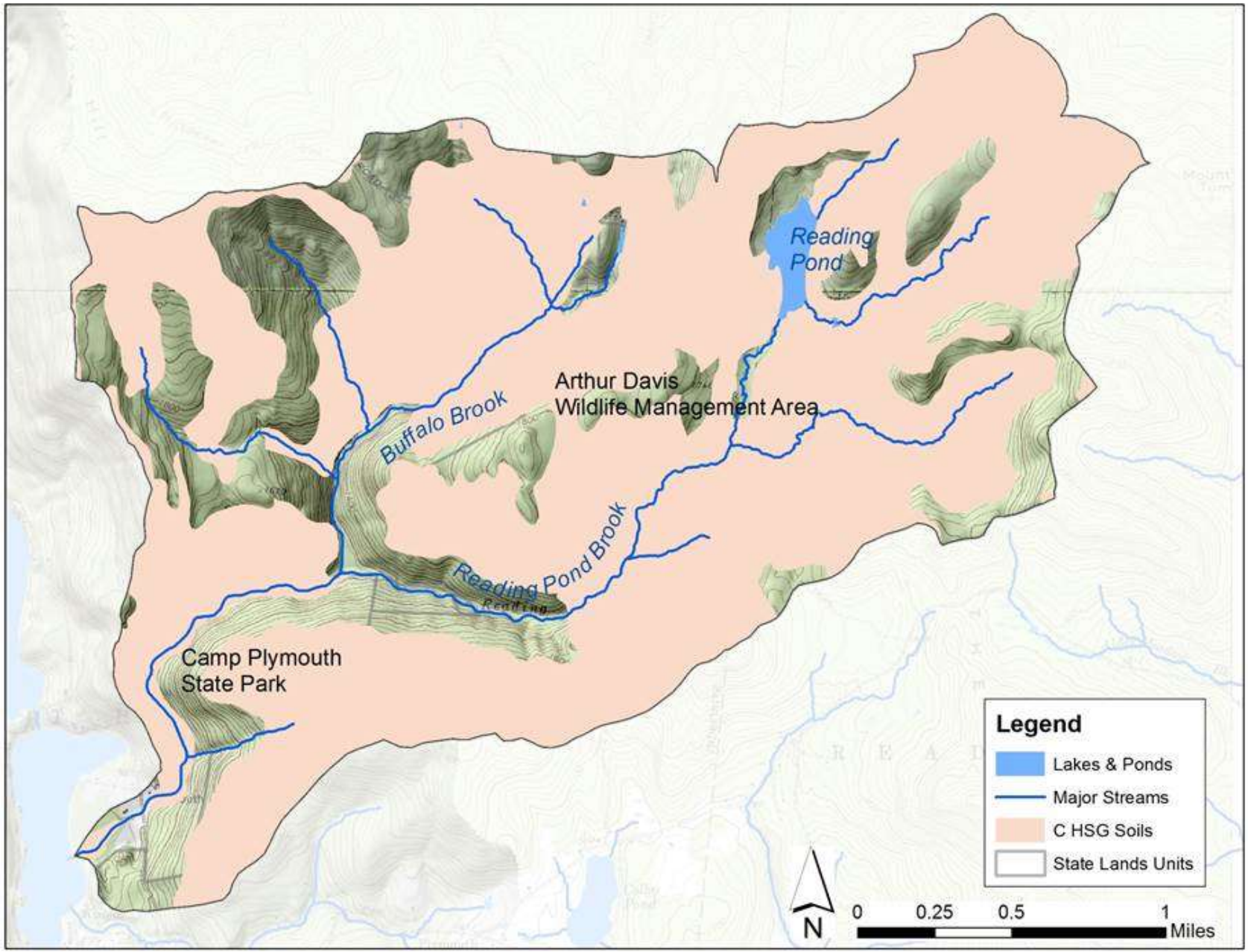
Reading
Pond
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Wildlife Management Area
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Camp Plymouth
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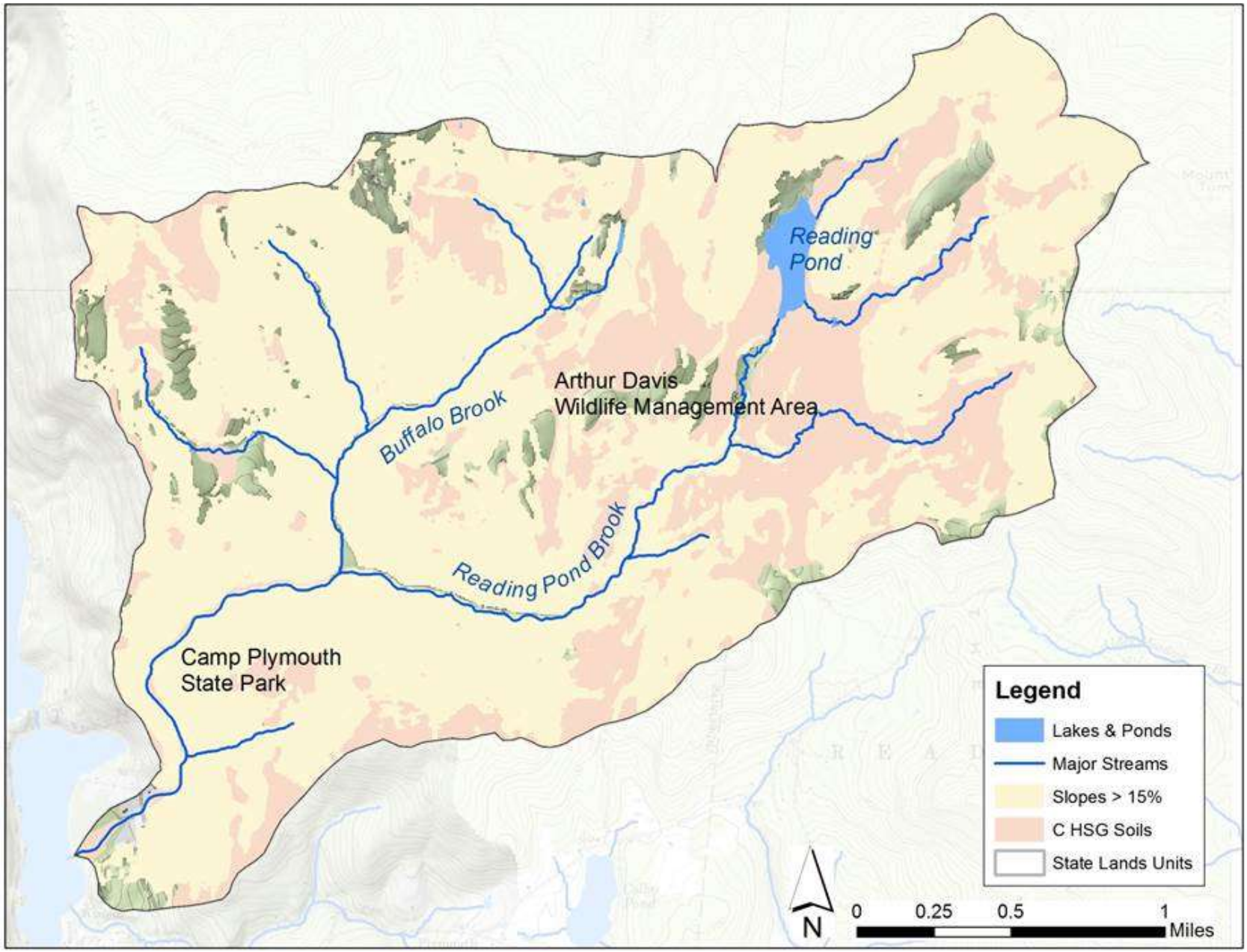
Reading Pond
Arthur Davis Wildlife Management Area
Buffalo Brook
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Lakes & Ponds
Major Streams
Slopes > 15%
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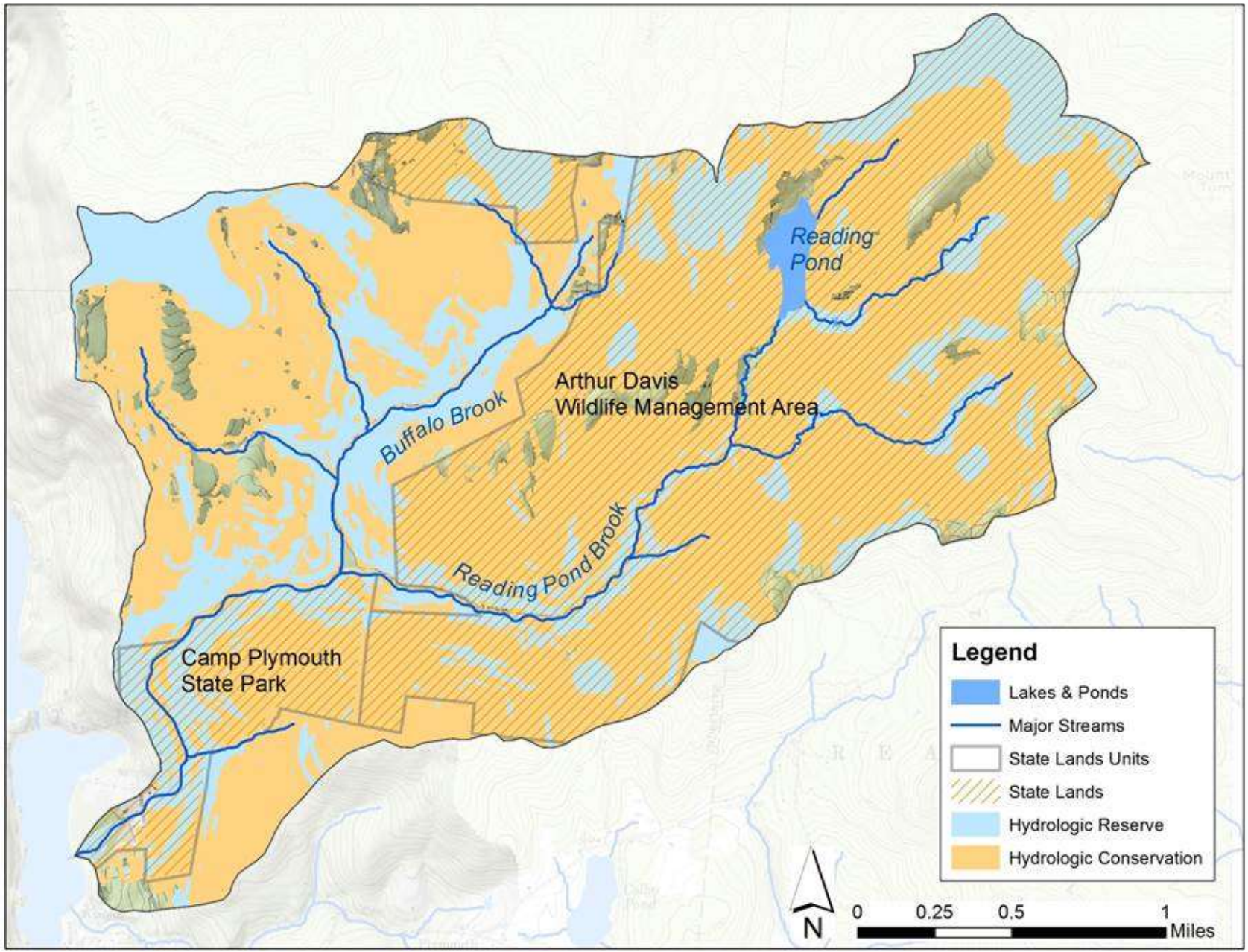
Reading Pond
Arthur Davis Wildlife Management Area
Buffalo Brook
Reading Pond Brook
Camp Plymouth State Park
Legend
Lakes & Ponds
Major Streams
State Lands Units
State Lands
Hydrologic Reserve
Hydrologic Conservation
N
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0.25
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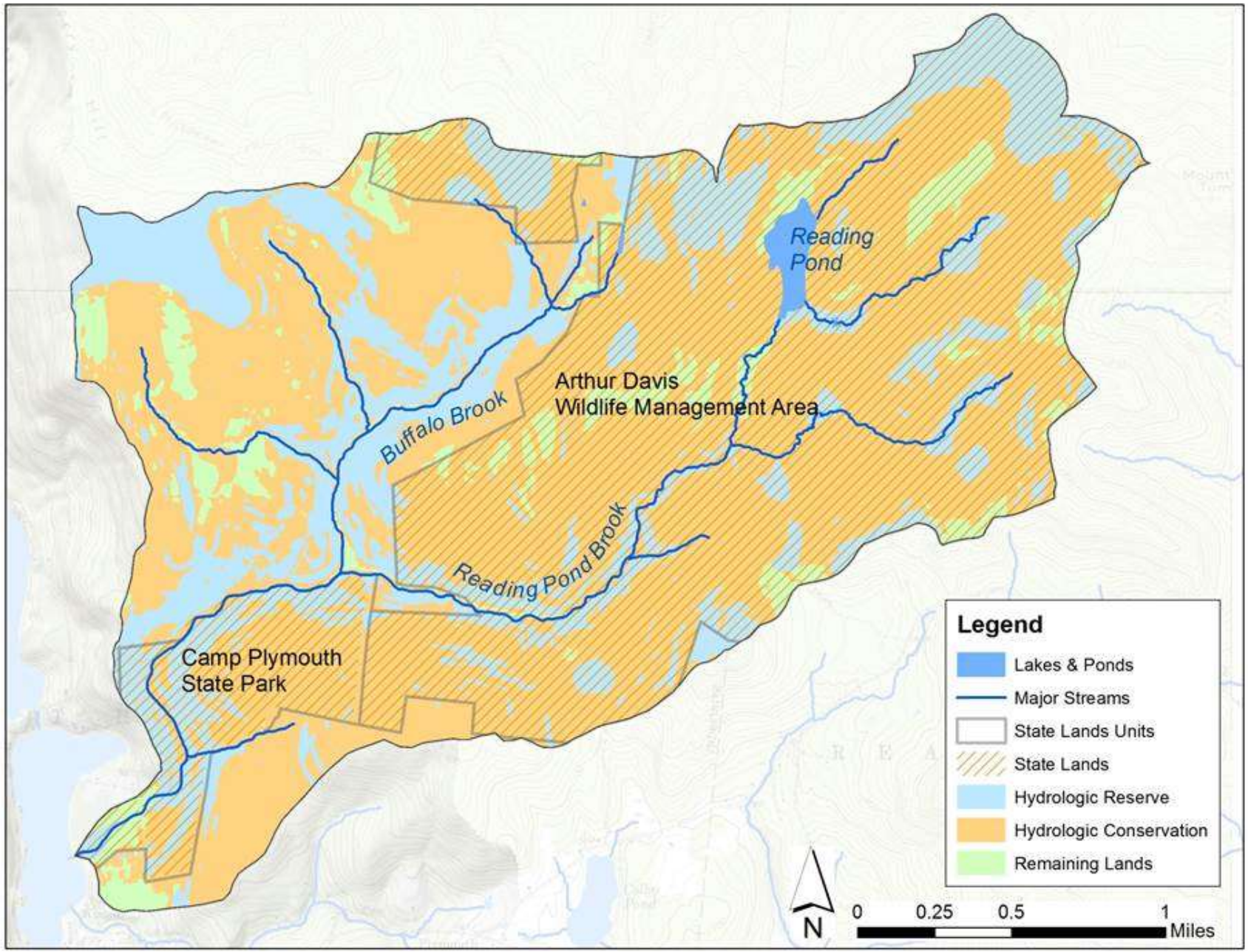
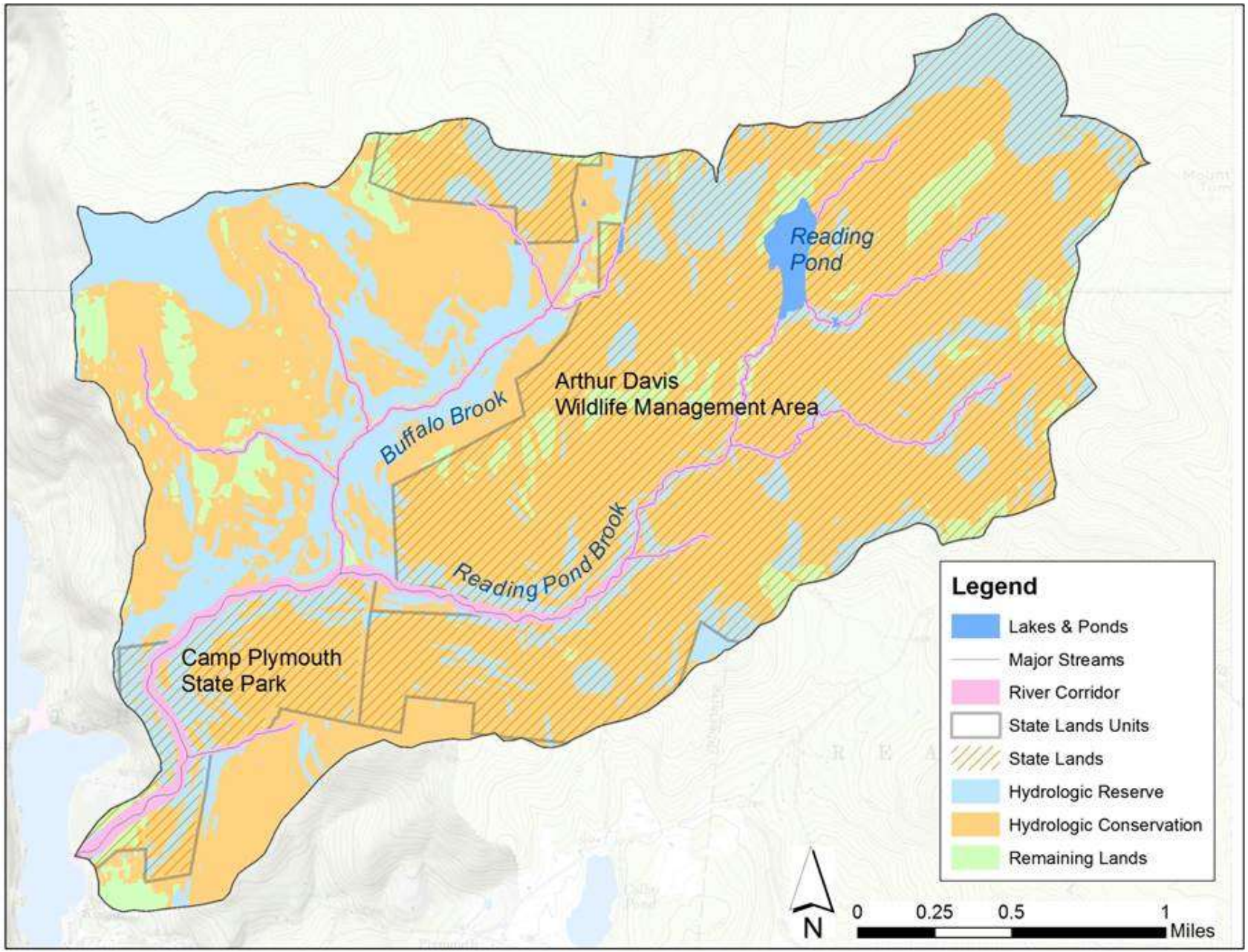
Miles

Full Triad

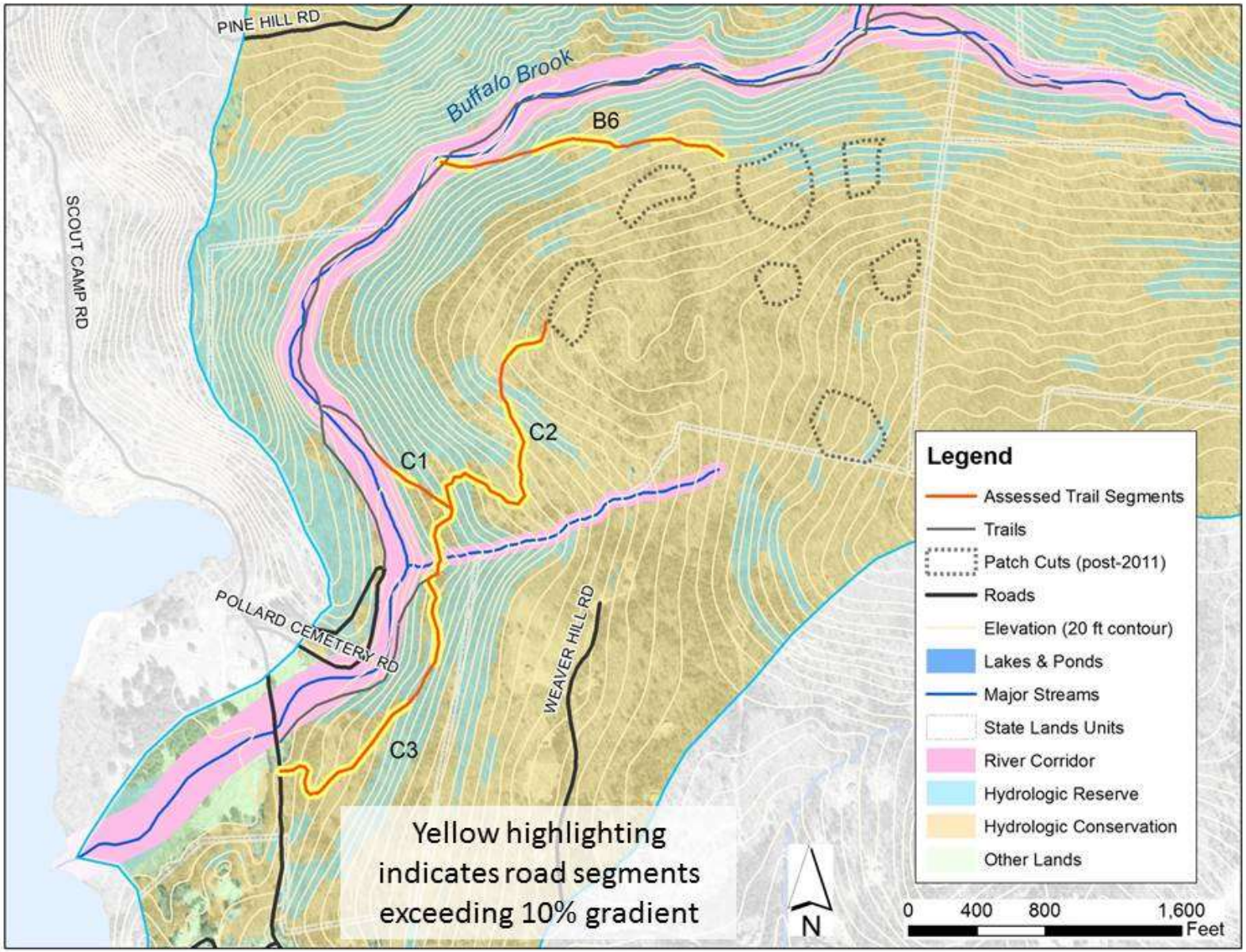
(plus River Corridor)


Reading Pond
Arthur Davis Wildlife Management Area
Buffalo Brook
Reading Pond Brook
Camp Plymouth State Park
Legend
Lakes & Ponds
Major Streams
State Lands Units
State Lands
Hydrologic Reserve
Hydrologic Conservation
Remaining Lands
N
0
0.25
0.5
1
Miles


Reading Pond
Arthur Davis Wildlife Management Area
Buffalo Brook
Reading Pond Brook
Camp Plymouth State Park
Legend
Lakes & Ponds
Major Streams
River Corridor
State Lands Units
State Lands
Hydrologic Reserve
Hydrologic Conservation
Remaining Lands
N
0
0.25
0.5
1
Miles

Camp Plymouth SP

Measure Conformance with AMPs


PINE HILL RD
Buffalo Brook
B6
SCOUT CAMP RD
C1
C2
POLLARD CEMETERY RD
WEAVER HILL RD
C3
Yellow highlighting indicates road segments exceeding 10% gradient
N
Legend
Assessed Trail Segments
Trails
Patch Cuts (post-2011)
Roads
Elevation (20 ft contour)
Lakes & Ponds
Major Streams
State Lands Units
River Corridor
Hydrologic Reserve
Hydrologic Conservation
Other Lands
0
400
800
1,600
Feet

Evaluation of Conformance to AMPs - Summary

Seg-ment	Length Assessed ft	Average slope of segment %	# functional drainage structures in place	# Drainage Structures Recom-mended	Percent Compliant with AMPs %	Percent of Length with Gradient >10% %	Percent of Length with Gradient >15% %
B6	1700	12.8	1	26	4%	59%	29%
C1	500	12.2	5	7.4	68%	40%	20%
C2	1800	16.3	15	32	47%	78%	61%
C3	2244	14.0	26	37.2	70%	85%	36%

Buffalo Brook watershed, Plymouth/Reading, Vermont 10/20/2014

Benchmark Assessment Tally

** After Town Forest Health Check, Vermont Family Forests, www.familyforests.org*

Forest Road Segment B6

Way-point	Seg-ment	Distance to Next Point Taped (Ft)	Average slope of segment %	# functional drainage structures in place	# Drainage Structures Recom-mended	Meet Bench-mark? Y	Meet Bench-mark? N	Notes
623		0						Jct w/ road along Buffalo Bk; downhill end of road segment
623	1	100	20	0	2.1		✓	
	2	100	17	0	1.9		✓	
624	3	100	10	0	1.3		✓	
626	4	100	9	0	1.2		✓	
627	5	100	8	0	1.1		✓	
628	6	100	10	0	1.3		✓	downhill exit of stream flow from road bed
629	7	100	12	0	1.5		✓	uphill entrance of stream flow to road bed
630	8	100	14	0	1.6		✓	
631	9	100	16	0	1.8		✓	
632	10	100	18	0	1.9		✓	
633	11	100	18	0	1.9		✓	
634	12	100	10	0	1.3		✓	
635	13	100	5	1	0.8	✓		wp636 = broad-based dip
637	14	100	15	0	1.7		✓	rill erosion
638	15	100	9	0	1.2		✓	
639	16	100	14	0	1.6		✓	
640	17	100	12	0	1.5		✓	Near post2011 patch cut clearing edge
	18							Uphill end of road segment
	19							
	20							
Total		1700		1	25.7	1	16	4%
Average			12.8					Compliant

Buffalo Brook watershed, Plymouth/Reading, Vermont 10/20/2014

Benchmark Assessment Tally

** After Town Forest Health Check, Vermont Family Forests, www.familyforests.org*

Forest Road Segment C1

Way-point	Seg-ment	Distance to Next Point Taped (Ft)	Average slope of segment %	# functional drainage structures in place	# Drainage Structures Recom-mended	Meet Bench-mark? Y	Meet Bench-mark? N	Notes
654		0						Downhill end assessed segment
655	1	100	10	1	1.3		✓	BBD at wp 655
656	2	100	20	1	2.1		✓	BBD at wp 657
658	3	100	9	1	1.2		✓	BBD at wp 659
660	4	100	10	1	1.3		✓	BBD at wp 661
662	5	100	12	1	1.5		✓	BBD at wp 662
	6							Uphill end segment; Jct w/ New skid road
	7							
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							
Total		500		5	7.4			68%
Average			12.2					Compliant

Buffalo Brook watershed, Plymouth/Reading, Vermont 10/20/2014

Benchmark Assessment Tally

** After Town Forest Health Check, Vermont Family Forests, www.familyforests.org*

Skid Road Segment C2

Way-point	Seg-ment	Distance to Next Point Taped (Ft)	Average slope of segment %	# functional drainage structures in place	# Drainage Structures Recom-mended	Meet Bench-mark? Y	Meet Bench-mark? N	Notes
		0						Jct btwn old road, new skid road (post 2011)
663	1	100	15	1	1.7		✓	WB conveying stream channel at wp 664
665	2	100	25	1	2.5		✓	WB at wp 665
667	3	100	28	2	2.7		✓	2 WBs at wp 668, 669
670	4	100	25	2	2.5		✓	2 WBs at wp 671, 672
673	5	100	16	1	1.8		✓	WB at wp 674
675	6	100	16	2	1.8		✓	2 WBs at wp 676, 677
678	7	100	16	1	1.8		✓	WB at wp 679
680	8	100	16	1	1.8		✓	WB at wp 681
682	9	100	14	1	1.6		✓	WB at 10 ft uphill from wp 682
684	10	100	24	0	2.4		✓	
686	11	100	24	0	2.4		✓	
688	12	100	13	2	1.5	✓		2 WBs at wp 689, 690
691	13	100	10	0	1.3		✓	
693	14	100	2	0	0.4		✓	
694	15	100	5	1	0.8	✓		WB at wp 695
696	16	100	22	0	2.2		✓	
698	17	100	16	0	1.8		✓	
699	18	100	7	0	1		✓	
700	19							
	20							
Total		1800		15	32			47%
Average			16.3					Compliant

Buffalo Brook watershed, Plymouth/Reading, Vermont 10/20/2014

Benchmark Assessment Tally

** After Town Forest Health Check, Vermont Family Forests, www.familyforests.org*

Skid Road Segment C3 = ~ 16 ft road width

Way-point	Seg-ment	Distance to Next Point Taped (Ft)	Average slope of segment %	# functional drainage structures in place	# Drainage Structures Recom-mended	Meet Bench-mark? Y	Meet Bench-mark? N	Notes
663		0						Uphill end segment; Jct old road w/ new skid road (post2011)
663	1	100	15	1	1.7		✓	WB ~10 ft uphill from wp 702
702	2	100	13	1	1.5		✓	WB at wp 703
704	3	100	18	2	1.9	✓		2 WBs at wp 705, 706
706	4	44	18	0	1.9		✓	estimated 2nd order stream crossing; scour, widening,
707	5	100	10	1	1.3		✓	WB at wp 708; Jct of old skid road/trail at wp 709
710	6	100	12	2	1.5	✓		2 WBs at 711, 712
714	7	100	12	1	1.5		✓	WB at 715
716	8	100	14	1	1.6		✓	WB at 717
718	9	100	16	2	1.8	✓		2 WBs at 718, 719
720	10	100	11	1	1.4		✓	WB at 721
722	11	100	7	1	1	✓		WB at 723; river at base of 53% slope below skid road
724	12	100	9	2	1.2	✓		2 WBs at 725, 726
727	13	100	5	2	0.8	✓		2 WBs at wp 728, 729
729	14	100	11	1	1.4		✓	WB at 730
731	15	100	17	1	1.9		✓	WB at 732
733	16	100	16	1	1.8		✓	WB at 734
735	17	100	14	1	1.6		✓	WB at 736
737	18	100	13	2	1.5	✓		WB and perennial stream crossing at 737 +5ft, WB at 738 -5 ft
738	19	100	23	0	2.3		✓	gullied stream crossing at wp 739; drains to gullied old skid road
740	20	100	12	1	1.5		✓	WB at 741
742	21	100	12	1	1.5		✓	WB at 743
744	22	100	17	1	1.9		✓	WB at 745, 746
746	23	100	28	0	2.7		✓	erosional gully (TS Irene) exits to flats along north side trail
	24							
	25							log cribbing stabilizing downslope side road at wp 727
Total		2244		26	37.2			70%
Average			14.0					Compliant

Appendix C

Optimal Conservation Practices - outlined

30 June 2015 FINAL DRAFT

DRAFT

OPTIMAL CONSERVATION PRACTICES (OCPs)

for

Attenuating Flood Damage & Enhancing Water Quality
in the Forested Headwaters of Vermont

by David Brynn & Kristen Underwood
March 2, 2015

Introduction

It is predicted that a changing climate in Vermont will result in: earlier spring high flows, ice jams and flooding; a decrease in snowpack and ice; lower, warmer, and less-oxygenated streams and rivers; less habitat for cold-water fish species; increased nutrient inputs; more soil erosion and sedimentation; increased precipitation; and an increase in the number and power of storm events.[1] Although efforts to minimize the negative impacts of global climate change must continue, it is also prudent to identify land conservation practices that will enhance forest resilience in the face of the anticipated gully-washing storm events. The *Optimal Conservation Practices* are intended to help move Vermont's forests away from being the *ditched watersheds* they have become back toward the *spongy catchments* they were at the time of settlement. It is understood that this will require changing our conservation priorities, the ways we access forests and manage the vegetation, adaptive management, multi-disciplinary cooperation, and time. It is also understood that our forests retain the capacity to be active partners in this process.

Optimal Conservation Practices

The Optimal Conservation Practices are designed to slow the rate of water flow, increase the amount of water infiltration, reduce the amount of soil detachment, enhance the capacity of forests to trap sediment, and to maintain water quality even during storm events. In addition they are designed to reduce exposure of streams and rivers to direct solar radiation.

Section I

Practices to be Applied in Hydrologic Reserves

[1] J. Curt Stager and Mary Thill. 2010. Climate Change in the Champlain Basin: What natural resource managers can expect and do. The Nature Conservancy, Montpelier, VT

1. Avoid slopes over 35% - Close and rewild existing legacy access networks, refrain from timber harvesting, and avoid other soil-disrupting activities in areas that are over 35% in slope.

2. Avoid hydric soils - Close and rewild existing legacy access networks, refrain from timber harvesting, and avoid other soil-disrupting activities in areas with hydric soils – including natural communities such as floodplain forests, hardwood swamps, softwood swamps, spring seeps and vernal pools, marshes and sedge meadows, wet shores and shrub swamps

3. Avoid shallow-to-bedrock & D HSD soils -Close and rewild existing legacy access networks, refrain from timber harvesting, and avoid other soil-disrupting activities in areas with shallow-to-bedrock soils and D HSD soils – including natural communities such as upland shores, outcrops & upland meadows, and cliffs and talus slopes and including shallow soils -- should be reserved from timber harvest, access networks, and other soil-disrupting forest management activities.

Section II

Practices to be Applied in Hydrologic Conservation Zones

Access Networks

"Mass soil movement in forested watersheds is a catastrophic event often triggered by road construction." (Brown 1983)

"Although water-quality effects from forest harvesting have been regarded as temporary, effects from improperly constructed or maintained forest roads can pose a major, long-tern problem (Biodiversity on the Forests of Maine page 126 - Kahl 1996).

Access systems – including truck roads, forwarding paths, and recreation trails -- should be planned, designed, constructed, maintained, and monitored: to optimally serve the intended uses of the entire basin; to minimize the width, number, and extent of roads, paths, and trails particularly in or near stream crossings, riparian buffer zones, streams, surface waters and other wet areas, and steep slopes; to attenuate flood damage; and to maintain water quality during significant flood events. (Swift, L.W. page 324)

4. Use Forwarders.

5. All access networks should be constructed with tracked excavators under dry summer conditions.

6. Access networks -- including truck roads, forwarding paths, and log landings --- should only be used when adequately dry or frozen.

7. Post-harvest use of access networks should be restricted as required and monitored in order to prevent erosion, compaction, site disruption, overland flow and stream sedimentation during storm events.

8. Access networks – including truck roads, forwarding paths, and recreation trails -- should be systematically monitored on an annual basis and maintained as required to attenuate storm damage and stream sedimentation.

9. Access networks -- including truck roads, forwarding paths, recreation trails, and log landings --- should occupy less than 5% of the acreage they serve.

10. Access networks – including truck roads and forwarding paths – should have an average grade of 7% or less.

11. Truck roads and forwarding paths should be designed and constructed to be 12 feet wide or narrower, with near vertical cut banks, with few or no inside ditches, and with outsloping surfaces. (Swift, L.W. page 323)

12. Access networks should be designed, constructed, and maintained so that storm waters are removed from the surface of roads, paths, and trails in small amounts and at frequent intervals by turn-ups and durable broad-based dips (when active) and deep waterbars (when closed) at spacing according to Table 1 – Distance Between Waterbars. (Swift, L.W. page 324) (VT FP&R. 2011. AMPs)

13. Log landings should: be located on nearly-level, stable ground; be kept out of stream and other surface waters protective strips; have water diversions installed; and be graded to prevent erosion and sedimentation.

14. All cut and fill slopes should be re-vegetated before September 15. (Swift, L.W. page 323)

15. Brush barriers should be installed at the toe of fills if fills are located within 150 feet of a defined stream channel. (Swift, L.W. page 323)

16. Steep pitches greater than 12% on truck roads and forwarding paths should not exceed 200 feet in length.

17. Unnecessary maintenance of access networks should be avoided.

Riparian Buffer Zones

Riparian buffer zones should be retained adjacent to streams and other surface waters such as beaver meadows, vernal pools, spring seeps, and wetlands in order to attenuate damage and to maintain water quality during significant flood events. Any forest management activities in riparian buffer zones should be conducted under frozen winter conditions only.

18. The width of the forest and shrub riparian buffer strip should be a minimum of 100 feet as measured horizontally and perpendicular to the edge of the historic stream channel or surface water.

19. Optimal condition of retained riparian buffer area. – characterized by little or no soil disturbance, 80%+ tree and shrub canopy closure; and one 16 inch DBH or larger wind-firm legacy trees per 50 linear feet of buffer zone.

20. Areas of exposed soil that occur within the protective strip should be seeded with native species and sources, mulched with material free of invasive exotics, and applied according to Table 3, before September 15.

21. Stream buffer strips should: be kept free of logging vehicles; have little or no tree cutting; and be at least 50 feet wide.

22. Soil disturbance that extends beyond the A soil horizon should be avoided.

23. Down dead wood recruitment and retention.

Stream Crossings

Stream crossing number and location should be optimized so that there are a minimum number of crossings and at the most favorable locations possible in conjunction with a stable and suitable access network capable of withstanding storm events, maintaining water quality, and providing excellent service with minimal maintenance over time.

24. The number of stream crossings should be minimized.

25. Stream Crossings should be located where……

26. Streams should be crossed with bridges or open-arch culverts which are properly sized according to Table 2 and properly installed at right angles to the stream.

27. Fording of streams by motorized vehicles should be avoided.

28. Drainage ditches should not feed directly into streams and other surface waters.

29. Sediment should be prevented from reaching streams by using turn-ups or broad-based dips on access roads, paths and trails prior to stream crossings.

30. Streams and all surface waters shall be kept free of slash and other logging debris unless part of a carefully-designed, dead wood recruitment treatment approved by DEC.

31. Roadbeds that drain into stream channels should be fully graveled to create an erosion-resistant pavement. (Swift, L.W. page 323)

Silviculture in Forested Headwaters: Vegetation Retention & Management

Single tree and small group selection and shelterwood methods should be used for natural forest communities with gap-phase replacement (e.g. northern hardwoods) and the irregular shelterwood method should be used for natural forest communities with stand-replacing disturbance regimes (e.g. spruce-fir). Use forwarders. Log under frozen winter conditions.

32. Practice uneven-aged management by area regulation with 15+ year cutting cycles and long rotation ages.

33. Whole-tree harvesting should be avoided and down dead wood recruitment and retention should be encourage. In general leave as much biomass on the site as possible including all materials that are less than 3 inches in diameter.

34. Promote a vertical stand structure that includes over-story, mid-story, and shrub, and herbaceous vegetation layers.

35. Low-impact logging equipment, including small forwarders, should be used to minimize disruption of the O horizon, soil compaction, and increased overland flow.

36. Logging activities, except for the necessary and proper construction of stream crossing structures and approved ecological restoration shall be kept out of stream channels and meander zones.

37. Soil disturbance including rutting that extends beyond the A soil horizon should be avoided.

38. Legacy tree retention - retain a minimum of three vigorous and wind-firm legacy trees per acres measuring over 19 inches DBH.

39. Manage for at least four downed trees or 16+ feet long logs per acre on average with one exceeding 21 inches DBH and four exceeding 15 inches DBH.

40. Manage for at least four large and secure cavity, snag, and/or decadent, living trees per acre with one exceeding 21 inches DBH and four exceeding 15 inches DBH.