# Detecting and Eliminating Illicit Discharges in Rutland County to Improve Water Quality

# Final Report

**March 31, 2014**

***Dye flushed down a toilet in Fair Haven discharges to the Castleton River at outfall FH280, confirming presence of a sanitary wastewater connection***



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# 1.0 INTRODUCTION

Seven towns participated in the Rutland County Illicit Discharge Detection and Elimination Project: Benson, Castleton, Fair Haven, Poultney, Proctor, Wallingford, and West Rutland (Appendix C, Map 1). The goal of the project was to improve water quality by identifying and eliminating contaminated, non-stormwater discharges entering stormwater drainage systems and discharging to the Otter Creek, the Poultney River, and their tributaries. The geographic scope included the entire extents of the municipal closed drainage systems in these towns. Prior to this assessment, the Vermont Department of Environmental Conservation (DEC) prepared stormwater infrastructure maps for all seven towns. This infrastructure mapping was used to plan the assessment in each town and to guide further investigations in systems with suspected illicit discharges.

Between April and October, 2013, Stone assessed stormwater outfalls and selected manholes and catchbasins in each participating town for the presence of illicit discharges. A total of 227 stormwater drainage systems were assessed. Field tests were performed for ammonia, total chlorine, common anionic detergents [using the methylene blue active substances (MBAS) method], and optical brighteners. Optical brighteners are fluorescent whitening dyes contained in most laundry detergents. Specific conductance was also measured.

Among the 227 stormwater drainage systems assessed, contaminants indicating a possible illicit discharge were detected in 20, one in Castleton, five in Fair Haven, one in Poultney, five in Proctor, four in Wallingford, and four in West Rutland (Table 1). There were no indications of possible illicit discharges in Benson. A letter was prepared for the Town of Benson stating that no illicit discharges were detected and thanking them for their participation.

**Table 1. Summary of stormwater drainage systems assessed in 2013**

| **Town** | **Closed Drainage Systems Assessed** | **Suspected Illicit Discharges** | **Confirmed Illicit Discharges** |
|---|---|---|---|
| Benson | 6 | 0 | 0 |
| Castleton | 26 | 1 | 0 |
| Fair Haven | 36 | 5 | 4 |
| Poultney | 16 | 1 | 1 |
| Proctor | 66 | 5 | 5 discharges in 3 systems |
| Wallingford | 13 | 4 | 3 |
| West Rutland | 64 | 4 | 1 |
| **Total** | **227** | **20** | **14** |

Following the initial assessment, investigations were conducted to verify the presence of illicit discharges in these 20 drainage systems and to attempt to determine their sources. This report presents the results of the investigation of these 20 drainage systems and the measures taken or plans made to correct the identified illicit discharges.

# 2.0 METHODS

## 2.1 Preparing for the assessment

Preparation for the illicit discharge assessment included obtaining and assembling necessary equipment and supplies; preparing a field data form (Appendix A), field maps, a Health and Safety Plan, and other documents and organizing these in a project notebook; and meeting with RNRCD and each of the participating towns to gather information and plan the project in detail. Large format field maps were prepared by overlaying DEC's stormwater infrastructure mapping on the best available orthophotography. These maps were consulted in the kickoff meetings and were annotated in the field. RNRCD arranged the kickoff meeting with each participating town. Information collected during the meetings included:

- Contact information for municipal managers and public works personnel.
- General schedules of road and wastewater and stormwater collection system projects to occur in 2013 (to avoid conflict with construction activities).
- Locations of any known, suspected, or potential cross connections, combined sewer overflows, and sanitary sewer overflows. These may be areas where complaints have been received about sewage odors or other nuisance conditions.
- In-house capabilities of the Public Works or Highway Department to inspect pipelines and perform other advanced investigation techniques.

## 2.2 Dry weather survey

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

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

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

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

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

## 2.3 Water analysis methods

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

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

**Figure 1. Optical brightener monitoring pads under UV light**

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

**Table 2. Water quality tests performed at flowing structures**

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

### 2.3.1 *E. coli* and phosphorus

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

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

**Table 3. Laboratory sample analyses**

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

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

## 2.4 Advanced investigations

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

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

**Table 4. Benchmark concentrations for determination of illicit discharges**

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

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

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

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

The following sections present the findings of illicit discharge investigations in each town. No suspected illicit discharges were identified in Benson; therefore no further investigation occurred. In Castleton, an illicit discharge was suspected in one system (CA180); however, presence of an illicit discharge was not confirmed. One or more illicit discharges were positively identified in each of the remaining towns, for a total of 14 across the participating towns (Table 1). In nearly all cases, correction of these illicit discharges is slated to occur in 2014.

# 3.0 CASTLETON RESULTS

Of the 26 stormwater drainage systems assessed in Castleton, an illicit discharge was suspected in only one, system CA180 (see description below). Through extensive bracket sampling, the apparent contamination (ammonia) in this system was determined to be of natural origin. Therefore, we found no confirmed illicit discharges in Castleton.

## System CA180

The CA180 outfall is a 36-in. diameter corrugated black plastic pipe. This system drains a series of catchbasins along South Street and an adjoining Castleton State College parking lot to the east (Appendix C, Map 2). Water quality data for this system are presented in Table 5. The outfall was flowing and discharge was clear with a musty odor when inspected on June 20, 2013. A low ammonia concentration (0.5 mg/L) was measured. The outfall pipe and the streambed below the pipe had substantial iron staining. Optical brightener was not detected at the outfall or catchbasin-CB-D, but a pad placed in catchbasin CB-E in the Castleton State College parking lot was indeterminate. Monitoring pads set on July 25, 2013 indicated no optical brightener at CB-E or at the outfall.

**Table 5. Water analysis data for outfall CA180**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 6/20/13 | Flowing | 0.5 | 1131 | 0.00 | 0.1 | Outfall and CB-D: negative<br>CB-E: indeterminate | Clear, musty odor, outfall structure iron stained |
| 7/25/13 | Flowing | -- | -- | -- | -- | Outfall and CB-E: negative | -- |
| 8/29/13 | Flowing | 0.5 | 1495 | 0.06 | 0.1 | MH-H, pipes A-E: all negative<br>CB-B and CB-D: negative | Elevated ammonia traced to wetlands |

Due to ammonia detection at the outfall, *E. coli* and total phosphorus samples were collected at the outfall and CB-E on August 6, 2013. No (zero) *E. coli* was detected at either structure. Total phosphorus concentrations at both structures were low: 28.9 µg/L at the outfall and 33.6 µg/L at CB-E.

On August 29, 2013, the source of ammonia in the system was traced to manhole MH-H (Appendix C, Map 2). All five pipes entering MH-H were sampled and ammonia was detected in pipes D and E. Pipe D drains a constructed wetland east of the parking lot. Pipe E drains a wetland between two parking lots. These wetlands were determined to be the sources of ammonia; therefore, the ammonia detected at the outfall appears to be naturally occurring. Optical brightener monitoring pads were also set throughout the system on August 29, including in all five pipes discharging to junction manhole MH-H. No optical brightener was detected on any pads. **Because no optical brightener was detected in this system, *E. coli* concentrations were below detection, and the ammonia source was determined to be natural, we do not believe an illicit discharge is present in this system. No further action is planned.**

# 4.0 FAIR HAVEN RESULTS

Of the 36 stormwater drainage systems assessed in Fair Haven, an illicit discharge was suspected in five. An Illicit discharge was definitively identified in four of these systems. The fifth system, FH080, appears to intercept a small flow of treated municipal water; however, detailed water leak detection is beyond the scope of this study.

## System FH080

The FH080 system drains This-A-Way Avenue. The outfall discharges on private property; therefore the first up-pipe catchbasin (CB-A) was assessed rather than the outfall. On May 15, 2013, a moderately high concentration of total chlorine (0.28 mg/L) was measured in CB-A. No ammonia, MBAS, or optical brightener was detected. On August 20 and August 21, 2013, low total chlorine concentrations (0.05 - 0.08 mg/L) were measured at CB-A. Three small diameter lines were found connected to this system, a 1-in. line and a 4-in. line entering CB-B and a 1-in. line entering CB-A. The 1-in. lines are likely sump pump outlets and the 4-in. line is likely a roof leader. Only the 1-in. line entering CB-A was flowing. Discharge from this line was intermittent and the flow was clear and contained no chlorine. The system was assessed again on October 22, 2013 and the chlorine concentration was below detection. Water quality data for this system are summarized in Table 6.

**Table 6. Water analysis data for outfall FH080**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 5/15/13 | Flowing | CB-A: 0.0 | CB-A: 217 | CB-A: 0.28 | CB-A: 0.0 | CB-A: negative | Clear, no odor |
| 8/20/13 | Trickle | -- | -- | CB-A: 0.05 | -- | -- | Clear, no odor |
| 8/21/13 | Trickle | CB-A: 0.0 | CB-A: 279 | CB-A: 0.08<br>CB-B: 0.03 | CB-A: 0.0 | -- | |
| 10/22/13 | Trickle | -- | -- | CB-A: 0.02 | -- | -- | Clear, no odor |

The moderately high total chlorine concentration measured on May 15, 2013 was not observed in follow-up investigation; however, we do suspect there is a water leak contributing a small flow of chlorinated water to the system. **We recommend the Town of Fair Haven perform leak detection in this vicinity.**

## System FH090

The FH090 outfall is a 6-in. diameter smooth plastic pipe. This system drains a single catchbasin in the parking area of the Fair Haven wastewater treatment plant. During the initial visit on May 8, 2013 the outfall was dripping and discharge was clear with no odor. An optical brightener monitoring pad placed at the outfall showed weak fluorescence. Optical brightener was again detected at the outfall on June 6, 2013. Water quality data for this system are presented in Table 7.

**Table 7. Water analysis data for outfall FH090**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 5/8/13 | Dripping | Insufficient flow | Insufficient flow | Insufficient flow | Insufficient flow | Outfall: positive (weak) | Clear, no odor |
| 6/6/13 | -- | -- | -- | -- | -- | Outfall: positive | -- |
| 8/27/13 | -- | -- | -- | -- | -- | CB-A: positive (spot) | -- |
| 10/2/13 | Dry | -- | -- | -- | -- | Outfall and CB-A: negative | |

During the initial investigation in this system, a utility sink in the wastewater treatment plant lab room was found to be improperly connected to the catchbasin in the parking lot. Shortly after this discovery, prior to August 27, 2013, the Town of Fair Haven removed the sink and sealed the drain (Figure 2). There do not appear to be any other direct connections to the system.

It is not certain that this sink was the source of optical brightener initially detected at the outfall. It is also possible that oil or small amounts of wastewater present on vehicles and on the road surface wash into catchbasin CB-A during rain events, although the pavement appears relatively clean. **The likelier explanation, however, is that materials washed down the sink resulted in positive optical brightener readings, and that elimination of the sink has corrected this problem. No further action is planned.**

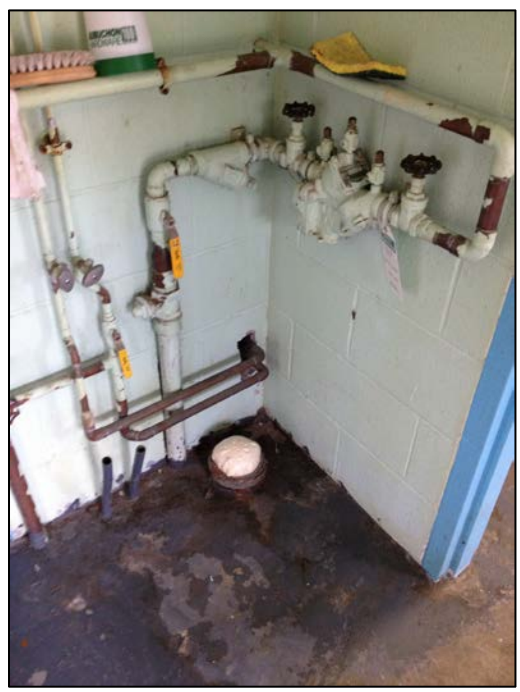

**Figure 2. Sealed utility sink drain**

## System FH240

East of the village along River Street a pipe was found discharging highly turbid water. The water had a cloudy, white appearance, similar to skim milk (Figure 3). If allowed to settle, a layer of white sediment formed on the bottom of the sample bottle. The pipe is on the north side of the Vermont Structural Slate property. We did not investigate the source because it clearly originates on private property.

When this issue was raised with Vermont DEC, Patrick Lowkes (Enforcement Division) and others clarified that DEC was already aware of the issue and was working with the facility through the MSGP process. According to Mr. Lowkes, the discharge consists of quarry hole water that is pumped periodically. **DEC is handling this issue and no action by the municipality is necessary.**

**Figure 3. Small stream receiving discharge from Vermont Structural Slate property**

## System FH280

The FH280 outfall is a 15-in. diameter corrugated steel pipe. This system drains a stream that originates east of South Main Street and enters the FH280 system west of Lee Avenue (Appendix C, Map 3). During the initial visit on May 8, 2013 the outfall was flowing and the discharge was clear with no odor. Water quality data for this outfall are presented in Table 8.

**Table 8. Water analysis data for outfall FH280**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 5/8/13 | Flowing | 0.0 | 415.0 | 0.04 | 0.1 | Outfall: positive | Clear, no odor |
| 6/6/13 | Flowing | -- | -- | -- | -- | Outfall: positive<br>Stream inlet: negative | Clear, no odor |

Optical brightener was detected in a pad set in the outfall on the initial visit. On a subsequent visit in June, 2013, optical brightener was detected at the outfall, but not at the stream inlet. Due to detection of optical brightener on multiple occasions, *E. coli* and total phosphorus samples were collected at the outfall on August 6, 2013. Moderate *E. coli* (600 MPN) and low total phosphorus (51.9 µg/L) concentrations were measured at the outfall. While it was clear that a source of optical brightener was present between the stream inlet and the outfall, the source of *E. coli* was not bracketed. Therefore, on August 22, 2013, *E. coli* samples were collected at the stream inlet (200 MPN/100 mL) and the outfall (220 MPN/100 mL). These *E. coli* levels are relatively low and also essentially identical, so they did not help isolate the source of wastewater contamination.

Investigation of the FH280 system was challenging because there is no access to the system between the stream inlet and the outfall. Many sanitary and stormwater structures depicted on old infrastructure maps do not exist or are buried. Neither the inlet nor the outfall end of the stormline is accessible for camera inspection due to drops and corrugations.

Notwithstanding these challenges, on January 21, 2014, Dave Braun and Ryan Sleeper met Bud Panoushek, Fair Haven Highway Superintendent, to dye test houses on Prospect Street. The first house tested, 12 Prospect Street, was found to have an illicit connection to system FH280. Dye added to the toilet in this house appeared in the sanitary sewer as expected but was also seen at the outfall (see cover photograph). This result suggests a badly leaking house sewer lateral. Two houses further up Prospect Street (#18 and #22) were also tested and no dye was observed at the outfall, which indicates that both house laterals as well as the sewer main on Prospect Street are not leaking. No one was home at the only other occupied house on this block, #24 Prospect Street, but this house is over 1000 feet from the FH280 line crossing. Therefore, we believe we have identified the only illicit connection to the FH280 system. **The Town of Fair Haven has agreed to take the lead in working with the property owner at 12 Prospect Street to address the leaking sewer lateral. Stone Environmental wrote a letter to the Town Manager, Herb Durfee, detailing these findings for the town to use in pursuing resolution of this matter.**

### System FH350

The FH350 outfall is an 18-in. diameter corrugated steel pipe. This system drains a series of catchbasins along South Main Street and a stream originating east of South Main Street, which enters the FH350 system by the M&B Snack Bar building (Appendix C, Map 4). During the initial visit on May 8, 2013 the outfall was flowing and discharge was clear with no odor. Water quality data for this outfall are presented in Table 9.

**Table 9. Water analysis data for outfall FH350**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 5/8/13 | Flowing | 0.3 | 110.9 | 0.02 | 0.1 | Outfall: positive (weak) | Clear, no odor. |
| 6/6/13 | Flowing | -- | -- | -- | -- | Outfall, CB-A, CB-B, CB-D, and culvert inlet: negative | -- |
| 8/20/13 | Flowing | -- | -- | -- | -- | -- | Faint laundry odor present in stream at embankment and CB-A |
| 8/22/13 | Flowing | -- | -- | -- | -- | -- | Wastewater odor detected at embankment |

A low concentration of ammonia (0.3 mg/L) was measured at the outfall during the initial visit on May 8, 2013. Optical brightener was detected on the pad set in the outfall during the same visit, although fluorescence was weak. Subsequently, on August 6, 2013, we collected an *E. coli* sample at the outfall and detected an exceedingly high concentration (> 24,200 MPN/100 mL). The total phosphorus concentration at the outfall was also elevated, 725 µg/L.

On August 22, 2013, we attempted to bracket the *E. coli* source by sampling at the outfall and in the small stream where it flows over the embankment (Appendix C, Map 4). We detected an exceedingly high *E. coli* concentration (>24,190 MPN/100 mL) at the embankment and a low concentration (70 MPN/100 mL) at the outfall.

While inspecting the FH350 system on June 6, 2013, staff scientist Dan Homeier spoke with an employee of M&B Snack Bar, who mentioned that occasionally she could smell a sewage odor wafting from the area of the stream. She suspected that a nearby house may be leaking wastewater. Corroborating this story, a wastewater odor was detected at the culvert inlet during inspection on August 20, 2013. Catchbasins CB-B and CB-C were dry on this date.

On August 21, 2013, project staff met with Town Manager Herb Durfee and Highway Superintendent Bud Panoushek to discuss suspected illicit discharges in Fair Haven. The likelihood that a failed septic system upstream of the M&B Snack Bar property is the source of *E. coli* in the stream was discussed. The elevated *E. coli* concentration detected on August 22, 2013 at the embankment supports this theory, as does the odor present in this area. Based on our inspection of aerial imagery, there appears to be only one residence upstream, at #70 South Main Street, a property just east of the American Legion building. **The Town of Fair Haven has agreed to take the lead in working with the property owner at #70 South Main Street to inspect the septic system on the property. Stone Environmental wrote a letter to Mr. Durfee detailing these findings for the town to use in pursuing resolution of this matter.**

# 5.0 POULTNEY RESULTS

Of the 16 stormwater drainage systems assessed in Poultney, an illicit discharge was suspected in only one, system PY140. Further investigation of this system confirmed the presence of an illicit discharge of sanitary wastewater in this system, but did not resolve a specific source.

## System PY140

The PY140 outfall is an 18-in. diameter corrugated steel pipe (Figure 4). This system drains a series of catchbasins on Wilson Avenue, York Street, and College Street North (Appendix C, Map 5). During our initial visit on June 19, 2013 the outfall was flowing and the discharge was clear with no odor.

**Figure 4. Outfall PY140**

Water quality data for this outfall are presented in Table 10. Optical brightener was detected in a pad set at the outfall on the initial visit, although fluorescence was weak. Monitoring pads set throughout the system on July 25, 2013 indicated presence of optical brightener only at the outfall and in a catchbasin CB-C on Branch A, although fluorescence in the catchbasin was weak. There do not appear to be any inappropriate connections in catchbasin CB-C on Branch A and we suspect this detection was a false positive reading, possibly resulting from motor oil.

**Table 10. Water analysis data for outfall PY140**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 6/19/13 | Flowing | 0.0 | 403 | 0.01 | 0.0 | Outfall: positive (weak) | Clear, no odor |
| 7/25/13 | Flowing | -- | -- | -- | -- | Outfall and Branch A CB-C: positive (weak)<br>Main line CB-C; Branch B CB-A, CB-D, and CB-I; Branch A CB- A: all negative | Clear, no odor |
| 8/20/13 | Flowing | 0.75 | -- | -- | -- | Outfall: positive<br>Structures A and B: negative | Distinct wastewater odor |
| 9/11/13 | Flowing | Structure C: 0.25<br>Outfall: 0.75 | -- | -- | -- | -- | Outfall: distinct wastewater odor<br>Structure C: clear, no odor |

On August 6, 2013, samples collected at the outfall had a high *E. coli* concentration (6,490 MPN/100 mL) and moderate total phosphorus concentration (455 µg/L). These results confirmed the presence of sanitary wastewater in the system.

On August 20, 2013, all accessible structures between York Street and the outfall were evaluated. The outfall was flowing, but there was no flow at the next accessible structure up the line (Structures B) or in manhole MH-C. Structure B is a narrow access port located in the yard of #54 York St. Extension, apparently the same structure labelled “sewer lamp hole” on 1959 plans. Consistent with the flow observations, optical brightener monitoring pads placed in Structures A and B on August 20 were negative while the pad at the outfall was positive. These results bracketed the source of contamination between Structure B and the outfall.

The PY140 stormline crosses York Street Extension in the vicinity of Boyce Street. Given the proximity to the sanitary sewer, we focused on this crossing as a likely area for a cross-connection. The sanitary manhole at the intersection of York Street Extension and Boyce Street (labeled MH A-6 on the 1959 plans) was opened; however, no irregularities were observed. A force main discharging to this manhole from a single property located due north of the intersection was dripping when inspected.

On September 11, 2013, Dave Braun worked with Wayne Tracey, Superintendent of the wastewater treatment plant, to investigate the system between Structure B and the outfall. During this visit a distinct sanitary wastewater odor was detected at the outfall. The inaccessible structure named Structure C (Appendix C, Map 5) was opened with an excavator. No wastewater odor was observed in this structure and no obvious direct connections were found. Mr. Tracey then commenced a series of dye tests of properties located on York Street Extension. Over many weeks, he reportedly dye tested all the houses on York Street Extension between Structure C and the outfall. Houses north of the Poultney Avenue intersection have onsite wastewater treatment systems. No dye was observed at the outfall in any tests.

Based on a conversation with Mr. Tracey on January 15, 2013, the Town of Poultney is apparently pursuing a stormwater project intended to alleviate drainage problems on York Street, provide stormwater treatment, and eliminate the problematic section of repurposed sanitary sewer now discharging at PY140. Mr. Tracey is considering a plan to route stormwater from roughly MH-C on York Street, down York Street to a proposed treatment pond adjacent to the wastewater treatment plant. According to Mr. Tracey, assuming the project goes forward, the problematic section of line between Structure B and the PY140 outfall will be sealed. This plan should eliminate any illicit discharge at PY140. Mr. Tracey is in discussion with an engineering firm to design the system. **Given the lack of success to date isolating the illicit discharge in the PY140 system, Stone encourages the Town of Poultney to pursue this infrastructure improvement as a solution to the illicit discharge problem.**

# 6.0 PROCTOR RESULTS

Of the 66 stormwater drainage systems assessed in Proctor, an illicit discharge was suspected in five systems. Upon further investigation, no illicit discharges were found in two of these systems (PR280 and PR 590). However, a second discharge was identified in two of the previously flagged systems (PR240 and PR390) and discharge of chlorinated water in system PR220 was confirmed, for a total of five illicit discharges identified in three stormwater drainage systems.

## System PR220

The PR220 outfall is a 28-in. diameter corrugated metal pipe. This system drains a series of catchbasins along North Grove Street. Water quality data for this outfall are presented in Table 11. The outfall was flowing and discharge was clear with no odor when inspected on April 26, 2013. A low concentration (0.09 mg/L) of total chlorine was measured.

**Table 11. Water analysis data for outfall PR220**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (μs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 4/26/13 | Flowing | 0.0 | 182.3 | 0.09 | 0.0 | Outfall: negative<br>CB-D: negative | Clear, no odor |

The source of the chlorine was determined to be a blow-off valve at a water storage tank on Olympus Road. The blow-off water was tested on August 29, 2013 and found to contain 1.3 mg/L of total chlorine (very high). The flow rate was estimated at 3 liters per second.

The Town of Proctor is well-aware of the problem at the blow-off, as is the State of Vermont, which issued an Assurance of Discontinuance to the Town related to this problem. During a September 9, 2013 meeting, the Superintendent of the Proctor Water and Sewer Department, Todd Blow, stated that the town is currently installing a new water supply well to service the town and will decommission the water tank (and blow-off valve) by the end of 2014. The Town recently issued a request for proposals for construction of the remaining water system improvements. In the meantime, due to pressure constraints on the water main, the overflow must remain open. **These water system improvements will remedy the problem, therefore no additional actions are recommended.**

## System PR240

This system drains portions of South Street, Holden Avenue, and Park Street via a stone box culvert running west from Holden Avenue beneath South Street and the La Fond's Auto building. The PR240 system was incorrectly mapped as discharging southwest of Grove Street and South Street, directly to the Otter Creek. In fact, the outfall is located behind La Fond's Auto on the west side of South Street (Appendix C, Map 6). The outfall could not be located during the initial assessment, on April 26, 2013, because it is buried in rubble; therefore the first up-pipe catchbasin (CB-J) was assessed. On this date, pipes B and C in catchbasin CB-J were flowing, while pipe A (the main line draining Holden Avenue) and pipe D (from CB-I) were not flowing. Pipes B and C were tested for optical brightener, which was detected at pipe B only (Table 12).

**Figure 5. Catchbasin CB-J in System PR240.**

**Table 12. Water analysis data for catchbasin PR240-J**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result |
|---|---|---|---|---|---|---|
| 4/26/13 | Flowing | Pipe B: 0.0<br>Pipe C: 0.0 | Pipe B: 653<br>Pipe C: 580 | Pipe B: 0.03<br>Pipe C: 0.03 | Pipe B: 0.0<br>Pipe C: 0.0 | Pipe B: positive<br>Pipe C: negative |
| 8/29/13 | Flowing<br>(pipes B and C) | Pipe B: 0.25 | Pipe B: 608 | Pipe B: 0.00 | Pipe B: 0.0 | Pipe B: positive<br>Pipe C: negative<br>MH-Q: negative |
| 9/5/13 | -- | -- | -- | -- | -- | CB-J Pipe B: positive<br>CB-K Pipe A: positive |

The outfall was located and assessed on May 3, 2013. The discharge was clear with no odor. Moderate concentrations of MBAS detergent (1.0 mg/L) and total chlorine (0.11 mg/L) were measured and optical brightener was detected at the outfall (Table 13).

**Table 13. Water analysis data for outfall PR240**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 5/3/13 | Flowing | 0.0 | 527 | 0.11 | 1.0 | Positive | Clear, no odor |

Due to positive optical brightener results at the outfall and in pipe B in catchbasin CB-J, samples were collected on August 15, 2013 for total phosphorus and *E. coli* analysis. Total phosphorus concentrations were very low at CB-J pipe B (21.1 µg/L) and pipe C (7.62 µg/L) and at the outfall (16.6 µg/L). *E. coli* concentrations were low at both pipe B (51.6 MPN/100 mL) and pipe C (108.9 MPN/100 mL). However, the *E. coli* concentration measured at the outfall was high (1,249.8 MPN/100 mL).

On September 5, 2013, we observed that the sanitary sewer line on South Street is exposed within the box culvert that runs beneath South Street. The high *E. coli* concentration at the outfall may result from a leak in the sanitary sewer line that passes through the box culvert on South Street. **Mr. Blow has agreed to inspect the sanitary sewer line on South Street near the box culvert with a sewer camera. The Town of Proctor has allocated funds to slip-line the sanitary sewer at this junction if warranted.**

Optical brightener was again detected in CB-J pipe B on September 5, 2013. Up-pipe from CB-J, CB-K pipe A also tested positive for optical brightener. We concluded there were two possible sources of the optical brightener detected at CB-K pipe A, a leak in the sanitary sewer main on Holden Avenue or one or more leaking house sewer laterals crossing the stormline. The stormline parallels the Holden Avenue sanitary sewer line and the sanitary sewer invert along Holden Avenue is relatively shallow (3-4 feet below grade), which suggests that wastewater leaking from the sanitary sewer line could migrate to the stormline between MH-Q and CB-K.

To investigate whether a house sewer lateral was responsible, dye tests and plumbing inspections were performed on January 21, 2014 at each of the three houses on the south side of Holden Avenue (#1, #3, and #11 Holden Avenue). All three houses had a single sewer pipe at the foundation penetration. No dye was observed at CB-K, CB-J, or the outfall following the dye tests. Dye was quickly observed in a sanitary manhole on Holden Avenue (Figure 6) after tests at #3 and #11, while no down-pipe sanitary manhole could be accessed for the test at #1 Holden Avenue. These results indicated that the house sewer laterals are not the source of optical brightener.

In the sanitary sewer manhole (Figure 6) opened to observe the dye tests at #3 and #11 Holden Avenue, dye was observed within the open PVC channel spanning the structure and also on the floor of the manhole. The dye appeared to flow onto the floor of the manhole from beneath the incoming PVC pipe (on left in Figure 6). It also appears that wastewater pools on the floor of the structure. This wastewater may be migrating from the manhole (and possibly other points along the vitrified clay line) to the stormline between MH-Q to CB-K. Given the substantial increase in flow along pipe A from MH-Q to CB-K, the shallow depth of the pipe, and the wastewater leak into the manhole beneath the PVC pipe, we strongly suspect that wastewater is migrating from the sewer line to the stormline on Holden Avenue.

**According to Mr. Blow, the Town of Proctor has allocated funds to slip-line the sanitary sewer on Holden Avenue if warranted.**

**Figure 6. Sanitary manhole on Holden Avenue in Proctor**

## System PR280

The PR280 outfall is an 18-in. diameter corrugated metal pipe. This system drains a catchbasin on the south side of Chatterton Park Road and discharges on the north side of the road (Appendix C, Map 7). Water quality data for this outfall are presented in Table 14. The outfall was flowing and discharge was clear with no odor when inspected on April 26, 2013. Optical brightener was detected at the outfall on April 26 and again on May 15, 2013, but the fluorescence on both pads was weak.

**Table 14. Water analysis data for outfall PR280**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (μs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 4/26/13 | Flowing | 0.0 | 457 | 0.01 | 0.0 | Outfall: positive (weak) | Clear, no odor |
| 5/15/13 | -- | -- | -- | -- | -- | Outfall: positive (weak) | -- |
| 9/5/13 | -- | -- | -- | -- | -- | Outfall: negative<br>CB-A: negative | -- |

Due to detection of optical brightener, the outfall was sampled for total phosphorus and *E. coli* on August 15, 2013. Very low concentrations of total phosphorus (4.43 μg/L) and no *E. coli* (0 MPN/100 mL) were found. Pads set on September 5, 2013 in the outfall and in catchbasin CB-A (the only surface inlet) indicated no optical brightener. There are no visible pipes entering catchbasin CB- A. These findings, in conjunction with the very low total phosphorus concentration and no *E. coli*, suggest that the original source of optical brightener was either transient or that the detection (reported as weak) was false. **No further action is planned.**

## System PR390

The PR390 outfall is a large concrete tunnel. The system drains the southern (Branch 1) and western (Branch 2) portions of Main Street and extends south of Main Street to include Church Street (Appendix C, Map 8). A large pond west of the village drains into Branch 2, contributing substantial dry weather flow. The outfall was flowing when originally assessed on May 1, 2013. On this date, low total chlorine concentrations were found in the first catchbasin (CB-A) off Branch 1 and in manhole MH-H on Cliff Street (Table 15). A low MBAS detergent concentration (0.25 mg/L) was also found in MH-H. Optical brightener was also found in two catchbasins along Branch 1, CB-C1 and CB-F2, although fluorescence was weak or spotty.

Optical brightener was detected in catchbasins CB-L and CB-M on the second lateral off Branch 2. The fluorescence was strong. These structures are located in the driveway (CB-L) and yard (CB-M) of an Omya building.

**Table 15. Water analysis data for the PR390 system**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result |
|---|---|---|---|---|---|---|
| 5/1/13 | Flowing | CB-A, pipe B: 0.0<br>MH-H: 0.0 | CB-A, pipe B: 1,076<br>MH-H: 2,670 | CB-A, pipe B: 0.08<br>MH-H: 0.06 | CB-A, pipe B: 0.0<br>MH-H: 0.25 | CB-C1: positive (spot)<br>CB-F2: positive (weak)<br>CB-L: positive<br>CB-M: positive |
| 9/5/13 | Flowing | -- | -- | -- | -- | MH-I (above CB-K): positive<br>CB-C: negative<br>CB-F: negative<br>CB-L: positive<br>CB-M: positive<br>Omya portico: positive |

Due to detection of optical brightener in catchbasins CB-L and CB-M, total phosphorus and *E. coli* samples were collected on August 15, 2013 from pipe A in catchbasin CB-K (the pipe leading from the driveway of the Omya building). Elevated total phosphorus (402.5 µg/L) and very high *E. coli (*15,531 MPN/100 mL) concentrations were measured. On this date, the laterals off Branch 1 were dry.

On September 5, 2013 pads were placed in structures CB-C and CB-F, and no optical brightener was detected. The weak and spotty fluorescence observed on pads placed in CB-C1 and CB-F2 in May are believed to have been false detections, likely resulting from seal coating a parking area draining to CB-F2 and dumpster juice entering CB-C1. On all subsequent visits the CB-C1 and CB-F2 catchbasins have not been flowing.

Strong fluorescence was observed on pads placed in CB-L and CB-M on September 5, 2013, as well as in the inlet on the west side of the Omya building (the "portico drain"). The portico drain is connected to catchbasin CB-M and this pipe appears to be the source of wastewater entering the storm drain. The next structure up-pipe from the portico drain, on the south side of the Omya building, was not flowing and optical brightener was not detected in this structure.

During our September 26, 2013 meeting, Todd Blow indicated that a sanitary sewer line runs beneath the Omya building. The connection between this sewer line and the stormline on the south and west sides of the building (which connects the catchbasin behind the building to the portico drain) is not clear. However, it is clear that wastewater crosses from the sanitary system to the stormwater system on the west side of the Omya building. **Regardless of the exact connection(s), Mr. Blow stated that he intended to have the old sanitary sewer slip-lined and the antiquated sewer manholes sealed with shotcrete. This work was reportedly completed in December 2013. The results of this assessment were used to demonstrate the need to rehabilitate this line.**

On September 5, 2013, optical brightener was also detected in manhole MH-I on the main line up-pipe from catchbasin CB-K. The detection of optical brightener at MH-I came late in our assessment. On September 26, 2013, optical brightener monitoring pads were deployed throughout the PR390 system up-pipe of MH-I to bracket the source of optical brightener detected in MH-I. In catchbasin CB-N, we observed a slight wastewater odor and a suspicious pipe discharging to the basin from the direction of the sanitary sewer main. By placing pads in catchbasin CB-N above, below, and within this pipe, we confirmed that the pipe in question is the source of optical brightener. The pipe invert had a grayish film, presumably due to bacterial or fungal growth fed by the wastewater stream, but no wastewater solids were observed. The pipe outlet is quite deep and there are no apparent surface inlets. It is possible that this is an abandoned sewer line, and that wastewater is infiltrating the line from a leak in the active sanitary sewer. **The Town of Proctor has been notified of this finding; however no plan to resolve the matter has been discussed to date. A meeting with the Town of Proctor's new Public Works Director is planned for May, 2014, to clarify the source of this discharge and pursue its elimination.**

### System PR590

The PR590 outfall is a 6-in. diameter smooth plastic pipe. The system drains one catchbasin (CB-A) and a footing drain behind the Union Church on Church Street (Appendix C, Map 9). The outfall was dripping when originally inspected on May 7, 2013. The discharge was clear and had no odor. On this visit a low concentration of ammonia (0.25 mg/L) was measured and optical brightener was detected. Water quality data for this outfall are presented in Table 16.

**Table 16. Water analysis data for outfall PR590**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (μs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 5/7/13 | Dripping | 0.25 | 1,047 | 0.04 | 0.1 | Outfall: positive | Clear, no odor |
| 9/5/13 | Dripping | -- | -- | -- | -- | Outfall: negative<br>CB-A top pipe: negative<br>CB-A bottom pipe: negative | -- |

Due to the apparent detection of optical brightener at the outfall, total phosphorus and *E. coli* samples were collected on August 15, 2013. A very low total phosphorus concentration (16.3 μg/L) was measured and no *E. coli* were present (0 MPN/100 mL). No optical brightener was detected at the outfall or in the up-pipe catchbasin (CB-A) during a visit on September 5, 2013. Because repeated testing of this system did not indicate a wastewater or washwater source, the initial detection of optical brightener was likely a false reading. **No further action is planned.**

# 7.0 WALLINGFORD RESULTS

Of the 13 stormwater drainage systems assessed in Wallingford, an illicit discharge was suspected in four. Upon further investigation, no illicit discharges were found in one of these systems (WA050). A past or present illicit discharge was identified in the three remaining systems.

## Systems WA040

Figure 7. Seep in area of former mill building in Wallingford

The WA040 system consists of the remains of an abandoned combined sewer line (Appendix C, Map 10). No known structures drain via this abandoned line. The mapped outfall does not exist; however there is a large concrete structure in the vicinity of the mapped outfall that appears to have been a water control structure for an old mill (Figure 7). Groundwater surfaces in the vicinity of the concrete structure. When originally assessed on May 17, 2013, a low ammonia concentration (0.5 mg/L) was measured and optical brightener was detected in the seep (Table 17). The surfacing flow had a musty odor and substantial iron floc floating throughout.

**Table 17. Water analysis data for outfall WA040**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 5/17/13 | Flowing | 0.5 | 683 | 0.02 | 0.0 | Seep: positive | Musty odor, iron floc |
| 8/2/13 | -- | -- | -- | -- | -- | Seep: positive | -- |

On June 13, 2013 monitoring pads were placed in all the structures in the WA060 system in case an illicit discharge in that system was making its way into the WA040 system (Appendix C, Map 10). No optical brightener was detected in any of these structures. On August 2, 2013 optical brightener was again detected in the seep. Due to detection of optical brightener, the seep was sampled for total phosphorus and *E. coli* analyses on August 6, 2013. Low total phosphorus (278 µg/L) and *E. coli* (50 MPN/100 mL) concentrations were found.

An explanation for the presence of optical brightener in the seep was provided by town officials (Julie Sharon and Maureen Duchesne) in a meeting held on August 21, 2013. Apparently a telephone company punctured the sewer main on Railroad Street when installing a pole in May 2013, just before our monitoring in Wallingford began. The optical brightener detected may have resulted from wastewater leaking from the broken line. The town reportedly repaired the break within 48 hours. Since our August 21 meeting, the town inspected the sanitary sewer line with a camera and found the repair to be in good condition. **No further action is needed.**

The catchbasin labeled CB-A on Appendix C, Map 10 was mapped as connected to the WA040 outfall; however, this catchbasin is part of the WA060 system. A broken vitrified clay sanitary sewer line passes through CB-A. Historically, the line appears to have discharged to sanitary manhole MH-A. Within catchbasin CB-A, this vitrified clay line is entirely plugged with sand and gravel. **As a precaution against any future discharge from this potential cross connection, we recommended the town cut out the section of pipe passing through CB-A and then grout the pipe stubs, which they agreed to do.**

## System WA050

The WA050 outfall is a 24-in. diameter corrugated metal pipe. The system drains the catchbasins on the south side of Depot Street (Appendix C, Map 10). Note that a pipe in WA060 CB-A appears connected to WA050 CB-A, but there is no actual connection. The outfall was dripping when originally inspected on May 18, 2013. The discharge had a sheen but no odor. Optical brightener was detected at the outfall, although fluorescence was weak. On two subsequent visits, one in June and one in August, no optical brightener was detected. Water quality data are presented in Table 18.

**Table 18. Water analysis data for outfall WA050**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | OB Result |
|---|---|---|
| 5/18/13 | Dripping | Outfall: positive (weak) |
| 6/13/13 | -- | Outfall and CB-A through CB-F: all negative |
| 8/2/13 | -- | Outfall: negative |
| 8/6/13 | Dry | -- |
| 8/20/13 | Dry | -- |

The outfall was dry when visited on August 6 and 20, 2013. On August 20, we inspected all the connected catchbasins and found nothing out of the ordinary. The entire drainage system appears higher in elevation than the sanitary sewer line on Railroad Street. Considering that optical brightener was not detected in any of the connected structures in June and there appear to be no abnormal connections within the catchbasins, we have concluded that the original detection of optical brightener was either false or possibly associated with the sanitary sewer break described in the proceeding section. **No further action is needed.**

## System WA080

The WA080 outfall is a 12-in. diameter concrete pipe. The system drains the cemetery pond on the east side of South Main Street. The outfall was flowing when originally inspected on May 21, 2013. The discharge was clear with no odor. Water quality data for this outfall are presented in Table 19. A low total chlorine concentration (0.10 mg/L) was detected during this visit. Low concentrations of chlorine were since detected at the outfall on two occasions.

**Table 19. Water analysis data for outfall WA080**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 5/21/13 | Flowing | 0.0 | 180.9 | 0.10 | 0.0 | Negative | Clear, no odor |

During our August 21, 2013 meeting, town officials stated they were investigating a substantial water leak on South Main Street. Leak detection work has commenced. This leak is the likely cause of the chlorine detected at the outfall. **The Town of Wallingford is actively pursuing correction of this water leak.**

## System WA090

The WA090 system drains a series of catchbasins along South Main Street south of Mill Street (Appendix C, Map 11). The eastern branch of the system drains catchbasins on Church Street. All dry weather flow to this eastern branch is from a spring-fed stream originating north of Church Street. The stream flows through a culvert under Church Street, flows a short distance into another culvert that crosses behind two houses, daylights in an ornamental pool behind the Stone Shop, flows over a weir into a box culvert beneath the Stone Shop, daylights in the front yard of the Stone Shop, and flows in an open channel a short distance to an inlet under South Main Street.

The outfall was flowing when originally inspected on May 22, 2103. The discharge was clear with no odor. On this date, moderate chlorine (0.26 mg/L) and low MBAS detergent (0.15 mg/L) concentrations were measured (Table 20). Optical brightener was detected at catchbasin CB-A. On August 6, 2013, total phosphorus and *E. coli* samples were collected from the box culvert outlet. Low total phosphorus (19.2 µg/L) and moderate *E. coli* (350 MPN/100 mL) concentrations were found.

**Table 20. Water analysis data for outfall WA090**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result |
|---|---|---|---|---|---|---|
| 5/22/13 | Flowing | 0.0 | 256 | 0.26 | 0.15 | CB-A: positive |
| 6/13/13 | Flowing | -- | -- | -- | -- | CB-A through CB-C: positive<br>CB-D through CB-I: negative |
| 8/2/13 | Flowing | -- | -- | -- | -- | CB-A and CB-C: negative<br>CB-B and box culvert: positive (strong) |
| 8/28/13 | Flowing | -- | -- | -- | -- | WA100: negative<br>Box culvert: positive |

Subsequent optical brightener testing has yielded somewhat contradictory results; however, the results that have been entirely consistent are repeated detection of optical brightener at CB-B and at the outlet of the box culvert in the front yard of the Stone Shop. No optical brightener was detected at WA100, the road culvert beneath Church Street (Appendix C, Map 11). The furthest upstream that optical brightener was detected is the point where the box culvert daylights in the front yard of the Stone Shop. No pipes are visible in the open channel section between WA100 and the box culvert inlet behind #56 Church Street. Therefore, the source of the optical brightener was determined to lie within the box culvert.

When this system was observed on August 20, 2013, a laundry odor was detected at both the inlet and the outlet of the box culvert. The odor was strongest emanating from the open end of the box culvert inlet. On this date, Dave Braun met the owner of Vermont Handmade, who claims to have observed detergent suds in the ornamental pool in the back of the business and its connected residence. The owner of the property believes an upstream neighbor is discharging detergent to the stream.

There are four properties that could conceivably have a plumbing connection to this stream: the Vermont Handmade store (the “Stone Shop”), the church at the corner of South Main Street and Church Street, and two private residences on Church Street (#46 and #56). The reported observations of detergent suds in the ornamental pool suggest the source of detergents is upstream of the Vermont Handmade property. The church is unlikely to have a washing machine. Finally, the house at #46 Church Street was in foreclosure and empty since July 26, 2013 or earlier, according to Maureen Duchesne, manager of the Wallingford Fire District 1. #46 Church Street cannot be the source of the optical brightener because optical brightener was detected in pads deployed August 20-27, 2013, more than three weeks after #46 Church Street was vacated. The observation of a strong laundry odor at the box culvert inlet on August 20, 2013 also indicates detergent discharge well after #46 Church Street was vacated.

By a process of elimination, #56 Church Street was identified as the likely source of optical brightener. We recommended the Town compel the owner of the house to have the wastewater piping in this house inspected, particularly the plumbing connections for the washing machine. We sent a letter to the town detailing the relevant findings for the town to use in resolving of this matter. The Wallingford Select Board contacted the owner of #56 Church Street to pursue resolution of this issue.

The Wallingford Town Administrator, Sandi Switzer, has been in regular contact with the homeowner of #56 Church Street. The homeowner reportedly scheduled a plumbing inspection on several dates, but no inspection was performed. Most recently, on January 22, 2014, Ms. Switzer clarified that the home has an onsite wastewater treatment system, and the homeowner is making arrangements with Wallingford Fire District 1 (Maureeen Duchesne) to connect to the sanitary sewer system in the spring of 2014. **We expect that connection of this home to the sanitary sewer will eliminate the illicit discharge of laundry detergent to the stream, and will likely reduce the elevated *E. coli* concentration measured as well.**

# 8.0 WEST RUTLAND RESULTS

Of the 64 stormwater drainage systems assessed in West Rutland, an illicit discharge was suspected in four. Upon further investigation, no illicit discharges were found in three of these systems. Only system WR460 had a confirmed illicit discharge and this has reportedly been resolved.

## System WR170

The WR170 outfall is a 24-in. diameter corrugated black plastic pipe. The system drains one catchbasin on Thrall Avenue and a series of catchbasins on Marble Street (Appendix C, Map 12). The outfall was dripping when originally inspected on April 25, 2013. On this visit, very low levels of ammonia (0.25 mg/L), total chlorine (0.05 mg/L), and MBAS detergents (0.25 mg/L) were detected. No optical brightener was detected. The discharge was clear with no odor. Water quality data for this outfall are presented in Table 21.

**Table 21. Water analysis data for outfall WR170**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 4/25/13 | Dripping | 0.25 | 781 | 0.05 | 0.25 | Outfall: negative | Clear, no odor |
| 5/15/13 | -- | -- | -- | -- | -- | Outfall: negative<br>CB-A through CB-J: negative | -- |
| 9/5/13 | Outfall: flowing<br>CB-B: outlet trickling<br>CB-C: no flow | 0.1 | 143.4 | 0.83, 0.07 | 0.2 | -- | -- |
| 9/26/13 | Dry | -- | -- | -- | -- | -- | -- |
| 10/8/13 | Trickle | -- | -- | 0.05 | -- | -- | -- |

Concentrations of total phosphorus (28.9 µg/L) and *E. coli* (156.3 MPN/100 mL) were low in samples collected on August 15, 2013. The outfall was dry on several other occasions.

During a visit on September 5, 2013, total chlorine was detected at the outfall; concentrations in samples collected 30 minutes apart were 0.83 mg/L and 0.07 mg/L. A small trickle of flow appeared to enter the stormline between catchbasins CB-B and CB-A; CB-C was not flowing.

We inspected the system with West Rutland's wastewater superintendent, Ed Savage, on September 26, 2013 and found the system dry. Mr. Savage speculated that a water service line (or valve) to a house at the corner of Marble Street and Thrall Avenue might be leaking. A final sample collected on October 8, 2013 had a total chlorine concentration of 0.05 mg/L (approximately the limit of detection) and the flow rate was miniscule. These results did not confirm the presence of an illicit discharge, although it is possible that a water leak is being intercepted by the stormwater line under certain conditions. **The Town will pursue further investigation (leak detection) if it deems the issue to be significant.**

## System WR280

The WR280 outfall is a 36-in. diameter corrugated black plastic pipe. The system drains two catchbasins on the southwest side of Main Street and an inlet on Route 4 (Appendix C, Map 13). The outfall was flowing when originally inspected on April 25, 2013. The discharge was clear, with no odor. Water quality data for this system are presented in Table 22.

**Table 22. Water analysis data for outfall WR280**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 4/25/13 | Flowing | -- | -- | -- | -- | CB-A: indeterminate (red) | Clear, no odor |
| 5/15/13 | Flowing | -- | -- | -- | -- | CB-A: negative<br>CB-B and outfall: indeterminate (red) | -- |
| 8/21/13 | Flowing | CB-A: 0.0 | CB-A: 176.4 | CB-A: 0.05 | CB-A: 0.0 | CB-A: negative | -- |

Optical brightener monitoring of this system has yielded anomalous results. On two occasions, in April and in May, a strong red fluorescence was observed on pads placed in the outfall. Due to the anomalous red fluorescence, samples were collected on August 15, 2013 for total phosphorus and *E. coli* analysis. A low total phosphorus concentration (165 µg/L) was measured. However, the *E. coli* level was elevated (544.8 MPN/100 mL). On August 21, 2013 the site was revisited and no optical brightener was detected.

On September 5, 2013 Dave Braun met with the owners of the houses located immediately north and south of the WR280 system. Both homeowners claimed to have no connections to the storm drain and no inlets in their yards. Visual inspection approximately 25 feet up the pipe revealed no inlets. However, there is considerable sediment and detritus in this pipe. Having no other explanation, we speculate that the elevated *E. coli* levels and possibly the red fluorescence may result from animal activity in this large pipe. **No further action is planned.**

## System WR360

The WR360 outfall is a 12-in. diameter corrugated metal pipe. The system drains two catchbasins in the parking lot of the Stewart's gas station on Main Street (Appendix C, Map 14). The outfall was dripping when originally inspected on April 25, 2013. The discharge was clear, with no odor. Water quality data for this outfall are presented in Table 23.

**Table 23. Water analysis data for outfall WR360**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result |
|---|---|---|---|---|---|---|
| 4/25/13 | Dripping | Insufficient flow | Insufficient flow | Insufficient flow | Insufficient flow | Outfall: positive |
| 5/15/13 | -- | Insufficient flow | Insufficient flow | Insufficient flow | Insufficient flow | Outfall and CB-B: positive<br>CB-A: negative |

Optical brightener was detected at the outfall in April, 2013. Monitoring pads set at the outfall and CB-B on May 15, 2013 both indicated that optical brightener was present. Further inspection of the system on August 21, 2013 revealed no irregularities throughout the system. However, suspecting Stewart's employees were dumping mop water into catchbasin CB-B, Dave Braun spoke with the Stewart's store manager about advising employees not to dispose of mop water in the catchbasins. On a subsequent visit on September 5, 2013, Dave Braun spoke with an employee who said she had recently dumped mop water into catchbasin CB-B and had not gotten the message from the store manager. **In communication with the Town of West Rutland and the store manager, Stone installed a metal marker on the catchbasin grate to remind Stewarts' employees not to discharge wastes to the basin (Figure 8). No further action is planned.**


**Figure 8. Catchbasin grate (CB-B) with "No Dumping" placard**

### System WR460

The WR460 outfall is a 15-in. diameter corrugated metal pipe. The system drains one catchbasin on Tower Lane (Appendix C, Map 15). The outfall was flowing when originally inspected on April 26, 2013. The discharge was clear, with no odor. Water quality data for this system are presented in Table 24.

**Table 24. Water analysis data for outfall WR460**

| Date assessed | Dry, Wet/no flow, Dripping, or Flowing? | Ammonia (mg/L) | Sp. conductance (μs/cm) | Total chlorine (mg/L) | MBAS (mg/L) | OB Result | Observations |
|---|---|---|---|---|---|---|---|
| 4/26/13 | Flowing | 0.0 | 1239 | 0.00 | 0.1 | Outfall: positive | Clear, no odor |
| 5/15/13 | -- | -- | - | -- | -- | Outfall and CB-A: negative | -- |
| 8/21/13 | -- | -- | -- | -- | -- | Outfall and CB-A: negative | -- |

Optical brightener was detected at the outfall during the initial visit in April but was not detected subsequently. Further inspection of the system on August 21, 2013 revealed no intersecting pipes, infiltration, or potential for contamination from the sanitary sewer line. The sanitary sewer line is at least three feet deeper than the WR460 system. Therefore, we have concluded that the initial detection of optical brightener was false and that this system is not contaminated with wastewater or washwater. **No further action is planned.**

# 9.0 SUMMARY OF INVESTIGATED DISCHARGES

A thorough assessment was made of the stormwater drainage systems in Benson, Castleton, Fair Haven, Poultney, Proctor, Wallingford, and West Rutland for the presence of illicit discharges. A total of 227 systems were assessed in these towns. Based on water quality data and our observations during the dry weather surveys, 20 systems were designated as warranting further investigation due to suspected illicit discharges. Further investigation of these drainage systems confirmed 14 illicit discharges in 12 stormwater drainage systems. No illicit discharges were confirmed in the remaining systems.

Plans are in place to correct the majority of the illicit discharges identified in this report and two have already been addressed. The illicit discharges identified through this project are summarized as follows, together with the current plans to resolve them.

- Systems PR280 and PR590 in Proctor, WA050 in Wallingford, and WR280 and WR460 in West Rutland do not appear to have illicit discharges. Optical brightener detected at the outfalls of these systems was likely due to false positive readings or transient sources.
- System CA180 in Castleton does not appear to receive an illicit discharge. Ammonia detected at the outfall appears to be naturally occurring.
- There are four systems that appear to discharge treated municipal water.

- System FH080 in Fair Haven appears to discharge a small flow of chlorinated water. We recommend the Town of Fair Haven perform leak detection on the water line.
- System PR220 in Proctor receives a large flow of chlorinated water from a blow-off valve on a municipal water storage tank. The Town of Proctor will decommission the tank and blow-off when the municipal well water supply becomes operational in 2014. There is no immediate solution.
- Elevated total chlorine concentrations in WA080 in Wallingford are likely due to a water main leak on South Main Street. The Town of Wallingford is attempting to locate and fix the water leak.
- System WR170 in West Rutland appears to have an intermittent discharge of chlorinated water. The outfall is usually dry and the flow was miniscule on the dates chlorine was detected. The Town is aware of this finding.

- There are seven systems that appear to discharge, or formerly discharged, sanitary wastewater:
  - System FH280 in Fair Haven receives sanitary wastewater from a single house located at #12 Prospect Street, presumably due to a leaking sewer lateral. The Town of Fair Haven has taken the lead in resolving the matter with the property owner.
  - System FH350 in Fair Haven and System WA090 in Wallingford appear to receive effluent from malfunctioning septic systems. Both towns are working with the affected property owner to resolve the matter. In the WA090 system, the plan is to connect the house to the town sewer.
  - Systems PR240 and PR390 in Proctor each appear to receive wastewater from two distinct sources. The Town of Proctor has committed to rehabilitating sections of sanitary sewer that are suspected of leaking. A section of sanitary sewer beneath an OMYA building in the PR390 system was slip-lined in December, 2013.
  - System PY140 in Poultney receives sanitary wastewater although the source has not been identified. The Town is now planning to eliminate the problematic section of stormdrain and reroute stormwater to a new treatment pond.
  - In System WA040 in Wallingford, optical brightener detected in a seep in the location of the mapped outfall is likely the result of a wastewater leak that occurred when the sewer main on Railroad Street was broken this past spring. The sewer main was fixed within days of the break. Camera inspection of this sewer main does not show other failures.
- There are two systems that formerly discharged washwater and the contamination sources have been eliminated.
  - System FH090 received washwater from an inappropriately connected sink at the Fair Haven wastewater treatment plant. The sink has been removed and the pipe opening sealed.
  - Contamination of System WR360 resulted from regular dumping of mop water into a catchbasin in the Stewart’s parking lot. This problem has been discussed with the store manager who indicated she would tell her employees to stop dumping in the basin.

Stone installed a marker on the grate to remind employees not to dump wastes into the basin.

- System FH240 in Fair Haven discharges sediment-laden water from the Vermont Structural Slate property. Vermont DEC is aware of this issue and is working with the facility through the MSGP program.

# 10.0 PHOSPHORUS LOADING ESTIMATES

Estimation of phosphors load reductions due to elimination of illicit discharges was not possible in most cases because repairs are pending. Projections were made for the three single family homes found to have mis-connected sewer laterals or malfunctioning septic systems, based on literature values for phosphorus excretion. Table 25 summarizes potential phosphorus loading reductions for the illicit discharges identified in this project.

**Table 25. Estimated phosphorus reductions for selected discharges**

| System | Type of discharge | Potential P reduction |
|---|---|---|
| FH280, FH350, WA090 | Three single family home connections | Assuming occupancy of each home by 3 people, the potential P reduction from eliminating these discharges is:<br>2 g /P/capita/day[1]<br>x 3 residents/home<br>x 3 homes<br>x 365 day/year<br>**= 6.6 kg P/year** |
| PR240, PR390 (two), and PY140 | Leaks or cross-connections in municipal wastewater collection systems | Elimination of these discharges is pending; therefore no post-repair phosphorus concentration data are available. |
| FH080, PR220, WA080, WR170 | Four municipal water leaks | If corrected, P reduction assumed to be negligible |
| FH090 | Improperly connected sink eliminated | P reduction assumed to be negligible |
| FH240 | Discharge from Vermont Structural Slate | P reduction not estimated |
| WR360 | Mop water discharge discontinued | P reduction assumed to be negligible |

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

# APPENDIX A: ASSESSMENT DATA FORM

## Rutland County IDDE Project Assessment Data Form

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

# APPENDIX B: STONE ENVIRONMENTAL INC. SOPS

## STANDARD OPERATING PROCEDURE

## SEI-5.23.3

# *MAINTENANCE AND CALIBRATION OF THE pH/CON 10 METER*

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

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

## 1.0 OBJECTIVE

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

## 2.0 POLICIES

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

## 3.0 SAFETY ISSUES

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

## 4.0 PROCEDURES

### 4.1 Equipment and Materials

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

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

3. Clean beakers or other appropriate containers

4. Log or other appropriate medium to record calibration.

### 4.2 Meter Set-up and Conditioning

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

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

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

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

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

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

### 4.3 pH Calibration

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

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

3. Dip the probe into the calibration buffer. The end of the probe must be completely immersed into the buffer. Stir the probe gently to create a homogeneous buffer solution. Tap probe to remove any air bubbles.
4. Press CAL/MEAS to enter pH calibration mode. The primary display will show the measured reading while the smaller secondary display will indicate the pH standard buffer solution.
5. Press  or  keys to scroll up or down until the secondary display value is the same as the pH buffer value (pH 4.00, 7.00 or 10.00).
6. Wait for the measured pH value to stabilize. The READY indicator will display when the reading stabilizes. After the READY indicator turns on, press ENTER to confirm calibration. A confirming indicator (CON) flashes and disappears. The meter is now calibrated at the buffer indicated in the secondary display.
7. Repeat steps 3, 5, and 6 using a second or third pH standard.
8. Press CAL/MEAS to return to pH measurement mode.

### 4.4 Conductivity Calibration

1. Select a conductivity standard with a value near the sample value expected. The meter should be calibrated by the user(s) at the beginning of each day of use.
2. Pour out two separate portions of your calibration standard and one of deionized water into separate clean containers.
3. Press MODE key to select Conductivity. The ΦS or mS indicator will appear on the right side of the display.
4. Rinse the probe with deionized water, and then rinse the probe in one of the portions of calibration standard. Record the calibration standard on the per use maintenance form or other appropriate medium.
5. Immerse the probe into the second portion of calibration standard. The meter♣s 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 equipment maintenance log for regular use maintenance needs. Any maintenance must include documentation of whether the maintenance was routine and followed the SOP or not.

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

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

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

## 5.0 RESPONSIBILITIES

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

## 6.0 DEFINITIONS

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

## 7.0 REFERENCES

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

## 8.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

None

## 9.0 AUTHORIZATION

Revised by:______________________________________ Date:_____________

Michael Nuss, Staff Scientist

Approved by:______________________________________ Date:_____________

Christopher T. Stone, President

## 10.0 REVISION HISTORY

Revision number 1:

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

Revision number 2:

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

Revision number 3:

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

## STANDARD OPERATING PROCEDURE

## SEI-6.38.1

# *OPTICAL BRIGHTENER TESTING*

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

## 1.0 OBJECTIVE

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

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

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

## 2.0 POLICIES

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

## 3.0 SAFETY ISSUES

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

## 4.0 PROCEDURES

### 4.1 Equipment and Materials

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

### 4.2 Sampling Procedure and Sample Handling

#### *4.2.1 Optical Brightener Pad Assembly*

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

#### *4.2.2 Optical Brightener Pad Placement*

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

2. If a suitable anchor is not present, a heavy object may be placed in the flow stream or channel to anchor the pad. For example, a pad may be anchored in a stream by tying it to a concrete block.
3. Two or more optical brightener monitoring pads may be placed at monitoring points if appropriate. If more than a single pad is used, the pads should be anchored so that they do not become entangled.
4. Record the date each pad is deployed and any other relevant information in a field logbook or on a specified sample collection form.

#### *4.2.3 Optical Brightener Pad Retrieval and Handling*

1. After a 4-10 day period of exposure, optical brightener pads should be collected. The collection of each pad should be recorded in a field logbook or on a specified sample collection form.
2. Any object inserted in a pipe or other structure to anchor the pad should be removed.
3. Pads should be placed in individually labeled resealable plastic bags. The sample label should indicate the monitoring point identification.
4. The pad should be removed from the screen envelope using scissors to cut open the envelope. The pad should be gently rinsed using cold tap water. Lightly squeeze out excess water with a clean hand. Do not wring out the pad. When processing the pads be aware that you may spread dye from one pad to another with your hands. Wear disposable gloves.
5. The pad should then be returned immediately to the labeled bag.
6. Pads should be air dried. The pad may be hung on a line to dry within the labeled bag. If a resealable plastic bag is used, cut the bottom corners of the bag to allow airflow to the pad.

### 4.3 Optical Brightener Analysis

1. When the pad is dry, expose the pad under a high quality long range UV light in a room that is completely dark. A non-exposed and an exposed pad are used as controls and compared to each test pad as it is exposed to the UV light.
2. There are three qualitative results: Positive, Negative, and Indeterminate. A pad will very definitely glow (fluoresce) if it is positive. If it is negative it will be noticeably drab and similar to the control pad. All other tests are indeterminate. Pads may be sorted into the basic categories: positive test, negative test, and indeterminate. Further, for positive tests, the pads may be sorted into categories by the relative strength of the fluorescence. A pad that is fluoresces brightly over most or all of its surface may be considered a strongly positive test, whereas a pad on which fluorescence appears patchy or faint may be considered a weakly positive test. Indeterminate results generally dictate that the test be repeated.
3. In some instances, only a portion of the pad or simply the outer edge will fluoresce after being exposed to optical brightener. This can be caused by many factors but is usually the result of an uneven exposure to the dye in the flow stream due to sedimentation or the way the pad was

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

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

## 5.0 RESPONSIBILITIES

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

## 6.0 DEFINITIONS

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

## 7.0 REFERENCES

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

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

## 8.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

None

## 9.0 AUTHORIZATION

Revised by:_______________________________________ Date:_____________

Dave Braun, Project Scientist/Water Quality Specialist

Approved by:______________________________________ Date:_____________

Christopher T. Stone, President

## 10.0 REVISION HISTORY

Revision number 1:

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

# APPENDIX C: MAPS

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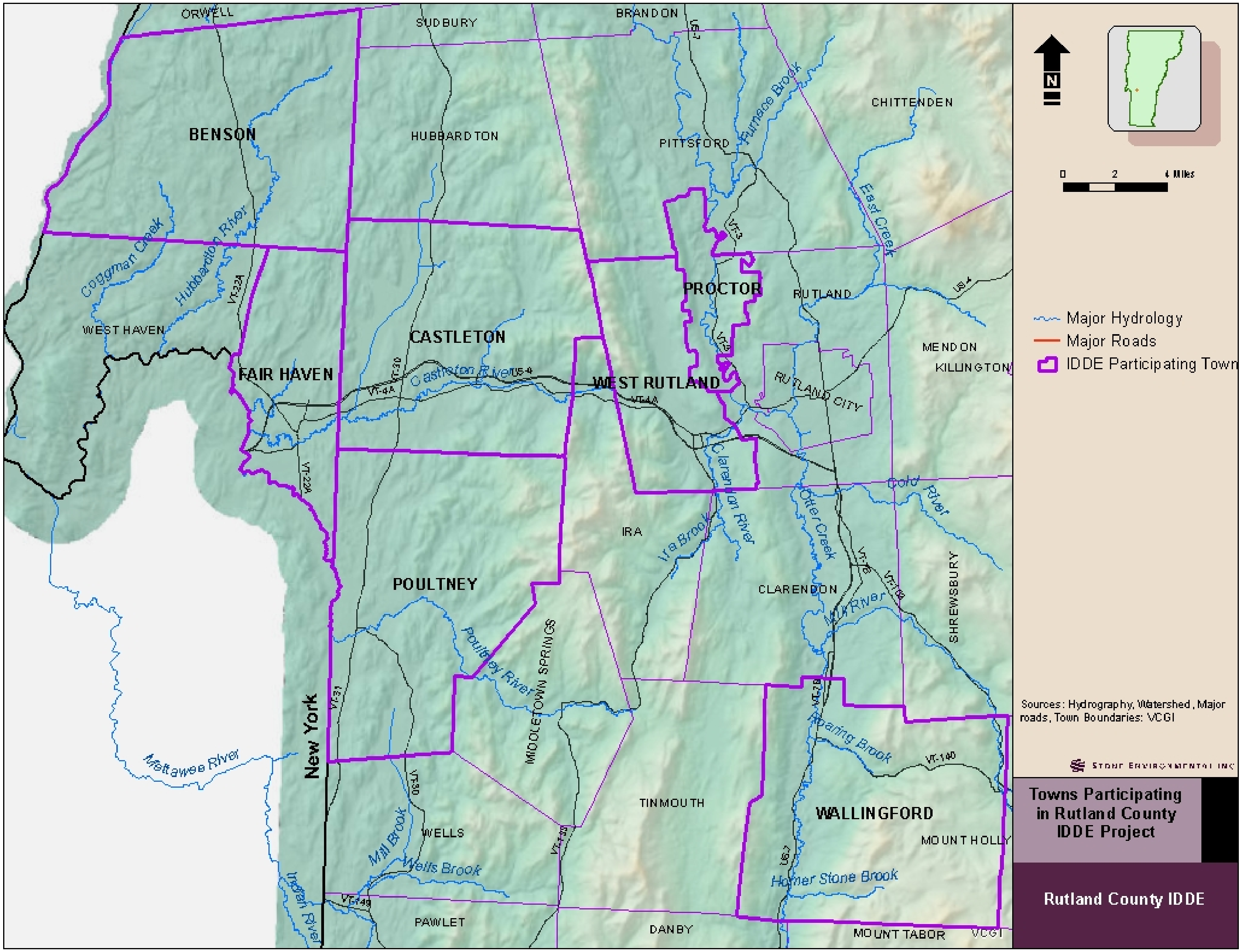
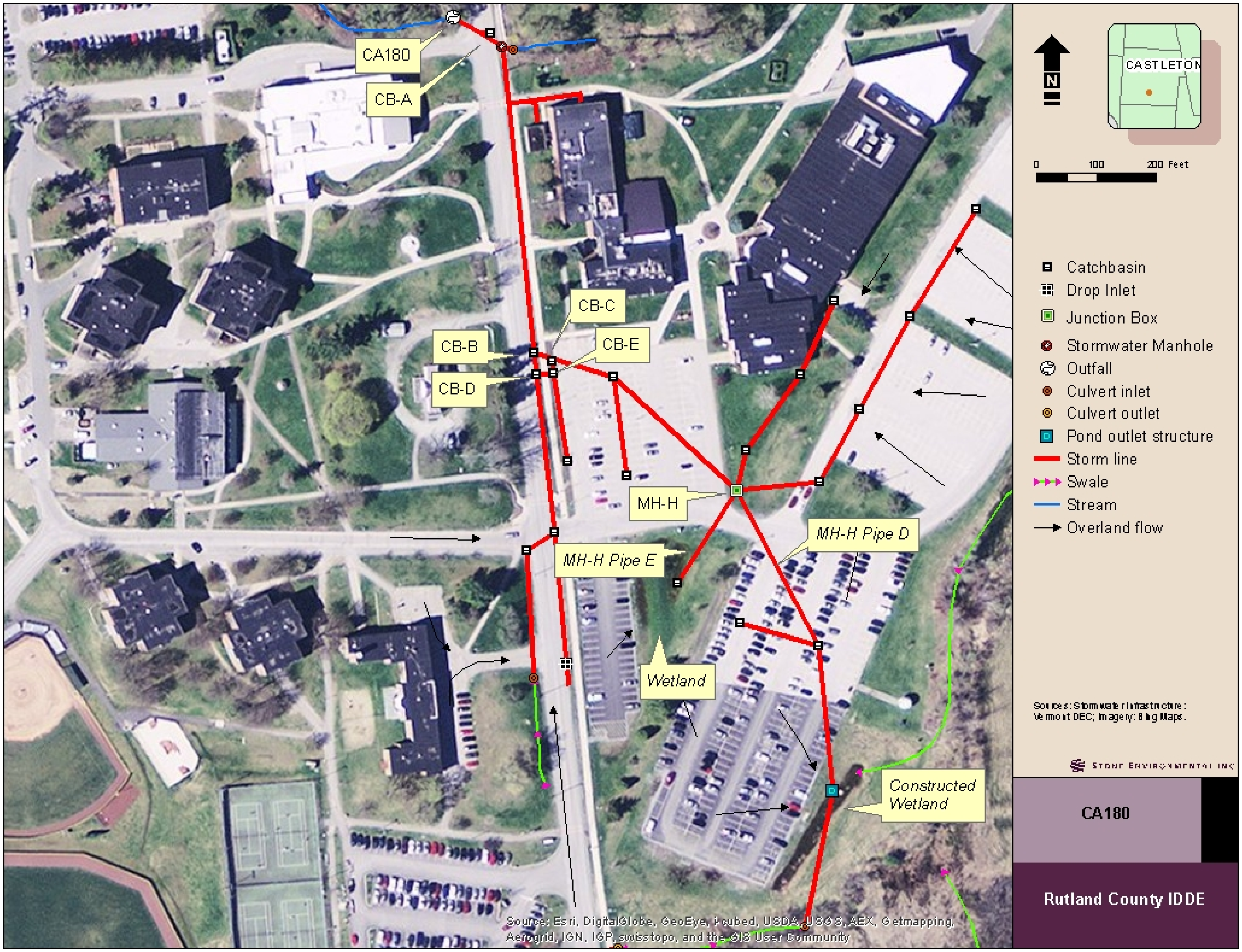
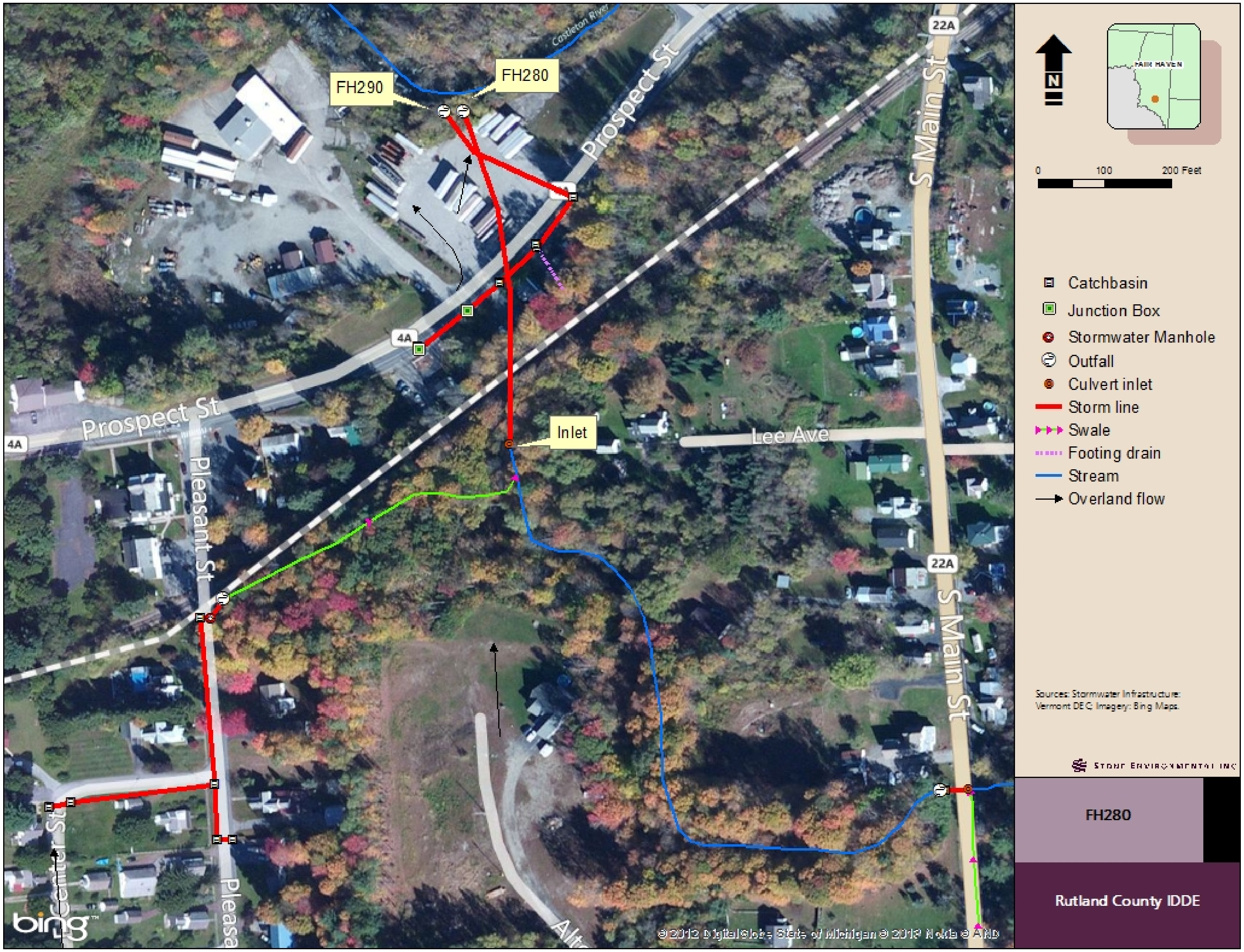
## Map 1. Participating towns



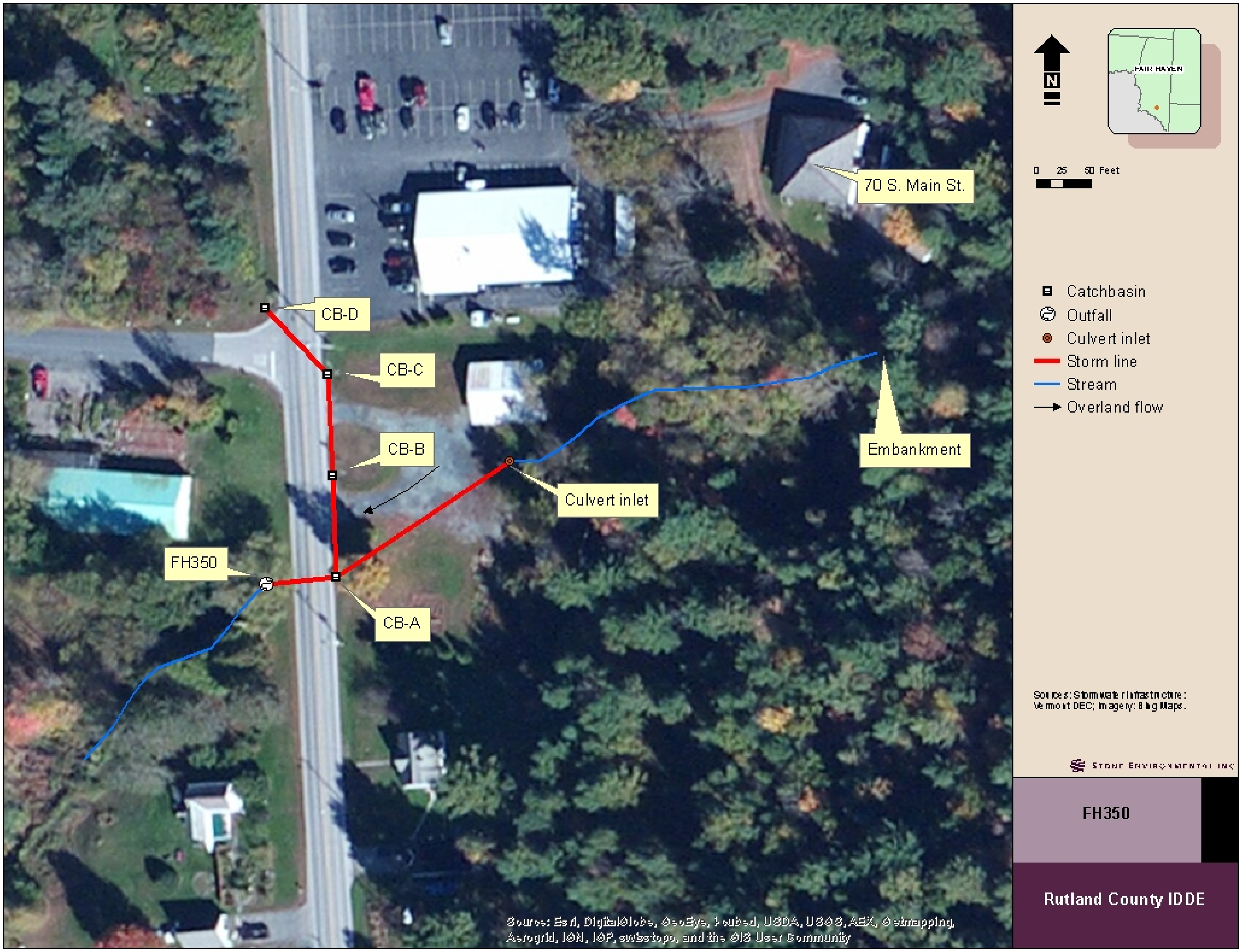
## Map 2. System CA180



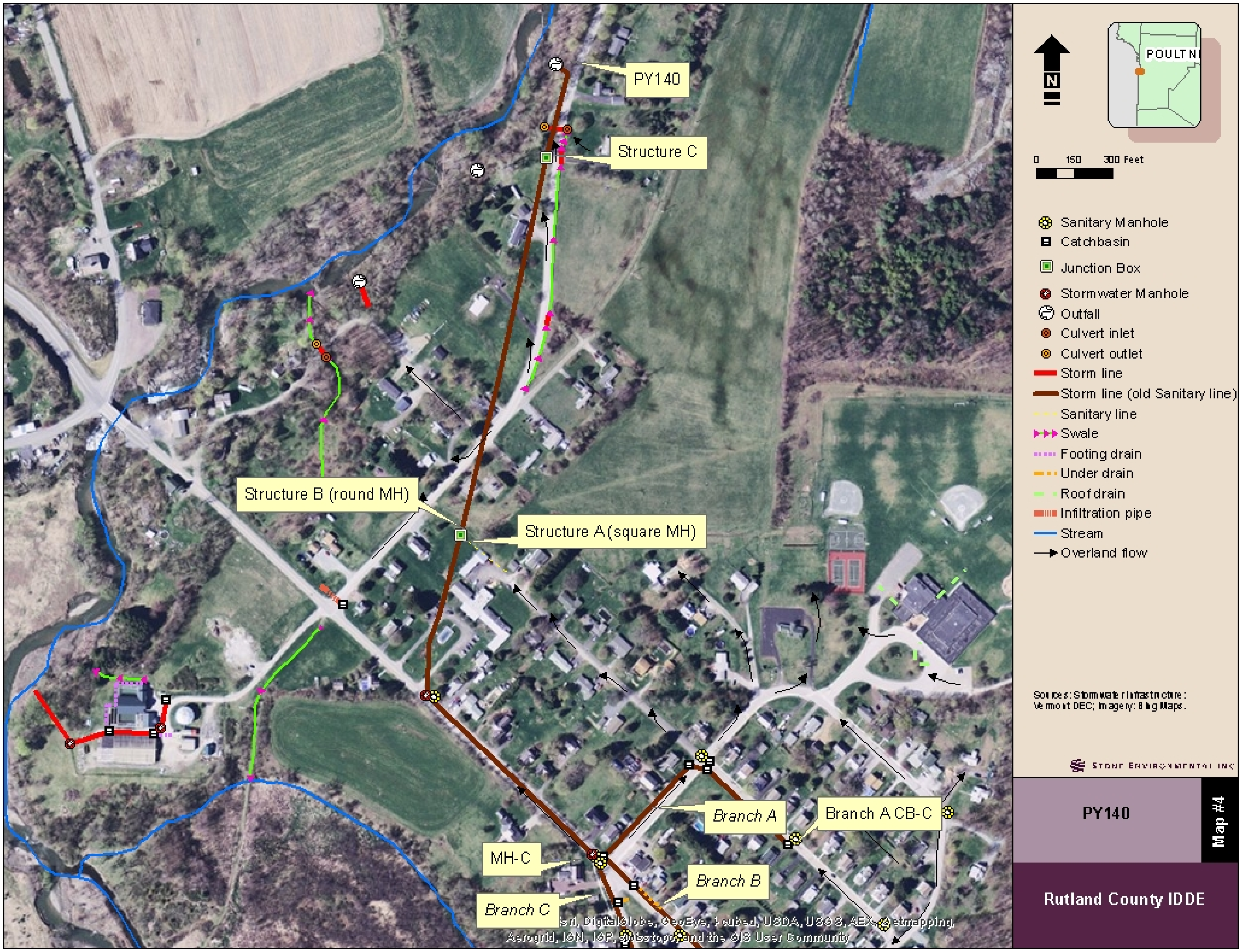
## Map 3. System FH280



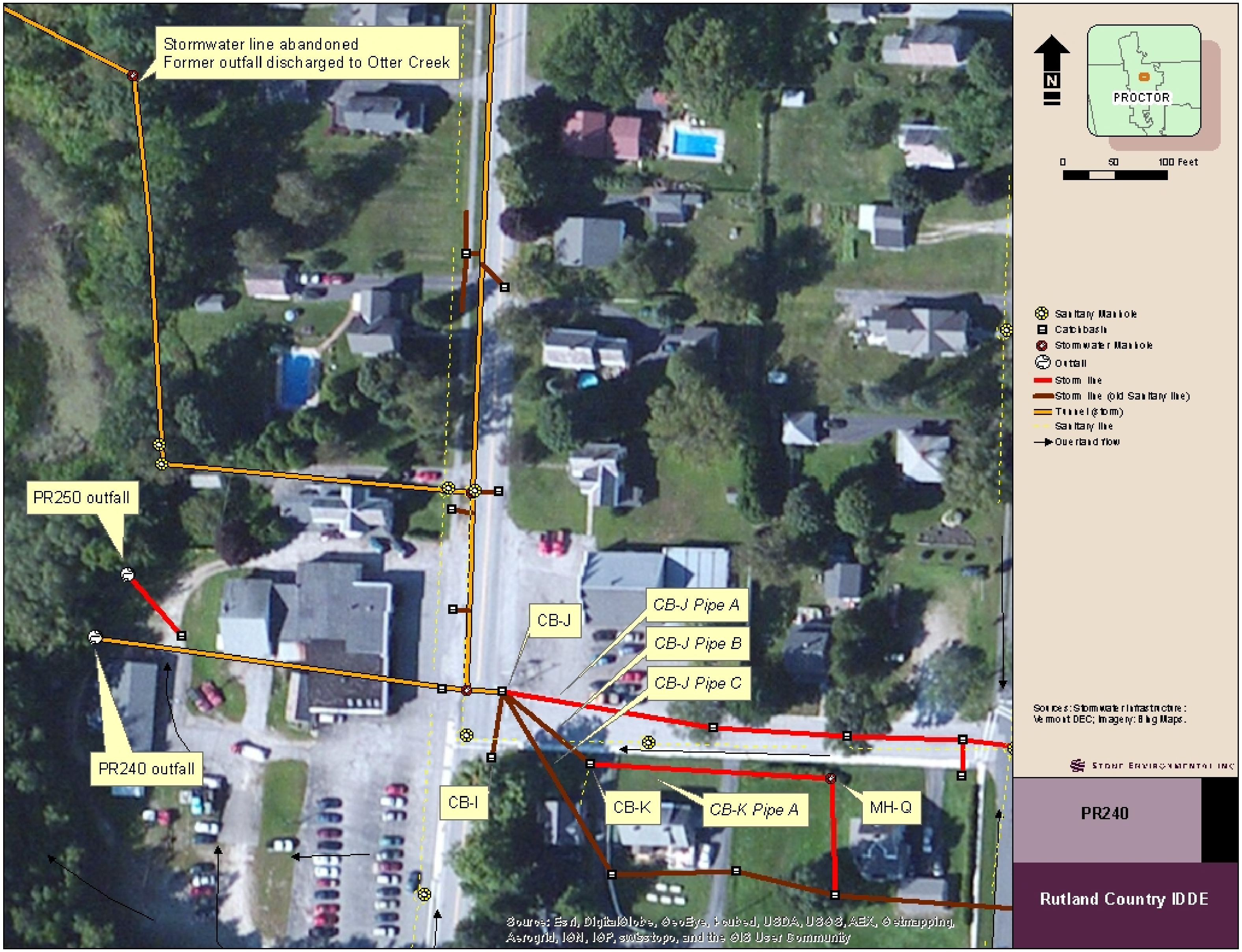
## Map 4. System FH350



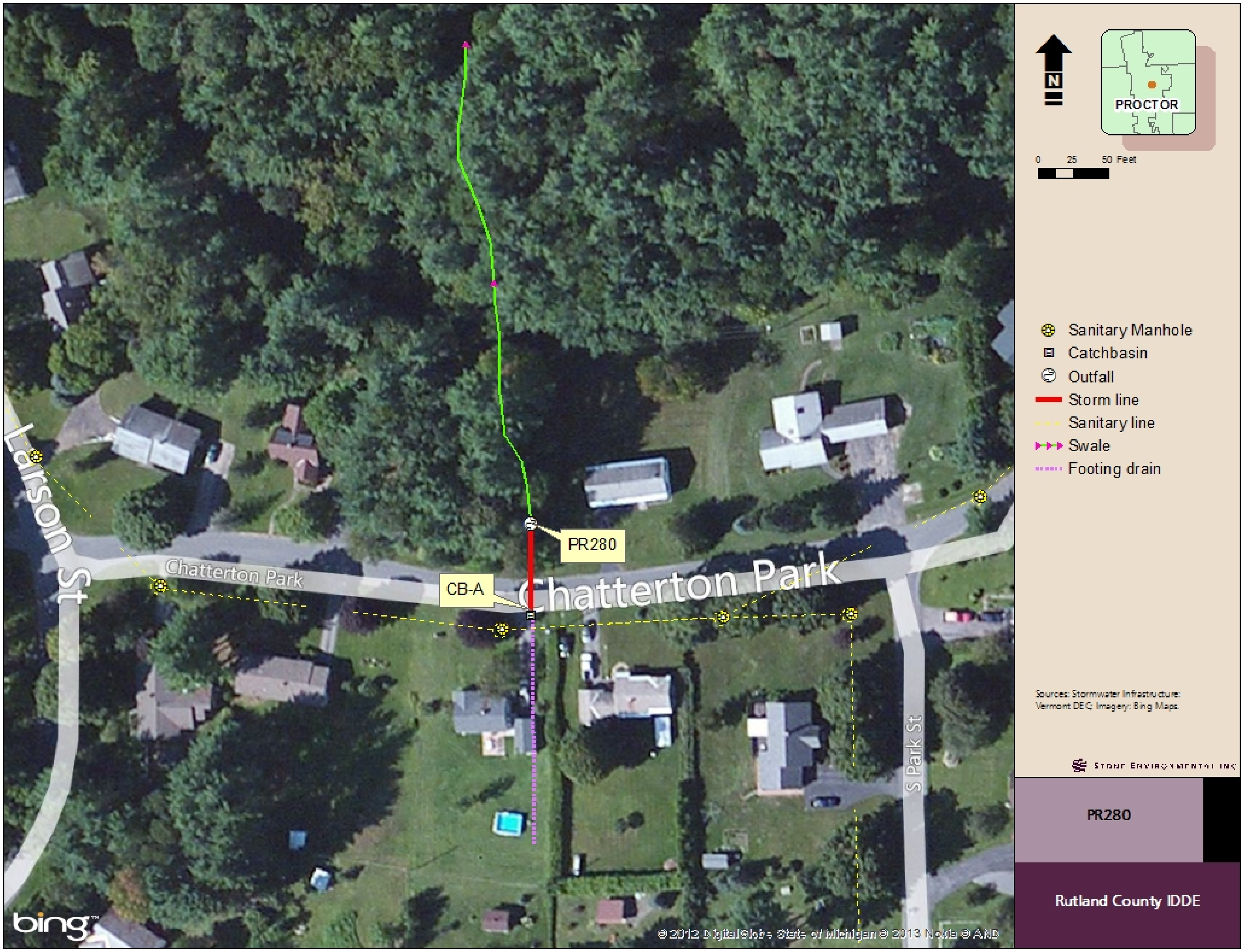
## Map 5. System PY140



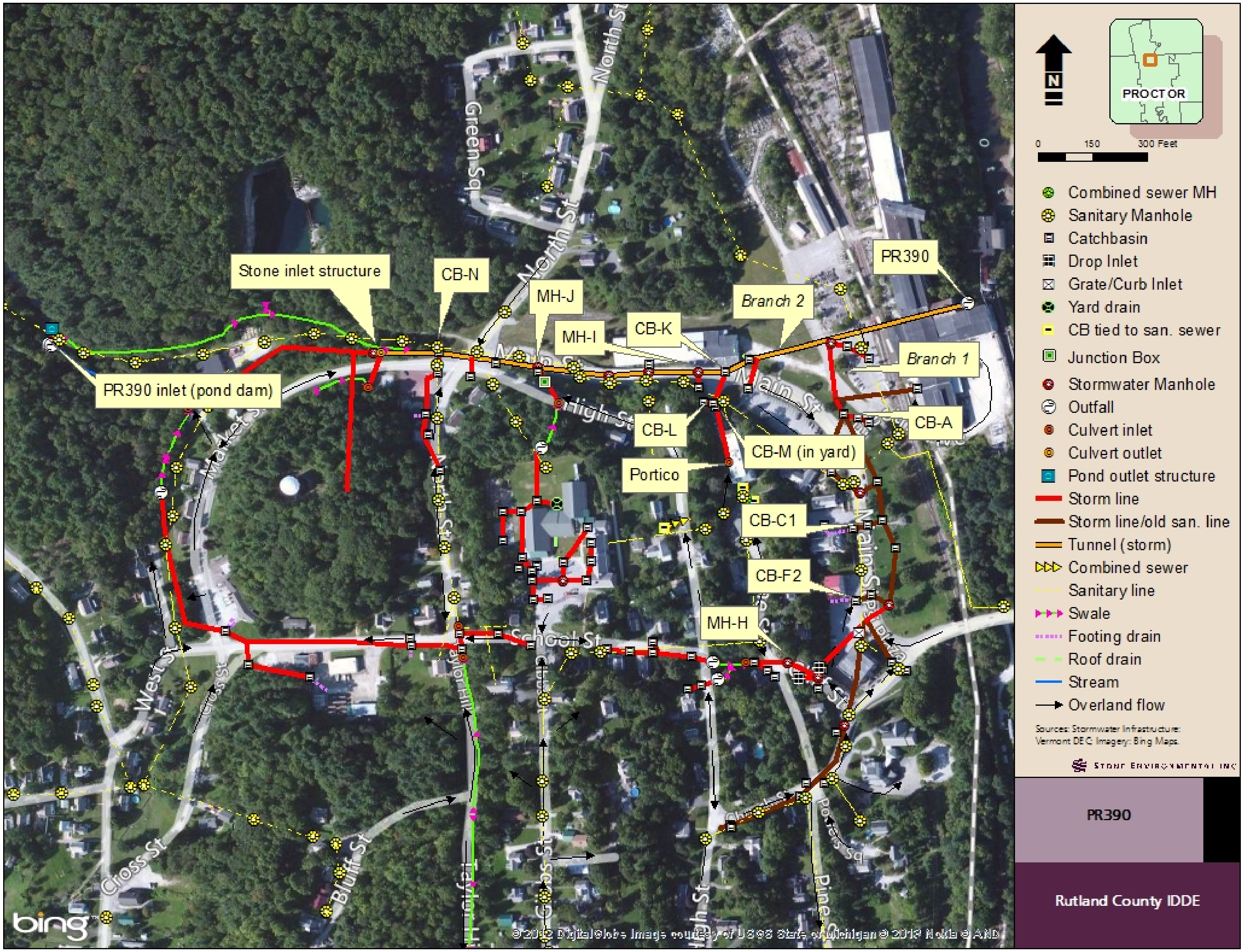
## Map 6. System PR240



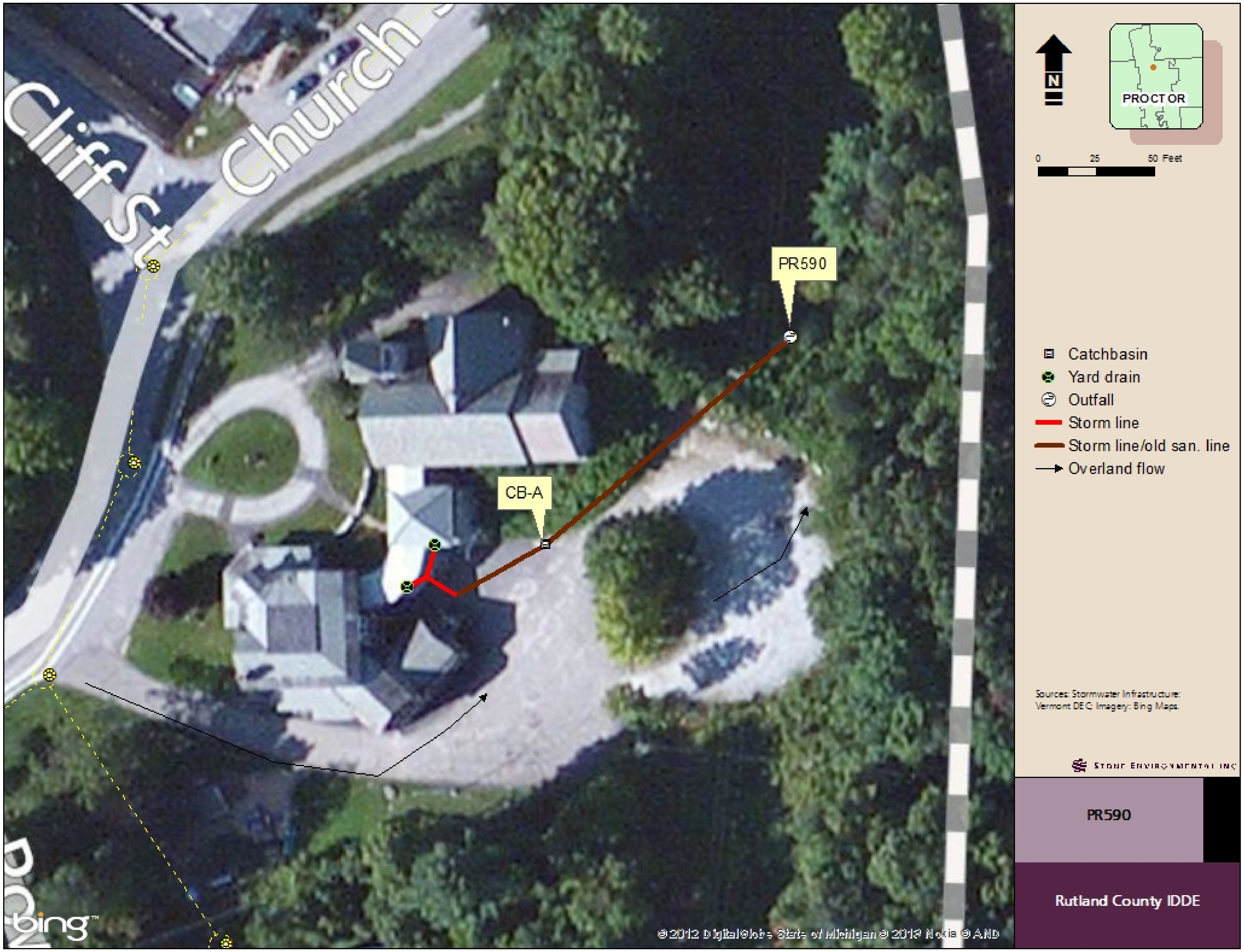
## Map 7. System PR280



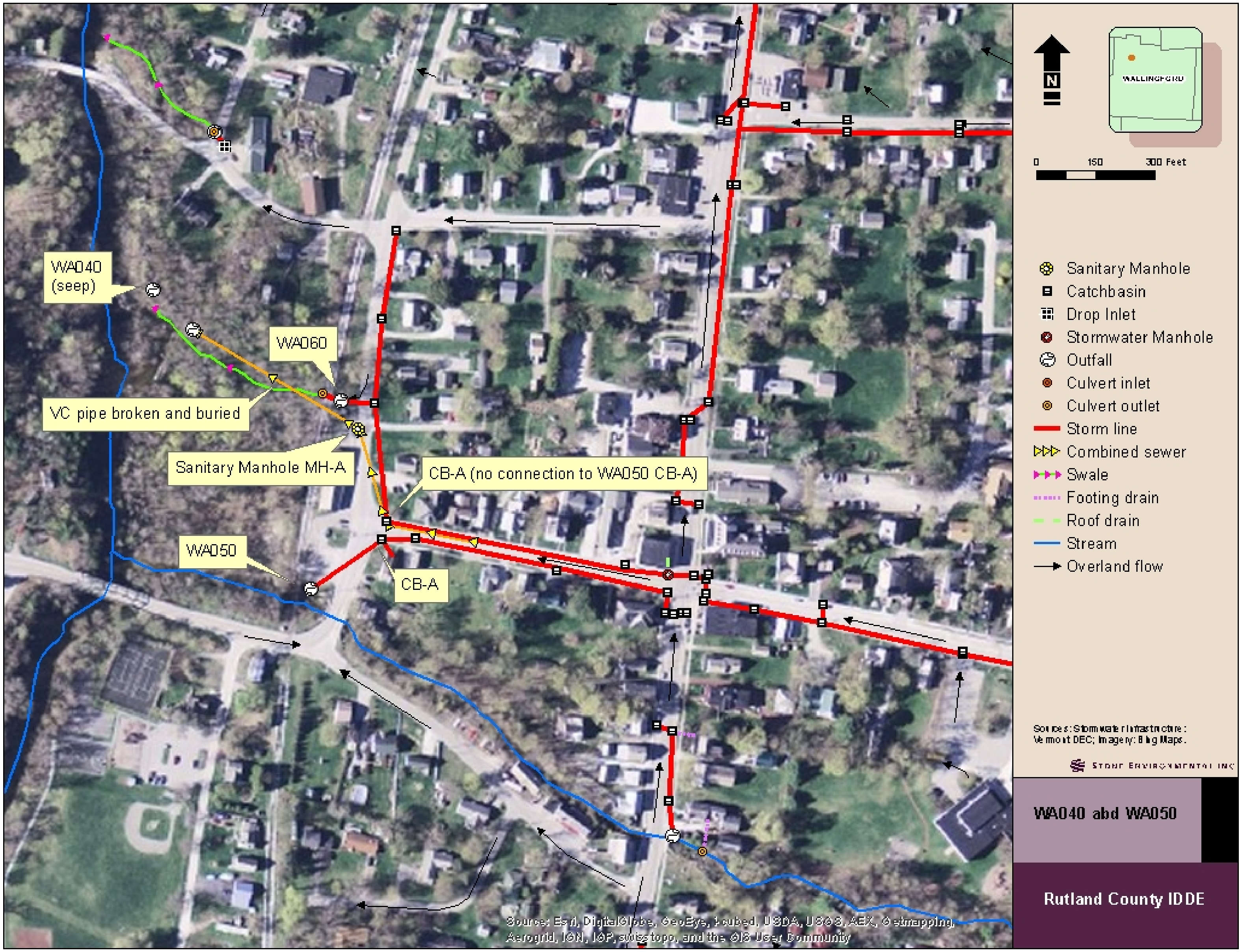
**Map 8. System PR390**



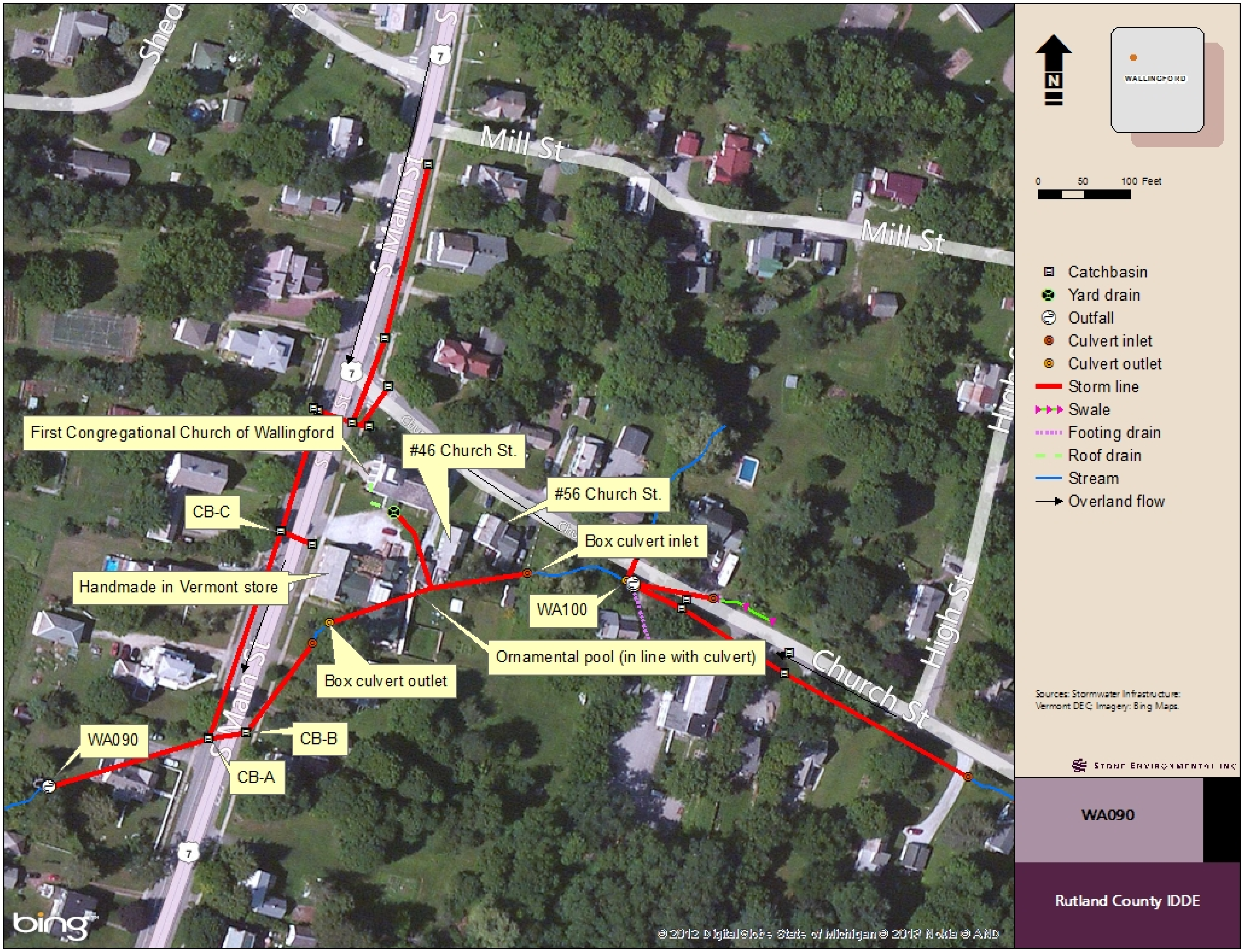
## Map 9. System PR590



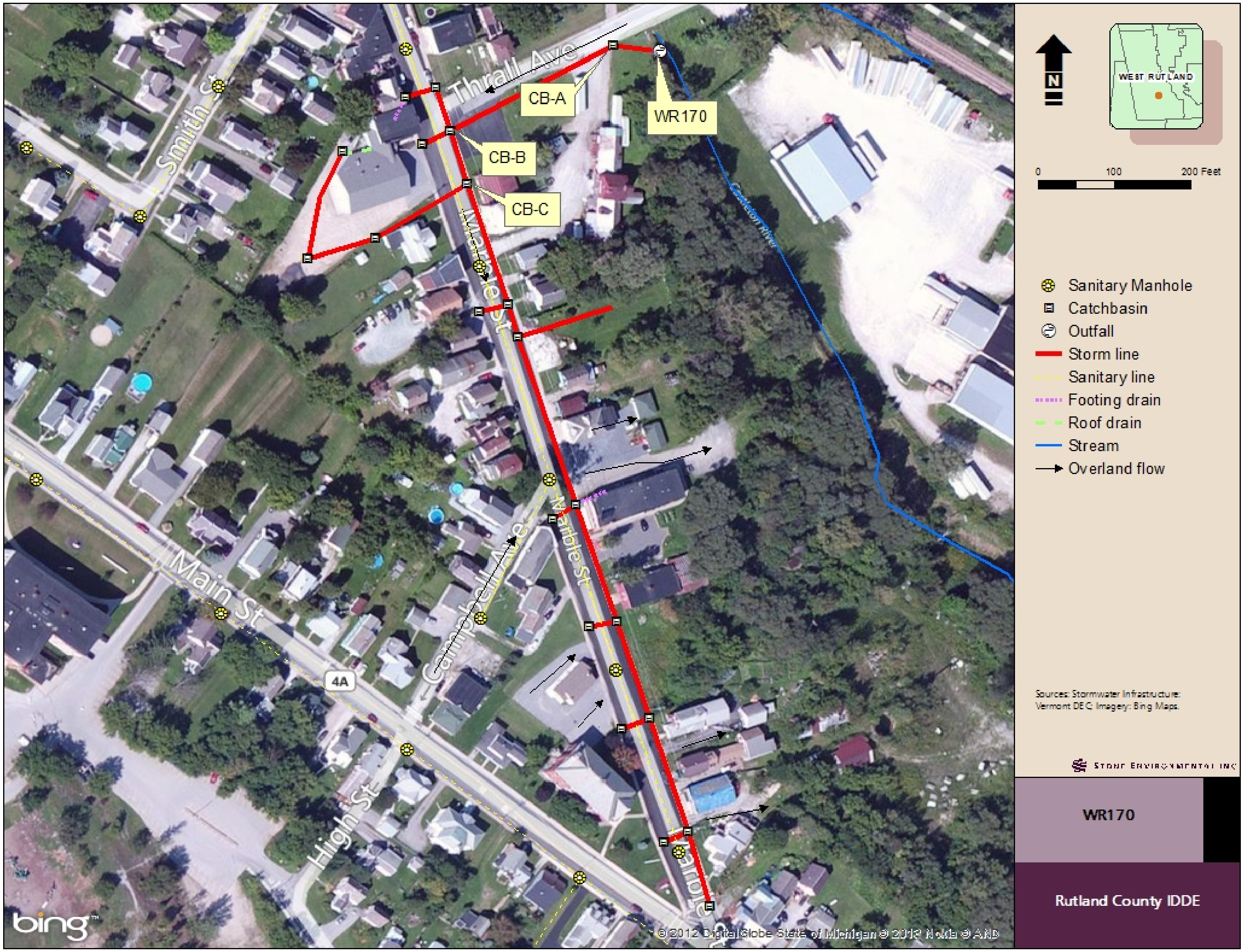
## Map 10. Systems WA040, WA050, and WA060



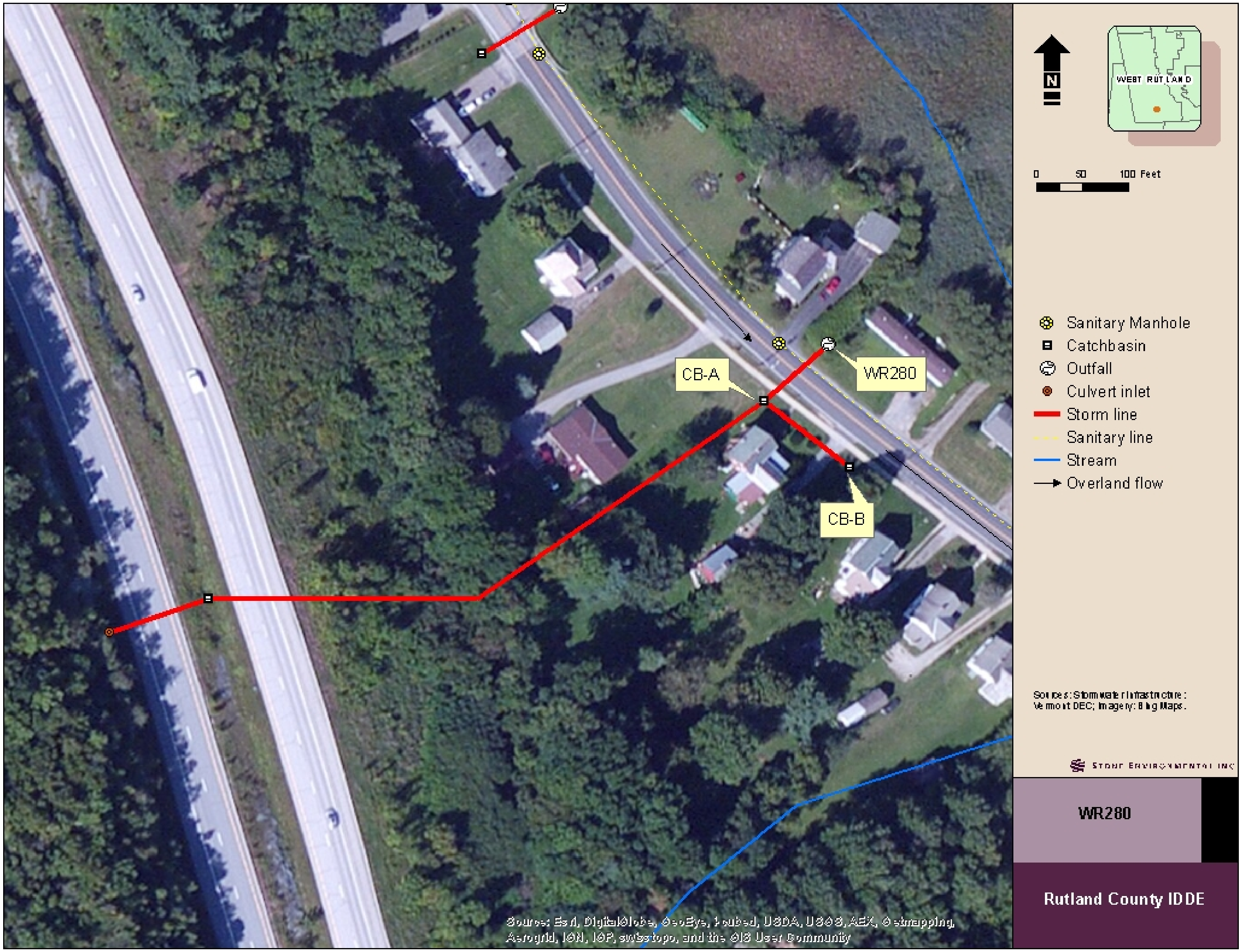
## Map 11. System WA090



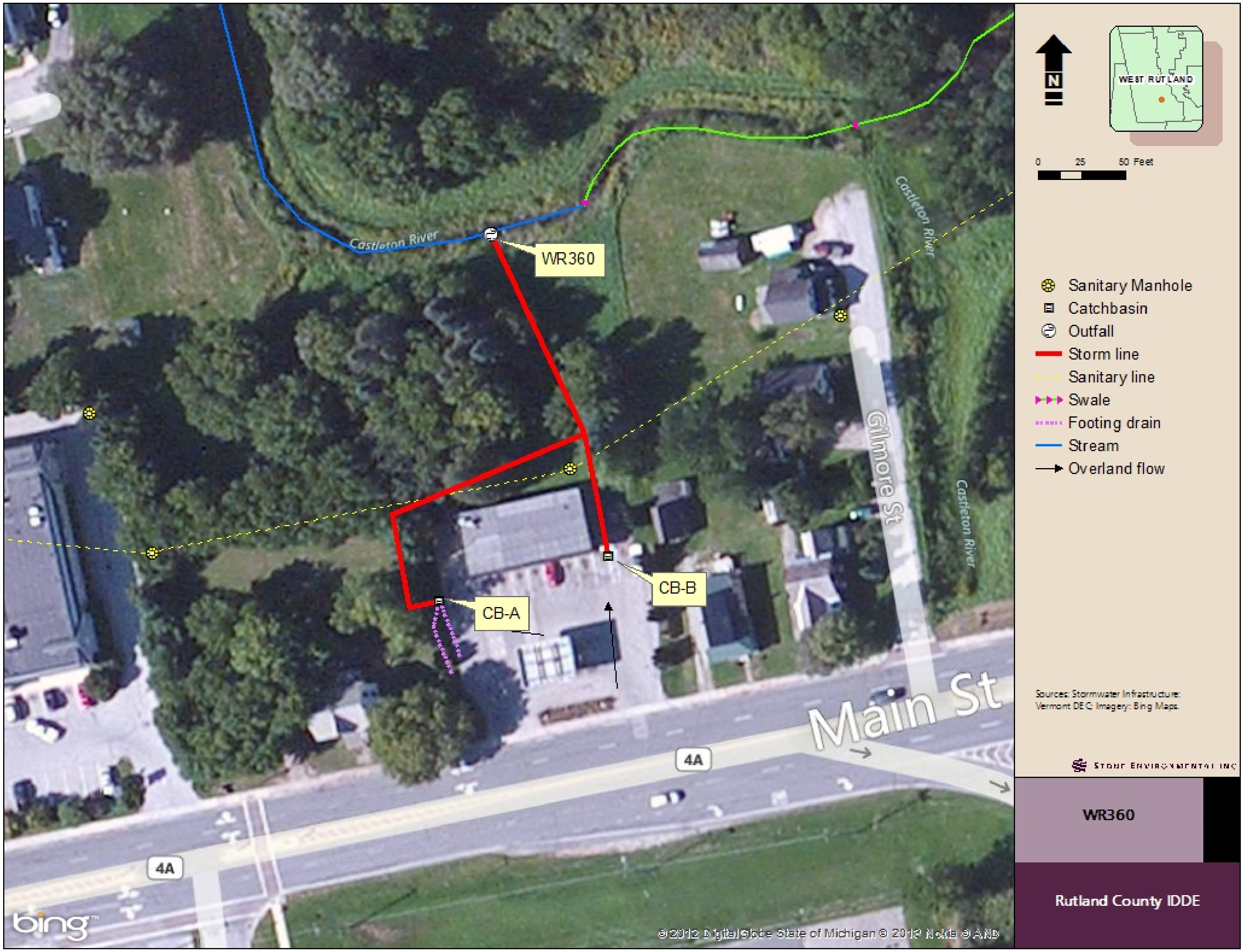
## Map 12. System WR170



## Map 13. System WR280



## Map 14. System WR360



## Map 15. System WR460