2021 Watershed Management Bureau in Review: Program achievements and data quality report

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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EXECUTIVE SUMMARY

The year 2021 was again dominated by a worldwide COVID-19 public health pandemic. With the availability of several vaccine options, however, COVID-19 cases and risk of exposure were severely reduced. Nevertheless, field and lab work within the Jody Conner Limnology Center (JCLC) and the Watershed Management Bureau (WMB) continued to be affected, but to a more limited extent.

As in past years, the WMB oversaw the implementation of over 20 programs to monitor, protect and restore the state's surface waters, including its lakes and ponds, rivers and streams, coastal, wetlands, and public bathing facilities. In all cases, these programs are designed to promote the health of one of New Hampshire's most valuable natural resources: water. In 2021, a majority of the surface water monitoring programs operated out of the JCLC returned to some semblance of full-capacity with the exception of synoptic river and lake monitoring. These two watershed monitoring programs were suspended for the second year.

JCLC staff kept in place several COVID-19 protective measures including contactless drop-off and pick-up bins outside the building, increased spacing between lab instruments, a recommendation that staff sharing vehicles wear face coverings, and a constant supply of personal protective equipment to staff.

With these protective measures in place, the hiring of seven seasonal staff people, and the dedication of 11 full-time JCLC staff, 40 river trend stations were monitored three times, more than 15,000 samples were processed from 180 lakes participating in the volunteer lakes assessment program, support was provided to 25 volunteer river assessment groups, lake trophic surveys were completed on 11 waterbodies, fecal bacteria counts were tracked at 32 freshwater beaches and 16 coastal beaches, nearly 800 samples were microscopically inspected for cyanobacteria, 80 waterbodies surveyed for the presence of invasive plants, and macroinvertebrate samples collected from and continuous water temperature sensors placed in approximately 40 river sampling stations.

Additionally, the shellfish program collected thousands of bacteria and phytoplankton samples to ensure New Hampshire’s shellfish resources were harvested during periods that minimized human-health risks. Long-standing acid deposition and mercury in fish tissue programs continued to track statewide conditions. The Clean Vessel Act (CVA) program funded a mobile wastewater collection vessel that removed more than 11,000 gallons of wastewater from private recreational boats.

Several lake “special studies” were completed including water quality samples and continuous data sensors at Silver Lake, Hollis, NPDES permit monitoring on Marsh Pond, New Durham, ice-out sampling on Country Pond, Kingston and Lake Kanasatka, Moultonborough, and monitoring Nippo Lake, Barrington in conjunction with the application of aluminum compounds. A lake trophic survey was also initiated on Squam Lake for the first time since 1988. Last, a year-long EPA-supported project was completed that included monthly samples for aluminum, hardness and dissolved organic carbon from a subset of stations included in the river trend network.

WMB environmental data quality is ensured through Quality Assurance Project Plans (QAPP) or detailed standard operating procedure (SOPs). In both cases, these documents spell out specific procedures to confirm the acceptance of only high-quality data. These data are housed in NHDES' environmental monitoring database (EMD). The EMD contains millions of unique data records from over 46,000 monitoring stations and 800 individual projects. The EMD serves as a vital component in meeting the bureau's data management needs and responsibilities. The data is used for a variety of purposes including water quality assessment reports, total maximum daily loads, watershed management plans, water quality criteria development and permit issuance.

As part of NHDES’ ongoing efforts to provide reports on the condition of the state’s surface waters, a new report was completed titled, “Designated Use Assessment and Condition Estimates of New Hampshire’s Lakes, Ponds and Reservoirs 2017 – 2019, a statewide probability survey.” The report documents the condition of New Hampshire’s lakes and ponds based on results from 50 waterbodies. The results are compared to current New Hampshire water quality

criteria and to conditions from similar waterbodies on a national and regional scale. The report is NHDES publication R-WD-22-02 and is posted on the NHDES website (Lake Condition Report). Additionally, the NHDES Biomonitoring Program advanced the state's capacity to evaluate the condition of warmwater stream fish communities through the completion of a warmwater index of biotic integrity. The report (NHDES report R-WD-21-10) describing this index's development and use is available for public consumption on the NHDES website (Warmwater Fish Index Report). Other reports completed by the Biology Section staff regarding the condition of the state's surface waters can be found on the NHDES website on the River and Lake Monitoring homepage.

The following report describes the various program activities within the WMB that collected data, utilized the facilities of the JCLC in 2021, or provided services to the public. The report is organized into three sections; the first section provides individual program summaries in a standardized template for quick reference; the second section includes an account of the various quality assurance efforts that are undertaken, and the third section provides brief description of the lab and field safety measures that are in place.

I. WATERSHED AMBIENT MONITORING PROGRAM SUMMARIES

1.1 Jody Connor Limnology Center (JCLC)

Challenges Addressed: The JCLC practices rigorous science to ensure that water quality data can be used by communities and industry to make decisions about lake and river management. JCLC also has the capacity to respond to water quality emergencies such as toxic algal blooms and chemical spills. The JCLC provides the necessary equipment, expertise, and space to allow for the processing of thousands of water quality samples and field work associated with surface water assessments conducted throughout the state.

Data usage: Data processed through JCLC is used to complete surface water quality assessments, for issuance of public health advisories, completion of waterbody-specific reports, compliance with regulatory activities and general investigations of surface water quality.

Approach: JCLC provides equipment, analytical services and sampling services to support probability-based, synoptic and trend monitoring activities.

Parameters measured: JCLC and the Colby-Sawyer College satellite laboratory provide analysis for approximately 25 chemical and physical parameters as well as more than a half dozen biological parameters.

Method of data collection: Discrete samples are analyzed by JCLC. Continuous data records are generated by deployment of remote water quality sensors.

Achievements: In 2021, JCLC and the Colby-Sawyer College (CSC) satellite laboratory created 15,098 chemical records. JCLC analyzed 327 biological samples and made 2659 species-specific identifications. These numbers reflect near normal operations after a sharp decline in 2020 due to the pandemic. For more specific information on the achievements of the JCLC and the CSC laboratory in 2021 see Section 2.2 below.

Quality Assurance Measures: JCLC and the (CSC) each maintain a laboratory manual detailing quality assurance measures and procedures for each specific analysis. In-lab quality assurance measures include blanks, duplicate analyses, continuing calibration verification (CCV) samples and spikes where appropriate. An in-depth summary of all quality assurance measures can be found in Section 2 of this report.

In 2021 a Minimum Detection Level (MDL) study was completed for the Chlorophyll-a analysis. The study was performed with the assistance from PHL Drinking Water Lab using their methodology and calculation tools. Two different low-level aliquots were examined and calculated independently, and both yielded an MDL level significantly below 0.5 µg/l and therefore that level was assigned a reporting level in the database.

Funding: General funds (1000 account) and federal funds (Account 7602).

Program needs: Vital roles within the JCLC are shared amongst WMB monitoring staff. The Lab Safety Officer Walt Henderson, QA/QC Officer and Data Administrator Scott Ashley all have ambient monitoring programs responsibilities. The JCLC took a small step by hiring a dedicated intern to manage JCLC analysis and data entry operations for the past three summers, which has been quite successful. The JCLC has been fortunate each year to find some dedicated and competent candidates for this pivotal position. It would be an asset to the JCLC if this position had more permanence.

A replacement for the aging JCLC database is currently part of the NHDES IT Plan and the lab's highest priority. Moving forward with this project would be a benefit to the efficient operation of the JCLC.

1.2 Volunteer Lake Assessment Program (VLAP)

Challenges Addressed: VLAP works with lake associations to assess and protect the health of New Hampshire's lakes and ponds. Over 500 volunteers monitor summer water quality at 180 lakes. These data allow for the identification of potential problems and to fix them before they impact recreation or fishing. VLAP reports are routinely requested by realtors and lakefront property buyers.

Data usage: Data generated through VLAP are utilized annually to create approximately 180 annual individual lake reports. VLAP is a primary source of lake and pond data utilized to complete surface water quality assessments for the federally required section 305(b) / 303(d) water quality report. VLAP data are also utilized by NHDES to complete Total Maximum Daily Loads (TMDLs), watershed management plans, and by lake associations and organizations to apply for grant funds. The New Hampshire Lake Trend Report: Status and trends of water quality indicators utilized VLAP data collected from 1991 to 2018 in 150 lakes and was published in June 2020.

Approach: Trend Monitoring - Repetitive visits to set of established sampling locations annually or on an established schedule for the purpose of tracking water quality parameters over time.

Parameters measured: VLAP measures a total of 13 chemical and biological parameters including: pH, conductivity, turbidity, apparent color, chloride, total phosphorus, alkalinity, *E. coli*, dissolved oxygen, temperature, transparency, chlorophyll-*a* and phytoplankton (including cyanobacteria).

Method of data collection: VLAP collects discrete samples at multiple in-lake and tributary stations.

Achievements: In 2021, despite the COVID-19 pandemic, VLAP and its associated satellite laboratory Colby-Sawyer College, accomplished the following (~10% reduction of workload from normal years):

- 380 individual sampling events conducted by volunteers (an increase over normal years).
- 174 lake deep spots and 400 river/stream stations monitored.
- 15,075 individual chemical and biological sample results generated.
- Approximately 3,507 hours collecting water quality samples.
- Approximately $99,000 value of volunteer time collecting water quality samples.

Quality Assurance Measures: VLAP operates under an EPA-approved Quality Assurance Project Plan (QAPP), RFA# 19074, dated April 2019. VLAP is required to update the plan once every five years and submit to EPA for approval. VLAP is also required to complete an annual program audit detailing any deviations from the methods and data criteria stated in the QAPP and resolutions to those deviations.

Funding: General Fund (1000 Account).

Program needs: VLAP receives requests from lake associations and Watershed Management Bureau staff to add lakes or increase monitoring to supplement the development of water quality plans and to understand current lake conditions. VLAP is at its maximum capacity and can no longer accept new lakes. To provide expanded services requires additional staff to support operations in the Jody Connor Limnology Center and complete annual biologist visit trainings and audits at participating lakes.

1.3 Volunteer River Assessment Program (VRAP)

Challenges Addressed: VRAP was initiated in 1998 to promote awareness and education of the importance of maintaining water quality in New Hampshire's rivers and streams. VRAP volunteers monitor water quality from May through October in rivers and streams throughout the state, allowing NHDES to analyze water quality trends, identify potential problems and fix them before they cause degradation in water quality.

Data usage: VRAP is primarily a data procurement mechanism to determine whether rivers or streams are impaired or potentially impaired based on surface water quality criteria and designated uses (e.g., swimming, fishing and aquatic life support). Data collected through VRAP are used to develop the federally required section 305(b) / 303(d) water quality report. Almost 40% of the surface water quality assessments of riverine assessment units included in the 2020 303(b) report was provided by VRAP. Currently this data contributed to the assessment of over 3,000 miles of rivers and streams.

Approach: VRAP conducts trend monitoring via repetitive visits to established sampling locations on an established schedule. Targeted monitoring is also conducted to investigate suspected sources of pollution or to measure the water quality impacts as they relate to changes in the landscape such as development.

Parameters measured: VRAP measures field parameters including dissolved oxygen, pH, turbidity, specific conductance, water temperature and flow. Laboratory parameters include *E.coli*, nutrients, chloride and chlorophyll-*a*.

Method of data collection: VRAP collects discrete samples at multiple river and riverine impoundment stations.

Achievements: In 2021, data generated by VRAP volunteers are summarized as follows (~70% reduction of workload from previous years):

- 25 VRAP groups supported.
- Approximately 150 river/stream stations monitored across 3,000 miles of streams
- Approximately 3,500 individual chemical and biological sample results generated.

Quality Assurance Measures: VRAP operates under an EPA-approved QAPP dated May 17, 2017. VRAP is required to update the plan once every five years and submit to EPA for approval. VRAP is also required to complete an annual program audit detailing any deviations from the methods and data criteria stated in the QAPP and the resolutions to those deviations.

Funding: Federal funds (Account 7602).

Program needs: The day-to-day operations of VRAP are currently done by a part time staff member. If this position were to be made full time it would reduce the need for assistance from current full-time staff, reduce turnover in the current part time position, and provide consistency in program operations.

1.4 River Trend Monitoring Program (RTMP)

Challenges Addressed: RTMP began in the early 1970s, and prior to 2012, it was known as the Ambient River Monitoring Program (ARMP). In 2013, NHDES updated its surface water monitoring strategy to include 40 river and stream stations that are visited three to five times per year. The monitoring network includes stations that span a wide range of watershed sizes, levels of development, and geographic locations. All Data collected are maintained in NHDES' Environmental Monitoring Database (EMD). The RTMP is implemented directly by NHDES staff and measures water quality in rivers and streams throughout the state. Ultimately, it is used by many programs both within the bureau and outside.

Data usage: RTMP is primarily a data procurement mechanism to determine whether river or stream conditions are declining, improving or remaining stable over time. The data are used to assess if river segments are impaired or potentially impaired, based on surface water quality standards and designated uses (e.g., swimming, fishing and aquatic life support). Data collected through RTMP are used to develop the federally required section 305(b) / 303(d) water quality report. In 2019, data collected, in part, through RTMP was used to complete a report on the status and trends of water quality conditions in New Hampshire rivers.

Approach: RTMP conducts trend monitoring via repetitive visits to established sampling locations with the purpose of tracking water quality parameters over time. RTMP also conducts confirmation monitoring to determine if waterbodies can be removed from the 303(d) list. Targeted monitoring of previously unsampled waterbodies is also completed to gain additional information about the condition of New Hampshire surface water resources. Targeted sampling is done by sampling locations chosen from 10-digit hydrologic drainage units (HUC 10) using predetermined schedule.

Parameters measured: RTMP measures field parameters including dissolved oxygen, pH, turbidity, specific conductance, and water temperature. These parameters are collected via instantaneous measurements and deployable multi-parameter dataloggers. Laboratory parameters include nutrients (nitrogen and phosphorus), chloride, chlorophyll-*a*, metals, cations and other parameters as needed.

Method of data collection: RTMP collects discrete and continuous samples at multiple river and riverine impoundment stations. In 2021, over 2,100 individual chemical and biological sample results were generated.

Quality Assurance Measures: RTMP operates under an EPA-approved QAPP that is required to be updated every five years and submit to EPA for approval. An updated QAPP received approval from EPA in 2019. The RTMP is also required to complete an annual program audit detailing any deviations from the methods and data criteria stated in the QAPP and resolutions to those deviations.

Funding: Federal funds (Account 7602).

Program needs: The River Trend Monitoring Program requires continued financial support for laboratory and equipment costs. Annual costs to process water quality samples through this program are approximately $30,000. The equipment used by this program includes both handheld meters and multiparameter dataloggers that require regular maintenance and replacement. A recently identified limitation is the lack of funds for laboratory analyses of contaminants of emerging concern, such as PFAS.

1.5 Lake Trophic Survey Program (LTSP)

Challenges Addressed: LTSP was initiated in the mid-1970s to provide basic information on the hundreds of lakes and ponds in New Hampshire. The LTSP was revamped and reinitiated by the Biology Section in 2013 in order to generate periodic data on a portion of NH lakes and ponds.

Data usage: To establish or update lake trophic ratings and determine if waterbodies meet their designated uses as required by sections 305(b) / 303(d) report for the Federal Clean Water Act. In 2020, a report documenting the status and trends of lakes in New Hampshire was completed. The report is based, in part, on data collected as part of the LTSP.

Approach: Targeted monitoring. Lakes are selected from an annual schedule of targeted watersheds on a rotational basis using 10-digit hydrologic drainage units (Synoptic monitoring). The selection process is conducted by several biologists in the WMB and takes into consideration the age of available water quality data, public accessibility, and recreational use.

Parameters measured: At the deepest point(s) of a lake, a dissolved oxygen/temperature profile is collected, and the degree of stratification is assessed. Secchi depth transparency is measured. A composite water sample from the mid-metalimnion is collected and analyzed for Chlorophyll-*a*, and a plankton haul is collected to mid-metalimnion depth. A discrete mid-epilimnion sample is collected and analyzed for alkalinity, pH, conductivity, apparent color, chloride, calcium, magnesium, NO_2 and NO_3 nitrogen, TKN nitrogen, total phosphorus, potassium, sodium, sulfate, silica and dissolved organic carbon. If the dissolved oxygen/temperature profile reveals anoxic conditions (< 1 mg/L) in the hypolimnion a discrete sample is taken from the mid-hypolimnion and analyzed for pH, conductivity, chloride and total phosphorus. Beginning in 2016, spring sampling after ice-out and shoreline habitat data collection at 10 stations around each waterbody was added for newly selected waterbodies.

Method of data collection: The LTSP collects discrete samples.

Achievements: In 2021, 11 lakes were sampled. Due to the COVID-19 pandemic the 10 new lakes selected for sampling on a rotational basis in 2021 were postponed until a future date; however, staff opted to target Squam Lake, New Hampshire's second-largest lake, which was last surveyed in 1988. The initial sample effort took four days. The remaining 10 sampled were initiated in 2019. Overall, a total of 175 chemical records were generated. Additionally, 10 summary reports were finalized from the 2018 selection of lakes. Lake trophic survey reports can be found on the Lake Information Mapper.

Quality Assurance Measures: LTSP's QAPP RFA #21039 was approved by EPA in 2015 and updated in 2021. All analyses are performed in accordance with the JCLC laboratory manual or the Department of Health and Department of Health and Human Services – Public Health Lab (DHHS-PHL) NELAC certification.

Funding: General funds (Account 1000) and federal funds (Account 7602).

Program needs: The LTSP requires continued financial support in order to maintain its current staffing level, laboratory analysis, and field equipment costs. It is important to note, however, that there are often 50 or more candidate lakes with data that are 20 years or older. At the current level of support the program is only able to select 10 new lakes each year for sampling. At this pace the NHDES will not be able to update the data on all lakes and ponds in New Hampshire without increased capacity for sampling.

1.6 Biomonitoring

Challenges Addressed: The biomonitoring program was established in 1995 to determine the ability of the state's surface waters to support a healthy community of aquatic organisms. Sampling is completed each in summer and fall and serves to satisfy federal water quality reporting requirements under sections 303(d) / 305(b) for the Clean Water Act. To date, sampling by the biomonitoring program has been primarily focused on rivers and streams.

Data usage: Data produced through the biomonitoring program are used to complete water quality assessments to determine whether rivers or streams are impaired or potentially impaired, based on surface water quality criteria and designated uses (aquatic life support). Biological data are used in the development of water quality criteria and in making regulatory decisions. Data collected through the biomonitoring program are used to develop the federally required section 305(b) / 303(d) water quality report. The data are also used to track site-specific trends in biological condition and characterize the variability associated with macroinvertebrate data.

Approach: Starting in 2013, biological monitoring expanded to support three elements of the NHDES surface water quality monitoring strategy: trend, synoptic (targeted) and probability-based monitoring. Trend monitoring is conducted in collaboration with River Trend Monitoring Program and encompasses approximately 28 long-term stations monitored annually. Synoptic monitoring selects stations within specified HUC10 watersheds each year. In 2021, the biomonitoring program assisted other WMB staff with deployment and retrieval of 28 water temperature loggers and completing water quality monitoring at 40 trend monitoring sites between May and October. Biomonitoring staff were responsible for coordinating the collection of macroinvertebrate data at 28 trend monitoring sites. With assistance from WMB staff, rock baskets were deployed and retrieved approximately eight weeks later. Macroinvertebrate collection at 12 of the 28 trend sites was also done using kick-nets. Collection of fish data occurred for six events at six locations. For the seventh consecutive year, NHDES and the New Hampshire Fish and Game Department worked cooperatively to complete fish surveys at several trend sites.

Parameters measured: Fish, macroinvertebrates, dissolved oxygen, pH, specific conductance, water temperature, flow, physical habitat characters and various laboratory generated water chemistry parameters.

Method of data collection: Discrete water quality samples and physical habitat measurements. Continuous water temperature data. Surveys of biological communities including fish and macroinvertebrates.

Achievements: In 2021 the Biomonitoring Program accomplished the following:

- Temperature Loggers: Assisted other WMB staff with deployment and retrieval of 28 water temperature loggers.
- Water Quality: Assisted WMB staff with water quality monitoring at 40 trend sites.
- Macroinvertebrate samples: Deployment and retrieval of 97 samples at 43 sample sites (>19,000 data points).
- Fish surveys: Six sample sites (>1,900 data points).
- Completion of a warmwater index of biotic integrity (Warmwater Fish Index Report).

Quality Assurance Measures: The Biomonitoring Program operates under the RTMP QAPP, an EPA-approved QAPP that is required to be updated every five years and approved by EPA. The QAPP received EPA approval in 2015 and again in 2019. The Biomonitoring Program is also required to complete a bi-annual program audit detailing any deviations from the methods and data criteria stated in the QAPP and resolutions to those deviations. Specifics on the Biomonitoring Program's QAQC efforts can be found in Section 2.4.

Funding: Federal funds (Account 7602).

Program needs: The Biomonitoring Program requires continued support for sample processing, supplies and equipment on an annual basis. Although expensive, the program would be enhanced by microalgal sampling and toxicological analysis.

1.7 Fish Tissue Mercury Monitoring Program

Challenges Addressed: To collect data on the mercury content in tissue of freshwater fish species within the State of New Hampshire. The source of mercury contamination is from airborne stack emissions regionally and from the west due to prevailing winds. This makes mercury contamination of fish a widespread problem in New Hampshire.

Data usage: The data are used to conduct risk assessments for mercury exposure from fish consumption. Risk assessments are used to update statewide and, if appropriate, waterbody-specific fish consumption advisories. The data are also used to track trends over time in the mercury content in fish tissue. A summary report was initiated in 2015 and was finalized in 2018. The report includes data from 1992 through 2017.

Approach: Trend and targeted monitoring. Most samples are supplied by volunteers who bring in fish from the lake where they live or often fish. Additional fish may be obtained through specific studies related to regulatory changes designed to reduce the deposition of atmospheric mercury. Additionally, certain waterbodies have been targeted for long-term collection to perform trend monitoring.

Parameters measured: Mercury content in fish tissue expressed as mg of elemental mercury/kg of fish, weight and length of the fish.

Method of data collection: Discrete.

Achievements: In 2021, 43 fish were collected. Mercury in fish tissue data for 238 lakes can also be found as individual waterbody mercury reports on the Lake Information Mapper.

Quality Assurance Measures: The scale used for the weight is inspected and certified annually by a third party (contractor). Blanks, duplicates, continuing calibration verification (CCV) and spikes are performed in accordance with JCLC laboratory manual protocols.

Funding: General Fund (Account 1000B).

Program needs: A revised sampling design is required to maintain consistency in the number of fish analyzed, waterbodies sampled, and fish species assessed. Implementation of the revised design requires collaboration from the Fish and Game Department.

1.8 Acid Rain Deposition Program

Challenges Addressed: To collect data on acid rain deposition and determine its effects on sensitive lakes and ponds. Acid deposition is caused when SO_2 and NO_X is released into the atmosphere from burning hydrocarbon fuels. In New Hampshire most emission sources result from westerly stack emissions brought in on prevailing winds, regional stack emissions and automotive emissions.

Data usage: Data are used to conduct trend analysis on the effects of acid rain deposition and the effectiveness of air pollution regulations. Data have been used by the New Hampshire Fish and Game Department to make stocking decisions on acid sensitive ponds and lakes. In 2015, a summary report was completed utilizing data collected from the mid-1980s through 2014.

Approach: Trend Monitoring. Lakes and ponds included in this monitoring program have been monitored consistently for more than 30 years. Twenty ponds are sampled by WMB staff, and 10 remote ponds are sampled cooperatively by Fish and Game during helicopter stocking. Rain is also collected in Concord, NH, and analyzed to verify source inputs to lakes and ponds.

Parameters measured:

- Lakes/Ponds **–** pH, acid neutralizing capacity, conductivity, color, sulfate, nitrate, and chloride.
- Rain – pH, nitrate, sulfate and total phosphorus.

Method of data collection: Discrete. Samples are collected from specified lake outlets in fall and spring. Rain event samples are collected at NHDES headquarters in Concord.

Achievements: In 2021, 287 chemical records were generated to support the remote and non-remote lakes monitoring effort during the spring and fall collection events. The collection of rain resumed for 2021 as more normal operations occurred at 29 Hazen Drive (NHDES headquarters). A total of 31 rain events were collected resulting in 136 chemical analyses.

Quality Assurance Measures: This program is included in the Lake Trophic Survey Program QAPP that was approved by EPA in 2015.

Funding: General funds (Account 1000B) and federal funds (Account 7602).

Program needs: Continued support for current staffing, laboratory analyses and equipment needs.

1.9 Surface Water Quality Complaints

Challenges Addressed: Investigate concerns impacting surface water quality reported to the Watershed Management Bureau by staff and the public.

Data usage: Data are used to evaluate whether an issue or water quality criterion violation exists. If an issue exists, there may be administrative action taken by NHDES or a referral to another agency for action to be taken.

Approach: If an investigator deems monitoring is warranted, targeted sampling is completed at strategically located stations. All complaints are logged into a complaint module of the Environmental Monitoring Database (EMD).

Parameters measured: Depends on the nature of the complaint.

Method of data collection: Continuous monitoring or discrete samples depending on the nature of the complaint.

Achievements: In 2021, 61 complaints were received, 23 were investigated, 15 were office resolved and 23 were referred to or worked with other bureaus. No samples were processed for complaints in the JCLC.

Quality Assurance Measures: Parameter specific based on the JCLC Laboratory Manual or DHHS water lab protocols.

Funding: General funds (1000 account).

Program needs: This program is administered by one person who has other duties. In the summer when monitoring activities are at their maximum, resources for a field investigations and sampling are be limited. These resources include vehicles and sampling equipment.

1.10 Public Bathing Facility Program (PBFP)

Challenges Addressed: RSA 485A:26 requires NHDES to operate a year-round statewide program to ensure health and safety of public bathing facilities such as pools and spas. Exposure to contaminated, poorly managed and maintained pool and spa water in New Hampshire has resulted in lung, skin, ear and eye infections, as well as gastric illness caused by pool chemicals or airborne and waterborne pathogens such as Legionella, Cryptosporidium, Giardia, Staphylococcus, Norovirus and E. Coli. The program has established standards of design and operation to ensure that construction provides for safe use, that scheduled maintenance is regularly performed, and that water quality is routinely monitored and maintained at all times.

Data usage: Data generated through PBFP are used to evaluate facility compliance with state and federal public health and safety laws, determine enforcement actions, prioritize seasonal/regional inspections, shape educational outreach efforts and make historical comparison to evaluate program effectiveness. The U.S. Center for Disease Control makes periodic requests for data in studying chlorinated aquatic venues.

Approach: Targeted monitoring. PBFP conducts periodic routine inspections to evaluate public health and safety and responds to illness complaints.

Parameters measured: PBFP measures a total of 10 chemical and biological parameters. In-situ analysis includes temperature, pH, free chlorine, total chlorine, combined chlorine, bromine, turbidity, total dissolved solids, cyanuric acid, hardness and alkalinity. Field samples are submitted to DHHS-PHL for *E. coli* and total coliform analysis.

Method of data collection: PBFP collects discrete samples at public bathing facilities statewide.

Achievements: In 2021, inspection activity was limited to pre-opening inspections because of COVID-19 restrictions. In total, the PBFP achieved the following:

- 9 facility inspections.
- Collected 18 samples for chemical analysis.
- Identified 0 water quality violations.
- Found 0 safety/facility violations.
- Issued 0 Letter of Deficiencies.
- Issued 0 Notice of Deficiencies.
- Issued 14 full design permits for new construction.

Quality Assurance Measures: Follows and updates the PBFP Field Inspection QA and SOP manual (last updated 5/23/2017). PBFP staff follows JCLC quality assurance measures for specific analysis. PBFP is also required to complete an annual program audit detailing any deviations from the methods and data criteria stated in the QA manual and resolutions to those deviations.

Funding: Newly established dedicated account- (1045) – funded by design review fees and annual PBF self-certifications.

Program Needs: Additional staff funded through the self-certification component or other sources is required to make this program more successful.

1.11 Public Beach Inspection Program (PBIP)

Challenges Addressed: PBIP personnel collect water from coastal and freshwater beaches to test for fecal bacteria to protect the public health of swimmers. During the 2021 summer swim season (Memorial Day to Labor Day), NHDES personnel sampled 32 freshwater public bathing beaches and 16 coastal beaches. The freshwater beaches are sampled on a monthly or semi-monthly schedule. The coastal beaches are sampled on a semi-weekly, weekly or semi-monthly basis according to a tiered monitoring plan. When the bacteria counts at a designated public beach are higher than the State criteria, an advisory is issued and the public is notified approximately 24 hours after sampling.

Data usage: The main goal of the program is to use the data collected to protect public health and inform the public of potential health risks at public beaches. Over time, data from beach sampling are used to determine impairment for the 303(d) list of impaired waters.

Approach: Targeted. Samples are collected at individual beaches based on a predetermined schedule and used to make daily advisory decisions regarding public health and safety. Follow-up sampling at beaches with advisories is completed as necessary until fecal bacterial levels fall below State criteria.

Parameters measured: The main parameters measured are fecal bacteria (*E. coli* – freshwater beaches; enterococci – coastal beaches). Beach inspections also include measuring water temperature and salinity, recording the number of bathers, waterfowl, and dogs, as well as assessing the general beach and water conditions. Additionally, water clarity, coastal tide levels and any other concerns or comments are noted during visits to beaches.

Method of data collection: Discrete data points are collected during each beach visit.

Achievements: In 2021, a total of 333 *E. coli* samples were collected from New Hampshire freshwater beaches during swim season. This resulted in 13 advisories at 10 different beaches, totaling 77 advisory days. In 2021, there were 877 enterococci samples collected from New Hampshire coastal beaches during swim season. This resulted in 18 advisories from seven of the coastal beaches, totaling 52 advisory days.

Quality Assurance Measures: An EPA-approved PBIP QAPP was updated in April 2017 (RFA# 17075).

Funding: Federal funds, Org. Code: 2065, Approximately $190,000 per year.

Program needs: There has been frequent changes to the freshwater beach sampling schedule in recent years in terms of what beaches are being sampled and how often. There is a need to establish a routine schedule that will help to increase the sampling frequency at popular beaches with reoccurring advisories. There is also a need to establish protocols for self-samplers, who can collect more samples and, in turn, produce valuable data, through a volunteer beach inspection program.

1.12 Clean Vessel Act (CVA) Program

Challenges Addressed: The New Hampshire CVA program works to ensure that wastewater from boats is disposed of properly. Given the vast and growing number of boaters in New Hampshire, education is much more important than enforcement. The program works with marinas and the boating public to educate boat owners about how to manage sewage and graywater in a way that protects New Hampshire's surface water quality. The program provides funding for mobile and stationary pumpout facilities to ensure plenty of options for wastewater offload are available.

Data usage: The locations, availability and status of operation of stationary and mobile pumpout resources are tracked to provide this information to the public boating community and to identify potential CVA funding assistance opportunities. Additionally, data from the mobile pumpout services are collected and stored.

Approach: Targeted information is collected annually about stationary and mobile pumpout resources through grantees, contractors and facility owners. The CVA program offers grants year-round to help keep pumpouts operational.

Parameters measured: Information collected may include the location of the pumpout resource, whether it is stationary or mobile, marina amenities, pumpout system mechanical information, system availability, usage fee collected (if any), participant contact information, vessel name, vessel type and estimated wastewater gallons pumped. Information for the boat inspection database is collected from individual boat registrations and wastewater systems that include graywater and marine sanitation devices. Details on location, dates of inspections and/or re-inspections, and compliance/non-compliance issues are documented by the boat inspector.

Method of data collection: Staff use data sheets for site visits of a stationary facility. Grantees are required to document boater information and wastewater estimates in logbooks to receive annual reimbursement for upkeep costs. The mobile pumpout services collect information using a physical receipt during each service. The boat inspection program collects data on physical forms or may enter directly onto a laptop in the field if one is available.

Achievements: In 2021, the program accomplished the following:

- The mobile pumpout boat documented about 893 captain hours, 543 serviced boats and approximately 11,242 gallons of wastewater pumped.
- Since 2002, the mobile pumpout services have pumped off approximately 229,033 gallons of boater wastewater.

Quality Assurance Measures: Input from data sheets, logbooks and receipts are verified either by the seasonal intern or CVA program coordinator. Boat inspection database entries are reviewed by either the boat inspection program staff or CVA program coordinator.

Funding: Federal Funds, Org. Code 2061, SFY 2021 $320,112.

Program Needs: Currently the program funds 50% of a full-time staff position as the program coordinator and a summer intern position. Since 2018 the boat inspector position has been vacant but typically the position works weekends, about 5 hours a week or less. The summer intern position was filled in 2018 after many years of vacancy and filled again in 2019. In 2020, it was not filled due to pandemic restrictions. Future goals include increasing the percent of time for 100% of a full-time staff position. The boat inspector position was difficult to fill due to its very limited hours and the limited hours also led the position to be less effective. It may be beneficial to the inspection program for the program coordinator position to assume the boat inspection responsibilities.

1.13 Exotic Species Program

Challenges Addressed: The primary purpose of New Hampshire's Exotic Aquatic Plant Program is to "prevent the introduction and further dispersal of exotic aquatic weeds and to manage or eradicate exotic aquatic weed infestations in the surface waters of the state" (RSA 487:17, II). Aquatic invasive species are a constant threat to the ecological, biological, recreational, and economic values of New Hampshire's waterbodies. Infestations lead to waterbody impairments and reduced values of the resource.

Data usage: Data generated through the Exotic Species Program are used to guide control activities on waterbodies. Data are also used to track concentrations of aquatic herbicides that may be used in various waterbodies and to determine the presence/absence of invasive aquatic plants in waterbodies.

Approach: Trend Monitoring. Repetitive visits are made to infested waterbodies to track infestations (size, density, distribution) over time. Targeted water quality monitoring may also be performed to document conditions before, during, and after implementation of the control practices

Parameters measured: Plant location, density and percent cover are surveyed annually on infested waters. Water depth, clarity, dissolved oxygen concentrations, herbicide concentrations, nutrient concentrations, temperature and turbidity may also be monitored.

Method of data collection: Discrete samples and observations at multiple stations in lakes and ponds for plant surveys or as needed for special studies. Data loggers are occasionally deployed for continuous data collection for parameters like dissolved oxygen.

Achievements: In 2021, the Exotic Species Program collected the following data:

- 91 waterbodies infested (dating back to 1965).
- One new infestation of a state-listed aquatic invasive plant (spiny naiad, *Najas minor*) was documented in Country Pond in Newton.
- >250 plant identifications.
- >80 field inspections (GPS).

Quality Assurance Measures: Activities performed by the Exotic Species Program are described in the Quality Assurance Project Plan for the program, which was approved in 2014 by EPA, with an update and revision approved by EPA in 2019.

Funding: State Fee Funds derived from boat registrations total approximately $893,000 annually.

Program Needs: Additional funding is needed to expand control efforts. Currently, just under half of the waterbodies with infestations are being managed. Grant awards for management are provided by the state, but local entities assume at least 60% of the cost of management on the municipal or non-profit level. Also, additional work is needed to expand knowledge of the out-of-state boater decal requirement that was initiated in June 2021, so that more boaters visiting New Hampshire are aware of the need for a decal, if their vessel is registered in a state other than New Hampshire.

1.14 Chloride Reduction efforts

Challenges Addressed: Chlorides are toxic to aquatic organisms, plants and to the infrastructure that supports our roads and bridges. NHDES has measured increasing chloride pollution in both lakes and rivers over the past 20 years. The primary source of those chlorides is road salt used for winter maintenance. NHDES has a number of programs to address this issue that include implementation monitoring for chloride Total Maximum Daily Loads (TMDL) of water bodies in the vicinity of the I-93 corridor from Massachusetts to Manchester, NH, and a voluntary commercial salt applicator certification program (Green SnowPro or GSP). Each of these programs has been successful in their respective efforts to reduce chloride contamination of the environment.

Data usage: The data is used to determine track surface water trends, compliance with the TMDLs, and judge success of the commercial salt applicator program.

Approach:

- Monthly monitoring at river trend monitoring sites and lakes that participate in VLAP.
- Continuous datasonde monitoring at four stations within the I-93 Corridor.
- Handheld measurement and grab samples at one site weekly and all sites every three weeks.
- Datasonde QA/QC checks, data download and maintenance every six weeks.
- Number of approved certified applicators.

Parameters measured (TMDL, River Trend, VLAP): Temperature, specific conductance and chloride. The chloride samples are processed in the Jody Connor Limnology Center**.**

Parameters measured (GSP): Applications received and meeting the approval criteria as specified in RSA 489-C.

- Method of data collection (TMDL): Continuous (datasonde) and discrete (chloride).
- Method of data collection (GSP): Electronic (PDF or Word attachments), facsimile or direct mailing of hard copy applications.

Achievements:

- 34,000-35,000 data points per station per year.
- Over 1,200 certified salt applicator certificates issued since 2011.

Quality Assurance Measures (TMDL): A full description of all the data quality control measures are contained in a 2006 EPA-approved QAPP, the 2018 Ambient River Monitoring Program QAPP and updated field SOPs for the I93 Implementation monitoring.

Quality Assurance Measures (GSP): Certified Salt Applicators must apply for certification annually and meet the requirements listed in the RSA.

Funding (TMDL): NHDES has expended all the funding dedicated for the TMDL and monitoring by NHDOT as part of the I-93 study. Additional monitoring funds may become available as a result of the future Exit 4A project.

Funding (GSP): The Commercial Certified Salt Applicator Program became fee-based as of June 2018. Application costs are tiered and written into the RSA. These funds support a part-time Salt Reduction Coordinator position within NHDES.

Program Needs (GSP): The Green SnowPro salt reduction coordinator position was filled in August 2018. The position is part time and tasked with processing hundreds of applications each year, planning for the annual Salt Symposium, organizing and hosting full and refresher training courses, assisting with database development, conducting outreach, education, and evaluating and implementing new marketing opportunities. The scope of work associated with this program merits a full-time coordinator.

1.15 NHDES Shellfish Program

Challenges Addressed: The mission of the Shellfish Program is to ensure that the shellfish harvested in New Hampshire meet standards for human consumption. The program monitors coastal waters for bacteria, viruses and algal blooms that produce biotoxins that can accumulate to potentially fatal levels in shellfish. The program creates the regulatory conditions that allow the commercial shellfish industry to legally harvest and engage in interstate commerce. Recently, the commercial shellfish industry has grown rapidly in New Hampshire, adding two to three commercial aquaculture farms per year since 2011. In 2021, there were 28 oyster farms, four oyster upwellers and five blue mussel farms. The program also ensures the safety of recreational shellfishing.

Data usage: Data generated by the Shellfish Program are used to prepare and update Sanitary Survey reports for the eight major shellfish growing areas in the state's jurisdiction. Data generated by the program are also used to make daily and weekly management decisions regarding which harvesting areas are open or closed based on current information on public health threats such as red tide levels, recent rainfall, boating and mooring surveys and others. These decisions are communicated through a hotline message and internet-based tools.

Approach: The shellfish monitoring program implements a systematic random sampling program to maintain updated bacteria data on 70 monitoring stations in the state's tidal waters. Data from event-based seawater and shellfish tissue testing after pollution events such as heavy rainfall events are used to supplement the ambient program and to support management decisions. Additional monitoring programs include Harmful Algal Bloom Monitoring, Shoreline Survey Program, and new monitoring programs focused on *Vibrio* bacteria risk assessment and on viral indicators of sewage pollution.

Parameters measured: Seawater and shellfish tissue sampling programs document fecal coliform bacteria, water temperature, salinity and other observations; phytoplankton monitoring and biotoxin levels in blue mussels and other shellfish species; water temperatures near commercial oyster farms and Vibrio bacteria levels in oysters; and Male Specific Coliphage (virus) levels in municipal wastewater treatment facility effluent, as well as in oysters, softshell clams and blue mussels.

Achievements: In 2021, the Shellfish Program accomplished the following:

- 51 rounds of sampling on tidal waters.
- 1,077 seawater samples collected.
- 27 rounds of sampling in response to rainfall events.
- 59 red tide samples collected.
- 109 rounds of phytoplankton/seawater sampling completed for harmful algal bloom identification.
- 568 commercial harvesting decisions generated.
- 108 wastewater treatment facility calls evaluated.
- 70 harvesting hotline updates implemented.
- 1,985 properties surveyed and tracked for pollution.
- 16 marina/mooring field surveys performed.
- 891 pollution sources tracked.
- 53 rounds of pollution source sampling completed.

Quality Assurance Measures: The Shellfish Program operates under three EPA-approved Quality Assurance Project Plans (QAPPs), dated May 2013, addressing ambient monitoring, Red Tide monitoring and shoreline survey monitoring. All three are currently being redrafted for the five-year updates. These updates will be submitted to EPA for approval in 2022. The "Red Tide" monitoring QAPP is being revised into a "Harmful Algal Bloom" QAPP that will incorporate new monitoring programs involving weekly sampling and enumeration of selected marine phytoplankton. The Shellfish Program is also required to complete a program audit every other year detailing any deviations from the methods and data criteria stated in the QAPPs and resolutions to those deviations.

Funding: General fund (1523) FY 22 $441,753.

Program Needs: Increased capacity for offshore/nearshore monitoring of Harmful Algal Blooms needs to be developed, especially with respect to the algae genus *Pseudo-nitzschia*, and the biotoxin domoic acid. Increased capacity for laboratory testing of shellfish tissue and field screening methods for marine biotoxins is needed. Increased capacity for managing growing commercial aquaculture industry also needed.

1.16 Special Studies

Challenges Addressed: Short-term monitoring to collect data for the purposes of evaluating the environmental impact of a temporary event such as construction, answer a specific scientific question, evaluate a data collection method, or solve a specific problem within a waterbody or watershed.

Data usage: The primary use of data will fulfill the goal of the study. Any ambient monitoring data will be available via the EMD for other programs to use.

Approach: Targeted monitoring approach.

Parameters measured: Determined by study design.

Method of data collection: Determined by study design.

Achievements: From October 2020 to October 2021, NHDES partnered with EPA for a one-year special study investigating dissolved organic carbon (DOC) levels in rivers around the state. Twenty river sites were sampled monthly, and 40 river sites were sampled June through August for DOC and other water quality parameters to better understand temporal and spatial DOC variability and to assist NHDES in adopting EPA's 2018 aquatic life criteria for aluminum. NHDES also partnered with EPA for enhanced monitoring on Silver Lake in Hollis, NH. EPA provided a multiparameter, continuous monitoring sonde that was deployed at the deep spot location of the waterbody from May through September. This sonde collected > 80,000 data points. Additionally, NHDES paired the sonde with a continuous monitoring dissolved oxygen/ temperature array to better understand stratification patterns.

A new monitoring effort was initiated by NHDES to sample Marsh Pond in Alton under the provisions the NPDES permit issued to Powder Mill Fish Hatchery in New Durham. Marsh Pond was monitored twice a month from May 2021 to October 2021.

For 2021, seven special studies were in progress involving the JCLC, including: 1162 analyses for the Nippo Lake Alum treatment the first such treatment in the state in about four decades; 190 analyses for the Silver Lake Special Study; 72 analyses for the Spiny Water Flea monitoring project; 288 analyses for the Lake Regional Monitoring Network; 109 analyses for the River Regional Monitoring Network; 101 analyses for the Marsh Pond NPDES permit; and 3766 analyses for the River DOC project.

Quality Assurance Measures: As determined by study design.

Funding: Various.

Program Needs: A sustained source of funds is required to support focused lake studies where cyanobacteria blooms occur regularly. These funds would be used it identify the source of nutrient loads, level of cyanobacteria toxicity and bloom likelihood, and implementation of lake management actions to reduce cyanobacteria bloom likelihood.

1.17 Harmful Algal/Cyanobacterial Bloom Program (HAB)

Challenges Addressed: HAB program personnel collect water from lakes, ponds and rivers in response to the presence of algal and cyanobacterial blooms. When a cyanobacterial bloom is observed, the public are encouraged to take a photo and report the location of the bloom. When the cyanobacteria cell counts are higher than the state thresholds, an advisory is issued to notify the public of its severity. The program also responds to complaints about other algae and suspicious anomalies needing microscopic identification. In 2021, NHDES instituted a cyanobacteria "alert." Alerts notify interested parties when blooms are occurring but are not at a level that require an advisory.

Data usage: The main goal of the program is to use the data collected to protect public health and inform the public of potential health risks. These data are also used to determine impairment for the 303(d) list of impaired waters. Cyanobacteria data further help to inform the safety of surface water supplies for public drinking water.

Approach: Targeted data collection. Samples are collected from the location(s) of the complaint that was reported. Public access sites such as beaches and boat launches are also sampled. Follow up sampling at waterbodies with advisories is completed weekly until cyanobacteria levels fall below state criteria.

Parameters measured: Samples are analyzed for the microscopic identification of algae or cyanobacteria, the concentration of the cells per volume of water, and concentrations of select cyanotoxins by way of enzyme-linked immunosorbent assay (ELISA). Additionally, water clarity, weather, temperatures and any other concerns or comments are noted during site inspections. Data are entered under complaints of the EMD.

Method of data collection: Grab samples or discrete data points are collected during each inspection.

Achievements: In 2021, a total of 755 samples were collected from New Hampshire waterbodies for cyanobacteria or microscopic identification due to algae complaints.

Quality Assurance Measures: SOPs and QAPPs are under development.

Funding: General funds, Org. Code: 1000.

Program needs: This newly formed program is need of an approved QAPP that details the operations for data management, communication and reporting for cyanobacterial blooms and algal complaints.

1.18 Surface Water Quality Assessments (305(b)/303(d))

Challenges Addressed: The water quality status of New Hampshire's surface waters are reported in accordance with Section 305(b) and 303(d) of the Clean Water Act (CWA), and New Hampshire Statutes Chapter 485-A:4.XIV. Per the ClWA, assessments are to be completed biennially on even numbered years.

Data usage: Assessments are viewed and used by the general public, local, state and federal agencies, as well as non-governmental organizations. Assessment results are formally sent to EPA for transmital to Congress. All assessment results are made availiable to the public via the program website and a web-based data mapper.

Assessments determine if a waterbody meets its designated uses. Waters that do not meet one or more designated use are considered impaired. In cases where a waterbody meets one or more of its designated uses, protection measures may be an appropriate management action. The Surface Water Quality Assessment Program does not take any actions based upon the attainment determinations, but rather provides that information to other programs. Impaired waters become eligible for 319 restoration funds. Impairment status may influence certain permitting actions.

Method of data collection: The primary source of data for the assessments is the EMD. Every two years, as part of the assessment process, a snapshot of "recent" samples is imported to the Supplimental Assessment Database (SADB) for processing and tracking. The snapshot includes discrete and continuous data records.

Achievement: For the combined 2020/2022 cycle, the Surface Water Quality Assessment Program reviewed the following to complete designated use support decisions:

- 230 different project sources of data.
- 9,815 monitored stations.
- 466,520 individual sampling events.
- 488,477 day/parameter combinations from datalogger record sets.
- 1,758,189 individual chemical and biological grab sample results.
- 4,867,942 individual water quality standard comparisons were made.

Quality Assurance Measures: In addition to the quality assurance methods of each of the data sources, the assessment is guided by set of standard procedures called the Consolidated Assessment and Listing Methodology (CALM). More information is available on CALM on the Surface Water Quality Assessment publications website.

Asessments are conducted in a stepwise fashion. First, the SADB manages all imported sample data and performs the initial sample level water quality standard comparisons. Next, each waterbody/parameter combination is summarized in bulk and those bulk assessments are quality assured by a second individual. Third, the detailed lists of waterbodies with significant changes and/or borderline assessments are subjected to detailed review using a tool that allows all samples to be paired up with weather and flow data. Finally, all new impairments and de-impairments are vetted through professional staff to confirm that the data are sufficient to support those decisions.

Funding: Federal funds, Org. Code: 7602.

Program Needs: The process of the biennial vetting of assessments through NHDES professional staff could be streamlined.

1.19 TMDL Program

Challenges Addressed: The TMDL Program develops pollution budgets for impaired waters. TMDLs have been developed for rivers/streams and lakes/ponds. In the past several years the focus of TMDL development has been on bacteria and nutrient impairments. A lake phosphorous TMDL was completed on Locke Lake in Barnstead in 2020. In 2021, the TMDL Program is developing another lake phosphorous TMDL on Daniels Lake in Weare.

Data usage: The TMDL Program uses in the NHDES Environmental Database (EMD) to estimate nutrient loads and develop estimated reductions necessary to achieve water quality targets. Where needed, supplemental data are collected to develop, update and/or confirm existing data.

Approach: Data used in the development of TMDLs are targeted to the specific waterbody of interest or those draining into or out of the waterbody of interest.

Method of data collection: When necessary, the TMDL program collects discrete and continuous data in lakes, ponds, rivers and streams where applicable to develop each TMDL project. Samples are collected following the applicable EPA approved programmatic QAPP(s).

Achievement: Since 2000, EPA has approved 947 TMDLs in New Hampshire. In 2017, EPA approved the Northeast Regional Mercury TMDL, which accounted for 5,124 additional TMDLs.

Quality Assurance Measures: The TMDL program uses data in the EMD that has been collected according to an EPA approved programmatic QAPP. The TMDL program is also required to complete an annual program audit detailing any deviations from the methods and data criteria and resolutions to those deviations.

Funding: Federal funds, Org. Code: 7602.

Program Needs: The program would benefit from additional staff resources to develop TMDLs.

1.20 Rivers and Lakes Management and Protection Programs

Challenges Addressed: The Rivers and Lakes Management and Protection Programs provide a mechanism for public recognition and management of important state waterbodies. In addition, it participates in the development and implementation of statewide surface water management policies.

Data usage: The Instream Flow (ISF) Program uses stream flow data to determine when management such as water use alternatives and flow releases is needed on designated rivers for which protected instream flows have been established. The Program also measures river stage and flow to develop rating curves for locations without stream gages.

Method of data collection: Continuous, seasonal data records are obtained for stream flow, conductivity, water level and water temperature. Discrete field measurements of stream velocity, depth and width are collected to estimate stream flow when gages are not available.

Achievements:

- Cold River protected instream flow criteria presented to the public and documented in a final report.
- 19 Designated Rivers; 1,010 total Designated River miles.
- 22 Local River Management Advisory Committees (LACs).
- 200+ active volunteers.
- 229 permit applications reviewed by local citizens in 2021.
- 8 State-owned surplus land disposals reviewed in 2021 ensuring that public access to state waters is maintained.
- 27 letters of testimony submitted during the 2021 New Hampshire legislative session by the state-wide Rivers and Lakes Management Advisory Committees.
- Installed one water level/stream flow station on a designated river with a real-time data uplink interface to the web.

Rivers Program staff assisted four LACs with successfully funded grant applications to update river corridor management plans on five designated rivers. Plans are expected to be complete in 2022.

In 2021, staff contracted with a consultant to conduct the Ashuelot River protected instream flow study. Field work to develop protected instream flow criteria was continued on the Warner River and begun on the Ashuelot River. Staff placed dataloggers in four rivers to collect water quality data as part of the long-term monitoring process to determine program success.

Quality Assurance Measures: Elevation surveys and streamflow measurements are assessed by repeated measurements to evaluate the variability of individual measurements and estimate the overall accuracy of the results. Water temperature and water conductivity are compared using hand-held meters.

- NHDES Instream Flow Priorities for Annual Monitoring/Sampling.
- NHDES Instream Flow Protocols for Performing Instream Flow Studies.
- NHDES Instream Flow Protocols for Conductivity, Temperature, and Water Level Dataloggers.
- NHDES Protocols for Long-Term Monitoring of Riparian Ecosystems.
- NHDES Procedures for River Stage and Streamflow Measurement.
- NHDES Protocols for Streamflow Station Data Management (in development).
- NHDES Protocols for Stream Gradient and Floodplain Transect Survey.

Funding: General Funds: Org. Code 1518 (FY2021 $486,200); Federal Funds: Org. Code 7602 (FY2021 $116,078).

Program Needs: In 2020, two part-time and one full-time staff took positions in other areas of NHDES. One part-time position was filled in 2021, resulting in continuing impacts to LAC, RMAC and LMAC support. The ISF Program needs one additional part-time biologist to evaluate fish, wildlife and riparian plant community health and to develop long-term

monitoring protocols for determining the effectiveness of program implementation. The Program also needs additional contract funds of $100,000 to $200,000 per year over FY21 funding levels, depending on the length of the river under development, to hire consultants to develop protected instream flows at the rate of one river per year. Budget cuts in FY22 and FY23 have resulted in larger rivers requiring two to three years for development of protected instream flows.

The Lakes Management and Protection Program requires funding for a Lakes Coordinator in order to provide support to the Lakes Management Advisory Committee and lake management efforts throughout the state. The Lakes Program is currently unfunded.

1.21 Coastal Program

Challenges Addressed: The Coastal Program protects clean water, restores coastal habitats, and helps make communities more resilient to flooding and other natural hazards through staff assistance and funding to 42 coastal towns and cities as well as other local and regional groups. Coastal areas are especially vulnerable to storm surge, flooding and sea level rise, putting coastal infrastructure, property and habitats at risk. The Coastal Program helps local decision-makers to minimize damage and increase preparedness for these natural hazards.

Achievements:

Wagon Hill Farm Living Shoreline Project

The Town of Durham received a NHDES Coastal Program Coastal Resilience Grant to complete design plans to control erosion problems at Wagon Hill Farm, a popular public recreation spot at the mouth of the tidally influenced Oyster River, through the construction of a living shoreline. This includes saltmarsh habitat and provides space for the marsh to move inland as sea levels rise. Thanks in part to the Coastal Program grant and staff technical assistance, the Wagon Hill Farm living shoreline project was awarded construction funding by the NHDES ARM fund. Construction was completed in 2019.

"Building a Flood Smart Seacoast" Workshop Series

From cracked foundations, totaled cars and destroyed utility systems, recurrent coastal flooding has already inflicted considerable damage in Hampton Beach. This issue is prompting residents to search for ways to protect and continue enjoying their properties for years to come. The Coastal Program, in partnership with the Seabrook-Hamptons Estuary Alliance, hosted the first-in-the-state "Building a Flood Smart Seacoast" workshop series focused on helping property owners make better-informed decisions about how to make their properties more flood resilient.

Dune Restoration Hampton-Seabrook Estuary

New Hampshire's Hampton-Seabrook Estuary has lost 86% of its historic sand dunes since they were first mapped out in 1776. Sand dunes create a natural buffer from storms, shield from flooding and provide habitat. A project initiated by the NH Sea Grant and UNH Cooperative Extension with the support of two Coastal Program resiliency grants continues to restore and protect dunes. The project has focused on replanting and protecting vulnerable and eroded areas in Hampton. Work has included the installation of signs showing where people can access the paths across the sand dunes to the beach and re-vegetation by community volunteers.

Funding: Federal Funds (The Coastal Program is funded by The National Oceanic and Atmospheric Administration). Org. Code 3642; Received $1,172,000 for FFY20.

Program Needs: Funding and staff to help communities prepare for coastal hazards through grants, technical assistance and outreach and training.

II. NHDES WATERSHED MANAGEMENT BUREAU DATA QUALITY CONTROL

2.1 Watershed Management Bureau QAPPs and Standard Operating Procedures (SOPs)

The Watershed Management Bureau maintains several Quality Assurance Project Plans (QAPP) and Standard Operating Procedures (SOP) (Table 1). QAPPs are documents submitted to and approved by the Environmental Protection Agency (EPA), which describe the scope of a monitoring project, defining what is to be monitored, how it is to be monitored, and the procedures to be carried out to ensure high data quality. SOPs outline specific procedures for things such as field data collection, laboratory sample handling, sample preparation and sample analysis.

Table 1: Current Watershed Management Bureau QAPPs and SOPs

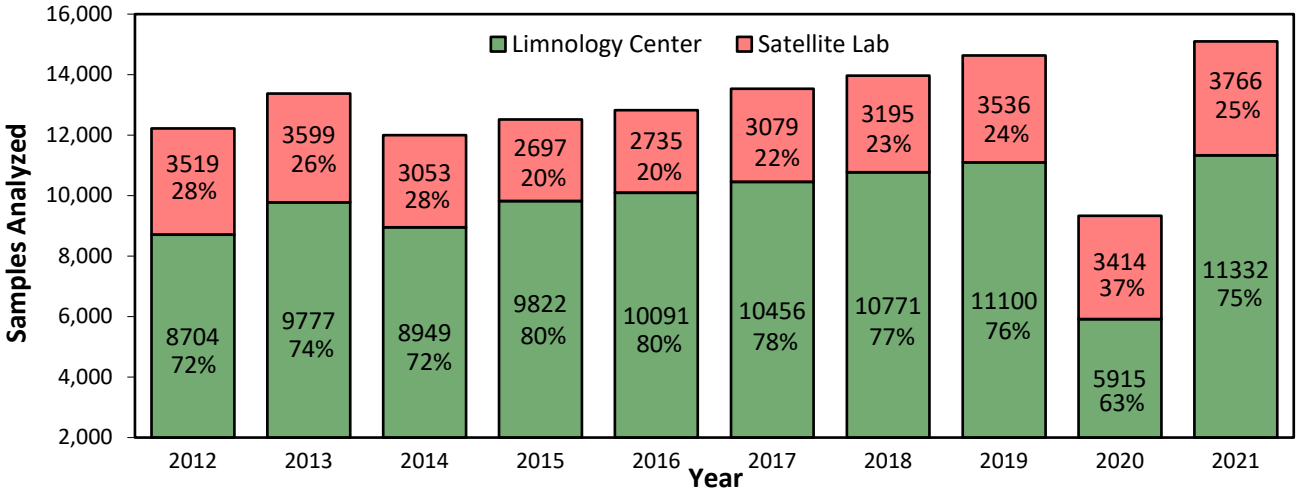
Program Name	Document Title	EPA RFA number	Type	Year Created	Last Update
Jody Connor Limnology Center (JCLC)	NHDES Jody Connor Limnology Center Laboratory Manual	-	SOP	2001	2019
Lake Assessment Program and special projects	Lake Assessment Program Quality Assurance Plan	21039	QAPP	2015	2021
Volunteer Lake Assessment Program	NHDES Volunteer Lake Assessment Program Quality Assurance Project Plan	19074	QAPP	2003	2019
Volunteer River Assessment Program	NHDES Volunteer River Assessment Program Quality Assurance Project Plan	7083	QAPP	2003	2017
Beach Inspection Program	NHDES Beach Program Generic Quality Assurance Project Plan	17075	QAPP	2003	2017
Shellfish Program	Quality Assurance Project Plan for Shellfish Ambient Water Quality Monitoring		QAPP	2002	2013
Shellfish Program	Quality Assurance Project Plan for Shellfish Sanitary Surveys		QAPP	2002	2013
Shellfish Program	Quality Assurance Project Plan for Paralytic Shellfish Poisoning Monitoring		QAPP	2002	2013
Exotic Species Program	NHDES Exotic Species Program Quality Assurance Project Plan	-	QAPP	2014	2019
River Monitoring Program	NHDES River Monitoring Program Quality Assurance Project Plan		QAPP	2014	2019
Instream Flow Program	NHDES Instream Flow Priorities for Annual Monitoring/Sampling	-	SOP	2020	2020
Instream Flow Program	NHDES Instream Flow Protocols for Conductivity, Temperature, and Water Level Dataloggers	-	SOP	2018	2020
Instream Flow Program	NHDES Protocols for Streamflow Measurement and Data Management	-	SOP	2020	2021
Instream Flow Program	NHDES Protocols for Prioritizing Protected Instream Flow Studies	-	SOP	2020	2020
Instream Flow Program	NHDES Protocols for Long-Term Monitoring of Riparian Ecosystems	-	SOP	2020	2020
Instream Flow Program	NHDES Protocols for Stream Gradient and Floodplain Transect Survey	-	SOP	2020	2020

2.2 Jody Connor Limnology Center

Jody Connor Limnology Center (JCLC) staff processed 11,332 chemical analyses in 2021, which is very similar to 2019 before the pandemic (Figure 1). Additionally, 5,376 samples were collected by JCLC programs in 2021 but analyzed by DHHS-PHL. These numbers reflect a resumption of near normal operation in the JCLC and Watershed Management Bureau's monitoring programs.

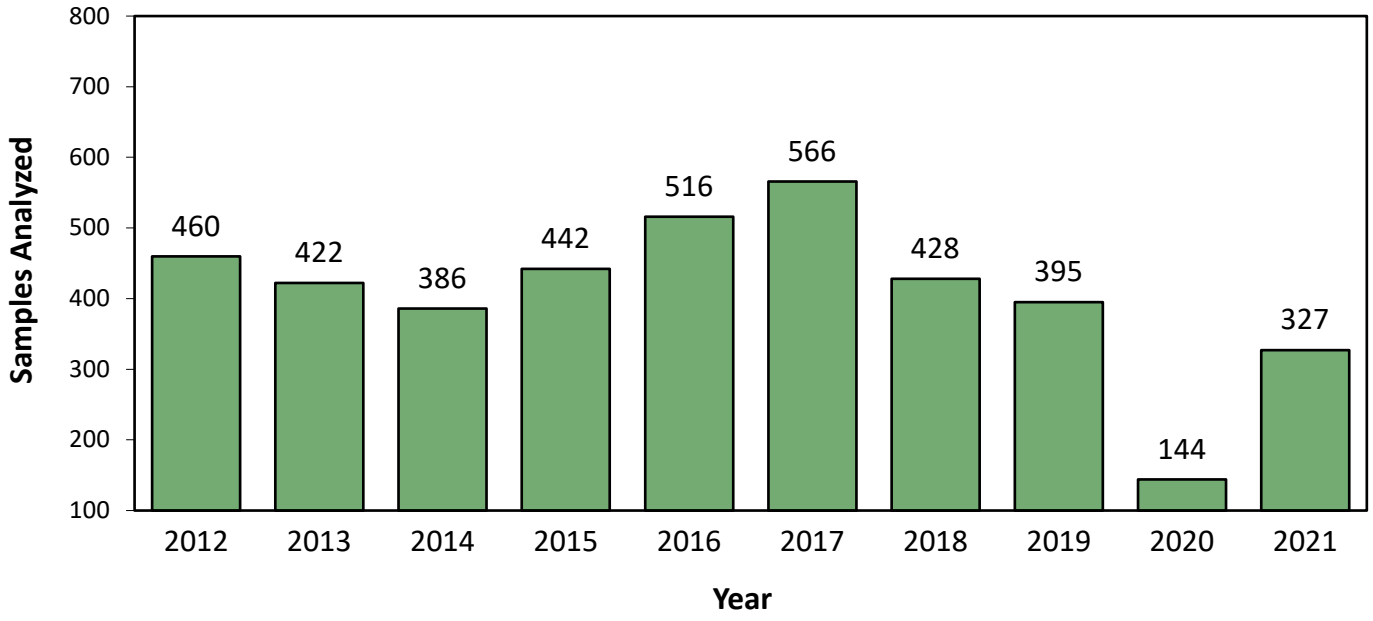
JCLC provides volunteer monitors additional services by making available and providing support to a satellite laboratory at Colby-Sawyer College (CSC). The laboratory is a cooperative effort between CSC and the Lake Sunapee Protective Association (LSPA). In 2021, 3,766 chemical analyses were processed at the CSC satellite laboratory the most productive year for that laboratory (Figure 1).

Figure 1: Satellite vs JCLC Analysis Last 10 Years.



The JCLC also processes biological samples of phytoplankton, zooplankton, and macrophyte identifications. Cyanobacteria complaints are processed and tracked separately through the Harmful Algal Bloom Program (see Harmful Algal Bloom/Cyanobacteria Program Summary). The number of annual biological analyses performed has hovered between 400 and 500 for several years except for last year (Figure 2). In 2021 biological samples processed in the JCLC recovered to 327.

Figure 2: NHDES JCLC Total Annual Biological Analyses Last 10 Years.



2.2.1 JCLC and Satellite Lab Data Quality Objectives

Quality control (QC) is an important component assuring the production of high-quality data. At both JCLC and the CSC satellite lab, QC samples are processed regularly. Over 1,900 QC sample analyses were conducted by the two laboratories in 2020.

JCLC and the CSC satellite laboratory met their data quality objective (DQO) requirement of completing replicate analyses on 10% of the processed samples. Since establishing this DQO objective in 1999, the cumulative laboratory replicate percentage has surpassed the 10% requirement each year. All laboratories also continued to follow both Continuing Calibration Verification (CCV) (Table 2) and Critical Range (CR) criteria (Table 3). The CCV and CR processes verify that the laboratory equipment and personnel are all meeting established standards and confirming that high-quality, reliable data are being produced. The 2020 NHDES QA Self-Audit was completed by both the JCLC and CSC labs in early 2021, results and recommendations were issued early in 2022.

Table 2: JCLC and CSC Laboratory CCV Acceptance Criteria

Parameter	Frequency	CCV Standard	Acceptance Limit
pH and Alkalinity	10% or at the end of the day's analyses, whichever comes first	6.0 pH	+/- 0.1 pH unit
Conductivity		100 µS/cm	+/- 10% = 90-110 µS/cm
Chloride		100 mg/l	+/- 15% = 85-115 mg/L
Turbidity		10 NTU	+/- 10% = 9-11 NTUs
Color Hanna		50 CPU	+/- 10 CPU
Total Phosphorus*		50 PPB	+/- 10%

* CSC lab only

Table 3: JCLC and CSC Laboratory Duplicate Critical Range Criteria

Parameter		Acceptance Limit	Parameter	Acceptance Limit
pH		+/- .5 units	Chlorophyll-a	+/- 3.0 µg/L= 3mg/m3
Alkalinity		+/- 1.20 mg/L	T. Phosphorus*	+/- 0.004 mg/L
Conductivity		< 10%	Color Hanna	+/- 10 CPU
Turbidity		0-20 NTU: +/- 1	Color Nessler	+/- 2.0 CPUs
		>20-100 NTU: +/- 3	Chloride	< 15%
		>100 NTU +/- 10	E. coli*	< 5% of count

* CSC lab only

2.2.2 JCLC Laboratory

As a result of requirements set forth in the NHDES Quality Management Plan (QMP), JCLC began to track new staff training in 2003. Tracking staff training is a critical component to verify competency on equipment use, DQO procedures, CR and CCV procedures. Over the past two field seasons the JCLC has improved intern training in laboratory procedures. Now each newly hired intern attends a full-day training session consisting of different elements including JCLC lab procedures and safety, training on database entry, and sample login procedures. The training also includes an afternoon of hands-on, practical training using JCLC bench meters with oversight by full-time JCLC staff. As part of this training, each intern must pass a competency check on each meter in the JCLC.

The JCLC and CSC-LSPA lab analyze two aliquots (replicates) from the same sample as a QC for at least 10% (Table 4). Replicate samples processed in the JCLC are evaluated using split mean range (SMR) and relative percent difference (RPD) measures and are used to demonstrate consistency in data quality. The SMR is the range and the RPD is the percent difference, which is calculated when a replicate QC analysis is performed. Depending on analysis factors such as the range of the analytical instrument used, either a SMR or RPD is calculated for each QC sample. The JCLC generates SMR/RPDs as a quantitative measure to review that replicate ranges are consistent with historical SMRs/RPDs. In 2020,

all parameters exhibited SMRs or RPDs that were well within the acceptable range established range for the parameter (Table 4). Lastly, over 98% of laboratory replicates met established critical range criteria for their respective parameters.

Table 4: 2019 calendar year JCLC chemical analyses quality assurance summary.

Parameter	2021 Replicate Analyses	2021 Sample Analyses	2021 Replicate Percent	Mean Relative Percent Difference or Split Mean Range					
				2016	2017	2018	2019	2020	2021
Alkalinity (ANC) mg/L (Range)	55	518	10.62	0.56	0.49	0.27	0.16	0.58	0.25
Apparent Color cpu (Range)	20	187	10.70	0.53	0.69	0.71	0.71	0.88	0.60
Color in Water - Hanna (Range)	81	745	10.86		4.32	5.09	4.51	4.29	3.46
Chloride mg/L (Range)	217	1921	11.30	1.55	1.53	1.89	1.46	1.44	1.08
Chlorophyll-a mg/L (Range)	66	545	12.11	0.46	0.38	0.54	0.51	0.34	0.54
Conductivity µmhos/cm (RPD)	250	2259	11.07	1.33	1.38	1.78	1.61	1.95	1.45
Mercury mg/L (Range)	-	-	-	0.03	0.01	0.05	0.02	0.01	-
pH units (Range)	306	2756	11.10	0.12	0.27	0.07	0.06	0.08	0.04
Turbidity NTU (Variable Range)	268	2410	11.12	0.16	0.13	0.14	0.18	0.13	0.14

In 2020 the QC Officer/Database Administrator began an initiative to document quality control and data administration procedure within the JCLC database by producing several instructional videos. The videos consist of screen recordings along with narration outlining specific procedures and functions within the JCLC database. Six videos were produced in 2020 and four more were produced in 2021 all covering JCLC database operation and data management procedures.

These videos were leveraged during the 2021 intern training as part of a 100% virtual training, thus avoiding all intern staff gathering in the training room. Over the past few years, the intern training has evolved and has been refined with input from all the JCLC staff. This effort predated the pandemic and had already paid dividends with a better trained intern staff and a smoother running JCLC lab. Also, the changes made and tools developed for training made the process nimbler and easier to adapt to the challenges during the pandemic.

In 2021 no fish were analyzed for mercury content and the 2021 QC data in Table 4 is blank, this is because the Direct Mercury Analyzer purchased in 2005 became inoperable. In 2021, 43 fish were collected, processed and remain frozen awaiting analysis, along with 13 from 2020. The bid process for a replacement Mercury Analyzer was completed in late 2021 and the JCLC awaits the delivery of the new machine.

2.2.3 Satellite Laboratory

The Colby-Sawyer College – Lake Sunapee Protective Association (CSC-LSPA) Satellite Laboratory continues to be well operated and serves as a model for producing high quality data in support of NHDES' volunteer water quality monitoring programs. In 2018 the lab gained the ability to analyze for chloride and color. There is now four years of split mean range annual averages to look at for each parameter and that data is more useful in drawing conclusions regarding quality. The ranges have become tighter and lower over the last four years reflecting the fact that the analyses are becoming tightly engrained within the CSC lab operations and better data is the result.

The CSC-LSPA lab has consistently met or exceeded the replicate DQO for all parameters since 2016 (Table 5). In addition, the 2021 split mean remained consistent with previous years (Table 5). Lastly, 98% of CSC-LSPA lab replicates met established critical range criteria for their respective parameters.

Table 5: 2019 calendar year CSC-LSPA Laboratory chemical analyses quality assurance summary.

Parameter	2021 Replicate Analyses	2021 Sample Analyses	2021 Replicate Percent	Mean Relative Percent Difference or Split Mean Range					
				2016	2017	2018	2019	2020	2021
Alkalinity (ANC) mg/L (Range)	11	73	15.07	0.36	0.28	0.63	0.11	0.14	.33
Color in Water (Hanna) (Range)	11	99	11.11			1.25	6.79	2.76	1.82
Chloride (Range)	66	502	13.15			1.82	0.68	1.37	0.54
Chlorophyll-a mg/L (Range)	20	125	16.00	0.11	0.37	0.53	0.16	0.41	0.69
Conductivity µmhos/cm (RPD)	84	679	12.37	0.87	1.54	1.37	1.46	1.25	0.77
pH units (Range)	84	668	12.57	0.04	0.07	0.05	0.07	0.06	0.04
Turbidity NTU (Range)	81	674	12.02	.07	0.23	0.28	0.17	0.18	0.27
E. coli counts/100ml (Range)	19	88	21.59	0.00	.33	1.62	0.44	0.34	2.87
Total Phosphorus µg/L (Range)	88	6.15	14.31	1.5	1.0	0.8	0.6	1.0	0.1

2.3 Volunteer Lake Assessment Program (VLAP)

VLAP program participation has remained fairly stable since 2016 due to staffing resources, and at this time, VLAP is not accepting new lakes. VLAP received one request from a lake association to join the program in 2021. Since 2018, the total number of requests to participate has increased, likely due to increased concern over noticeable changes in water quality, plant and algal growth, and concerns of climate impacts to New Hampshire lakes. In 2021, despite the COVID-19 pandemic and alterations to VLAP sampling and laboratory operations, the concern over local lake quality persisted and volunteers accomplished much more than expected in 2021. The pandemic also resulted in increased recreational use of lakes throughout the state and maintaining surface water quality monitoring program was crucial to evaluate these impacts as well as impacts from climate change driven drought conditions. COVID-19 and resulting modifications to 2021 VLAP sampling resulted in 95% participation rate and a slight decrease in sampling events and results generated (Table 6). However, VLAP operating under normal conditions has resulted in an overall significant increase in results generated in the past 20 years (Figure 3 and Table 7).

Table 6: Program Participation.

Year	# Of volunteers	# Of lakes	New or returning lakes	# Of deep spots	# Of annual bio visits	# Of volunteer sampling events	Total # sampling events*	Est. # of volunteer hours	Monetary value of vol. hrs.	# Of individual sample results generated
2021	400	167	0	174	61	380	441	~3,057	$99,000	15,075

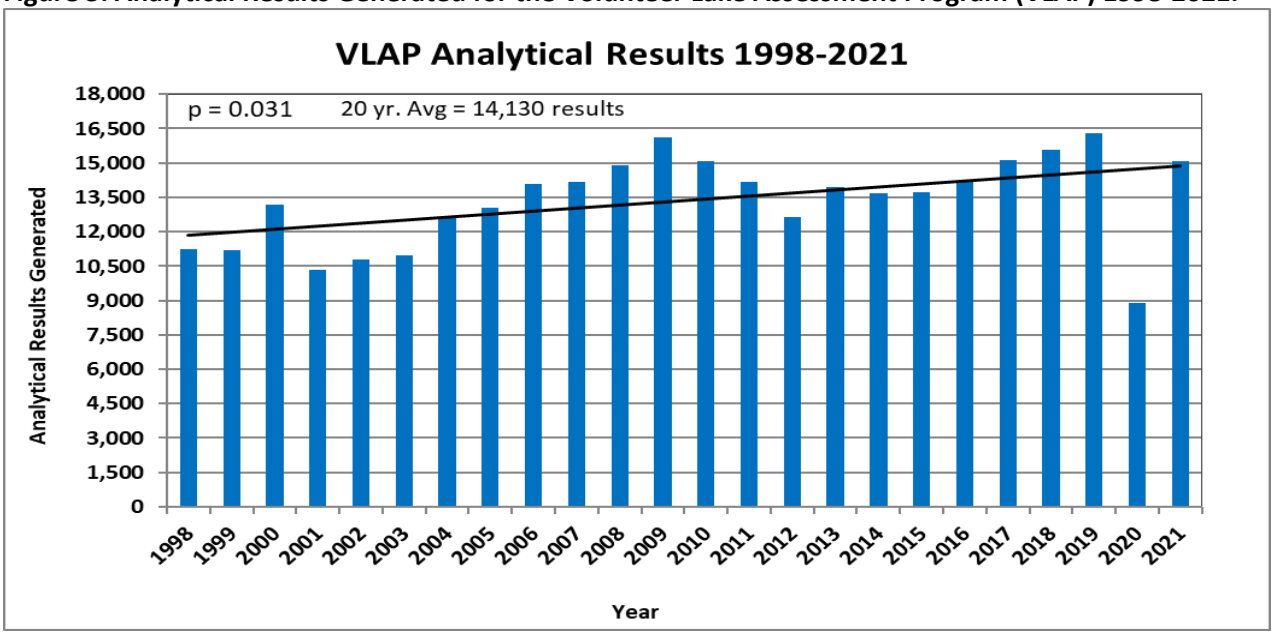
Table 7: Number of VLAP Sample Results Generated by Parameter and by Laboratory (2021).

Lab	Alk.	App. Color	Chl-a	Cl-	Cond.	Do/Temp Profile	*E. coli*	TN	TP	Phyto	Secchi	Secchi Scope	pH	Turb.
CSC/LSPA*	72	94	121	488	660	52	50		667		62	110	653	654
NHDES**	362	412	372	1,112	2,028	176	299	15	1,931	119	344	333	2,026	2,030
Total	**434**	**506**	**493**	**1,600**	**2,688**	**228**	**349**	**15**	**2,598**	**119**	**406**	**443**	**2,679**	**2,684**

* = The Colby-Sawyer College - Lake Sunapee Protective Association Satellite Laboratory

** = NHDES JCLC and NH DHHS Water Analysis Laboratory. The NH DHHS Laboratory analyzes the total phosphorus, and *E. coli* samples, while pH, ANC, conductivity, chloride, turbidity, chlorophyll, and phytoplankton are analyzed in the JCLC and Secchi disk depth is measured in the field.

Figure 3: Analytical Results Generated for the Volunteer Lake Assessment Program (VLAP) 1998-2021.



2.3.1 Quality Assurance and Quality Control Management

The Generic VLAP Quality Assurance Project Plan (QAPP) was submitted to EPA in 2019 for its five-year review and revision. The VLAP QAPP review was completed and the QAPP approved by EPA in June 2019. The QAPP, which outlines the standard operating procedures for sample collection, sample analysis, data management, data assessment and data reporting, was followed by all NHDES JCLC and satellite laboratory staff during the 2019 sampling season. Volunteer monitors were provided updated training materials in 2020 to access online in lieu of an in-person workshop typically held in May. In-person biologist visits were not conducted in 2020 but did resume in 2021 at a reduced capacity. The VLAP Coordinator and CSC satellite Lab Manager were in constant communication with volunteers, reviewed sampling procedures upon sample drop-off if necessary, and made corrective actions to ensure each monitoring followed the standard operating procedures for sample collection as outlined in the QAPP.

2.3.2 Quality Assurance and Quality Control

The VLAP QAPP specifies that Quality Assurance and Quality Control (QA/QC) samples, including field duplicate samples, are collected and analyzed for specific parameters sampled through the program. However, most volunteers from the lakes and ponds participating in the program do not collect field duplicate samples as standard practice. This is due to the following reasons:

1. Long-term water quality trend analysis, not a single sample result, is used for decision making within NHDES.
2. There are no available funds within NHDES to pay for the analysis of VLAP QA/QC samples, including total phosphorus and E. coli duplicate samples.

Therefore, in 2002, the VLAP Coordinator, Biology Section QA/QC Officer and the JCLC Director decided that the field collection and laboratory analysis of QA/QC samples, as outlined in the VLAP QAPP, will be incorporated into the program as feasible under the existing program structure and the operating constraints of the JCLC.

Specifically, volunteer monitoring groups that decide to pursue additional federal grant programs, and wish to use VLAP monitoring activities as a match, are required to conduct QA/QC sampling in accordance to the VLAP QAPP. In this case, the JCLC agrees to run these additional QA/QC samples, but the volunteer monitoring group is required to bear the additional cost, as necessary.

2.3.3 VLAP Duplicate Sampling

In 2021, due to the COVID-19 pandemic, VLAP biologist visits were reduced by approximately 50%. Field duplicate sample collection was conducted during the biologist visits and by the Lake Sunapee Protective Association (LSPA).

The duplicate samples are compared not just to the total number of routine samples conducted during the biologist visits, but for the whole program respectively. This routinely meets a 7% to 8% duplicate range rather than a 10% range. However, if compared with just the number of samples generated during biologist visits only, it would be well above the 10% range.

Table 8: VLAP Duplicate Quality Assurance Samples Collected (2021).

Parameter	Duplicate Samples Collected	Routine Samples Collected	Percentage of Duplicate Samples Collected	Meets Target (10%)
Alkalinity*	13	434	3.0	n/a
Apparent Color	22	506	4.3	n/a
Chlorophyll-a	34	493	6.9	n/a
Chloride	69	1600	4.3	n/a
Conductivity	141	2688	5.2	n/a
DO/Temp Profile	17	106	16	n/a
pH	139	2679	5.2	n/a
Total Phosphorus**	35	2598	1.3	n/a
Turbidity	141	2684	5.3	n/a

* = During the Spring of 2002, the Biology Section QA Officer determined that it was not feasible for the Limnology Center to handle the additional workload of duplicate samples for Alkalinity and phytoplankton parameters. These analyses take much longer to conduct than the pH, turbidity, and conductivity analyses.

** = Volunteers are asked to collect and pay for duplicate sample analysis for phosphorus and *E. coli* on a voluntary basis. There is no internal funding source available to pay for the analysis of QA/QC samples that are processed in the NH DHHS Water Analysis Laboratory. All total phosphorus duplicate samples are conducted through the CSC-LSPA laboratory and paid for by the LSPA

Field duplicate sample results were analyzed at the end of the season to determine if the relative percent difference (RPD) or critical range for each parameter of interest exceeded the QA/QC standard outlined in the VLAP QAPP. A very low number and percentage of duplicate samples failed to meet the QA/QC standard during the 2021 sampling season (Table 9).

Table 9: VLAP Duplicate QA/QC Samples (2021).

Parameter	Duplicate Samples Collected	Duplicate Samples Failing QA/QC	Percentage of Failed Duplicate Samples
Alkalinity*	13	0	0
Apparent Color	22	4	18.2
Chloride*	34	1	3
Chlorophyll-a*	69	0	0
Conductivity*	141	1	0.7
DO/Temp Profile***	17	0	0
pH*	139	0	0
Total Phosphorus*	35	5	14.3
Turbidity**	141	3	2.1

* = The QA/QC standard for duplicate ANC, chloride, chlorophyll, conductivity, pH and total phosphorus samples is the 20% Relative Percent Difference.

** = The QA/QC standard for duplicate turbidity standards is the critical range standard used in the NHDES JCLC.

*** = Individual dissolved oxygen duplicate profiles acceptance limit of +/- 2 mg/L.

2.3.4 VLAP Intern Training

The training and assessment of the VLAP intern's ability to perform field sampling activities according to the program standard operating procedures is the responsibility of the coordinator. At the beginning of the sampling season, the coordinator trains or re-trains the intern in the proper field sampling standard operating procedures, as outlined in Appendix C of the VLAP QAPP.

In 2021, due to the COVID-19 pandemic, one full-time three-month and one part-time five-month intern were hired to conduct laboratory analyses and assist VLAP program operations in the JCLC. This resulted in one intern in the field and one intern in the laboratory Monday-Friday. The VLAP Coordinator trained each intern on COVID-19 safety measures, auditing volunteers during biologist visits, preparing equipment and bottle pick-ups for volunteers, receiving samples from volunteers, laboratory sample analysis and monthly data reporting. Each VLAP intern was required to fulfill the JCLC training requirements before they were allowed to independently log-in and analyze samples in the JCLC.

2.3.4 VLAP Volunteer Training

During the annual visit to each lake or pond, the biologist (the VLAP coordinator, biologist or one of the interns) conducts a "Sampling Procedures Assessment Audit" for each monitoring group. Specifically, the biologist observes the performance of each monitoring group and fills out an assessment audit form to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor's Field Manual).

The assessment identifies areas of sample collection in which volunteer monitors are not following the proper procedures and provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that samples collected by volunteer monitors are truly representative of actual lake and tributary conditions. Overall, the assessments show that the majority of the monitoring groups follow the proper sampling techniques.

In 2011, it was necessary for VLAP to alter its schedule for annual biologist visits. The schedule for biologist visits changed from an annual visit at each lake to a biennial visit at each lake depending on a lake's name. In 2021, due to the COVID-19 pandemic, biologist visits were reduced by 50%.

To compensate for the lack of an annual biologist sampling procedure assessment audit, VLAP developed additional training videos for volunteers to view and review sampling procedures prior to sampling on their own. The videos are posted on YouTube and a link is available via the VLAP website. The video has also proved a useful training tool during the VLAP annual refresher workshop. VLAP developed a Volunteer Monitor Field Sampling Procedure Checklist for volunteers to complete every time they sample without a biologist. The checklist acted as a self-audit for field sampling procedures to minimize improper sampling techniques and has been very successful. Volunteer feedback has been positive and resulted in overall better-quality samples collected. The form will continue to be implemented in subsequent sampling seasons.

When volunteer monitors dropped off samples at the JCLC and the CSC-LSPA Satellite Laboratory, the laboratory staff continued to use the sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. Specifically, the purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future occurrences of improper sampling techniques. When necessary, volunteer monitors were contacted by laboratory personnel with questions so that the samples could be logged into the system properly. In some cases, it was necessary to retrain volunteers in proper sample collection techniques, and, in a few severe cases, samples were not accepted for analysis.

2.4 Biomonitoring Program QAQC

Fish identification data quality control measures relied on having an expert fish taxonomist on-site during sampling. Any unknown species were documented with photos and/or retained for laboratory analysis and further consultation with other state agencies and partners.

All field data are reviewed for quality assurance and entered into the biomonitoring program's Ecological Data Application System (EDAS) database. Additional data checks for completeness and accuracy are performed prior to uploading data to the NHDES Environmental Monitoring Database and later to the Environmental Protection Agency's WQX Database.

Macroinvertebrate data quality control measures rely on enumeration and identification by outside contractors: primary and quality control. In additional to in-house quality control measures performed by the primary contractor, quality control measures are performed by a separate quality control (QC) contractor. Ten percent of all samples are sent to the QC contractor and re-picked to account for individuals missed by the primary contractor. If the primary contractor does not meet the required threshold (95% of individuals found during the initial pick), sorted debris from all samples are re-picked, with additional individuals identified and enumerated. In addition to re-picking the sorted debris, a voucher set of all individuals found each year is assembled by the primary contractor and sent to the QC contractor for identification. This is completed as a "blind" voucher set with voucher identifications sent to NHDES for review. Any discrepancies are reconciled, and data updated to reflect any necessary corrections.

Taxonomy must be performed by a professional freshwater macroinvertebrate taxonomist that, at a minimum, holds and maintains for the duration of the contract a certification from the Society of Freshwater Science for eastern genera in group 1 (Crustacea and Arthropods other than EPT and Chironomidae), group 2 (Ephemeroptera, Plecoptera, and Trichoptera nymphs and larvae only) and group 3 (Chironomidae larvae only).

2.5 Instream Flow Program QAQC

2.5.1 Datalogger Studies

The data collected for each station are plotted in scatterplot graphs, with the date on the x-axis. Plotting the data allows users to visually identify trends and any incongruities. Once plotted, the graph is visually examined for outliers or impossible data points. For example, if the temperature values erratically rise and fall faster than typically observed in the water, it is presumed that the datalogger was in-and-out of the water. Non-representative data, such as periods where the datalogger was suspected to be out of the water, are removed from the analysis.

Next, the field duplicate measurements made with calibrated, hand-held conductivity/temperature meters or a folding ruler are reintroduced to the dataset and compared to the measurements recorded by the datalogger.

a. If the field duplicate measurements for conductivity do not fall within 20% of the logged values, the dataset must be processed using HOBOware Pro® Conductivity Assistant 2.1 or later. HOBOware Pro® Conductivity Assistant will calibrate the readings and adjust for drift caused by fouling. The field calibration measurements of conductivity and temperature and times from the deployment and recovery are recorded on the Field Data Sheet.
b. If the field duplicate measurements for temperature do not fall within 20% of the logged values, the dataset must be processed manually within the spreadsheet. [No software to apply – one would calculate the initial/final variances and create a line with slope, that could be used to correct the data.]
c. If the field duplicate measurements for water level do not fall within 20% of the logged values, the dataset must be processed manually within the spreadsheet [No software to apply – one would calculate the initial/final variances and create a line with slope, that could be used to correct the data.]

Fish identification data quality control measures relied on having an expert fish taxonomist on-site during sampling. Any unknown species were documented with photos and/or retained for laboratory analysis and further consultation with other state agencies and partners.
All fish identification field data are reviewed for quality assurance and entered into the biomonitoring program's Ecological Data Application System (EDAS) database. Additional data checks for completeness and accuracy are performed prior to uploading data to the NHDES Environmental Monitoring Database and later to the Environmental Protection Agency's WQX Database.

2.5.2 Water Level Stations

Stream Flow Measurement

For quality assurance purposes, replicate analyses are required on at least 10% of all incremental velocity/depth measurements collected as part of each flow measurement event. For every set of 10 increments where velocity and depth are recorded, replicate the velocity *(V)* and depth measurements for one full increment are recorded on the data sheet. Quality control is based on a comparison of flow calculated for each replicate increment and should be less than 10% different. If greater than 10%, repeat the measurements and recalculate the flow until the measurements meet QA/QC criteria.

Staff Gage Installation and Monitoring

When the elevation survey has been completed, Person #1 reacquires the beginning survey point. Person #2 carefully rotates the autolevel to sight on the beginning point, and re-reads the middle crosshair, recording the value as the Elevation QA Check in the field logbook. If the two values differ by more than 0.02 inches, the variance is considered excessive, and the survey must be repeated. Field check of instrument accuracy and stability is included in the Field Procedures – Elevation Survey (Subsection A6.3, Step 7). In addition, each autolevel is annually certified for accuracy; see Attachment F for an example of Survey Autolevel Calibration and Certification.

River Stage Measurement

The staff gage/game camera or staff gage/water level station set-up is inspected periodically during deployment, and a photograph of the staff gage is taken during each visit. Following recovery of the game camera pictures and creation of a data file of river stage measurements, the staff gage measurements obtained from the game camera photographs are compared to the periodic inspection photographs for quality control/quality assurance.

On an ongoing basis, the water depth measurements obtained from each water level station are compared to the periodic staff gage readings for quality control/quality assurance. This continuing check not only monitors for water depth sensor drift, but also checks for physical movement of the stilling well/water depth sensor. A consistent difference between the water depth measurements and staff gage readings is expected.

Training for Use of Equipment/Methodology

Prior to conducting a stream flow measurement or installing a staff gage/game camera, staff are trained on site, both on use of the flowmeter and the stadia rod/autolevel by the Instream Flow Program Manager. This information, initial or review training, is noted on the data sheet for that site. Training includes how to hold and operate the flowmeter, set up the measuring tape, hold the stadia rod, tripod setup, autolevel setup, sighting/reading the stadia rod with the autolevel, setting temporary benchmarks, operating the game camera, completing the data sheets, and data processing.

2.5.3 Riparian Ecosystem Surveys

To ensure quality data, all individuals performing habitat assessment surveys will be trained in these procedures, prior to data collection. There will be a team of two or more people for each survey, so an individual observer can consult the team when any uncertainty arises. Additionally, before beginning the survey at each site, the team will discuss the SOP, address any questions, and clarify any discrepancies to ensure consistency between all team members.

When the elevation survey has been completed, Person #1 reacquires the beginning survey point. Person #2 carefully rotates the autolevel to sight on the beginning point, and re-reads the middle crosshair, recording the value as the Elevation QA Check in the field logbook. If the two values differ by more than 0.02 inches, the variance is considered excessive, and the survey must be repeated. Field check of instrument accuracy and stability is included in the Field Procedures – Elevation Survey (Subsection A6.3, Step 7). In addition, each autolevel is annually certified for accuracy; see Attachment F for an example of Survey Autolevel Calibration and Certification.

Additionally, after completion of every 10^{th} habitat assessment survey, a replicate site survey will be completed. One of the 10 previously surveyed sites will be re-visited and re-surveyed at a later date within the same year, and the data between the two visits will be compared to ensure that quality control standards are being met. The Instream Flow Program will be evaluating what quality control standards are sufficient to meet program needs.

III. NHDES WATERSHED BUREAU SAFETY PROCEDURES

3.1 Watershed Management Bureau Safety Training

The Watershed Management Bureau (WMB) workload involves various types of work in multiple environments. Safety is of great importance and guidelines and training are provided and updated as concerns and new methods arise. NHDES institutes agency-wide training, which the Watershed Management Bureau participates in.

Department-wide trainings cover topics such as Active Shooter Training, Defensive Driving and Cyber Security, the last covering the safety of our data and our business. Some of these training programs are required to be repeated every year, with the defensive driving every three years at a minimum. All NHDES employees, full time, part time and interns, are required to take these safety programs.

3.2 Watershed Management Bureau Vehicle and Watercraft Safety

Defensive Driving is required before any individual may operate a state vehicle. Those individuals that use large vehicles or trailers are also required to take a safe backing course that deals with issues involving trailers, blind spots and trucks. Much of the work the WMB does requires trailering or using full-sized vehicles, therefore many WMB personnel are required to take this extra defensive driving training. Each WMB vehicle is equipped with a first aid kit, insurance information and a procedure in case of accident.

Some of the workload done by the WMB requires the use and operation of boats. New Hampshire law requires all PWC or boat operators who are 16 years old or older and operating a motorboat over 25 horsepower to complete the New Hampshire Boater Safety Course and to carry a Safe Boating Certificate. The official NHDES policy goes a step further as any employee who wishes to operate a NHDES power boat is required to take the course and obtain the certificate. This course covers basic watercraft rules and operation as well as the safety involved in the use of state boats, and is offered by the state of New Hampshire's Department of Safety as an online course. WMB staff that routinely use our boats also accompany and train new personnel and interns in the operation of the individual watercraft that are available for use. This training covers canoes and kayaks as well as tiller-steered outboards, steering-wheeled driven outboards, and a Diver assisted Suction Harvester (DASH) unit. All individuals are required to wear a personnel flotation device (PFD) whenever in a boat. To facilitate the comfortable use of PFDs, inflatable suspender style PFDs are purchased for all employees who commonly use boats as well as sufficient spares to accommodate those who need them on occasions. All of our boats carry a fire extinguisher and a noise-making device as well as extra PFDs. All power boats are equipped with a usage log to record usage time and note any issues. Trailer wiring and lights are inspected and tested annually each spring and necessary repairs and replacements are made. All tires and spares are inspected and worn tires are replaced.

3.3 Watershed Management Bureau Lab and Field Safety

The Jody Connor Limnology Center (JCLC) contains laboratory equipment designed to analyze surface waters along with the chemicals associated with the analysis and, as such, safety procedures and training that go beyond normal workplace safety have been developed. This training involves personnel protective equipment, the operation of laboratory equipment, and safe handling and disposal of chemicals. Locations of fire extinguishers, acid spill kits, broken glass containers and other safety equipment are labeled and obvious in the lab. Small group training is given to all new hires and interns of the Watershed Management Bureau. A copy of the training manual can be found electronically on the NHDES network and in the JCLC Laboratory Manual. This manual is reviewed and updated yearly. The lab also includes a ventilation hood that is inspected regularly and a small chemical storage cabinet.

A majority of sampling and monitoring done by the WMB involves working in the field in both urban and remote sites. Working in the field requires yet another set of safety items. These include things like personnel attire and protection to weather and field conditions. Wading in fast moving or deep water, insect and plant interactions, as well as interactions with the public, also bring up safety concerns. These safety issues and procedures are addressed in the NHDES Standard Operating Procedure for Field Safety. However, each monitoring program within the WMB present unique safety risks. For this reason, supervisors spend several days training staff on the field and safety protocols for each specific program.

The biomonitoring program completes fish surveys regularly using backpack electroshocking units that discharge an electrical current into the water. To prevent injury, non-breathable waders and electrical gloves must be worn. Optional, but highly recommended, additional personal equipment include a hat and polarized sunglasses. Electrofishing is strenuous work and staff are encouraged to drink fluids and eat food regularly to maintain proper hydration and energy levels. Staff typically work in teams of four and are in constant communication with each other during a sampling event and use simple code words to indicate start and stop of electrical discharge.

The WMB also has a few people certified as "Self-Contained Underwater Breathing Apparatus" (SCUBA) divers. Most of this work involves aquatic invasive species. This is done in water less than 30 feet deep (one atmosphere); most operations are in 10 feet or less of water. Diving operations are always done in pairs. Safety procedures can be found in the NHDES Water Division, Watershed Management Bureau SCUBA Dive Safety Protocol.

3.4 JCLC COVID-19 Lab and Field Safety Procedures

Lab and field safety operations in 2021 were less affected by COVID-19 as compared to 2020. In New Hampshire, infection rates through the summer 2021 were relatively low with approximately 100 new infections daily and total cumulative infections statewide around 100,000. During this time, JCLC staff worked in the lab, office, and remotely depending on the duties of their jobs. As in 2020, the JCLC COVID-19 field and lab operating procedure was closely followed. As opposed to 2020, COVID-19 vaccines were widely available to the public in 2021 to reduce the risk of infection and serious disease. All full-time JCLC staff were fully vaccinated during by spring 2021.

In the lab, occupancy continued to be limited to 10 individuals at any given time with aisles limited to 2 to 3 individuals. In order to accommodate a 6-foot physical distancing requirement, lab equipment workstations were reconfigured to alternate locations within the lab Several bottles of hand sanitizer were made available, spray sanitizer was provided to wipe down work spaces and equipment, and hand soap offered for hand washing. Staff tracked their date and approximate time in the lab on a separate spreadsheet file in order to maintain a record in case contract tracing was necessary. Travel to and from field sample or investigation destinations was not limited and included multiple staff per vehicle. Volunteer sample and equipment were delivered or picked up from JCLC staff, for the most part, using large bins placed outside the NHDES building allowing for contactless sample exchange. Overall, while several safety measures remained in place, lab and field operations were much more "normal."