FINAL REPORT

Wisconsin Lake Management Planning Grant

for the

FORESTVILLE MILLPOND

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Prepared by:
Door County Soil and Water
Conservation Department

Submitted to:
Door County Airport and Parks Committee

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Executive Summary

The Forestville Millpond is a small man-made lake in southern Door County Wisconsin located near the village of Forestville. The Millpond is a dammed reservoir fed by the waters of the upper reaches of the Ahnapee River. Concerns expressed by members of the local community regarding a perceived change in the Millpond's condition prompted the Door County Airport and Parks Department to pursue a Wisconsin Lake Management Planning Grant for the purpose of this study. A diminished sport fishery accompanied by conditions undesirable for swimming were determined to be the primary concerns. The purpose of this report is to evaluate base line conditions and develop a list of potential management alternatives. A two year study was conducted to inventory land uses in the watershed, sediment and phosphorus delivery to surface waters, water and sediment chemistry, stream bank erosion, septic system limitations and animal waste management limitations.

Nonpoint sources of pollution and the proliferation of Eurasion water milfoil were identified as having the largest impact on the water quality of the Forestville Millpond. Uses of the Millpond are limited by its small water volume, lack of winter water inflow and aeration, and summer season intermittence in its headwater streams. These factors contribute to a high risk of winter kill of sport fish.

The 7,612 acres of cropped farmland (approx. 60% of the watershed) are largely responsible for the nutrients and sediment delivered to the Millpond. Water quality problems in the watershed has made the Ahnapee River a high priority in the Wisconsin Nonpoint Source Pollution Abatement priority watershed program selection process. Controlling agricultural nonpoint sources of pollution is considered a management option and is likely to have a long term impact on improving water quality. Other management options considered include drawing down the Millpond for a period of time, harvesting aquatic plants, dredging bottom sediments, developing a lake management district, undertaking an intensive educational effort, removing the dam, and reconstructing the dam to allow for bottom gates which might flush out accumulated bottom sediments.

Some members of the community expressed that the problems of the Millpond are the result of the dam's gate design and management. This study indicates that the Millpond is in a eutrophic state. It is likely that eutrophication and sediment loading would occur regardless of the dam's design. Nutrient loading, turbidity, abundant nuisance aquatic vegetation, rough fish populations and winter season dissolved oxygen depletion are problems that must be addressed in order to enhance fishing and swimming.

The selection of a set of actions for management of the Millpond hinges on a defined objective for its future use. The management needs must be based on the desired outcome. As it exists, the Wisconsin DNR considers the Millpond a fishable, swimmable body of water which provides habitat to wildlife. The level with which it delivers fishing and swimming is less than the expectations of many who use it. The conditions that provide for the current uses may degrade if a management plan is not adopted. Enhancement of its current uses is possible and can be planned for if a goal is identified.

The next step in the process is for the Airport and Parks Committee to make the decision of what they want to see come of the Forestville Millpond. **The committee must define the Millpond's long term goals and objectives for its use.** A management plan can be designed around the goal and a set of options can then be implemented to achieve that goal. Management of the Millpond has been haphazard in the past. A strategy for the implementation of a management plan must be adopted and adhered to so that past management mistakes are not repeated.

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Background

The Forestville Millpond is located in sections 19, 29, and 30 of Forestville Township, T.26N.-R25E., one-quarter mile northwest of the village of Forestville. Door County Airport and Parks Department operates a park of approximately 40 acres of land located at the south end of the Millpond which includes the dam and pond.

The Millpond is a 72 acre shallow reservoir approximately one and one half miles in length. It is fed by the main channel of the Ahnapee River. The Ahnapee River is a low gradient stream characterized as having good to fair water quality with some significant organic pollution in the upper reaches. The watershed which drains into the Millpond is approximately 27 square miles (Watermolen, 1995). The primary land use of the watershed is cropland which comprises 60 percent of the land area (map 1). Another 25 percent is wooded or wetland. Less than 4 percent of the land area is in "developed land uses".

In September of 1993, the Door County Airport & Parks Committee elected to pursue a lake Management Grant to study the water chemistry, aquatic plant life, land use and potential management alternatives for the Millpond. The grant proposal was written with the assistance of the Door County Soil & Water Conservation Department and approved by the WDNR in March of 1994.

The Door County Soil & Water Conservation Department was contracted by the Airport & Parks Department to complete the study. The objective of the study was to examine baseline conditions of the Millpond's watershed, water quality in the Millpond, and to develop a list of management options which, if implemented, could ultimately improve water quality and diversify the Millpond's current uses. The study consisted of six main components:

1. Upland Watershed Land use and Pollutant Source Study
2. Adjacent Millpond Land use and Pollutant Source Study
3. Millpond and Tributary Water Chemistry Sampling and Testing
4. Millpond Sediment Sampling and Analysis
5. Consideration of Watershed / Millpond Management / Use Alternatives
6. Informational Program

The inventory and analysis was completed in December of 1995.

Forestville Millpond History

In the early 1870's, an entrepreneur and civil war veteran by the name of John Fetzer settled in the village of Forestville. Mr. Fetzer was an established businessman in the lumber milling trade with his partner G.W. Youngs (who operated lumber mills in Northern Door County). As wheat production became a mainstay of Wisconsin's young agricultural heritage and southern Door County became an intensive area of production, the need for a regional grist mill arose. Mr. Fetzer took it upon himself to fill that need (Tlachac, 1970).

In 1877, John Fetzer began the construction of the dam on the Ahnapee River in the young community of Forestville. The dam would provide the power to run his flour mill. The dam was constructed of heavy timbers, rock and earth. The mill was opened on January 14, 1878. As the business flourished and wheat production increased, so too did the need for the mill to expand. In the early 1880's, the dam was expanded to accommodate greater milling capacity (Tlachac, 1970).

In December of 1883, a twenty foot portion of the dam washed away. This slowed the mill's operation until repairs could be made that following spring. This coincided with the addition of a steam power house to augment the waterpower. From then on, the mill relied on steam power during periods of low water flow (fall and winter) and waterpower in periods of high water flow (spring and summer) (Poh, 1996).

From the 1890's through the 1920's, wheat became a less significant crop because disease was damaging production. At this same time, dairying played a much larger role locally. The mill's business shifted from flour milling to the grinding of feed grain for cattle (Engel, 1988).

In 1897, John Poh, a long time miller at the Forestville operation bought half interest in the mill. He would eventually become full owner and operate the mill until March of 1920 when both dam gates washed out. It is unlikely that the mill ever operated after 1920 (Engel, 1988). Poh would die in 1925; however, his grandson still resides in the vicinity of the dam to this day.

In 1934, a new dam was constructed by the Works Progress Administration. The following year, the dam was dedicated as the Poh Community Dam and Lake. There were 7,500 people on hand for the ceremony. In 1949, John Poh sold the dam and property to the town of Forestville for \$6,000.^{00} (Engel, 1992). In December of 1963, the town gave the park and dam structure to the county of Door.

On February 7, 1968 a meeting with the Soil Conservation Service and the Forestville Fish and Game Club occurred. Water samples were taken through the ice and photos from the previous spring were examined. Water tests indicated a very high content of phosphate. Dissolved oxygen levels were above 6 ppm with the exception of one sample measuring below 3 ppm. Photos examined by SCS biologist Vern Stricker showed evidence of milfoil and algae.

During 1982, the dam spillway structure was replaced for a total cost of approximately \$160,000.^{00}. During this time, the county made an effort to dredge near the dam structure to improve the swimmable waters of the park. Two years later in September of 1984, DNR fisheries employees drew down the Millpond water level and chemically treated the upper reaches to kill off the entire fish population. The pond was then refilled and during the following year restocked with northern pike, and large and small mouth bass. There was strong evidence that the fish were surviving through the winters until 1988 when a winter kill was documented by the DNR. Again the pond was restocked.

A large scale fish kill was documented by Tim Rasmen, DNR on January 3, 1990. Water chemistry samples were taken at the dam. Results indicated a depletion of dissolved oxygen. It was estimated that the low oxygen levels were the result of low inflow of aerated water accompanied by an ice cover. The presence of an odor of Hydrogen Sulfide (a bi-product of anaerobic decomposition related to enhanced plant decay) suggested a lack of dissolved oxygen. DNR officials prefer not to commit to any further stocking efforts due to the risk of winter kills.

On January 26 1994, the Door County Airport and Parks Department submitted a proposal for a Wisconsin Lake Management Planning Grant for the Forestville Millpond. The Door County Soil and Water Conservation Department conducted the study throughout 1994 and 1995 which culminated with this report. The Ahnapee River is considered a high priority watershed and is in the selection process for the next four years to take part in the Wisconsin Nonpoint Source Pollution Abatement program.

Inventory Results

1. **Millpond and Tributary Water Chemistry**

Four sample sites (F1, F2, F3 & F4) were selected to represent water flowing into and out of the Millpond (map 2). Site F1 is located in the deepest area of the Millpond, and is just above the dam. Site F2 was located where the Ahnapee River entered the Millpond. Site F2 was later discarded from the sampling schedule because of poor accessibility and repetitive analysis of water entering the Millpond. Site F3 is located at the intersection of County Highway H and the Ahnapee River. Site F4 is located 0.7 miles east of site F3 where an unnamed tributary to the Ahnapee intersects County Highway H. Refer to attachment 1 for test site locations.

Water sampling was conducted once a month with additional sampling after holidays and major rainfall (0.5"). Sampling was sometimes limited because of low flow rates at site F4 and frozen conditions at all sites. Water quality parameters, sampling dates and results are summarized in water sample site tables F1, F2, F3 and F4 (Attachments 1,2,3&4).

Water Chemistry Results

A) Dissolved Oxygen: Dissolved oxygen (D.O.) is the most important parameter for the survival of aquatic organisms. Levels below 5.0 ppm (mg/l) will stress and kill some fish species and is the Wisconsin DNR legal standard for dissolved oxygen. Low D.O. levels also trigger the release of sediment held phosphorus, which in turn promotes summer algae blooms. Oxygen is produced when green aquatic plants grow in sunlight through a process called photosynthesis. When aquatic plants are not exposed to sunlight (nighttime, turbid or snow and ice covered conditions), carbon dioxide is produced and oxygen is used in a process called respiration. D.O. levels approached stressful levels on the following dates at the indicated depth for the Millpond (Site F1) [1]. The results indicate that dissolved oxygen is a problem in the Millpond (Attachments 5,6,&7).

7-21-94	3.7 ppm	bottom
8-17-94	4.4 ppm	bottom
9-16-94	4.0 ppm	bottom
3-06-95	3.8 ppm	bottom
7-19-95	5.48 ppm	1 meter
8-14-95	0.37 ppm	bottom
9-14-95	4.0 ppm	bottom

B) Dissolved and Total Phosphorus: Dissolved and total phosphorus is the major nutrient contributor to excessive aquatic plant growth including algae blooms. Dissolved phosphorus is the amount of phosphorus

[1] At Site F1: D.O., conductivity, salinity, and temperature were measured at the surface, 1 meter and at the bottom. Table Site F1 includes only the 1 meter readings.

immediately available for plant growth. Total phosphorus includes dissolved phosphorus and phosphorus tied up in suspended sediments, plants, and animal fragments. Total phosphorus is considered a better indicator of a lake's nutrient status because its levels remain more stable than dissolved phosphorus. Phosphorus originates from a variety of sources, including animal wastes, soil erosion, detergents, septic systems and runoff from lawns and farmland. To prevent summer algae blooms in impoundments such as the Millpond, concentrations should be less than 10 μg/l (micrograms per liter or 0.01 mg/l) for dissolved phosphorus and less than 30 μg/l (0.03 mg/l) for total phosphorus. Both concentration levels were exceeded several times at the various sites during the 14 month sampling period (Attachment 8).

C) <u>Nitrogen:</u> Nitrogen is second only to phosphorus in contributing to excessive aquatic vegetation growth and algae blooms. Nitrogen is not a naturally occurring mineral in soil, but rather a component of all organic matter (plants and animals). Decomposing organic matter releases ammonia, which is converted to nitrate in the presence of oxygen. Nitrate (NO_3^-), Nitrite (NO_2^-), and Ammonium (NH_4^+) are the inorganic forms of nitrogen available for aquatic plants and algae. Nitrogen contributing sources include rainfall, lawn and field fertilizers, animal wastes, and seepage from septic systems. If the previous inorganic forms of nitrogen exceed 0.3 mg/l in spring, there is sufficient nitrogen to support summer algae blooms. The majority of the nitrogen results exceed this standard (Attachments 9 & 10).

D) <u>Chloride:</u> Typical levels for surface waters in Door County should range from 3 mg/l to 10 mg/l. Levels higher than 10 mg/l would indicate possible water pollution. Chloride, however, does not affect plant or algae growth, but it could be toxic to aquatic organisms at higher concentrations. The presence of increased chloride levels would also suggest that other nutrients are entering the Millpond. Chloride pollution sources would include: septic systems, animal wastes, potash fertilizers and drainage from road salting. The one sampling for chloride occurred on March 31, 1995, and the result of 18.8 mg/l indicates an influx of chloride and possibly other pollutants.

E) <u>pH, Alkalinity and Hardness:</u> Alkalinity and hardness are indicators for a lakes acid buffering capacity. Buffering increases with the presence of calcium or magnesium rich limestone deposits. If the pH were to drop below 5.0, the spawning of the Millpond fishery would be inhibited. At no time did the Millpond pH drop below 6.6 High levels of hardness (greater than 150 mg/l) and alkalinity can cause marl ($CaCO_3$) to precipitate. Hard water lakes also have a tendency to control algae blooms by precipitating phosphorus with the marl. Alkalinity; however, is not a limiting factor for the proliferation of Eurasian water milfoil. The alkalinity level measured 252 mg/l and the hardness calculated out to 292 mg/l on March 31, 1995. See attachment 11 for pH test results.

F) Sodium and Potassium: Levels of sodium and potassium are low in both soil and water. Their presence may indicate pollution caused by human activity. Road salt, fertilizers, and human or animal wastes are again the possible sources. Sodium and potassium levels measured 6.8 mg/l and 3.4 mg/l respectfully on March 31, 1995. The levels present on March 31, 1995 indicate that an influx of pollutants is occurring.

G) Sulfate: Sulfate concentrations for surface waters in Door County should range from 10 mg/l to 20 mg/l. Sulfate in surface water is primarily related to acid rain and to the types of minerals found in the watershed (dolomite, the native bedrock is not a source). In oxygen depleted water, sulfate can be reduced to hydrogen sulfide (H_2S). Hydrogen sulfide gas smells like rotten eggs and is toxic to aquatic organisms. Sulfide ions can also cause lower metal concentrations by forming sulfide precipitates. A sulfate level of 15 mg/l was observed on March 31, 1995.

H) Conductivity: Conductivity measures waters ability to conduct an electrical current. Conductivity is thus related to the amount of substances dissolved in the water. If conductivity values are greater than twice the water hardness, the water is likely receiving high concentrations of contaminants. On March 31, 1995, the conductivity measured 330 μmhos/cm versus a calculated hardness of 292 mg/l. The results indicate a moderate level of pollutant loading (Attachments 12 and 13).

I) Water Clarity: Water clarity indicates a lakes overall quality and is determined by measuring certain chemical and physical properties. The secchi disc reading, turbidity and chlorophyll *a* concentrations are the three main components of water clarity. Secchi disc readings are taken with an 8-inch diameter weighted disc painted black and white. The depth which the disc disappears from sight, and then raised until it's just visible would be the secchi reading. The Millpond had an average secchi reading of 4 feet, which would be classified eutrophic[2] and poor water clarity (see Table 1).

Turbidity is also a measure of water clarity that measures suspended particles, rather than dissolved organic compounds. Turbidity can also be caused by algae blooms, which is also the most common reason for low secchi readings. Chlorophyll *a* measures the amount of algae in the water, thus one can determine whether low secchi readings were caused by runoff particulate and/or by an algae bloom. Both chlorophyll *a* results indicate eutrophic water conditions (See Table F1 H_2O samples).

[2] Eutrophic lakes are high in nutrients, support a large biomass and experience frequent winterkills.

Table 1.

Water Clarity Index	
Water Clarity	**Secchi Depth (ft)**
Very Poor	3
MILLPOND AVERAGE	*4*
Poor	5
Fair	7
Good	10
Very Good	20
Excellent	32

Note: Interpretations of test results are based on Klessig, L., Mechenich, C.& Shaw, B., 1993.

2. **Millpond Sediment Sampling and Analysis:**

Sediment samples were collected at site F1 on July 5, 1994 with the assistance of WI-DNR staff. Samples collected were sent to the State Laboratory of Hygiene for analysis of herbicide residues, pesticide residues, and metals. See attachment 14 for results.

Sediment sample results for herbicide and pesticide residues are below detectable level. Screening for metals indicate that arsenic is below detectable levels. However, lead and mercury were detectable in the sediments.

3. **Animal Lot Runoff**

Runoff from animal lots and other livestock feeding, loafing and pasturing areas to surface waters can be a significant source of pollutants. Phosphorus, Nitrogen, Bacteria, and COD's are the major pollutants which can have adverse effects on surface and/or ground water quality. Due to limitations of the computer model used for this analysis, only phosphorus impacts was evaluated.

A total of 49 animal lot operations were inventoried and evaluated (map 3) for their impacts on the watershed's surface water resources. The inventory was completed during 1995 by Door County Soil and Water Conservation Department staff. Of the 49 animal lots, 24 are located above the Millpond and remaining 25 are located below the Millpond.

Of the 24 animal lot operations located **above the Millpond**, it was determined that 13 lots discharge runoff into surface waters. This represents an annual load of approximately 304.8 pounds of phosphorus. The remaining 11 animal lots do not impact the surface water quality directly. These lots discharge runoff into closed depressions and/or rock hole openings, which will directly impact the areas groundwater quality and possibly the Millpond.

Of the 25 animal lot operations located **below the Millpond**, it was determined that 19 lots discharge runoff into the Ahnapee River waters. This represents an annual load of approximately 506.2 pounds of phosphorus. The remaining 6 animal lot operations do not impact the surface water quality directly. These lots discharge runoff to closed depressions and/or rock hole openings, which will impact the areas groundwater quality and possibly the Ahnapee River.

Animal Lot Inventory Results - Surface Water
Table 2.

Subwatershed		Number of Animal Lots	Total Phosphorus[3] (lbs)
Silver Creek	(SV)	3	53.5
Ahnapee River	(AR)	4	102.2
Maplewood Swamp	(MS)	4	129.5
Forestville Millpond	(MP)	2	19.6
Millpond Totals		13	304.8
Rosiere	(RS)	5	272.3
Kolberg/Forestville	(KF)	14	233.9
Ahnapee River Totals		19	506.9
Watershed Totals		32	811

[3]Based on Annual Phosphorus Loads

4. Upland Erosion and Sediment Delivery

Agricultural activity has caused considerable amounts of sediment to reach the watershed's surface water resources. The shift from conventional dairy based agriculture to truck or cash crop based agriculture in recent years has accelerated soil loss and sediment delivery rates throughout the watershed. To determine the impacts of this change on the water quality of the Ahnapee River and the Forestville Millpond, a landuse inventory was conducted and sediment delivery was estimated.

Step one of the inventory was to divide the watershed into six subwatersheds (attached maps). A delineation was made of all cropped fields documenting the field's acreage, predominate soil type, the slope's length and percentage, cropping history for the past 10 years, and any apparent conservation practices. Non-cropped acerage was also documented to complete a 100% inventory of the watershed. The information was entered into a database. After the database was completely populated, WINHUSLE (Wisconsin's Nonpoint Source program sediment and phosphorus delivery model based on the Universal Soil Loss Equation {USLE}) was applied. WINHUSLE estimates the amount of sediment delivered from a particular field to a water body. The model also estimates the amount of sediment deposited into a surface water body and the amount of sediment which remains in suspension.

The WINHUSLE model allows an analysis of the entire watershed or it can be run on small segments. The model was run for the Millpond's subwatersheds (results given it Table 3). The analysis estimates the amount of sediment delivered by simulating ten years of rain and snow and taking the average for each field, adding sediment loads together and routing them to surface water.

Results from WINHUSLE Model per Subwatershed from Cropland
Table 3.

Subwatershed	Cropland Acres	Sediment Load (T/yr)	Sediment Rate (T/ac/yr)	Phosphorus Load (lbs/yr)
Silver Creek (SV)	2,273.5	987	0.43	11,844
Maplewood Swamp (MS)	2,613.1	567	0.22	6,804
Forestville Millpond (MP)	322.8	323	0.32	3,876
Ahnapee River (AR)	2,403.4	637	0.26	7,644
Millpond Totals	7,612.8	2,514	NA	30,168
Rosiere (RS)	2,273.5	987	0.43	11,844
Kolberg/Forestville (KF)	6,106.4	5,215	0.85	62,568
Below Millpond Totals	8,849.8	6,034	NA	74,412
Watershed Totals	16,462.6	8,548	NA	104,580

An evaluation of the 16,754 acres in the Millpond subwatershed yielded a total of 2,514 tons of sediment delivered to water bodies annually. It was determined that approximately 381 tons of sediment enter the Millpond's waters each year. The volume of phosphorus contained in 381 tons of sediment roughly equals 4,600 pounds.

An evaluation of the cropland sediment delivered to the surface waters below the Millpond dam structure was completed and the data was represented in the table below. However the WINHUSLE model was not segmented for the area below the Millpond due to the lack of information available to route the surface waters back to the Ahnapee River. This information represents the sediment load to all surface waters and is not representative of what is entering the Ahnapee River.

A comparison of *total* and *cropland only* sediment delivery above and below the Forestville Millpond Dam for the portion of the Ahnapee River watershed within Door County.
Table 4.

	Millpond	Below Millpond	Totals
Total Acreage	16,754	13,367	30,121
Sediment Delivered	3,069 T/yr	6,821 T/yr	9,890 T/yr
Cropland Acres	7,613	8,850	16,463
Cropland Sediment Delivered to Surface Waters	2,514 T/yr	6,034 T/yr	8,548 T/yr
Cropland Sediment Delivered to Millpond	381 T/yr	NA	NA
Cropland Sediment Delivery Rates Tons/acre/year	0.27	0.74	0.50

The differences in the sediment delivery rates of the upper and lower portions of the watershed are likely the result of the differences in topography, soil types and land use. The upper portion is interpreted as gently sloping and vegetative cover near stream channels provide a greater buffering effect than is observed in the lower portions of the watershed.

5. **Manure Management/Nutrient Management for Surface Water Considerations**

An inventory of animal operations and associated lands was completed in 1995 by Door County SWCD. After the inventory was completed, an analysis of each landowner/operator's manure management practices was completed. This included the analysis of all cropland acres owned and/or operated by a landowner/operator which are within 1.5 miles of the livestock housing (map 3). A parameter of 1.5 miles is used because it is unlikely that a farmer will haul manure a greater distance in winter.

As part of the surface water analysis, the number of acres of cropland which are determined as unsuitable for winter spreading manure for each livestock operation in the watershed were calculated. Unsuitable acres are defined as cropland which has a slope greater than nine percent, are within a ten year flood plain, or a calculated distance from water bodies and discharge points. Animal manure spread on these acres during the winter months is very susceptible to runoff and will impact surface water quality. Due to limitations of the study, hazards to groundwater were not directly addressed by this analysis.

Nutrient Management, as defined by Natural Resource Conservation Service specification 590, allows for a maximum of 75 lbs. of phosphorus per suitable tilled acre of cropland, to be spread during the winter months. The maximum rate that a landowner should be spreading manure equals 25 tons of dry manure per suitable acre or an equivalent tonnage which would equal 75 lbs. of phosphorus.

This analysis was completed on all 46 livestock operations in the watershed. If an operation had an existing animal waste storage facility, the volume of the storage facility was calculated. If adequate storage was present for the number of animals identified at the time of the inventory, then that operation did not have any further analysis completed. Four operations met these requirements. If the computed volume of manure exceeded the existing storage then further analysis was completed. Forty two operations were analyzed for manure management practices.

It was determined that 30 operations had an excess of high hazard land after all suitable acres were utilized for manure spreading. Approximately 745 acres of unsuitable land is being utilized for winter spreading. If these acres were spread with manure at the acceptable rate of 25 ton/acre, approximately 6671 tons of animal waste would be placed on unsuitable acres. The phosphorus values associated with this tonnage equals approximately 177,897 lbs or 89 tons. The model used for this analysis does not determine the amount of manure which enters a body of water; however, it is the method used by the Nonpoint Source Program in determining manure storage needs.

6. **Streambank Erosion**

A survey of a representative sample of streams was conducted to determine rates of lateral streambank recession in the watershed above the Forestville Millpond. Approximately five miles of streams were evaluated.

Observations of recession rates were made from walking the channel or canoeing the stream. Estimates were made of the length and height of the eroding bank. The rate of lateral recession was then estimated utilizing standard indicators. These indicators included amounts of undercutting, exposed roots, fallen trees and the volume of deposited sediment on the opposite stream bank. The causes of the erosion i.e. natural recession, trampling of the bank by wildlife or livestock, and adjacent land use was noted. This data was then entered into a spreadsheet where the volume of eroded soil was calculated.

The results of the inventory indicate that of the 26,100 feet inventoried, 3,460 feet showed evidence of significant erosion with a total rate of erosion at 8.5 tons/year. Slightly over half of streambank erosion was attributed to the 1,185 feet of streambank which was trampled by livestock.

The average of 2 tons per year of sediment contributed to surface water per mile of streambank is a relatively low rate of erosion. The low erosion rates are largely attributed to the topography and soil types. The Ahnapee River and its tributaries are low grade low flow streams with meandering channels, wide stream beds and flood plains with persistent wetland vegetation growing through much of the stream channel (map 4). These characteristics keep stream velocities low which in turn prevents the water from doing the work of cutting away the streambank.

The existing conditions of the streams in the Ahnapee and its tributaries provide low rates of streambank erosion. Opportunities to improve upon the existing conditions, with few exceptions, are limited.

7 Urban Storm Water Runoff

Two storm and runoff events were studied in the village of Forestville during the autumn of 1995. Direction, destination and flow types were noted to generate a routing map (map 5). The map was then used to determine if urban runoff impacts the Millpnd.

The village has a storm sewer that flows west beneath Main St. (CTY J) and is discharged into the Ahnapee River below the dam. Culverts are in place to allow ease of flow under roadways along areas that do not have a direct link to the storm sewer. A road side curb exists on a portion of HWY 42 and Main St. which channels water in the direction of the storm sewer or the Ahnapee River.

Yard and pet wastes, misapplication of lawn fertilizers and the disposal of automobile waste in storm sewers are concerns of urban nonpoint source pollution. The village of Forestville is largely of residential and light commercial land use with substantial buffering. Only a small, undeveloped portion of the northeast corner of the village lies within the Millpond's watershed. For this reason, the village should be considered a limited risk to the Millpond's water quality. The remainder of the village lies in the Kolberg / Forestville subwatershed which drains into the Ahnapee below the dam and cannot be considered a concern to the Millpond.

8. Septic System Limitations

Failing or improperly located septic systems are a greater concern to groundwater than surface water. The soils within the watershed were evaluated for their suitability to septic systems common to Door County. Criteria used for the analysis included *depth to bedrock* and *hydro groupings* as determined by the Door County Soil Survey[4]. The study showed that approximately 70% of the watershed is considered unsuitable for conventional, mound and in-ground pressure septic systems (leaving holding tanks as the only waste water option). Of the 219 year-round and seasonal residences in the watershed, 145 exist in this area, many of which still use conventional septic systems. (Note: an inventory of *existing septic systems in use* was not a part of this study; thus, exact numbers are not available.) Another 2% of the area is considered unsuitable for conventional septic systems but are suitable for in-ground pressure septic systems. Only about 28% of the total land area is suitable for conventional septic systems (map 6).

Inventory Summary

Dissolved oxygen levels in the Millpond measured lower than state standards on several occasions. Phosphorus and nitrogen were often above thresholds necessary for summer algae blooms. Chloride levels were measured at concentrations nearly 90% greater than acceptable levels. Lead and mercury were present in the bottom sediments sampled. These results indicate that nonpoint sources of pollution exist which are enhancing eutrophication of the Millpond.

Sediment and phosphorus delivery models run on the 7,612 acres of cropland in the Millpond's watershed point to agricultural activity as a primary source of nonpoint sources of pollution. Results of animal lot and manure storage inventories suggest animal waste as another likely contributor of nutrients which enhance the eutrophication of the Millpond. Yet another potential source of pollutants are residences using conventional septic systems in 85% of the watershed unsuitable for this style of waste water disposal. All these factors contribute to eutrophication.

A small portion of the Millpond's watershed is affected by urban runoff and is not considered a significant concern at this time. Streambank erosion is also a relatively minor factor in contributing sediments and phosphorus to the Millpond. Low gradient stream with abundant wetland buffering adjacent to a large portion of the streambanks is more the rule than the exception.

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[4] The Door County Soil Survey is a generalized soils map designed for broad scale planning. Site specific analysis is necessary to determine actual septic system needs.

Potential Objectives

The purpose of this report is to assist the Door County Airport and Parks Committee in developing a lake management plan for the Forestville Millpond. The management plan must include an objcective or goal for the Millpond's use, a single or combination of management option(s) put in place to achieve that goal, and a strategy for the implementation of the management options. **The next step in the process then must be to decide the objective of the management plan** taking into consideration the Millpond's potential and fiscal limitations. Four possible objectives for uses of the Millpond are - 1.) Fishable waterbody, 2.) Swimmable waterbody, 3.) High quality wildlife habitat and 4.) Expanded recreational use. Each objective will require the implementation of a unique set of management options.

The DNR considers the Millpond under the general classification of a *warm water sport fishery* (NR 102 Water Quality Standards). This term is a descriptive label that reflects the Millpond's character and not necessarily a management goal for long term use. The county could define these use standards based on a given set of parameters (such as those used in the Inventory Water Chemistry Results, pages 4-7) that provide conditions conducive for a given use. The water chemistry standards could then be written into this and future lake management plans. Since no set of parameters has yet been established, the Airport and Parks Committee must define an objective for the level of improvement to current uses for a management plan to be adopted.

For the purposes of this report, it will be assumed that the existing conditions already allow for the aforementioned uses of fishing, swimming, wildlife habitat and recreation. The concern is of the level with which the Millpond delivers these uses. The goals should then be based upon improving one or more of the current uses.

Improvements to the Sport Fishery:

As a sport fishery, the greatest limitation is winter fish kill. The primary cause of winter kills is the abundance of aquatic vegetation. Improvements to the sport fishery would have to include measures that would reduce (but not eliminate) aquatic vegetation. Carp are competitors for habitat with desirable fish species and have a negative impact on dissolved oxygen. Carp also root the bottom which increases turbidity (reducing water clarity). Controlling or eliminating the carp population would have a positive impact on the sport fishery.

A perpetual stocking program is necessary as an element of a long term management plan for the sport fishery of the Millpond. It is likely that winter fish kills will be experienced for a time after a management plan is adopted; thus, populations will need to be artificially supported. The fishery that was managed and stocked for in the past were Northern Pike, Small Mouth Bass and Large Mouth Bass. Consensus will have to be reached between the community, fisheries managers and bodies funding a restocking program regarding the species makeup for the fishery (pan fish, Northern Pike etc.). Table 5 indicates the fish stocking efforts of the DNR. (Note that the DNR has discontinued the fish stocking efforts; thus, any further efforts for stocking will need to be funded by another source.)

Past Fish Stocking Efforts (DNR)
Table 5.

Year	Species	Count	Length (in)	Description
1985	Large Mouth Bass	20	12	Adult
1985	Northern Pike	325	9	Fingling
1985	Northern Pike	65,000	-	Fry
1986	Small Mouth Bass	2,000	3	Fingerling
1986	Northern Pike	325	9	Fingerling
1987	Northern Pike	325	9	Fingerling
1990	Northern Pike	100,000	-	Fry
1991	Large Mouth Bass	7,000	3	Fingerling
1992	Large Mouth Bass	3,250	3	Fingerling
1993	Large Mouth Bass	7,000	3	Fingerling

Enhancements to Swimmable Waters:

Swimming in the Millpond is hindered by a lack of water clarity and the abundance of nuisance aquatic vegetation. A mucky nearshore bottom and thick vegetation on adjacent shoreline make conditions for swimming undesirable. Any measure taken to improve swimming conditions must address the excessive aquatic vegetation and abundant algae.

Reduction of carp is a necessary element of a management plan that requires higher water clarity. Carp may have been introduced by local communnity members who took it upon themselves to control water weeds. Carp root in the bottom sediments which may have the impact of eventually reducing aquatic vegetation. Rooting action by the carp also has the negative impact of suspending bottom sediments which releases nutrients and increases turbidity.

The installation or management of a high quality swimming area may be a measure to consider. A beach area could be established by identifying a desirable site, removing sediment to a level of stable substrate, grading the adjacent shoreline, installing a base of pea gravel or a permeable liner and covering with a layer of beach sand. Such an installation would require periodic maintenance and additions of sand. It will still be necessary to address low water clarity to make the swim area more attractive.

Wildlife Habitat

Under the existing conditions, the Forestville Millpond provides habitat to wildlife. Ducks, geese, swans, cranes and herons are frequently sited nesting or feeding in the area. Vegetation and animals indigenous to wetlands and estuaries have made a home in the Millpond or in its shoreland areas. Enhancements may be added like shelterbelts and feed plots to improve the rookery and attract a diverse community of species.

Enhancements to fishing and swimming will likely hinder the Millpond's capabilities to support other wildlife. Uses for wildlife often conflict with swimming, fishing and other recreational uses. Management for wildlife would likely be the least cost and the easiest objective to achieve. The conditions of the Millpond currently meet these needs. Controlling the impact of humans on the waterbody may be the most important measure taken to maintain the Millpond's quality as wildlife habitat.

Expanded Recreational Uses

Motor boating, water skiing, hiking and camping are potential recreational uses that are currently limited by the Millpond's character. To enhance the recreational uses of the Millpond, some measures that could be examined would include deepening the Millpond either by dredging or increasing the effective height of the dam and spillway. Effort would be needed in improving facilities which accommodate boating. Expansion of the park, construction of hiking trails and camp sites would be recommended to achieve this objective. Private interests could be encouraged to provide facilities conducive to these uses.

It is evident that committing to an objective of expanded recreational use is likely the most expensive alternative. It would require extensive modifications and continuous maintenance. Intensive recreational uses would likely have the most costly effects on its existing use as wildlife habitat as well. Intensive human activity would encroach on nesting areas and be detrimental to habitat suitable to shoreland species.

Forestville Millpond Management Options

The following list of options represents possible management measures to consider as elements of a lake management plan. A management plan may require a combination of management options to effect the desired results. Selection of a set of options should be based on the needs for the desired objective for a use of the Millpond. Most options require further studies for potential impacts and feasibility before implementation. The task of compiling this list was taken on by SWCD and Air & Parks staff, a panel of scientific experts and members of the community at large. Each option would require further study to determine potential impacts and costs versus benefits before implementation.

1. **DO NOTHING** - This option will not require any further spending or actions.

pros - A) least cost management alternative
B) allows system to remain in established equilibrium
C) maintain wildlife benefits

cons - A) does not address long term sedimentation problems
B) publicly less acceptable

next step - requires no further action

This is the "take no action alternative". It is likely that water chemistry and clarity parameters would remain the same or decline slightly. Existing carp populations would stabilize at a sustainable level with occasional winter kills. Sport fish would suffer frequent winter kills and unless restocked, could vanish completely. Aquatic vegetation might eventually be controlled by the carp. Enhanced turbidity would likely result from the rooting activity of the carp. The pond would remain habitat for amphibians and waterfowl while being utilized for recreational activities such as hunting, canoeing and limited sport fishing for the short term. The limited impact of human activity encourages wildlife to utilize the Millpond for habitat.

The Millpond serves as a sediment basin. The pooling of the Ahnapee's waters behind the dam allows sediments to settle out. This is a function which improves water quality downstream and reduces the volume of sediment delivered to Lake Michigan.

2. **DREDGE** - For sediment removal, excavation for beach preparation or fisheries improvement. The extent of the dredging necessary is dependent upon the desired outcome. This option would require permits and a disposal area.

pros - A) temporary solution to sediment problem
B) reduces aquatic vegetation temporarily
C) expands pond's water volume

cons - A) high cost
B) need to secure disposal area for spoils
C) permitting process
D) does not address long term sedimentation and nutrient enrichment problems

next step - secure funding for dredging activities
secure location for spoils material disposal
obtained required permits

Dredging would be a high cost, high impact alternative. An important factor in this option is the extent of which dredging would be utilized. On the grand scale, dredging could be used to reduce aquatic vegetation and sediment to increase depth over a large portion of the water body. It could be used on a limited scale as a needed measure to create a manmade swimming beach. Depending on the source of funding or permitting process, dredging could require an environmental analysis or impact statement. Further analysis would be required in determining depth of sediment and stratification, substrate analysis and appropriate disposal site. Dredging could be done in conjunction with a draw down to reduce the costs of sediment removal.

3. **HARVEST AQUATIC VEGETATION** - Mechanical or Chemical treatment to reduce or eliminate nuisance water weeds.

pros - A) temporary reduction in aquatic plants
B) reduced risk of winter fish kills
C) reduced plant nuisance would make waters more swimmable

cons - A) only addresses aquatic plant problem in areas which are deemed harvestible.
B) need disposal area for harvested plant material
C) associated high costs
D) does not address sedimentation and nutrient enrichment problems
E) introduction of chemical pollutants to surface, groundwater & sediment

next step - secure funding source
secure professional services
secure location for aquatic plant disposal
acquire necessary permits

For the purposes of this study, hand harvesting of vegetation was the only method of weed control considered. Water depths are inadequate for most mechanical harvesters. Uses of herbicides in an aquatic environment, especially one that provides a high quality habitat to waterfowl and amphibians is undesirable. Removal and disposal of vegetation is required by state statute and would be necessary regardless of the method used to kill the vegetation to prevent decaying plant material from causing another significant fish kill. Hand harvesting would likely be best conducted in conjunction with some form of pond draw down.

Some vegetation would be necessary as cover to support a sport fishery; therefore, total elimination of aquatic plants would be undesirable. The excess of vegetation contributes to oxygen deficits in the winter months encouraging conditions which foster winter fish kills. In order to sustain some form of sport fishery, the population of Eurasian water milfoil must be greatly reduced and controlled.

4. **REDUCE AGRICULTURAL RUNOFF** - install best management practices, participate in programs including Priority Watersheds, Farmland Preservation, and Nutrient Management.

pros -
- A) long term reduction of nutrient and sediment loading to Millpond
- B) addresses nonpoint loading to downstream areas of the Ahnapee River and Lake Michigan
- C) possible cost share moneys available to landowners
- D) also addresses issues concerning groundwater

cons -
- A) benefits are measured over long term, not immediate
- B) participation may be low
- C) may be costly

next step - Support all efforts to identify the Ahnapee River Watershed as a high priority in the Wisconsin Nonpoint Source Pollution Abatement selection processes.
Outreach to farmers to encourage using practices which reduce soil erosion and protect water resources.

This option would be used to enhance water quality over a long period of time by installing agricultural best management practices in the watershed. It is necessary to reduce nutrients entering the Millpond in order to slow down the eutrophication process. Agricultural activity is the primary source of human enhanced nutrient and sediment enrichment. Installing best management practices can reduce nonpoint sources of pollution which in turn will add longevity to the implementation of a management plan.

Regardless of the objectives for long term use of the Forestville Millpond, the Door County SWCD is committed to implementing this management option in all watersheds. The advantage of implementing agricultural best management practices is that they improve the land's productivity while protecting ground and surface water resources. It is a long term management goal for the Twin Door Kewaunee Basin to reduce agricultural nonpoint source pollution delivered to Lake Michigan. In turn; implementation of these measures serve to improve water quality in the Millpond, the Ahnapee river, and Lake Michigan.

5. **DEVELOP A LAKE MANAGEMENT DISTRICT or VOLUNTARY LAKE ASSOCIATION**

pros -
- A) local influence on lake management issues are increased
- B) good starting point for future Millpond management planning activities
- C) the district becomes its own revenue source
- D) those whom benefit most share the cost

cons - A) individual landowners may not want to participate
B) revenues for administrative unit could increase local taxes

next step - Select either *public inland lake protection and rehabilitation district* or *voluntary lake association.* Develop public support. Delineate boundaries, file articles of incorporation and/or bylaws.

This option provides the local residents with greater decision making authority. It also provides the Millpond with another source of revenue to fund the implementation of a management plan. With state and federal moneys drying up, this option could be the necessary source of funds to achieve the management plan and objectives for the Forestville Millpond.

Public lake management organizations include special districts, like public inland districts, town sanitary districts, and commissions formed by local governments. *Voluntary lake management organizations* include unincorporated associations and nonprofit corporations (UW-Extension, 1995).

A lake management association or a local civic organization (such as a sports club or a "Friends of the Forestville Millpond" should take a lead role in order to make the implementation of any lake management plan successful. Technical support could be provided by the Wisconsin DNR, Door County SWCD, the Fish and Wildlife Service, and nearby universities. Decisions made at the local level are more likely to be acted on. Outreach and education provided by those who live in the community tends to be more effective than from a governmental body. This option invests the local community in the outcome of the lake management plan.

6. **<u>CONDUCT AN INTENSIVE EDUCATIONAL EFFORT</u>.** Publish a newsletter, continue all monitoring efforts, maintain an informational bulletin board at the county park, community picnics, sponsor watershed/shoreline trash clean-up day, etc.

pros - A) would keep landowners informed on the status of Millpond issues
B) provides education to those who have the greatest impact on managing the resource
C) promotes local ownership

cons - A) an indirect approach - may not be effective in implementing a management plan.

next step - identify a funding source to carry out I&E activities
identify who will carry out the effort

This alternative would be used largely in conjunction with option 4 and/or 5. This measure would best be implemented by a local civic organization or a lake management association with technical support from the Door County SWCD, Wisconsin DNR, and the Fish and Wildlife Service. This is an indirect approach relying on the efforts of the community to make the plan effective.

7. **<u>ELIMINATE THE MILLPOND, RETURN AHNAPEE TO UNINTERUPPTED STREAM</u>** - return to natural conditions. This alternative may include the removal of the entire dam structure or just a small portion to allow the stream to return to its natural course. This may be the least cost management option for greatest impact.

pros -
A) recreates the river's natural condition
B) no further maintenance costs
C) easier to manage park
D) greatly reduces human impacts on system

cons -
A) hard to sell to landowners adjacent to the pond
B) requires permits from DNR
C) potential negative impacts to downstream ecosystem with increased sedimentation
D) does not address sedimentation and nutrient enrichment problems of the Ahnapee River Watershed.
E) disruption of aquatic bird and other animal habitats
F) need to acquire disposal site for materials excavated from dam
D) potential of sea lamprey establishing habitat in upper reaches of the Ahnapee river

next step -
acquire permits from DNR and Army Corps of Engineers
identify area for disposal of dam materials.

Communities have used this alternative to return their streams to their natural state. This action would eliminate the pond completely and eliminate future management expenses. The Millpond's capacity to trap sediment would also be lost along with its capacity for aquatic habitat. Loss of the dam might also mean a loss of the barricade which prevents sea lamprey from reaching upstream. What is now aquatic habitat would become terrestrial habitat.

The initial cost of eliminating the dam could be high but removal of a section of the dam would be less costly. The long term costs would be nonexistent except for a possible need for sea lamprey control. Shoreland may be gained, but its value may be minimal to the owner.

8A. **<u>A *FULL YEAR* DRAW DOWN OF THE MILLPOND'S WATER LEVELS</u>** based on a predetermined cycle - This management alternative would require permits from the DNR.

pros -
A) freeze out undesirable species of fish and plants
B) sediments would create hard pan and would not be re-suspended when the pond is refilled
C) aesthetics of pond would improve
D) low cost management option

cons -
A) potential odors associated with plant material decay
B) disruption/destruction in aquatic habitats
C) potential negative impacts downstream during draw down and refill

next step - obtain needed permits from DNR and Army Corp of Engineers

Wisconsin DNR suggested this alternative at a meeting of the scientific and technical community. This action would allow bottom sediments (not in the stream channel) to encrust and compact. Undesirable aquatic vegetation would be greatly reduced for the short term and rough fish species may all but die out for the short term. Weed harvesting and / or dredging activities may be undertaken while the pond is drawn down at a reduced cost. When the pond is refilled, the quality of the water would be improved.

In 1984, the Millpond was drawn down and some sediment flushing was observed; but only within the defined stream channel. Rates of draw down must be strictly regulated according to DNR standards. The roots of the abundant vegetation anchors soft sediments in place. Low water flow rates from areas where water is pooled does not allow for enough water velocity to suspend sediments.

Restocking[5] the Millpond with selected fish species would be a necessary measure after the draw down if an enhanced sport fishery is the desired objective. Reductions of aquatic vegetation, compaction or removal of bottom sediment and control of the rough fish population would be the greatest benefits of this measure. The elimination or reduction of the carp population resulting from draw down would improve water clarity.

8B. A *WINTER SEASON ONLY* DRAW DOWN OF THE MILLPOND'S WATER LEVELS based on an undetermined cycle - This management alternative would require permits from the DNR.

pros - A) freeze out undesirable species of fish and plants
B) aesthetics of pond would increase
C) low cost management option

cons - A) limited disruption of aquatic habitats
B) potential negative impacts downstream during draw down and refill

next step - obtain needed permits from DNR. Determine minimum and maximum rates of downstream flow

This option would have similar impacts as option 8A with the exception of the compacting and encrusting of the bottom sediments. This option may be more acceptable to the local community because the Millpond will not be drawn down during the summer months; however, a winter season draw down would not be as effective a tool as the full year draw down.

[5] Any restocking effort would be the responsibility of the county, a local unit of government or a community group.

9. **<u>RECONSTRUCT BOTTOM GATES AND SPILLWAY</u>** so that they will drain from the bottom and allow bottom sediments to be expelled through the gates. Excess sediment would be allowed to flow downstream.

pros -
- A) may allow greater rates of water turnover and may flush some sediments near the bottom gates
- B) may reduce weed problem in the vicinity of the gates

cons -
- A) expense of replacing existing gates
- B) negative impacts downstream from sedimentation
- C) legality and permitting

next step - Conduct feasibility study. Secure permits, seek out funding sources.

This alternative was generated by comments heard at two public informational meetings. The community members that attended these meetings suggested that this action would most closely replicate the conditions of the original dam structures. Older community members recall the unregulated short term draw downs that would occur when community members would remove gate planks which discharged bottom sediments. They urged that this practice was the reason for a better sport fishery than exists today and attributed the perceived decline in the fishery on the existing dam.

Observations of the 1984 draw down indicated that any flushing of the bottom sediments occurred in areas immediately adjacent to the dam and in the stream channel itself. Water movement in pooled areas would be at too low of a flow rate to re-suspend settled sediments. The roots of the abundant aquatic vegetation anchors the soft sediments in place. It is unlikely that reconstructing the dam would better manage the sediments.

Public Informational Meetings

A component of this report was to outreach to the local community to inform them of the preliminary findings of the study and to get feedback on the management options. Two meetings were conducted which provided the opportunity for input from both rural and village communities. Both meetings informed the attendees of the background of the study, a brief history of the Millpond, and an explanation of the list of management options. Management options may be selected either singularly or in conjunction with others. A poll was then taken. Each attendee selected three options weighting the selections from most to least favorable.

Results: (most favorable to least favorable)

RURAL

Town of Forestville Village Hall
February 8, 1996
Attendance - 30

1. Reconstruct Bottom Gates and Spillway (option 9)
2. Draw Down (option 8)
3. Dredge (option 2)
4. Remove Dam Structure (option 7)
5. Reduce Agricultural Runoff (option 4)
6. Harvest Aquatic Vegetation (option 3)
7. Do Nothing (option 1)
8. Educational Effort (option 6)
9. Develop Lake Management District (option 5)

VILLAGE

Forestville Village Hall
March 5, 1996
Attendance - 19

1. Reconstruct Bottom Gates and Spillway (option 9)
2. Dredge (option 2)
3. Reduce Agricultural Runoff (option 4)
4. Harvest Aquatic Vegetation (option 3)
5. Draw Down (option 8)
6. Develop Lake Management District (option 5)
7. Remove Dam Structure (option 7)
8. Educational Effort (option 6)
9. Do Nothing (option 1)

CUMULATIVE POLL RESULTS OF BOTH MEETINGS

	Weighted Average
1. Reconstruct Bottom Gates and Spillway (option 9)	41%
2. Draw Down (option 8)	16%
3. Dredge (option 2)	15%
4. Reduce Agricultural Runoff (option 4)	11%
5. Remove Dam Structure (option 7)	07%
6. Harvest Aquatic Vegetation (option 3)	07%
7. Educational Effort (option 6)	01%
8. Develop Lake Management District (option 5)	01%
9. Do Nothing (option 1)	01%

The poll was intended to provide the Airport & Parks Committee with a sense of what the community's vision of the preferred use of the Millpond and how to reach that goal. The sentiments expressed by those who attended leaned strongly toward improving the Millpond's capacity as a swimmable, fishable waterbody regardless of the cost to the county. The opportunity for a local body to manage and take fiscal responsibility for implementation of a management plan was generally not accepted according to the poll of the meeting attendees. Several comments expressed referred to memories of a plentiful sport fishery and clearer swimming waters. Some comments were hostile, blaming the county constructed and operated dam for the perceived decline in the conditions of the Millpond. A minority expressed their reservations toward making any changes to the management and use citing realistic limitations of the Millpond as a waterbody.

Findings of the Study

The factors limiting the current uses of the Forestville Millpond include shallowness of the waterbody (small water volume), lack of winter inflow and aeration, intermittence and stagnation of summer flow in the headwaters (Kirk, & Gansberg, 1996), loading of nutrients and sediments, and abundance of nuisance aquatic plants. The presence of carp which root the substrate causing re-suspension of bottom sediments degrades the water clarity. These limitations contribute to dissolved oxygen depletion, a risk of winter kill of desirable fish populations and increases turbidity making the water undesirable for swimming. Conditions are favorable for undesirable rough fish populations which further harms the sport fishery.

Nonpoint sources of pollution have impacted the water quality of the Forestville Millpond. The Carlson's Trophic State Model (utilizing total phosphorus, water clarity and chlorophyll *a* as indicators of eutrophication - see attachment 15) indicates that the Millpond is in a eutrophic state. *Eutrophic* is a condition where waters are rich in organic nutrients, encouraging the proliferation of algae and other aquatic plants. This condition reduces dissolved oxygen and stresses or eliminates the capacity of the waterbody to support other organisms. Analysis of water and sediment samples support this finding.

Eutrophication is a natural process which occurs in fresh waterbodies. In general, lakes tend to move through a three stage life cycle. - *1) oligitrophic* (having cool, deep waters low in nutrient and nearly void of aquatic vegetation), 2) *mesotrophic* (a state of transition between oligitrophic and eutrophic) and *3) eutrophic.* This life cycle trend is accelerated when the body is small and fed primarily by surface waters. Nutrient and sediment loading as well as the introduction of exotic plant species are factors that contribute to eutrophication. Reservoirs like the Forestville Millpond are likely to make this transition much faster than natural lakes of a similar size. Sediment and Phosphorus delivery models suggest that croplands and animal lots are significant sources of nutrients feeding into the Millpond.

Accompanying algae as a prevalent species of aquatic vegetation is the Eurasion water milfoil. The Eurasion milfoil is an undesirable invader species which has overwhelmed many freshwater bodies in North America. Eurasion milfoil tends to crowd out native aquatic plants and make habitat less hospitable for desirable fish species. Its presence in high densities is symptomatic of excessive nutrients in the water body. Agricultural activity in the watershed has increased the nutrient loads that feed the milfoil.

The sport fishery on the Millpond has declined in the last three decades. Its recreational use has moved away from swimming and fishing as a result of the changing conditions. Local community members attribute this decline to the existing dam structure which prevents the annual flushing of bottom sediments. Although changes in the condition of the Millpond is largely attributed to other natural and human enhanced processes, there is reason to believe that the change in dams and dam management did play a role in trapping sediments.

The pond has become a popular breeding and resting place for geese and other waterfowl. Its usage is currently best described as wildlife habitat. It is not likely that the Millpond will be used as a sport fishery to the extent it was in the past due to a lack of interest from the DNR in continuing restocking efforts. The risk of winter kills remain high and will remain that way until a long term change in conditions occurs. It may be unlikely that the Millpond will ever return to the clarity of its youth and the Millpond's fishery may not return to what it once was for those who fished its waters years ago.

A lake management plan for the Forestville Millpond must include - 1.) the plan's objective for the Millpond's use, 2.) one or more management options or actions to be put in place to achieve that objective, and 3.) the strategy for the implementation of the plan. The next step in the process requires the Airport and Parks Committee to define the objective for the Millpond's long term use. Only then can a set of actions from the management options list be selected based on the needs of the objective. Most of the management options require further study to determine feasibility and potential long term impacts.

Airport and Parks must be cautioned regarding past mistakes. Historically, management of the Millpond has been haphazard. For a management plan to work, options must be selected which complement each other's outcomes. A strategy for the implementation of the plan must be adopted and adhered to for the objectives to be achieved.

The Forestville Millpond currently is considered a fishable, swimmable waterbody providing limited recreational opportunities and habitat to both aquatic and terrestrial wildlife. The Airport and Parks Committee, along with the community must identify which of the current uses to improve before implementing a set of management options. The expectations for the future uses of the Millpond must be weighed with the costs. It would be impractical to attempt to overcome all of the Millpond's limitations. The costs may be too great and resources are scarce.

It is necessary to keep the community informed and to encourage community involvement in the adoption of a management plan. The responsibility of implementing most management options will require community participation. The community may also be responsible for bearing the burden of a portion of the cost of the management plan.

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Attachment 1

SITE F1 H_2O Samples

Date Sampled	7/5/94	7/21/94	8/17/94	9/6/94	9/16/94	9/27/94	10/28/94	11/15/94	12/28/94	3/6/95	3/31/95 [2]	5/30/95	7/19/95	8/14/95	9/14/95
Chlorophyll A uncorrected ug/L	33.5		17.3												
Ammonia-N mg/l	0.096		0.058	0.064	0.033	0.053	0.049	0.042	<0.027		<0.027				
Nitrate Plus Nitrite-N mg/l	0.264		0.326	0.446	0.322	0.761	2.32	2.78	4.22		2.06				
Total Kjeldahl Nitrogen mg/l	1.10		1.25	1.09	1.15	1.02	0.9	0.9	0.7		1.1				
Total phosphorous mg/l	0.076	0.024	0.040	0.041	0.047	0.123	0.030	0.02	0.008	0.01	0.02				
Dissolved phosphorous mg/l	0.005		<0.002			0.053		<0.002	<0.002	<0.002					
Suspended solids mg/l			7.0	5.0	9.0	10.0	4.88	4.88	4.88						
Temp. Field °C @ 1 meter		25.9°	21°	19.0°	23.6°	13.3°	7.5°	7.3°	4.0°	2.5°	4.2°	16.5°	23.3°	22.6°	19.3°
Dissolved mg/l Oxygen @ 1 meter		12.74	15.0	11.0	10.62	6.67	13.27	11.14	14.85	6.88 [1]	12.90	6.30	5.48	5.92	6.90
Secchi Depth ft.		4.5	0.9	4.5	3.0	1.5	6.5	7.0	Surface Frozen	Surface Frozen	7.1' bottom	5.0	4.0	2.0	2.0
Conductivity UMHOS/CM		505		470	485	210	430	430	423	410	330	500	470	470	395
pH Field su		8.4		8.4	8.4	6.6	7.8	8.0	7.4	6.8	7.5	7.2	8.4	8.2	8.6
Salinity		<1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cloud Cover			5%	20%	0%		100%	0%	100%	100%		0%	90%	50%	100%
Calcium mg/l											64				
Chloride mg/l											18.8				
Alkalinity mg/l											252				
Magnesium mg/l											32				
Potassium mg/l											3.4				
Sodium mg/l											6.8				
Sulfate mg/l											15				
Turbidity NTU											0.7				
Millpond Elevation				592.3'	592.5'	593.2'	592.4'	592.4'	592.5'	592.3'	592.5'	592.6'	592.4'	592.4'	592.3'

[1] Additional dissolved oxygen tests within the millpond ranged from 0.5 ppm (bottom) to 10.9 2.0' below surface.

[2] Samples taken just after ICE-OUT.

Site F2 H_2O Samples

Date Sampled	7/21/94
Total phosphorous mg/l	0.0360
Dissolved Oxygen mg/l	8.27
pH Field SU	8.0
Specific Conductance umhos/cm	650
Salinity	<1
Temp °C Field	22.3°

NOTE: Sample location was deleted from the study due to repeated representation of the Millpond's water quality.

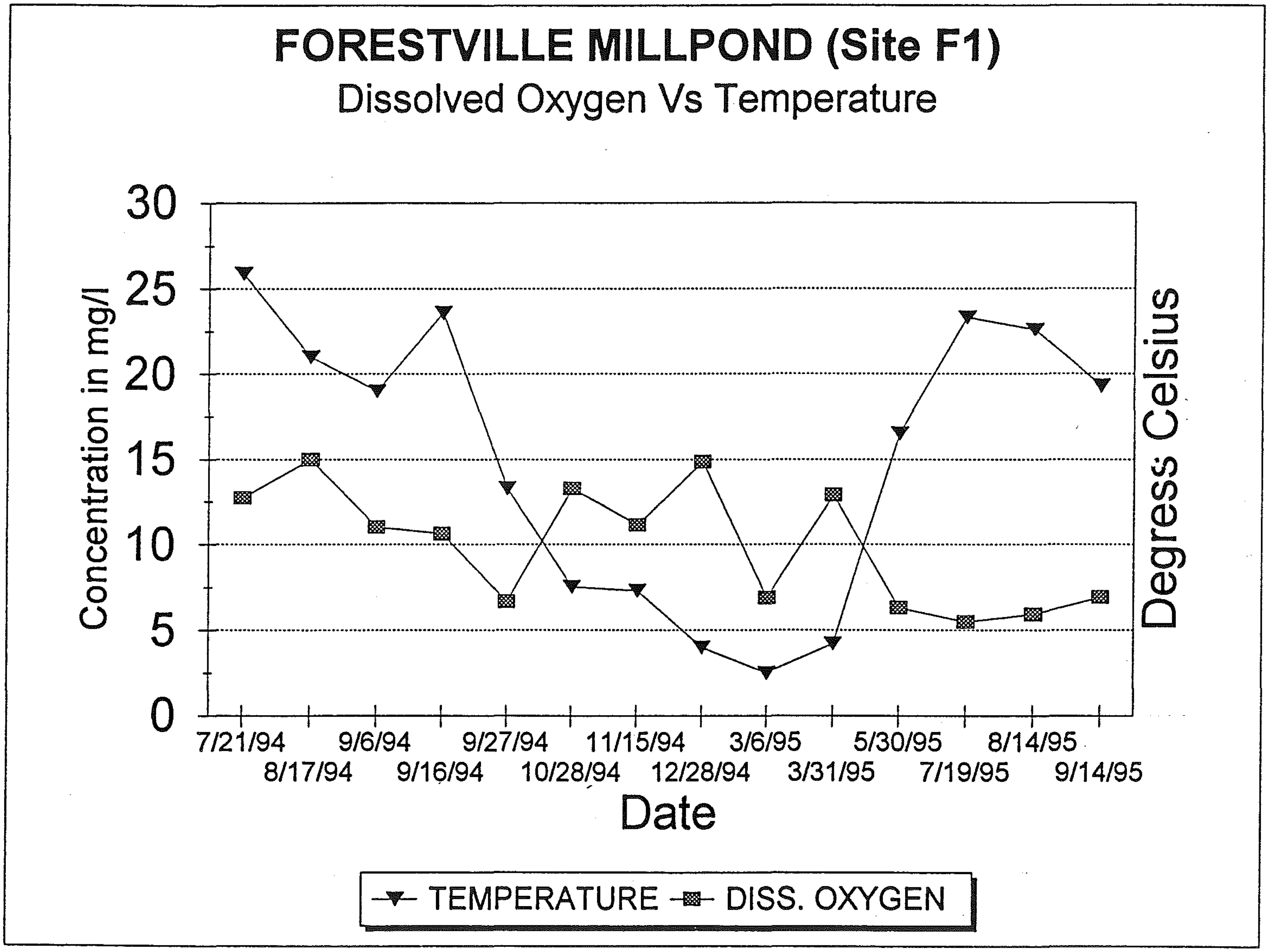
Attachment 3

Site F3 H_2O Samples

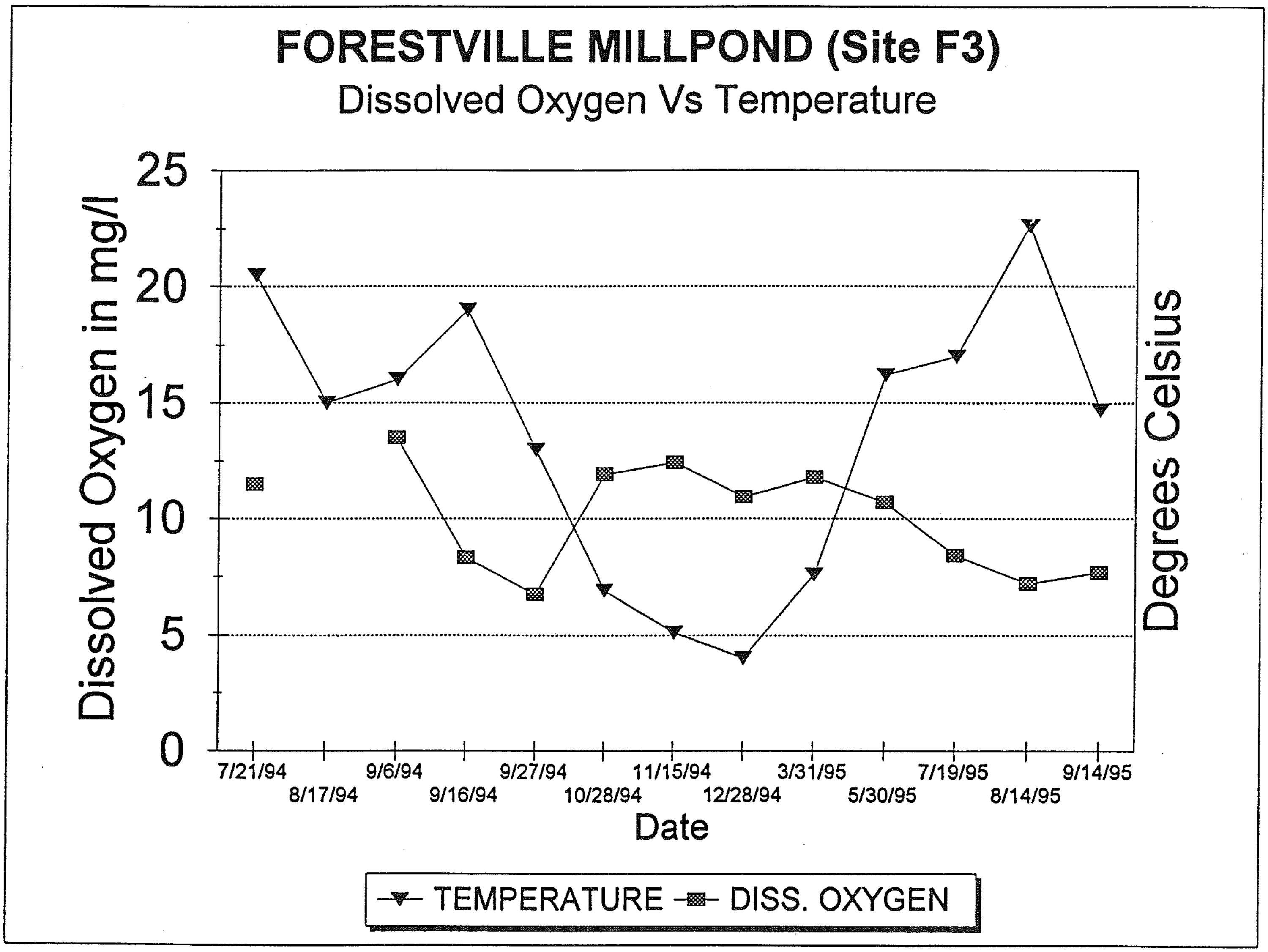
Date Sampled	7/21/94	8/17/94	9/6/94	9/16/94	9/27/94	10/28/94	11/15/94	12/28/94	3/31/95	5/30/95	7/19/95	8/14/95	9/14/95
Ammonia-N mg/l		0.021	0.011	0.034	0.027	0.027	0.027	0.030					
Nitrate Plus Nitrite-N mg/l		6.05	6.23	2.81	0.429	5.86	5.79	5.84					
Total Kjeldahl Nitrogen mg/l		0.48	0.41	1.03	0.90	0.7	0.7	0.3					
Total mg/l Phosphorous	0.02	0.010	0.016	0.056	0.109	0.037	0.03	0.02					
Dissolved phosphorous mg/l		0.002			0.042		0.013	0.020					
Suspended solids mg/l		<2	2	3	12	4.88	4.88	4.88					
Temp °C Field @ 1 foot	20.5°	15°	16°	19°	13°	6.9°	5.1°	4.0	7.6	16.2	17.0	22.6	14.7
Dissolved Oxygen @ 1 ft mg/l	11.5		13.5	8.3	6.74	11.93	12.42	10.94	11.80	10.70	8.41	7.20	7.67
Conductivity UMHOS/CM	610	(@ 25°C) 698	510	550	240	460	439	422	420	502	600	600	550
pH Field Su	8.0	8.22	7.7	7.8	6.6	7.6	7.4	7.2	6.3	8.0	8.1	7.8	7.9
Salinity	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity		317											

Site F4 H_2O Samples

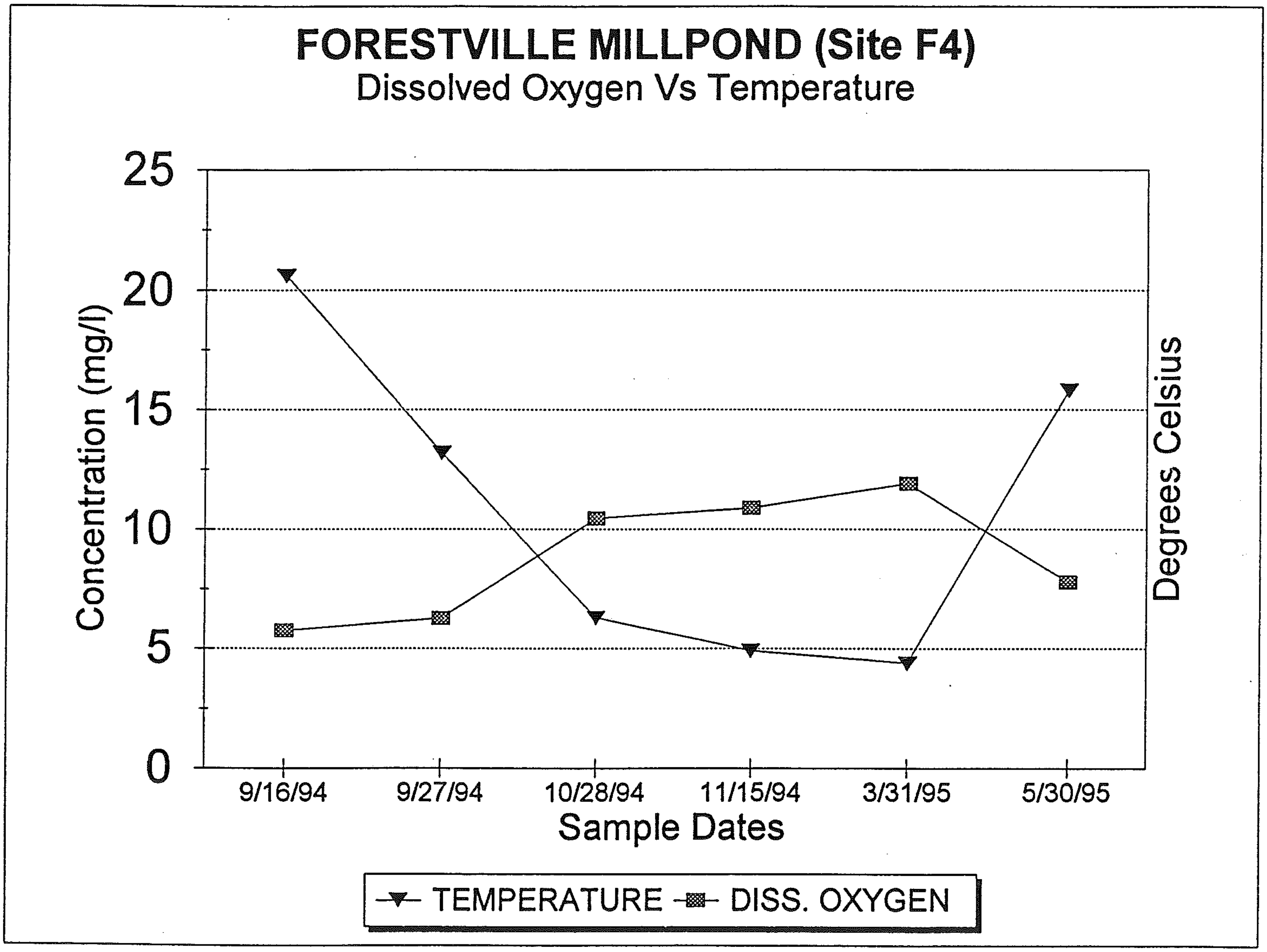
Date Sampled	9/16/94	9/27/94	10/28/94	11/15/94	12/28/94	3/31/95	5/30/95	7/19/95	8/14/95	9/14/95
Ammonia N mg/l		0.027	0.027	0.027	No			No	No	No
Nitrate Plus Nitrite-N mg/l		0.791	0.01	0.01	Sample			Flow	Flow	Flow
Total Kjeldahl Nitrogen mg/l		1.19	1.2	1.1	Frozen			Observed	Observed	Observed
Total Phosphorus mg/l		0.184	0.035	0.02	Channel					
Dissolved mg/l Phosphorous		0.112		0.004						
Suspended solids mg/l			4.88	4.88						
Temp °C Field @ 1 foot	20.6°	13.2°	6.3°	4.9°		4.4	15.8			
Dissolved Oxygen @ 1 ft mg/l	5.75	6.27	10.45	10.88		11.90	7.80			
Specific Conductance umhos/cm	440	240	430	415		339	450			
pH Field	7.4	6.6	6.8	7.4		6.5	7.7			
Salinity	<1	<1	<1	<1		<1	<1			

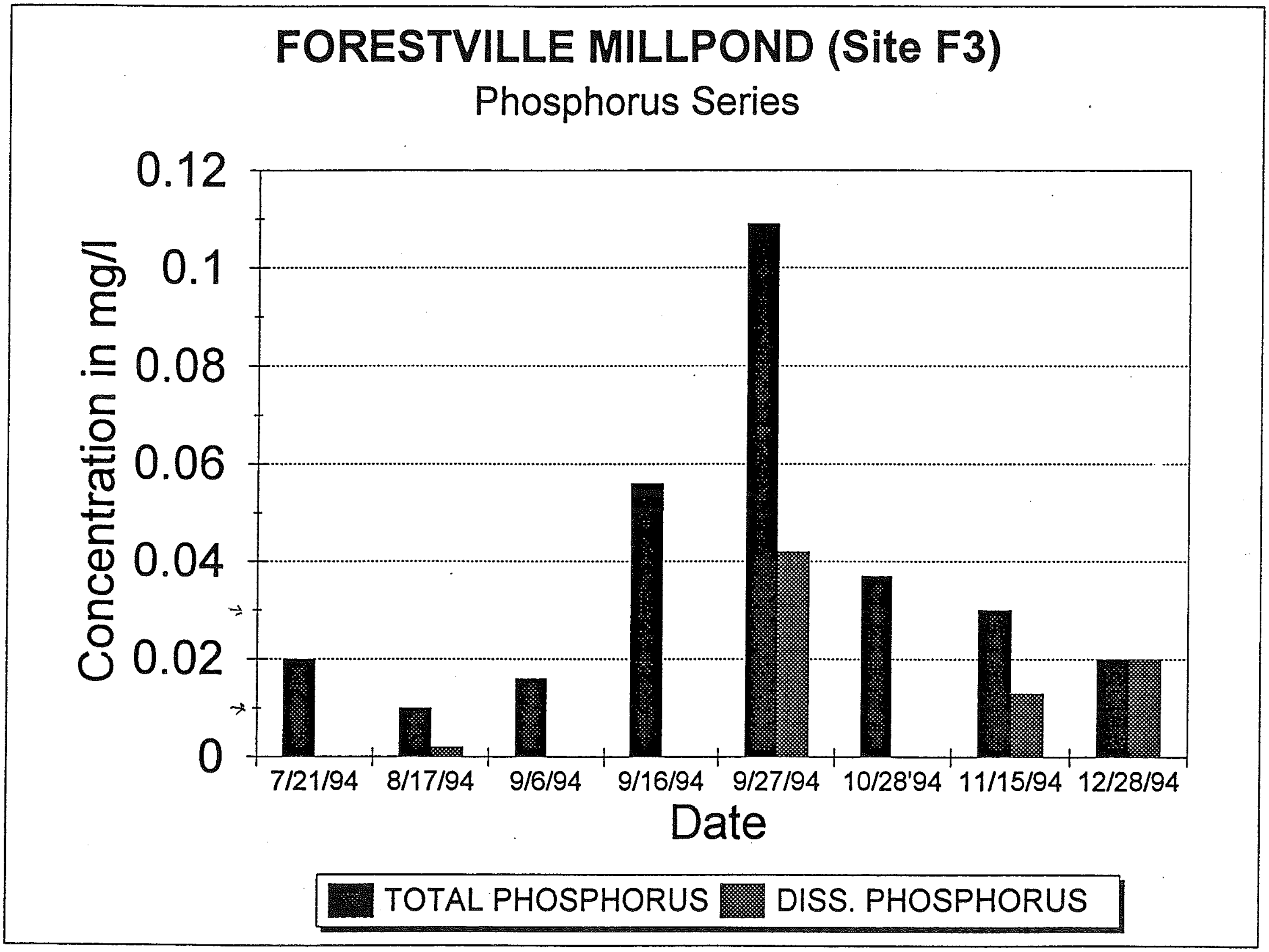


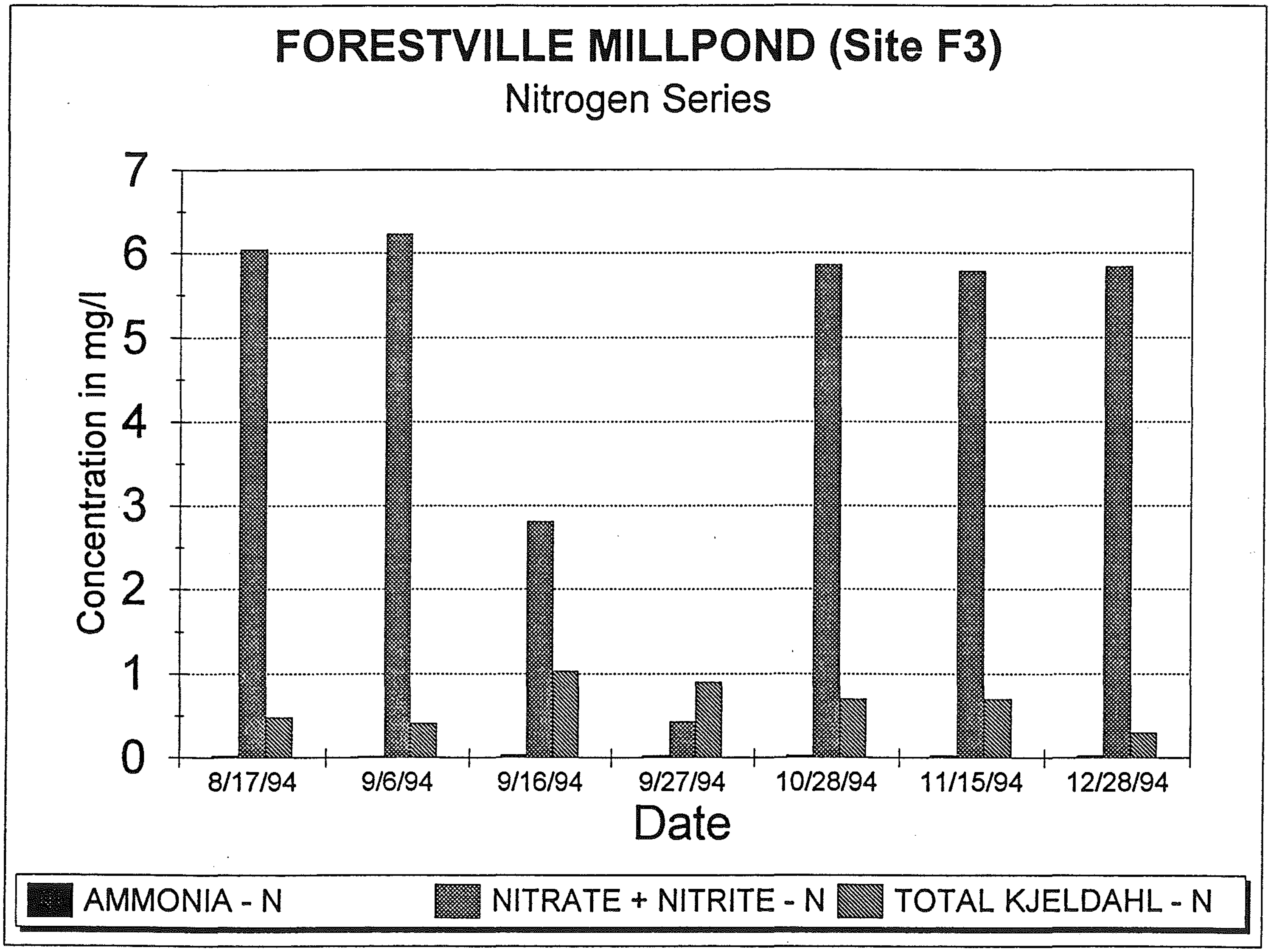
FORESTVILLE MILLPOND (Site F1)
Dissolved Oxygen Vs Temperature
Concentration in mg/l
Degress Celsius
30
25
20
15
10
5
0
7/21/94
8/17/94
9/6/94
9/16/94
9/27/94
10/28/94
11/15/94
12/28/94
3/6/95
3/31/95
5/30/95
7/19/95
8/14/95
9/14/95
Date
TEMPERATURE
DISS. OXYGEN



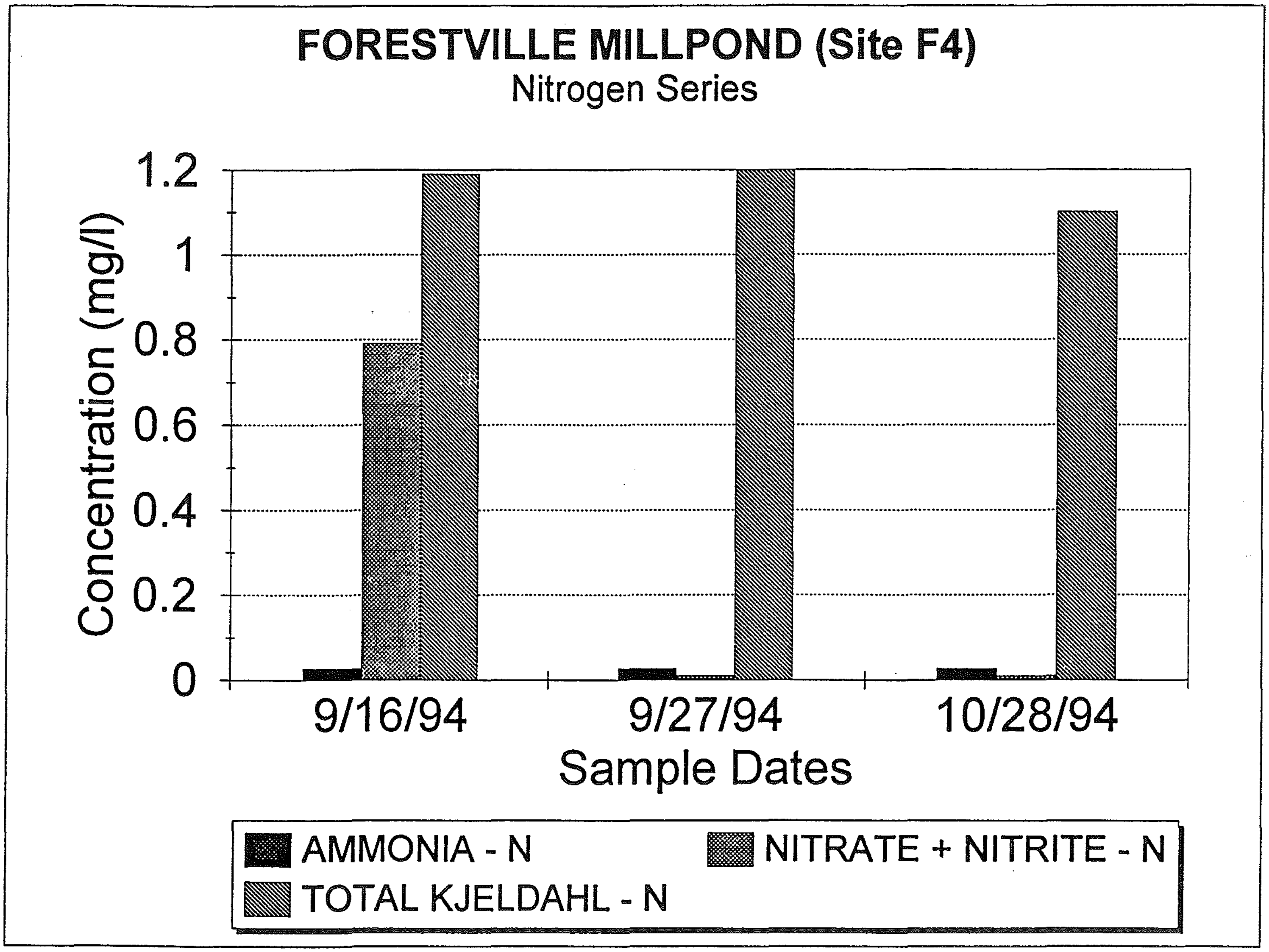
FORESTVILLE MILLPOND (Site F3)
Dissolved Oxygen Vs Temperature
Dissolved Oxygen in mg/l
Degrees Celsius
0
5
10
15
20
25
7/21/94
8/17/94
9/6/94
9/16/94
9/27/94
10/28/94
11/15/94
12/28/94
3/31/95
5/30/95
7/19/95
8/14/95
9/14/95
Date
TEMPERATURE
DISS. OXYGEN

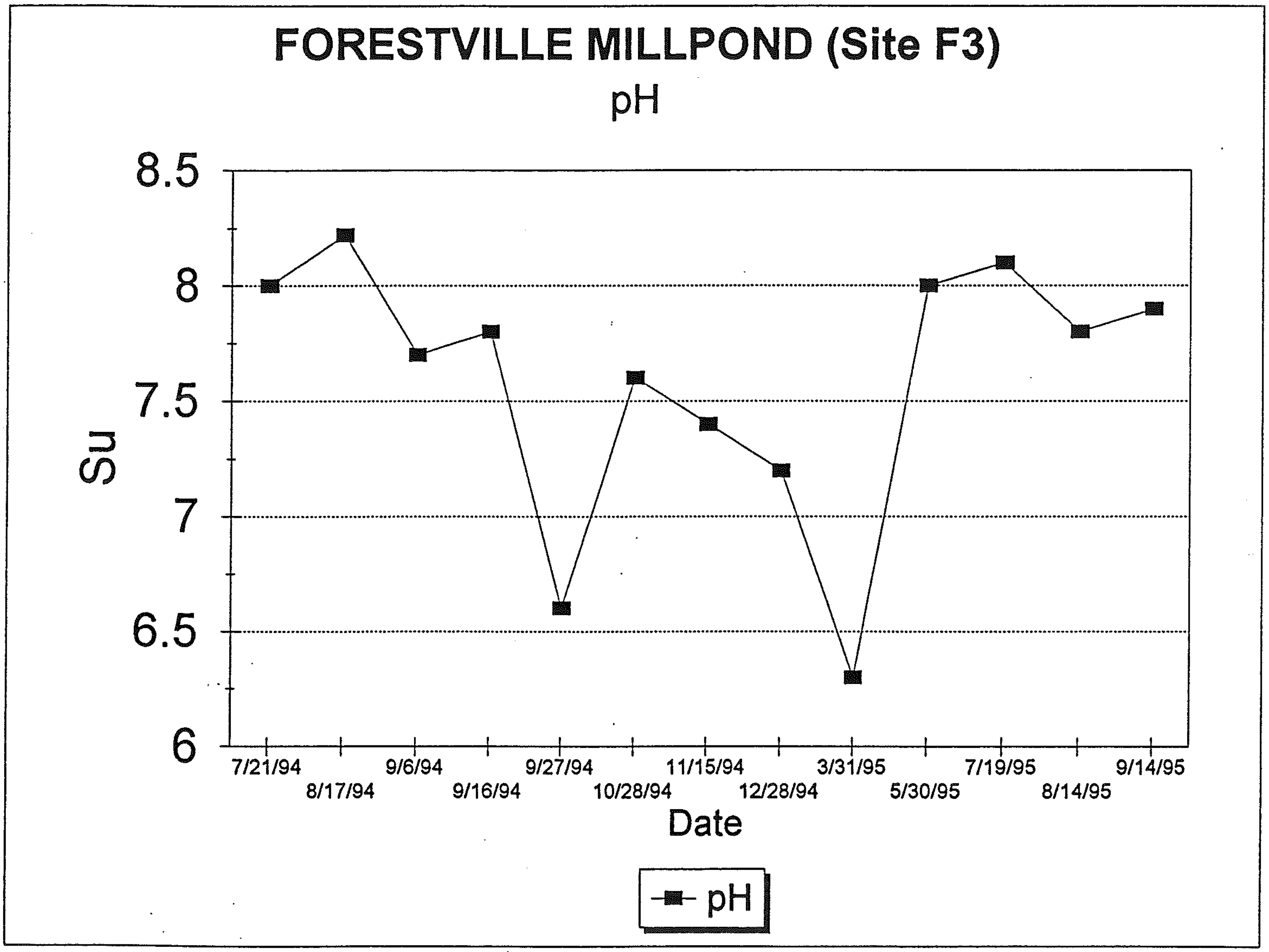

FORESTVILLE MILLPOND (Site F4)
Dissolved Oxygen Vs Temperature
Concentration (mg/l)
Degrees Celsius
25
20
15
10
5
0
9/16/94
9/27/94
10/28/94
11/15/94
3/31/95
5/30/95
Sample Dates
TEMPERATURE
DISS. OXYGEN


FORESTVILLE MILLPOND (Site F3)
Phosphorus Series
Concentration in mg/l
0.12
0.1
0.08
0.06
0.04
0.02
0
7/21/94
8/17/94
9/6/94
9/16/94
9/27/94
10/28'94
11/15/94
12/28/94
Date
TOTAL PHOSPHORUS
DISS. PHOSPHORUS

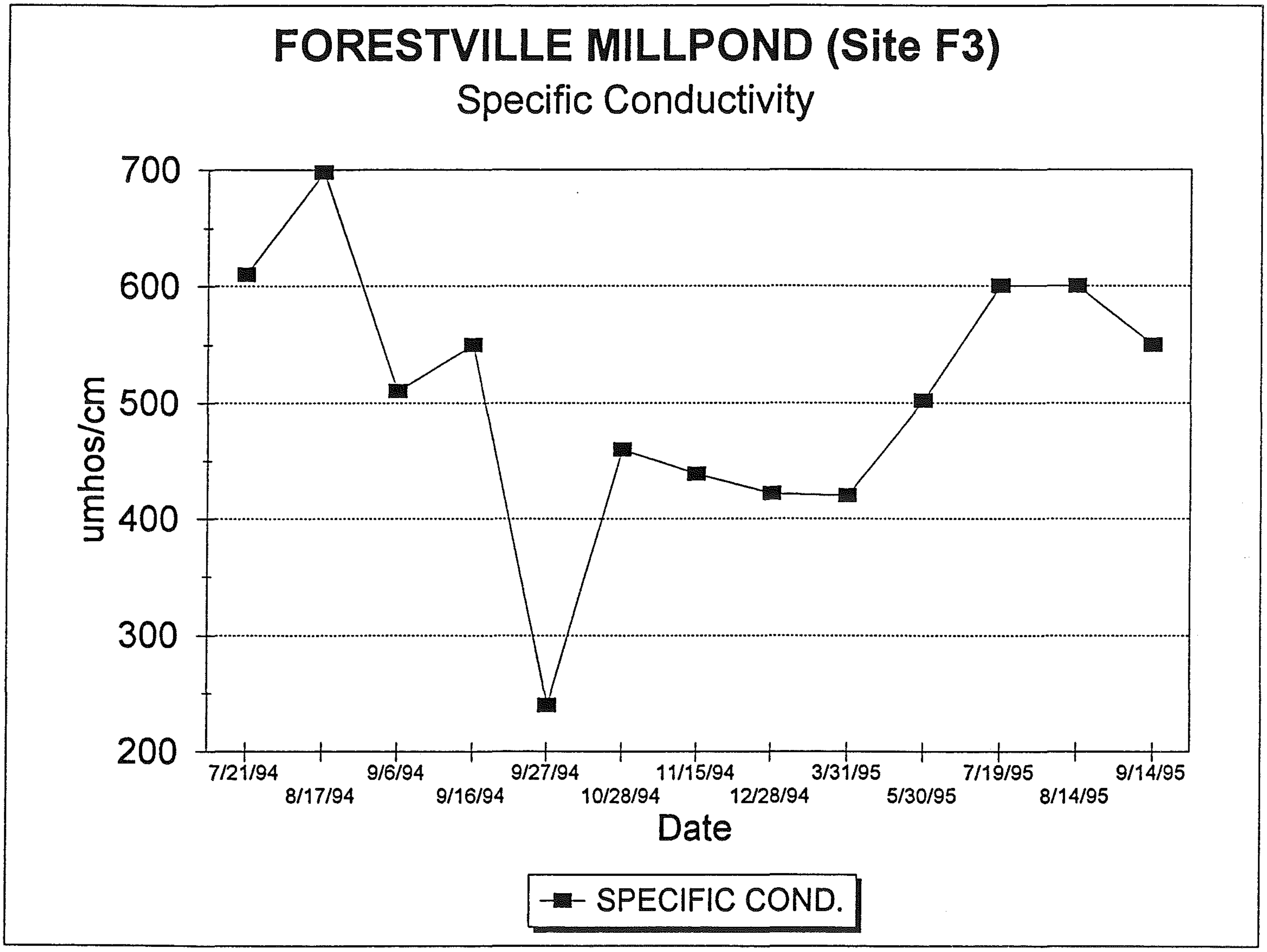


FORESTVILLE MILLPOND (Site F3)
Nitrogen Series
Concentration in mg/l
0
1
2
3
4
5
6
7
8/17/94
9/6/94
9/16/94
9/27/94
10/28/94
11/15/94
12/28/94
Date
AMMONIA - N
NITRATE + NITRITE - N
TOTAL KJELDAHL - N

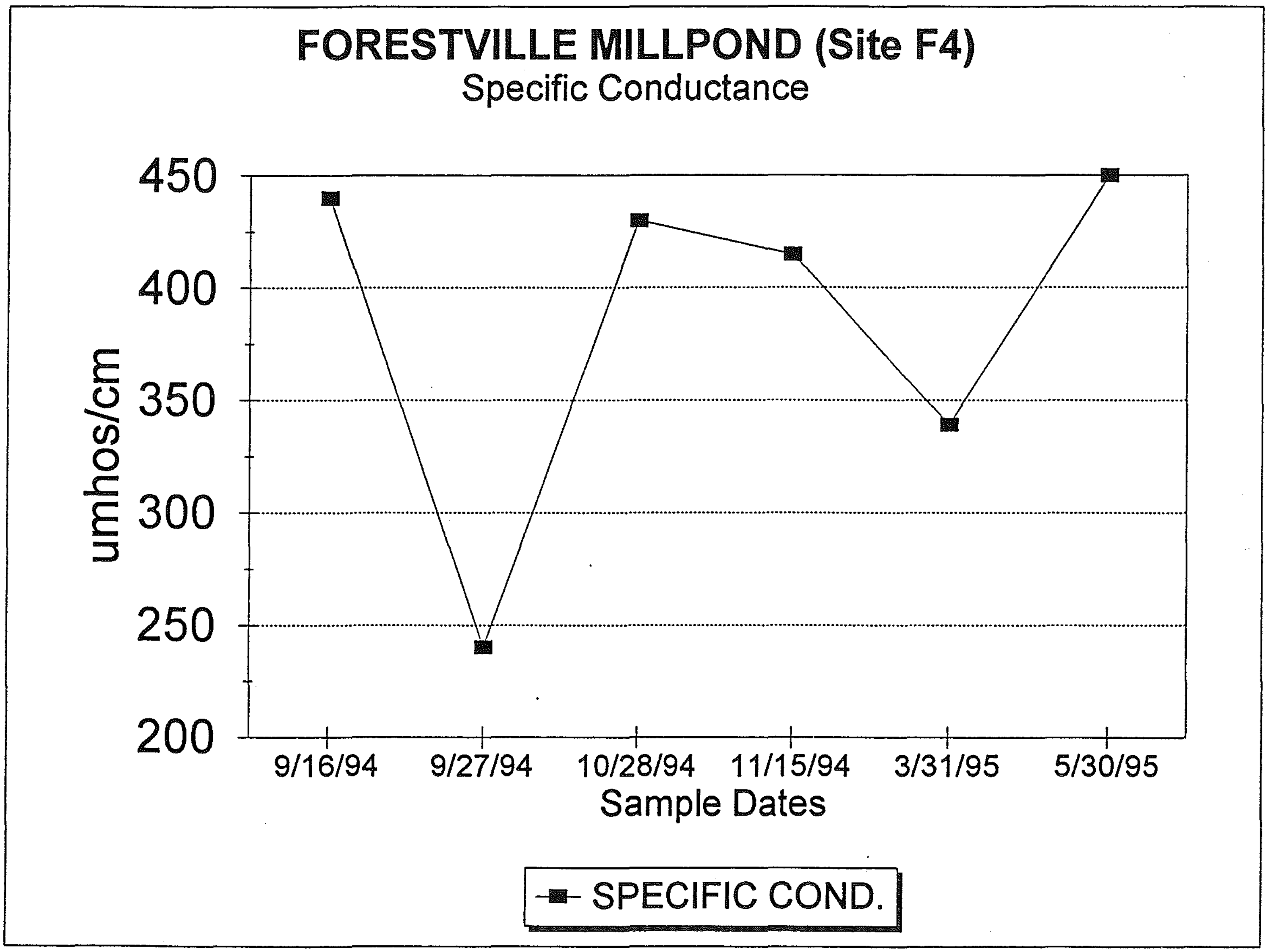

FORESTVILLE MILLPOND (Site F4)
Nitrogen Series
Concentration (mg/l)
1.2
1
0.8
0.6
0.4
0.2
0
9/16/94
9/27/94
10/28/94
Sample Dates
AMMONIA - N
NITRATE + NITRITE - N
TOTAL KJELDAHL - N



NOTE: Su = Standard units for pH



FORESTVILLE MILLPOND (Site F3)
Specific Conductivity
700
600
500
400
300
200
umhos/cm
7/21/94
8/17/94
9/6/94
9/16/94
9/27/94
10/28/94
11/15/94
12/28/94
3/31/95
5/30/95
7/19/95
8/14/95
9/14/95
Date
SPECIFIC COND.


FORESTVILLE MILLPOND (Site F4)
Specific Conductance
umhos/cm
450
400
350
300
250
200
9/16/94
9/27/94
10/28/94
11/15/94
3/31/95
5/30/95
Sample Dates
SPECIFIC COND.

<u>SITE F1</u> - Sediment

Date Sampled	7/5/94
Test Temperature	23°C

Test: Sediment and Soil for Herbicide Residue

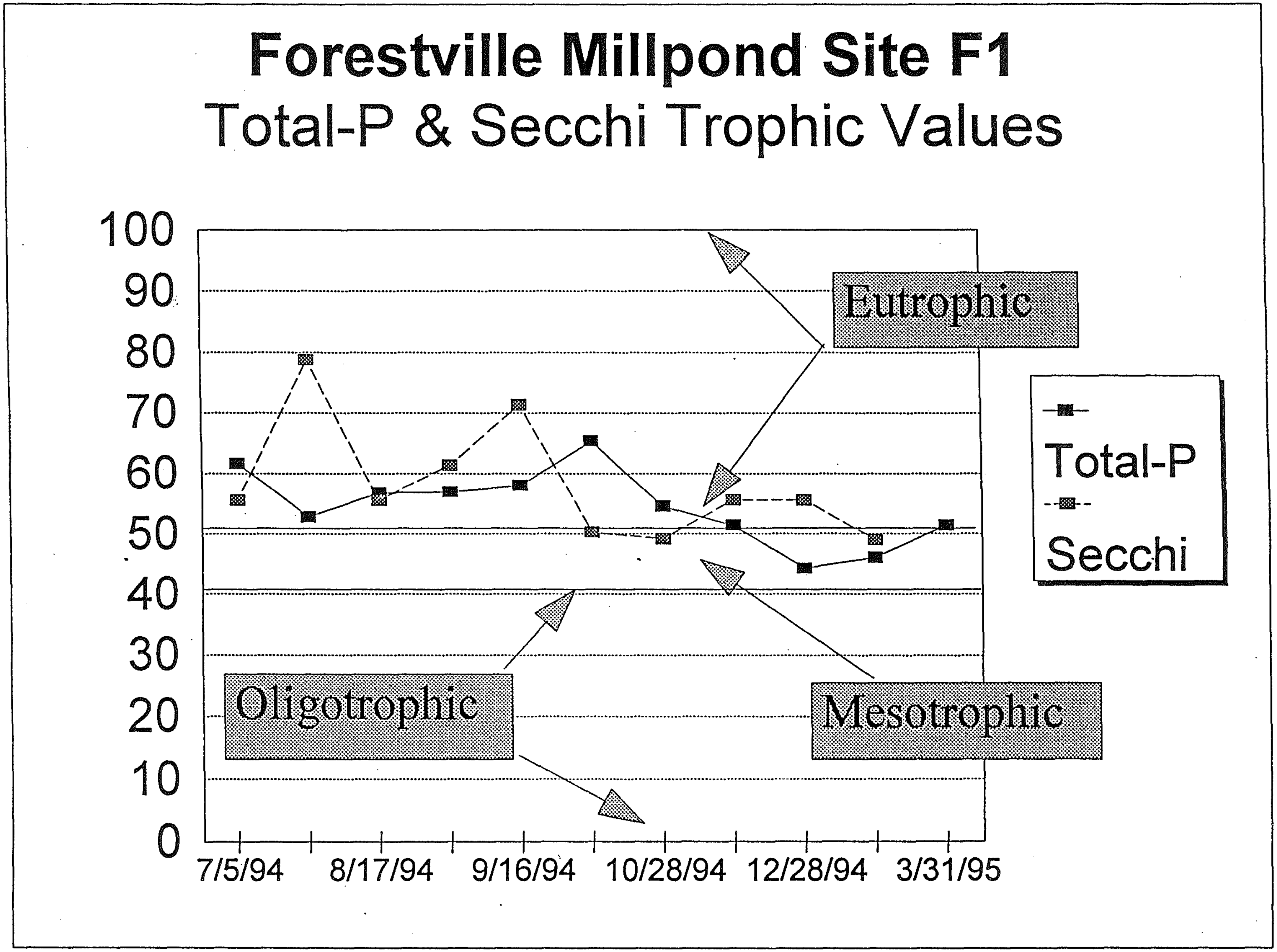
Atrazine	< 0.10 μg/g Dry
Alachlor (Lasso)	< 0.10 μg/g Dry
Cyanazine (Bladex)	< 0.10 μg/g Dry
Metolachor (Dual)	< 0.10 μg/g Dry

Test: Pesticide Residue in Soil

Linuron (Lorox)	< 0.10 μg/g Dry
Pendimehalin (Prowl)	< 0.10 μg/g Dry
214-D Chlorophenoxy	< 0.10 μg/g Dry

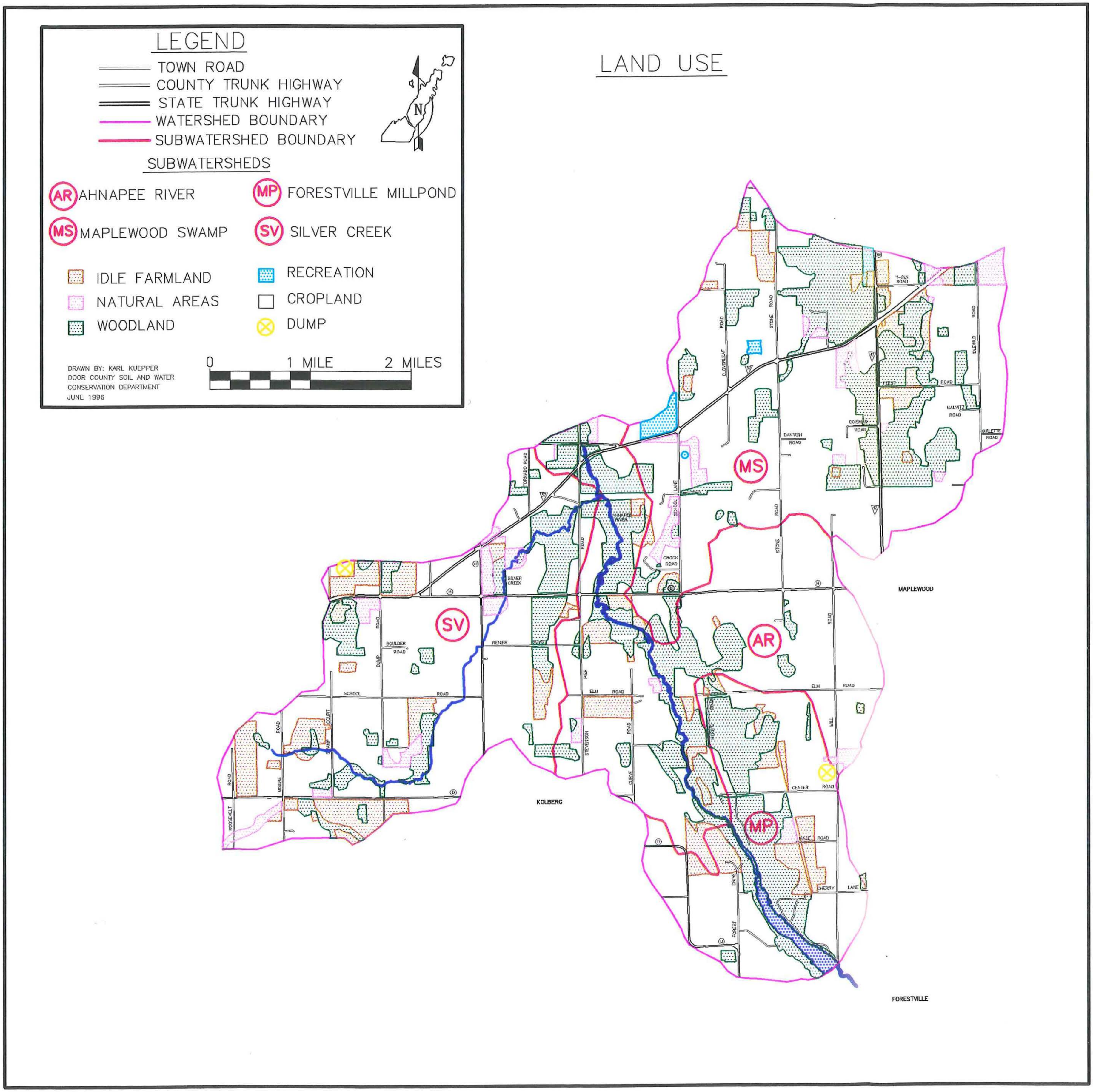
Test: Metals

Arsenic Dry WT	< 20. mg/Kg
Lead Dry WT	8. mg/Kg
Mercury Dry WT	0.08 mg/Kg

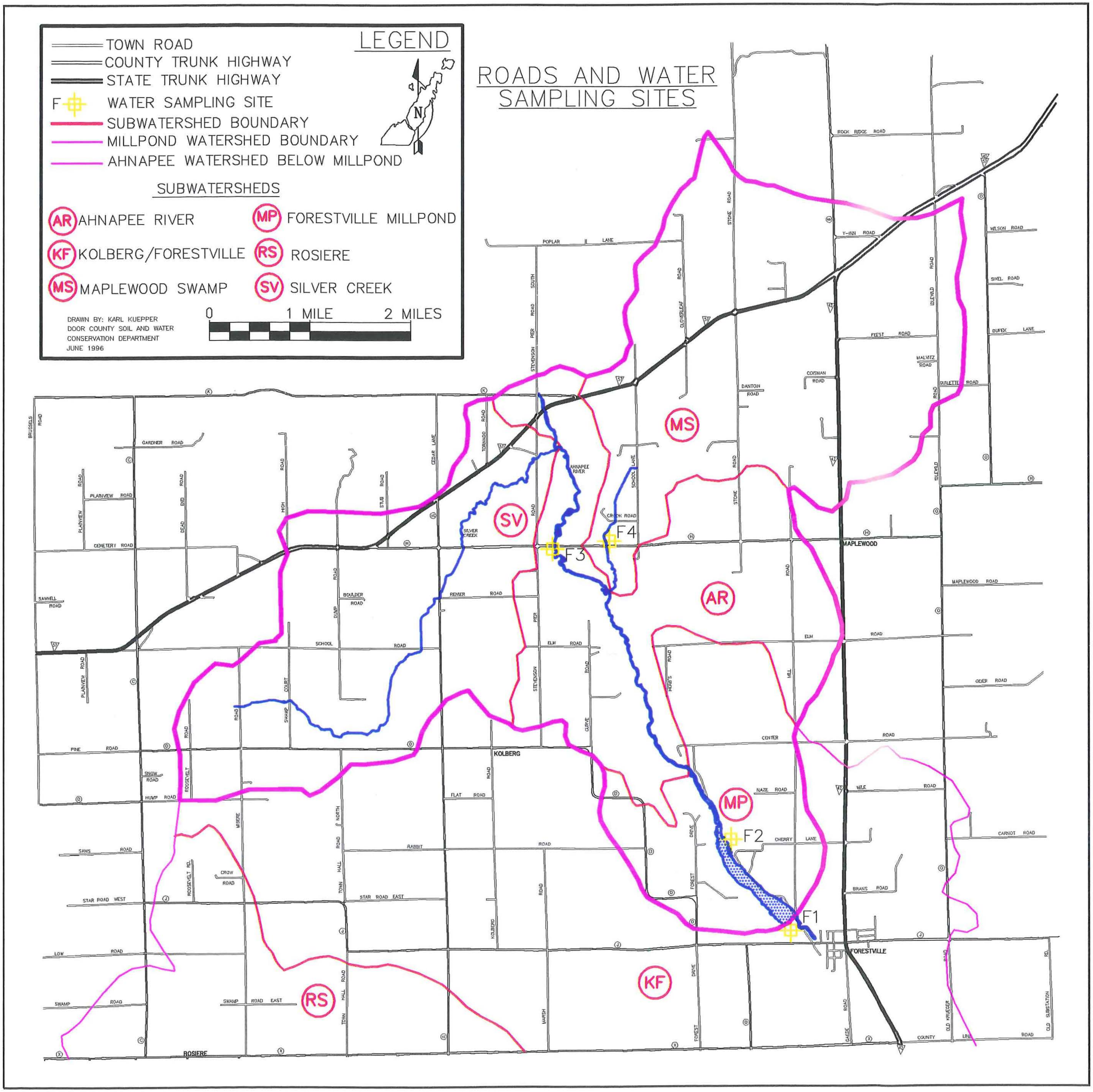


Attachment 15

FORESTVILLE MILLPOND WATERSHED

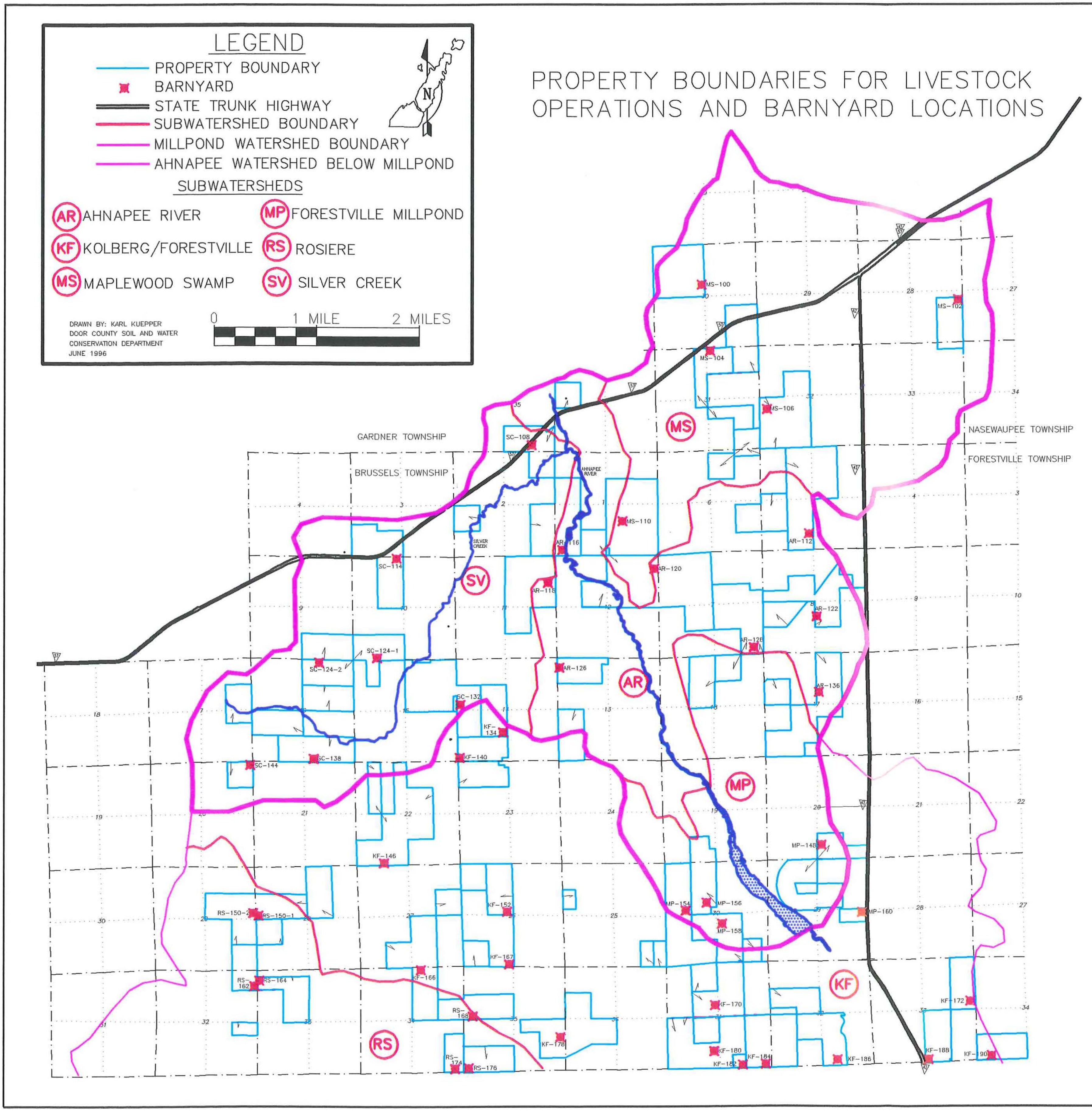


FORESTVILLE MILLPOND WATERSHED

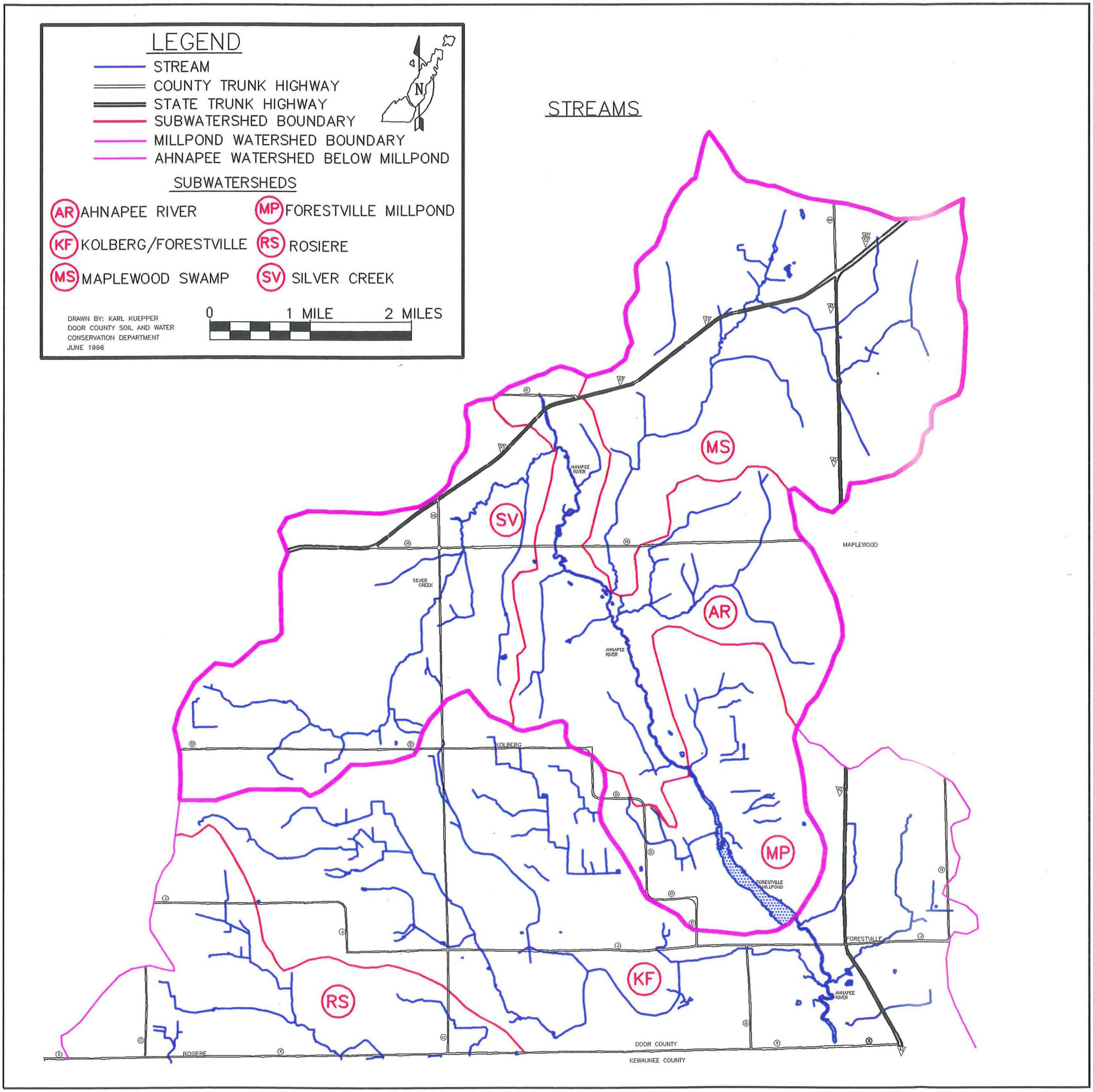


MAP 2

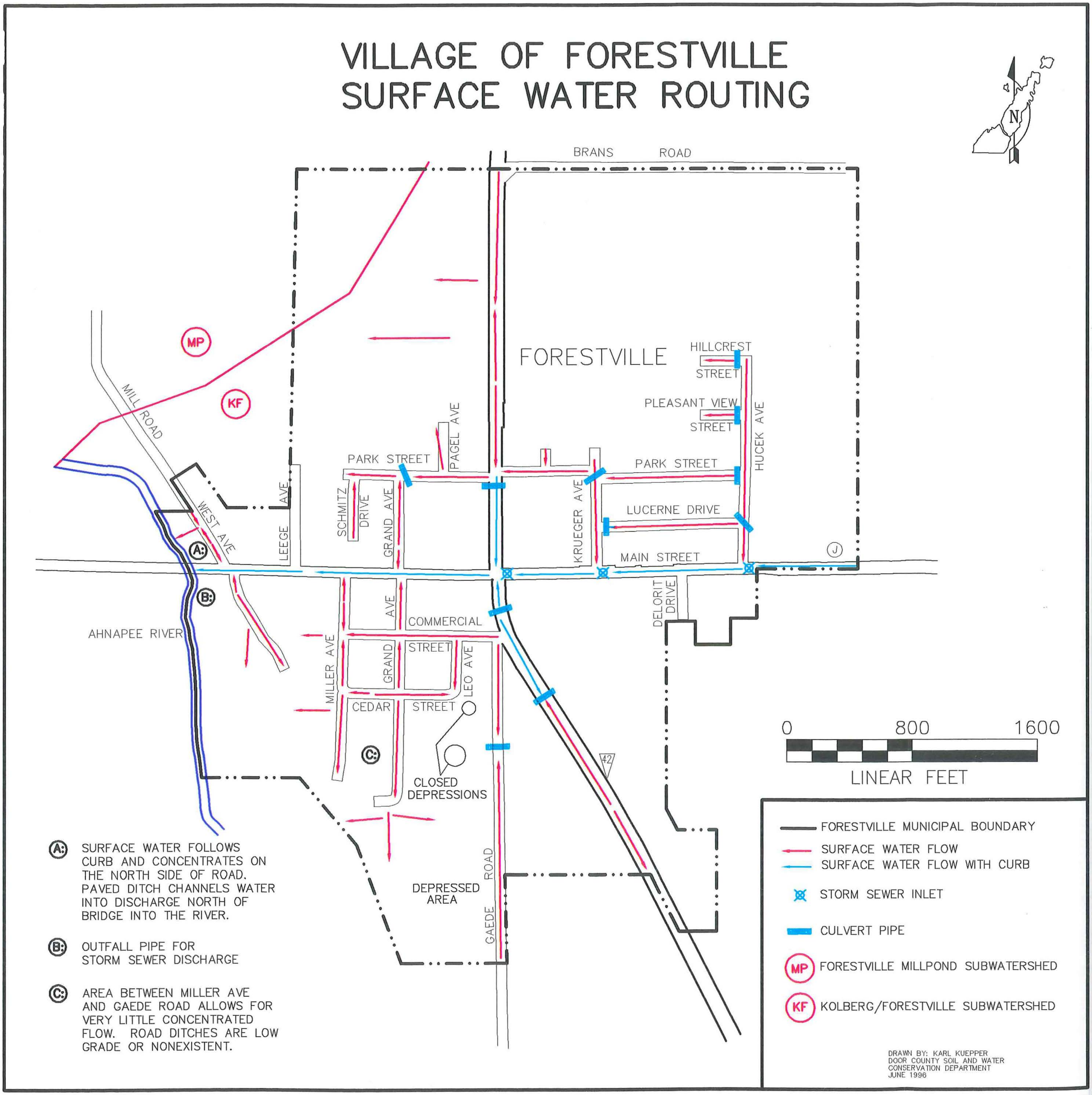
FORESTVILLE MILLPOND WATERSHED



FORESTVILLE MILLPOND WATERSHED

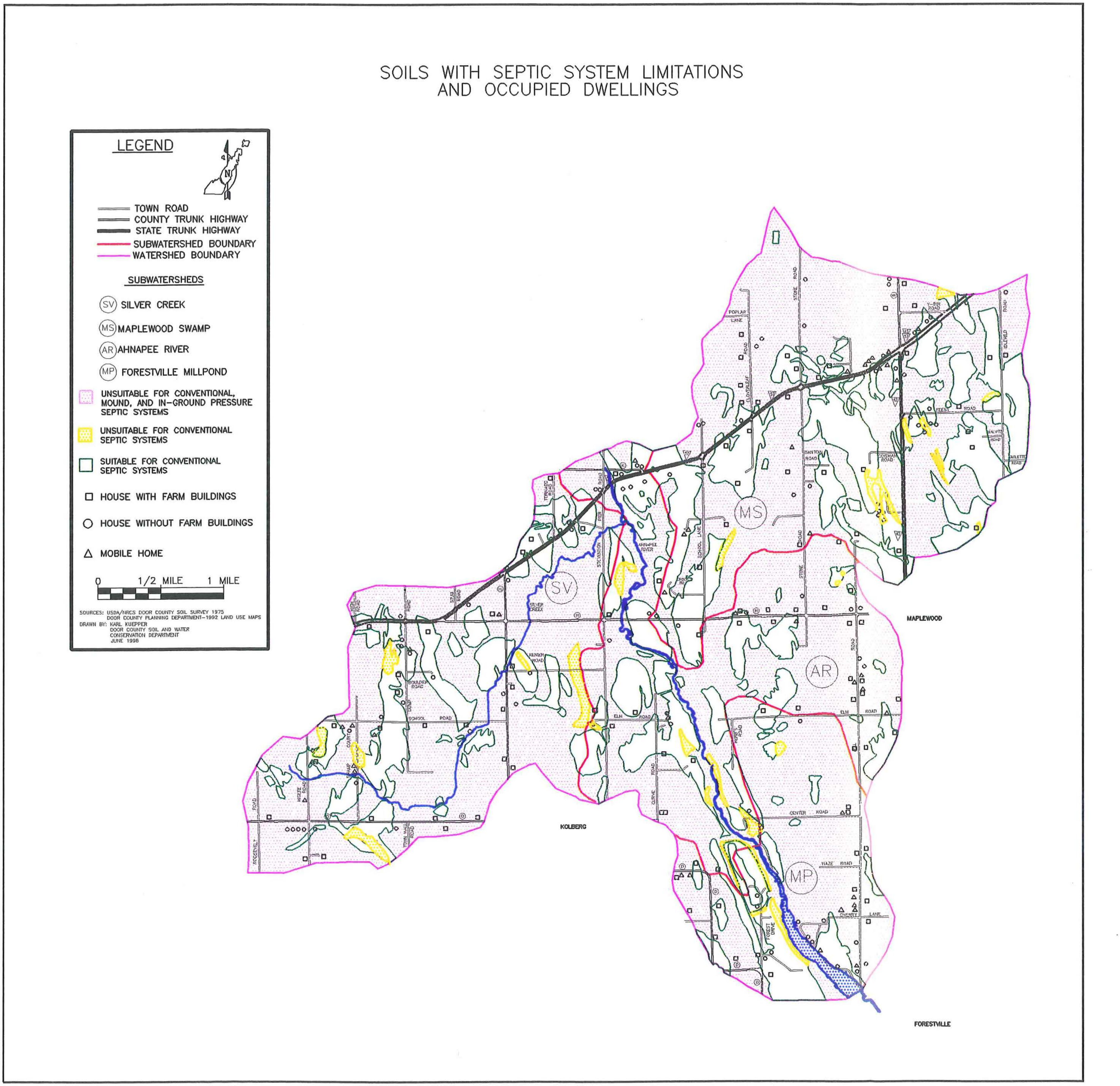


MAP 4


VILLAGE OF FORESTVILLE
SURFACE WATER ROUTING
N
BRANS ROAD
FORESTVILLE
HILLCREST STREET
PLEASANT VIEW STREET
HUCEK AVE
PARK STREET
LUCERNE DRIVE
MAIN STREET
KRUEGER AVE
DELORIT DRIVE
PAGEL AVE
PARK STREET
SCHMITZ DRIVE
GRAND AVE
LEEGE AVE
WEST AVE
MILL ROAD
MP
KF
A:
B:
AHNAPEE RIVER
COMMERCIAL STREET
AVE
GRAND
MILLER AVE
LEO AVE
CEDAR STREET
C:
CLOSED DEPRESSIONS
DEPRESSED AREA
GAEDE ROAD
42
J
0 800 1600
LINEAR FEET
FORESTVILLE MUNICIPAL BOUNDARY
SURFACE WATER FLOW
SURFACE WATER FLOW WITH CURB
STORM SEWER INLET
CULVERT PIPE
MP FORESTVILLE MILLPOND SUBWATERSHED
KF KOLBERG/FORESTVILLE SUBWATERSHED
A: SURFACE WATER FOLLOWS CURB AND CONCENTRATES ON THE NORTH SIDE OF ROAD. PAVED DITCH CHANNELS WATER INTO DISCHARGE NORTH OF BRIDGE INTO THE RIVER.
B: OUTFALL PIPE FOR STORM SEWER DISCHARGE
C: AREA BETWEEN MILLER AVE AND GAEDE ROAD ALLOWS FOR VERY LITTLE CONCENTRATED FLOW. ROAD DITCHES ARE LOW GRADE OR NONEXISTENT.
DRAWN BY: KARL KUEPPER
DOOR COUNTY SOIL AND WATER CONSERVATION DEPARTMENT
JUNE 1996

MAP 5

FORESTVILLE MILLPOND WATERSHED



MAP 6