





Final Report

NEIWPCC Job Code: 0995-002-001

Project Code: LS-2019-057

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Date Submitted: June, 2020

Stormwater Mitigation Final Designs – Berlin, Vermont

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This is a Lake Champlain Basin Program funded project 54 West Shore Road Grand Isle, VT 05482 802.372.3213 www.lcbp.org

This project was selected for funding by the Lake Champlain Basin Program (LCBP) Steering Committee and it has been supported directly by an agreement or sub-award issued by NEIWPCC. NEIWPCC manages LCBP's personnel, contracts, grants, and budget tasks through a partnership with the LCBP Steering Committee.

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Executive Summary

The Central Vermont Regional Planning Commission (CVRPC) and the Town of Berlin, Vermont have been working together for the past few years to address stormwater runoff within the municipality. In 2017, a Stormwater Master Plan for the Town of Berlin funded through the Vermont Department of Environmental Conservation (DEC) was completed. This plan identified five priority projects that received 30% designs to further to final design. The CVRPC received a sub-award from the Lake Champlain Basin Program (LCBP) to bring three of the five priority sites to final design. The completed final designs will enable the Town to implement the projects in the future, which will reduce water quality impacts from impervious surface pollution in the Lake Champlain Basin.

The names and locations of the three stormwater mitigation sites are:

- 1. Chimney Sweep Fireplace Shop, 1284 US Route 302, Berlin, VT.
- 2. Berlin Elementary School, 372 Paine Turnpike N, Berlin, VT.
- 3. Berlin Fire Department, 338 Paine Turnpike N, Berlin, VT.

The main goal of the project was to complete the final designs for the three stormwater mitigation sites in the Town of Berlin, Vermont. Objectives of the project included completing the 60%, 90% and 100% phases of the design process along with stakeholder/landowner approval of designs. The final design process began in August of 2019 with the hiring of Watershed Consulting Associates, LLC (WCA) and Civil Engineering Associates (CEA), both of Burlington, Vermont. These two firms took the following actions to complete this project: site visits, meetings with stakeholder/landowners, soils analysis, hydrologic modelling, surveying, drafting engineering designs, and preparing cost estimates, bid documents, and permit applications for future construction. The project was completed in June, 2020.

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1 Project Introduction

This project involved completing final engineering designs for the three following stormwater mitigation sites in Berlin, Vermont:

- 1. Chimney Sweep Fireplace Shop, 1284 US Route 302, Berlin, VT.
- 2. Berlin Elementary School, 372 Paine Turnpike N, Berlin, VT.
- 3. Berlin Fire Department, 338 Paine Turnpike N, Berlin, VT.

The Town of Berlin has been heavily interested in mitigating the effects of stormwater runoff in their community since the effort to complete a town-wide Stormwater Master Plan in 2017. The three sites listed above were among the top five priority sites identified in the plan for mitigation. The main goal for the project was to bring these sites to final design to put them in good standing to be shovel-ready for future construction. The proposed treatment in the final designs include bioretention features and grass conveyance swales at the Berlin Elementary School and the Berlin Fire Department, and a subsurface sand filter at the Chimney Sweep Fireplace Shop. The purpose for implementing these projects is to reduce stormwater discharge from impervious surfaces entering nearby surface waters, thereby reducing sediment and phosphorus loading in the Steven's Branch, a tributary to the Winooski River, which is in the Lake Champlain Basin.

Reducing nutrient loading through the treatment of stormwater runoff is a key objective and strategy for the Lake Champlain Basin Program (LCBP) making this project an important part of the goal for the clean-up of Lake Champlain. For the Winooski River Basin, Berlin, VT is a critical area of development where runoff from impervious surfaces can be reduced through the design of the green stormwater infrastructure projects. These final designs will help the LCBP to work towards meeting these objectives and its Clean Water Goal.

2 Tasks Completed

CVRPC completed the following tasks as outlined in the work plan to carry out the project:

Task 1. Hire Design Engineer and QAPP Development

CVRPC issued a request for scope of work and cost estimate from pre-qualified contractors for the final design of three identified stormwater mitigation sites in the Town of Berlin from the Stormwater Master Plan. CVRPC received three proposals/cost estimates. Watershed Consulting Associates, LLC (WCA) of Burlington, VT and Civil Engineering Associates, Inc. (CEA) of South Burlington, VT were retained by CVRPC to complete the final designs.

As part of their contract with CVRPC, WCA developed the Quality Assurance Project Plan (QAPP) for this project. WCA developed the QAAP to outline the hydrologic modeling methodology as well as to ensure survey and soil characteristic data was collected to required specifications. The QAPP was approved by the LCBP and NEIWPCC in November, 2019.

Task 2. Kickoff Meeting & 60 Percent Design

Once CVRPC and WCA entered a contract agreement, CVRPC organized a kickoff meeting with the contractors, the Berlin Town Administrator, and the Berlin Fire Department President followed by sites visits to the Fire Station and the Chimney Sweep Fireplace Shop. CVRPC also convened meetings with the Chimney Sweep landowners and Berlin Elementary School stakeholders that corresponded with site visits.

Once the design engineer and CVRPC met with stakeholders and received feedback from them, the original concept designs from the Stormwater Master Plan were expanded to 60 percent completion along with cost estimates. WCA investigated possible required local and state permits. The design engineer ensured additional necessary surveying and soils testing were completed during this phase and incorporated findings into both hydrological analyses and design plans. Upon completion of the designs and cost estimates, CVRPC convened meetings with the necessary stakeholders for feedback and to ensure future construction feasibility.

Task 3. 90 Percent Designs

Based on the outcomes of the 60% design review stakeholder meetings, WCA and CEA amended the designs to the 90 percent completion level. The designs were accompanied by updated cost estimates, as well as complete construction bid documents containing material lists, quantities and technical specifications. The CVRPC convened another round of stakeholder meetings for feedback before finalizing the plans and closing out the project.

Task 6: 100 Percent Designs

The 90 percent design plans, bid documents, and cost estimates were refined and any changes discussed at the 90% stakeholder meetings were incorporated. This final report includes details of the process with the Town, design engineer and the stakeholders as well as links for project deliverables including site photos, cost estimates, design drawings and bid documents provided by the contractor.

3 Methodology

1. Task 1: Hire Design Engineer and QAAP Development:

The CVRPC evaluated three proposals using a process that weighted the three following categories for scoring each proposal: Submission Completeness and Responsiveness (20%), Scope of Work Format and Contents (50%), and Cost Proposal (30%) for a total maximum score of 100. Watershed Consulting Associates, LLC (WCA) of Burlington, VT and Civil Engineering Associates, Inc. (CEA) of South Burlington, VT scored the highest among two of the three reviewers based on their knowledge and experience of the projects and were selected to complete the final designs.

The QAAP was developed by WCA. In order to complete the three final engineered designs, field survey and soil characteristics data needed to be collected and stormwater modeling was needed to accurately calculate the practice storage volumes for each stormwater infrastructure project. The QAPP ensured that any field data collected as well as the modeling methodology used to calculate storage volumes for the project was accepted by the LCBP/NEIWPCC and EPA and provided accurate, precise, comparable and repeatable data.

2. Task 2: Kickoff and Stakeholder Meeting & 60% Designs:

Meetings and Site Visits:

Once the contractors were hired, CVRPC arranged a kickoff meeting among stakeholders (Town of Berlin and Fire Department representatives), CVRPC and contractors. Immediately following the kickoff meeting, WCA and CEA conducted site visits at the Fire Department (Figure 1) and Chimney Sweep Fireplace Shop (Figure 2). A kickoff meeting and site visit at the Berlin Elementary School was delayed due to obtaining permission from the School District and conducted separately in late September, 2019 (Figure 3). During the site visits,

CEA and WCA observed current site conditions, evaluated the feasibility of the concept designs and how they may need to be adjusted, and took several photos.



Figure 1: Parking lot of Berlin Fire Dept.



Figure 2: Parking lot and treatment area at Chimney Sweep Fireplace Shop



Figure 3: Contractor site visit with Berlin Elementary Staff, School Board member, and School District Superintendent

Surveying:

Following the initial site visits, CEA conducted field work to collect surveying data when publicly available data was not complete or of sufficient detail for the design of the three stormwater BMPs. For example, if the 1-foot contour data was not sufficient to fully understand flow paths, field-surveyed topographic data was used to supplement the existing

data. Existing stormwater infrastructure, utilities, and features important to the proposed BMP design were located and verified by the survey crew. CEA utilized a total station surveying system, which is designed and calibrated to capture precise X, Y, and Z coordinates for each collected point and this equipment was used only by trained professionals, ensuring accuracy and precision. The total station was equipped with an on-board computer that collects and stores survey data. This data was then transferred to CEA's computers for incorporation into the engineering designs. CEA used standard surveying methodologies so that results are complete and comparable to other surveys. The surveying data was then fed into the hydrologic and hydraulic models to update the storage volume calculations for the proposed treatments.

Hydrologic Modeling:

To support the development of 100% concept designs, hydrologic and hydraulic modeling for these stormwater management practices were completed in HydroCAD, a computer aided design tool. The VT DEC STP Calculator

(https://anrweb.vt.gov/DEC/CleanWaterDashboard/STPCalculator.aspx) was used for pollutant load modeling to ensure accuracy, precision, and comparability by VT DEC's pollutant load reduction standards.

This modeling required acquisition or utilization of the following data, which was linked to or thoroughly described in the final hydrologic report (Appendix A) to ensure comparability:

- USDA Natural Resources Conservation Service (NRCS) soil data for the Town of Berlin (format: ESRI ArcGIS file geodatabase feature class; source: downloaded from the VCGI Open Geodata Portal; use: inputs for HydroCAD models)
- Topography data 1' LiDAR-derived contours. LiDAR data was collected between 10/24/2014 and 4/19/2015 with a 0.7m spatial resolution, quality level 2. Elevation data is used to aid in delineation of BMP drainage areas and for hydrologic and hydraulic modeling, specifically in calculating the time of concentration. (format: ESRI ArcGIS file geodatabase feature class; source: downloaded from the VCGI Open Geodata Portal; use: to inform HydroCAD models and STP Calculator inputs)
- Stormwater infrastructure data, mapped by the VT Department of Environmental Conservation, is also used to aid in delineation of BMP drainage areas. (format: ESRI ArcGIS file geodatabase feature class; source: downloaded from the VCGI Open Geodata Portal; use: to inform HydroCAD models and STP Calculator inputs)
- BMP drainage areas (format: ESRI ArcGIS file geodatabase feature class; source: generated by Watershed staff utilizing existing elevation data and refined during field visits; use: to inform HydroCAD models and STP Calculator inputs)
- National Oceanographic and Atmospheric Administration (NOAA) Atlas 14
 precipitation data for Washington County, VT. (format: Atlas 14 database embedded
 into HydroCAD program and accessed via pre-defined lookup tables that define
 rainfall distribution and rainfall depth; source: NOAA; use: to inform HydroCAD
 modeling)
- The best available satellite and/or aerial imagery, which varied from site to site, was
 used to generate site-specific landuse classification that was heads up digitized in
 ArcGIS 10.x. Best available was determined by currency and spatial resolution.
 (format: server-hosted tiled imagery; source: either VCGI or ESRI depending on
 location; use: to inform HydroCAD models and STP Calculator inputs)

The most current version of the modeling software HydroCAD was used for modeling runoff volumes and for sizing of retrofits for the 30% design plans. This program allows for automated modeling of stormwater runoff from small urban drainage areas using TR-20 and TR-55 modeling algorithms (methods of calculating runoff from small drainage areas were developed by the USDA Soil Conservation Service, now the NRCS). TR-55, a manual method for calculating runoff and peak discharge, used landuse, soils characteristics, and rainfall information for standardized storms. TR-20 was an early computer model that used the unit-hydrograph runoff procedure incorporated in HydroCAD and was adapted from TR-55. HydroCAD expands on the methods and calculations found in TR-20 as it uses automated modeling of the time of concentration, curve-number lookup, hydraulic calculations for outlets, exfiltration calculations, and pond storage calculations. HydroCAD is the industry standard for modeling stormwater BMPs and is well-established and accepted in Vermont for regulatory permitting decisions, ensuring accuracy, precision, representativeness, and comparability.

The HydroCAD model was calibrated to the region using the best available NRCS soils data and NOAA Atlas 14 precipitation information for the three modeled sites, ensuring that the data used was representative of the sites being modeled. This data is standard for VT DEC regulatory approval and is comparable across stormwater models as such. It has been deemed both accurate and precise enough by the VT DEC for these modeling tasks. The landuse data utilized in the model was generated for each of the three project locations through on-screen heads-up digitizing completed by qualified stormwater professionals at WCA using the best available imagery to ensure accuracy and precision. See list of modeling inputs above for more information about these data. This data is readily available, ensuring comparability.

Accuracy and completeness of modeling was ensured through the QC process by qualified stormwater professionals at WCA. Completeness was defined as fully representing conditions (land cover classes) in the drainage area, modeling BMP size and routing, and utilizing the most applicable rainfall data (based on location). Accuracy was defined as representing the conditions found in the drainage area correctly. A review of publicly available GIS and precipitation data via supplied metadata was completed to ensure that acquired data was representative and of sufficient quality and detail for the intended use. To be considered complete, publicly available data must cover the drainage area for the proposed practice and be of a sufficient scale to accurately describe the site. For example, contour data at a 20-foot interval would not describe the topography of a site in enough detail to determine stormwater flow paths over the BMP drainage areas for the three practices. However, contour data at a 1-foot interval would be of sufficient detail to allow for identification of flow paths in most cases.

Surveying and updated hydrologic modeling data was used to update the concept designs to the 60% level. Upon completion of the 60% designs, CVRPC and contractors reconvened with stakeholders to present the designs and obtain comments prior to advancing to the 90% stage. Meetings held included one with the Town and Fire Department, one with the Berlin Elementary School, and one with the landowners of the Chimney Sweep Fireplace Shop. The CVRPC and WCA also presented the 60% designs to the Berlin Selectboard for feedback.

3. Task 3: 90% Designs

WCA and CEA revised the 60% designs based on feedback from landowners and stakeholders of the three sites and any adjustments informed by subsequent hydrologic

modeling. Once the plans were revised, CVRPC convened meetings with all stakeholders to present the 90% designs. Construction cost estimates and bid documents were also developed for each site. A follow up meeting for the 90% designs was not needed with the Chimney Sweep Fireplace Shop because they did not have any changes for the plans. WCA and CVRPC also presented the 90% designs to the Berlin Selectboard for their feedback and they had no specific comments.

4. Task 4: 100% Designs

To finalize the designs, WCA conducted field work in May of 2020 to assess soils at the Berlin Elementary School and the Fire Department to confirm the need for underdrains in the proposed bioretention systems. Soil assessments were conducted to determine if soils were of sufficient quality to allow for infiltration as specified under the Vermont Stormwater Management Manual (2017) for the Berlin Elementary School and the Berlin Fire Department. The project team found high groundwater at the sites and determined that soil characteristics will make infiltration practices unsuitable and therefore did not test for infiltration. This is why underdrains were incorporated into the design. Soils were logged for texture, structure, consistence, moisture content, and redoximorphic features and mottling. Soils were assessed using the "Field Book for Describing and Sampling Soils" Version 3.0 published by the National Soil Survey Center, Natural Resources Conservation Service (NRCS), U.S. Department of Agriculture and be consistent with the Vermont Wastewater System and Potable Water Supply Rules. As such, additional soil analyses such as percent moisture was not calculated. The NRCS field book was referenced during soil characterization by WCA staff members. Photo documentation was taken for each soil horizon. Using this standardized methodology, referring to the abovementioned reference NRCS book in the field, and taking photo documentation ensured that soil assessments were accurate, precise, complete, and comparable. The soil assessment was completed where the proposed BMP would be located, ensuring that the soils assessed were representative of those where the BMP will be constructed.

All soil-related data was collected and maintained in digital format by WCA. All soil characteristics results were entered into a secure mobile app hosted by Fulcrum (www.fulcrumapp.com). No physical samples were taken during the soil assessment.

Based on comments from meetings during the 90% phase and soils data, WCA and CEA updated the hydrologic modeling, design plans, and cost estimates and created bid documents for each site to be used during the construction phase. Completed designs, cost estimates, updated drainage map, hydrologic modelling reports, bioretention planting plans, and a design for an educational sign are included in this link.

4 Quality Assurance Tasks Completed

WCA completed the Quality Assurance Project Plan (QAPP) development on behalf of the CVRPC. The CVRPC worked with the LCBP to review the QAPP drafts provided by WCA. The QAPP was approved by LCBP and NEIWPCC in November, 2019. The QAPP was necessary to ensure field data (surveying and soils) collected and hydrologic/hydraulic modeling was done accurately and through procedures accepted by the EPA and LCBP. As mentioned earlier in the Methodology section of this report, accuracy and completeness of the hydrologic modeling was ensured through the QC process by qualified stormwater professionals at WCA.

All data acquired or generated was fully documented as to original source, quality, and history. All data products were reviewed by the Project QA Officer to ensure quality and corrected if

necessary.

A. Surveying: Data collected during the site surveys was reviewed by members of the CEA and WCA team to ensure that all data was collected to industry standards.

<u>B. Soil Assessment:</u> Soils were assessed using the "Field Book for Describing and Sampling Soils" Version 3.0 published by the National Soil Survey Center Natural Resources Conservation Service, U.S. Department of Agriculture. This book was referenced during soil characterization by WCA. Data was reviewed by WCA staff trained in soil assessments to ensure that recorded information matched soil characteristics observed in soil horizon photos.

As a derivation from the QAPP, WCA augered a test hole at the Fire Department just to make sure that an underdrain was required. At the Berlin Fire Department site, soils are mapped as Hydrologic Soil Group D, which indicates very low infiltration potential and potentially high groundwater. Previous field visits to the site confirmed that soils on site were not well drained as puddling and ponding was noted on site following rain events.

<u>C. Stormwater Modeling</u>: Configurations for the HydroCAD models were verified by WCA staff who are trained to run the modeling programs. Outputs were evaluated for accuracy based on best professional judgement and WCA's team experience running these modeling programs for hundreds of sites.

For preventing the spread of invasive species, WCA specified native vegetation be planted in the bioretention practices.

5 Deliverables Completed

Task 1: QAPP Approval RFP, Selected Contractor Proposal/Cost estimate, and winning proposal. Quarterly Progress Report.

CVRPC delivered the request for scope of work and cost estimate for the work along with the first Quarterly report in June of 2019. The winning contractor, WCA, began the QAPP as soon as they were hired by CVRPC and LCBP and NEIWPCC approved it in November, 2019.

Task 2: CVRPC facilitated a kickoff meeting in August, 2019 with the Town and the Fire Department to discuss the design concepts with the engineers. Site visits of the Fire Department and the Chimney Sweep Fireplace Shop followed the meeting. WCA conducted an initial meeting and site visit with the Berlin Elementary School stakeholders at the end of September, 2019 and with the Chimney Sweep Fireplace Shop landowners in October, 2019. Due to changes in school personnel and difficulty with receiving communication back from both the school and the Chimney Sweep landowners, initial meetings and site visits for these sites were delayed, which ended up delaying the completion of the 60% designs until February, 2020. This did not affect the completion of the subsequent tasks for the project.

Kickoff meeting minutes for all three sites were delivered to LCBP and NEIWPCC with the 2nd Quarterly Report in October, 2019. The third Quarterly Report was delivered to LCBP and NEIWPCC at the end of December, 2019, which explained the revision of the concept design for the Berlin Elementary School based on the stakeholders wanting the treatment in another area on the school grounds.

When the 60% designs were complete, a second round of meetings were held with stakeholders to obtain feedback before forwarding to the 90% phase. The three 60% designs and cost

estimates were delivered to LCBP in February, 2020. Also included in the deliverables were a drainage map and a summary report from WCA.

Task 3: During the 90% design phase, WCA and CEA revised the 60% designs to incorporate changes to the 60% designs based on feedback from stakeholders. Another round of meetings were held remotely due to the COVID-19 pandemic. The Chimney Sweep landowners were happy with the 90% designs and no further changes were needed. Minor changes were discussed for the designs for the School and the Fire Department due to site constraints. WCA presented the 90% designs to the Berlin Selectboard in May, 2020 and there were no changes suggested from the Selectboard.

CVRPC delivered the 90% designs, updated cost estimates, draft bid documents, and WCA summary report to LCBP in the end of April, 2020, which was on time with the work plan. CVRPC also submitted the 4th Quarterly Report to LCBP and NEIWPCC in April, 2020.

Task 4: Despite the delay in the kickoff and 60% design phase, the three 100% designs including cost estimates and construction bid documents were completed on time. During the final phase of the project, the project team learned that a wetland permit was going to be required for the Berlin Elementary School site. WCA is working with the school district and the CVRPC to submit an application to the Vermont Wetlands Program to ensure a permit is in place prior to construction. A permit is needed due to the proposed swale collecting stormwater from the parking lot being located in the buffer of a wetland. The implemented project will not cause impact to the wetland but will actually reduce sediment loading and stormwater volume from the parking lot. The permit will be submitted to the Vermont Wetlands Program by July 31, 2020.

The 5th Quarterly Report, which depicted the final phases of the project, was submitted to LCBP and NEIWPCC in early June, 2020.

6 Conclusions

In conclusion, the Berlin Stormwater Mitigation Final Designs project has resulted in the following outcomes:

- Brought all stakeholders to consensus on the importance of stormwater improvement and the treatments to accomplish the reduction in stormwater runoff from the sites;
- Developed final designs and bid documents necessary for construction contractors to follow:
- Developed cost estimates to include with grant applications to determine funding needed for implementation;
- Enabled the future implementation of stormwater mitigation to facilitate phosphorus loading reduction in the Lake Champlain Basin. The calculated phosphorus loading reduction estimates along with the cost estimates will also be an important factor in communicating the cost per pound of phosphorus reduction needed for funding.

The CVRPC has learned the following lessons from this project:

- Ensure to enable more time for QAPP development if subcontracting that task;
- To not delay project start up, ensure that stakeholders are on board with concept designs before obtaining grant funding as there may be changes in personnel.

By developing these final designs and the associated deliverables that will forward the projects to clean up tributaries of Lake Champlain, the CVRPC, landowners, and Town of Berlin are ready to forward to the construction phase and to contribute to the following objective in the LCBP Opportunities for Action.

Objective I.C. for the Clean Water Goal in the OFA is to Reduce Nutrient Loading and under this objective is Strategy I.C.3, which is to **Fund Programs to Reduce Nutrient Inputs from Developed Lands: Target inputs from stormwater runoff and wastewater treatment facilities. Task Area** I.C.3.c under this objective is to Fund design and implementation of GSI/LID projects in critical areas. Support a grant program targeting design and installation of green stormwater infrastructure (GSI) projects in critical watersheds.

7 References

Stormwater Master Plan for the Town of Berlin, Vermont, Final Report Watershed Consulting Associates, LLC, January, 2018.

Quality Assurance Project Plan (QAPP), Stormwater Mitigation Final Designs – Berlin, VT, Watershed Consulting Associates, LLC, November, 2019.

8 Appendices

Appended Documents: None – see link under Electronic Data

Photos: Photos of the project sites are available for download through these links: <u>Berlin Elementary School</u>, <u>Chimney Sweep</u>, and <u>Fire Station</u>.

Electronic Data: All electronic data has either been emailed to LCBP or shared for download via this <u>link to final documents.</u>