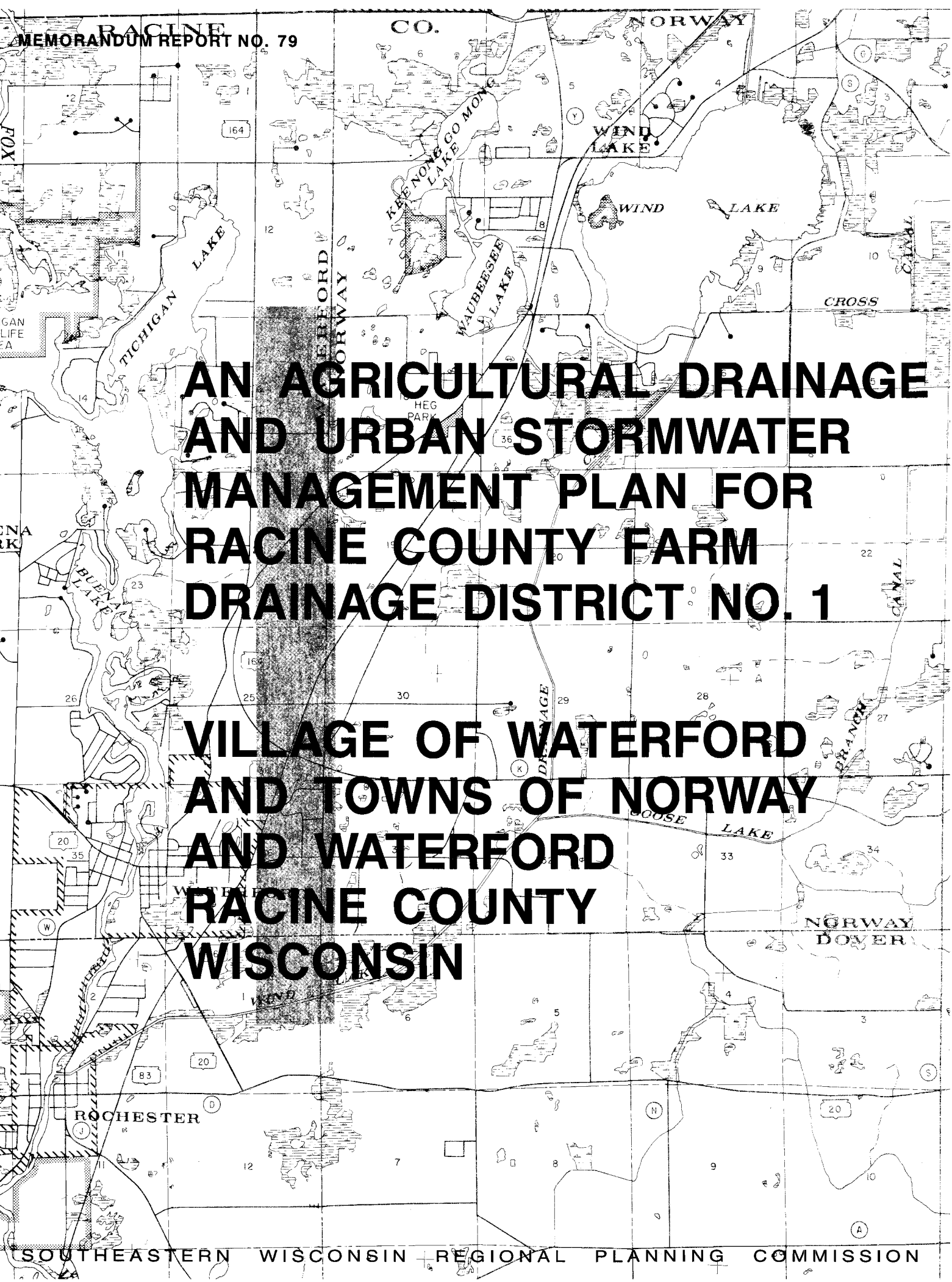
MEMORANDUM REPORT NO. 79



AN AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT PLAN FOR RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1

VILLAGE OF WATERFORD AND TOWNS OF NORWAY AND WATERFORD RACINE COUNTY WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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Mr. Arthur M. Stratton

LEGAL COUNSEL TO RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1

Mr. Kenneth F. Hostak

[a]As of July 2, 1993, this body of commissioners was discontinued and the Drainage District was placed under the supervision of the Racine County Farm Drainage Board in accordance with Sections 88.161 and 88.17 of the Wisconsin Statutes.

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Special acknowledgement is due Michael G. Hahn, SEWRPC Principal Engineer, for his contribution to this report.

MEMORANDUM REPORT
NUMBER 79

AN AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT PLAN FOR RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1

VILLAGE OF WATERFORD AND TOWNS OF NORWAY AND WATERFORD RACINE COUNTY, WISCONSIN

Prepared by the

Southeastern Wisconsin Regional Planning Commission
P. O. Box 1607
Old Courthouse
916 N. East Avenue
Waukesha, Wisconsin 53187-1607

September 1993

Inside Region	$10.00
Outside Region	$20.00

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SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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September 22, 1993

Mr. Alvin R. Wilks, Chairman
Racine County Farm Drainage Board
17629 Durand Avenue
Union Grove, Wisconsin 53182

Dear Mr. Wilks:

In accordance with the terms of the agreement entered into on February 6, 1992, between the Town of Waterford, Racine County Farm Drainage District No. 1, and the Regional Planning Commission, the Commission staff, working in cooperation with the former Commissioners of the Farm Drainage District and the legal counsel of the District, has completed an agricultural and stormwater drainage plan for Racine County Farm Drainage District No. 1. We are pleased to provide to you herewith the report documenting the recommended agricultural and stormwater drainage plan for the area concerned.

The plan presented in the report is consistent with regional as well as local land use development objectives and is intended to serve as a guide to public officials in the making of sound decisions over time concerning the provision and improvement of agricultural and stormwater drainage facilities within the Farm Drainage District.

The Regional Planning Commission is particularly appreciative of the contributions of the former District Commissioners and the legal counsel for the Drainage District during the preparation of the plan. The Commission stands ready to assist the County Farm Drainage Board in securing the adoption of the plan and in promoting its implementation over time.

Sincerely,

Kurt W. Bauer
Executive Director

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Chapter I

INTRODUCTION

In accordance with the letter agreement entered into on February 6, 1992, between the Town of Waterford, Racine County Farm Drainage District No. 1, and the Regional Planning Commission, the Commission staff undertook a stormwater runoff and agricultural drainage management study of the Farm Drainage District located in the Towns of Norway and Waterford and the Village of Waterford. The study area is shown on Map 1. This memorandum report documents the findings and recommendations of that study. The study included an inventory of existing land use and drainage facility conditions; the preparation of forecasts of probable future land use conditions; formulation of design criteria to be used in the analysis, design, and evaluation of alternative system plans; and the selection of a recommended plan and identification of the measures necessary to implement that plan.

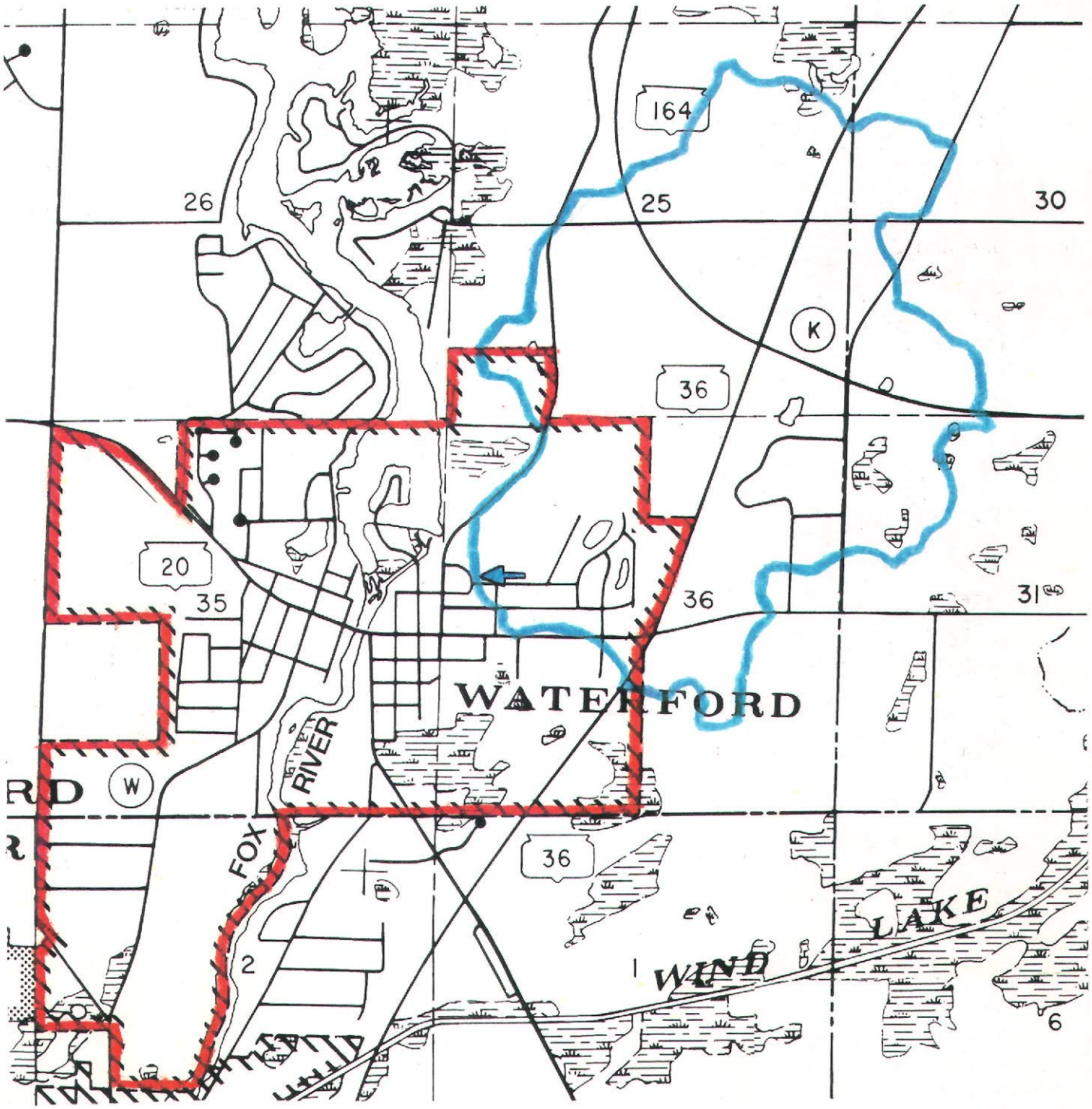
OBJECTIVE OF THE STUDY

The study area includes a mixture of rural and urban development. The agricultural drainage system and the urban stormwater drainage system of the study area are interrelated and, over time, the two systems have become interconnected. Because of that interconnection, neither system can be viewed in isolation from the other, even though the two systems are generally intended to serve different purposes. Agricultural drainage systems are provided to regulate high groundwater levels and to dispose of runoff from smaller, more-frequently occurring storms. Urban stormwater drainage systems are intended to dispose of runoff from larger storms in order to avoid drainage-related inconvenience, property damage, and public health and safety hazards. The interconnection of the two systems has limited the effectiveness of each system because the addition to the pre-existing agricultural drainage system of stormwater runoff from urban and transportation land uses was not offset by an increase in the capacities of the agricultural drain tiles located downstream of the stormwater connections added to the system, or by a significant increase in the pumping capacity at the outlet of the system. Thus, this study addresses the problem of providing an integrated system which can adequately meet both the existing and probable future agricultural drainage and urban stormwater management needs of the area in a coordinated and systematic manner.

A stormwater management plan for areas of the Village of Waterford, including but not limited to portions of the Farm Drainage District study area, was prepared by the Village consulting engineer--the firm of Welch, Hanson & Associates--in December of 1992. Pertinent sections of that report were reviewed during preparation of this plan and the alternatives considered herein include components which are consistent with the recommendations contained in the Village plan.

Map 1

LOCATION OF STUDY AREA



LEGEND

STUDY AREA BOUNDARY

VILLAGE OF WATERFORD CORPORATE LIMITS

STUDY AREA OUTLET

GRAPHIC SCALE

0 1/8 1/4 MILE

0 1000 2000 FEET

Source: SEWRPC.

Chapter II

INVENTORIES AND FORECASTS

SOURCES OF INFORMATION

The records of the Farm Drainage District, which are on file with the Racine County Clerk of Courts, indicate that the District was established in 1921 and the agricultural drain tile system was installed shortly thereafter. Those files were consulted in an attempt to locate design drawings and maps of the drain tile system and to verify maintenance and modifications to the system which have occurred in the 70-year period since the system was constructed. The files indicate that the original clay drain tiles have been repaired and replaced over the ensuing years. However, no records could be found indicating the size, type, and total length of replacement tile in any given year, or the precise location, elevation or grade of the replacement. The drain tile sizes and alignments shown on Map 2 located in the pocket at the back of this report are based on the 1921 design maps; historic records on file with the County Clerk of Courts; 1977 storm sewer plans prepared for the Foxmead subdivision by the firm of Michael J. Losik & Associates, Consulting Engineers; field survey data provided by the firm of Nielsen, Madsen & Barber, Consulting Civil Engineers; Wisconsin Department of Transportation as-built drawings for STH 36 and STH 164; field observations by Commission staff; and personal interviews with Farm Drainage District Commissioners.

Information on the Village of Waterford stormwater drainage system was obtained from the Village storm sewer system map; from supplemental information on recent development supplied by Welch, Hanson & Associates, Village consulting engineers; and from design drawings for the Foxmead subdivision. Data regarding the Farm Drainage District lift station were provided by Maas & Sons, Inc. Water Systems, who installed the pumps, and from Nielsen, Madsen & Barber, engineering consultants to the District.

STUDY AREA DESCRIPTION

Pertinent features of the 1.33-square-mile study area are shown on Map 2. The study area consists primarily of the land tributary to the subsurface agricultural drainage system maintained by the Farm Drainage District. Approximately 0.23 square mile, or 18 percent of the study area, is located within the Town of Norway; 0.84 square mile, or 63 percent of the study area, is located within the Town of Waterford; and 0.26 square mile, or 19 percent of the study area, is located within the Village of Waterford.

Existing and Future Land Uses

In 1990, about 80 percent of the land in the study area was in rural uses including cropland, pasture and other agricultural land, unused land, wetlands, and woodlands. The remaining 20 percent was developed for urban use including low, medium, and high density residential, commercial, and transportation uses. Based on the recommended year 2010 land use plan as documented in SEWRPC Planning Report No. 40, A Regional Land Use Plan for Southeastern Wisconsin--2010, January 1992, about 65 percent of the land in the study area is recommended to remain in rural uses similar to the existing uses, while urban uses would increase to about 35 percent of the total study area. The increase in urban use

would consist primarily of new residential and commercial uses located in the STH 36 corridor near the southern portion of the study area, adjacent to the current corporate limits of the Village of Waterford. The Racine County Planning and Development Department, in cooperation with the Regional Planning Commission, prepared a more detailed land use plan for the STH 36 corridor in the Village of Waterford area. This plan serves to refine and detail, but does not basically change the adopted regional land use plan.

State Trunk Highway 36 bisects the study area from north to south. The Wisconsin Department of Transportation (WisDOT) plans to reconstruct and widen the existing two-lane section to a four-lane divided section in 1995 and 1996. Design of the proposed improvement is scheduled to begin in 1993. Preliminary drawings obtained from WisDOT indicate that the proposed highway would have a rural cross section with two 35-foot-wide pavements separated by a 44-foot wide median. The Farm Drainage District Commissioners expressed concern over the impact of the highway improvement and of the anticipated urban development on runoff to and performance of the drain tile system.

Soils in the Study Area

The Regional Planning Commission, in cooperation with the U.S. Department of Agriculture, Soil Conservation Service, in 1966, completed a detailed, operational soil survey of the area concerned. Soils in the study area were classified in that survey as being in hydrologic groups C and D. Such soils have slow to very slow infiltration rates when thoroughly wetted.

Surface Water Drainage Pattern

The drainage pattern of the study area is poorly developed. There is no stream system which conveys runoff from the outer limits of the watershed to its outlet. Scattered topographic depressions located throughout the study area receive runoff from relatively large areas. That runoff collects and ponds in those depressions, necessitating the provision of subsurface tile drainage in order for the low-lying land to be farmed. The surface runoff outlet from the study area and the pumped outlet from the agricultural drain tile system both discharge to the Fox River.

As shown on Map 2, stormwater runoff from the extreme southwestern portion of the study area in the Village of Waterford is conveyed in the Village storm sewer system. Much of that area drains to two detention basins which were constructed in 1977 as part of the Foxmead subdivision. Agricultural drain tile lines B, B2, B2a, B2b, B2c, B4, and B5 also discharge to those detention basins. The detention basins are located in series and the downstream basin discharges to a portion of the Village storm sewer system, which then combines with agricultural drain tile line A and discharges to the main drain tile line.

Chapter III

EXISTING DRAINAGE FACILITY CONDITIONS AND IDENTIFICATION OF PROBLEMS

The existing agricultural and stormwater drainage system in the study area is shown on Map 2. Drainage problems have been reported in the study area, including increased periods of wet soil conditions, excessive operation of residential sump pumps, and increased operation and maintenance costs of the District lift station. The existing system and the identified problems are described in this chapter.

INTERCONNECTIONS BETWEEN THE AGRICULTURAL AND STORMWATER DRAINAGE SYSTEMS

As previously noted, the stormwater drainage system which serves urban development in the study area has over time been interconnected with the agricultural drain tile system, resulting in overloading of the drain tile system and of the lift station operated by the Farm Drainage District. The major interconnection occurred when the Foxmead subdivision was developed in 1977. The subdivision was constructed along the portion of drain tile, line B, which at the time originated near STH 36 and ran northwesterly to the abandoned electric interurban railway right-of-way now used as a bike path. Most of tile B was abandoned in 1977 and the subdivision drainage system now receives flow from drain tile lines B, B2, B2a, B2b, B2c, B4, and B5, as well as local urban stormwater runoff. The combined flow so received is detained in two detention basins constructed in the subdivision and gradually released through storm sewers which connect with drain tiles conveying flow from the remainder of the agricultural drainage system. The total flow is then conveyed in the main drain tile to the Farm Drainage District lift station where it is pumped into a short reach of open channel, which is then enclosed in a 318-foot-long, 72-inch wide by 44-inch high corrugated metal pipe (CMP) culvert which discharges to a short reach of open channel upstream of Milwaukee Avenue. That open channel is then enclosed in a 250-foot-long 72-inch wide by 44-inch high CMP culvert which discharges to the Fox River.

Another interconnection between the urban stormwater drainage system and the agricultural drainage system occurs in subbasin 12B in the Town of Waterford at the west end of South Gale Circle where a surface inlet admits runoff from a portion of a small development along South Gale Circle into drain tile line B2. The area tributary to that inlet is relatively small, and due to the relatively low density of residential development in the tributary area, it may be concluded that that runoff does not significantly add to the flow in the drain tile system. However, more such interconnections in that area should be avoided.

The lift station at the outlet of the drain tile system was installed around 1963, in an effort to improve drainage from the low-lying lands along tile line A. Drainage from that area was impeded by relatively high Fox River levels at the tile outlet and by ground subsidence resulting from settlement along the drain tile lines following the initiation of drainage in the 1920s. District records of hearings in Racine County Court indicate that at the time that construction of a lift station was being evaluated, consideration was also given to relaying sections of the drain tile to obtain greater cover and improve the conveyance of water to the lift station. That option was apparently rejected as being too costly.

According to Mr. William Maas of Maas & Sons, the existing pumps, which were installed about 15 years ago as replacements for previous pumps, include one pump with a capacity of about 550 gallons per minute (gpm), or 1.2 cubic feet per second (cfs); and one pump with a capacity of about 1,150 gpm, or 2.6 cfs, for a total maximum pumping capacity of about 1,700 gpm, or 3.8 cfs. Each pump has a separate discharge line. That lift station capacity determines the outflow rate from the agricultural drainage system and the interconnected stormwater drainage system. That limited capacity is one important factor contributing to ponding of surface runoff which collects in topographic depressions located along drain tile lines A and A4. Ponded water resulting from relatively frequent storm events has been observed to remain for several weeks at a time. Thus, although the 24-inch diameter reinforced concrete outlet pipe from the downstream detention basin in the Foxmead subdivision was designed to have a full-flow capacity of about 8.0 cfs, only a small portion of that capacity is utilized due to the limited capacity of the pumping station. The consequence is prolonged detention of runoff in the Foxmead detention basins with corresponding high pond levels and increased groundwater levels. This creates a potential for basement seepage problems at surrounding residences and excessive operation of basement sump pumps. Any further connection of stormwater drainage facilities to the existing drain tile system will further aggravate the existing agricultural and urban stormwater drainage problems and could quite possibly create drainage problems for any new urban development proposed to be served by the urban stormwater drainage facilities so connected.

When the Foxmead subdivision was developed in 1977, an agreement was executed between the Farm Drainage Board of Racine County, the Village of Waterford, and the developers of the subdivision, calling for the developers to install additional pumping capacity at the site of the Farm Drainage district lift station and for the developers to pay the District $20,000. The terms of the agreement were apparently never met by the subdivision developers and the matter was eventually settled in court with the developers paying the District $25,000. However, the pumping capacity was not upgraded.

There are about five houses in the Village of Waterford located along Edmund Street to the south of the main drain tile that have gravity foundation drains connected to the agricultural drain tile. At times when the District lift station is inoperable, those houses experience backups of water necessitating operation of their sump pumps until such time that the District lift station is again operational.

DETERIORATION AND MISALIGNMENT OF DRAIN TILES

Although the District has provided maintenance of drain tile lines over the approximately 70 years of existence of the drainage system, significant lengths of the tiles have now collapsed, partially blocking portions of the tile system and creating holes which are hazards to farm machinery. As shown on Map 2, significant sections of deteriorated drain tile were found at the following locations: 1) Line A north and south of STH 164 where intermittent broken 16-inch diameter tiles are visible over a total length of about 500 feet; 2) Line A west of STH 36 where intermittent broken 16- and 18-inch diameter tiles are visible over a total length of about 800 feet; 3) Line B2 southeast of the intersection of South Division Road and CTH K where intermittent broken 12-inch diameter tiles are visible over a total length of about 500 feet; and 4) Line B2 between South Division Road and South Gale Circle where intermittent broken 14- and 15-inch diameter tiles are visible over a total length of about 230 feet.

No investigations were made to determine the condition of tiles not visible from the surface.

One reason for the deterioration which has occurred in the condition of the tiles is the age of the tiles, since it is possible that some of the tiles may still be the original tiles which were installed about seventy years ago. Several of the sections of deteriorated pipe are located in areas of organic soils and it is likely that relatively rapid settlement and subsidence of those soils occurred in the period following commencement of drainage of the land. Also, accelerated wind erosion may have occurred from the organic soils which dried out when drained. Thus, the loss of soil cover over sections of the pipes may have lead to larger loadings from farm machinery being transferred to the pipes, contributing to the breaking of tiles.

Information in District files at the County Clerk of Courts office; survey information provided by Nielsen, Madsen & Barber; and information obtained during interviews with District Commissioners indicate that sections of the drain tile system are vertically misaligned. The available data indicate the possibility of adverse, or negative, slopes along the following pipe segments in the system: 1) about 1,000 feet of the main tile line, extending from the pumping station upstream to the bike path along the abandoned electric inter-urban railway right-of-way; 2) the 30-inch-diameter, 62-foot-long reinforced concrete storm sewer from the Foxmead subdivision located immediately upstream of the main tile; 3) the downstream end of the 18-inch diameter portion of Line A where it joins with the 30-inch storm sewer mentioned under Item 2; and possibly 4) the 1,815-foot-long section of the 16-inch diameter portion of Line A located south of STH 164. Such misalignment significantly impedes the proper functioning of the drain tiles, necessitating the buildup of a head of water above the elevation of the high point of the pipe before flow will occur.

The intended slopes indicated on the 1921 design profiles for those portions of the drain tile system which now appear to have adverse slopes range from 0.04 to 0.05 percent, or one foot in 2,500 feet to one foot in 2,000 feet. Such extremely flat slopes leave little margin for error in construction, and adverse slopes could readily develop in such lines due to relatively small amounts of differential settlement of pipe sections following construction.

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Chapter IV

DOCUMENTATION OF PLAN DESIGN CRITERIA

INTRODUCTION

This chapter sets forth engineering design criteria and describes analytical procedures used in the preparation and evaluation of the alternative stormwater runoff and agricultural drainage management plans considered under this study. These criteria and procedure include the engineering techniques used to design the alternative plan elements, to test the physical feasibility of those elements, and to make necessary economic comparisons between the plan elements. This chapter thus documents the degree of detail and the level of sophistication employed in the preparation of the recommended plan and thus is intended to provide a better understanding for all concerned of the plan and of the need for refinement of some aspects of the plan prior to, and during, implementation.

SIMULATION OF RUNOFF

Rainfall Intensity-Duration-Frequency Data

Under its comprehensive water resources planning program, the Regional Planning Commission has developed a set of rainfall intensity-duration-frequency relationships for use in the Region. The data were developed from the 84-year rainfall record from 1903 through 1986 collected by the National Weather Service at the first order weather station at Mitchell International Airport in Milwaukee. Total rainfall amounts of various frequencies were used in the estimation of rates and volumes of runoff from the Farm Drainage District study area. The rainfall curves and attendant mathematical equations are shown on Figures 1 through 3 and Table 1.

Procedures for Estimating Rates and Volumes of Runoff

Rates and volumes of runoff from the study area under both existing and planned land use and drainage conditions were simulated using procedures developed by the U.S. Soil Conservation Service (SCS) and documented in Section 4, "Hydrology," of the National Engineering Handbook. Two-, 10-, and 100-year recurrence interval storms of 24-hour duration were used in the analysis and designs.

Proposed system components were evaluated using a hydrologic model of the study area which was developed for the study based upon the U.S. Army Corps of Engineers HEC-1 Flood Hydrograph Package computer program.

SIZING OF PROPOSED SYSTEM COMPONENTS

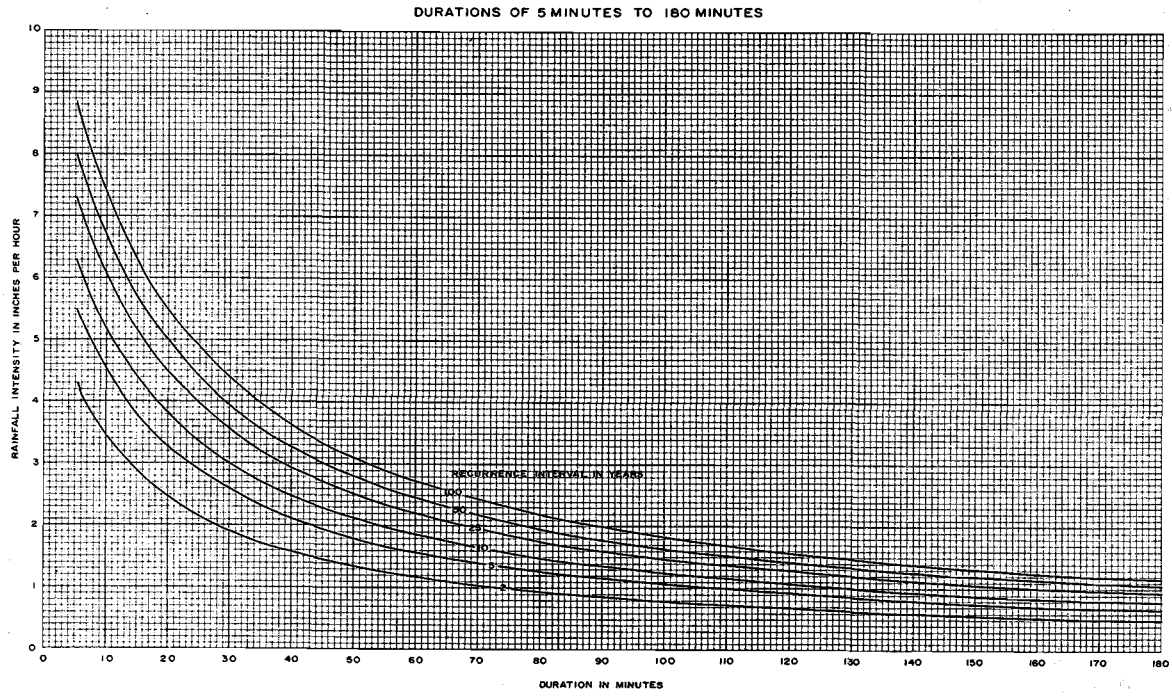
The procedures used in sizing agricultural drainage components called for under the alternative and recommended plans herein considered are consistent with the 1992 standards of the American Society of Agricultural Engineers as set forth in "Design and Construction of Subsurface Drains in Humid Areas," ASAE EP260.4, and in "Design of Agricultural Drainage Pumping Plants," ASAE EP369.1.

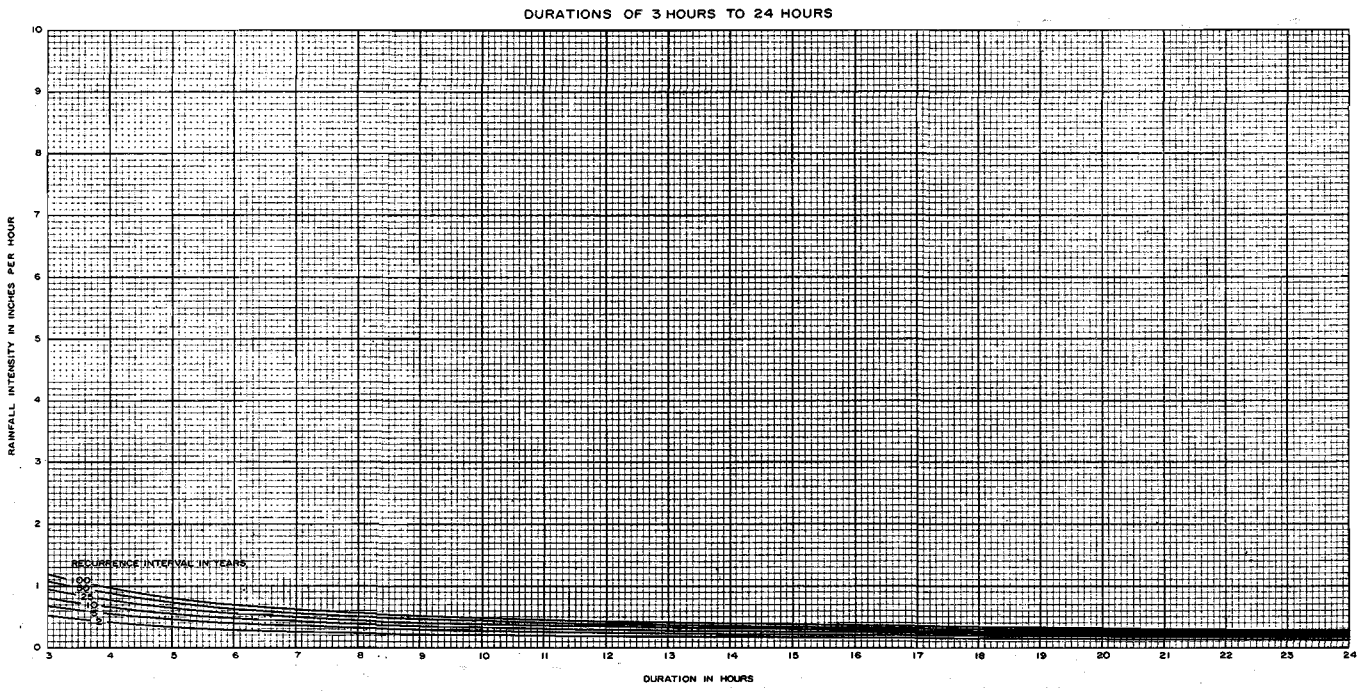
The hydraulic capacity of existing and recommended agricultural drain tiles and storm sewers was computed using Manning's equation and full flow conditions. A Manning's roughness coefficient, "n", of 0.013 was used as characteristic of

Figure 1

POINT RAINFALL INTENSITY-DURATION-FREQUENCY CURVES FOR MILWAUKEE, WISCONSIN AND THE SOUTHEASTERN WISCONSIN REGION[a]

POINT RAINFALL INTENSITY-DURATION-FREQUENCY RELATIONSHIPS FOR MILWAUKEE, WISCONSIN





[a]The curves are based on Milwaukee rainfall data for the 84-year period of 1903 to 1986. These curves are applicable within an accuracy of ± 10 percent to the entire Southeastern Wisconsin Planning Region.

Revised 3/88

Source: SEWRPC.

Table 1

POINT RAINFALL INTENSITY-DURATION-FREQUENCY EQUATIONS FOR THE SOUTHEASTERN WISCONSIN REGION[a]

Recurrence Interval (years)	Duration of Five Minutes or More But Less than 60 Minutes[b]	Duration of 60 Minutes or More Through 24 Hours[b]
2	$i = \frac{85.1}{14.8 + t}$	$i = 26.9\, t^{-0.771}$
5	$i = \frac{118.9}{16.7 + t}$	$i = 36.4\, t^{-0.771}$
10	$i = \frac{143.0}{17.8 + t}$	$i = 43.3\, t^{-0.773}$
25	$i = \frac{172.0}{18.7 + t}$	$i = 51.0\, t^{-0.772}$
50	$i = \frac{193.4}{19.2 + t}$	$i = 56.8\, t^{-0.771}$
100	$i = \frac{214.4}{19.4 + t}$	$i = 63.0\, t^{-0.773}$

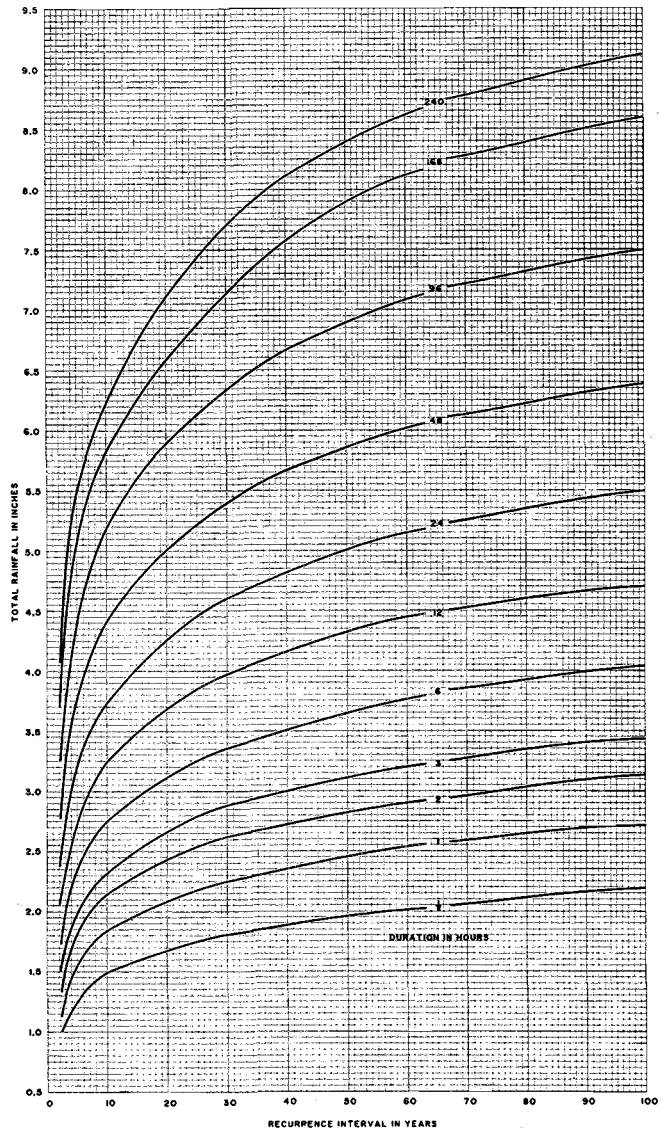
[a]The equations are based on Milwaukee rainfall data for the 84-year period 1903 to 1986. These equations are applicable, within an accuracy of ± 10 percent, to the entire Southeastern Wisconsin Planning Region.

[b]i = Rainfall intensity in inches per hour
t = Duration in minutes

Source: SEWRPC.

Figure 2

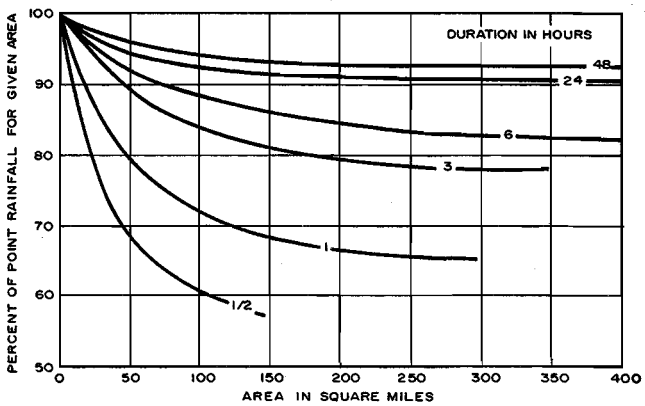
POINT RAINFALL DEPTH-DURATION-FREQUENCY RELATIONSHIPS IN THE SOUTHEASTERN WISCONSIN REGION



Source: SEWRPC.

Figure 3

RAINFALL DEPTH-DURATION-AREA RELATIONSHIPS IN THE REGION



Source: National Weather Service and SEWRPC.

existing clay and smooth-wall plastic drain tiles and for existing and recommended reinforced concrete storm sewers and culverts. A Manning's "n" of 0.020 was used as characteristic of corrugated plastic drain tile.

Water surface profiles in significant open channel components were determined using the U.S. Army Corps of Engineers HEC-2 Water Surface Profiles Computer Program. The backwater computations utilized Manning's equation with a roughness coefficient of 0.030 as characteristic of a turf-lined open channel.

In the design of alternative plans under this study, proposed drain tiles and pumping stations were sized to remove within about 48 hours the runoff from a two-year recurrence interval storm occurring over a 24-hour period. A two-year recurrence interval storm is the rainfall amount which has a 50 percent probability of occurring in any given year. With the drain tile system improved as called for by this recommended removal rate criterion, it may be expected that water will be ponded in depressions in the fields for about two days following the cessation of a two-year recurrence interval design storm. That removal time is based on the assumption that no additional rainfall occurs in the 48-hour period following the design storm. The occurrence of additional rainfall in that period would extend the duration of ponding. Ponding would occur for shorter times following smaller, more-frequent storms.

Ideally, the minimum slope for drain tile systems should be 0.0040 foot per foot, or 0.40 percent. That slope can be achieved using standard construction procedures and insures the attainment of flow velocities which are high enough to remove any sediment which may be deposited in the pipes. Because of the very flat terrain in portions of the study area where drain tiles are required, it was necessary to use a minimum slope less than the ideal minimum. Experience indicates that achievable tolerances in the construction of agricultural drain tile systems permit use of a minimum drain tile slope of about one inch per 100 feet, or 0.0010 foot per foot, or 0.10 percent. As noted above, the design profiles for the original drain tile system called for slopes as flat as 0.04 percent. The use of a minimum slope steeper than the original design slopes results in tiles laid at a greater depth and, thus, a tile system which requires a greater pumping lift at the system outfall.

To insure adequate lowering of groundwater levels and to avoid damage to drain tiles from heavy machinery loads, a minimum depth of cover of three feet over the top of proposed drain tiles should be maintained. In the design of alternative plans under this study, that cover requirement was relaxed in cases where segments of drain tile were proposed to be relaid, but downstream tiles which were to be retained and matched with the relaid tile were at such depths that three feet of cover could not be attained on the new tile.

In those portions of the study area which are proposed to be developed for urban use by the year 2010, design storm criteria appropriate for the design of urban stormwater drainage systems were applied. There are two distinct drainage systems to be considered in the management of urban runoff: the minor system and the major system. The minor system is intended to minimize the inconveniences attendant to inundation from relatively frequent storms, generally up to and including a 10-year recurrence interval storm event. The minor drainage system consists of drainage swales in sideyards and backyards, street curbs and gutters, roadside swales, storm sewers and appurtenances, some storage facilities, and pumping or lift stations.

The major stormwater drainage system is designed for the conveyance and storage of stormwater runoff during large storm events when the capacity of the minor system is exceeded. The major system consists of the entire street cross section and interconnected drainage swales, watercourses, and stormwater storage facilities. This system is designed to adequately accommodate the runoff from a 100-year recurrence interval storm event.

This plan includes recommendations for minor and major system facilities in areas of planned new development when the provision of such facilities is essential to the proper functioning of the interrelated stormwater and agricultural drainage systems.

ECONOMIC EVALUATION

The economic evaluations conducted under this planning program include capital cost estimates and annual operation and maintenance cost estimates. Those two cost components were used to compute an average annual cost, assuming an interest rate of 6 percent and a project life of 50 years. The computation of an average annual cost enables the comparison of alternative plans on a consistent cost basis. It is assumed that the least costly alternative system that meets the plan objectives will be the most desirable alternative economically. All costs are based on a 1993 Engineering News-Record Construction Cost Index of 5,390. If, at a future time, it is desired to adjust the cost estimates to account for changes in cost over time, the updated costs can be determined using the Construction Cost Index applicable at the time of the adjustment.

Capital costs include construction contract costs plus engineering; inspection; contract administration costs; and, where applicable, easements or land acquisition. Base unit cost data for agricultural drain tile, pumps, and pump station discharge lines were obtained from manufacturers and then adjusted to reflect the costs of construction. Those adjustments included the costs of labor, equipment, ancillary parts and structures, freight, contractor overhead and profit, engineering, administration, and contingencies. Pump station operation and maintenance costs were estimated accounting for the costs of power, inspection, and supplies.

Construction and annual operation and maintenance costs of storm sewers, culverts, and open channels were obtained from a cost data base developed under the Commission stormwater management planning program. The capital and annual operation and maintenance costs of detention storage facilities were obtained from SEWRPC Technical Report No. 31, Costs of Urban Nonpoint Source Water Pollution Control Measures, June 1991.

Actual costs will vary from the estimates presented herein, reflecting site-specific conditions, local availability and supply of materials, and labor costs.

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Chapter V

WETLAND CONSIDERATIONS

INTRODUCTION

The governing body of Racine County Farm Drainage District No. 1 expressed concern regarding the potential for certain formerly drained lands within the District which were and are still intended for agricultural use to revert to legally defined wetlands in locations where there is inadequate drainage of low-lying areas. The determination of permissible, or potentially permissible, activities in a wetland may involve shoreland and nonshoreland wetland regulations as administered by Racine County, the former under the oversight of the Wisconsin Department of Natural Resources; wetland water quality standards set forth by the Wisconsin Department of Natural Resources in Chapter NR 103 of the Wisconsin Administrative Code; and regulations administered by the U.S. Army Corps of Engineers under Section 404 of the Federal Clean Water Act regarding the discharge of dredged or fill materials to wetlands. U.S. Department of Agriculture (USDA) policies and programs regarding benefits to farmers may also be of concern.

DEFINITIONS AND MAPPING OF WETLANDS

In the Southeastern Wisconsin Region, the primary sources of wetland mapping are the Wisconsin Wetland Inventory maps compiled on the Commission's 1980 aerial photography at a scale of one inch equals 2000 feet and the Commission's 1990 inventory maps which are compiled at a scale of one inch equals 400 feet. Those maps are updated at five-year intervals based on interpretation of aerial photographs and on field inspections. In addition, wetland boundaries are updated when site-specific field delineations are made by Commission staff. Wetlands within the study area as shown on the Commission maps are set forth on Map 3 in this report.

The Wisconsin Wetland Inventory maps are the reference maps used by the Wisconsin Department of Natural Resources for regulatory purposes. On these maps, the boundaries of wetlands down to two acres in area are delineated, while smaller wetlands--between one and two acres--are denoted by symbols only. Wetlands within the study area as shown on the maps are set forth on Map 4 in this report. Although the 1980 Commission inventory maps were originally compiled from the Wisconsin Wetland Inventory maps, a comparison of Maps 3 and 4 shows that the two maps differ due to updates to the Commission maps since 1980.

The U.S. Soil Conservation Service (SCS) has also prepared wetland maps on one inch equals 660 foot scale and on one inch equals 1,000 foot scale aerial photographs. The SCS wetland maps for the study area were prepared in 1987. Those maps are used by the SCS in administering programs mandated under the Food, Agriculture, Conservation and Trade Act of 1990, commonly referred to as the 1990 Farm Bill. The SCS wetland maps and the Wisconsin Wetland Inventory maps are used as a reference tool by the U.S. Army Corps of Engineers in administering the Corps' regulatory program for wetlands. The Corps relies on actual site conditions to determine whether an area is wetland. Wetlands within the study area as shown on the SCS maps are set forth on Map 5 in this report.

Map 3

WETLANDS DELINEATED ON THE 1990 SEWRPC LAND USE INVENTORY MAPS

LEGEND

STUDY AREA BOUNDARY

VILLAGE OF WATERFORD CORPORATE LIMITS

STUDY AREA OUTLET

WETLAND BOUNDARY

GRAPHIC SCALE

0 1/8 1/4 MILE

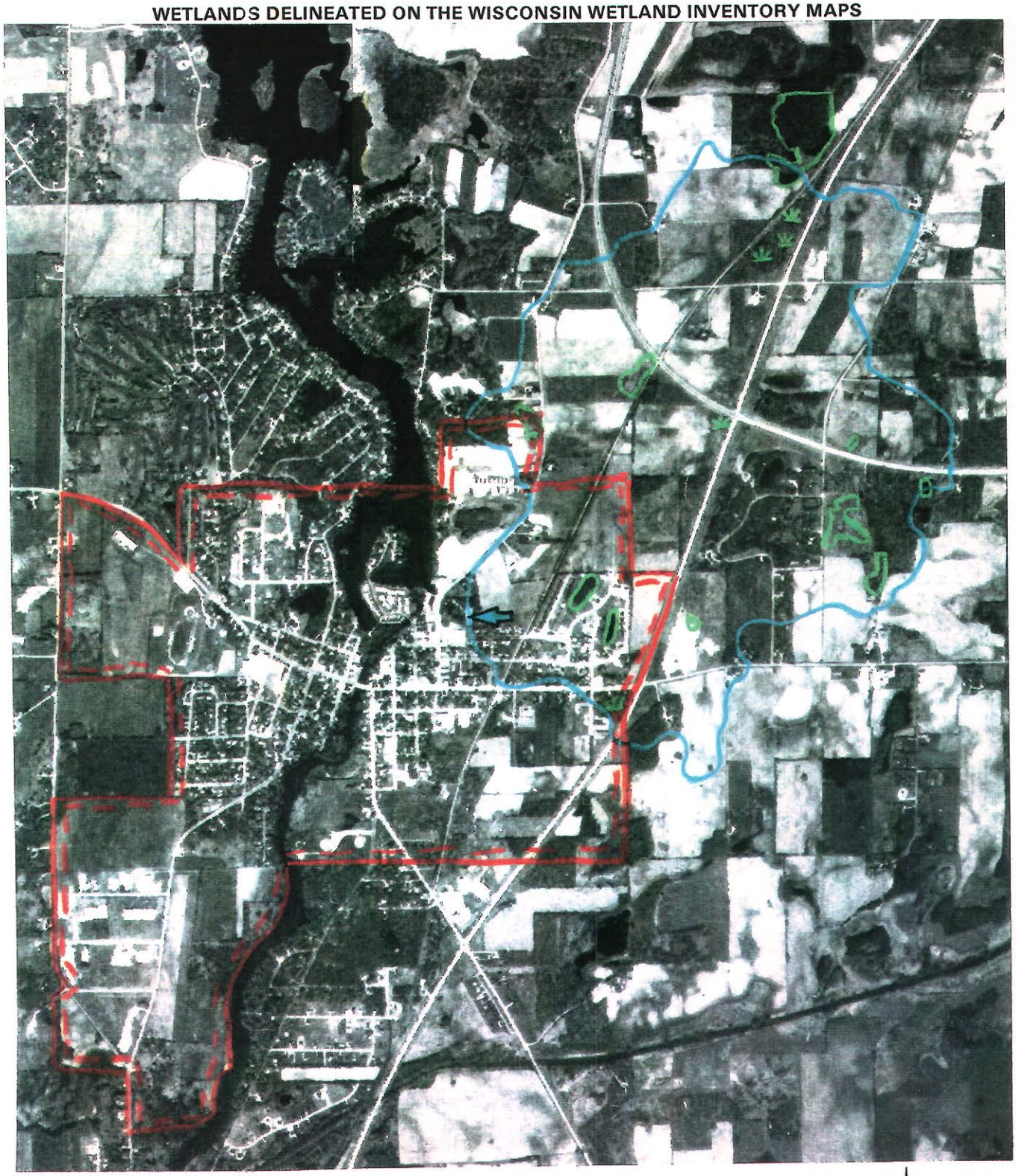
0 1000 2000 FEET

DATE OF PHOTOGRAPHY: APRIL 1990

Source: SEWRPC.

Map 4

WETLANDS DELINEATED ON THE WISCONSIN WETLAND INVENTORY MAPS



LEGEND

- STUDY AREA BOUNDARY
- VILLAGE OF WATERFORD CORPORATE LIMITS
- STUDY AREA OUTLET
- WETLAND BOUNDARY
- WETLANDS SMALLER THAN TWO ACRES

GRAPHIC SCALE

0 1/8 1/4 MILE

0 1000 2000 FEET

DATE OF PHOTOGRAPHY: APRIL 1990

Source: SEWRPC.

As may be seen from a comparison of Maps 3 and 5, the SCS and Commission wetland maps are not always in agreement. In general, the SCS maps show more wetland areas than do the Commission maps. The primary reason for the differences in the delineation of wetland boundaries is the application of different definitions of what constitutes a wetland. The definition of a wetland used by the Commission is that used by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency (EPA). According to that definition, wetlands are "areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." The definition of a wetland used by the SCS is "land that has wet, saturated soil during some part of the growing season, and would support plants that grow in wet soils (cattails, willow trees, sedges, smartweeds, and similar plants) if the area was not disturbed by tillage, mowing or similar actions." The Corps and EPA definition used by the Commission is less inclusive than the SCS definition in that the Corps and EPA definition requires that the site actually support wetland vegetation under normal conditions, while the SCS definition only requires that conditions be such that the site be capable of supporting such plants, regardless of whether such plants are actually present on the site.

A third definition, which is applied by the State of Wisconsin and which is set forth in Chapter 23 of the State Statutes, defines a wetland as "an area where water is at, near or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation, and which has soils indicative of wet conditions." In practice both agencies consider very poorly drained and poorly drained soils as hydric soils meeting their "wet condition" criterion. The State definition as actually applied is, however, more inclusive than the SCS definition in that the Department includes somewhat poorly drained soils in the hydric category.

The foregoing notwithstanding, the Commission maps are considered to be the best source for wetland delineations within the Region and they are regularly used as the basis of the inventory.

As seen from Map 6, there are several Commission-identified wetlands of significant size located along the drain tile system on lands that were once farmed. The large wetland along drain tile line A west of STH 36 has reverted to wetland--by Commission definition--since the 1985 Commission inventory. Some areas on the margins of other identified wetlands have also reverted to wetland since 1985. The areas classified as wetlands include areas adjacent to the sections of drain tile which have collapsed. Thus, the ultimate effect of the subsidence of the ground along portions of the drain tile coupled with the reduced efficiency of the agricultural drainage system over time was to create conditions which resulted in the reversion of the land to wetland under the Commission definition.

In order to determine the options available to the District as far as restoring drainage to those lands, or replacing drain tiles crossing those lands in order to improve drainage of upstream lands, further consideration of the various wetland regulatory programs concerned is necessary.

Map 5

WETLANDS DELINEATED BY THE U. S. SOIL CONSERVATION SERVICE: 1987

LEGEND

- STUDY AREA BOUNDARY
- VILLAGE OF WATERFORD CORPORATE LIMITS
- STUDY AREA OUTLET
- WETLAND BOUNDARY
- FARMED WETLANDS

GRAPHIC SCALE

0 1/8 1/4 MILE

0 1000 2000 FEET

DATE OF PHOTOGRAPHY: APRIL 1990

Source: SEWRPC.

JURISDICTION OF THE U.S. ARMY CORPS OF ENGINEERS

Waters of the United States, including wetlands, are regulated under the Clean Water Act (P.L. 92-500). Section 404 of the Clean Water Act authorizes the Secretary of the Army, acting through the Chief of Engineers, to issue permits for the discharge of dredged or fill materials into waters of the United States, including wetlands. The Corps evaluates permit applications for the discharge of dredged fill materials into a water of the U.S. in accordance with guidelines published in 1980 by the U.S. Environmental Protection Agency. These guidelines are known as the 404(b)(1) guidelines.

The Corps may authorize a project with an individual permit, or it may confirm that the project is authorized by an existing general permit. General permits include nationwide general permits as well as some that have been issued just for Wisconsin. For example, discharges of dredged or fill material impacting more than two acres of a wetland would require an individual permit. Similar projects impacting between one and two acres of wetlands would require pre-discharge notification to the Corps and could be authorized by a Department of the Army nationwide general permit if the wetland is isolated or is located above the headwaters of the adjacent tributary system. Projects resulting in wetland impacts of less than one acre would be eligible for authorization under Department of the Army nationwide general permit No. 26. If the project site were below the headwaters, the project would require an individual permit no matter how small the impact, unless the project itself were specifically authorized by a general permit for bank stabilization, boat ramps, or placement of concrete in a tightly sealed form.

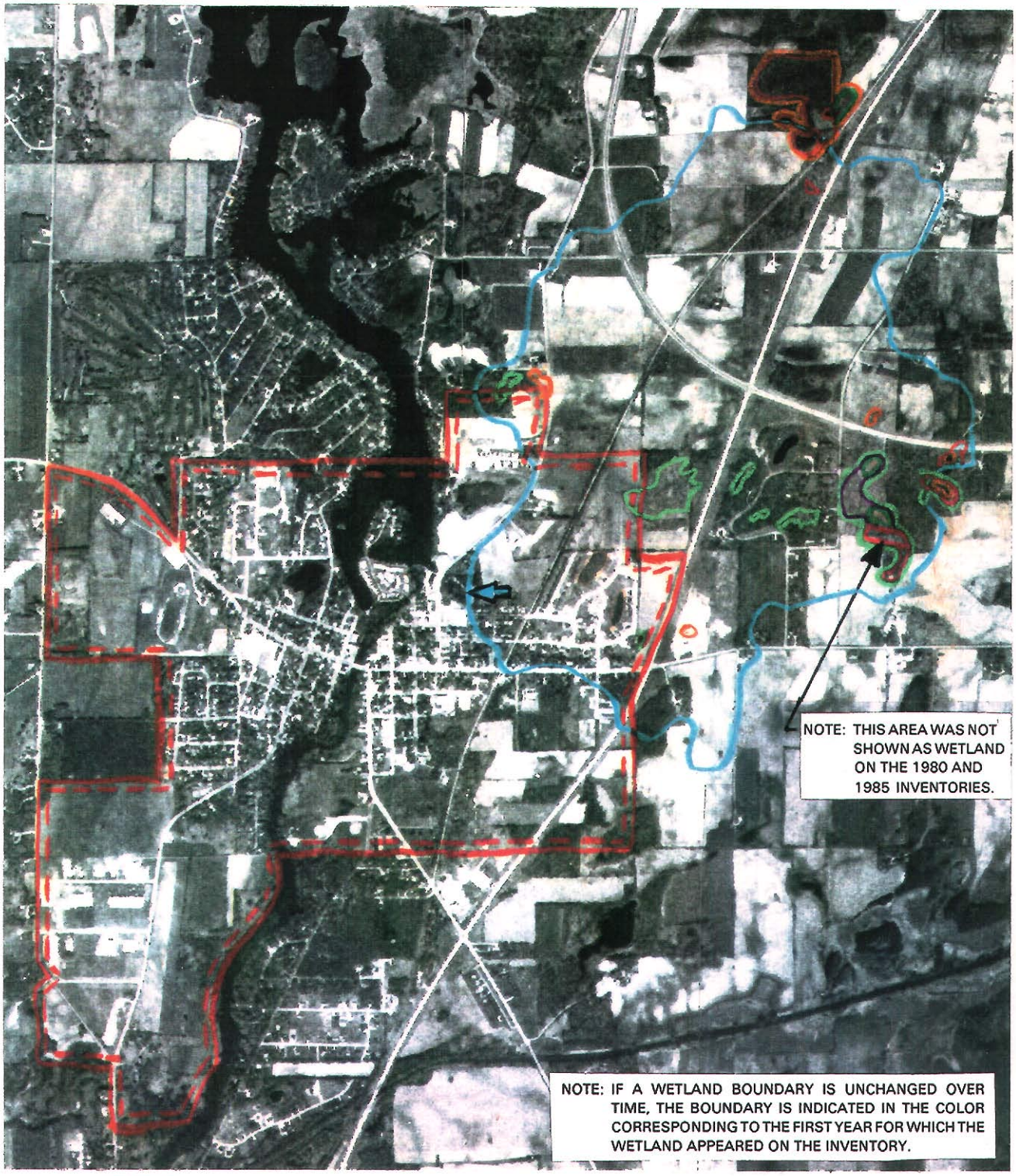
The specific criterion used to determine if an area is within the headwaters is whether the project site is located above, or along, a stream reach that maintains an average annual streamflow of five cubic feet per second (cfs). In Racine County, the Corps defines the headwaters as drainage basins having a total watershed area of eight square miles or less. It is unlikely that the 1.33-square-mile study area has an average annual streamflow greater than 5 cfs, thus, it would be classified as a headwaters area.

Wisconsin Department of Natural Resources (DNR) review and water quality certification and a Coastal Zone Management Consistency determination would be required for any project requiring a Department of the Army permit under Section 404 of the Clean Water Act. The DNR must grant a water quality certification and Coastal Zone Management consistency determination for the Department of the Army nationwide permit No. 26 to be valid. The DNR could deny water quality certification if a project is in conflict with State regulations and water quality standards. A discussion of applicable State regulations and standards is presented in the following section of this report.

Any drain tile construction through wetlands in the study area would likely involve a discharge of dredged or fill material during excavation and subsequent backfilling. Such discharges of dredged or fill material require a Department of the Army permit. In considering a permit application to discharge dredged or fill materials into a wetland, the Corps may also consider other impacts of the proposed project, such as whether the project would result in draining of wetlands. That impact could be considered for any proposal to restore drainage to a previously farmed area which has now reverted to a wetland.

Map 6

WETLAND BOUNDARIES SHOWN ON THE SEWRPC LAND USE INVENTORY MAPS: 1970-1990



Source: SEWRPC.

The construction, or replacement of storm sewers or agricultural drain tiles which traverse wetlands would require evaluation by the Corps to determine if a Department of the Army permit would be required. The Corps may, as part of the permit issuance, impose special permit conditions requiring special construction techniques, such as requiring that a pipeline be sealed to avoid wetland drainage; covering the trench with six inches of native soil; and restoring the original grade and vegetation. The Wisconsin Department of Natural Resources would normally be notified by the Corps of any such permit applications and would be requested to provide water quality certification of the proposed activity.

Based upon Commission staff interpretation of Corps regulations and policies, it appears that the installation of drain tiles through wetlands in the study area would require a Corps permit and that permit, if granted, may require that the project meet special conditions, including a condition not to drain the wetlands concerned. Such tile lines could, under such a conditional permit, be used only for improving drainage from upstream areas, not for restoring drainage to the areas which have reverted back to wetlands. The need for a Corps permit to install agricultural drain tile can depend upon a determination, made by the U.S. Soil Conservation Service (SCS), whether an area meets the definition of "prior converted cropland." If lands are "prior converted cropland," a Department of the Army permit would not be required for tile installation. However, if a "prior converted" area is not cropped for five consecutive years and exhibits wetland characteristics, the area would again be considered wetlands and a Corps 404 permit would be required. If an area is designated as "farmed wetland" SCS, a Department of the Army permit would be required for drain tile installation regardless of cropping intervals. A description of the SCS programs is set forth in a subsequent section of this chapter.

REGULATIONS AND STANDARDS OF THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES

State regulations regarding wetlands include Chapter NR 115 of the Wisconsin Administrative Code, "Wisconsin's Shoreland Management Program" and Chapter NR 117, "Wisconsin's City and Village Shoreland-Wetland Protection Program." Chapter NR 103 sets forth "Water Quality Standards for Wetlands."

All counties, cities, and villages are required by State statute to have shoreland-wetland zoning ordinances which meet the minimum requirements set forth in either Chapter NR 115 (counties) or NR 117 (cities and villages). The Wisconsin Department of Natural Resources has authority to monitor the administration and enforcement of shoreland-wetland zoning ordinances, and the Department must review--and can effectively veto--local decisions granting special exceptions, variances, appeals, and rezonings.

Shorelands are defined by State law as lands within 300 feet of the ordinary high-water mark of a navigable stream; 1,000 feet of the ordinary high-water mark of a lake, pond, or flowage; or lands within the 100-year recurrence interval floodplain, whichever distance is greater. Definitive determination of navigability on a case-by-case basis is the responsibility of the Department. In Racine County, those portions of a wetland five acres or more in size which are located within the shoreland jurisdictional boundary and are shown on the Wisconsin Wetland Inventory maps are classified as shoreland-wetlands and are, thus, regulated under County shoreland-wetland zoning.

There are at present no shoreland-wetlands as legally defined in the study area. Some lands shown on the Commission land use inventory maps which are in the shoreland jurisdictional boundary have reverted to wetlands from cropland since the Wisconsin Wetland Inventory maps were prepared. However, such areas are not considered to be shoreland-wetlands until such time as the Wisconsin Wetland Inventory maps are accordingly revised or amended.

Activities involving agricultural drainage could also be subject to the requirements of Chapter NR 103. Practically speaking, the only way that the requirements of NR 103 would be applied would be if the Department were notified of the activity through a permit request, or if Department funds were involved in a project which proposed certain activities in wetlands. In the case of any proposed drain tile maintenance within the District, notification to the Department would most likely occur through the U.S. Army, Corps of Engineers in the course of Corps review of a permit application from the District to temporarily discharge fill to a wetland.

Chapter NR 103, which became effective on August 1, 1991, establishes water quality standards for wetlands. The rules set forth in Chapter NR 103 consist of two parts: 1) a set of standards intended to protect water-quality related functions of wetlands including sediment and pollution control, stormwater and floodwater storage, hydrologic cycle maintenance, shoreline erosion protection, habitat protection for aquatic organisms and other wildlife species, and recreational uses; and 2) implementation procedures for application of the water quality standards. The Wisconsin Department of Natural Resources is responsible for the review of proposed projects for compliance with Chapter NR 103.

A project would not be in compliance with the provisions of Chapter NR 103 if it is not wetland dependent--meaning that it does not necessarily require location in or adjacent to wetlands to fulfill its basic purpose, and if a practicable alternative to the project exists. Under a practicable alternatives analysis, the proposed project would be compared to the practicable alternatives considering relative monetary costs, logistical limitations, technological limitations, and other pertinent positive or negative aspects of the alternatives. If there is an alternative to the project which is practicable, will not adversely impact wetlands, and will not have other significant adverse environmental consequences; then that alternative would be selected.

If, following the practicable alternatives analysis, no suitable alternative is identified, an assessment of the impacts of the project on the functional values of the wetland must be made. That assessment must provide information on the potential impacts on the wetlands. Those impacts would then be considered by the Department in making a determination that the requirements of Chapter NR 103 are satisfied.

Chapter NR 103 applies to both shoreland and nonshoreland wetlands where a State permit and/or State water quality certification is required. As already noted, application to the Corps for a Section 404 permit will initiate Department review of a proposal to replace drain tile through a wetland. Based on past Commission experience with Department interpretation, it is highly unlikely that a proposal to drain a wetland through replacement of a drain tile traversing that wetland would be approved under Chapter NR 103. It is possible, however, that construction of a sealed pipe to enable improvement of upstream drainage may be permitted.

In a situation where an existing drain tile traverses a wetland and connects with a downstream network of drain tile which ultimately discharge to a pumping or lift station, proposed modifications to the lift station--such as increased pumping capacity--would not require review by the Corps under Section 404 of the Clean Water Act or by the Department under Chapter NR 103 since no permit would be necessary and no direct discharge of fill materials to the wetland would be involved. An increase in the pumping capacity of the lift station could result in alteration of the hydrologic regime of the upstream wetland traversed by the drain tile lines and it might be possible to resume farming of the wetland. Such a condition could occur along drain tile line B2a east of South Division Road in Subbasin 12A.

U.S. SOIL CONSERVATION SERVICE

Involvement in wetland matters by the Soil Conservation Service (SCS) is primarily related to the administration of programs distributing U.S. Department of Agriculture (USDA) benefits as mandated under the Federal Food, Agriculture, Conservation and Trade Act of 1990, commonly referred to as the 1990 Farm Bill.

Land Classifications

The SCS has established four land classification categories which relate to the status of agricultural lands as wetland or cropland. These classifications are defined as follows:

1. Prior Converted Cropland--land that may contain wetlands that were cleared, drained, filled, or otherwise manipulated to make them cropable prior to December 23, 1985. These lands are flooded for no more than 14 consecutive days during the growing season. If prior converted cropland is not cropped, managed, or maintained for agricultural production for five consecutive years, and the land reverts to wetland, the land would be regulated by the Corps under Section 404. Reversion to wetland requires that the land exhibit the three mandatory wetlands criteria set forth under the Corps and EPA wetland definition--hydric soils, wetland vegetation, and hydrologic characteristics associated with wetlands. Such reversions from prior converted cropland to wetland have occurred within the study area, as noted above.

2. Farmed Wetland--land that was cleared, or drained, or filled, and cropped prior to December 23, 1985, and, in many years, still floods or ponds in the spring or fall. These lands are flooded for 15 or more consecutive days during the growing season, or for 10 percent of the length of the growing season, whichever time is shorter. These wetlands are regulated under Section 404, but normal farming of these lands is allowed.

3. Wetland--land that has wet, saturated soils and would support wetland vegetation if not tilled or mowed.

4. Not Inventoried--land that may contain wetlands, but has not been designated, either because the existing vegetation makes wetland designation difficult, or because the area has low potential for use as cropland.

The SCS obtains aerial photographs annually and those photographs are used to identify saturated soils and to document land use practices, including deter-

minations of the number of consecutive years for which land has not been cropped.

Conversions of wetlands which occur after December 23, 1985, can affect the eligibility of landowners to receive U.S. Department of Agriculture subsidies. If a drainage district converts wetland to cropland, the landowner of the converted wetland who is assessed by the drainage district and who uses the conversion to increase agricultural production could lose his rights to such Federal subsidies. If a drainage district implements measures which convert wetland areas after November 28, 1990, and the conversion is outside the control of the landowner of the property containing the wetland, Federal subsidies would not be lost if no agricultural commodities are planted or if no hay or forage crops are harvested.

If a wetland conversion began prior to December 23, 1985, and attempts to improve drainage have occurred since 1985, the project may be classified as a commenced conversion and the landowner or farmer may be able to produce an agricultural commodity on the land without losing Federal subsidies. When a drainage district is involved in a conversion, it is necessary that, 1) a detailed drainage plan was officially adopted; 2) that the installation of drainage measures began before December 23, 1985, or that contracts were executed before December 23, 1985, for the purchase of materials for the conversion of the wetlands; and 3) that the landowner or farmer was assessed for the project, or legally obligated to pay such an assessment before December 23, 1985. Soil Conservation Service staff have indicated that drain tile replacement would qualify as an attempt to improve drainage, but pump maintenance would probably not. Thus, in the case of Racine County Farm Drainage District No.1, it may be possible that drainage activities in the wetlands within the District could be considered commenced conversions in those cases where tile maintenance has occurred since December 23, 1985. It is assumed that the long-term operation of the District and its drainage system, according to all legal requirements, would meet the condition for official adoption of a drainage plan.

Decisions by an SCS field office regarding the wetland status of a particular parcel of land may be appealed by the landowner. The initial appeal would be made to the field office, the staff of which would make a field determination in response to the appeal. Further appeals would be made to the SCS Area, State, and Washington, D.C. offices.

SCS Land Conservation Programs Related to Wetlands

The Wetlands Reserve Program was authorized by the Federal Farm Bill of 1990. Restorable farmed wetlands and prior converted cropland qualify for enrollment under that program. Lands classified by the SCS as wetlands are not eligible for enrollment. To enroll land in the program, the landowner must declare his intention to enroll; obtain a wetland reserve plan of operation; and submit a bid to the U.S. Agricultural Stabilization and Conservation Service (ASCS) for either a 30-year easement or a permanent easement to restore and maintain the wetlands. The easement is attached to the property deed as a restriction on future landowners. In order to restore wetland conditions, it would be necessary for the existing drainage system to be abandoned.

The landowner continues to pay taxes on the land over the term of the easement; however, because the land value decreases due to the elimination of possible alternative uses, the taxes paid on the land would typically decrease in comparison to the taxes if the land were in other uses. No crop production on the

land is permitted over the term of the easement; however, haying, grazing, and timber harvesting may be allowed depending on the requirements of the wetland reserve plan of operation agreed to by the owner and the ASCS. Access to the restored wetland is controlled by the landowner. According to the Racine County SCS office, no lands in the District have been enrolled in the Wetland Reserve Program in the past and no lands will be enrolled in the program in 1993, but it is possible that the program will be implemented in future years.

Enrollment in the Wetlands Reserve Program would only be available to land owners who wish to remove farmed wetlands or prior converted cropland from agricultural production for an extended period of time. Thus, the program would not provide owners of lands within the Farm Drainage District which are presently classified as wetland an opportunity to receive any benefits for not growing crops on those lands.

The Water Bank Program is a ten-year-long wetland conservation program also administered by the ASCS which provides annual payments to farmers with a possibility of contract renewal for an additional ten years. At least ten acres of wetland and upland, including a minimum of two acres of cat-tail, bulrush, lake sedge, bur reed, or open water marsh, along with at least five acres of upland cropland is required for enrollment. The cropland must be planted in alfalfa and/or grasses which will provide sufficient nesting cover for wildlife. Applications for enrollment are considered based on a prioritization established by various Federal agencies and the Wisconsin Department of Natural Resources.

It may be possible for wetlands in the Farm Drainage District to be enrolled in the Water Bank Program. Such enrollment would require the removal of some cropland from production as set forth above and it would also require that the wetland be cat-tail, bulrush, lake sedge, bur reed, or open water marsh. Such conditions do not currently exist, but could possibly be established in either the wetland located west of STH 36 or the wetland located east of South Division Road. Establishment of those conditions may involve activities within the wetlands which would require permits under Section 404 of the Federal Clean Water Act and also from the State of Wisconsin; however, because the purpose of the activities is habitat improvement, it may be expected that permit applications would be approved.

CONCLUSIONS

There is land within Racine County Farm Drainage District No. 1 which was formerly drained and cropped and has now reverted to wetland due, at least in part, to the agricultural drainage system problems described in Chapter IV, including overloading of interconnected urban stormwater sources and the deterioration of the drain tile system over time due to lack of proper maintenance. Review of the State and Federal regulations regarding activities related to wetlands leads to the conclusion that restoring drainage to those lands which have reverted to wetlands may be subject to approval by the Wisconsin Department of Natural Resources and/or the U.S. Army Corps of Engineers. In some cases, this approval requirement will depend upon the length of time the lands have not been cultivated and when the lands reverted to wetlands. In such cases, it is possible that replacement of existing damaged or inadequate drain tiles which traverse wetlands may be permitted if the replacement pipes are sealed and construction measures are taken to prevent draining of the wetland. Such an installation would enable the provision of adequate drainage to upstream lands. There is no Federal or State jurisdiction in cases where an existing drain tile

traverses a wetland and the efficiency of that tile is improved through improvement of a downstream pumping or lift station and no modifications are proposed to the drain tile traversing the wetland. Such an increase in pumping capacity could result in alteration of the hydrologic regime of the upstream wetland traversed by the drain tile and it may be possible to resume farming of the wetland.

Another consideration is the relationship of wetlands to agricultural production and to eligibility for subsidy programs administered by the U.S. Department of Agriculture under the Federal Food, Agriculture, Conservation and Trade Act of 1990, commonly referred to as the 1990 Farm Bill. In general, conversion of wetlands to cropland after December 23, 1985, would result in the farmer losing Federal subsidies. However, if a wetland conversion began prior to December 23, 1985, and attempts to improve drainage have occurred since 1985, the project may be classified as a commenced conversion and the landowner or farmer may be able to produce an agricultural commodity on the land without loss of subsidies.

The U.S. Department of Agriculture administers two programs for the preservation of wetlands: the Wetlands Reserve Program and the Water Bank Program. The Wetlands Reserve Program would not provide owners of lands within the Farm Drainage District which are presently classified as wetland an opportunity to receive any benefits for not growing crops on those lands. It might be possible for wetlands in the Farm Drainage District to be enrolled in the Water Bank Program. Such enrollment would require the removal of some cropland from production.

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Chapter VI

ALTERNATIVE AGRICULTURAL AND STORMWATER DRAINAGE PLANS

Ten alternative agricultural and stormwater drainage plans were considered under this study. Each alternative is briefly described in this chapter. The estimated costs of the individual alternative drainage systems are set forth in Tables 2 through 11. The cost tables show an estimate of the costs which would be borne by Racine County Farm Drainage District No. 1, the Village of Waterford, the Wisconsin Department of Transportation, and the private sector, as well as the total costs.

As noted in Chapter I of this report, the agricultural and stormwater drainage systems of the study area are interrelated and interconnected. Due to that interconnection, neither system can be considered in isolation from the other. Thus, the alternatives address the problem of providing a combined system which adequately meets both the existing and probable future agricultural and stormwater drainage needs of the area in a coordinated and systematic manner.

The agricultural drainage alternative measures proposed for the Farm Drainage District drain tile system are shown on Maps 7 and 8 located in the pocket at the back of this report. The provision of the proposed measures for the District drain tiles and pumping station would also improve drainage conditions on lands with local lateral field drains due to the improvement of the outlets for those laterals. The alternatives also consider the major urban stormwater drainage measures which would serve existing and planned urban development in those areas of the Village of Waterford which are within the Farm Drainage District.

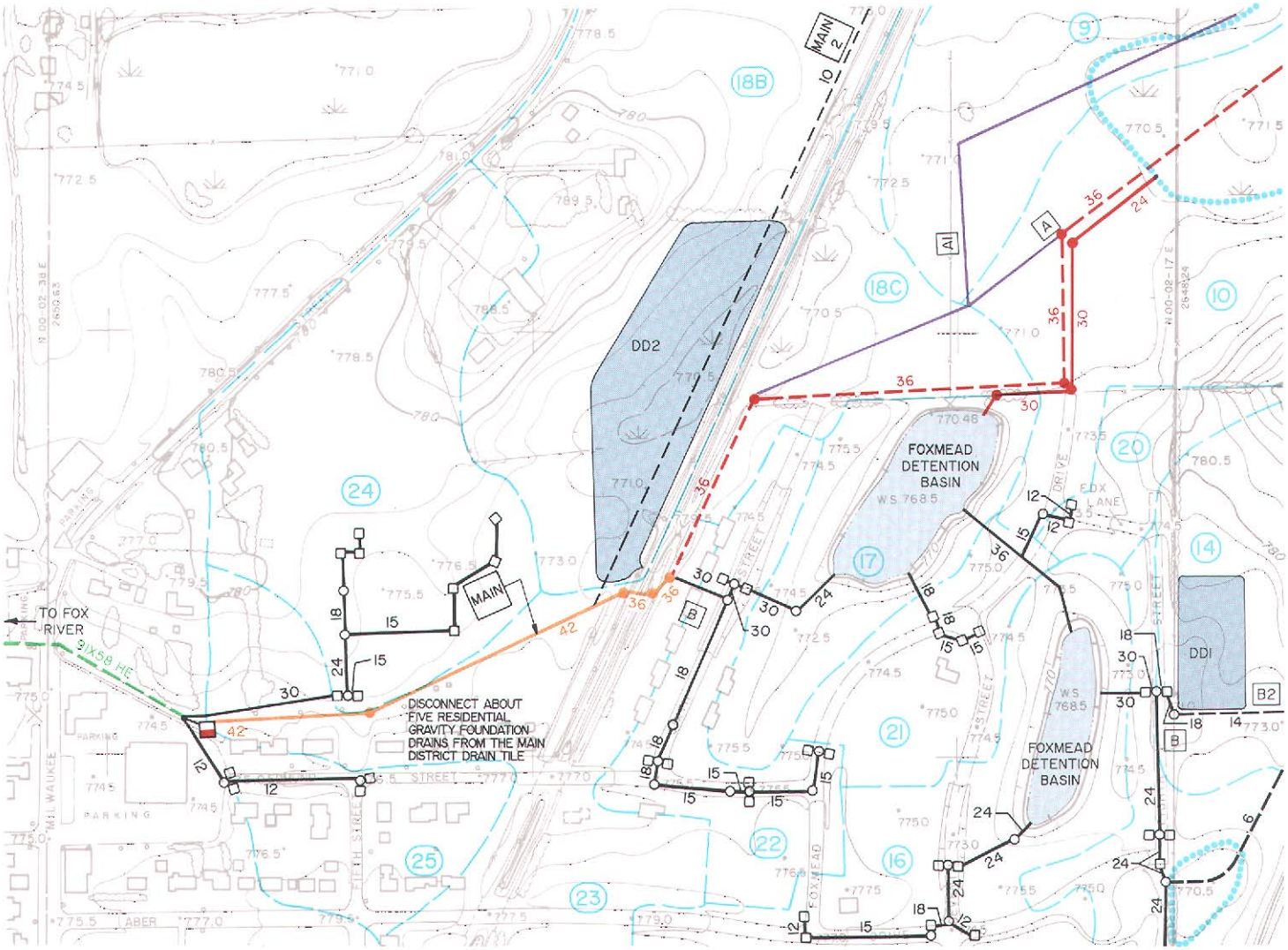
Alternatives No. 1A through 4A, and 2B through 4B, essentially incorporate the same basic framework of agricultural and stormwater drainage facilities, differing only in certain specific components within the same overall framework. Thus, the alternative plans are described herein in terms of modifications to the basic alternative set forth in Alternative No. 1A. Map 7 presents proposed agricultural drainage features which are common to Alternative Plans No. 1A through 4A, and 1B through 4B. Map 8 presents proposed agricultural drainage features which are common to Alternative Plans No. 5A and 5B.

ALTERNATIVE PLAN NO. 1A - CENTRALIZED PUMPING AND DETENTION STORAGE

As shown in graphic summary form on Maps 7 and 9, Alternative Plan No. 1A calls for the replacement of about 7,740 lineal feet of existing 8- to 18-inch diameter agricultural drain tile with about 8,390 lineal feet of 15- to 36-inch diameter corrugated plastic pipe; the replacement of about 960 lineal feet of existing 6- to 30-inch diameter corrugated metal drain tile with 12- to 24-inch diameter reinforced concrete pipe; the replacement of about 140 lineal feet of existing 8-inch diameter drain tile with 12-inch diameter reinforced concrete pipe; the replacement of 63 lineal feet of 30-inch diameter reinforced concrete storm sewer with 36-inch diameter reinforced concrete storm sewer; the replacement of 68 lineal feet of 24- and 27-inch diameter drain tile with 36-inch diameter reinforced concrete storm sewer; and the replacement of 1,015 lineal feet of mixed 24-, 27-, and 30-inch diameter drain tile with 42-inch diameter reinforced concrete storm sewer. The alternative also calls for the construction of 300 lineal feet of 24-inch diameter and 550 lineal feet of 30-inch

Map 9

ALTERNATIVE PLAN NO. 1A FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA—CENTRALIZED PUMPING AND DETENTION STORAGE[a]



LEGEND

- SUBBASIN BOUNDARY
- (10) SUBBASIN DESIGNATION
- WETLAND BOUNDARIES AS SHOWN ON 1990 SEWRPC LAND USE INVENTORY MAPS
- 18 [A] EXISTING DISTRICT TILE, WITH SIZE IN INCHES, AND DESIGNATION
- 24 EXISTING VILLAGE OF WATERFORD STORM SEWER WITH SIZE IN INCHES, AND MANHOLE TO BE RETAINED
- EXISTING STORMWATER INLET
- EXISTING DRAIN TILE TO BE ABANDONED UNDER PLANNED DEVELOPMENT CONDITIONS
- 30 PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE
- 36 PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE EXISTING DRAIN TILE OR STORM SEWER
- 9IX58 HE PROPOSED REPLACEMENT CULVERT, AND SIZE IN INCHES
- 36 PROPOSED DRAIN TILE, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE DISTRICT DRAIN TILE (TO BE SEALED IN EXISTING WETLANDS)
- PROPOSED REPLACEMENT LIFT STATION-ONE 33cfs (14,810gpm) PUMP, AND ONE 15cfs (6,720gpm) PUMP
- EXISTING WET DETENTION BASIN TO BE RETAINED
- DD2 PROPOSED DRY DETENTION BASIN AND DESIGNATION

[a] SEE MAP 7 FOR THE COMPONENTS OF THIS ALTERNATE PLAN IN AREAS OUTSIDE OF THE BOUNDARIES OF THIS MAP.

GRAPHIC SCALE
0 200 400 FEET

Source: SEWRPC.

diameter reinforced concrete storm sewer to serve planned urban development in Subbasins 9, 10, and 18C; the construction of the 1.6-acre-foot dry Detention Basin No. 1 to serve planned urban development in the area between the Foxmead subdivision and STH 36; and the construction of the 10.7-acre-foot dry Detention Basin No. 2 primarily to serve planned urban development in Subbasin 18B, but also to collect runoff from Subbasins 18C and 23. The peak 10-year recurrence interval storm outflow from the entire area tributary to the existing lift station would be pumped by a new 48 cubic feet per second (cfs), or 21,500 gallon per minute (gpm), lift station located at the site of the existing Farm Drainage District pump station.

Because of its widespread use, ease of installation, and relatively low cost, corrugated plastic pipe has become the material of choice for construction of agricultural drain tiles in recent years. It is, therefore, assumed in this study that this material type will be used for replacement of the existing drain tiles. As set forth in Table 2, perforated corrugated plastic pipe would generally be used, except along portions of Lines A and B2 where 1,100 lineal feet and 1,500 lineal feet, respectively, of sealed corrugated plastic pipe is called for to avoid draining wetlands. The relayed drain tiles along Line B2 in the vicinity of the two wetlands are proposed to be realigned for two reasons: 1) there is not adequate cover available along the existing alignment; and 2) realignment will avoid locating the tiles in wetlands. Sealed pipe is still called for at those locations because unsealed pipe could lower wetland groundwater levels due to the close proximity of the pipes to the wetlands.

The existing 60-inch diameter corrugated metal pipe (CMP) culvert from the lift station outlet through N. Milwaukee Street to the Fox River has inadequate capacity to convey the peak 100-year recurrence interval flood flow from the study area under planned land use and drainage conditions. Therefore, in order to provide adequate major stormwater drainage system outlet capacity, it is proposed to replace the existing culvert with a 600-foot-long, 91-inch-wide by 58-inch-high horizontal elliptical (HE) reinforced concrete pipe culvert. The installation of this culvert is a recommendation which is common to all of the alternative plans herein considered.

The proposal for construction of two dry detention basins is consistent with the recommendation of the Welch, Hanson & Associates stormwater plan for the Village which calls for an unspecified amount of detention storage to serve areas of proposed urban development. The Welch, Hanson & Associates plan called for limiting outflow from the smaller of the two detention basins to the capacity of the existing downstream storm sewer and for limiting outflow from the area tributary to the larger basin during a 100-year recurrence interval storm under planned land use and drainage conditions to the 10-year storm outflow from the tributary area under existing conditions. The basins proposed under this alternative represent a refinement of the Welch, Hanson & Associates recommendation in that storage volumes are specified and the functioning of the basins is evaluated in the context of the overall agricultural and urban stormwater drainage system.

It is recommended that the foundation drains of the five houses in the Village of Waterford along Edmund Street be disconnected from the main drain tile and that those houses rely on sump pumps to remove seepage collected in the foundation drains, discharging the sump pumps to the lawn areas. This is a recommendation which is common to all alternative plans presented herein. Disconnection

Table 2

COMPONENTS AND COSTS OF ALTERNATIVE PLAN NO. 1A
FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY
FARM DRAINAGE DISTRICT NO 1 STUDY AREA--CENTRALIZED PUMPING AND DETENTION STORAGE

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1	Tile Line A5	1. Replace 620 feet of 12-inch-diameter drain tile with 18-inch-diameter District No. 1 perforated corrugated plastic pipe	$ 9,300	$ 250
	Tile Line A4	2. Replace 630 feet of 8-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	6,100	250
		3. Replace 320 feet of 10-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	3,100	130
	Tile Line A	4. Replace 340 feet of 14-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	11,200	140
		5. Replace 330 feet of 16-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	10,900	130
		6. Replace 1,220 feet of 16-inch-diameter drain tile with 36-inch-diameter perforated corrugated plastic pipe	81,300	230
		7. Replace 595 feet of 16-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	39,600	110
		8. Replace 505 feet of 18-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	33,600	100
		9. Replace and reroute 1,530 feet of 18-inch diameter drain tile with 1,820 feet of 36-inch diameter perforated corrugated plastic pipe	121,300	350
	Tile Line B2	10. Replace 280 feet of 12-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,700	110
		11. Replace and reroute 580 feet of 12-inch diameter drain tile with 640 feet of 15-inch diameter sealed corrugated plastic pipe to avoid draining adjacent wetland	6,200	260
		12. Replace and reroute 560 feet of 14-inch diameter drain tile with 860 feet of 15-inch diameter sealed corrugated plastic pipe at an 0.08 percent slope to avoid draining the adjacent wetland	8,300	340
		13. Replace 230 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,200	90
	Tile Line B	14. Replace 140 feet of 8-inch-diameter drain tile with 12-inch-diameter reinforced concrete pipe	6,700	60
Racine County Farm Drainage District No. 1		Subtotals	$ 342,500	$ 2,550

Table 2 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Village of Waterford	--	15. Replace the existing 60-inch diameter corrugated metal pipe culvert at the study area outlet with a 600-foot-long, 91-inch wide by 58-inch high horizontal elliptical reinforced concrete pipe	$ 217,100	$ 110
Village of Waterford		Subtotals	$ 217,100	$ 110
Costs Shared by the Farm Drainage District and the Village of Waterford	Tile Line B	16. Replace 12 feet of 24-inch-diameter drain tile, 56 feet of 27-inch-diameter drain tile, and 63 feet of 30-inch diameter reinforced concrete of storm sewer with 131 feet of 36-inch-diameter reinforced concrete storm sewer	$ 25,300	$ 20
	Tile Line MAIN	17. Replace 1,015 feet of mixed 24-, 27-, and 30-inch diameter drain tile with 42-inch diameter reinforced concrete storm sewer	277,800	190
	--	18. Construct a new lift station at the site of the existing Farm Drainage District station. Provide one pump with a capacity of 33 cfs (14,810 gpm) and one pump with a capacity of 15 cfs (6,720 gpm)	132,000	1,100
Costs Shared by the Farm Drainage District and the Village of Waterford		Subtotals	$ 435,100	$ 1,310
Wisconsin Department of Transportation	Tile Line A3	19. Replace 240 feet of 6-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe if found to be damaged when STH 36 is widened	$ 11,500	$ 100
	Tile Line A	20. Replace 140 feet of 15-inch-diameter corrugated metal pipe under STH 164 with 24-inch-diameter reinforced concrete pipe	10,100	60
	Tile Line B2	21. Replace 335 feet of 15-inch-diameter corrugated metal pipe under STH 36 with 15-inch-diameter reinforced concrete pipe	18,100	130
	Tile Line B4	22. Replace 240 feet of 8-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe	11,500	100
Wisconsin Department of Transportation		Subtotals	$ 51,200	$ 390
Private Sector	Subbasins 9 and 10	23. Construct 300 feet of 24-inch-diameter storm sewer to serve planned development	$ 21,300	$ 120
		24. Construct 550 feet of 30-inch-diameter storm sewer to serve planned development	48,300	220
	Subbasin 14	25. Construct a 1.6-acre-foot dry detention basin to serve planned development	67,300	1,200
	Subbasin 18B	26. Construct a 10.7-acre-foot dry detention basin. Basin would primarily serve planned development	314,700	3,100

Table 2 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Private Sector	Subbasins 23 and 25	27. Disconnect about five residential gravity foundation drains from the main District tile line	$ 1,000	0
Private Sector		Subtotals	$ 452,600	$ 4,640
		TOTAL	$1,498,500	$ 9,000
		EQUIVALENT ANNUAL COST	$ 104,000	

[a]Costs for 1993 Engineering News-Record Construction Cost Index = 5,390. Costs include engineering, administration, and contingencies.

Source: SEWRPC.

of the foundation drains from the drain tile system would protect the houses against basement flooding if the pumps in the District lift station were to fail.

Utilizing an annual interest rate of 6 percent and a project life and analysis period of 50 years, the average annual cost of this alternative plan is estimated to be about $104,000. This cost consists of the amortization of the $1,498,500 capital cost and $9,000 in annual operation and maintenance costs. As set forth in Table 2, the capital costs are apportioned as follows: $342,500, or 23 percent of the total, to Racine County Farm Drainage District No. 1; $217,100, or 15 percent of the total, to the Village of Waterford; $51,200, or 3 percent of the total, to the Wisconsin Department of Transportation; and $452,600, or 30 percent of the total, to the private sector. The remaining $435,100, or 29 percent, would be shared by the Farm Drainage District and the Village of Waterford.

ALTERNATIVE PLAN NO. 1B - CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL

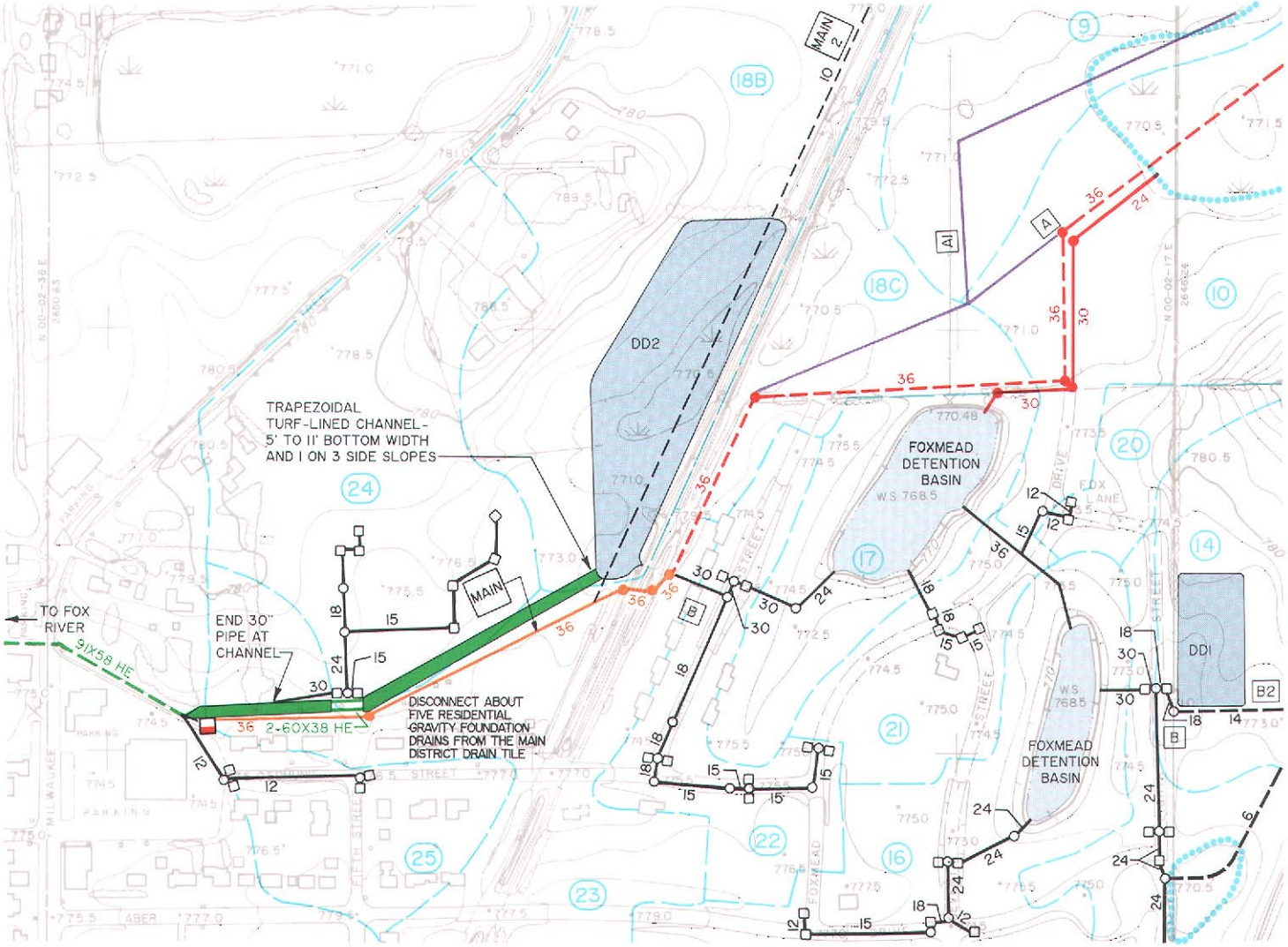
As shown in graphic summary form on Maps 7 and 10, Alternative Plan No. 1B is the same as Alternative Plan No. 1A, with the exception that all of the runoff from a 10-year recurrence interval storm is not pumped and an impervious liner is provided for Detention Basin No. 2. A 1,000-foot-long, trapezoidal, turf-lined open channel would be constructed from the outlet of Detention Basin No. 2 to the upstream end of the proposed 91-inch-wide by 58-inch-high HE culvert, conveying outflow from the detention basin and bypassing the proposed pump station. Two 60-inch-wide by 38-inch-high HE reinforced concrete pipe culverts, each 65 feet long would be installed under 5th Street to convey flow in the proposed channel. That installation would require realignment of the existing 8-inch diameter water main in 5th Street to avoid the proposed culverts. Construction of the channel enables the lift station which is proposed to be constructed at the site of the existing lift station to pump only the peak 10-year recurrence interval outflow from the area tributary to the Foxmead subdivision, reducing the required pumping capacity to 17 cfs, or 7,620 gallon per minute (gpm). Also, the 1,015 lineal feet of reinforced concrete replacement sewer specified for the main drain tile line can be reduced in size to 36-inch diameter under this alternative.

The downstream portion of the existing 30-inch-diameter reinforced concrete storm sewer at the outlet of Subbasin 24 could be removed, allowing the storm sewer to discharge directly to the proposed channel. The impervious liner is provided for Detention Basin No. 2 to limit pumping costs by eliminating seepage from the basin as a source of inflow to the lift station.

Utilizing an annual interest rate of 6 percent and a project life and analysis period of 50 years, the average annual cost of this alternative plan is estimated to be about $108,000. This cost consists of the amortization of the $1,546,200 capital cost and $9,420 in annual operation and maintenance costs. As set forth in Table 3, the capital costs are apportioned as follows: $342,500, or 22 percent of the total, to Racine County Farm Drainage District No. 1; $332,500, or 22 percent of the total, to the Village of Waterford; $51,200, or 3 percent of the total, to the Wisconsin Department of Transportation; and $536,600, or 35 percent of the total, to the private sector. The remaining $283,400, or 18 percent would be shared by the Farm Drainage District and the Village of Waterford.

Map 10

ALTERNATIVE PLAN NO. 1B FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA—CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL[a]



LEGEND

- SUBBASIN BOUNDARY
- SUBBASIN DESIGNATION
- WETLAND BOUNDARIES AS SHOWN ON 1990 SEWRPC LAND USE INVENTORY MAPS
- 18 A — EXISTING DISTRICT TILE, WITH SIZE IN INCHES, AND DESIGNATION
- 24 — EXISTING VILLAGE OF WATERFORD STORM SEWER WITH SIZE IN INCHES, AND MANHOLE TO BE RETAINED
- EXISTING STORMWATER INLET
- EXISTING DRAIN TILE TO BE ABANDONED UNDER PLANNED DEVELOPMENT CONDITIONS
- 30 — PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE
- 36 — PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE EXISTING DRAIN TILE OR STORM SEWER
- 2-60X38 HE — PROPOSED CULVERT AND SIZE IN INCHES
- 91X58 HE — PROPOSED REPLACEMENT CULVERT, AND SIZE IN INCHES
- 36 — PROPOSED DRAIN TILE, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE DISTRICT DRAIN TILE (TO BE SEALED IN EXISTING WETLANDS)
- PROPOSED REPLACEMENT LIFT STATION-ONE 11cfs (4,930gpm) PUMP, AND ONE 6cfs (2,690gpm) PUMP
- PROPOSED OPEN CHANNEL
- EXISTING WET DETENTION BASIN TO BE RETAINED
- DD2 — PROPOSED DRY DETENTION BASIN AND DESIGNATION

[a] SEE MAP 7 FOR THE COMPONENTS OF THIS ALTERNATE PLAN IN AREAS OUTSIDE OF THE BOUNDARIES OF THIS MAP.

GRAPHIC SCALE
0 200 400 FEET

Source: SEWRPC.

Table 3

COMPONENTS AND COSTS OF ALTERNATIVE PLAN NO. 1B FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA-CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1	Tile Line A5	1. Replace 620 feet of 12-inch-diameter Farm Drainage drain tile with 18-inch-diameter perforated corrugated plastic pipe	$ 9,300	$ 250
	Tile Line A4	2. Replace 630 feet of 8-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	6,100	250
		3. Replace 320 feet of 10-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	3,100	130
	Tile Line A	4. Replace 340 feet of 14-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	11,200	140
		5. Replace 330 feet of 16-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	10,900	130
		6. Replace 1,220 feet of 16-inch-diameter drain tile with 36-inch-diameter perforated corrugated plastic pipe	81,300	230
		7. Replace 595 feet of 16-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	39,600	110
		8. Replace 505 feet of 18-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	33,600	100
		9. Replace and reroute 1,530 feet of 18-inch-diameter drain tile with 1,820 feet of 36-inch-diameter perforated corrugated plastic pipe	121,300	350
	Tile Line B2	10. Replace 280 feet of 12-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,700	110
		11. Replace and reroute 580 feet of 12-inch-diameter drain tile with 640 feet of 15-inch-diameter sealed corrugated plastic pipe to avoid draining adjacent wetland	6,200	260
		12. Replace and reroute 560 feet of 14-inch-diameter drain tile with 860 feet of 15-inch-diameter sealed corrugated plastic pipe at an 0.08 percent slope to avoid draining the adjacent wetland	8,300	340
		13. Replace 230 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,200	90
	Tile Line B	14. Replace 140 feet of 8-inch-diameter drain tile with 12-inch-diameter reinforced concrete pipe	6,700	60

Table 3 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1		Subtotals	$ 342,500	$ 2,550
Village of Waterford	--	15. Replace the existing 60-inch diameter corrugated metal pipe culvert at the study area outlet with a 600-foot-long, 91-inch wide by 58-inch high horizontal elliptical (HE) reinforced concrete pipe	$ 217,100	$ 110
	--	16. Construct a 1,000-foot-long, trapezoidal, turf-lined open channel from the outlet of Detention Basin 2 to the upstream end of the proposed 91-inch by 58-inch HE culvert	85,000	500
	Fifth Street	17. Install a double 60-inch-wide by 38-inch-high HE reinforced concrete culvert with a total pipe length of 130 feet. Relocate 8-inch diameter water main in 5th Street.	30,400	20
Village of Waterford		Subtotals	$ 332,500	$ 630
Costs Shared by The Farm Drainage District and the Village of Waterford	Tile Line B	18. Replace 12 feet of 24-inch-diameter drain tile, 56 feet of 27-inch-diameter drain tile, and 63 feet of 30-inch-diameter reinforced concrete storm sewer with 131 feet of 36-inch-diameter reinforced concrete storm sewer	$ 25,300	$ 20
	Tile Line MAIN	19. Replace 1,015 feet of mixed 24-, 27-, and 30-inch diameter drain tile with 36-inch diameter reinforced concrete storm sewer	196,100	190
		20. Construct a new lift station at the site of the existing Farm Drainage District station. Provide one pump with a capacity of 11 cfs (4,930 gpm) and one pump with a capacity of 6 cfs (2,690 gpm).	62,000	1,000
Costs Shared by the Farm Drainage District and the Village of Waterford		Subtotals	$ 283,400	$ 1,210
Wisconsin Department of Transportation	Tile Line A3	21. Replace 240 feet of 6-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe if found to be damaged when STH 36 is widened	$ 11,500	$ 100
	Tile Line A	22. Replace 140 feet of 15-inch-diameter corrugated metal pipe under STH 164 with 24-inch-diameter reinforced concrete pipe	10,100	60
	Tile Line B2	23. Replace 335 feet of 15-inch-diameter corrugated metal pipe under STH 36 with 15-inch-diameter reinforced concrete pipe	18,100	130
	Tile Line B4	24. Replace 240 feet of 8-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe	11,500	100
Wisconsin Department of Transportation		Subtotals	$ 51,200	$ 390

Table 3 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Private Sector	Subbasins 9d and 10	25. Construct 300 feet of 24-inch-diameter and 10 storm sewer to serve planned development	$ 21,300	$ 120
		26. Construct 550 feet of 30-inch-diameter storm sewer to serve planned development	48,300	220
	Subbasin 14	27. Construct a 1.6-acre-foot dry detention basin to serve planned development. Detention Basin No. 1	67,300	1,200
	Subbasin 18B	28. Construct a 10.7-acre-foot dry detention basin with an impervious liner. Basin would primarily serve planned development. Detention Basin No. 2	398,700	3,100
	Subbasins 23 and 25	29. Disconnect about five residential gravity foundation drains from the main District drain tile	1,000	0
Private Sector		Subtotals	$ 536,600	$ 4,640
		TOTAL	$1,546,200	$ 9,420
		EQUIVALENT ANNUAL COST	$ 108,000	

[a]Costs for 1993 Engineering News-Record Construction Cost Index = 5,390. Costs include engineering, administration, and contingencies.

Source: SEWRPC.

ALTERNATIVE PLAN NO. 2A - DECENTRALIZED PUMPING AND CENTRALIZED DETENTION STORAGE WITH MOST AREAS OF PROPOSED DEVELOPMENT DISCONNECTED FROM THE AGRICULTURAL DRAIN TILE SYSTEM

Alternative Plan No. 2A is designed to avoid any further interconnection between the rural agricultural and the urban stormwater drainage systems, except where necessary because an area of proposed development is now tributary to the Foxmead system and separation would be impractical. As shown on Maps 7 and 11, this alternative calls for the agricultural drainage system in areas upstream of proposed urban development as do Alternatives No. 1A and 1B. Under this alternative, Detention Basin No. 2 would not collect runoff from Subbasin 23 as it would under Alternatives No. 1A and 1B, however, it would collect runoff from subbasins 9, 10, 18B, and 18C and the required size for Basin No. 2 would still be 10.7 acre-feet. Detention Basins No. 1 and 2 would be provided as under Alternative 1B, with an impervious line in Basin No. 2.

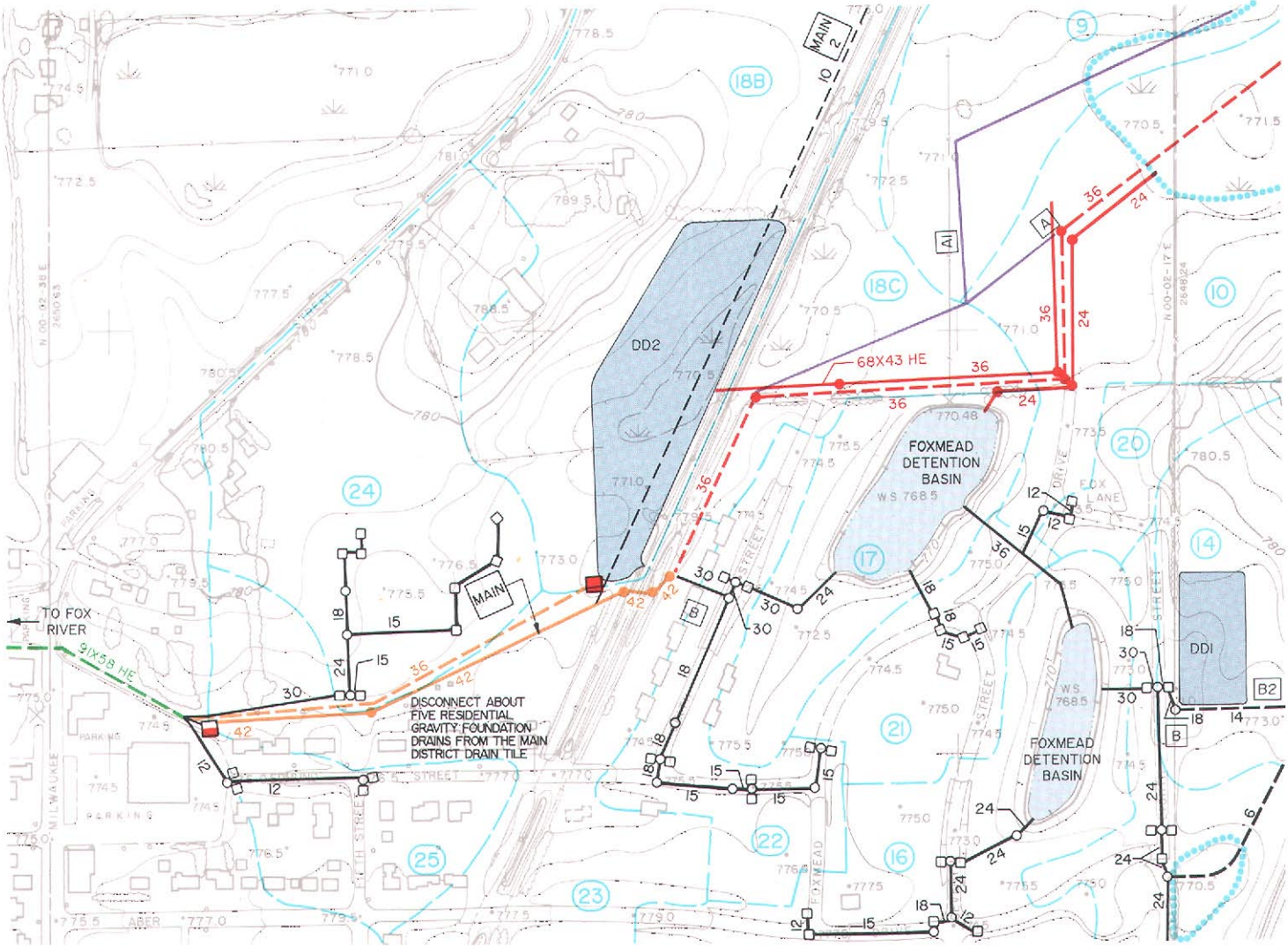
For tile Line B, 12 feet of 24-inch and 56 feet of 27-inch diameter drain tile along with 63 feet of 30-inch diameter storm sewer would be replaced with 131 feet of 42-inch diameter reinforced concrete storm sewer. Also, about 1,015 lineal feet of the main drain tile line would be replaced with 42-inch diameter reinforced concrete storm sewer.

As shown in graphic summary form on Map 11, this alternative plan would provide for the pumping of agricultural and urban stormwater runoff by two pumping stations. One station, proposed to be located just downstream of proposed Detention Basin No. 2, would be designed to pump the peak 10-year recurrence interval outflow of 40 cfs, or 17,940 gpm, from areas of planned rural and urban land use in Subbasins 18B, 18C, 9, and the west part of 10. That pumping station would have a 1,100-foot-long, 36-inch diameter steel discharge line running to the upstream end of the proposed 91-inch-wide by 58-inch-high HE culvert. The other station, which would be located at the site of the existing Farm Drainage District lift station, would have a capacity of 34 cfs, or 15,250 gpm. That station would pump agricultural and stormwater runoff and base flow, up to the peak 10-year flow, from all areas not served by the other station. Urban stormwater runoff from Subbasins 9 and 10 would be conveyed to detention basin DD2 in 915 lineal feet of proposed 36-inch diameter reinforced concrete storm sewer and 285 lineal feet of 68-inch-wide by 43-inch-high HE storm sewer. About 850 lineal feet of 24-inch-diameter reinforced concrete storm sewer would be installed in Subbasins 10 and 17 to convey agricultural runoff from upstream areas through the proposed new development to the western Foxmead detention basin.

Utilizing an annual interest rate of 6 percent and a project life and analysis period of 50 years, the average annual cost of this alternative plan is estimated to be about $136,000. This cost consists of the amortization of the $1,983,100 capital cost and $10,130 in annual operation and maintenance costs. As set forth in Table 4, the capital costs are apportioned as follows: $342,500, or 17 percent of the total, to Racine County Farm Drainage District No. 1; $217,100, or 11 percent of the total, to the Village of Waterford; $51,200, or 3 percent of the total, to the Wisconsin Department of Transportation; and $958,600, or 48 percent of the total, to the private sector. The remaining $413,700, or 21 percent, would be shared by the Farm Drainage District and the Village of Waterford.

Map 11

ALTERNATIVE PLAN NO. 2A FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA—DECENTRALIZED PUMPING AND CENTRALIZED DETENTION STORAGE WITH MOST AREAS OF PROPOSED DEVELOPMENT DISCONNECTED FROM THE AGRICULTURAL DRAIN TILE SYSTEM[a]



LEGEND

- SUBBASIN BOUNDARY
- (10) SUBBASIN DESIGNATION
- WETLAND BOUNDARIES AS SHOWN ON 1990 SEWRPC LAND USE INVENTORY MAPS
- 18 A — EXISTING DISTRICT TILE, WITH SIZE IN INCHES, AND DESIGNATION
- 24 — EXISTING VILLAGE OF WATERFORD STORM SEWER WITH SIZE IN INCHES, AND MANHOLE TO BE RETAINED
- EXISTING STORMWATER INLET
- EXISTING DRAIN TILE TO BE ABANDONED UNDER PLANNED DEVELOPMENT CONDITIONS
- 36 — PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE
- 42 — PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE EXISTING DRAIN TILE OR STORM SEWER
- 9IX58 HE — PROPOSED REPLACEMENT CULVERT, AND SIZE IN INCHES
- 36 — PROPOSED DRAIN TILE, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE DISTRICT DRAIN TILE (TO BE SEALED IN EXISTING WETLANDS)
- PROPOSED REPLACEMENT LIFT STATION-ONE 21cfs (9,420gpm) PUMP, AND ONE 13cfs (5,830gpm) PUMP
- PROPOSED PUMP STATION-THREE 13.3cfs (5,960gpm) PUMPS
- 36 — PROPOSED STEEL DISCHARGE PIPE WITH SIZE IN INCHES
- EXISTING WET DETENTION BASIN TO BE RETAINED
- DD2 — PROPOSED DRY DETENTION BASIN AND DESIGNATION

[a] SEE MAP 7 FOR THE COMPONENTS OF THIS ALTERNATE PLAN IN AREAS OUTSIDE OF THE BOUNDARIES OF THIS MAP.

GRAPHIC SCALE
0 200 400 FEET

Source: SEWRPC.

Table 4

COMPONENTS AND COSTS OF ALTERNTIVE PLAN NO. 2A FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA-DECENTRALIZED PUMPING AND CENTRALIZED DETENTION STORAGE WITH MOST AREAS OF PROPOSED DEVELOPMENT DISCONNECTED FROM THE AGRICULTURAL DRAIN TILE SYSTEM

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1	Tile Line A5	1. Replace 620 feet of 12-inch-diameter Farm Drainage drain tile with 18-inch-diameter perforated corrugated plastic pipe	$ 9,300	$ 250
	Tile Line A4	2. Replace 630 feet of 8-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	6,100	250
		3. Replace 320 feet of 10-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	3,100	130
	Tile Line A	4. Replace 340 feet of 14-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	11,200	140
		5. Replace 330 feet of 16-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	10,900	130
		6. Replace 1,220 feet of 16-inch-diameter drain tile with 36-inch-diameter perforated corrugated plastic pipe	81,300	230
		7. Replace 595 feet of 16-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	39,600	110
		8. Replace 505 feet of 18-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	33,600	100
		9. Replace and reroute 1,530 feet of 18-inch diameter drain tile with 1,820 feet of 36-inch-diameter perforated corrugated plastic pipe	121,300	350
	Tile Line B2	10. Replace 280 feet of 12-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,700	110
		11. Replace and reroute 580 feet of 12-inch diameter drain tile with 640 feet of 15-inch diameter sealed corrugated plastic pipe to avoid draining adjacent wetland	6,200	260
		12. Replace and reroute 560 feet of 14-inch diameter drain tile with 860 feet of 15-inch diameter sealed corrugated plastic pipe at an 0.08 percent slope to avoid draining the adjacent wetland	8,300	340
		13. Replace 230 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,200	90
	Tile Line B	14. Replace 140 feet of 8-inch-diameter drain tile with 12-inch-diameter reinforced concrete pipe	6,700	60

Table 4 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1		Subtotals	$ 342,500	$ 2,550
Village of Waterford	--	15. Replace the existing 60-inch diameter corrugated metal pipe culvert at the study area outlet with a 600-foot-long, 91-inch wide by 58-inch high horizontal elliptical reinforced concrete pipe	$ 217,100	$ 110
Village of Waterford		Subtotals	$ 217,100	$ 110
Costs Shared by the Farm Drainage District and the Village of Waterford	Tile Line B	16. Replace 12 feet of 24-inch-diameter drain tile, 56 feet of 27-inch-diameter drain tile, and 63 feet of 30-inch-diameter reinforced concrete storm sewer with 131 feet of 42-inch-diameter reinforced concrete storm sewer	$ 35,900	$ 20
	Tile Line MAIN	17. Replace 1,015 feet of mixed 24-, 27-, and 30-inch diameter drain tile with 42-inch diameter reinforced concrete storm sewer	277,800	190
		18. Construct a new lift station at the site of the existing Farm Drainage District station. Provide one pump with a capacity of 21 cfs (9,420 gpm) and one pump with a capacity of 13 cfs (5,830 gpm).	100,000	900
Costs Shared by the Farm Drainage District and the Village of Waterford		Subtotals	$ 413,700	$ 1,110
Wisconsin Department of Transportation	Tile Line A3	19. Replace 240 feet of 6-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe if found to be damaged when STH 36 is widened	$ 11,500	$ 100
	Tile Line A	20. Replace 140 feet of 15-inch-diameter corrugated metal pipe under STH 164 with 24-inch-diameter reinforced concrete pipe	10,100	60
	Tile Line B2	21. Replace 335 feet of 15-inch-diameter corrugated metal pipe under STH 36 with 15-inch-diameter reinforced concrete pipe	18,100	130
	Tile Line B4	22. Replace 240 feet of 8-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe	11,500	100
Wisconsin Department of Transportation		Subtotals	$ 51,200	$ 390
Private Sector	Subbasins 9 and 10	23. Construct 850 feet of 24-inch-diameter storm sewer to convey upstream agricultural runoff through proposed development to the Foxmead detention basin	$ 60,200	$ 340
		24. Construct 915 feet of 36-inch-diameter storm sewer to serve planned development	97,200	170

Table 4 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Private Sector	Subbasins 9 and 10	25. Construct 285 feet of 68-inch-wide by 43-inch-high HE storm sewer to serve planned development	$ 62,800	$ 50
	Subbasin 14	26. Construct a 1.6-acre-foot dry detention basin to serve planned development. Detention Basin No. 1	67,300	1,200
	Subbasin 18B	27. Construct a 10.7-acre-foot dry detention basin with an impervious liner. Basin would primarily serve planned development. Detention Basin No. 2.	398,700	3,100
	--	28. Construct a new pump station at the site of the proposed Detention Basin No. 2. Provide three pumps, each with a capacity of 13.3 cfs (5,960 gpm)	112,000	900
	--	29. Install 1,100 lineal feet of 36-inch diameter steel discharge pipe from the pump station called for under Item 28 to the upstream end of the proposed 91-inch by 58-inch HE culvert	159,400	210
	Subbasins 23 and 25	30. Disconnect about five residential gravity foundation drains from the main District drain tile	1,000	0
Private Sector		Subtotals	$ 958,600	$ 5,970
		TOTAL	$1,983,100	$10,130
		EQUIVALENT ANNUAL COST	$ 136,000	

[a]Costs for 1993 Engineering News-Record Construction Cost Index = 5,390. Costs include engineering, administration, and contingencies.

Source: SEWRPC.

ALTERNATIVE PLAN NO. 2B - CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL AND WITH MOST AREAS OF PROPOSED DEVELOPMENT DISCONNECTED FROM THE AGRICULTURAL DRAIN TILE SYSTEM

As shown in graphic summary form on Maps 7 and 12, this alternative plan is the same as Alternative No. 2A, with the exception that all of the runoff from a 10-year recurrence interval storm is not pumped. Instead, a 1,000-foot-long, trapezoidal, turf-lined open channel would be constructed from the outlet of Detention Basin No. 2 to the upstream end of the proposed 91-inch-wide by 58-inch-high HE culvert, conveying outflow from the detention basin and bypassing a proposed lift station at the site of the existing station. Two 60-inch-wide by 38-inch-high HE reinforced concrete pipe culverts, each 65 feet long would be installed under 5th Street to convey flow in the proposed channel. That installation would require realignment of the existing 8-inch diameter water main in 5th Street to avoid the proposed culverts. The downstream portion of the existing 30-inch-diameter reinforced concrete storm sewer at the outlet of Subbasin 24 could be removed, allowing the storm sewer to discharge directly to the proposed channel. Construction of the channel enables elimination of the Detention Basin No. 2 pumping station which was proposed under Alternative No. 2A.

Utilizing an annual interest rate of 6 percent and a project life and analysis period of 50 years, the average annual cost of this alternative plan is estimated to be about $126,000. This cost consists of the amortization of the $1,827,100 capital cost and $9,510 in annual operation and maintenance costs. As set forth in Table 5, the capital costs are apportioned as follows: $342,500 or 19 percent of the total, to Racine County Farm Drainage District No. 1; $332,500, or 18 percent of the total, to the Village of Waterford; $51,200, or 3 percent of the total, to the Wisconsin Department of Transportation; and $687,200, or 38 percent of the total, to the private sector. The remaining $413,700, or 22 percent, would be shared by the Farm Drainage District and the Village of Waterford.

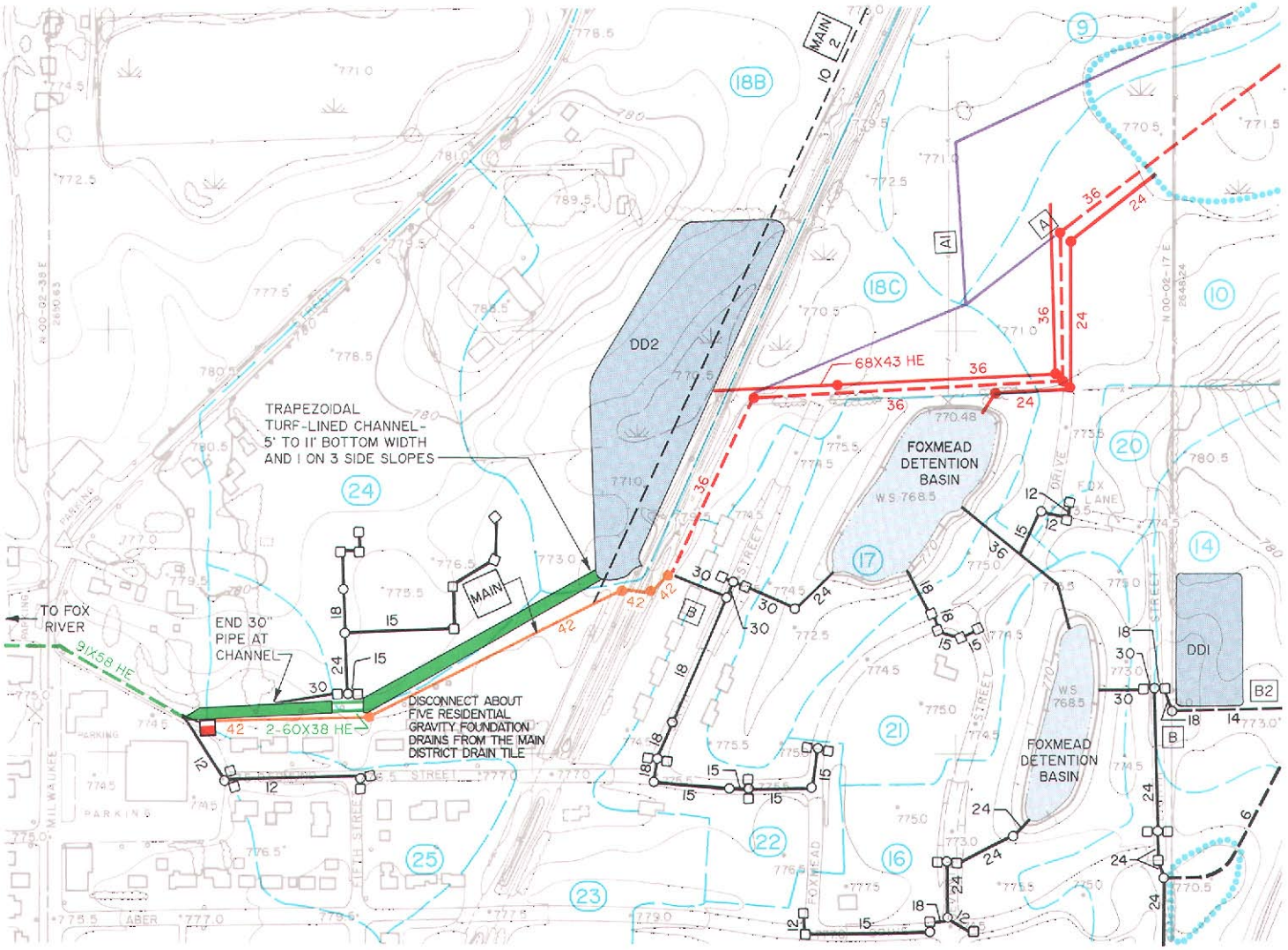
ALTERNATIVE PLAN NO. 3A - DECENTRALIZED PUMPING AND CENTRALIZED DETENTION STORAGE

This alternative plan is similar to Alternative No. 2A, except that under this plan runoff from areas of new development is not separated from the agricultural drainage system. This alternative calls for the same agricultural drainage system in areas upstream of proposed urban development as do the preceding alternatives. Detention Basins No. 1 and 2 would be provided and Basin No. 2 would have an impervious liner. Detention Basin No. 2 would collect runoff from Subbasins 18B, 18C, and 23 as it would under Alternatives No. 1A and 1B.

As shown in graphic summary form on Map 13, Alternative Plan No. 3A would provide for the pumping of agricultural and urban stormwater runoff through the use of two stations. One station, which is proposed to be located just downstream of proposed Detention Basin No. 2 would be designed to pump the peak 10-year recurrence interval outflow of 48 cfs, or 21,520 gpm, from the entire tributary study area. Only runoff from Subbasins 24 and 25, which drain by gravity under existing conditions would not be pumped. That pumping station would have a 1,100-foot-long, 36-inch diameter steel discharge line running to the upstream end of the proposed 91-inch-wide by 58-inch-high HE culvert. The other station, which would be located at the site of the existing Farm Drainage District lift station, would have a capacity of 7 cfs, or 3,140 gpm. That station would pump only drain tile flow from agricultural lands tributary to drain tile Line A.

Map 12

ALTERNATIVE PLAN NO. 2B FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA—CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL AND WITH MOST AREAS OF PROPOSED DEVELOPMENT DISCONNECTED FROM THE AGRICULTURAL DRAIN TILE SYSTEM[a]



LEGEND

- SUBBASIN BOUNDARY
- (10) SUBBASIN DESIGNATION
- WETLAND BOUNDARIES AS SHOWN ON 1990 SEWRPC LAND USE INVENTORY MAPS
- 18 [A] EXISTING DISTRICT TILE, WITH SIZE IN INCHES, AND DESIGNATION
- 24 EXISTING VILLAGE OF WATERFORD STORM SEWER WITH SIZE IN INCHES, AND MANHOLE TO BE RETAINED
- EXISTING STORMWATER INLET
- EXISTING DRAIN TILE TO BE ABANDONED UNDER PLANNED DEVELOPMENT CONDITIONS
- 36 PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE
- 42 PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE EXISTING DRAIN TILE OR STORM SEWER
- 2-60X38 HE PROPOSED CULVERT AND SIZE IN INCHES
- 91X58 HE PROPOSED REPLACEMENT CULVERT, AND SIZE IN INCHES
- 36 PROPOSED DRAIN TILE, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE DISTRICT DRAIN TILE (TO BE SEALED IN EXISTING WETLANDS)
- PROPOSED REPLACEMENT LIFT STATION-ONE 21cfs (9,420gpm) PUMP, AND ONE 13cfs (5,830gpm) PUMP
- PROPOSED OPEN CHANNEL
- EXISTING WET DETENTION BASIN TO BE RETAINED
- DD2 PROPOSED DRY DETENTION BASIN AND DESIGNATION

[a] SEE MAP 7 FOR THE COMPONENTS OF THIS ALTERNATE PLAN IN AREAS OUTSIDE OF THE BOUNDARIES OF THIS MAP.

GRAPHIC SCALE
0 200 400 FEET

Source: SEWRPC.

Table 5

COMPONENTS AND COSTS OF ALTERNATIVE PLAN NO. 2B FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA--CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL AND WITH MOST AREAS OF PROPOSED DEVELOPMENT DISCONNECTED FROM THE AGRICULTURAL DRAIN TILE SYSTEM

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1	Tile Line A5	1. Replace 620 feet of 12-inch-diameter Farm Drainage drain tile with 18-inch-diameter perforated corrugated plastic pipe	$ 9,300	$ 250
	Tile Line A4	2. Replace 630 feet of 8-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	6,100	250
		3. Replace 320 feet of 10-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	3,100	130
	Tile Line A	4. Replace 340 feet of 14-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	11,200	140
		5. Replace 330 feet of 16-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	10,900	130
		6. Replace 1,220 feet of 16-inch-diameter drain tile with 36-inch-diameter perforated corrugated plastic pipe	81,300	230
		7. Replace 595 feet of 16-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	39,600	110
		8. Replace 505 feet of 18-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	33,600	100
		9. Replace and reroute 1,530 feet of 18-inch diameter drain tile with 1,820 feet of 36-inch-diameter perforated corrugated plastic pipe	121,300	350
	Tile Line B2	10. Replace 280 feet of 12-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,700	110
		11. Replace and reroute 580 feet of 12-inch-diameter drain tile with 640 feet of 15-inch-diameter sealed corrugated plastic pipe to avoid draining adjacent wetland	6,200	260
		12. Replace and reroute 560 feet of 14-inch-diameter drain tile with 860 feet of 15-inch-diameter sealed corrugated plastic pipe at an 0.08 percent slope to avoid draining the adjacent wetland	8,300	340
		13. Replace 230 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,200	90
	Tile Line B	14. Replace 140 feet of 8-inch-diameter drain tile with 12-inch-diameter reinforced concrete pipe	6,700	30

Table 5 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1		Subtotals	$ 342,500	$ 2,520
Village of Waterford	--	15. Replace the existing 60-inch diameter corrugated metal pipe culvert at the study area outlet with a 600-foot-long, 91-inch wide by 58-inch high horizontal elliptical reinforced concrete pipe	$ 217,100	$ 110
	--	16. Construct a 1,000-foot-long, trapezoidal, turf-lined open channel from the outlet of Detention Basin 2 to the upstream end of the proposed 91-inch by 58-inch HE culvert	85,000	500
	Fifth Street	17. Install a double 60-inch-wide by 38-inch-high HE reinforced concrete culvert with a total pipe length of 130 feet. Relocate 8-inch diameter water main in 5th Street.	30,400	20
Village of Waterford		Subtotals	$ 332,500	$ 630
Costs Shared by the Farm Drainage District and the Village of Waterford	Tile Line B	18. Replace 12 feet of 24-inch-diameter drain tile, 56 feet of 27-inch-diameter drain tile, and 63 feet of 30-inch-diameter reinforced concrete storm sewer with 131 feet of 42-inch-diameter reinforced concrete storm sewer	$ 35,900	$ 20
	Tile Line MAIN	19. Replace 1,015 feet of mixed 24-, 27-, and 30-inch diameter drain tile with 42-inch diameter reinforced concrete storm sewer	277,800	190
	--	20. Construct a new lift station at the site of the existing Farm Drainage District station. Provide one pump with a capacity of 21 cfs (9,420 gpm) and one pump with a capacity of 13 cfs (5,830 gpm).	100,000	900
Costs Shared by the Farm Drainage District and the Village of Waterford		Subtotals	$ 413,700	$ 1,110
Wisconsin Department of Transportation	Tile Line A3	21. Replace 240 feet of 6-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe if found to be damaged when STH 36 is widened	$ 11,500	$ 100
	Tile Line A	22. Replace 140 feet of 15-inch-diameter corrugated metal pipe under STH 164 with 24-inch-diameter reinforced concrete pipe	10,100	60
	Tile Line B2	23. Replace 335 feet of 15-inch-diameter corrugated metal pipe under STH 36 with 15-inch-diameter reinforced concrete pipe	18,100	130
	Tile Line B4	24. Replace 240 feet of 8-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe	11,500	100
Wisconsin Department of Transportation		Subtotals	$ 51,200	$ 390

Table 5 (cont'd)

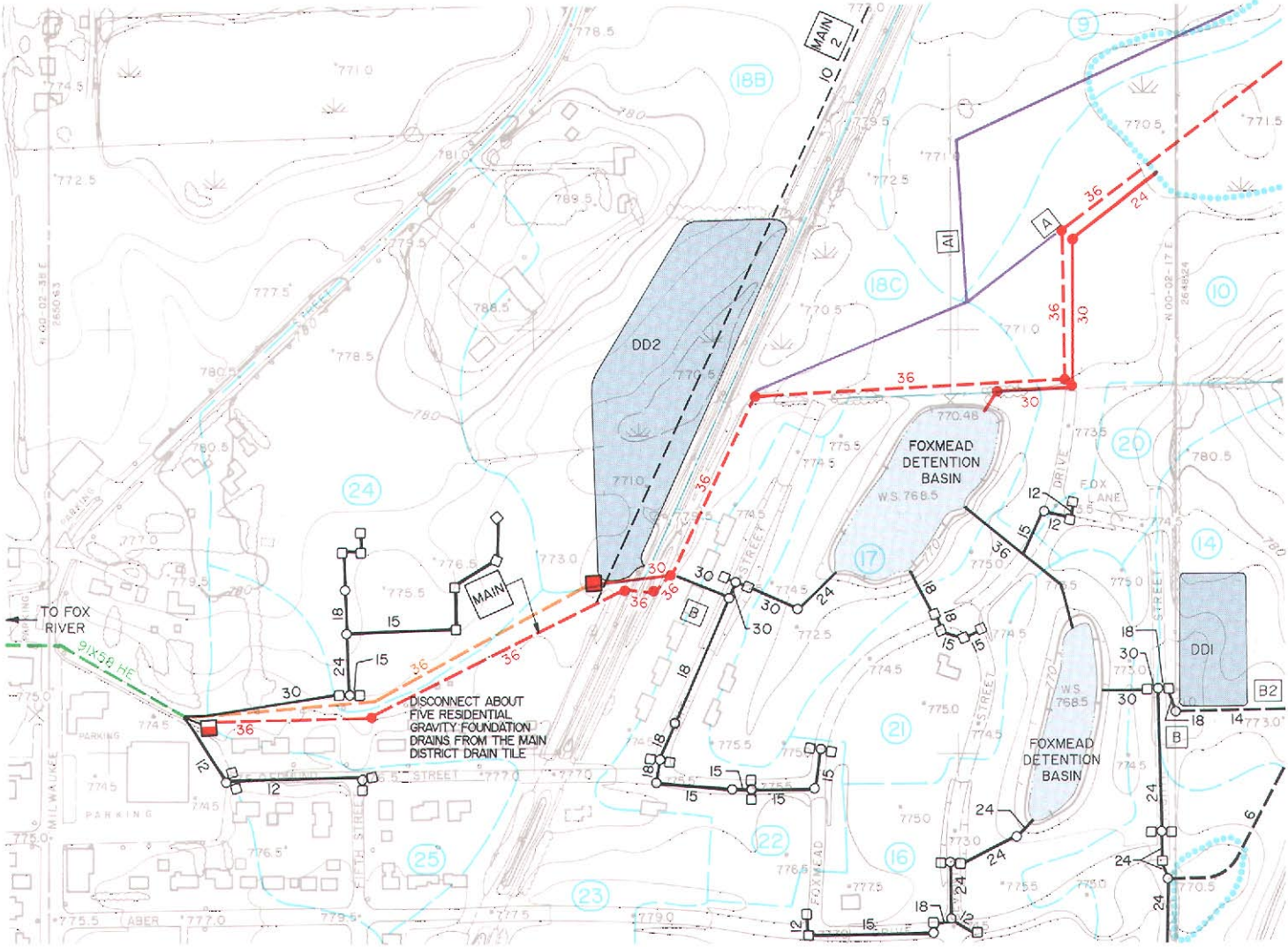
Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Private Sector	Subbasins 9 and 10	25. Construct 850 feet of 24-inch-diameter storm sewer to convey upstream agricultural runoff through proposed development to the Foxmead detention basin	$ 60,200	$ 340
		26. Construct 915 feet of 36-inch-diameter storm sewer to serve planned development	97,200	170
		27. Construct 285 feet of 68-inch-wide by 43-inch high HE storm sewer to serve planned development	62,800	50
	Subbasin 14	28. Construct a 1.6-acre-foot dry detention basin to serve planned development. Detention Basin No. 1	67,300	1,200
	Subbasin 18B	29. Construct a 10.7-acre-foot dry detention basin with an impervious liner. Basin would primarily serve planned development. Detention Basin No. 1	398,700	3,100
	Subbasins 23 and 25	30. Disconnect about five residential gravity foundation drains from the main District drain tile	1,000	0
Private Sector		Subtotals	$ 687,200	$ 4,860
		TOTAL	$1,827,100	$ 9,510
		EQUIVALENT ANNUAL COST	$ 126,000	

[a]Costs for 1993 Engineering News-Record Construction Cost Index = 5,390. Costs include engineering, administration, and contingencies.

Source: SEWRPC.

Map 13

ALTERNATIVE PLAN NO. 3A FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA—DECENTRALIZED PUMPING AND CENTRALIZED DETENTION STORAGE[a]



LEGEND

- SUBBASIN BOUNDARY
- (10) SUBBASIN DESIGNATION
- WETLAND BOUNDARIES AS SHOWN ON 1990 SEWRPC LAND USE INVENTORY MAPS
- 18 A — EXISTING DISTRICT TILE, WITH SIZE IN INCHES, AND DESIGNATION
- 24 — EXISTING VILLAGE OF WATERFORD STORM SEWER WITH SIZE IN INCHES, AND MANHOLE TO BE RETAINED
- EXISTING STORMWATER INLET
- EXISTING DRAIN TILE TO BE ABANDONED UNDER PLANNED DEVELOPMENT CONDITIONS
- 30 — PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE
- 91X58 HE — PROPOSED REPLACEMENT CULVERT, AND SIZE IN INCHES
- 36 — PROPOSED DRAIN TILE, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE DISTRICT DRAIN TILE (TO BE SEALED IN EXISTING WETLANDS)
- PROPOSED REPLACEMENT LIFT STATION-ONE 4cfs (1,790gpm) PUMP, AND ONE 3cfs (1,350gpm) PUMP
- PROPOSED PUMP STATION-ONE 31cfs (13,900gpm) PUMP, ONE 11cfs (4,930gpm) PUMP, AND ONE 6cfs (2,690gpm) PUMP
- 36 — PROPOSED STEEL DISCHARGE PIPE WITH SIZE IN INCHES
- EXISTING WET DETENTION BASIN TO BE RETAINED
- DD2 — PROPOSED DRY DETENTION BASIN AND DESIGNATION

[a] SEE MAP 7 FOR THE COMPONENTS OF THIS ALTERNATE PLAN IN AREAS OUTSIDE OF THE BOUNDARIES OF THIS MAP.

GRAPHIC SCALE
0 200 400 FEET

Source: SEWRPC.

The combined total of 131 feet of 24- and 27-inch diameter drain tile and 30-inch storm sewer at the outlet from the Foxmead subdivision would be replaced and extended with 185 lineal feet of 30-inch reinforced concrete storm sewer to convey runoff to the larger pump station. The 1,015 lineal feet of mixed 24-, 27-, and 30-inch diameter drain tile upstream of the existing pump station would be replaced and extended with 1,145 lineal feet of sealed 36-inch diameter corrugated plastic pipe.

The alternative also calls for the construction of 300 lineal feet of 24-inch diameter and 550 lineal feet of 30-inch diameter reinforced concrete storm sewer to serve planned new development in Subbasins 9, 10, and 18C.

This alternative incorporates the recommendations in the stormwater management plan prepared by Welch, Hanson & Associates for the Village regarding the approximate location and function of a new pumping station to pump runoff from Subbasin 18B and areas tributary to the Foxmead subdivision, but it does not limit the pumping capacity as under the Welch, Hanson alternative. The stormwater management plan used a 10 cfs pumping capacity limitation based on the provision of a pressure discharge line from the pump station to the existing 30-inch diameter reinforced concrete storm sewer which runs from 5th Street to the upstream end of the existing 60-inch diameter CMP culvert at the study area outlet. That storm sewer has an available capacity of about 10 cfs during a 10-year storm. Under existing land use conditions, a pump capacity of 10 cfs would result in some improvement in drainage in the Foxmead subdivision and in the upstream drain tile lines in comparison to the current 3.8 cfs rate, but such a rate would not meet the 10-year design storm criterion under either existing or planned land use conditions. Therefore, the pumping capacity has been increased to 48 cfs under this alternative. It should be noted that the provision of Detention Basin No. 2 significantly reduces peak flows, greatly reducing the required pumping rate compared to that without the provision of detention storage.

Utilizing an annual interest rate of 6 percent and a project life and analysis period of 50 years, the average annual cost of this alternative plan is estimated to be about $104,000. This cost consists of the amortization of the $1,489,600 capital cost and $9,490 in annual operation and maintenance costs. As set forth in Table 6, the capital costs are apportioned as follows: $464,800 or 31 percent of the total, to Racine County Farm Drainage District No. 1; $217,100, or 15 percent of the total, to the Village of Waterford; $51,200, or 3 percent of the total, to the Wisconsin Department of Transportation; and $452,600, or 30 percent of the total, to the private sector. The remaining $303,900, or 21 percent, would be shared by the Farm Drainage District and the Village of Waterford.

ALTERNATIVE PLAN NO. 3B - DECENTRALIZED PUMPING AND CENTRALIZED DETENTION STORAGE WITH AN OPEN CHANNEL

As shown in graphic summary form on Maps 7 and 14, Alternative Plan No. 3B is the same as Alternative No. 3A, with the exception that all of the runoff from a 10-year recurrence interval storm is not pumped. Only the stormwater runoff from the area tributary to the Foxmead basin is to be pumped. The remainder would drain by gravity flow in a 1,000-foot-long, trapezoidal, turf-lined open channel which would be constructed from the outlet of Detention Basin No. 2 to the upstream end of the proposed 91-inch-wide by 58-inch-high HE culvert, conveying outflow from the detention basin and bypassing a proposed enlarged

Table 6

COMPONENTS AND COSTS OF ALTERNATIVE PLAN NO. 3A FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA-DECENTRALIZED PUMPING AND CENTRALIZED DETENTION STORAGE

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1	Tile Line A5	1. Replace 620 feet of 12-inch-diameter drain tile with 18-inch-diameter perforated corrugated plastic pipe	$ 9,300	$ 250
	Tile Line A4	2. Replace 630 feet of 8-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	6,100	250
		3. Replace 320 feet of 10-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	3,100	130
	Tile Line A	4. Replace 340 feet of 14-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	11,200	140
		5. Replace 330 feet of 16-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	10,900	130
		6. Replace 1,220 feet of 16-inch-diameter drain tile with 36-inch-diameter perforated corrugated plastic pipe	81,300	230
		7. Replace 595 feet of 16-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	39,600	110
		8. Replace 505 feet of 18-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	33,600	100
		9. Replace and reroute 1,530 feet of 18-inch-diameter drain tile with 1,820 feet of 36-inch-diameter perforated corrugated plastic pipe	121,300	350
	Tile Line B2	10. Replace 280 feet of 12-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,700	110
		11. Replace and reroute 580 feet of 12-inch-diameter drain tile with 640 feet of 15-inch-diameter sealed corrugated plastic pipe to avoid draining adjacent wetland	6,200	260
		12. Replace and reroute 560 feet of 14-inch-diameter drain tile with 860 feet of 15-inch-diameter sealed corrugated plastic pipe at an 0.08 percent slope to avoid draining the adjacent wetland	8,300	340
		13. Replace 230 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,200	90
	Tile Line B	14. Replace 140 feet of 8-inch-diameter drain tile with 12-inch-diameter reinforced concrete pipe	6,700	60
	Tile Line MAIN	15. Replace and extend 1,015 feet of mixed 24-, 27-, and 30-inch diameter drain tile with 1,145 feet of 36-inch diameter sealed corrugated plastic pipe	76,300	220
		16. Construct a new lift station at the site of the existing Farm Drainage District station. Provide one pump with a capacity of 4 cfs (1,790 gpm) and one pump with a capacity of 3 cfs (1,350 gpm)	46,000	600

Table 6 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1		Subtotal	$ 464,800	$ 3,370
Village of Waterford	--	17. Replace the existing 60-inch diameter corrugated metal pipe culvert at the study area outlet with a 600-foot-long, 91-inch wide by 58-inch high horizontal elliptical reinforced concrete pipe	$ 217,100	$ 110
Village of Waterford		Subtotals	$ 217,100	$ 110
Costs Shared by the Farm Drainage District and the Village of Waterford	Tile Line B	18. Replace and extend 12 feet of 24-inch-diameter drain tile, 56 feet of 27-inch-diameter drain tile, and 63 feet of 30-inch-diameter reinforced concrete storm sewer with 185 feet of 30-inch-diameter reinforced concrete storm sewer	$ 18,500	$ 70
	Subbasin 18B	19. Construct a new pump station at the site of the proposed Detention Basin No. 2. Provide three pumps: one with a capacity of 31 cfs (13,900 gpm), one with a capacity of 11 cfs (4,930 gpm), and one with a capacity of 6 cfs (2,690 gpm)	126,000	700
	--	20. Install 1,100 lineal feet of 36-inch diameter steel discharge pipe from the pump station called for under Item 27 to the upstream end of the proposed 91-inch by 58-inch HE culvert	159,400	210
Costs Shared by the Farm Drainage District and the Village of Waterford		Subtotals	$ 303,900	$ 980
Wisconsin Department of Transporation	Tile Line A3	21. Replace 240 feet of 6-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe if found to be damaged when STH 36 is widened	$ 11,500	$ 100
	Tile Line A	22. Replace 140 feet of 15-inch-diameter corrugated metal pipe under STH 164 with 24-inch-diameter reinforced concrete pipe	10,100	60
	Tile Line B2	23. Replace 335 feet of 15-inch-diameter corrugated metal pipe under STH 36 with 15-inch-diameter reinforced concrete pipe	18,100	130
	Tile Line B4	24. Replace 240 feet of 8-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe	11,500	100
Wisconsin Department of Transportation		Subtotals	$ 51,200	$ 390
Private Sector	Subbasins 9 and 10	25. Construct 300 feet of 24-inch-diameter storm sewer to convey agricultural runoff and runoff from proposed development to the Foxmead detention basin	$ 21,300	$ 120
		26. Construct 550 feet of 30-inch-diameter storm sewer to serve planned development	48,300	220
	Subbasin 14	27. Construct a 1.6-acre-foot dry detention basin to serve planned development. Detention Basin No.1	$ 67,300	$ 1,200

Table 6 (cont'd)

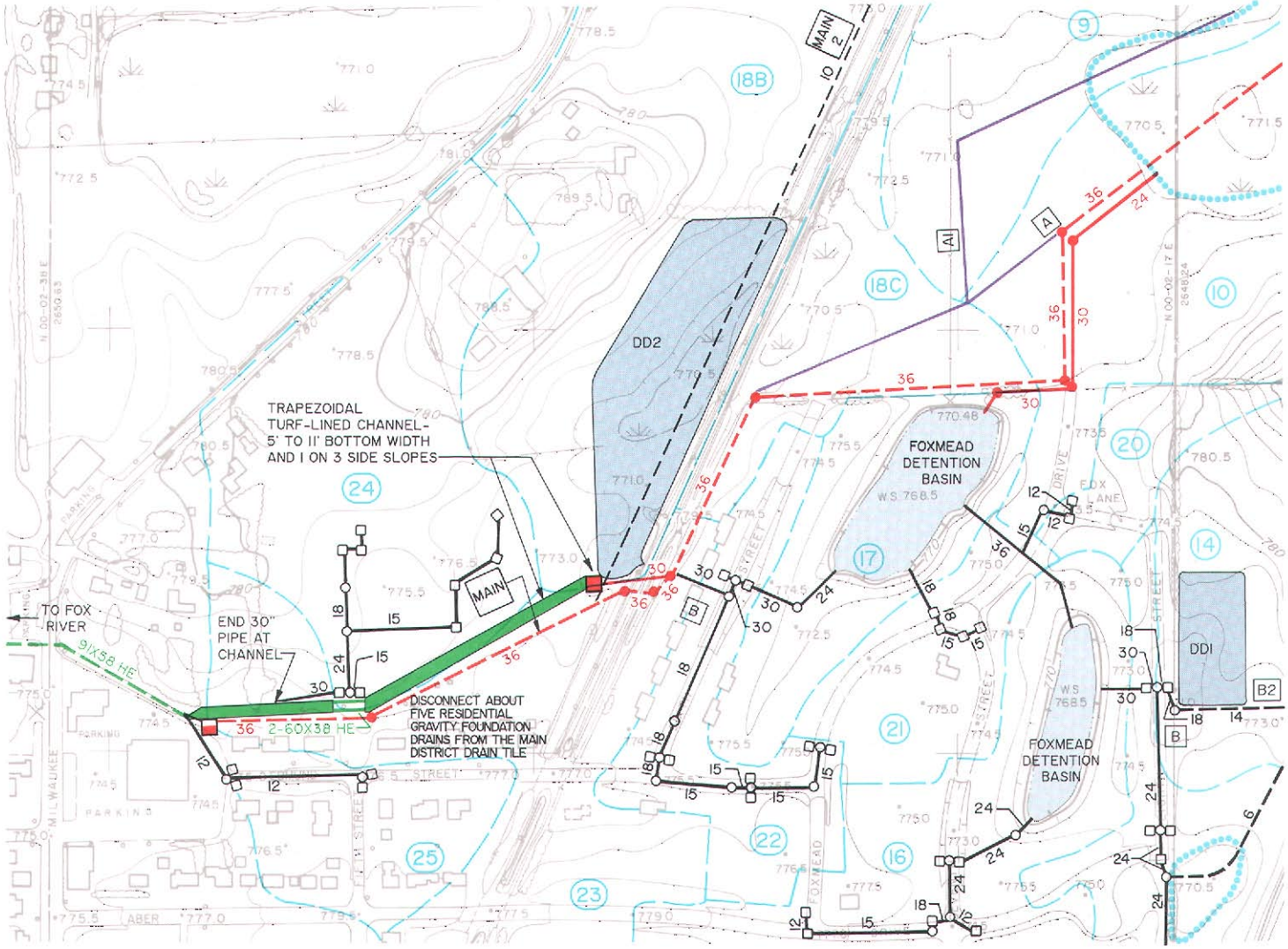
Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Private Sector	Subbasin 18B	28. Construct a 10.7-acre-foot dry detention basin. Basin would primarily serve planned development. Detention Basin No. 2	$ 314,700	$ 3,100
	Subbasins 23 and 25	29. Disconnect about five residential gravity foundation drains from the main District drain tile	1,000	0
Private Sector		Subtotals	$ 452,600	$ 4,640
		TOTAL	$1,489,600	$ 9,490
		ANNUAL EQUIVALENT COST	$ 104,000	

[a]Costs for 1993 Engineering News-Record Construction Cost Index = 5,390. Costs include engineering, administration, and contingencies.

Source: SEWRPC.

Map 14

ALTERNATIVE PLAN NO. 3B FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA—DECENTRALIZED PUMPING AND CENTRALIZED DETENTION STORAGE WITH AN OPEN CHANNEL[a]



LEGEND

- SUBBASIN BOUNDARY
- (10) SUBBASIN DESIGNATION
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- 18 A — EXISTING DISTRICT TILE, WITH SIZE IN INCHES, AND DESIGNATION
- 24 — EXISTING VILLAGE OF WATERFORD STORM SEWER WITH SIZE IN INCHES, AND MANHOLE TO BE RETAINED
- EXISTING STORMWATER INLET
- EXISTING DRAIN TILE TO BE ABANDONED UNDER PLANNED DEVELOPMENT CONDITIONS
- 30 — PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE
- 2-60X38 HE — PROPOSED CULVERT AND SIZE IN INCHES
- 9IX58 HE — PROPOSED REPLACEMENT CULVERT, AND SIZE IN INCHES
- 36 — PROPOSED DRAIN TILE, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE DISTRICT DRAIN TILE (TO BE SEALED IN EXISTING WETLANDS)
- PROPOSED REPLACEMENT LIFT STATION-ONE 4cfs (1,790gpm) PUMP, AND ONE 3cfs (1,350gpm) PUMP
- PROPOSED LIFT STATION-ONE 11cfs (4,930gpm) PUMP, ONE 6cfs (2,690gpm) PUMP-DISCHARGE TO OPEN CHANNEL
- PROPOSED OPEN CHANNEL
- EXISTING WET DETENTION BASIN TO BE RETAINED
- DD2 — PROPOSED DRY DETENTION BASIN AND DESIGNATION

[a] SEE MAP 7 FOR THE COMPONENTS OF THIS ALTERNATE PLAN IN AREAS OUTSIDE OF THE BOUNDARIES OF THIS MAP.

GRAPHIC SCALE
0 200 400 FEET

Source: SEWRPC.

lift station at the site of the existing station. Two 60-inch-wide by 38-inch-high HE reinforced concrete pipe culverts, each 65 feet long would be installed under 5th Street to convey flow in the proposed channel. That installation would require realignment of the existing 8-inch diameter water main in 5th Street to avoid the proposed culverts. The downstream portion of the existing 30-inch-diameter reinforced concrete storm sewer at the outlet of Subbasin 24 could be removed, allowing the storm sewer to discharge directly to the proposed channel. Construction of the channel enables reducing the size of the lift station to be constructed downstream of Detention Basin No. 2. Under this alternative that station would pump a peak 10-year recurrence interval outflow of 17 cfs, or 7,620 gpm. That station would have a 50-foot-long, 18-inch diameter steel discharge line running to the proposed open channel.

Utilizing an annual interest rate of 6 percent and a project life and analysis period of 50 years, the average annual cost of this alternative plan is estimated to be about $97,000. This cost consists of the amortization of the $1,375,600 capital cost and $9,520 in annual operation and maintenance costs. As set forth in Table 7, the capital costs are apportioned as follows: $464,800, or 34 percent of the total, to Racine County Farm Drainage District No. 1; $332,500, or 24 percent of the total, to the Village of Waterford; $51,200, or 4 percent of the total, to the Wisconsin Department of Transportation; and $452,600, or 33 percent of the total, to the private sector. The remaining $74,500, or 5 percent, would be shared by the Farm Drainage District and the Village of Waterford.

ALTERNATIVE PLAN NO. 4A - CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN INTERMEDIATE LIFT STATION

As shown in graphic summary form on Maps 7 and 15, Alternative Plan No. 4A is the same as Alternative No. 1A, with the exception that an intermediate lift station would be provided in drain tile Line A just to the west of the Village corporate limits. That in-line station would be provided to lift agricultural runoff to a higher elevation, enabling proposed downstream drain tile and storm sewer lines to be constructed at shallower depths and reducing construction costs for those pipelines. The proposed intermediate station would have a capacity of 6.7 cfs, or 3,000 gpm. The lift station proposed to be located at the study area outlet would have the same 48 cfs, or 21,530 gpm capacity, as under Alternative No. 1A, but the head against which the proposed pump would work would be reduced from about 15 feet under Alternative 1A to 11 feet under this alternative.

Utilizing an annual interest rate of 6 percent and a project life and amortization period of 50 years, the average annual cost of this alternative plan is estimated to be about $104,000. This cost consists of the amortization of the $1,406,900 capital cost and $9,200 in annual operation and maintenance costs. As set forth in Table 8, the capital costs are apportioned as follows: $378,500, or 27 percent of the total, to Racine County Farm Drainage District No. 1; $217,100, or 15 percent of the total, to the Village of Waterford; $51,200, or 4 percent of the total, to the Wisconsin Department of Transportation; and $451,600, or 32 percent of the total, to the private sector. The remaining $308,500, or 22 percent, would be shared by the Farm Drainage District and the Village of Waterford.

Table 7

COMPONENTS AND COSTS OF ALTERNATIVE PLAN NO. 3B FOR AGRICULTURAL DRAINAGE AND AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA--DECENTRALIZED PUMPING AND CENTRALIZED DETENTION STORAGE WITH AN OPEN CHANNEL

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1	Tile Line A5	1. Replace 620 feet of 12-inch-diameter Farm Drainage drain tile with 18-inch-diameter perforated corrugated plastic pipe	$ 9,300	$ 250
	Tile Line A4	2. Replace 630 feet of 8-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	6,100	250
		3. Replace 320 feet of 10-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	3,100	130
	Tile Line A	4. Replace 340 feet of 14-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	11,200	140
		5. Replace 330 feet of 16-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	10,900	130
		6. Replace 1,220 feet of 16-inch-diameter drain tile with 36-inch-diameter perforated corrugated plastic pipe	81,300	230
		7. Replace 595 feet of 16-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	39,600	110
		8. Replace 505 feet of 18-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	33,600	100
		9. Replace and reroute 1,530 feet of 18-inch diameter drain tile with 1,820 feet of 36-inch diameter perforated corrugated plastic pipe	121,300	350
	Tile Line B2	10. Replace 280 feet of 12-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,700	110
		11. Replace and reroute 580 feet of 12-inch-diameter drain tile with 640 feet of 15-inch-diameter sealed corrugated plastic pipe to avoid draining adjacent wetland	6,200	260
		12. Replace and reroute 560 feet of 14-inch-diameter drain tile with 860 feet of 15-inch-diameter sealed corrugated plastic pipe at an 0.08 percent slope to avoid draining the adjacent wetland	8,300	340
		13. Replace 230 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,200	90
	Tile Line B	14. Replace 140 feet of 8-inch-diameter drain tile with 12-inch-diameter reinforced concrete pipe	6,700	60

Table 7 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1	Tile Line MAIN	15. Replace and extend 1,015 feet of mixed 24-, 27-, and 30-inch diameter drain tile with 1,145 feet of 36-inch diameter sealed corrugated plastic pipe	$ 76,300	$ 220
	--	16. Construct a new lift station at the site of the existing Farm Drainage District station. Provide one pump with a capacity of 4 cfs (1,790 gpm) and one pump with a capacity of 3 cfs (1,350 gpm)	46,000	600
Racine County Farm Drainage District No. 1		Subtotals	$ 464,800	$ 3,370
Village of Waterford	--	17. Replace the existing 60-inch diameter corrugated metal pipe culvert at the study area outlet with a 600-foot-long, 91-inch wide by 58-inch high horizontal elliptical reinforced concrete pipe	$ 217,100	$ 110
	--	18. Construct a 1,000-foot-long, trapezoidal, turf-lined open channel from the outlet of Detention Basin 2 to the upstream end of the proposed 91-inch by 58-inch HE culvert	85,000	500
	Fifth Street	19. Install a double 60-inch-wide by 38-inch-high reinforced concrete culvert with a total pipe length of 130 feet. Relocate 8-inch diameter water main in 5th Street.	30,400	20
Village of Waterford		Subtotals	$ 332,500	$ 630
Costs Shared by the Farm Drainage District and the Village of Waterford	Tile Line B	20. Replace and extend 12 feet of 24-inch-diameter drain tile, 56 feet of 27-inch-diameter drain tile, and 63 feet of 30-inch-diameter reinforced concrete storm sewer with 185 feet of 30-inch diameter reinforced concrete storm sewer	$ 18,500	$ 70
	Subbasin 18B	21. Construct a new lift station south of proposed Detention Basin No. 2. Provide two pumps: one with a capacity of 11 cfs (4,930 gpm) and one with a capacity of 6 cfs (2,690 gpm)	53,000	400
	--	22. Install 50 lineal feet of 18-inch diameter steel discharge pipe from the lift station called for under Item 21 to the upstream end of the proposed open channel called for under Item 18	3,000	20
Costs Shared by the Farm Drainage District and the Village of Waterford		Subtotals	$ 74,500	$ 490
Wisconsin Department of Transportation	Tile Line A3	23. Replace 240 feet of 6-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe if found to be damaged when STH 36 is widened	$ 11,500	$ 100
	Tile Line A	24. Replace 140 feet of 15-inch-diameter corrugated metal pipe under STH 164 with 24-inch-diameter reinforced concrete pipe	$ 10,100	$ 60

Table 7 (cont'd)

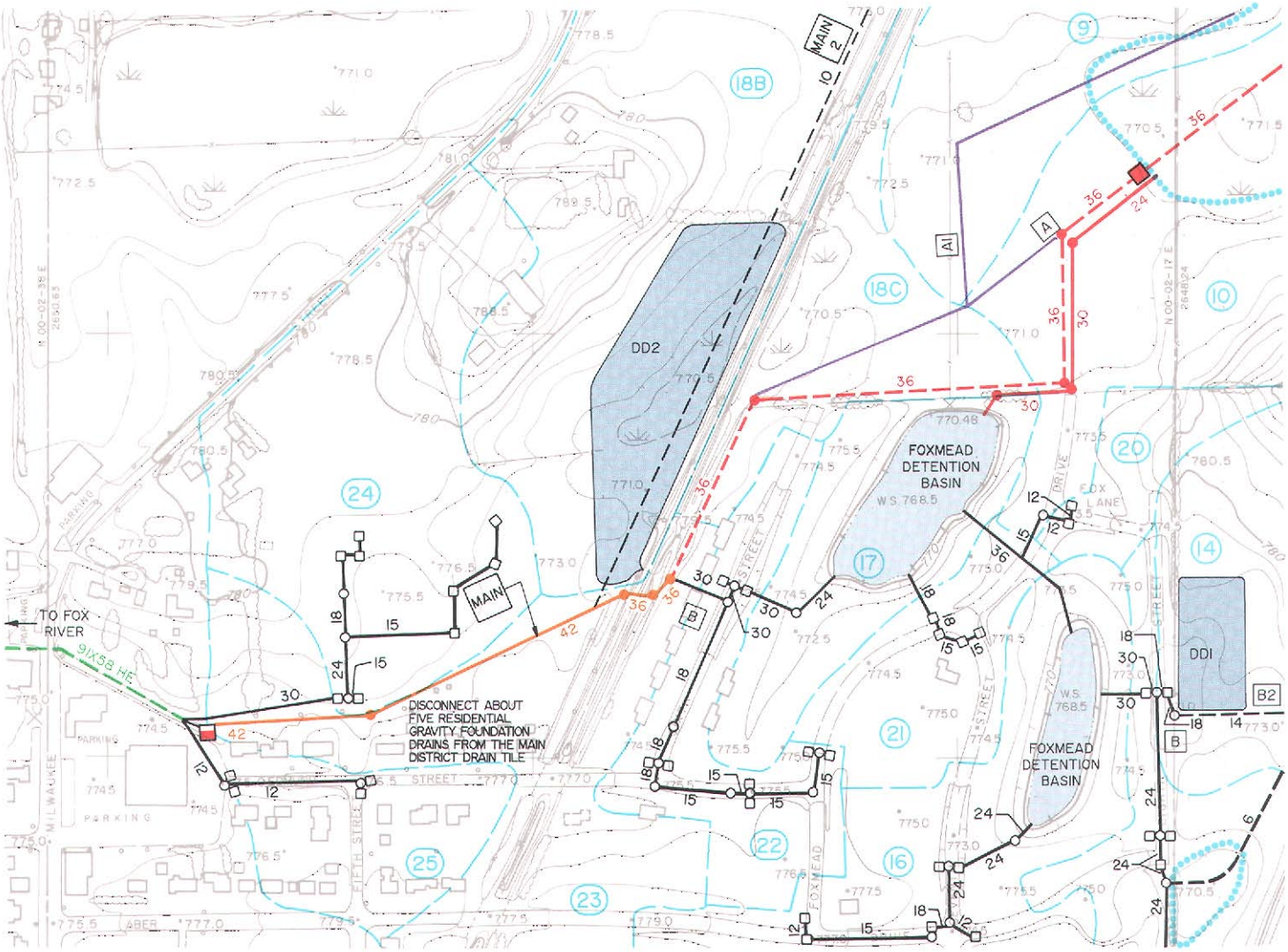
Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Wisconsin Department of Transportation	Tile Line B2	25. Replace 335 feet of 15-inch-diameter corrugated metal pipe under STH 36 with 15-inch-diameter reinforced concrete pipe	$ 18,100	$ 130
	Tile Line B4	26. Replace 240 feet of 8-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe	11,500	100
Wisconsin Department of Transportation		Subtotals	$ 51,200	$ 390
Private Sector	Subbasins 9 and 10	27. Construct 300 feet of 24-inch-diameter storm sewer to convey agricultural runoff and runoff from proposed development to the Foxmead detention basin	$ 21,300	$ 120
		28. Construct 550 feet of 30-inch-diameter storm sewer to serve planned development	48,300	220
	Subbasin 14	29. Construct a 1.6-acre-foot dry detention basin to serve planned development. Detention Basin No. 1	67,300	1,200
	Subbasin 18B	30. Construct a 10.7-acre-foot dry detention basin with an impervious liner. Basin would primarily serve planned development. Detention Basin No. 2	314,700	3,100
	Subbasins 23 and 25	31. Disconnect about five residential gravity foundation drains from the main District drain tile	1,000	0
Private Sector		Subtotals	$ 452,600	$ 4,640
		TOTAL	$1,375,600	$ 9,520
		EQUIVALENT ANNUAL COST	$ 97,000	

[a]Costs for 1993 Engineering News-Record Construction Cost Index = 5,390. Costs include engineering, administration, and contingencies.

Source: SEWRPC.

Map 15

ALTERNATIVE PLAN NO. 4A FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA—CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN INTERMEDIATE LIFT STATION[a]



LEGEND

- SUBBASIN BOUNDARY
- SUBBASIN DESIGNATION
- WETLAND BOUNDARIES AS SHOWN ON 1990 SEWRPC LAND USE INVENTORY MAPS
- 18 A — EXISTING DISTRICT TILE, WITH SIZE IN INCHES, AND DESIGNATION
- 24 — EXISTING VILLAGE OF WATERFORD STORM SEWER WITH SIZE IN INCHES, AND MANHOLE TO BE RETAINED
- EXISTING STORMWATER INLET
- EXISTING DRAIN TILE TO BE ABANDONED UNDER PLANNED DEVELOPMENT CONDITIONS
- 30 — PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE
- 36 — PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE EXISTING DRAIN TILE OR STORM SEWER
- 91X58 HE — PROPOSED REPLACEMENT CULVERT, AND SIZE IN INCHES
- 36 — PROPOSED DRAIN TILE, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE DISTRICT DRAIN TILE (TO BE SEALED IN EXISTING WETLANDS)
- PROPOSED REPLACEMENT LIFT STATION-ONE 33cfs (14,810gpm) PUMP, AND ONE 15cfs (6,720gpm) PUMP
- PROPOSED LIFT STATION-ONE 6.7cfs (3,000gpm) PUMP
- EXISTING WET DETENTION BASIN TO BE RETAINED
- DD2 — PROPOSED DRY DETENTION BASIN AND DESIGNATION

[a] SEE MAP 7 FOR THE COMPONENTS OF THIS ALTERNATE PLAN IN AREAS OUTSIDE OF THE BOUNDARIES OF THIS MAP.

GRAPHIC SCALE
0 200 400 FEET

Source: SEWRPC.

Table 8

COMPONENTS AND COSTS OF ALTERNATIVE PLAN NO. 4A FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA--CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN INTERMEDIATE LIFT STATION

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1	Tile Line A5	1. Replace 620 feet of 12-inch-diameter drain tile with 18-inch-diameter perforated corrugated plastic pipe	$ 9,300	$ 250
	Tile Line A4	2. Replace 630 feet of 8-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	6,100	250
		3. Replace 320 feet of 10-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	3,100	130
	Tile Line A	4. Replace 340 feet of 14-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	11,200	140
		5. Replace 330 feet of 16-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	10,900	130
		6. Replace 1,220 feet of 16-inch-diameter drain tile with 36-inch-diameter perforated corrugated plastic pipe	81,300	230
		7. Replace 595 feet of 16-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	39,600	110
		8. Replace 505 feet of 18-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	33,600	100
		9. Construct a new lift station west of the wetland in Subbasin 10. Provide one pump with a capacity of 6.7 cfs (3,000 gpm)	36,000	400
		10. Replace and reroute 1,530 feet of 18-inch diameter drain tile with 1,820 feet of 36-inch-diameter perforated corrugated plastic pipe	121,300	350
	Tile Line B2	11. Replace 280 feet of 12-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,700	110
		12. Replace and reroute 580 feet of 12-inch diameter drain tile with 640 feet of 15-inch diameter sealed corrugated plastic pipe to avoid draining adjacent wetland	6,200	260
		13. Replace and reroute 560 feet of 14-inch diameter drain tile with 860 feet of 15-inch diameter sealed corrugated plastic pipe at an 0.08 percent slope to avoid draining the adjacent wetland	8,300	340
		14. Replace 230 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,200	90

Table 8 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
	Tile Line B	15. Replace 140 feet of 8-inch-diameter drain tile with 12-inch-diameter reinforced concrete pipe	$ 6,700	$ 60
Racine County Farm Drainage District No. 1		Subtotals	$ 378,500	$ 2,950
Village of Waterford	--	16. Replace the existing 60-inch diameter corrugated metal pipe culvert at the study area outlet with a 600-foot-long, 91-inch wide by 58-inch high horizontal elliptical reinforced concrete pipe	217,100	110
Village of Waterford		Subtotals	$ 217,100	$ 110
Costs Shared by the Farm Drainage District and the Village of Waterford	Tile Line B	17. Replace 12 feet of 24-inch-diameter drain tile, 56 feet of 27-inch-diameter drain tile, and 63 feet of 30-inch-diameter reinforced concrete storm sewer with 131 feet of 36-inch-diameter reinforced concrete storm sewer	$ 25,300	$ 20
	Tile Line MAIN	18. Replace 1,015 feet of mixed 24-, 27-, and 30-inch diameter drain tile with 42-inch diameter reinforced concrete storm sewer	153,200	190
	--	19. Construct a new lift station at the site of the existing Farm Drainage District station. Provide one pump with a capacity of 33 cfs (14,810 gpm) and one pump with a capacity of 15 cfs (6,720 gpm), both at a head of 10 feet	130,000	900
Costs Shared by the Farm Drainage District and the Village of Waterford		Subtotals	$ 308,500	$ 1,110
Wisconsin Department of Transportation	Tile Line A3	20. Replace 240 feet of 6-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe if found to be damaged when STH 36 is widened	$ 11,500	$ 100
	Tile Line A	21. Replace 140 feet of 15-inch-diameter corrugated metal pipe under STH 164 with 24-inch-diameter reinforced concrete pipe	10,100	60
	Tile Line B2	22. Replace 335 feet of 15-inch-diameter corrugated metal pipe under STH 36 with 15-inch-diameter reinforced concrete pipe	18,100	130
	Tile Line B4	23. Replace 240 feet of 8-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe	11,500	100
Department of Transportation		Subtotals	$ 51,200	$ 390
Private Sector	Subbasins 9 and 10	24. Construct 300 feet of 24-inch-diameter storm sewer to serve planned development	21,300	120
		25. Construct 550 feet of 30-inch-diameter storm sewer to serve planned development	48,300	220

Table 8 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Private Sector	Subbasin 14	26. Construct a 1.6-acre-foot dry detention basin to serve planned development. Detention Basin No. 1	$ 67,300	$ 1,200
	Subbasin 18B	27. Construct a 10.7-acre-foot dry detention basin. Basin would primarily serve planned development. Detention Basin No.2	314,700	3,100
	Subbasins 23 and 25	28. Disconnect about five residential gravity foundation drains from the main District drain tile	1,000	0
Private Sector		Subtotals	$ 451,600	$ 4,640
		TOTAL	$1,406,900	$ 9,200
		EQUIVALENT ANNUAL COST	$ 99,000	

[a]Costs for 1993 Engineering News-Record Construction Cost Index = 5,390. Costs include engineering, administration, and contingencies.

Source: SEWRPC.

ALTERNATIVE PLAN NO. 4B - CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL AND AN INTERMEDIATE LIFT STATION

As shown in graphic summary form on Maps 7 and 16, Alternative Plan No. 4B is the same as Alternative No. 4A, with the exception that all of the runoff from a 10-year recurrence interval storm is not pumped and an impervious liner is provided for Detention Basin No. 2. Only the stormwater runoff from the area tributary to the Foxmead basin is to be pumped. The remainder would drain by gravity flow in a 1,000-foot-long, trapezoidal, turf-lined open channel which would be constructed from the outlet of Detention Basin No. 2 to the upstream end of the proposed 91-inch-wide by 58-inch-high HE culvert, conveying outflow from the detention basin and bypassing the lift station which is proposed to be constructed at the site of the existing station. Two 60-inch-wide by 38-inch-high HE reinforced concrete pipe culverts, each 65 feet long would be installed under 5th Street to convey flow in the proposed channel. That installation would require realignment of the existing 8-inch diameter water main in 5th Street to avoid the proposed culverts. The downstream portion of the existing 30-inch-diameter reinforced concrete storm sewer at the outlet of Subbasin 24 could be removed, allowing the storm sewer to discharge directly to the proposed channel. Construction of the channel enables elimination of the Detention Basin No. 2 pump station which is proposed to be constructed under Alternative No. 4A. The impervious liner is provided for Detention Basin No. 2 to limit pumping costs by eliminating seepage from the basin as a source of inflow to the lift station.

Under this alternative, a station which would pump a peak 10-year recurrence interval outflow of 17 cfs, or 7,620 gpm, would be located at the site of the existing District lift station. The mixed 24-, 27-, and 30-inch diameter drain tiles which discharge to the existing station would be replaced with 36-inch diameter reinforced concrete storm sewer.

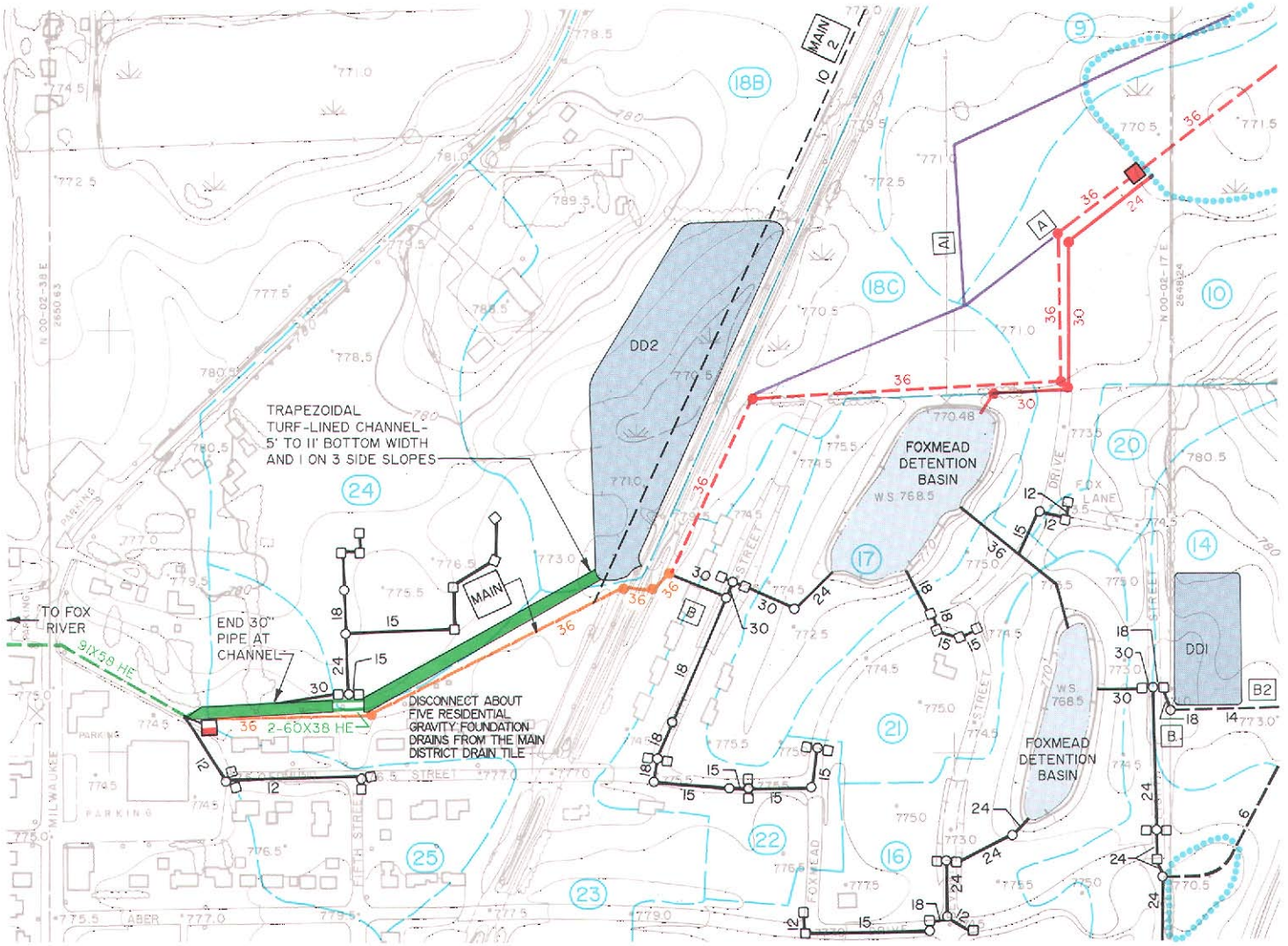
Utilizing an annual interest rate of 6 percent and a project life and analysis period of 50 years, the average annual cost of this alternative plan is estimated to be about $104,000. This cost consists of the amortization of the $1,491,400 capital cost and $9,620 in annual operation and maintenance costs. As set forth in Table 9, the capital costs are apportioned as follows: $378,500, or 26 percent of the total, to Racine County Farm Drainage District No. 1; $332,500, or 22 percent of the total, to the Village of Waterford; $51,200, or 3 percent of the total, to the Wisconsin Department of Transportation; and $536,600, or 36 percent of the total, to the private sector. The remaining $192,600, or 13 percent, would be shared by the Farm Drainage District and the Village of Waterford.

ALTERNATIVE PLAN NO. 5A - CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL AND LIMITATIONS ON DRAIN TILE CAPACITIES

Alternative Plan No. 5A is intended to provide some improvement in the agricultural drainage system, although it would not fully meet the criterion set forth in Chapter IV of this report, and to provide an urban stormwater drainage system which meets the capacity criteria established in Chapter IV. As shown on Maps 8 and 17, this alternative plan calls for the replacement of about 6,170 lineal feet of existing 8- to 18-inch diameter agricultural drain tile with about 6,820 lineal feet of 12- to 24-inch diameter corrugated plastic pipe; the replacement of about 140 lineal feet of existing 8-inch diameter drain tile with 12-inch diameter reinforced concrete pipe; the replacement of about 960 lineal feet of

Map 16

ALTERNATIVE PLAN NO. 4B FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA—CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL AND AN INTERMEDIATE LIFT STATION[a]



LEGEND

- SUBBASIN BOUNDARY
- SUBBASIN DESIGNATION
- WETLAND BOUNDARIES AS SHOWN ON 1990 SEWRPC LAND USE INVENTORY MAPS
- EXISTING DISTRICT TILE, WITH SIZE IN INCHES, AND DESIGNATION
- EXISTING VILLAGE OF WATERFORD STORM SEWER WITH SIZE IN INCHES, AND MANHOLE TO BE RETAINED
- EXISTING STORMWATER INLET
- EXISTING DRAIN TILE TO BE ABANDONED UNDER PLANNED DEVELOPMENT CONDITIONS
- PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE
- PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE EXISTING DRAIN TILE OR STORM SEWER
- PROPOSED CULVERT AND SIZE IN INCHES
- PROPOSED REPLACEMENT CULVERT, AND SIZE IN INCHES
- PROPOSED DRAIN TILE, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE DISTRICT DRAIN TILE (TO BE SEALED IN EXISTING WETLANDS)
- PROPOSED REPLACEMENT LIFT STATION-ONE 11cfs (4,930gpm) PUMP, AND ONE 6cfs (2,690gpm) PUMP
- PROPOSED LIFT STATION-ONE 6.7cfs (3,000gpm) PUMP
- PROPOSED OPEN CHANNEL
- EXISTING WET DETENTION BASIN TO BE RETAINED
- PROPOSED DRY DETENTION BASIN AND DESIGNATION

[a] SEE MAP 7 FOR THE COMPONENTS OF THIS ALTERNATE PLAN IN AREAS OUTSIDE OF THE BOUNDARIES OF THIS MAP.

GRAPHIC SCALE
0 200 400 FEET

Source: SEWRPC.

Table 9

COMPONENTS AND COSTS OF ALTERNATIVE PLAN NO. 4B FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA--CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL AND AN INTERMEDIATE LIFT STATION

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1	Tile Line A5	1. Replace 620 feet of 12-inch-diameter drain tile with 18-inch-diameter perforated corrugated plastic pipe	$ 9,300	$ 250
	Tile Line A4	2. Replace 630 feet of 8-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	6,100	250
		3. Replace 320 feet of 10-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	3,100	130
	Tile Line A	4. Replace 340 feet of 14-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	11,200	140
		5. Replace 330 feet of 16-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	10,900	130
		6. Replace 1,220 feet of 16-inch-diameter drain tile with 36-inch-diameter perforated corrugated plastic pipe	81,300	230
		7. Replace 595 feet of 16-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	39,600	110
		8. Replace 505 feet of 18-inch-diameter drain tile with 36-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	33,600	100
		9. Construct a new lift station west of the wetland in Subbasin 10. Provide one one pump with a capacity of 6.7 cfs (3,000 gpm)	36,000	400
		10. Replace and reroute 1,530 feet of 18-inch diameter drain tile with 1,820 feet of 36-inch-diameter perforated corrugated plastic pipe	121,300	350
	Tile Line B2	11. Replace 280 feet of 12-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,700	110
		12. Replace and reroute 580 feet of 12-inch diameter drain tile with 640 feet of 15-inch diameter sealed corrugated plastic pipe to avoid draining adjacent wetland	6,200	260
		13. Replace and reroute 560 feet of 14-inch diameter drain tile with 860 feet of 15-inch diameter sealed corrugated plastic pipe at an 0.08 percent slope to avoid draining the adjacent wetland	8,300	340

Table 9 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1	Tile Line B2	14. Replace 230 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	$ 2,200	$ 90
	Tile Line B	15. Replace 140 feet of 8-inch-diameter drain tile with 12-inch-diameter reinforced concrete pipe	6,700	60
Racine County Farm Drainage District No. 1		Subtotals	$ 378,500	$ 2,950
Village of Waterford	--	16. Replace the existing 60-inch diameter high corrugated metal pipe culvert at the study area outlet with a 600-foot-long, 91-inch wide by 58-inch high horizontal elliptical reinforced concrete pipe	$ 217,100	$ 110
	--	17. Construct a 1,000-foot-long, trapezoidal, turf-lined open channel from the outlet of Detention Basin 2 to the upstream end of the proposed 91-inch by 58-inch HE culvert	85,000	500
	Fifth Street	18. Install a double 60-inch-wide by 38-inch-high HE reinforced concrete culvert with a total pipe length of 130 feet. Relocate 8-inch diameter water main in 5th Street.	30,400	20
Village of Waterford		Subtotals	$ 332,500	$ 630
Costs Shared by the Farm Drainage District and the Village of Waterford	Tile Line B	19. Replace 12 feet of 24-inch-diameter drain tile, 56 feet of 27-inch-diameter drain tile, and 63 feet of 30-inch-diameter reinforced concrete storm sewer with 131 feet of 36-inch diameter reinforced concrete storm sewer	$ 15,700	$ 20
	Tile Line MAIN	20. Replace 1,015 feet of mixed 24-, 27-, and 30-inch diameter drain tile with 36-inch diameter reinforced concrete storm sewer	121,900	190
	--	21. Construct a new lift station at the site of the existing Farm Drainage District station. Provide one pump with a capacity of 11 cfs (4,930 gpm) and one pump with a capacity of 6 cfs (2,690 gpm)	55,000	800
Costs Shared by the Farm Drainage District and the Village of Waterford		Subtotals	$ 192,600	$ 1,010
Wisconsin Department of Transportation	Tile Line A3	22. Replace 240 feet of 6-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe if found to be damaged when STH 36 is widened	$ 11,500	$ 100
	Tile Line A	23. Replace 140 feet of 15-inch-diameter corrugated metal pipe under STH 164 with 24-inch-diameter reinforced concrete pipe	10,100	60
	Tile Line B2	24. Replace 335 feet of 15-inch-diameter corrugated metal pipe under STH 36 with 15-inch-diameter reinforced concrete pipe	18,100	130

Table 9 (cont'd)

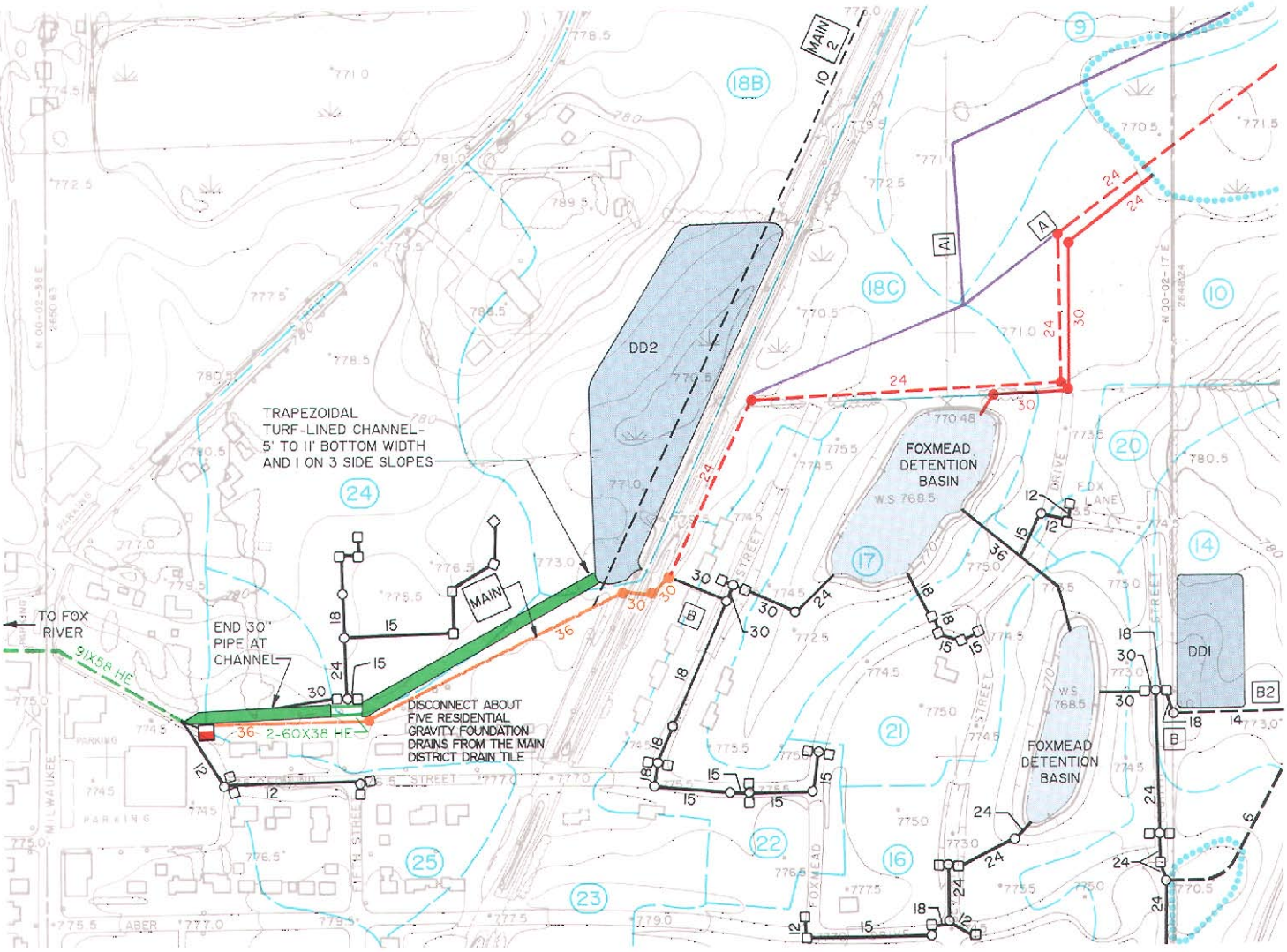
Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Wisconsin Department of Transportation	Tile Line B4	25. Replace 240 feet of 8-inch-diameter corrugated metal pipe under STH 36 with 12-inch diameter reinforced concrete pipe	$ 11,500	$ 100
Wisconsin Department of Transportation		Subtotals	$ 51,200	$ 390
Private Sector	Subbasins 9 and 10	26. Construct 300 feet of 24-inch-diameter storm sewer to serve planned development	$ 21,300	$ 120
		27. Construct 550 feet of 30-inch-diameter storm sewer to serve planned development	48,300	220
	Subbasin 14	28. Construct a 1.6-acre-foot dry detention basin to serve planned development. Detention Basin No. 1	67,300	1,200
	Subbasin 18B	29. Construct a 10.7-acre-foot dry detention basin with an impervious liner. Basin would primarily serve planned development. Detention Basin No.2	398,700	3,100
	Subbasins 23 and 25	30. Disconnect about five residential gravity foundation drains from the main District drain tile	1,000	0
Private Sector		Subtotals	$ 536,600	$ 4,640
		TOTAL	$1,491,400	$ 9,620
		EQUIVALENT ANNUAL COST	$ 104,000	

[a]Costs for 1993 Engineering News-Record Construction Cost Index = 5,390. Costs include engineering, administration, and contingencies.

Source: SEWRPC.

Map 17

ALTERNATIVE PLAN NO. 5A FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA—CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL AND LIMITATIONS ON DRAIN TILE CAPACITIES[a]



LEGEND

- SUBBASIN BOUNDARY
- (10) SUBBASIN DESIGNATION
- WETLAND BOUNDARIES AS SHOWN ON 1990 SEWRPC LAND USE INVENTORY MAPS
- 18 A — EXISTING DISTRICT TILE, WITH SIZE IN INCHES, AND DESIGNATION
- 24 — EXISTING VILLAGE OF WATERFORD STORM SEWER WITH SIZE IN INCHES, AND MANHOLE TO BE RETAINED
- EXISTING STORMWATER INLET
- EXISTING DRAIN TILE TO BE ABANDONED UNDER PLANNED DEVELOPMENT CONDITIONS
- 24 — PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE
- 36 — PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE EXISTING DRAIN TILE OR STORM SEWER
- 2-60X38 HE — PROPOSED CULVERT AND SIZE IN INCHES
- 91X58 HE — PROPOSED REPLACEMENT CULVERT, AND SIZE IN INCHES
- 24 — PROPOSED DRAIN TILE, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE DISTRICT DRAIN TILE (TO BE SEALED IN EXISTING WETLANDS)
- PROPOSED REPLACEMENT LIFT STATION-ONE 12cfs (5,380gpm) PUMP, AND ONE 5cfs (2,240gpm) PUMP
- PROPOSED OPEN CHANNEL
- EXISTING WET DETENTION BASIN TO BE RETAINED
- DD2 — PROPOSED DRY DETENTION BASIN AND DESIGNATION

[a] SEE MAP 8 FOR THE COMPONENTS OF THIS ALTERNATE PLAN IN AREAS OUTSIDE OF THE BOUNDARIES OF THIS MAP.

GRAPHIC SCALE
0 200 400 FEET

Source: SEWRPC.

existing 6- to 15-inch diameter corrugated metal pipe drain tile with 12- to 18-inch diameter reinforced concrete pipe; and the replacement of about 1,085 lineal feet of mixed 24-, 27-, and 30-inch diameter drain tile with 36-inch diameter reinforced concrete storm sewer. Where corrugated plastic pipe is called for, perforated pipe was generally used, except along portions of Lines A and B2 where 1,100 lineal feet and 1,500 lineal feet, respectively, of sealed corrugated plastic pipe is specified to avoid draining wetlands.

The alternative also calls for relaying 63 lineal feet of 30-inch diameter reinforced concrete storm sewer at a steeper slope; the construction of 300 lineal feet of 24-inch diameter and 550 lineal feet of 30-inch diameter reinforced concrete storm sewer to serve planned new development in Subbasins 9, 10, and 18C; the construction of the 1.6-acre-foot dry Detention Basin No. 1 to serve planned commercial development in the area between the Foxmead subdivision and STH 36; and the construction of the 10.7-acre-foot dry Detention Basin No. 2 with an impervious liner to primarily serve planned development in Subbasin 18B, but also to collect runoff from Subbasins 18C and 23.

All of the runoff from a 10-year recurrence interval storm is not pumped under this alternative. Instead, a 1,000-foot-long, trapezoidal, turf-lined open channel would be constructed from the outlet of Detention Basin No. 2 to the upstream end of the proposed 91-inch-wide by 58-inch-high HE culvert, conveying outflow from the proposed detention basin and bypassing the proposed lift station. Two 60-inch-wide by 38-inch-high HE reinforced concrete pipe culverts, each 65 feet long would be installed under 5th Street to convey flow in the proposed channel. That installation would require realignment of the existing 8-inch diameter water main in 5th Street to avoid the proposed culverts. The downstream portion of the existing 30-inch-diameter reinforced concrete storm sewer at the outlet of Subbasin 24 could be removed, allowing the storm sewer to discharge directly to the proposed channel. Construction of the channel enables the lift station which is proposed to be constructed at the site of the existing station to only pump the peak 10-year recurrence interval outflow from the area tributary to the Foxmead subdivision along with the agricultural runoff from lands upstream of Foxmead and from the area tributary to District drain tile Main 2. The station would have a required capacity of 17 cfs, or 7,620 gpm.

As under the other alternative plans, the existing 60-inch diameter corrugated metal pipe (CMP) culvert from the lift station outlet through N. Milwaukee Street to the Fox River would be replaced with a 600-foot-long, 91-inch-wide by 58-inch-high horizontal elliptical reinforced concrete pipe culvert. Also, it is recommended that the foundation drains of the five houses in the Village of Waterford along Edmund Street be disconnected from the main drain tile and that those houses rely on sump pumps to remove seepage collected in the foundation drains, discharging the sump pumps to the lawn areas. Disconnection of the foundation drains from the drain tile system would protect the houses against basement flooding if the pumps in the District lift station were to fail.

Utilizing an annual interest rate of 6 percent and a project life and analysis period of 50 years, the average annual cost of this alternative plan is estimated to be about $103,000. This cost consists of the amortization of the $1,320,100 capital cost and $9,470 in annual operation and maintenance costs. As set forth in Table 10, the capital costs are apportioned as follows: $171,200, or 13 percent of the total, to Racine County Farm Drainage District No. 1; $332,500, or 25 percent of the total, to the Village of Waterford; $49,300, or 4 percent of the total, to the Wisconsin Department of Transporta-

Table 10

COMPONENTS AND COSTS OF ALTERNATIVE PLAN NO. 5A FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA-- CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL AND LIMITATIONS ON DRAIN TILE CAPACITIES

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1	Tile Line A	1. Replace 340 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	$ 3,300	$ 140
		2. Replace 330 feet of 16-inch-diameter drain tile with 18-inch-diameter perforated corrugated plastic pipe	4,900	130
		3. Replace 1,220 feet of 16-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	40,300	490
		4. Replace 595 feet of 16-inch-diameter drain tile with 24-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	19,700	240
		5. Replace 505 feet of 18-inch-diameter drain tile with 24-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	16,700	200
		6. Replace and reroute 1,530 feet of 18-inch diameter drain tile with 1,820 feet of 24-inch diameter perforated corrugated plastic pipe	60,200	730
	Tile Line B2	7. Replace 280 feet of 12-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,700	110
		8. Replace and reroute 580 feet of 12-inch-diameter drain tile with 640 feet of 15-inch-diameter sealed corrugated plastic pipe to avoid draining adjacent wetland	6,200	260
		9. Replace and reroute 560 feet of 14-inch-diameter drain tile with 860 feet of 15-inch-diameter sealed corrugated plastic pipe at an 0.08 percent slope to avoid draining the adjacent wetland	8,300	340
		10. Replace 230 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,200	90
	Tile Line B	11. Replace 140 feet of 8-inch-diameter drain tile with 12-inch-diameter reinforced concrete pipe	6,700	60
Racine County Farm Drainage District No. 1		Subtotals	$ 171,200	$ 2,790
Village of Waterford	--	12. Replace the existing 60-inch diameter corrugated metal pipe culvert at the study area outlet with a 600-foot-long, 91-inch wide by 58-inch high horizontal elliptical reinforced concrete pipe	$ 217,100	$ 110
	--	13. Construct a 1,000-foot-long, trapezoidal, turf-lined open channel from the outlet of Detention Basin 2 to the upstream end of the proposed 91-inch by 58-inch HE culvert	85,000	500

Table 10 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Village of Waterford	Fifth Street	14. Install a double 60-inch-wide by 38-inch-high HE reinforced concrete culvert with a total pipe length of 130 feet. Relocate 8-inch diameter water main in 5th Street.	$ 30,400	$ 20
Village of Waterford		Subtotals	$ 332,500	$ 630
Costs Shared by the Farm Drainage District and the Village of Waterford	Tile Line B	15. Relay 63 feet of 30-inch-diameter reinforced concrete storm sewer at a steeper slope	$ 9,100	$ 30
	Tile Line MAIN	16. Replace 1,085 feet of mixed 24-, 27-, and 30-inch diameter drain tile with 36-inch diameter reinforced concrete storm sewer	163,400	210
	--	17. Construct a new lift station at the site of the existing Farm Drainage District station. Provide one pump with a capacity of 12 cfs (5,380 gpm) and one pump with a capacity of 5 cfs (2,240 gpm). Total head of about 11 feet	58,000	800
Costs Shared by the Farm Drainage District and the Village of Waterford		Subtotals	$ 230,500	$ 1,040
Wisconsin Department of Transportation	Tile Line A3	18. Replace 240 feet of 6-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe if found to be damaged when STH 36 is widened	$ 11,500	$ 100
	Tile Line A	19. Replace 140 feet of 15-inch-diameter corrugated metal pipe under STH 164 with 18-inch-diameter reinforced concrete pipe	8,200	60
	Tile Line B2	20. Replace 335 feet of 15-inch-diameter corrugated metal pipe under STH 36 with 15-inch-diameter reinforced concrete pipe	18,100	130
	Tile Line B4	21. Replace 240 feet of 8-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe	11,500	100
Wisconsin Department of Transportation		Subtotals	$ 49,300	$ 390
Private Sector	Subbasins 9 and 10	22. Construct 300 feet of 24-inch-diameter storm sewer to serve planned development	$ 21,300	$ 120
		23. Construct 550 feet of 30-inch-diameter storm sewer to serve planned development	48,300	220
	Subbasin 14	24. Construct a 1.6-acre-foot dry detention basin to serve planned development. Detention Basin No. 1	67,300	1,200
	Subbasin 18B	25. Construct a 10.7-acre-foot dry detention basin with an impervious liner. Basin would primarily serve planned development. Detention Basin No.2	$ 398,700	$ 3,100
	Subbasins 23 and 25	26. Disconnect about five residential gravity foundation drains from the main District drain tile	1,000	0

Table 10 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Private Sector		Subtotals	$ 536,600	$ 4,640
		TOTAL	$1,320,100	$ 9,490
		EQUIVALENT ANNUAL COST	$ 93,000	

[a]Costs for 1993 Engineering News-Record Construction Cost Index = 5,390. Costs include engineering, administration, and contingencies.

Source: SEWRPC.

tion; and $536,600, or 41 percent of the total, to the private sector. The remaining $230,500, or 17 percent, would be shared by the Farm Drainage District and the Village of Waterford.

ALTERNATIVE PLAN NO. 5B - CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL AND AN INTERMEDIATE LIFT STATION OF LIMITED CAPACITY

As shown in graphic summary form on Maps 8 and 18, Alternative Plan No. 5B is the same as Alternative Plan No. 5A, with the exception that an intermediate lift station would be provided in drain tile Line A just to the west of the Village corporate limits. That in-line station would be provided to lift agricultural runoff to a higher elevation, enabling proposed downstream drain tile and storm sewer lines to be constructed at shallower depths and reducing construction costs for those pipelines. The proposed intermediate station would have a capacity of 4.3 cfs, or 1,930 gpm. The lift station proposed to be located at the study area outlet would have the same 17 cfs, or 7,620 gpm capacity, as under Alternative No. 5A, but the head against which the proposed pump would work would be reduced from about 11 feet under Alternative 5A to 9 feet under this alternative.

Utilizing an annual interest rate of 6 percent and a project life and analysis period of 50 years, the average annual cost of this alternative plan is estimated to be about $93,000. This cost consists of the amortization of the $1,310,200 capital cost and $9,970 in annual operation and maintenance costs. As set forth in Table 11, the capital costs are apportioned as follows: $200,200, or 15 percent of the total, to Racine County Farm Drainage District No. 1; $332,500, or 25 percent of the total, to the Village of Waterford; $49,300, or 4 percent of the total, to the Wisconsin Department of Transportation; and $536,600, or 41 percent of the total, to the private sector. The remaining $191,600, or 15 percent, would be shared by the Farm Drainage District and the Village of Waterford.

COMPARISON OF ALTERNATIVE PLANS

The alternative plans were compared with respect to cost, implementability, the degree to which the plan objectives for providing adequate agricultural and stormwater drainage were met, and environmental impacts. A comparison of the total capital, annual operation and maintenance, and average annual costs of each alternative is given in Table 12.

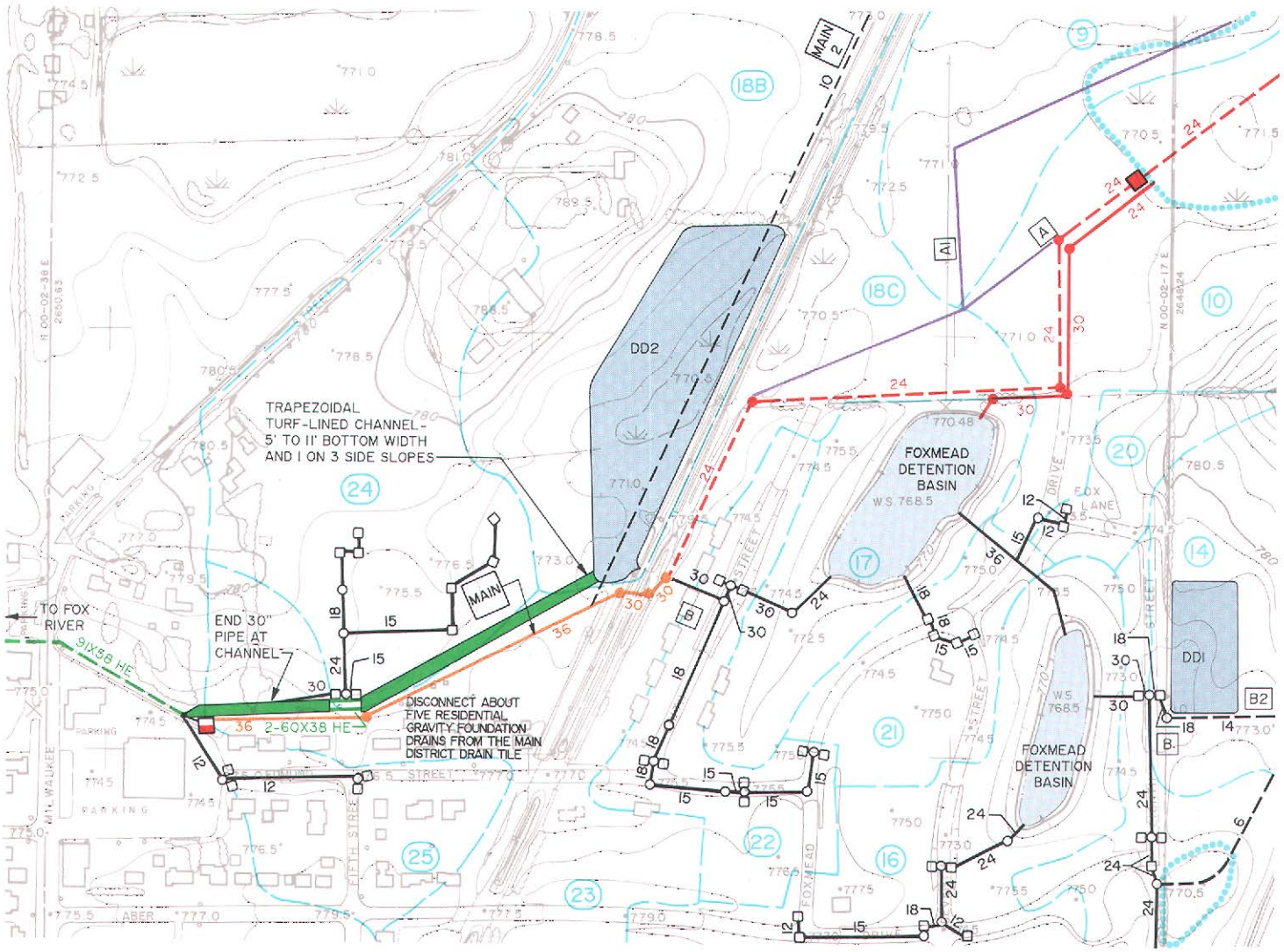
Degree to Which the Plan Objectives For Providing Adequate Drainage Are Met

Alternative Plan Nos. 1A through 4A and 1B through 4B all provide agricultural drainage facilities adequate to remove the runoff from a two-year recurrence interval storm occurring over a 24-hour period within about 48 hours from areas outside of wetlands.

Alternative Plan Nos. 5A and 5B would provide the same level of agricultural drainage benefits for the areas served by District Lines B; B2; B2a, b, and c; B4; B5; and Main 2 as would the other alternatives. Under Alternatives 5A and 5B, more-limited facilities are provided along District Line A such that the time to remove the runoff from a 2-year recurrence interval storm occurring over a 24-hour period would be about 75 hours from areas outside of wetlands.

Map 18

ALTERNATIVE PLAN NO. 5B FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA—CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL AND AN INTERMEDIATE LIFT STATION OF LIMITED CAPACITY[a]



LEGEND

- SUBBASIN BOUNDARY
- (10) SUBBASIN DESIGNATION
- WETLAND BOUNDARIES AS SHOWN ON 1990 SEWRPC LAND USE INVENTORY MAPS
- 18 [A] EXISTING DISTRICT TILE, WITH SIZE IN INCHES, AND DESIGNATION
- 24 EXISTING VILLAGE OF WATERFORD STORM SEWER WITH SIZE IN INCHES, AND MANHOLE TO BE RETAINED
- EXISTING STORMWATER INLET
- EXISTING DRAIN TILE TO BE ABANDONED UNDER PLANNED DEVELOPMENT CONDITIONS
- 24 PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE
- 36 PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE EXISTING DRAIN TILE OR STORM SEWER
- 2-60X38 HE PROPOSED CULVERT AND SIZE IN INCHES
- 91X58 HE PROPOSED REPLACEMENT CULVERT, AND SIZE IN INCHES
- 24 PROPOSED DRAIN TILE, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE DISTRICT DRAIN TILE (TO BE SEALED IN EXISTING WETLANDS)
- PROPOSED REPLACEMENT LIFT STATION-ONE 12cfs (5,380gpm) PUMP, AND ONE 5cfs (2,240gpm) PUMP
- PROPOSED LIFT STATION-ONE 4.3cfs (1,930gpm) PUMP
- PROPOSED OPEN CHANNEL
- EXISTING WET DETENTION BASIN TO BE RETAINED
- DD2 PROPOSED DRY DETENTION BASIN AND DESIGNATION

[a] SEE MAP 8 FOR THE COMPONENTS OF THIS ALTERNATE PLAN IN AREAS OUTSIDE OF THE BOUNDARIES OF THIS MAP.

GRAPHIC SCALE
0 200 400 FEET

Source: SEWRPC.

Table 11

COMPONENTS AND COSTS OF ALTERNATIVE PLAN NO. 5B FOR AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANGEMENT IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO 1 STUDY AREA--CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL AND AN INTERMEDIATE LIFT STATION OF LIMITED CAPACITY

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1	Tile Line A	1. Replace 340 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	$ 3,300	$ 140
		2. Replace 330 feet of 16-inch-diameter drain tile with 18-inch-diameter perforated corrugated plastic pipe	4,900	130
		3. Replace 1,220 feet of 16-inch-diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	40,300	490
		4. Replace 595 feet of 16-inch-diameter drain tile with 24-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	19,700	240
		5. Replace 505 feet of 18-inch-diameter drain tile with 24-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	16,700	200
		6. Construct a new lift station west of the wetland in Subbasin 10. Provide one one pump with a capacity of 4.3 cfs (1,930 gpm)	29,000	400
		7. Replace and reroute 1,530 feet of 18-inch-diameter drain tile with 1,820 feet of 24-inch-diameter perforated corrugated plastic pipe	60,200	730
	Tile Line B2	8. Replace 280 feet of 12-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,700	110
		9. Replace and reroute 580 feet of 12-inch-diameter drain tile with 640 feet of 15-inch-diameter sealed corrugated plastic pipe to avoid draining adjacent wetland	6,200	260
		10. Replace and reroute 560 feet of 14-inch-diameter drain tile with 860 feet of 15-inch-diameter sealed corrugated plastic pipe at an 0.08 percent slope to avoid draining the adjacent wetland	8,300	340
		11. Replace 230 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,200	90
	Tile Line B	12. Replace 140 feet of 8-inch-diameter drain tile with 12-inch-diameter reinforced concrete pipe	6,700	60
Racine County Farm Drainage District No. 1		Subtotals	$ 200,200	$ 3,190

Table 11 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Village of Waterford	--	13. Replace the existing 60-inch diameter corrugated metal pipe culvert at the study area outlet with a 600-foot-long, 91-inch wide by 58-inch high horizontal elliptical reinforced concrete pipe	217,100	110
	--	14. Construct a 1,000-foot-long, trapezoidal, turf-lined open channel from the outlet of Detention Basin 2 to the upstream end of the proposed 91-inch by 58-inch HE culvert	$ 85,000	$ 500
	Fifth Street	15. Install a double 60-inch-wide by 38-inch-high HE reinforced concrete culvert with a total pipe length of 130 feet. Relocate 8-inch diameter water main in 5th Street.	30,400	20
Village of Waterford		Subtotals	$ 332,500	$ 630
Costs Shared by the Farm Drainage District and the Village of Waterford	Tile Line B	16. Relay 63 feet of 30-inch-diameter reinforced concrete storm sewer at a steeper slope	$ 6,300	$ 10
	Tile Line MAIN	17. Replace 1,085 feet of mixed 24-, 27-, and 30-inch diameter drain tile with 36-inch diameter reinforced concrete storm sewer	130,300	210
	--	18. Construct a new lift station at the site of the existing Farm Drainage District station. Provide one pump with a capacity of 12 cfs (5,380 gpm) and one pump with a capacity of 5 cfs (2,240 gpm). Total head of about 9 feet	55,000	900
Costs Shared by the Farm Drainage District and the Village of Waterford		Subtotals	$ 191,600	$ 1,120
Wisconsin Department of Transportation	Tile Line A3	19. Replace 240 feet of 6-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe if found to be damaged when STH 36 is widened	$ 11,500	$ 100
	Tile Line A	20. Replace 140 feet of 15-inch-diameter corrugated metal pipe under STH 164 with 18-inch-diameter reinforced concrete pipe	8,200	60
	Tile Line B2	21. Replace 335 feet of 15-inch-diameter corrugated metal pipe under STH 36 with 15-inch-diameter reinforced concrete pipe	18,100	130
	Tile Line B4	22. Replace 240 feet of 8-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe	11,500	100
Wisconsin Department of Transportation		Subtotals	$ 49,300	$ 390
Private Sector	Subbasins 9 and 10	23. Construct 300 feet of 24-inch-diameter storm sewer to serve planned development	$ 21,300	$ 120
		24. Construct 550 feet of 30-inch-diameter storm sewer to serve planned development	48,300	220

Table 11 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
	Subbasin 14	25. Construct a 1.6-acre-foot dry detention basin to serve planned development. Detention Basin No. 1	$ 67,300	$ 1,200
	Subbasin 18B	26. Construct a 10.7-acre-foot dry detention basin with an impervious liner. Basin would primarily serve planned development. Detention Basin No.2	398,700	3,100
	Subbasin 23	27. Disconnect about five residential gravity foundation drains from the main District tile line	1,000	0
Private Sector		Subtotals	$ 536,600	$ 4,640
		TOTAL	$1,310,200	$ 9,970
		EQUIVALENT ANNUAL COST	$ 93,000	

[a]Costs for 1993 Engineering News-Record Construction Cost Index = 5,390. Costs include engineering, administration, and contingencies.

Source: SEWRPC.

Table 12

COSTS OF ALTERNATIVE AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT PLANS FOR RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1

Alternative	Costs			
	Capital[a]	Amortized Capital	Annual Operation and Maintenance	Total Annual[b]
1A. Centralized Pumping and Detention Storage	$1,498,500	$ 95,000	$9,000	$104,000
1B. Centralized Pumping and Detention Storage With an Open Channel	$1,546,200	$ 99,000	$9,000	$108,000
2A. Decentralized Pumping and Centralized Detention Storage With Most Areas of Proposed Development Disconnected From the Agricultural Drain Tile System	$1,983,100	$126,000	$10,000	$136,000
2B. Centralized Pumping and Centralized Detention Storage With an Open Channel and With Most Areas of Proposed Development Disconnected From the Agricultural Drain Tile System	$1,827,100	$116,000	$10,000	$126,000
3A. Decentralized Pumping and Centralized Detention Storage	$1,489,600	$ 95,000	$ 9,000	$104,000
3B. Decentralized Pumping and Centralized Detention Storage With an Open Channel	$1,375,600	$ 87,000	$10,000	$ 97,000

Table 12 (cont'd)

Alternative	Costs			
	Capital[a]	Amortized Capital	Annual Operation and Maintenance	Total Annual[b]
4A. Centralized Pumping and Detention Storage With an Intermediate Lift Station	$1,406,900	$ 90,000	$9,000	$ 99,000
4B. Centralized Pumping and Detention Storage With an Open Channel and an Intermediate Lift Station	$1,491,400	$ 94,000	$10,000	$104,000
5A. Centralized Pumping and Detention Storage With an Open Channel and Limitations on Drain Tile Capacities	$1,320,100	$ 84,000	$ 9,000	$ 93,000
5B. Centralized Pumping and Detention Storage With an Open Channel and an Intermediate Lift Station of Limited Capacity	$1,310,200	$ 83,000	$10,000	$ 93,000

[a]Costs for 1993 Engineering News-Record Construction Cost Index = 5,390.

[b]Amortized capital cost is based on an interest rate of 6 percent and a project life of 50 years.

Source: SEWRPC.

All of the alternative plans call for minor stormwater drainage system facilities which would adequately accommodate the runoff from a 10-year recurrence interval storm and major system facilities to accommodate the runoff from a 100-year recurrence interval storm.

Implementability

All of the alternatives would have similar requirements for the purchase of drainage easements and land for detention basin construction. Alternative Plan Nos. 1A through 4A might be somewhat more readily implemented than the other alternatives because 1A through 4A involve the purchase of relatively narrow drainage easements for a buried pumping station discharge line, rather than easements for the construction of an open channel. However, even with implementation of one of Alternatives Plan Nos. 1A through 4A, the Village will still find it necessary to provide an open channel or overland flow drainage easement along the approximate discharge line alignment in order to assure adequate major system capacity.

Environmental Impacts

The most significant potential environmental impacts associated with the alternative plans are those related to wetlands. In those instances where replacement agricultural drainage line is proposed to cross a wetland, each alternative calls for the use of sealed pipe with periodic impervious cutoffs in the pipe trench to prevent draining of the wetland. Also, under each alternative, improvement of the tile system and upgrading of the pumping station capacity downstream of tile Line B2A in the wetland in Subbasin 12A could alter the hydrologic regime of the wetland through lowering of groundwater levels. Therefore, the environmental impacts of each alternative are essentially the same.

Cost Comparison and Selection of Recommended Plan

Comparison of Alternative Plans: Implementation of any one of Alternative Plan Nos. 1A through 4A or 1B through 4B would provide essentially the same level of agricultural and stormwater drainage benefits and would also have similar environmental impacts. As noted above, Alternative Plan Nos. 1A through 4A might be somewhat more readily implemented due to the need to obtain less extensive drainage easements; however, the main deciding factor between Alternative Plan Nos. 1A through 4A and 1B through 4B is relative cost.

A review of Table 12 shows that the capital and average annual costs of the alternative plans are similar except for Alternative Plan Nos. 2A and 2B. Those alternatives are more costly due to the need to provide additional facilities to separate the stormwater drainage systems which would serve future urban development from the agricultural drainage system. Because they are more costly and because they offer no significant advantages over the other alternatives, Alternative Plan Nos. 2A and 2B should be eliminated from further consideration.

Alternative Plans 4A and 4B are essentially the same as Alternative Plan Nos. 1A and 1B, respectively, except that under both 4A and 4B an intermediate lift station would be constructed along District drain tile Line A in order to pump agricultural runoff to a higher elevation. That lift station enables proposed downstream drain tile and storm sewer lines to be constructed at shallower depths, reducing construction costs for those pipelines. Thus, Alternative Plan Nos. 1A and 1B, which are more costly, should be eliminated from further consideration on the basis of cost.

Alternative Plan No. 3A, which is similar to 3B, and Plan 4B, which is similar to 4A, should also be eliminated on the basis of cost, leaving Alternative Plans 3B and 4A which have essentially identical capital and average annual costs.

Alternative Plan No. 3B incorporates the Village stormwater management plan recommendations regarding the approximate location and function of a new lift station to pump runoff from Subbasin 18B and areas tributary to the Foxmead subdivision, but it calls for a pumping capacity of 17 cfs, rather than 10 cfs as under the local stormwater management plan. Alternative Plan 3B is preferred over 4A because it is more consistent with the recommendation of the Village stormwater management plan and because its capital and average annual costs are slightly less than those for 4A. By process of elimination, the remaining alternative plans to be considered are, therefore, 3B - Decentralized Pumping and Centralized Detention Storage With an Open Channel, 5A - Centralized Pumping and Detention Storage With an Open Channel and Limitations on Drain Tile Capacities, and 5B - Centralized Pumping and Detention Storage With an Open Channel and an Intermediate Lift Station of Limited Capacity.

As already noted, Alternative Plan Nos. 5A and 5B would provide the same level of agricultural drainage benefits as would the other alternatives in all areas served by District drain tile except along District Line A where the time to drain storm runoff would be about 50 percent longer under Alternative Plan Nos. 5A and 5B. Thus, Alternative Plan No. 3B has the advantage compared to these alternatives of providing somewhat more efficient agricultural drainage along tile Line A.

The least costly alternatives in terms of both capital cost and average annual cost are Alternative Plan Nos. 5A and 5B. The capital and annual operation and maintenance costs to be incurred by each unit of government as well as by the private sector would be similar under either alternative. Thus, neither alternative has a clear advantage in that regard. Because Alternative 5A calls for one lift station with two pumps, rather than two lift stations with three pumps as under Alternative Plan No. 5B, Alternative 5A would present fewer potential problems due to pumps malfunctioning. Therefore, Alternative Plan No. 5A is considered preferable to Alternative 5B.

The cost comparison between Alternative Plan Nos. 3B and 5A presented in Table 13 indicates that the total capital and average annual costs of 5A would be about 4 percent less than those of 3B. The capital and average annual costs to be borne by the Wisconsin Department of Transportation would be about the same under either alternative. The capital and average annual costs to be borne by the private sector would be 18 and 15 percent higher, respectively, under Alternative Plan No. 5A than under 3B. The total capital and average annual costs to the Village of Waterford, including the Village portion of the costs to be shared by the Village and the District would be about 22 percent higher under Alternative Plan No. 5A than under Alternative Plan No. 3B. The total costs to the Drainage District would be about 44 percent less under 5A than under 3B.

Conclusion and Recommendation

Overall, the least costly plan would be Alternative Plan No. 5A. That alternative plan would provide somewhat reduced agricultural drainage benefits along District Line A where the time to drain storm runoff would be about 50 percent longer than under Alternative Plan No. 3B. However, under Alternative Plan No. 5A, the runoff from a 24-hour storm with a recurrence interval of two years

Table 13

COMPARISON OF COSTS OF ALTERNATIVE PLANS NO. 3B AND 5A WITH SHARED COSTS APPORTIONED BETWEEN THE FARM DRAINAGE DISTRICT AND THE VILLAGE OF WATERFORD

Capital Cost Assignment	Alternative Plan No. 3B			Alternative Plan No. 5A		
	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost	Average Annual Cost	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost	Average Annual Cost[b]
Racine County Farm Drainage District No. 1	$ 502,000[c]	$ 3,770	$36,000	$ 283,500[c]	$ 3,640[d]	$22,000
Village of Waterford	369,800[c]	720[d]	24,000	450,700[c]	820[d]	29,000
Wisconsin Department of Transportation	51,200	390[d]	3,000	49,300	390	3,000
Private Sector	452,600	4,640	34,000	536,600	4,640	39,000
Total	$1,375,600	$ 9,520	$ 97,000	$1,320,100	$ 9,490	$93,000

[a]Costs for 1993 Engineering News-Record Construction Cost Index=5,390.

[b]Amortized capital cost is based on an interest rate of 6 percent and a project life of 50 years.

[c]Shared Village/District capital cost apportioned based on cost to the District of corrugated plastic pipe required for agricultural drainage only and relative pumping requirements for agricultural and stormwater drainage.

[d]Annual operation and maintenance costs apportioned based on proportion of total area tributary to the facility which lies within the District or the Village, as appropriate. Eighty-two percent of the shared costs is assigned to the District and 18 percent is assigned to the Village.

Source: SEWRPC.

would still be drained within 75 hours, which is within generally acceptable limits.

It is, therefore, recommended that Alternative Plan No. 5A be implemented to provide adequate agricultural and stormwater drainage under existing and planned land use conditions in the Racine County Drainage District No. 1 study area. This option is described in more detail in Chapter VII.

Chapter VII

RECOMMENDED AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT PLAN

REFINEMENT OF THE PRELIMINARY RECOMMENDED AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT PLAN

The preliminary recommended agricultural drainage and urban stormwater management plan was reviewed by the Racine County Farm Drainage Board Commissioners and the staffs of the Village of Waterford, the Wisconsin Department of Natural Resources, the Wisconsin Department of Transportation, the U.S. Army Corps of Engineers, and the U.S. Soil Conservation Service. Comments were provided either in writing or during a September 15, 1993, interagency meeting at which the plan was reviewed and discussed. Based on the comments and suggestions made by those who reviewed the plan, and on refinements initiated by Regional Planning Commission staff, the preliminary plan was refined and a final recommended plan was prepared.

Under the preliminary recommended plan, agricultural and stormwater runoff from the Foxmead subdivision and lands upstream would be conveyed to a proposed new lift station at the site of the existing District station and then pumped. About 70 percent of the shared Village and District costs under that plan are for the 36-inch diameter reinforced concrete storm sewer required to convey the flows from the Foxmead subdivision outlet to the site of the proposed lift station. The cost of that storm sewer could be eliminated by locating the station on the east side of the bike trail, but near the subdivision outlet. Discharge from the station could then be conveyed in the open channel which is already proposed under the plan.

By locating the lift station just downstream of the junction of the existing drain tile with District Line Main2 from the north, all of the agricultural land in the District would be served, but the section of the existing drain tile between the junction of Lines Main and Main2 and the existing lift station would be abandoned. Because the plan calls for all residential foundation drains to be disconnected from the tile that would be abandoned, abandonment would be feasible.

The preliminary recommended plan called for the proposed open channel to discharge to a new 91-inch wide by 58-inch high horizontal elliptical reinforced concrete culvert which was to replace the existing 60-inch diameter corrugated metal pipe culvert at the study area outlet to the Fox River. The Administrator of the Village of Waterford noted that the upstream portion of the existing 60-inch diameter culvert was recently installed and thus, the culvert had a significant remaining useful life. He asked Commission staff to review the option of providing the necessary hydraulic capacity in a manner which would avoid replacement of the existing culvert. After review, it was found that the option suggested by the Village would result in a cost savings. Accordingly, the preliminary recommended plan was revised to retain the existing culvert and to add a parallel 72-inch diameter corrugated metal pipe culvert. The upstream invert of the proposed 72-inch diameter culvert would be at elevation 767.1 feet above National Geodetic Vertical Datum, 1929 adjustment (NGVD), or 2.4 feet below that of the existing culvert. The lower invert elevation is required to

accommodate the proposed upstream open channel. The parallel culvert could be constructed at the same time as the planned reconstruction of Milwaukee Avenue from the existing culvert north to Oak Lodge Avenue.

The staff of the U.S. Soil Conservation Service asked that the plan address the possibility of providing additional excavated detention storage in the wetland located primarily in the Town of Waterford in Subbasins 6, 9, and 10 to the west of STH 36. It was suggested that the provision of additional storage could improve wildlife habitat and might reduce the size of recommended detention basin DD2 which is recommended to be constructed on potentially developable land in the Village. Under the preliminary recommended plan, the existing storage in the wetland was recommended to be maintained and the effect of that storage on peak rates of runoff under planned land use and drainage conditions was accounted for in the hydrologic and hydraulic analyses. The existing natural wetland storage would have a significant effect on planned condition flood flows, reducing the 10-year recurrence interval peak flood flow by 96 percent, from 230 cfs to 9 cfs, and reducing the peak 100-year flood flow by 98 percent, from 390 cfs to 10 cfs. Expansion of the detention storage capacity would only produce a marginal reduction in flood flows which would not significantly change the size of any facilities which are recommended to be constructed in the Village downstream of the wetland. Thus, the expanded detention storage is not recommended at the site of the wetland.

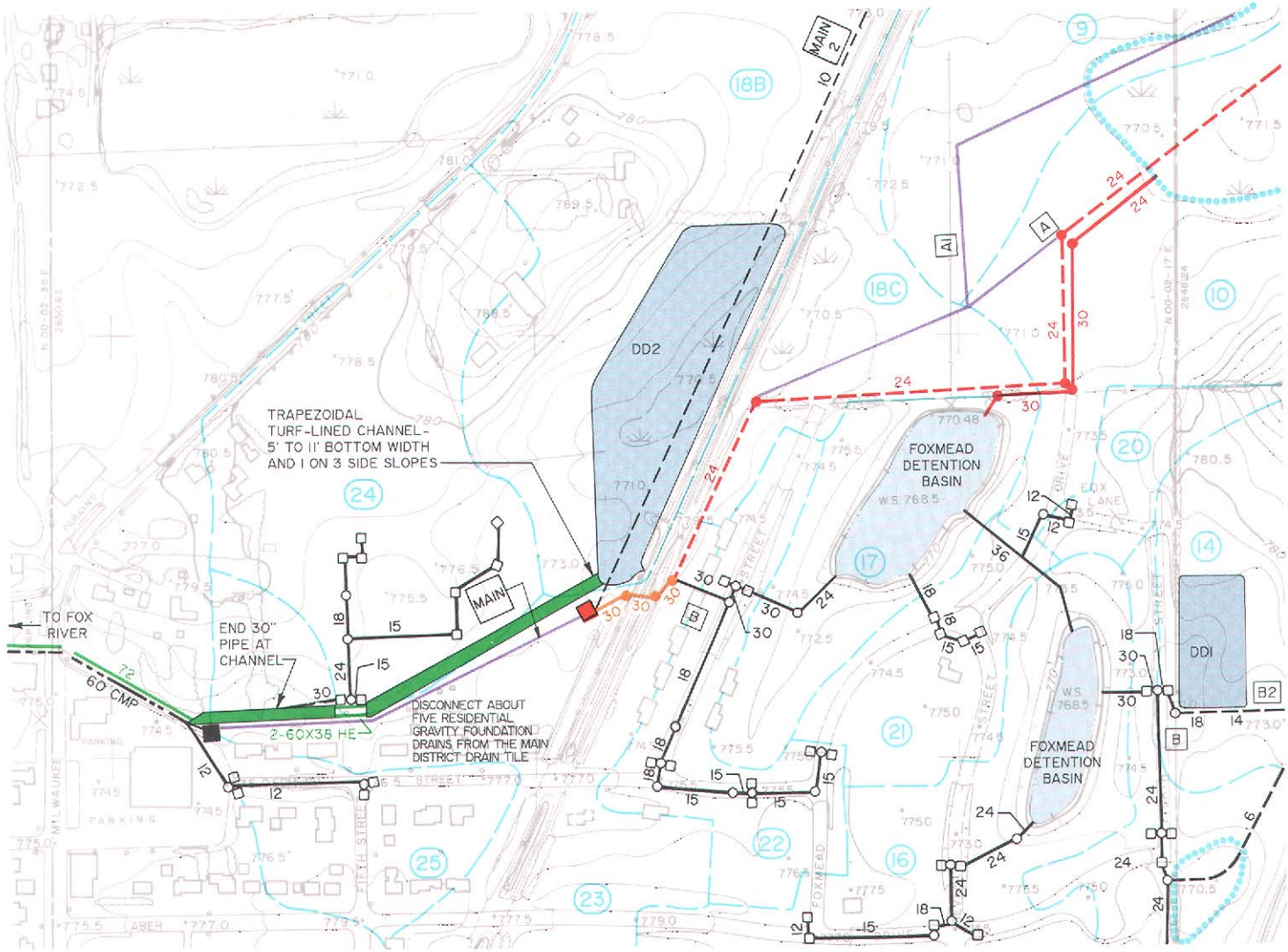
The Administrator of the Village of Waterford asked the Commission staff to consider moving dry detention basin DD1, which is proposed to be located between Eighth Street and STH 36, to a wetland which is about 400 feet south of the proposed site. As configured under the preliminary recommended plan, basin DD1 would be located to maximize the amount of runoff collected from tributary areas of future development within the Village, based on existing topography. The exact location of the basin would be subject to some adjustment at the time that actual development plans are prepared, in order to accommodate modifications to the site topography. However, the basin location as set forth under the preliminary recommended plan is considered preferable to the wetland location because the recommended location maximizes the amount of runoff collected and it avoids potential significant regulatory permitting problems if the basin were to be located in the wetland. Therefore, the site of basin DD1 is unchanged under the final recommended system plan.

DESCRIPTION OF THE RECOMMENDED PLAN

The recommended plan is intended to improve the agricultural drainage system of the Farm Drainage District and to provide an urban stormwater drainage system which substantially meets the capacity criteria established in Chapter IV. As shown in graphic form on Maps 8 and 19 and as set forth in Table 14, the plan calls for the replacement of about 6,170 lineal feet of existing 8- to 18-inch diameter agricultural drain tile with about 6,820 lineal feet of 12- to 24-inch diameter corrugated plastic pipe; the replacement of about 140 lineal feet of existing 8-inch diameter drain tile with 12-inch diameter reinforced concrete pipe; and the replacement of about 960 lineal feet of existing 6- to 15-inch diameter corrugated metal pipe drain tile with 12- to 18-inch diameter reinforced concrete pipe. Also, 63 lineal feet of 30-inch diameter reinforced concrete storm sewer at the outlet from the Foxmead subdivision would be relayed at a steeper slope and a 160-foot-long, 30-inch diameter reinforced concrete pipe extension would be provided downstream of the relayed pipe to convey flow from the Foxmead subdivision and upstream lands to a proposed lift station. Approxi-

Map 19

RECOMMENDED AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT PLAN FOR RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1[a]



LEGEND

- SUBBASIN BOUNDARY
- (10) SUBBASIN DESIGNATION
- WETLAND BOUNDARIES AS SHOWN ON 1990 SEWRPC LAND USE INVENTORY MAPS
- 18 A — EXISTING DISTRICT TILE, WITH SIZE IN INCHES, AND DESIGNATION
- 24 — EXISTING VILLAGE OF WATERFORD STORM SEWER WITH SIZE IN INCHES, AND MANHOLE TO BE RETAINED
- EXISTING STORMWATER INLET
- EXISTING DRAINAGE DISTRICT LIFT STATION TO BE ABANDONED
- 60 CMP — EXISTING CULVERT TO BE RETAINED AND SIZE IN INCHES
- EXISTING DRAIN TILE TO BE ABANDONED UNDER PLANNED DEVELOPMENT CONDITIONS
- 30 — PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE
- 30 — PROPOSED STORM SEWER, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE EXISTING DRAIN TILE OR STORM SEWER
- 72 — PROPOSED CULVERT AND SIZE IN INCHES
- 24 — PROPOSED DRAIN TILE, WITH SIZE IN INCHES, AND MANHOLE TO REPLACE DISTRICT DRAIN TILE (TO BE SEALED IN EXISTING WETLANDS)
- PROPOSED LIFT STATION-ONE 12cfs (5,380 gpm) PUMP AND ONE 5cfs (2,240gpm) PUMP-TO DISCHARGE TO PROPOSED OPEN CHANNEL
- PROPOSED OPEN CHANNEL
- EXISTING WET DETENTION BASIN TO BE RETAINED
- DD2 — PROPOSED DRY DETENTION BASIN AND DESIGNATION

[a] SEE MAP 8 FOR THE COMPONENTS OF THE RECOMMENDED PLAN IN AREAS OUTSIDE OF THE BOUNDARIES OF THIS MAP.

GRAPHIC SCALE
0 200 400 FEET

Source: SEWRPC.

Table 14

COMPONENTS AND COSTS OF THE RECOMMENDED PLAN FOR AGRICULTURAL AND STORMWATER DRAINAGE IN THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA--CENTRALIZED PUMPING AND DETENTION STORAGE WITH AN OPEN CHANNEL AND LIMITATIONS ON DRAIN TILE CAPACITIES

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Racine County Farm Drainage District No. 1	Tile Line A	1. Replace 340 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	$ 3,100	$ 130
		2. Replace 330 feet of 16-inch-diameter drain tile with 18-inch-diameter perforated corrugated plastic pipe	4,700	130
		3. Replace 1,220 feet of 16-inch diameter drain tile with 24-inch-diameter perforated corrugated plastic pipe	38,300	460
		4. Replace 595 feet of 16-inch-diameter drain tile with 24-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	18,700	230
		5. Replace 505 feet of 18-inch-diameter drain tile with 24-inch-diameter sealed corrugated plastic pipe to avoid draining wetland	15,900	190
		6. Replace and reroute 1,530 feet of 18-inch diameter drtain tile with 1,820 feet of 24-inch diameter perforated corrugated plastic pipe	57,200	690
	Tile Line B2	7. Replace 280 feet of 12-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,600	110
		8. Replace and reroute 580 feet of 12-inch diameter drain tile with 640 feet of 15-inch diameter sealed corrugated plastic pipe to avoid draining adjacent wetland	5,900	240
		9. Replace and reroute 560 feet of 14-inch diameter drain tile with 860 feet of 15-inch diameter sealed corrugated plastic pipe at an 0.08 percent slope to avoid draining the adjacent wetland	7,900	330
		10. Replace 230 feet of 14-inch-diameter drain tile with 15-inch-diameter perforated corrugated plastic pipe	2,100	90
	Tile Line B	11. Replace 140 feet of 8-inch-diameter drain tile with 12-inch-diameter reinforced concrete pipe	6,300	50
		12. Drainage District share of cost to relay 63 feet of 30-inch-diameter reinforced concrete storm sewer at a steeper slope	4,300[b]	20[c]
	Tile Line MAIN	13. Drainage District share of cost to replace 160 feet of mixed 24-, 27-, and 30-inch diameter drain tile with 30-inch diameter reinforced concrete storm sewer	11,000[b]	50[c]

Table 14 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
	--	14. Drainage District share of cost to construct a new lift station just to the west of the bike trail and downstream of the junction of District drain tile Lines Main and Main2. Provide one pump with a capacity of 12 cfs (5,380 gpm) and one pump with a capacity of 5 cfs (2,240 gpm). Total head of about 13 feet	35,300[d]	780[c]
Racine County Farm Drainage District No. 1		Subtotals	$ 213,300[e]	$ 3,500[c]
Village of Waterford	--	15. Install a 570-foot-long, 72-inch diameter corrugated metal pipe (CMP) culvert parallel to the existing 60-inch diameter CMP at the study area outlet	$ 144,000	$ 110
	--	16. Construct a 1,000-foot-long, trapezoidal, turf-lined open channel from the outlet of Detention Basin 2 to the upstream end of the proposed 91-inch by 58-inch HE culvert	85,000	500
	5th Street	17. Install a double 60-inch-wide by 38-inch-high HE reinforced concrete culvert with a total pipe length of 130 feet. Relocate 8-inch diameter water main in 5th Street	30,400	20
	Tile Line B	18. Village of Waterford share of cost to relay 63 feet of 30-inch-diameter reinforced concrete storm sewer at a steeper slope	4,600[b]	10[c]
	Tile Line MAIN	19. Village of Waterford share of cost to replace 160 feet of mixed 24-, 27-, and 30-inch diameter drain tile with 30-inch diameter reinforced concrete storm sewer	11,600[b]	10[c]
	--	20. Village of Waterford share of cost to construct a new lift station just to the west of the bike trail and downstream of the junction of District drain tile Lines Main and Main2. Provide one pump with a capacity of 12 cfs (5,380 gpm) and one pump with a capacity of 5 cfs (2,240 gpm). Total head of about 13 feet	24,800[d]	180[c]
Village of Waterford		Subtotals	$ 300,400	$ 830
Wisconsin Department of Transportation	Tile Line A3	21. Replace 240 feet of 6-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe if found to be damaged when STH 36 is widened	$ 11,500	$ 100
	Tile Line A	22. Replace 140 feet of 15-inch-diameter corrugated metal pipe under STH 164 with 18-inch-diameter reinforced concrete pipe	8,200	60
	Tile Line B2	23. Replace 335 feet of 15-inch-diameter corrugated metal pipe under STH 36 with 15-inch-diameter reinforced concrete pipe	18,100	130
	Tile Line B4	24. Replace 240 feet of 8-inch-diameter corrugated metal pipe under STH 36 with 12-inch-diameter reinforced concrete pipe	11,500	100

Table 14 (cont'd)

Capital Cost Assignment	Location	Project and Component Description	Estimated Capital Cost[a]	Estimated Annual Operation and Maintenance Cost
Wisconsin Department of Transportation	Tile Line B4	25. Wisconsin DOT share of cost of agricultural drain tile, agricultural portion of storm sewers, and agricultural pumping costs (Items 1 through 14)	$ 11,200	$ 180
Wisconsin Department of Transportation		Subtotals	$ 60,500[e]	$ 570[c]
Private Sector	Subbasins 9 and 10	26. Construct 300 feet of 24-inch-diameter storm sewer to serve planned development	$ 21,300	$ 120
		27. Construct 550 feet of 30-inch-diameter storm sewer to serve planned development	48,300	220
	Subbasin 14	28. Construct a 1.6-acre-foot dry detention basin to serve planned development. Detention Basin No. 1	67,300	1,200
	Subbasin 18B	29. Construct a 10.7-acre-foot dry detention basin with an impervious liner. Basin would primarily serve planned development. Detention Basin No.2	398,700	3,100
	Subbasins 23 and 25	30. Disconnect about five residential gravity foundation drains from the main District drain tile	1,000	0
Private Sector		Subtotals	$ 536,600	$ 4,640
		TOTAL	$1,110,800	$ 9,540

[a]Costs for 1993 Engineering News-Record Construction Cost Index=5,390.

[b]Capital cost apportioned based on cost to the District of corrugated plastic pipe required for agricultural drainage only. Fifty percent of the cost is assigned to the Village, 47.5 percent is assigned to the District, and 2.5 percent is assigned to the Wisconsin Department of Transportation.

[c]Annual operation and maintenance costs apportioned based on proportion of total area tributary to the facility which lies within the District, the Village, or the State Trunk Highway right-of-way, as appropriate. Seventy-eight percent is assigned to the District, 18 percent is assigned to the Village, and 4 percent is assigned to the Wisconsin Department of Transportation. Costs are rounded to the nearest $10.

[d]Capital cost apportioned based on ratio of base pump costs. Fifty-seven percent of the total is assigned to the Farm Drainage District, 40 percent is assigned to the Village of Waterford, and 3 percent is assigned to the Wisconsin Department of Transportation.

[e]Capital cost apportioned between the District and the Wisconsin Department of Transportation based on the volume of runoff contributed to the agricultural drainage system by State Trunk Highways for the 2-year recurrence interval, 24-hour design storm occurring under both existing 1990 and planned 2010 land use conditions within the study area.

Source: SEWRPC.

mately 925 lineal feet of mixed 24-, 27-, and 30-inch diameter District drain tile located west of the bike trail would be abandoned. Also, 1,100 lineal feet of 6-inch diameter District tile and 800 lineal feet of 18-inch District tile located on lands planned to be developed would be abandoned. Where corrugated plastic pipe is called for, perforated pipe would generally be used, except along portions of Lines A and B2 where 1,100 lineal feet and 1,500 lineal feet, respectively, of sealed corrugated plastic pipe is specified to avoid draining wetlands.

The recommended plan also calls for the construction of 300 lineal feet of 24-inch diameter and 550 lineal feet of 30-inch diameter reinforced concrete storm sewer to serve planned new development in Subbasins 9, 10, and 18C; the construction of a 1.6-acre-foot dry Detention Basin No. 1 to serve planned commercial development in the area between the Foxmead subdivision and STH 36; and the construction of a 10.7-acre-foot dry Detention Basin No. 2 with an impervious liner to primarily serve planned development in Subbasin 18B, but also to collect runoff from Subbasins 18C and 23. In addition, the plan assumes the maintenance of existing depression storage in wetlands and agricultural lands upstream of the corporate limits of the Village. That storage would significantly reduce peak flood flows during large storms when the capacity of the recommended agricultural drainage system would be exceeded. The reduction in peak flood flows would benefit the Village of Waterford because it would enable the use of smaller urban stormwater management facilities than if the storage were eliminated.

The proposal for construction of two dry detention basins is consistent with the recommendation of the stormwater management plan for the Village which calls for an unspecified amount of detention storage to serve the same areas of new development. The Village stormwater management plan calls for limiting outflow from the smaller of the two detention basins to the capacity of the existing downstream storm sewer and for limiting outflow from the area tributary to the larger basin during a 100-year recurrence interval storm under planned land use and drainage conditions to the 10-year storm outflow from the tributary area under existing conditions. The detention basins recommended herein represent a refinement of the recommendation of the Village plan in that storage volumes are specified and the functioning of the basins is evaluated in the context of the overall agricultural and stormwater drainage system. An impervious liner is called for under Detention Basin No. 2 to decrease agricultural pumping requirements by avoiding seepage from the detention basin into the drain tile line designated as Main 2. The construction of the recommended detention basins enables the use of smaller and less costly downstream conveyance facilities such as storm sewers and open channels, because the basins reduce peak flood flows.

A 1,000-foot-long, trapezoidal, turf-lined open channel would be constructed from the outlet of Detention Basin No. 2 to the upstream end of the existing 60-inch diameter corrugated metal pipe (CMP) which discharges to the Fox River. That channel would convey outflow from the proposed detention basin. Two 60-inch-wide by 38-inch-high HE reinforced concrete pipe culverts, each 65 feet long would be installed under 5th Street to convey flow in the proposed channel. That installation would require realignment of the existing 8-inch diameter water main in 5th Street to avoid the proposed culverts. The downstream portion of the existing 30-inch-diameter reinforced concrete storm sewer at the outlet of Subbasin 24 could be removed, allowing the storm sewer to discharge directly to the proposed channel. Construction of the open channel and Detention Basin

No. 2 may require a permit from the State of Wisconsin under Chapter 30.19 of the State Statutes.

The existing District lift station would be abandoned and a new station would be constructed just downstream of the junction of District tile Lines Main and Main2 on the west side of the bike path. That station would pump the peak 10-year recurrence interval outflow from the area tributary to the Foxmead subdivision along with agricultural runoff from lands upstream of Foxmead and the area which drains to District tile line Main 2. The station would have a capacity of 17 cfs, or 7,620 gpm, and it would discharge to the proposed open channel through a 50-foot-long, 18-inch diameter steel pipe.

The existing 60-inch diameter CMP culvert which runs from the pump station outlet through N. Milwaukee Street to the Fox River would be retained and a parallel 570-foot-long, 72-inch diameter CMP culvert would be constructed. The upstream invert of the parallel culvert should be constructed at elevation 767.1 feet NGVD to accommodate the proposed upstream open channel. The new culvert would consist of a 320-foot-long continuous pipe and a 250-foot-long continuous pipe separated by a short section of open channel, as does the existing culvert. That configuration would enable the collection of runoff from areas of the Village located between Milwaukee Avenue and the inlet to the upstream segment of the culvert. The outlet to the proposed culvert would be located below the ordinary high water mark of the Fox River, thus the culvert installation would require a permit from the Wisconsin Department of Natural Resources.

It is recommended that, when the main District drain tile is abandoned, the foundation drains of the five houses in the Village of Waterford along Edmund Street be disconnected from the main drain tile and that those homeowners rely on their existing sump pumps or improved sump pump systems to remove seepage collected in their foundation drains.

The Village of Waterford should ensure that an adequate major stormwater drainage system is provided, both within planned development to accommodate the runoff from that development and within areas of existing development to accommodate runoff from existing and new upstream development. Of particular concern in this regard is the conveyance of major system flows, up to the peak 100-year recurrence interval flow, through the bike trail embankment and through the area west of the bike trail to the Fox River. This will require careful attention to street layouts and street grades.

It is recommended that consideration be given to enrolling land in and adjacent to the wetlands in Subbasin 12A southeast of the intersection of CTH K and South Division Road in the USDA Water Bank Program. Enrollment in the Water Bank Program would require the removal of some cropland from production as detailed in Chapter V.

The capital cost of the recommended plan is estimated to be $1,110,800. Annual operation and maintenance costs are estimated to be $9,540. As set forth in Table 14, the capital costs may be apportioned as follows: $213,300, or 19 percent of the total, to Racine County Farm Drainage District No. 1; $300,400, or 27 percent of the total, to the Village of Waterford; $60,500, or 6 percent of the total, to the Wisconsin Department of Transportation; and $536,600, or 48 percent of the total, to the private sector. This cost apportionment represents a refinement of that set forth in Chapter VI of this report for the preliminary recommended plan. Under this apportionment, 5 percent of the agricultural drain

tile costs, of the agricultural portion of storm sewer costs, and of agricultural pumping costs is assigned to the Wisconsin Department of Transportation. The basis for that cost assignment is that the runoff volume from state trunk highways is about 5 percent of the total runoff tributary to the agricultural drainage system under both existing and planned land use conditions.

If the Racine County Farm Drainage Board concludes that the costs set forth above are not affordable, then consideration could be given to working with the U.S. Soil Conservation Service staff to enroll portions of the lands in the USDA Water Bank, Wetlands Reserve, or Conservation Reserve Programs.[1]

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[1]As of July 2, 1993, the board of drainage commissioners of the Racine County Farm Drainage District No. 1 was replaced by a County drainage board appointed by the County Circuit Court under Sections 88.161 and 88.17 of the Wisconsin State Statutes. Thus, the Drainage District continues to exist as a geographic entity for purposes of drainage system construction, operation, and maintenance, and for assessment of the costs of those functions, but the administration of the District has been transferred to the County drainage board. Accordingly, in this report all further references to the administrative body for the Drainage District cite the Racine County Farm Drainage Board.

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Chapter VIII

PLAN IMPLEMENTATION

INTRODUCTION

The recommended agricultural and stormwater drainage plan described in this report is designed to attain, to the maximum extent practicable, the objectives set forth in Chapter IV. In a practical sense, however, the plan is not complete until the steps to implement it--that is, to convert the plan into action policies and programs--have been specified. Realization of the plan will require a long-term commitment to the objectives of the plan and a high degree of coordination and cooperation among Racine County Farm Drainage Board officials, Town of Norway and Waterford officials, Village of Waterford officials, Wisconsin Department of Transportation officials, land developers, and concerned citizens. The cooperation of each of those parties is essential in undertaking the substantial investments and actions needed to provide an adequate agricultural and stormwater drainage system in the Farm Drainage District.

EFFECTS OF IMPLEMENTATION OF THE RECOMMENDED PLAN

Implementation of the recommended plan would greatly improve the efficiency of the agricultural drainage system in the Farm Drainage District. Under planned year 2010 land use conditions, the areas served by District Lines B; B2; B2a, b, and c; B4; B5; and Main 2 would have agricultural drainage facilities adequate to remove the runoff from a 2-year recurrence interval storm occurring over a 24-hour period within about 48 hours from areas outside of wetlands. Also under planned land use conditions, District Line A would be provided with facilities to remove the runoff from a 2-year recurrence interval storm occurring over a 24-hour period within about 75 hours from areas outside of wetlands. Under existing land use and drainage conditions, runoff from storms which occur several times a year on the average has been observed to be ponded in depression areas for weeks at a time.

Implementation of the recommended plan would provide minor stormwater drainage system facilities which would adequately accommodate the runoff from a 10-year recurrence interval storm, minimizing the inconveniences attendant to inundation from relatively frequent storms, and major system facilities to accommodate the runoff from a 100-year recurrence interval storm, preventing structure flooding when the capacity of the minor system is exceeded.

Because the recommended plan provides a system with increased hydraulic capacity, the duration of high water levels in the two detention basins in the Foxmead subdivision, as well as in depression areas which collect agricultural runoff, would be decreased. That should alleviate basement problems associated with high groundwater levels in the subdivision.

As discussed in Chapter V of this report, the conversion of some lands which were historically farmed, but have since reverted to wetlands, is not likely to be permissible under current State and Federal regulations. It may be possible to achieve some monetary benefit from those lands through their enrollment in the USDA Water Bank Program.

PLAN IMPLEMENTATION

Plan Adoption

An important first step in plan implementation is the formal adoption of the recommended agricultural and stormwater drainage plan by the Racine County Farm Drainage Board as the governing body of the Racine County Farm Drainage District No. 1, by the Towns of Norway and Waterford, and by the Village of Waterford. In addition, the plan should be endorsed by the Wisconsin Department of Transportation. Such formal adoption signifies agreement with, and official support of, the recommendations contained in the plan.

Implementation Procedures

Under current procedures, approval of Farm Drainage District expenditures and authorization of assessments to property owners within the District requires a hearing in Racine County Court. That process is cumbersome and is not conducive to the efficient operation of the District. The legal counsel to Farm Drainage District No. 1 prior to the District being placed under the supervision of the County Farm Drainage Board has suggested formation of a utility district covering the drainage area concerned in the Towns of Norway and Waterford and Village of Waterford. The District would be supervised by a single commission established through an intermunicipal agreement as provided for in Section 66.30 of the State Statutes.[1] Under that agreement, bonds could be issued for the construction of capital improvements. The bonds could be retired through the ad valorem property tax, special assessments, impact fees for certain new development, and/or assessments based on the amount of runoff contributed by individual land parcels. Through the supervising commission, such a district could have jurisdiction over both agricultural and urban stormwater drainage improvements within district boundaries. The formation of a utility district under the supervision of a single commission could have advantages over the present system in that it would recognize the interrelationship between the agricultural and urban stormwater drainage systems within the district and it would enable improvement of those systems in a manner consistent with the recommendations of this system plan. If such a district was legally established, implementation of the plan recommended herein could be accomplished through a program for capital improvements and through establishment of public works construction, operation, and maintenance procedures. Under a utility district approach, the Village of Waterford would retain its functions of land subdivision plat approval and extraterritorial review of development outside Village boundaries. In light of the substantial costs involved in implementation of the recommended agricultural and stormwater drainage plan, the Racine County Farm Drainage Board, the Towns of Norway and Waterford, and the Village of Waterford should consider pursuing establishment of a utility district.

If the current administrative framework for the Farm Drainage District is maintained, implementation of the plan would require considerable coordination between the Farm Drainage Board and the Village of Waterford because of the need

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[1]The legal counsel has advised that the most feasible legal means of establishing the desired utility district framework would be for each of the three civil divisions to establish a utility district covering that portion of the total drainage area which lies within that civil division. Under the supervision of a single commission that would be created pursuant to Section 66.30 of the Wisconsin Statutes, the three districts would effectively function as a single district.

for common facilities to serve both agricultural and stormwater drainage functions and because even those measures which are not specified for District/Village cost-sharing are essential for the overall agricultural and stormwater drainage system to function as intended. Under the current arrangement, funding of Village costs associated with implementation of the recommended plan would come through the property tax levy, special assessments, issuance of general obligation bonds, and reserve funds. District costs would have to be funded through the process under which assessments are approved by the County Court based on benefits derived. Under current District assessment procedures, it is unlikely that the District would be able to raise the funds necessary to implement its share of the plan. Thus, the formation of a utility district may be the only means of obtaining adequate funding to execute the plan.

PRELIMINARY PLAN SCHEDULE FOR IMPLEMENTATION

Prioritization of Capital Improvements

A preliminary prioritization of the recommended capital improvements is given in Table 15. This prioritization is provided to identify those projects that should be implemented to alleviate the most pressing agricultural and stormwater drainage problems and to identify a necessary sequence for implementation of certain interdependent components of the total system. For this prioritization, a project is defined as a set of components that should be constructed in concert in order for the set to function properly by itself and within the context of the larger total system of which it is a part.

The sequence in which projects are actually implemented and the time at which they are implemented will ultimately depend on a number of factors not related solely to agricultural and stormwater drainage considerations. Such factors include District and Village budgetary constraints, the need to implement other projects in the Village of Waterford capital improvements program, and variations in future development patterns as determined by the urban land market. However, where a specific sequence for a series of components comprising a unified project is required, that sequence should be followed to ensure the proper functioning of the system.

Identification of Critical Implementation Sequences

The following discussion identifies projects for which the implementation sequence is critical.

Project No. 1 - Installation of Parallel Culvert at the Study Area Outlet and Project No. 2 - Construction of Open Channel and Associated Culverts: It is essential to the proper functioning of all upstream components of the system plan and to the provision of adequate major stormwater drainage system capacity under planned land use conditions that the 570-foot-long, 72-inch diameter CMP culvert which is recommended to be installed at the study area outlet to the Fox River be constructed first, followed by construction of the approximately 1,000-foot-long, trapezoidal open channel.

Project No. 4 - Construction of New Lift Station and Associated Storm Sewers: This project must be constructed following Projects 1 and 2 and prior to any improvement of the upstream agricultural drain tile system. Without provision of the higher capacity lift station called for under this project, the agricultural drain tile system would not function efficiently even with the recommended larger drain tile in place.

Table 15

PRIORITIZATION OF RECOMMENDED AGRICULTURAL AND STORMWATER DRAINAGE PROJECTS FOR RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1

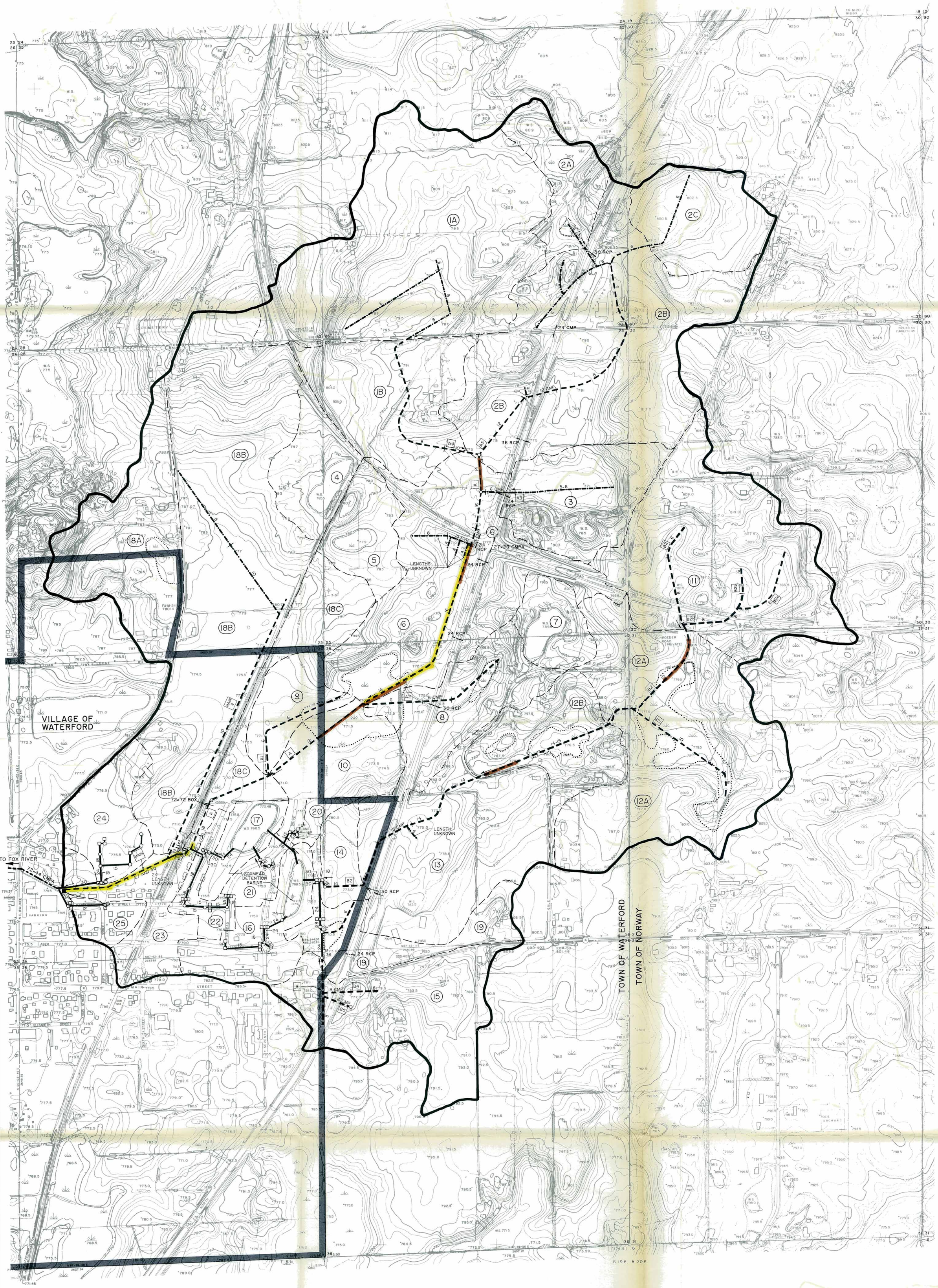
Project Priority Number and Description	Project Component Numbers as Listed in Table 14	Farm Drainage District Capital Cost[a]	Village of Waterford Capital Cost[a]	Wisconsin Department of Transportation Capital Cost[a]	Private Sector Capital Cost[a]	Total Capital Cost of Components[a]
1. Installation of Parallel Culvert at the Study Area Outlet	15	$ 0	$ 144,000	$ 0	$ 0	$ 144,000
2. Construction of Open Channel and Associated Culverts	16 and 17	0	115,400	0	0	115,400
3. Disconnection of Residential Foundation Drains	30	0	0	0	1,000	1,000
4. Construction of New Lift Station and Associated Storm Sewers	14, 18, 19, 20, and 25	50,600	41,000	2,700	0	94,300
5. Replacement of Agricultural Drain Tile Along District Line A	1 through 6, 21, 22, and 25	137,900	0	26,900	0	164,800
6. Replacement of Agricultural Drain Tile Along District Line B2	7 through 10, 23, and 25	18,400	0	19,100	0	37,500
7. Replacement of Agricultural Drain Tile Along District Lines B and B4	11, 24, and 25	6,400	0	11,800	0	18,200
8. Construction of Detention Basin No. 1	27	0	0	0	67,300	67,300
9. Construction of Detention Basin No. 2	28	0	0	0	398,700	398,700
10. Construction of Storm Sewers to Serve Planned Development	25 and 26	0	0	0	69,600	69,600
Total		$213,300	$300,400	$60,500	$536,600	$1,110,800

[a]Costs for 1993 Engineering News-Record Construction cost Index=5,390. Costs include engineering, administration, and contingencies.

Source: SEWRPC.

Project No. 5 - Replacement of Agricultural Drain Tile Along District Line A, Project No. 6 - Replacement of Agricultural Drain Tile Along District Line B2, and Project No. 7 - Replacement of Agricultural Drain Tile Along District Lines B and B4: These projects can be constructed independently of one another, however, each should proceed from downstream to upstream to enable complete utilization of the additional hydraulic capacity made available as segments of tile are replaced.

Project No. 9 - Construction of Detention Basin No. 2: This detention basin should be constructed prior to any new significant development occurring in the area tributary to the basin, which includes Subbasins 18B, 18C, and 23. It may be necessary for the Village to fund the cost of constructing the basin and to then recover that cost from developers as urbanization of the tributary area proceeds.



LEGEND

- STUDY AREA BOUNDARY
- SUBBASIN BOUNDARY
- SUBBASIN OUTLET
- (16) SUBBASIN DESIGNATION
- A 18 EXISTING DRAINAGE DISTRICT TILE, DIAMETER IN INCHES, AND DESIGNATION°
- 10 EXISTING PRIVATE TILE AND DIAMETER IN INCHES°
- 24 EXISTING VILLAGE OF WATERFORD STORM SEWER AND DIAMETER IN INCHES (REINFORCED CONCRETE PIPE)
- EXISTING MANHOLE
- EXISTING STORMWATER INLET
- EXISTING DRAINAGE DISTRICT LIFT STATION
- VILLAGE OF WATERFORD CORPORATE LIMITS

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PVC POLYVINYL CHLORIDE
RCP REINFORCED CONCRETE PIPE
CMPA CORRUGATED METAL PIPE ARCH

- WETLAND BOUNDARIES AS SHOWN ON 1990 SEWRPC LAND USE INVENTORY MAPS
- APPROXIMATE LOCATION OF DRAIN TILE OBSERVED TO BE IN DETERIORATED CONDITION - 1992
- SECTIONS OF DRAIN TILE OR STORM SEWER WITH POSSIBLE NEGATIVE SLOPES
- 24 EXISTING CULVERT AND SIZE IN INCHES

° THE ORIGINALLY INSTALLED DISTRICT DRAIN TILE WERE CLAY PIPE. DUE TO SYSTEM MAINTENANCE SINCE 1922, THE SYSTEM COMPONENTS ARE NOW A MIXTURE OF CLAY, CONCRETE, CORRUGATED METAL, AND SMOOTH-WALL CORRUGATED POLYETHYLENE PIPE. THE PIPE DIAMETERS AND ALIGNMENTS GIVEN ON THE MAP ARE BASED ON THE BEST AVAILABLE DATA WHICH INCLUDE THE 1921 DESIGN MAPS, HISTORIC RECORDS ON FILE WITH THE RACINE COUNTY CLERK OF COURTS, THE 1977 FOXMEAD SUBDIVISION STORM SEWER PLANS, PREPARED BY MICHAEL J. LOSIK & ASSOCIATES, FIELD SURVEY DATA PROVIDED BY NIELSEN, MADSEN & BARBER CONSULTING CIVIL ENGINEERS, WISCONSIN DEPARTMENT OF TRANSPORTATION AS-BUILT DRAWINGS FOR STH 36 AND STH 164, AND INFORMATION OBTAINED FROM INTERVIEWS WITH DRAINAGE DISTRICT COMMISSIONERS.

Map 2

EXISTING AGRICULTURAL DRAINAGE AND URBAN STORMWATER MANAGEMENT SYSTEM

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

COMBINATION SCALE AND SEA LEVEL REDUCTION FACTOR: 0.99990475

HORIZONTAL DATUM IS BASED ON THE WISCONSIN STATE PLANE COORDINATE SYSTEM, SOUTH ZONE.

VERTICAL DATUM OF 1929.

BASE MAP PREPARED USING SAME SIZE PHOTOGRAPHIC COPIES OF 1"=200' SCALE, 2' CONTOUR INTERVAL, TOPOGRAPHIC MAPS WHICH WERE COMPILED TO NATIONAL MAP ACCURACY STANDARDS BY STEREO PHOTOGRAMMETRIC METHODS.

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SECTION 36, T. 4 N., R. 19 E.--1"=200' SCALE, SOURCE: RACINE CO., DATE OF PHOTOGRAPHY: APRIL 1968 AND APRIL 1979.

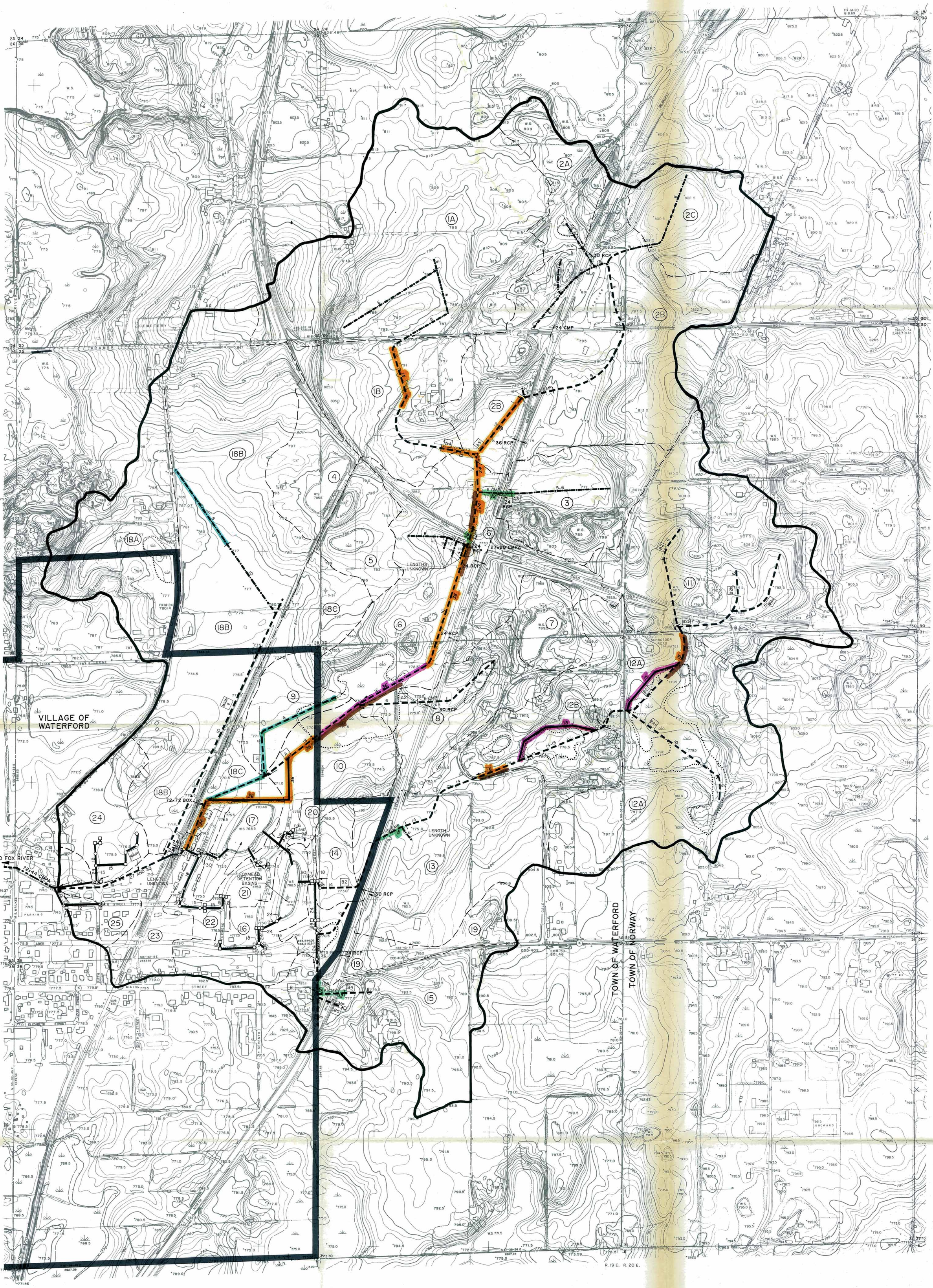
TOPOGRAPHIC MAP OF THE RACINE COUNTY FARM DRAINAGE DISTRICT NO. 1 STUDY AREA

GEODETIC NORTH / GRID NORTH +01° 14' 14"

SCALE: 1"= 400'
CONTOUR INTERVAL: 2'

200 0 200 400 600

BASE MAP DESIGN: K. W. BAUER	
DRAWN BY: J. C. JOHNSON	DATE: DEC. 7, 1992
CHECKED BY: M. G. HAHN	DATE: DEC. 11, 1992
APPROVED BY:	DATE:



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- EXISTING STORMWATER INLET
- EXISTING DRAINAGE DISTRICT LIFT STATION
- VILLAGE OF WATERFORD CORPORATE LIMITS
- WETLAND BOUNDARIES AS SHOWN ON 1990 SEWRPC LAND USE INVENTORY MAPS
- APPROXIMATE LOCATION OF DRAIN TILE OBSERVED TO BE IN DETERIORATED CONDITION - 1992
- 36 PROPOSED PERFORATED CORRUGATED PLASTIC PIPE TO REPLACE DISTRICT DRAIN TILE AND DIAMETER IN INCHES
- 36 PROPOSED SEALED CORRUGATED PLASTIC PIPE TO REPLACE DISTRICT DRAIN TILE AND DIAMETER IN INCHES
- 15 PROPOSED REINFORCED CONCRETE PIPE TO REPLACE DISTRICT DRAIN TILE AND DIAMETER IN INCHES
- EXISTING DRAIN TILE TO BE ABANDONED UNDER PLANNED DEVELOPMENT CONDITIONS
- 24 EXISTING CULVERT AND SIZE IN INCHES

CMP CORRUGATED METAL PIPE — RCP REINFORCED CONCRETE PIPE
PVC POLYVINYL CHLORIDE — CMPA CORRUGATED METAL PIPE ARCH

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Map 7

PROPOSED AGRICULTURAL DRAINAGE FEATURES WHICH ARE COMMON TO ALTERNATIVE PLANS NO. 1A THROUGH NO. 4A, AND NO. 1B THROUGH NO. 4B

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

COMBINATION SCALE AND SEA LEVEL REDUCTION FACTOR: 0.99995475

HORIZONTAL DATUM IS BASED ON THE WISCONSIN STATE PLANE COORDINATE SYSTEM, SOUTH ZONE.

VERTICAL DATUM OF 1929.

BASE MAP PREPARED USING SAME SIZE PHOTOGRAPHIC COPIES OF 1"=200' SCALE, 2' CONTOUR INTERVAL, TOPOGRAPHIC MAPS WHICH WERE COMPILED TO NATIONAL MAP ACCURACY STANDARDS BY STEREO PHOTOGRAMMETRIC METHODS.

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GEODETIC NORTH / GRID NORTH +01°14'14"

SCALE: 1" = 400'
CONTOUR INTERVAL: 2'

200 0 200 400 600

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DRAWN BY: J. C. JOHNSON	DATE: DEC. 7, 1992
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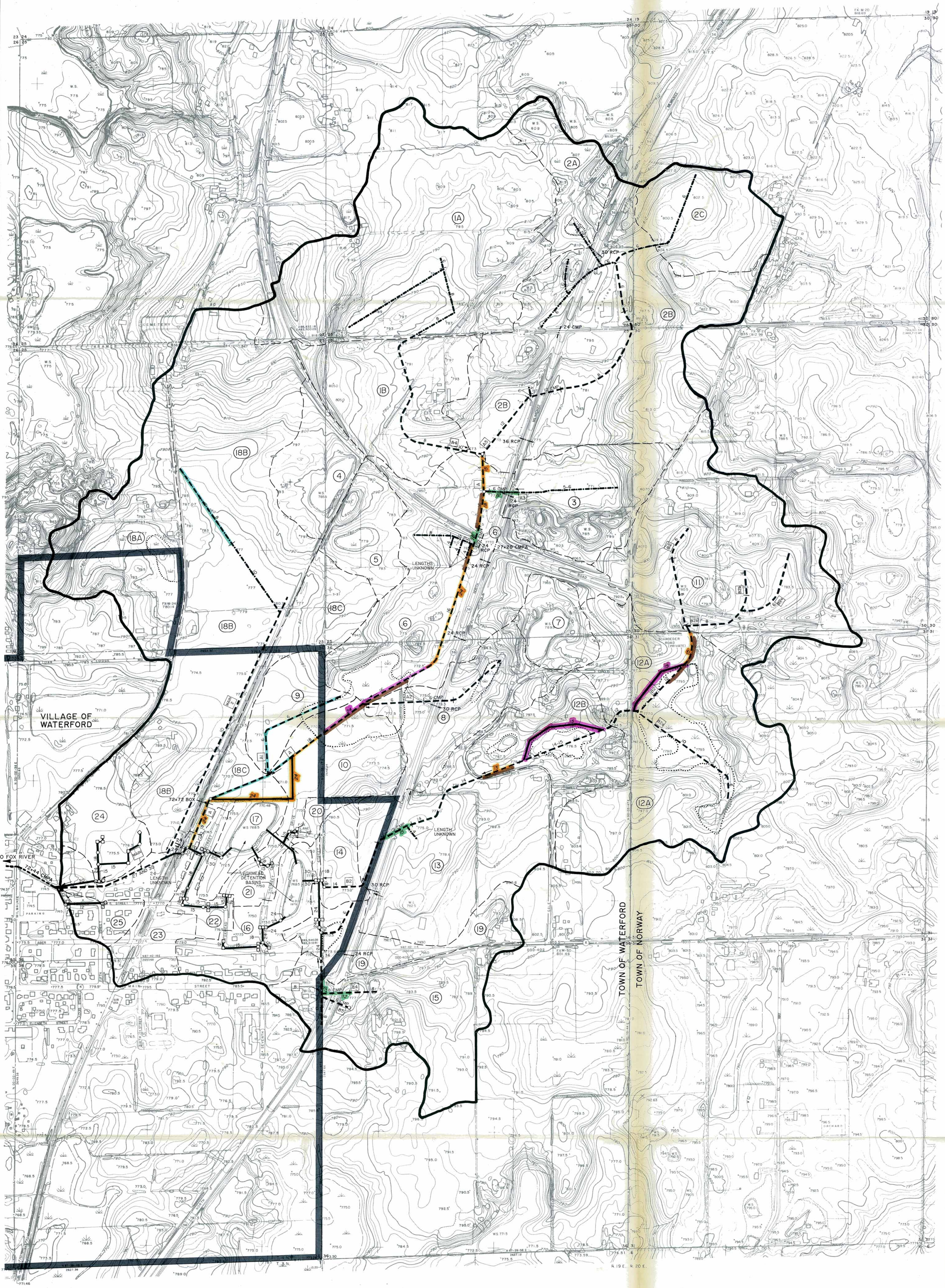

LEGEND

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Map 8

PROPOSED AGRICULTURAL DRAINAGE FEATURES WHICH ARE COMMON TO ALTERNATIVE PLANS NO. 5A AND NO. 5B

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

COMBINATION SCALE AND SEA LEVEL REDUCTION FACTOR: 0.99995475.

HORIZONTAL DATUM IS BASED ON THE WISCONSIN STATE PLANE COORDINATE SYSTEM, SOUTH ZONE.

VERTICAL DATUM OF 1929.

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