2004 Vegetation Monitoring in Mill River Freshwater Tidal Marshes: A Summary of Six Years of Baseline Data Collection

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Prepared by

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As part of the ongoing evaluation of the lower Mill River corridor and the potential environmental effects of the Whitney Water Treatment Plant (WTP), the South Central Connecticut Regional Water Authority conducts annual monitoring of plant communities in the freshwater tidal marsh. This marsh, created in part by downstream tidegates belonging to the City of New Haven, is an unusual vegetation type that contributes significantly to the biological diversity and wildlife populations in the lower Mill River and East Rock Park.

The Water Authority's Environmental Study Team (EST), in its 1999 assessment of potential impacts of the proposed treatment plant, recommended that vegetation in the marsh be monitored annually or biennially, both prior to construction of the plant to provide baseline data and after the plant is placed in operation. Data from these vegetation studies, along with monitoring of soil salinity, river flow, water quality, and aquatic life in the lower Mill River, will be used to evaluate environmental impacts of treatment plant operation. The new treatment plant was placed in operation on April 20, 2005. Therefore, data collected from 1998 through 2005 (no monitoring was performed in 1999) provides a six-year set of baseline data. The baseline sampling provides information on plant communities in the marsh under variety of precipitation and flow conditions not affected by withdrawals for water-supply use.

Vegetation Sampling Methods

In 2004, Penni Sharp and Vincent Kay conducted quantitative vegetation sampling of the Mill River marshes on September 7. Monitoring in 1998 and 2001-2003 was performed 2-3 weeks later, in late September; in 2000, monitoring was done about 2 weeks earlier, in August. Preliminary sampling in the area of the northern transect was also performed in September 1991. Soil water salinity measurements have been made in spring and late summer from three monitoring wells on each transect, installed in September 2000. In addition to these annual measurements, Penni Sharp conducted a field survey of *Phragmites* colonization of the freshwater tidal marsh area in March 2005.

Vegetation sampling was conducted along two permanent transects, which were also monitored in 1998 and in 2000-2003. The upstream or northern transect, MR-N, is about 2,000 feet below the Whitney dam, just south of the East Rock Park footbridge and about 700 feet north of the East Rock Road bridge. This transect passes through one of the largest and most varied parts of the marsh. The downstream transect, MR-S, passes through a narrower and less varied marsh community about 300 feet south of the East Rock Road bridge.

Permanent transects at both sites are approximately perpendicular to the river, with marker stakes placed every 5 meters. Transect MR-N is 100 m in length, but only 18 of the surveyed stakes are sampled regularly; the stake at the upland origin of the transect is outside the tidal area, while the two stakes closest to the river are typically inundated and can be sampled only during unusually low flow conditions. Transect MR-S is 55 m long and ends at a low levee at the river; since it does not extend into the typically inundated low marsh along

the river's edge, all 12 stakes are sampled regularly. Vegetation sampling is performed by extending 5-meter sampling chains south from each stake perpendicular to the permanent transect. A dowel rod is inserted into the vegetation at 0.5 m. intervals along the sampling chain, for a total of 10 sampling points per chain, and all species touching the rod (or an imaginary upward extension of it) are recorded. Maps of these transects, and a detailed description of the methodology, appear in the report by Lee Rogers included in the EST's *Lake Whitney Water Treatment Plant Environmental Evaluation: Volume Two* (January 1999).

Results and Discussion

River and Soil Conditions

Growing-season precipitation in the Mill River wetlands in 2004 was normal overall, but was marked by an unusually dry month of June. Total precipitation for April through September was 24.29 inches, close to the 93-year average of about 23 inches at the Whitney gage. In June 2004, only 0.88 inches of rain fell, well below the average of 3.58 inches for the month. Precipitation during the first three months of 2004 was also below normal, about 6.5 inches compared with an average of about 11 inches, producing less inundation of the marsh than normal during these months of dormancy. Appendix A shows precipitation data for 1998-2005, the period in which baseline vegetation monitoring has been performed, as well as monthly, annual, and growing season averages for the 93-year period of record. Since this wetlands study was initiated, the lowest precipitation occurred during the 1999 growing season, with only 16.26 inches of rain; no vegetation sampling was done in that year. The highest was in 2000, when about 28 inches fell during April-September.

Soil water in the transect monitoring wells was sampled on April 6 and July 29, 2004, during both high and low tide conditions. Monitoring well data for 2003 and 2004 is included in Appendix A. Salinity in the Mill River adjacent to the transects was 0.1 ppt (parts per thousand) in all samples. In 2004, spring salinities in monitoring well MRN-1, furthest from the river, reached 0.3 ppt at both high and low tide, higher than in the 2003 samples. Salinities in the other MRN wells were only 0.1 ppt, somewhat lower than in 2003. Salinities in the MRS wells showed a similar pattern but salinities in well MRS-1 reached only 0.2 ppt. Relatively low precipitation in the first three months of 2004 may have resulted in higher groundwater salinities in the upland wells, while groundwater in the wells closer to the river may be more influenced by flow conditions in the river at the time of sampling.

Under seasonal low-flow conditions in July, salinities were slightly higher than April readings in both 2003 and 2004, but again remained in the range of 0.1-0.3 ppt. In the relatively dry July of 2002, soil salinities as high as 0.7 ppt were measured on transect MR-N and 0.4 ppt on MR-S. In 2001, with July precipitation higher but still below the 2004 level, peak salinities of 0.4 ppt on MR-N and 0.5 ppt on MR-S were measured. Even with these July peaks observed in one well on each transect, salinities of 0.1-0.2 ppt in April each year suggest that salinity throughout the marsh has remained below 0.5 ppt as an annual average. This is considered the limit of tolerance for freshwater marsh plants.

2004 Vegetation Monitoring

Vegetation monitoring results for 2004 are presented in Appendix B, along with a detailed description of the vegetation zonation on each transect. The actual count of each species encountered at each sampling chain is shown in appendix Table N (MR-N transect) and Table S (MR-S transect), which show the data collected on the north and south transects, respectively. These tables illustrate zonation in the marshes, providing a profile of the two marsh areas. The marshes are subdivided into zones based on topography and vegetation, as described in the vegetation report in the EST's *Lake Whitney Water Treatment Plant Environmental Evaluation: Volume Two* (Rogers 1999).

Percent cover of all species encountered on the transects during the six years of baseline sampling are provided in Appendix C. Percent cover is the percentage of all points sampled at which a species occurred. For each transect, this information is arranged both in decreasing order of percent cover in 2004 and alphabetically by scientific name. The tables in this section summarize some of the information from the data base in the appendix.

Table 1 shows the total number of species and total percent cover measured on each transect during the six years of sampling. Total percent cover is generally more than 100 percent, as it is obtained by adding the percent cover for all species, several of which may be encountered at one sampling point. Table 1 also shows growing-season precipitation conditions: for purposes of this table, rainfall below the long-term growing-season average of 23 inches was considered "low," 23-26 inches "normal," and above 26 inches "high." Since the time of sampling could also affect species distribution, the approximate sampling date for each year is also included in the table. Tables 2 and 3 show the changes in percent cover, on transects MR-N and MR-S respectively, for selected dominant or common species over the years since monitoring began. Herbaceous and shrub species are shown separately for each transect.

Table 1
Mill River Freshwater Tidal Marsh
Total Cover and Number of Species on Each Transect, 1998-2004

Year	Sampling date	Growing-season rainfall	Transect MR-N			Transect MR-S		
			Total Cover		Total # spp.	Total Cover		Total # spp.
			Percent	Rank		Percent	Rank	
1998	9/21	26.18" - high	215.6	6	31	228.3	6	23
2000	8/18	27.99" - high	259.4	5	29	244.2	5	17
2001	9/24	20.25" - low	359.4	2	40	258.3	3	27
2002	9/24	24.15" - normal	315.0	3	28	279.0	2	23
2003	9/25	27.58" - high	290.0	4	31	256.7	4	21
2004	9/7	24.29" - normal	366.7	1	26	338.3	1	17

Table 2
Percent Cover of Dominant Species – Transect MR-N

Dominant Species	Year and Rainfall Conditions					
HERBS	2004 normal	2003 high	2002 normal	2001 low	2000 high	1998 high
Impatiens capensis	66.7	40.6	45.0	42.8	23.3	13.9
Typha angustifolia	46.7	44.4	47.2	51.7	46.7	45.0
Lythrum salicaria	30.6	15.6	20.6	17.2	17.8	7.2
Leersia oryzoides	22.2	11.1	8.9	11.7	3.3	2.2
Polygonum sagittatum	20.0	1.7	0.0	10.6	0.0	0.0
Bohemeria cylindrical	15.6	6.7	5.6	10.6	5.0	8.3
Mikania scandens	15.6	30.6	48.3	28.9	21.7	31.1
Thalypteris palustris	14.4	16.7	13.3	17.8	11.1	0.0
Polygonum hydropiper	12.2	3.9	3.9	4.4	0.0	0.0
Cuscuta gronovii	8.9	5.0	1.1	3.9	0.0	0.0
Peltandra viginica	7.2	6.1	2.8	3.9	3.3	2.2
Onoclea sensibilis	6.1	8.3	5.6	7.2	7.2	2.2
Pilea pumila	5.0	0.0	0.0	0.0	0.0	1.1
SHRUBS						
Cornus amomum	46.1	40.6	45.6	37.8	47.2	41.1
Viburnum dentatum	8.3	20.0	20.0	25.6	17.8	15.6
Hibiscus moscheutos	6.1	7.8	5.0	5.0	5.0	2.8
Cephlanthus occidentalis	0.0	5.6	2.8	5.0	3.3	1.7

Table 3
Percent Cover of Dominant Species – Transect MR-S

Dominant Species	Year and Rainfall Conditions					
HERBS	2004 normal	2003 high	2002 normal	2001 low	2000 high	1998 high
Typha angustifolia	83.3	75.0	81.7	80.0	78.3	66.7
Impatiens capensis	74.2	56.7	69.2	42.5	42.5	32.5
Mikania scandens	33.3	21.7	31.7	28.3	35.8	65.0
Polygonum arifolium	21.7	12.5	0.0	8.3	0.0	9,2
Pilea pumila	14.2	0.0	0.0	0.0	0.0	0.0
Bohemeria cylindrical	13.3	6.7	5.8	5.8	5.8	1.7
Peltandra viginica	13,3	12.5	8.3	8.3	10.8	1.7
Polygonum sagittatum	12.5	5.8	2.5	2.5	4.2	0.0
Lythrum salicaria	11.7	14.2	10.8	15.8	6.7	0.8
SHRUBS						
Cornus amomum	12.5	9.2	5.0	8.3	8.3	5.8
Viburnum dentatum	11.7	12.5	11.7	10.0	14.2	8.3
Hibiscus moscheutos	6.7	3.3	5.0	4.2	4.2	2.5

Total percent cover can be taken as a surrogate for overall community diversity, since it reflects the presence of multiple species at each sampling point. As Table 1 shows, this figure was highest in years of low to normal rainfall and lowest in the three years when growing-season precipitation was relatively high. The total number of species encountered on the transects showed a similar pattern, although in 2004 the number of species was somewhat low for a year of normal rainfall. This negative association of species diversity with precipitation is expected: In drier years, species that might be limited by excessive wetness can survive in the marsh, and plants ordinarily confined to the higher areas of the marsh can grow closer to the river, thus appearing at more sampling points along with species normally found in the lower marshes.

Tables 2 and 3 illustrate the variability in the structure of the marsh communities from year to year under baseline conditions. Several patterns or trends in this data are discussed below.

The dominant emergent (herbaceous) species at both transects throughout the study are narrow-leaved cattail (*Typha angustifolia*) and spotted jewelweed (*Impatiens capensis*). Narrow-leaved cattail is a species favored by slightly elevated salinity, unlike its relative *Typha latifolia*, which is common in freshwater marshes. Its percent cover in the Mill River marshes has remained fairly constant throughout the study. It fluctuates between 40 and 50 percent at MR-N and 75-85 percent at MR-S, except for an unusually low value of 66.7 percent at the latter site in the first year of the study.

In contrast, jewelweed cover has varied widely over the course of the study, ranging from about 14 to 67 percent at MR-N and 32 to 74 percent at MR-S. Our studies in other wetlands have indicated that this species, like many other wetland annuals, is highly variable from year to year. In the Mill River marshes, however, this plant appears to be increasing over time. In 2004, its percent cover at both sites was the highest in the study. At transect MR-N, it became the dominant species, surpassing the percent cover of cattail for the first time.

Purple loosestrife (*Lythrum salicaria*) is an invasive introduced species that has caused serious displacement of native species in many northeastern wetlands. Its percent cover in the Mill River marshes has shown some increase over time at both sites. At transect MR-S it appears to have stabilized since 2001 at about 10-15 percent cover. At MR-N it also showed a fairly stable cover of 15-20 percent for the years 2000 through 2003; in 2004, however, its cover increased dramatically to over 30 percent. At site MR-N, rice cutgrass (*Leersia oryzoides*) and, to a lesser extent, water pepper (*Polygonum hydropiper*) have also increased in cover over the course of the study.

Many other wetland plants, especially annual species, are highly variable in wetland communities, responding to specific wetland conditions at the time of germination and establishment. In the Mill River marshes, one such species is the composite vine *Mikania scandens*, which is found in close association with the cattails but shows much greater variability in cover. Other notable examples of species with highly variable cover in these marshes include the tearthumbs (*Polygonum sagittatum* and *P. arifolium*), false nettle (*Bohemerica cylindrica*), and clearweed (*Pilea pumila*). The variability of arrow arum

(*Peltandra virginica*), a plant of the frequently inundated lower marsh, is probably related to river flow levels at critical periods in its life cycle. Ferns such as marsh fern (*Thelypteris palustris*) and sensitive fern (*Onoclea sensibilis*) have remained fairly consistent in their percent cover.

The dominant shrub in the Mill River marshes is silky dogwood (*Cornus amomum*), which forms dense thickets in a mosaic with the cattail-dominated emergent marsh. Dogwood cover has remained fairly constant, around 40 percent, at transect MR-N, suggesting it is in equilibrium under present conditions. At MR-S, silky dogwood may be increasing gradually over time, from about 6 to 12 percent over 7 years, indicating a successional process. The second most common shrub, northern arrowwood (*Viburnum dentatum*), has been fairly stable at both sites, between 8 and 14 percent at MR-S and generally 15-25 percent at MR-N, although its cover in 2004 was an unusually low 8.3 percent. Other shrubs in these marshes have less than 10 percent cover. Swamp rosemallow (*Hibiscus moscheutos*) appears to be increasing slowly at both sites, probably due to the growth of one or two specimens present on the transect. Buttonbush (*Cephlanthus occidentalis*) on MR-N also showed a gradual increase through 2003, but disappeared from the transect in 2004; again, this probably reflects a single plant, which may have died. Other shrubs at MR-S occur only in the upland transitional zone and have remained stable during the study.

Although it is not represented in the transect area, another common invasive species, *Phragmites australis,* occurs in the Mill River tidal marshes. Results of a field survey conducted in March 2005 are included in Appendix D. In this study, P. Sharp found two small patches (2,000-3,000 square meters) of *Phragmites* on the west bank of the Mill River that had not been mapped in previous studies. One of these occurs at the upland edge of the marsh north of the East Rock Road bridge at the outfall of a storm sewer drain, which probably created the conditions that favored the *Phragmites* over native species. The other patch is in the middle of the marsh south of transect MR-S; at this time it is not known what conditions might have led to the establishment of *Phragmites* at this location. Sharp also found that the margins of the two large areas of *Phragmites* further downstream have expanded since 1974. These stands of *Phragmites* initially became established as a result of filling and other alterations associated with construction of schools and athletic fields.

Discussion and Conclusions: Plant Community Baseline Variability, 1998 – 2004

The six years making up the baseline data for the Mill River freshwater tidal marsh plant communities have covered a variety of precipitation and flow conditions, but did not include any years of extreme drought or extremely high rainfall. Still, they provide a good basis of comparison for future years with the new Whitney Water Treatment plant in operation.

The data presented in this report show that these marshes, though variable from year to year, are fairly stable under present conditions. The only significant exceptions are (1) a slight increase in shrub cover, especially at site MR-S, which may be due to successional

changes; and (2) a gradual increase in the invasive species *Lythrum salicaria*, as well as an increase in *Phragmites australis* limited to the margins of previously existing stands and to two small patches within the marshes, one of which lies at a storm drain outfall.

Since the new water treatment plant was placed on line in early 2005, future vegetation monitoring at these sampling sites may reflect impacts of water-supply withdrawals. It therefore is appropriate to evaluate the baseline data to identify possible future changes that might indicate negative impacts. Four such possibilities stand out:

1. Since the relative cover of shrub and emergent marsh at MR-N appears stable, an increase in shrub cover, especially of *Cornus amomum*, may indicate drying of the marsh.
2. Percent cover of *Typha angustifolia*, the dominant emergent species typical of tidal freshwater marshes has been fairly stable during the baseline years; loss of cover by this species could indicate drying of the marsh or an increase in salinity beyond its level of tolerance.
3. At present the increase of *Lythrum salicaria* on the sampling transects is gradual, and *Phragmites australis* is not present in the area of the transects; marked increases in the rate of invasion by these species may be indicate adverse changes in marsh conditions.
4. The only low-marsh species that occurs in our samples with sufficient frequency to be useful as a quantitative indicator is *Peltandra virginica*, which occurs in the upper part of the low marsh; any sustained reduction in cover by this or other low-marsh species could indicate a decrease in inundation by the river or an increase in salinity.

Changes in percent cover by these species may indicate water-supply-related impacts if they are clearly outside the normal range of variation as shown by the baseline data, occur during years when precipitation does not differ greatly from that in the baseline years, and/or are sustained over multiple years. Any such changes should be analyzed in conjunction with information on river and soil water salinities, streamflow, and seasonal precipitation distribution to ascertain whether they are consequences of water-supply withdrawals and to identify appropriate mitigating measures.

It should be noted that these projections assume that only freshwater flows in the Mill River will be altered as a result of treatment plant operation, and that the tidal influence will be constant; that is, that the downstream tide gates will remain in place and function approximately as they do at present. Removal of these tide gates would restore most of the freshwater tidal marshes to their natural condition as salt marshes. This is an alteration considered desirable in many areas, mostly where lowering of salinity in combination with other changes such as filling or contamination has resulted in large, nearly monotypic stands of *Phragmites*. In the Mill River tidal marshes, however, *Phragmites* invasion is limited, and most of the area is freshwater marsh. The variable conditions of inundation and salinity to which this freshwater tidal marsh is subjected have produced a complex marsh ecosystem that is far rarer than salt marshes along the New England coast. It supports a great variety of species of both vegetation and wildlife, and offers significant outdoor recreational value as well as enhancing environmental diversity in the area.

Appendices

Appendix A
Precipitation and Salinity in the Mill River Marshes

Table A1
Lake Whitney Precipitation, 1998-2004

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	G.S.*
1998	5.00	4.69	5.59	3.98	5.51	8.30	1.11	4.92	2.36	3.23	1.81	0.95	47.45	26.18
1999	6.85	4.76	3.90	1.50	2.75	0.32	1.22	3.42	7.05	3.86	2.91	2.41	40.95	16.26
2000	2.44	1.89	4.14	4.68	3.31	5.95	7.04	2.72	4.29	0.44	4.45	2.41	43.76	27.99
2001	1.62	2.05	7.29	1.53	5.32	4.26	2.87	3.43	2.84	1.18	1.03	2.18	35.60	20.25
2002	1.67	1.27	4.09	3.45	5.56	3.35	1.90	3.16	6.73	4.20	4.15	4.06	43.59	24.15
2003	1.47	2.48	4.13	2.92	4.11	6.57	1.57	5.47	6.94	5.36	2.18	3.62	46.82	27.58
2004	1.38	2.09	3.08	5.77	2.69	0.88	2.95	4.52	7.48	1.97	3.19	3.27	39.27	24.29
6-yr Aver.	***2.92***	***2.75***	***4.60***	***3.40***	***4.18***	***4.23***	***2.67***	***3.95***	***5.38***	***2.89***	***2.82***	***2.70***	***42.49***	***23.81***
93-yr Aver.	**3.66**	**3.25**	**4.34**	**4.12**	**3.96**	**3.58**	**3.63**	**3.99**	**3.76**	**3.57**	**4.02**	**3.98**	**45.84**	**22.95**

***** Growing season precipitation, April-October.

Table A2
Groundwater Monitoring Well Data, 2003-2004

	Groundwater Salinity (ppt)							
	4/16/03 (high flow)		7/31/03 (low flow)		4/6/04 (high flow)		7/29/04 (low flow	
Monitor well	**Low tide**	**High tide**	**Low tide**	**High tide**	**Low tide**	**High tide**	**Low tide**	**High tide**
MRN-1	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.3
MRN-2	0.2	0.2	0.2	0.3	0.1	0.1	0.2	0.2
MRN-3	0.2	0.3	0.3	0.2	0.1	0.1	0.1	0.2
River@ MR-N	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MRS-1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
MRS-2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2
MRS-3	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1
River@ MR-S	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Appendix B
Transect Descriptions and 2004 Vegetation Monitoring Results

MR-N Transect

The upstream or northern transect, MR-N, is about 2,000 feet below the Whitney dam, just south of the East Rock Park footbridge and about 700 feet north of the East Rock Road bridge. This transect passes through one of the largest and most varied parts of the marsh. As surveyed, the transect is about 100 meters long; approximately 75 meters of this length passes through high marsh, a mosaic of shrubs and emergent marsh (primarily cattails), which is seasonally or occasionally flooded but not subject to daily tidal inundations. About 25 meters of low marsh bordering the river is alternately flooded and exposed as a result of daily tidal fluctuations in the river; portions of the low marsh are often inaccessible due to flooding by tidal action or high river flows. On transect MR-N, sampling begins at the second stake, since the stake at the origin of the transect is located within a swale with little vegetation other than canopy trees overhanging from the adjacent upland forest. A total of 18 stakes are sampled, for a total of 18 chains and 180 sampling points; two additional stakes were installed and surveyed on the riverward end of this transect but are typically inundated and have not been accessible for sampling.

As shown in Table N, the upper marsh on transect MR-N is dominated by spotted jewelweed (*Impatiens capensis*), which gradually gives way to narrow-leaved cattail (*Typha angustifolia*), an emergent marsh plant tolerant of relatively high salinities. Cattail dominates the middle marsh, along with the climbing composite *Mikania scandens*. The transect then passes through a broad area where emergent marsh intermingles with shrub thickets, apparently depending on small changes in elevation; this area appears in Table N as three zones, "Shrub thicket," "Shrub/marsh" (the lowest area), and "Dogwood thicket." In the higher areas of this complex, silkly dogwood (*Cornus amomum*) dominates, intermixed with several herbaceous species, including cattail, mikania, jewelweed, and goldenrod (*Solidago gigantea*). Swamp rosemallow (*Hibiscus moscheutos*) is also among the shrubs in this area. In the lower swale, northern arrowwood (*Viburnum dentatum* var. *recognitum*) is the dominant shrub; buttonbush (*Cephlanthus occidentalis*), a shrub highly tolerant of periodic inundation, appears in the lowest and wettest areas. Cattails (*T. angustifolia*) are absent in the low shrub/marsh, and jewelweed (*I. capensis*) is the dominant herbaceous species. As the ground rises slightly on the riverward side, there is a dense thicket of silky dogwood (*C. amomum*), again intermixed with cattails as well as jewelweed. Below this rise, the substrate descends fairly rapidly toward the river. Silky dogwood is still common on higher ground, but cattails disappear in the low marsh, which is subject to frequent tidal inundation. *Mikania scandens*, purple loosestrife (*Lythrum salicaria*), and jewelweed occur among the dogwood, but give way to arrow arum (*Peltandra virginiana*), and then (beyond stake 18) to other species tolerant of regular submersion, including arrowhead (*Sagittaria* sp.), pickerel weed (*Pontederia* sp.), and white waterlily (*Nymphaea odorata*).

Table N: MILL RIVER FRESHWATER TIDAL MARSH VEGETATION, NORTH SITE (MR-N) -- FREQUENCY BY SPECIES AND ZONE, 2004

Vegetation Zone:	***Upper marsh***					***Mid.marsh***		***Shrub thicket***			***Shrub/marsh***		***Dogwood thicket***			***Low marsh***				
Species	Chain no.: Chains are 5 m. apart and 5 m. long, with 10 sampling points per chain: Total 180 points																		**2004**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**Total**	**%Cover**
Iris pseudacorus	1																		1	0.6
Viburnum lentago	2																		2	1.1
Bidens frondosa														2					2	1.1
Symplocarpus foetidus	4																		4	2.2
Polygonum sagittatum		6	8	2	6			4	10										36	20.0
Polygonum arifolium	3	1																	4	2.2
Impatiens capensis	10	10	9	7	4	3	6	8	6	2	10	10	10	6	5	3	4	7	120	66.7
Onoclea sensibilis	2	9								3									14	7.8
Strophostylus helvola		1																	1	0.6
Mikania scandens			1	1	2	5	3	3	5	4				5	2	1			32	17.8
Typha angustifolia		10	10	10	10	10	10	9	10	6				8	1				94	52.2
Lythrum salicaria		1	3	5	7	9	6	2		9				1		7		5	55	30.6
Todxicodendron radicans		4	2																6	3.3
Thelypteris palustris		4	8	10	4									2					28	15.6
Apios americana			1																1	0.6
Pilea pumila				1	1	3	1	2							1				9	5.0
Bohemeria cylindrica					3	9	7	6	1	2									28	15.6
Epilobium coloratum					1		2							1					4	2.2
Cuscuta gronovii						3		2				4	3	1		1		2	16	8.9
Hibiscus moscheutos							5	6											11	6.1
Parthenocissus quinquefolia					1						3	3							7	3.9
Geum rivale						1		1											2	1.1
Vernonia novaboracensis									2										2	1.1
Laportea sp.									1										1	0.6
Aster simplex											3	4	2						9	5.0
Cornus amomum								5	10	5	5	7	10	4	7	10	10	10	83	46.1
Solidago gigantea							1		4							9			14	7.8
Eupatorium perfoliatum							2												2	1.1
Leersia oryzoides				1					5	10	3			5	7				31	17.2
Viburnum dentatum										1	7	4			1		5		18	10.0
Rorippa palustris											1								1	0.6
Mimulus ringens										1									1	0.6
Polygonum hydropiper						1						2	2	9	6			2	22	12.2
Cephalanthus occidentalis																			0	0.0
Sium suave															1			1	2	1.1
Eupatoriadelphus maculatus														2					2	1.1
Trifolium sp.																		1	1	0.6
Helenium autumnale																	1	1	2	1.1
Lobelia cardinalis																	1	1	2	1.1
Peltandra virginiana															2	4	2	4	12	6.7
																	TOTALS		**682**	**378.9**

MR-S Transect

The downstream transect, MR-S, passes through a narrower and less varied marsh community about 300 feet south of the East Rock Road bridge. This transect is about 55 meters long from upland edge to river. The high marsh, about 45 meters wide, consists primarily of cattail marsh, with shrub thickets on elevated hummocks. The remaining 10 meters of the transect is in low marsh bordering the river. For transect MR-S, sampling begins at the origin of the permanent transect (stake 1) and extends through stake 12, for a total of 12 chains and 120 sampling points.

As shown in Table S, sampling at site MR-S, begins in an area of transition between upland forest and marsh, dominated by spicebush (*Lindera benzoin*), silky dogwood (*Cornus amomum*), and multiflora rose (*Rosa multiflora*); jewelweed is the dominant herb. In the upper marsh, narrow-leaved cattail (*Typha angustifolia*) and jewelweed (*Impatiens capensis*) are dominant, while in the middle marsh, jewelweed becomes less common and cattails share dominance with *Mikania scandens*. The transect then crosses a small rise or hummock, where a few shrubs such as swamp rosemallow (*Hibiscus moscheutos*) intermix with the cattail community. Beyond this is low marsh, where cattails and jewelweed are replaced by arrow arum. The last sampling chain crosses part of a small levee adjacent to the river, where a large silver maple (*Acer saccharinum*) and other upland species occur.

Table S: MILL RIVER SOUTH (MR-S) VEGETATION FREQUENCY BY SPECIES AND ZONE, 2004

Vegetation Zone:	***Trans.shrub***		***Upper marsh***			***Middle marsh***			***Hummock***		***Lower marsh***			
Species	**Chain No. (Total of 12 chains, 120 sampling points)**												**2004**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**%Cover**
Lindera benzoin	7												7	5.8
Acer rubrum	5												5	4.2
Impatiens capensis	5	9	10	10	10	9	7	6	10	6	7	1	90	75.0
Parthenocissus quinquefolia	1												1	0.8
Symplocarpus foetidus	1												1	0.8
Cornus amomum	1	9									5		15	12.5
Chelone glabra		2											2	1.7
Polygonum arifolium		10	3	3	4	1	4	1					26	21.7
Cuscuta gronovii											1	1	2	1.7
Viburnum dentatum			9	5									14	11.7
Pilea pumila			3	5	5	4							17	14.2
Typha angustifolia		10	10	10	10	10	10	10	10	10	9	1	100	83.3
Mikania scandens				10	1	4	10	8	6	1			40	33.3
Peltandra virginica			1						2		4	9	16	13.3
Lythrum salicaria			4		1				1		3	5	14	11.7
Bohemeria cylindrica			1		6	1	3	1			4		16	13.3
Epilobium coloratum			2	1									3	2.5
Onoclea sensibilis				3									3	2.5
Polygonum sagittatum					7	2					6		15	12.5
Hibiscus moscheutos										8			8	6.7
Mimulus ringens											1		1	0.8
Acer saccharinum *												9	9	7.5
											TOTALS		405	337.5

* *Overhanging canopy of tree rooted on adjacent levee*

Appendix C
Baseline Vegetation Sampling Data

1. **MR-N Transect**
   - List of Species by Percent Cover in 2004, 1998-2004
   - Alphabetical List of Species and Percent Cover, 1998-2004
3. **MR-S Transect**
   - List of Species by Percent Cover in 2004, 1998-2004
   - Alphabetical List of Species and Percent Cover, 1998-2004

MR-N Transect - Summary of Species by Percent Cover
1998* - 2004

Species	1998		2000		2001		2002		2003		2004	
	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover
Impatiens capensis	25	13.9	42	23.3	77	42.8	81	45.0	73	40.6	120	66.7
Typha angustifolia	81	45.0	84	46.7	93	51.7	85	47.2	80	44.4	84	46.7
Cornus amomum	74	41.1	85	47.2	68	37.8	82	45.6	73	40.6	83	46.1
Lythrum salicaria	13	7.2	32	17.8	31	17.2	37	20.6	28	15.6	55	30.6
Leersia oryzoides	4	2.2	6	3.3	21	11.7	16	8.9	20	11.1	40	22.2
Polygonum sagittatum	0	0.0	0	0.0	19	10.6	0	0.0	3	1.7	36	20.0
Bohemeria cylindrica	15	8.3	9	5.0	19	10.6	10	5.6	12	6.7	28	15.6
Mikania scandens	56	31.1	39	21.7	52	28.9	87	48.3	55	30.6	28	15.6
Thelypteris palustris	0	0.0	20	11.1	32	17.8	24	13.3	30	16.7	26	14.4
Polygonum hydropiper	0	0.0	0	0.0	8	4.4	7	3.9	7	3.9	22	12.2
Cuscuta gronovii	0	0.0	0	0.0	7	3.9	2	1.1	9	5.0	16	8.9
Viburnum dentatum	28	15.6	32	17.8	46	25.6	36	20.0	36	20.0	15	8.3
Peltandra virginica	4	2.2	6	3.3	7	3.9	5	2.8	11	6.1	13	7.2
Hibiscus moscheutos	5	2.8	9	5.0	9	5.0	9	5.0	14	7.8	11	6.1
Onoclea sensibilis	4	2.2	13	7.2	13	7.2	10	5.6	15	8.3	11	6.1
Aster simplex	0	0.0	0	0.0	13	7.2	20	11.1	8	4.4	9	5.0
Pilea pumila	2	1.1	0	0.0	0	0.0	0	0.0	0	0.0	9	5.0
Parthenocissus quinquefolia	11	6.1	13	7.2	12	6.7	0	0.0	10	5.6	7	3.9
Toxicodendron radicans	4	2.2	0	0.0	4	2.2	10	5.6	7	3.9	6	3.3
Solidago gigantea	3	1.7	9	5.0	9	5.0	13	7.2	2	1.1	5	2.8
Epilobium coloratum	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	2.2
Eupatorium maculatum	4	2.2	1	0.6	1	0.6	3	1.7	1	0.6	4	2.2
Polygonum arifolium	3	1.7	6	3.3	5	2.8	1	0.6	4	2.2	4	2.2
Symplocarpus foetidus	0	0.0	1	0.6	1	0.6	0	0.0	0	0.0	4	2.2
Geum rivale	4	2.2	1	0.6	0	0.0	1	0.6	0	0.0	3	1.7
Viburnum lentago	7	3.9	5	2.8	4	2.2	5	2.8	4	2.2	3	1.7
Bidens frondosa	0	0.0	0	0.0	6	3.3	0	0.0	2	1.1	2	1.1
Eupatorium perfoliatum	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	2	1.1
Helenium autumnale	0	0.0	0	0.0	8	4.4	3	1.7	0	0.0	2	1.1
Lobelia cardinalis	0	0.0	6	3.3	6	3.3	0	0.0	0	0.0	2	1.1
Sium suave	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	2	1.1
Vernonia novaboracensis	0	0.0	1	0.6	1	0.6	0	0.0	1	0.6	2	1.1
Apios americana	0	0.0	3	1.7	4	2.2	0	0.0	0	0.0	1	0.6
Iris pseudacorus	6	3.3	5	2.8	7	3.9	7	3.9	1	0.6	1	0.6
Acer rubrum **	0	0.0	15	8.3	11	6.1	0	0.0	0	0.0	0	0.0
Aster umbellatus	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Bidens connata	6	3.3	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0
Cephalanthus occidentalis	3	1.7	6	3.3	9	5.0	5	2.8	10	5.6	0	0.0
Chelone glabra ***	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Cinna latifolia	6	3.3	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0
Clethra alnifolia **	0	0.0	5	2.8	8	4.4	0	0.0	0	0.0	0	0.0
C. amomum SDLG ***	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Ilex verticillata **	0	0.0	4	2.2	4	2.2	0	0.0	0	0.0	0	0.0
Laportea sp.	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0
Lycopus uniflorus ***	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Mimulus ringens	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0
Nymphaea odorata	8	4.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Panicum clandestinum ***	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Polygonum scandens ***	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Quercus sp SDLG	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Rorippa palustris	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0
Rosa multiflora	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Sagittaria rigida	7	3.9	4	2.2	4	2.2	0	0.0	0	0.0	0	0.0
Scutellaria lateriflora	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0
Smilax rotundifolia **	0	0.0	5	2.8	6	3.3	0	0.0	0	0.0	0	0.0
Solanum dulcamara	0	0.0	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0
Solidago uliginosa	1	0.6	0	0.0	0	0.0	3	1.7	0	0.0	0	0.0
Strophostyles helvola	2	1.1	0	0.0	15	8.3	0	0.0	1	0.6	0	0.0
Trifolium sp.	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0
Verbena hastata	1	0.6	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0
Verbena urticifolia	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0
Viburnum dentatum SDLG	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	0	0.0
TOTALS	388	215.6	467	259.4	647	359.4	567	315.0	522	290.0	660	366.7
Number of Species	31		29		40		28		31		26	

*** These species occur in an overhanding canopy and were sampled in 2000 and 2001 only.*

MR-N Transect - Alphabetical List of Species and Percent Cover
1998* - 2004

Species	1998		2000		2001		2002		2003		2004	
	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover
Acer rubrum **	0	0.0	15	8.3	11	6.1	0	0.0	0	0.0	0	0.0
Apios americana	0	0.0	3	1.7	4	2.2	0	0.0	0	0.0	1	0.6
Aster simplex	0	0.0	0	0.0	13	7.2	20	11.1	8	4.4	9	5.0
Aster umbellatus	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Bidens connata	6	3.3	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0
Bidens frondosa	0	0.0	0	0.0	6	3.3	0	0.0	2	1.1	2	1.1
Bohemeria cylindrica	15	8.3	9	5.0	19	10.6	10	5.6	12	6.7	28	15.6
Cephalanthus occidentalis	3	1.7	6	3.3	9	5.0	5	2.8	10	5.6	0	0.0
Chelone glabra ***	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Cinna latifolia	6	3.3	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0
Clethra alnifolia **	0	0.0	5	2.8	8	4.4	0	0.0	0	0.0	0	0.0
Cornus amomum	74	41.1	85	47.2	68	37.8	82	45.6	73	40.6	83	46.1
C. amomum SDLG ***	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Cuscuta gronovii	0	0.0	0	0.0	7	3.9	2	1.1	9	5.0	16	8.9
Epilobium coloratum	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	2.2
Eupatorium maculatum	4	2.2	1	0.6	1	0.6	3	1.7	1	0.6	4	2.2
Eupatorium perfoliatum	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	2	1.1
Geum rivale	4	2.2	1	0.6	0	0.0	1	0.6	0	0.0	3	1.7
Helenium autumnale	0	0.0	0	0.0	8	4.4	3	1.7	0	0.0	2	1.1
Hibiscus moscheutos	5	2.8	9	5.0	9	5.0	9	5.0	14	7.8	11	6.1
Ilex verticillata **	0	0.0	4	2.2	4	2.2	0	0.0	0	0.0	0	0.0
Impatiens capensis	25	13.9	42	23.3	77	42.8	81	45.0	73	40.6	120	66.7
Iris pseudacorus	6	3.3	5	2.8	7	3.9	7	3.9	1	0.6	1	0.6
Laportea sp.	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0
Leersia oryzoides	4	2.2	6	3.3	21	11.7	16	8.9	20	11.1	40	22.2
Lobelia cardinalis	0	0.0	6	3.3	6	3.3	0	0.0	0	0.0	2	1.1
Lycopus uniflorus ***	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Lythrum salicaria	13	7.2	32	17.8	31	17.2	37	20.6	28	15.6	55	30.6
Mikania scandens	56	31.1	39	21.7	52	28.9	87	48.3	55	30.6	28	15.6
Mimulus ringens	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0
Nymphaea odorata	8	4.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Onoclea sensibilis	4	2.2	13	7.2	13	7.2	10	5.6	15	8.3	11	6.1
Panicum clandestinum ***	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Parthenocissus quinquefolia	11	6.1	13	7.2	12	6.7	0	0.0	10	5.6	7	3.9
Peltandra virginica	4	2.2	6	3.3	7	3.9	5	2.8	11	6.1	13	7.2
Pilea pumila	2	1.1	0	0.0	0	0.0	0	0.0	0	0.0	9	5.0
Polygonum arifolium	3	1.7	6	3.3	5	2.8	1	0.6	4	2.2	4	2.2
Polygonum hydropiper	0	0.0	0	0.0	8	4.4	7	3.9	7	3.9	22	12.2
Polygonum sagittatum	0	0.0	0	0.0	19	10.6	0	0.0	3	1.7	36	20.0
Polygonum scandens ***	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Quercus sp SDLG	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Rorippa palustris	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0
Rosa multiflora	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Sagittaria rigida	7	3.9	4	2.2	4	2.2	0	0.0	0	0.0	0	0.0
Scutellaria lateriflora	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0
Sium suave	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	2	1.1
Smilax rotundifolia **	0	0.0	5	2.8	6	3.3	0	0.0	0	0.0	0	0.0
Solanum dulcamara	0	0.0	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0
Solidago gigantea	3	1.7	9	5.0	9	5.0	13	7.2	2	1.1	5	2.8
Solidago uliginosa	1	0.6	0	0.0	0	0.0	3	1.7	0	0.0	0	0.0
Strophostyles helvola	2	1.1	0	0.0	15	8.3	0	0.0	1	0.6	0	0.0
Symplocarpus foetidus	0	0.0	1	0.6	1	0.6	0	0.0	0	0.0	4	2.2
Thelypteris palustris	0	0.0	20	11.1	32	17.8	24	13.3	30	16.7	26	14.4
Toxicodendron radicans	4	2.2	0	0.0	4	2.2	10	5.6	7	3.9	6	3.3
Trifolium sp.	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0
Typha angustifolia	81	45.0	84	46.7	93	51.7	85	47.2	80	44.4	84	46.7
Verbena hastata	1	0.6	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0
Verbena urticifolia	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0
Vernonia novaboracensis	0	0.0	1	0.6	1	0.6	0	0.0	1	0.6	2	1.1
Viburnum lentago	7	3.9	5	2.8	4	2.2	5	2.8	4	2.2	3	1.7
Viburnum dentatum	28	15.6	32	17.8	46	25.6	36	20.0	36	20.0	15	8.3
Viburnum dentatum SDLG	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	0	0.0
TOTALS	388	215.6	467	259.4	647	359.4	567	315.0	522	290.0	660	366.7
Number of Species	31		29		40		28		31		26	

** A slightly different transect in this area was also sampled in 1991; the 1991 results are available in previous reports.*

*** These species occur in an overhanding canopy and were sampled in 2000 and 2001 only.*

**** Occurred in 1991 sample only*

MR-S Transect - Summary of Species by Percent Cover in 2004
1998 - 2004

Species	1998		2000		2001		2002		2003		2004	
	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover
Typha angustifolia	80	66.7	94	78.3	96	80.0	98	81.7	90	75.0	100	83.3
Impatiens capensis	39	32.5	51	42.5	51	42.5	83	69.2	68	56.7	89	74.2
Mikania scandens	78	65.0	43	35.8	34	28.3	38	31.7	26	21.7	40	33.3
Polygonum arifolium	11	9.2	0	0.0	10	8.3	0	0.0	15	12.5	26	21.7
Pilea pumila	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	17	14.2
Bohemeria cylindrica	2	1.7	7	5.8	7	5.8	7	5.8	8	6.7	16	13.3
Peltandra virginica	2	1.7	13	10.8	10	8.3	10	8.3	15	12.5	16	13.3
Cornus amomum	7	5.8	10	8.3	10	8.3	6	5.0	11	9.2	15	12.5
Polygonum sagittatum	0	0.0	5	4.2	3	2.5	3	2.5	7	5.8	15	12.5
Lythrum salicaria	1	0.8	8	6.7	19	15.8	13	10.8	17	14.2	14	11.7
Viburnum dentatum	10	8.3	17	14.2	12	10.0	14	11.7	15	12.5	14	11.7
Acer saccharinum *	10	8.3	10	8.3	10	8.3	10	8.3	10	8.3	9	7.5
Hibiscus moscheutos	3	2.5	5	4.2	5	4.2	6	5.0	4	3.3	8	6.7
Lindera benzoin	7	5.8	9	7.5	5	4.2	5	4.2	5	4.2	7	5.8
Acer rubrum	0	0.0	0	0.0	4	3.3	4	3.3	5	4.2	5	4.2
Cuscuta gronovii	4	3.3	0	0.0	10	8.3	5	4.2	0	0.0	3	2.5
Epilobium coloratum	0	0.0	1	0.8	0	0.0	2	1.7	1	0.8	3	2.5
Onoclea sensibilis	1	0.8	2	1.7	6	5.0	0	0.0	0	0.0	3	2.5
Chelone glabra	0	0.0	0	0.0	2	1.7	1	0.8	3	2.5	2	1.7
Aster umbellatus	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	1	0.8
Mimulus ringens	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8
Parthenocissus quinquefolia	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8
Symplocarpus foetidus	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	1	0.8
Apios americana	0	0.0	1	0.8	1	0.8	0	0.0	0	0.0	0	0.0
Bidens frondosa	0	0.0	0	0.0	3	2.5	0	0.0	0	0.0	0	0.0
Carex crinata	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0
Cinna latifolia	3	2.5	0	0.0	2	1.7	0	0.0	0	0.0	0	0.0
Cornus amomum SDLG	0	0.0	1	0.8	1	0.8	2	1.7	0	0.0	0	0.0
Geum lacinatum	1	0.8	0	0.0	0	0.0	0	0.0	2	1.7	0	0.0
Helenium autumnale	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0
Leersia oryzoides	4	3.3	10	8.3	3	2.5	1	0.8	3	2.5	0	0.0
Lobelia cardinalis	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0
Lonicera morowii	0	0.0	0	0.0	0	0.0	4	3.3	0	0.0	0	0.0
Lycopus americana	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0
Mentha arvensis	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Rosa multiflora	2	1.7	5	4.2	1	0.8	5	4.2	1	0.8	0	0.0
Sambucus canadensis	1	0.8	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0
Solanum dulcamara	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0
Solidago uliginosa	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Strophostylus helvola	2	1.7	1	0.8	0	0.0	1	0.8	0	0.0	0	0.0
Toxicodendron radicans	0	0.0	0	0.0	0	0.0	2	1.7	0	0.0	0	0.0
Vernonia novaboracensis	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0
V. dentatum SDLG	0	0.0	0	0.0	0	0.0	2	1.7	0	0.0	0	0.0
TOTALS	274	228.3	293	244.2	310	258.3	324	270.0	308	256.7	406	338.3
Number of Species	23		17		27		23		21		17	

** Overhanging branches of tree rooted on adjacent levee*

MR-S Transect - Alphabetical List of Species and Percent Cover
1998 - 2004

Species	1998		2000		2001		2002		2003		2004	
	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover
Acer rubrum	0	0.0	0	0.0	4	3.3	4	3.3	5	4.2	5	4.2
Acer saccharinum *	10	8.3	10	8.3	10	8.3	10	8.3	10	8.3	9	7.5
Apios americana	0	0.0	1	0.8	1	0.8	0	0.0	0	0.0	0	0.0
Aster umbellatus	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	1	0.8
Bidens frondosa	0	0.0	0	0.0	3	2.5	0	0.0	0	0.0	0	0.0
Bohemeria cylindrica	2	1.7	7	5.8	7	5.8	7	5.8	8	6.7	16	13.3
Carex crinata	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0
Chelone glabra	0	0.0	0	0.0	2	1.7	1	0.8	3	2.5	2	1.7
Cinna latifolia	3	2.5	0	0.0	2	1.7	0	0.0	0	0.0	0	0.0
Cornus amomum	7	5.8	10	8.3	10	8.3	6	5.0	11	9.2	15	12.5
Cornus amomum SDLG	0	0.0	1	0.8	1	0.8	2	1.7	0	0.0	0	0.0
Cuscuta gronovii	4	3.3	0	0.0	10	8.3	5	4.2	0	0.0	3	2.5
Epilobium coloratum	0	0.0	1	0.8	0	0.0	2	1.7	1	0.8	3	2.5
Geum lacinatum	1	0.8	0	0.0	0	0.0	0	0.0	2	1.7	0	0.0
Helenium autumnale	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0
Hibiscus moscheutos	3	2.5	5	4.2	5	4.2	6	5.0	4	3.3	8	6.7
Impatiens capensis	39	32.5	51	42.5	51	42.5	83	69.2	68	56.7	89	74.2
Leersia oryzoides	4	3.3	10	8.3	3	2.5	1	0.8	3	2.5	0	0.0
Lindera benzoin	7	5.8	9	7.5	5	4.2	5	4.2	5	4.2	7	5.8
Lobelia cardinalis	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0
Lonicera morowii	0	0.0	0	0.0	0	0.0	4	3.3	0	0.0	0	0.0
Lycopus americana	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0
Lythrum salicaria	1	0.8	8	6.7	19	15.8	13	10.8	17	14.2	14	11.7
Mentha arvensis	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Mikania scandens	78	65.0	43	35.8	34	28.3	38	31.7	26	21.7	40	33.3
Mimulus ringens	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8
Onoclea sensibilis	1	0.8	2	1.7	6	5.0	0	0.0	0	0.0	3	2.5
Parthenocissus quinquefolia	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8
Peltandra virginica	2	1.7	13	10.8	10	8.3	10	8.3	15	12.5	16	13.3
Pilea pumila	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	17	14.2
Polygonum arifolium	11	9.2	0	0.0	10	8.3	0	0.0	15	12.5	26	21.7
Polygonum sagittatum	0	0.0	5	4.2	3	2.5	3	2.5	7	5.8	15	12.5
Rosa multiflora	2	1.7	5	4.2	1	0.8	5	4.2	1	0.8	0	0.0
Sambucus canadensis	1	0.8	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0
Solanum dulcamara	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0
Solidago uliginosa	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Strophostylus helvola	2	1.7	1	0.8	0	0.0	1	0.8	0	0.0	0	0.0
Symplocarpus foetidus	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	1	0.8
Toxicodendron radicans	0	0.0	0	0.0	0	0.0	2	1.7	0	0.0	0	0.0
Typha angustifolia	80	66.7	94	78.3	96	80.0	98	81.7	90	75.0	100	83.3
Vernonia novaboracensis	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0
Viburnum dentatum	10	8.3	17	14.2	12	10.0	14	11.7	15	12.5	14	11.7
V. dentatum SDLG	0	0.0	0	0.0	0	0.0	2	1.7	0	0.0	0	0.0
TOTALS	274	228.3	293	244.2	310	258.3	324	270.0	308	256.7	406	338.3
Number of Species	23		17		27		23		21		17	

** Overhanging branches of tree rooted on adjacent levee*

Appendix D
Survey of *Phragmites australis* in the Lower Mill River

Penelope Sharp
March 2005

Penelope C. Sharp
ENVIRONMENTAL CONSULTANT
225 Reeds Gap Road East ~ Northford, CT 06472
Telephone/Facsimile (203) 484-0134

March 8, 2005

Mr. John P. Hudak
South Central Connecticut Regional
Water Authority
90 Sargent Drive
New Haven, Connecticut 06511

Re: *Phragmites australis* in Mill River Floodplain

Dear Mr. Hudak:

At your request, I have examined the patches of *Phragmites australis* that occur within the Mill River floodplain between the Lake Whitney dam and the Orange Street bridge. The investigation was conducted on Friday, March 4, 2005.

The northernmost patch occurs on the west side of the river near a storm sewer outlet that is located at a bend in the trail that enters East Rock Park just west of the East Rock Road bridge. The GPS coordinates for the patch are 41° 19' 54" North and 72° 54' 38" West and the approximate dimensions of the patch are 70m by 40m or 2800 square meters.

Approximately 320 m south of the first patch, also on the west side of the river, there is a second stand of *Phragmites australis*. The northern edge of the stand is at GPS 41° 19' 42" North and 72° 54' 36" West and the southerly edge is at GPS 41° 19' 40" North and 72° 54' 36" West. This stand measures approximately 75m by 30m or 2250 square meters. A small patch has developed on the east side of the Mill River approximately 35m south of the southern patch. This patch appears to be about 30m by 10m or 300 square meters. It is located on a point that protrudes at the bend in the river.

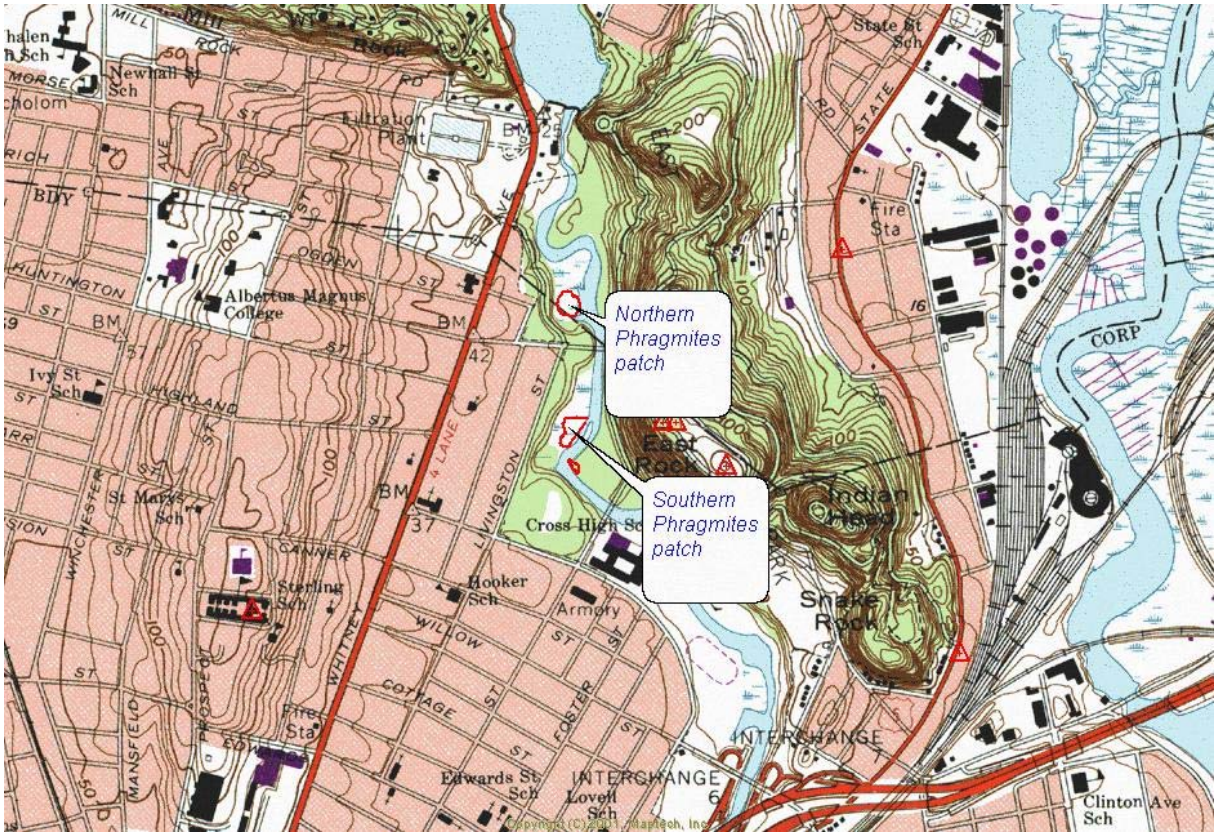
From the map that documents the *Phragmites* in both 1974 and 1995 (copy enclosed), it appears that the grass has spread since the time it was last measured ten years ago. This is not entirely surprising due to the invasive nature of the species and its location along a river that is subject to tidal action. Despite the spread of *Phragmites*, the Mill River marshes continue to maintain a high diversity of species as documented by the RWA sampling along the north and south transects. The *Phragmites* patches should continue to be monitored as further spread will ultimately reduce the overall biodiversity of the wetlands.

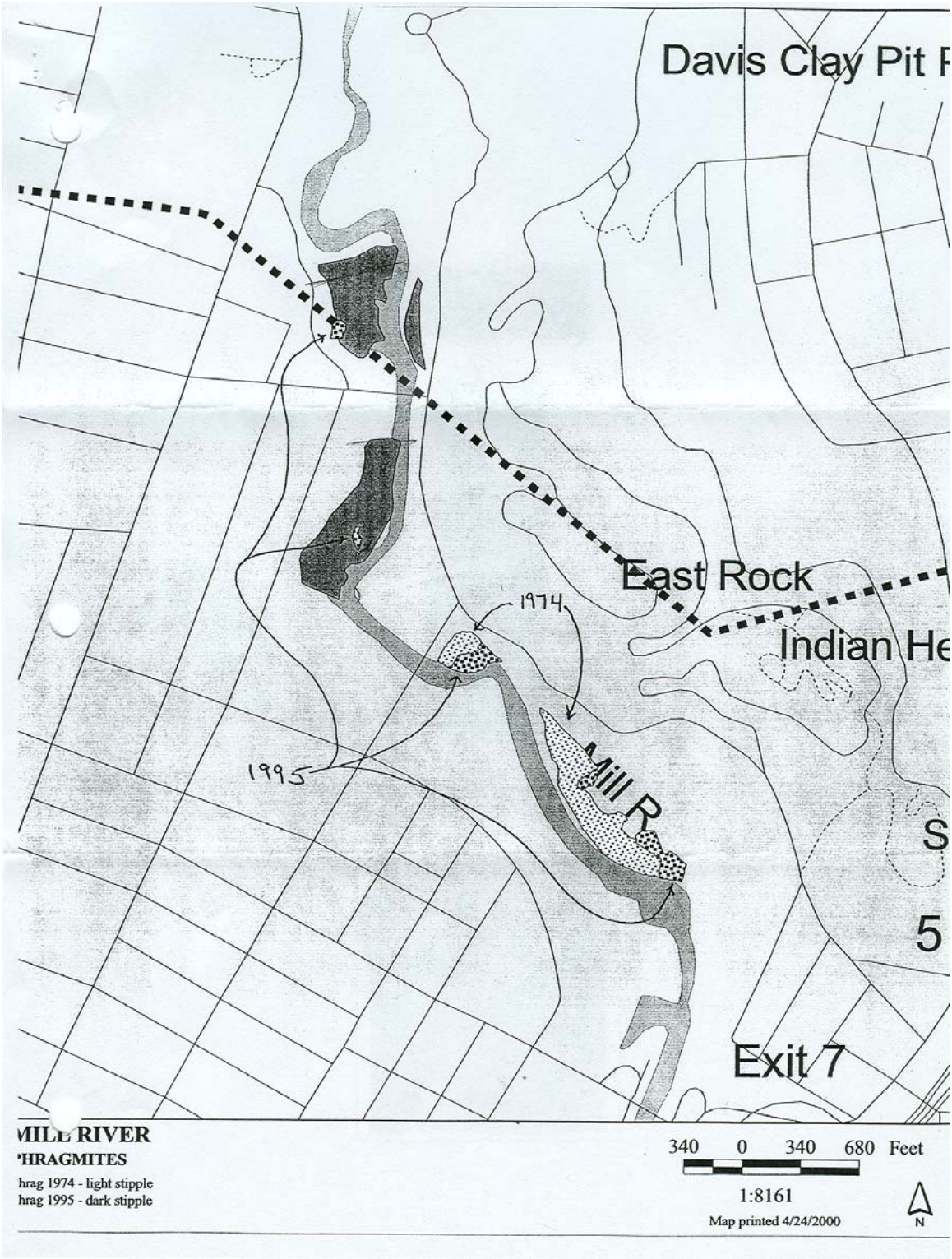
Please contact me if you have any questions regarding this letter.

Sincerely,

Penelope C. Sharp

Penelope C. Sharp


Northern Phragmites patch
Southern Phragmites patch
Albertus Magnus College
Newhall St Sch
Filtration Plant
Ivy St Sch
St Mary's Sch
Sterling Sch
Hooker Sch
Armory
Cross High Sch
East Rock
Indian Cliffs
Snake Rock
Fire Sta
State St Sch
Edwards St Sch
Lovell Sch
Clinton Ave Sch
INTERCHANGE
4 LANE
CORP


Davis Clay Pit
East Rock
Indian He
1974
1995
Mill R
S
5
Exit 7
MILL RIVER
PHRAGMITES
hrag 1974 - light stipple
hrag 1995 - dark stipple
340 0 340 680 Feet
1:8161
Map printed 4/24/2000
N