Watershed Field Inventories and Land Use Regulatory Review Tankerhoosen River Watershed

Friends of the Hockanum River
Linear Park of Vernon, Inc.

In Association With:

Town of Vernon
North Central Conservation District
Rivers Alliance of Connecticut
Hockanum River Watershed Association
Belding Wildlife Trust

Vernon, CT

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FUSS & O'NEILL
Disciplines to Deliver

Fuss & O'Neill, Inc.
78 Interstate Drive
West Springfield, MA 01089

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1.0 INTRODUCTION

The Friends of the Hockanum River Linear Park of Vernon, Inc. (the "Friends") has retained Fuss & O Neill to prepare a Watershed Management Plan for the Tankerhoosen River watershed. The Watershed Management Plan will be developed through a collaborative effort with a Technical Advisory Committee consisting of the Friends, the Town of Vernon (Planning Department and Conservation Commission), the North Central Conservation District, the Hockanum River Watershed Association, Rivers Alliance of Connecticut, and the Belding Wildlife Trust. The Plan will identify action items to be implemented by the municipalities and private groups which will protect and improve the health of the Tankerhoosen River watershed.

There are two key reports that provide the basis for recommendations in the Watershed Management Plan: 1) Baseline Watershed Assessment and 2) Watershed Field Inventories and Regulatory Review. The Baseline Watershed Assessment (Fuss & O Neill, May 2008) evaluates the existing conditions of natural resources and pollutant sources in the watershed to prioritize watershed protection and restoration strategies. This report, the Watershed Field Inventories and Land Use Regulatory Review, describes the stream corridor and upland assessments conducted by Fuss & O Neill to identify and evaluate pollutant sources in the watershed, as well as, review of local zoning and land use regulations for selected towns within the Tankerhoosen River watershed. Findings of the Baseline Watershed Assessment and the Watershed Field Assessment and Land Use Regulatory Review will serve as the basis for development of a watershed management plan for the Tankerhoosen River.

2.0 WATERSHED FIELD INVENTORIES

Field inventories were performed during summer 2008 to further assess existing watershed conditions and potential sources of pollution. The field inventories are screening level tools for locating potential pollutant sources and environmental problems in a watershed along with possible locations where restoration opportunities and mitigation measures can be implemented. The field inventories included selected stream corridors and upland areas within priority subwatersheds, which were identified in the Baseline Watershed Assessment report based on a comparative subwatershed evaluation that considered vulnerability to future development impacts and restoration potential to improve upon existing conditions. Field inventories were performed within the following priority subwatersheds (Figure 1):

- Clarks Brook,
- Gages Brook,
- Gages Brook South Tributary,
- Lower Tankerhoosen River,
- Middle Tankerhoosen River,
- Tucker Brook,
- Walker Reservoir.

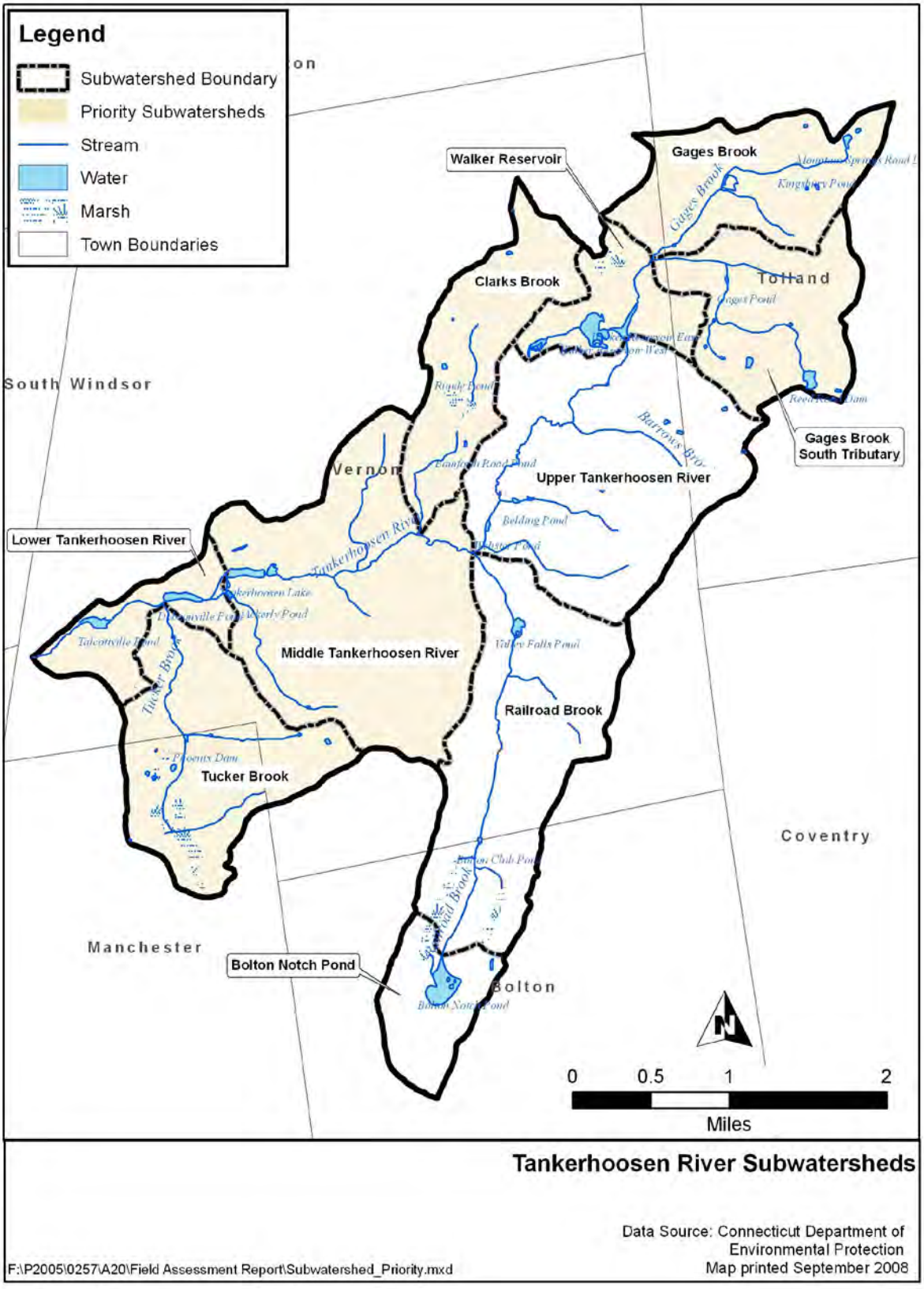


Figure 1. Tankerhoosen River Watershed

The stream corridor assessment procedure used in this study is adapted from the U.S. EPA Rapid Bioassessment (RBA) protocol (EPA, 1999) and the Center for Watershed Protection's Unified Stream Assessment (USA) method (CWP, 2005). Upland areas and activities that may impact stream quality were also assessed using methods adapted from the Center for Watershed Protection's Unified Subwatershed and Site Reconnaissance (USSR) techniques (CWP, 2005). The upland assessments included inventories of selected representative residential neighborhoods, streets and storm drainage systems, and land uses with higher potential pollutant loads (i.e., "hotspot" land uses). Field assessment efforts were targeted on stream segments and upland areas with the greatest potential for direct impacts to the streams. These areas were identified through aerial and land use mapping. To the extent possible, efforts were also focused on publicly-owned land, which typically offers greater opportunities for retrofits and mitigation projects as opposed to privately-owned land.

During the field inventories, crews assessed approximately 8.7 miles of stream corridors, six potential hotspot locations, five representative residential neighborhoods, and a number of streets and storm drainage systems associated with the residential neighborhoods and hotspot land uses. Field inventory nomenclature used throughout this report is summarized in Table 1. Copies of completed field assessment forms are provided in Appendix A (stream corridor assessments) and Appendix B (upland assessments). Photographs of specific or representative pollutant sources and problem areas are included throughout this document for illustrative purposes. All of the photographs taken during the field inventories are included on a CD in Appendix C.

Table 1: Field Inventory Nomenclature

Subwatershed	Abbreviation
Clarks Brook	CB
Lower Tankerhoosen River	LTR
Middle Tankerhoosen River	MTR
Walker Reservoir	WR
Gages Brook	GB
Gages Brook South Tributary	GBST
Tucker Brook	TB
Stream Corridor Assessment	**Abbreviation**
Reach Level Assessment	RCH
Channel Modification	CM
Severe Bank Erosion	ER
Impacted Buffer	IB
Stormwater Outfall	OT
Stream Crossing	SC
Trash & Debris	TB
Utilities	UT
Upland Assessment	**Abbreviation**
Hotspot Investigation	HSI
Neighborhood Site Assessment	NSA
Streets and Storm Drains	SSD

2.1 Summary of Findings

A variety of common issues and problems were identified during the field inventories. Some prevalent issues throughout the watershed are described below. These findings will be used to develop recommendations for the Watershed Management Plan.

- Overall in-stream habitat in the assessed reaches was mixed. Some of the assessed reaches have high quality habitat, with riparian cover, good floodplain connection, varied substrate, and significant stream shading. In other segments, in-stream habitat is marginal to poor due to bank erosion, buffer encroachment, trash and debris, lack of shading, and in-stream sedimentation. However, the majority of the stream reaches assessed appear to be either supporting biological communities (fish, frogs, birds, etc.) or sufficient to support such communities. Many potential barriers to fish passage were observed throughout the watershed, including perched culverts, culverts with very shallow flow, and natural and manmade dams. Therefore, the impact of potential fish barriers and the feasibility of fish barrier removal efforts should be investigated further.

- Stream buffer encroachments are prevalent along stream corridors in or near areas of residential and commercial development. Residential lawns and some commercial lawns extend down to the banks of the stream in many areas, particularly in residential back yards. Yard waste such as grass clippings, leaves, and brush and waste materials were also common occurrences in and near these areas where easy access exists to the streams. Education, signage, stream buffer regulations, and stream cleanups are potential approaches for improving buffer management.

- Residential areas appear to contribute significant quantities of rooftop runoff to the storm drainage system, particularly in medium and high-density residential neighborhoods with smaller yards. Many small outfall pipes were observed from the backyards of residential areas, which are presumably associated with foundation drains, yard drains, or roof downspouts. Opportunities exist to disconnect residential rooftop runoff from the storm drainage system and reduce the quantity of runoff by redirecting the runoff to pervious areas or through the use of rain barrels or rain gardens.

- Numerous outfalls were observed from virtually all of the land uses encountered during the stream assessments. Many appear to be associated with sources having low potential for water quality impacts (i.e., residential foundation drains), while others were of unknown origin and should be the focus of future investigation. A watershed-wide illicit discharge investigation is recommended in targeted areas and land uses.

- Invasive species (phragmites, cattails, reed canary grass, etc.) were observed in stream corridors in many areas of the watershed. Invasive species management should be incorporated into stream corridor restoration activities.

- Parking lots associated with apartment complexes, institutional land uses (schools), and commuter lots are potential candidates for stormwater retrofits to reduce site runoff and improve water quality through the use of bioretention, water quality swales, buffer strips/level spreaders, and other small-scale LID approaches.

- The field assessments identified very little evidence of storm drain stenciling or watershed stewardship signage, with the exception of a residential subdivision in the Tucker Brook subwatershed.

- Most of the developed areas surveyed have inadequate stormwater quality controls. Many of the residential developments were constructed prior to the advent of modern stormwater quality regulations and design requirements. Therefore, most of the development observed in the watershed employs traditional curb and gutter storm drainage collection systems with little, if any, stormwater management beyond detention basins for peak flow control. In most cases, the stormwater management controls that were observed at newer developments were not being maintained.

- No Low Impact Development (LID) design practices were observed in the watershed. With the recent shift toward LID site design and stormwater management requirements, as demonstrated by the Town of Tolland's new LID regulations and design manual, the watershed is an ideal candidate to showcase LID practices for both new development and retrofit applications. Local LID demonstration sites are a valuable tool for public education and promoting the widespread use of such practices. Incorporating LID into town projects, including roadway projects, can also serve as a proactive model for private development.

- Stormwater runoff from Interstate 84, other state roads such as Route 30 and 31, and local roads typically receives little or no treatment prior to discharge. Such discharges are a source of sediment and other pollutants to the receiving water bodies. Opportunities exist for stormwater retrofits at roadway stormwater outfalls

- Relatively isolated areas of moderate to severe streambank erosion were observed throughout the assessed portions of the watershed. Most of these areas are located at or downstream of stormwater outfalls in developed areas of the watershed. Access to many of these areas is limited; therefore, potential candidate sites for bank stabilization projects should be evaluated further for overall feasibility.

- Very few active construction sites were observed in the watershed. However, a large amount of developable land exists in the watershed, and future construction activity is a major potential source of polluted runoff. Approaches for stronger soil erosion and sedimentation controls include regulating building envelopes, encouraging property owners to minimize clearing for other purposes, and requiring drainage review for activities that disturb less than ½ acre.

- Due to limited project funding, not all stream segments in the priority subwatersheds were assessed, and other subwatersheds (Railroad Brook, Bolton Notch Pond, and Upper Tankerhoosen River) were not assessed as they were determined to be a lower priority. A schedule should be established for assessing the remaining stream segments and subwatersheds.

The following sections present a more detailed discussion of the stream corridor and upland assessment methods and findings.

2.2 Stream Corridor Assessment

Stream corridors within the Tankerhoosen River watershed were assessed during June 3 through 6, 2008, and on July 2 and 10, 2008. The weather on these days was sunny, overcast or partly cloudy and not raining, with the exception of June 4, which had intermittent and heavy rain at times. Field crews consisted of staff from Fuss & O Neill, the North Central Conservation District, and volunteers with Friends of the Hockanum River Linear Park of Vernon. Stream corridors were assessed along selected reaches within priority subwatersheds using methods adapted from the U.S. EPA Rapid Bioassessment (RBA) protocol (EPA, 1999) and the Center for Watershed Protection's Unified Stream Assessment (USA) (CWP, 2005).

The stream assessment method used in this study is a continuous stream walk method that identifies and evaluates the following impact conditions for each reach:

- Outfalls (OT), including stormwater and other manmade point discharges;
- Severe Bank Erosion (ER), such as bank sloughing, active widening, and incision;
- Impacted Buffer (IB), which is a narrowing or lack of natural vegetation;
- Utilities in the stream corridor (UT), such as leaking or exposed pipes;
- Trash and Debris (TR), such as drums, yard waste, and other illegal dumping;
- Stream Crossings (SC), which are hard objects, whether natural or artificial, that restrict or constrain the flow of water. These may include bridges, culverts, dams, and falls;
- Channel Modification (CM), where the stream bottom, banks, or direction have been modified;
- Miscellaneous (MI), other impacts or features not otherwise covered; and
- Reach Level Assessment (RCH), the average characteristics of each reach.

The stream assessment method also includes a semi-quantitative scoring system as part of the reach level assessment to evaluate the overall condition of the stream, riparian buffer, and floodplain, based on a consideration of in-stream habitat, vegetative protection, bank erosion, floodplain connection, vegetated buffer width, floodplain vegetation and habitat, and floodplain encroachment.

Field data forms were completed for each stream reach assessed (Appendix A). The information was entered into a database and used to quantify the overall condition of stream corridors in the watershed, compare subwatersheds within the watershed to each other, and prioritize areas for restoration, stormwater retrofit, land preservation, and other stewardship opportunities.

Stream reaches were assigned a subwatershed abbreviation followed by a two-digit numerical identifier. Reaches were generally numbered sequentially from downstream to upstream when in series and west to east upstream from confluences. A reach was considered to be a stream segment with relatively consistent geomorphology and surrounding land use, and generally less than one-half mile in length. Features noted at reach junctions (e.g., culvert crossings) were associated with the downstream reach. Impact conditions within each reach were numbered sequentially with an abbreviation followed by a two-digit number. For example, the second stream crossing in a reach would have the identifier SC-02.

Forty-one stream reaches were evaluated in the Tankerhoosen River watershed using this stream assessment protocol. Table 2 summarizes the number of impact conditions identified and reach level assessments that were performed within each subwatershed.

Table 2: Number of Reach Level Assessments Performed and Impact Conditions Identified

Subwatershed	RCH	CM	ER	IB	OT	SC	TD	UT
Clarks Brook	5	--	2	--	10	8	2	--
Lower Tankerhoosen River	1	--	--	--	1	1	--	--
Middle Tankerhoosen River	5	--	1	--	14	5	7	--
Walker Reservoir	5	--	--	--	6	6	--	--
Gages Brook	12	1	8	5	21	12	3	1
Gages Brook South Trib.	7	1	1	1	3	8	--	--
Tucker Brook	6	--	2	4	9	9	3	--

Reach level assessment scores were assigned by field crews based upon the overall stream, buffer, and floodplain conditions. A subjective determination of eight criteria is assessed on a scale of 0 to 20; 0 relating to poor conditions and 20 being optimal conditions. The total of these scores provides a quantitative index of overall stream health and condition. The maximum possible number of points that would be assigned for a fully optimal stream reach is 160 points.

Streams were assessed relative to a base condition, which for this study, is the highest scoring stream reach in the Tankerhoosen River watershed (153 points). All other assessed stream reaches were assigned a numerical score and categorized relative to the base score of 153 points (Table 3). Reaches scoring greater than 90% of the base condition (138 points) are considered "excellent", between 75% and 90% of the base condition are categorized as "good", between 55% and 75% of the base condition are categorized as "fair", between 35% and 55% of the base condition are categorized as "poor", and less than 35% of the base condition are categorized as "very poor". Table 4 summarizes stream reach assessment scores and classifications for the assessed stream reaches.

Table 3: Stream Reach Classifications

Category	Percentile	Point Threshold
Excellent	90%	≥138
Good	75%	≥115
Fair	55%	≥84
Poor	35%	≥54
Very Poor	<35%	<54

Table 4: Stream Reach Assessment Scores and Classifications

Excellent		Good		Fair		Poor		Very Poor	
Reach ID	Score	Reach ID	Score	Reach ID	Score	Reach ID	Score	Reach ID	Score
MTR-08	153	GBST-02	127	GB-09	114	TB-04B	83	GB-05B	53
GB-10	146	GB-02	120	GBST-03	111	MTR-01	82	WR-01	35
GBST-04A	146	GBST-09B	120	LTR-03	111	GB-04	80		
GBST-01	145	TB-02	119	GB-07	105	WR-02	80		
MTR-07	139	GBST-04B	117	CB-03	104	WR-04	76		
CB-04	138	TB-01	116	GB-01	102	GB-03B	72		
		GB-08	115	GB-03A	97	GBST-09A	59		
				MTR-09	94				
				GB-05A	93				
				CB-02	93				
				TB-03	92				
				TB-04A	92				
				WR-03	91				
				GB-06	88				
				MTR-02	87				
				CB-01	85				
				WR-05	84				

Note: TB04C and CB-05 were not scored during the reach level assessment

As depicted in Figure 2, MTR-08 is the highest rated stream reach due to good riparian cover and bed material. WR-03 is considered fair due to the presence of invasive species within the riparian corridor. TB-04B and GB-05B are poor and very poor, respectively, because of poor channel characteristics, outfalls, stream crossings, trash and debris and lack of stream buffer and stream bank erosion in the case of GB-05B.

The following sections summarize the major issues identified during the stream corridor assessments for each priority subwatershed. Specific locations are identified according to the stream reach and impact condition IDs described previously. Identification of "right" and "left" stream banks is from the observer's perspective facing downstream.

Figure 2: Examples of Stream Reaches in Various Classification Categories

2.2.1 Clarks Brook

Clarks Brook is a tributary of the Tankerhoosen River that flows into the Middle Tankerhoosen River subwatershed. Clarks Brook is divided into five stream segments, labeled CB-01 through CB-05 (Figure 3). All five stream segments were assessed. Segments CB-01 through CB-03 were inventoried on July 2, 2008, while segments CB-04 and CB-05 were assessed on July 10, 2008. Land use in this subwatershed includes residential, commercial/industrial, retail, and some undeveloped land. Interstate 84 crosses Clarks Brook in the southern portion of the watershed.

CB-01
Stream segment CB-01 begins at the mouth of Clarks Brook and continues upstream to Bolton Road. The surrounding land use is primarily forested and open fields, with one residence along the left bank.

- RCH – The overall stream conditions are optimal to suboptimal with the exception of bank vegetative protection which is rated as poor due to lack of stream buffer along portions of the left bank. The dominant bed substrate is cobble; there are no attached or floating plants in the stream; wildlife such as fish, frogs, and birds are present; and the stream is approximately 50 percent shaded. The reach has good accessibility.

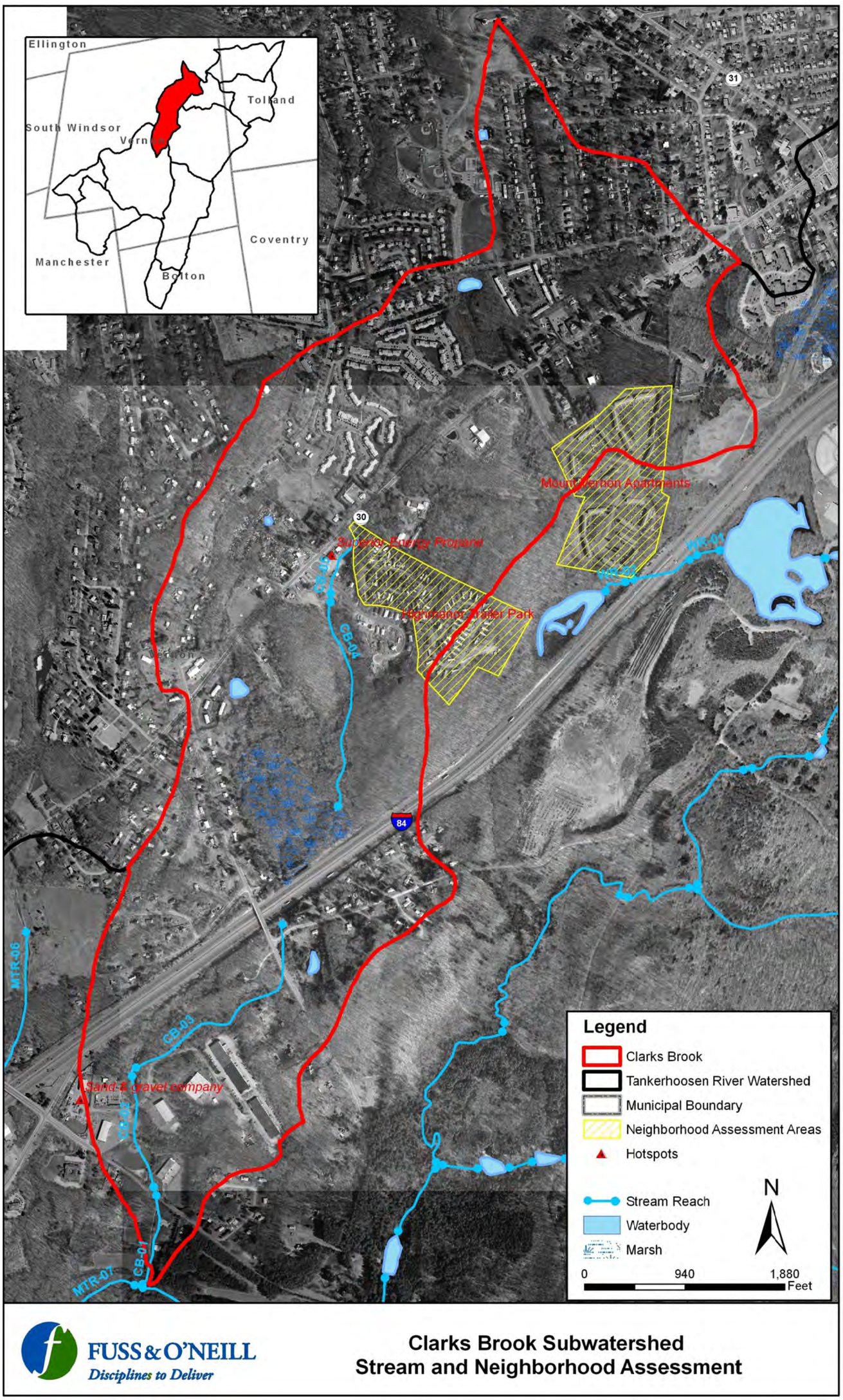


Figure 3. Clarks Brook Subwatershed Field Assessment Locations

- OT – The reach contains several outfall pipes, including several 4-inch plastic pipes which are believed to be connected to residential foundation drains or roof downspouts (no dry weather flows observed) and two 18-inch outfalls conveying roadway drainage (no dry weather flows observed). None of the observed outfall pipes appears to be contributing dry weather discharges or causing stream bank erosion.

- SC – Clarks Brook crosses under Bolton Road within a 5.5-foot circular concrete culvert. The upstream side of the culvert was partially blocked by brush and debris, and the concrete on the inside of the culvert is deteriorating. The sharp drop in elevation immediately downstream of the culvert creates a "perched" condition and a physical barrier to fish passage. This culvert is a potential candidate for fish barrier removal to address the perched outlet and cleaning/repair.

CB-02

Stream segment CB-02 flows along a baseball field and industrial properties, from Bolton Road to Industrial Park Road. The stream enters a culvert prior to Industrial Park Road and re-emerges on the other side of the road.

- RCH – The stream conditions are generally suboptimal to marginal. The instream habitat is considered optimal while the floodplain connection, vegetated buffer width, floodplain habitat and floodplain encroachment received a marginal rating. Clarks Brook flows at 100 percent of the channel width in this section, with clear water and some attached plants in the stream. The dominant substrate is sand and cobble and there is evidence of sediment deposition.

- OT – There are three outfalls along this reach. The first, OT-01, is a plastic pipe on the right bank originating from the parking lot of an adjacent industrial facility, was observed to have a trickle of discharge and brown benthic growth on the pipe. Outfall OT-02 is an earthen open channel approximately 4 feet deep and 5 feet wide. A trickle of discharge was also observed in the channel. The final outfall, OT-03, is a 4-inch diameter plastic pipe on the right back. No flow or microbial growth/discoloration was observed from the pipe.

- ER – Some moderate, isolated bank erosion was observed on the left bank. This area is a potential candidate for bank stabilization.

- SC – An approximately 400-foot long circular culvert conveys Clarks Brook under a parking lot. The triple barrel metal culverts are 2 feet in diameter. The outlets of the culverts are perched slightly above elevation of the stream bottom. This culvert is a potential candidate for fish barrier removal to address the perched outlet.

- TR – Significant quantities of trash and debris (an estimated 1 pickup truck load) were observed including tires, automotive waste, appliances and a closed 55-gallon drum of unknown contents. The debris and waste materials should be removed and disposed in accordance with applicable local, state, and federal regulations.

Trash and debris along reach CB-02

CB-03

Reach CB-03 begins on the north side of Industrial Park Road, continues through the underpass of Bamforth and Baker Roads, and ends at Interstate 84. The stream passes through mostly forested areas, although the stream also flows along an industrial park for a short distance and then under the two roads.

- RCH – The stream conditions are generally rated suboptimal. The in-stream habitat and floodplain vegetation are rated optimal. The vegetative protection, bank erosion, floodplain connection, habitat and encroachment are considered suboptimal. The bank erosion on the left bank and buffer width on the right bank are considered marginal. The stream flows at 75-100% of the channel width, which is dominated by boulder substrate. The water is clear with no aquatic plants in the stream, and the stream surface is mostly shaded. Access to the reach is rated fair or difficult.

- OT – There are two outfalls along this reach. OT-01 is a drainage channel, originating from a wooded area adjacent to Interstate 84, approximately 1 foot deep and 2 feet wide. OT-02 is an 18-inch concrete drainage outfall pipe with moderate flow.

- ER – An approximately 30-foot long area of severe bank erosion was observed on the left bank downstream of a wooden foot bridge. The area has good access for construction equipment for potential restoration of the bank. This area is a potential candidate for bank stabilization.

- SC – Stream crossing SC-01 is a wooden foot bridge over Clarks Brook. Debris under the bridge is causing partial blockage of the stream. Removal of the debris is recommended. Crossing SC-02 is a circular culvert below Bamforth Road. The double metal barrels are approximately 4.5 feet in diameter and 60 feet long. The culvert outlet is elevated above the elevation of the stream bed, restricting fish passage. This culvert is a potential candidate for fish barrier removal to address the perched outlet. The third stream crossing in this segment is SC-03, which conveys flow underneath

Baker Road inside a circular double barrel metal culvert. The culverts are 4 feet in diameter and approximately 100 feet in length.

Bamforth Road crossing (perched culvert) along reach CB-03

- TR – Automotive debris was observed along the stream near a residential area, and should be removed as part of a stream cleanup in this reach.

CB-04

Stream segment CB-04 extends from the wetlands on the northern side of Interstate 84 through a forested area and ending at the edge of a residential neighborhood at Rockledge Drive.

- RCH – This segment is rated as optimal using the stream assessment criteria in every category except floodplain habitat, which is rated suboptimal. The dominant substrate is cobble, the water is clear and there are no aquatic plants in the stream. There is evidence of fish, frogs and songbirds and the stream is mostly shaded. There is some evidence of sediment deposition in the stream channel.

- OT – A 12-inch concrete outfall pipe is located on the right bank near Rockledge Drive. The pipe is surrounded by dense knotweed and appears to originate from the adjacent residential area. A trickle of flow was observed, and the flow appeared to be cloudy and orange in color.

- SC – There are several stream crossings along Clarks Brook in this segment. The first two crossings consist of a low-head concrete dam located immediately upstream of an approximately 4-foot diameter concrete culvert, which is located below a forested dirt road. The concrete dam and forest road culvert (perched approximately 3 to 4 inches above the elevation of the streambed at the culvert outlet, and having very shallow flow) are potential barriers to fish passage. Both are potential candidates for fish barrier removal. The third crossing is a concrete culvert below Rockledge Drive. Both culverts identified in this reach showed evidence of cracking and deterioration, and should be evaluated for potential repair or replacement.

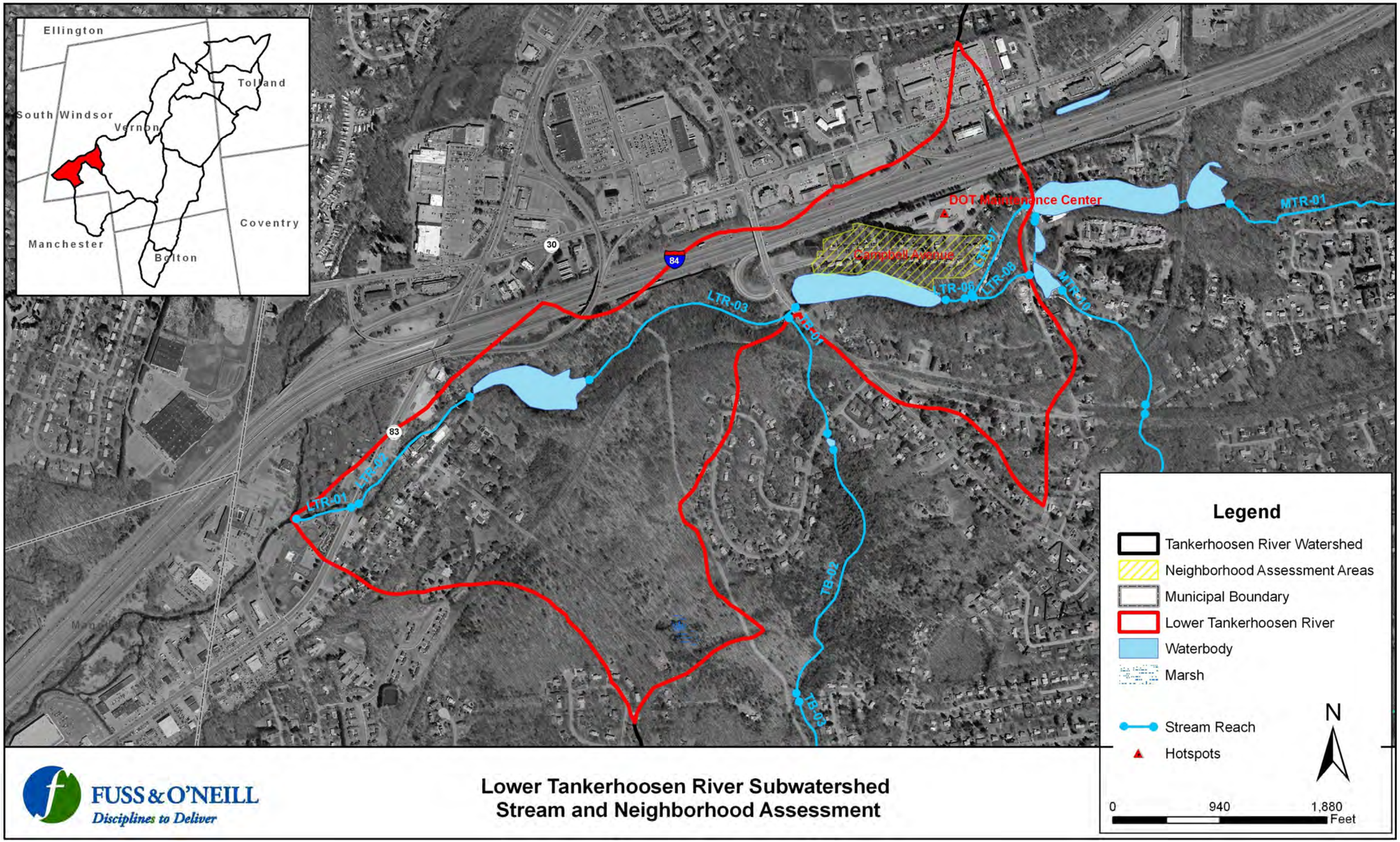


Figure 4. Lower Tankerhoosen River Subwatershed Field Assessment Locations

RCH – The reach level assessment characterized this segment as generally suboptimal. The vegetated buffer width and floodplain vegetation is rated as optimal. The surrounding forested land provides good stream habitat. The beginning and end of the stream segment are altered by the manmade impoundments at both ends. The stream flows at 75 to 100% of the channel width and the substrate is dominated by cobble. The water is somewhat cloudy and has a naturally stained color. There are no plants in the stream and the surface is mostly shaded. The most significant issue observed along this reach is a stormwater detention basin associated with runoff from Interstate 84.

- OT – A stormwater outfall pipe conveys stormwater runoff from Interstate 84 to a detention basin located adjacent to the stream. The inside of the outfall pipe was observed to have an orange, rusty color, and an oily stain. A rusty, oily sludge was observed in the bottom of the detention basin. No standing water or discharge from the basin was observed at the time of the inspection. A discharge investigation is recommended to observe the basin function during wet weather and assess possible pollutant contribution to the stream. The basin and stormwater discharge is a potential stormwater retrofit candidate.

- SC – The dams that impound Dobsonville Pond and Talcotville Pond are manmade barriers to fish passage. Confirming with Brian Murphy at DEP the potential for fish passage at these ponds and Tankerhoosen Lake.

2.2.3 Middle Tankerhoosen River

Reaches in this subwatershed are labeled MTR-01 through MTR-12. Stream assessments were conducted on representative reaches including MTR-01, MTR-02, MTR-07, MTR-08 and MTR-09 (Figure 5). Segments MTR-01, MTR-02 and portions of MTR-09 were inventoried on June 4, 2008, while the remaining segments were assessed on June 5, 2008. Residential use is the dominant land use in the subwatershed, and Interstate 84 traverses the northern portion of the subwatershed. The Upper Tankerhoosen River and Clarks Brook drain to the Middle Tankerhoosen River, which feeds the Lower Tankerhoosen River.

MTR-01
This stream segment begins at the inlet to Tankerhoosen Lake and ends at the confluence of segments MTR-02 and MTR-09. The stream flows parallel to the back yards of a residential neighborhood

- RCH – The reach level assessment indicates suboptimal in-stream habitat, vegetative protection, bank erosion and floodplain connection. The overall buffer and floodplain conditions are generally marginal, with limited vegetative buffer width, floodplain vegetation and habitat and moderate floodplain encroachment. The dominant in-stream substrate is gravel and cobble, and 50 percent of the stream surface is shaded.

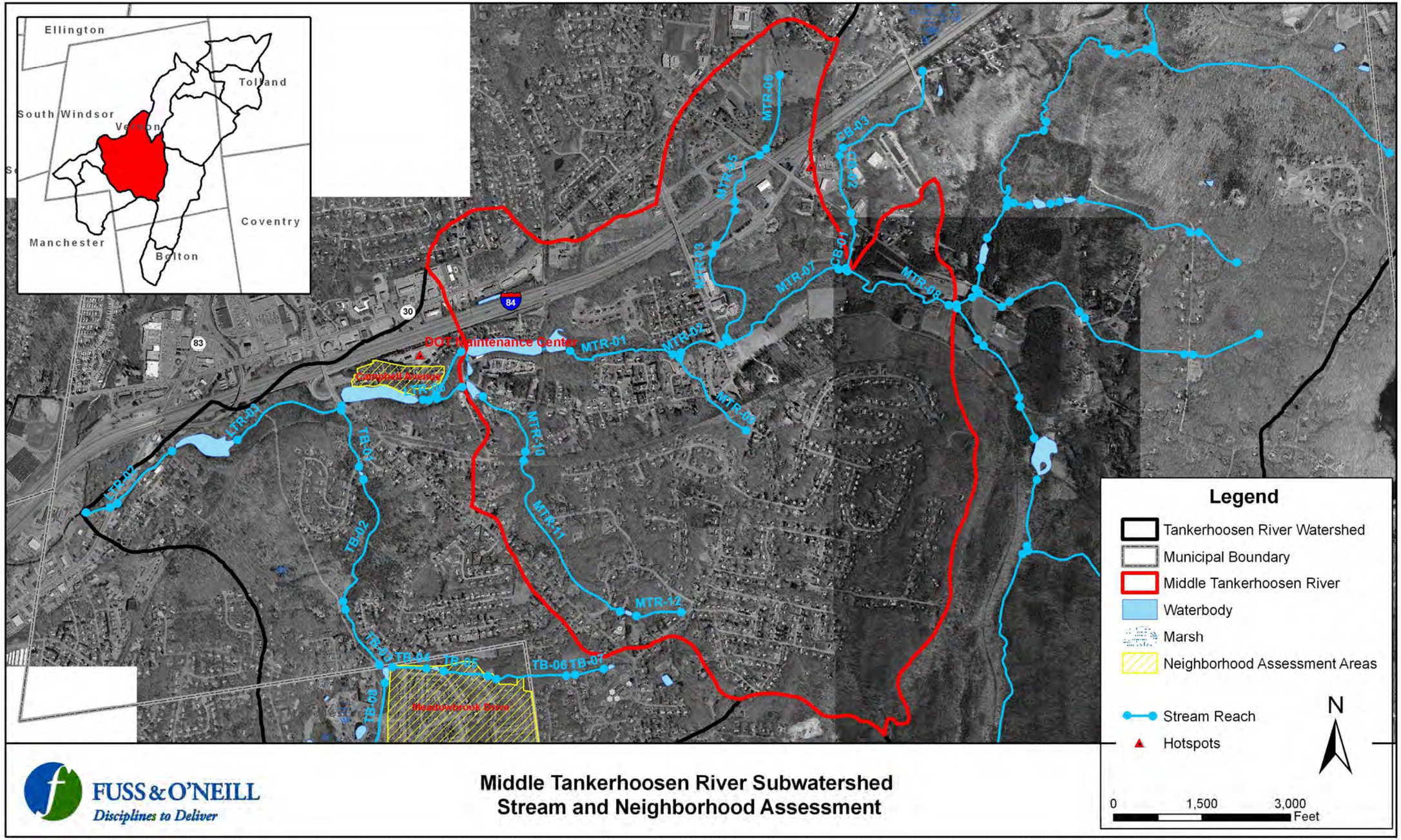


Figure 5. Middle Tankerhoosen River Subwatershed Ffield Aassessment Locations

Stream segment MRT-01 has areas with little or no vegetative buffer.

- OT – Four outfalls were observed along the left bank of the stream. Three of the outfalls are storm drainage pipes that convey stormwater runoff from the adjacent residential development. Sediment accumulation was observed at the outlets of several of the outfalls. An ABS outfall pipe was observed behind a residence. The pipe was submerged below the stream water surface at the time of the inspection. The source of this pipe and the nature of the potential discharge from the pipe should be investigated further.

- TR – Three instances of trash and/or debris were observed along this segment. TR-01 is a commercial-grade 55-gallon plastic drum located within the stream. The contents of the drum could not be determined. TR-02 consists of brush and debris stockpiled along the bank of the stream. The material was placed by the Town of Vernon following removal of a beaver dam, but never removed. TR-03 consists of approximately 16 plastic buckets that are submerged or partially submerged below the water surface of the stream. The contents of the buckets are unknown. Both areas should be the focus of stream cleanup efforts.

- IB – The left bank along much of the stream segment consists of residential lawns immediately adjacent to the stream, with little or no stream buffer. Stream bank erosion was observed in some areas along the left bank, including evidence of animal burrows in the stream bank below the exposed roots of the lawn.

MTR-02

Reach MTR-02 begins at the confluence with MTR-09 and ends at Tunnel Road. This braided stream segment also flows adjacent to residential properties.

- RCH – The right bank consists primarily of residential lawns with little or no buffer, while the left bank has a modest vegetated buffer consisting of shrubs and mature forest. The in-stream flow fills the channel, and the substrate is dominated by gravel. There are no aquatic plants in the stream, and the water surface is approximately 50

percent shaded. Sediment deposits were observed in areas of the stream channel. Generally, the stream ranges from suboptimal to marginal for overall stream conditions and buffer and floodplain conditions. The left bank is characterized as optimal for bank erosion and vegetated buffer width. The right bank has poor vegetative protection.

- OT – A 14-inch diameter concrete pipe conveys stormwater runoff from Tunnel Road. No dry-weather flow or other visible evidence of pollution was observed.

- SC – Twin box culverts carry flow below Tunnel Road. The culverts are concrete, approximately 4 feet in diameter and 13 feet in length.

MTR-07
This segment begins at Tunnel Road and ends at the confluence of the Tankerhoosen River and Clarks Brook. The primary land use along stream segment MTR-07 is forested and agricultural land, with a small area of adjoining residential land near Tunnel Road.

- RCH – The reach level assessment identifies this segment as generally optimal, with high ratings for overall stream conditions and buffer and floodplain conditions. The reach is dominated by gravel and cobble substrate, clear water, no in-stream vegetation, observed fish and terrestrial wildlife, and a mostly shaded stream.

MTR-08
Segment MTR-08 begins at the confluence of Clarks Brook and the Tankerhoosen River and ends at the confluence of Railroad Brook and the Tankerhoosen River. The surrounding land use is forest or cleared fields.

- RCH – This segment is characterized by gravel and cobble substrate, no attached or floating aquatic plants, wildlife including fish, deer, raccoon, and songbirds, and the stream is mostly shaded. Some evidence of channel widening was observed. The overall stream, buffer and floodplain conditions are rated as optimal.

MTR-09
Stream segment MTR-09 is a tributary of the Tankerhoosen River that begins at the main stem of the Tankerhoosen River and extends upstream, crossing Warren Avenue and ultimately ending at Tunnel Road. The surrounding land uses are residential, forested, and wetlands, including a section of the Rails to Trails.

- RCH – The reach level assessment rates this segment as suboptimal to marginal. Bank erosion and floodplain connection for the reach is rated as marginal. The floodplain habitat and encroachment are also at a marginal level. The dominant substrates are sand, gravel and cobble. There are no aquatic plants in the stream, and the water surface is mostly shaded. There is evidence of bank scour along the reach. Issues identified along this reach include stormwater outfalls, severe bank erosion, stream crossings, and trash and debris.

- OT – A total of 10 stormwater outfalls were identified along this reach. A majority of the outfall pipes are smaller than 8 inches in diameter, appear to be residential foundation drains, and do not warrant further investigation. Several of the outfall pipes

are associated with the roadway drainage system. There are two 2-foot diameter pipes along the left bank which do not have dry-weather discharge and are clean and not submerged. A black ABS pipe observed in the stream appeared to originate from a residence along Warren Avenue. A trickle of flow was observed from the pipe, and brown sediment accumulation was observed in the stream near the outfall. The source of this pipe and the nature of the potential discharge from the pipe should be investigated further.

- ER – An area of bank erosion was observed along the left bank, measuring approximately 20 feet in length and 6 feet high. The erosion severity is moderate and there is good access to the bank from the residential areas north of Warren Avenue. This area is a potential candidate for bank stabilization.

- SC – There are two road crossings and a rail crossing along this reach. The stone blocks on the outside of the Rails to Trails culvert crossing are partially dislodged and in need of repair. The Tunnel Road stream crossing has debris partially blocking the outlet of the culvert. The outlet of a concrete box culvert located north of Warren Avenue is perched approximately 14 inches above the elevation of the stream bed and is a potential barrier to fish passage. This culvert is a potential candidate for fish barrier removal to address the perched outlet.

The Tunnel Road stream crossing (A) and the Rails to Trails crossing (B).

- TR – Four instances of trash and debris were noted along this stream segment. Three consist of minor quantities of yard waste, while the fourth consists of approximately 2 to 3 pickup truckloads of leaves, logs, tree stumps and tires. This stream segment is a potential candidate for a stream cleanup.

2.2.4 Walker Reservoir

Reaches assessed in this watershed include WR-01 through WR-05 (Figure 6). Land use in this watershed includes a former outdoor sports complex, a Connecticut Department of Transportation (ConnDOT) commuter parking lot, the Interstate 84 and Route 31 interchange, and several residential areas. The water bodies along the stream reaches in this subwatershed, including Walker Reservoir East and West, receive upstream flow Gages Brook and the Gages Brook South Tributary, as well as runoff from Interstate 84, Route 31, and

residential developments. Segments WR-03 and WR-05 were assessed on June 3, 2008, while the remaining segments were inventoried on June 4, 2008.

WR-01
This reach is located between Walker Reservoir West and Interstate 84, and receives flow from an upstream pond and the highway. The stream is braided and is surrounded primarily by forested land.

- RCH - The reach is generally braided with a sandy bottom and a mostly-shaded stream surface. Channel widths were variable due to the braided nature of the stream, with the flow containing less than 25 percent of the channel width. Stream condition metrics in this reach are extremely poor with little habitat potential. Buffer metrics were somewhat better, with suboptimal (25-50 feet) width and mature forest vegetation. No notable floodplain was present.

- OT - A drainage ditch outfall originating from Interstate 84 is present near the upstream end of the reach. The channel contained excessive debris that should be removed. There was no flow when it was observed.

- SC - A stream crossing is present below Route 84. The 24-inch, steeply-sloped, corrugated metal pipe conveys flow from an upstream pond and reach WR-02 located north of the highway. The culvert is acting as grade control and has significant accumulated debris near its outlet. This reach also includes a chain link fence associated with the highway that has significant accumulated debris on the upstream side of the stream. The debris should be removed.

WR-02
This reach is located immediately upstream of the Interstate 84 culvert crossing and downstream of a pond, and situated at the southern end of the Mount Vernon Apartments.

- RCH - This reach is mostly shaded with a variable bottom of gravel, sand, and cobble. In stream habitat and vegetative protection was generally marginal, with suboptimal bank stability and floodplain connection. Buffer and floodplain condition was generally suboptimal to marginal, with significant impacts from human activities and little habitat diversity.

- SC – The Interstate 84 stream crossing described above is located at the downstream end of this reach. Generally, stream crossings separating reaches were considered to be associated with the downstream reach. However, the characteristics of the culvert inlet differ from the outlet; the upstream inlet is a 4-foot diameter pipe while the outlet is a 2-foot diameter pipe. A transition is suspected to occur at some point within the crossing.

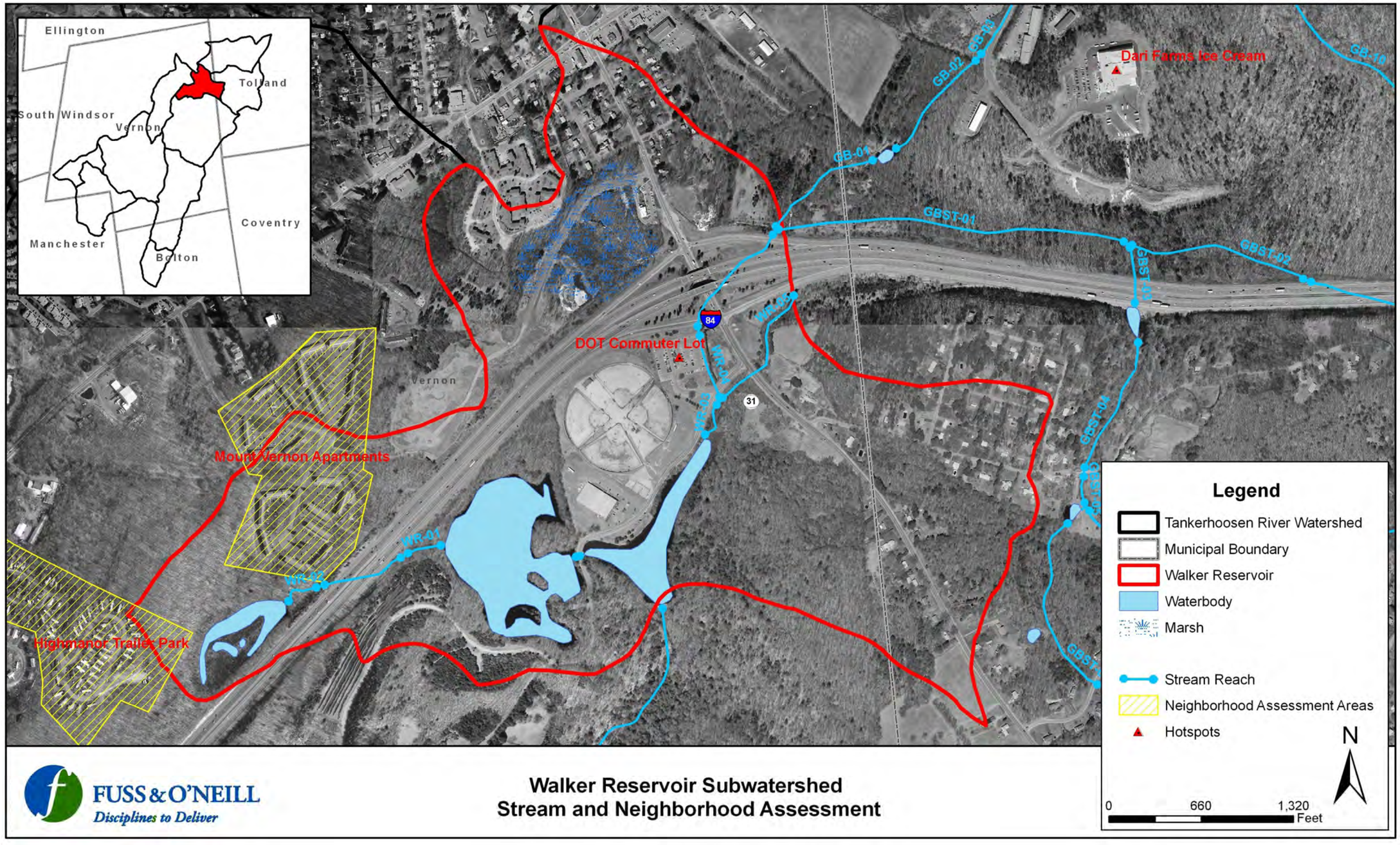


Figure 6. Walker Reservoir Subwatershed Field Assessment Locations

WR-03
This stream reach connects Walker Reservoir East with reaches WR-04 and WR-05 and runs parallel to the east side of Reservoir Road, opposite the former outdoor sports complex.

- RCH - This reach is mostly shaded and includes a bottom of fine material including silts, clays, and sand. The reach is variable in width and depth, but is generally well shaded. A variety of wildlife was observed, including fish, beaver, deer, snails, and birds. Evidence of channel widening and sediment deposition was observed. The overall stream condition is generally suboptimal, with the in-stream habitat, vegetated buffer width on the right bank and floodplain encroachment rated as marginal.

- SC – A 4.5-foot diameter circular metal pipe is located on the right bank near the upstream end of the reach. The culvert appears to originate from stream reach WR-04 and crosses under Reservoir Road.

WR-04
The stream reach WR-04 begins on the south side of Reservoir Road at the confluence of segments WR-03 and WR-05. WR-04 is a drainage ditch that flows parallel to the commuter parking lot between the Interstate 84 off-ramp at Exit 67 and Reservoir Road.

- RCH – Stormwater runoff from the commuter parking lot discharges directly into the stream through an outfall. The channel near the commuter lot contains significant invasive wetland vegetation (cattails and reed canary grass). The stream assessment rated this segment as generally suboptimal to marginal. The channel substrate is fine material including silt/clay and sands (sediment deposition). The water is observed to be turbid and there are some aquatic plants in the stream, which is partially shaded. The stream segment is readily accessible from the adjacent commuter parking lot.

- OT – The outfall that drains the commuter parking lot discharges to the stream through a 3-foot diameter concrete pipe. This outfall is a potential stormwater retrofit candidate to treat runoff from the parking lot.

- SC – Stream crossing SC-01 conveys flow below Reservoir Road and consists of a circular 4.5-foot diameter circular metal pipe. The pipe inlet is partially clogged with autumn olive and maintenance should be performed to remove the blockage. The second stream crossing in this segment, SC-02, is at the upstream end of the segment and crossed underneath the off-ramp for Exit 67 on Interstate 84. The culvert is circular with a diameter of 4 feet. There is evidence of sediment deposition, but otherwise the culvert is in good condition.

WR-05
Segment WR-05 is located between the confluence of WR-04 and WR-03 on the south side of Reservoir Road and the on-ramp for Exit 67 on Interstate 84. The stream flows in a southwesterly direction along this reach, crossing under Route 31 (Mile Hill Road).

- RCH – This segment is rated as suboptimal in the categories of in-stream habitat, vegetative protection and bank erosion, and rated as poor floodplain connection. The buffer conditions are generally marginal and there is extensive floodplain

encroachment. The surrounding land use includes public roads (Interstate 84 and Route 31) and a portion of the commuter parking lot. There is a small vegetated buffer along the stream corridor on the upstream portion of the stream segment, although beyond the buffer are cleared fields. The dominant substrates are sand and gravel, with limited cobble. There is evidence of fish, raccoon, great blue heron and Canada geese in the stream corridor. The stream has evidence of sediment deposition and portions have been channelized.

- OT – Stormwater outfall OT-01 is an earthen channel located on the left bank upstream of the Route 31 crossing. The channel originates from an adjacent residential property and was observed to have significant (3 to 4 feet deep) headcutting (erosion of the channel progressing upstream). A moderate flow of clear water was discharging from the channel at the time of the inspection. The property owner indicated that the source of the flow is groundwater seepage and surface runoff from upgradient areas. A discharge investigation is recommended, and this channel is a potential candidate for stream bank stabilization. The second outfall, OT-02, is a paved asphalt channel on the right bank, 8-inches deep and approximately 3 feet wide. The channel conveys road runoff.

Eroded channel and discharge from a residential property.

- SC – Two stream crossings were identified along this reach. SC-01 is the stream crossing underneath Route 31 (Mile Hill Road), and SC-02 is the culvert underneath the on-ramp for I-84. Both crossings consist of twin concrete box culverts approximately 6 feet wide and 9 feet in height. Both have embedded bottoms. Sediment deposition was observed in the stream channel at both locations, which is believed to originate from Interstate 84 and channel erosion described above.

Twin box culvert along reach WR-05 underneath the onramp for I-84.

2.2.5 Gages Brook

A total of 2.2 stream miles were assessed in Gages Brook (Figure 7), including segments GB-01 through GB-10, during June 3 through 5, 2008. The primary land uses in this subwatershed include commercial development along Route 30, industrial uses associated with the Tolland Industrial Park, and residential and forested areas in the eastern portions of the watershed. The Gages Brook stream assessments performed for this study augment previous stream surveys performed by the North Central Conservation District in October 2007 between the Tolland Agricultural Center footbridge and Industrial Park Road West.

GB-01
This primarily forested reach of approximately 0.18 miles is the downstream-most reach of Gages Brook and extends from the Interstate 84 culvert crossing to the footbridge behind the Tolland Agricultural Center (TAC).

- RCH - The reach was mostly shaded, with optimal habitat, and vegetation and floodplain characteristics ranging between suboptimal and marginal.

- OT - Two outfalls were identified, both of which are believed to be drainage ditches associated with Interstate 84 located just upstream of the highway. Little discharge was present despite intermittent rain over the previous 1 to 2 days. The drainage ditches are potential candidates for stormwater quality retrofits.

- ER - Two areas of severe bank erosion were identified. ER-01 included a 300-ft length of severe bank scour downstream of one of the outfalls described above. In a small section (30-40 feet), the stream was flowing mostly within an undercut section of the back, such that the channel bottom was mostly dry. ER-01 appeared to be located on private property and would be difficult to access. ER-02 included a 150-ft section of

undercut bank at a 90-degree bend where the stream enters CM-01. ER-01 may be located on State property but may also be difficult to access. While both areas of erosion are in need of restoration, limited site access may make bank stabilization impractical.

- CM – An approximately 200-foot long section of stream immediately upstream of the Interstate 84 crossing appeared to be straightened, disconnected from the floodplain, and modified to create a riprap-lined channel with trapezoidal cross section.

- TR - A deposit of brush, logs, and disassembled fencing was observed immediately adjacent to the stream less than 100 feet downstream of the footbridge at the TAC grounds. The material should be removed during a stream cleanup.

GB-02

This reach of approximately 0.17 miles continues upstream from the TAC footbridge northeast to a transition from forest to old field. The reach is generally wooded with significant wetlands located in the floodplain.

- RCH - The stream is mostly shaded with some evidence of sediment deposition. In-stream habitat was marginal, with other in-stream metrics ranging from suboptimal to optimal. The reach includes a high-quality buffer and good floodplain connection, with associated metrics ranging from suboptimal to optimal.

- TR - A small quantity of automotive debris was observed and should be removed. Access is difficult, although cleanup would be straightforward.

Trash and debris in stream segment GB-02

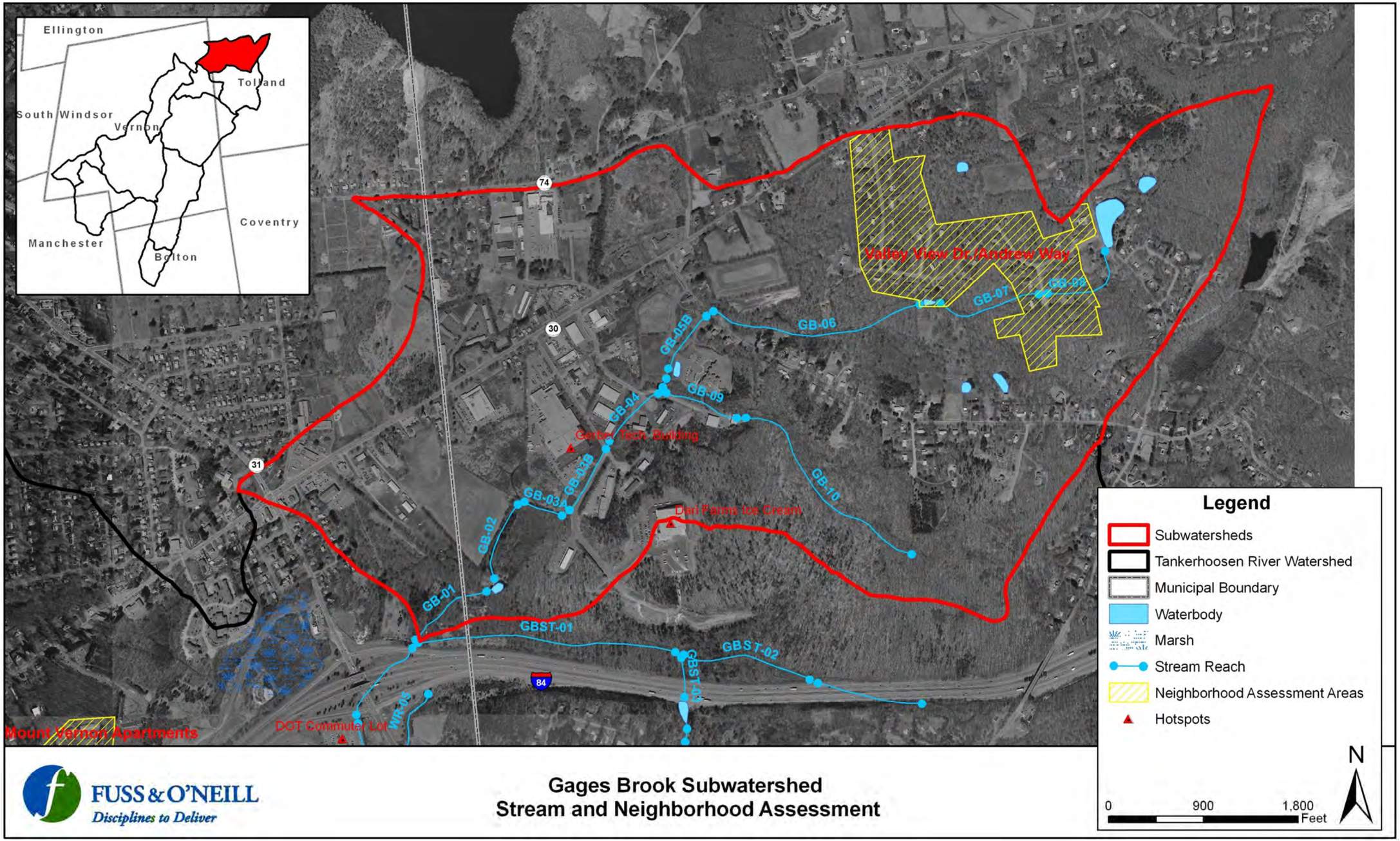


Figure 7. Gages Brook Subwatershed Field Assessment Locations

GB-03A

This reach begins where GB-02 emerges from the forest and extends east, with the forest to the south and the old field to the north, ending at Gerber Drive in the Tolland Industrial Park.

- RCH - The reach is mostly shaded with old field to the right and forest to the left. Bed scour and bank scour were observed in some areas. Most stream, buffer, and watershed condition metrics were in the marginal to suboptimal range, with low-end marginal habitat and marginal floodplain connection. However, there was little floodplain encroachment, and the vegetated buffer was high-end suboptimal to optimal in condition.

- OT - A wet stormwater basin associated with the industrial park discharges to the stream at the upstream end of the reach. Dense vegetation was growing in the riprap and erosion was present on the adjacent downstream bank in GB-03A

- ER - An approximately 100-foot long area of bank scour was observed in a straight section of the right bank. The severity of the erosion was relatively minor and appeared to originate downstream of OT-01. Access to this area is fair, although it is likely in private ownership.

- SC - A stream crossing is present below Gerber Drive and consists of two elliptical corrugated metal culverts. Fish passage may be difficult through these culverts due to shallow depth of flow during low-flow conditions.

GB-03B

This reach of approximately 0.14 miles runs parallel and adjacent to Gerber Drive between the crossings at Gerber Drive and Industrial Park Road West. The reach is located in a narrow, modified channel between the road/retaining wall and the parking lot of an adjacent industrial facility.

- RCH - Stream condition metrics in this reach were generally suboptimal. Buffer and floodplain metrics were marginal to poor since significant encroachment is present on both sides of the stream. Artificial fish habitats (lunkers) were found along the stream banks, and fish were observed in the stream as well as evidence of raccoons and songbirds in the stream corridor.

- OT - Four outfalls were present in this reach, including two paved asphalt swales ("leakoffs") directing surface runoff to the stream from adjacent parking lots, a 12-inch concrete pipe originating from the parking lot of an adjacent industrial facility, and a 24-inch concrete pipe suspected to be associated with the roadway drainage system. Significant trash was present at the outlet of one of the leakoffs.

- IB – The majority of the stream reach has limited and highly impacted stream buffers. At the downstream end of the reach, a retaining wall is located along the top of the right bank, and industrial parking lots are located close to the left bank. Due to the limited area on both sides of the stream, there is low potential for stream restoration along this reach.

Concrete retaining wall adjacent to Gerber Drive along segment GB-03B

- SC - The reach terminates at the Industrial Park Road West stream crossing, which consists of three 72-inch corrugated metal pipe culverts. The left barrel was slightly out of round. The majority of flow was through the left barrel; the bottom of the center barrel was dry, and the right barrel appeared to have some backflow. The flow depth in these culverts may be insufficient for effective fish passage during low-flow conditions. This crossing is a potential candidate for fish barrier removal. The inlet of the culverts was partially obstructed by brush and debris, which should be removed.

GB-04

Reach GB-04 is located between Industrial Park Road West and Industrial Park Road East. The reach includes numerous outfalls and significant sedimentation.

- RCH - The reach is mostly shaded, although the buffer is significantly impacted on both sides. Stream condition metrics were generally within the suboptimal range, although poor floodplain connection was observed. The vegetated buffer width is suboptimal on the left and marginal on the right, and the vegetation quality is at the lower limit of the suboptimal range. Both the floodplain habitat and floodplain encroachment metrics were poor.

- OT - Six outfalls were observed in this reach, originating from the industrial areas or associated roadways. These included an 8-inch corrugated metal pipe, a 6-inch plastic pipe, a 7-inch plastic pipe (OT-03) with some sediment deposition immediately downstream, a 12-inch concrete pipe draining a parking lot, a double 42-inch culvert that conveys roadway storm drainage, and a 24-inch concrete pipe conveying roadway drainage to the stream. The source of the sedimentation at OT-03 should be investigated.

- SC - This crossing includes triple 72-inch culverts below Industrial Park Road East. The depth in one pipe was approximately 6-12 inches, while the other two barrels were blocked with leaves, branches and sediment. The blockage should be cleared by removing the material.

GB-05A

This reach continues upstream from GB-04 to GB-05B. The reach GB-05 was subdivided into two separate reaches because the confluence of GB-09 and GB-04 occurred a few hundred feet upstream of the location shown in the original mapping (the figure shows the updated reach segments).

- RCH - This reach is mostly shaded with a gravel and cobble bottom, with some sedimentation and bank scour observed. In-stream habitat was optimal, with a mix of stable and naturally occurring substrate and habitat conditions. The majority of the remaining stream, floodplain, and buffer condition metrics were in the suboptimal range, although with marginal floodplain connection and encroachment.

- OT - One outfall pipe was observed on the left bank just upstream of Industrial Park Road East and appeared to originate from an adjacent industrial area.

GB-05B

This reach extends from the confluence of GB-05A and GB-09 upstream to Old Post Road. The stream passes through the landscaped grounds of a technology company and much of the reach is unshaded. This reach may provide an opportunity for bank stabilization and stream buffer restoration, since it appears to be located on land owned by a single (although private) owner. Community garden plots were observed adjacent to the stream, and solar panels were being constructed on-site, indicating that the owner may be environmentally-motivated. A wet stormwater basin is located on the property between an on-site parking lot and the stream.

- RCH - Stream condition metrics in this reach are generally suboptimal to poor, with little or no vegetative buffers, significant erosion problems, and little floodplain or floodplain connection. Water from the stream appears to be diverted through the on-site stormwater basin via a catch basin diversion structure. Buffer and floodplain condition metrics were marginal to poor, with narrow vegetated buffer width (10-25 feet) floodplain vegetation consisting of turf, little or no wetland habitat, and significant floodplain encroachment.

- OT - An 8-inch PVC outfall was observed originating from the on-site stormwater basin. Bank erosion and riprap was observed at the outfall. Some debris was present at the outfall, including pieces of plastic pipe.

- ER - A significant area of bank erosion was observed in a bend in the stream. The erosive cut was approximately 5.5 feet in height and greater than 100 feet in length. This area is a potential candidate for stream bank stabilization.

Stream segment GB-05B showing limited vegetative buffer and a small footbridge crossing the stream.

- IB – Little or no vegetative buffer exists along the stream through the commercial/office building site. Mowed lawn borders much of the stream on both sides, and several footbridges have been constructed over the stream. This stream segment is a potential candidate for stream buffer restoration.

Stream segment GB-05B showing area of stream bank erosion.

- SC - Two stream crossings were observed, including a 36-inch culvert below the facility access road and a 50-inch culvert below Old Post Road. Both culverts are perched on the downstream side approximately 2 to 4 inches above the bottom of the stream, and both have very shallow flow (less than 1 inch), which presents a barrier to fish passage.

The former appeared to be in good condition and the latter appeared to have been recently slip-lined. These culverts are potential candidates for fish barrier removal.

GB-06

This reach of approximately 0.4 miles in length continues from Old Post Road to a former pond located south of a residential subdivision on Valley View Drive.

- RCH - The reach was mostly shaded with a bottom of gravel, cobbles, and boulders. Evidence of downcutting was present along much of the reach since many of the boulders were sharp-edged. In general, stream condition metrics were marginal or poor, with significant erosion, marginal vegetative protection, and marginal floodplain connection due to downcutting. Overall buffer and floodplain characteristics were generally suboptimal, with a relatively wide buffer of young forest and a mix of wetland and upland habitat.

- OT - Three outfalls were present at the downstream terminus of the reach. These included 12-inch and 15-inch storm lines and a paved asphalt leakoff conveying stormwater runoff to the stream.

- ER - Numerous areas of significant erosion were identified along this stream segment. Three areas of bank scour on the outside banks of bends were observed. One area included a low-head concrete dam where the stream eroded the abutment, creating a bypass channel around the structure. The last area included active downcutting ending at a nick point behind several residences at the terminus of the reach. These areas are potential candidates for stream bank stabilization.

Stream segment GB-06 showing area of stream bank erosion.

- IB – An impacted buffer was observed at the terminus of GB-06 near a footbridge on private property. Residential landscape vegetation (pachysandra) was observed growing up to the bank's edge.

- SC - Three stream crossings were present in this reach, each of which likely prevents upstream fish passage. The first is located adjacent to Old Post Road at the downstream end of the reach. This crossing consists of an embankment such as a dam or railroad grade that does not include a culvert or opening. The stream appeared to be flowing through interstices in the embankment. The second crossing consisted of a dam with a total hydraulic drop of approximately 9 feet. The third crossing is a former road with a corrugated metal pipe culvert and a drop at the culvert outlet of approximately 5 inches. These crossings are potential candidates for dam removal and/or fish barrier removal.

GB-07

This reach of approximately 0.2 miles in length continues upstream to the east from GB-06 to Andrew Way. The stream corridor is generally forested, surrounded by residential development along Valley View Drive, Andrew Way, and Old Post Road.

- RCH - The reach is mostly shaded with a bottom of cobbles and boulders. Typical channel dynamics include downcutting and bed scour. The reach is mostly shaded. Stream conditions were generally within the suboptimal to marginal range, while buffer and floodplain characteristics were generally optimal to the high end of suboptimal.

- IB – Similar to the residential encroachment observed in reach GB-06, an isolated area of pachysandra and lawn were present on both sides of the stream where the stream enters SC-01.

- SC - This crossing includes an approximately 200-foot long, 24-inch concrete culvert below Andrew Way. A series of small drops (approximately 24 inches) were present downstream of the outlet. These drops were resulting from the boulders lining the channel. These drops and shallow flow in the culvert under low-flow conditions would likely limit upstream fish passage. This culvert is a potential candidate for fish barrier removal.

GB-08

This reach of 0.15 miles is the uppermost stream segment on Gages Brook, which is located between Andrew Way and a privately-owned pond situated north of Mountain Spring Road. The stream segment flows primarily through residential and forested areas.

- RCH - This reach is mostly shaded with a sand and gravel bottom and a stable channel with little noticeable erosion. Stream condition metrics are within the suboptimal range in this reach, while buffer and floodplain connection generally are within the optimal and suboptimal ranges.

- OT - An outfall was identified adjacent to a residence near the downstream limit of this reach. The outfall consisted of a 2.5-inch diameter PVC pipe with a screen projecting

over the water surface by approximately 6 inches. The pipe may be the outlet of a foundation or yard drain.

- IB - Residences and lawn are located adjacent to the stream for approximately 300 feet on both sides of the stream near the downstream end of the reach.

- SC - The upstream limit of this reach consists of a low-head dam with an outlet weir discharging directly to an 18-inch concrete culvert below Mountain Spring Road.

- TR - An area of trash and debris was observed in the stream and buffer (right side) near the outlet of SC-01. Observed debris consisted of a tire, two 55-gallon drums (partially crushed with holes) and a bathtub. This debris should be removed and disposed of properly.

GB-09

This 0.15 mile reach parallels an access road and industrial facility located at the end of Industrial Park Road East.

- RCH - This reach has a gravel and cobble bottom, is mostly shaded, and has evidence of downcutting, bed scour, and bank failure. In-stream habitat is generally optimal to the high end of suboptimal. Buffer and floodplain characteristics are generally suboptimal to marginal due to the reach's incised nature and industrial land use along the left side.

- OT - This reach includes two outfalls. The first is a paved asphalt leakoff from a parking lot paired with a 6-inch PVC outfall causing slight bank erosion. The other outfall, OT-02, is an 18-inch plastic pipe discharging from the direction of the industrial facility. There was significant iron staining around this outfall. The source of the discoloration should be investigated.

- SC - A small dam is present in this reach, consisting of a weir with a drop of approximately 32 inches. Immediately downstream of the weir an area of soil has been undercut by the stream, forming a natural culvert, although one that is unlikely to significantly alter passage during low flow conditions.

GB-10

This reach of approximately 0.43 miles extends from the upstream limit of GB-09 into an extensive wetland complex where the stream originates in an area of groundwater seeps. This reach passes through a recently-constructed subdivision off of Old Post Road that does not appear on the aerial photos in the project mapping.

- RCH - This reach is mostly shaded with a gravel and cobble bottom and included some evidence of downcutting and sedimentation. The overall stream, buffer, and floodplain conditions were in the optimal range for every metric. The majority of the stream is surrounded by an extensive old-forest/wetland complex that is well connected to the stream channel. There is little evidence of encroachment except at the subdivision crossing.

- OT - One stormwater outfall to the stream was identified. The outfall originates from a new subdivision road and discharges to a stormwater basin/constructed wetland. The basin contained a significant quantity of leaves and other sediment. Stormwater discharged to the buffer of the stream via overland flow and continued to the stream. There appeared to be potential for future erosion where overland flow is occurring. Two other stormwater basins associated with this subdivision were observed, but the outfall locations could not be identified.

- SC - A new stream crossing was observed under the subdivision road, consisting of a 24-inch concrete pipe. A boulder was present below the flared-end outlet. The culvert outlet is perched several inches above the stream bed, and the depth of flow in the pipe was approximately 1-inch. Due to the headwater location of the culvert, upstream fish passage is unlikely to be an issue in this portion of the watershed.

New stream crossing on segment GB-10.

2.2.6 Gages Brook South Tributary

An unnamed tributary to Gages Brook (referred to as the Gages Brook South Tributary in this study) drains an area located south of the Gages Brook subwatershed. Reaches GBST-01 through GBST-04B and GBST-09A and GBST-09B were assessed on June 5, 2008, totaling approximately 1.3 stream miles (Figure 8). The subwatershed is bisected by Interstate 84 and contains forested and residential land uses.

GBST-01
This reach is approximately 0.5 mile in length and extends along Interstate 84 in an area that is otherwise relatively undeveloped.

- RCH - The stream is well-shaded, has a cobble and gravel bottom, and was found to be in optimal condition in terms of both overall stream, buffer, and floodplain characteristics. Evidence of downcutting, sedimentation, and scour were observed in

some areas, but in general the reach is well-connected to the floodplain and appeared to provide optimal wildlife habitat and vegetation conditions. Moss was observed on portions of the stream banks where erosion had occurred, indicating that the banks have since stabilized.

GBST-02

This reach of approximately 0.26 miles begins at its confluence of GBST-03 and continues upstream to the east generally running parallel to Interstate 84. The upstream end is a pair of culverts, one of which conveys the stream below Interstate 84 and the other which parallels the highway.

- RCH - This reach includes a bottom of gravel, cobbles, and boulders and has portions that are downcut and channelized. This reach is mostly shaded and was evaluated to be in the suboptimal range for most stream condition metrics. However, vegetative protection of the banks was generally optimal, as was the vegetated buffer width, floodplain vegetation, and floodplain habitat in most areas. Encroachments on the stream's buffer and floodplain were limited to an area where the stream was channelized along Interstate 84.

- OT - Several outfalls were identified along this reach. Each appeared to be associated with drainage from Interstate 84. Discharges were observed from both OT-02 and OT-03, and although rain fell the previous day. Significant sediment accumulation was observed at the outlet of OT-03 and SC-01. No discharge was present from OT-01, although significant erosion was present downstream of this outfall, which discharges approximately 300 feet from the wetland surrounding the reach. Minor bank erosion was observed downstream of OT-02.

- SC - This stream crossing conveys the tributary below Interstate 84. The crossing is a concrete culvert several hundred feet long. The crossing is partially blocked by accumulated sediment.

Stream crossing (SC-01) below I-84 and outfall (OT-03) along reach GBST-02.

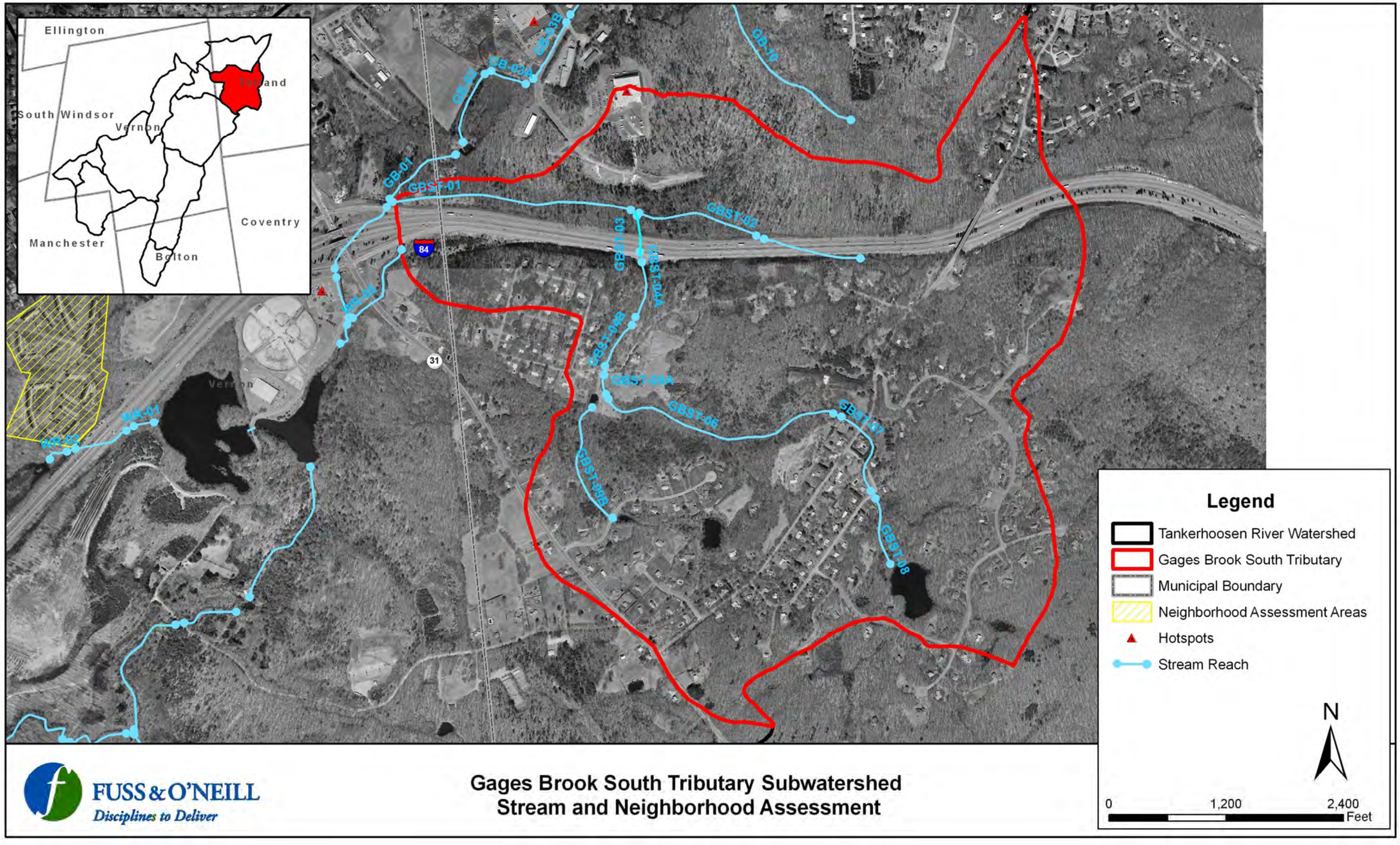


Figure 8. Gages Brook South Tributary Subwatershed Field Assessment Locations

- CM - The channel of GBST-02 has been modified significantly at the upstream end of the reach, which is channelized parallel to Interstate 84 for a length of approximately 700 feet. The channel is a uniform trapezoidal cross-section disconnected from a floodplain and lined with stone riprap.

GBST-03
This is a short reach located between GBST-01 and GBST-04A, which flows below Interstate 84.

- RCH - The reach has a relatively steep bottom of boulders, cobble, and sand, and is well-shaded. Stream condition metrics are generally in the suboptimal range since some bank erosion was observed, and the area was generally well vegetated, although modification of the banks was evident. Buffer and floodplain condition metrics were generally suboptimal as well, although the floodplain appeared to be an even mix of wetland and non-wetland habitats with evidence of standing water (optimal) and to have significant encroachment (marginal).

- SC - The stream crossing below Route 84 is a significant restriction to the upstream passage of fish. The 48-inch diameter concrete pipe has drop of approximately 4 feet at its outlet, and a series of boulders located downstream yield an additional stepped drop of approximately 10 feet. Additionally, the flow of water in the pipe was shallow. Despite these fish passage restrictions, this crossing is an unlikely restoration candidate since the pipe is below Interstate 84.

GBST-04A
This reach continues upstream from the Interstate 84 crossing to a small dam behind a residence. The field team observed a definitive break in stream and floodplain characteristics at this dam. The reach passes through an area of residential land use. Some evidence of downcutting was observed.

- RCH - This reach is generally well-shaded and has a variable bottom with some silt and clay along the downstream portion and with cobbles and boulders upstream. The downstream portion appeared to be a pond that has filled with sediment. Stream condition metrics were all within the optimal range. Overall buffer and floodplain conditions were also optimal, although floodplain was only present in a limited area.

- OT - A riprap drainage ditch along Route 84 discharges to the stream near its southern end.

- SC - A low-head dam crossing the stream was defined as the upstream limit of this reach. The dam includes a drop of approximately 42 inches.

GBST-04B
This reach continues from GBST-04A to the downstream limit of GBST-06 and GBST-09. The reach passes behind several residences and includes a pond filled with sediment at its lower limit.

- RCH - This reach is mostly shaded with a variable bottom of generally fine material (silt/clay, sand, and gravel). In-stream habitat was marginal, and dense invasive vegetation was present on both banks. Floodplain connection was optimal, however, since the stream was not deeply incised and high flows could easily enter the floodplain.

View of reach GBST-04B

- IB - Impacted buffer was present near the downstream end of this reach. In this area, the left bank is forested, although the right bank is vegetated with turf, lawn, and shrubs. A single-family home was also located near the stream.

- SC - The upstream limit of this reach is located at Loehr Road. The stream flows below the road through a 60-inch corrugated metal pipe. The pipe was deformed at the downstream end, but the invert was inundated by tailwater, indicating that fish passage may be possible.

GBST-09A

The downstream end of this reach is located at its confluence with GBST-06 prior to entering the culvert GBST-04B SC-01. The reach is short in length, receiving the discharge from a small privately-owned pond.

- RCH - This reach includes a bottom of cobbles and boulders and appeared to be channelized. The reach is partially-shaded. Stream metrics were generally in the suboptimal to marginal range, although poor floodplain connection was observed. The channel has a buffer consisting of shrubs and brush. Little floodplain is present with poor habitat and connection to the stream.

- SC - Two stream crossings are present in this reach. One (SC-01) includes double 16-inch HDPE culverts below an unpaved road. The culvert slope is relatively flat but has a shallow water depth that would be unlikely to allow fish passage. SC-02 includes the

dam for a small pond. The discharge of the pond could not be viewed, but is likely to be a significant barrier to fish passage.

GBST-09B
This reach begins from the inlet of the pond at the upstream end of GBST-09A and continues upstream to another pond located at the Tolland Farms Road residential subdivision.

- RCH - The reach is mostly shaded with a bottom of gravel, cobbles, and boulders. The stream is downcut and has areas of bank failure and bank scour. As a result, stream condition metrics were generally within the suboptimal range, although floodplain connection was poor. The majority of the buffer and floodplain metrics were found in the optimal range, with ideal vegetated buffer of mature forest and very little floodplain encroachment, although floodplain habitat consisted of a mix of wetland and upland without ponded water (suboptimal).

- OT - No outfalls were observed along this reach. However, stormwater runoff from the residential subdivisions on Tolland Farms Road, Deer Meadow and Reed Road is believed to ultimately drain to this reach of the Gages Brook South Tributary. The pond located upstream of Tolland Farms Road may provide some attenuation of peak flows and stormwater quality renovation for this upstream drainage area.

- ER - Significant bank erosion was observed on the outside bank of two adjacent bends, each section of erosion being approximately 80 feet in length and 6 to 7 feet in height. This area is a potential candidate for bank stabilization, although site access is difficult in this area.

- SC - Two stream crossings were observed along this reach. SC-01 included three 15-inch concrete pipes below an unpaved, likely privately-owned, road. The slope of the pipes is moderate, and a drop of approximately 5 inches is present on the downstream end, which is a barrier to fish passage. Limited access, private property ownership, and headwater location make this culvert a poor candidate for fish barrier removal. SC-02 is a 24-inch culvert below Tolland Farms Road. This culvert receives discharge from the control structure of the upstream pond.

2.2.7 Tucker Brook

Tucker Brook is a tributary of the lower Tankerhoosen River. The Tucker Brook subwatershed includes portions of Vernon and Manchester. The predominant land uses in the Tucker Brook subwatershed are residential and forested land. Reaches assessed in this subwatershed include TB-01, TB-02, TB-03, and TB-04 (Figure 9).

TB-01
This lower reach extends from the confluence with the Tankerhoosen River upstream to Brookview Drive. Partially demolished cement building foundations and stream crossings from demolished industrial-era infrastructure remain along the downstream portion of the stream. The upper portion of the reach has significant stream buffers, native vegetation, stream shading and flood plains.

Examples of impacted buffers along reach TB-01. A cement retaining wall (A) for the street and bridge on the right bank near the confluence with the Tankerhoosen River and partially demolished cement infrastructure along the banks (B).

- RCH – The reach is mostly shaded with native vegetation, has no attached or floating plants in the stream, and has a sand and cobble substrate bed. There is evidence of bed scour, bank failure and sedimentation along the reach. The overall stream, buffer and floodplain conditions are rated in the suboptimal range.

- OT – A 12-inch circular outfall pipe was observed on the right bank, although was not submerged and did not have flow. A possible earthen-type stormwater outfall was identified on the left bank which could collect storm drainage from the highway, but was not flowing during the assessment.

- ER – Bank failure and scour is present on the right bank along an approximately 50-foot meandering portion of the stream. The bank is currently stabilized by tree roots and other hanging woody debris. The bank appears to be stable.

- IB – There is a bridge abutment on the right bank of Tucker Brook at the confluence with the lower Tankhoosen River. The Dobson Road overpass abutment extends approximately 40 feet upstream and is approximately 10 feet from the stream bank. The stream banks and riparian area along the downstream end of the reach at the confluence with the Tankerhoosen River lack a tree canopy; the stream is unshaded in this area. This area is a potential candidate for reforestation.

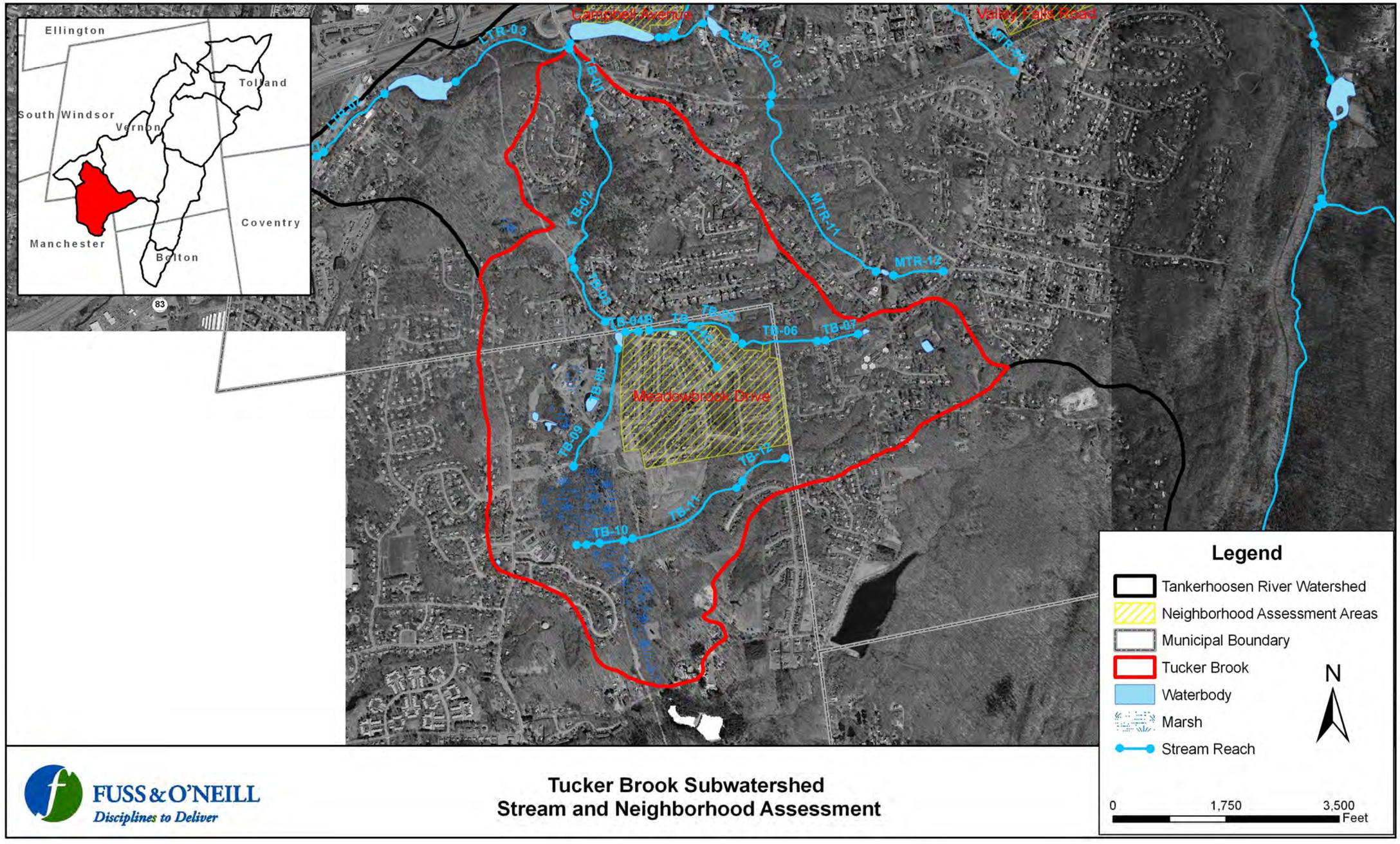


Figure 9. Tucker Brook Subwatershed Field Assessment Locations

The left and right streambanks along the lower portion of Tucker Brook (foreground) at the confluence with the Tankerhoosen River (background) are potential candidates for reforestation.

- SC – Four stream crossings exist along this reach. SC-01 is an abandoned concrete abutment which was formally a road crossing. The stream crossing has a natural bed so is not an impediment to fish passage, although is a floodplain encroachment concern. SC-02 is a large arch-shaped railroad crossing constructed of stone which is approximately 125 feet long. The archway is in good condition but creates a barrier to fish passage and is suffering from downstream scour. SC-03 is an open-bottom box culvert with some evidence of downstream scour. The final stream crossing, SC-04, is at the upstream end of the reach and consists of a double barrel 6-foot concrete culvert below Brookview Drive. The circular culverts are in good condition although there is downstream pooling and scouring. The boulders placed in the stream for energy dissipation may serve as a barrier to fish passage. Crossings SC-03 and SC-04 are potential candidates for fish barrier removal.

TB-02

A reach level assessment was conducted for this section by examining characteristics of the downstream end, and not traversing the entire reach. The land use around this reach is forested, the stream is mostly shaded, the dominant bed substrate is sand and cobble, and the base flow is less than 25% of the channel width. The overall stream conditions are optimal for bank erosion and floodplain and suboptimal for instream habitat and vegetative protection. There is optimal buffer width along the stream and suboptimal floodplain characteristics.

Arch-type railroad crossing (SC-02) constructed of stone and extending approximately 125 feet. The crossing may prevent fish passage and is suffering from downstream scour evidenced by the large pool shown in the photograph.

TB-03

This stream segment is adjacent to a residential neighborhood (on Ironwood Drive) along the right bank and a gas pipeline corridor along the left bank.

- RCH – Overall stream conditions in this section are rated marginal to suboptimal. The vegetative buffer limited due to the close proximity of private residential properties. The stream is flowing at almost 100% of the channel width, is mostly shaded, and has a variable bed substrate consisting of silt, sand, gravel and cobble. There is evidence of downcutting, aggrading, bank failure and scour.

- OT – A drainage outfall conveying roadway runoff is located at the upstream end of the reach near Phoenix Street. No dry weather flow was observed.

- ER – Bank failure and scour were observed in several meanders along the right stream bank, totaling approximately 125 feet in length. A privately owned shed is located approximately 3 feet from the edge of the bank and is in danger of being damaged by further erosion. This site is a potential candidate for bank stabilization.

- IB – Three areas of buffer impacts were noted along this reach. IB-01 is on the right bank and approximately 50 feet long. Dense non-native vegetation associated with a residential backyard is growing on the stream bank. IB-02 and IB-03 are areas along the left stream bank with a reduced buffer resulting from vegetation clearing in the gas pipeline right-of-way.

This section of river is abutted by residential properties along the right bank and has an impacted buffer on this side of the stream from lawn vegetation and items such as this shed.

- SC – The first stream crossing, SC-01, consists of a small manmade dam constructed of boulders and cinder blocks. The dam is approximately 1 foot high and spans the width of the stream. SC-02 is a 48-inch concrete culvert below Phoenix Street. The crossing is in good condition and not a barrier to fish passage.

TB-04A

Stream segment TB-04 was further subdivided into three smaller segments based on field conditions at the time of the surveys. Segment TB-04A begins at the Phoenix Street crossing and ends approximately 500 feet upstream at a beaver dam.

- RCH – The reach level assessment revealed invasive species along the stream, a silt and sand-dominated bed substrate, and mostly shaded stream. There is marginal in-stream habitat, vegetative protection and floodplain characteristics. The bank erosion and floodplain characteristics are optimal due to low banks and wide floodplain. The buffer width is suboptimal because a pumping station and Phoenix Street are in close proximity to the stream.

TB-04B

Stream segment TB-04B is a short segment which begins at the boundary of the Meadowbrook Drive neighborhood and flows to the inlet of the pond created by the beaver dam. This stream segment is characterized by significant growth of invasive species. A stormwater basin associated with the adjacent residential subdivision discharges to this section of the stream.

- RCH – The reach level assessment characterized the stream conditions in this section as suboptimal to marginal due to a lack of vegetative protection along the banks, little in-stream habitat and some bank erosion. The overall buffer and floodplain condition ranges from poor floodplain habitat to suboptimal floodplain vegetation. There is some floodplain encroachment along the reach. The dominant substrate is silt/clay and gravel, and the water is naturally stained. The largest issue observed in the stream segment is the presence of invasive species which are growing over the stream.

- OT – Stormwater outfall OT-01 flows from the stormwater basin that serves the upland residential neighborhood. The outfall is a circular concrete pipe, 18 inches in diameter. Dry weather flow was observed, although the pipe is partially submerged in the stream. There is evidence of bank erosion at the outlet of the pipe and the basin appears to be in need of regular maintenance, including detailed inspection to further assess the condition of the basin.

- TR – A small amount of yard waste (TR-01) was observed along the right bank. The debris consists of grass and brush clippings.

TB-04C

Stream segment TB-04C continues through the Meadowbrook Drive subdivision, ending at a system of 6 culverts which cross under Meadowbrook Drive.

- RCH – The stream segment flows behind houses, often adjacent to the property line. The close proximity of the stream to these residences has resulted in numerous stormwater outfalls, impacted buffers, stream crossings, and occurrences of trash and debris in the stream.

- OT – There are five stormwater outfalls along this reach, ranging in size from 4 to 8-inch diameter pipes. The outfalls appear to be associated with residential yard drains, foundation drains, or roof downspouts. All but one outfall pipe had dry weather flow at the time of inspection. The flowing outfall, OT-04, had a trickle of orange discharge, which may be naturally-occurring iron precipitate associated with groundwater discharge. A discharge investigation is recommended nevertheless to confirm the source of the discharge.

Outfall pipe originating from a residential property on the left bank of segment TB-04C.

- IB – There are two areas of stream buffer impacts along this stream segment. Both consist of residential lawn or scrub/shrub vegetation adjacent to the stream. Stream buffer restoration potential is limited due to private land ownership.

- SC – There are two manmade dams and one road crossing along this segment. The road crossing forms the upstream end of this segment, and consists of 6 metal arch culverts approximately 13 feet in diameter and 5 feet in height. The culverts extend approximately 70 feet in length under Meadowbrook Drive. The other two stream crossings are manmade dams; one is a stone dam that creates a pool and cascade downstream. The second dam creates a waterfall and redirects the stream sharply. Both dams are physical barriers to upstream fish passage and should be considered potential candidates for removal, although private land ownership may limit this potential.

- TR – There are two instances of trash and debris along this segment. Both are piles of yard waste, including a tree that has been cut into logs and a pile of leaves and yard clippings.

2.3 Upland Assessment

Fuss and O Neill conducted upland assessments in the Tankerhoosen watershed on July 16, 2008. The field observations assist in identifying pollution prevention and potential restoration opportunities at hotspot land uses and residential neighborhoods in the watershed. Factors that were considered when determining which hotspots and neighborhood areas to prioritize for assessment include:

- Stream condition (assessed during stream corridor inventory),
- Site proximity to the stream,
- Land use type and development density,
- Land ownership,
- Restoration potential.

The assessment framework was adapted from the Unified Subwatershed and Site Reconnaissance (USSR) method developed by the Center for Watershed Protection. USSR is a "windshield survey" evaluation method in which field crews drive and walk through areas of the watershed to quickly identify pollution prevention and restoration opportunities. The three major components to the upland assessments conducted in the Tankerhoosen watershed are: hotspots, residential neighborhoods, and streets and storm drains. Field data forms that were completed during the assessments are provided in Appendix B.

2.3.1 Hotspot Site Investigation

Hotspot site investigations were conducted for six representative sites with a high potential to contribute polluted stormwater runoff to the storm drain system and receiving streams. The purpose of the investigation was to qualitatively assess the potential for stormwater pollution from previously identified commercial, industrial, municipal or transport-related sites. The hotspot investigation was limited in scope to representative hotspot facilities in order to evaluate and illustrate common issues. The investigation was not intended to be an exhaustive review of all potential hotspot facilities in the entire watershed nor a detailed inspection or audit of each facility, which are beyond the scope of this study.

The hotspots examined in the field were located within the Lower Tankerhoosen River, Walker Reservoir, Clarks Brook, and Gages Brook subwatersheds. Representative priority hotspots were selected to cover a range of watersheds and land uses, including three industrial sites, one commercial site, one transportation-related site, and one state/municipal site. Sites are identified by the watershed abbreviation, followed by "HSI" and a numeric identifier. Table 5 summarizes the selected hotspots that were evaluated. Several of the sites that were investigated are privately owned, and field crews were unable to gain full access to the sites to closely evaluate the storm drainage and other site characteristics.

Table 5: Hotspot Site Investigation Summary

Site ID (Watershed)	Land Use Category	Description of Site Operations
GB-HSI-01 (Gages Brook)	Industrial	Industrial Park – Gerber Technologies Office Building
GB-HSI-02 (Gages Brook)	Industrial	Dari Farms Ice Cream Distribution Center
WR-HIS-01 (Walker Reservoir)	Transport-related	ConnDOT Commuter Lot
CB-HIS-01 (Clarks Brook)	Commercial	Superior Energy – Propane
CB-HIS-02 (Clarks Brook)	Industrial	Sand, gravel, construction storage/processing facility
LTR-HIS-01 (Lower Tankerhoosen River)	State/Municipal	ConnDOT Maintenance and Service Center

Gerber Technologies Office Building

The Gerber Technologies office building is located in the Tolland Industrial on Industrial Park Road West. The site is located adjacent to Gages Brook (see stream assessment discussion in Section 2.2.5). The office building has landscaped areas around the building with shrubs and turf lawn. The site is characterized by a large amount of impervious cover, consisting of building roof areas and parking lots. Approximately 100 vehicles were parked in the employee parking lots at the time of the inspection. Stormwater runoff from the site appears to discharge to the stormwater basin located near the southern limit of the site. The stormwater basin is a wet pond design containing a permanent pool of water and is approximately 70 feet wide by 140 feet long. The basin contained accumulated sediment captured from the site runoff. The basin outfall discharges to Gages Brook via a riprap spillway.

The stormwater basin that receives runoff from the Gerber Technologies facility incorporates many of the recommended elements to meet current stormwater quantity and quality design criteria. However, the basin is also in need of maintenance as demonstrated by the sediment accumulation near the center of the basin and the overgrown woody vegetation at the overflow spillway. Existing stormwater basins such as this one may also be good retrofit candidate to improve treatment effectiveness by incorporating a sediment forebay at the basin inlet, which may also facilitate routine sediment removal.

Stormwater basin at the Gerber Technologies facility on Industrial Park Road West. Sediment has built up near the center of the basin (A) and the basin overflow spillway is overgrown with vegetation (B).

Dari Farms Ice Cream Distribution Facility

The Dari Farms distribution facility is also located in the Tolland Industrial Park on Research Way/Gerber Drive near the divide between the Gages Brook and Gages Brook South Tributary subwatersheds. The facility is estimated to be less than 5 years old, as evidenced by the facility's modern pollution prevention site design elements including a covered fueling station, no visible outdoor storage of materials, and well maintained landscaping on the grounds. Possible pollution sources to the storm drainage system are the runoff from the large impervious areas on the site (the roof and parking areas) and potential vehicle fluids from truck fueling activities and employee vehicles. It could not be determined whether stormwater is managed on-site, by the downgradient stormwater basin near the Gerber Technologies facility, or both. The site did not appear to incorporate Low Impact Development (LID) design features such as vegetated swales or parking lot bioretention. New commercial/industrial facilities with significant impervious area, such as this one, are potential candidates for on-site LID and stormwater treatment practices to reduce runoff volume and pollutant loads.

The Dari Farms Ice Cream Distribution Facility has a covered fueling station and landscaped grounds (shown in the foreground).

ConnDOT Commuter Parking Lot

The hotspot investigation included the Connecticut Department of Transportation commuter parking lot at exit 67 of Interstate-84, which is located in the Walker Reservoir subwatershed (see stream assessment discussion in Section 2.2.4). Approximately 150 vehicles were parked at the lot during the site visit, which occurred on a weekday during mid-day. The site is contains significant impervious cover and high-intensity vehicle usage and is therefore a source of automobile-related stormwater pollutants including hydrocarbons, sediment, and metals. The entire parking lot drains to a double catch basin located on the southeastern side of the lot. The catch basin discharges through a short wetland corridor and subsequently to the stream segment located upstream of Reservoir Road and Walker Reservoir East. An easily accessible grass strip exists between the paved lot and the adjacent wetland and stream corridor. This site is a potential stormwater retrofit candidate (bioretention or water quality swale) to encourage infiltration and provide additional treatment for the parking lot runoff.

The southeastern side of the Interstate 86 Exit 67 commuter parking lot showing the edge of the lot on the left side of the photograph and the wetland corridor on the right side. The center of the photograph shows the easily accessible and open area for a potential stormwater retrofit.

Superior Energy

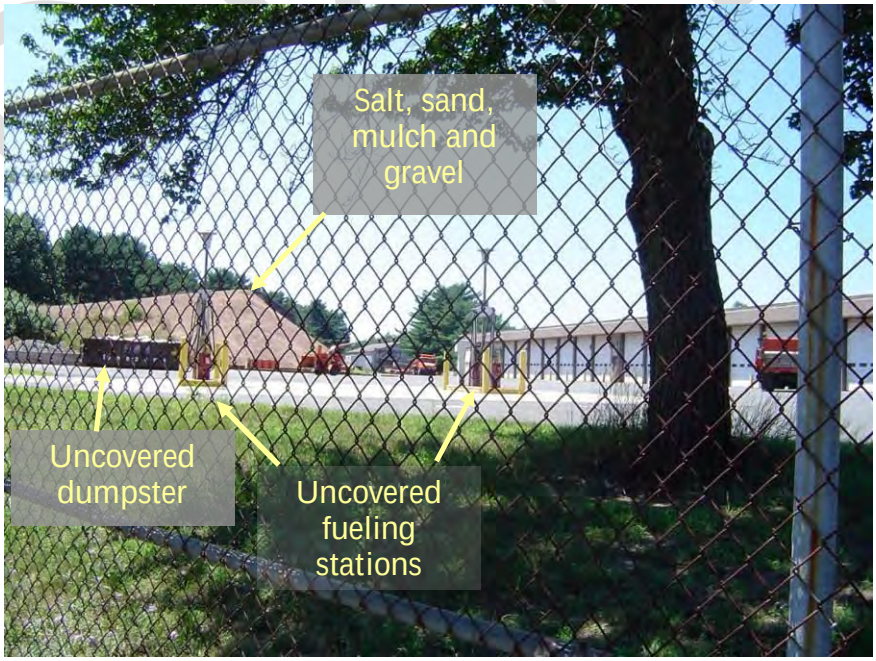
Superior Energy is a propane gas and related equipment distributor located on Hartford Turnpike (Route 30) in Vernon. The site is located within the Clarks Brook subwatershed (see stream assessment discussion in Section 2.2.1) near the headwaters of Clarks Brook. The property consists of a retail store, a paved parking lot for delivery trucks, and outdoor storage of propane tanks. It is unknown if vehicle maintenance or fueling occurs on-site. As described previously, the site appears to have been modified in the past through grading/filling based on an inspection of the existing site drainage and discussions with facility personnel. This site should be further investigated to better define potential impacts of the historical filling, current drainage issues, and plans for additional site development.

Sand & Gravel Facility

The facility is located on Clark Road at the western end of Industrial Park Road and near the western limit of the Clarks Brook subwatershed. Facility operations appear to include storage and processing of sand, gravel and other construction materials. The site contains one building, which is assumed to be an office and/or maintenance area. The majority of the site consists of an unpaved yard used for the storage of sand and gravel piles and equipment to process the materials and load transport vehicles. The site contains numerous potential sources of sediment and other pollutants associated with the sand and gravel stockpiles, heavy equipment and vehicles, waste construction materials stored outdoors, and pipes and debris in the yard. Sand and gravel operations such as this should employ stormwater pollution prevention practices and source controls as required by the DEP *General Permit for Stormwater Discharges Associated with Industrial Activity*, in addition to stormwater treatment practices to reduce sediment and hydrocarbon loadings in site stormwater runoff.

DOT Maintenance Service Center

The State of Connecticut operates a Department of Transportation Maintenance Service Center for District #1 located on Campbell Avenue in Vernon, which is located in the Lower Tankerhoosen River subwatershed. The facility has an office building, garages for vehicle storage and maintenance, a small parking lot, outdoor storage of sand, salt, gravel and mulch, and an uncovered outdoor fueling station. Vehicle maintenance activities and outdoor vehicle fueling are potential sources of stormwater pollution, in addition to the outdoor stockpile storage. A rolloff dumpster was observed to be overflowing and uncovered at the time of the windshield survey. Municipal and state-operated highway maintenance facilities such as this should employ source controls, pollution prevention, and stormwater treatment practices as necessary in accordance with the DEP *General Permit for Stormwater Discharges Associated with Industrial Activity*.



ConnDOT District #1 Maintenance Service Center, Campbell Avenue

2.3.2 Neighborhood Source Assessment

Stormwater runoff from existing residential neighborhoods and future residential development in the watershed is an important consideration for this study, since approximately 40 percent of the Tankerhoosen River watershed consists of residential land use and future buildout of the watershed could result in conversion of an additional 10 percent of the watershed to residential land use. Neighborhood source assessments were conducted on July 16, 2008 to evaluate pollution source areas, stewardship behaviors, and residential restoration opportunities within individual residential neighborhoods throughout the watershed. The residential behaviors that contribute to stormwater quality were assessed by considering the following source areas for "average" neighborhoods throughout the subwatershed:

- Yards and Lawns;
- Driveways, Sidewalks, and Curbs;
- Rooftops;
- Common Areas.

Neighborhoods were selected for assessment based on their proximity to stream corridors and their overall potential to contribute pollutants to the stream. The selected neighborhoods include a variety of residential types, including low- and high-density single-family residential and multi-family residential (apartments and condos). One field sheet was completed for each neighborhood assessed. The selected neighborhoods are located in the Tucker Brook, Lower Tankerhoosen River, Clarks Brook, Walker Reservoir, and Gages Brook subwatersheds, as summarized in Table 6.

Each neighborhood was assigned a score for pollution severity and restoration potential. Pollution severity is a measure of how much nonpoint source pollution a neighborhood is likely generating based on easily observable features such as lawn care practices, drainage patterns, oil stains, etc. Restoration potential is a measure of the feasibility of on-site retrofits or behavior changes based on available space, number of opportunities, presence of a strong homeowners association, and other factors.

Table 6: Neighborhood Source Assessments Conducted in the Tankerhoosen River Watershed

Neighborhood/Subdivision Name	Subwatershed	Residential Type	Pollution Severity	Restoration Potential
Mount Vernon Apartments	Walker Reservoir	Multi-family	Moderate	Moderate
Campbell Avenue	Lower Tankerhoosen River	High-density, single-family	Moderate	Low
Valley View Drive/Andrew Way	Gages Brook	Medium-density, single-family	None	Low
High Manor Mobile Home Park	Clarks Brook	High-density, single-family	Moderate	Moderate
Meadowbrook Drive	Tucker Brook	Medium-density, single-family with open space areas	None	Low

Mount. Vernon Apartments

The Mount Vernon apartments are a 33-acre multi-family housing complex situated between Hartford Turnpike (Route 30) and Interstate 84 in the Walker Reservoir subwatershed. The apartments are served by outdoor surface parking lots in front of each building. Site imperviousness is estimated at approximately 50 percent. Runoff downspouts are connected directly to the site stormwater drainage system, and parking areas are served by traditional curb and gutter drainage. The complex is generally well-maintained, with generally clean gutters, catch basins, and parking areas. Some oil staining was observed on the pavement within individual parking stalls. The overall pollution severity is rated as moderate due to the large amount of directly connected impervious area and potential pollutant sources from parking areas. This site is a potential retrofit candidate to reduce stormwater runoff from the site, including disconnecting downspouts from the storm drainage system and redirecting them to pervious grass areas, rain barrels/cisterns, and rain gardens. Multi-family parking lots, such as the parking lots at this complex, may also be good candidates for stormwater retrofits. The following photograph depicts an existing landscaped area adjacent to the parking lot that could potentially function as a bioretention/rain garden.

The Mount Vernon apartment complex buildings showing clean and well-maintained parking areas and landscaping (A) and a landscaped area that has the potential to be used as a rain garden (B).

Campbell Avenue

The Campbell Avenue residential development is a 13-acre neighborhood of single family homes on approximately ¼ acre lots. The neighborhood is located off of Dobson Avenue and is situated between Interstate 84 and the ConnDOT Maintenance Service Center to the north and Dobsonville Pond to the south. The age of the neighborhood is estimated as approximately 50 years. Almost none of the homes has a garage, and nearly all have impervious driveways connected to the street curb and gutter drainage system. No on-site or centralized stormwater management practices were observed, other than curb and gutter drainage. Most of the homes have downspouts that are directed to pervious lawn areas near the house. Landscaping practices were minimal. This type of older, high density single family residential neighborhood has limited potential for stormwater retrofits due to limited land area.

Valley View Drive/Andrew Way

The Valley View Drive/Andrew Way neighborhood is approximately 55 acres in size and located near the headwaters of Gages Brook. The neighborhood is approximately 25 years old

and consists of single family homes occupying approximately 1-acre lots. Most of the homes have garages and a high percentage of the lots are covered by lawn (60%) and landscaped areas (20%). The subdivision is served by traditional curb and gutter drainage. No centralized stormwater management measures were observed. Approximately three quarters of the roof downspouts are connected to adjacent pervious areas. Overall, the neighborhood was rated as having low pollution potential and limited potential for stormwater retrofits.

A typical lot in the Valley View Drive/Andrew Way neighborhood.

High Manor Mobile Home Park

High Manor Mobile Home Park is an approximately 28-acre neighborhood located in the Clarks Brook subwatershed, situated between Route 30 and Interstate 84. The park is believed to have been developed in the 1970s. The average lot in the neighborhood has approximately 40 percent impervious cover, including the home and driveway, 40 percent grass cover, and 20 percent landscaped area. Approximately 90 percent of the homes have roof downspouts that discharge to lawns. The streets have traditional curb and gutter drainage, and storm drain inlets were observed to be clean. No centralized stormwater management measures were observed.

A street view of the High Manor Mobile Home Park showing turf lawns with some mature trees on the properties.

Meadowbrook Drive

The Meadowbrook Drive neighborhood is an approximately 100-acre residential neighborhood in the northeast corner of Manchester. The neighborhood is situated in the central portion of the Tucker Brook subwatershed, and Tucker Brook flows partially through and along the north and west sides of the development (see stream assessment discussion in Section 2.2.7). The subdivision is estimated as approximately 10 years old, and the average lot size for the single family homes in the subdivision is approximately ½ acre. All of the homes have garages. The driveway, sidewalks and curb areas are clean and dry. A majority of the homes have roof downspouts that discharge to pervious lawn areas. The street storm drains are stenciled. An approximately 1-acre wet stormwater basin near the corner of Yale and Chatham Drives receives runoff from the subdivision storm drainage system. The basin outlet discharges to Tucker Brook. At the time of the inspection the stormwater basin outlet was observed to be overgrown with vegetation, and stream bank erosion was observed at the outfall to the stream. As noted in Section 2.2.7, the basin appears to be in need of regular maintenance. Buffer encroachment, stream crossings, residential drain outfalls, and yard waste dumping were common in residential areas along the stream corridors in this subdivision.

Typical conditions in the Meadowbrook Drive neighborhood showing landscaping, lot sizes, and general cleanliness.

2.3.3 Streets and Storm Drain Assessment

Urban streets and storm drains can be a source of stormwater pollutants if not maintained on a regular basis. The condition of the local road and storm drain infrastructure can be assessed to determine if existing maintenance practice could reduce pollutant accumulation. Selected streets and storm drains were assessed during the upland field inventories conducted on July 16, 2008. Most of the streets and storm drains that were assessed are located in or near hotspot or neighborhood source assessment locations. Findings of the street and storm drain assessment are summarized below. Photographs of the storm drains and the street conditions evaluated are provided as Table 7, and the completed field forms are included in Appendix B.

Table 7: Streets and Storm Drain Assessment Photographs

Location	Storm Drains		Streets
Campbell Avenue			
Mount Vernon Apartments			
Valley View Drive/Andrew Way			
High Manor Mobile Home Park			
Gerber Technologies			
Clark Road Industrial Park			[No photo]

Most of the streets were clean, free of sediment and debris, and in good condition. The one exception is Industrial Park Road in the Clark Road Industrial Park where roads were observed to be in poor condition (cracked, broken, and sediment accumulation). Storm drains along Industrial Park Road were also partially obstructed with sediment, leaves, and trash, and one of the catch basins had standing water above the elevation of the stream water surface, indicating blockage of the outlet pipe. Many of the inspected catch basins had varying degrees of sediment accumulation and nearly all could benefit from increased clean-out and street sweeping. With the exception of the Meadowbrook Drive subdivision in the Tucker Brook subwatershed, none of the storm drains observed during the field assessments were stenciled.

3.0 LAND USE REGULATORY REVIEW

3.1 Introduction

Municipal land use regulations control patterns of new development and redevelopment and can play a significant role in protecting water quality and other natural resources in a watershed. These commonly include local plans of conservation and development, zoning regulations, subdivision regulations, inland wetland regulations, and stormwater regulations, all of which influence the type and density of development that can occur within a watershed. Local land use regulations often vary by town within a watershed, and regulations are periodically revised in response to development pressure, shifts in attitude toward natural resource protection, and political and socioeconomic factors.

A key element in the development of a Watershed Management Plan is to identify potential land use regulatory mechanisms (i.e., new or modified land use regulations) that can be implemented by the watershed towns to strengthen existing land use controls and better protect natural resources within the watershed. Many Connecticut communities are in the process of developing new or modified land use regulations that incorporate Low Impact Development (LID) and related stormwater management approaches to address stormwater quantity and quality objectives. Communities in urbanized areas are also faced with a mandate to meet State and Federal Phase II stormwater permit requirements under the National Pollutant Discharge Elimination System (NPDES) program, as well as addressing local concerns about the damaging effects of increased impervious cover and uncontrolled stormwater runoff from land development and suburban sprawl. An opportunity exists for the watershed towns to develop revised and/or new regulatory mechanism to satisfy Phase II stormwater requirements, while also protecting water quality and other natural resources in the Tankerhoosen River watershed.

This section summarizes the following information:

1. Existing municipal land use planning entities and regulations for each of the watershed communities based on information obtained from a land use questionnaire conducted by the North Central Conservation District in 2005 as part of the *Hockanum River State of the Watershed Report* (Fuss & O Neill, 2005). The information was updated where necessary to reflect current conditions.

2. Existing land use regulations and related planning documents that pertain to stormwater management and natural resource protection issues, as well as potential approaches for developing regulatory mechanisms to incorporate improved stormwater

CB-05

The most upland reach in Clarks Brook, CB-05, could not be visually assessed because the segment flows entirely belowground in a culvert system. The flow is directed below a commercial building occupied by Superior Energy Propane and continues to flow through the culvert for approximately 650 feet, parallel to Route 30 until re-emerging on the north side of Middle Terrace. Historical filling of the Superior Propane site appears to have occurred, as evidenced by water seepage from the ground surface at the southeast corner of the site and the presence of a significant stand of phragmites adjacent to the site. A storm drain exists on the site. Representatives from Superior Propane indicated a desire to pave additional areas of the site and/or divert the water on the site to alleviate the wet soil conditions. This site should be further investigated to better define potential impacts of the historical filling, current drainage issues, and plans for additional site development.

2.2.2 Lower Tankerhoosen River

The Lower Tankerhoosen River subwatershed is the outlet for the main stem of the Tankerhoosen River prior to its confluence with the Hockanum River and is fed directly by Tucker Brook and the Middle Tankerhoosen River (Figure 4). Only stream segment LTR-03 was assessed in this subwatershed (on June 5, 2008) due to limited time and staff availability.

LTR-03

Stream segment LTR-03 is approximately 0.5 mile long and extends east to west, parallel to Interstate 84, from the inlet to Talcottville Pond through a forested area to the Dobsonville Pond dam and Dobson Road. The width of the stream varies from 20 feet to 50 feet and the upstream end of the segment near the dam has very steep banks.

The upstream side of Dobsonville Pond dam at the upstream limit of reach LTR-03. The photograph is taken near the confluence with reach TB-01.

management, including LID concepts and opportunities to reduce impervious cover, into the local land use regulations. The regulatory review was performed for the towns of Tolland and Vernon because they comprise the majority of the land area in the Tankerhoosen River watershed and have the greatest potential for future development.

3.2 Summary of Municipal Land Use Planning Entities and Regulations

The 2005 land use questionnaire provided information from the watershed municipalities on the current land use regulations in each town, including information on wetlands and watercourses regulations, zoning regulations, plans of development, open space planning, and stormwater regulations. The following paragraphs summarize information obtained from the questionnaire.

Local land use regulations are administered by various Town commissions, boards, and agencies. Land use commissions in the Tankerhoosen River watershed communities are summarized below (Table 8).

Table 8: Tankerhoosen River Watershed Land Use Commissions

Town	Land Use Commissions
Manchester	• Planning and Zoning Commission (acts as Inland Wetlands and Watercourses Agency) • Zoning Board of Appeals
Vernon	• Planning and Zoning Commission • Inland Wetlands and Watercourses Agency • Conservation Commission
Tolland	• Planning and Zoning Commission • Inland Wetlands and Watercourses Commission • Conservation Commission • Design Advisory Board
Bolton	• Planning and Zoning Commission • Inland Wetlands Commission • Conservation Commission • Open Space Preservation, Acquisition, and Conservation Committee

Source: Hockanum River – State of the Watershed Land Use Questionnaire, North Central Conservation District, 2005

Table 9 summarizes the current plan of development, subdivision, inland wetlands, zoning, floodplain management, and stormwater regulations for the watershed towns. The table lists the last revision date for the applicable land use regulations.

Table 9: Municipal Land Use Regulations

Regulation	Manchester	Vernon	Tolland	Bolton
Plan of Development	2004	2001	1999	1990
Subdivision Regulations	2005	2007	2008	2004
Wetlands Regulations	2007	2006	2007	2006
Zoning Regulations	2008	2006	2008	2005
Floodplain Management	1994	In Zoning Regs.	None	2005
Stormwater Regulations	2004 Connecticut Stormwater Quality Manual	In Zoning Regs.	2008 (LID)	2004

Source: Hockanum River – State of the Watershed Land Use Questionnaire, North Central Conservation District, 2005

Inland Wetlands & Watercourses

Regulating activity with the potential to affect wetlands and watercourses is an essential component in preserving or improving the water quality and overall health of the Tankerhoosen River. In Connecticut, the Inland Wetlands and Watercourses Act requires that each municipality establish an Inland Wetlands and Watercourses Agency or Commission and local regulations regulating private and municipal work located in or affecting wetlands or watercourses. Each of the surveyed watershed towns has an inland wetlands agency, and each town has defined an upland review area, or distance from wetlands and watercourses that is subject to review. Three of the four watershed towns indicated that they have identified wetlands or watercourses that are impaired or that require restoration or require special protection. Table 10 summarizes the regulating agencies, upland review areas, and identified wetlands and watercourses of special significance for the surveyed watershed towns.

Table 10: Inland Wetlands and Watercourses Regulations

Town	Regulating Agency	Upland Review Area	Wetlands and Watercourses of Special Significance
Manchester	Planning & Zoning Commission	50 'wetlands and watercourses	None identified
Vernon	Inland Wetlands & Watercourses Agency	100 'wetlands 200 'designated watercourses	• Vernal pools on Box Mountain Road • Tankerhoosen River • Hockanum River • Belding Preserve and Wildlife Management Areas
Tolland	Inland Wetlands & Watercourses Commission	50 'wetlands 100 'watercourses	Preliminary*

Bolton	Inland Wetlands Commission, Conservation Commission	100 'wetlands and watercourses	Yes*

Source: Hockanum River – State of the Watershed Land Use Questionnaire, North Central Conservation District, 2005
*Information available from the individual towns.

Stormwater Management and Soil Erosion and Sediment Control

Development of the landscape with impervious surfaces can alter the hydrology of a watershed and has the potential to adversely affect water quality and aquatic habitat. As a result of development, vegetated and forested land that consists of pervious surfaces is largely replaced by land uses with impervious surfaces. This transformation increases the amount of stormwater runoff from a site, decreases infiltration and groundwater recharge, and alters natural drainage patterns. Natural pollutant removal mechanisms provided by on-site vegetation and soils have less opportunity to remove pollutants from stormwater runoff. During construction, soils are also exposed to rainfall, which increases the potential for erosion and sedimentation. Development can also introduce new sources of pollutants from everyday activities associated with residential, commercial, and industrial land uses.

Stormwater runoff both during construction and following completion of construction for new development and redevelopment projects is regulated at the local and state levels. All of the watershed towns have erosion and sediment control regulations as mandated by the Soil Erosion and Sediment Control Act. Most Connecticut municipalities have adopted regulations requiring that a soil erosion and sediment control plan be submitted with any application for development within the municipality when the disturbed area of such development is more than one-half acre. Projects that disturb greater than 5 acres of land are subject to regulation under the DEP General Permit for the Discharge of Stormwater and Dewatering Wastewaters Associated with Construction Activities. This permit applies to discharges of stormwater and dewatering wastewaters from construction activities including, but not limited to, clearing, grading, and excavation that result in the disturbance of 5 or more acres of total land area on a site. Pursuant to Phase II of the NPDES Stormwater Program, construction activities disturbing between 1 and 5 acres have been delegated by DEP to the municipalities provided that the erosion and sediment control plan is reviewed and receives approval from the town, under the Soil Erosion and Sedimentation Control Act.

Post-construction stormwater quantity and quality are also regulated by the watershed municipalities through municipal planning and zoning and inland wetlands and watercourses regulations. All of the watershed towns are subject to the requirements of the NPDES Phase II stormwater program, which is regulated under the DEP General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 General Permit). The MS4 General Permit regulates the quality of municipal stormwater discharges and requires the creation of a Stormwater Management Plan that addresses the following six minimum control measures:

1. Public education and outreach on storm water impacts required throughout the entire municipality;
2. Public involvement/participation required throughout the entire municipality;

3. Illicit discharge detection and elimination required throughout the entire municipality including mapping all storm water discharges from a pipe or conduit with a diameter of 15 inches or greater (or equivalent cross-sectional area) owned or operated by the municipality;
4. Construction site storm water runoff control required throughout the entire municipality;
5. Post-construction storm water management in new development and redevelopment; and
6. Pollution prevention/good housekeeping for municipal operations.

The DEP *Connecticut Stormwater Quality Manual* provides guidance on the measures necessary to protect the waters of the State of Connecticut from the adverse impacts of post-construction stormwater runoff. It is intended for use as a planning tool and design guidance document by the regulated and regulatory communities involved in stormwater quality management in Connecticut. The manual provides uniform guidance for developers, engineers, and review agencies on the selection, design, and application of stormwater control measures. All of the watershed towns in the Tankerhoosen River watershed have indicated that they use the stormwater manual in reviewing development proposals for stormwater management issues.

The Town of Tolland recently (February 2008) amended its zoning and subdivision regulations to require that Low Impact Development (LID) techniques be implemented on all development to protect high quality wetlands, watercourses, open water bodies and other sensitive areas from the impacts of point and nonpoint sources of stormwater due to land development projects. Tolland also developed a companion LID design manual.

Open Space

Open space plays a critical role in protecting and preserving the health of a watershed by limiting development and impervious coverage, preserving natural pollutant attenuation characteristics, and supporting other planning objectives such as farmland preservation, community preservation, and passive recreation. Open space includes preserved natural areas as well as lightly developed parks and playgrounds. While approximately 40 percent of the Tankerhoosen River watershed consists of undeveloped land uses, much of this land is not considered open space because it may be privately owned and ultimately developed. Protected open space areas include deeded open space that is privately owned, parcels owned by land trusts, state and federally-owned land, land owned by water companies, and municipal park land. Such land is protected against future development. Each of the watershed towns has prepared an open space plan for their respective communities (Table 11).

Table 11: Status of Municipal Open Space Plans
in the Tankerhoosen River Watershed

Town	Open Space Plan
Manchester	2004
Vernon	2002
Tolland	2006
Bolton	2004

Source: Hockanum River – State of the Watershed Land Use Questionnaire, North Central Conservation District, 2005

In addition to the designation of protected open space through donation, purchase of land by a town, conservation or land trusts, or other private and/or public agencies, towns also require that some land be dedicated as open space with the development of new subdivisions. The subdivision regulations of all of the towns in the Tankerhoosen River watershed require the set aside of a percentage of new subdivisions as open space, and all but Manchester have provisions for fee-in-lieu-of open space. Table 12 summarizes responses from the surveyed watershed communities regarding their current open space regulations.

A majority of the surveyed watershed towns also allow "cluster development" and "open space subdivisions" in their subdivision regulations. These are compact forms of development that concentrate density in one portion of the site in exchange for reduced density elsewhere, thereby reducing overall site imperviousness and associated stormwater impacts and potentially avoiding development in sensitive areas of a site.

Table 12. Open Space Regulations

Town	Allow 'Cluster' Development	Allow 'Open Space' Subdivisions	Subdivision Open Space	
			Required	Fee in lieu of
Manchester	Yes	No	Yes, 6%	No
Vernon	No	No	Yes	Yes
Tolland	Yes	Yes	Yes, 10%	Yes
Bolton	Yes	Yes	Yes	Yes

Source: Hockanum River – State of the Watershed Land Use Questionnaire, North Central Conservation District, 2005

3.3 Summary of Existing Regulations and Preliminary Recommendations

The following policy, regulatory and planning documents were reviewed for the towns of Vernon and Tolland relative to stormwater management and natural resource protection:

- Subdivision Regulations,
- Zoning Regulations,
- Inland Wetland and Watercourses Regulations,
- Plan of Conservation and Development/Open Space Plan.

3.3.1 Town of Vernon

The Town of Vernon has a number of land use regulations that regulate construction and post-construction stormwater runoff from new development and redevelopment activities, and provide for protection of natural resources. The local regulations are particularly strong in terms of erosion and sediment control (as well as consistent between the various regulations), open space protection, and regulating activities that can potentially affect wetlands and watercourses, including requirements for watercourse buffers. However, there are several areas where the regulations and design standards and guidance could be strengthened through amendments or new regulations to clarify and strengthen stormwater management requirements and better promote the use of LID principles.

This section contains preliminary recommendations for the town of Vernon based on the review of the existing land use regulations and planning documents. The recommendations in this section are a summary of the more detailed regulatory review, which is provided in a technical memorandum dated June 9, 2008 (Appendix D).

1. Town Design Manual

- Develop a Town stormwater and LID design manual. A local manual should reference applicable sections of the Connecticut Stormwater Quality Manual to take advantage of the existing design guidance, but also include more detailed guidance and stronger emphasis on LID practices and include specific stormwater standards tailored to the characteristics and needs of the Town (see Recommendation 2). The Town land use regulations should also reference the local stormwater design manual, thereby serving as a single, unifying guidance document that could be updated without the need for major revisions to the land use regulations.

- Include a section of the design manual that addresses stormwater retrofits for redevelopment and drainage system upgrade and maintenance projects. Stormwater retrofits for residential and commercial redevelopment projects are an important element for the Town's stormwater management strategy given the level of existing development in the Town. Stormwater retrofits also present an opportunity to implement lot-level LID strategies as opposed to larger end-of-pipe controls where land may not be available for stormwater management facilities.

- Incorporate/reference stormwater quantity and conveyance sections of the Connecticut DOT Drainage Manual for consistency with state drainage standards.

2. Stormwater Management Standards

- Develop and incorporate into the Town stormwater design manual a set of stormwater management standards, which would become regulatory standards referenced by the existing Town land use regulations and/or new stormwater ordinance (see Recommendation 3). Development of stormwater management standards would allow Vernon to establish clearer, specific standards that all projects must meet in order to obtain local land use permits. The stormwater standards could include LID requirements, complement the hydrologic sizing criteria in the *Connecticut Stormwater Quality Manual* and be tailored (using variable minimum performance standards) to protect specific water bodies or sensitive resources in the Town of Vernon. An example set of stormwater management standards is included with the full memorandum in Appendix D.

3. New or Modified Stormwater Regulations

- Develop and implement new or revised stormwater regulations to 1) satisfy Phase II Stormwater Program regulatory requirements, 2) encourage or require LID principles to be implemented for development projects in Vernon, and 3) address other local drainage and natural resource protection issues identified by the Town. Two potential approaches have been identified – 1) a new stand-alone stormwater ordinance, or 2) addition/amendments to the existing Zoning Regulations.

- Form an advisory committee or workgroup consisting of representatives from the various land use commissions and selected Town departments to further evaluate and select the best approach for Vernon, including key decisions regarding:

    - If a new, stand-alone stormwater ordinance is selected, which department or commission will have responsibility for administering the program (i.e., the "Stormwater Authority")?
    - Which projects and activities will the new ordinance apply to (i.e., applicability)?
    - How will applications be received and reviewed?
    - Who will be responsible for inspections and enforcement?
    - Will additional staff be required to handle the increased workload to review and process applications?

3.3.2 Town of Tolland

Zoning and Subdivision Regulations

The Town of Tolland recently amended its zoning and subdivision regulations to:

1. Incorporate Low Impact Development (LID) principles. The Town also developed a companion LID Design Manual that provides recommendations for site design, road design, and stormwater management.
2. Create a natural Resource and Wildlife Protection Overlay Zone around sensitive habitat areas and steep slopes throughout the town.

3. Adopt density-based zoning to replace the minimum lot size requirements.

Tolland is the first town in Connecticut to adopt comprehensive LID regulations. The regulations are a good model for the other watershed communities to require the use of LID practices. The regulations are currently in the early stages of implementation. The Town should continue to monitor the effectiveness of the LID regulations as development projects subject to the new regulations are designed, reviewed, and constructed.

Consistent with the recommendations for the Town of Vernon, Tolland should also consider adopting a River Protection Overlay District for the Tankerhoosen River (Gages Brook). Such a district would establish a contiguous and parallel buffer strip on either side of the river and would supplement the underlying zoning regulations, with the added provision that the land within the buffer areas and the river itself would remain in a natural, undisturbed state.

Inland Wetlands and Watercourses Regulations

The Inland Wetlands and Watercourses regulations were amended in 2007, and are in accordance with the Connecticut General Statues. The regulations define an Upland Review Area extending a minimum 50 feet from the edge of a wetlands and/or watercourse and a extending a minimum of one hundred 100 feet from any watercourse, including intermittent watercourses. The width of the Upland Review Area may be doubled in cases where the slopes bordering the wetland and/or watercourse are in excess of 15%, the presence of highly erodible soils, or unique and/or easily damaged wetland ecosystems exist.

Permit application requirements include documentation that proposed stormwater quality management systems, at a minimum, conform to the "2004 Connecticut Stormwater Quality Manual", as amended. The Inland Wetlands and Watercourses Regulations should be revised to require that projects also meet the design requirements contained in the Tolland LID Design Manual, for consistency with the zoning and subdivision regulations and to promote the use of LID. The town should also consider incorporating more explicit watercourse buffer requirements, including minimum buffer widths, similar to the watercourse buffer provisions in the Town of Vernon Inland Wetlands and Watercourses Regulations.

Plan of Conservation and Development

The Tolland Planning & Zoning Commission is in the process of updating the 1999 Plan of Conservation & Development (POCD) in accordance with the Connecticut General Statutes which requires the plan to be updated every ten years. The plan will establish a common vision for the future of the community and determine policies that will help attain that vision. The plan will address a range of themes, including natural resources, open space, utility infrastructure, and community development.

The Town's planning consultant has prepared draft recommendations related to conservation issues as part of the POCD update process. The recommendations address surface and groundwater quality, important habitat areas, drainage issues, green infrastructure, and open space protection. Some of the key recommendations for natural resource protection that also apply within the Tankerhoosen River watershed include (Planimetrics, 2008):

- Future development should occur in a manner and in locations that are environmentally sustainable,
- Impacts from existing development should be minimized through education, incentives, and town leadership.

Open Space and Conservation Plan

The 2006 Tolland Open Space and Conservation Plan inventoried natural resources throughout the town, including wetlands, rivers and streams, lakes and ponds, vernal pools, water supply watersheds, forest resources, and wildlife resources. In addition to the Open Space and Conservation Plan, the town has also completed or is implementing the following open space preservation activities (Planimetrics, 2008)::

- Establishing an Open Space Acquisition Fund,
- Setting up a structured process for open space procurement and management,
- Promoting the use of open space, with trail maps and programmed activities,
- Tapping into a volunteer group for maintenance (Tolland Conservation Corps).

4.0 REFERENCES

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APPENDIX A

Stream Corridor Assessment Field Forms and Data

APPENDIX B

Upland Assessment Field Forms

APPENDIX C

Photographs on CD

APPENDIX D

Vernon Regulatory Review Memorandum