Illicit Discharge Detection and Elimination in Richmond, Waterbury, Moretown, and Waitsfield

FINAL REPORT

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1. INTRODUCTION

The Mid-Winooski Illicit Discharge Detection and Elimination (IDDE) Project was a collaboration by the Friends of the Winooski River (FWR), the Friends of the Mad River (FMR), Stone Environmental, and four municipalities in the mid-Winooski River watershed: Richmond, Waterbury, Moretown, and Waitsfield. The project provided a comprehensive assessment of the occurrence of contaminated, non-stormwater flows in separated stormwater drainage systems discharging to the Winooski River in Richmond and Waterbury, Thatcher Brook in Waterbury, and the Mad River in Moretown and Waitsfield. Stormwater infrastructure maps prepared by DEC were used in organizing and documenting the assessment.

In older town centers, the discharge of materials other than stormwater through the stormwater drainage system can be a source of bacteria and other contaminants of concern. Locating and eliminating illicit discharges can be a cost-effective element of a long-term strategy to reduce water pollution. Richmond and Waterbury have aging wastewater collection systems and Moretown and Waitsfield have on-site wastewater treatment. Both centralized wastewater collection systems and on-site wastewater systems can contribute illicit discharges to surface waters. Other potential sources of contamination include contaminated discharges from industrial facilities and petroleum contaminated groundwater from former industrial sites, gas stations, and town garages. Municipal tap water leaks are often identified, the correction of which reduces chlorine entering the environment and saves water.

Illicit discharges enter the stormwater drainage system through either direct connections or indirect connections. Examples of direct connections include:

- Wastewater piping either mistakenly or deliberately connected to the stormdrain system;
- A shop floor drain that is connected to the stormdrain system; and
- A cross-connection between the sanitary sewer and stormdrain system.

Examples of indirect connections include:

- Infiltration into the stormdrain system from a leaking sanitary sewer line;
- Infiltration or surface discharge into the stormdrain system from a failed septic system;
- A spill flowing to a catchbasin; and
- Materials (e.g., paint or used oil) dumped directly into a catchbasin.

FWR and Stone have worked together on two previous IDDE projects. In both projects, we identified a variety of problems, some of which would have been obvious to an untrained observer and some that we found only through water testing. We documented pollutants entering stormwater drainage systems from leaking wastewater and water supply infrastructure, hazardous materials releases, and improper pipe connections. In a 2006 project in Barre City, we assessed 78 outfalls, 60 of which had dry weather flow. Contaminated dry weather flows were found at 21 outfalls. The most significant of the contaminated discharges we identified was a substantial flow of raw wastewater discharging from a broken joint in a sewer main through a stormdrain into the Stevens Branch. The City of Barre Public Works Department help to track and correct several issues. In 2008 and 2009, we assessed 346 discharges on the Dog River in Northfield (35), North Branch in Montpelier (95), Stevens Branch in Berlin (65), Stevens Branch in Montpelier (5), Blanchard Brook in Montpelier (5), and Winooski River in Montpelier (141). A total of 26 discharge points, mostly in Montpelier, had test results indicating a source of pollution was present. The City of Montpelier Public Works Department worked with us to find and eliminate the pollutant source.

Prior to this project, there had been no systematic assessment of stormwater infrastructure in Richmond, Waterbury, Moretown, or Waitsfield for the presence of illicit discharges. These communities are not subject to the requirements of the EPA Phase II stormwater rule, which include a requirement to perform IDDE; therefore they had not initiated IDDE programs. Our thorough assessment has indicated that the incidence of contaminated dry weather flows was lower in these communities than in FWR's and Stone's past IDDE projects. This report describes the assessment and its results.

1.1. Goal of the study

The goal of this project was to improve water quality by identifying and eliminating contaminated, non-stormwater discharges entering stormwater drainage systems and discharging to the Winooski River and its tributaries in Richmond, Waterbury, Moretown, and Waitsfield.

1.2. Project roles and responsibilities

The Friends of the Winooski River provided project administration, outreach to Richmond and Waterbury, assisted with the field survey and follow up investigations, and co-authored the final report with Stone.

The Friends of the Mad River provided outreach to Moretown and Waitsfield and assisted with the field survey and follow up investigations.

Stone Environmental developed the testing protocol, led the field assessment, made corrections to the DEC created maps of outfall locations, consulted with municipal officials regarding suspected contamination sources, and co-authored the final report with the Friends of the Winooski River.

The project team's primary municipal contacts were:

Richmond: Geoff Urbanik, Town Administrator

Waterbury: Alec Tuscany, Director of Public Works

Moretown: Rae Washburn, Road Commissioner

Waitsfield: Valerie Capels, Town Administrator

2. METHODS

2.1. Overview

DEC had previously completed mapping of stormwater systems in Richmond, Waterbury, and Waitsfield. Stormwater systems in Moretown were not mapped prior to the project, but are of such limited extent that the few structures present were mapped in the course of the illicit discharge assessment. DEC's stormwater infrastructure maps were used to guide the field assessment. The primary tasks performed were 1) to record observations and perform basic water quality tests at flowing outfalls, other discharge points, and selected catchbasins and junction manholes during dry-weather periods; and 2) where monitoring indicated contamination, to work with the community or business to investigate potential pollutant sources through the stormwater drainage system. The scope of this assessment included the entire extent of the municipal closed drainage system discharging to the Winooski River in Richmond and Waterbury, Thatcher Brook in Waterbury, and the Mad River in Moretown and Waitsfield.

2.2. Preparations for the assessment

Preparations for the illicit discharge assessment included obtaining and assembling necessary equipment and supplies; preparing a field data form, field maps, a Health and Safety Plan, and other documents and organizing these in a project notebook; and meeting with municipal representatives to gather information and plan the project in each community. Field equipment was assembled from Stone's inventory. Consumable supplies, including but not limited to test reagents, sample bottles, latex gloves, and ice packs, were purchased to meet the needs of the project. The field data sheet included as Appendix A was prepared. Large format field maps were prepared by overlaying DEC's stormwater infrastructure mapping and the best available orthophotography. These maps were consulted in planning meetings with municipal representatives and were annotated in the field. A Health and Safety Plan was prepared with directions to emergency medical facilities. A project notebook was assembled containing all these documents plus contact information, laboratory chain of custody forms, standard operating procedures, and other documents.

Members of the project team met with town officials in Richmond, Waterbury, and Waitsfield to gather information and plan the illicit discharge assessment in detail. An official in Moretown was contacted to describe the project and solicit any pertinent information available. Information collected during the meetings included:

- Contact information of municipal managers and public works personnel.
- General schedules of any wastewater and stormwater collection system projects to occur in 2010 (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 sanitary sewer lines were converted to stormwater lines, where there is a history of pipe back-ups or failures, or where complaints have been received about sewage smells or other nuisance conditions.

- Fluoridation and disinfection practices of municipal drinking water facilities. This information determined whether we tested dry weather flows for fluoride.
- The municipality's capabilities to inspect pipelines and perform other advanced investigation techniques, either with municipal staff and equipment or using a contractor specializing in such work.
- The municipality's preferences concerning safe work practices in the public right-of-way.

During the introductory meeting with each municipality, poster sized maps of the stormwater drainage system were reviewed to plan the assessment.

2.3. Dry weather survey

Field scientists assessed all accessible stormwater outfalls and selected catchbasins and manholes in the participating municipalities during dry weather. The catchbasins and manholes selected for assessment in this initial assessment were generally those located at junctions of branched collection systems. Stormwater outfalls, catchbasins, and manholes were accessed along the public right-of-way or from the receiving water body, as appropriate. In certain cases stormwater structures located on private property were assessed if these structures were connected to a municipal system and assuming permission was granted. In general we completed assessment of individual separate stormwater systems before moving to a new area.

Stormwater structures were assessed during dry weather to minimize dilution by stormwater. Dry weather was defined as negligible rainfall (less than 0.1 inches) since approximately 12:00 p.m. on the previous day. With certain exceptions, structures where no dry-weather flow was observed were assumed not to have illicit connections and no further assessment was made. Further assessment of dry structures was made only if there was evidence of contamination in the area below the outfall or in a catchbasin or manhole sump, such as deposits, staining, or offensive odors.

Every outfall or other stormwater structure assessed was assigned a unique identifying code. Scientists described the physical condition of each discharge point, the condition immediately surrounding each discharge point, and the characteristics of any dry weather discharge. Field data were entered on printed forms and noted on field maps. Dry weather flows were sampled by hand or using a telescoping pole sampler. At catchbasins and manholes located at junctions in the storm sewer, samples were collected independently from each inflowing pipe, if possible.

Water analysis methods

Table 1 identifies the water analysis methods scientists used to characterize water samples. Samples were tested for ammonia concentration immediately upon collection using Aquacheck ammonia test strips. Samples intended for specific conductance and fluoride analysis were collected in clean HDPE bottles and analyzed within 24 hours at Stone Environmental's facility in Montpelier. Specific conductance was measured using a calibrated Oakton model conductivity meter. Samples collected in Richmond and Waterbury, which have fluoridated water supplies, were analyzed for fluoride concentration using a Hach DR/890 Colorimeter according to Hach Method 8029. The presence of fluoride is generally a strong indication of a municipal tapwater leak or wastewater source.

Optical brighteners are fluorescent whitening agents (dyes) added to most laundry detergents. Optical brightener monitoring was performed to detect wastewater or washwater flows at outfalls and selected catchbasins and manholes that were flowing at the time of inspection. To test for optical brightener, a cotton pad was placed in the flow stream for a period of 4-10 days, after which the pad was rinsed, dried, and viewed under a long range ultraviolet light (“black light”). The optical brightener test method is further described in Stone Environmental SOP SEI-6.38.0 (Appendix C). Fluorescence of the pad usually indicates presence of laundry detergents, although oil has been demonstrated to cause false positive results. The pads are held in a mesh sleeve, clipped to the outfall structure or secured with fishing line to a rock or other anchor. At catchbasins and manholes located at junctions in the storm sewer, pads were deployed in incoming pipes if possible, but were more often hung from the grate or manhole rim 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.

Table 1. Water quality tests performed at flowing outfalls and selected catchbasins and manholes

Parameter	Sample Container	Analytical Method
Ammonia	Plastic beaker	Aquacheck ammonia test strips
Specific conductance	HDPE bottle	SEI SOP 5.23.3
Optical brighteners	Cotton test pads	SEI SOP 6.38.0
Fluoride	HDPE bottle	Hach Method 8029

2.4. Follow-up testing of stormwater discharge points

At all outfalls or other discharge points where optical brightener was detected and/or where the ammonia concentration in dry weather flow equaled or exceeded 0.3 mg/L, water samples were collected for *E. coli* and total phosphorus analysis, unless the discharge point was not flowing when revisited. Total phosphorus and *E. coli* analyses were conducted by DEC’s LaRosa Laboratory in Waterbury. Samples intended for total phosphorus analysis were collected in glass digestion vials supplied by the LaRosa Laboratory. Samples collected for *E. coli* analysis were collected in sterile, plastic 100 mL bottles preserved with sodium thiosulfate. Table 2 identifies the *E. coli* and total phosphorus analytical methods used by the LaRosa Laboratory. Because quantifying *E. coli* over the wide range of concentrations found in contaminated waters is of greater interest than accuracy at very low concentrations, a 10:1 dilution was made of all *E. coli* samples prior to analysis, to minimize the number of results exceeding the analytical range.

Table 2. Laboratory sample analyses

Parameter	Sample Container (vol. required)	Analytical Method	Sample Preservation	Holding Time
Total phosphorus	Glass vial (50 mL)	SM20 4500 P-H	Cool (4°C)	28 days
E. coli	Plastic (100 mL)	SM20 9223B QuantiTray	Cool (4°C), sodium thiosulfate	6 hours

Flow Measurement

At all outfalls or other discharge points where optical brightener was detected and/or where ammonia concentrations in dry weather flow equaled or exceeded 0.3 mg/L, and 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. Depending on the flow rate and the structure of the discharge point, flow was measured by timing the filling of a container of known volume or by determining the wetted channel (or pipe) cross sectional area and measuring current velocity.

2.5. Isolating contaminant sources within storm sewer segments

If, based on the results of the dry weather survey, a storm sewer was suspected of passing illicit discharges, additional observations and testing were performed within the collection system to locate or bracket the origin of the contaminated flow.   We also consulted with the storm system managers to gain additional background information on the drainage area. 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

In attempting to locate or bracket contaminant sources within storm sewer segments, the same field observations and testing methods or a subset were used as in the dry weather survey phase. For example, if ammonia was detected at the outfall, ammonia testing was used in attempting to find or bracket the source of the contamination, as was the case for the system discharging at outfall WB-060 in Waterbury. If optical brightener was detected, more intensive optical brightener testing of storm sewer structures was performed, as was the case for the system discharging at RI-003 in Richmond (although this is now believed to have been a false positive reading). The presence, appearance, and odor of dry-weather flows were also useful in isolating sources of contamination within storm sewer segments.

3. RESULTS

Results of the illicit discharge assessment in Richmond, Waterbury, Moretown, and Waitsfield are provided in Appendix B and summarized below in Table 3. These tables present data on outfalls, catchbasins, manholes, and a few small streams assessed during the study. For brevity, these tables do not include catchbasins that were quickly observed to determine whether or not they were flowing. The column in Table 3 labeled "Watch List" identifies outfalls that warrant further observation. Outfall RI-003 should be checked periodically to verify that the soil remediation effort at the Richmond Town

Garage is successful in reducing petroleum contamination in the system. In the case of RI-086, WB-380, WB-460, and WB-470, no clear problems were identified in follow-up investigations, however one or more test results were concerning. Structures that were subject to additional investigation (repeated sampling, bracket sampling) in this study are individually labeled in Figures 1 through 8. Other structures are also labeled in Figures 1 through 8 where these are identified in the text.

If follow-up sampling was conducted for total phosphorus concentration and assuming it was possible to measure the flow rate, a total phosphorus mass loading rate was calculated. These data are tabulated in in the report sections for certain outfalls in Richmond and Waterbury. These mass loading rates are based on analysis of a single grab sample and an instantaneous measurement of flow rate. The instantaneous mass loading rate is expressed in kilograms per year by convention; however, these data are clearly insufficient to calculate an estimate of annual phosphorus loading.

Table 3. Summary of structures assessed and contaminated discharges indicated

Municipality	Outfalls Assessed	Other Structures Assessed	Contaminated Dry Weather Flows Suspected	Contaminated Dry Weather Flows Corrected	Watch List
Richmond	20*	37	1	1	RI-003 RI-086
Waterbury	18	29	1	0	WB-380 WB-460 WB-470
Moretown	2	2	0	0	None
Waitsfield	4	7	0	0	None
Totals	44	75	2	1	5

*Includes one outfall pipe in Jonesville

3.1. Richmond

The stormwater systems mapped by DEC in Richmond are presented in Figure 1. Initial illicit discharge assessment in Richmond occurred over three dates in May, 2010. The assessment data are presented in Appendix B. With the exception of one outfall labeled as “N.F.” (not found) in Figure 1, all the stormwater outfalls mapped by DEC were assessed. Selected catchbasins and manholes in larger systems were also assessed.

At the suggestion of the Richmond Town Manager, Jonesville was also assessed, although this area had not been mapped by DEC. In the approximately 0.5-mile length between the Cochran Road bridge and the Interstate-89 overpass, only one outfall was found on the north (right) bank of the Winooski River. This was a 32-inch diameter outfall located immediately upstream of the bridge and it was dry when assessed on September 27, 2010.

Of the 20 outfalls identified (including the Jonesville outfall), 9 were dry when assessed. Among the flowing outfalls, four were considered to warrant investigation (RI-003, RI-086, RI-220, and RI-249). A fifth system we investigated drains to a catchbasin (RI-096) on Bridge Street, where we detected a foul odor. The outfall from this catchbasin, which discharged to a ditch along the railroad tracks, was dry when observed on May 19, 2010, however the catchbasin sump held water and wet soil below the outfall indicated recent discharge. Because the outfall was dry but we suspected there could be a problem further up the drainage system, catchbasin RI-096 was sampled. Results of investigations of catchbasin RI-096 and the four outfalls are described individually below.

Outfall RI-003

Outfall RI-003 is the discharge point for the storm sewer at the Richmond town garage (see Figure 2). As illustrated in the photograph below, this outfall is an 18-inch diameter corrugated black plastic pipe with a persistent trickle of flow in dry weather. This system was investigated in detail after optical brightener was detected and exceedingly high specific conductance (6,280 µS/cm) was measured in the initial assessment. Suds and some iron staining were observed at the outfall. Analytical data collected at this outfall are summarized in Table 4; the data in bold face are concerning.

Outfall RI-003 from the Richmond Town Garage

Table 4. Water analysis data for outfall RI-003

Date	Flow depth (in.)	Ammonia (mg/L)	Sp. conductance (µs/cm)	Fluoride (mg/L)	Optical brightener	Discharge (L/s)	*E. coli* (MPN/100 mL)	Total P Conc. (mg/L)	Total P loading (kg/yr)
05/19/10	0.25	0.0	**6,280**	0.3	**Positive**	NS	NS	NS	NA
06/02/10	0.25	0.1	**3,870**	0.3	**Positive**	0.019	Lab error	0.056	0.03
07/01/10	NR	NS	NS	NS	NS	NR	**862**	NS	NA
08/26/10	NR	NS	NS	NS	NS	NR	**1120**	NS	NA
NA = Not applicable; NS = no sample collected; NR = not recorded									

On June 2, 2010 samples were collected from the outfall for analysis of total phosphorus and *E. coli* and an investigation was performed to attempt to bracket the source of the apparent optical brightener. The total phosphorus concentration was not high and a laboratory error invalidated the *E. coli* result. Monitoring pads were placed in all the structures shown in Figure 2. The test results were positive for manhole RI-400 and all catchbasins except RI-380, RI-390, and RI-410. Sediments in manhole RI-400 appeared coated with petroleum and likely metal oxides. Water samples collected in catchbasins RI-370 and RI-380 had exceedingly high specific conductance and apparently elevated fluoride. On July 1, 2010 *E. coli* sampling at the outfall was repeated, and the level was found to be moderately high (862 MPN/100 mL).

Subsequent to the July 1, 2010 investigation, we suspected two problems contributing to poor water quality at the RI-003 outfall: seepage of petroleum and possibly metals contaminated groundwater to the structures on the backside of the garage and also a wastewater source arising somewhere on the property. The Richmond Town Garage is a listed contaminated site due to historic petroleum releases (from failed fuel tanks and purportedly a waste dumping area). Road salt has also been stored on the property. We attributed the high specific conductance values to salt and/or metals contamination of groundwater arising from these past uses.

On August 26, 2010 we attempted to determine if a wastewater connection existed in the stormdrain. *E. coli* samples were collected at outfall RI-003 and catchbasins RI-360 and RI-370. We bracketed the area where the stormline crosses the sanitary sewer line by sampling at RI-360 (120 MPN/ 100 mL) and RI-003 (1,120 MPN/100 mL). These data suggest a possible diluted wastewater source in this area; however, further up the stormline at catchbasin RI-370 the *E. coli* level was 910 MPN/100 mL and the flows were comparable. Given the variability inherent in *E. coli* analysis, the data at RI-370 and RI-003 should be regarded as no different. Further, the sanitary sewer crosses substantially beneath the stormline and it is therefore an unlikely source of contamination. To determine if the sanitary service line to the town garage was connected appropriately, the toilet in the garage was dye tested. Dye was quickly observed in the sanitary sewer main and not observed at outfall RI-003, indicating that there is no problem in this connection. Neighboring properties are reportedly tied in to the sanitary sewer, and in any case, it is difficult to conceive how any neighboring home could affect *E. coli* levels at RI-370, given their relative locations.

Our current explanations for the observed water quality data at the town garage site are as follows:

- High conductivity in the system is associated with contaminated groundwater from historic uses.
- Optical brightener testing yielded false positives due to the petroleum contamination (which is an interference we have confirmed in our own testing).
- Fluoride concentrations measured at the outfall and in RI-370 and RI-380 were not accurate due to interference by dissolved iron, which is a well-documented interference in the method.
- *E. coli* levels were elevated (although not particularly high) in the stormdrain due to ongoing site activities and not because of a wastewater source, because possible sources were investigated and excluded.

Remediation efforts at the Richmond Town garage site were expanded during the summer of 2010. 185 cubic yards of contaminated soils were reportedly excavated. The impact this soil remediation effort will have on petroleum contamination of the storm sewer is unknown, but it should improve water quality over the long term. The town garage is a recognized contaminated site and the responsibility of the Town of Richmond (with oversight by the DEC Sites Management Section). The only recommendation we make is that outfall RI-003 be tested periodically to confirm reduction in petroleum contamination. Therefore, the outfall is included on the Watch List in Table 3

Outfall RI-086

Outfall RI-086 discharges into a ditch on the upslope side of the railroad tracks. The contributing drainage system consists of several catchbasins on Route 2 and one catchbasin and an inlet from a small drainage swale towards the end of Pleasant Street. Optical brightener and a low concentration of ammonia were found at the outfall during the initial assessment in May, 2010. Results of the initial assessment and follow-up sampling at outfall RI-086 are presented in Table 5; the data in bold face are concerning.

Table 5. Water analysis data for outfall RI-086

Date	Ammonia (mg/L)	Sp. conductance (µs/cm)	Fluoride (mg/L)	Optical brightener	Discharge (L/s)	*E. coli* (MPN/100 mL)	Total P conc. (mg/L)	Total P loading (kg/yr)
05/19/10	0.2	710	0.2	**Positive** (smeared)	NR	NS	NS	NA
06/02/10	0.0	NS	NS	Negative	0.573	Lab error	0.038	0.69
07/01/10	NS	NS	NS	NS	NR	149	NS	NA
NA = Not applicable; NS = no sample collected; NR = not recorded								

Due to the detection of optical brightener on May 19, 2010, an investigation was performed on June 2, 2010 to attempt to bracket the source of the apparent optical brightener. Neither the swale inlet nor the catchbasin on Pleasant Street permit inspection or sampling of the main stormline, because these structures are offset from the main stormline. The only other access points on this system are the catchbasins on Route 2. Monitoring pads deployed on June 2, 2010 at the outfall and at catchbasins RI-330 and RI-340 on Route 2 were negative. Because the optical brightener monitoring pad placed at the outfall on May 19, 2010 had an atypical appearance (a smeared patch in an otherwise clean pad) and no optical brightener was detected in follow-up sampling, it is likely that the first result was a false positive.

Total phosphorus and *E. coli c*oncentrations were low in samples collected on June 2 and July 1, 2010, respectively. Taken together these results suggest that there is no illicit discharge occurring in this system. However, it is possible there is an intermittent source of wastewater and we therefore recommend that this outfall be retested periodically. The outfall is included on the Watch List in Table 3.

Catchbasin RI-096

Catchbasin RI-096 is the terminal catchbasin on the storm sewer running up Bridge Street to the intersection of Route 2 (Figure 1). This catchbasin discharges via an outfall to a ditch adjacent to and upslope of the railroad tracks. During the initial assessment and four subsequent visits, this outfall was dry. However, during the initial assessment the sump at RI-096 was full and a foul odor was detected. Therefore, to test for intermittent discharges, an optical brightener monitoring pad was placed in the catchbasin. The result of the optical brightener test was not definite. The test was repeated on June 2, 2010 and the result was negative.

In our experience, sampling stagnant water in catchbasin sumps can yield misleading results. However, on June 2, 2010 the sump was sampled for *E. coli* and total phosphorus analysis, because the question concerning the odor detected on May 19, 201 remained unresolved. The *E. coli* test was repeated on July 1, 2010 due to a lab error. The phosphorus result (0.220 mg/L) from June 2, 2010 was slightly elevated above the expected range and the *E. coli* result (2,790 MPN/100 mL) on July 1, 2010 was high for dry weather flows. These results are summarized in Table 6. However, these results are not particularly high compared with typical stormwater runoff concentrations.

In two subsequent visits (July 28 and September 15, 2010) there was no flow in the catchbasin. Based on these repeated observations, the odor observed on May 19, 2010 and the elevated total phosphorus concentration (June 2, 2010) and *E. coli* level (July 1, 2010) were attributed to stormwater runoff and stagnant water conditions in the catchbasin.

Table 6. Water analysis data for catchbasin RI-096

Date	Flow depth (in.)	Ammonia (mg/L)	Optical brightener	*E. coli* (MPN/100 mL)	Total P conc. (mg/L)	Total P loading (kg/yr)
05/19/10	No flow	NS	Indeterminate (spots)	NS	NS	NA
06/02/10	No flow	0.0	Negative	Lab error	0.220	0.000
07/01/10	No flow	NS	NS	2,790	NS	NA
07/28/10	No flow	NS	NS	NS	NS	NA
09/15/10	No flow	NS	NS	NS	NS	NA
NA = Not applicable; NS = no sample collected; NR = not recorded						

Outfall RI-220

Outfall RI-220 is an 18-inch diameter concrete pipe draining a small system of catchbasins at the Richmond Middle School. When first assessed on May 19, 2010, the specific conductance was very high, 1,933 µS/cm. On July 25, 2010 the outfall was dry. When on September 15, 2010 it was assessed for a third time, specific conductance was low (78 µS/cm), ammonia and fluoride concentrations were below detection, and the *E. coli* level was low (31 MPN/100 mL). Based on these results we concluded that there was no illicit discharge present and that no further investigation is warranted. It is possible the high conductivity value measured in May 19, 2010 may have resulted from accumulated road salt.

Outfall RI-249

Outfall RI-249 is located along the access road to the Richmond Middle School. When this outfall was assessed on May 19, 2010, the optical brightener test was indeterminate, showing small spots. Optical brightener testing was negative when repeated on June 2, 2010. We concluded that additional investigation is not warranted because this outfall appears uncontaminated.

3.2. Waterbury

The stormwater systems mapped by DEC in Waterbury are presented in Figures 3 and 4. Initial illicit discharge assessment in Waterbury occurred over four dates in July, 2010. The assessment data are presented in Appendix B. With the exception of one outfall labeled as “N.F.” (not found) and three labeled “N.A.” (not assessed) in Figure 3, all the stormwater outfalls mapped by DEC were assessed. The three outfalls labeled “N.A.” are from very small systems that were not assessed due to an oversight. In addition to the outfalls, selected catchbasins and manholes in larger systems were also assessed.

Of the 18 outfalls assessed, four were not flowing and several were only dripping when assessed. Six outfalls were considered to warrant investigation or repeated sampling (WB-060, WB-200, WB-296, WB-380, WB-460, and WB-470). These are described individually as follows.

Outfall WB-060

Outfall WB-060 is the discharge point for the most extensive storm sewer in Waterbury (Figure 5). It discharges to a swale on the backside of Randall Street. During the initial assessment, the optical brightener monitoring test was negative. However, water samples collected on July 6 had slightly elevated specific conductance and ammonia and fluoride concentrations. These data are presented in Table 7. In addition to the outfall, seven other structures in the WB-060 system were assessed on July 6 (manholes WB-070 and WB-093 and catchbasins WB-050, WB-090, WB-091, WB-092, and WB-100). There was negligible flow at WB-093 and the flow rate increased to WB-070. Specific conductance and ammonia and fluoride concentrations at WB-070 were similar to levels at the outfall. No structures were identified that had substantially higher concentrations of these constituents.

Samples were collected at outfall WB-060 for *E. coli* and total phosphorus analysis on July 28, 2010. Concentrations of both *E. coli* (370 MPN/100 mL) and total phosphorus (0.218 mg/L) were not high but were elevated as compared with typical levels in dry weather flows.

Additional samples were collected from catchbasin WB-100 on July 28, 2010; concentrations of ammonia and fluoride were below the detection limit, while the specific conductance remained elevated. Two other catchbasins further up the storm sewer were not flowing.

Table 7. Water analysis data for outfall WB-060

Date	**Ammonia (mg/L)**	**Sp. conductance (μs/cm)**	**Fluoride (mg/L)**	**Optical brightener**	**Discharge (L/s)**	***E. coli*** **(MPN/100 mL)**	**Total P conc. (mg/L)**	**Total P loading (kg/yr)**
07/06/10	0.25	1,405	0.3	Negative	NA	NS	NS	NA
07/28/10	NS	NS	NS	NS	0.25	370	0.218	1.72
NA = Not applicable; NS = no sample collected; NR = not recorded								

Because no structures in the WB-060 system were identified with higher specific conductance or fluoride or ammonia concentrations than were present at the outfall on July 6, no illicit discharge to the system was indicated. The slightly elevated ammonia and fluoride concentrations in the system do not warrant further investigation at this time.

Outfall WB-200

Outfall WB-200 discharges to a small detention area south of the state office complex. The outfall was dry when assessed on July 6, 2010. Optical brightener monitoring pads were installed in the outfall and three catchbasins (WB-230, WB-240, and WB-250) in the system, although these catchbasins were also dry. The pads collected from the catchbasins were negative, while the pad deployed at the outfall was indeterminate. The outfall was dry when revisited on July 28, 2010. Because the outfall was dry on both occasions and there were no signs of contamination, we concluded that the spotting on the monitoring pad was likely due to oil in stormwater runoff and that no further investigation was warranted.

Outfall WB-296

Outfall WB-296 is the discharge point for a small storm sewer located immediately north of the Route 2 bridge over the Winooski River (see Figure 3). The outfall was dripping when assessed on July 7, 2010 and had a low, but detectable, ammonia concentration of 0.25 mg/L. Optical brightener was not detected. The outfall was revisited on July 13 and July 28, 2010 and was dry on both occasions. Based on these results, we concluded that there is no illicit discharge to this system.

Outfall WB-380

Outfall WB-380 discharges to Thatcher Brook near the intersection of Route 100 and Blush Hill Road (see Figure 4). Assessment data for this outfall are presented in Appendix B and are summarized in Table 8. A trickle of flow was present on each occasion this outfall was visited. Samples collected from this outfall on July 8, 2010 had high specific conductance and a moderate fluoride concentration. No ammonia was detected and the optical brightener test was negative. Follow-up samples collected on July 28, 2010 had very low total phosphorus but moderately high *E. coli* concentration (690 MPN/100 mL). Results of a final set of samples collected on September 15, 2010 had a similar fluoride concentration and specific conductance to the July 8 samples, but *E. coli* was low compared with the July 28 sampling.

Table 8. Water analysis data for outfall WB-380

Date	Flow depth (in.)	Ammonia (mg/L)	Sp. conductance (µs/cm)	Fluoride (mg/L)	Optical brightener	Discharge (L/s)	*E. coli* (MPN/100 mL)	Total P conc. (mg/L)	Total P loading (kg/yr)
07/08/10	<0.25	0.0	3,320	0.4	Negative	NA	NS	NS	NA
07/28/10	NR	NS	NS	NS	NS	0.029	690	0.0193	0.02
09/15/10	NR	0.0	2,260	0.4	NS	0.020	31	NS	NA
02/24/11	NR	0.0	5,140	0.3	NS	NA	NS	NS	NS
NA = Not applicable; NS = no sample collected; NR = not recorded									

On July 28, 2010, the flow present at the outfall was traced to a catchbasin (WB-400) near the front entrance of the Best Western Hotel. This structure was not opened or sampled because it is on private property. A pipe entering the catchbasin from the direction of the building was flowing. No odor was detected.

On February 24, 2011, outfall WB-380 was resampled and two catchbasins on the entrance road to the Best Western were sampled, with assistance from Randy Donald, Best Western's maintenance foreman. Mr. Donald stated that the pipe entering catchbasin WB-400 is the outlet from a foundation drain. Distinctly gray water was dripping from this pipe; more water entered the catchbasins around the pipe penetration. There was no pronounced odor at the catchbasins or outfall W-380. Ammonia was below detection at all sampled structures. Chlorine concentrations were low (0.05 mg/L) but detectable at the outfall. Fluoride concentrations were 0.3 mg/L at the outfall and 0.5 mg/L at catchbasin WB-390, near the intersection of the Best Western access road and Blush Hill Road. Specific conductance was very high, over 1,000 µs/cm at all sampling points. The roads and parking lot appeared whitish from salt application, which likely contributed to the high specific conductance. Detergents were also tested, but the results were inconclusive (a green color developed instead of the indicator blue color). Because these results are consistent with a leak somewhere above catchbasin WB-390, outfall WB-380 is included on the watch list in Table 3.

A catchbasin in the parking lot of the Shell station at the intersection of Route 100 and Blush Hill Road was observed on February 24. This catchbasin appears to discharge to a swale that drains to outfall WB-380, but the outlet pipe could not be located in the deep snow. Water was flowing into the catchbasin at a pipe penetration. A gray paper waste was visible in the catchbasin sump. This had the appearance of toilet paper, but it may have been napkins or other trash. Permission was not immediately granted to open this catchbasin to inspect or sample it and the grate was also frozen in place. When the WB-380 system is further investigated, the outlet pipe from this catchbasin should be sampled.

Outfalls WB-460/WB-470

Two flowing pipes, WB-460 and WB-470, were assessed at the Ben and Jerry's factory property on July 8, 2010 (see Figure 6). The photograph below was taken at WB-470, where flow enters the stormwater pond. During the initial assessment on July 8, 2010, the ammonia concentration and the specific conductance were elevated at outfall WB-460 and the fluoride and specific conductance were elevated at outfall WB-470. These data are included in Appendix B and summarized in Table 9; the data in bold face are concerning. Iron staining was observed at both outfalls. Optical brightener was not detected at either outfall. Follow-up sampling on July 28, 2010 at WB-460 yielded a higher ammonia concentration (1.0 mg/L), high specific conductance, and fluoride. At WB-470, ammonia, specific conductance, and fluoride were somewhat lower than on July 8. *E. coli* and total phosphorus concentrations were very low at both outfalls on July 28, 2010.

Outfall WB-470

Note that the flow appears orange due to the presence of iron oxide

Table 9. Water analysis data for outfalls WB-460, WB-470, and WB-500 (Ben and Jerry's)

Structure ID	**Date**	**Flow depth (in.)**	**Ammonia (mg/L)**	**Sp. conductance (µs/cm)**	**Fluoride (mg/L)**	**Total chlorine (mg/L)**	**Optical brightener**	**Discharge (L/s)**	***E. coli* (MPN/100 mL)**	**Total P conc. (mg/L)**	**Total P loading (kg/yr)**
WB-460	07/08/10	<0.25	**0.3**	**1,803**	0.0	NS	Negative	NA	NS	NS	NA
WB-460	07/28/10	NR	**1.0**	**1,732**	**0.4**	NS	NS	0.006	61	0.0079	0.002
WB-460	08/19/10	NR	**0.40***	**1,870**	0.3	0.04	NS	NA	NS	NS	NA
WB-470	07/08/10	<0.25	0.2	**1,912**	**0.4**	NS	Negative	NA	NS	NS	NA
WB-470	07/28/10	NR	0.1	**1,597**	0.3	NS	NS	0.047	<20	0.0436	0.07
WB-470	08/19/10	NR	0.19*	**1,528**	0.3	0.20	NS	NA	NS	NS	NA
WB-500	09/15/10	0.25	0.0	**1,200**	0.3	NS	NS	0.30	95	NS	NA

NA = Not applicable; NS = no sample collected; NR = not recorded
*Data presented are for the Hach Salicylate Method #8155.

On August 19, 2010 these data were discussed with Randy Thompson of Ben and Jerry's in a meeting at the factory. Possible explanations for the elevated specific conductance and ammonia and fluoride concentrations were considered. Additional samples were also collected. The fluoride and specific conductance data for the August 19 samples were comparable to earlier sampling. Ammonia was quantitated both using Aquacheck test strips and the Hach Salicylate Method #8155. The results from the two methods compared closely. The ammonia concentration at both outfalls was low but detectable on August 19.

Randy Thompson described aspects of the facility's process water, sanitary wastewater, and stormwater collection and handling systems. Process waters are collected and pre-treated prior to discharge with untreated sanitary wastewater to the Waterbury municipal wastewater treatment plant. Stormwater is collected in catchbasins around the facility and discharged via pipes that daylight on vegetated slopes around the periphery. There are three catch basins on the patio of the Scoop Shop. According to Mr.

Thompson, the patio area is pressure washed daily, using no detergents. Below these pipe outlets, grass swales collect runoff and convey it to several structures, including WB-460 and WB-470. Mr. Thompson further described how within the preceding two weeks, after learning of the preliminary findings, he had placed dye in all sumps in the facility and in a catchbasin in the parking lot beneath the trash compactor to ascertain whether any of these drains were connected to the stormwater systems. No dye was found issuing from the storm drain outlets and therefore he concluded there were no inappropriate connections within the facility.

During the meeting we inspected the storm drainage system in several locations. There were no dry weather stormwater flows to the structures in question. Both structures were flowing as a result of groundwater seepage into the grass swales. There were orange particles of iron oxide on the surface of the water in both swales. This is common where groundwater lacking oxygen surfaces causing dissolved ferrous iron to form iron oxide (rust). No foam or foul odors were observed. The pulsing flow observed previously at WB-460 was diminished, but closer inspection indicated that it is simply a result of the outfall pipe hydraulics, due to some corrugation or misaligned pipe joint. The inflow to the pipe was not pulsing.

Based on the statements and testing of Mr. Thompson and on our observations, we do not believe that there is an illicit discharge problem at the facility. The iron staining is a likely consequence of groundwater discharge from the fill slope; the pulsing flow was simply a misleading observation; the low ammonia levels may result from decomposition of organic nitrogen under reducing conditions in the saturated swales; and the fluoride may result from use of municipal drinking water for cleaning the Scoop Shop patio and other public areas. The foam observed on July 8 at WB-470 is a little more puzzling; however, organic acids leached from vegetation can cause foaming in natural waters and perhaps that is all that is occurring here.

While a reasonable explanation may be found for all the observations and water quality results, it is prudent to repeat sampling periodically to rule out the possibility that we have missed something significant. Both WB-460 and WB-470 are included on the Watch List in Table 3.

3.3. Moretown

On June 22, 2010 we assessed stormwater infrastructure in Moretown during dry-weather conditions. Results of this assessment are presented in Appendix B. The system consists of several connected catchbasins along Route 100B (see Figure 7). The discharge point, which is believed to be over a steep embankment above the Mad River, could not be found. Therefore, the next catchbasin up the stormline from the outfall (MT-040, which is near the fire station) was assessed. At MT-040, only the stormline crossing the road from the catchbasin on the east side of Route 100B was flowing, and this pipe was only dripping. Up the system from MT-040, the catchbasin identified as MT-030 was also dripping. There was insufficient flow to sample either MT-030 or MT-040 and there were no observations in either structure indicating contamination.

Also assessed were two four-inch diameter pipes (MT-010 and MT-020) which discharge to the stream that crosses Route 100B approximately 200 feet north of the point labeled MT-040. These pipes are likely to be footing drains and they were both dry.

The only potential problem identified in Moretown was a pipe discharging in the area of MT-030 that appears to be the outlet for a sump pump located in the church building (see Figure 7), although this was not confirmed. This pipe was not flowing when observed. Therefore, the only recommendation FWR and FMR will make in the final letter to Moretown is to advise the town to check in the church building for any improper plumbing connections to this pipe.

3.4. Waitsfield

Stormwater infrastructure mapped by DEC in Waitsfield is shown on Figure 8. On June 4, 2010 the municipal stormwater outfalls were assessed. Only two outfalls were identified as flowing during dry weather: WF-010, a 4-inch diameter pipe found to be dripping, and WF-080, an 18-inch diameter pipe flowing at a depth of approximately 1 inch. Iron staining was present at both WF-010 and WF-080, but there were no definite indications of contamination in water samples collected at either pipe and optical brightener tests were negative. Iron staining can be associated with contamination, but very often it is simply an indication of groundwater seepage. The storm sewer outfall on the left bank of the Mad River immediately downstream of the Bridge Street covered bridge (WF-070) was dry. The storm sewer discharging to the right bank of the Mad River immediately upstream of the covered bridge (this system is not mapped) was also dry. All catchbasins inspected were dry except for a catchbasin (WF-100) in the parking lot of the Big Picture Theater that drains to outfall WF-080 and a series of catchbasins in the Mad River Green area. A dripping, iron stained pipe was observed discharging to catchbasin WF-100. Beyond documenting whether certain structures were flowing, assessment in these areas was complicated by the fact that most of the structures are on private property. After the June 4 assessment, repeated attempts were made by the Friends of the Mad River to contact property owners for permission to sample at WF-100 and stormwater structures in the Mad River Green area.

Segments of the Mad River were scouted on June 4, 2010 to search for undocumented discharge points. No direct, non-stormwater discharges or contaminated groundwater seeps were identified in scouting along the Mad River. Samples collected in four small tributaries to the Mad River (locations WF-020, WF-030, WF-040, and WF-050) did not appear contaminated.

On September 14, 2010, we attempted to sample catchbasin WF-100. With assistance of the theater staff, we dug out the catchbasin grate, but found that the grate was rusted firmly to the frame. A slow drip was visible from an iron-stained pipe leading from the direction of the theater. There was no offensive odor in the catchbasin. Ammonia was near the limit of detection (0.1 mg/L) in a sample collected through the grate from the catchbasin sump.

On September 14, 2010, the stream culvert (WF-110) under Carroll Road was sampled, because stormwater from the Mad River Green area drains to this stream and direct sampling of the structures was not possible due to private property. Ammonia and specific conductance were low and there were no offensive odors or visual indications of contamination. From these results, we concluded that further investigation was not warranted. A catchbasin (WF-090) in a parking lot on the east side of Route 100, opposite Carroll Road, was also sampled and found to have moderately high specific conductance and no detectable ammonia or offensive odors.

From the data collected on June 4 and September 14, 2010, we did not identify any illicit discharges in Waitsfield and we concluded that further investigation is not warranted at this time.

4. CONCLUSIONS

The Friends of the Winooski River, Friends of the Mad River, and Stone Environmental conducted a thorough assessment of closed stormwater drainage systems in Richmond, Waterbury, Moretown, and Waitsfield, Vermont during the 2010 field season. A total of 44 outfalls and 75 other structures (mostly catchbasins) were assessed. Only one illicit discharge was confirmed: contaminated groundwater seepage to the stormwater drainage systems at the Richmond town garage. A substantial contaminated soil remediation project occurred at the site during the course of this IDDE project. Beyond this finding, there were three outfalls in Waterbury—WB-380, WB-460, and WB-470—and one outfall in Richmond, RI-086, at which we recommend periodic sampling. If contaminant levels are found to exceed those documented here, additional bracket sampling and/or advanced investigation techniques (camera inspection, smoke testing, and dye testing) may be called for.

5. REFERENCES

American Public Health Association, Standard Methods for the Examination of Water and Wastewater, 20th edition, Washington D.C., 1999.

Hach Company. Hach Method #8029 and Method #8155. 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.

6. FIGURES

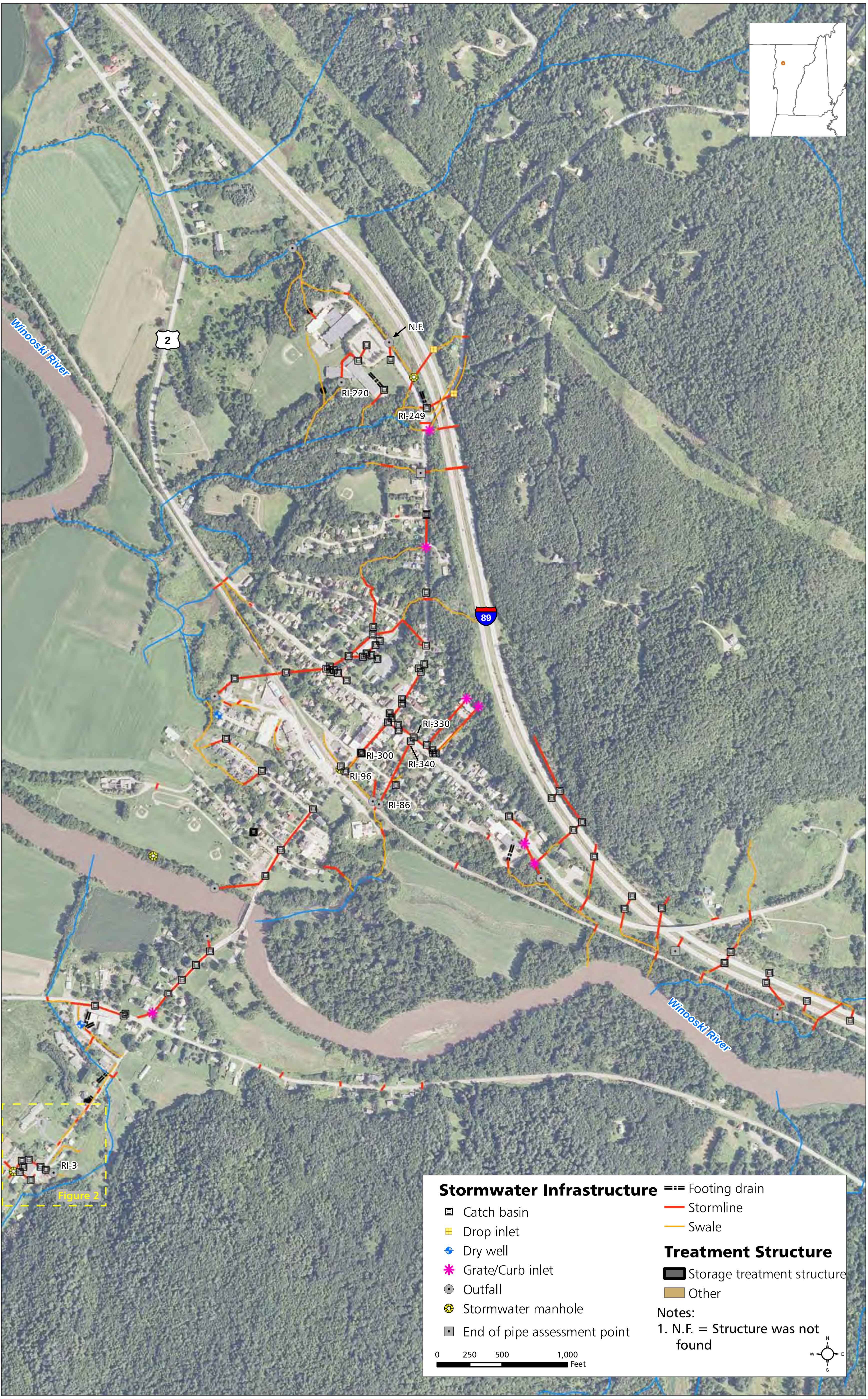

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Figure 1. Richmond Illicit Discharge Assessment

Mid-Winooski IDDE

Sources: NAIP 2009; DEC: Stormwater Infrastructure

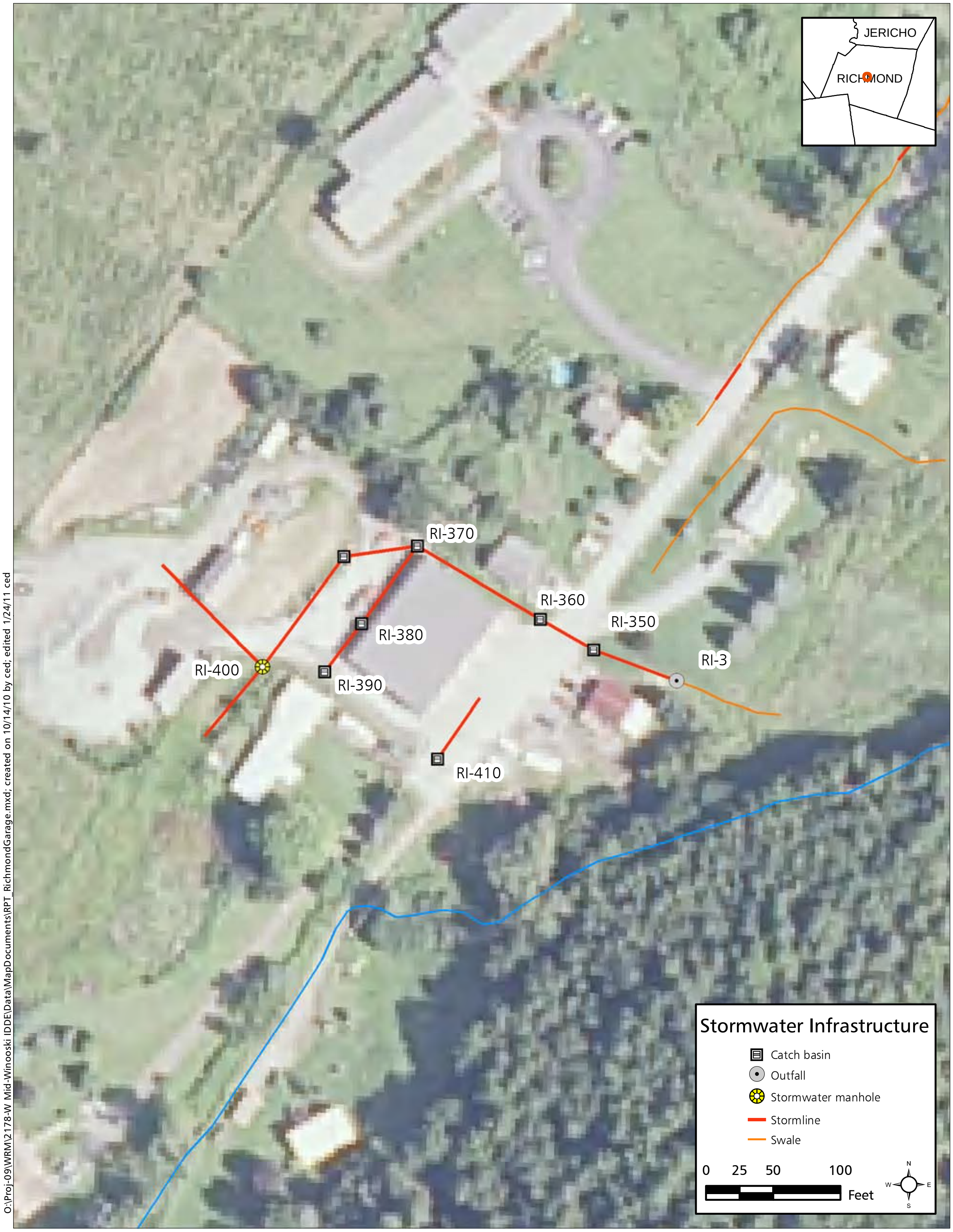

Figure 2. Richmond Town Garage Illicit Discharge Assessment

Mid-Winooski IDDE

Sources: NAIP 2009; DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

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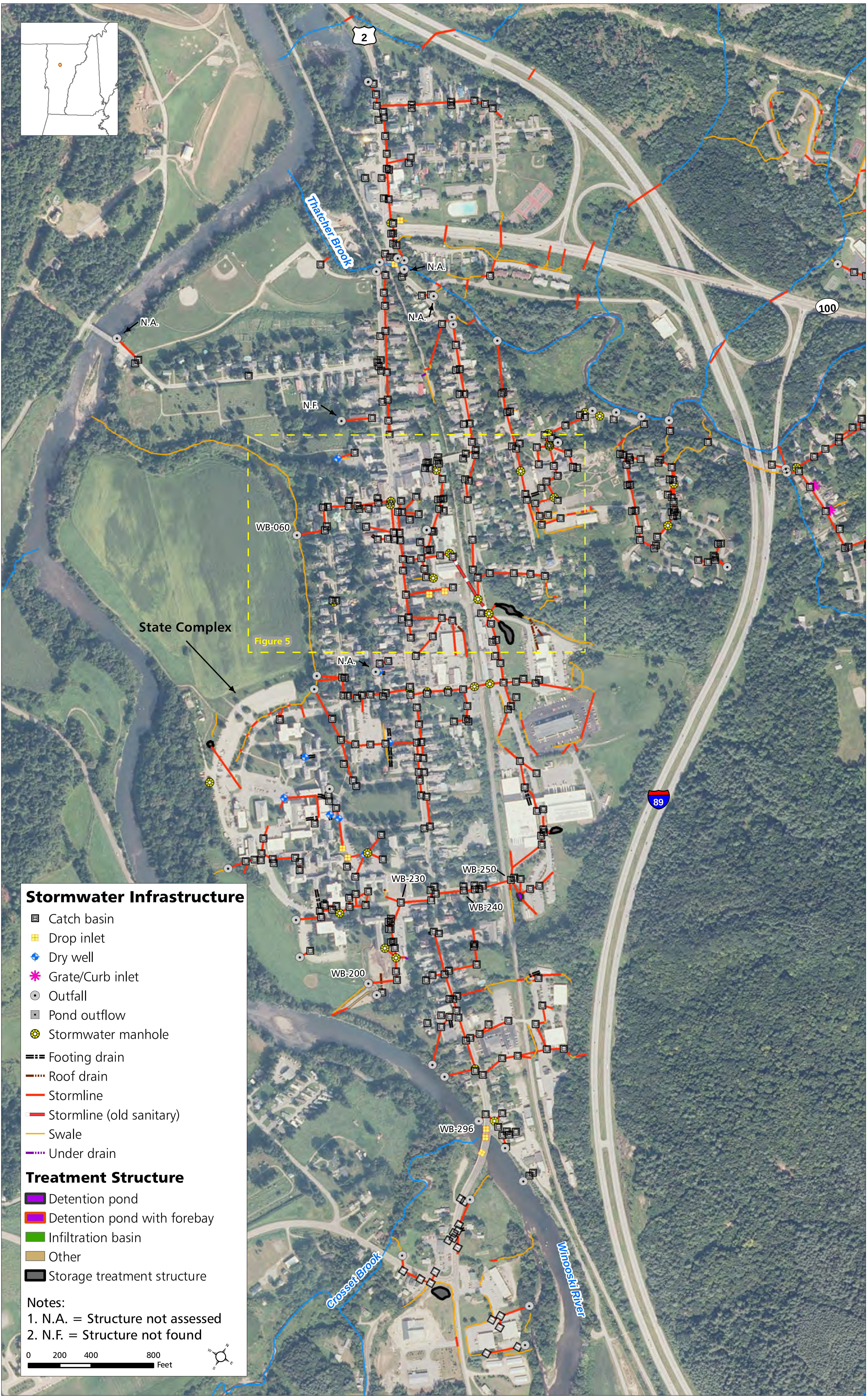

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Figure 3. Waterbury (West of I-89) Illicit Discharge Assessment

Mid-Winooski IDDE

Sources: NAIP 2009; DEC: Stormwater Infrastructure

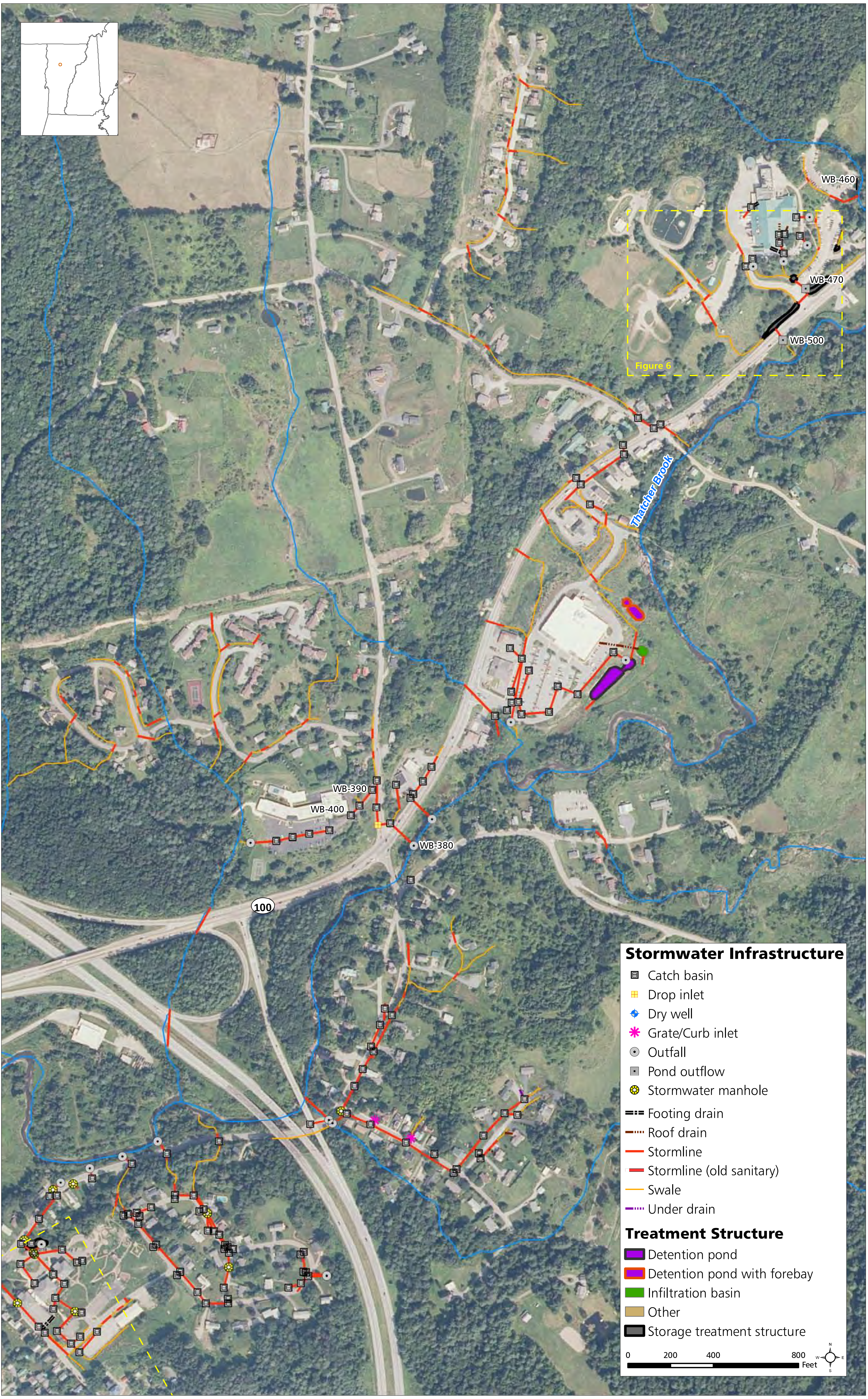

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Figure 4. Waterbury (East of I-89) Illicit Discharge Assessment

Mid-Winooski IDDE

Sources: NAIP 2009; DEC: Stormwater Infrastructure

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Figure 5. Waterbury WB-060 System Illicit Discharge Assessment

Mid-Winooski IDDE

Sources: NAIP 2009; DEC: Stormwater Infrastructure

Stone Environmental Inc

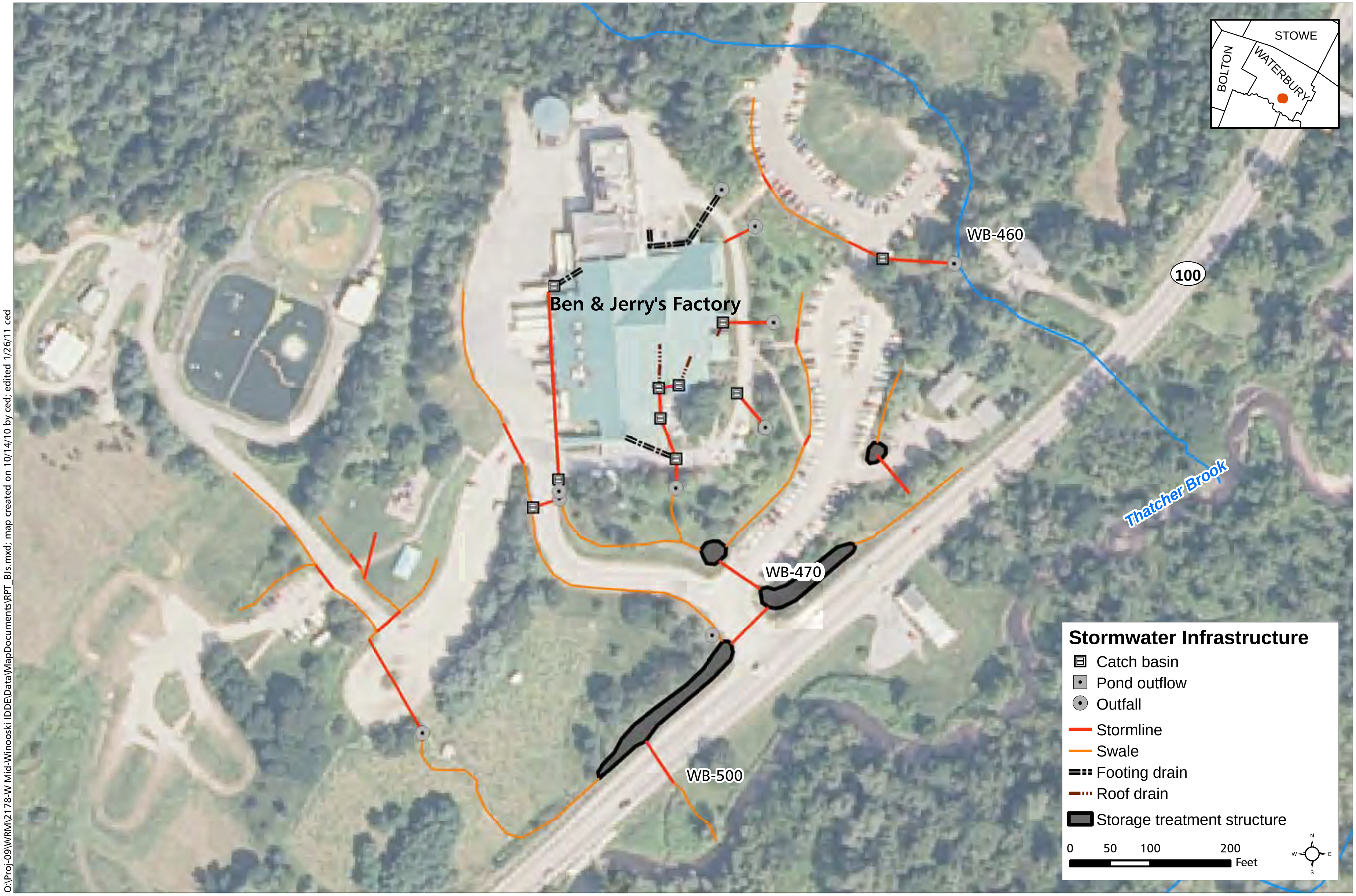

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Figure 6. Ben & Jerry's Stormwater System Illicit Discharge Assessment
Mid-Winooski IDDE

Sources: NAIP 2009; DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

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Figure 7. Moretown Illicit Discharge Assessment

Mid-Winooski IDDE

Sources: NAIP 2009; Stone Environmental: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

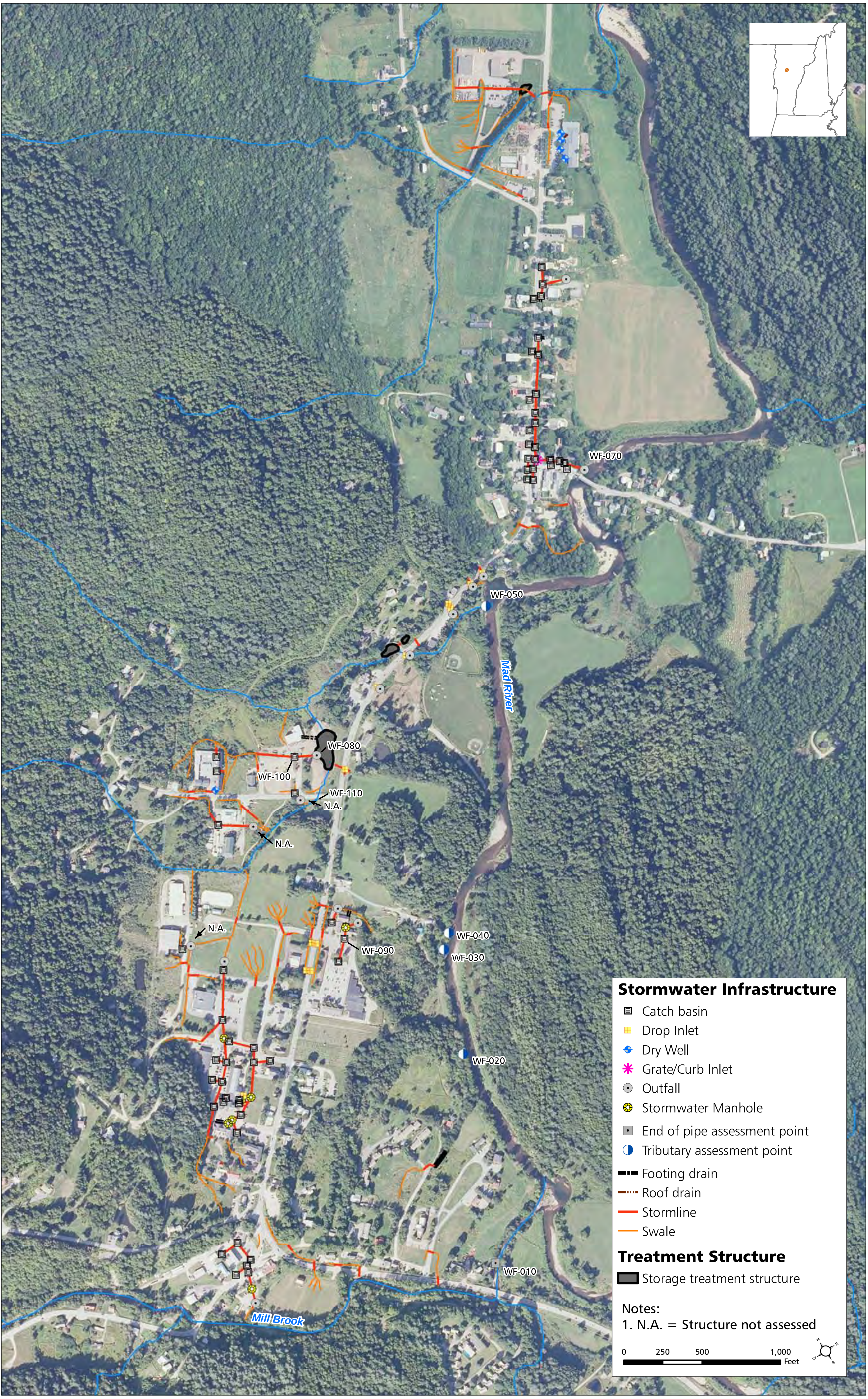

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Figure 8. Waitsfield Illicit Discharge Assessment

Mid-Winooski IDDE

Sources: NAIP 2009; DEC: Stormwater Infrastructure

APPENDICES

APPENDIX A: FIELD DATA SHEET

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	dripping	depth ____________________(in.)	
Pipe position (outfall only):	Free flow	partially submerged	submerged	If partially submerged, surcharged? YES NO	
Erosion at outfall	none	If present, describe: ____			
Flow observations (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, spauling	corrosion	crushed	other____________________
Obstructions:	none	partially obstructed		fully obstructed	other________________
OB pad set? YES NO			Date OB pad retrieved______________________		
Ammonia__________ mg/L					
Sample collected for analysis of fluoride, chlorine, and/or sp. conductance? YES NO NA					
Sample collected for *E. coli* analysis: YES NO NA			Time: ______________________		
Sample collected for TP analysis: YES NO NA			Time: ______________________		
Flow measurement (if *E. coli* and/or TP sample collected):					
Comments:					

APPENDIX B: WATER QUALITY DATA

Structure ID	Date	Inspector	Town	Structure type	Material	Diameter (in.)	Pipe position	Flow depth (in.)	Flow observation	Floatables	Deposits/ stains	Damage	Ammonia (mg/L)	Sp. conductance (µs/cm)	Fluoride (mg/L)	Optical brightener	Comments
MT-030	06/22/10	CED	Moretown	Catchbasin	NA	NA	NA	Dripping		NA	NA	NA	NS	NS	NS	Negative	Flow too low to sample; the church appears to have a sump pump which discharges to the stream entering pipe A
MT-040	06/22/10	CED	Moretown	Catchbasin	NA	NA	NA	Dripping	Pipe A&C dry; pipe B dripping	NA	NA	NA	NS	NS	NS	Negative	Flow too low to sample
MT-010	06/22/10	CED	Moretown	Outfall	PVC	4	Free flow	Dry	None	None	None	None	NS	NS	NS	NS	
MT-020	06/22/10	CED	Moretown	Outfall	PVC	4	Free flow	Dry	None	None	None	None	NS	NS	NS	NS	
RI-096	05/19/10	CS	Richmond	Catchbasin	NA	NA	NA	No flow	No flow, but foul odor	NA	NA	NA	NS	NS	NS	Indeterminate (spots)	
RI-096	06/02/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	No flow	Turbid, no odor	NA	NA	NA	0.0	NS	NS	Negative	Not flowing, but evidence of recent discharge to ditch
RI-096	07/01/10	DCB	Richmond	Catchbasin	NA	NA	NA	No flow		NA	NA	NA	NS	NS	NS	NS	
RI-096	07/28/10	AES	Richmond	Catchbasin	NA	NA	NA	No flow		NA	NA	NA	NS	NS	NS	NS	No flow (standing water)
RI-096	09/15/10	CED	Richmond	Catchbasin	NA	NA	NA	No flow		NA	NA	NA	NS	NS	NS	NS	Water in sump, but not enough to sample
RI-107	05/19/10	DCB	Richmond	Catchbasin	NA	NA	NA	Flowing	Clear	NA	NA	NA	0.2	NS	NS	Negative	Unable to open catchbasin - No sample taken
RI-118	05/19/10	CS	Richmond	Catchbasin	NA	NA	NA	Flowing	Clear	NA	NA	Corrosion	0.2	654 (pipe B)	0.1 (pipe B)	Negative	OB pad set in sump; pipe A is dry, pipe B is flowing
RI-154	05/19/10	DCB	Richmond	Catchbasin	NA	NA	NA	Flowing	Clear	NA	NA	NA	0.2	324 (pipe A)	0.1 (pipe A)	Negative	OB pad set in outlet pipe; pipe A is flowing, pipe B is dry
RI-169-A	05/19/10	CS	Richmond	Catchbasin	NA	NA	NA	Flowing	Clear	NA	NA	NA	0.2	687	0.1	Negative	
RI-169-B	05/19/10	CS	Richmond	Catchbasin	NA	NA	NA	Flowing	Clear	NA	NA	NA	0.2	306	0.1	Negative	From RI-236
RI-171	05/19/10	CS	Richmond	Catchbasin	NA	NA	NA	Flowing	Clear	NA	NA	NA	0.2	670	0.1	Negative	Flagged by Kendal Chamberlin as possibly contaminated
RI-187-A	05/19/10	CED	Richmond	Catchbasin	NA	NA	NA	Dry		NA	NA	NA	NS	NS	NS	NS	No flow from inflow pipe
RI-216	05/19/10	CED	Richmond	Catchbasin	NA	NA	NA	Dry		NA	NA	NA	NS	NS	NS	NS	Sump dry
RI-231	05/19/10	DCB	Richmond	Catchbasin	NA	NA	NA	Flowing	Clear	NA	NA	NA	0.1	327 (pipe A)	0.1 (pipe A)	NS	Pipe A flowing, pipe B dry; No pad set due to filter fabric
RI-300	06/02/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Pad lost	Catch basin is off the main line, minimal outflow
RI-310	06/02/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	NA	Stagnant	NA	NA	NA	NS	NS	NS	NS	
RI-320	06/02/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	NA	Stagnant	NA	NA	NA	NS	NS	NS	Negative	
RI-330	06/02/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	NA	Clear	NA	NA	NA	NS	NS	NS	Negative	
RI-340	06/02/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	NA	Clear	NA	NA	NA	NS	NS	NS	Negative	
RI-350	06/02/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	NA	Turbid	NA	NA	NA	NS	NS	NS	Positive	At Richmond town garage
RI-360	06/02/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	NA	Turbid	NA	NA	NA	NS	NS	NS	Positive	At Richmond town garage
RI-360	08/26/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	NR		NA	NA	NA	NS	NS	NS	NS	At Richmond town garage
RI-370	06/02/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	6,770	0.5	Positive	At Richmond town garage near propane tank
RI-370	08/26/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	NR		NA	NA	NA	NS	NS	NS	NS	At Richmond town garage near propane tank
RI-380	06/02/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	11,800	0.6	Negative	At Richmond town garage
RI-390	06/02/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	At Richmond town garage
RI-410	06/02/10	DCB, AES	Richmond	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	At Richmond town garage, cannot determine connection to any outlet
RI-838	05/19/10	CED	Richmond	Catchbasin	NA	NA	NA	Dry		NA	NA	NA	NS	NS	NS	NS	
RI-854	05/18/10	CS	Richmond	Catchbasin	NA	NA	NA	Flowing		NA	NA	NA	NS	NS	NS	NS	Unable to open
RI-857	05/19/10	CED	Richmond	Catchbasin	NA	NA	NA	Dry		NA	NA	NA	NS	NS	NS	NS	
RI-893	05/18/10	CS	Richmond	Catchbasin	NA	NA	NA	Flowing		NA	NA	NA	NS	NS	NS	NS	Pipe A is flowing, pipe B is dry
RI-021	05/19/10	CED	Richmond	Culvert	Corrugated steel	96	Free flow	2		None	Sediment	None	0.0	465	0.1	Negative	Inspected end of culvert
RI-032	05/19/10	CS	Richmond	Culvert	Corrugated steel	NR	Free flow	Flowing	Stream	None	Iron staining	None	0.0	120	0.0	Negative	Culvert inlet for stream
RI-236	05/19/10	CS	Richmond	Culvert	Corrugated steel	24	Free flow	NA	Clear	None	None	None	0.1	291	0.1	NS	Culvert inlet
RI-239	05/19/10	CED	Richmond	Culvert	Corrugated steel	44	Free flow	Dry	Clear	None	Sediment	Partially filled	NS	NS	NS	NS	Inspected end of culvert
RI-241	05/19/10	CED	Richmond	Culvert	Corrugated steel	44	Free flow	Dry		None	Sediment	Partially filled	NS	NS	NS	NS	Inspected end of culvert
RI-242	05/19/10	CED	Richmond	Culvert	Corrugated steel	6	Free flow	0.5		None	None	None	0.0	399	0.1	Negative	Inspected end of culvert
RI-244	05/19/10	CED	Richmond	Culvert	Concrete	44	Free flow	Dry		None	None	Partially filled	NS	NS	NS	NS	Inspected end of culvert
RI-245	05/19/10	CED	Richmond	Culvert	Concrete	90	Partially submerged	No flow		None	None	None	NS	NS	NS	NS	Inspected end of culvert; 3 ft. of stagnant water
RI-247	05/19/10	CED	Richmond	Culvert	Corrugated steel	30	Partially submerged	3		None	None	Partially filled	0.0	216	0.1	Negative	Inspected end of culvert
RI-299	05/24/10	CED	Richmond	Culvert	Concrete	NR	Free flow	NA	Clear	None	None	None	0.0	548	0.1	NS	End of culvert
RI-754	05/18/10	CS	Richmond	Culvert	NR	NR	NR	Dry		None	None	None	NS	NS	NS	NS	
RI-400	06/02/10	DCB, AES	Richmond	Manhole	NA	NA	NA	NA		Oily	Iron staining	None	NS	10,230	0.5	Positive	At Richmond town garage
RI-003	05/19/10	DCB	Richmond	Outfall	Corrugated black plastic	18	Free flow	0.25	Rust in flow, some algae	None	Iron staining	None	0.0	6,280	0.3	Positive	Richmond town garage outfall
RI-003	06/02/10	DCB, AES	Richmond	Outfall	Corrugated black plastic	18	Free flow	0.25	Turbid	Suds	Iron staining	None	0.1	3,870	0.3	Positive	Richmond town garage outfall
RI-003	07/01/10	DCB	Richmond	Outfall	Corrugated black plastic	18	Free flow	NR	NR	NR	NR	NR	NS	NS	NS	NS	Richmond town garage outfall
RI-003	08/26/10	DCB	Richmond	Outfall	Corrugated black plastic	18	Free flow	NR	NR	NR	NR	NR	NS	NS	NS	NS	Richmond town garage outfall
RI-049	05/19/10	CS	Richmond	Outfall	Corrugated black plastic	15	Partially submerged	Dry	Dry, half filled with sediment	None	None	Partially filled	NS	NS	NS	NS	
RI-054	05/19/10	CS	Richmond	Outfall	NR	NR	Free flow	Dry		None	None	None	NS	NS	NS	NS	
RI-056	05/19/10	CED	Richmond	Outfall	Corrugated steel	30	Free flow	1		None	None	None	0.0	651	0.1	Negative	Pulsing flow
RI-059	05/19/10	CED	Richmond	Outfall	Corrugated black plastic	13	Free flow	Dry	Clear	None	None	None	NS	NS	NS	NS	
RI-086	05/19/10	DCB	Richmond	Outfall	Corrugated steel	15	Free flow	0.5	Clear	None	None	Rusted through	0.2	710	0.2	Positive (smeared)	
RI-086	06/02/10	DCB, AES	Richmond	Outfall	Corrugated metal	18	Free flow	Rusted out	Clear, no odor	Suds	None	Rusted through	0.0	NS	NS	Negative	
RI-086	07/01/10	DCB	Richmond	Outfall	Corrugated metal	NR	Free flow	Rusted out		NR	NR	Rusted through	NS	NS	NS	NS	
RI-138	05/19/10	DCB	Richmond	Outfall	Corrugated black plastic	24	Free flow	1.5	Clear	None	None	None	0.1	351	0.1	Negative	
RI-1516	05/18/10	CS	Richmond	Outfall	Corrugated steel	NR	Free flow	Dry		None	None	Crushed, corroded	NS	NS	NS	NS	
RI-213	05/19/10	CED	Richmond	Outfall	NR	NR	Free flow	0.5		NR	NR	Pipe in sections	NS	NS	NS	NS	
RI-220	05/19/10	CED	Richmond	Outfall	Concrete	18	Free flow	Trickle		None	None	Section broken off	0.0	1,933	0.2	NS	Unable to set OB pad
RI-220	07/25/10	CED, AES	Richmond	Outfall	Concrete	18	Free flow	Dry		NA	NA	NA	NS	NS	NS	NS	
RI-220	09/15/10	CED	Richmond	Outfall	Concrete	18	Free flow	NR		Suds	None	Cracking, spauling	0.0	78	0.0	NS	
RI-237	05/19/10	CS	Richmond	Outfall	Ceramic	4	Partially submerged	0.5	Clear	None	None	None	0.1	933	0.1	NS	
RI-238	05/19/10	DCB	Richmond	Outfall	Corrugated black plastic	15	Partially submerged	Dry	Dry, partially buried	None	None	Partially filled	NS	NS	NS	NS	
RI-243	05/19/10	CED	Richmond	Outfall	Corrugated steel	6	Free flow	Dry		None	Sediment	None	NS	NS	NS	NS	
RI-246	05/19/10	CED	Richmond	Outfall	Concrete	36	Free flow	1		None	None	None	0.0	299	0.1	Negative	Inspected end of culvert
RI-248	05/19/10	CED	Richmond	Outfall	Corrugated steel	30	Free flow	0.5		None	None	Segmented	0.0	366	0.2	Negative	Inspected end of culvert; series of broken pipes with flow beneath pipe
RI-249	05/19/10	CED	Richmond	Outfall	Corrugated steel	24	Partially submerged	0.5		None	Sediment	Crushed	0.0	778	0.1	Indeterminate (spots)	
RI-249	06/02/10	DCB	Richmond	Outfall	Corrugated steel	24	Free flow	0.5	Orange foam	None	Iron staining	None	0.0	NS	NS	Negative	
RI-250	05/19/10	CED	Richmond	Outfall	Corrugated steel	24	Free flow	0.5	Clear with iron deposits	None	Iron staining	None	0.0	682	0.1	Negative	Inspected end of pipe
RI-251	05/19/10	CED	Richmond	Outfall	Corrugated black plastic	8	Free flow	Dry		None	None	None	NS	NS	NS	NS	
RI-757	05/18/10	CS	Richmond	Outfall	NR	NR	NR	Dry		None	None	NR	NS	NS	NS	NS	
RI-235	05/18/10	DCB	Richmond	Stormline	NA	NA	NA	Flowing		NA	NA	Cracking	0.1	347	0.1	Pad lost	Accessed via break in stormline crossing tracks
WF-090	09/14/10	DCB, CN	Waitsfield	Catchbasin	NA	NA	NA	NA	Clear, no odor	None	None	Frame not secure	0.0	1,292	0.17	NS	In the bookstore parking lot
WF-100	09/14/10	DCB, CN	Waitsfield	Catchbasin	NA	NA	NA	NA		NA	NA	Grate rusted to frame	0.1	NS	NS	NS	Next catchbasin up from WF-080; an inflowing pipe from the direction of the movie theater was dripping and iron stained

Structure ID	Date	Inspector	Town	Structure type	Material	Diameter (in.)	Pipe position	Flow depth (in.)	Flow observation	Floatables	Deposits/ stains	Damage	Ammonia (mg/L)	Sp. conductance (µs/cm)	Fluoride (mg/L)	Optical brightener	Comments
WF-110	09/14/10	DCB, CN	Waitsfield	Culvert	Corrugated metal	NR	Free flow	Trickle	Clear, no odor	None	None	Corrosion	0.0	429	0.24	NS	
WF-010	06/04/10	CED	Waitsfield	Outfall	Steel	4	Free flow	Dripping	No odor	None	Iron staining	None	0.0	255	0.1	Negative	Pipe is downstream of Mad River Massage on left bank of Mill Brook
WF-060	06/04/10	CED	Waitsfield	Outfall	Corrugated metal	16	Free flow	Dry	None	None	None	Crushed	NS	NS	NS	NS	Appears non-functional
WF-070	06/04/10	CED	Waitsfield	Outfall	Corrugated metal	24	Free flow	Dry	None	None	None	Corrosion	NS	NS	NS	NS	
WF-080	06/04/10	CED	Waitsfield	Outfall	Corrugated metal	18	Free flow	1.0		None	Iron staining	NR	0.0	193	0.2	Negative	
WF-020	06/04/10	CED	Waitsfield	Stream	NA	NA	NA	0.5	Clear flow	Suds	NA	NA	0.0	308	0.2	Negative[1]	Sampled at foot bridge on the Mad River Path on stream near the Capels/Shupe residence. Pad had fluorescent yellow spots.
WF-030	06/04/10	CED	Waitsfield	Stream	NA	NA	NA	0.5-1.0	Clear, no odor	None	NA	NA	0.0	672	0.2	Negative	Stream flows through Baird property
WF-040	06/04/10	CED	Waitsfield	Stream	NA	NA	NA	NR		None	NA	NA	0.0	1,224	0.2	Negative	Small stream on Baird residence; sampled at confluence
WF-050	06/04/10	CED	Waitsfield	Stream	NA	NA	NA	NR	Clear, no odor	None	NA	NA	0.0	211	0.1	Pad lost	Stream flows by Full Circle Auto and a residence
WB-010	07/02/10	CED. AES	Waterbury	Catchbasin	NA	NA	NA	Dry		NA	NA	NA	NS	NS	NS	NS	
WB-020	07/02/10	CED. AES	Waterbury	Catchbasin	NA	NA	NA	Dry		NA	NA	NA	NS	NS	NS	NS	
WB-090	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	Dripping	Pipes A & C dripping	NA	NA	NA	NS	NS	NS	Negative	Unable to open grate to collect sample
WB-091	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	Wet		NA	NA	NA	0.25	244	0.0	Negative	Sampled sump
WB-091	07/28/10	CED	Waterbury	Catchbasin	NA	NA	NA	No flow		NA	NA	NA	NS	NS	NS	NS	
WB-092	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	No flow		NA	NA	NA	0.5	750	0.0	Negative	Sampled sump
WB-092	07/28/10	CED	Waterbury	Catchbasin	NA	NA	NA	No flow		NA	NA	NA	NS	NS	NS	NS	
WB-100	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA	Pipe A flowing, pipe B dry	NA	NA	NA	0.25 (pipe A)	1,407 (pipe A)	0.3 (pipe A)	Negative (pipe A)	
WB-100	07/28/10	CED	Waterbury	Catchbasin	NA	NA	NA	NA		NA	NA	NA	0.0 (pipe A)	1,373 (pipe A)	0.1 (pipe A)	NS	
WB-125	07/07/10	CED	Waterbury	Catchbasin	NA	NA	NA	Dripping	Pipe A dripping, pipe B is 2-in. diam.	NA	NA	NA	NS	NS	NS	Negative	
WB-130	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	Standing water, did not sample
WB-140	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	Standing water, did not sample
WB-150	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	Standing water, did not sample
WB-160	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	Standing water, did not sample
WB-170	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	Standing water, did not sample
WB-180	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	Standing water, did not sample
WB-190	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	Dry		NA	NA	NA	NS	NS	NS	Negative	Basin dry when OB pad retrieved (7/18/10)
WB-220	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	Standing water, did not sample
WB-230	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	Standing water, did not sample
WB-240	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	Standing water, did not sample
WB-250	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	Standing water, did not sample
WB-260	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA	Flowing	NA	NA	NA	0.0	108	0.1	Negative	
WB-270	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA	Pipe A dry, pipe B flowing	NA	NA	NA	0.0	100	0.0	Pad lost	
WB-280	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	Standing water, did not sample
WB-290	07/06/10	LR, CS	Waterbury	Catchbasin	NA	NA	NA	NA		NA	NA	NA	NS	NS	NS	Negative	Standing water, did not sample
WB-310	07/07/10	CED, AS	Waterbury	Catchbasin	NA	NA	NA	NA	Pipe A&C dry; pipe B dripping	NA	NA	NA	NS	NS	NS	Negative	
WB-340	07/07/10	CED, AS	Waterbury	Catchbasin	NA	NA	NA	NA		None	NA	None	NS	NS	NS	Negative	Standing water
WB-390	07/08/10	CED, CS	Waterbury	Catchbasin	NA	NA	NA	<0.25		None	None	NA	NS	NS	NS	Negative	On Best Western property-- did not attempt to open grate
WB-390	02/24/11	DCB	Waterbury	Catchbasin	NA	NA	NA	NA	No odor	NA	NA	NA	0.0	NR	0.1	NS	
WB-400	07/08/10	CED, CS	Waterbury	Catchbasin	NA	NA	NA	NA	No odor	NA	NA	NA	NS	NS	NS	Negative	On Best Western property, Pipe A (flowing) entering from building direction
WB-400	02/24/11	DCB	Waterbury	Catchbasin	NA	NA	NA	NA	No odor; grayish water dripping from footing drain pipe	NA	NA	NA	0.0	NR	0.5	NS	
WB-420	07/08/10	CED, CS	Waterbury	Catchbasin	NA	NA	NA	Dripping		NA	NA	NA	NS	NS	NS	Negative	Pipe A (possible underdrain) trickling; pipe B (culvert) dry
WB-070	07/07/10	CED	Waterbury	Manhole	NA	NA	NA	0.5	Pipes A & C not flowing, pipe B (old sanitary) flowing	None	None	None	0.2	1,361	0.3	Negative	
WB-430	07/08/10	CED, CS	Waterbury	Manhole	NA	NA	NA	Flowing		None	None	None	0.0	2,500	0.2	Negative	Source of flow unknown
WB-030	07/02/10	CED, AS	Waterbury	Outfall	Concrete	24	Free flow	Dripping		None	None	Cracked in segments	0.0	387	0.2	Negative	Pipe dry on 7/8/10 when OB pad retrieved
WB-040	07/02/10	CED, AS	Waterbury	Outfall	Concrete	NR	NR	No flow	No flow (standing water)	NR	NR	NR	NS	NS	NS	NS	
WB-060	07/06/10	LR, CS	Waterbury	Outfall	Corrugated black plastic	36	Free flow			None	None	None	0.25	1,405	0.3	Negative	
WB-060	07/28/10	CED	Waterbury	Outfall	Corrugated black plastic	36	Free flow			NR	NR	NR	NS	NS	NS	NS	
WB-110	07/06/10	LR, CS	Waterbury	Outfall	Corrugated black plastic	24	Free flow	Dripping		None	None	None	0.0	541	0.2	Negative	
WB-120	07/06/10	LR, CS	Waterbury	Outfall	Corrugated metal	24	Partially submerged	Dry		None	None	Crushed	NS	NS	NS	Negative	Standing water, did not sample
WB-200	07/06/10	LR, CS	Waterbury	Outfall	Corrugated black plastic	24	Free flow	Dry		None	None	None	NS	NS	NS	Indeterminate (spots)	
WB-200	07/28/10	CED	Waterbury	Outfall	Corrugated black plastic	24	Free flow	Dry		NR	NR	NR	NS	NS	NS	NS	
WB-210	07/06/10	LR, CS	Waterbury	Outfall	Corrugated metal	12	Submerged	No flow	No apparent flow, standing water	None	None	Crushed	NS	NS	NS	Negative	Standing water, did not sample
WB-296	07/07/10	CED	Waterbury	Outfall	Corrugated metal	NR	Free flow	Dripping	Drip every 10 seconds, rotten odor	None	Algae	None	0.25	335	0.2	Negative	No flow on 7/13/10
WB-296	07/28/10	CED	Waterbury	Outfall	Corrugated metal	NR	Free flow	Dry		NR	NR	NR	NS	NS	NS	NS	
WB-300	07/07/10	CED, AS	Waterbury	Outfall	Corrugated metal	24	Free flow	Dripping	Drip every 2 seconds	None	None	Crushed	0.2	577	0.3	Negative	
WB-360	07/08/10	CED, CS	Waterbury	Outfall	Concrete	10	Partially submerged	0.25	Not able to locate source of flow	None	None	Cracking, spauling	0.0	782	0.3	Negative	
WB-370	07/08/10	CED, AS	Waterbury	Outfall	Smooth plastic	18	Free flow	<0.25	Not able to locate source of flow	None	None	None	NR	929	0.1	Negative	
WB-380	07/08/10	CED, CS	Waterbury	Outfall	Concrete	24	Free flow	<0.25		None	None	Cracking, spauling	0.0	3,320	0.4	Negative	Best Western outfall
WB-380	07/28/10	CED	Waterbury	Outfall	Concrete	24	Free flow	NR		NR	NR	Cracking, spauling	NS	NS	NS	NS	
WB-380	09/15/10	CED	Waterbury	Outfall	Concrete	24	Free flow	NR		NR	NR	Cracking, spauling	0.0	2,260	0.4	NS	
WB-380	02/24/11	DCB	Waterbury	Outfall	Concrete	24	Free flow	NR	Clear, no odor	NR	NR	NR	0.0	5,140	0.3	NS	
WB-410	07/08/10	CED, AS	Waterbury	Outfall	Corrugated metal	36	Partially submerged	0.5		None	None	None	0.0	NR	NR	Negative	
WB-440	07/08/10	CED, CS	Waterbury	Outfall	Corrugated metal	12	Partially submerged	Unknown	Leaking from within pipe joint	None	None	Corrosion	0.0	925	0.3	Negative	Flow from wetland on N.E. side of car wash
WB-450	07/08/10	CED, AS	Waterbury	Outfall	Corrugated black plastic	18	Free flow	<0.25		None	None	None	0.0	182	0.1	Negative	
WB-460	07/08/10	CED, AS	Waterbury	Outfall	Corrugated black plastic	12	Free flow	<0.25	Pulsing flow	None	Iron staining	None	0.3	1,803	0.0	Negative	Ben and Jerry's facility
WB-460	07/28/10	CED	Waterbury	Outfall	Corrugated black plastic	12	Free flow	NR		NR	NR	NR	1.0	1,732	0.4	NS	Ben and Jerry's facility
WB-460	08/19/10	DCB, AS	Waterbury	Outfall	Corrugated black plastic	12	Free flow	NR		NR	NR	NR	0.4	1,870	0.3	NS	Ben and Jerry's facility
WB-470	07/08/10	CED, AS	Waterbury	Outfall	Corrugated black plastic	12	Free flow	<0.25		None	Iron staining	None	0.2	1,912	0.4	Negative	Ben and Jerry's facility
WB-470	07/28/10	CED	Waterbury	Outfall	Corrugated black plastic	12	Free flow	NR		NR	NR	NR	0.1	1,597	0.3	NS	Ben and Jerry's facility
WB-470	08/19/10	DCB, AS	Waterbury	Outfall	Corrugated black plastic	12	Free flow	NR		NR	NR	NR	0.2	1,528	0.3	NS	Ben and Jerry's facility
WB-500	09/15/10	CED	Waterbury	Outfall	Corrugated metal	18	Free flow	0.25	Clear, no odor	None	None	Corrosion	0.0	1,200	0.3	NS	Ben and Jerry's outfall

Notes: NA= Not applicable; NS = No sample; NR= Not reported

APPENDIX C: STONE STANDARD OPERATING PROCEDURES

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 autoranging 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 equipments 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-6.38.0

OPTICAL BRIGHTENER TESTING

SOP Number: SEI-6.38.0	Date Issued: 09/11/08
Revision Number: 0	Date of Revision: NA

1.0 OBJECTIVE

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

Optical brightener monitoring can be used to indicate the presence of wastewater in stormwater drainage systems, streams, and other water courses. 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 4-8 days, after which the pad is rinsed, air dried, and viewed under a long range ultraviolet 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 40 CFR Part 160, Subpart E, Section 160.81, a testing facility 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. Field notebook, sample collection form, or other acceptable medium for recording field data.
5. 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). 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.

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. When sampling culverts or stormwater outfall pipes, the pad may be attached to a rock or other heavy object placed in the end of the pipe. When placed in a culvert or outfall pipe, the pad should trail several inches from the anchor point and lie flat against the bottom surface of the pipe.

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 4-8 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 resealable bags. The sample label should indicate the monitoring point identification.

4. The pad should be gently rinsed using the monitored flow stream, cold tap water, or bottled water. Do not rinse the pad in the receiving water body. Lightly squeeze out excess water with a clean hand. Do not wring out the pad.

5. The pad should be removed from the screen envelope using scissor to cut open the envelope. 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 resealable plastic bag is used, cut the bottom corners of the bag and perforate 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 ultraviolet light (“black” 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 U.V. light.

2. There are three qualitative results: Positive, Negative, and Retest. 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 undetermined or retests. Pads may be sorted into the basic categories: positive test, negative test, and retest. 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.

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 placed in 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 specks or spots of fluorescence 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