

Spring Creek Name : Mill Stream 4M

General Watershed Description

The Mill Stream watershed, at just over 2000 acres, is the largest spring creek watershed within the study area. Much of the upper watershed includes small depressions that may only hold water on a seasonal basis. Unless very wet conditions prevail, most of the water within these depressions either infiltrates into the ground or is lost to evapotranspiration. During wet conditions, particularly frozen-ground, snowmelt-runoff periods, these depressions may fill up with enough water to outlet to Mill Stream. This relationship also holds true for the two headwaters lakes, Sand Lake and Hay Lake. Outflow from Sand Lake through the ephemeral channel within William O'Brien State Park has occasionally occurred in the past. Downstream of the ephemeral channel that outlets from Sand Lake, the perennial portion of Mill Stream starts within a rich fen/cattail swamp located just west of the Park Headquarters. From this northerly point, Mill Stream flows south for about 1.5 miles to the village of Marine-on-St. Croix. Within this 1.5 mile reach, flows increase significantly, as groundwater discharges off the terrace slope located to the west of Mill Stream. Within the lower-most portion of this reach, DNR Parks has restored wetland communities and approximately 1000 feet of tributary channel that historically flowed to Mill Stream from the numerous springs within this reach. This restoration site, referred to as the Minnow Farm Site, historically consisted of a series of four large ponds and several smaller ponds contained by berms and water control structures. The ponds were fed by numerous groundwater seeps along the terrace slope to the west.

Downstream of the Minnow Farm Site, Mill Stream is impounded (Upper Mill Pond) behind a concrete weir constructed across what was historically a waterfall. Below the Upper Mill Pond, Mill Stream flows as a high gradient stream over bedrock within a deep valley for several hundred feet. Approximately 200 feet upstream of Highway 95, the gradient of Mill Stream lessens considerably as it flows across the middle terrace of the St. Croix River and through the center of Marine-on-St. Croix. Just above Judd Street, Mill Stream is again impounded behind a concrete weir, forming the Lower Mill Pond. Below the concrete weir, Mill Stream flows under the Brookside Bar and outlets over a second waterfall. Below the second waterfall, Mill Stream flows several hundred more feet through a floodplain forest where it discharges into the St. Croix River.

The watershed of Mill Stream is a diverse mixture of agricultural land, large-lot residential, forest, and woodland and grassland. The lower section of the stream flows through a relatively dense urban community with substantial direct drainage of impervious surfaces, mostly from a combination of residential streets, Highway 95 and CR 4, which all converge near the lower end of the creek and convey storm flows directly to Mill Stream.

Significant Features

Mill Stream is the largest spring creek in the study area in terms of base flow and stream length. Brook Trout (*Salvelinus fontinalis*) are known to occur throughout the entire stream, including the recently restored tributaries on the Minnow Farm site. The best habitat, however, is within the lower sections of the creek below the Upper Mill Pond. In particular, the section directly above Highway 95 contains good habitat and contains fish as large as ten inches. The headwaters of Mill Stream within William O'Brien State Park contain a large, groundwater-dependent wetland complex. This wetland complex has probably been ditched and altered from past grazing more than other wetlands in the area. However, some portions of this wetland complex do include good quality tamarack swamp, mixed hardwood seepage swamp and rich fen. Below Highway 95, Mill Stream flows through an additional groundwater-fed wetland complex. This second wetland complex encompasses many of the same wetland types and is generally of higher quality than wetlands within the headwaters.

Key Management Recommendations

1. Stabilize streambank of Mill Stream on cut bank just above footbridge in Zoller's Ravine.
2. Within Zoller's Ravine, establish shade-tolerant understory shrubs and groundcover species to stabilize stream bank and improve fish habitat.
3. Encourage landowners to retain woody debris within stream channel to improve fish habitat.
4. Within Mill Stream just upstream of Highway 95, place rock or stone deflectors within channel to reverse aggrading.
5. The Highway 95 culvert should be replaced, with the upstream and downstream culvert invert placed below the existing stream grade. Alternatively, options to raise the grade of the stream (to reduce the head between the upstream and downstream end of the culvert) should be considered.
6. Work with the City of Marine-on-St. Croix and private landowners to create a continuous vegetative buffer of native vegetation between Highway 95 and the Brookside Bar and Grill at Judd Street.
7. Work with the City of Marine-on-St. Croix to install stormwater infiltration and rainwater gardens to intercept stormwater runoff that is currently discharging into Mill Stream from impervious surfaces.
8. Remove sediment from City Mill Pond and partially route Mill Stream around pond. Install native vegetative buffer around edges of pond.
9. Where Mill Stream crosses under Judd Street, install trench drains to intercept stormwater and discharge it to water quality treatment waterway/vegetative swale.

Key Policy Recommendations

1. Retain overall groundwater recharge.
2. Maintain stormwater volume for the 2-year event at predevelopment levels.
3. Maintain stormwater peak flow rates for the 2-year event at predevelopment levels.
4. Where infiltration functions are lost due to creation of impervious surfaces, reintroduce through practices that replace these functions.
5. Where private or public infrastructure is upgraded, retrofit or incorporate improvements to hydrologic and water quality conditions.
6. Require phosphorus concentration standard of 50 µg/L for stormwater discharges to tributaries of the St. Croix River.
7. Ditches, tiles, storm sewers and roadway surfaces should not collect and concentrate stormwater into drainage systems tributary to spring creeks.
8. Require an erosion control plan, consistent with the specifications of the MPCA manual "*Protecting Water Quality in Urban Areas*" for all projects that result in 10,000 ft² of disturbance.
9. Identify stream and/or wetland restoration sites that improve and/or protect other important groundwater-dependent resources.
10. Establish protective riparian corridors along streams, and buffers around wetlands.
11. Initiate a citizen monitoring program.

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Watershed Size 5,076 acres
Total Stream Length 0.55mile
Stream Type
 Slightly entrenched, meandering, gravel dominated, riffle/pool channel.

Land Cover Category	%
Grassland	32.6
Agricultural Land	8.7
Forest and Woodlands	30.3
Lakes and Open Water Wetlands	3.0
Maintained Natural Areas	.2
Wetlands	9.6
0%-10% Impervious Cover	5.2
11%-25% Impervious Cover	6.6
26%- 50% Impervious Cover	2.2
51%-75% Impervious Cover	.1
76%-100% Impervious Cover	1.6

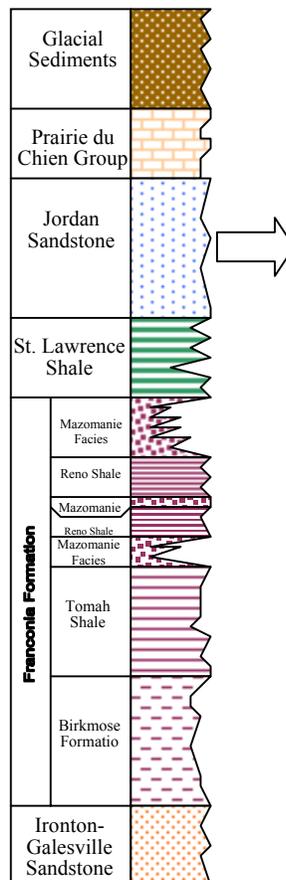
Macroinvertebrate Data

Metric	Score	Among Springs Mean ^c
Chironomidae Species Richness	20	21
Invertebrate Taxa Richness	35	31.75
HBI	4.13	4.4
%EPT	64.4	36.9
% Dominance	39.1	35.5
Most Common Families	Midges, Small Minnow Mayfly, Netspinner Caddisfly	

Hydrology

Base flow 4.5 cfs
 Estimated Bank full flow 6.7 cfs

Groundwater source



The springs emanate mostly from the Jordan Sandstone near the headwaters of the stream. The stream cuts down through several bedrock units before reaching the St. Croix River, but seeps from the lower units (St. Lawrence and Franconia Formations) contribute relatively little groundwater discharge to the creek. The result is similar water chemistry in samples collected far upstream and downstream of the Brookside Tavern.

The relatively high magnesium concentration and low calcium/magnesium ratio indicate that much of the recharge of the spring water is coming from lakes. The influence of lake water may be higher than in other spring creeks because the Superior lobe till has several large “holes” (relatively sandy areas with little or no thickness of the till) immediately to the west. The till holes may allow more downward vertical migration of water from the lakes than occurs in other areas.

Water Chemistry

Parameter	Site Mean	Site σ	MPCA NCHF Benchmark MIS ^a /St. Croix River ^b		Among Springs Mean ^c
TP [$\mu\text{g/L}$]	28.4	21.0	90	55	42.47
NO ₂ +NO ₃ [mg/L]	0.98	0.26	0.1	0.203	2.15
TSS [mg/L]	3.27	2.03	8.8	7.50	15.96
Temperature [C]	10.80	5.80	13.0	10.30	9.95

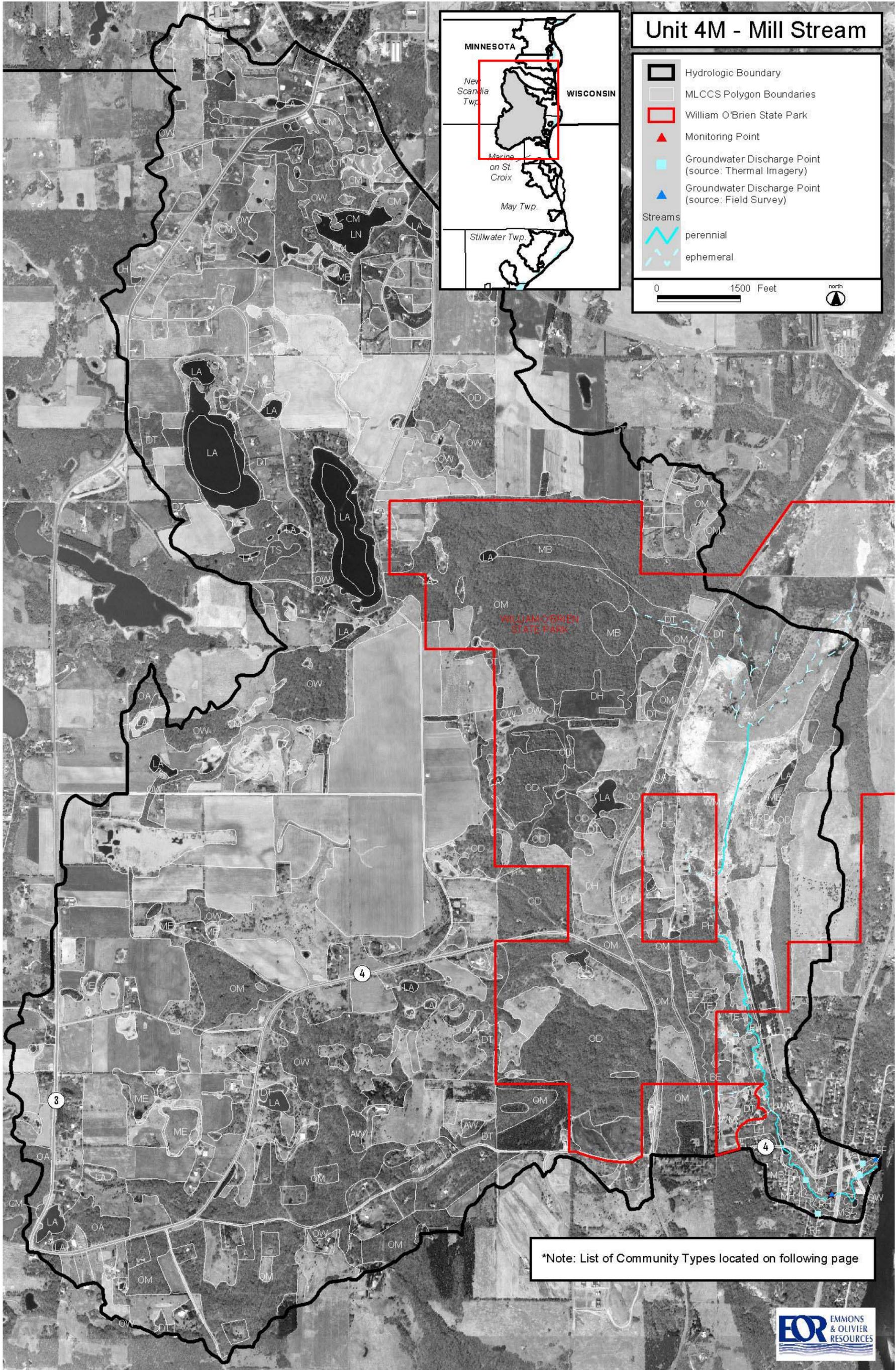
Unit 4M - Mill Stream



	Hydrologic Boundary
	MLCCS Polygon Boundaries
	William O'Brien State Park
	Monitoring Point
	Groundwater Discharge Point (source: Thermal Imagery)
	Groundwater Discharge Point (source: Field Survey)
Streams	
	perennial
	ephemeral

0 1500 Feet

north



*Note: List of Community Types located on following page

Label	Community Type
AB	Aspen-Birch forest
AF	Aspen Forest
AS	Alder swamp
AW	Aspen Woodland
BA	Black Ash Swamp
BE	Black Ash Swamp Seepage subtype
CM	Cattail Marsh
DB	Dry Prairie Bedrock Bluff subtype
DC	Midwest Sandstone Dry Cliff
DG	Dry Prairie Sand-Gravel subtype
DH	Dry Prairie Hill subtype
DI	Dry Oak Savanna Hill subtype
DO	Dry Oak Savanna
DP	Dry Prairie
DT	Disturbed Deciduous Woodland
FF	Floodplain Forest
LA	Lake Bed
LH	Lowland Hardwood Forest
LN	Northern Water Lily Aquatic Wetland
MB	Maple Basswood Forest
MC	Midwest Sandstone Moist Cliff
ME	Mixed Emergent Marsh
MF	Mixed Pine-Hardwood Forest
MH	Mixed Hardwood Swamp
MM	Moderate Cliff
MO	Mesic Oak Savanna
MS	Mixed Hardwood Swamp Seepage Subtype
NH	Northern Hardwood Forest
OA	Oak Forest
OC	Open Cliff
OD	Oak Forest dry subtype
OM	Oak Forest mesic subtype
OW	Oak Woodland Brushland
PB	Paper Birch Forest
PH	Poor fen shrub subtype
PW	Midwest Pondweed Submerged Aquatic Wetland
RC	Eastern Red Cedar Woodland
RF	Rich fen
RH	Rich fen - shrub subtype
TC	Wet Cliff
TE	Tamarack swamp seepage subtype
TM	Tamarack swamp minerotrophic subtype
TS	Tamarack swamp
WH	White Pine-hardwood Forest
WM	Wet meadow