DETECTION AND ELIMINATION OF NON-STORMWATER DISCHARGES TO THE STREAMS OF THE CITY OF BARRE

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FRIENDS OF THE WINOOSKI RIVER
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Contents

INTRODUCTION

Background

The Stevens Branch, a major tributary to the Winooski River, runs through the City of Barre. The Stevens, in turn, has several tributaries that drain portions of the City; these include the Jail Branch, Gunner Brook, Potash Brook, Edgewood Brook and Aldrich Brook. Although only Gunner Brook (VT08-16) is included on Vermont's 2006 List of Impaired Surface Waters (due to the presence of metals and nutrients attributed to landfill leachate and urban runoff), the other streams in Barre are also affected by the urbanization of their watersheds.

In older urban centers such as Barre, one of the primary water quality concerns is the discharge of materials other than stormwater in the stormwater drainage system. The stormwater drainage system is designed to collect and convey urban runoff. If water is flowing from a stormdrain outfall during a dry period and the source is not one of the generally allowable discharges indicated in the box to the right, then the discharge may be considered illicit. Illicit discharges enter the stormwater drainage system through either direct connections or indirect connections.

Allowable (non-stormwater) discharges to stormwater drainage systems typically include:

- groundwater,
- water line flushing,
- landscape/lawn irrigation,
- diverted stream flows,
- springs,
- water from crawl space pumps,
- potable water,
- foundation/footing drains,
- air conditioner condensation,
- individual car washing,
- dechlorinated swimming pool water, and
- street and bridge wash water.

Examples of **direct connections** include:

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

Examples of **indirect connections** include:

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

The City of Barre's stormwater drainage system discharges to streams and rivers via approximately 130 outfalls within the City limits. These outfalls were recently digitized from the City's utility maps into a Geographic Information System. In addition to documented City-owned outfall pipes, there are a variety of other types of pipes entering Barre streams: outfall pipes from stormwater drainage systems located on private property; foundation drains; relict pipes, which may be disconnected or clogged; and municipal and industrial discharge pipes.

In 2003, the Friends of the Winooski River conducted a visual assessment of 112 discharge points into the streams of Barre City. The assessment was conducted during dry weather, to distinguish between potentially illicit dry weather flows and stormwater runoff. The coordinator and volunteer assistants walked up most of the Stevens Branch and its tributaries. They evaluated any outfall pipe encountered, regardless of its connection to City's stormwater drainage system. Most of the outfall pipes evaluated (approximately 80%) are part of the City's stormwater drainage system. The rest are private. The data recorded for each outfall included notes concerning any obvious pollutant discharges (oily substances, sewage smells, discolored liquids, foams, etc.); type and condition of pipe; and erosion at the outfall site. The coordinator and assistants marked pipe locations on field maps as well as recorded the location of most pipes with a Global Positioning System (GPS) unit. The outfall data were categorized to produce a comprehensive table of information pertaining to each outfall. Although no water samples were collected, the field observations indicated potential pollution entering the City's streams from numerous outfalls. Outfalls with suspected illicit discharges were flagged for follow-up investigation.

Goals of 2006 Study

In 2006, the Friends of the Winooski River proposed a water quality study to follow up on the 2003 observations. This proposal was accepted by the City of Barre and the Department of Environmental Conservation under a Supplemental Environmental Project. FWR subsequently hired Water Science Services, LLC, to design and coordinate the project. The goal of this study was to determine if there were non-stormwater discharges entering the streams of Barre City via the municipal stormwater drainage system, to locate the sources of suspected illicit discharges, and to recommend strategies for eliminating pollution sources where feasible. Because the focus of the study was on detecting and eliminating illicit, non-stormwater discharges, the approach was to evaluate outfalls during dry weather periods.

This study differs from the 2003 assessment in several respects: outfall pipes were selected for monitoring in advance of the field work, based on a review of Barre's utility maps and the data from the 2003 assessment; water quality tests were performed to help identify potential contaminated discharges; and a greater emphasis was placed on following up observed problems through investigation of the contributing stormdrain systems.

This project was not intended as a comprehensive evaluation of outfalls within the Barre City limits. It was intended to cover the major stormwater discharge locations in the City, pipes observed to be flowing or marked for follow-up investigation in FWR's 2003 survey, and other discharge points selected in the field. Many isolated cross-culverts, 1-5 catchbasin drainage networks, and small diameter, unmapped pipes were not evaluated.

METHODS

The general study approach was to select outfalls for monitoring that were considered to have the highest potential for inappropriate discharges; during a dry weather period, to record observations and perform basic water quality tests at these outfalls. Any additional outfalls encountered that were flowing at the time of inspection were also evaluated. FWR and WSS worked with the Public Works department to identify the origin of any suspected inappropriate discharges.

Outfall Selection

FWR selected seventy-eight outfall pipes to monitor during dry weather periods. Most of these outfalls are part of the City of Barre's municipal stormdrain system, but some are private. The following categories of outfalls were prioritized for monitoring:

1) Outfalls evaluated in the 2002-2003 assessment that were either:
    a. Flowing when observed (during dry weather); and/or
    b. Suspected of discharging inappropriate flows at some time and were therefore noted for further review.
2) Outfalls in the City of Barre’s stormdrain system that drain:
    a. The greatest contributing land areas (i.e., those outfalls with the largest “storm sewersheds”); and/or
    b. Industrial areas.

As noted previously, outfalls from small stormdrain systems (i.e., those with five or fewer catchbasins), isolated cross-culverts, and many small diameter, unmapped pipes were generally not selected.

Prior to starting the field work, a series of GIS maps were created which overlaid the City stormwater outfalls and the outfalls observed by FWR in 2002-03 onto orthophotographs. All City outfalls were denoted in green and the FWR outfalls in pink. In both cases, priority outfalls (based on the selection criteria above) were marked with a square. Non-priority outfalls were marked with a triangle. When the FWR outfall data layer and the City outfall data layer were overlaid in GIS, several obvious duplicates could be eliminated from the selected set of outfalls. However, reconciling the outfall positions was not possible in many instances due to inaccuracy in the mapped outfall locations. Therefore, a number of duplicates were identified and reconciled during the field work.

A search of the Vermont Department of Environmental Conservation records was done to identify all permitted (legal) discharges in Barre City, considering both permitted wastewater discharges and permitted stormwater discharges. The only permitted non-stormwater discharge is for the Barre wastewater treatment plant, which is subject to effluent water quality criteria. There are several permitted stormwater discharges, mostly in newer subdivisions.

Outfall Evaluation

<u>General Description</u>

The field work was conducted by Ann Smith of the Friends of the Winooski River, and Dave Braun of Water Science Services, LLC (WSS). Mr. Braun has an extensive background in designing and executing water quality studies. He was primarily responsible for the field design of this study. His resume can be found in Appendix A.

The field work was executed by stream, starting with the smaller streams (Edgewood Brook, Potash Brook and Gunner Brook) and finishing with the larger rivers (Jail Branch and Stevens Branch). The naming convention for the samples was based on receiving stream (SB = Stevens Branch, JB = Jail Branch etc), type of test (stream or outfall) and a sequential number system. Hence SB-O-01 is the first outfall tested on the Stevens Branch. JB-S-02 is the second stream test on the Jail Branch.

The majority of the selected outfalls were inspected when there had been no rain in the preceding 48 hours. A small number were inspected when there had been a minor precipitation event 24 to 48 hours prior to inspection. Because stormdrain systems are designed to carry stormwater, in dry weather all discharges are considered suspect. The goal of dry-weather screening was to document which pipes were flowing and to determine where illicit discharges may be occurring. At the same time that outfalls were being tested, conditions in the receiving stream were monitored to provide a benchmark against which to compare sample results. In-stream monitoring was performed immediately below the most downstream outfall pipe and above the most upstream outfall pipe investigated on a given day. These surface water monitoring data also provide a clearer picture of the water quality of the Stevens Branch, Jail Branch, Edgewood Brook, Potash Brook, and Gunner Brook.

<u>Specific Observations, Tests, and Process</u>

The prioritized outfalls were observed for deposits and stains, abnormal vegetation conditions (noting abundant algae, inhibited plant growth, or other potentially significant conditions), and damage to the structure. The field observation form can be found in Appendix B.

Use of multi-parameter probe at SB-O-18.

If present, dry-weather flows were observed for color, odor, turbidity, and floatable matter. Temperature, pH and conductivity measurements were also made in the field using an Oakton Series 10 multi-parameter probe.

Grab samples of the dry weather flow were collected for laboratory analysis of four water quality parameters: *Escherichia coli (E. coli)*, chlorine (free and total) and potassium. These parameters were measured because they can indicate the presence or absence of a specific type of discharge.

E. coli is a bacteria species prevalent in the gut and feces of all warm blooded animals. It is commonly used as an indicator of the presence of sanitary wastewater. Grab samples were collected from flowing outfalls into sterilized, 100-mL polycarbonate bottles.

Approximately 10% of the samples were collected in duplicate. Samples were placed on ice in the field and transported to the Barre Wastewater Treatment Plant laboratory within 4 hours of collection. A membrane filtration method was used to enumerate *E. coli*. Samples were shaken and an aliquot was withdrawn using a sterile transfer pipette. The aliquot was filtered using a 0.45 micron membrane filter followed by a wash with sterile dilution water. Filters were incubated in growth media for 24 hours. *E. coli* colonies were then counted on the plates. In order to differentiate strongly polluted discharges from elevated background levels, only 1 mL of each outfall sample was typically filtered, instead of the 100 mL generally used in these tests, reducing the number of results given as "too numerous to count". For stream samples, 10 mL aliquots were typically filtered.

Collecting water quality samples at JB-O-12.

Chlorine is added to public water supplies as a disinfectant. It is an indicator of the presence of treated water, which aids in identifying discharges from leaking water supply systems. These tests were conducted by Ms. Smith or Mr. Braun using the LaMotte Dual Range Chlorine Model SL-16 3314 test kit, which tests for free available chlorine and total residual chlorine. Concentrations of combined chlorine may be calculated from these two numbers. The presence of chlorine is indicated by a pink or red color after the reagent is added to the sample. The kit has a detection limit of 0.1 parts per million.

Potassium is a by-product of certain industrial processes and can serve as an indicator of an array of industrial discharges. These tests were conducted by Ms. Smith or Mr. Braun using the LaMotte Potassium Model KIW 3138 test kit. The presence of potassium is indicated by the formation of a white precipitate. The kit has a detection limit of 6 parts per million.

Optical brighteners are the fluorescent white dyes used in laundry detergents. This test will indicate the presence of laundry detergent, which aids in identifying discharges from laundry facilities, failing septic systems, sewage exfiltration, and stormdrain cross-connections. An untreated cotton pad in a mesh bag was placed in the outfalls for 5-7 days. An approximately 5-day exposure period is considered sufficiently long to capture an optical brightener signal from the discharge of laundry washwater to the system. The bag is retrieved, rinsed and dried, and placed under a long wave fluorescent (UVA or “black”) light. Fluorescence indicates optical brighteners. Optical brightener monitoring has the

Optical brightener pad in SB-O-10.

advantage of integrating dry weather flows over the period of exposure (whereas the *E. coli*, chlorine, and potassium analyses were performed on grab samples). Therefore, some types of intermittent or dilute discharges may be detected using optical brightener testing.

The above observations and tests were conducted at all selected outfalls if dry weather flow was present. If no dry weather flow was present, only the visual observations were made and an optical brightener pad was placed in the outfall.

Exceptions to Screening Process

There were a few exceptions to this process. In several cases, there was water back-up(surcharge) from the receiving stream into the pipe. In some cases, the grab samples were collected as far into the outfall as possible; however, in four cases, no grab samples were collected as the flow was deemed too compromised by stream flow. Eight outfalls were not tested with optical brightener pads. Six of these contained backed up water or heavy sedimentation that would have compromised the test. Two pads were lost due to high storm flow.

Follow up Testing Techniques

FWR and WSS worked with the City of Barre to follow up on outfalls that tested at high levels for contaminants. The exact approach depended on the nature of the suspected problem and the drainage system for that outfall. Since there was a significant correlation between high *E. coli* counts and positive optical brightener tests (see below), one approach was to place additional optical brightener pads in catch basins and at key junctions in the drainage system. Through this approach, a problem could be isolated to a particular section(s) of the drainage system. Once this was done, the City would perform dye tests and/or run a camera through the suspect section to identify leaks and cross connections. Additional *E. coli* tests were also conducted at key junctions in the system.

RESULTS AND ANALYSIS

Overview of Results

A total of seventy-eight outfalls were evaluated during a dry weather period. Of the seventy-eight outfalls evaluated, dry weather flows were present at sixty. Twenty-one outfalls had test results that indicated a source of pollution was present. Many of these outfalls tested positive for more than one indicator. Seven of the outfalls had *E. coli* levels above 500 colonies/100 mL. Of these outfalls, six also tested positive for optical brighteners. An additional four outfalls tested positive for optical brighteners but did not have elevated *E. coli* levels. Three had a potassium level equal to or exceeding 6 parts per million. One of these also had a high *E. coli* count. Six outfalls had high conductivity. One of those also had a high *E. coli* count. Two outfalls had a water temperature of greater than 22º centigrade. Two outfalls did not have field or laboratory tests that indicated a problem but one had a sudsy discharge and the other a very strong smell of solvents. A table with the all the data associated with these twenty-one outfalls is included in Appendix C.

As noted in the Methods section, stream samples were taken on each field day, above the most upstream outfall and below the most downstream outfall sampled that day. All results were within expected ranges except for some high *E. coli* results on Potash Brook. In one section of the Stevens Branch, an oily sheen was noted on the surface of the water. These issues are discussed in more detail in the next sections.

Parameter/Test	**Number of Outfalls**
E. coli > 500 colonies/100 mL	7
Chlorine > 0.1 ppm	0
Potassium > 6 ppm	3
Conductivity > 2000 µS/cm	6
Optical brighteners detected	10
Temperature > 22º C	2
Illicit discharge indicated by field observation ONLY	2

Results for Specific Outfalls

There were twenty-one outfalls where the field or laboratory tests or visual observation indicated a potential pollution source. The location of these outfalls is described in the following sections and is indicated on the map in Appendix D.

1. <u>Outfalls with high *E. coli* counts (7)</u>

All but one of the seven outfalls that had high (>500 cfu/100 mL) *E. coli* also tested positive for optical brighteners. The one exception was SB-O-01.

Edgewood Brook EB-O-3 (Camp/Hill/Berkeley)

Location: Outfall into ravine beyond soccer field off Camp Street south of bridge over Edgewood Brook
Description: 18 in. corrugated steel pipe (rusted out). Drains portions of Hill St., Nelson, St., Woodland Drive, Berkeley St., and Camp St.
Water quality: Date = 7/17/06
Flow observation: Clear, slight septic smell
E. coli = Too Numerous To Count (>10,000 cfu/100mL)
Optical brighteners = Positive (strong)
Conductivity: 1067 µS/cm (high)
Retesting on 7/24/06 confirmed high *E. coli* (TNTC)
Follow up: The sanitary and storm sewer lines run very close to each other along Hill Street between Woodland and Nelson. Detergent foam was observed in the storm sewer line on Hill Street and flow had a strong septic smell. The storm system has been jetted with the Vac-Con and televised. The pipe appeared to be in good condition. However, dye testing indicated a possible cross connection. The City plans to conduct additional dye tests and camera work in order to identify possible pipe fracture or misalign joints.

Edgewood Brook EB-O-4 (Camp/Tremont/Delmont)

Location: Pipe discharges into box culvert where Camp St. crosses Edgewood Brook

Description: 24 in. concrete pipe. Drains portions of Camp St., Tremont St., Delmont Ave., Clifton St., and Cassie St.
Water quality: Date = 7/17/06
Flow observation: Clear, slight septic smell
E. coli = 1050 cfu/100 mL
Optical brighteners = Positive
Conductivity: 1174 μS/cm (high)
Retesting on 7/24/06 confirmed fairly high *E. coli* (700 cfu/100 mL)
Follow up: This system drains several blocks on Camp Street and Delmont Street. The Delmont Street line also drains part of Tremont Street. The two flows come together at the intersection of Camp and Tremont Streets. A series of subsequent optical brightener and *E. coli* tests at various points in the drainage system indicated that the most significant problem was in the Delmont Street line from above Clifton Street to Tremont Street. The system was flushed and televised. Follow up sample indicated no E. Coli present. The City will continue to monitor this system semiannually.

Gunner Brook GB-O-4 (Maple Avenue)

Location: Pipe discharges from behind #114 Maple Ave. to Gunner Brook, approximately 300 feet north of Brook St. bridge
Description: 18 in. corrugated steel pipe, rusted through. Drains portion of Maple Ave.
Water quality: Date = 7/27/06
Flow observation: Clear, faint septic smell
E. coli = 4,900 cfu/100 mL
Optical brighteners = Positive
Conductivity: 420 μS/cm (low)
Resampling on 7/31/06 confirmed elevated *E. coli*, though level was lower (1,400 cfu/100 mL)
Follow up: This outfall drains a lengthy section of Maple Avenue from Bridge Street to well above the intersection of Maple Avenue and Merchant Street. There is a drain line on both sides of the street. The west side line runs the entire length of the drainage area. The east side line is only on the lower section of the street and crosses over to join the west side line at the bottom of that line. A subsequent series of *E. coli* tests along the line indicated problems (very high E. coli levels) on the lower sections of both the east and west side lines. Both lines needed to be cleaned to eliminate blockages that were creating stagnant water. Also the line crossing from east side line to the west is in need of some repair work. The City was to conduct additional repair, cleaning and *E. coli* tests. The Friends do not have those results.

Gunner Brook GB-O-5 (Farwell/Newton Street)

Location: Pipe discharges downstream of retaining wall by Buzzi's garage.
Description: 24 in. corrugated steel pipe. Drains portions of Farwell St., Newton St., and Elmwood Ave.

Water quality: Date = 7/27/06
Flow observation: Clear, faint septic smell
E. coli = 1,900 cfu/100 mL
Optical brighteners = Positive
Conductivity: 1659 µS/cm (high)
Resampling on 7/31/06 confirmed elevated *E. coli*, though level was lower (800 cfu/100 mL)

Follow up: Investigation here has been confusing as *E. coli* and OB results at various points in the drainage system seem to be contradictory. Results were also complicated by the accumulated dirt and debris in the line. The lines were cleaned. The City conducted additional *E. coli* tests. The Friends do not have those results.

Stevens Branch SB-O-1 (South Main Street)

Location: Pipe discharges at top of steep bank off South Main St. downhill (west) of Lazer Wash.

Description: 8 in. clay pipe. Drains portions of South Main St. and Quarry St.

Water quality: Date = 8/7/06
Flow observation: Slightly sudsy, amber color. Flow rate only a dribble.
E. coli = 1,700 cfu/100 mL
Optical brighteners = Negative
Conductivity: 210 µS/cm (low)

Follow up: This is the only outfall that had a high *E. coli* count that did not have a positive optical brightener test. The pipe was not flowing when the second field visit was made therefore it was not possible to locate the origin of the *E. coli*. It is possible that at high groundwater levels the storm drainage system is intercepting wastewater flow from a break in the sanitary sewer line, and as the groundwater level falls, the wastewater flow is no longer intercepted but continues to percolate to groundwater. This outfall should be sampled again under higher groundwater levels.

Stevens Branch SB-O-13 (River Street)

Location: Pipe discharges from bank below ball field on River Street.

Description: 12 in. plastic pipe. Drains portions of River St., Center St., and George St.

Water quality: Date = 8/10/06
Flow observation: Strong wastewater odor, grayish color, toilet paper
E. coli = Too Numerous To Count
Optical brighteners = Positive (strong)
Conductivity: 1020 µS/cm
Potassium = 9 ppm (highest observed)

Follow up: In the first storm drain manhole on River St. up from the outfall, a sewer main crossing through the manhole appeared to be leaking. The City patched a hole in the sewer main crossing the first storm drain manhole up from the discharge point.

Follow up visual inspections indicates the joint is watertight. To confirm the correction of the problem, a sample was collected for *E. coli* analysis on 8/30/06. Flow from the pipe appeared clear. The 1,660 cfu/100 mL result indicates that *E. coli* were either still flushing through or that there is a second break in the sanitary line. A subsequent optical brightener pad in early October returned a very low positive result. A subsequent *E. coli* test revealed no additional contamination. The City will continue to monitor this outfall as it has been added to the prevention plan.

Jail Branch JB-O-3 (So. Main/Ayers/Hill St.)

Location: Pipe discharges at south (downstream) side of bridge abutment on west side of South Main St. bridge over Jail Branch.

Description: 16 in. clay pipe. Drains portions of South Main St., Ayers St., Hill St., French St., Orange St., Webster St., Liberty St., Huntington St., and Hilltop Ave.

Water quality: Date = 7/31/06
Flow observation: Clear, no odor. Flow rate only a dribble.
E. coli = 6,600 cfu/100 mL
Optical brighteners = Positive (strong)
Conductivity: 4,650 µS/cm (very high)
Resampling on 8/7/06 yielded higher *E. coli* level of 16,900 cfu/100 mL.

Follow up: The pipe was not flowing when the second field visit was made therefore it was not possible to locate the origin of the *E. coli.* It is possible that at high groundwater levels the storm drainage system is intercepting wastewater flow from a break in the sanitary sewer line, and as the groundwater level falls, the wastewater flow is no longer intercepted but continues to percolate to groundwater. This outfall should be sampled again under higher groundwater levels.

2. <u>Outfalls with Positive Optical Brightener Results but low *E. coli* counts (4)</u>

There were four outfalls where optical brighteners were detected but *E. coli* levels were low or zero. One of the four is the discharge from the Barre Wastewater Treatment Plant, a result that was expected given the presence of detergents in wastewater and effluent disinfection. Results are not presented for the wastewater treatment plant (SB-O-30) because this is a permitted discharge.

Potash Brook PB-O-5 (Veeder Avenue)

Location: Pipe discharges down bank opposite Veeder Ave. at intersection with Currier St.

Description: 10 in. corrugated steel. Drains Veeder Ave. and portions of Currier St. and Snow Ave.

Water quality: Date = 7/20/06
Flow observation: Clear, no odor
E. coli = 100 cfu/100 mL

Optical brighteners = Positive (low)
Conductivity: 1086 µS/cm

Follow up: Dry weather flow observed in drain lines from Currier St. and Snow Ave. and in the catch basin on Veeder Ave. just above Snow Ave. intersection. On 8/30/06, optical brightener results were negative in catch basins on lines draining Currier St. and Snow Ave. Optical brightener was positive but low at the catch basin on Veeder Ave. drain line above Snow Ave. intersection. Also at this catch basin, sound of water running through a valve was heard through drop inlet grate. There is a need to further isolate the problem(s) on Veeder Street.

Stevens Branch SB-O-7 (Granite Street bridge)

Location: Pipe discharges from left (south) bank of Stevens Branch immediately downstream of Granite Street bridge

Description: 24 in. plastic pipe. Drains portions of River St, Granite St., and Garfield Ave.

Water quality: Date = 8/7/06
Flow observation: Clear, no odor
E. coli = 0 cfu/ 100 mL
Optical brighteners = Positive (low)
Conductivity: 1224 µS/cm (low)

Follow up: A second optical brightener pad test was conducted in early October. It tested negative.

Stevens Branch SB-O-14 (Rte. 62 bridge)

Location: Pipe discharges from right (north) bank of Stevens Branch immediately downstream of Rte. 62 bridge

Description: 30 in. concrete pipe. Drains portions of North Main St., Maple Ave., Cottage St., Central St., Granite St., Summer St., Campbell Place, Summer St., and Seminary St.

Water quality: Date = 8/10/06
Flow observation: Partially submerged, clear, no odor
E. coli = 300 cfu/100 mL
Optical brighteners = Positive
Conductivity: 1124 µS/cm

Follow up: A second optical brightener pad test was conducted in early October. It was washed away during a strong storm. A new optical brightener pad needs to be reset.

3. <u>Outfalls with high conductivity (6)</u>

There were six outfalls with conductivity levels in excess of 2000 µS/cm. One of them was JB-O-03, which also had a high *E. coli* level and was described above.

Stevens Branch SB-O-08, SB-O-09, SB-O-10, SB-O-11

Location: These four pipes discharged on the left bank downstream of the Granite Street bridge in very close proximity to each other.

Description: See individual description of outfalls in Appendix C.

Water quality: Date = 8/10/06
Flow observation: All flows were clear with no odor
E. coli = SB-O-09, SB-O-10, SB-O-11: 0 cfu/100 mL
SB-O-08: 100 cfu/100 mL
Optical brighteners = All negative
Conductivity: 2670, 2800, 3220, 3810 µS/cm for SB-O-08, SB-O-09, SB-O-10, SB-O-11 respectively.

Follow up: These four outfalls are in very close proximity to each other. They are on the left bank, not far downstream from the Granite Street bridge. River Street runs very close to the river at this point. On the other side of River Street is an extremely steep hill. Burnham Street and Foster Street angle up this hill from River Street. The investigators speculate that considerable road salt may be used in this area due to the steepness and that these salts may be making their way into the stormdrain system through groundwater flow, resulting in high electrical conductivity. A very wet seep like area where snow may be stored and salts may accumulate was noted on the hill side of River Street, almost directly across from the outfalls.

Jail Branch JB-O-5 (Spaulding High School)

Location: Pipe discharges from left bank of the Jail Branch at the Boynton Street end of the Spaulding High School playing fields.

Description: 16 in. concrete pipe. Drains portions from the Spaulding playing fields.

Water quality: Date = 7/31/06
Flow observation: Clear, no odor; Depth 0.5 to 2 inches
E. coli = 0 cfu/100 mL
Optical brighteners = Negative
Conductivity: 2260 µS/cm

Follow up: No additional follow up was conducted. It may be useful to research what turf treatments are done to the playing field or if there is storage of materials or snow piles in the area.

4. <u>Outfalls with high temperatures (2)</u>

Jail Branch JB-O-1 and JB-O-2 (EF Wall Complex)

Location: Both pipes discharge below building in EF Wall complex.

Description: JB-O-1: Flowing 3 in. pipe contained in 12 in. pipe
JB-O-2: Flowing 5 in. iron pipe

Water quality: Date = 7/31/06
Flow observation: Clear, warm (both pipes)
E. coli = 0 cfu/100 mL (both pipes)
Optical brighteners = Negative (both pipes)
Conductivity: JB-O-1=177 µS/cm (low); JB-O-2=1seventy-eight µS/cm (low)
Temperature: 34 deg Celsius (both pipes)
Chlorine: below 0.1 ppm but detectable pink color (both pipes)

Follow up: These are industrial discharges. There is no apparent contributing stormdrain system. There are no facilities in this area that have a permitted (NPDES) discharge to the Jail Branch. City of Barre to contact owners concerning remedy for apparently illicit discharge of heated water.

5. <u>Outfalls flagged due to field observation (2)</u>

Jail Branch JB-O-12 (Batchelder Street)

Location: Pipe discharges from south (downstream) side of bridge abutment on east side of Ayers St./Batchelder St. bridge over Jail Branch.

Description: 18 in. corrugated steel pipe, rusted out.

Water quality: Date = 7/31/06
Flow observation: Foam issuing from pipe and collecting in large pool of foam below outfall. No odor.
E. coli = 100 cfu/100 mL
Optical brighteners = negative
Conductivity: 777 µS/cm (average)

Follow up: On three subsequent visits, no foam was observed flowing from pipe or in pool below outfall. Based on lack of optical brightener and low *E. coli* result, the foam observed is not likely to have originated from wastewater. It is more likely from vehicle or equipment washing and runoff into a catch basin. City of Barre to will work with Bellavance Trucking and any other businesses in area that may wash vehicles and equipment to ensure wash water does not enter storm drainage system.

Jail Branch JB-O-08 (Boynton St.)

Location: Pipe discharges on the left bank along Boynton Street in the midst of several granite companies.

Description: 14 in. plastic pipe, partially submerged

Water quality: Date = 7/31/06
Flow observation: Clear strong flow with a strong solvent odor.
E. coli = 0 cfu/100 mL
Optical brighteners = negative
Conductivity: 1039 µS/cm (average)

Follow up: Although this outfall tested negative for all of the field and laboratory tests, the strong solvent odor is very troubling. Further investigation and tests should be conducted to determine the source of this odor.

6. <u>Outfalls with high potassium levels (3)</u>

Three outfalls, two of which were described in the previous sections, showed detectible levels ($\geq$ 6 ppm) of potassium. Outfall SB-O-11, described in the “high conductivity” section, had a potassium concentration of 6 ppm. SB-O-13, described in the “high *E. coli*” section, had a concentration of 9 ppm.

Stevens Branch SB-O-20 (Berlin Street)

Location: Pipe discharges on left bank, 150 ft above Berlin St.

Description: 12 in. corrugated steel pipe, rusted out.
Water quality: Date = 8/10/06
Flow observation: The pipe was mostly submerged with stagnant, gray water. No odor.
Potassium level: 18 ppm
E. coli = 100 cfu/100 mL
Optical brighteners = No pad set due to submerged pipe
Conductivity: 772 µS/cm (average)
Follow up: To date no additional follow up has been done.

<u>Specific Stream Monitoring Results</u>

E. coli results on Potash Brook

The stream testing showed potential wastewater contamination of Potash Brook. Samples taken between Maple Grove St. downstream to Jefferson St., where Potash Brook splits in two and flows underground, yielded elevated but highly variable *E. coli* levels. On 7/20/06, the highest result, 1,700 cfu/100 mL, was observed above Jefferson St., just upstream of the split. On 7/26/06, the highest result (1,900 cfu/100 mL) was recorded at the upstream side of the bridge at Maple Grove. It was not possible to pinpoint any outfalls entering Potash Brook through this length that had elevated *E. coli*, although several outfalls were either completely or partially submerged and therefore could not be sampled effectively. The elevated *E. coli* may result from contaminated groundwater seepage into the brook, an undetected outfall, or a submerged or partially submerged outfall, or it may simply be from upstream sources, with the variable levels along the reach a product of timing of flow and deposition, resuspension, or die-off processes occurring through the reach. On August 17th, a comprehensive set of samples was taken along the suspect stretch of Potash Brooke. Levels were generally low, 0-260 cfu/100 mL, possibly due to a drop in the groundwater table. Due to the lack of any identified contaminated inflows, no further investigation was performed.

Our recommended strategy is to perform additional stream sampling along Potash Brook between Jefferson St. upstream to Tremont St. in the spring when groundwater levels are higher, after upstream sources at EB-O-3 and EB-O-4 have been corrected. Identify places where *E. coli* levels increase dramatically (~e.g., 500 cfu/100 mL) between adjacent sampling points. Proceed with investigation of storm drain and/or sanitary sewer near suspected problem spots.

Stevens Branch at Granite Street

An oily sheen was observed in an eddy on the right bank (north) just below the Granite Street bridge. The investigators believe that the sheen is coming from the Barre Coal Tar site which is located just upstream. According to EPA documents, coal tar was discovered to be discharging into the Winooski River from the site in 1983. The property owners, at the direction of theVermont Department of Environmental Conservation (DEC), conducted a site investigation. A large plume of coal tar was identified beneath the surface of the property. The plume was found to be migrating toward the river. Coal tar was discharging to the river causing a noticeable sheen. From 1987 until 1990, property owners operated a series of recovery wells as part of a collection system to recover coal tar. Operation of the recovery wells has minimized, but not eliminated the discharge to the river. In 1990, the property owner filed for bankruptcy, and DEC took over the operation of the recovery system. In 2000, DEC requested EPA's assistance to maintain the recovery system. Federal funding was available to rebuild and maintain the oil recovery system. In 2005, EPA conducted water quality, sediment and biological tests and concluded that there was no detrimental impact from the site. Ms. Smith of FWR has forwarded documentation including a photograph showing the oily sheen to Richard Spiese of DEC.

DISCUSSION

There was a strong correlation between high *E. coli* levels and positive optical brightener results. As noted above, six of the seven outfalls with high *E. coli* levels also tested positive for optical brighteners. An additional three outfalls tested positive for optical brightener but had low *E. coli* levels. This correlation supports the use of optical brightener pads as a screening technique to identify problem outfalls. The advantage of optical brightener testing is that it is inexpensive, easy to perform, and it does not require any special training. The testing can be repeated as needed. Because the pad is left in the pipe for several days, the pipe does not need to be observed while it is flowing. If an outfall does test positive for optical brighteners, the pads can be inserted into catchbasins and tied off on the inlet grate to help isolate the source. Additional tests, including an *E. coli* test, can also be conducted.

Unusually high precipitation and water levels may have had some impact on the results of this study. As noted in the *Specific Results* section, two outfalls (SB-O-01 and JB-O-03) were flowing when first observed and grab samples indicated high *E. coli* levels. By the time follow-up testing was attempted, both outfalls were dry. It may be that at higher levels of groundwater, there is flow occurring between old, leaky sanitary lines and the stormwater lines. For these two outfalls, weekly or bi-weekly observation and testing should begin in the spring, when water tables are likely to be higher, and extend into the drier summer months.

RECOMMENDATIONS

- The drainage systems of outfalls with high *E. coli* levels should be further investigated to isolate the source(s) of the *E. coli.* Once isolated, corrective measures should be taken.
- The City of Barre and the Vermont Department of Environmental Conservation should work with businesses along the streams, particularly those mentioned in the preceding sections, to ensure that they are in compliance with water quality permits and standards. Outfalls of particular note are JB-O-01, JB-O-02, JB-O-08, JB-O-12, and the area of the Stevens Branch upstream of the Granite Street bridge near the site of the gasification plant.

- Land use, particularly road salt application or snow storage, should be investigated near the outfalls with high conductivity. These outfalls are JB-O-05, SB-O-08, SB-O-09, SB-O-10 and SB-O-11.
- A comprehensive in-stream sampling program should be done on Potash Brook. This may be a good project for a high school science class or environmental club.
- Optical brightener tests of untested outfalls should be completed. This project can be completed by volunteers. An outfall with a positive test should be referred to the City for follow-up.
- Education on illegal dumping into storm drains including storm drain stenciling.

DAVID C. BRAUN

EDUCATION

University of Vermont, Burlington, Vermont
M.S., Water Resources, 1997
Thesis: Patterns of Phosphorus Export in Relation to Land Use in the LaPlatte River Watershed, Vermont

Bard College, Annandale-on-Hudson, New York
B.A., Biology, 1992

WORK EXPERIENCE

Water Science Services, LLC.
Montpelier, Vermont, USA
President, founded 2006
Provide technical support for municipalities in stormwater management. Design and manage water resources experiments and monitoring programs.

Stone Environmental, Inc.
Montpelier, Vermont, USA
Project Scientist, 2001 – present
Conduct water resources projects including hydrologic assessments, stormwater modeling and design, water quality monitoring, and field experiments evaluating the fate and transport of pesticides, nutrients, and microbial pathogens in the environment. Responsible for designing studies, executing field trials, presenting and interpreting data, and preparing reports. Perform all phases of project fieldwork. Supervise project staff and subcontractors. Prepare and manage project budgets and schedules. Lead development of Stone Environmental's services in agricultural runoff science.

Stone Environmental, Inc.
Montpelier, Vermont
Staff Scientist, 1997 – 2001
Conducted water resources investigations and studies assessing the environmental fate and transport of pesticides. Performed all phases of project field work, including research site selection, site characterization, instrumentation, and sampling. Analyzed and presented pesticide residue and hydrologic data.

University of Vermont
Burlington, Vermont
Research Assistant, 1995 – 1997
Evaluated phosphorus management strategies in the Winooski River watershed: collected data on phosphorus cycling; constructed phosphorus mass balance models; and performed GIS spatial analyses.

University of Vermont
Burlington, Vermont
Research Assistant, 1994 – 1995
Researched relationships between phosphorus loading and land use in the LaPlatte River watershed. Conducted water sampling and stream gaging at 28 monitoring stations; analyzed samples; and performed GIS spatial analysis.

PUBLICATIONS

Author of numerous confidential reports for private sector clients

Braun, D.C., and D.W. Meals. 2004. "Demonstration of Methods to Reduce *E. coli* Levels in Agricultural Runoff in Vermont." Abstract Proceedings of the American Water Resources Association 2004 Annual Conference.

Braun, D.C., L.J. Windhausen, and D. Wang. 1996. "Seasonal variation in phosphorus export as a function of land use in subwatersheds of the LaPlatte River Basin, VT." Ecological Society of America Bulletin, 77(3):51 (poster and abstract).

Cassell, E.A., J.M. Dorioz, R.L. Kort, J.P. Hoffman, D.W. Meals, D. Kirschtel, and D.C. Braun. 1998. "Modeling Phosphorus Dynamics in Ecosystems: Mass Balance and Dynamic Simulation Approaches." *J. Environmental Quality* 27:293-298.

Cassell, E.A., R.L. Kort, and D.C. Braun. 1998. "Dynamic Simulation Modeling for Watershed Ecosystem Analysis of Phosphorus Budgets." University of Vermont, USDA, and NRCS.

Etnier, C., D.C. Braun, A. Grenier, A. Macrellis, R.J. Miles, and T.C. White. Submitted. "Micro-scale evaluation of phosphorus removal—Part II: Alternative wastewater system evaluation." National Decentralized Water Resources Capacity Development Project. Project No. WU-HT- 03-22. St. Louis, Missouri.

Meals, D.W., and D.C. Braun. 2006. "Demonstration of Methods to Reduce *E. coli* Runoff from Dairy Manure Application Sites." *J. Environmental Quality* 35:1088-1100.

Meals, D.W., and D.C. Braun. 2005. "Demonstration of Methods to

Reduce Indicator Bacteria Levels in Agricultural Runoff in Vermont." Final Report. Lake Champlain Basin Program, Grand Isle, Vermont.

Wang, D., J.M. Dorioz, D. Trevisan, D.C. Braun, L.J. Windhausen, and J.Y. Vansteeleant. 2003. "Using a landscape scale approach to interpret diffuse phosphorus pollution and assist with water quality management in the basins of Lake Champlain (Vermont) and Lac Leman (France)." In T.O. Manley and P.L. Manley, eds., Lake Champlain in the New Millenium. Water Science and Application. Vol. 2. American Geophysical Union.

Wang, D., E.A. Cassell, J.C. Drake, J.P. Hoffman, S. Levine, D.W. Meals, D.C. Braun, A. Brown, D. Pelton, H. Sabunia, L.J. Windhausen. 1996. "Influences on phosphorus output from a rural river in the Lake Champlain Basin, Vermont." Ecological Society of America Bulletin, 77(3):467 (poster and abstract).

Windhausen, L.J., D.C. Braun, and D. Wang. 2003. "A landscape scale evaluation of phosphorus retention in wetlands of the LaPlatte River Basin, Vermont, USA." In T.O. Manley and P.L. Manley, eds., Lake Champlain in the New Millenium. Water Science and Application. Vol. 2. American Geophysical Union.

ADDITIONAL EDUCATION

Stormwater Hydrology and Volumetric Design. SUNY College of Environmental Science and Forestry. February 1-2, 2005

Infiltration and Filtering Practices for Stormwater. SUNY College of Environmental Science and Forestry. March 29-30, 2005

Erosion and Sediment Control Site Planning. SUNY College of Environmental Science and Forestry. May 3-4, 2005

Phase 2 Stream Geomorphic Assessment Training. Vermont Department of Environmental Conservation. May 24-26, 2005

Hydrology for Engineers. USDA Graduate School, 2003

Hazardous Waste General Site Worker Training (OSHA 29CFR1910.120), 1998, 2002

Microsoft Access level II, 6/14/02

PMI Project Management Seminar Series, 2001. Presented by Project Management Institute, Waterbury, VT, January 23, 2001

Good Laboratory Practices Practical Approach Seminar. Montpelier, Vermont, March 30, 2000, West Coast Quality Training Institute

EPA Worker Protection Training - Certified Pesticide Handler, 1999

HONORS AND AWARDS

Paul Williams Scholarship for academic distinction and commitment to public service, May 1991.

SKILLS

Installation, programming, and use of flow meters, automatic samplers, pressure transducers, water quality sondes, and weather stations

Monitoring well installation

Hydraulic conductivity testing of saturated zone and vadose zone sediments

Soil classification and sampling

Stream discharge measurement

Basic topographic survey

Water quality analyses: phosphorus, TSS, pH, alkalinity, DO, BOD, chlorophyll a, total coliform

Hydrologic modeling: TR55 and TR20

Computer applications: Microsoft Office suite, Microsoft Access, ArcMap GIS, Microcal Origin, Corel Draw, Aquifer Test

PROFESSIONAL AND COMMUNITY ACTIVITIES

American Water Resources Association

Water Environment Federation

Secretary of the *Friends of the Winooski River*, 1997 – 2002
Promote organizational development and manage local pollution reduction projects.

Appendix B

Barre Outfall Inspection Checklist and Sampling Form

Structure ID: ________________________________							
Date: ____________________		Time: _____________________					
Inspector: ____							
Date of last rainfall greater than 0.1 inches: ________________________							
Physical Observations (circle and/or comment as appropriate)							
Is mapped location accurate?	Yes	No	(If NO, mark correction)				
Pipe flow depth:	dry	<½ in.	½ - 2 in.	2 - 4 in.	4 – 8 in.	>8 in.	
Observations on flow (Color, odor, turbidity, trash):							
Observation at outlfall (Deposits, stains, abnormal vegetation condition):							
Damage to structure:	None	cracking, chipping	erosion	corrosion	other_________________________		
Water quality (field):	Temp (ºC):		Conductivity (µS/cm^2):			pH:	
Water quality (lab)	Free Cl (ppm):		Total Cl (ppm):			K (ppm):	
OB pad set?	No	Yes	If YES, OB Sampler ID_____________________				
Water sample for *E. coli* collected?	No	Yes	If YES, Sample ID_________________________				
Comments:							

Appendix C

Potential Problem Outfalls

Structure ID: EB-O-03 *Ownership* Public *Location:* Side channel near ballfield on Camp St *Outfall Description:* 18 in corrugated steel Completely ru
Obs # 1 *Flow Depth:* Unknown *Flow Observations:* Clear, slight septic *Temperature:* 19.4 *pH:* 7.3 *Conductivity:* 1067
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* > 10000 *Optical Brightener Results:* Positive
FWR ID None *Study Year:* 2006 *2006 Comment* sampled instream due to pipe failure
2003 Key Data *Discharge:* *Volume:* *Turbidity:* *Remarks:*

Structure ID: EB-O-03 *Ownership* Public *Location:* Side channel near ballfield on Camp St *Outfall Description:* 18 in corrugated steel Completely ru
Obs # 2 *Flow Depth:* Unknown *Flow Observations:* Clear, slight septic *Temperature:* 18.6 *pH:* 7.5 *Conductivity:* 1066
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* > 10000 *Optical Brightener Results:* Positive
FWR ID None *Study Year:* 2006 *2006 Comment* sampled instream due to pipe failure
2003 Key Data *Discharge:* *Volume:* *Turbidity:* *Remarks:*

Structure ID: EB-O-04 *Ownership* Public *Location:* In box culvert under street *Outfall Description:* 24 in concrete None
Obs # 1 *Flow Depth:* .5 - 2 in *Flow Observations:* Clear, slight septic *Temperature:* 19.3 *pH:* 7.5 *Conductivity:* 1174
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 1050 *Optical Brightener Results:* Positive
FWR ID EB-MB-04 *Study Year:* Both *2006 Comment*
2003 Key Data *Discharge:* Yes *Volume:* Slow *Turbidity:* Clear *Remarks:* Stormwater from street drains. Outlet under bridge.

Structure ID: EB-O-04 *Ownership* Public *Location:* In box culvert under street, Delmont St? *Outfall Description:* 24 in concrete None
Obs # 2 *Flow Depth:* .5 - 2 in *Flow Observations:* Clear, slight septic *Temperature:* 18.8 *pH:* 7.9 *Conductivity:* 997
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 700 *Optical Brightener Results:* Positive
FWR ID EB-MB-04 *Study Year:* Both *2006 Comment*
2003 Key Data *Discharge:* Yes *Volume:* Slow *Turbidity:* Clear *Remarks:* Stormwater from street drains. Outlet under bridge.

Structure ID: GB-O-04 *Ownership* Public *Location:* Across from GB-O-5, A bit downstream *Outfall Description:* 18 in CSP Rusted out, fl
Obs # 1 *Flow Depth:* .5 to 2 in *Flow Observations:* Clear, faint septic s *Temperature:* 18.8 *pH:* 7.7 *Conductivity:* 420
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 4900 *Optical Brightener Results:* Positive
FWR ID GB-MB-1 *Study Year:* Both *2006 Comment* FWR GPS was off = City pt at Newton, FWR GPS
2003 Key Data *Discharge:* Yes *Volume:* Trickle *Turbidity:* Clear *Remarks:* FLAG. Extends 5' from bank. Pipe is cracked and rusted, water disch

Potential Problem Outfalls

Structure ID: GB-O-04 *Ownership* Public *Location:* Across from GB-O-5, a bit downstream *Outfall Description:* 18 in CSP Rusted out, fl

Obs # 2 *Flow Depth:* .5 to 2 in *Flow Observations:* Clear, faint septic s *Temperature:* *pH:* *Conductivity:*

Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 1400 *Optical Brightener Results:* Positive

FWR ID GB-MB-1 *Study Year:* Both *2006 Comment* FWR GPS was off = City pt at Newton, FWR GPS

2003 Key Data *Discharge:* Yes *Volume:* Trickle *Turbidity:* Clear *Remarks:* FLAG. Extends 5' from bank. Pipe is cracked and rusted, water disch

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Structure ID: GB-O-05 *Ownership* Public *Location:* Near intersection of Newton&Farwell *Outfall Description:* 24 in CSP Minor corrsio

Obs # 1 *Flow Depth:* < .5 in *Flow Observations:* Clear, faint septic *Temperature:* 17.3 *pH:* 7.4 *Conductivity:* 1659

Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 1900 *Optical Brightener Results:* Positive

FWR ID GB-MB-1 *Study Year:* Both *2006 Comment* FWR GPS was off = City pt at Newton, FWR GPS

2003 Key Data *Discharge:* Yes *Volume:* Trickle *Turbidity:* Clear *Remarks:* Grey silt near outlet - granite dust? New granite placed along bank ups

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Structure ID: GB-O-05 *Ownership* Public *Location:* Near intersection of Newton&Farwell *Outfall Description:* 24 in CSP Minor corrsio

Obs # 2 *Flow Depth:* < .5 in *Flow Observations:* Clear, faint septic *Temperature:* *pH:* *Conductivity:*

Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 800 *Optical Brightener Results:* Positive

FWR ID GB-MB-1 *Study Year:* Both *2006 Comment* FWR GPS was off = City pt at Newton, FWR GPS

2003 Key Data *Discharge:* Yes *Volume:* Trickle *Turbidity:* Clear *Remarks:* Grey silt near outlet - granite dust? New granite placed along bank ups

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Structure ID: JB-O-01 *Ownership* Privat *Location:* Below business in EF Wall Plaza *Outfall Description:* 3 pipes inside 12 in pi Minor corrosi

Obs # 1 *Flow Depth:* < .5 in *Flow Observations:* Clear, warm *Temperature:* 34.3 *pH:* 7.2 *Conductivity:* 177

Free Cl (ppm): < .1 *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 0 *Optical Brightener Results:* Negative

FWR ID JB-FC-01 *Study Year:* Both *2006 Comment* Three pipes (3 in and two 2 in ones) inside a 12 in pipe; All iron; The 3 inch was running; no city poir

2003 Key Data *Discharge:* Yes *Volume:* Fast *Turbidity:* Clear *Remarks:* Hot water. Flag. Opposite GMP transfer station.

Structure ID: JB-O-02 *Ownership* Privat *Location:* Below business in EF Wall Plaza *Outfall Description:* 5 inch iron pipe Corrosion an

Obs # 1 *Flow Depth:* < .5 in *Flow Observations:* Clear, warm *Temperature:* 34.1 *pH:* 7.1 *Conductivity:* 178

Free Cl (ppm): < .1 *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 0 *Optical Brightener Results:* Negative

FWR ID JB-FC-02 *Study Year:* Both *2006 Comment* Right next to JB-O-1, both are below the Wall Street Plaza

2003 Key Data *Discharge:* Yes *Volume:* Modera *Turbidity:* Clear *Remarks:* Hot water. Factory opposite GMP transfer station. Flag.

Potential Problem Outfalls

Structure ID: JB-O-03 *Ownership* Public *Location:* Next to Main St bridge abutment on down *Outfall Description:* 16 in clay Cracked
Obs # 1 *Flow Depth:* < .5 in *Flow Observations:* Clear, no odor *Temperature:* 20.6 *pH:* 7.6 *Conductivity:* 4650
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 6600 *Optical Brightener Results:* Positive
FWR ID None *Study Year:* 2006 *2006 Comment* DS of Main St bridge abutment
2003 Key Data *Discharge:* *Volume:* *Turbidity:* *Remarks:*

Structure ID: JB-O-03 *Ownership* Public *Location:* Next to Main St bridge abutment on down *Outfall Description:* 16 in clay Cracked
Obs # 1 *Flow Depth:* < .5 in *Flow Observations:* Clear, no odor *Temperature:* *pH:* *Conductivity:* 4650
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 16900 *Optical Brightener Results:* Positive
FWR ID None *Study Year:* 2006 *2006 Comment* DS of Main St bridge abutment
2003 Key Data *Discharge:* *Volume:* *Turbidity:* *Remarks:*

Structure ID: JB-O-05 *Ownership* Privat *Location:* Below Boynton St end of Spaulding playin *Outfall Description:* 16 in concrete None
Obs # 1 *Flow Depth:* .5 in to 2 i *Flow Observations:* Clear, no odor *Temperature:* 16.9 *pH:* 7.0 *Conductivity:* 2260
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 0 *Optical Brightener Results:* Negative
FWR ID JB-FC-04 *Study Year:* Both *2006 Comment* Directly across stream from JB-FC-05 (an 8 in steel (dry) pipe)
2003 Key Data *Discharge:* Yes *Volume:* Trickle *Turbidity:* Clear *Remarks:* Iron pipe set in concrete block. Opposite JB-FC-05

Structure ID: JB-O-08 *Ownership* Public *Location:* Before long building on Boynton St *Outfall Description:* 14 in plastic, partially s None
Obs # 1 *Flow Depth:* 2-4 in *Flow Observations:* Strong flow, clear w *Temperature:* 15.6 *pH:* 7 *Conductivity:* 1039
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 0 *Optical Brightener Results:* Negative
FWR ID JB-FC-07 *Study Year:* Both *2006 Comment*
2003 Key Data *Discharge:* Yes *Volume:* Modera *Turbidity:* Clear *Remarks:* Recently installed - storm?

Structure ID: JB-O-12 *Ownership* Public *Location:* Below Ayers Street bridge, 5 ft up in bridg *Outfall Description:* 18 in CSP pipe, Rusted out
Obs # 1 *Flow Depth:* .5 to 2 in *Flow Observations:* Flow is foamy, hug *Temperature:* 17.7 *pH:* 7.5 *Conductivity:* 777
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 100 *Optical Brightener Results:* Negative
FWR ID JB-FC-10 *Study Year:* Both *2006 Comment* DS of Ayers St bridge, in wall
2003 Key Data *Discharge:* Yes *Volume:* Trickle *Turbidity:* Clear *Remarks:*

Potential Problem Outfalls

Structure ID: PB-O-05 *Ownership* Public *Location:* Behind house at Veeder St/Currier *Outfall Description:* 10 in corrugated steel, minor corrosi

Obs # 1 *Flow Depth:* < .5 in *Flow Observations:* Clear, no odor *Temperature:* 19.3 *pH:* 8 *Conductivity:* 1086

Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 100 *Optical Brightener Results:* Positive

FWR ID None *Study Year:* 2006 *2006 Comment* Photo 7

2003 Key Data *Discharge:* *Volume:* *Turbidity:* *Remarks:*

Structure ID: SB-O-01 *Ownership* Public *Location:* High up on bank, downstream from Laser *Outfall Description:* 8 in clay None

Obs # 1 *Flow Depth:* < .5 *Flow Observations:* Slightly sudsy, amb *Temperature:* 20.8 *pH:* 6.7 *Conductivity:* 210

Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 s *E. coli Results per 100mL:* 1700 *Optical Brightener Results:* Negative

FWR ID None *Study Year:* 2006 *2006 Comment* Very high up on bank, straight in from manhole; not running when rechecked a week or two later

2003 Key Data *Discharge:* *Volume:* *Turbidity:* *Remarks:*

Structure ID: SB-O-07 *Ownership* Public *Location:* Downstream of Granite St. bridge on left *Outfall Description:* 24 in plastic None

Obs # 1 *Flow Depth:* .5 to 2 in *Flow Observations:* Clear, no odor *Temperature:* 17 *pH:* 7.5 *Conductivity:* 1224

Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 0 *Optical Brightener Results:* Positive

FWR ID SB-FC-16 *Study Year:* Both *2006 Comment*

2003 Key Data *Discharge:* Yes *Volume:* Slow *Turbidity:* Clear *Remarks:* Pale grey deposits on bank material beneath outfall

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Structure ID: SB-O-08 *Ownership* Public *Location:* Below Granite St, Left bank @ end of row *Outfall Description:* 18 in plastic None

Obs # 1 *Flow Depth:* Trickle *Flow Observations:* Clear, no odor *Temperature:* 18.5 *pH:* 7.4 *Conductivity:* 2670

Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 100 *Optical Brightener Results:* Negative

FWR ID None *Study Year:* 2006 *2006 Comment* Three pipes (8, 9, 10) all together

2003 Key Data *Discharge:* *Volume:* *Turbidity:* *Remarks:*

Structure ID: SB-O-09 *Ownership* Privat *Location:* Below Granite St, Left bank @ end of row *Outfall Description:* 18 in plastic None

Obs # 1 *Flow Depth:* Trickle *Flow Observations:* Clear, no odor *Temperature:* 17.5 *pH:* 7.2 *Conductivity:* 2800

Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 0 *Optical Brightener Results:* Negative

FWR ID None *Study Year:* 2006 *2006 Comment* Three pipes (8, 9, 10) all together

2003 Key Data *Discharge:* *Volume:* *Turbidity:* *Remarks:*

Potential Problem Outfalls

Structure ID: SB-O-10 *Ownership* Public *Location:* Below Granite St, Left bank @ end of row *Outfall Description:* 12 in plastic None
Obs # 1 *Flow Depth:* < .5 *Flow Observations:* Clear, no odor *Temperature:* 17.1 *pH:* 7.2 *Conductivity:* 3220
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 0 *Optical Brightener Results:* Negative
FWR ID SB-FC-14 *Study Year:* Both *2006 Comment* Three pipes (8, 9, 10) all together
2003 Key Data *Discharge:* Yes *Volume:* Trickle *Turbidity:* Clear *Remarks:*

Structure ID: SB-O-11 *Ownership* Public *Location:* Along River St on left bank *Outfall Description:* 16 in plastic None
Obs # 1 *Flow Depth:* < .5 in *Flow Observations:* Clear, no odor *Temperature:* 13.2 *pH:* 7.4 *Conductivity:* 3810
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* = 6 *E. coli Results per 100mL:* 0 *Optical Brightener Results:* Negative
FWR ID SB-FC-13 *Study Year:* Both *2006 Comment*
2003 Key Data *Discharge:* Yes *Volume:* Trickle *Turbidity:* Clear *Remarks:*

Structure ID: SB-O-13 *Ownership* Public *Location:* At ballfield on River St *Outfall Description:* 12 in plastic None
Obs # 1 *Flow Depth:* .5 to 2 in *Flow Observations:* Strong septic odor, *Temperature:* 16.6 *pH:* 7.5 *Conductivity:* 1020
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* = 9 *E. coli Results per 100mL:* >10000 *Optical Brightener Results:* Positive
FWR ID SB-FC-11 *Study Year:* Both *2006 Comment* Raw water sample was cloudy but less than < 6 for K
2003 Key Data *Discharge:* Yes *Volume:* Slow *Turbidity:* Clear *Remarks:* Stream culvert?

Structure ID: SB-O-14 *Ownership* Privat *Location:* On right bank just below Rte 62 *Outfall Description:* 30 in concrete None
Obs # 1 *Flow Depth:* 2 to 4 in *Flow Observations:* Partially submerged *Temperature:* 17.5 *pH:* 7.8 *Conductivity:* 1124
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 *E. coli Results per 100mL:* 300 *Optical Brightener Results:* Positive
FWR ID SB-FC-10 *Study Year:* Both *2006 Comment*
2003 Key Data *Discharge:* Yes *Volume:* Slow *Turbidity:* Clear *Remarks:* Carrying hundreds of cigaret butts. In wing wall of Rt 62 bridge.

Structure ID: SB-O-20 *Ownership* Public *Location:* On left bank, 150 ft above Berlin St *Outfall Description:* 12 in CSP ??
Obs # 1 *Flow Depth:* Mostly su *Flow Observations:* Stagnant, gray, no *Temperature:* 18.7 *pH:* 7.8 *Conductivity:* 772
Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* = 18 *E. coli Results per 100mL:* 100 *Optical Brightener Results:* NA
FWR ID SB-FC-01 *Study Year:* Both *2006 Comment*
2003 Key Data *Discharge:* Yes *Volume:* Slow *Turbidity:* Turbid *Remarks:* Grey discharge from pipe, pooling halfway up bank, & plume in river. S

Potential Problem Outfalls

Structure ID: SB-O-30 *Ownership* Privat *Location:* Below WWTP, main outfall *Outfall Description:* Concrete box, WWTP None

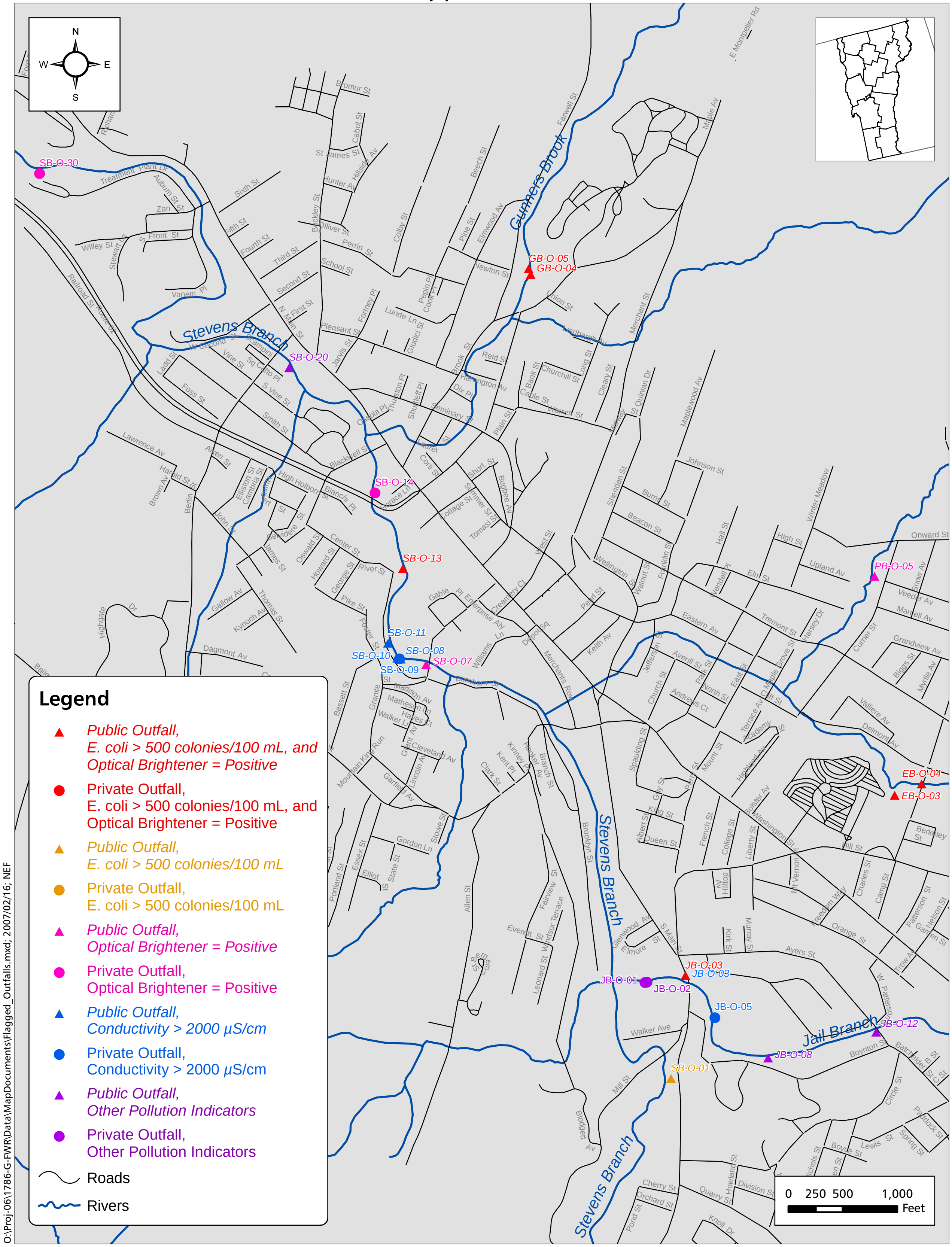
Obs # 1 *Flow Depth:* Strong flo *Flow Observations:* Grayish, laundry sm *Temperature:* 17.8 *pH:* 7.4 *Conductivity:* 913

Free Cl (ppm): < 0. *Total Cl (ppm):* < 0. *Potassium (ppm):* < 6 s *E. coli Results per 100mL:* 0 *Optical Brightener Results:* Positive

FWR ID SB-DB-03 *Study Year:* Both *2006 Comment*

2003 Key Data *Discharge:* Yes *Volume:* Fast *Turbidity:* Clear *Remarks:* Grey tint, foamy, laundry detergent smell. Barre WWT plant discharge.

Appendix D



O:\Proj-06\1786-G-FWR\Data\MapDocuments\Flagged_Outfalls.mxd; 2007/02/16; NEF

City of Barre Outfall Assessment 2006 Potential Pollution Sources
Friends of the Winooski River
Central City of Barre

Sources: National Hydrography Data, Streetmap USA, Outfall Data

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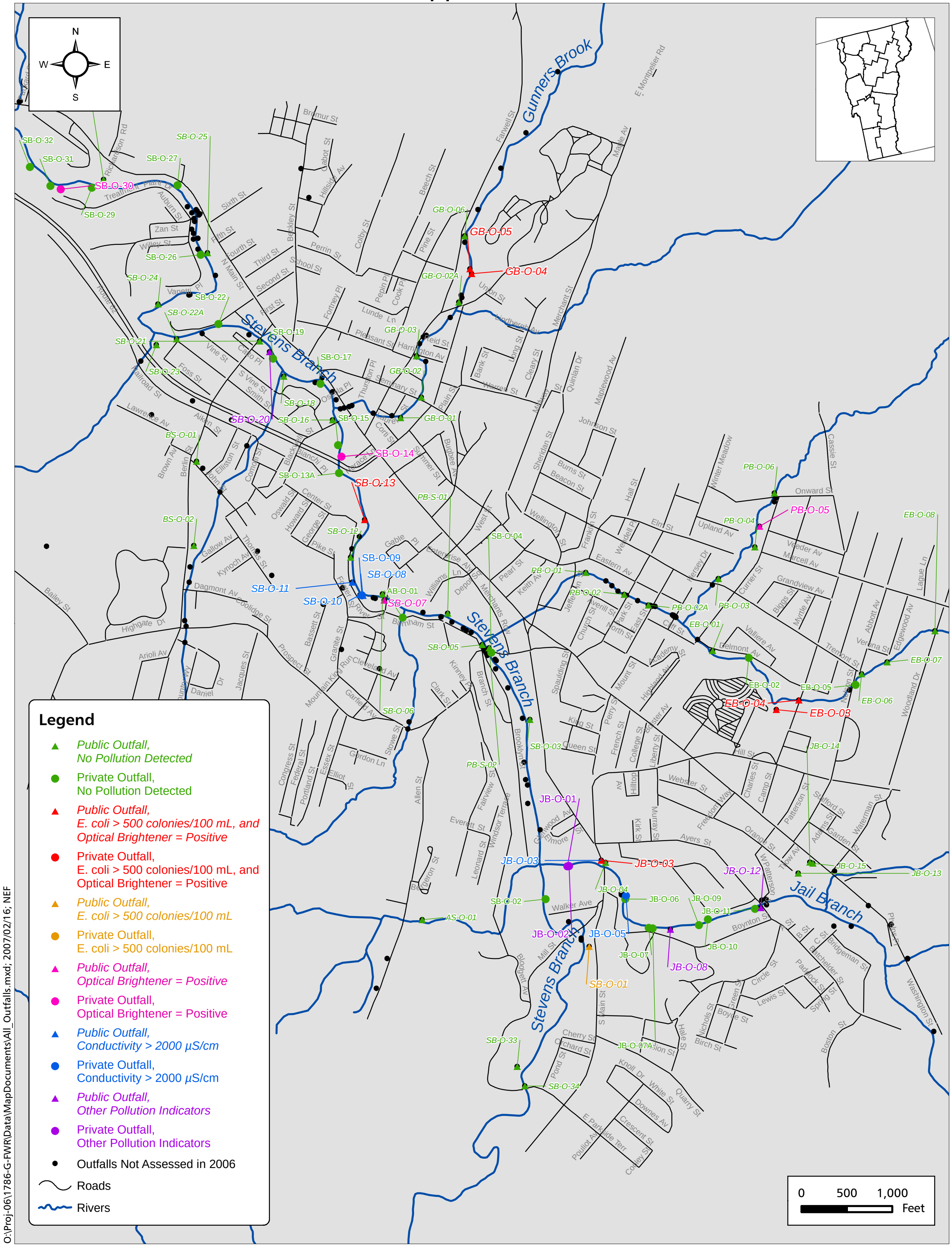
Appendix E



O:\Proj-06\1786-G-FWR\Data\MapDocuments\All_Outfalls.mxd; 2007/02/16; NEF

City of Barre Outfall Assessment 2006
Friends of the Winooski River

Central City of Barre

Sources: National Hydrography Data, Streetmap USA, Outfall Data

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