Water Quality Assessment Report (TAR)
2024

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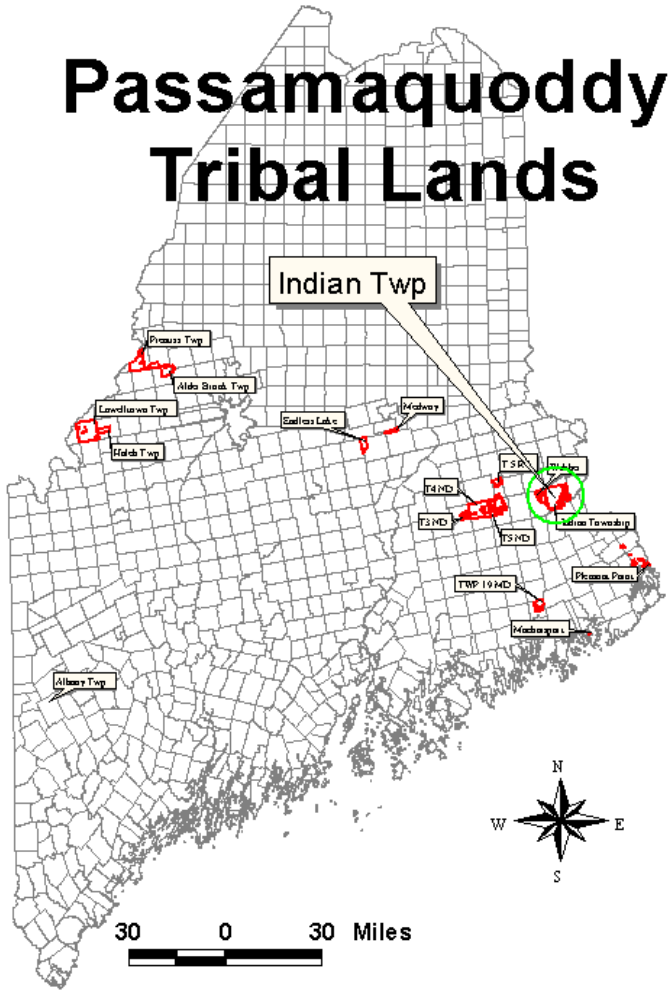


Figure 1: Location of Indian Township, Maine.

Introduction

Background

The Passamaquoddy Tribe at Indian Township (PIT) began its Water Resources Planning and Inventory Program in April 1993 with funding from a multi-media grant from the U.S. Environmental Protection Agency (US EPA), and a Bureau of Indian Affairs (BIA) Water Resources contract. The US EPA requires a Quality Assurance Project Plan (QAPP) as a prerequisite for funding of monitoring programs. The QAPP details the program's procedures for field work, transportation, data use, laboratory and field protocols, and safety. For data to be useful, procedures must be consistent and reliable. The QAPP is submitted to, reviewed, and approved by the US EPA for each year of monitoring.

Indian Township has a wealth of water resources. Bordering the southern edge of the Reservation is part of a long series of reservoirs controlled by Woodland Pulp LLC as part of the St. Croix River drainage. The Reservation waters include Big Lake, Long Lake, Lewey Lake, Grand Falls Flowage and its tributary Tomah Stream. These water bodies make up a significant section of the 647 mi^2 West Branch of the St. Croix River basin. Reservoir water levels are controlled and used for power generation, mill effluent dilution, fisheries, and flood control. Indian Township's lake levels are controlled at the Grand Falls Dam in Woodland. In addition to Tribal land inside Indian Township, the Passamaquoddy Tribe has in Trust over 115,000 acres distributed over 7 counties in the State of Maine.

Purpose

The Indian Township Water Quality Monitoring Program was undertaken to compile baseline data for reservation water bodies. Water quality is the biological, chemical, and physical composition of the water in its natural state, considering any human inputs and alterations. To protect water quality in the future, one must have an idea of the current water quality, the sources of pollution currently entering the system, and the trends of the system. Determining trophic state and water quality trends are nearly impossible without data to back up those determinations. A reliable, long term monitoring program can help identify problems before the degradation of water quality is irreversible. To further complicate the water quality issue, watersheds cross municipal, state, tribal and national boundaries. Reliable data can also provide the necessary scientific backing to elicit the political will to address pollution sources.

General Program Summary

We restarted the Water Quality Sampling Program in 2008 with sampling the original four Township lakes: Big Lake, Long Lake, Lewey Lake, and Grand Falls Flowage. The 2009 season built on this foundation by continuing sampling of the Township lakes, as well as adding in monthly sampling of 13 other lakes and ponds, most of which had been regularly sampled in the past. The 2010 Water Quality Sampling Season continued our 2009 season with sampling of the same 17 lakes and ponds. In 2011 we continued to build on 2010 by adding in 4 more lakes: East and West Musquash Lake, Pleasant Lake, and West Grand Lake. We also added in sampling of a small pond known locally as Bassett Pond, which is evidently fishless, in the summer of 2013.

All those additions combined with slowly eroding budgets and, of course, inflation, have caught up to us. We were forced to cut back sampling to reduce costs and man hours. Bassett Pond, while interesting and unique, was given the axe for now. It would be best focused on with a special project. Shaw and Mill Privilege were also cut after just one visit in 2017, as the access is poor and causes damage to equipment. The three ponds in the Jackman area were also cut for now, as they require the most resources to get to for data gained. In 2021 sampling was scaled back to once a month instead of twice. Staffing limits and the emergence of variable-leaved water milfoil as a serious aquatic invasive issue in Big Lake has the Department reorganizing priorities. Starting in August of 2022 we again scaled down our water quality sampling regiment to prioritize invasive milfoil surveys: down from 16 lakes once a month to 6 lakes once a month. Big, Long, Lewey, Grand Falls, Side Pistol, and Killman were sampled May – September. The remaining lakes listed below only sampled May – July. 2023 completed the downsizing, limiting our water quality program to once a month testing on just Big, Long, Lewey, Grand Falls, Side Pistol, and Killman, this was the same schedule for 2024.

An updated look at our sampling lakes in 2024 are as follows: **Big Lake**, **Long Lake**, **Lewey Lake**, and **Grand Falls Flowage** (the original four lakes to be sampled), **Side Pistol Lake** (drains into the Passadumkeag River, and eventually the Penobscot River), and **Killman Pond** (drains into Upper Chain Lake). If looked at the watershed level, five of our lakes and ponds sampled are part of the St. Croix River watershed, while only one remains (Side Pistol) included of the extensive Penobscot River watershed.

A full sampling regiment of parameters in 2024 includes the following: **Dissolved Oxygen** (DO), **Temperature**, **pH**, **Conductivity**, **Transparency** (Secchi depth), **Chlorophyll-a** (Chla), **Total Phosphorus** (TP), **Alkalinity**, and **True Color** analysis. Each one of those parameters will be explained in greater detail later on in the report.

Monthly Program Summary

May Our weather station on the reservation recorded about 2.5" of rain this month, compared to 1.9" for May 2023, 2.4" for May 2022, 3.6" for 2021, 3.4" for 2020, 4.90" for 2019, 2.20" for 2018, 4.75" for 2017, 2.75" for 2016. The overall start of the 2024 field season would be considered an early, relatively dry Spring. A warm winter with lots of rain events kept ice thickness low, and it broke up earlier than usual with ice fishermen mostly unable to safely access their tradition after March 1st. A typical season goes until late March, even the start of April on some years.

A full QAPP rewrite was completed and approved in May 2021, a fresh rewrite is due May 2026. Our 2020 16' boat was serviced in May and is running great; truck was serviced Oct 2023 and is running great. Ryan Gabriel returns for another season as our field assistant. Our yearly retraining with Lake Stewards of Maine is likely to occur in June or July. **(Sampling Events: (6/6): 100%)**

June Our weather station on the reservation recorded about 3.6" of rain for June 2024. For comparison, we had 4.7" of rain for June 2023, 2" for 2022, 2" for 2021, 2.75" for 2020, 7.3" for 2019, 5.0" for 2018, 1.9" for 2017, and 2.80" for 2016. Quite the difference a year makes. June was mostly hot and sunny and relatively dry. Water levels in the lakes are quite low on the reservation especially. Water clarity has been about the best we've ever seen. **(Sampling Events: 6/6: 100%)**

July All six sites were sampled on time and as expected in July. Our weather station on the reservation only had partial data for July this year: 1.9" of rain in the second half of the month. Compare that (somewhat) to the recorded 6.2" of rain for July 2023, which is quite high. Compare this to 4.3" for July 2022, 5.8" for 2021, 1.75" for 2020, 3.8" for 2019, 1.5" for 2018, 1.4" of rain in 2017, 3.8" of rain for July 2016. July continues to be pretty dry with lake levels rebounding a bit, but mostly due to altering dam levels based on relaxed holding requirements upstream in West Grand Lake. **(Sampling Events: 6/6: 100%)**

August continues to be a great weather month. Much of it has been dry and sunny, with one large rain event, 3", making up the majority of the month's 3.7" total. We had 3.95" for August 2023, 1.8" for 2021, 2.6" in 2020, 4.2" for 2019, 4.5" for 2018, only 1.0" of rain for August 2017, about 3.25" of rain for 2016. Water levels on the lakes continue to be very low with great clarity. No issues to report in samples or equipment. **(Sampling Events: 6/6: 100%)**

September 2024 was very dry, only 1.3" of rain for the entire month. Conversely, in 2023 on Sept 16th the remnants of hurricane Lee dropped around 4" of rain, giving us a total of 7.05" for the month. In comparison 6.7" of rain fell in September 2021, 1.3" in 2020, 4.2" in 2019, 2.4" in 2018, 1.4" in 2017, 2.0" of rain for September 2016. Water levels in reservation lakes are the lowest I've ever seen in the twenty years here. Many things along the shoreline were exposed with low water levels from the pre-dam years of log

drives. Many boat launches were unusable to trailered boats and traveling on the water was dangerous at speed in certain areas. Water clarity remains outstanding. **(Sampling Events: 6/6: 100%)**

Parameter Summary

In order to further measure our sampling success, the following shows each parameter sampled and its associated success rate (measured by valid samples taken/possible samples taken) not including quality control duplicate samples.

- **Dissolved Oxygen/Temperature Profiles:** 30/30 (100%) The 2024 season finished what 2023, 2022 and 2021 started: Going down to 6 lakes surveyed each once per month. We normally replace the ProDO probe tip every Spring and that's normally the only maintenance required. However, our ProDO was upgraded to the newer model ProSOLO early in 2023, which don't require new probe tips yearly. These meters have both shown to be extremely accurate in DO and Temp readings and having a 40m cable allows us to take readings to the bottom of even the deepest lakes in the area.

- **Chlorophyll-a:** *30/30 (100%) Three Chl-a samples were tested 1-2 days past holding time in June. Chl-a readings ranged from a low of 1.8 ppb (the reporting limit is 1ppb) on Killman to a high of 4.9 ppb also Killman! It's not surprising to see lower values overall with the dry summer compared to 2023's very wet summer season. Typically, Chl-a is our most important parameter for measuring a lake's trophic state index (TSI), as high color lakes (like the Township lakes usually are) are not accurately categorized by secchi or total phosphorus, leaving Chl-a as the most reliable measurement. This year's drought however kept the lake water extremely clear, dropping them below the threshold to be considered a 'colored' lake, and making the secchi and TP readings a viable TSI measurement.

- **Transparency/Secchi:** 30/30 (100%) No secchi readings were missed in 2024. The secchi disk hit bottom just twice this season, early season Side Pistol and late (low water) season in Lewey. The very dry summer led to great secchi values and lake transparency, some of the best we've seen. Secchi depth ranged from 2.85m (Killman) in the shallowest to 6.80m (Side Pistol) at the deepest.

- **Total Phosphorus:** 30/30 (100%) No TP samples were missed in 2024. The low precipitation for the summer should reduce TP values in general from less runoff. The values in 2024 were on average slightly less than those in 2023, a very wet summer. Our TP range for 2024 was a low of 3ppb (Big Lake) with a high of 12ppb (Long and Lewey once each).

- **pH:** 30/30 (100%) No major issues to report. The refillable probe continues to be reliable. We emptied and flushed the old fluid at the start of the season, replacing it with fresh solution. Our pH low for the season was 6.66 (Killman Pond) and a high of 7.20 (Lewey).

- **Alkalinity:** 30/30 (100%) No additional samples were lost. No problems to report. Our low alkalinity reading for the season was 6.5 mg/l of CaCO3 (Killman) with a high of 9.0 mg/l of CaCO3 (Long, Lewey, and Grand Falls Flowage). These readings are very stable from year to year, usually trending up slightly as the summer goes on, especially in dry years.

- **Conductivity:** 28/30 (93%) We lost one day of readings (2) due to a failed QA check at the end of the day. QA, or Quality Assurance checks happen at the end of a sampling trip to ensure the equipment is still operating accurately after a day of use. Our low conductivity reading was 19.0 UMHOS/cm (Side Pistol) with a high of 22.9 UMHOS/cm (Grand Falls Flowage).

- **Color:** 30/30 (100%) We didn't lose any true color readings for 2024. Our lowest true color reading was 6 PCU (Side Pistol Lake like always), with a high reading of 36 PCU (Grand Falls Flowage). True, or filtered color is very much affected by precipitation in the reservation. The four lakes all have major tributaries that consist of bogs and fens, which hold large amount of peat. The peat releases dark brown tannins that make their way into the lakes with consistent rain events, turning crystal clear water into what looks like root beer after a big rain.

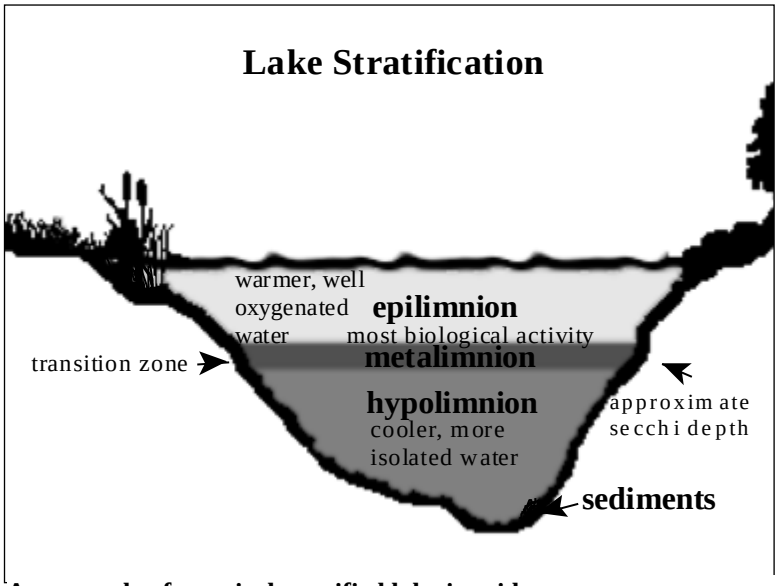
General Information

Stratification

Holdren et al (2001) defines stratification as a process in which several horizontal water layers of different density form in some lakes. These layers are classified as follows:

Epilimnion – the well-mixed and uniformly warm surface waters
Hypolimnion – the uniformly unmixed bottom waters
Metaliminion - zone of rapidly changing temperature and density separating the epilimnion and the hypolimnion

The lake is stratified when warm water, the epilimnion, floats on the significantly colder water, the hypolimnion. The metalimnion is formed in the region where the temperature gradient decreases markedly. This separation also allows little mixing of the upper layer with the bottom waters. After stratification, the hypolimnion has a finite quantity of oxygen until fall turnover.



An example of a typical stratified lake in midsummer.
Hill, R., Williams, S. 2008 Maine Lakes Report

Dissolved Oxygen

Dissolved Oxygen (D.O.) is the measure of the amount of oxygen dissolved in the water. All living organisms, except for certain types of bacteria, need oxygen to survive. Organisms living in the water have the ability to use the oxygen dissolved in the water to breathe. Too little oxygen severely reduces the diversity and population of aquatic communities. Therefore the amount of D.O.in the water is very important to aquatic life. Low oxygen can directly kill or stress organisms such that they will not be able to successfully reproduce or grow. Water with less than 1 part per million (ppm) of oxygen is considered anoxic (no oxygen present); less than 5 ppm of oxygen is generally considered so stressful that most coldwater fish will avoid these areas. Anoxic conditions can also promote TP release from sediments (VLMP, 2008 Maine Lakes Report).

Chlorophyll-a

A pigment found in algae and other plants used to estimate biological productivity of lake ecosystems. By measuring the concentration of Chl-a in lake water, the algae population can be estimated. Chl-a is measured in parts per billion (ppb). Chlorophyll-a samples are generally obtained from an integrated water column sample because the greatest concentration of algal growth typically occurs from the surface of the lake to the bottom of the epilimnion or the top of the thermocline (VLMP, 2008 Maine Lakes Report).

Chlorophyll is what makes plants green. Some nice Spring poison ivy with fresh green leaves and flowers. The flowers often open before the leaves come out.

Transparency

A measure of water clarity; the distance one can see down into the water column. Factors that affect transparency include algal growth, zooplankton, natural watercolor, and suspended silt particles. Because algae are the most abundant particles in most lakes, transparency indirectly measures algal growth. Transparency values vary widely in Maine lakes. Unless a lake is highly colored or turbid from suspended sediment, transparency readings of 2 meters or less generally indicates a severe algal bloom (VLMP, 2008 Maine Lakes Report).

Situations like a blocked culvert shown here cause water to run over roads, picking up sediments that will reduce a lake's transparency.

Total Phosphorous

A measure of all forms of phosphorus (organic and inorganic) in the water. Phosphorus is one of the major nutrients needed for plant growth. Because its natural occurrence in lakes is very small, phosphorus "limits" the growth of algae in lake ecosystems. Small increases in phosphorus in lake water can cause substantial increases in algal growth.

Phosphorus is measured in parts per billion (ppb). Phosphorus concentrations may be based on samples taken from the surface of the lake or from discrete samples taken at specific depths, or from an integrated water column (epilimnetic core) sample (VLMP, 2008 Maine Lakes Report).

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Manure is great for plants, but the nitogren and phosphorus it contains is not good for the health of our waters.

pH

A measure of the relative acid-base status of lake water, pH helps determine which plant and animal species can live in the lake, and it governs biochemical processes that take place. The pH scale ranges from 0-14, with 7 being neutral. Water is increasingly acidic below 7, and increasingly alkaline above 7. A one unit change in pH represents a tenfold change in acidity or alkalinity. The pH scale is the inverse log of the hydrogen ion concentration (VLMP, 2008 Maine Lakes Report).

Some plants prefer different levels of soil pH. This iris likes it a bit acidic with lots of moisture.

Alkalinity

A measure of the capacity of water to neutralize acids, or buffer against changes in pH, alkalinity is also referred to as "buffering capacity." It is a measure primarily of naturally available bicarbonate, carbonate, and hydroxide ions in the water. Alkalinity is measured in milligrams per liter (mg/l) (VLMP, 2008 Maine Lakes Report).

Too much acidity eats away at the shells of things like big mama snapping turtle here, or clams, mussels, and snails.

Specific Conductance

A measure of the ability of water to carry an electrical current, conductivity is directly related to the level of dissolved ions in the water. Conductivity levels will generally increase if there is an increase in the concentration of pollutants in the water. Conductivity is measured in micro-siemens per centimeter (µS/cm) or micro-mhos per centimeter (or µmhos/cm) (VLMP, 2008 Maine Lakes Report).

Our remote floating lake 'lab' hard at work. Testing around the West Branch of the St Croix every summer.

Color

The concentration of natural, dissolved, humic acids in lake water, organic "Humic" acids leach from vegetation in the lake watershed. Color is measured in Standard Platinum Units (SPU). Lakes with color levels greater than 25 SPU are considered to be colored. This can cause transparency to be reduced, and phosphorus levels to be elevated. The water in highly colored lakes often has the appearance of tea. When lakes are highly colored, the best indicator of algal growth is chlorophyll-a (VLMP, 2008 Maine Lakes Report).

A pair of loon eggs on a floating bog island. Their color reminds you of a very humic lake, filled with tannins seeping out of the peat.

Methods

Site Selection

Lakes on or near tribal lands to be included in the monitoring program were selected according to accessibility by road. Bathymetric maps were obtained from the Maine Department of Inland Fisheries and Wildlife for the following water bodies: **Killman Pond, Side Pistol Lake.** These were all incorporated into the monitoring program along with the four lakes on Indian Township: **Big Lake, Long Lake, Lewey Lake, Grand Falls Flowage**. See Table 1 for summary of water bodies sampled each season.

Joe Musante and Ryan Gabriel taking samples on Lewey Lake, July 2019.

Table 1. Waterbodies included in ITTG Monitoring Program

Waterbodies Sampled in the ITTG Water Quality Program by Year														
93-'99	**00-'02**	**2002**	**03-'04**	**2005**	**06-'07**	**2008**	**09-'10**	**11-'12**	**13-'16**	**2017**	**18-'19**	**2020**	**21-'22**	**23-'24**
Big	Big	Big	Big	Big (2)	No	Big	Big	Big	Big	Big	Big	*Big	Big	Big
Long	Long	Long	Long	Long	sampling	Long	Long	Long	Long	Long	Long	*Long	Long	Long
Lewey	Lewey	Lewey	Lewey	Lewey	done	Lewey	Lewey	Lewey	Lewey	Lewey	Lewey	*Lewey	Lewey	Lewey
Grand Falls	Grand Falls	Grand Falls	Grand Falls	Grand Falls(2)	these	Grand Falls	Grand Falls	Grand Falls	Grand Falls	Grand Falls	Grand Falls	*Grand Falls	Grand Falls	Grand Falls
			Tomah Str.	Tomah Str	two	Tomah Str	Tomah Str							
	*Side Pistol	Side Pistol	Side Pistol	Side Pistol	years.		Side Pistol	Side Pistol	Side Pistol	Side Pistol	Side Pistol	*Side Pistol	Side Pistol	Side Pistol
	*Upper Chain	Upper Chain	Upper Chain	Upper Chain		*Upper Chain	Upper Chain	Upper Chain	Upper Chain	Upper Chain	Upper Chain	*Upper Chain	Upper Chain	
		Duncan	Duncan	Duncan		*Duncan	Duncan	*Duncan	*Duncan					
		Junior	Junior	Junior			Junior	Junior	Junior	Junior	Junior	*Junior	Junior	
		Killman	Killman	Killman		*Killman	Killman	Killman	Killman	Killman	Killman	*Killman	Killman	Killman
		Mill Privilege	Mill Privilege	Mill Privilege			Mill Privilege	Mill Privilege	Mill Privilege	*Mill Privilege				
		Pocumcus	Pocumcus	Pocumcus			Pocumcus	Pocumcus	Pocumcus	Pocumcus	Pocumcus	*Pocumcus	Pocumcus	
		Scraggly	Scraggly	Scraggly			Scraggly	Scraggly	Scraggly	Scraggly	Scraggly	*Scraggly	Scraggly	
		Shaw	Shaw	Shaw			Shaw	Shaw	Shaw	*Shaw				
		Sysladobsis	Sysladobsis	Sysladobsis			Sysladobsis	Sysladobsis	Sysladobsis	Sysladobsis	Sysladobsis		Sysladobsis	
				Mary Petuche		*Mary Petuche	Mary Petuche	*Mary Petuche	*Mary Petuche					
						*Hall	Hall	*Hall	*Hall					
				East Grand			Middle Chain	Middle Chain	Middle Chain	Middle Chain	Middle Chain	*Middle Chain	Middle Chain	
								West Grand	West Grand	West Grand	West Grand	*West Grand	West Grand	
								Pleasant	Pleasant	Pleasant	Pleasant	*Pleasant	Pleasant	
								E. Musquash	E. Musquash	E. Musquash	E. Musquash	*E. Musquash	E. Musquash	
								W. Musquash	W. Musquash	W. Musquash	W. Musquash	*W. Musquash	W. Musquash	
									Bassett					

*Only sampled once or twice this year

Sample Collection and Field Measurements

Samples were collected and *in situ* measurements were taken according to procedures outlined in *Maine Department of Environmental Protection's 1993 Standard Field Methods for Lake Water Quality Monitoring by Judy Potvin and Linda Bacon.* These methods have been updated throughout the years, but that document was the start of our program.

Laboratory Analysis

Alkalinity samples are typically titrated within 48 hours of collection by staff in the office, some however are tested later, but well within the 14 day holding time. True color samples are processed by staff in the office within 48 hours of collection. Chl *a* samples are filtered within 24 hours using a hand held filter apparatus. The filter is then stored in the freezer waiting to be sent to the Health and Environmental Testing Lab (HETL) in Augusta to be processed. TP samples are immediately placed in the fridge. Within the appropriate time period (generally within a week) Chl a and TP samples are mailed to HETL for analysis. The holding time for Chl-a and TP samples to be processed by the lab (assuming the Chl-a has been filtered and frozen) is 28 days.

Statistical Analysis

The formulas for calculating the Carlson Trophic State Index values for Secchi disk, chlorophyll *a*, and total phosphorus are presented below. Also presented is a table that lists the trophic state values and the corresponding measurements of the three parameters. Ranges of trophic state index values are often grouped into trophic state classifications. The range between 40 and 50 is usually associated with mesotrophy (moderate productivity). Index values greater than 50 are associated with eutrophy (high productivity). Values less than 40 are associated with oligotrophy (low productivity).

Maine DEP Lake Assessment Criteria for Calculating Valid TSIs

1. Samples are to be taken from open water.
2. Five months of data are necessary; one reading per month is acceptable, but 2 readings per month are preferred.
3. Sampling period is May through November.
4. It is not permissible to be missing any 2 consecutive months of data.
5. The mean used in the equations shall be calculated as the mean of the monthly means in order that all months be equally weighted in the calculation.
6. Integrated cores should be taken to a depth equal to that of the late summer epilimnion or to the 2.0 mg/l D.O. level, whichever is less.
7. Secchi Transparency readings must not have hit the lake bottom.

Formulas

All lakes: TSIc = 70 log (mean Chlorophyll a in ppb + 0.71)

Lakes having color less than or equal to 25 Standard Platinum Units:

TSIp = 70 log (0.33 mean total phosphorus in ppb + 0.7)

TSIsd = 70 log [(105 / mean Secchi transparency^2) + 0.7]

Note: Secchi transparency in meters

TSI Table

TSI	Chlorophyll a (ppb)	Secchi Transparency (m)	Total Phosphorus (ppb)
0	0.3	18.7	0.9
10	0.7	12.3	2.1
20	1.2	9.2	3.1
30	2.0	7.3	6.0
40	3.0	5.9	9.2
50	4.5	4.8	13.6
60	6.5	4.0	19.7
70	9.3	3.4	28.2
80	13.2	2.8	40
90	18.6	2.4	56.4
100	26.1	2.0	79.2

Note: Avoid making comparisons using raw data for the various parameters; the criteria assure that the TSIs are representative of the water quality for the open water season of May through November.

Results: Reservation Waters

Big Lake, Washington County, Maine

Table 2, Big Lake

2024 Big Lake			Site: BIG2				
Date	Chl-a(µg/L)	TP(µg/L)	Secchi(m)	Alka(mg/l CaCO3)	pH	Cond(UMHOS/CM)	Color (PCU)
05/21/24	1.9	3	6.10	8.0	6.85	19.9	30
06/18/24	2.9	8	5.25	8.0	7.01	21.0	29
07/29/24	3.5	8	5.10	8.0	7.01	21.8	20
09/04/24	2.5	8	5.55	8.0	7.15	22.2	21
09/23/24	2.7	9	4.55	8.0	7.15	22.1	17
Year Mean:	**2.7**	**7**	**5.31**	**8.0**	**7.03**	**21.4**	**23**
Maximum:	**3.5**	**9**	**6.10**	**8.0**	**7.15**	**22.2**	**30**
Minimum:	**1.9**	**3**	**4.55**	**8.0**	**6.85**	**19.9**	**17**
Stand Dev:	**0.58**	**2.39**	**0.57**	**0.00**	**0.12**	**0.96**	**5.77**
TSI:	**37**	**33**	**45**				
			All TSI values are valid.				

Table 2 shows Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color mean, max, min, standard deviations, and TSI values for Big Lake for May – September 2024. Big Lake is about 10,300 acres, with a max depth of 70 feet (21m) and is part of the St. Croix River watershed. Our sample site is in a shallower basin of 30 feet (9m). Sampling has been done on this lake since 1993.

Long Lake, Washington County, Maine

Table 3, Long Lake

2024 Long Lake			Site: LNG2				
Date	Chl-a(µg/L)	TP(µg/L)	Secchi(m)	Alka(mg/l CaCO3)	pH	Cond(UMHOS/CM)	Color (PCU)
05/21/24	2.4	9	6.00	7.5	6.94	19.8	31
06/18/24	2.4	12	5.35	7.5	6.94	21.0	30
07/29/24	4.1	8	4.75	7.5	7.04	21.7	20
09/04/24	1.9	8	5.65	9.0	7.18	22.1	20
09/23/24	1.9	9	4.70	8.0	7.19	22.2	17
Year Mean:	**2.5**	**9**	**5.29**	**7.9**	**7.06**	**21.4**	**24**
Maximum:	**4.1**	**12**	**6.00**	**9.0**	**7.19**	**22.2**	**31**
Minimum:	**1.9**	**8**	**4.70**	**7.5**	**6.94**	**19.8**	**17**
Stand Dev:	**0.91**	**1.64**	**0.57**	**0.65**	**0.12**	**0.99**	**6.43**
TSI:	**35**	**40**	**45**				
			All TSI values are valid.				

Table 3 shows Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, and standard deviations for Long Lake for May – September 2024. Long Lake is about 595 acres and is part of the St. Croix River watershed. It has been sampled since 1993. It also should be noted in Long Lake that from June to late August the hypoliminion usually becomes anoxic. This results in an increase of anaerobic bacteria and production of hydrogen sulfide. Water collected from the hypolimnion typically has a rotten egg odor when anoxic. Numerous seasonal and year-round residences and camps occur on its western and southern shores.

Lewey Lake, Washington County, Maine

Table 4, Lewey Lake

2024 Lewey Lake			Site: LWY1				
Date	Chl-a(µg/L)	TP(µg/L)	Secchi(m)	Alka(mg/l CaCO3)	pH	Cond(UMHOS/CM)	Color (PCU)
05/21/24	1.9	7	5.30	7.5	6.92	19.9	32
06/18/24	2.8	12	4.50	7.5	6.97	21.0	31
07/29/24	3.2	8	5.25	8.0	7.05	21.6	21
09/04/24	2.4	8	5.65	9.0	7.20	22.1	21
09/23/24	2.3	8	5.50	8.0	7.10	22.3	20
Year Mean:	**2.5**	**9**	**5.24**	**8.0**	**7.05**	**21.4**	**25**
Maximum:	**3.2**	**12**	**5.65**	**9.0**	**7.20**	**22.3**	**32**
Minimum:	**1.9**	**7**	**4.50**	**7.5**	**6.92**	**19.9**	**20**
Stand Dev:	**0.50**	**1.95**	**0.44**	**0.61**	**0.11**	**0.97**	**5.96**
TSI:	**35**	**40**	**46**				
			All TSI values are valid.				

Table 4 shows Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, and standard deviations values for Lewey Lake for May – September 2024. Lewey Lake is about 447 acres, and is part of the St. Croix River watershed. It has been sampled since 1993. It is very populated along its eastern and southern shores, Indian Township and Princeton respectively.

Grand Falls Flowage, Washington County, Maine

Table 5, Grand Falls Flowage

2024 Grand Falls Flowage			Site: GFF1				
Date	Chl-a(µg/L)	TP(µg/L)	Secchi(m)	Alka(mg/l CaCO3)	pH	Cond(UMHOS/CM)	Color (PCU)
05/21/24	1.9	6	5.35	8.0	6.75	20.8	36
06/18/24	3.8	10	4.50	9.0	6.99	21.7	36
07/29/24	4.5	10	4.00	8.0	6.99	22.9	26
09/04/24	2.3	10	5.10	8.5	7.08	22.4	28
09/23/24	3.5	9	5.20	8.0	7.07	22.7	20
Year Mean:	**3.2**	**9**	**4.83**	**8.3**	**6.98**	**22.1**	**29**
Maximum:	**4.5**	**10**	**5.35**	**9.0**	**7.08**	**22.9**	**36**
Minimum:	**1.9**	**6**	**4.00**	**8.0**	**6.75**	**20.8**	**20**
Stand Dev:	**1.08**	**1.73**	**0.57**	**0.45**	**0.13**	**0.86**	**6.87**
TSI:	**41**	**40**	**50**				
			***CHLA only valid TSI due to mean color >25**				

Table 5 shows Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, and standard deviations values for Grand Falls Flowage for May – September 2024. Grand Falls Flowage expands to 6,691 acres of mostly shallow coves due to the impoundment of the dam. Not far below the dam does this watershed finally meet the St. Croix River. Maximum depth is listed at 29 feet (9 m), but our sampling site is located at 20 feet (6m). There are numerous seasonal and year-round residences along its shores, primarily to the south.

Results: Trust Lands

Killman Pond, Hancock County, Maine

Table 6, Killman Pond

2024 Killman Pond			Site: KLL1				
Date	Chl-a(µg/L)	TP(µg/L)	Secchi(m)	Alka(mg/l CaCO3)	pH	Cond(UMHOS/CM)	Color (PCU)
05/22/24	1.8	7	4.05	6.5	6.80	NONE	32
06/17/24	4.9	9	3.80	6.5	6.66	19.8	28
07/31/24	3.3	7	4.15	7.5	6.94	20.8	21
09/03/24	3.0	8	3.50	7.5	7.02	20.4	20
09/25/24	2.6	8	2.85	7.0	6.98	20.8	18
Year Mean:	**3.1**	**8**	**3.67**	**7.0**	**6.88**	**20.5**	**24**
Maximum:	**4.9**	**9**	**4.15**	**7.5**	**7.02**	**20.8**	**32**
Minimum:	**1.8**	**7**	**2.85**	**6.5**	**6.66**	**19.8**	**18**
Stand Dev:	**1.14**	**0.84**	**0.52**	**0.50**	**0.15**	**0.46**	**5.93**
TSI:	**41**	**37**	**65**				
			All TSI values are valid.				

Table 6 shows Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, and standard deviations values for Killman Pond for May – September 2024. Killman Pond is a small pond of about 17 acres flowing into Upper Chain Lake via a small stream. It is part of the St. Croix River watershed. There are no camps or structures along its shores, but it does have a maintained dirt road within 100 feet along its north shore, which undoubtedly adds runoff and sediments. The boat launch is only accessible to canoes and the like. This pond is strongly stratified most of the field season and is about 23 feet (7m) at its deepest. This pond has been sampled most years since 2002.

Side Pistol Lake, Hancock County, Maine

Table 7, Side Pistol Lake

2024 Side Pistol Lake			Site: SPL1				
Date	Chl-a(µg/L)	TP(µg/L)	Secchi(m)	Alka(mg/l CaCO3)	pH	Cond(UMHOS/CM)	Color (PCU)
05/22/24	2.6	6	6.80	7.0	7.04	NONE	8
06/17/24	3.0	10	5.85	7.5	7.00	20.0	8
07/30/24	3.6	7	5.10	7.0	6.96	19.0	7
09/03/24	3.7	10	4.95	7.5	7.12	20.0	8
09/25/24	2.9	10	4.25	7.0	7.06	19.0	6
Year Mean:	**3.2**	**9**	**5.39**	**7.2**	**7.04**	**19.5**	**7**
Maximum:	**3.7**	**10**	**6.80**	**7.5**	**7.12**	**20.0**	**8**
Minimum:	**2.6**	**6**	**4.25**	**7.0**	**6.96**	**19.0**	**6**
Stand Dev:	**0.47**	**1.95**	**0.97**	**0.27**	**0.06**	**0.57**	**0.89**
TSI:	**41**	**40**	**44**				
			All TSI values are valid.				

Table 7 shows Chl-*a*, TP, Secchi, Alkalinity, pH, Conductivity, and True Color; mean, max, min, and standard deviations values for Side Pistol Lake for May – September 2024. Side Pistol Lake is a small lake of 147 acres in a series of small lakes known as the Pistol's. Maximum depth of the lake is 26 feet (8m). There are only a few seasonal camps on this lake, as well as a small boat launch able to handle small trailered boats. This lake is mostly sand bottomed near the launch (NE corner), and is very clear, almost blue-green colored. This lake chain is the only lake sampled in the Springfield or Township area that isn't part of the St. Croix River watershed; it flows into the Passadumkeag River, and finally the Penobscot River. Side Pistol Lake has been sampled somewhat since 2000. The boat launch has washed out into the lake repeatedly over the last ten or more years. Earthwork was done at the launch and up the hill to add and replace culverts, hopefully reducing sediment loads into the lake moving ahead.

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Invasive Aquatic Species Program 2024

Passamaquoddy Tribe at Indian Township

Since its discovery in Clifford Bay, Big Lake in the fall of 2019, variable watermilfoil (VWM), *Myriophyllum heterophyllum,* has been a large piece of the Environmental Department's focus. Being a new threat to the water resources of the Passamaquoddy Tribe, it's been a process to mold and adapt our current programs to face this new challenge. Our focus is on building our invasive aquatic species program to **Locate**, **Remove**, and **Restore** resources affected by invasive aquatic species.

This threat of VWM to the Tribe's surface water resources cannot be understated. The window to try to get this infestation under control is short. The littoral habitat for VWM here is extensive in this dammed river system. Much of the flooded land is very shallow, soft bottomed and sheltered. These conditions describe entire coves: hundreds of acres each. If VWM was thoroughly established in these areas, they would no longer be accessible to many tribal and non-tribal traditions and uses.

To accomplish this long-term goal, the Tribe has been very fortunate to have numerous allies to assist in funding, setting up the program, and doing this important work. Environmental Protection Agency (EPA) 319 and 106 funding, as well as additional monies from the Bureau of Indian Affairs (BIA) have provided staff, development and equipment needed for getting the work done. The Maine Department of Environmental Protection (MDEP) has also been heavily involved in the response to the VWM discovery, providing training and removal time and funding to the Tribe and other local stakeholders (especially Downeast Lakes Land Trust and Big Lake Camp Meeting) through their invasive aquatic species program. Lake Stewards of Maine (LSM), a nonprofit organization, having worked with our water resources program for many years, has been an immense help in setting up the response and donating survey time with our program and the local communities. All these partners have worked together in assembling a defense against invasive aquatic species (IAS) threatening our local water resources.

Locate: Part A

Locating any aquatic invasive plant is a time-consuming endeavor. The more eyes on the lookout the more efficient the work. For these reasons we've divided this goal into two parts: *Education* and *Surveys*. These two parts are discussed below along with what we've done over the last year to address them.

Education is the building block of developing any program. We've broken down our education component into three different categories: build staff capacity, build local capacity, and build partnerships.

Staff Capacity:

Building staff capacity is comprised of both funding to support staff time, as well as training opportunities to build skills. Without these dedicated funding agencies none of this work would be possible.

- Full time staff consists of a water resources biologist (WRB) and a field assistant (FA). The staff roughly split their time between traditional water quality sampling (25%) and IAS (75%). Rodney, funded through Tribal Government, also joined our milfoil crew for much of the field season, providing additional help and energy to the program.

- The water resources biologist completed the PADI introduction to open water scuba diving certification in spring 2022. This certification, coupled with scuba dive gear, gives the department the ability to do deeper water surveys and removal activities. Spring of 2023 we trained two additional staff from the Tribe's Natural Resources Department in open water scuba. No additional divers were trained in 2024, but we did incorporate one of the divers, Coty, that trained with us from the Tribal fire department in the fall for off-time removal work going forward. This currently leaves the Tribe with four trained and equipped personnel for VWM submerged removal work.

- On August 9th, 2023 MDEP trained our two new Natural Resource Department divers in underwater removal techniques, shallow water removal and benthic barrier deployments. MDEP also trained some other local divers in the same skills that day in case they were able to assist with removal work in the future, including Coty. No additional divers were trained by MDEP in 2024, but MDEP IAS has yearly training sessions for when the need arises in the future.

Joe (left) and Coty (right) suit up for some milfoil training and removal on the new DASH/Diving boat, Sept 2024.

- Two high school students and one supervisor worked with the IAS Program in 2023. Kaiden, Frank, and Matt participated in the tribal Summer Youth Program, which trains and employs young tribal members (16-25 years of age) and their supervisors in identifying and surveying for VWM. These extra staff really added in critical manpower during the height of the summer season. Their primary duties are assisting in VWM surveys and being surface support for divers removing VWM on the lake bottom.

- The Summer Youth Program involved even more youth in 2024 than in 2023, bringing back Kaiden for two months while utilizing two teams of students for three weeks each during July and August. The first team consisted of Kaiden, Nate, Quoqsis, and Isaac; while the second team was Kaiden, Theo, Louis, and Chayeden. The youth received valuable working experience and milfoil training while our department gained extra eyes and hands in our work. Hopefully some of these students will be future assets or employees in protecting tribal water resources. They did a great job.

Some action shots of the summer staff surveying and supporting divers in our quest to manage VWM.

Local Capacity

Building up local capacity is an important piece to the long-term success of any invasive species project. Without the assistance and buy-in of residents it would be just too difficult to monitor such a large area for species of concern. The more concerned and educated residents we have keeping an eye out the better. The most formal tool we have in place for building local capacity is to host a regular 'on the water' 'plant paddle' training put on by LSM. This training is used to introduce people to the program (and points of contact), what VWM looks like, and get them familiar with native plant species verses invasive aquatic plants. Taking them out on the water and showing them just what VWM looks like growing in the lake gives a good mental picture to recognize it later on. While we would love to have most residents volunteering to do formal IAS surveys around the lakes, we recognize for most this is a big ask. Just having them recognize something as suspicious, (or likely VWM) while out on the lake is still very valuable. Many of our new VWM populations found since 2022 were reported by fisherman or boaters to tribal staff. This is a very important development track to the success of managing VWM here.

- In 2024 we were very fortunate to have LSM provide two different trainings in our area to build IAS capacity. The first training was their 'live ID', a classroom setting training hosted by the Meddybemps Lake Association at their community center on July 23rd. Meddybemps Lake is only 12 miles from Grand Falls Flowage.

- The second training, an 'on the water' plant paddle, was held on July 24th, and was hosted by the Tribe at Grand Falls Flowage. The plant paddle format focuses on survey and collection techniques as well as identifying specimens to rule out invasive species. It's a great second step in training volunteers.

Right: Bret from LSM discusses plant ID at the plant paddle training, Route 1 bridge, Tribal Reservation.

Impromptu discussions when the opportunity presents itself are also important pieces of building local capacity. VWM samples were kept on hand in the office to show to any and all that came in for whatever reason. Having live samples on hand to show people was especially helpful since many that were on the water could connect them to floating fragments they would see on the lake. The next step hopefully will be to go out in boats with them, individually or through future Plant Paddles to show them what they look like growing out of the sediment in the lake bottom. We feel like we've made a lot of progress as a staff and community in education and outreach.

- 5+ Office interactions with the community and another 10-15 interactions with landowners/boaters while on the water working.
- The ENV Department also had a booth at the tribal Health Faire again in October 2024, showing and speaking with children and adults from the local community on invasive milfoil. (Approximately 61 adults and 23 children spoken with). While speaking with people at the health faire we learned of four different people removing fragments from the lake and shoreline, as well as one of our previously trained summer youth supervisors teaching his family how to spot milfoil on the lake. Thanks Lou!

Joe at the Tribal Health Faire 2024 with a milfoil touch tank for the kids along with the tools of the trade.

Another example of building local capacity is that we are involved with our partners in the Big Lake Milfoil Coalition in getting educational information out into local businesses to increase exposure. ENV staff are still involved in virtual presentations and meetings with other regional stakeholders to increase awareness and build on relationships for the future.

- Monthly Zoom calls with stakeholders during the field season, hosted by LSM. These meetings give updates on VWM activities and help keep people involved and informed.

***Left*: A zoomed-in section of the flower stalk of VWM. A fully definitive ID of VWM is impossible without seeing this, and most colonies that are young won't develop them. To get around this problem many samples get genetically tested by MDEP for new infestations.**

Partnerships

Lakes, ponds, and streams are not a water resource for a singular entity, nor are they singular units on the landscape. They are parts of huge, sprawling watersheds moving across the landscape to the ocean. Just as you need to manage these water resources as part of a larger watershed, the same holds true for communities intwined with that watershed. The Passamaquoddy Tribe is but one stakeholder in the west branch of the St Croix River watershed. For this reason, the Tribe has joined the Big Lake Milfoil Coalition (BLMC), a group of state and regional stakeholders working together to fight the VWM infestation of the Big Lake area. This coalition asks members to bring whatever resources they can contribute to the VWM battle.

To facilitate, organize, and invest stakeholders, LSM started regular Zoom calls to bring all those interested to the table. These meetings occur monthly during the field season as talked about above. Attending and participating in these regular meetings has become an important part of developing the Tribe's IAS Program, as well as reinforcing partnerships with stakeholders, volunteers, and community members.

***Right*: Downeast Lakes Land Trust organized a milfoil removal mission with the Combat Wounded Veteran's Challenge for four days in 2023. Milfoil coalition members (Camp Meeting, MDEP, PIT, and DLLT) and local residents helped support the event by providing boats, captains, training, and meals to the mission. Photo: Prepping for an afternoon training dive at Big Lake.**

***Left*: PIT dive crew after a day on and under the water removing VWM in Cass Cove, Big Lake with resident volunteer Brenda Smith and LSM uber IPPer Bunny Wescott in 2023. Photo left to right: Joe Musante, Ryan Gabriel, Brenda Smith, Justin Socobasin, Matt Dana I, and Bunny Wescott and Ross Wescott manning the camera. Working side by side with residents to eliminate invasive plants are one of the key pieces of this program. The more eyes the better.**

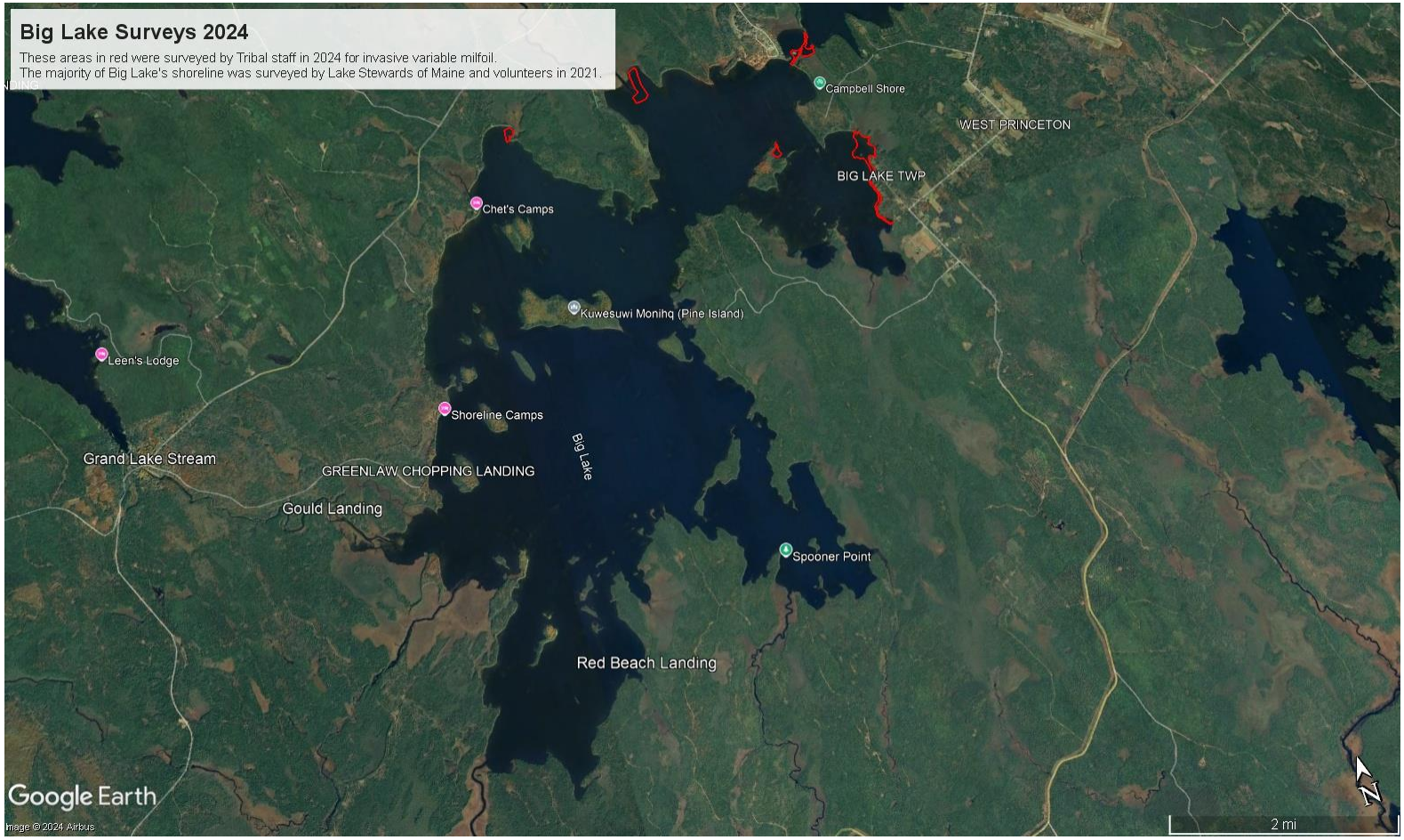
***Right*: : PIT dive crew (Joe) after a short day on and under the water removing VWM in Cass Cove, Big Lake. Summer resident volunteer Brenda Smith surveyed and marked VWM for us to come and remove. The difference in volumes shows a great improvement from 2023 to 2024.**

Locate: Part B

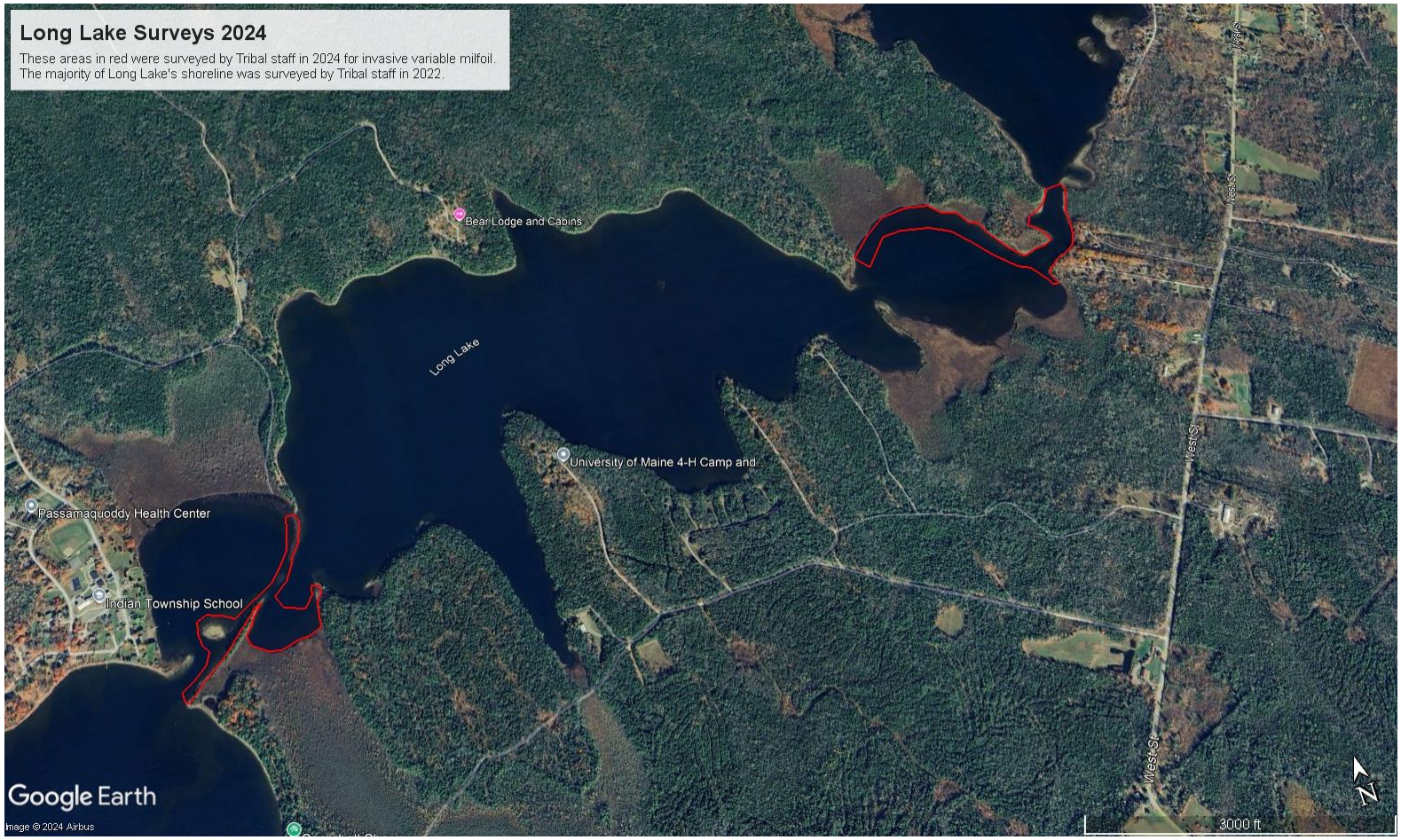
The second half of *Locate* is getting out on the water to conduct some form of a survey. These surveys are not all conducted the same way, but they are all after the same result: *is there an invasive aquatic plant here or not*? In our Quality Assurance Project Plan (QAPP) we've put specific guidelines on how surveys are conducted by department staff. These survey plans have specific goals in mind, based on limitations due to survey conditions, training, or equipment. While it would be beneficial for volunteers and community members to also follow these QAPP guidelines, we recognize there is still significant value to their eyes on the water looking for plants. Simply spotting something suspicious, grabbing a sample or taking down a location is an important piece of developing local capacity to fight invasive aquatic species.

Pre-removal Surveys

Big Lake was surveyed heavily in 2021, Long and Lewey Lakes, along with a large amount of Grand Falls Flowage were completed in 2022. The 2023 season knocked off some more of Grand Falls Flowage when conditions allowed. Now in 2024 we again finished off some sections of Grand Falls Flowage in the early season, but more remain for the future. We also did some surveys in areas where new reports of VWM had us looking. Overall, more and more time has needed to be spent on post removal surveys and removal activities, taking away from pre-removal work.

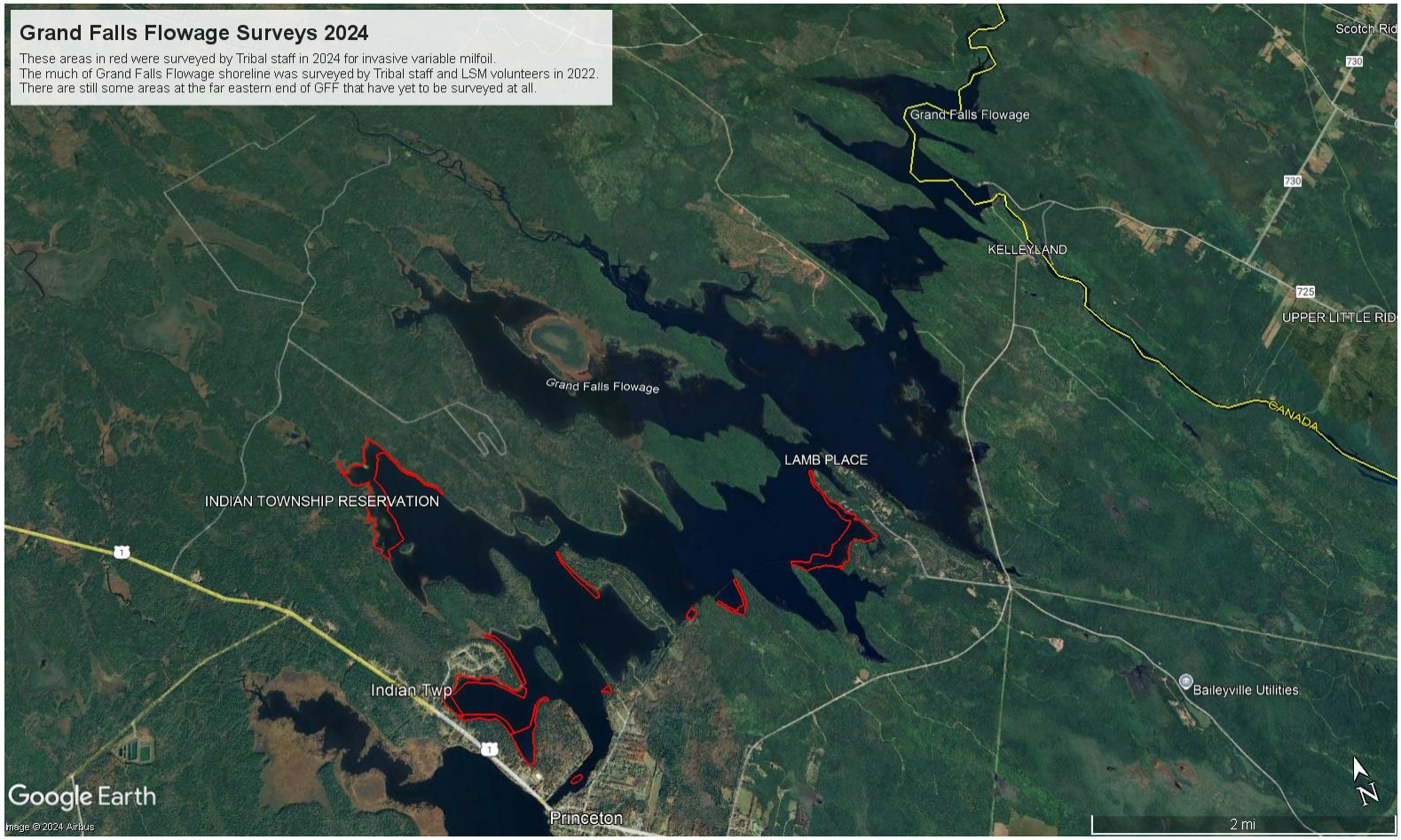


Red marks areas surveyed in 2024 by Tribal Staff for VWM. Overall the survey conditions for 2024 were as good as you could hope for: lots of sun, shallow water levels, and great water clarity in general. The direct opposite of 2023. The larger area at 'Big Lake TWP' was due to a report of new populations. The other areas were in regard to post removal survey work being done. The Tribe, MDEP, and NEMilfoil also did some post herbicide surveys in and around Clifford Bay (Spooner Point area on the map).



Red marks areas surveyed in 2024 by Tribal Staff for VWM. These surveys are a combination of pre and post removal surveys as both areas have established VWM populations or plants nearby. Overall the survey conditions for 2024 were as good as you could hope for: lots of sun, shallow water levels, and great water clarity in general. The direct opposite of 2023.

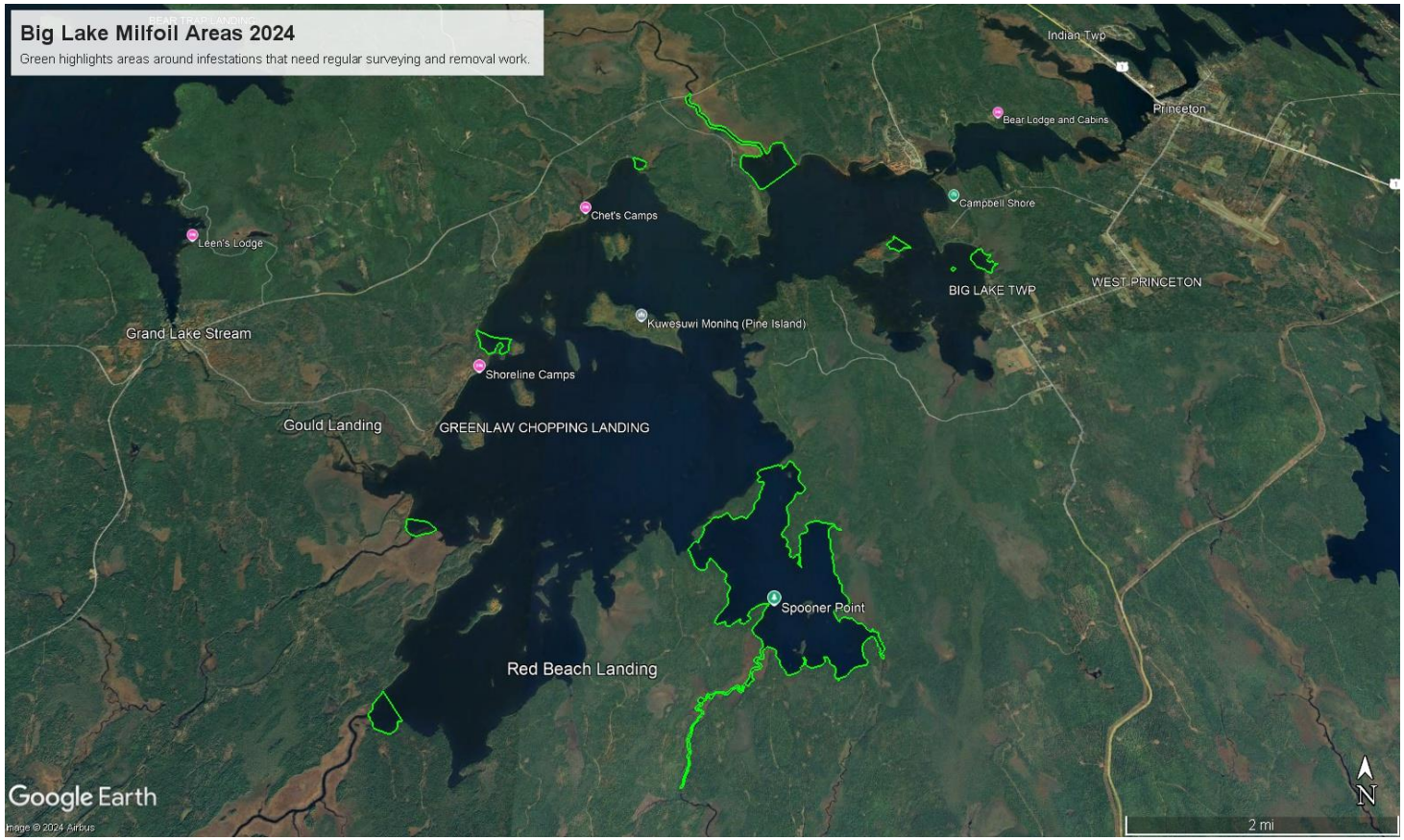
Red marks areas surveyed in 2024 by Tribal Staff for VWM. These surveys are a combination of pre and post removal surveys as both areas have established VWM populations or plants nearby. Overall the survey conditions for 2024 were as good as you could hope for: lots of sun, shallow water levels, and great water clarity in general. The direct opposite of 2023. The area on the western shore of Lewey Lake was a new reported VWM population. This area was confirmed by Tribal staff and later removed. More surveys will need to happen there in 2025 to determine just how big it is.



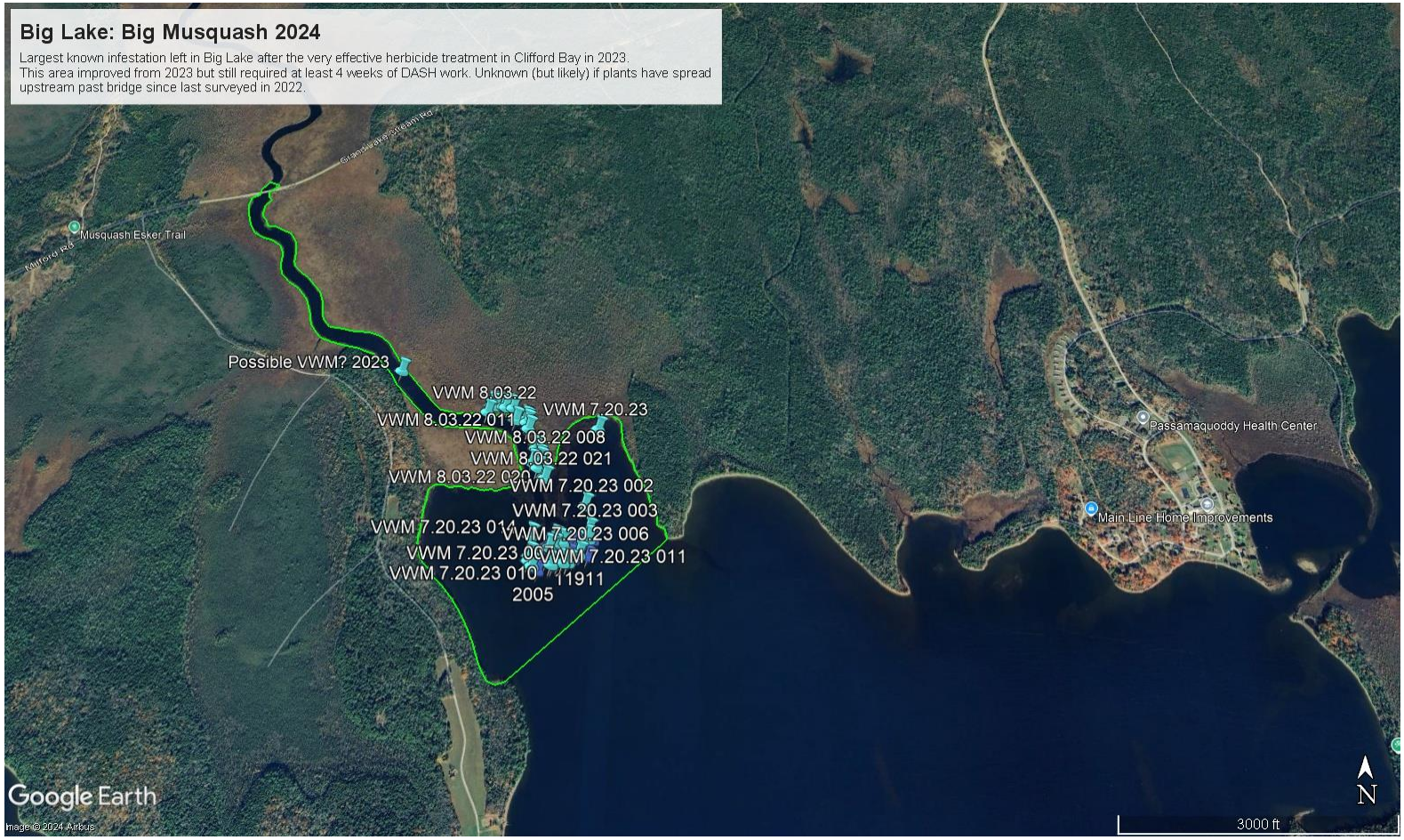
Red marks areas surveyed in 2024 by Tribal Staff for VWM. These surveys are a combination of pre and post removal surveys as both areas have established VWM populations or plants nearby. Overall the survey conditions for 2024 were as good as you could hope for: lots of sun, shallow water levels, and great water clarity in general. The area in George Brook Flowage (NW red area) was the finishing of an initial survey in this area started in 2023. Nothing was found. The area to the far east was a newly reported VWM population by our Fisheries Department that was then surveyed by our VWM staff for mapping and removal. The other areas were post removal surveys around prior established VWM plants or populations.

Post-removal Surveys

Most of the surveys at this point would be classified as post-removal surveys: a situation where we go back to known infestations to look for new or regrown VWM. This includes areas near other infestations where we expect VWM to become established, or areas surveyed in lesser conditions in the past. The following maps are broken up by lake.

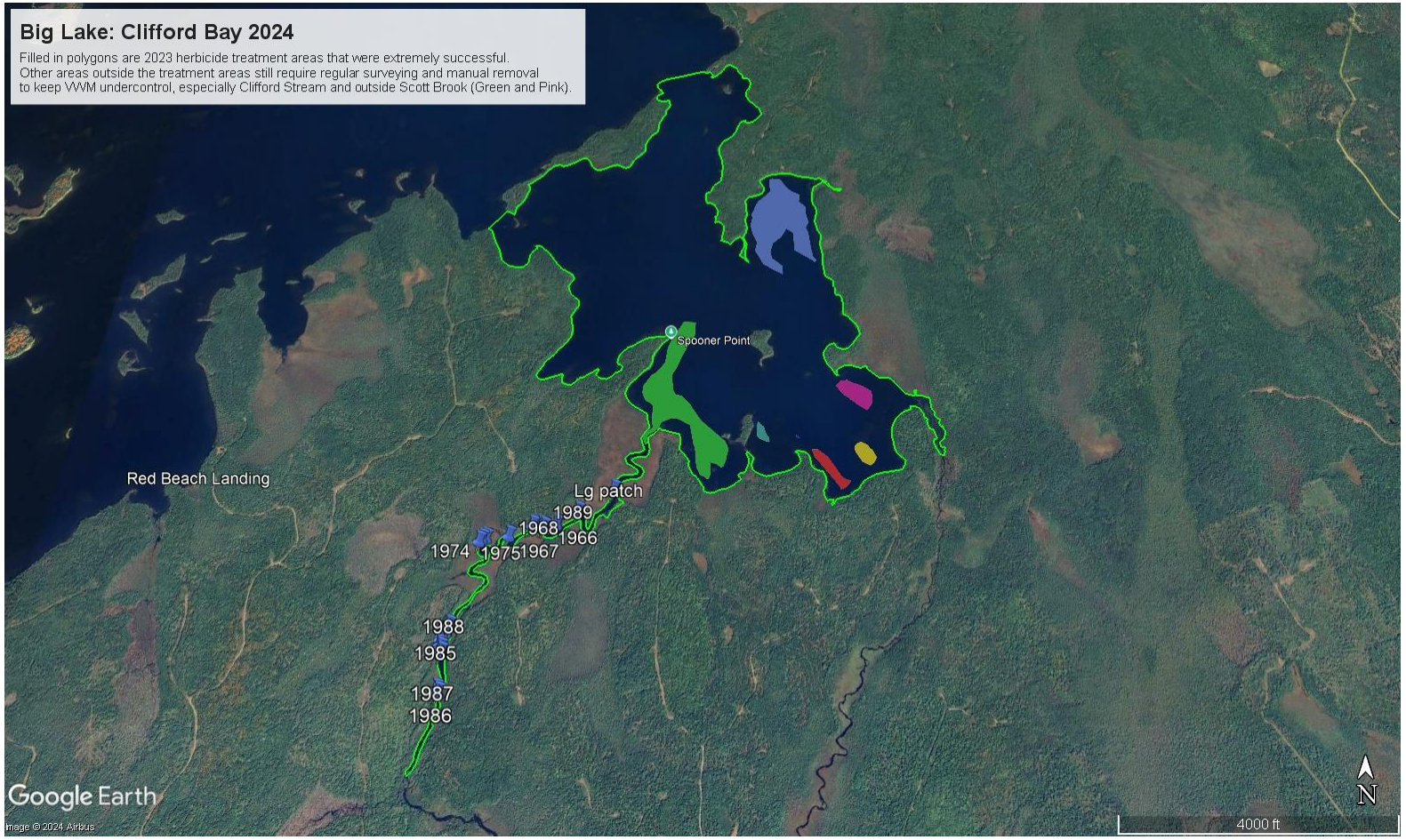


This overview map should help give the readers an idea on the spread of VWM found in Big Lake. The green areas are areas surrounding smaller populations. The highlighted areas do not accurately gauge the boundaries of the infestation, but instead represent an area of concern for yearly surveys.

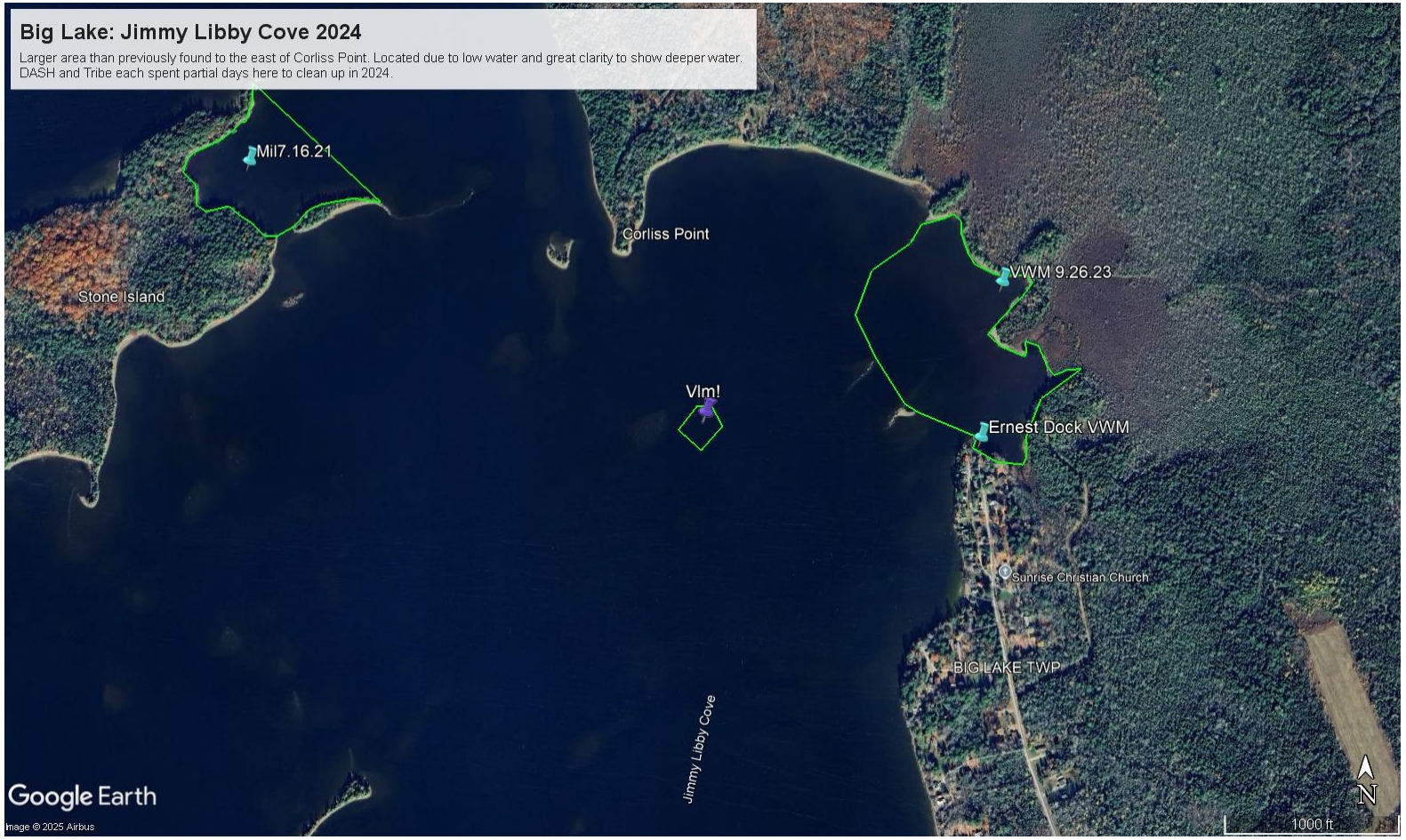


The mouth of big musquash stream is currently the largest infestation of VWM in the system since the effective herbicide treatment of Clifford Bay. This area was worked on by NEMilfoil's DASH crew for at least four weeks this season and will be a focus for years to come. Thanks to the removal work in this area in 2023, there were far less fragments reported in the Spring by fishermen, reducing the chances for new establishing populations. This area receives lots of boat traffic going up the stream and from fishermen.

The infestation in Cass Cove continues to decline thanks to regular surveys and marking by camp owner Brenda Smith. She marks them and we pull them! Brenda also reported very few fragments found on her beach this year, likely a result of the herbicide treatments in Clifford Bay reducing total biomass significantly. We're very excited to see the ongoing progress here from what it was in 2021.

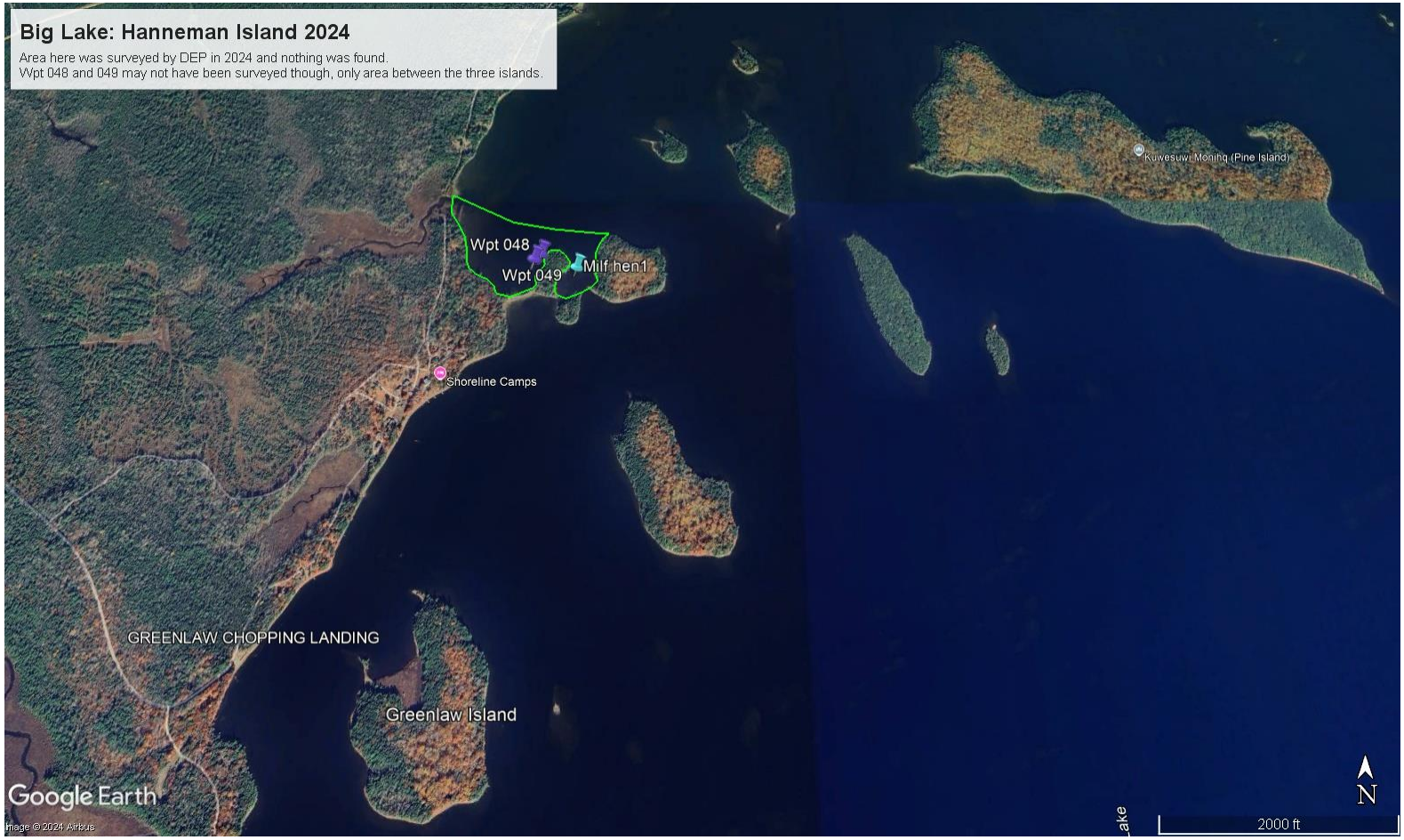


Maine DEP contracted to have the largest (and likely initial colonization) populations of VWM treated with a milfoil specific herbicide in August 2023, about 85 acres in total. The hope was that the treatment knocks it back enough to make DASH removal a viable option going forward. That hope was realized in 2024 when most all of the treatment areas were fully devoid of VWM. Acres of VWM monoculture is now bare bottom substrate. While a resounding victory, these areas will need to be monitored to prevent recolonization from other nearby populations. Most pressing is Clifford Stream, which received about a week's worth of DASH attention in 2024 and will need consistent work moving forward.

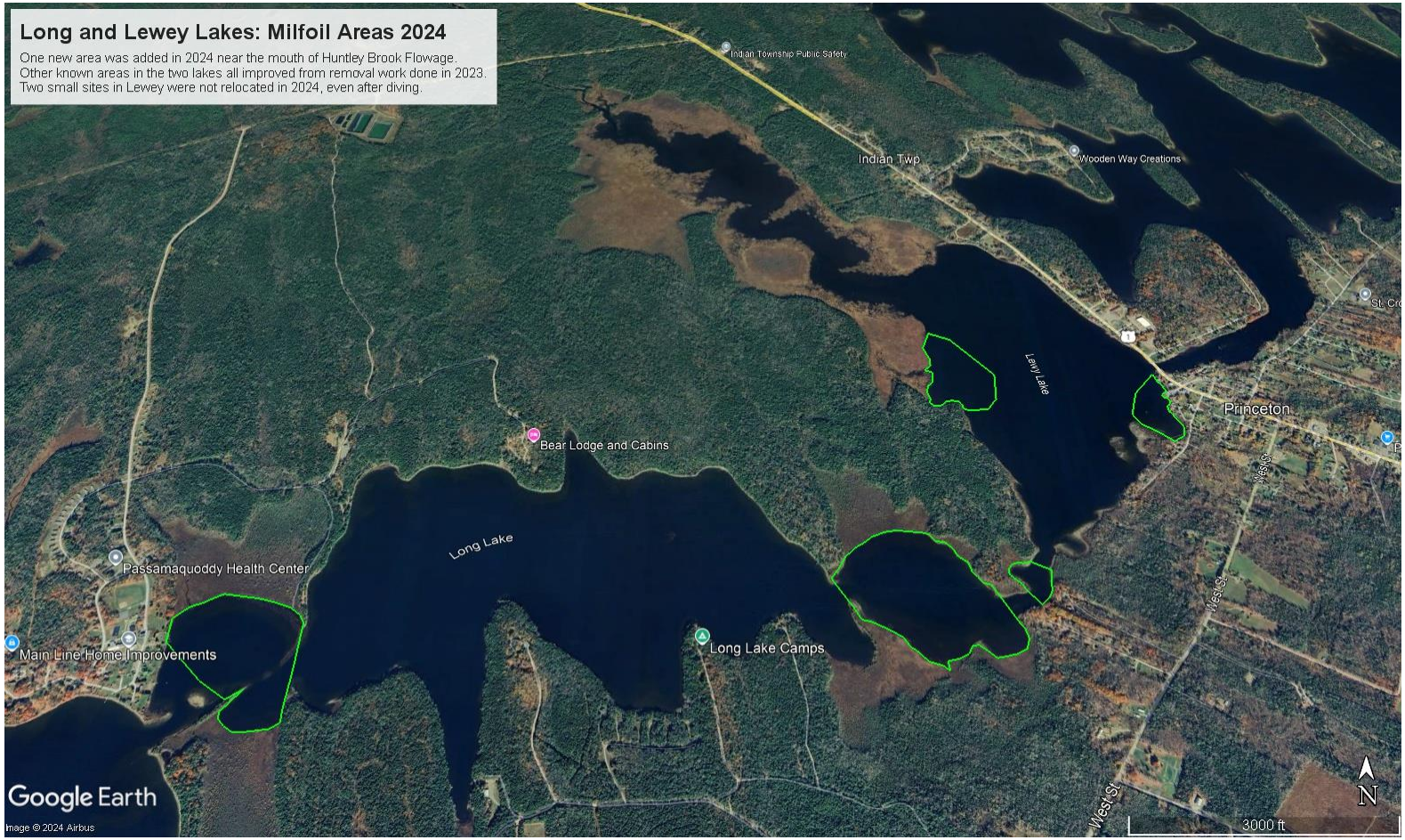


Jimmy Libby Cove is completely within the 10ft depth requirements of VWM and some locations are starting to be found in this area. The regular flow of the lakes does not come into this extensive cove, only boats and wind driven fragments. Spring of 2024 brought reports of VWM around the ledges north of the Camp Meeting community by our Fisheries Department while doing bass surveys. Due to great survey conditions in 2024 we were able to map out scattered plants in water up to 9 feet deep for removal.

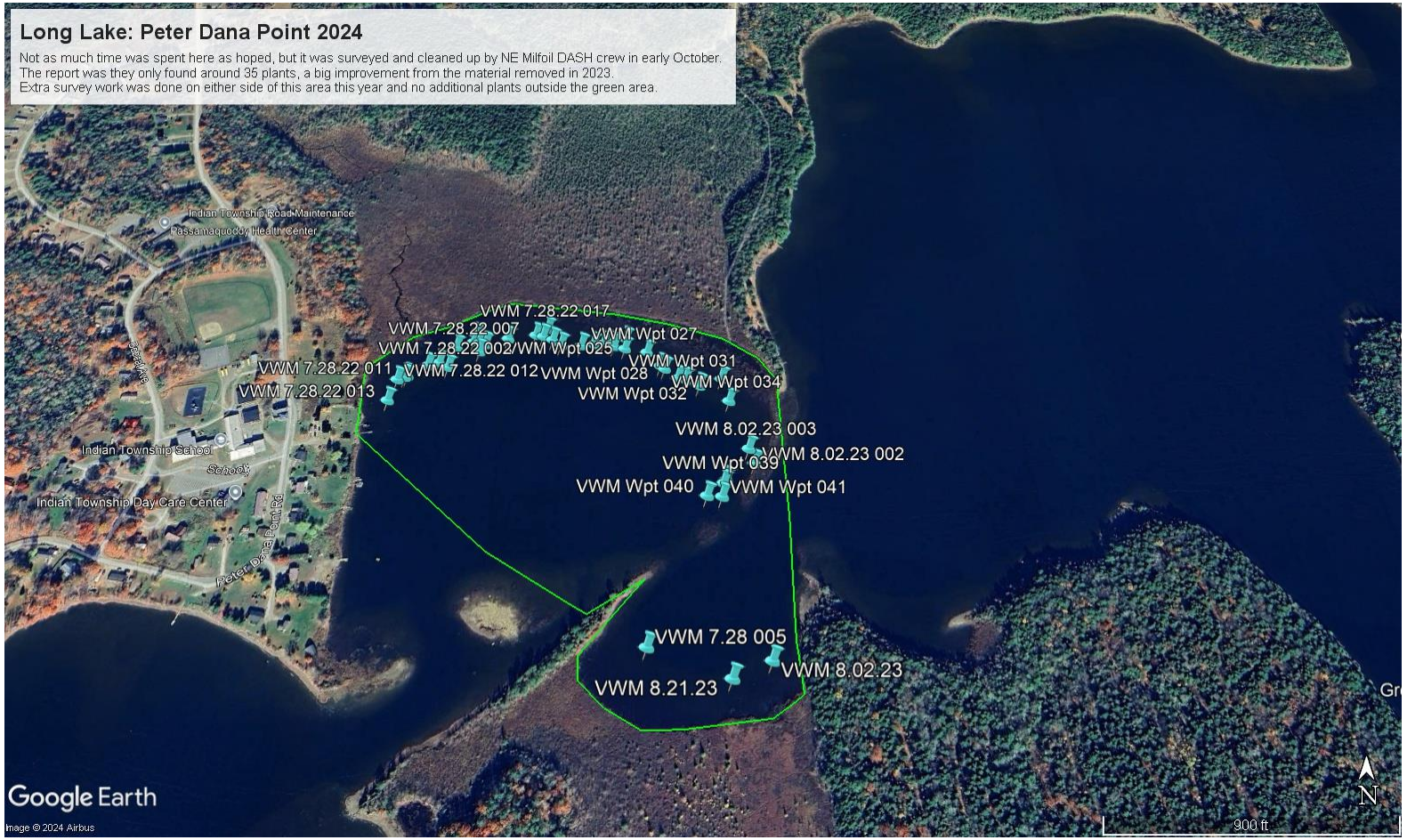
These two areas were not visited in 2024. This part of the system is the most time consuming for us to reach, and its attention suffers for it. The Milner sites were not relocated in 2023 after 2021 removal, and the WP051 site in Little River is a small, established site that was removed yearly from 2021 – 2023. Little Musquash Stream, which dumps into the lake at the Milner sites needs to be surveyed upstream, as well as Lamb Cove to the Southeast.



The VWM sites around Hanneman Island have been removed since 2021, but nothing was found while being visited by MDEP in 2024. Considering the area was large and dense enough to employ benthic barriers a few years ago, its great news to report nothing found in 2024.



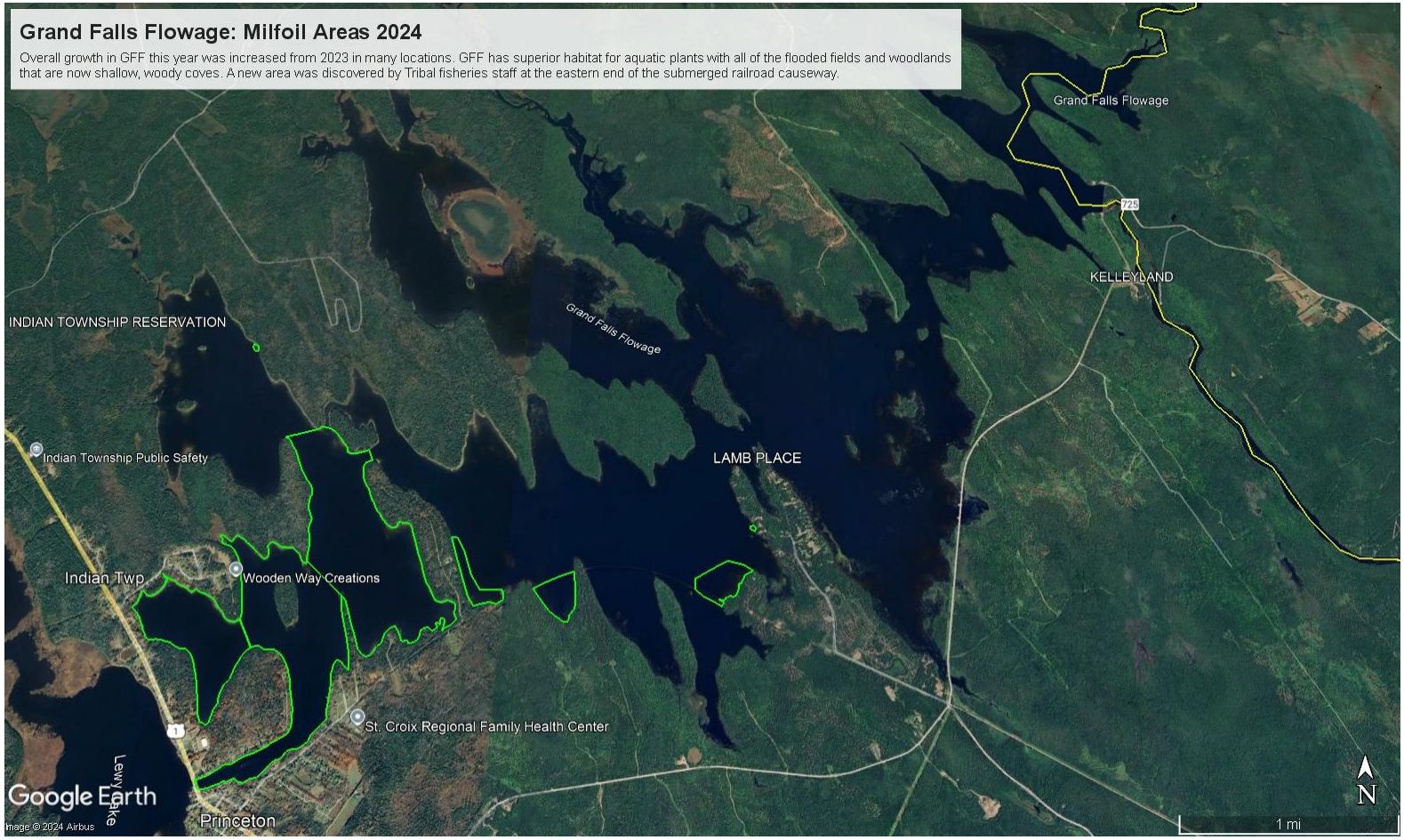
This overview map should help give the readers an idea on the spread of VWM found in Long and Lewey Lakes. The green areas are areas surrounding smaller populations. The highlighted areas do not accurately gauge the boundaries of the infestation, but instead represent an area of concern for yearly surveys.



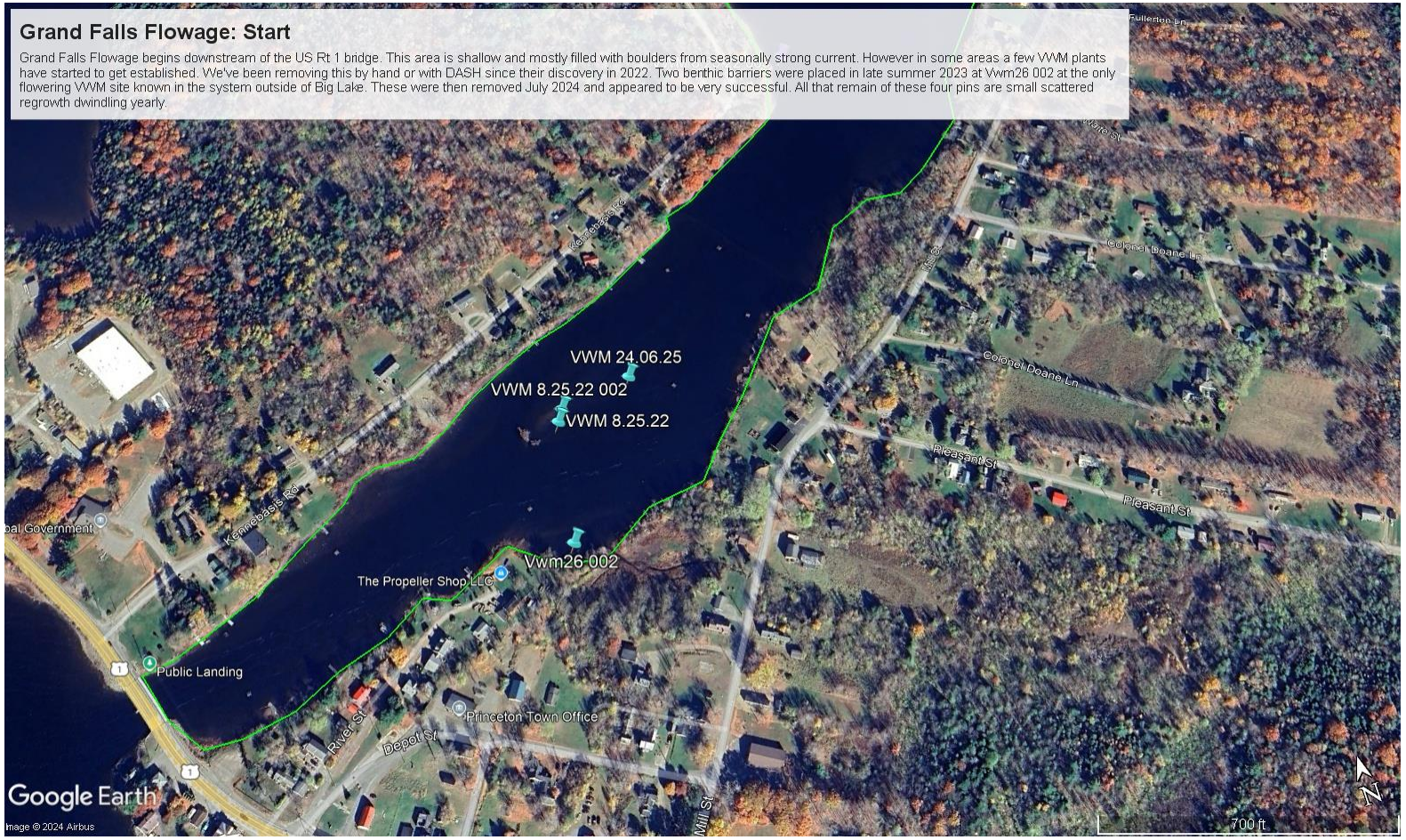
This area off Peter Dana Point in Long Lake will take some consistent work to keep under control and remove newly rooted fragments. It is heavily fished, and the boat traffic spreads fragments. Fragments coming out of Big Lake get hung up here and establish themselves. 2024 saw a large improvement in this area from 2023 in terms of removal time. NEMilfoil spent one partial day here and reported only about 35 plants, a fraction of what was taken in 2023.

The second area downstream in Long Lake, some scattered VWM populations. Just like the western end of Long Lake, the eastern end showed a very positive response to 2023's removal activities. Numerous plants that were removed in 2023 were not located or were much smaller. Wpt 043 was not found for the first time since its initial discovery and yearly removal in 2020!

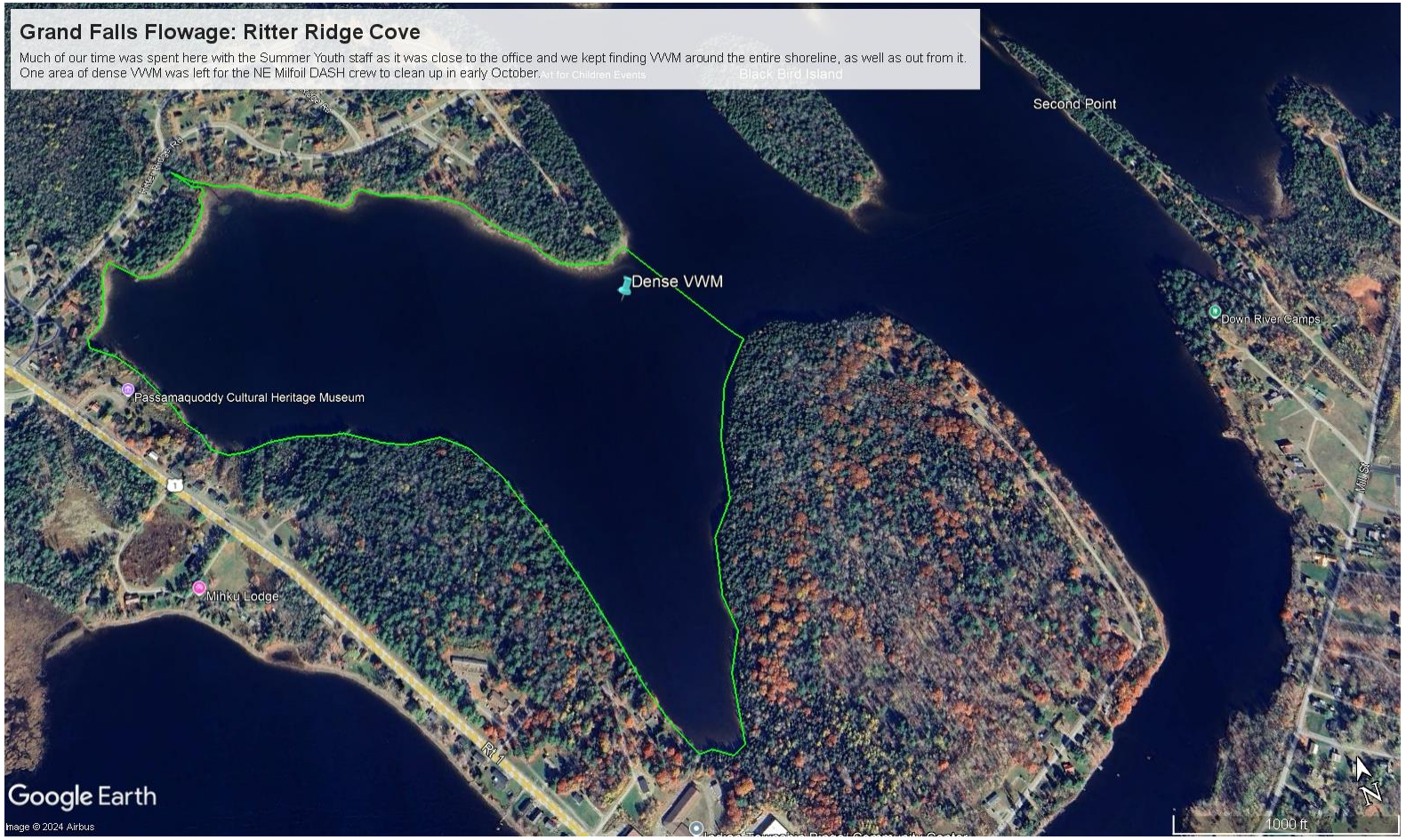
2024 had reports of VWM by avid fisherman Tom, a Princeton resident, in a cove along the western shore of Lewey Lake. Once surveyed by PIT staff we confirmed the small, scattered plants inside the cove, and found some more extensive scattered populations in deeper water offshore. These were removed by PIT staff, but we will be prioritizing a more intensive diver tow survey for 2025 in this area to hopefully nip this in the bud. Thanks Tom!



This overview map should help give the readers an idea on the spread of VWM found in Grand Falls Flowage. The green areas are areas surrounding smaller populations. The highlighted areas do not accurately gauge the boundaries of the infestation, but instead represent an area of concern for yearly surveys.



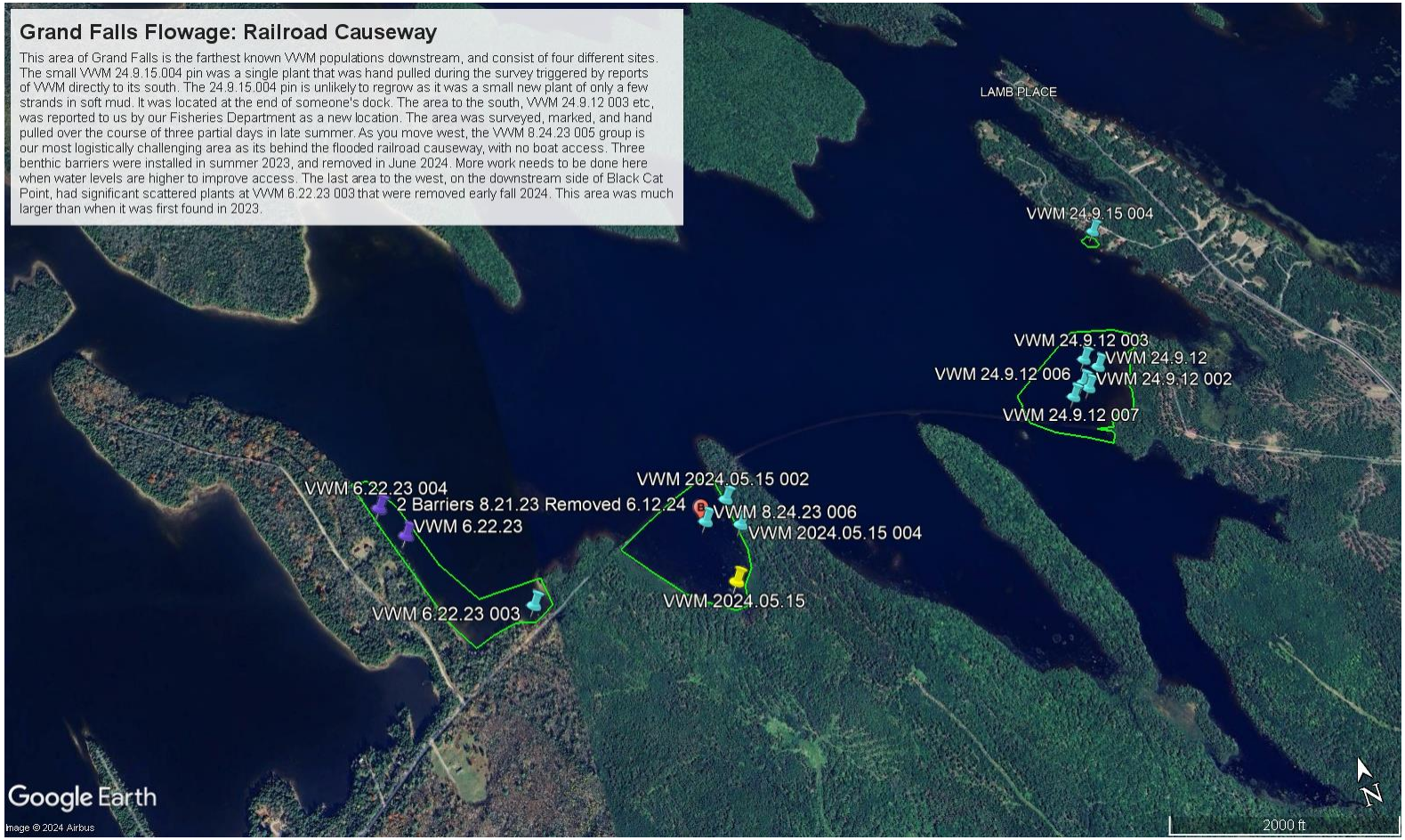
This map shows the start of Grand Falls Flowage at the US Rt 1 bridge in Princeton. Numerous small populations were found and removed in 2022, 2023, and 2024. Two benthic barriers were placed in 2023 at Vwm26 002 and taken up in July 2024. All that remains are scattered small plants to be cleaned up yearly in these sites.



Just downstream of the map on the previous page. This area was the focus of staff and summer youth in 2024. This entire cove is under 10 feet of depth with heavy plant growth. VWM was found ringing the entire shoreline here with a previously known 'dense population' pinned on the map. This will take consistent effort to keep under control as its very heavily boated by fisherman from the Tribe, Princeton, and renters at Down River Camps. The growth in this cove has been very rapid even with some yearly removal work the last two years.

The Black Bird Island section of Grand Falls Flowage was not as heavily surveyed as we would have liked in 2024 due to time constraints. Aqua pins were VWM sites found and removed, while the purple pins were last surveyed in 2023. The cove to the north of Down River Camps was improved from 2023, taking only 1 diver half a day to clear up scattered regrowth vs 3 divers the same amount of time in 2023. There remains a stubborn thick patch in woody debris in the back of the cove, something we're finding more regularly in Grand Falls Flowage due to the flooded timber restricting access to plant roots consistently.

The next infested area downstream is Black Cat Point. This area to the east is shallow, flooded timber with lots of scattered plants. The pins in aqua were removed by NEMilfoil in October, as they were the last two seasons, but they are still multiplying. This shoreline receives lots of pounding waves from predominant westerly winds with lots of submerged woody debris. The wind causes high amount of fragmentation and movement, while the wood restricts access to roots for effective removal. This area will be a constant battle.



These locations mark the furthest found VWM downstream in Grand Falls Flowage. Seeing how extensive the populations are behind and around the old railroad bed, we'll be resurveying these two coves again in 2025, as well as the coves to the north. The area to the far east of the map were again reported by our Fisheries Department found while doing bass surveys during the summer of 2024. Much of the plants in this area were unusual as they were established in a very rocky gravel shoreline in shallow water, something we don't see usually.

Remove

After all the leg work has been done, the most satisfying step of the project is the removal work. Putting your wetsuit on, getting in the water, digging VWM out of the mud and sending it off to the compost pile. In 2024 we had three different organizations doing some removal activities on our four lakes, with another one contributing in another important way. The following few pages highlight their work.

The picture to the right shows some fresh green growth on VWM, along with some new roots forming along the older growth. These older stems vegetatively reproduce in two ways. One: they fragment in the spring or fall and float off to sink and root in a new location. Two: they will also lay down in place, still attached to the mother plant, and root all along the stem. Then from there they put up new vertical stems all along the length of the old stem. Think of it like an old tree that blows down and sends up new shoots all along its trunk. This form of spread creates dense monocultures in a location, while the fragmentation helps colonize new areas, perhaps miles and miles away. Both methods produce genetically identical plants.

The Passamaquoddy Tribe at Indian Township

The Tribe has worked hard since 2022 to develop their own trained and equipped dive team (described more thoroughly earlier in this report). Removal activities in 2024 for PIT began in June and continued through the first week of October. The Tribe acquired a 24 foot skiff to be used as our working DASH boat and dive platform. The DASH equipment will be put into use starting in the summer of 2025, but in the meantime was used as a very large and stabile dive platform for hand removal and survey work. We are digging and pulling VWM with scuba or snorkel gear, stuffing it into a mesh bag, then bringing it to a boat to be disposed of.

Depending on the size of the patch and the number of staff available, sometimes a kayak aids in the process: floating around to keep tabs on the diver, shuttling full bags to the 'mothership', marking more plants, and chasing down fragments. This works very well, especially when dealing with lots of small patches in a small area. Seeing as we are hand pulling plants, the tribal team focuses its efforts on smaller, more scattered populations that are less efficient for a DASH crew to set up on. When an area is too large and dense, then the NEM DASH crew was called in to finish it off (more on that on the next page).

Most of the work done by the tribal crew was in Grand Falls Flowage, while also doing the few locations in Lewey Lake, about half of Long Lake infestations, and finally a few smaller locations in Big Lake.

Downeast Lakes Land Trust

Downeast Lakes Land Trust has been a key partner for VWM removal activities in and around Big Lake. In 2024 DLLT organized and supported the main piece of our removal puzzle: contracted NE Milfoil DASH crew.

NE Milfoil: (http://www.newenglandmilfoil.com/) was contracted by DLLT through granted MDEP funding for new aquatic invasive species infestations. This contracted work by NEMilfoil has been going on for 4-12 weeks per summer since 2020, with about 10 weeks of work done in 2024. This photo to the right is of their DASH boat (Diver Assisted Suction Harvest) with owner/operator Cliff. The general operation of the boat/system is as follows:

A scuba (or surface supplied air as in this case) diver digs and pulls up rooted vegetation on the lake bottom, feeding it into a vacuum nozzle, giving the invasive VWM a quick ride onto the boat. The water and material dump over the side of the boat through a mesh net, capturing all the plant material, and flushing the water and sediment back into the lake. This suction harvest system gives the diver much higher work efficiency than a hand pulling diver since they can remain on target the entire dive. A hand pulling diver must surface to shuttle material to the support boat. This not only saves dive time, but also helps with preserving some of the precious visibility lost during ascent and descent.

As the plant material piles up onboard, the deckhand fills 10 gallon fish crates and stacks them on the deck. The more deck space the more material can be stored before having to head to shore to offload. DLLT has purchased a dump trailer and contracted to have it emptied weekly in a gravel pit for safe composting. Cliff has generously agreed to help the Tribe setup and organize their DASH boat with his 20+ years of experience in the field.

Maine Department of Environmental Protection

Maine DEP IAS program has been in integral partner in our IAS program here, not only granted funds for NEMilfoil DASH work, but also helpful yearly site visits, on-site training sessions for divers, and a source of general program expertise. In 2024 MDEP was on location for a few days to help survey the 2023 herbicide treatment areas, as well as spending a day doing some surveying and removal work in Big Musquash and Hanneman Island in Big Lake. John, Denise, and Toni are always available for questions, even traveling all the way up to meet with Tribal leaders on VWM management plan development for the area.

Campmeeting

The local community at Campmeeting has been with us from the start in 2020. Located along the eastern shore of Big Lake, across from Peter Dana Point, the Campmeeting community hosted a plant paddle workshop in 2021 to help train residents in invasive plant identification. From that point forward community members have been involved in many planning and logistics aspects of the VLM battle in the area. They offer up free lodging to surveyors, workers, and most importantly, the NEMilfoil DASH crew throughout much of the summer and fall. Finding lodging in the area during the busy summer is a challenge and is costly. Thanks to Campmeeting for their generous donations throughout the years.

Restore

Restoration activities currently are not a priority. Most of the sites we've removed were very small and should be recolonized quickly by nearby native plants. If a site is heavily disturbed, we will want to look into recolonizing with local native plants. This is something that will need to be investigated for the future. A possible area to investigate will be the herbicide treatment areas that now have acres of uncolonized substrate. Future surveys will give us a better idea of recolonization with (hopefully) native plants.