# Assessment of stormwater system outfalls in Marshfield, VT

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# Contents

# 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 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 Marshfield.

*A note about outfall ownership:* Most of the outfalls within the village of Marshfield are state owned, particularly in cases where a stormwater system line and the outfall are both along Routes 2 or 215. In some cases, the ownership of an outfall (and the responsibility to address any problems associated with it) may be unclear. For example, when a stormwater system line includes multiple drains, some of which are on state roads and some of which are on town streets, it may be more difficult to assign ownership to an outfall. Stormwater runoff from town–owned or individually owned properties may also cause erosion or sedimentation problems at outfalls technically owned by the state or vice versa. Cooperation between town and state may therefore be required in determining appropriate responses to problem outfalls.

# 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 Marshfield outfalls, outfall pipes were located and, when possible, 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 assessed for four water quality parameters: 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 measured 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 or dripping outfalls, an optical brightener detection pad ("OB pad") was affixed to the inside bottom of the outfall and left in place for 6 days. These pads consist of an untreated cotton pad placed inside a mesh bag. Optical brighteners are present in most laundry soaps and bind to the cotton in these pads. After the bags were retrieved, they were rinsed, dried, and placed under a long wave UV-A ("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 wet outfall was almost completely obstructed by sediment, an OB pad was instead lowered into the catch basin (street drain) immediately up the stormwater system line from 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 "M" for Marshfield), the type of structure (outfall, catch basin, or culvert), and a sequential number system counting by tens. Hence, M-O-010 is the first structure tested in Marshfield and is an outfall, and M-C-070 is the seventh structure tested and is a culvert. Structures with suspected illicit discharges or other problems were flagged for follow-up investigation.

## Exceptions to Screening Process

There were a few exceptions to this process. In two cases (M-O-100 and M-O-110, below Route 2 and Grist Mill Place, respectively), the outfalls were inaccessible due to very steep slopes and/or thick vegetation. M-O-100 could not be reached or observed, so the catch basin immediately above it was inspected (and found to be dry). Outfall M-O-110 was visible from the top of the slope above, but it was not possible to determine whether the outfall was flowing, in good condition, or causing any erosion. The catch basin above M-O-110 was dry. We were also unable to locate outfall M-O-130 (on the upstream side of the Gilman Street bridge). A large pile of brush dumped on the slope may have obscured this outfall.

In one case (M-C-070), a culvert that passed below a residential building and a rubble pile was also tested for water quality.

# Results

**Overview of Results**

Of the 19 mapped outfalls in Marshfield, 17 were found and assessed, along with one culvert (see map of assessed outfalls, Appendix C). One of the mapped outfalls (M-O-130, near the Gilman Street bridge over the Winooski River) could not be located due to a large amount of brush/debris dumped on the bank at that site, and two outfalls were inadvertently overlooked: one at the bottom of Hollister Hill, and one along the drive across from the fire station. These outfalls were difficult to see on the DEC map.

Three structures (M-O-030, M-C-070, and M-O-180) were observed to be flowing despite dry weather. All three of these were tested for ammonia, detergents, chlorine, and conductivity, and all three were found to have acceptable levels of these water quality parameters. Optical brightener pads were left in all flowing outfalls and in the catch basin immediately up the line from one fully obstructed, wet outfall (M-O-170). All tested negative for the presence of optical brighteners. A culvert (M-C-070, also flowing) that passes below a rubble pile and a garage/sugarhouse was also tested for water quality.

Two outfalls (M-O-160 and M-O-170, both along Route 2) were found to be fully obstructed by sediment, and one of these (M-O-170) appeared to be tipping forwards. It appeared as if the obstruction of the M-O-160 outfall pipe (and, perhaps the line that leads to it) was preventing stormwater to drain off Route 2, allowing it to flow across the road and erode the shoulder.

Three outfalls appeared to be contributing sediment to the Winooski River, either by causing erosion on slopes below the outfalls, or by transporting sediment from other areas up the stormwater system. M-O-090, on the south side of Route 2 west of Marshfield Village, appears to be causing an incision to form on the slope below it, an outfall along Gilman Street (M-O-140) is transporting a significant amount of sediment, and the M-O-170 outfall along Route 2 east of the village seems to be both transporting a good deal of sediment and contributing to the formation of a gully below.

Outfall M-O-130, off of Gilman Street, could not be located. Erosion and sediment flow was also observed along Gilman Street above this outfall.

A table with the all the data associated with all 17 assessed structures is included in Appendix B.

**Results for Specific Outfalls and Catch Basins**

**1. <u>Outfalls that were damaged</u>**

One outfall, M-O-170, was possibly damaged.

**Marshfield outfall M-O-170 (Route 2 and Folsom Hill Road)**

Location: On the north side of Route 2 just west of the intersection with Folsom Hill Road.

Description: Concrete header. Diameter of outfall not measurable due to sediment accumulation in front of the outfall. Drains Folsom Hill Road and the area southwest of the Folsom Hill Road/Route 2 intersection, where a large area has been cleared and remains bare. <u>Probably state owned.</u>

Damage: Header appears to be tipping over forwards. Because the outlet of the outfall pipe was almost completely covered by sediment, however, it was difficult to determine the extent of the damage.

**2. <u>Outfalls that were partially or completely obstructed with sediment</u>**

One outfall (M-O-160) was completely obstructed with sediment such that flow through it appeared to be blocked. Another (M-O-170) was almost completely obstructed.

**Marshfield outfall M-O-160 (Route 2, northeast of Marshfield Village)**

Location: North of Route 2, just past the easternmost house in the row of houses across from Folsom Hill Rd.

Description: ~18 inch concrete pipe that drains the swale on the south side of Route 2. <u>State owned.</u>

Obstruction: The outfall pipe is completely full of sediment and very little stormwater, if any, appears to be making its way through this line. The catch basin above is obstructed with brush.

Significant erosion at the road shoulder across from this catch basin and above the outfall is evidence that the stormwater is bypassing this line and running over the bank.

**Marshfield outfall M-O-170 (Route 2 and Folsom Hill Road)**

Location: On the north side of Route 2 just west of the intersection with Folsom Hill Road.

Description: Concrete header. Diameter of outfall pipe not measurable due to sediment accumulation in front of the outfall. Drains Folsom Hill Road and area southwest of the Folsom Hill Road/ Route 2 intersection, where a large area has been cleared and remains bare. <u>Probably state owned.</u>

Obstruction: Outfall is almost completely obstructed with the sediment that has accumulated in front of it. Only a small clearance remains.

**3. <u>Outfalls that seem to be causing erosion or contributing sediment to nearby streams</u>**

Three outfalls (M-O-090, M-O-140, and M-O-170) 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 phosphorous.

**Marshfield outfall M-O-090 (Southeast side of Route 2)**

Location: Outfall on Route 2 west of Marshfield Village near 1832 US Rte 2

Description: ~13 inch smooth plastic. Drains a small section of Route 2. <u>State owned.</u>

Erosion description: Incision below outfall.

**Marshfield outfall M-O-140 (Gillman Street/School Street)**

Location: Outfall on the north side of Gillman Street near its intersection with School Street.

Description: ~20 inch smooth plastic. Drains the south side of Gilman Street. Town owned.

Erosion description: Significant sediment below this outfall that seems to originate above the outfall.

**Marshfield outfall M-O-170 (Route 2 and Folsom Hill Road)**

Location: On the north side of Route 2 just west of the intersection with Folsom Hill Road.

Description: Concrete header. Diameter of outfall not measurable due to sediment accumulation in front of the outfall. Drains Folsom Hill Road and the area southwest of the Folsom Hill Road/Route 2 intersection, where a large area has been cleared and remains bare. (See photo in section 1 above) Probably state owned.

Erosion description: Significant gully channel below outfall. (The photo of this outfall above does not show this erosion.) A large amount of sediment deposited below this outfall indicates this outfall may also be transporting sediment from areas up the stormline from this outfall.

**4. Outfalls and other structures flagged for other reasons:**

**Marshfield outfall M-O-130 (Gilman Street Bridge)**

Location: Outfall on the upstream side of the Gilman Street Bridge north of the Winooski River.

Reason for flag: This outfall could not be found. Rubble and brush have been dumped on the slope where this outfall is mapped, perhaps blocking it. Erosion and sediment flow is occurring on the street above. Probably state owned.

**Drainage hose between outfalls M-O-040 and M-O-050**

Location: Behind trailer on Creamery Road between outfalls M-O-040 and M-O-050 along Creamery Brook.

Reason for flag: Follow-up needed to determine what is being drained with this hose (grey water or condensation from an air conditioner are possibilities). Town responsibility.

## Summary and Recommendations

Outfall monitoring in the town of Marshfield by the Friends of the Winooski River during the summer and fall of 2013 resulted in these major findings (summarized in Table 1 below and given in detail in Appendix B):

Two outfall pipes and one culvert (M-O-030, M-O-180, and M-C-070) were flowing despite dry weather, but water quality tests of the discharge from these outfalls revealed no evidence of illicit discharge into the town's stormwater system. Five of the town's 19 mapped outfalls were not observed directly. Two were inaccessible due to steep slopes and thick vegetation (M-O-100 and M-O-110), and two outfalls (at the bottom of Hollister Hill and along the private drive off Route 2 and across from the fire station) were not visited. The fifth un-assessed outfall on the upstream side of Gilman Street Bridge could not be located and is likely under a large pile of rubble and discarded brush. Erosion and sediment flow along the road above this outfall was severe. The Friends of the Winooski plan to return to these outfalls and make assessments in 2014.

Most of the outfalls in Marshfield appeared to be in good condition. Two outfalls (M-O-160 and M-O-170) along Route 2 east of Marshfield Village, however, were completely (or almost completely) full of sediment and it appeared the stormwater lines were essentially blocked. Because of this blockage, the stormwater that drains through the M-O-160 outfall diverts across Route 2 and appears to be causing significant erosion along the road shoulder. Cleaning out these lines, however, will probably only serve to temporarily solve these problems. A more permanent solution would involve reducing stormwater flow, erosion above these outfalls, and the amount of road sand in the runoff from Route 2.

Three outfalls (M-O-090, M-O-140, and M-O-170) appeared to be causing erosion or transporting sediment from elsewhere to the river. An erosional incision was observed below M-O-090 and a substantial gully has formed below M-O-170. Outfall M-O-140 appears to be transporting sediment from the upstream drainage area since a large sediment deposit was seen below it. Similarly, large sediment deposits directly below M-O-170 indicate that this outfall is transporting sediment that originates up the storm system line. Sediment carries phosphorous into streams and rivers, which in turn transport it to lakes and ponds. Elevated phosphorous reduces water quality of streams, rivers, ponds, and lakes and can cause algal blooms that further reduce water quality. Both sediment transport and erosion can be addressed by stemming the amount and velocity of stormwater running through stormwater lines. Stormwater flow can be reduced by encouraging property owners and the town to reduce paved and bare areas, convert lawn to perennials or woody plants, install rain gardens, disconnect gutters and footing drains from the stormwater system, and redirect gutters to vegetated areas and away from pavement.

## Table 1. Summary of problem outfalls and catch basins:

| Structure ID | Location | Problem | Follow-up recommended |
|---|---|---|---|
| Drainage hose between M-O-040 and M-O-050 (Marshfield) | Behind trailer on Creamery Road, along Creamery Brook. | It is not clear whether this hose is draining grey water, sewage, or some allowable discharge. | Revisit this hose to clarify what is being drained from the trailer to the stream bank. |
| M-O-090 (VTrans) | South side of Route 2 west of Marshfield Village and near 1832 US Rte 2 | Incision below outfall may be carrying sediment into the Winooski River. | Take steps to reduce and slow the flow of stormwater into this outfall. |
| M-O-130 (VTrans?) | Upstream side of the Gilman Street Bridge north of the Winooski River | Large brush and rubble pile over the mapped location of the outfall, severe erosion on road above. | Remove brush and rubble pile, locate and inspect outfall for flow, damage, erosion, and transport of sediment. Stem erosion along the road above. If this outfall cannot be located, the storm lines above should be inspected. |
| M-O-140 (Marshfield) | Near the intersection of Gilman and School streets | Significant sediment has accumulated below this outfall. | Encourage nearby property owners to reduce stormwater runoff and erosion from their properties. |
| M-O-160 (VTrans) | North side of Route 2 east of Marshfield Village. | Outfall is full of sediment and line is unable to transport stormwater. Flow diverts across the road above and is eroding the road shoulder. | Clean out drain system along this line and remove brush on top of the catch basin immediately above this outfall. Take steps to locate the source of the sediment and reduce the sediment load and stormwater flow to this stormwater line. |
| M-O-170 (VTrans and Marshfield) | North of Route 2 east of Marshfield Village | Outfall is blocked by accumulated sediment and gully has formed below. | Remove accumulated sediment in front of the outfall and within the stormwater line above it if necessary. Take steps to locate the source of the sediment and reduce the sediment load and stormwater flow to this stormwater line. |
| Two un-assessed outfalls (one VTrans?, one Marshfield) | One at the bottom of Hollister Hill Road, and one along the drive across from the fire station. | These outfalls were inadvertently overlooked in the initial assessment because they were hard to see on the DEC map. | Revisit the locations of these outfalls and assess. |

**General recommendations:**

- **Address erosion along Gilman Street near the bridge crossing the Winooski River.**
- **Remove brush pile on the upstream (northwest) side of the Gilman Street Bridge and locate M-O-130. Test for water quality if running. If this outfall cannot be found, investigate the catch basins up the line.**
- **Remove the sediment blocking outfalls M-O-160 and M-O-170 along Route 2 and take steps to reduce the amount of sediment and stormwater entering these outfalls. VTDEC will contact VTrans about these two outfalls.**
- **Revisit M-O-090 and M-O-170 to determine if reinforcement of the banks below is needed and feasible.**
- **Revisit the locations of the two outfalls that were overlooked in 2013 and assess.**
- **Determine what is being discharged through the drainage hose behind the trailer near the intersection of Creamery and Main Streets.**
- **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. Examples of strategies to enhance infiltration are 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 community members and road crews about the importance of keeping catch basins and outfalls clear of brush and debris.**

# 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:** | | | | | |

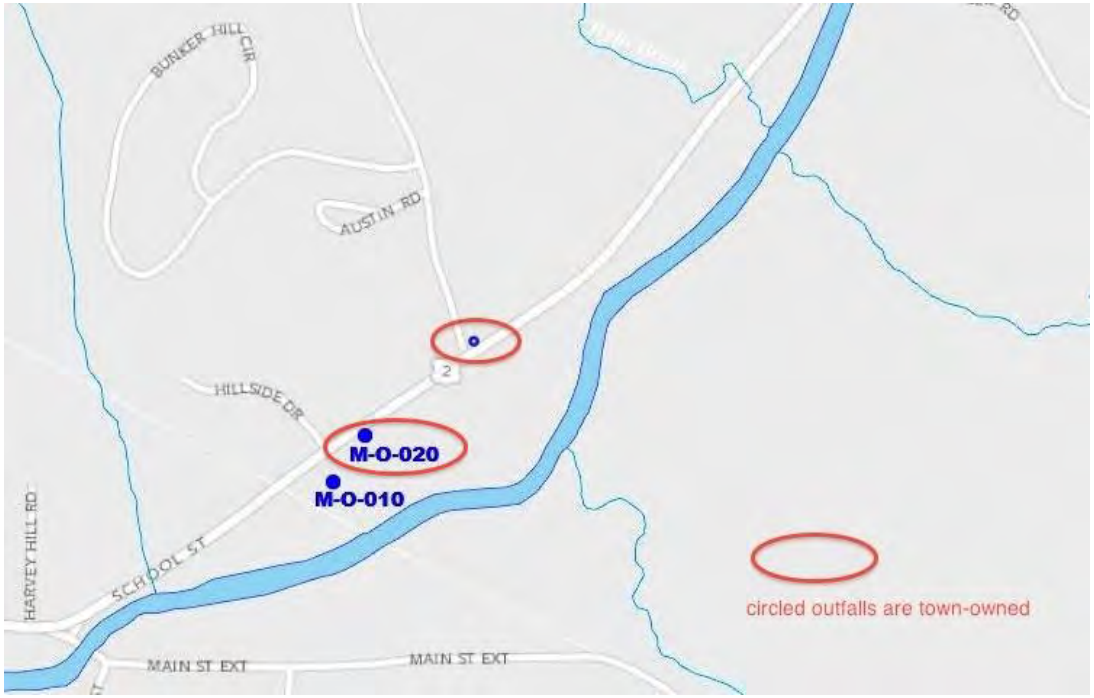
## Appendix B. Table of results

| Structure ID | Date | ID1 | ID2 | Structure type | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M-O-010 | 9/6/13 | AS | SW | outfall | 16 | corrugated metal | dry | na | free flow | none | na | na | na | none |
| M-O-020 | 9/6/13 | AS | SW | outfall | 24 | concrete | dry | na | free flow | none | na | na | na | none |
| M-O-030 | 9/6/13 | AS | SW | outfall | 24 | corrugated metal | flowing | na | free flow | none | na | na | na | Some vegetation |
| M-O-040 | 9/6/13 | AS | SW | outfall | 24 | concrete | dry | na | free flow | none | na | na | na | none |
| M-O-050 | 9/6/13 | AS | SW | outfall | 18 | smooth plastic | dry | na | free flow | none | na | na | na | none |
| M-O-060 | 9/6/13 | AS | SW | outfall | 12 | corrugated metal | dry | na | free flow | none | na | na | na | none |
| M-C-070 | 9/6/13 | AS | SW | outfall | 12 to 18 | corrugated black plastic | flowing | 2" | partially submerged | | | | | |
| M-O-080 | 9/10/13 | AS | SW | outfall | 14 | concrete | dry | na | free flow | none | na | na | na | none |
| M-O-090 | 9/10/13 | AS | SW | outfall | 13 | smooth plastic | dry | na | free flow | Y | small incision | na | na | none |
| M-O-100 | 9/10/13 | AS | SW | outfall | | unknown | unknown | unknown | unknown | unknown | unknown | unknown | unknown | unknown |
| M-O-110 | 9/10/13 | AS | SW | outfall | 12 | corrugated black plastic | dry | na | free flow | unknown | unknown | unknown | unknown | unknown |
| M-O-120 | 9/10/13 | AS | SW | outfall | 6 | corrugated metal | dry | na | free flow | none | na | na | na | none |
| M-O-130 | 9/10/13 | AS | SW | outfall | | | | | | | | | | |
| M-O-140 | 9/10/13 | AS | SW | outfall | 20 | smooth plastic | dry | na | free flow | sediment | na | na | na | none |
| M-O-150 | 9/19/13 | AD | SW | outfall | 18 | concrete | wet | na | partially submerged | none | na | clear, no odor | none | none |
| M-O-160 | 9/19/13 | AD | SW | outfall | 18 | concrete | dry | na | obstructed with sediment | none | na | na | none | sediment |
| M-O-170 | 9/19/13 | AD | SW | outfall | unknown | concrete | wet | na | obstructed with sediment | Y | gully below | clear | none | sediment |
| M-O-180 | 9/19/13 | AD | SW | outfall | 24 | corrugated black plastic | flowing | 0.25 | free flow | none | na | clear, no odor | none | none |

## Appendix B. Table of results, continued

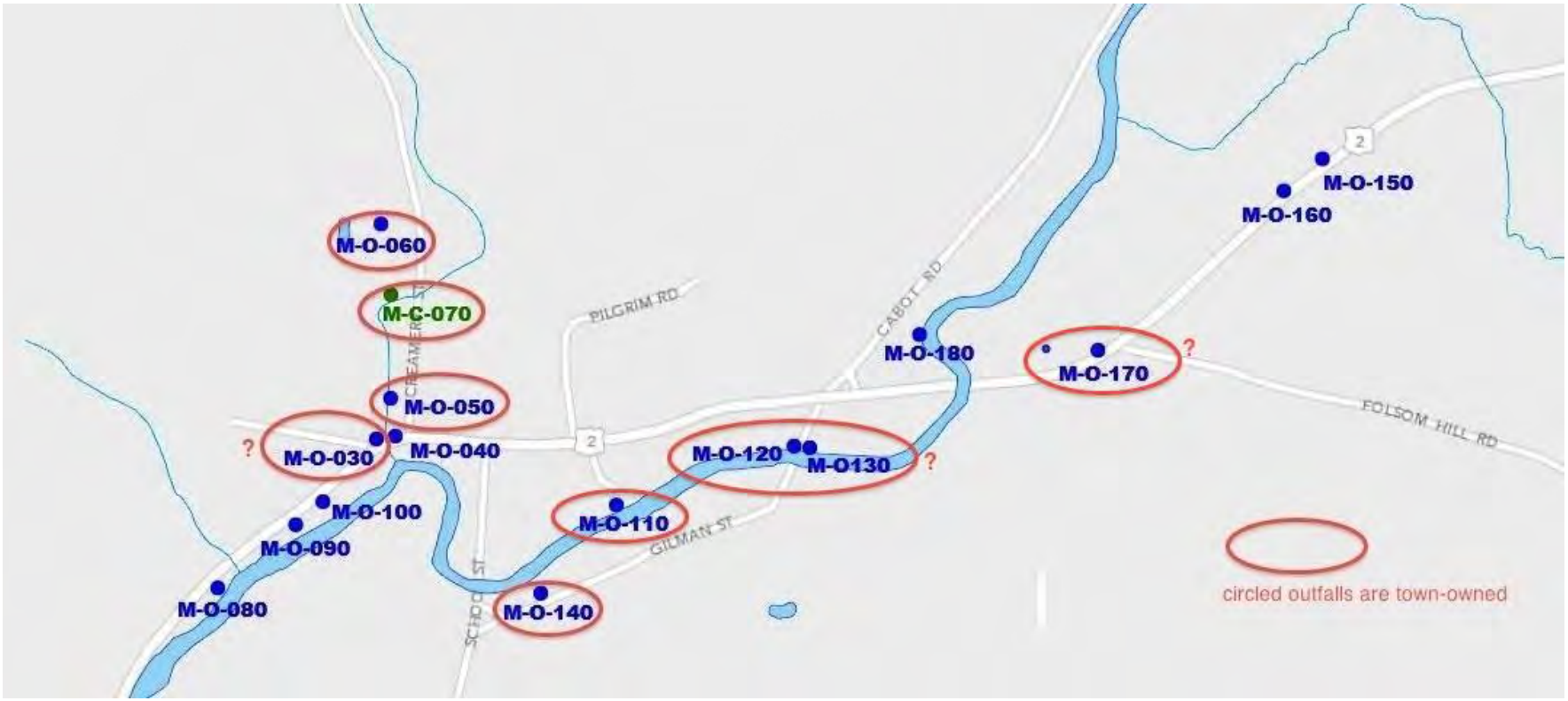
| Structure ID | Damage | Obstructions | OB pad set? | Date OB pad retrieved | OB Result | Ammonia (mg/L) | Sp. conductance (µs/cm) | Total Chlorine (mg/L) | MBAS detergents (mg/L) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| M-O-010 | none | none | N | na | na | na | na | na | na | on Plainfield map; by Maple Valley |
| M-O-020 | none | none | N | na | na | na | na | na | na | on Plainfield map; across from Tim's gas station |
| M-O-030 | none | none | Y | 9/19/13 | negative | 0.3 | 196 | 0.05 | 0.0 | Creamery Brook @ Rte 2W; Swale along N side of English Cemetery Rd was flowing into into storm line; swale on S side of road was dry |
| M-O-040 | none | none | N | na | na | na | na | na | na | Creamery Brook @ Rte 2W; end of long storm line; dry again on 9/10 |
| M-O-050 | none | none | N | na | na | na | na | na | na | slightly up Creamery Brook from Rte 2 |
| M-O-060 | none | none | N | na | na | na | na | na | na | At church on Creamery St. Flows into swale which empties into a culvert that runs below trash and rubble pile. |
| M-C-070 | | | Y (10/9/13) | 10/25/13 | negative | <0.25 | | 0 | 0 | Seems to flow from combined line from swale along Creamery Brook and from culvert that runs below rubble pile. No photo taken. |
| M-O-080 | none | none | N | na | na | na | na | na | na | first outfall along Rte 2 entering town from the West |
| M-O-090 | none | none | N | na | na | na | na | na | na | 2nd outfall along Rte 2 entering town from the West |
| M-O-100 | unknown | unknown | N | na | na | na | na | na | na | 3rd outfall along Rte 2; not observed directly, but catchbasin upstream was dry |
| M-O-110 | unknown | unknown | N | na | na | na | na | na | na | at the end of Grist Mill Place; no photo taken; not observed from below |
| M-O-120 | none | none | N | na | na | na | na | na | na | Gilman Street at the bridge over the Winooski |
| M-O-130 | | | | | | | | | | not located; probably under rubble and brush; *fairly severe erosion along the street above |
| M-O-140 | none | none | N | na | na | na | na | na | na | Gilman Street, lots of sediment below |
| M-O-150 | none | none | N | na | na | na | na | na | na | Rte 2 NE of Marshfld, standing water, no apparent flow, not in res/ag area, no photo taken |
| M-O-160 | none | fully obstructed | N | na | na | na | na | na | na | Rte 2 NE of town, line seems to be fully obstructed, water seems to be bypassing line and crossing the road, where the edge of the pavement is eroding |
| M-O-170 | tipping over? | fully obstructed | Y (in CB above) | 9/25/13 | negative | na | na | na | na | Rte 2, Pad set in CB opposite, sediment obscures OF, needs digging out |
| M-O-180 | none | none | Y | 9/25/13 | negative | 0.25ppm | 196 | 0.03 (free Cl) | 0.125 | On Cabot Rd. Water seems to be coming from footing drain from house across from 58 Cabot and from ditch/stream near footing drain |

## Appendix C. Maps




Locations of mapped outfalls on the southwest side of the town of Marshfield. The small dot near the intersection of Route 2 and Hollister Hill Road (unlabeled) indicates one of two outfalls that were missed in the assessment. Outfalls circled in red are town-owned, while the un-circled outfalls are probably state-owned.

**Appendix C. Maps, continued**




The locations of Marshfield Village outfalls and culverts monitored in this study. The structures were numbered in the order in which they were assessed. Outfalls are shown in blue, culverts in green. The small, unlabeled dot near M-O-170 was one of two outfalls missed in the assessment. Outfalls and culverts circled in red are town-owned, while the un-circled outfalls are probably state-owned. Outfalls M-O-030, M-O-120, M-O-130, M-O-170 and the unassessed outfall (small dot) may have joint ownership.