Section 4
Storm Water Management System

4.1 Introduction

The storm water management system within the New Berlin study area includes storm sewer, drainage ditches, culverts, streams, and wetlands. An inventory of the storm water management system was conducted as part of the preparation of this Storm Water Management Master Plan. The information gathered is used to provide input into the modeling analyses, help define the existing storm water related problems, and provide the database needed to develop storm water management measures.

4.2 Hydraulic Structure Inventory

An inventory to identify and document drainage and hydraulic control structures was conducted by Ruekert and Mielke, Inc. staff during the Summer of 1997. The primary purpose of the inventory was to collect data on the roadway culverts and storm sewers.

Nearly 1,400 culverts were observed and documented during the inventory. The inventory included culverts that crossed public roads. During the inventory, each culvert was assigned an identification number based on its location. The identification number includes the public land survey section, the quarter section, and a culvert number. For example culvert 36-01-03 is located in section 36, and is in the 01 quarter section and is culvert number 3. The inventory included:

- visual survey of all roadways within the study area to identify culvert crossing locations,
- field inspection and survey of each culvert or structure, and
- completion of a culvert inventory worksheet.

The field inspection documented:

- the shape, dimensions, length, and construction material of the culvert,
- the upstream and downstream inverts,
- the percent blocked,
- the culvert end condition, and
- the structural condition of each culvert.

A copy of a completed inventory worksheet is shown on Figure 4-1. The information collected during the field inspection, along with the nearest cross street, is

Figure 4-1: Culvert Inventory Field Form

INSPECTOR: AJS/SW6
DATE: 10/20/97
PROJECT #: 14-a2026

NEW BERLIN CULVERT INVENTORY FORM

SHEET 37 OF 54

						Dimension		Mat'l Type		End Condition			Pipe End w/o Grate		Ditch Depth (ft)		Distance To Pavement		Other	Apparent Flooding Problem Area				
						Size	Length	RCP, CMP, OTHER	Top of Road Elev.	Good	Fair	Poor	High	Low	High	Low	High	Low		Flood Debris/Dep.	Resident Report	Pond'g/Std'g Water	Other	% Blockage
													(Circle One)											
CUE	10-04-13	PT#	3433	Street	160 st.	24x36							≥ 60"	36"-60"	>5	3-5	>2	<2						0
CUE	10-04-14		3434	Street	160 st.	24x36							≥ 60"	36"-60"	>5	3-5	>2	<2						0
CUE	10-04-15		3435	Street	Esmnt.								≥ 60"	36"-60"	>5	3-5	>2	<2						0
CUE	15-02-01		3436	Street	166 st	48x86	53						≥ 60"	36"-60"	>5	3-5	>2	<2		1.0				25
CUE	15-02-02		3467	Street	166 st	48x66	53						≥ 60"	36"-60"	>5	3-5	>2	<2		2.0				50
CUE	15-02-03		3468	Street	166 st	48x66	53						≥ 60"	36"-60"	>5	3-5	>2	<2		1.0				25
CUE	15-02-04		3437	Street	Victor	21x30	54						≥ 60"	36"-60"	>5	3-5	>2	<2		.7 1/2		.2		25
CUE	15-02-05		3438	Street	Victor	21x30	48						≥ 60"	36"-60"	>5	3-5	>2	<2		.7 1/2		.2		25
CUE	15-02-06		3439	Street	Victor	36x58	49						≥ 60"	36"-60"	>5	3-5	>2	<2		1.0 1/2		.2		33
CUE	15-02-07		3444	Street	Victor	36x58	49						≥ 60"	36"-60"	>5	3-5	>2	<2						0
CUE	15-02-08		3447	Street	Calhoun	60	66	CMP				✓	≥ 60"	36"-60"	>5	3-5	>2	<2	.4 Lower W/E			1.5		0
CUE	15-02-09		3448	Street	Calhoun	60	66	CMP				✓	≥ 60"	36"-60"	>5	3-5	>2	<2	.4 Lower W/E			1.5		0
CUE	15-02-10		3449	Street	Calhoun	60	66	CMP				✓	≥ 60"	36"-60"	>5	3-5	>2	<2	.4 Lower W/E			1.5		0
CUE	15-02-11		3451	Street	Calhoun	60"	63'	CONC					≥ 60"	36"-60"	>5	3-5	>2	<2		.2				5
CUE	15-02-12		3478	Street	Calhoun	60							≥ 60"	36"-60"	>5	3-5	>2	<2		.1				5
CUE	15-02-13		3479	Street	Calhoun	60							≥ 60"	36"-60"	>5	3-5	>2	<2		.5				10
CUE	15-02-14		3452	Street	Coffee	24"	38'	CMP	N 898.89 S 898.30				≥ 60"	36"-60"	>5	3-5	>2	<2		1.0				65
CUE	15-02-15		3453	Street	Coffee	21 x 27"	38'	CMP	S 899.21 N 898.67				≥ 60"	36"-60"	>5	3-5	>2	<2		1.0				65
CUE	15-02-16		3457	Street	Coffee	36"	209	CMP					≥ 60"	36"-60"	>5	3-5	>2	<2						0
CUE	15-02-17		3458	Street	Coffee	36"	43						≥ 60"	36"-60"	>5	3-5	>2	<2	Same lenght as 02. INV S/E 899.80					0
CUE	15-01-01		3462	Street	Coffee	3 30x48		CMP					≥ 60"	36"-60"	>5	3-5	>2	<2						0
CUE	15-01-02		3463	Street	Coffee	24"	43	CMP					≥ 60"	36"-60"	>5	3-5	>2	<2						0
CUE	15-02-18		3473	Street	Victor	36x58	49						≥ 60"	36"-60"	>5	3-5	>2	<2						0
CUE	15-02-19		3474	Street	Victor	24"	59						≥ 60"	36"-60"	>5	3-5	>2	<2						0
CUE	15-01-03		3485	Street	Montery Dr	18x30							≥ 60"	36"-60"	>5	3-5	>2	<2	18"	.25				

summarized on a database which is presented in Appendix C and was provided to the City of New Berlin.

Of the 1,400 culverts observed, 65 culverts were identified as being more than 50 percent blocked. The culverts with the most significant maintenance problems which require near term maintenance have been identified in a separate memorandum submitted to the City for prompt corrective action.

4.3 Water Resources System

The water resource system within the study area includes waterways, storm sewers, and drainage ditches. Approximately 20 percent of the study area is serviced by storm sewer and the remainder of the study area is serviced by drainage ditches and culverts.

A majority of the City of New Berlin is serviced by drainage ditches and culverts. The condition and size of the drainage ditches are widely varied. Field inspection indicated that some sections of the drainage ditch system have been filled or are otherwise blocked.

Storm sewer system service areas throughout the City of New Berlin. The storm sewered areas are generally located east of Moorland Road and north of Beloit Road.

Each subwatershed was divided into subbasins in order to evaluate the hydraulics and water quality impacts. In general, the subbasins are delineated so that each subbasin contains an area which drains to a specific inflow point or connecting point on the main storm water drainage system. The subbasins vary in size from approximately 10 acres to more than 900 acres. The majority of the subbasins are less than 300 acres. The subbasins are delineated based on a review of existing topographic maps, existing storm sewer maps, and, if necessary, field inspection.

Major features of the New Berlin drainage system are presented on a water resources map shown on Plate 1 in Appendix A. Major features shown on the map include:

<Watershed boundaries
<Subwatershed boundaries
<Subbasin areas
<Primary drainage system
<Culverts and storm sewers
<Road planimetry
<Stream rating
<Water quantity problem areas
<Water quality problem areas

4.4 Streambank Inventory

Streambank erosion is responsible for the delivery of hundreds of tons of sediments to receiving streams annually. In order to reduce the sediment loading existing and

potential streambank erosion areas must be identified and repaired. A detailed field inventory of the stream channels within the study area was conducted to evaluate the channel stability and to prioritize streambank reaches which require stabilization measures. Approximately 34 miles of channel were evaluated using field techniques developed by the U.S. Department of Agriculture. The channels included in the inventory are shown on Plate 1 in Appendix A. The inventory technique used, known as the Pfankuch Method, evaluates nine stability indicators of the upper and lower bank areas of the stream channel. Each indicator is classified as excellent, good, fair, or poor. The Pfankuch Method assigns a numeric value to each classification which, when totaled for all of the indicators, results in an overall stream reach classification. A description of the indicators and classifications is presented in Table 4-1.

The streambank inventory included:

- Identification of streams within the study area based on base maps provided by the City of New Berlin.
- Field inspection of identified streams including completion of a field form evaluating each stream reach.
- Evaluation of overall streambank conditions.

Figures 4-3, 4-4, and 4-5 show examples of stream reaches inventoried and the classification rating.

The inventory of the streambank conditions indicated that:

- Of the streambanks inventoried, the overall reach condition of 19.8 miles, or 59 percent, is classified good; 13.4 miles, or 40 percent, is classified fair, and 0.2 miles, or 1 percent, is classified poor.
- Bank rock content is classified poor for 88 percent of the stream. This indicates that 20 miles of streambank have less than 30 percent rocks in the bank and is a reflection of the overall geology of the area.
- Vegetative bank protection, debris jam potential, and landform slope are the most common indicators, other than bank rock content, to be rated fair or poor.
- 9.5 miles, or 29 percent, of the streambanks have less then 70 percent plant density.
- 8.7 miles, or 26 percent, of the streambanks have the quantity and size materials present for the potential to create a flow deflection or debris jam.
- 7.2 miles, or 22 percent, of the streambanks have a slope greater steeper than 40 percent.

- Evidence of mass wasting was generally not observed in the streambank inventoried.

- The Upper Root River, Poplar Creek, Calhoun Creek, and Underwood Creek subwatersheds have the greatest percentage of treambanks showing significant signs of erosion, streambanks with an overall classification of fair or poor.

- The Deer Creek, Tess Corners Creek, and Mill Creek subwatersheds have the greatest percentage of streambanks in good overall condition. Poplar Creek and Deer Creek subwatersheds have the most miles of streambank in good overall condition.

A summary of the streambank classifications is presented in Table 4-2 and shown on Figure 4-6. Inventory results for each reach of stream inventoried are presented in Appendix B. The overall stream classification rating based on the inventory is also shown on Plate 1 in Appendix A.

Based on overall condition of the streambanks, the stream reaches with the most significant stability concerns are summarized in Section 7. The reaches identified with significant stability concerns should be repaired. Alternatively, streambanks which received the highest ratings, should be protected. The streambank reaches rated most stable are summarized in Appendix B.

Table 4-1: Summary of Stream Inventory Indicators and Classification

Location	Indicator Item Rated	Classification			
		Excellent	**Good**	**Fair**	**Poor**
Upper Bank - *area between normal high water line and extreme high water line*	Landform Slope - *steepness of land adjacent to the channel, related to extent and ease of erosion*	Slope <30%	Slope 30 - 40 %	Slope 40-60%	Slope >60%
	Mass Wasting or Failure - *detachment of soil and movement downslope, potential for large volumes of material to be introduced into the stream*	No evidence of occurrence	Infrequent or very small occurrences	Moderate frequency and size occurrences	Frequent or large occurrences
	Debris Jam Potential - *floatable objects such as branches or logs located along the bank, potential for the development of flow deflection and creation of debris jams*	Essentially absent	Mostly small twigs and limbs	Present - quantity and size of material increasing	Moderate to heavy amounts - mostly large size materials
	Vegetative Bank Protection - *density of vegetation on the bank, related to stability of bank soils and reduction in erosion potential*	Over 90% plant density	70-90% plant density	50-70% plant density	<50% Plant density
Lower Bank - *area between the waters edge during low flow period to the normal high water line*	Channel Capacity - ability of channel to transmit the volume of water	Ample for present flow and increases	Adequate - Overbank flow rare	Barely contains present peak flow	Inadequate - overbank flow common
	Bank Rock Content - amount and size of rocks in the bank materials, related to the resistance to flow forces which may cause erosion	65% rock - large boulders >12" diameter	40-65% rock - mostly small boulders and cobbles 6-12" diameter	20-40% rock - 3-6" diameter	<20% rock - 1-3" diameter
	Obstructions - objects within the stream channel, obstructions may change in flow direction and velocity	Rocks/old logs embedded - flow pattern without cutting or deposition	Some present - causing erosive cross currents and minor pool filling	Moderately frequent - causing bank cutting and filling of pools	Frequent obstructions - causing yearlong bank erosion and channel migration
	Cutting - loss of vegetation protection on bank or increase in bank steepness	Little or none evident: raw banks infrequent and less than 6" high	Some present: raw banks up to 12" high	Significant: raw banks 12-24" high	Almost continuous cuts: some over 24" high
	Deposition - deposition of sediment resulting in growth of sediment bars, indication of upstream erosion	Little or no evidence	Some new increases	Moderate deposition	Extensive deposition

Source: *Stream Reach Inventory and Channel Stability Evaluation* (U.S. Department of Agriculture Forest Service 1975)

Figure 4-3: Examples of stream reaches rated good.

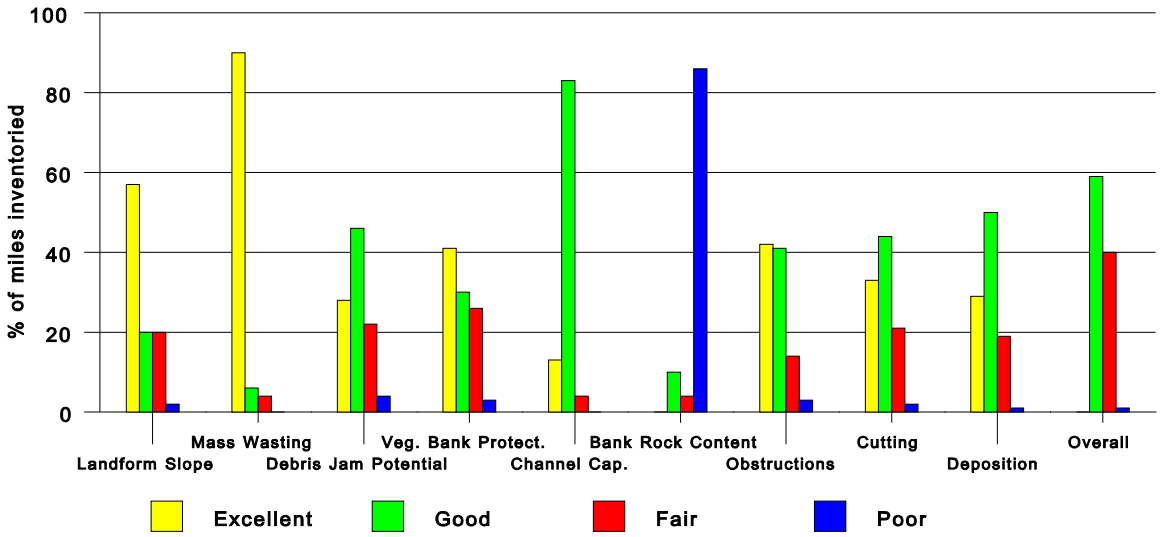
Figure 4-4: Examples of stream reaches rated fair.

Figure 4-5: Examples of stream reaches rated poor.

Table 4-2: Summary of Streambank Condition

SUBWATERSHED	UPPER BANK																LOWER BANK																							
	Landform Slope				Mass Wasting or Failure				Debris Jam Potential				Vegetative Bank Protection				Channel Capacity				Bank Rock Content				Obstructions				Cutting				Deposition				Overall Reach Conditions			
	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor
Deer Creek																																								
# of Reaches	20	5	7	1	25	6	2	0	22	7	3	1	16	17	0	0	14	17	2	0	0	13	4	16	18	10	3	2	18	9	6	0	16	8	9	0	0	25	8	0
Miles of Stream	3.9	0.6	1	0.1	4.6	0.8	0.2	0	3.3	1.8	0.4	0.1	2.7	2.9	0	0	2.1	3	0.5	0	0	1.8	0.7	3.1	2.9	2	0.4	0.3	3.1	1.8	0.7	0	2.6	1.6	1.4	0	0	4.6	1	0
Upper Root River																																								
# of Reaches	16	9	14	5	25	9	9	1	7	28	9	0	8	17	16	3	4	37	3	0	1	11	2	30	15	22	7	0	8	22	12	2	18	17	9	0	0	21	21	2
Miles of Stream	2.6	1.1	1.8	0.5	3.7	1.1	1.1	0.1	1.1	4	0.9	0	1.2	2.6	1.9	0.3	0.5	5.2	0.3	0	0.1	1.4	0.2	4.3	2	2.8	1.2	0	1	3.1	1.7	0.2	2.4	2.7	0.9	0	0	3	2.8	0.2
Tess Corners Creek																																								
# of Reaches	2	4	1	0	7	0	0	0	3	3	0	1	3	2	1	1	0	6	1	0	0	1	2	4	5	1	0	1	4	0	3	0	1	2	2	2	0	5	2	0
Miles of Stream	0.6	0.5	0.2	0	1.3	0	0	0	0.8	0.4	0	0.1	0.7	0.4	0.1	0.1	0	1	0.3	0	0	0.1	0.3	0.9	1.1	0.1	0	0.1	1	0	0.3	0	0.3	0.2	0.3	0.5	0	1.1	0.2	0
Underwood Creek																																								
# of Reaches	1	1	1	0	3	0	0	0	0	0	3	0	0	0	3	0	0	3	0	0	0	0	0	3	0	3	0	0	0	1	1	1	0	2	1	0	0	0	3	0
Miles of Stream	0.3	0.2	0.5	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0.2	0.3	0.5	0	0.2	0.8	0	0	0	1	0
Calhoun Creek																																								
# of Reaches	11	6	5	0	23	0	0	0	3	12	8	0	5	10	8	0	0	22	1	0	0	0	0	23	8	11	4	0	4	17	2	0	5	16	2	0	0	9	14	0
Miles of Stream	3.1	1.4	1.5	0	6	0	0	0	1.4	2.8	1.8	0	1.2	2.5	2.3	0	0	5.8	0.2	0	0	0	0	6	1.8	3.2	1	0	1.2	4.3	0.5	0	1.3	4.4	0.3	0	0	2.5	3.5	0
Poplar Creek																																								
# of Reaches	32	9	6	0	46	1	0	0	10	23	11	3	29	6	10	2	3	43	1	0	0	0	1	46	24	17	5	1	17	19	11	0	12	27	8	0	0	30	17	0
Miles of Stream	7.5	3	1.8	0	12.1	0.2	0	0	2.9	5	3.2	1.2	7.2	1.2	3.4	0.5	1.6	10.5	0.2	0	0	0	0.1	12.2	5.6	4	2.1	0.6	4.7	4.1	3.5	0	3.2	6.3	2.8	0	0	7.4	4.9	0
Mill Creek																																								
# of Reaches	2	0	0	0	2	0	0	0	0	2	0	0	1	1	0	0	0	2	0	0	0	0	0	2	1	1	0	0	0	2	0	0	0	2	0	0	0	2	0	0
Miles of Stream	1.2	0	0	0	1.2	0	0	0	0	1.2	0	0	0.7	0.5	0	0	0	1.2	0	0	0	0	0	1.2	0.7	0.5	0	0	0	1.2	0	0	0	1.2	0	0	0	1.2	0	0
Total																																								
# of Reaches	84	34	34	6	131	16	11	1	45	75	34	5	62	53	38	6	21	130	8	0	1	25	9	124	71	65	19	4	51	70	35	3	52	74	31	2	0	92	65	2
Miles of Stream	19.2	6.8	6.8	0.6	29.9	2.1	1.3	0.1	9.5	15.2	7.3	1.4	13.7	10.1	8.7	0.9	4.2	27.7	1.5	0	0.1	3.3	1.3	28.7	14.1	13.6	4.7	1	11	14.7	7	0.7	9.8	16.6	6.5	0.5	0	19.8	13.4	0.2
% Based on Miles	57	20	20	2	90	6	4	0	28	46	22	4	41	30	26	3	13	83	4	0	0	10	4	86	42	41	14	3	33	44	21	2	29	50	19	1	0	59	40	1

Figure 4-6: Summary of the Streambank Indicator Classification



4.5 Wetlands Inventory

The value of wetlands include their capacity to drain surges of storm water runoff and their ability to remove sediment and nutrients from surface water. The large storage capacity and controlled outfall of many wetlands detain storm water and release it slowly in more evenly distributed flow after a storm event. The long detention time, complex flow patterns, and nutrient uptake by wetland plants combine to make many wetlands very effective for removal and storage of sediment and for the removal and transformation of some dissolved nutrients from surface waters. The physical attributes of wetlands which provide storage capacity and flow control, such as very slow flow and a large storage capacity, also are favorable for water quality improvements.

An inventory of wetlands greater than two acres located within the study area was conducted. The wetlands inventory evaluated existing wetlands, as well as, wetlands which have been previously disturbed and prior converted wetlands. The purpose of the wetland inventory is to evaluate the existing wetland conditions based on:

- effectiveness - the existing wetland capacity to contribute to storm water management, and
- opportunity - the potential of the wetland to provide additional storm water management benefits with modification or restoration.

Wetlands which are currently effective have high functional value and typically posses little opportunity for improvement, while wetlands which are not currently effective have high opportunity for improvement.

The wetland inventory conducted for the study area included:

- Location and mapping of wetlands in the study area over two acres based on the following information:

  <topographic maps (1 inch = 200 feet scale)
  <1995 SEWRPC aerial photographs
  <WDNR, 1986, Final Wetland Inventory maps for New Berlin
  <NRCS Draft Wetland Inventory Maps showing an estimated boundary of wetland, farmed wetland, and prior-converted wetland areas.

- Field inspection of mapped existing and previously altered/prior converted wetland areas

- Evaluation of the effectiveness of the wetland areas to provide flood flow detention, sediment retention, and nutrient removal and transformation based on:

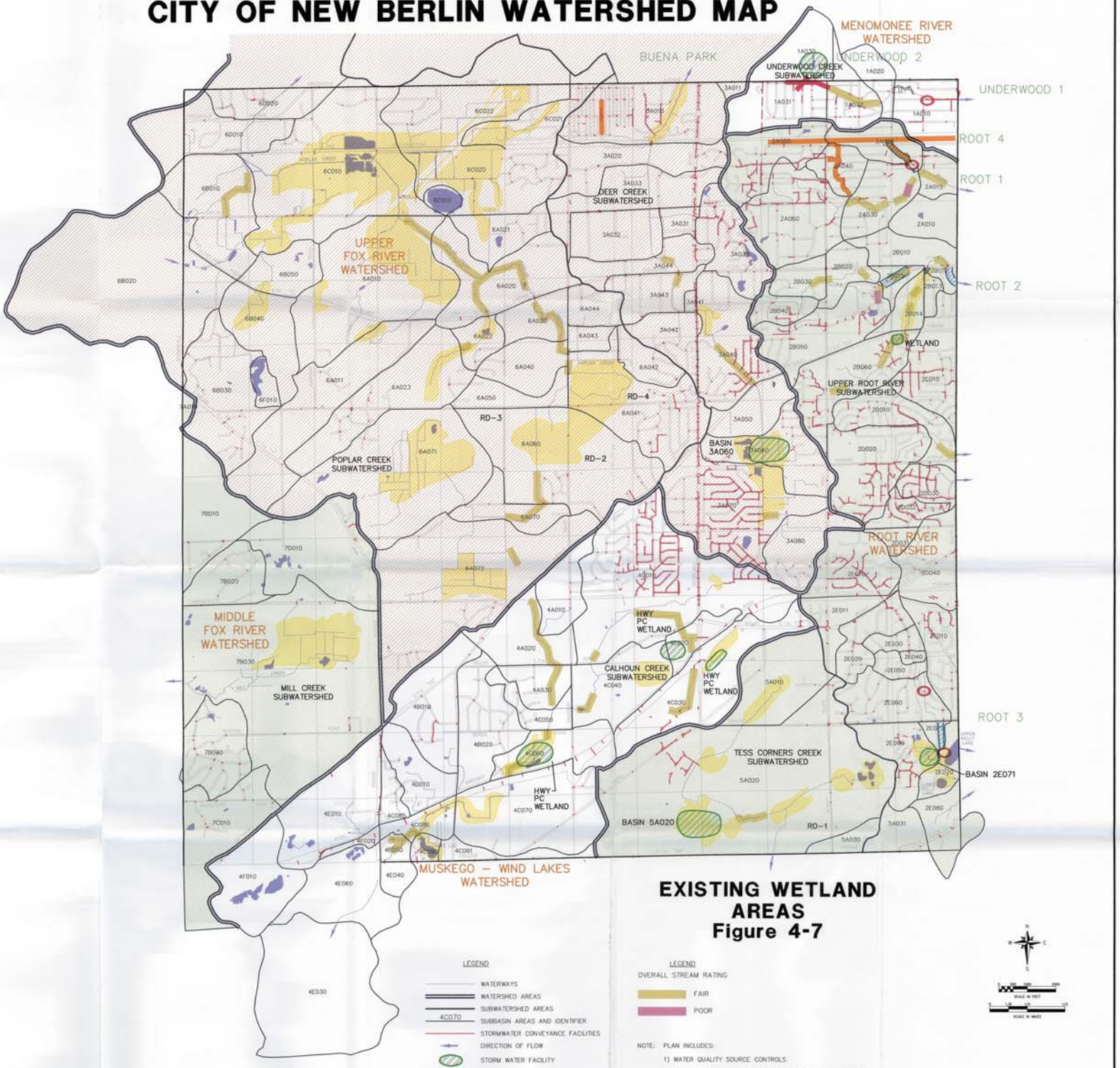
  <wetland acreage,
  <slope,
  <wetland soil elevation relative to the mean water surface elevation,
  <presence of inlets and outlets,
  <outlet water level control and flow characteristics, and
  <flooding extent and duration.

- Evaluation of the opportunity of each wetland area to perform flow and water quality improvement functions based on:

  <sediment and nutrient sources within the drainage basin of the wetland,
  <surface water drainage area of the wetland,
  <size of the wetland relative to its watershed,
  <relationship to other wetlands within the subbasin, and
  <local slope and topography related to delivery of surface water runoff to the wetland.

The inventory identified 82 wetland areas within the study area incorporating 2,800 acres, or 12 percent of the total study area. The inventoried wetlands are shown on Figure 4-7. Over half (57%) of the total wetland areas are designated as prior converted. The prior converted wetland areas incorporate 1,570 acres. All of the wetland areas identified have been disturbed by development activities. Wetland areas within each subwatershed are summarized on Table 4-3.

CITY OF NEW BERLIN WATERSHED MAP



EXISTING WETLAND AREAS
Figure 4-7

LEGEND

- WATERWAYS
- WATERSHED AREAS
- SUBWATERSHED AREAS
- 4C070 SUBBASIN AREAS AND IDENTIFIER
- STORMWATER CONVEYANCE FACILITIES
- DIRECTION OF FLOW
- STORM WATER FACILITY
- FLOODPLAIN LOWERING/INLINE STORAGE
- EXISTING WETLAND AREAS
- CULVERT UPGRADE FOR PROBLEM AREA
- DITCH REGRADING
- STORM SEWER

LEGEND

OVERALL STREAM RATING

- FAIR
- POOR

NOTE: PLAN INCLUDES:

1) WATER QUALITY SOURCE CONTROLS
2) ANNUAL STREAMBANK, DITCH AND CULVERT IMPROVEMENTS

SCALE IN FEET

SCALE IN MILES

CDM Camp Dresser & McKee Inc.

Ruekert | Mielke
Professional Engineers
Registered Land Surveyors
W239 N1812 Rockwood Drive
Waukesha, Wisconsin 53188 (414) 542-5733

Table 4-3: Summary of Wetland Areas within the New Berlin Study Area

Subwatershed	Total Acres of Wetlands Inventoried	Acres of Existing Wetlands	Acres of Prior Converted Wetlands	Total Value Acres [1]	Total Potential Acres [2]
Deer Creek	172.0	79.8	92.2	63.3	108.7
Upper Root River	37.6	37.6	0.0	37.6	0.0
Tess Corners	116.9	53.5	63.4	53.5	96.3
Underwood Creek	--	--	--	--	--
Calhoun Creek	242.4	140.4	102	134.8	107.6
Poplar Creek	1982.4	776.9	1205.8	732.1	1542.0
Mill Creek	249.3	123.8	125.5	123.8	125.5

notes: 1- total value acres = the total acres with a current value (effectiveness) rating of moderately-high or greater.

2- total potential acres = the total acres with a potential for additional effectiveness (opportunity) rating of moderately high or higher.

A more detailed summary of the analysis results including the evaluation of each inventoried wetland is presented in Appendix C.

The evaluation of the wetland areas indicates that:

- 1,145 acres, 41 percent, of the wetland areas inventoried currently have at least moderately high value for surface water quality and flow improvement.
- 1,982 acres, 71 percent, of the wetland areas inventoried currently have at least moderately high additional potential for surface water improvement.
- A majority of the wetland areas with high potential for storm water management are in prior converted wetland areas. Many of the prior converted wetlands have been ditched.
- Ditching has substantially impacted the hydrology of 74 percent of the wetland areas inventoried.
- The area with the highest potential for storm water management is located northwest of the City of New Berlin, within the Poplar Creek watershed.
- All of the wetland areas inspected in the City of New Berlin were disturbed, most of them severely.

Although all of the existing wetland areas identified in the inventory were disturbed by urban development, two areas maintain a high value as a wetland area and should be protected from future disturbance. The wetland areas which are identified as having the greatest value are summarized in Table 4-4.

Table 4-4: Significant Wetland Areas within the New Berlin Study Area

Subwatershed	Wetland Reference Number: Location	Area (acres)	Importance
Poplar Creek	5-1: North of railroad tracks and south of the intersection of Birchwood Lane and Norwood Drive	36	These wetland areas are important because they contain tamarack conifer swamp, which was one of the most common presettlement wetland vegetation types of New Berlin.
	5-3: South of railroad tracks and northeast of the intersection of Lincoln Avenue and Johnson Road	197	These wetland areas are important ecologically because they contain an uncommon species of goldenrod, Solidago ohioensis, Ohio goldenrod.