Exhibit NN-JG-2

Environmental Impacts of the Proposed 500 kW Photovoltaic Solar Array Upper Loveland Road, Norwich, Vermont

Submitted by: Jennifer Goulet
185 Upper Loveland Road
Norwich, VT 05055

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Summary

The project area is mapped as a resource and ridgeline protection area, with little potential for solar development. The sun is blocked by ridgetops and mature forest to the south and the west. The area is part of a core habitat block mapped by the Vermont Agency of Natural Resources. Vegetation consists of a hemlock stand, hemlock-hardwood forest, and invasive shrubs on the adjacent powerline. Red oak (*Quercus rubra*) and American beech (*Fagus grandifolia*) in the project area provide important mast for wildlife. This habitat supports necessary wildlife and Rare, Threatened and Endangered species (RTE). The presence of top of the food chain predators, such as bobcat, coyote and black bear, are signs of ecosystem health. The project area is an important deer wintering area and provides habitat and autumn food sources for black bears. Jefferson salamanders and other amphibians breed in Goodhawk vernal pool each spring and then migrate back into the forested project area.

This project would have an undue, adverse effect on necessary wildlife habitat, impacting Jefferson salamanders, black bear, and white-tailed deer. Clearcutting acres of mature forest with no seasonal restriction would fragment terrestrial salamander habitat and harm a rare species. A deer wintering area and bear habitat would be destroyed. Noxious weeds would spread into the forest interior and Goodhawk vernal pool. The fenced installation would disrupt movements of bear and deer across the landscape and animal-vehicle collisions will likely increase.

This project would also have an undue, adverse impact on streams, wetlands and residents. The project staging area will obstruct a headwater stream. The construction road, staging area and solar arrays will be built on top of the only channel that drains the project area. Clearcutting the steep forested basin and filling these two channels will cause runoff, erosion, flooding, and spread microplastics affecting downstream wetlands, roads and residents. Clearcutting the lower ridgeline, directly above residents homes, will exacerbate runoff, erosion and flooding that are already problematic. It will also create the potential for windthrown trees.

Site Description

Plant Communities

The proposed Upper Loveland Road project area consists of a forested basin between a lower and an upper ridgeline (Figure 1a). The basin slopes north and the hillside as a whole slopes east. The eastern boundary of the proposed solar array is a low ridgeline approximately 680 ft in elevation. The canopy is composed of a dense stand of eastern hemlock (*Tsuga canadensis*)[1] with some red oaks (*Quercus rubra*) and a few paper birch (*Betula papyrifera*) interspersed (Figure 1b). The basin vegetation consists of hemlock-hardwood forest. Tree species include American beech (*Fagus grandifolia*), yellow birch (*Betula alleghaniensis*),

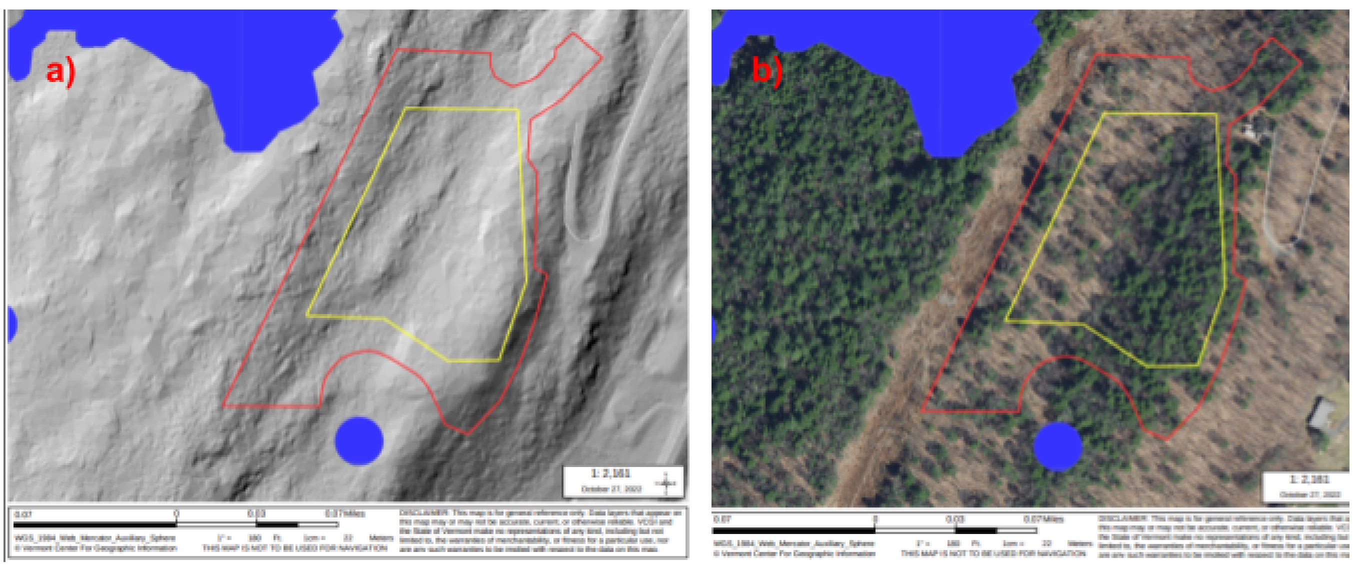

Figure 1. a) Sloped, basin-like topography and b) forested vegetation of the proposed Norwich Solar Technologies project area off Upper Loveland Road in Norwich, Vermont. The yellow outline represents the fenceline. The red outline shows the area to be clearcut for the 500 kW photovoltaic solar array. Blue polygons represent locations of wetlands and other known Act 174 constraints. Images created using Vermont Center for Geographic Information (VCGI 2022).

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[1] Plant nomenclature is according to *Kartesz* 2015.

hemlock and sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), and a few basswood (*Tilia americana*). White ash (*Fraxinus americana*), red oak, Eastern hop-hornbeam (*Ostrya virginiana*) and white birch (*Betula papyrifera*) grow towards the top of the basin where it meets the upper ridgeline. The Arrowwood Environmental (AE) natural resources assessment reported that there are no stands of red oak or American beech at the project site (Barton 2021). Yet, there are many mature red oak and American beech trees growing on the project site. Diameter at breast height measurements taken randomly from red oaks and American beech in the project area are presented in Appendix A to show that these trees are present and large enough to produce mast for wildlife. American beech are quite abundant. Beech is the only tree species that is regenerating in the project area (Appendix B). Photos of the all tree species mentioned above are in Appendix B & C.

The western boundary of the project area is an upper ridgeline, approximately 720 ft in elevation. A power line runs along this ridge. Exotic invasive species, European honeysuckle (*Lonicera* spp.) and glossy buckthorn (*Frangula alnus*), are the most abundant shrubs in the plant community. The Vermont Agency of Agriculture, Food and Markets (2022) considers both of these species Class B noxious weeds, meaning that they are detrimental to the environment and pose a serious threat to the state. Bracken fern (*Pteridium aquilinum*) and hay-scented fern (*Dennstaedtia punctilobula*), two native ferns considered to be aggressive growers, are common in the understory. Green Mountain Power controls the growth of woody vegetation on the powerline with herbicide applications.

Solar Potential

Vermont receives an annual average of 4.13 peak hours of sunlight per day (Turbine Generator 2022). During peak hours sunlight is strongest, at least 1.0 kW/m^2, so panels do not underperform. However, the project location reduces the number of peak sunlight hours substantially. Much of the proposed project site would occupy a north-sloping forest basin that is located below the height of the land (Figure 1a). Figure 2 is a map of solar potential within the project fence line (yellow boundary) based on the slope of the land. It shows very little moderately sloped terrain, represented by the pink rectangles. The western side of the basin is

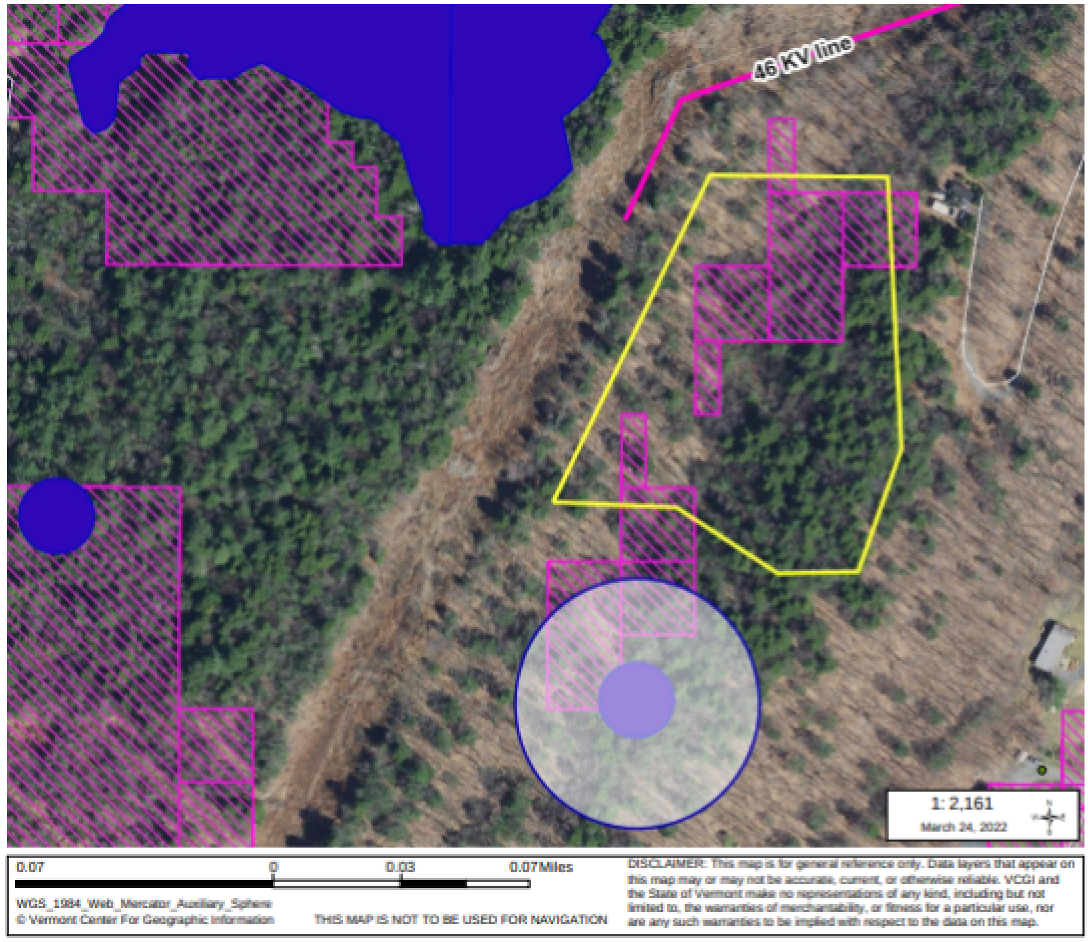

Figure 2. Vermont Act 174 Ground Mount Solar Potential within the fenceline (yellow) of the proposed Norwich Solar Technologies project area. The pink rectangles indicate areas with a 4 - 10% slope that could be a potential solar resource. The blue polygons represent wetlands and other known Act 174 constraints. An approximate 100 ft buffer zone is shown around Goodhawk vernal pool. Image created with VCGI (2022).

steep with a slope of approximately 35 % (NRCS 2022). The top of the ridgeline and adjacent forest block sunlight from the south and the west. These obstructions will cast shade on the panels when the sun is strongest. The 100 ft buffer of uncut trees surrounding Goodhawk pool to the south of the project area will cast additional shade on the adjacent panels. Overall, this map of solar potential shows that the majority of the project area is a poor choice for siting a solar array.

Surface Waters

Over eight inches of rain fell on the project area in July 2021 (Weather Underground 2021), more than twice the monthly average precipitation (U.S. Climate Data, 2022). Yet, on July 31 and August 1, AE failed to identify two channels in the project area, mistakenly concluding that there were no surface waters present (Barton 2021, Appendix D). First, the location of the watershed headwaters was misidentified. Figure 3 shows that Schmidt Bog, located in the adjacent town forest, is the actual headwaters of this small watershed. The project area is located below Schmidt bog in a basin that drains north. The headwater stream

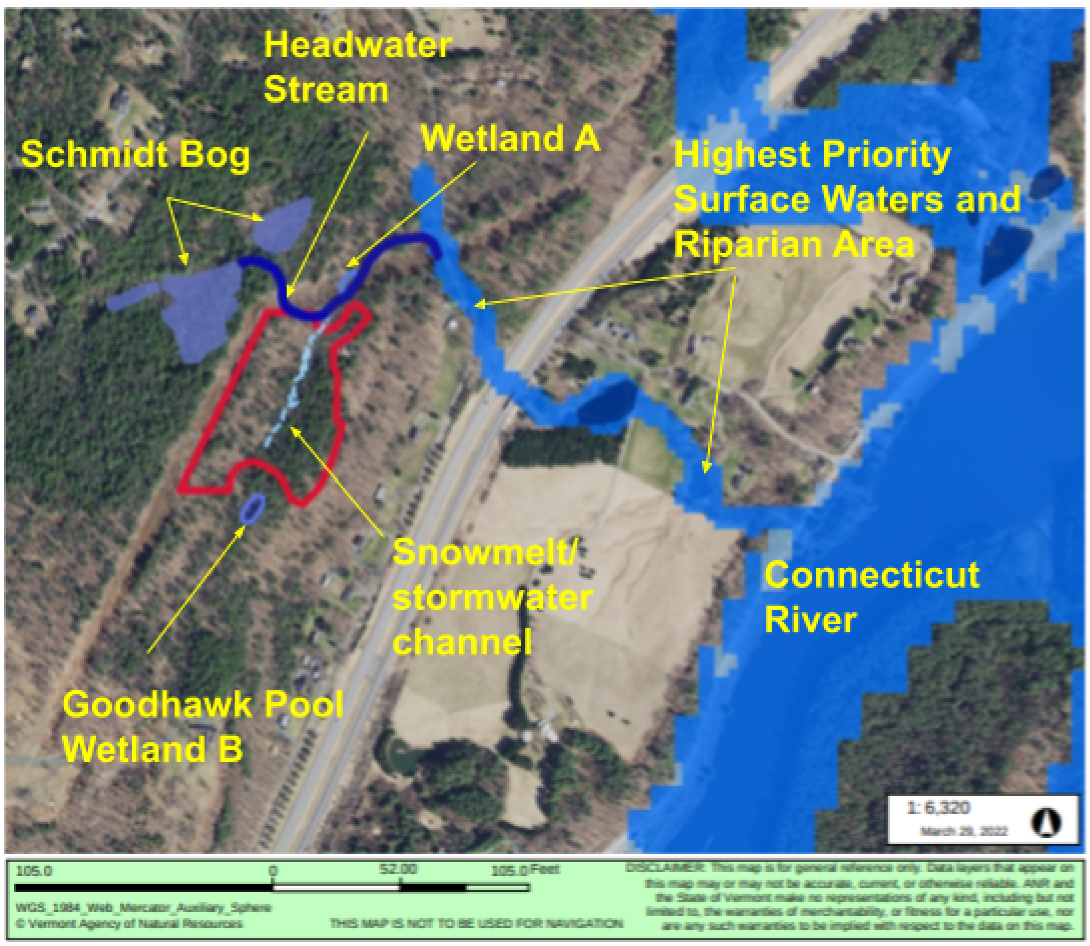

Figure 3. Location of Schmidt Bog, the origin of the headwater stream that intersects the project staging area (red outline). The headwater stream connects with an ephemeral snowmelt/stormwater channel north of the staging area. These combined waters eventually flow into the Connecticut River. Image created in Biofinder (VCGI 2022).

flows east from the bog (Figure 4a), through the project staging area. The second unmapped channel flows through the project area from south to north (Figure 4b) and intersects with the headwater stream directly below the project staging area (Figure 4c). This channel drains the project area during spring snowmelt and large storm events. The combined channels then flow through wetland A delineated by AE and join with a mapped stream designated as “Highest Priority Surface Water and Riparian Areas” by the ANR (Figure 3). This mapped stream flows east through several small wetlands adjacent to Upper Loveland Road and then through Larry Ufford’s and Janna Pendard’s ponds. Ultimately these waters drain into the Connecticut River.

Figure 4. Photographs of a) Snowmelt/stormwater channel that drains the proposed project area, b) headwater stream taken near Schmidt bog and c) their hydrologic connection. Photographs were taken January 12 and March 19, 2022. Additional photos of the snowmelt/stormwater channel are in Appendix E.

Core Habitat for Necessary Wildlife

The AE report neglected to mention that the Vermont Agency of Natural Resources (ANR) has mapped the proposed project area as core habitat for wildlife (Figure 5). Core habitat refers to large (> 250 acres) blocks of continuous forest or other natural communities that have not been affected by human development. These habitat blocks contain little or no permanent fragmentation from human disturbances such as roads, powerlines, houses, etc. (Sorenson and Osborne 2014). Necessary wildlife live in and utilize the project area, which is located within core habitat and wildlife corridors. Although the AE report concluded that no necessary wildlife habitats were present (Barton 2021), the eastern ridgeline is a deer wintering area (p.11). The project area supports black bears (p.15) and it is home to rare Jefferson salamanders (p.19).

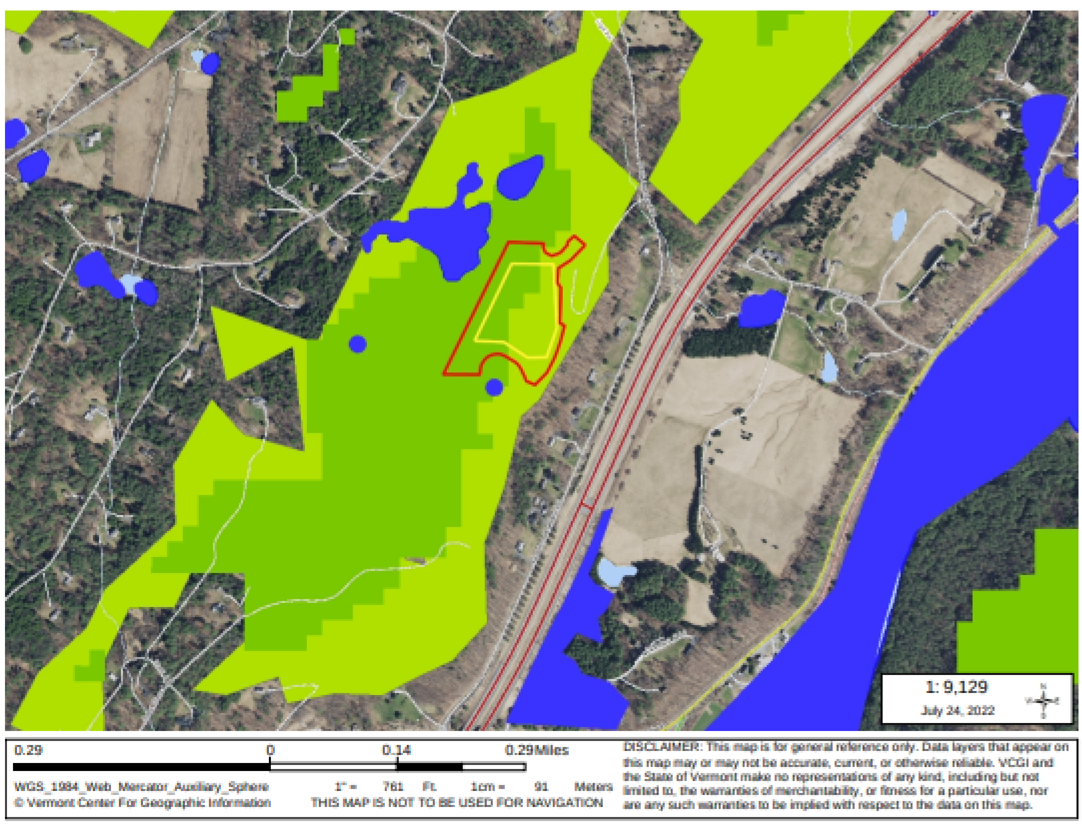

Figure 5. The largest contiguous block of core habitat (darker green polygon) and wildlife corridors (lighter green polygon) in the village of Norwich. The red outline approximates the extent of the clearcut for the proposed project. The yellow outline indicates the approximate location of the fence. Wetlands and other known Act 174 constraints are shown in blue. Image created with VCGI (2022).

Necessary wildlife are supported by a diverse ecological community and a healthy food web. Table 1 lists wildlife species observed in the project area over the past 5 years. This list is

Table 1. Wildlife observations and sign in the proposed Norwich Solar Technologies project area off Upper Loveland Road in Norwich, Vermont. Observations made by Lindsey Putnam, Joy Kenseth, Jennifer and Daniel Goulet from 2017 to 2022.

Species	Adult	Juvenile	Sign
Barred Owl	x	x	calls, nests
Black Bear	x	x	scat, claw marks on telephone poles
Eastern Bobcat	x	x	tracks
Eastern Newt	x	x	red efts in terrestrial leaf litter, adult in Goodhawk pool
Chipmunk	x	x	
Eastern Coyote	x	x	tracks, scat, howls, deer kills
Fisher	x		tracks
Gray Fox	x		tracks
Gray Squirrel	x	x	tracks, nests
Long-tailed Weasel	x		
Moose	x		tracks
Mice	x		tracks
Opossum	x		tracks
Pileated Woodpecker	x		oblong holes in trees, calls
Porcupine	x	x	
Raccoon	x		tracks
Red Fox	x		tracks
Red Squirrel	x	x	tracks, nests
River Otter	x		tracks
Snowshoe Hare			tracks
Spotted salamander	x	x	egg masses in Goodhawk pool (Wetland B)
Jefferson salamander	x	x	egg masses in Goodhawk pool (Wetland B)
White-tailed Deer	x	x	trails, tracks, scat, browse, rubs, scrapes
Wild Turkey	x	x	tracks, scat, scratchings
Wood Frog	x	x	egg masses in adjacent vernal pool (Wetland B)

not comprehensive. Rather, the objective is to demonstrate that the project area is used by a diverse assemblage of wildlife and that the area functions as part of the core habitat block. Necessary wildlife do not exist in a vacuum. Most of the species in Table 1 are not considered rare, threatened or endangered. However, this community is important because it is biologically diverse and supports necessary wildlife. For instance, the presence of small mammals in the project area is important because they create burrows that are used as underground refugia by Jefferson and spotted salamanders once breeding season comes to an end. Small mammals are also an important part of the food web that supports carnivores and omnivores, such as black bears.

The project area, as part of the core habitat block, provides seasonal visitors and permanent residents with the necessities of water, food, cover and space. For instance, water is available in the wetlands and streams in and adjacent to the project area (Figures 3 & 4). The observations in Table 1 suggest that this core habitat supports a balanced food web, representing many trophic levels. Some animals including white-tailed deer (Figure 6d), squirrels, snowshoe hare, porcupine and mice (Figure 6a) are considered primary consumers eating only vegetation, including leaves, twigs and bark. Acorns and nuts produced by the red oaks and American beech, and seeds produced by the other tree species are an important source of protein and fat for these animals. Other animals observed in the project area are secondary consumers that eat vegetation and/or primary consumers. Examples include Jefferson salamanders, chipmunks, fox, and wild turkey (Figure 6c). The primary and secondary consumers are preyed upon by top-of-the food chain carnivores and omnivores, such as black bear, fisher, bobcat, coyote and barred owls (Figure 6b). The presence of these top of the food chain predators is a key indicator of ecosystem health (Morse 2022).

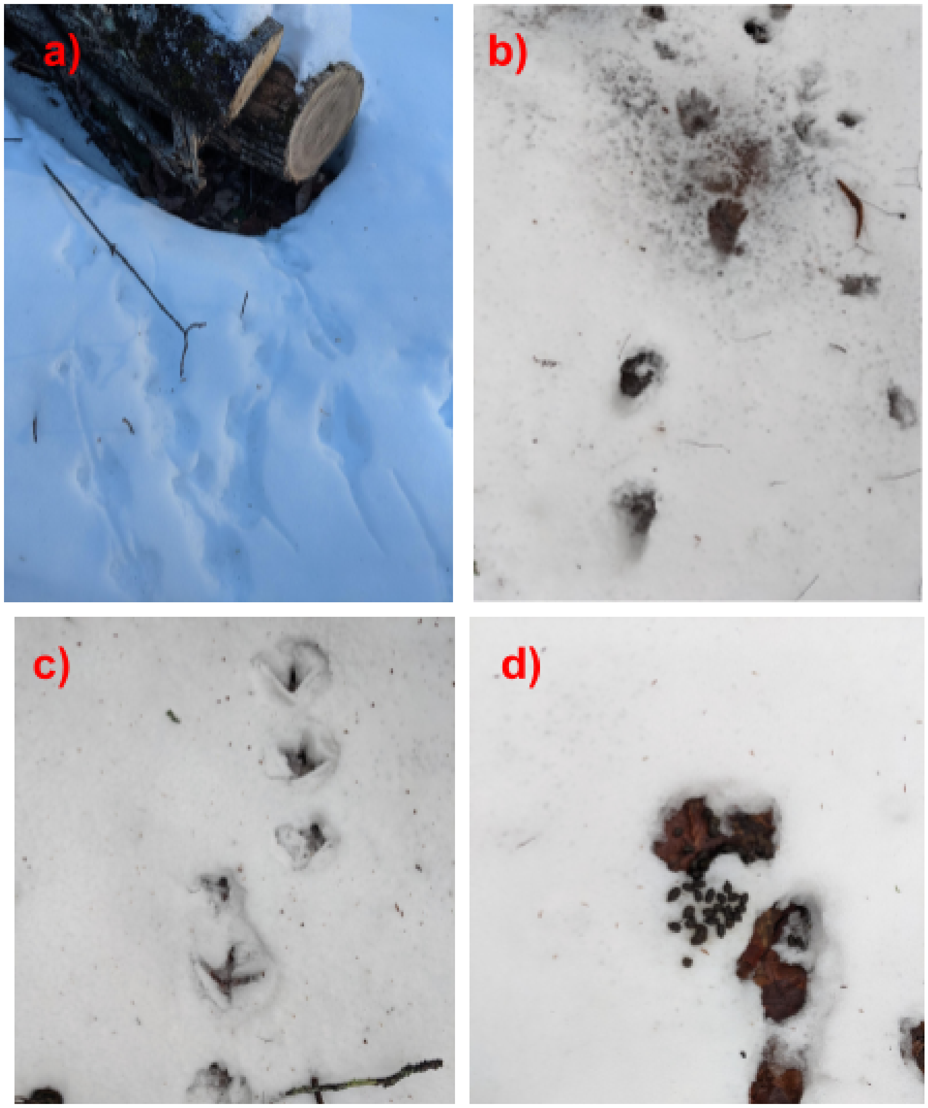

Figure 6. Tracks from a) mouse, b) fisher, c) wild turkey and d) white-tailed deer in the proposed Norwich Solar Technologies project area, off upper Loveland Road in Norwich Vermont. Photographs were taken in January 2022.

As part of a core habitat block, the proposed project area also provides cover for necessary wildlife in the village of Norwich. Cover protects animals from the weather and predators while they are feeding, breeding and nesting. For necessary wildlife, the dense forest canopy provides cool, shady habitat in summer and cover for young black bears to escape from predators. In winter, dense conifer cover on the eastern ridgeline shelters deer from winter winds and cold temperatures. Fallen trees, hollow logs and rocky ledges provide shelter black bears. Burrows created by small mammals serve as underground refugia for Jefferson salamanders and other amphibians (Faccio 2003).

This forest block also provides space for animals to establish separate territories for nesting, breeding, or bedding. For example, in autumn white-tailed deer that live north and south of the project area travel to the forested basin most evenings to access acorns and beech nuts and to breed. Bucks mark their territories in the project area with scrapes and rubs in order to attract mates. Bucks of different ages use different parts of the project area during breeding season. Mature bucks bed on the western boundary of the project area, along the upper ridgeline. The ridgeline provides a safer vantage point from which to spot approaching mates, rivals, and predators. Young bucks and spikehorns are relegated to less desirable bedding locations during breeding season. They bed on the lower ridge that comprises the eastern boundary of the project area where the potential for interaction with humans is greater.

Deer Wintering Area

The lower ridgeline of the project area is also used by white-tailed deer (*Odocoileus virginianus*) as a wintering area. Although this habitat is less desirable in autumn during the rut, once the snow flies deer seem to prefer the protection offered by the hemlock canopy fairly close to human development. Close proximity to human habitation in the winter can offer an escape from predation. Coyotes are less likely to pursue deer into areas adjacent to houses. AE concluded that deer do not use the project as a wintering area because they were unable to find evidence of it during a midsummer site visit and because Vermont ANR has not mapped the area (Barton 2021). Yet, the eastern edge of the project area meets all of the identification criteria described by Reay et al. (1990) for a deer wintering area (Figure 7).

The core range of this winter habitat is located along the lower ridgeline running from Goodhawk pool to just north of the cell tower. The hemlock dominated canopy is closed,

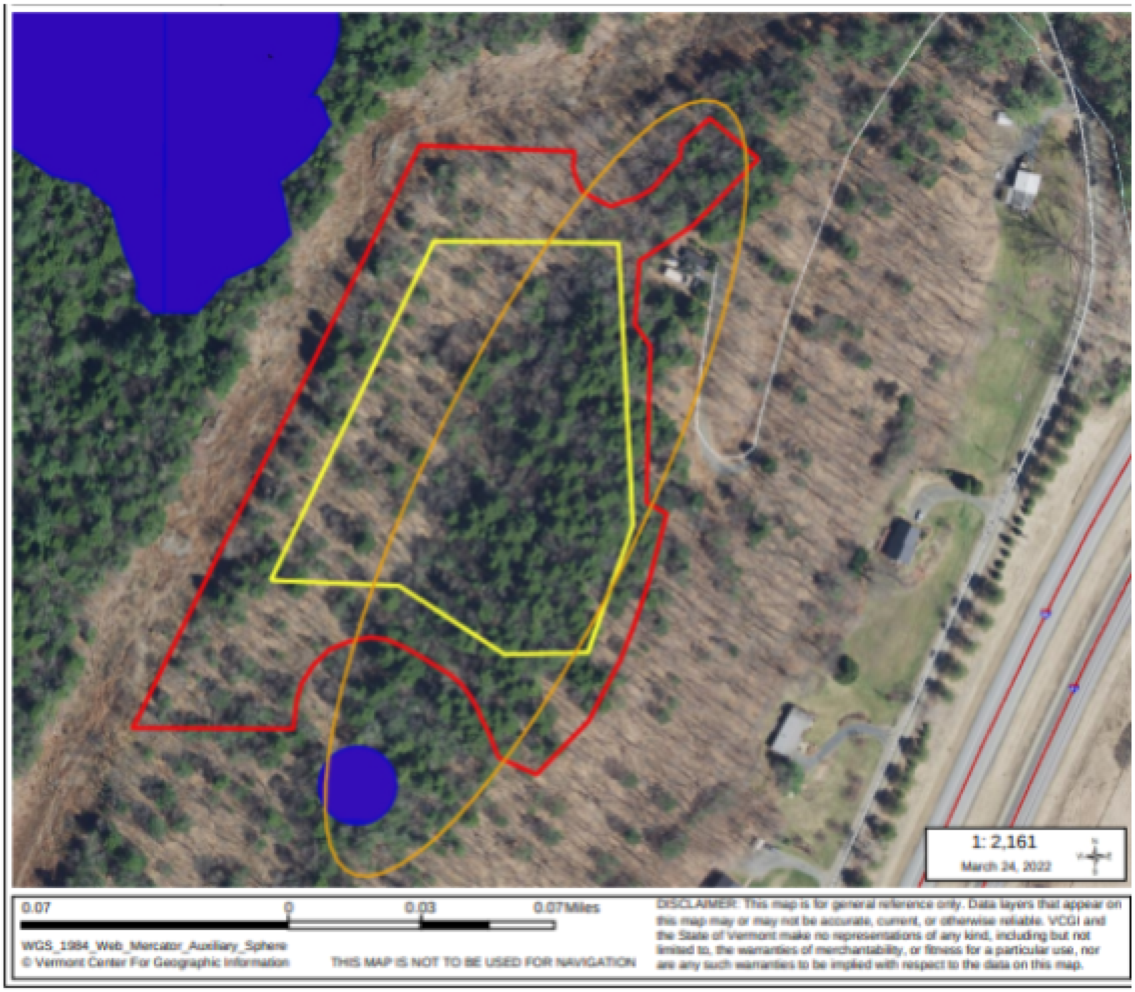

Figure 7. Location of the core range of a white-tailed deer wintering area (orange oval) according to Reay et al. (1990), in the area to be clearcut (red) and the fenceline (yellow) of the proposed project area, off upper Loveland Road in Norwich Vermont. Wetlands and other known ACT 174 constraints are shown in blue. Image created with VCGI (2022).

creating a beneficial microclimate for wintering deer. Because wind and snow are blocked by the dense canopy, the climate under the hemlocks is warmer and more humid than adjacent deciduous forest. Cold, northwesterly winter winds are also blocked by the upper ridgeline and the adjacent town forest to the west. This deer wintering area is characterized by well worn deer trails, tracks, scat, and beds (Figure 8a-d).

Figure 8. White-tailed deer sign in core winter habitat a) deer trail, b) bed, c) browse on shelf fungi, and d) scat located within the proposed project area, off Upper Loveland Road in Norwich Vermont. Photographs were taken within the intersection of the orange oval and the yellow fence line shown in Figure 7, in January 2022.

Food is always scarce during Vermont winters and early springs. There is no regeneration of most tree species in the core range of this deer wintering area because deer quickly devour seedlings. Likewise, in the adjacent hemlock-hardwood hardwood basin, only American beech is regenerating, by root sprouts (Appendix B, photo c). White-tailed deer do not eat American beech, unless they have no other choice. Other tree species are preferentially browsed as seedlings. This monoculture of beech in the forest understory is typical of Vermont forests where the number of deer exceeds the environment's capacity to sustain them (Marcus Bradley, Redstart Forestry, *personal communication*, August 2020). Yet, there are many other

Figure 9. White-tailed deer browse on deciduous shrubs adjacent to core winter habitat a) shrubs on the powerline, b) yew at 133 Upper Loveland Road, c) semi-dwarf apple tree and d) redosier dogwood at 185 UpperLoveland Road. Photographs taken March 11, 2021.

sources of food adjacent to the core wintering area. Deer browse shelf fungi (Figure 8c), deciduous shrubs on the powerline (Figure 9a) and hemlock boughs when heavy snow puts low-hanging branches within reach. Ornamental shrubs adjacent to the deer wintering area are another winter food source. At 133 Upper Loveland Road yews (*Taxus* spp.) (Figure 9b) and crabapples (*Malus* spp.) are particular favorites. At 185 Loveland Road they browse eastern arborvitae (*Thuja occidentalis*), highbush cranberry (*Viburnum opulus*), red-osier dogwood (*Cornus alba*) and occasionally fruit trees (Figure 9c - d). In the spring of 2021, twenty-one white-tailed deer were observed grazing newly sprouted grass in the field at 185 Upper Loveland Road.

Black Bear Habitat

The core habitat block and wildlife corridors that were mapped by the ANR (Figure 5), serve as year round habitat for young adult black bears (*Ursus americanus*) without permanent territories. Black bears are elusive and mostly solitary animals. Their ranges are large, encompassing a variety of habitats and seasonally available food sources. According to the Vermont Department of Fish and Wildlife, the best black bear habitat is a mixture of coniferous trees and hardwoods, wetlands, and variation in terrain (VTFWD 2022a). The project area (Figure 1a & 1b) and the adjacent sedge wetland (Figure 10a), contain all of these features. It also contains potential denning sites such as rocky ledges, hillsides, hollow logs and trees.

Bears have been observed using the project area, mapped core habitat and the adjacent wildlife corridors in spring, summer and fall (Figure 10 b-d). In springtime, young adult bears have been spotted in the adjacent town forest, on Loveland and Upper Loveland Roads (Figure 10b, Tom Sterling 2021, Joy Kenseth 2022, *personal communications*). The small sedge dominated wetland just north of the project area is one early spring food source (Figure 10a). Jack-in-the-pulpit (*Arisaema triphyllum*) and wild lettuce (*Lactuca* spp.) sprout in the deciduous forest and along its edges. Dandelions and shade tolerant grasses, such as fowl manna grass (*Glyceria striata*) and white cut grass (*Leersia virginica*) grow north of the project area on forest edges, along Upper Loveland Road. In May, newborn fawns provide a source of protein. Solitary young bears are also observed in summer when insects, berries, and apples become available along the powerline (Figure 10c).

Mature females and their cubs access the project area in autumn from the powerline that functions as a corridor for wildlife. The oak and beech trees in the project area are a fall food source for bears of all ages. These mast-producing trees are mature enough to function as a high protein food source for wildlife (Appendices A & B). The calories in beechnuts and acorns are critical for surviving Vermont winters. One October, a cub was observed gorging itself on acorns at the southeast end of the project area, near the cluster of oaks shown in

Figure 10a) The small sedge-shrub wetland adjacent to the project area is one spring food source for black bears. b) In May, a bear heading northeast from the project area. c) In July, a black bear passes an apple tree on the powerline moving north towards utility pole #45 shown in Figure 11. d) bear eating drops under an apple tree adjacent to the project area. e) bear scat in the wildlife corridor north of the project area. f) bear scat in the wildlife corridor north of the project area. Photographs taken April 19, May 13, July 19, September 2, and October 9, 2022.

Appendix A. One September, an adult bear was seen running through the forested basin of the project area, headed south toward the vernal pool. In September 2021, a large adult bear was spotted heading from the project area northeast towards Upper Loveland Road (Jennifer Goulet, *personal observations* 2017 - 2021). Hunters have watched bears feeding on the apple trees scattered along the powerline and on acorns in the project area for over 25 years (Figure 10d, Westley Mattern, Bryan Dube, and Daniel Goulet, *personal communications,* 2021). Old claw marks on utility poles corroborate these observations, suggesting that bears have marked and used this territory for many years (Figure 11b).

Although this area has not been mapped as bear habitat by the ANR, territorial markings on utility poles and apple trees show that bears use it as habitat nonetheless. Fresh bite marks on utility pole #45 near the project area suggest that bears are still actively marking this corridor as their territory (Figure 11a). The fresh claw marks on apple trees just north of the project area indicate that bears continue to climb these trees in search of food (Figure 11c and 11d). Likewise, bear scat provides more evidence that bears use this area as habitat (Figures 10 e and f). In fact, bear scat is so common that someone stepped in a fresh pile on the cell tower driveway during the PUC site visit, on October 25, 2022.

Figure 11. Bear territorial markings adjacent to the proposed project area, a) recent bear bite marks on utility pole #45, b) older bear claw marks on utility pole #54, and c-d) fresh claw marks on two apple trees adjacent to the project area suggest that bears currently inhabit this area. Photographs taken March 11, August 13 and October 9, 2022.

Rare, Threatened and Endangered (RTE) Species

The project area and the vernal pool, on its southern border, provide habitat for amphibians and invertebrates. The pool, which was labeled Wetland B in the AE report, is known locally as the Goodhawk vernal pool (Figure 12a and b). In spring, Jefferson salamanders (*Ambystoma jeffersonianum*), spotted salamanders, eastern newts, fairy shrimp and wood frogs breed in the pool (Figure 12 a-d). Although wood frogs, spotted salamanders, eastern newts and fairy shrimp are quite common across Vermont, Jefferson salamanders are not. With a state natural heritage rank of S2 (rare), they are a species of special concern in Vermont. Jefferson salamanders have also been designated a Species of Greatest Conservation Need (high priority) in Vermont's Wildlife Action Plan (VTFWD 2015). Vernal pool research conducted in Woodstock, Vermont found that female Jefferson salamanders migrate an average distance of 508 ft (155 m) into upland forest after breeding (Faccio 2003). These amphibians spend most of their lives in mature hemlock-hardwood forests characterized by a matrix of coarse woody debris, leaf litter, underground refugia such as small mammal burrows. In Vermont, Jefferson salamanders are threatened by habitat fragmentation, habitat alteration and human disturbance (VTFWD 2015). Therefore, preventing clearcutting and forest fragmentation near breeding pools is extremely important because this is where salamanders spend most of their lives.

The presence of Jefferson salamander egg masses and adults in Goodhawk vernal pool has been corroborated by Vermont Natural Heritage Inventory (VTFWD 2022b), the Vermont Reptile and Amphibian Atlas (Andrews 2022) and the Vernal Pool Monitoring Project (Vermont Center for Ecostudies 2022).

Figure 12. Goodhawk vernal pool, south of the Upper Loveland Road project area, in a) April and b) August. Amphibian species include c) Jefferson salamander, d) Jefferson salamander egg mass, e) spotted salamander, and f) spotted salamander egg mass. Photographs taken by Lindsey Putnum (April 2021) and Jennifer Goulet and April 16, 24 and August 21, 2022.

Project Impacts

The project area off Upper Loveland Road in Norwich, is mapped as a resource protection area and a ridgeline protection area, in the town plan (NPC 2020) (Figure 13). Inexplicably, the Norwich Planning Commission and the Selectboard have violated the town plan by allowing this project to go forward. A total of 8.2 acres of mature forest would be clearcut. The lower and upper ridgelines would be denuded. Natural resources will be destroyed. The largest contiguous habitat block in the village of Norwich would be fragmented, destroying habitat for necessary wildlife and RTE species. Class B noxious weeds would spread into the forest interior and greenhouse gasses would be released into the atmosphere. Aquatic resources will be filled and built upon, creating runoff and erosion that will affect downstream waters, including wetlands, ponds and the Connecticut River.

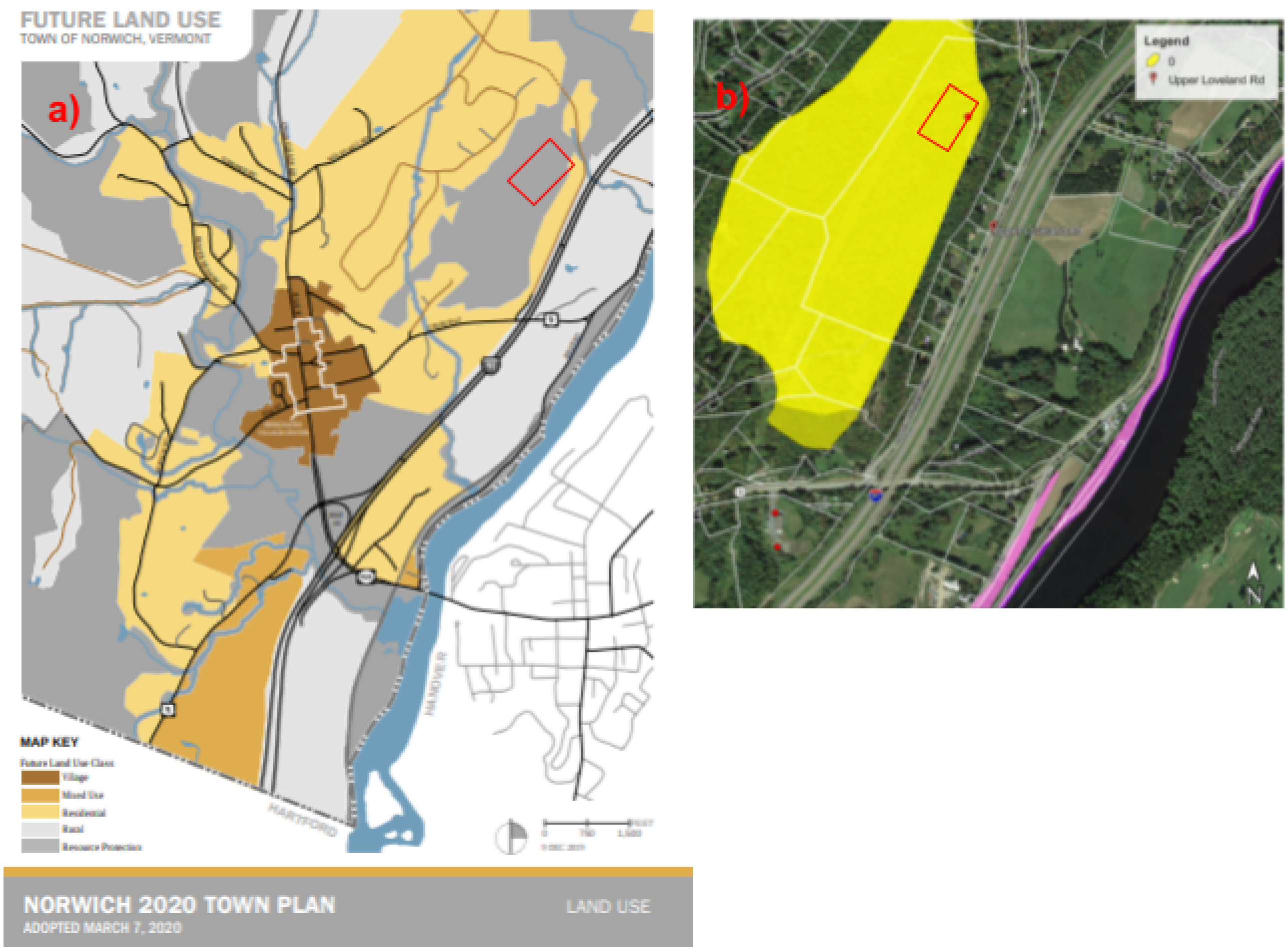

Figure 13. Approximate project area location (red outlines) within a) a resource protection area and b) a ridgeline protection area described in the Norwich Town Plan (NPC 2020).

Impacts to Plant Communities

Clearcutting mature forest in the project area will fragment core habitat and spread of exotic invasive shrubs from the adjacent powerline. When core habitat is disturbed by human activities the environmental impact extends far beyond the footprint of the project area. Habitat fragmentation creates an edge effect. Edge effect refers to the abiotic alterations to the forest interior created by human development. These changes include an increase in available sunlight, increased temperature, reduced humidity and soil moisture when compared to the interior of undisturbed forest (Sorenson and Osborne 2014). All of these factors affect forest structure and plant community composition. Every soil contains seeds that have accumulated over time. Buckthorn and honeysuckle seeds from the adjacent powerline are present in this forest's seed bank because wildlife ingest the fruits and spread seeds throughout the forest in their scat (Cygan 2018). In fact, buckthorn berries have a laxative effect that causes animals and birds to expel the berries before their bodies can process the sugars. Currently, the dense shade of the forest canopy keeps seeds dormant. Once the forest is clearcut, the increased sunlight in the project area will cause the seed bank to sprout. Edge effects will change the structure of the forest interior well past the project footprint. Invasive shrubs quickly outcompete native plants and take over forest habitats because they grow rapidly and wildlife preferentially browses native plants (Sorenson and Osborne 2014, Cygan 2018). The importance of an invasive species management plan for the project area and the Goodhawk vernal pool can not be underestimated.

Greenhouse Gas (GHG) Emissions

This project will create unnecessary GHG emissions that could be avoided by properly siting the facility in an sunny, non-forested area. Land-use changes, primarily the clearing of forests, are responsible for one-third of net carbon dioxide emissions to the atmosphere since 1850 (Rhemtulla et.al 2009). Mature forest performs critical ecosystem services including absorbing and sequestering carbon dioxide — a greenhouse gas. According to the Norwich Planning Commission (2020), the release of carbon from clearing forests diminishes the climate benefits of solar development on forested sites. Living trees remove carbon dioxide from the atmosphere and store it as biomass. An average acre of Vermont forest stores 389 metric tons of carbon dioxide equivalents as above ground and below ground biomass. Each acre of forest sequesters an additional 1.3 metric tons of tons of carbon dioxide equivalents each year (Kosiba 2021). If the forest in the project area was left standing, a total of 3,190 metric tons of carbon dioxide equivalents would remain in storage. An additional 266.5 metric tons would be sequestered over the 25 year life span of the solar array. Instead, trees will be cut, chipped and spread over the site. As the wood chips decay, 3,190 metric tons of carbon dioxide equivalents will be released into the atmosphere over a period of 4 or 5 years.

The logging operation itself will also create GHG emissions. GHG emissions are produced by the use of fossil fuels, grease, lubricant and coolants that are required to manufacture the logging equipment, transport equipment to the site, prepare the landing and log roads, cut, skid slash and chip trees. Most trees in the project area are only suitable for chipping because they have crooked boles, extensive branching, disease or are too small for sawlogs. In Vermont an average acre of forest contains 58 metric tons of live biomass (Morin et al. 2020). Forty kilograms of carbon dioxide equivalents are emitted for each metric ton of biomass that is harvested and chipped (Weyrens et al. 2022). Thus, an estimated 19 metric tons of carbon dioxide equivalents will be emitted while harvesting and chipping trees in the project area.

The solar panels and equipment also have a carbon footprint because the extremely high temperatures required to manufacture panels can only be achieved by combusting fossil fuels. Elements of the carbon life cycle for solar panels include mining and purifying raw materials, manufacturing panels, and transporting panels from the manufacturing location in Asia, to Norwich, Vermont, as well as installation and maintenance operations. GHG emissions are also created from manufacturing and installing racking, string inverters, fencing, etc. One study estimated that over the lifecycle of a multi-crystalline solar array, such as this one, an average of 44.3 grams of GHGs were released per kWh of electricity generated (Nugent and Sovacool 2013). Assuming that 900,000 kWh/year of electricity are generated at the Upper Loveland location for a period of 25 years (Staskus 2022), the estimated carbon footprint of the panels and equipment is 997 metric tons of carbon dioxide equivalents.

Over its lifetime, the solar array is estimated to avoid the release of approximately 15,950 metric tons of greenhouse gas (Staskus 2022). Yet, this project will release approximately a quarter of this amount, 4,200 metric tons of carbon dioxide equivalents, during site preparation and the manufacture, installation and operation of the solar array. After 25 years panels become obsolete, requiring construction of new panels, infrastructure and more GHG emissions. Yet, Norwich Solar Technologies describes these GHG emissions as "short term and minimal" (Staskus 2021).

Impacts to surface waters and wetlands

The proposed solar project will have an undue, adverse impact on local roads and downstream waters because AE failed to correctly identify two stream channels in the project area (Figures 3 & 4). Preparing a site for a solar array typically involves removing vegetation, and filling, grading and compacting soils. All of these practices can create significant increases in onsite runoff and soil erosion. The streams will not be adequately protected by buffer zones, because they were not correctly identified. Instead, they will likely be filled with wood chips and graded. The project staging area will obstruct the headwater stream. The construction road, staging area and the solar arrays will be built on top of the ephemeral channel. This channel provides the only drainage in the project area, since the basin is surrounded by ridge to the east, west and south (Figure 1a). Filling and building upon these streams will create runoff, erosion and flooding. Eventually, flooding and erosion could undermine the stability of the arrays and/or wash out Upper Loveland Road or the cell tower driveway entrance. In the past ten years, large storms have washed out Upper Loveland Road above the project area twice. As our climate changes large storm events are occurring more frequently. Once the forest is clearcut and these two channels are blocked, flooding is likely to impact Upper Loveland Road and the cell tower driveway downhill from the project area.

The access road to be built around the north side of the cell tower will have an undue, adverse impact on downstream waters by spreading microplastics throughout the soil in the project area. The forest floor surrounding the cell tower is littered with the plastic branches that were used to disguise the tower as a pine tree (Figure 14). Strong winds blow these branches fall off the tower and they land on the forest floor, where they are covered with leaves and begin to decompose into the soil. The needle-like leaves on these branches are composed of

Figure 14. Imitation pine tree branches decompose, depositing microplastics in forest soils surrounding the cell tower. Photo taken November 2022.

a number of plastic compounds, the most common being polyvinyl chloride (PVC). Decomposing microplastics are actually more toxic to aquatic life than the intact needles and branches (Xia et al. 2022). The runoff and erosion that result from clearcutting the forest will transport these microplastics into downstream waters affecting water quality and aquatic organisms. Soils around the cell tower should be remediated before the microplastics are spread by construction equipment.

Currently, the forest acts as green infrastructure that minimizes runoff and erosion in this steeply sloped basin. The canopy intercepts and slows rain drops. As water velocity decreases, more water infiltrates the soil where much of it is absorbed by tree roots. Forests remove as much as 70% of incoming precipitation (VDFPR 2015). This project will replace acres of green infrastructure with acres of impermeable surface. The stationary panels redistribute precipitation, creating spatial differences in infiltration and soil moisture (Elamri et al. 2018). Rainfall is concentrated along the lower edges of panels. These conditions can cause splash erosion and erosion from concentrated flows in micro-channels. In contrast, soils underneath the panel receive little or no rain. As a result, grass will be difficult to establish in place of the trees. Grass prefers full sun and will not thrive in the dry shade created by the stationary panels.

Without the green infrastructure of the forest to ameliorate runoff and erosion, water quality downstream will suffer (VDFPR 2015). In addition to storm water runoff and sediment, other potential pollutants include fertilizer runoff from hydroseeding the grass and possibly, herbicide from treating invasive shrubs and the prolific beech root sprouts in the southern end of the project area and microplastics from the area around the cell tower. Runoff from the cleared area and the filled channels will flush sediment and other pollutants, such as microplastics, into the headwater stream below the project area affecting the wildlife in wetland A and the larger riparian/wetland complex adjacent to Upper Loveland Road (Figure 3). Runoff from herbicides and fertilizers negatively affects the growth and survival of amphibians and invertebrates in wetlands and streams (Baker et al. 2013). Microplastics have been shown to decrease growth in green algae (Wang et al. 2020) and cause irreversible damage to DNA in trout (Boháčková 2021). The roadside wetland and the stream that flows through it are designated as a “Highest Priority Surface Water and Riparian Area” by the Vermont ANR because it is important for maintaining an ecologically functional landscape. The ecological integrity of the Connecticut River is critically tied to the condition of this stream and the adjacent riparian area (Sorenson and Zaino 2018). Runoff and erosion from human development should be kept to a minimum in these areas.

Further downstream, runoff from the project area would have an undue adverse effect on the ponds at 64 and 37 Loveland Road (Figure 3). Residents are concerned that runoff from a commercial scale solar installation will affect the water quality of their ponds (Larry Ufford, *personal communication,* 3/4/21). With regard to water purity, sediments from the project area would increase turbidity and water temperature. Herbicide runoff would kill aquatic plant life. Fertilizer runoff could lead to algae blooms, anoxic waters and dead zones. Large blooms of cyanobacteria is a health and safety threat, as it would make the water unsafe for swimming or drinking. The natural environment would also be affected because these ponds are important water sources for wildlife, particularly the pond at 64 Upper Loveland, that is surrounded by mature balsam fir (*Abies balsamea*) that provides cover for white-tailed deer and small mammals.

After passing through these ponds, sediments and pollution from the project area would flow into the Connecticut River affecting the use of natural resources and the public health and safety. This section of the river, from the stream junction to the Ledyard bridge, is a popular recreation area for residents of Vermont and New Hampshire. From spring through fall people use this natural resource for rowing, launching boats, swimming and paddleboarding. Maintaining water purity in the Connecticut River is important for the tourism/recreation industry, the rowing program at Dartmouth College, and for the health and safety of millions of people living downstream.

The AE report recommended a standard 50 ft buffer surrounding the headwater stream and wetland A (Barton 2021). The recommended buffer will not mitigate the downstream impacts of nonpoint source pollution on residents or the environment due to AE's failure to identify the ephemeral stream channel and the steep slope of the project area. The literature suggests that buffer width of headwater streams should vary based on geomorphic setting, naturally occurring vegetation, and the primary management objective (Fischer and Fischenich 2000). Wider buffers are recommended to maintain water quality and to protect headwater streams and wetlands when logging steep, forested slopes, such as those in the project area. Buffers surrounding headwater streams are particularly important because they protect the quality of all downstream waters. The literature suggests that in steeply sloped landscapes and headwaters, buffers should be at least 100 ft (≥ 30 m) when water quality is the management objective (Fischer and Fischenich 2000). A buffer of 110 ft (33.5 m) is sufficient to prevent stream sedimentation when logging slopes ranging from 40% - 80% (Bowker et al. 2020). Because this project requires clearcutting steep slopes, a 100 ft buffer zone should be implemented around the two streams that intersect the project area to preserve the quality of downstream waters. The staging area, construction road, and solar arrays should be reconfigured so that they are located outside of this buffer zone.

Impacts to Necessary Wildlife

This project would fragment the largest contiguous block of core wildlife habitat in the village of Norwich (Figure 2). One result is that less water and food will be available to wildlife in the forest interior. Fewer sources of fresh water will be available to wildlife because the project, as proposed, will fill streams in the project area and staging area. The fence will prevent larger animals, such as white-tailed deer and black bear, from accessing segments of the headwater stream (Figure 3). Clearcutting ± 8.2 acres of forest trees will remove primary producers, mast producing trees, from the base of the food web. Less energy will enter the food web in the form of proteins and fats. Necessary wildlife, such as deer and bear will be forced to find alternative food sources. Competition for food will increase. It is likely the search for food will bring animals into conflict with local residents, particularly those with gardens and bird feeders.

The project will also reduce the space available to wildlife, creating stress as a result of competition for territories. For instance, deer breeding, bedding and wintering areas located in the project area will be destroyed. Deer will no longer have access as the area will be clearcut and fenced. The solar array and the fence surrounding it would also create a physical barrier preventing large animals from moving across the landscape. This barrier could affect gene flow between the populations of deer living north and south of the project area. Disruptions to preferred movement patterns can increase animal-vehicle collisions as wildlife is forced to find new corridors through the landscape (Sorenson and Sanborne 2014). Signs of stress in white-tail deer populations can include high fawn mortality, skewed sex ratios, reduced antler growth and slow molting in adults and fawns. Diseases and parasites spread quickly when animals are crowded and in close contact with one another. Over time, this fragmented habitat block may no longer sustain species with larger ranges, such as black bear. Adult female bears and their cubs may no longer use the habitat seasonally.

Impacts to Rare, Threatened and Endangered (RTE) Species

Unfortunately, in regard to this project, all feasible and reasonable means of preventing or lessening the destruction of Jefferson salamanders habitat or individuals have not been applied. The Vermont ANR could restrict logging of the project area to the winter months, when the ground is frozen and amphibians are hibernating underground. However, they have not done so (Karin McNeill, email 1/3/22).

In addition, the proposed 100 ft buffer is insufficient to protect amphibians from the effects of clearcutting (Fischer and Fischenich 2000). The installation of a commercial scale solar array will alter terrestrial salamander habitat north of Goodhawk pool. In clearcut forests migrating amphibians are exposed to increased temperatures and predation. At the same time, there is less cover available and their food sources are reduced. Clearcuts reduce amphibian size, weight and vigor, even when wetlands are protected by an uncut 98 ft (30 m) buffer zone (Veysey-Powell and Babbitt 2015). Vernal pool research conducted in Vermont and Maine suggests that buffer width should be biologically relevant, protecting terrestrial as well as wetland habitats. Buffer widths should be based on average amphibian migration distances. These distances vary from 400 ft for salamanders (Faccio 2003) to 633 ft for wood frogs (Baldwin et al 2006). The Vermont Center for Ecostudies in Norwich recommends a buffer width of 500 ft around vernal pools to protect amphibians (2022). This larger buffer zone is critical because female Jefferson salamanders migrate an average distance of 508 ft into upland forest (155 m) after breeding (Faccio 2003). Jefferson salamanders are a rare species in Vermont, so protecting a known habitat is especially important. Expanding the buffer zone to 500 ft would also help to prevent Goodhawk pool from being taken over by buckthorn.

The buffer zone of 100 ft, recommended by AE, would not protect Goodhawk pool, from becoming overrun by buckthorn because changes to vegetation extend up to 98 ft (30 m) into the interior forest on north-facing forest edges (Fraver 1994). According to the Vermont ANR (2022), glossy buckthorn tolerates a wide variety of conditions but thrives in wet or moist soils. It is therefore found in wetlands, bogs, river and streambank habitats, and wet meadows, as well as roadsides and disturbed areas. Schmidt bog, located in the town forest adjacent to the project area, provides an example (Figure 3). At one time, orchids were common along the wetland margins (Dan Goulet, Craig Lane *personal communications,* 2010 & 2017). Glossy buckthorn became established and changed the structure and composition of the wetland plant community. Buckthorn leafs out early and drops its leaves later than native plants, easily outcompeting them for light and other resources. As a result of the dense shade cast by the buckthorn, very few herbaceous plants are able to grow in the wetland any more. Orchids have not been seen in Schmidt bog since before 2009. In addition, the increased transpiration from a thick shrub layer will affect wetland hydroperiod. Jefferson salamanders egg masses require a longer hydroperiod. These amphibians typically breed in semi-permanent pools. If buckthorn becomes established in Goodhawk pool, increased transpiration from the invasive shrubs could alter the wetland hydroperiod making the habitat unsuitable for rare Jefferson salamanders.

Impacts to local residents

Clearcutting the steep slope along the eastern edge of the project area directly above homes at 117, 133 and 147 Upper Loveland Road is of great concern to residents (Figure 15). Here the shallow soils are mapped as rocky, Glover-Vershire Complex. The slope increases from 15 to 35 percent, at the top of the ridgeline, to 35 to 60 percent at the base of the hill behind residents' homes (NRCS 2022). Residents currently experience flooding in their basements during large storm events (Laila Lakshamair, Joy Kenseth, and Jin Kim, *personal communications,* 12/28/21-3/15/22). Flooding occurs so frequently at 147 Upper Loveland Road that Samin Kim constructed a french drain around his backyard to divert runoff away from his house during large storm events (Jin Kim, *personal communication*, 12/28/21).

Clearcutting the forest 250 ft above these houses is likely to make a bad situation worse. As mentioned previously, the dense hemlock canopy acts as green infrastructure, ameliorating the majority of stormwater by intercepting rainfall and absorbing soil waters. In addition, the roots of mature trees penetrate deep into fissures in the bedrock where available, anchoring the shallow soil-root matrix on the steeply sloped hillside. Although grass will be planted a top wood chips in the clearcut area, grass roots are not as deep as those of the trees and will not provide the anchorage of tree roots. Runoff and erosion will likely increase, particularly if grass fails to establish on the shady eastern slope. Although grass is highly rated for its ability to remove sediment from storm waters, it does little to stabilize banks or prevent bank failures (Fischer and Fischenich 2000). Without the root matrix of the mature forest to stabilize soils, erosion and mass wasting events are possible following large storm events.

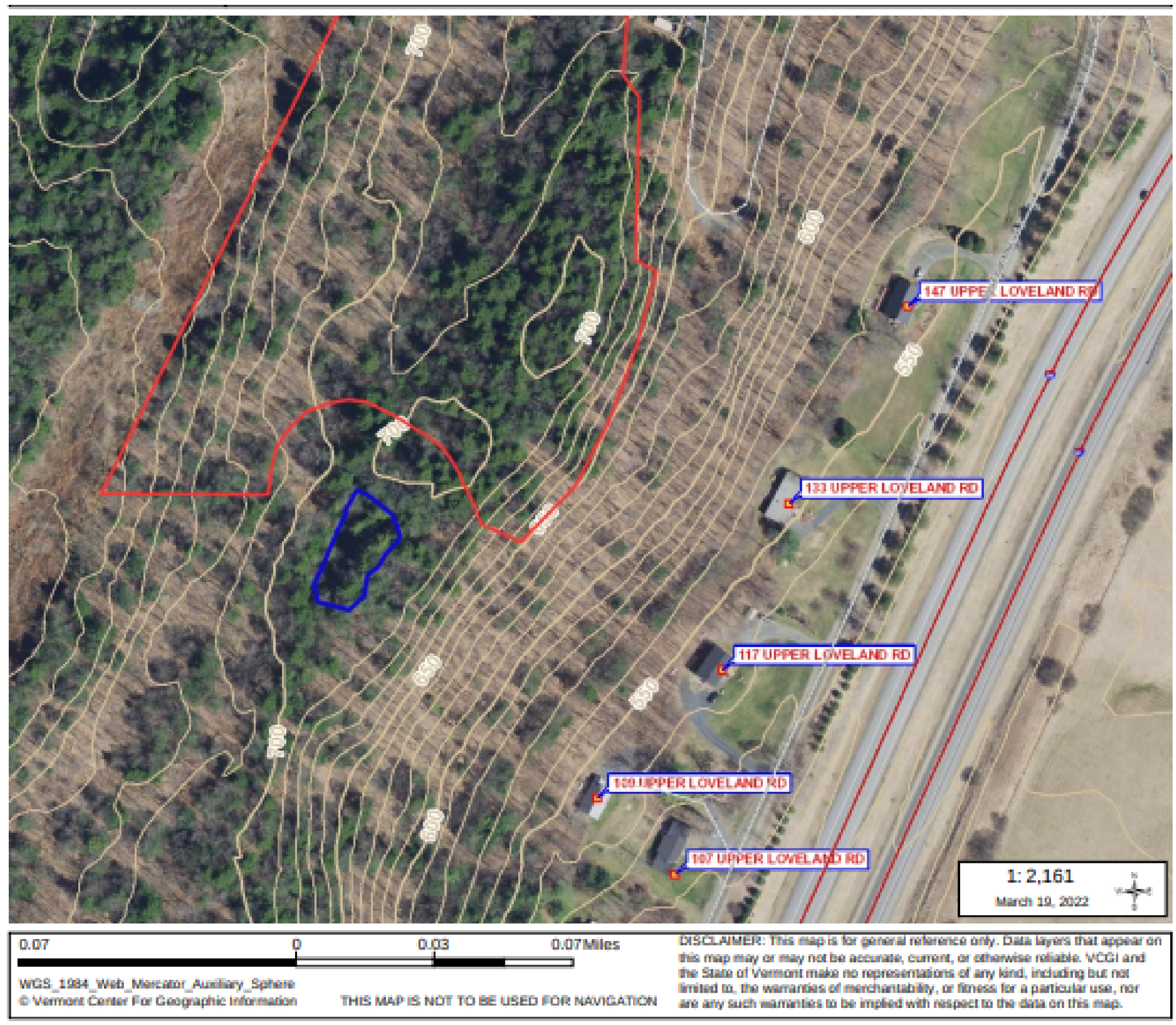

Figure 15. Elevation decreases from 700 ft in the proposed project area to 560 ft, behind residents homes on Upper Loveland Road in Norwich, VT. The red polygon shows the approximate extent of the forest clearcut. From the left to right, the addresses are 117, 133 and 147 Upper Loveland Road. Image was created using VCGI (2022).

Planting native shrubs in the clearcut area outside the fence line would help stabilize soils and act as green infrastructure to ameliorate runoff and erosion, particularly on the steep slope above residents homes. These shrubs could also help remedy other project impacts.

Since the project will remove mast producing trees from the base of the food web, planting *Viburnum* spp., winterberry (*Ilex verticillata*), elderberry (*Sambucus nigra*) and hazelnut (*Corylus* spp.), willows (*Salix* spp.), dogwoods (*Cornus* spp.) would provide new food sources for wildlife. Native shrubs would provide browse in the winter, as well as nuts and fruit for herbivores in fall. Winter browse would keep shrubs low so that they dont shade the solar panels. Another benefit is that suckering shrubs such as elderberry, dogwood and willow will take up space, providing competition for the invasive shrubs in the seed bank. Also, the plants would sequester carbon to help offset the large carbon footprint of the project.

A final concern is windthrow (Joy Kenseth, *personal communication,* 2/23/22). The proposed project calls for clearcutting the lower ridgeline and its eastern slope directly above residents homes. The remaining trees will experience stronger winds from the northwest and the west. The area's surficial geology consists of a shallow layer of glacial till, unsorted silt, sand, clay and gravel, over bedrock. Erosion has reduced the depth of the till layers in the uplands when compared to adjacent valleys (VCGI 2022). Because soils are shallow, trees develop predominately shallow root systems, exploiting cracks and fissures in the underlying bedrock whenever possible to increase stability on steep slopes. However, the combination of increased wind velocity and extremely steep slopes of up to 60 percent, will make the remaining trees vulnerable to windthrow in areas where the bedrock lacks fissures.

Conclusion and Recommendations

There is very little public good associated with siting a commercial scale solar array off Upper Loveland Road in Norwich. This shady, steeply sloped location is a poor choice for a solar project. The mature forest provides many ecosystem services including sequestering carbon, reducing runoff and erosion, and providing food and habitat for a diverse animal community, including rare Jefferson salamanders. The project would fragment core habitat, clearcut Jefferson salamander habitat, destroy a deer wintering area, remove trees that produce mast for wildlife, spread Class B noxious weeds, fill and build upon stream channels, and create flooding hazards. Surely there are sunnier, flatter areas where installation and construction would have less effect on streams, wildlife, wetlands and residents.

The following recommendations would help to lessen impacts to the environment and to abutters.

- The project area should be logged when the ground is frozen, to better protect rare Jefferson salamanders (S2).

- A 500 ft buffer zone around Goodhawk pool is recommended to protect the terrestrial life stage of the Jefferson salamanders (Vermont Center for Ecostudies 2022).

- An invasive species management plan reviewed and administered by the ANR is recommended to prevent the spread of Class B noxious weeds.

- Forest soils surrounding the cell tower should be remediated by the Lessee to remove microplastics before construction begins.

- The location of the project staging area, construction road and solar arrays should be reconfigured so as not to obstruct stream channels. In addition, both the headwater stream and the ephemeral drainage channel should be protected by a 110 ft buffer (Bowker et al. 2020) to prevent runoff, erosion and flooding.

- In addition to grass, native shrubs should be planted outside of the project area fence to the woodline. Shrubs would help prevent erosion, provide food for wildlife and provide competition for the invasive shrubs in the seed bank.

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APPENDICES

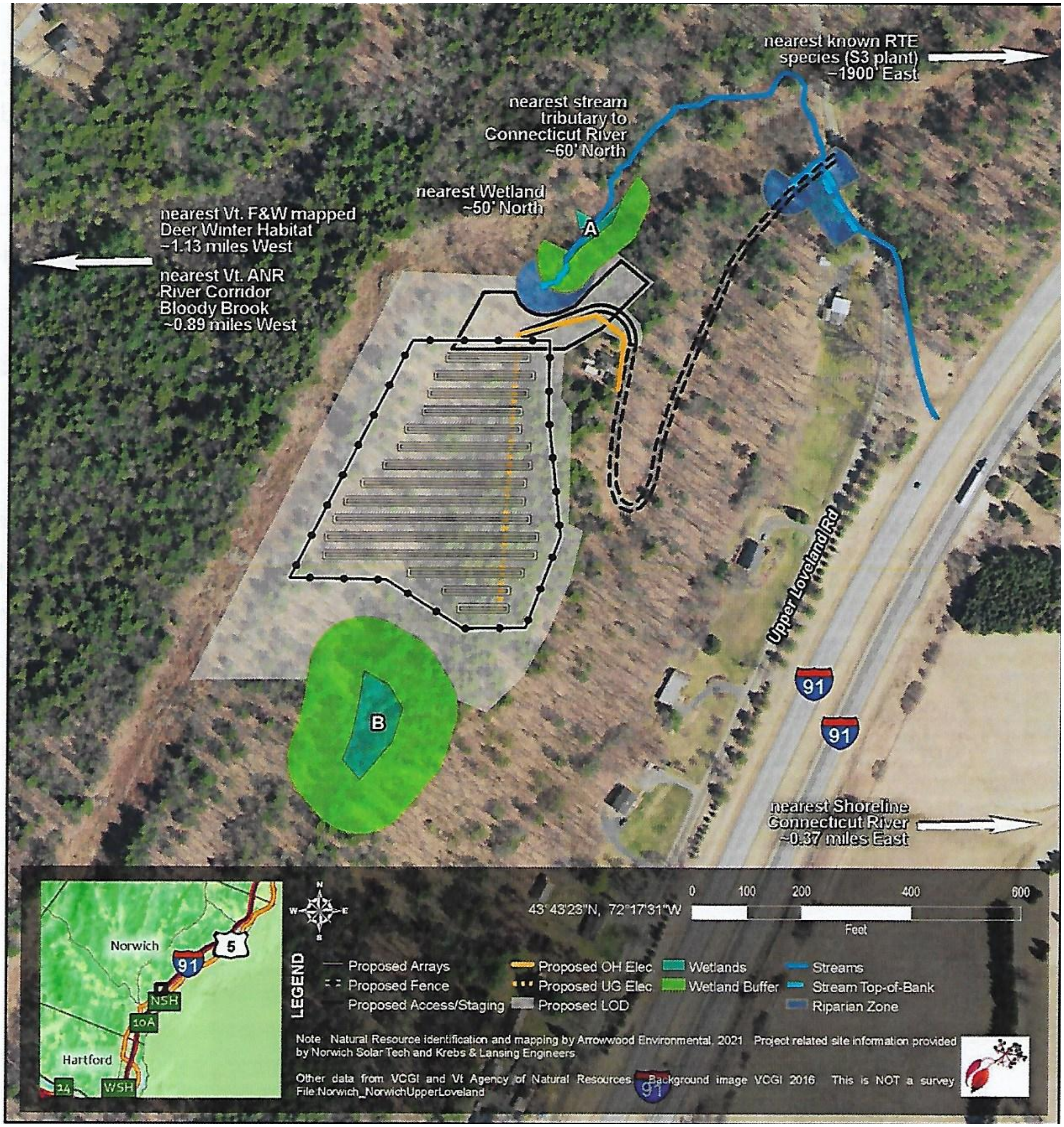
Appendix A. Diameter at breast height measurements of some Red Oak (*Quercus rubra*) and American Beech (*Fagus grandifolia*) in the proposed Norwich Solar Technologies project area off Upper Loveland Road in Norwich Vermont. Observations were made by Daniel and Jennifer Goulet on January 31, 2022. Red oaks reach peak acorn production when the diameter of the trunk at breast height (DBH) measures at 19 to 22 inches. Beech trees begin heavy nut production at around 50 years or 8 inches DBH (Bennett 2010).

Red Oak DBH (in)	American Beech DBH (in)
19.4	12.1
26.8	13.7
16.9	18.5
16.6	22.9
16.6	8.3
26.1	8.6
22.0	11.8
20.1	10.8
20.4	13.7
15.0	8.9
13.7	13.4
	17.8
	20.1
	10.5
	23.2
	11.8
	10.8
	12.1

Appendix B. Photographs of mast producing trees in the proposed Norwich Solar Technologies project area off Upper Loveland Road in Norwich Vermont. Photographs were taken on January 31, 2022. a) A cluster of six red oak (*Quercus rubra*) surrounded by eastern hemlock (*Tsuga canadensis*) on the lower, eastern ridgeline; b) Mature American beech (*Fagus grandifolia*) in the hemlock-hardwood basin; c) American beech regeneration from root sprouts in the hemlock-hardwood basin.

Appendix C. Photographs of tree species that provide food and habitat for wildlife in the proposed Norwich Solar Technologies project area off Upper Loveland Road in Norwich Vermont. a) sugar maple (*Acer saccharum*), b) red maple (*Acer rubrum*), c) eastern hop-hornbeam (*Ostrya virginiana*), d)Yellow birch (*Betula alleghaniensis*), e) Basswood (*Tilia americana*), f) paper birch (*Betula papyrifera*) surrounded by Eastern hemlock (*Tsuga canadensis*) and g) white ash (*Fraxinus americana).* Photographs were taken on January 31, 2022.

Appendix D. Location of wetlands and streams identified by Arrowwood Environmental during their field visits in the summer of 2021 (Barton 2021).



Appendix E. Additional photographs of the ephemeral channel taken March 19, April 8, and April 19, 2020.