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LAKE MANAGEMENT

Cushman Pond
2019 Vegetation Survey and Water Quality Report

SUBMITTED TO: Mr. Jim Ellis, Pinecrest Property Owners' Association
SUBMITTED BY: Amanda Mahaney, Solitude Lake Management
RE: 2019 Vegetation survey report at Cushman Pond (approx. 28 – acres)
including vegetation assemblage, bathymetry, sediment depth & type, vegetation biovolume

Introduction

Cushman Pond is located in Hubbardston, Massachusetts in Worcester county. It is approximately 28-acres with an average depth of 2.5 feet. The majority of the pond is relatively shallow, with the deepest area of 8.0 feet in the north-east corner by the beach.

SOLitude Lake Management was hired to perform a vegetation survey at Cushman Pond, inclusive of the collection of a single water quality spectrum, sediment polling, and vegetation biovolume. Cushman Pond was visited by SOLitude Lake Management on two separate occasions; July 22nd and October 16th. In July, the vegetation survey was conducted. In October, the sediment depth, vegetation biovolume, and water quality samples were collected.

Vegetation Survey

At the time of the survey, thirteen native species, including three floating-leaf species and ten submersed species were observed (Figure 1). Refer to table 1 for the list of species present. At the time of the survey, purple bladderwort and floating-leaf species were the most dominant. Purple bladderwort was floating at the surface and was in flower, presenting tall purple flowers above the surface. During the fall visit, purple bladderwort had dropped out of the water column, but was resting on the bottom. Due to the shallow nature of the pond, contiguous growth of waterlily was spread throughout the pond, making navigation by boat difficult.

Table 1: Aquatic vegetation species present

Common Name	Scientific Name
Watershield	Brasenia schreberi
Yellow Waterlily	Nuphar variegata
White waterlily	Nymphaea odorata
Purple Bladderwort	Utricularia purpurea
Common Bladderwort	Utricularia vulgaris
Humped bladderwort	Utricularia gibba
Low-water milfoil	Myriophyllum humile
Long-leaf Pondweed	Potamogeton natans
Thin-leaf Pondweed	Potamogeton pusillus
Ribbon-leaf Pondweed	Potamogeton epihydrus
Slender Naiad	Najas gracillima
Spikerush	Eleocharis spp.
Floating Burreed	Sparganium fluctuans
Sedge	Carex spp.
Variable Watermilfoil	Myriophyllum heterophyllum

Water Quality

Sediment Polling

During the October visit, sediment polling was completed to determine the maximum amount of organic matter present within the pond. A total of 34 points were polled, collecting water depth, sediment depth, and sediment type. A total of 21 of the 34 points had variable depths of organic matter, with an average of 2.0 feet of organic matter and 3.7 feet of water. Please refer to Figure 3 for depth of organic matter. In addition, biovolume and water depth were recorded using sonar technology, analyzed by CiBiobase. Refer to Figures 4 and 5 for biovolume and water depth.

Water Quality Analysis

A single water quality round was collected at the "deep hole" during the October visit. Parameters collected included E. Coli, turbidity, total alkalinity, conductance, total Kjedahl nitrogen, total phosphorus, and soluble phosphorus. The results from the sample collection are listed below in Table 2 and are then further analyzed in the paragraphs below.

Table 2: Water Quality Sample Results

Parameter	Unit	Detection Limit	Result
E. Coli	MPN/100mL	1	<1.00
Turbidity	NTU	0.20	0.58
Total Alkalinity	Mg CaCo3/L	2.00	3.20
Specific Conductance	Umhos/cm	10	140
Total Kjedahl Nitrogen	mg/L	0.300	0.324
Total Phosphorus	mg/L	0.010	ND
Soluble Phosphorus	Mg/L	0.010	ND

E. Coli (Low)

Bacterial analysis is used to determine the probability of fecal contaminants. E. Coli is present in the digestive tract of humans and animals, and therefore, is a reliable indicator of fecal inputs. Typical standards for E. Coli bacteria for the protection of human health in freshwater are <235 colonies/100 mL. *The E. Coli sample collected was present below <10 colonies/100mL.*

Turbidity (Low)

Turbidity is a relative measurement of the amount of suspended material in the water. It is measured through a process involving light diffraction of the pond sample as compared to a series of prepared samples. Turbidity values can range from less than one to thousands of units, however, values in most ponds and lakes rarely rises above 5 NTU. *Turbidity values remained <1.0 NTU.*

Alkalinity (average)

Alkalinity is the measure of the water's capacity to neutralize acids. A higher alkalinity can buffer the water against rapid pH changes, which in turn prevents undue stress on aquatic biota due to fluctuating pH levels. The alkalinity of a lake is primarily a function of the watersheds soil and rock composition. Limestone, dolomite and calcite are all a source of alkalinity. High levels of precipitation in a short amount of time can decrease the waters alkalinity. A typical freshwater lake has an alkalinity of 20-200 mg/L. A lake with a low alkalinity typically also has a low pH, which can limit the diversity of aquatic biota. *Alkalinity was fairly low at 3.2 mg/L. As a shallow pond, low alkalinity is expected, due to the rate of water exchange, precipitation influence, and plant growth.*

Specific Conductance (average)

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chlorine, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Organic compounds like oil, phenol, alcohol, and sugar do not conduct electrical currents very well and therefore have a low conductivity when in water. Conductivity is also affected by temperature; the warmer the water, the higher the conductivity. For this reason, conductivity is reported at 25 degrees C. Inland fresh waters supporting good mixed fisheries typically have conductivity values of less than 1000 micromhos per centimeter (µmhos/cm). Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates. *The specific conductance measurement was 140 umhos/cm and is within the desirable range.*

Total Kjedahl Nitrogen (relatively low)

Total Kjedahl Nitrogen (TKN) measures the sum of ammonia and organic nitrogen in the water. High nitrogen levels can increase algae and chlorophyll-A levels, but is generally less of a concern in fresh water than phosphorus. Nitrogen can indicate the presence of sewage, animal waste, fertilizer, erosion, or other types of pollution. Generally, TKN levels of <1.0 mg/l are considered desirable. *TKN levels at 0.324 mg/L are within the desirable range.*

Total Phosphorus (Non-detectable levels)

Total Phosphorus (TP) is considered the limiting nutrient for aquatic plant growth in freshwater environments. The amount of phosphorus present in the water column determines the amount of phytoplankton and, to a lesser degree, aquatic plants that will grow in the water body. Generally, TP over 30 parts per billion (ppb), or 0.03 mg/l, is the threshold at which algal growth can become problematic. Increased total phosphorus levels in the hypolimnion can most likely be attributed to the biomass accumulation of dead algae cells and release from the bottom sediments. *Total Phosphorus was present at non-detectable levels (<0.010 mg/L) at the time of the sample collection.*

Dissolved Phosphorus (Non-detectable level)

Dissolved phosphorus is phosphorus that remains in the water after filtration of the sample to remove particulate matter. Dissolved phosphorus can be a special problem because a) it is highly "bioavailable" to algae (i.e. it supports rapid algal growth and reproduction, and b) dissolved phosphorus remains in the water while particulate phosphorus settles to lake bottoms where it may no longer be available to algae. Generally, dissolved phosphorus over 20 parts per billion (ppb; or 0.02 mg/l) is the threshold at which algal growth can become problematic. *Dissolved phosphorus was present below detectable levels (0.010 mg/L) at the time of the collection.*

Temperature and Dissolved Oxygen

Table 3: Dissolved Oxygen and temperature reading

Depth (Feet)	*Dissolved Oxygen (mg/L)*	*Temperature (°C)*
SW	5.20	13.75
2	5.27	13.72
4	5.42	13.49
6	5.72	12.94
7	5.83	12.96

Dissolved oxygen (DO) is very important in pond systems. Fish and other aquatic biota require adequate levels of oxygen, and DO affect many aspects of the water chemistry. Values below 3.0-5.0 mg/l are undesirable for most aquatic life; however, lower values are not uncommon near the sediment layer where oxygen demand is great and oxygen influx is at a minimum. Under extreme anoxic conditions (<1.0 mg/l), phosphorus can be released from the sediment and stimulate algal blooms. Under stratified conditions, which occur in deeper waterbodies, anoxia can occur in a significant portion of the water column, possibly endangering fish populations, especially cold-water species. *Dissolved oxygen was collected at* ***the deepest area of the pond abutting the dam. This "deep hole" was appr****oximately 7.5-8 feet. Dissolved oxygen was stable throughout the water column. Although a 5.48 mg/L dissolved oxygen average is relatively low, it still provides enough oxygen for aquatic wildlife to survive.*

Conclusion & Recommendations

In general, Cushman Pond supports a desirable assemblage of aquatic and emergent vegetation. However, due to the shallow nature of the pond, submersed and emergent species have expanded throughout the majority of the pond. With that said, dense vegetation has stifled recreational activities making access across the pond by boat difficult. Furthermore, the non-native, invasive species, variable watermilfoil, was observed at the deepest area of the pond in sparse patches. In addition to the nuisance abundance of vegetation, low dissolved oxygen levels were observed. Low dissolved oxygen and dense vegetation can negatively influence the overall health of the waterbody. The management techniques listed below will succeed at meeting the goals of the Pinecrest Property Owner's Association. First, herbicide applications are a management technique used to reduce growth of aquatic vegetation. This can be a cost-effective and selective approach to decrease density of invasive and nuisance vegetation that is currently occupying much of the water column in Cushman Pond. Second, the hydro-rake is an effective, mechanical approach to remove aquatic vegetation with large rhizome root structures such as waterlilies and build-up of organic material at the bottom of the pond. The hydro-rake can best be described as a "floating backhoe" with a York Rake attachment installed on a floating platform. The barge is paddle wheel driven to facilitate operation in shallow water (> 2 feet) and it can effectively work to depths of about 10 feet. It works from the water, thereby avoiding damage to sensitive shoreline habitat and property. Working slowly, the hydro-rake enables mobile aquatic organisms to move out of the way before any harm may occur. Thirdly, there is a second mechanical approach, referred to as diver assisted suction harvesting or DASH that could be utilized at Cushman Pond. DASH utilizes a pontoon boat and a single diver. The diver carries a long tube attached to the boat that vacuums up the target vegetation from below the surface while the boat above collects and stores the vegetation.

Herbicide applications do not require a lot of time to apply and depending on the chosen herbicide, results can be seen quickly. Mechanical techniques do take some time to perform as both hydro-raking and DASH machines move slowly and do often require additional services to remove the vegetation from the machines and from the site. The DASH approach also works best where density of target vegetation is low due to the time it requires to identify and collect the vegetation from the pond bottom.

Please reach out to us for further management information. We look forward to working with the Pinecrest Property Owners Associations during the 2020 season.

FIGURE 1: Density & Distribution of Submersed Aquatic Vegetation

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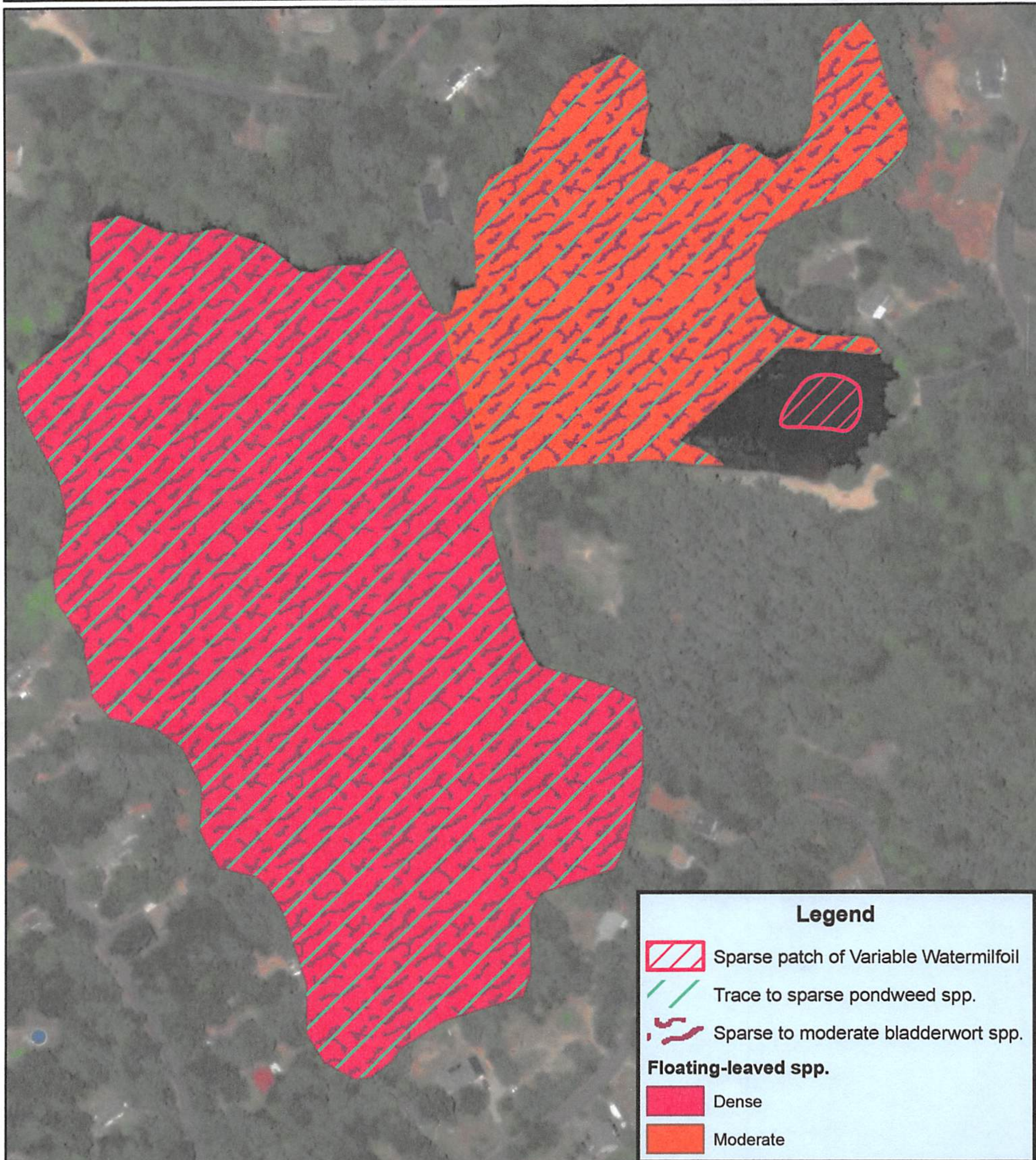

Cushman Pond
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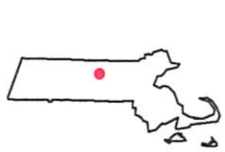

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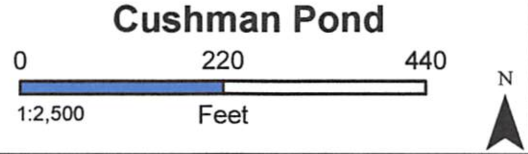

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Figure 2: Sediment Type

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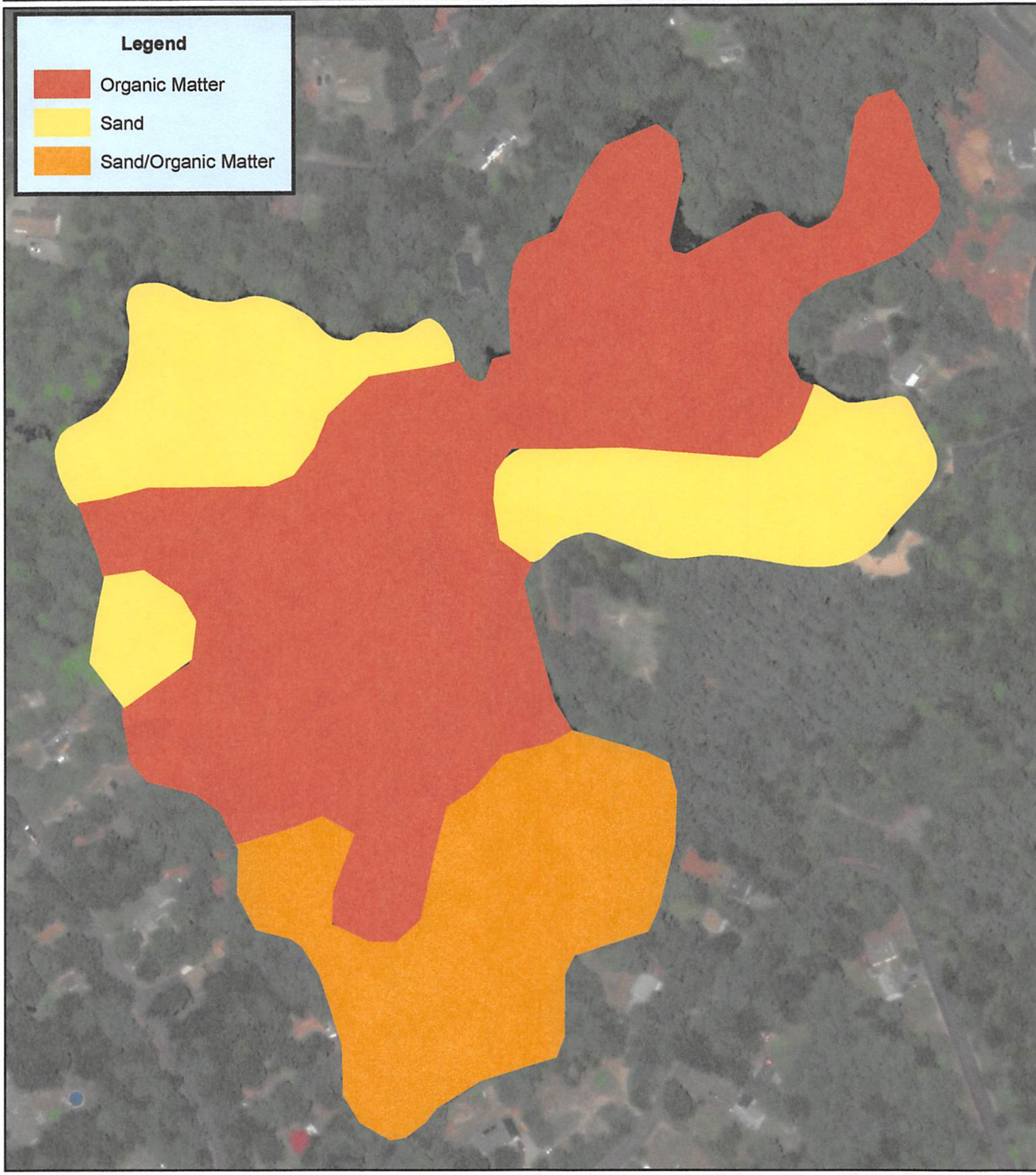

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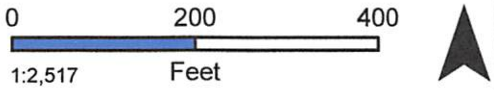

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FIGURE 3: Depth of Sediment in Cushman Pond

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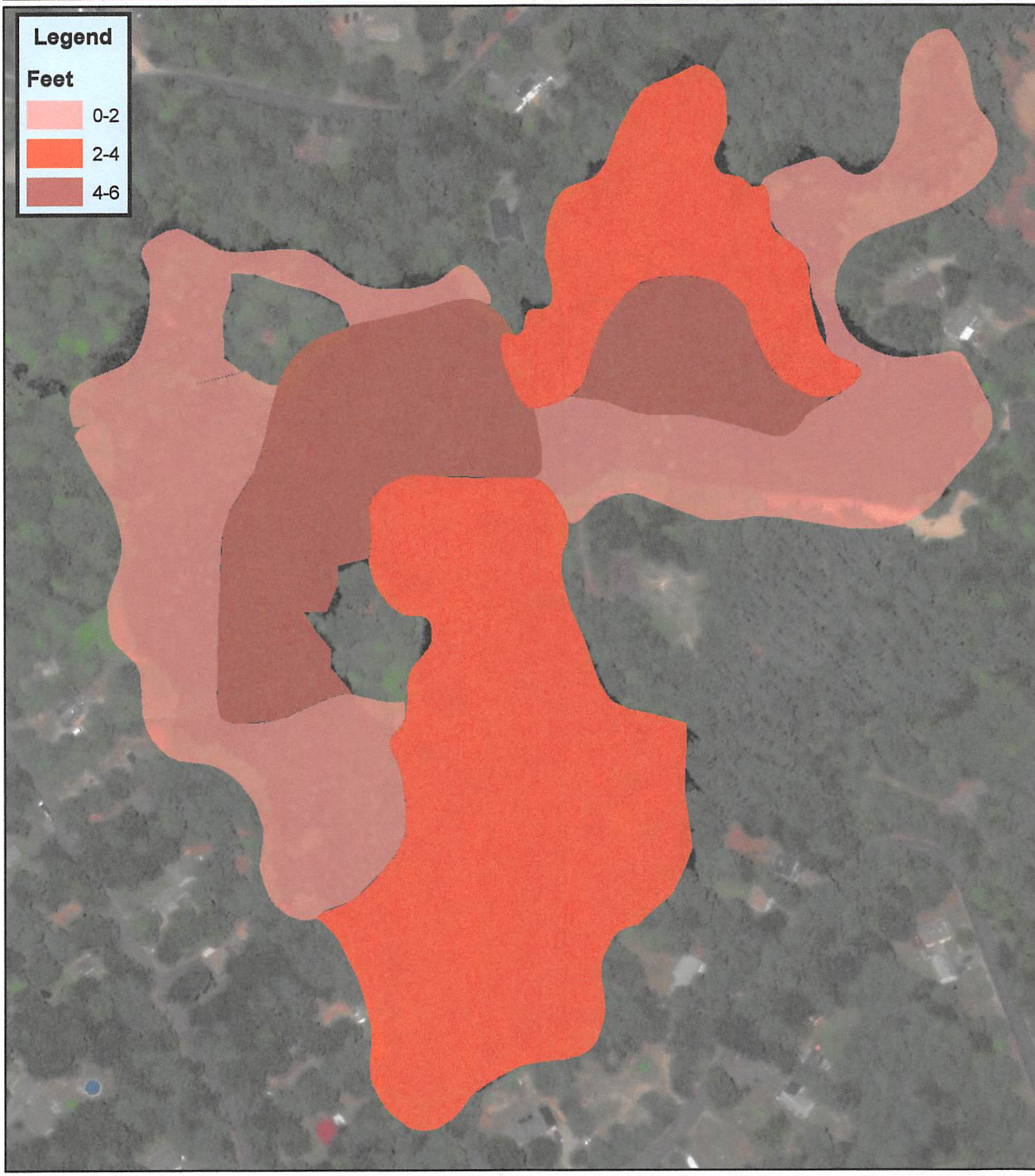

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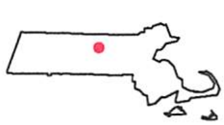

Cushman Pond

0 220 440

1:2,400 Feet

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FIGURE 4: Water Depth of Cushman Pond (CiBiobase)

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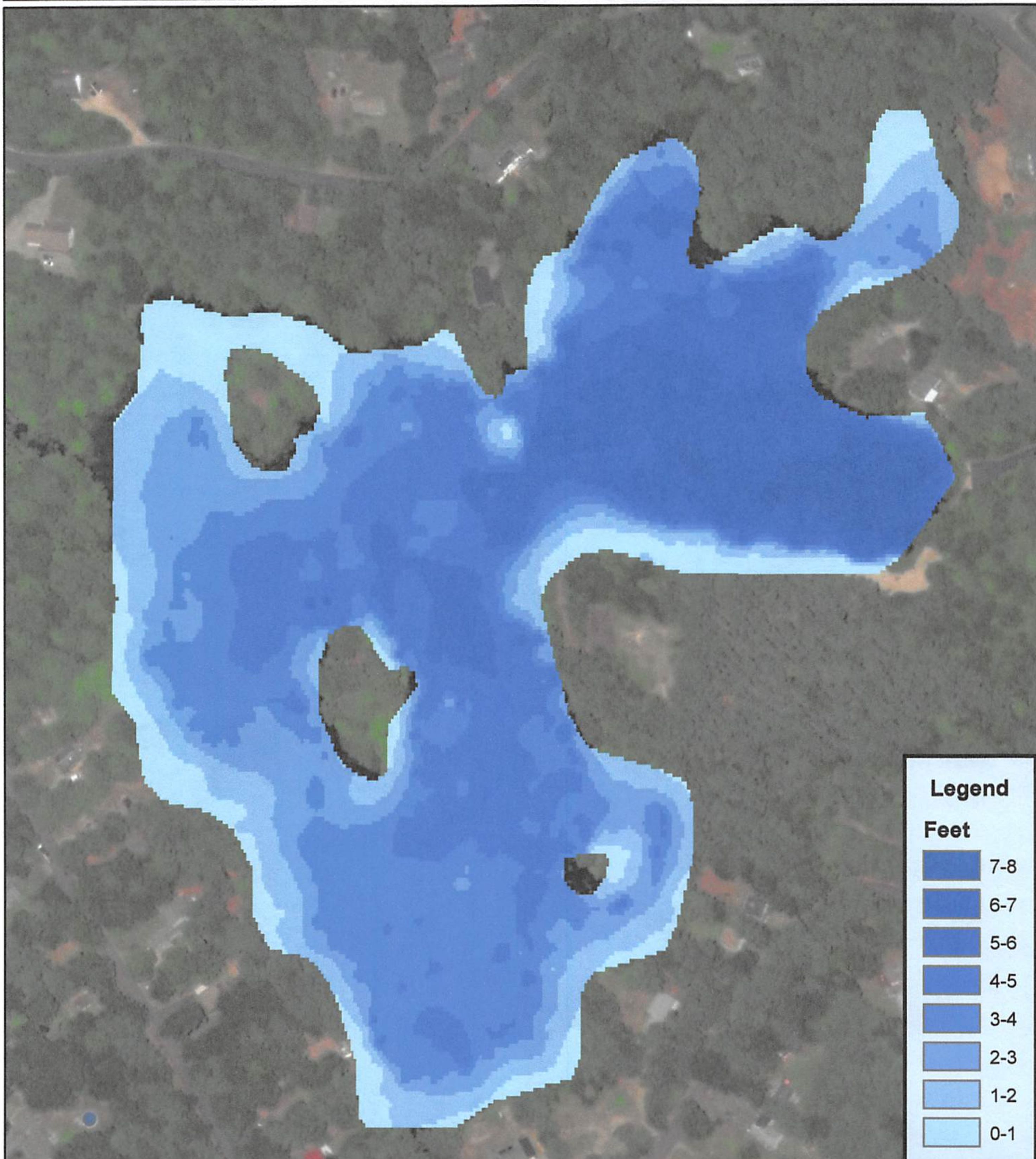

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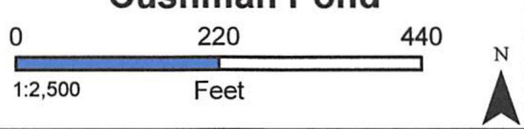

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ANALYTICAL REPORT

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Project Number:	Not Specified
Report Date:	10/18/19

Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0574), IL (200077), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #P330-17-00196).

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