Detection of illicit discharge from stormwater system outfalls in Plainfield, VT

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Introduction

Stormwater drainage systems are designed to collect and transport rainwater and snowmelt away from developed areas such as roads, parking lots, and buildings. Water flowing through such drainage systems empties into streams and rivers at outfall pipes at the end of storm system lines as shown in Figure 1 below.

Figure 1. Typical stormwater system outfall after a rainstorm.

During dry periods, the stormwater system should also be dry unless it also conveys diverted streams, groundwater, or an allowable, temporary discharge resulting from such activities as water line flushing, individual car washing, lawn/landscape irrigation, pumping of water out of crawl spaces, air conditioner condensation, draining of de-chlorinated swimming pool water, and , and firefighting.

Sometimes stormwater systems carry illicit types of discharge, especially in municipalities with older sanitary sewers and stormwater systems. These problematic discharges can result from direct or indirect connections with the stormwater lines. Examples of direct connections include wastewater piping or shop drains intentionally or unintentionally connected to the stormwater system and cross-connections between the sanitary sewer line and the stormwater system. Indirect discharges can occur when sanitary sewer lines leak into stormwater lines, or when failed septic systems infiltrate into the stormwater system.

Illicit discharge into streams and rivers reduces their water quality. Water quality monitoring efforts by The Friends of the Winooski River in partnership with the Vermont Department of Environmental Conservation have documented elevated levels of phosphorous and the bacterial species *Escherichia coli* (*E. coli*) in the Winooski River, particularly where it flows through settled areas. This species is found in the lower gut of mammals and is used as an indicator for fecal matter and the potential presence of disease-causing organisms. Sources of *E. coli* include untreated sewage, manure, pet waste, and wild animal waste. Illicit discharges into stormwater system outfalls can therefore be the source of *E coli* found in waterways. The catch basins, pipes, and outfalls of closed-drainage stormwater systems are designed for conveyance—not for pollutant removal. Once pathogens, nutrients, sediment, hydrocarbons, and other pollutants reach the

stormwater system, they are efficiently conveyed to the Winooski River. Detecting and eliminating cross-connections and other illicit discharges is thus an effective strategy for improving water quality in the river. Although sediment transport in closed drainage systems is not usually caused by illicit discharges, the sediment loading and erosion associated with outfalls can substantially impact water quality by affecting turbidity and phosphorus levels. Chlorides from road salts and hydrocarbons from gasoline or oil leaks and spills are other examples of pollutants that can be transported to waterways via the stormwater system.

The Vermont Department of Environmental Conservation (VT DEC) recently mapped the stormwater systems, both town-owned and private, in the towns of Plainfield, Marshfield and Cabot. In order to detect any non-stormwater discharges and locate potential sources of *E. coli* and other pollutants, Friends of the Winooski River staff visited and assessed the mapped outfall locations in these three towns during the summer of 2013. The assessment methods were developed in collaboration with Stone Environmental, an environmental consulting firm based in Montpelier, VT. This effort was funded under the State of Vermont Ecosystem Restoration Program as part of an Integrated Field Assessment (IFA) to collect data on a variety of water resource and water quality issues. The goal of the IFA is to provide the Towns of Cabot, Marshfield and Plainfield with specific recommendations to better protect water resources and town infrastructure. This report describes the results of outfall assessments in the town of Plainfield.

Methods

Since the goal of this study was to detect non-stormwater discharge, outfall assessments were conducted on dry days when there had been no rain for at least 24 hours. Using the VT DEC maps of Plainfield outfalls, outfall pipes were located and an assessment made.
Data recorded for each outfall included notes concerning any obvious pollutant discharges (oily substances, sewage smells, discolored liquids, foams, sediment, etc.); the type and condition of pipe; and erosion at the outfall site. The field observation form used is shown in Appendix A. If an outfall was flowing or dripping, the flow was observed for color, odor, turbidity, and floatable matter and an approximately 250 mL sample was taken. This sample was then used for four water quality tests: chlorine, ammonia, detergents, and conductivity. These parameters were measured because they can indicate the presence or absence of specific types of discharge such as treated water or wastewater. Chlorine tests were performed using Hach DPD total chlorine reagent foil pillows for 10mL samples and a Hach DR 890 colorimeter. Ammonia levels were determined using Hach AquaCheck water quality test strips, and detergent levels were found using a Chemetrics Detergent test kit. Conductivity was measured using an OakTon PC 300 multimeter. All tests were performed in the field within 1 hour after the samples were taken with the exception of conductivity, which was measured within 48 hours.

For flowing, dripping, or wet outfalls, an optical brightener detection pad ("OB pad") was affixed to the inside bottom of the outfall and left in place for 4 to 16 days. These pads consist of untreated cotton pad placed inside a mesh bag. The cotton in these pads binds to optical brighteners present in most laundry soaps. After the bags were retrieved, they were rinsed, dried, and placed under a long wave (UV-A, or "black") light. When viewed under UV-A light, optical brighteners fluoresce and serve as an indicator of possible domestic wastewater contamination. In one case where a flowing outfall was damaged, an OB pad was lowered into the catch basin (street drain) closest to the outfall.

The data collected for all the outfalls and catch basins were categorized to produce a comprehensive table of information pertaining to each outfall (see Appendix B). The naming convention for the samples was based on the town where the assessments were done (using "P" for Plainfield), the type of structure (outfall or catch basin), and a sequential number system counting by tens. Hence, P-O-010 is the first structure tested in Plainfield and is an outfall, and P-CB-100 is the tenth structure tested and is a catch basin. Outfalls or catch basins with suspected illicit discharges were flagged for follow-up investigation and *E. coli* testing

Exceptions to Screening Process

There were a few exceptions to this process. In three cases (P-O-060, P-O-110, and P-O-120), the outfalls were inaccessible due to very steep slopes and/or thick vegetation. For these outfalls, a visual assessment was made from the closet point possible. Two of these outfalls appeared to be dry, but one was dripping (P-O-060). Since it could not be accessed, no sample was taken and no OB pad was set.

The condition of some outfalls prevented sampling and the setting of OB pads. One outfall was dripping but was so damaged that the discharge leaked out of the pipe well before it reached the opening, making it impossible to set a pad or take a sample. Another was submerged in the stream it emptied into, so no effort was made to get a sample or set OB pads since stream water would have compromised the tests.

Results

Overview of Results

Of the 21 mapped public and private outfalls in Plainfield, 19 were found and assessed (see map in Appendix C). One of the mapped outfalls (west of the Maple Valley Restaurant) could not be located and may have been removed. Another seemed to be a small footing (dry) footing drain behind the Plainfield Health Center and was not assessed further. Twelve of the outfall pipes evaluated are part of the Town of Plainfield's stormwater drainage system, and the rest (7) are private and situated on the Goddard College campus or the Plainfield Health Center property.

Five outfalls (P-O-060, P-O-090, P-O-130, P-O-160, and P-O-200) were found to be dripping or flowing despite dry weather. Only one of these outfalls (P-O-200) was tested for all of the water quality parameters, however, since clean samples of sufficient volume could not be obtained from the remaining four outfalls. Outfalls P-O-090 and P-O-130 were so heavily damaged that a clean sample was not obtainable, P-O-060 was inaccessible and could only be observed at a distance, and the flow from P-O-160 was too slow to obtain a sufficient sample volume. Ammonia tests, which can be done using a dipstick and a very small sample volume, were performed on the discharge from the P-O-130 and P-O-160 outfalls. While both of these locations had slightly elevated ammonia levels (~0.5 mg/L) on the first visit, and foam was observed in the stream below P-O-130 (see below), follow-up visits did not reveal any obvious problems or elevated ammonia levels. The ammonia, chlorine, detergent, and conductivity levels of the discharge from the P-O-200 outfall were all within acceptable limits.

Optical brightener pads were left in all wet outfalls except P-O-060, which could not be reached. Only one (P-O-090) tested positive for optical brighteners. The catch basin immediately up the line from this outfall also tested positive for optical brighteners, and smelled of laundry detergent on two separate visits. Upon close inspection, this catch basin appeared to have an unmapped inlet, which seemed to be the source of the dry weather flow. A sample of the flow from this pipe had no detectable *E. coli* (<1 MPN/100 mL).

Five outfalls (P-O-090, P-O-120, P-O-130, P-O-160, and P-O-190) were found to have suffered damage or corrosion, seven (P-O-060, P-O-070, P-O-080, P-O-150, P-O-160, P-O-190, and P-O-200) appeared to be contributing sediment to nearby streams, and two (P-O-070, P-O-080) were partially obstructed by sediment.

A table with the all the data associated with all 21 structures is included in Appendix B.

Results for Specific Outfalls and Catch Basins

1. <u>Structures that tested positive for optical brighteners</u>

Of the 19 outfalls that were assessed, one tested positive for optical brighteners. The catch basin immediately up the line from this outfall had flow on each of three visits, and also tested positive for optical brightener. The two catch basins and one drop inlet further up within the stormwater system were dry.

Plainfield outfall P-O-090 (Towne Avenue/Martin Meadow Road)

Location: Outfall behind 29 Martin Meadow Road

Description: 12-inch concrete (broken, see below), drains Towne Avenue and a swale along Robert Lane, and empties into the Winooski River.

Water Quality: Date: 08/23/13
Flow observation: steady flow, clear, no odor

Date 10/09/13
Flow observation: steady flow, clear, no odor
Optical brighteners: Positive (very strong)

Plainfield catch basin P-CB-100 (Towne Avenue/Martin Meadow Rd)

Location: Southeast corner of intersection between Martin Meadow Road and Towne Avenue.

Description: Deep catch basin immediately up the storm drain line from P-O-090.

Water quality: Date: 08/23/13
Flow observation: steady flow
Optical brighteners (sump): Positive (very strong)

Date: 10/09/13
Flow observation: steady flow, laundry/grey water odor
a "gush" of flow that lasted about 10-20 seconds was also observed from a deep, unmapped inlet ("Pipe C").
Optical brighteners (sump): Positive (very strong)
(Pipe C): Positive (very strong)

Date: 10/29/13
Flow observation: steady flow, strong laundry odor
E. coli: <1 MPN/100mL

Follow-up: On 10/09/13, the grate above this catch basin was removed in order to observe the inlets into the basin more easily. Three inlets were observed. Two inlets (Pipes A & B) seemed to correspond to the two expected, mapped connections from a nearby catch basin and a nearby drop inlet based on orientation and depth (see map in Appendix C). The third inlet ("Pipe C") was deeper and appeared to be the one contributing to the flow through the catch basin. An attempt was made to determine whether there was a direct connection between a nearby sanitary sewer line and this catch basin. The manhole cover was removed and the direction of the sewer lines noted. The sewer lines seemed to be shallower than the third inlet into the catch basin, and none of them headed in the direction of the catch basin. Loud sounds made at the opening to the sewer did not seem to transmit to the catch basin.

On 11/19/13, the catch basin was revisited with the head of the Plainfield Water and Wastewater Plant, Greg Chamberlin. Pipe C was flowing slowly, and some suds were observed in the sump. In order to determine if there was a direct connection between any of the nearby houses and Pipe C, the plumbing connections of three nearby houses were dye-tested under the supervision of Dave Braun of Stone

Environmental. For each house, dye was observed in the sanitary sewer lines, and no dye was detected in Pipe C.

Using a push camera, the Town of Plainfield plans to inspect the origin of pipe C and document any inappropriate pipe connections. If this effort does not reveal the source of the contaminated flow, FWR will work with the town to pursue additional dye testing at residences in the area.

2. <u>Outfalls that were damaged</u>

Five outfalls were observed to be, or appeared to be damaged.

Plainfield outfall P-O-090 (Towne Avenue/Martin Meadow Road)

Location: Outfall behind 29 Martin Meadow Road

Description: 12-inch concrete. Drains Towne Avenue and swale along Robert Lane; empties into the Winooski River.

Damage: Concrete outfall pipe is broken in two about 4 feet from the end. The concrete at the break has eroded away and the metal reinforcement is visible and rusting. The flow is running through this break and no longer reaches the end of the pipe.

Plainfield outfall P-O-120 (south of Main Street Extension/Route 2)

Location: Outfall behind the Blinking Light Gallery.

Description: Approximately 16-inch corrugated metal pipe. Drains Main Street west of the blinking light and empties into the Winooski River. Inaccessible.

Damage: Pipe and concrete header appear to be detached from the storm line. This outfall could only be observed from the top of the bank, however, and a close inspection was not made.

Plainfield outfall P-O-130 (north of Main Street Extension/Mill Street)

Location: Outfall behind Spiralworks and old River Run Restaurant.

Description: 12-inch ceramic outfall. Drains most of Main Street extension and empties into the Winooski River.

Damage: Outfall pipe is cracked longitudinally at the bottom in at least three places, perhaps due to the weight of the soil above. Discharge flows through these cracks and does not make it to the end of the pipe.

Plainfield outfall P-O-160 (southwest edge of Mill Street Bridge @ Great Brook)

Location: Outfall immediately downstream from the Mill Street Bridge on the left-hand side of Great Brook (facing downstream)

Description: 18-inch corrugated metal. Drains Barre Hill Road and the west side of upper Mill Street and empties into Great Brook.

Damage: Corrugated metal outfall is corroded at the bottom and slightly bent at the mouth so that a moderate amount of debris collects at the end, obstructing the flow to some extent.

Plainfield outfall P-O-190 (Recreation Field Road)

Location: Outfall behind the apartment house at the corner of Mill Street and Recreational Fields Road.

Description: 8-inch asbestos cement. Drains apartment house parking and lower Recreation Fields Road and empties into Great Brook.

Damage: Pipe is cracking.

3. <u>Outfalls that were partially obstructed with sediment</u>

Three outfalls were partially obstructed with sediment such that flow through them may be restricted.

Plainfield outfall P-O-070 (Pitkin Road, Goddard campus)

Location: Outfall off Pitkin Road on the Goddard College campus near the Community Building.

Description: 12-inch corrugated metal pipe. Drains Pitkin Road and empties into grassy area below the road.

Obstruction: Outfall and the drop inlet that drains into it are full of sediment. Bottom of outfall pipe outlet is below the soil surface.

Plainfield outfall P-O-080 (Routes 2 and 214)

Location: Outfall along south side of Main Street (Route 2), west of intersection with 214.

Description: 12-inch concrete. Difficult to access.

Obstruction: Outfall is ~¼ -full of sediment.

4. <u>Outfalls that seem to be carrying sediment into streams or causing erosion</u>

Seven outfalls appear to be causing erosion or to be carrying sediment from elsewhere into nearby waterways. Sediments affect water quality by increasing turbidity and the levels of nutrients such as phosphorus.

Plainfield outfall P-O-060 (Goddard Campus parking lot)

Location: Outfall below lower parking lot on the Goddard College campus.

Description: ~24 inch corrugated metal. Drains parking lot and swales in nearby field. Inaccessible on 8/23/13.

Erosion description: Significant gully/channel below outfall.

Plainfield outfall P-O-080 (Routes 2 and 214)

Location: Outfall along south side of Main Street (Route 2), west of intersection with 214.

Description: 12-inch concrete. Difficult to access.

Erosion description: Significant erosion channel below outfall.

Plainfield outfall P-O-090 (Towne Avenue/Martin Meadow Road)
Location: Outfall behind 29 Martin Meadow Road

Description: 12-inch concrete. Drains Towne Avenue and swale along Robert Lane, and empties into the Winooski River.

Erosion description: Significant erosion channel below outfall. Close to the Winooski River.

Plainfield outfall P-O-150 (Mill Street parking lot)

Location: Outfall south of parking lot, across from bookshop.

Description: 10-inch corrugated black plastic. Fed by a drop inlet off of Mill Street, drains into rain garden (and from there down the slope to the Winooski River.)

Obstruction: sediment Outfall is ¼ -full of sediment; brings into the rain garden.

Plainfield outfall P-O-160 (southwest edge of Mill Street Bridge @ Great Brook)
Location: Outfall immediately downstream from the Mill Street Bridge on the left-hand side of Great Brook (facing downstream).

Description: 18-inch corrugated metal. Drains Barre Hill Road and the west side of upper Mill Street and empties into Great Brook.

Sediment description: Outfall contains sediment and is probably transporting a moderate amount of sediment into Great Brook.

Plainfield outfall P-O-190 (Recreation Field Road)

Location: Outfall behind the apartment house at the corner of Mill Street and Recreational Fields Road.

Description: 8-inch concrete. Drains apartment house parking and lower Recreation Fields Road and empties into Great Brook.

Sediment description: Outfall contains sediment and is probably transporting some sediment into Great Brook.

Plainfield outfall P-O-200 (Route 2 east of blinking light)

Location: Outfall off of School Street (Route 2) behind 72 School Street.

Description: 54-inch corrugated metal. Drains lower School Street and the stream that runs between Harvey Hill Road and Hillside Drive.

Sediment description: Outfall contains a significant amount of sediment and is probably transporting sediment into the Winooski River.

5. <u>Outfalls and catch basins flagged for other reasons</u>:

Plainfield outfall P-O-060 (Goddard Campus parking lot)

Location: Outfall below lower parking lot on the Goddard College campus.

Description: ~24-inch corrugated metal. Drains parking lot and swales in nearby field. Inaccessible.

Reason for flag: Debris and dirt has been dumped at the edge of the woods on the slope above the outfall.

Plainfield outfall P-O-130 (north of Main Street Extension/Mill Street)

Location: Outfall behind Spiralworks and old River Run Restaurant.

Description: 12-inch cast metal, ceramic, or concrete outfall. Drains most of Main Street extension and empties into the Winooski River.

Reason for flag: On 8/23/13 suds were observed in the river below this outfall when the first visit was made. The discharge at this time was slightly turbid. In order to determine where the source of potential pollutants was, the catch basin immediately upstream was inspected (see below).

Follow-up: This outfall was visited again on 9/6/13. No flow (or suds) was observed on this date.

Plainfield catch basin P-CB-140

Location: Catch basin on Main Street Extension, immediately upstream from P-O-130, in front of Positive Pie.

Reason for flag: This catch basin was observed to be full of what appeared to be grey dry wall mud, plaster, or concrete when inspected on 8/23/13. Since renovations were being done inside Positive Pie, inquiries were made as to whether any of the contractors were disposing of waste material into the catch basin. One of the contractors admitted that he had been dumping materials into this catch basin and agreed to stop.

Follow-up: On 9/6/13, this catch basin was revisited and appeared to be clear of the grey material.

Plainfield outfall P-O-160

Location: Outfall immediately downstream from the Mill Street Bridge on the left-hand side of Great Brook (facing downstream).

Description: 18-inch corrugated metal. Drains Barre Hill Road and the west side of upper Mill Street and empties into Great Brook.

Reason for flag: The ammonia level in the discharge (dripping) from this outfall was ~0.5 mg/mL when first tested on 8/28/13. We used ammonia levels of 0.5 mg/mL of higher as the trigger value for follow-up investigation. When this outfall was retested on 10/9/13, it had an ammonia level of 0.125mL. The line of catch basins and swales leading to this outfall was also inspected for possible ammonia sources (such as wetlands). No obvious sources were found. One unmapped swale connection was noted, however, just above Brook Road on the east side of Barre Hill Road.

6. <u>Mapped outfalls that could not be located:</u>

Two outfalls shown on the VT DEC map of the Plainfield stormwater system could not be located and were not assessed. The map shows four outfalls behind the Plainfield Health Center above the retention pond, but only three were found -along with a small pipe that appeared to be a footing drain. The other missing outfall was along Route 2 just west of the Maple Valley Restaurant. This outfall could not be found despite extensive searching. The vegetation in this area was very thick, however, so the outfall may have been overlooked. Attempts to find the nearest catch basin were also unsuccessful. The next catch basin up the line (and at the farthest end of the line) was filled in, so it appeared that this line no longer exists.

Summary and Recommendations

Outfall monitoring in the town of Plainfield by the Friends of the Winooski River during the summer and fall of 2013 resulted in the following major findings, summarized in Table 1:

One unmapped and potentially illicit inlet into the catch basin at the southeast corner of the intersection of Towne Avenue and Martin Meadow Road was discovered. Based on the angle it enters the basin, this connection appears to originate somewhere to the north of the intersection. On four separate visits to this catch basin, flow was observed from the unmapped inlet. This flow tested positive for optical brighteners in three out of three tests. Dye testing of the plumbing connections in three of six houses in the neighborhood directly north of the intersection did not reveal any plugged systems or improper connections. Plumbing systems in these houses were also briefly inspected to determine whether they had a single plumbing outlet. One house, a four-plex on the corner of Martin Meadow and Towne Avenue, had a complex set of connecting sewer lines in its cellar, and it was not possible to determine whether a single sewer line exited this building. As of this writing, the nature of the unmapped connection had not yet been determined. Greg Chamberlin, of the Plainfield Water and Wastewater Departments, will dye test the remaining three houses in the area and will run a camera up the suspect (third) connection into the P-CB-100 catchbasin.

Five outfalls in Plainfield were found to have varying degrees of structural damage ranging from minor corrosion to cracks that disconnected the outfall pipes from the rest of the stormwater system. Two outfalls appeared to need repair or further investigation: P-O-090, behind 29 Martin Meadow Road, where the outfall pipe was broken in two 4 - 5 feet from the end, and P-O-120, behind the Blinking Light Gallery, where it appears that the outfall pipe and its concrete header have become disconnected from the stormwater system. Other outfalls have minor damage (P-O-130, P-O-160, and P-O-190), but follow-up inspection of these outfalls is still merited (see table below).

Three outfalls were partially blocked with sediment. The most severely obstructed outfall was P-O-070, on the Goddard College campus, and should be cleared out, especially if drainage in this area becomes a problem. An outfall along Route 2 (P-O-080) was also about 25% full of sediment, and should be cleaned out. Cleaning out these pipes, however, will probably only serve to temporarily solve these problems. A more permanent solution would involve reducing stormwater flow and erosion above these outfalls.

Seven of Plainfield's outfalls appeared to be contributing sediment to nearby streams, either by causing erosion on slopes below the outfall, or by transporting sediment from other areas through the stormwater system. Outfalls P-O-060, on the Goddard campus, P-O-080, off Route 2 west of the blinking light, and P-O-090, behind 29 Martin Meadow Road, all appeared to be causing significant erosion on downhill slopes. Outfall P-O-150, located along Mill Street near the parking area, is transporting a significant amount of sediment into the nearby rain garden and possibly into the Winooski River below. All four sites would benefit from reduction of stormwater flow through these outfalls. Removal of sediment from the rain garden would improve its capture of stormwater runoff. Outfalls P-O-160, at the Mill Street Bridge; P-O-190, off Recreation Field Road; and P-O-200, off Route 2 east of the blinking light, all seemed to be transporting sediment from up the line, with only P-O-200 contributing significant amounts of sediment to waterway where it empties (the Winooski River). This outfall drains a stream in addition to a section of School Street. The source of the sediment, therefore, could be erosion occurring along this stream or its tributaries. Efforts to reduce stormwater runoff into this stream and along School Street would help reduce the sediment transported into the Winooski via this outfall.

Two other problems associated with the Plainfield outfalls were noted during this monitoring effort. At the Goddard College outfall near the lower parking lot, sediment and debris had been dumped on the slope above the outfall, potentially contributing sediment to the stream below. Disposal of grey sludge into a catch basin on Main Street Extension near Positive Pie was also observed on one occasion, but appeared to have stopped when the site was revisited.

Table 1. Summary of problem outfalls and catch basins:

Structure ID	Location	Problem	Follow-up recommended
P-O-060 (private outfall)	Hill below Goddard lower parking lot	Sediment dumping, erosion, dripping in dry weather (but not sampled)	Take steps to reduce flow into this outfall, eliminate dumping debris and sediment on slope, revisit outfall before leaf-out and sample if flowing
P-O-070 (private outfall)	Goddard campus, off Pitkin	Accumulation of sediment within the structure	Remove sediment if flow reduction becomes a problem
P-O-080 (public outfall)	Route 2 near the intersection with 214.	Accumulation of sediment within the structure, erosion below outfall	Remove sediment if flow reduction becomes a problem, take steps to reduce flow entering this outfall
P-O-090 (public outfall)	Behind 29 Martin Meadow Road	Outfall is broken in two, concrete is disintegrating, eroding bank, positive OB (strong)	Repair outfall, take steps to reduce flow from storm system, install water-spreading skirt below the outfall and fortify bank if necessary, determine source of optical brighteners (see P-CB-100, below)
P-CB-100 (public catchbasin)	SE corner of intersection of Martin Meadow Road and Towne Ave.	Positive OB (strong), unmapped inlet with slow, constant flow	Complete dye-testing of the plumbing connections of nearby homes and businesses and inspect for inappropriate connections.
P-O-120 (public outfall)	S of intersection between Main St Ext and Rte 2, behind Blinking Light Gallery	Outfall pipe and concrete header appear to be disconnected from the storm line	Revisit outfall before leaf-out to confirm damage and inspect for flow and erosion.
P-O-130 (public outfall)	N of intersection of Main St Ext and Mill Street, behind Spiralworks	Outfall pipe is cracked longitudinally in 3 places, may be deforming due to pressure from above, sludge dumping	Inspect pipe to determine the extent of its damage, repair outfall if necessary, revisit occasionally to check for flow
P-O-160	SE side of Mill Street Bridge over Great Brook	Outfall pipe is corroded, edge of pipe is slightly damaged	Inspect pipe occasionally to monitor corrosion, repair when necessary
P-O-190	Off Recreation Fields Road behind apartment building	Concrete outfall is cracking	Inspect outfall pipe occasionally and repair when necessary.
P-O-200	Large outfall behind 72 School Street (Route 2)	Sediment is probably being transported into the Winooski River	Take steps to reduce flow into this outfall by reducing stormwater flow into the stream above and the stormwater system along School Street
P-O-210	Off of Route 2 just west of Maple Valley	Outfall could not be located	Try to locate this outfall in the spring before leaf-out.

General recommendations:

- **Track down the source of the illicit discharge into the catch basin at the intersection of Towne Avenue/Martin Meadow Road**
- **Repair outfalls P-O-090 and P-O-130, and, if necessary, P-O-120, P-O-160, and P-O-190.**
- **Retrofit outfalls P-O-060, P-O-080, and P-O-090 to address the erosion below them.**
- **Encourage the community and property owner about ways to reduce stormwater flow, especially in areas drained by outfalls with erosion and sediment problems. Methods for reducing stormwater runoff involve increasing stormwater infiltration on individual properties. Infiltration may be enhanced by reducing bare and paved areas, converting lawn to perennial gardens or woody shrubs and trees, redirecting gutters away from bare or paved areas and toward vegetation, and disconnecting gutters from the stormwater system.**
- **Educate the community, businesses, and contractors about illegal dumping into catch basins.**

Appendices

Appendix A. Outfall monitoring field observation form

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

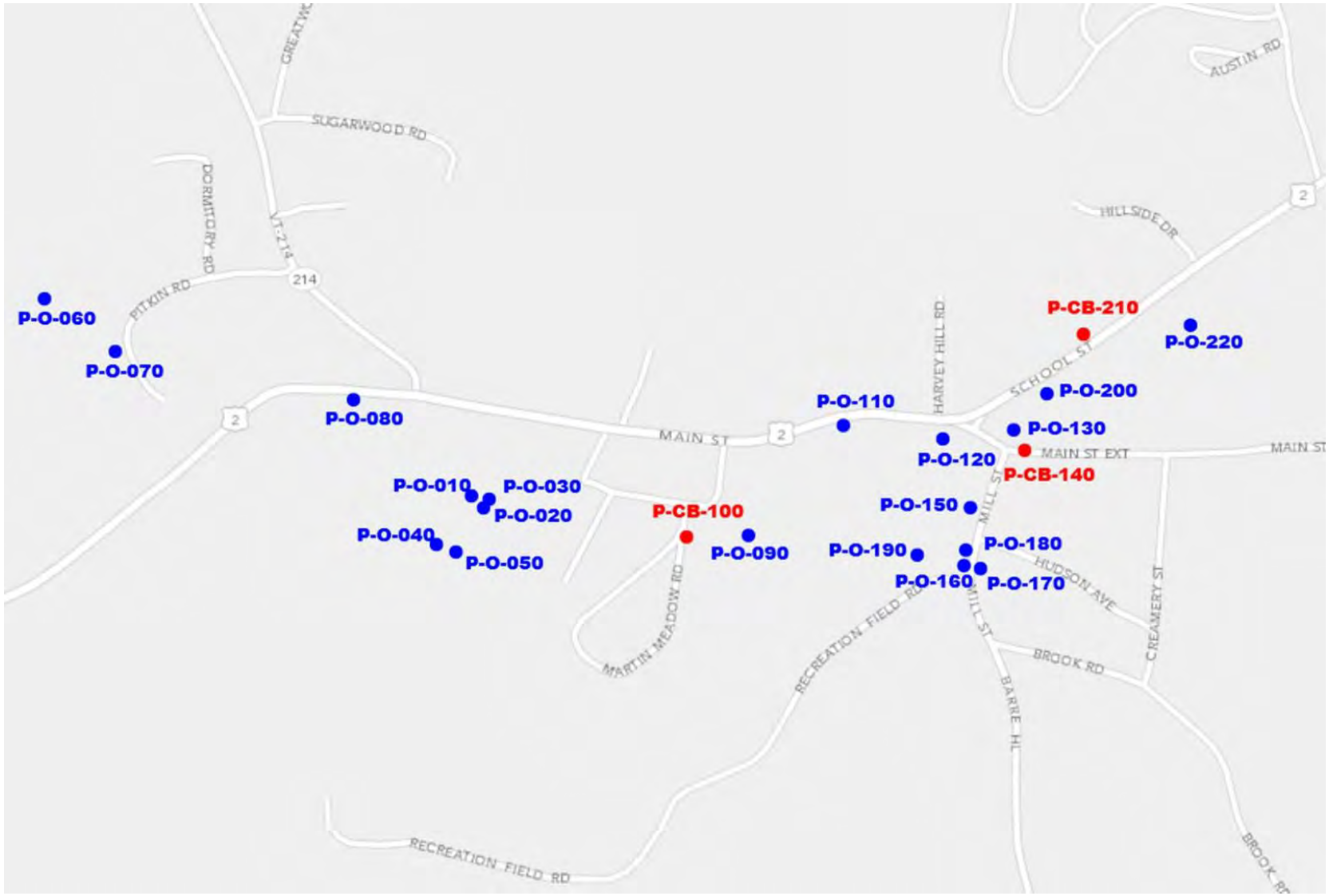
Appendix B. Table of results

Structure ID	Date assessed	Structure	Pipe diam. (in.)	Pipe material	Dry, Wet (no flow), Dripping, or Flowing?	Flow depth (in.)	Pipe position	Erosion	Erosion description	Discharge characteristics	Floatables	Deposits/ Stains	Damage
P-O-010	8/28/13	outfall	12	corrugated black plastic	wet (no flow)	na	free flow	none	na	na	na	flaky rust-colored sediment	none
P-O-020	8/28/13	outfall	12	smooth plastic (green)	dry	na	free flow	none	na	na	na	minor sediment	none
P-O-030	8/28/13	outfall	16	corrugated black plastic	dry	na	free flow	none	na	na	na	sediment and grass litter	none
P-O-040	8/28/13	outfall	16	corrugated black plastic	wet (no flow)	na	free flow	none	na	na	na	none	none
P-O-050	8/28/13	outfall	24	smooth plastic (green)	wet (no flow)	na	free flow	none	na	na	na	none	none
P-O-060	8/28/13	outfall	24	corrugated metal	dripping	unknown	free flow	yes	gully below outfall	unknown	unknown	unknown	unknown
P-O-070	8/28/13	outfall	12	corrugated metal	dry	na	partially buried	none	na	na	na	sediment	none
P-O-080	8/28/13	outfall	12	concrete	dry	na	free flow	yes	channel below	na	na	sediment (fills 1/4 - 1/2 of pipe)	none
P-O-090	8/28/13	outfall	12	concrete	flowing	0.25"	free flow	yes	channel below	clear, no odor	none	none	yes, see comments
	10/9/13												
P-CB-100	8/28/13	catchbasin			flowing								
	10/9/13				flowing								
	10/29/13				flowing					laundry smell			
P-O-110	8/28/13	outfall	12 to 16	corrugated metal	dry	na	free flow	none	na	na	na	none	none
P-O-120	8/28/13	outfall	16	corrugated metal	dry	na	free flow	unknown	na	na	na	none	yes, see comments
P-O-130	8/28/13	outfall	12	cast metal or ceramic	flowing	(see comments)	free flow	none	na	slightly turbid	suds	none	pipe is cracked at bottom
	9/6/13				dry								
P-CB-140	8/28/13	catchbasin											
	8/28/13	catchbasin											
P-O-150	8/28/13	outfall	10	corrugated black plastic	dry		free flow	none	na	na	na	sediment in outfall	none
P-O-160	8/28/13	outfall	18	corrugated metal	dripping	na	free flow	none	na	clear, no odor	none	sediment	corrosion
	9/6/13				dripping								
	10/9/13				dripping								
P-O-170	8/28/13	outfall	16	concrete or cast metal	dry	na	free flow	yes	none	na	na	none	none
P-O-180	8/28/13	outfall	16-18	concrete	dry	na	free flow	none	na	na	na	none	none
P-O-190	8/28/13	outfall	6 to 8	concrete	dry	na	free flow	none	na	na	na	sediment (1/8")	cracking
P-O-200	9/6/13	outfall	54	corrugated metal	flowing	1-2"	free flow	none	none	clear, no odor	none	sediment	none
	10/9/13												
P-CB-210	9/6/13	catchbasin											
P-O-220	9/6/13	outfall											

Table of results, continued.

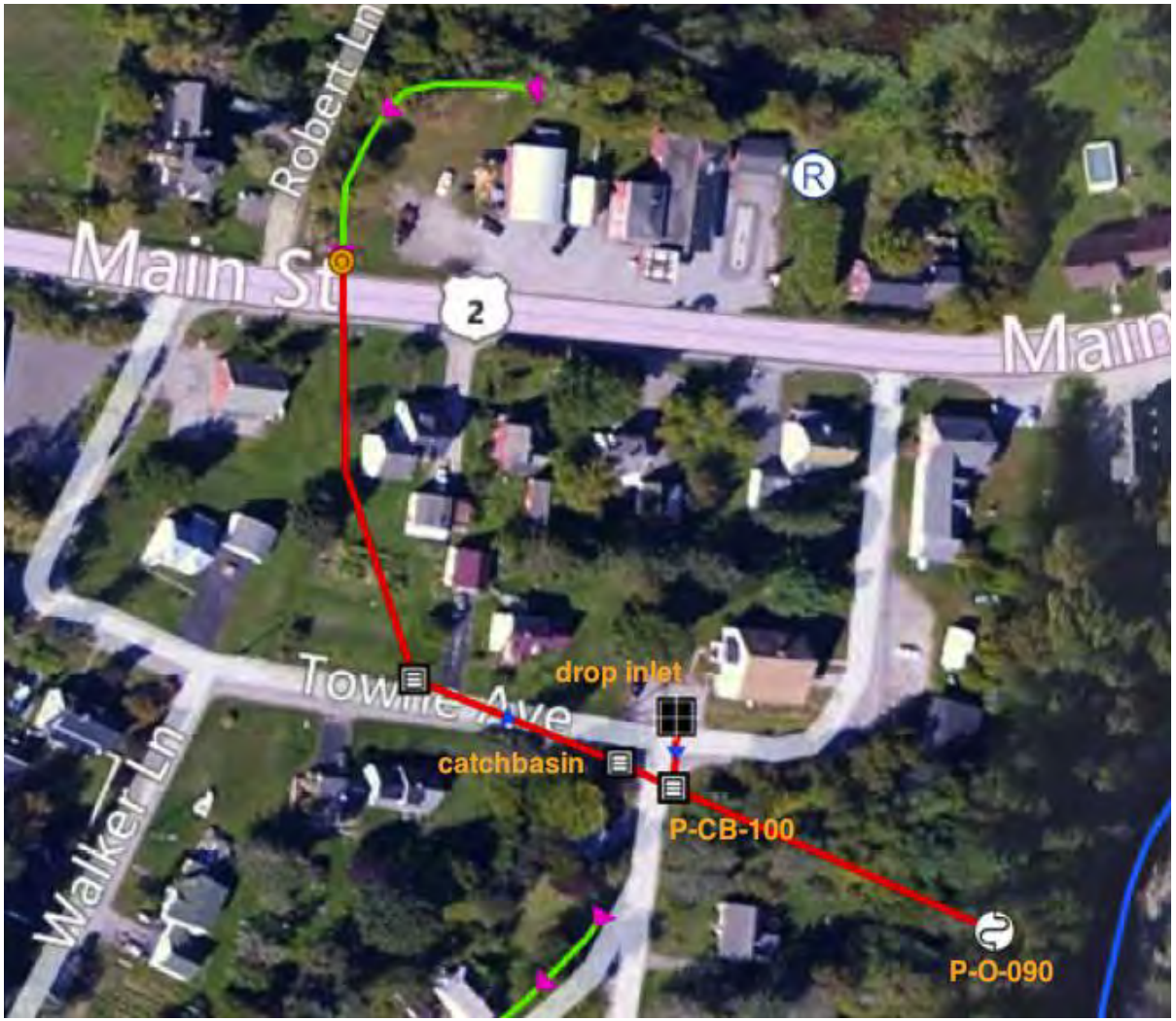
Structure ID	Damage	Obstructions	OB pad set?	Date OB pad retrieved	OB Result	Ammonia (mg/L)	Sp. conductance (µs/cm)	Total Chlorine (mg/L)	MBAS detergents (mg/L)	Date sampled for *E. coli*	*E. coli* (MPN)	Comments
P-O-010	none	none	N	na	na	na	na	na	na	na	na	rock apron, plastic skirt; behind Health Center, far leftmost outfall above pond
P-O-020	none	none	N	na	na	na	na	na	na	na	na	rock apron, plastic skirt; behind Health Center middle outfall above pond
P-O-030	none	none	N	na	na	na	na	na	na	na	na	rock apron, plastic skirt; behind Health Center right-most outfall above pond
P-O-040	none	none	N	na	na	na	na	na	na	na	na	rock apron, plastic skirt, behind Health Center left-most outfall below pond
P-O-050	none	none	N	na	na	na	na	na	na	na	na	rock apron, plastic skirt, behind Health Center right-most outfall below pond
P-O-060	unknown	unknown	N	na	na	na	na	na	na	na	na	Goddard lower parking lot, outfall hard to reach, sediment is being dumped above outfall at the edge of the woods
P-O-070	none	partially ot	N	na	na	na	na	na	na	na	na	off Pitkin, Goddard campus. Both drop inlet and outfall are full of sediment
P-O-080	none	partially ot	N	na	na	na	na	na	na	na	na	Off Rte 2 below Goddard, 1/4 to 1/2 full of sediment, hard to reach
P-O-090	yes, see comments	none	N	na	na	na	na	na	na	na	na	Off Martin Meadow Rd/Towne Ave. 4-5' of pipe end is broken off, concrete has disintegrated, metal frame is exposed
			Y	10/25/13	Positve							OB pad set this time (10/9/13) in section above the break.
P-CB-100			Y	09/06/13	Positive							CB above P-O-090
			Y	10/25/13	Positive							On 10/9/13, pulled grate and found there are 3 pipes connected to this CB (the map only shows two connections). Third pipe is trickling. Laundry/grey water smell. No obvious sewer connection. Set 2 pads: one in 3rd pipe, one in the sump.
										10/29/13	<1	Took sample from pipe that is running for E coli testing. Laundry soap smell.
P-O-110	none		N	na	na	na	na	na	na	na	na	Rte 2, photo taken from above
P-O-120	yes, see comments	none	N	na	na	na	na	na	na	na	na	Behind Blinking Light Gallery, not accessible. Pipe and concrete header appear to be detached from the stormline.
P-O-130	pipe is cracked at bottom	none	N	na	na	~0.5	na	na	na	na	na	Behind Sprialworks, flow went through crack at bottom of pipe and across rock shelf below pipe. Sudsing in water below pipe; dumping of concrete/drywall mud-type stuff by Positive Pie rennovators into CB above
												No suds in river.
P-CB-140												Catch basin in front of Positive Pie seems to be full (to the inlet & outlet) of sludge from Positive Pie rennovations. Communicated with rennovators who said they will stop dumping stuff into the CB. No evidence of dumping, sludge gone from CB
P-O-150	none	partially	N	na	na	na	na	na	na	na	na	Dicharges to Rain Garden. Forebay of RG is full of sediment. RG needs weeding & replanting
P-O-160	corrosion	1/8 full sec	Y	(lost)		~0.5	na	na	na	na	na	Mill Street Bridge downstream left bank
			Y	9/10/13	Negative							Reset lost pad.
			Y	10/25/13	Negative	0.125						10/9/13, followed CBs and swales up from this outfall tesing for NH3. All <0.5 mg/L. Found one connection not on map in BC just up from Barre Rd. This drains a swale to CB/dry well ond line under Barre Rd to CB.
P-O-170	none	none	N	na	na	na	na	na	na	na	na	Mill Street Bridge upstream left bank
P-O-180	none	none	N	na	na	na	na	na	na	na	na	Mill Street Bridge downstream right bank
P-O-190	cracking	none	N	na	na	na	na	na	na	na	na	Off Rec Field Rd
P-O-200	none	none	Y	(lost)		0 - 0.25	264	0.05	0.0	na	na	Across from 79 School Street. 9/19/13, pad lost and outfall submerged, so OB pad not reset
			Y	10/25/13	Negative							10/9/13 pad reset.
P-CB-210			Y	09/19/13	Negative							East of P-O-200 along old sanitary sewer line (converted)
P-O-220												Couldn't find this outfall or the CB directly up the line. CB further up was fill in. Whole line may not exist anymore.

Appendix C. Maps



The locations of Plainfield outfalls and catch basins monitored in this study. The outfalls were numbered in the order in which they were assessed. Blue dots indicate the locations of outfalls, red dots are catch basins.

Appendix C. Maps, continued



The stormwater system line that drains into problem outfall P-O-090. This outfall was flowing in dry weather and tested positive for optical brighteners, an indicator of gray water or raw sewage. An unmapped connection to the catch basin (P-CB-100) directly up the line from P-O-090 was found during this study and is suspected to be the source of the flow. The drop inlet across Towne Ave from P-CB-100 and the catch basin on the other corner were observed to be dry.