Detecting and Eliminating Illicit Discharges to Improve Water Quality in the Lamoille River Basin

Final Report

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Dye flushed down a toilet in the Hardwick Elementary School appeared in this catchbasin on South Main Street, confirming a sanitary wastewater connection to the stormwater drainage system

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1. INTRODUCTION

The goal of the Lamoille River Basin Illicit Discharge Detection and Elimination Project was to improve water quality by identifying and eliminating contaminated, non-stormwater discharges entering stormwater drainage systems and discharging to the Lamoille River and its tributaries. The need for a comprehensive illicit discharge assessment in this basin was recognized in the Draft Lamoille River Basin Water Quality Management Plan, which recommends action “to assist municipalities in the development of stormwater infrastructure maps, maintenance inventories and illicit discharge detection (IDDE) surveys” (page 67).

Eleven municipalities participated in the project: Cambridge, Fairfax, Georgia, Hardwick, Hyde Park, the Village of Jeffersonville, Jericho, Johnson, Morrisville, Underhill, and Wolcott. The geographic scope included the entire extents of the municipal closed drainage systems. Johnson State College was also assessed. Prior to this assessment, the Vermont Department of Environmental Conservation prepared stormwater infrastructure mapping for all of these municipalities with the exception of Wolcott. This infrastructure mapping was used to plan the assessment in each municipality and to guide further investigations in systems with suspected illicit discharges. Colchester and Milton were not included in either the infrastructure mapping or IDDE work because they are required to perform stormwater infrastructure mapping and IDDE in compliance with Vermont’s general permit for small municipal separate storm sewer systems (MS4).

Between June and December, 2012, Stone Environmental, Inc., assessed stormwater outfalls and certain manholes and catchbasins in each participating municipality for the presence of illicit discharges. A total of 305 stormwater drainage systems were assessed. Of the total, 297 systems were assessed at the outfall. Seven systems (three in Johnson, two at Johnson State College, and one each in Underhill and Morrisville) were assessed at the catchbasin immediately up-pipe from the mapped outfall location because the outfall could not be located. One system in Hardwick was assessed at the catchbasin immediately up-pipe from a junction with a combined sewer line. Field tests were performed for ammonia, total chlorine, common anionic detergents [using the methylene blue active substances (MBAS) method], and optical brighteners. Optical brighteners are fluorescent whitening dyes contained in most laundry detergents. Specific conductance was also measured. Of the 305 systems assessed, 80 were flowing or dripping when inspected.

Among the 305 stormwater drainage systems assessed, contaminants indicating a possible illicit discharge were detected in 26: four in Fairfax, one in Georgia, eight in Hardwick, two in Jericho and Johnson, and three each in Morrisville, Hyde Park, and Wolcott. Table 1 summarizes by municipality the number of systems assessed and the number in which an illicit discharge was suspected. There were no indications of possible illicit discharges in Cambridge Village, the Village of Jeffersonville, and Underhill. Letters were sent to each of these municipalities stating that no illicit discharges were detected and thanking them for their participation. This first phase of the project was summarized in an interim report dated February 23, 2013, which was sent to DEC and to each municipality.

Because Hardwick was the last municipality to be assessed, in late fall 2012, in some cases systems were designated for further investigation based on scant evidence of contamination (such as a single measurement of ammonia, chlorine, or MBAS near the detection limit). The designation of eight systems in Hardwick for investigation reflected an abundance of caution; follow-up sampling did not confirm the presence of an illicit discharge in most cases.

In 2013, Stone completed investigation of each of these 26 systems to verify the presence of illicit discharges and to attempt to determine their sources. Stone assisted the municipalities in developing plans for correction of confirmed illicit discharges. This report presents the results of the investigation of these 26 drainage systems and the measures taken or plans made to correct the identified illicit discharges.

Table 1. Summary of stormwater drainage systems assessments by municipality

Municipality	Systems Assessed at Outfall	Systems Assessed at Up-pipe Catchbasin	Outfalls Flowing or Dripping	Suspected Illicit Discharges	Confirmed Illicit Discharges
Cambridge Village	3	0	0	0	0
Fairfax	23	0	6	4	2
Georgia (South Village)	12	0	5	1	1
Hardwick	50	1	13	8	2
Hyde Park	21	0	5	3	1
Jeffersonville	10	0	1	0	0
Jericho	35	0	4	2	1
Johnson	44	3	11	2	0
Johnson State College	21	2	14	0	0
Morrisville	66	1	17	3	2
Underhill	2	1	0	0	0
Wolcott	10	0	4	3	2
Total	**297**	**8**	**80**	**26**	**11**

Stormwater drainage systems on Johnson State College property were not assessed on the same schedule as the municipal systems. Stormwater drainage systems at Johnson State College were assessed in June 2013 after permission to conduct the assessment was obtained. A total of 23 systems were assessed on Johnson State College property and no illicit discharges were identified.

2. METHODS

2.1 Preparing for the assessment

Preparation for the illicit discharge assessment included obtaining and assembling necessary equipment and supplies; preparing a field data form (Appendix A), field maps, a Health and Safety Plan, and other documents, and organizing these in a project notebook; and meeting with each of the participating municipalities to gather information and plan the project in detail. Large-format field maps were prepared by overlaying DEC's stormwater infrastructure mapping on the best available orthophotography. These maps were consulted in the kickoff meetings and were annotated in the field. The kickoff meeting with each municipality provided an opportunity to collect four key types of information, as presented below.

- Contact information for municipal managers and public works personnel.
- General schedules of road and wastewater and stormwater collection system projects (to avoid conflict with construction activities).
- Locations of any known, suspected, or potential cross connections, combined sewer overflows, and sanitary sewer overflows. These may be areas where complaints have been received about sewage odors or other nuisance conditions.
- In-house capabilities of the Public Works or Highway Department to inspect pipelines and perform other advanced investigation techniques.

2.2 Dry weather survey

Stormwater drainage systems were assessed during dry weather to minimize dilution by stormwater runoff. Dry weather was defined as negligible rainfall (less than 0.1 inches) since approximately 12:00 p.m. on the previous day. Stormwater drainage systems with 10 or fewer inlets were typically assessed only at the outfall. Within larger stormwater drainage systems, the effects of dilution must be considered; therefore, selected catchbasins and junction manholes were also assessed. Stormwater structures were accessed along the public right-of-way or from the receiving waterbody, as appropriate. Where access permission was obtained, stormwater structures located on private property were also assessed, particularly if these structures were connected to a municipal drainage system.

In addition to assessing all outfalls represented in the infrastructure mapping prepared by Vermont DEC, Stone scouted stream banks in densely developed areas (historic downtowns) to locate and assess any unmapped outfalls. Stone recorded the position of any unmapped outfalls identified in the course of the assessment.

Every outfall or other stormwater structure assessed was assigned a unique identifying code. A visual inspection was made of the condition of each discharge point and the area immediately below each discharge point. If present, dry-weather flows were observed for color, odor, turbidity, and floatable matter. Obvious deficiencies in the structure, such as severe corrosion, were noted. Dry weather flows were sampled by hand or using a telescoping pole. At catchbasins and manholes located at junctions in the storm sewer, samples were collected independently from each in-flowing pipe, when possible. Field data were entered on printed assessment forms (Appendix A).

Each dry weather discharge was tested for ammonia, methylene blue active substances (common detergents), and the presence of optical brightener to identify potential illicit discharges from laundry facilities, leaking sanitary sewers, and cross-connections. Optical brighteners are fluorescent dyes contained in most laundry detergents. Specific conductance was measured as an indication of the dissolved solids content. To detect treated municipal water leakage, samples were also analyzed for total chlorine concentration.

With few exceptions, structures that were not flowing at the time of the initial inspection were assumed not to have illicit connections and no further assessment of these structures was performed. Our general procedure is to provide additional assessment of non-flowing structures only if there is associated evidence of contamination, such as suds, odors, or certain deposits.

2.3 Water analysis methods

The ammonia concentration was tested using Aquacheck ammonia test strips. Samples were tested for methylene blue active substances using CHEMetrics test kit K-9400, a method consistent with APHA Standard Methods, 21st ed., Method 5540 C (2005). Total chlorine analysis was conducted with powdered DPD reagent (Hach Method 8167, equivalent to USEPA method 330.5) and a portable Hach DR/900 colorimeter. Specific conductance was measured using an Oakton model conductivity meter, according to Stone Environmental Standard Operating Procedure (SOP) 5.23.3 (Appendix B).

Optical brightener monitoring was performed at outfalls and selected catchbasins and manholes that were flowing at the time of inspection, according to Stone Environmental SOP 6.38.0 (Appendix B). To test for optical brightener, a cotton pad is placed in the flow stream for a period of 4-10 days, after which the pad is rinsed, dried, and viewed under a long-wave ultraviolet light (“black light”). Florescence of the pad (seen on the right pad in Figure 1) indicates the presence of optical brightener. Pads are held in a sleeve of fiberglass window screen, clipped to the rim of the outfall pipe or secured with fishing line to a rock or other anchor. At catchbasins and manholes located at junctions in the storm sewer, pads are deployed in incoming pipes if possible, but are more often hung from the catchbasin grate or manhole rung into the sump. An advantage of optical brightener monitoring is that some intermittent or dilute wastewater discharges may be detected due to the multiple-day exposure of the pad, whereas the contaminant may not be detected in tests performed on grab samples.

Figure 1. Optical brightener monitoring pads under UV light

Table 2 identifies water quality tests that Stone performed at all discharge points and selected catchbasins and manholes that were flowing at the time of inspection.

Table 2. Water quality tests performed at flowing structures

Parameter	Sample Container	Analytical Method
Ammonia	Plastic vial	Aquacheck ammonia test strips
MBAS detergents (anionic surfactants)	Plastic vial	APHA Standard Methods, 21st ed., Method 5540 C (2005)
Total chlorine	Glass jar	By DPD, Hach Method 8167 (EPA 330.5)
Specific conductance	Glass jar	Stone SOP 5.23.3
Optical brightener	Cotton test pads	Stone SOP 6.38.0

2.3.1 *E. coli* and phosphorus

In the Lamoille River Basin, phosphorus is a significant concern due to its effects on the ecology of Lake Champlain. *E. coli* bacteria levels provide an indication of fecal contamination; based on human health concerns, *E. coli* enumeration is recommended for all fresh waters used for contact recreation or for water supply. At discharge points where wastewater contamination was suspected (because of a positive optical brightener test, elevated ammonia, and/or septic odor), water samples were collected for *E. coli* and total phosphorus analysis. DEC's LaRosa laboratory performed both analyses.

Samples for *E. coli* analysis were collected in sterile, plastic 100-mL bottles and analyzed using Quanti-tray. Samples collected for total phosphorus analysis were collected in glass digestion vials provided by the DEC LaRosa laboratory. Total phosphorus was analyzed by DEC's Standard Operating Procedure (SOP) for Determination of Phosphorus by Flow Injection, Revision 6. The preservation and holding time requirements are given in Table 3, below.

Table 3. Laboratory sample analyses

Parameter	Sample Container	Analytical Method	Sample Preservation	Holding Time
Total P	Glass vial (50 mL)	DEC SOP, Revision 6	Cool (4°C)	28 days
E. coli	Plastic (100 mL)	SM 9223B (Colilert Quanti-Tray)	Cool (4°C), sodium thiosulfate	6 hours

At discharge points where wastewater contamination was suspected, at the same time that water samples were collected for *E. coli* and total phosphorus analyses, flow measurements were made to enable calculation of total phosphorus mass loading. Flow was measured by timing the filling of a container of known volume.

2.4 Advanced investigations

Our IDDE experience has given us an understanding of constituent concentrations likely to indicate presence of an illicit discharge. These benchmark concentrations are summarized in Table 4. Stormwater drainage systems were designated for follow-up sampling and/or investigation where these benchmarks were exceeded. In many cases, systems were resampled at a later date if low concentrations

(concentrations near the method detection limit) of ammonia, MBAS detergents, or chlorine were measured; and were not designated for intensive investigation unless elevated concentrations recurred.

Table 4. Benchmark concentrations for determination of illicit discharges

Test	Benchmark	Remarks
E. coli	>= 400 E. coli/100 mL	Undiluted municipal wastewater will generally have *E. coli* levels at least an order of magnitude higher than this benchmark. Pet waste and wildlife sources can also cause elevated *E. coli* levels.
Ammonia	>= 0.25 mg/L	In the absence of other wastewater indicators, investigation is performed when the ammonia concentration is 0.5 mg/L or higher. If other wastewater indicators are present, then the 0.25 mg/L benchmark is used. Decomposing vegetation under anoxic conditions can release ammonia to water, which can be misleading.
Anionic detergents (methylene blue active substances in anionic detergents)	>= 0.2 mg/L	Detection of low concentrations (0.1-0.3 mg/L) of anionic detergents is common at stormwater outfalls. Most detections are not correlated with other wastewater indicators and do not lead to a definite source. These detections may be attributable to outdoor washing. However, concentrations as low as 0.2 mg/L have occasionally led us to significant wastewater sources that might otherwise have been missed; therefore this is a useful test to trigger further sampling or investigation.
Optical brightener	presence	Presence usually indicates contamination by sanitary wastewater or washwater. Exposure of the test pad for 4-10 days means that diluted and intermittent discharges can be detected. Unfortunately, petroleum fluoresces at the same wavelength as optical brighteners. Optical brightener testing in catchbasins and manholes has proven to be our most effective method to bracket sources of contamination within storm sewers.
Total chlorine	Total chlorine: >= 0.06 mg/L	The field test used for total chlorine analysis is sufficiently sensitive to detect municipal tapwater sources diluted by groundwater or runoff approximately 3 to 10 fold, depending on the strength of the tapwater chlorine residual. Total chlorine is a good indicator of tapwater leaks and graywater sources. Chlorine is degraded in the presence of organic materials; therefore it is not a good wastewater indicator.

If a stormwater drainage system was suspected of passing illicit discharges based on the results of the dry weather survey, additional observations and testing were performed within the system to locate or bracket the origin of the contaminated flow. The goal was to bracket the contaminant source between adjacent structures, such as a stormline connecting a catchbasin to a down-pipe manhole. DEC’s stormwater infrastructure mapping was used to guide this effort.

To locate or bracket contaminant sources within storm sewer segments, the same testing methods or a subset were used as in the dry weather survey. The most reliable method to bracket sources of wastewater contamination is usually optical brightener monitoring throughout the drainage system. In several instances, we used optical brightener results to narrow the search area for illicit discharges to a specific structure or to the pipe between two structures. The presence and appearance of dry-weather flows were also useful in isolating sources of contamination within storm sewer segments.

Stone worked with each participating municipality to find specific improper connections, leaks, and other problems contributing the contaminated flows observed in the stormwater drainage systems. After bracketing the discharge source as closely as possible using the water quality test methods, Stone met with representatives of each municipality to describe our findings and discuss next steps. Engineering plans were reviewed to identify possible cross-connections between sanitary sewers and stormwater drainage systems, particularly locations where leakage from a sanitary line could be intercepted by the stormwater system. Dye testing was performed in Hardwick, Hyde Park, Morrisville, and Wolcott to identify specific improper connections.

The following sections present the findings of illicit discharge investigations in each municipality. No suspected illicit discharges were identified in Cambridge, the Village of Jeffersonville, and Underhill; therefore no further investigation occurred. In Johnson, two systems were designated for further investigation, but no illicit discharges were confirmed. In each of the remaining municipalities, one or two illicit discharges were confirmed. In nearly all cases, correction of these illicit discharges is slated to occur in 2014.

3. CAMBRIDGE RESULTS

Illicit discharge detection in Cambridge was performed on August 1, 2012. Three systems were assessed, all of which were dry. There was no evidence of contamination at any of the outfalls. However, a gully is eroding below outfall CC010.

4. FAIRFAX RESULTS

Illicit discharge detection in Fairfax was performed in August, 2012. Of the 23 systems assessed, six were either flowing or dripping during dry weather. Four systems were designated for further investigation due to detection of one or more contaminants. These four systems are described in detail below.

4.1 FX040

The FX040 outfall is a 24-in. corrugated black plastic pipe. This system drains a portion of Route 104/Main Street and discharges on the west side of Route 104 downhill from the Fairfax Commons development (Appendix C, Map 1). Water quality data for this outfall are presented in Table 5. The outfall was dripping and suds were present when inspected on August 1, 2012. A moderate concentration (0.8 mg/L) of MBAS detergent was measured. The source of the flow appeared to be Fairfax Commons. On two subsequent visits in August 2012, there was no flow at catchbasin CB-E, the furthest down-pipe catchbasin on the Fairfax Commons property.

Table 5. Water analysis data for outfall FX040

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	Observations
8/1/12	Dripping	0.0	464	0.03	0.8	Negative	Clear, no odor, suds present
8/14/12	Dripping	NS	NS	NS	NS	NS	No flow from Fairfax Commons
8/21/12	No flow	NA	NA	NA	NA	NA	No flow from Fairfax Commons or at outfall
8/6/13	Dripping	0.0	Insufficient sample	0.10	0.0	NA	No flow from Fairfax Commons

This system was reassessed on August 6, 2013. The outfall was dripping and the outflow pipes from catchbasins CB-A and CB-B (Appendix C, Map 1) were wet. The catchbasins in Fairfax Commons were not flowing. No suds were present in the system and no MBAS detergent was detected at the outfall. Neither chlorine nor ammonia was detected in catchbasins CB-A and CB-B. Elevated total chlorine (0.10 mg/L) was measured at the outfall, which must have resulted from poor sample quality, as there are no water lines in Fairfax south of the Lamoille River bridge. The chief operator of the Fairfax wastewater treatment plant, Randy Devine, has confirmed that there are no sanitary sewers or municipal water lines south of the Lamoille River bridge. Fairfax Commons has a private well and an onsite wastewater treatment system.

Based on our observations during repeated visits, we conclude that the MBAS detergents detected on August 1, 2012 were from a transient source in Fairfax Commons, such as sidewalk washing or direct dumping of mop water into a catchbasin. During our August 13, 2013 meeting, Randy Devine indicated he would discuss this possibility with the owners of Fairfax Commons. **Because after repeated sampling the only indication of contamination in this system was one measurement of MBAS, we have concluded that no chronic illicit discharge is present in this system.**

4.2 FX070

The FX070 outfall is an 18-in. smooth plastic pipe. This system drains a portion of Route 104/Main Street and discharges to a tributary of the Lamoille River on the northeast side of Main Street between its intersections with Maple Street and School Street (Appendix C, Map 2). Water quality data for this outfall are presented in Table 6. Low concentrations of chlorine and MBAS detergents were measured at the outfall on August 1, 2012. The flow had a yellow cast, musty odor, and suds. Optical brightener monitoring pads were placed throughout this system on August 14, 2012, except at the outfall, which is inaccessible. Optical brightener was detected (although fluorescence was weak) at the first catchbasin up-pipe from the outfall (CB-A). Due to the detection of optical brightener, follow-up sampling was conducted on September 20, 2012 for total phosphorus and *E. coli* analysis. The flow rate was moderate (0.13 L/s) and the concentrations of total phosphorus (86.9 µg/L) and *E. coli* (129 MPN/100 mL) were low.

Table 6. Water analysis data for outfall FX070

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	Observations
8/1/12	flowing (0.5 in.)	0.0	1546	0.06	0.5 (cloudy)	CB-A: positive (weak)	Yellow color, musty odor, suds
8/14/12	--	NS	NS	NS	NS	CB-A: positive (weak)	
9/20/12	--	0.0	869	0.00	0.0	NA	
8/6/13	_	NS	NS	0.02	0.25	NA	Traffic prevents close inspection

The system was revisited on August 6, 2013. The outfall was inaccessible and traffic at the bridge prevented removal of the CB-A catchbasin grate; therefore samples were fished through the grate. Total chlorine and MBAS were measured at or below the methods' limits of detection.

On August 13, 2013, the water quality test data were reviewed with Randy Devine and next steps for identifying cross connections to the system were discussed. Mr. Devine indicated that if a cross connection to the system were present, it was most likely from a property on the north side of lower

Main Street, uphill of catchbasin CB-A. Mr. Devine stated that he would inspect internal plumbing connections in several properties and perform dye testing if warranted, to identify any cross connections. **The outcome of these investigations is not known at the time of writing.**

4.3 FX120

The FX120 outfall is a 15-in. corrugated metal pipe. This system discharges on the southeast side of School Street (Appendix C, Map 3). The outfall pipe was dripping and had a musty odor and iron staining at the time of the initial assessment. Water quality data for this outfall are presented in Table 7. Moderate concentrations of ammonia (0.5-1.0 mg/L) were measured at the outfall on August 2 and 14; however, no ammonia was detected when the outfall was resampled on September 20, 2012. Low chlorine concentrations were measured on all three sampling dates. Due to detection of ammonia at the outfall, follow-up sampling was conducted on September 20, 2012 for total phosphorus and *E. coli* analysis. The flow rate was moderate (0.14 L/s) and the concentrations of total phosphorus (31.6 µg/L) and *E. coli* (74 MPN/100 mL) were low.

Table 7. Water analysis data for outfall FX120

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	Observations
8/2/12	Dripping	0.5	1286	0.05	0.1	negative	Clear, musty odor, iron staining
8/14/12	Dripping	1.0	1055	0.12	0.0	--	
9/20/12	Flowing	0.0	877	0.05	0.0	--	
8/6/13	Flowing	0.2	900	0.01	0.1	--	Source of water is ditch west of School Street

The FX0120 system was reassessed on August 6, 2013. The two catchbasins shown in Appendix C, Map 3 were dry. The only water entering the system appeared to be from the ditch flowing toward School Street from the northwest. This is a long ditch with wetland vegetation. Based on the lack of optical brightener and MBAS detergents and the low *E. coli* concentration, we concluded that the ammonia detected is naturally occurring, likely the result of organic matter decomposition in the ditch/wetland. The apparent chorine detection on August 14, 2012 was either from a transient source or resulted from organic matter in the sample. **Therefore, we have concluded that no chronic illicit discharge is present in this system.**

4.4 FX170

The FX170 outfall is an 18-in. diameter corrugated black plastic pipe. This system drains Rich Street and the development on Old Academy Street and discharges in a stormwater detention pond located southwest of the Old Academy Street circle (Appendix C, Map 4). Water quality data for this system are presented in Table 8. Up-pipe catchbasins were assessed because flow appears to bypass underneath the outfall pipe.

Due to elevated chlorine concentrations and detection of optical brightener (although fluorescence was weak), follow-up sampling was conducted on September 20, 2012 for total phosphorus and *E. coli* analysis. The flow rate was low (0.08 L/s) as were the concentrations of total phosphorus (30.9 µg/L) and *E. coli* (82 MPN/100 mL).

Table 8. Water analysis data for outfall FX170

Structure ID	Date assessed	Dry, Wet (no flow), Dripping, or Flowing?	Ammonia (mg/L)	Sp. cond. (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	Observations
FX170	8/2/12	wet (no flow)	CB-E: 0.0	CB-E: 1262	CB-E: 0.14	CB-E: 0.2 (cloudy)	CB-N: pos. (weak); CB-F, CB-H, & CB-K: neg.	Iron staining
CB-L	8/14/12	Flowing	Pipe A: 0.0 Pipe B: 0.0	Pipe A: 534 Pipe B: 933	Pipe A: 0.21 Pipe B: 0.13	Pipe A: 0.0 Pipe B: 0.0	--	Source of flow to CB-L Pipe A is between CB-M and next up-pipe catchbasin. Source of flow to CB-L Pipe B appears to be between CB-P and CB-Q.
CB-K	9/20/12	--	0.25	799	0.00	0.0	--	
CB-L	8/13/13	Flowing	NS	NS	Pipe A: 0.17 Pipe B: 0.16	NS	--	No flow at outfall; flow entering CB-L via Pipe A and Pipe B

On August 13, 2013, this system was visited with Randy Devine of the Town of Fairfax. We confirmed significant flows of chlorinated water entering catchbasin CB-L from both Pipe A and Pipe B. It is unclear whether the source is the municipally-owned water main or a privately owned lateral. **We have recommended that the Town perform leak detection on the municipal water line along Old Academy Street and on the line from Old Academy Street back to Main Street.**

5. GEORGIA RESULTS

Illicit discharge detection in Georgia was performed between June 15 and July 27, 2012. Twelve systems were assessed. Several of the outfalls assessed are located on commercial properties (PBM Nutritionals, Harrison Concrete, and an industrial park). Stone was granted permission to enter these properties. Testing was repeated at three locations, but only system GA080 was determined to be contaminated.

5.1 GA080

The GA080 outfall is an 18-in. corrugated black plastic pipe. This system drains a portion of Route 7 and discharges on the north side of Highbridge Road (104A) at its intersection with Route 7, behind an auto service station (Appendix C, Map 5). Water quality data for this outfall are presented in Table 9. On July 27, 2012 a petroleum odor was observed at the outfall; this may have resulted from fumes from the service station. A distinct laundry odor was observed in the first three catchbasins up-pipe from the outfall. The odor was strongest in the second catchbasin up-pipe from the outfall, CB-B. Water in the sump of CB-B was opaque and blue-gray in color (Figure 2). Ammonia and MBAS detergents were detected at low concentrations at the outfall and optical brightener was detected at the outfall and in the first three up-pipe catchbasins.

Table 9. Water analysis data for outfall GA080

Date assessed	Dry, Wet (no flow), Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	Observations
7/27/12	Flowing (0.5 in.)	0.25	1426	0.02	0.4	Outfall, CB-A, CB-B, & CB-C: positive CB-D: negative	Clear, petroleum odor, iron staining; Laundry odor in CB-A
9/20/12	Flowing	0.5	1500	0.02	0.1	--	--
8/13/13	--	--	--	--	--	Outfall, CB-A, CB-B, & CB-C: positive	Laundry odor in CB-B

Figure 2. Laundry washwater present in CB-B in system GA070

Due to the detection of optical brightener and ammonia at the outfall, follow-up sampling was conducted on September 20, 2012 for total phosphorus and *E. coli* analysis. The flow rate was low (0.08 L/s), as were the concentrations of both total phosphorus (17.9 µg/L) and *E. coli* (2 MPN/100 mL). The water quality tests and our observations strongly suggested a laundry/graywater discharge to this system.

Optical brightener monitoring pads were placed in catchbasins CB-A, CB-B, and CB-C on August 13, 2013 to confirm the presence of laundry detergent. A marked laundry detergent odor was observed in catchbasins CB-B and CB-C when the pads were deployed and again when they were retrieved on

August 23, 2013. Pads placed in CB-A, CB-B, and CB-C showed strong optical brightener fluorescence. Because no pipes enter CB-B and CB-C, we suspect the source of the laundry detergent is infiltration from the onsite wastewater treatment system at the tan ranch house located on Route 7 in front of the bike shop and kitchen store. A second possible source is infiltration from the newly constructed (2011) mound system at the Franklin West Supervisory Union building at 4497 Highbridge Road.

Given the presence of laundry detergent and the location of the tan house relative to the storm drain, we suspect that the onsite wastewater treatment system serving this property is not providing adequate wastewater treatment. The question becomes: what level of treatment constitutes failure? *E. coli* levels measured at the outfall were low; therefore the system may provide adequate pathogen removal. The phosphorus concentration was also low, suggesting that phosphorus removal in the leachfield soils may be adequate. We expect mobile constituents such as nitrogen, chloride, and optical brighteners to pass from onsite wastewater treatment systems to groundwater. This is not necessarily a problem. In our view, the strongest basis for finding that the system was not providing adequate wastewater treatment was the bluish-gray color observed in catchbasin CB-B on July 27, 2012 and the laundry odor repeatedly observed in CB-B and CB-C.

Because gaining access to the tan house located near catchbasin CB-C had been problematic, Vermont DEC sent a letter (dated November 20, 2013) to the owner requesting that he contact Stone to schedule a time to dye test the plumbing fixtures in the house. The homeowner has not responded to this request. The matter is currently being pursued through DEC enforcement.

6. HARDWICK RESULTS

Illicit discharge detection in Hardwick was performed in November, 2012. Of the 51 systems assessed, 13 were flowing or dripping at the time of the initial inspection. Eight systems were designated for further investigation due to detection of one or more contaminants. These eight systems are described below.

6.1 HA070

The HA070 outfall is an 8-in. smooth plastic pipe. This system drains a portion of Holton Hill Road and discharges on the northwest side of Route 15 (Appendix C, Map 6). The outfall pipe is located in the rock wall below the northwest corner of the triangular parking area at the intersection of South Main Street and Route 15. Exceedingly high ammonia concentrations (≥6 mg/L) were measured at the outfall on three sampling dates in 2012. The discharge had a fish odor, yellow-brown color, and suds when assessed on November 6, 2012. Water quality data for this outfall are presented in Table 10.

A very high total phosphorus concentration (9,650 µg/L) was measured in a sample collected on December 4, 2012 and the *E. coli* concentration exceeded the analytical range. The discharge rate measured at the time samples were collected was low, 0.018 L/s.

Table 10. Water analysis data for outfall HA070

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
11/6/12	flowing (0.25 in.)	>6	1,338	0.00	NA	negative	--	--	Fish odor, yellow - brown color, suds
11/27/12	--	6	1,740	"limit"	NA	--	--	--	
12/4/12	0.02 L/s	>6	1,090	NA	NA	--	>2,420	9,650	
5/2/13	--	Outfall, CB-B, and CB-C: >6	1,742	0.00	0.25	--	--	--	Fish odor at outfall, CB-B, and CB-C
7/17/13	Dry	--	--	--	--	--	--	--	School not in session

On November 5, 2013, a meeting was held with the Town Manager, Jon Jewett, to discuss IDDE findings in Hardwick. With assistance from public works staff, all the kitchen drains in the elementary school were dye tested; none were found to be connected with the HA070 system. Investigations were started in the kitchen due to the repeated observations of fish odors. A push camera was then deployed in catchbasin CB-C. Approximately 50 feet into the pipe a large diameter pipe intersected the line from the direction of the elementary school. Through sound checks, we confirmed the opposite end of the pipe, a ductile iron pipe that protruded through the basement wall and was sealed with a threaded cap. No visible building plumbing was connected to this pipe. Finally, toilets were dye tested in different areas of the elementary school building and a wing of the school with four bathrooms was determined to be connected to the HA070 system (Figure 3). The exact connection is unclear, but we suspect that the sanitary line from this wing of the building is plumbed to a roof downspout which intersects the ductile iron pipe just outside the basement wall.

Figure 3. Dye flushed down a toilet at the elementary school appeared in catchbasin CB-C

The school maintenance superintendent, Jeff LeCour, assisted with the dye testing. Mr. LeCour has been advised to correct the connection as soon as practicable. Correction of this problem will reportedly entail breaking into walls to access plumbing connections, which is not feasible while school is in session. **In calls to Jon Jewett on January 17, 2014 and to Jeff LeCour on January 29, 2014, both men confirmed that the correction would be scheduled over the summer break.**

6.2 HA190

The HA190 outfall is a 24-in. diameter concrete pipe. This system drains West Church Street and discharges on the west side of the road, just downstream from the bridge over the Lamoille River (Appendix C, Map 7). Water quality data for this outfall are presented in Table 11. Optical brightener was detected in catchbasin CB-A on November 6, 2012, although the fluorescence was weak. On November 21, 2012 monitoring pads placed in the outfall and CB-A did not indicate optical brightener.

Table 11. Water analysis data for outfall HA190

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
11/6/12	flowing (0.5 in.)	0.0	720	0.03	0.1	Outfall, CB-B, and CB-E: negative CB-A: positive (weak)	--	--	Clear, no odor, iron staining
11/21/13	--	--	--	--	--	Outfall and CB-A: negative	--	--	
12/4/12	0.17 L/s	0.0	602	0.01	0.0	--	<1	<5	
7/30/13	--	--	--	--	--	Outfall, CB-A, CB-B sump, and CB-B Pipe B: all negative	--	--	

On July 30, 2013 a third round of optical brightener monitoring indicated no optical brightener was present at the outfall, CB-A, or CB-B. Therefore, we concluded that the initial detection of optical brightener in CB-A (which was weak) was a false positive result. **We do not believe an illicit discharge is present in system HA190.**

6.3 HA250

The HA250 outfall is an 18-in. diameter corrugated black plastic pipe. This system drains a portion of the intersection of South Main Street/Route 15 and North Main Street and discharges on the east side of North Main Street upstream from the bridge over the Lamoille River (Appendix C, Map 8). Low concentrations (0.1-0.5 mg/L) of MBAS detergents were measured on three dates and the specific conductance was elevated. Very low total phosphorus and *E. coli* concentrations were measured in samples collected on December 4, 2012. Water quality data for this outfall are presented in Table 12.

Table 12. Water analysis data for outfall HA250

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
11/6/12	flowing (0.25 in.)	0.0	2,980	0.03	0.5	negative	--	--	Clear, no odor
11/27/12	--	0.0	810	0.01	0.1	--	--	--	
12/4/12	0.01 L/s	0.0	2,450	0.02	0.25 (cloudy)	--	16	8.88	
7/17/13	--	0.0	3,390	0.06	0.25	--	--	--	

Results of sampling conducted on July 17, 2013 were similar to 2012 results: MBAS and total chlorine concentrations were near the detection limit and specific conductance was elevated. Because no optical brightener or ammonia was detected and the *E. coli* concentration measured on December 4, 2012 was very low, a sanitary wastewater connection to this system is unlikely. These results likely indicate poor groundwater quality in the downtown area rather than a specific illicit discharge. **Therefore, we have concluded that no chronic illicit discharge is present in this system.**

6.4 HA260

The HA260 outfall is a 10-in. diameter ceramic pipe. This system drains a portion of Mill Street/Route 15 and discharges on the north side of the road behind the Center for an Agricultural Economy (Appendix C, Map 9). Very low concentrations of MBAS detergents (0.10-0.25 mg/L) were measured on two dates in 2012. Water quality data for this outfall are presented in Table 13.

Table 13. Water analysis data for outfall HA260

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	Observations
11/6/12	flowing (0.5 in.)	0.0	1,152	0.02	0.25	negative	Clear, no odor
11/27/12	--	0.0	1,208	0.02	0.10	--	
7/17/13	--	0.0	1,135	0.03	0.25	--	

The HA260 outfall was resampled on July 17, 2013. Results were similar to the 2012 results: the MBAS concentration was near the detection limit, the total chlorine concentration was below detection, and specific conductance was elevated. Because no ammonia or optical brightener was detected, a sanitary wastewater connection to this system is unlikely. These results likely indicate poor groundwater quality in the downtown area rather than a specific illicit discharge. **Therefore, we have concluded that no chronic illicit discharge is present in this system.**

6.5 HA290

The HA290 outfall is a 15-in. diameter vitrified clay pipe. This system drains a portion of Glenside Avenue and discharges behind Hay's Service Station on the north side of Route 15 (Appendix C, Map 10). A very low concentration (0.25 mg/L) of MBAS detergents was measured on one of two sampling dates. Water quality data for this outfall are presented in Table 14.

Table 14. Water analysis data for outfall HA290

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	Observations
11/7/12	flowing (0.25 in.)	0.0	274	0.02	0.25	Negative	Clear, no odor
11/27/12	--	0.0	305	0.01	0.0	--	
7/17/13	--	0.0	400	0.04	0.1	--	

Resampling at the outfall on July 17, 2013 did not demonstrate contamination; therefore we do not believe a chronic illicit discharge is present in this system.

6.6 HA300

The HA300 outfall is a 30-in. diameter corrugated metal pipe. This system drains a portion of Route 15 and discharges on the north side of the road between Hay's Service Station and the Village Motel (Appendix C, Map 11). Water quality data for this outfall are presented in Table 15. Very low concentrations (0.25 mg/L) of MBAS detergents were measured on two of the three sampling dates in 2012. A low total phosphorus concentration and no *E. coli* were measured in samples collected on December 4, 2012.

Table 15. Water analysis data for outfall HA300

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
11/7/12	flowing (0.25 in.)	0.0	1,023	0.02	0.25	negative	--	--	Clear, musty odor, iron staining in pipe and sediment
11/27/12	--	0.75	1,066	0.01	0.25	--	--	--	
12/4/12	0.03 L/s	0.0	974	0.01	0.0	--	<1	67.4	
7/17/13	--	0.0	1,446	0.04	0.2	--	--	--	

Resampling at the outfall on July 17, 2013 did not demonstrate contamination in this system; therefore we do not believe an illicit discharge is present in this system. While iron staining is pronounced, the water quality data do not suggest a sanitary wastewater source and there are no other indications of possible petroleum contamination. **Therefore, we have concluded that no chronic illicit discharge is present in this system.**

6.7 HA330

The HA330 outfall is a 24-in. corrugated black plastic pipe. This system drains portions of North Main Street and Hazen Union Drive and discharges on the east side of the road (Appendix C, Map 12). The outlet pipe is located in the rock wall south of the Hardwick Veterinary Clinic's parking area. Water quality data for this outfall are presented in Table 16. Total phosphorus and *E. coli* concentrations were below detection in samples collected on December 4, 2012.

Table 16. Water analysis data for outfall HA330

Structure ID	Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
HA330	11/7/12	flowing (0.5 in.)	0.25	1,143	0.02	0.25	negative	--	--	Clear, no odor
HA330	11/27/12	--	0.0	1,107	0.02	0.25 (cloudy)	--	--	--	
HA330 CB-G	11/27/12	--	NA	NA	NA	Pipe A: 0.25 (cloudy) Pipe B: 0.0	--	--	--	
HA330 CB-I	11/27/12	--	NA	NA	NA	0.0	--	--	--	
HA330	12/4/12	0.1 L/s	0.0	802	0.04	0.0	--	<1	<5	
HA330	7/17/13	--	0.0	1,962	0.04	0.25	--	--	--	Clear, no odor
HA330 CB-G	7/30/13	Pipes A and B flowing, pipe B dry	Pipe A: 0.25 Pipe B: 0.25	--	Pipe A: 0.15 Pipe B: 0.09	Pipe A: 0.1 Pipe B: 0.25	--	--	--	
HA330 CB-G	11/5/13	--	Pipe A: 0.0	Pipe A: 687	Pipe A: 0.00	Pipe A: 0.2 (hazy)	--	--	--	
HA330 CB-N	11/5/13	--	0.0	2,860	0.06	0.75 (green)	--	--	--	
HA330 CB-T	11/19/13	Inflow pipe dripping	0.0	1,938	0.02	0.75 (green)	--	--	--	Slight oily odor in CB-T

On July 17, 2013, MBAS detergents were detected at the outfall near the limit of detection. Three attempts were made in 2013 to bracket possible sources of detergent contamination in system HA330. On November 5, a very low concentration of MBAS (0.2 mg/L) was measured in the pipe discharging to CB-G from the system draining the Hazen Union High School parking lot (HA350), although the sample was described as hazy. When this HA350 outfall was sampled on November 5, 2013 the MBAS sample turned green. The outfall had an oily odor and appearance. The MBAS concentration (0.75 mg/L) was also measured in CB-N, just downhill of the entrance to Hazen Union High School, and this sample also appeared green. On November 19, a sample was collected from the sump of catchbasin CB-T, near the top of the HA330 system. The MBAS result was 0.75 mg/L and was also described as green.

In previous work we have found that petroleum can cause the MBAS sample to turn green rather than blue (we have been instructed by the test manufacturer to interpret color intensity rather than hue in determining the MBAS concentration). In this case we suspect that the MBAS results may be invalid and that the hazy and green appearance of the samples is due to petroleum. When sampled on November 19, 2013 catchbasin CB-T had a slight oily odor as did the system draining the Hazen Union High School parking lot. Our best theory at this time is that there is fairly widespread groundwater contamination on North Main Street contributing petroleum to the HA330 and HA350 drainage systems. **This question has been referred to DEC's Hazardous Waste Management Division.**

6.8 HA340

The HA340 outfall is a 12-in. diameter cast iron pipe that was dripping at the time of inspection. This system drains portions of Church Street and Maple Street and discharges to the Lamoille River (Appendix C, Map 13). The outlet pipe is located in the rock wall in the southeast corner of the Hardwick Veterinary Clinic's driveway. Water quality data for this outfall are presented in Table 17. Low total phosphorus and *E. coli* concentrations were measured in samples collected on December 4, 2012. The only indication of a problem in this drainage system has been the detection of optical brightener at the outfall on November 7, 2012.

On July 17, 2013, monitoring pads were placed at the outfall and in the first two catchbasins up-pipe from the outfall. Optical brightener was not detected in either catchbasin and the pad placed at the outfall was lost. On subsequent occasions the river level was too high to permit access to the HA340 outfall.

Table 17. Water analysis data for outfall HA340

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
11/7/12	dripping	0.0	1141	0.00	0.1	positive	--	--	Clear, no odor
12/4/12	0.01 L/s	0.0	758	0.00	0.0	--	5	16.9	
7/17/13	flowing (0.25 in.)	0.0	715	0.02	0.1	CB-A and CB-B: negative outfall: pad lost	--	--	

Assessment of this system was somewhat inconclusive because of the difficulty of safely accessing the outfall. Water samples were obtained using a sampling pole, but setting and retrieving pads at the outfall is not safe under most conditions. **Because no contamination has been found in the contributing drainage system and water samples collected at the outfall have not been contaminated, we suspect there is no chronic illicit discharge in this system.**

7. HYDE PARK RESULTS

Illicit discharge detection in Hyde Park was performed in August, 2012. Of the 21 systems assessed, 5 were flowing or dripping. Three systems were designated for further investigation due to detection of one or more contaminants. These three systems are described as follows.

7.1 HP090

The HP090 outfall is a 15-in. diameter corrugated metal pipe. This system drains Church Street and the portion of Main Street between Church Street and Johnson Street Extension, although few inlets exist (Appendix C, Map 14). The pipeline was formerly the combined sewer. West of Johnson Street Extension the line runs through a wooded ravine. Only the final length of pipe is corrugated metal pipe, which was evidently stubbed onto the old vitrified clay line.

Optical brightener was detected and a low MBAS detergent concentration was recorded when the outfall was initially assessed on October 23, 2012. A low total phosphorus concentration was measured in samples collected on December 4, 2012, while the *E. coli* concentration exceeded the analytical range. Water quality data for this outfall are presented in Table 18.

Table 18. Water analysis data for outfall HP090

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
10/23/12	flowing (0.5 in.)	0.0	1,044	0.03	0.25	positive	--	--	Clear, musty odor
11/13/12	--	NA	NA	NA	NA	Outfall, sinkhole, and MH-I: positive CB-D: negative	--	--	Condoms found at sinkhole. Wastewater odor noted at MH-I
12/4/12	0.25 L/s	0.0	1,112	0.01	0.0	--	>2,420	27	
8/6/13	--	0.0 sinkhole: 0.3	860 sinkhole: 692	0.00 sinkhole: 0.02	0.1 sinkhole: 1.0	--	--	--	Clear, no odor
11/4/13	-	MH-E: 3.0	MH-E: 424	MH-E: 0.00	MH-E: >3.0	CB-G, MH-E, and MH-I: positive	--	--	

On November 13, 2012, we attempted to follow the path of the buried stormline up from the outfall. The vitrified clay line is broken in places, creating two sinkholes. The sinkhole pictured in Figure 4 had a wastewater odor and condoms were visible, indicating a wastewater source. Optical brightener monitoring pads were placed at the outfall, the sinkhole, CB-D, and MH-I. Optical brightener was detected at the outfall, the sinkhole, and MH-I. Although the mapping of this system contained inaccuracies which confused interpretation of the data, the results indicated a direct sanitary wastewater connection somewhere within the system.

Figure 4. Sinkhole with gray film suggesting wastewater contamination

On August 27, 2013, a meeting was held with Ron Rodjenski, Town Administrator, and Carol Robertson, the Village General Manager, to discuss the HP090 system. A site visit was made immediately following a rain storm and substantial flows were observed discharging from both the outfall and the sinkhole into the ephemeral stream running through the ravine. A wastewater odor was observed at both the outfall and the sinkhole. Because it was unclear what the broken pipe in the sinkhole was connected to, a plan was made to excavate the pipe to determine its connections and create access for sampling closer to Johnson Street Extension.

On October 31, 2013 excavation at the sinkholes quickly revealed that they were holes over breaks in the former combined sewer main. In the previously sampled sinkhole (closer to Johnson Street Extension), both ends of the broken vitrified clay line were exposed. Because the line was the main and not a broken lateral, attention shifted to finding the source of the contamination within the downtown area. All residences located on Main Street between Church Street and Johnson Street Extension were dye tested on October 31, 2013 and over the following weekend. In every case, dye was seen in the sanitary system and not the stormwater system (at MH-I).

A second round of dye testing was performed on November 13, 2013 to check connections from residences located on Church Street. With one exception, all the houses plus the post office and Village garage were tested. Dye testing demonstrated that all the tested buildings have a plumbing connection to the sanitary sewer except the last house to be checked, a residence with two apartments at #230 Church Street. Dye flushed down the toilet in this house was not seen in the sanitary sewer and was seen at stormwater manhole MH-I. Evidently the building sewer, which extends around the back of the property to Main Street, was never switched over when the new sanitary sewer was constructed. A letter dated December 30, 2013 was sent to Mr. Rodjenski summarizing these investigations (which he participated in, along with Jim Pease) for him to use in negotiating with the property owner regarding this problem. **Mr. Rodjenski confirmed in a June 4, 2014 email that the sanitary connection from #230 Church Street was eliminated. The property is now connected to the Village wastewater system.**

7.2 HP130

The HP130 outfall is a 15-in. diameter corrugated metal pipe. This system drains a portion of East Main Street and discharges on the west side of Depot Street, across from the elementary school (Appendix C, Map 15). Low concentrations (0.25-0.35 mg/L) of MBAS detergents were measured on three dates and specific conductance was high. No optical brightener was detected. A very low total phosphorus concentration and no *E. coli* were measured in samples collected on December 4, 2012. Water quality data for this outfall are presented in Table 19.

Table 19. Water analysis data for outfall HP130

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
10/23/12	flowing (0.5 in.)	0.0	951	0.03	0.35	negative	--	--	Clear, no odor
10/31/12	flowing	0.25	1590	0.03	0.25	--	--	--	
12/4/12	0.15 L/s	0.0	1050	0.03	0.25	--	<1	11.9	
8/28/13	trickle	0.25	425	--	0.25 (cloudy)	--	--	--	No flow in CBs at school

Although concentrations were low, MBAS was detected repeatedly at the outfall. It is possible there is a small wastewater or washwater leak infiltrating this system, possibly within the road base on Depot Street. However, no *E. coli* or optical brightener was detected, which suggests that any wastewater present has been partially renovated.

During the August 27, 2013 meeting with Ron Rodjenski and Carol Robertson, Mr. Rodjenski described plans to replace the sidewalk and stormwater drainage infrastructure in this area in 2014. The HP130 system will be replaced. **We concluded that if there is in fact an inappropriate discharge to this system, the problem would likely be eliminated in construction of the stormwater drainage system improvements.**

7.3 HP190

The HP190 outfall is a 15-in. diameter corrugated black plastic pipe. This system drains a portion of Eden Street and discharges on the east side of the road, about 500 feet from its intersection with Route 15 (Appendix C, Map 16). A low concentration of MBAS (0.25 mg/L) was detected on October 23, 2012. Water quality data for this outfall are presented in Table 20.

Table 20. Water analysis data for outfall HP190

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	Observations
10/23/12	flowing (0.25 in.)	0.0	294	0.02	0.25	negative	Clear, no odor
11/27/13	Dry	--	--	--	--	--	
8/28/13	Dry	--	--	--	--	--	

Because the outfall was dry on two subsequent visits and the only indication of contamination has been one measurement of MBAS near the limit of detection, we have concluded that no chronic illicit discharge is present in this system.

8. JEFFERSONVILLE RESULTS

Illicit discharge detection in the Village of Jeffersonville was performed on August 1 and August 21, 2012. Ten systems were assessed, only one of which was flowing during dry weather. There was no evidence of contamination at any of the outfalls.

9. JERICHO RESULTS

Illicit discharge detection in Jericho was performed in August, 2012. Of the 35 systems assessed, only three were flowing or dripping. Two systems were designated for further investigation due to detection of one or more contaminants. These two systems are described as follows.

9.1 JR220

The JR220 outfall is a 12-in. diameter metal pipe. This system drains portions of the Mount Mansfield Union High School property on Browns Trace Road and discharges on the west side of the road across from parking lot exit (Appendix C, Map 17). Water quality data for this outfall are presented in Table 21. Moderate to high concentrations of ammonia (1.0-3.0 mg/L) and low concentrations of chlorine (0.04-0.10 mg/L) were measured at the outfall on three dates.

Follow-up sampling was conducted on September 20, 2012 for total phosphorus and *E. coli* analysis. The flow rate was moderate (0.14 L/s) and the concentrations of total phosphorus (12.9 µg/L) and *E. coli* (7 MPN/100 mL) were low.

Table 21. Water analysis data for outfall JR220

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	Observations
8/14/12	flowing (0.25 in.)	3	1098	0.10	0.0	negative	Clear, no odor, iron staining
8/23/12	--	1.0	NS	0.05	NS	--	
9/20/12	--	3	962	0.04	0.0	--	
8/6/13	flowing	Outfall: 2 CB-A: 2 CB-B: 0	1210	0.00	NS	--	All flow in system is from wetland north of the Mount Mansfield Union High School parking area

Due to the presence of ammonia, this system was reassessed on August 6, 2013. All flow in the system appeared to be from the wetland area north of the Mount Mansfield Union High School parking lot, adjacent to the exit lane. No inflows to this wetland were found. Nor was there flow to catchbasin CB-B. Because the source of the dry weather flow in this system is a wetland, we concluded that the ammonia present at the outfall and CB-A was natural occurring and that the low levels of chlorine also detected were likely due to reaction of organic material in the sample. **Therefore, we have concluded that no chronic illicit discharge is present in this system.**

9.2 JR310

The JR310 outfall is a 12-in. diameter corrugated metal pipe. This system drains a portion of the Green Crow property on Dickinson Street and discharges on the south side of the street (Appendix C, Map 18). Water quality data for this outfall are presented in Table 22. The outfall was wet but not flowing on August 14, 2012 and again when revisited on August 23, 2012; therefore no samples were collected. However, the outfall had a "fruity" odor at the time of inspection and the water in the pool below the outfall appeared turbid and gray. These observations suggested an intermittent discharge of some kind.

Table 22. Water analysis data for outfall JR310

Date assessed	Dry, Wet (no flow), Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	Observations
8/14/12	wet (no flow)	NS	NS	NS	NS	Negative	Water in pool below outfall is turbid and gray, with a "fruity" odor
8/6/13	Flowing	0.25	167	0.00	0.1	NA	Oily sheen in pool below outfall

The system was revisited on August 6, 2013. Water in the splash pool below the outfall had an oily appearance. The bottle used to obtain a sample from the pool became coated with an oily substance such that it needed to be discarded after use. We also observed that the water in our test vials did not form a meniscus. Clean water forms a meniscus in the test vials due to its surface tension. We suspect that hydrocarbons in the sample prevented formation of a meniscus. While no hydrocarbon analyses were performed, these physical observations strongly suggest that oil and/or other petroleum compounds were present in the system.

Based on these findings, the Town of Jericho's Planning and Development Coordinator, Jennifer Murray, contacted the property owner to resolve the issue. The owner indicated he would speak with employees of the facility about the apparent discharge, and determine whether there are floor drains in the maintenance garage. The property owner reportedly cleaned out certain drains on the property. Per General Permit 5697-9015, runoff from this property is apparently directed to a StormTech treatment system, which we presume is the drain to which the property owner referred. The Town agreed to work with the property owner to prevent further discharges to the system.

10. JOHNSON RESULTS

Illicit discharge detection in the Town of Johnson was performed in October, 2012. All mapped municipal drainage systems were assessed. Of the 47 systems assessed, 11 were flowing or dripping at the time of the initial inspection. Two systems were designated for further investigation due to detection of one or more contaminants. These two systems are described below.

10.1 JT040

The JT040 outfall is a smooth plastic pipe. This system is a footing drain in the Wolf Kahn Studio's walking path on Clay Hill Road (Appendix C, Map 19). It discharges on the west side of the road. A very low concentration (0.2 mg/L) of MBAS was measured on October 24, 2012. Water quality data for this outfall are presented in Table 23.

Table 23. Water analysis data for outfall JT040

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	Observations
10/24/12	Flowing (0.25 in.)	0.0	2,590	0.02	0.2	negative	Clear, no odor
7/30/13	Flowing	0.0	2,170	0.02	0.2	--	

The outfall was resampled on July 30, 2013 with similar results. The MBAS concentration was at the limit of detection. **Because there is no evidence of contamination in this system other than MBAS concentrations measured at the limit of detection, we conclude there is no illicit discharge in this system.**

10.2 JT200

The JT200 outfall is a 24-in. diameter corrugated black plastic pipe. This system drains a portion of Lower Main Street West and discharges on the south side of the road, behind an auto service station (Appendix C, Map 20). The outfall was dripping at the time of inspection. A low concentration of total chlorine (0.10 mg/L) was detected on October 24, 2012. Water quality data for this outfall are presented in Table 24.

Table 24. Water analysis data for outfall JT200

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	Observations
10/24/12	dripping	0.0	323	0.10	0.0	negative	Clear, no odor
7/30/13	flowing (0.25 in.)	0.0	617	0.04	0.1	--	
11/19/13	--	0.0	469	0.05	0.1	--	

The JT200 outfall was retested twice in 2013 (on July 30 and November 19) and no clear evidence of contamination was found (Table 24). Ammonia and MBAS concentrations were below detection and total chlorine concentrations were close to the detection limit. **Because there is no evidence of contamination in this system other than a single (possibly transient) chlorine measurement of 0.10 mg/L, we conclude there is no chronic illicit discharge in this system.**

11. JOHNSON STATE COLLEGE RESULTS

Stormwater drainage systems at Johnson State College were assessed in June 2013 after permission to conduct the assessment was obtained. A total of 23 systems were assessed. Due to detection of low concentrations of ammonia, chlorine, or MBAS detergents, sampling was repeated at several outfalls and these constituents were measured at or below their detection limits. No optical brightener was detected. Based on these data and our observations, we conclude that there are no chronic illicit discharges on Johnson State College property. A message has been sent to the Facilities Director, Woody Dionne, informing him of these results.

12. MORRISVILLE RESULTS

Illicit discharge detection in Morrisville was performed in October and November, 2012. Of the 67 systems assessed, 17 were flowing or dripping when inspected. Three systems were designated for further investigation due to detection of one or more contaminants. These three systems are described as follows.

12.1 MO150

The MO150 outfall is a 15-in. diameter corrugated metal pipe. This system drains the northern and southern parking areas at Copley Hospital (Appendix C, Map 21). The system discharges on the north side of Washington Highway between Mansfield Avenue and the entrance to Copley Hospital. The outlet is located about 125 yards into the woods and is accessible via a cleared path. High specific conductance (1,836-1,920 µs/cm) and low concentrations of MBAS detergents (0.25-0.50 mg/L) were measured on three dates in 2012. A very low total phosphorus concentration and no *E. coli* were measured in samples collected on December 4, 2012. Water quality data for this outfall are presented in Table 25.

Table 25. Water analysis data for outfall MO150

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
10/9/12	flowing (0.25 in.)	0.0	1836	0.02	0.25	negative	--	--	Clear, no odor
11/27/12	--	0.0	1849	0.00	0.5	--	--	--	
12/4/12	0.03 L/s	0.0	1920	0.01	0.25	--	<1	12.6	
7/17/13	--	0.0	545	0.00	0.1	--	--	--	

On July 17, 2013 samples were collected from all catchbasins that could be accessed on the north and west sides of the hospital. Moderately high ammonia concentrations (1-2 mg/L) were detected in catchbasins CB-D and CB-G adjacent to the north side of the building. A small diameter pipe discharges to each catchbasin. The alignment of these pipes suggests they are connected to interior drains in the hospital. Given its constancy, clarity, and lack of odor, it is likely that air conditioner condensation (generally an allowable discharge) comprised a portion of the flow. Yet the presence of moderately high concentrations of ammonia suggests that washwater is also being discharged, possibly via floor drains.

The possibility that drains within Copley Hospital may be connected to stormwater systems discharging to the environment requires further investigation.

12.2 MO300

The MO300 outfall is a 15-in. diameter concrete pipe. This system drains the portion of Route 100/Jersey Heights Road starting at its intersection with Best Street and discharges to the stream on the west side of A Street (Appendix C, Map 22). The outlet is located on the north side of Route 100. The pipe was dripping and the pool below had an oily sheen on October 16, 2012 when first inspected. There was insufficient flow to sample from the outfall; however, optical brightener was detected. Low concentrations of *E. coli*, total phosphorus, and MBAS detergent were measured when the system was revisited on December 4, 2012. No ammonia or total chlorine was detected on December 4, 2012. Water quality data for this outfall are presented in Table 26.

Table 26. Water analysis data for outfall MO300

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
10/17/12	dripping	NS	NS	NS	NS	positive	--	--	Oily sheen
11/13/12	--	--	--	--	--	Outfall and CB-A positive CB-B: negative	--	--	CB-C and CB-D dry
12/4/12	0.006 L/s	0.0	1690	0.00	0.25	--	40	44.6	
7/30/13	--	--	--	--	--	--	--	--	Trickle of flow enters CB-A from side of structure

Optical brightener monitoring conducted in November 2012 indicated that a wastewater or washwater source enters this system between CB-B and CB-A. Observations on July 30, 2013 suggest the contaminated flow may enter CB-A through the side of the structure facing Jersey Heights Road. Investigation of this system is challenging due to heavy traffic on a blind corner.

A meeting was held with John Tilton of Morrisville Water and Light on November 19, 2013 to discuss IDDE findings in Morrisville. Based on review of sewer plans, a plan was made to dye test two houses on the west side of Jersey Heights Road to confirm their connection to the sanitary sewer. These houses were considered the likeliest sources of wastewater or washwater discharge to the MO300 system. Mr. Tilton arranged for dye testing at 406 Jersey Heights Road, but was unable to reach anyone at the neighboring property, 426 Jersey Heights Road.

On January 28, 2014, dye testing was performed at 406 Jersey Heights Road. The sewer lateral for this house passes under Jersey Heights Road and discharges to a sanitary manhole located more than 200 feet downhill. We observed dye discharging to this manhole via the sewer lateral and did not observe it at the MO300 outfall or in the first catchbasin up the line (CB-A). However, test conditions were poor, as the outfall was frozen over and flow in CB-A was barely perceptible. The more interesting observation was the large volume of flow discharging from this sewer lateral prior to the dye test, at a time when the homeowner said he was not running any water. This observation suggests substantial groundwater infiltration into the sewer lateral, and therefore a cracked or broken lateral. In addition to being a source of infiltration to Morrisville's sanitary sewer, this observation suggests that the lateral may leak wastewater, which would be consistent with the detection of optical brightener at CB-A.

Although no one was home at 426 Jersey Heights Road, it appears highly unlikely that this house is not connected to the new sanitary sewer system, which runs the length of the road frontage on this parcel.

To rule out a problem in the new sanitary sewer main, the main was dye tested at the manhole in front of 406 Jersey Heights Road. The dye was quickly observed in the sanitary manhole across and down the street and was not observed in system MO300. In the manhole located next to the driveway at 406 Jersey Heights Road, there appears to be an unused pipe stub, presumably intended to connect 406 Jersey Heights to the sanitary sewer. It is unclear why the building sewer lateral was not routed to this inlet. In any case, if the existing house sewer lateral running under Jersey Heights Road is in poor condition, as we expect it is, it may be possible to connect this house directly to the manhole at the end of the driveway, avoiding the long pipe run across a heavily trafficked road.

Camera inspection of the sanitary sewer along Jersey Heights Road was performed on May 6, 2014. Unfortunately, the range of the camera was inadequate to inspect the section of the sewer lateral running under Jersey Heights Road; therefore the inspection was inconclusive.

Considering the water quality data, the layout of the sanitary sewer system, and the results and observations of the dye testing, we conclude that it is highly likely that the sewer lateral serving #406 Jersey Heights Road is leaking wastewater.

12.3 MO350

The MO350 outfall is an 18-in. diameter corrugated metal pipe. This system drains a portion of Route 15A/Park Street and discharges on the north side of the road, about 0.2 miles from its intersection with Copley Avenue (Appendix C, Map 23). Low concentrations of MBAS detergents (0.25-0.50 mg/L) were measured on three dates and specific conductance was very high. A very low total phosphorus concentration and no *E. coli* were measured in samples collected on December 4, 2012. Water quality data for this outfall are presented in Table 27.

Table 27. Water analysis data for outfall MO350

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
10/17/12	flowing (0.25 in.)	0.0	3,130	0.02	0.25	negative	--	--	Clear, no odor
11/27/12	--	0.0	3,030	0.03	0.5	--	--	--	
12/4/12	0.03 L/s	0.0	2,950	0.03	0.25	--	<1	5.05	
7/30/13	Outfall and CB-A: flowing	0.0 CB-A: 0.0	2,030 CB-A: 2,130	0.02	0.25 CB-A: 0.75	--	--	--	CB-B and CB-C not flowing

Dry-weather flow in this system appears to enter CB-A through the walls or floor of the structure. On November 19, 2013, we attempted to locate any manholes on the sanitary sewer line running west from the Morristown Elementary School down Park Street, for the purpose of dye testing the sanitary line to establish whether wastewater migrates from this line to the MO350 system. We have observed cases where wastewater leaking from a sanitary sewer passes through soil, which may adequately treat nutrients and pathogens but not remove conservative substances such as chloride, detergents, and optical brightener. This is the only plausible source of MBAS detergent, aside from ambient groundwater contamination. None of the sanitary manholes indicated in DEC's infrastructure mapping could be located; therefore dye testing was not possible.

Because any sanitary manholes on Park Street have been covered, dye testing was performed at the elementary school on Park Street on January 28, 2014. The school is believed to be the only facility connected to the Park Street line; therefore dye testing at the school should reveal whether a leak exists on the sanitary sewer main on Park Street. Dye was not observed at the MO350 outfall within four hours of flushing the dye.

No ammonia, optical brightener, *E. coli*, or other sanitary wastewater indicator was detected at the MO350 outfall. The high conductivity at the outfall and CB-A likely results from salt use on Park Street, especially as CB-A drains the road ditch at the base of the hill. Therefore, the only indication of a possible illicit discharge in this system was the low but consistent concentrations of MBAS detergents. We regard the MBAS test as the least reliable of the methods we use, subject to interferences. It is possible the high conductivity in this system (or rather the dissolved constituents causing the high conductivity) is interfering, causing the MBAS detections. **Although most wastewater indicators were absent, we cannot rule out the possibility of a sanitary wastewater leak some distance from the MO350 system. However, the trickle of water tested at the outfall does not appear to be of concern from either an environmental or a human health standpoint. Therefore, no further action is recommended.**

13. UNDERHILL RESULTS

Illicit discharge detection in Underhill was performed on August 14, 2012. Three systems were assessed, all of which were dry. There was no evidence of contamination at any of the outfalls.

14. WOLCOTT RESULTS

Illicit discharge detection in Wolcott was performed in November and early December, 2012. Of the ten systems assessed, four were flowing at the time of the initial inspection. Three systems were designated for further investigation due to detection of one or more contaminants. These three systems are described as follows.

14.1 WO010

The WO010 outfall is a 12-in. diameter corrugated metal pipe. This system discharges on the east side of the road, across from the Wolcott Volunteer Fire Department building (Appendix C, Map 24). Water quality data for this outfall are presented in Table 28. Low concentrations of ammonia were measured on two out of three sampling dates and low concentrations of MBAS detergents were measured on all three dates. A low concentration of *E. coli* was measured in samples collected on December 4, 2012 and total phosphorus was below detection.

Table 28. Water analysis data for outfall WO010

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
11/16/12	flowing (0.5 in.)	0.0	2,750	0.01	0.25	negative	--	--	Clear, musty odor, iron staining
11/21/12	--	0.5	2,960	0.02	0.25	--	--	--	
12/4/12	0.17 L/s	0.25	2,870	0.01	0.25	--	22	<5	
7/17/13	flowing (1 in.)	0.0	481	0.00	0.25	--	--	--	

Resampling at the outfall on July 17, 2013 did not demonstrate contamination in this system. The MBAS concentration measured was near the limit of detection and no ammonia was detected. The WO010 system is simply a road-spanning culvert. There are no visible drains at the fire station and there is no development upslope, so there is little possibility of an illicit discharge. **Therefore, we do not believe an illicit discharge is present in this system.**

14.2 WO040

The WO040 outfall is a 24-in. diameter corrugated metal pipe. This system drains a portion of Route 15 and discharges on the south side of the road behind a Buck's Furniture storage building (Appendix C, Map 25). Water quality data for this outfall are presented in Table 29. Moderate concentrations of ammonia (0.5-1.0 mg/L) were measured on three sampling dates in 2012. Suds were present at the time of initial inspection. A low total phosphorus concentration and no *E. coli* were measured in samples collected on December 4, 2012. Samples collected on July 17, 2013 had low ammonia and MBAS concentrations consistent with the 2012 samples.

Table 29. Water analysis data for outfall WO040

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
11/16/12	flowing (0.25 in.)	1.0	344	0.00	0.2	Negative	--	--	Clear, no odor, suds, iron staining
11/21/12	--	0.5	345	0.00	0.2 (cloudy)	--	--	--	
12/4/12	0.05	0.5	340	0.00	0.0	--	<1	45.7	
7/17/13	--	0.5	492	0.00	0.25	--	--	--	

On November 21, 2012 and again on July 17, 2013, the source of ammonia in the system was isolated to Pipe A discharging to catchbasin CB-B. Flow from this pipe had an ammonia concentration of 2.0 mg/L on both dates. The next up-pipe structure (CB-C) was not flowing.

The pipe connecting catchbasins CB-B and CB-C runs parallel to Route 15 within the right-of-way. The onsite wastewater treatment system serving Buck's Furniture is believed to be located beneath the parking area adjacent to Route 15, within 20 feet of this pipe. Although ammonia can be naturally occurring, due to the proximity of Buck's Furniture's leachfield to the stormline, we suspect the source of ammonia in this system is partially renovated wastewater infiltrating the stormline. An attempt was made on September 20, 2013 to prove a hydraulic connection by dye testing a sink at Buck's Furniture, but no dye appeared in catchbasin CB-B. **This issue was not pursued further because no water quality constituent appears to exceed water quality standards at the outfall.**

All wastewater ultimately returns to the environment. Determining whether an onsite wastewater system is providing adequate treatment depends on the constituents of concern. In this case, assuming the low concentrations of ammonia do in fact result from infiltration of partially treated wastewater from the leachfield at Buck's Furniture, whether this constitutes a problem depends on the standard applied. Because *E. coli* was not detected and the concentration of phosphorus--the nutrient with the greatest impact on Lake Champlain--was low, we have concluded that the discharge should not be considered illicit.

14.3 WO050

The WO050 outfall is a 4-in. diameter smooth plastic pipe. This system discharges on the south side of the road between the Wolcott Town Hall and the post office (Appendix C, Map 25). Low concentrations of ammonia (0.25-0.5 mg/L) were measured on three sampling dates in 2012. A low total phosphorus concentration was measured in a sample collected on December 4, 2012, while the *E. coli* concentration exceeded the analytical range. Water quality data for this outfall are presented in Table 30.

Table 30. Water analysis data for outfall WO050

Date assessed	Dry, Wet/no flow, Dripping, or Flowing?	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total chlorine (mg/L)	MBAS (mg/L)	OB Result	E. coli (MPN/100 mL)	Total P (µg/L)	Observations
11/16/12	flowing (0.25 in.)	0.25	249	0.00	0.0	negative	--	--	Clear, no odor, iron staining
11/21/12	--	0.25	314	0.00	0.0	--	--	--	
12/4/12	0.06 L/s	0.5	312	0.00	0.0	--	>2,420	31.7	
7/17/13	trickle	0.0	160	0.01	0.75	--	--	--	No odor

A meeting to discuss the IDDE results was held on September 12, 2013 with Wolcott Town officials (Linda Martin, Town Clerk and Belinda Clegg, Assistant Town Clerk and Select Board Chair) and Jim Ryan, the Lamoille River Basin Planner. Following the meeting, the Town Health Officer, Bernard Earle, determined that the septic system serving the Town Hall building was malfunctioning and was therefore a likely source of *E. coli* at the outfall. The Town constructed a new leach field and installed a pump vault to route septic tank effluent to the new leach field (Figure 5). The PVC pipe discharging at WO050 was routed around the septic system and the outfall was extended to the top of the river bank. When outfall WO050 was resampled on January 21, 2014, the *E. coli* concentration was low, 95 MPN/ 100 mL. This result suggests that replacement of the leach field may have reduced wastewater infiltration to the system.

Figure 5. Replacement septic system at the Wolcott Town Hall

On November 19, 2013, an attempt was made to determine the source of the flow at the WO050 outfall. In the basement of the Buck's Furniture showroom, a shallow trench dug along the perimeter of the basement wall conveys groundwater from the basement to a gravity drain in the southwest corner of the basement. This groundwater is believed to be the primary source of dry weather flow at the WO050 outfall. A wastewater pump chamber is located within two feet of this drain. While inspecting this interior drain a leak was noted in the corroded steel pump chamber, causing wastewater to leak into the perimeter ditch and into the drain (Figure 6). **According to our contact at Buck's Furniture, Ricky Fichtner, the owner indicated he would replace the leaking pump chamber expeditiously. However, six months after we notified the business this work still had not been performed. DEC is now pursuing its options to resolve the problem.**

Figure 6. Leaking wastewater pump chamber next to perimeter drain

15. PHOSPHORUS LOADING ESTIMATES

Estimation of phosphors load reductions due to elimination of illicit discharges was not possible in most cases because repairs are pending. Projections were made for the three single family homes found to have mis-connected sewer laterals or malfunctioning septic systems, based on literature values for phosphorus excretion. Table 31 summarizes potential phosphorus loading reductions for the illicit discharges identified in this project.

Table 31. Estimated phosphorus reductions for selected discharges

System	Type of discharge	Potential P reduction
MO150	Interior drain or cooling water discharge from hospital	If corrected, P reduction assumed to be negligible
GA080	Washwater or graywater connection from single family home	If corrected, P reduction assumed to be negligible
FX170	Municipal water leak	If corrected, P reduction assumed to be negligible
JR310, HA330	Petroleum contamination	P reduction assumed to be negligible
FX070	Possible leaks or cross-connection in municipal wastewater collection systems	Not estimated
HA070	Direct sanitary connection from wing of elementary school (4 classrooms)	Based on measured concentration and flow rate, the potential P reduction from eliminating this discharges is:: 9.7 mg/L x 0.018 L/s = **15 g P/d**
HP090	Direct sanitary connection from house with two apartments	Assuming occupancy of the home by 6 people, the potential P reduction from eliminating this discharges is: 2 g /P/capita/day[1] x 6 residents x 365 day/year **= 4.4 kg P/year**
MO300	Suspected broken sewer lateral from single family home	Assuming occupancy of the home by 3 people, the potential P reduction from eliminating this discharges is: 2 g /P/capita/day[1] x 3 residents x 365 day/year **= 2.2 kg P/year**
WO080	Leaking wastewater pump chamber	Elimination of this discharge is pending; therefore no post-repair phosphorus concentration data are available.

1. Source = U.S. EPA. 2002. *Onsite Wastewater Treatment Systems Manual*. US Environmental Protection Agency, Office of Water, February 2002, EPA/625/R-00/008. (adjusted for Vermont law reducing P content of automatic dishwashing detergents)

16. CONCLUSIONS

A thorough assessment was made of the stormwater drainage systems in 11 municipalities in the Lamoille River Basin for the presence of illicit discharges. A total of 282 systems were assessed in 2012. An additional 23 systems were assessed on Johnson State College property in June 2013. Based on water quality data and our observations during the dry weather surveys, 26 systems were designated as requiring further investigation. Further investigation of these drainage systems confirmed 11 illicit discharges in 10 stormwater drainage systems (considering two illicit discharges were identified in system WO050 in Wolcott). Plans are in place to correct the majority of these illicit discharges. The illicit discharges identified through this project are summarized below, with current plans to resolve them.

- System FX170 in Fairfax receives treated municipal water from one or more leaks in the water distribution system. We recommended the Town of Fairfax perform leak detection to pinpoint the exact location of the leak(s). Water leak detection is beyond the scope of this study.

- System MO150 in Morrisville appears to receive some type of washwater from two pipes leading from the Copley Hospital building.

- System GA080 in Georgia receives laundry washwater, likely from a property on Route 7 in the South Village. Vermont DEC is pursuing resolution of this issue through enforcement.

- Hydrocarbon contamination is suspected in two stormwater drainage systems.

  - Petroleum contamination in system JR310 was reportedly the result of a lapse in maintenance of a StormTech treatment unit on the property. The unit has reportedly been cleaned out.

  - System HA330 in Hardwick appears to receive petroleum contaminated groundwater. This system was referred to the Vermont DEC's Hazardous Waste Management Section for follow-up inspection.

- Sanitary wastewater was detected in five stormwater drainage systems:

  - In system FX070, the Town of Fairfax has agreed to inspect plumbing connections in several properties that may be the source of the optical brightener detected.

  - System HA070 in Hardwick has a direct sanitary connection from a wing of the Hardwick Elementary School. This connection is scheduled to be eliminated during the summer of 2014 (when school is not in session).

  - System HP090 in Hyde Park had a direct sanitary wastewater connection from #230 Church Street, a two-apartment house. This connection has now been eliminated.

  - System MO300 in Morrisville is believed to receive contaminated groundwater from a leak in the sewer lateral at #406 Jersey Heights Road. Morrisville Water and Light attempted to inspect this lateral in May 2014. Further investigation is needed to resolve this problem.

  - System WO050 in Wolcott has a sanitary wastewater connection from a leaking wastewater pump chamber in the basement of Buck's Furniture. Replacement of the leaking pump chamber was delayed and DEC is now pursuing the matter. A malfunctioning septic system serving the Wolcott town hall is also believed to have contributed wastewater to this system and this septic system has already been replaced by the Town of Wolcott.

17. REFERENCES

American Public Health Association, Standard Methods for the Examination of Water and Wastewater, 21th edition, Washington D.C., 2005.

Hach Company. Hach Method #8167. Loveland, CO.

Stone Environmental, Inc., SEI SOP 5.23.3: Maintenance and Calibration of the pH/Con 10 Meter. February 24, 2003.

Stone Environmental, Inc., SEI SOP 6.38.0: Optical Brightener Testing, September 11, 2008.

APPENDIX A: ASSESSMENT DATA FORM

Lamoille River Basin IDDE Project Assessment Data Form

IDDE ID: ____________________________			DEC ID Cross Ref.:____________________________		
Date: ______________	Time: ______________		Inspector: ____________________________		
Structure type: ____________________________			Inner diameter (outfall only)____________________in.		
Material (outfall only):	corrugated metal	concrete	corrugated black plastic	smooth plastic	other (describe): ______________
Flow depth (outfall only)::	dry	Wet (no flow)	dripping	Flowing depth ____________________(in.)	
Pipe position (outfall only):	Free flow	partially submerged	submerged	If partially submerged, surcharged? YES NO	
Erosion at outfall	none	If present, describe: ____________________________			
Discharge characteristics (observations on color, turbidity, and odor of flow):					
Floatables:	none	sheen	sewage	suds	other ______________
Deposits or staining:	none	sediment	oily	iron staining	other______________
Damage to structure:	none	cracking, spalling	corrosion	crushed	other______________
Obstructions:	none	partially obstructed		fully obstructed	other______________
OB pad set? YES NO			Date OB pad retrieved____________________		
Ammonia__________ mg/L			Specific conductance ____________µS/cm		
Total chlorine__________ mg/L			Free chlorine__________ mg/L		
Anionic surfactants__________ mg/L					
Sample collected for *E. coli* analysis: YES NO NA			Time: ____________________		
Sample collected for N analysis: YES NO NA			Time: ____________________		
Flow measurement (if *E. coli* and/or nutrients sample collected):					
Comments:					

APPENDIX B: STONE ENVIRONMENTAL INC. SOPS

STANDARD OPERATING PROCEDURE

SEI-5.23.3

MAINTENANCE AND CALIBRATION OF THE pH/CON 10 METER

SOP Number: SEI-5.23.3 Date Issued: 05/14/99

Revision Number: 3 Date of Revision: 02/24/03

1.0 OBJECTIVE

This standard operating procedure (SOP) explains the calibration and maintenance of the Oakton pH/Con 10 meter and the Cole-Parmer pH/Con 10 meter. The meters are identical except for the distributor's names. The meter is manufactured by Cole-Parmer and distributed by Cole-Parmer and Oakton. The operator's manual should be referred to for the applicable procedures described below. The pH/Con 10 meter is used for measuring the pH, conductivity, and temperature of water. The pH/conductivity meters generate and measure data, and thus must meet the requirements of 40 CFR part 160 subpart D.

2.0 POLICIES

1. According to 40 CFR Part 160, Subpart D, Section 160.61, Equipment used in the generation, measurement, or assessment of data and equipment used for facility environmental control shall be of appropriate design and adequate capacity to function according to the protocol and shall be suitable located for operation, inspection, cleaning, and maintenance.
2. Personnel will legibly record data and observations in the field to enable others to reconstruct project events and provide sufficient evidence of activities conducted.

3.0 SAFETY ISSUES

1. If necessary and appropriate, a site-specific health and safety plan shall be created for each study site. A template for creating a proper health and safety plan is provided on the SEI network.
2. If necessary and appropriate, all chemicals are required to be received with Material Safety Data Sheets (MSDS) or appropriate application label. These labels or MSDS shall be made available to all personnel involved in the sampling and testing.

4.0 PROCEDURES

4.1 Equipment and Materials

1. The pH/Con 10 meter, pH/conductivity/ temperature probe. The probe cable has a notched 6-pin connector to attach to probe meter.

2. If necessary and appropriate, standard solutions (e.g., standard pH 4.0 and 7.0, conductivity standards)

3. Clean beakers or other appropriate containers

4. Log or other appropriate medium to record calibration.

4.2 Meter Set-up and Conditioning

1. The pH/Con 10 meter uses a combination pH/conductivity/temperature probe. The probe cable has a notched 6-pin connector to attach the probe meter. Keep connector dry and clean.

2. To connect the probe, line up the notches and 6-pins on the probe connector with the holes in the connector located on the top of the meter. Push down and the probe connector will lock into place.

3. To remove probe, slide up the metal sleeve on the probe connector. While holding onto metal sleeve, pull probe away from the meter. Do not pull on the probe cord or the probe wires might disconnect.

4. Be sure to decontaminate the probe prior to use. The probe shall be tripled rinsed with distilled or deionized water. Further decontamination and cleaning procedures may be called for in special situations or outlined in approved protocols or work plans. This will be documented in field notes or in an appropriate logbook.

5. Be sure to remove the protective rubber cap of the probe before conditioning, calibration, or measurement. If the probe is clean, free of corrosion, and the pH bulb has not become dehydrated, simply soak the probe in tap water for ten minutes before calibrating or taking readings to saturate the pH electrode surface to minimize drift. Wash the probe as necessary in a mild detergent solution. If corrosion appears on the steel pins in the conductivity cell, use a swab soaked in isopropyl alcohol to clean the pins. Do not wipe the probe; this causes a build-up of electrostatic charge on the glass surface. If the pH electrode has dehydrated, soak it for 30 minutes in a 2M-4M KCI boot solution prior to soaking in tap water.

6. Wash the probe in deionized water after use and store in pH 4.0 standard solution or an approved boot solution (per the manufacturer's instruction).

4.3 pH Calibration

1. The meter is capable of up to 3-point pH calibration to ensure accuracy across the entire pH range of the meter. At the beginning of each day of use, perform a 2 or 3-point calibration with standard pH buffers 4.00, 7.00, and 10.00. Calibration standards that bracket the expected sample range should be used. Never reuse buffer solutions; contaminants in the solution can affect the calibration.

2. Press the MODE key to select pH mode. The pH indicator appears in the upper right corner of the display.

3. Dip the probe into the calibration buffer. The end of the probe must be completely immersed into the buffer. Stir the probe gently to create a homogeneous buffer solution. Tap probe to remove any air bubbles.

4. Press CAL/MEAS to enter pH calibration mode. The primary display will show the measured reading while the smaller secondary display will indicate the pH standard buffer solution.

5. Press □ or □ keys to scroll up or down until the secondary display value is the same as the pH buffer value (pH 4.00, 7.00 or 10.00).

6. Wait for the measured pH value to stabilize. The READY indicator will display when the reading stabilizes. After the READY indicator turns on, press ENTER to confirm calibration. A confirming indicator (CON) flashes and disappears. The meter is now calibrated at the buffer indicated in the secondary display.

7. Repeat steps 3, 5, and 6 using a second or third pH standard.

8. Press CAL/MEAS to return to pH measurement mode.

4.4 Conductivity Calibration

1. Select a conductivity standard with a value near the sample value expected. The meter should be calibrated by the user(s) at the beginning of each day of use.

2. Pour out two separate portions of your calibration standard and one of deionized water into separate clean containers.

3. Press MODE key to select Conductivity. The ΦS or mS indicator will appear on the right side of the display.

4. Rinse the probe with deionized water, and then rinse the probe in one of the portions of calibration standard. Record the calibration standard on the per-use maintenance form or other appropriate medium.

5. Immerse the probe into the second portion of calibration standard. The meter's auto-ranging function selects the appropriate conductivity range (four ranges are possible). Be sure to tap the probe to remove air bubbles. Air bubbles will cause errors in calibration.

6. Wait for the reading to stabilize. The READY indicator lights when the reading is stable. Press the CAL/MEAS key. The CAL indicator appears above the primary display. The primary display shows the measured reading and the secondary display shows the temperature. Record the initial calibration standard on the per-use maintenance form or other appropriate medium.

7. Press the □ or □ keys to scroll to the value of your conductivity standard. Press and hold the □ or □ keys to scroll faster. The meter automatically compensates for temperature differences using a factor of 2.00% per BC.

8. Press ENTER key to confirm calibration. Upon confirmation, the CON indicator appears briefly. The meter automatically switches back into Measurement mode. The display now shows the calibrated, temperature compensated conductivity value. However, if the calibration value input into the meter is different from the initial value displayed by more than 20% , the ERR annunciator appears in the lower left corner of the display

4.5 Temperature Calibration/Verification

1. The built-in temperature sensor is factory calibrated. Therefore, no additional calibration is necessary. However, the temperature may be verified against another working thermometer. However, if errors in temperature readings are suspected or if a replacement probe is used. Refer to the operating instructions if temperature calibration is necessary.

4.6 General and Annual Maintenance

Individual users are responsible for the calibration, cleaning, repair, and maintenance of the instrument.

Routine inspection and maintenance schedules vary from each piece of equipment. Typically there are minor maintenance needs each piece of equipment will need to undergo prior to use in the field (such as cleaning or conditioning). Always consult the manufacturer♣s instructions for general maintenance.

Specific per use maintenance needs for the pH /Con 10 meter include but are not limited to:

1. Inspect probe for physical damage and debris
2. Inspect meter for physical damage and debris
3. Clean probe w/ mild detergent
4. Rinse probe in distilled water
5. Clean conductivity pins with isopropyl alcohol (if necessary)
6. Condition probe
7. Calibrated to pH 7.0
8. Calibrated to pH 4.0
9. Calibrated to pH 10.0

The pH /con 10 meter shall be stored in a clean dry place, usually the padded box that it came in. Care should be given to keep the instrument from dust and contamination.

Wash the probe in distilled water after use, and store in pH 4 solution.

All maintenance, repairs, and calibrations are to be documented on an equipment maintenance log or other appropriate medium. Follow the checklist provided on the equipment maintenance log for regular use maintenance needs. Any maintenance must include documentation of whether the maintenance was routine and followed the SOP or not.

Equipment logs shall be brought to the field for documenting use and calibration. The logs will be returned to the office after each field use and filed in the equipment records filing cabinet.

In the event of failure due to breakage or loss of parts, an attempt will be made to repair or replace the necessary parts by the field personnel who discover the malfunction. All repairs will be documented in field notes and/or on a non-routine maintenance log. If the instrument is rendered "out of service" or "broken", it should be tagged as such. If further repair is necessary, return the instrument to the manufacturer following proper shipping procedures.

Non-routine repairs must include documentation of the nature of the defect, how and when the defect was discovered, and any remedial action taken in response to the defect.

5.0 RESPONSIBILITIES

1. All personnel will legibly record data and observations (including phone conversations) in accordance with this SOP to enable others to reconstruct project events and provide sufficient evidence of activities conducted.
2. Prior to use and after use, all equipment will be appropriately cleaned, decontaminated, calibrated (if necessary) and stored in accordance with the manufacturer's instructions and this SOP.

6.0 DEFINITIONS

1. *Decontamination* – Procedures followed to ensure cross contamination does not occur between sampling points or that potential contamination of equipment does not pose a hazard to sampling personnel.
2. *EPA* the U.S. Environmental Protection Agency.
3. *FIFRA* the Federal Insecticide, Fungicide, and Rodenticide Act as amended.
4. *Maintenance* – Actions performed on equipment to standardize and/or correct the accuracy and precision of a piece of equipment to ensure that the equipment is operating within the manufacturer's specifications and standard values.
5. *Study* means any experiment at one or more test sites, in which a test substance is studied in a test system under laboratory conditions or in the environment to determine or help predict its effects, metabolism, product performance (pesticide efficacy studies only as required by 40 CFR 158.640) environmental and chemical fate, persistence, or residue, or other characteristics in humans, other living organisms, or media. The term "study" does not include basic exploratory studies carried out to determine whether a test substance or a test method has any potential utility.

7.0 REFERENCES

40 CFR Part 160 Good Laboratory Practice Standards, August, 1989.

8.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

None

9.0 AUTHORIZATION

Revised by: ____ Date: _____________

Michael Nuss, Staff Scientist

Approved by: _______________________________________ Date: _____________

Christopher T. Stone, President

10.0 REVISION HISTORY

Revision number 1:

1. Changed title and references to Oakton in Sections 1.0 and 2.0 to enable this standard operating procedure to apply to both the Oakton pH/Con 10 meter and the Cole-Parmer pH/Con 10 meter, as these are identical meters.
2. Added instructions about cleaning and re-hydrating the probe to Section 3.1.
3. Added Section 9.0.
4. Reformatted.
5. Minor word editing.

Revision number 2:

1. Changed the title.
2. Removed sections 7.0 (Measurement) and 8.0 (Maintenance/Repairs).
3. Added section called (General and Annual Maintenance).
4. Minor editing.
5. Reformatted.

Revision number 3:

1. Minor wording edits in Section 1.0, Objective.
2. Updated style to match SEI Style Guide – font and text. Reformatted using MS Word.
3. Added standardized section headers: 2.0 Policies, 3.0 Safety, 5.0 Responsibilities, 6.0 Definitions, 7.0 References, 8.0 Tables, Diagrams, Flowcharts and Validation data. Authorization moved to Section 9.0, andSection10.0 Revision History.
4. Deleted section on logs being given to the QAU.
5. Other minor wording edits.

STANDARD OPERATING PROCEDURE

SEI-6.38.1

OPTICAL BRIGHTENER TESTING

SOP Number: SEI-6.38.1	Date Issued: 09/11/08
Revision Number: 1	Date of Revision: 03/18/13

1.0 OBJECTIVE

Optical brighteners are a class of fluorescent dyes used in almost all laundry detergents. Many paper products also contain optical brighteners. When optical brightener is applied to cotton fabrics, they will absorb ultraviolet (UV) rays in sunlight and release them as blue rays. These blue rays interact with the natural yellowish color of cottons to give the garment the appearance of being "whiter than white". Optical brightener dyes are generally found in domestic wastewaters that have a laundry effluent component. Because optical brighteners absorb UV light and fluoresce in the blue region of the visible spectrum, they can be detected using a long wave UV light (a "black" light).

Optical brightener monitoring can be used to indicate the presence of wastewater in stormwater drainage systems, streams, and other water bodies. Since optical brighteners are removed by adsorption onto soil and organic materials as effluent passes through soil and aquifer media, optical brightener monitoring may also be used to identify incompletely renovated wastewater effluent in groundwater at wastewater dispersal sites.

To test for optical brightener, a cotton pad is placed in a flow stream for a period of 4-10 days, after which the pad is rinsed, air dried, and viewed under a long range UV light. Florescence indicates the presence of optical brightener. Optical brighteners may be monitored in a wide range of structures and flow streams. For example, monitoring pads may be placed in stormwater outfall pipes, within catchbasins and manholes, or in any other man-made or natural water conveyance. Optical brightener pads may be placed in dry pipes or other dry structures to monitor possible intermittent flow streams. However, the more common application is to monitor discharge points that are flowing under dry weather conditions.

2.0 POLICIES

1. According to Stone's Corporate Quality Management Plan, Stone shall have standard operating procedures in writing setting forth study methods that management is satisfied are adequate to ensure the quality and integrity of the data generated in the course of a study.
2. Personnel will legibly record data and observations in the field to enable others to reconstruct project events and provide sufficient evidence of activities conducted.

3.0 SAFETY ISSUES

1. If necessary and appropriate, a site-specific health and safety plan shall be created for each study site. A template for creating a proper health and safety plan is provided on the SEI network.
2. Care must always be taken when approaching a sampling location. Do not, under any circumstances, place yourself in danger to collect a sample.
3. If necessary and appropriate, all chemicals are required to be received with Material Safety Data Sheets (MSDS) or appropriate application labels. These labels or MSDS shall be made available to all personnel involved in the sampling and testing.

4.0 PROCEDURES

4.1 Equipment and Materials

1. Untreated cotton pad measuring approximately 10 cm by 10 cm (e.g., VWR cat no. 21902-985 or equivalent).
2. Fiberglass or nylon screen to enclose the cotton pad (sewn or stapled).
3. Monofilament fishing line (approximately 20 to 50 lb. test).
4. Binder clips of various sizes.
5. Field notebook, sample collection form, or other acceptable medium for recording field data.
6. Protective gloves if contamination is suspected in the water to be sampled, or if cold weather may be hazardous with wet hands.

4.2 Sampling Procedure and Sample Handling

4.2.1 Optical Brightener Pad Assembly

To assemble an optical brightener monitoring pad, place an untreated cotton pad measuring approximately 10 cm by 10 cm (e.g., VWR cat no. 21902-985) in an envelope made of a screen material. A light fiberglass screen is preferred. The pad may be folded in half to double its thickness. Sew, staple, or otherwise secure all open sides of the screen envelope to enclose the pad.

4.2.2 Optical Brightener Pad Placement

1. Secure the pad at the monitoring point using high test nylon fishing line (20 - 50 lb. test), a binder clip, or both. The pad may be attached to any convenient anchor, provided the pad is as well exposed to the flow stream as possible and the anchor point appears stable enough to resist the force of high flow events. When sampling culverts or stormwater outfall pipes, the pad may be clipped directly to the inner rim of the outfall. The pad should lie flat against the bottom surface of the pipe. The pad may also be hung from a catchbasin grate or manhole rung.

2. If a suitable anchor is not present, a heavy object may be placed in the flow stream or channel to anchor the pad. For example, a pad may be anchored in a stream by tying it to a concrete block.

3. Two or more optical brightener monitoring pads may be placed at monitoring points if appropriate. If more than a single pad is used, the pads should be anchored so that they do not become entangled.

4. Record the date each pad is deployed and any other relevant information in a field logbook or on a specified sample collection form.

4.2.3 Optical Brightener Pad Retrieval and Handling

1. After a 4-10 day period of exposure, optical brightener pads should be collected. The collection of each pad should be recorded in a field logbook or on a specified sample collection form.

2. Any object inserted in a pipe or other structure to anchor the pad should be removed.

3. Pads should be placed in individually labeled, re-sealable plastic bags. The sample label should indicate the monitoring point identification.

4. The pad should be removed from the screen envelope using scissors to cut open the envelope. The pad should be gently rinsed using cold tap water. Lightly squeeze out excess water with a clean hand. Do not wring out the pad. When processing the pads be aware that you may spread dye from one pad to another with your hands. Wear disposable gloves.

5. The pad should then be returned immediately to the labeled bag.

6. Pads should be air dried. The pad may be hung on a line to dry within the labeled bag. If a re-sealable plastic bag is used, cut the bottom corners of the bag to allow airflow to the pad.

4.3 Optical Brightener Analysis

1. When the pad is dry, expose the pad under a high quality long range UV light in a room that is completely dark. A non-exposed and an exposed pad are used as controls and compared to each test pad as it is exposed to the UV light.

2. There are three qualitative results: Positive, Negative, and Indeterminate. A pad will very definitely glow (fluoresce) if it is positive. If it is negative it will be noticeably drab and similar to the control pad. All other tests are indeterminate. Pads may be sorted into the basic categories: positive test, negative test, and indeterminate. Further, for positive tests, the pads may be sorted into categories by the relative strength of the fluorescence. A pad that is fluoresces brightly over most or all of its surface may be considered a strongly positive test, whereas a pad on which fluorescence appears patchy or faint may be considered a weakly positive test. Indeterminate results generally dictate that the test be repeated.

3. In some instances, only a portion of the pad or simply the outer edge will fluoresce after being exposed to optical brightener. This can be caused by many factors but is usually the result of an uneven exposure to the dye in the flow stream due to sedimentation or the way the pad was

positioned in the water. Regardless, as long as a portion of the pad fluoresces, it should be considered positive.

4. Since paper and cotton dust is so pervasive, it is common to see fluorescent fibers or specks on the test or control pads. These should be ignored and not used to indicate a positive result.
5. With the lights back on, record the identification number and the test result for each pad.
6. It is advisable to have a second reader perform the pad observations independently. The results are then compared. Any conflicting interpretations may be resolved though repeated observation of the pad in question, or a by a third observer.

5.0 RESPONSIBILITIES

1. All personnel will legibly record data and observations (including phone conversations) in accordance with this SOP to enable others to reconstruct project events and provide sufficient evidence of activities conducted.

6.0 DEFINITIONS

1. *Study* means any experiment at one or more test sites, in which a test substance is studied in a test system under laboratory conditions or in the environment to determine or help predict its effects, metabolism, product performance (pesticide efficacy studies only as required by 40 CFR 158.640) environmental and chemical fate, persistence, or residue, or other characteristics in humans, other living organisms, or media. The term “study” does not include basic exploratory studies carried out to determine whether a test substance or a test method has any potential utility.

7.0 REFERENCES

40 CFR Part 160 Good Laboratory Practice Standards, August, 1989.

MASS Bay Program. 1998. An Optical Brightener Handbook.
http://www.thecompass.org/8TB/pages/SamplingContents.html

8.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

None

9.0 AUTHORIZATION

Revised by: ______________________________________ Date: ____________

Dave Braun, Project Scientist/Water Quality Specialist

Approved by: _____________________________________ Date: ____________

Christopher T. Stone, President

10.0 REVISION HISTORY

Revision number 1:

1. Minor clarifications and rewording throughout.
2. Changed 4-8 day pad exposure period to 4-10 day exposure period.
3. Changed description of indeterminate results.
4. Added use of binder clips to secure pads.
5. Updated procedure for processing exposed pads.

APPENDIX C: MAPS

Map 1. System FX040

Lamoille River Basin IDDE

Fairfax, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

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Map 2. System FX070

Lamoille River Basin IDDE

Fairfax, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Map 3. System FX120

Lamoille River Basin IDDE

Fairfax, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

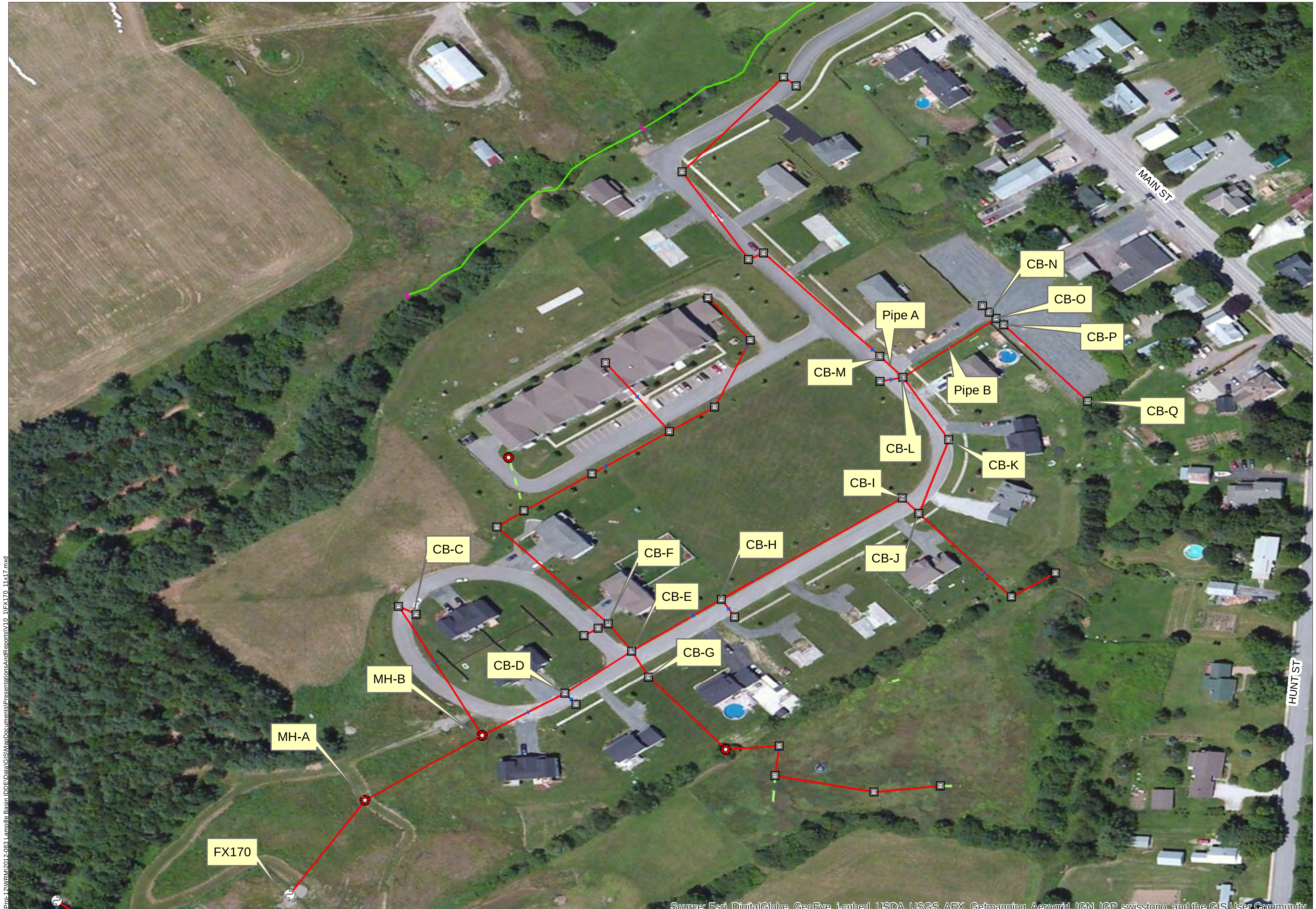
Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Map 4. System FX170

Lamoille River Basin IDDE

Fairfax, VT



Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

Sources: Esri: Imagery; DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Map 5. System GA080

Lamoille River Basin IDDE

Georgia, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Map 6. System HA070
Lamoille River Basin IDDE
Hardwick, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N E S W

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Map 7. System HA190

Lamoille River Basin IDDE

Hardwick, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

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Map 8. System HA250

Lamoille River Basin IDDE

Hardwick, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Map 9. System HA260

Lamoille River Basin IDDE

Hardwick, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

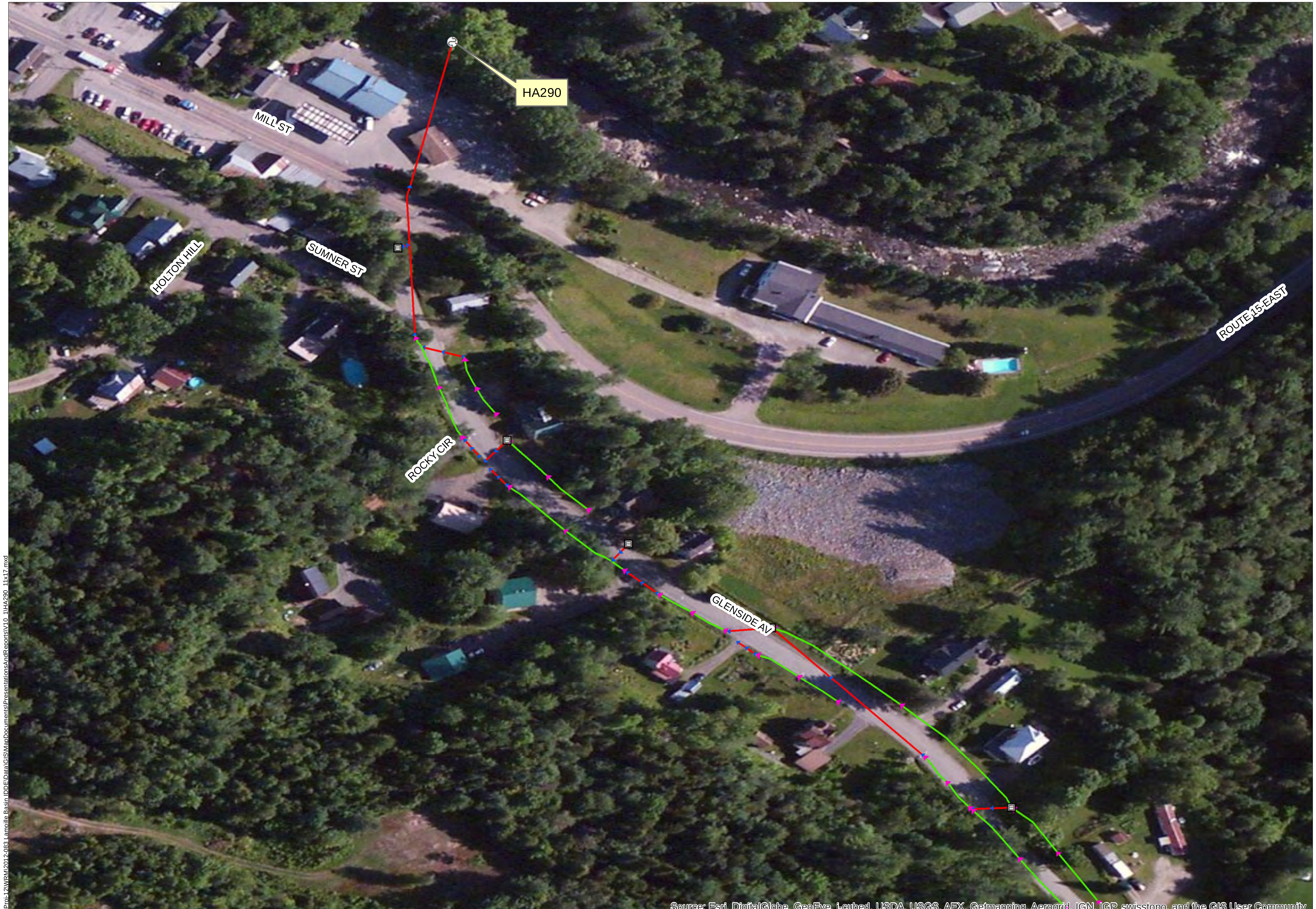
Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Map 10. System HA290

Lamoille River Basin IDDE

Hardwick, VT



Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery; DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Map 11. System HA300

Lamoille River Basin IDDE

Hardwick, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

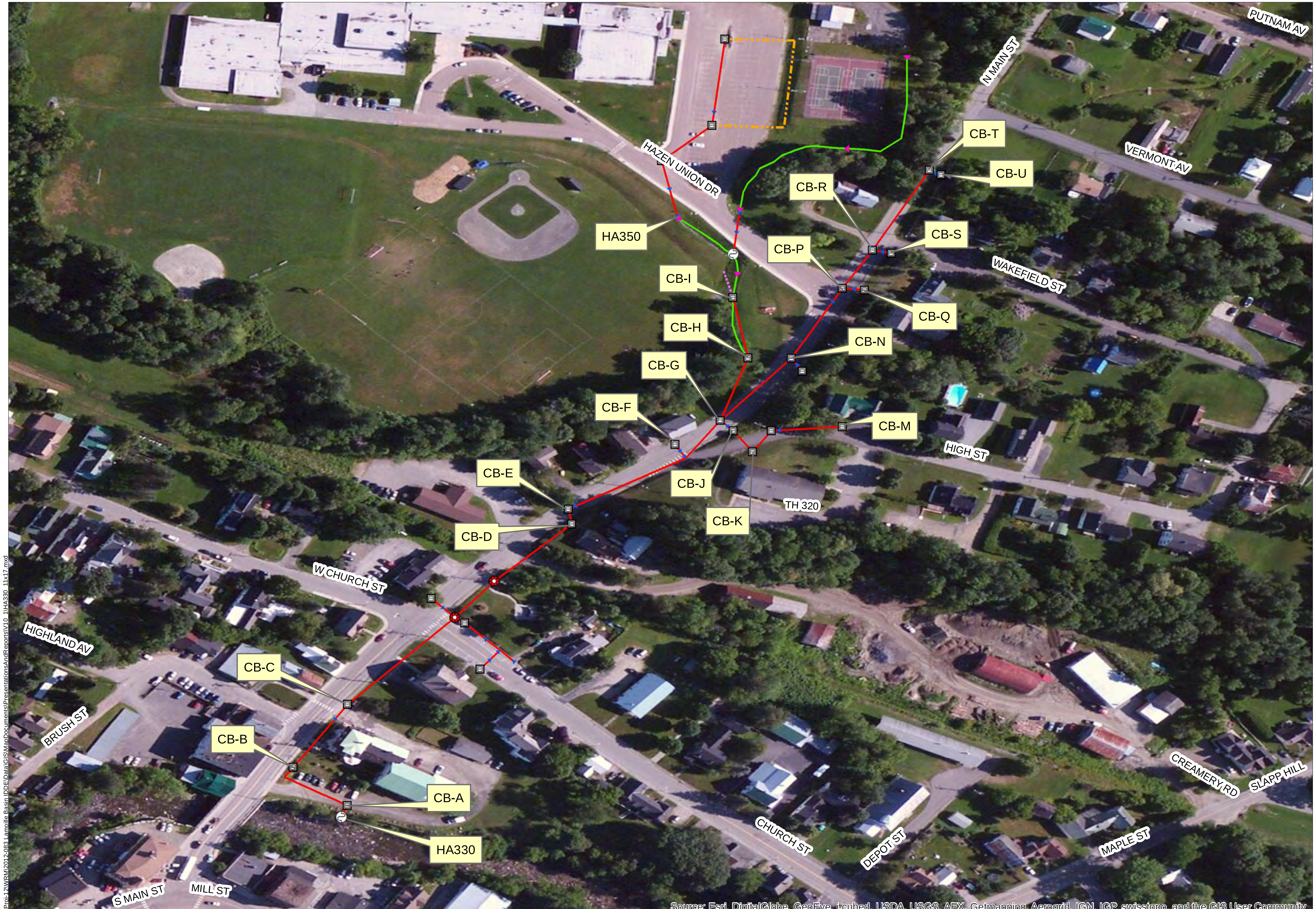
0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Map 12. System HA330
Lamoille River Basin IDDE
Hardwick, VT



Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Map 13. System HA340
Lamoille River Basin IDDE
Hardwick, VT

Stormwater Infrastructure
- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

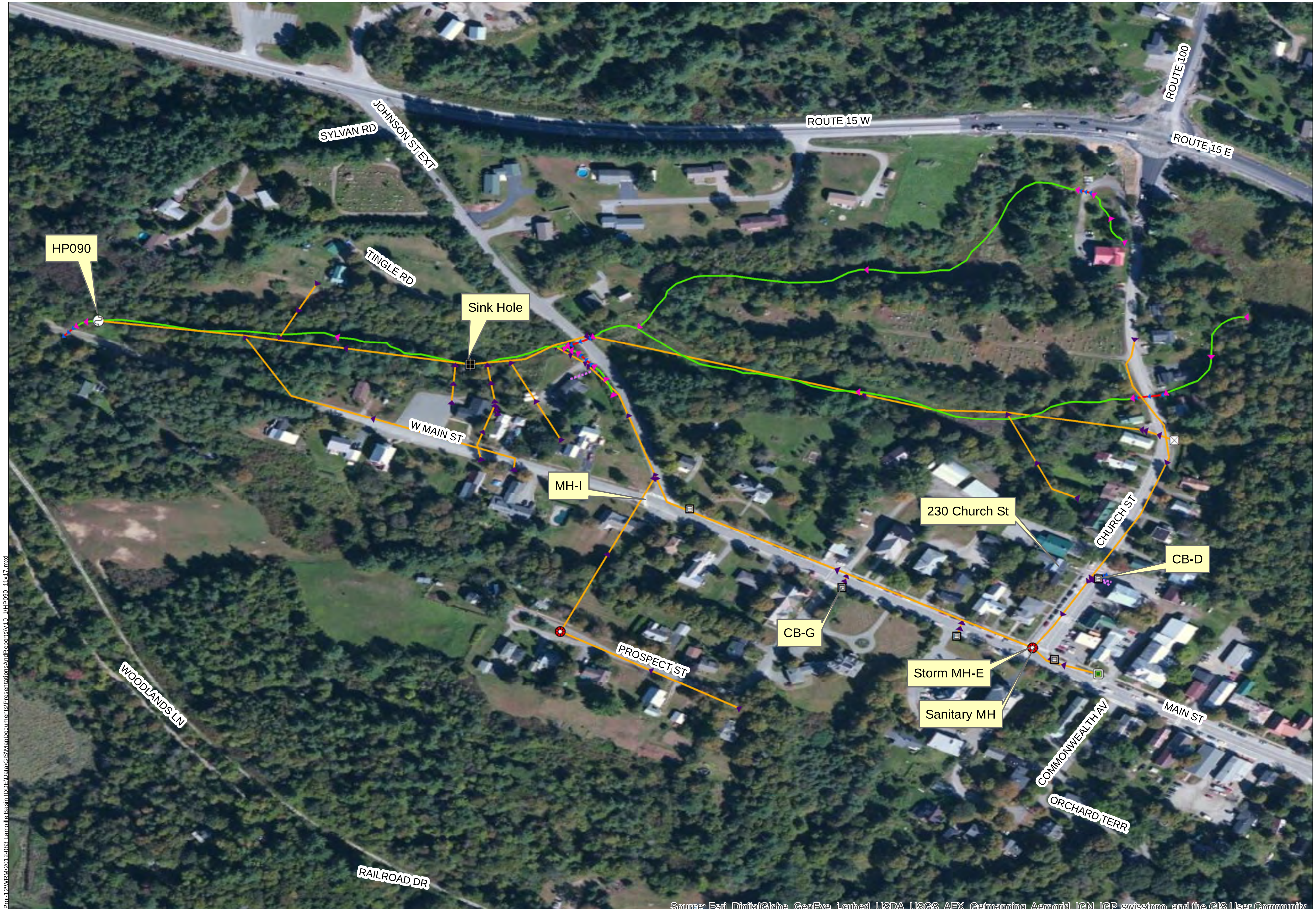
Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Map 14. System HP090

Lamoille River Basin IDDE

Hyde Park, VT



Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
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- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

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Map 15. System HP130
Lamoille River Basin IDDE
Hyde Park, VT

Stormwater Infrastructure
- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

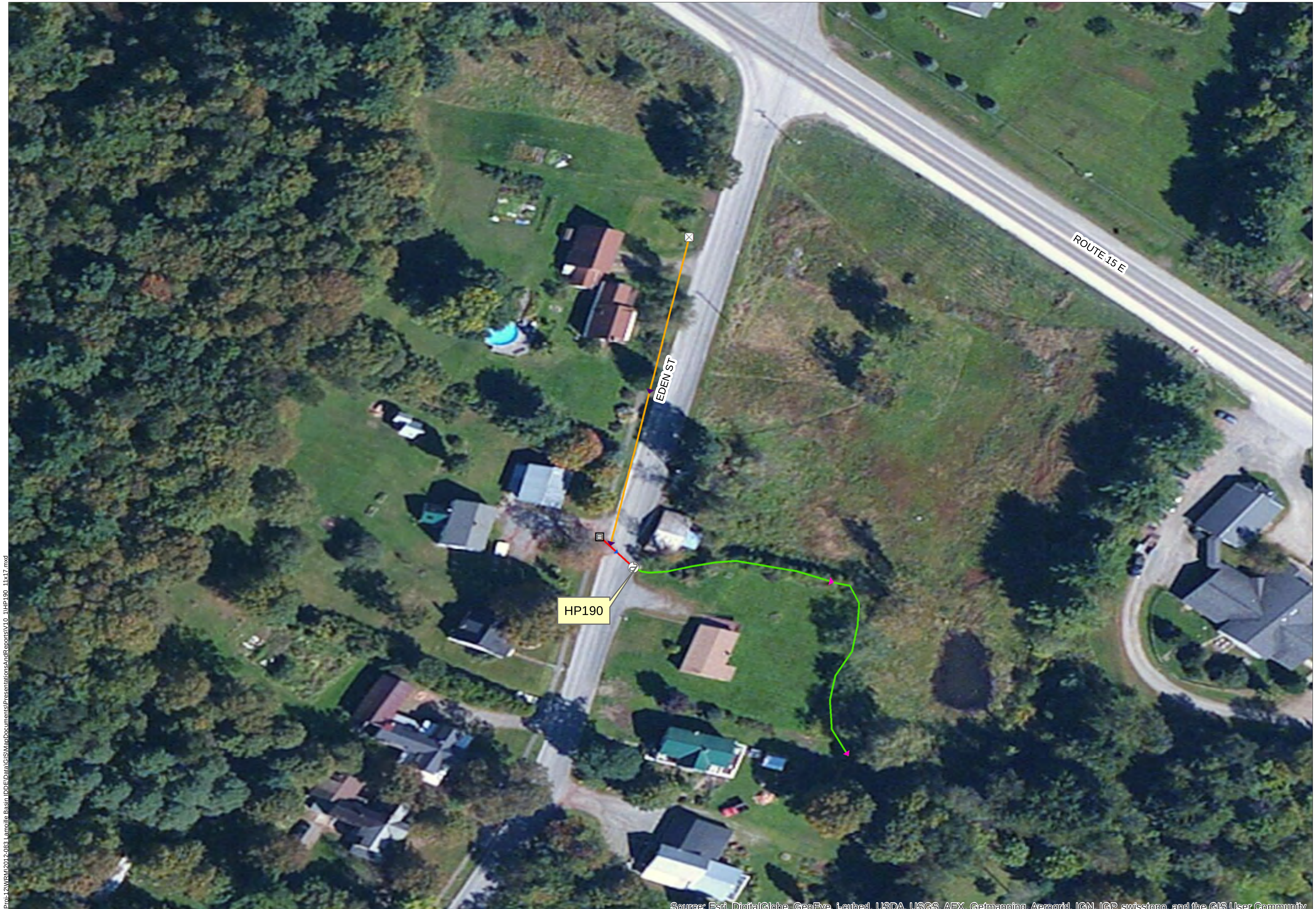
0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Map 16. System HP190
Lamoille River Basin IDDE
Hyde Park, VT



Stormwater Infrastructure
- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

Sources: Esri: Imagery; DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Map 17. System JR220
Lamoille River Basin IDDE
Jericho, VT

Stormwater Infrastructure
- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

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Map 18. System JR310
Lamoille River Basin IDDE
Jericho, VT

Stormwater Infrastructure
- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

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Map 19. System JT040
Lamoille River Basin IDDE
Johnson, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

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Map 20. System JT200

Lamoille River Basin IDDE

Johnson, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

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Map 21. System MO150

Lamoille River Basin IDDE

Morrisville, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N E S W

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

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Map 22. System MO300

Lamoille River Basin IDDE

Morrisville, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

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Map 23. System MO350

Lamoille River Basin IDDE

Morrisville, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

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Map 24. System WO010

Lamoille River Basin IDDE

Wolcott, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N E S W

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

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Map 25. System WO040 and WO050

Lamoille River Basin IDDE

Wolcott, VT

Stormwater Infrastructure

- Catchbasin
- Drop Inlet
- Grate/Curb Inlet
- Junction Box
- CB tied to sanitary sewer
- Stormwater Manhole
- Combined sewer MH
- Sanitary Manhole
- Outfall
- Storm line
- Storm line (old Sanitary line)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Trench drain
- French drain
- Infiltration pipe
- Tunnel (storm)
- Stream

0 25 50 100 Feet

N W E S

Sources: Esri: Imagery;
DEC: Stormwater Infrastructure

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