Summary Report
of the
Waterford Drainage District
Mapping and Benefits Assessment
April 13, 2018

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CIVIL ENGINEERS AND LAND SURVEYORS

INTRODUCTION

The following report was prepared by Nielsen Madsen + Barber (NMB), at the request of the Racine County Board of Drainage Commissioners on behalf of the Waterford Drainage District Farm No.1 hereafter referred to as the "District", to analyze the existing mapping and benefits of the District and update it to reflect any changes. The benefits were calculated using the method approved by the Department of Agriculture, Trade and Consumer Protection (DATCP) which is described in Chapter ATCP 48 of the Wisconsin Administrative Code.

WATERFORD DRAINAGE DISTRICT

The District encompasses parts of three municipalities within Racine County: the Town of Norway, the Town of Waterford and the Village of Waterford. The District contains 823 acres of land consisting of 408 parcels as well as road right-of-way. The Town of Norway contains 142 acres and 32 parcels within the District. The Town of Waterford contains 348 acres and 41 parcels within the District. The Village of Waterford contains 333 acres and 335 parcels within the District.

The drainage system within the District includes several storm sewer and tile systems which all lead to a pump station located along Rockrohr Court within the Village of Waterford. The pump station discharges district runoff to the Fox River. The storm sewer systems within the District are approximately 9,800 feet (1.86 miles) in length. The tile systems are approximately 28,900 feet (5.47 miles) in length.

The District is obligated, under Section 88.63 of the State Statutes, to maintain and repair District facilities. The cost of maintenance and repair is assessed based upon the benefits each parcel receives per Section 88.23 of the State Statutes. Property owners are assigned, in part, a proportionate "charge" based on the amount of runoff "generated" by their property.

The amount of runoff a property generates depends on the percent of impervious surface, ground cover / condition, topography and soil type. The total impervious area and percentage of the parcel thereof are the most important factors in generating runoff. Impervious surfaces are defined as solid or semi-solid surfaces that prevent rainfall from infiltrating into the ground thus creating excess "runoff". Runoff from lands with a high percentage of impervious surfaces is generally in greater quantities and at higher velocities than undeveloped (i.e. agricultural, forest, swamp) lands and typically includes increased pollutant loading.

While undeveloped properties typically generate a fraction of the runoff as compared to developed properties of comparable size, such undeveloped or agricultural properties contribute to the District-wide storm water runoff that must be managed. The undeveloped property in the District amounts to approximately 30.1% of the total area with all agricultural parcels being located within the Town of Norway and the Town of Waterford. There are currently no agricultural parcels within the Village of Waterford.

The District is a separate entity from the three municipalities within its boundary. Rights-of-way owned by the State of Wisconsin, Racine County and local municipalities make up 7.09%, 1.71% and 6.22%, respectively, of the land within the District boundary. In accordance with ATCP 48.02(5)(b) the District assesses each municipality (including Racine County) directly for their respective road rights-of-way. Racine County owns 14.06 acres of land within the District consisting of CTH K. The Wisconsin Department of Transportation (WisDOT) owns 58.4 acres of land within the District consisting of STH 164 and STH 36. The County will be assessed for their rights-of-way. However, in accordance with ATCP 48.02(5)(a), lands owned by the State of Wisconsin cannot be assessed unless the land is being used for agricultural purposes. Therefore, WisDOT will not be assessed for their road rights-of-way within the District.

There are a number of parcels within the District whose boundary extends to the centerline of the adjacent roadway. These parcel owners will be assessed for their entire parcel area, including what extends into the public roadway.

PARCEL DATABASE

A database was created which included all parcels within the District boundary. This database was built upon the existing infrastructure developed and maintained by Racine County.

As part of Racine County's Real Estate Description department, the Real Property Lister Division maintains the real estate tax roll for all municipalities within Racine County with the exception of the City of Racine. The County-maintained data applicable to the District's database includes the owner's name, tax key ID number, parcel size, mailing address, land use classification codes and acreages. The "land use" portion of the data originates from the assessors of the municipalities and is of particular importance to the District's database in that it contains a breakdown (by area) of each land use type for each individual parcel.

There are 12 land use classifications within the District. They are as follows:

(1) Agricultural Forest (5M)
(2) High-Density Residential less than 1/3 Acre (G1)
(3) Medium-Density Residential 1/3 Acre to 1 Acre (G1)
(4) Low-Density Residential greater than 1 Acre (G1)
(5) Commercial (G2)
(6) Agricultural (G4)
(7) Swamp Land (G5)
(8) Production Forest Land (G6)
(9) Agricultural – Improved (G7)
(10) County (X3)
(11) Local / Institutional (X4)
(12) Road Right of Way (R/W)

A breakdown by land use of all parcels within the District is as follows:

Breakdown of Land Use Classification by Area

District-wide Land Use Classification	Land Use Classification Code	Total Area (Acres)	Percentage of Total Area
Residential less than 1/3 Acre (High-Density)	G1	46	5.6%
Residential 1/3 Acre to 1 Acre (Medium-Density)	G1	38	4.6%
Residential greater than 1 Acre (Low-Density)	G1	99	12.0%
Commercial	G2	149	18.1%
Agricultural	G4	204	24.8%
Swamp/Wasteland	G5	37	4.5%
Forest Land	5M / G6	6	0.8%
Agricultural - Improved	G7	3	0.4%
County	X3	2	0.3%
Local / Institutional	X4	79	9.6%
Local Road Right of Way	R/W	65	8.0%
State Road Right of Way	-	58	7.1%
Undefined / Water Bodies	-	37	4.2%
	Total	**823**	

EXISTING BENEFITS ANALYSIS METHODOLOGY

The District has an existing methodology in place to determine the benefits for each parcel. This analysis was based on parcel runoff which is the product of two factors: parcel area (in acres) and the runoff coefficient as a function of underlying soil composition.

PROPOSED BENEFITS ANALYSIS METHODOLOGY

NMB is proposing to use the same basic method as previous assessments, in which benefit points were determined by parcel size and runoff coefficient, for determining the total benefit points for each parcel. For assessment purposes, the individually calculated runoff amounts were used to determine the total “benefit points” for each parcel. The District has historically assigned a minimum number of benefit points for smaller residential and commercial parcels. These parcels typically contain more improvements and run the risk of suffering higher damages should the District system not be properly maintained. To determine the assessment rate for each parcel, the overall District assessment was divided by the total benefit points for all parcels producing a cost per benefit point. This cost was then multiplied by the total

benefit points for each parcel, producing the overall assessment. This method can be utilized uniformly for all developed, undeveloped and agricultural parcels. This method also allows for ease of future benefits analysis updating since changes in the runoff coefficient and parcel size are easily calculated.

The runoff coefficient ranges from 0 to 1 and is the ratio of the amount of rainfall that is not absorbed by the surface to the total amount of rainfall during any given storm event. Parcels which have a larger proportion of "impervious" surface (streets, rooftops, sidewalks, patios, parking lots, driveways and other similar surfaces) will have a larger runoff coefficient than parcels which have a larger proportion of "pervious" surface (lawn, landscaping, agricultural lands and other similar surfaces).

NMB believes that the use of runoff coefficients satisfies the consideration requirements of ATCP 48.08(1)(c) through 48.08(1)(f). These considerations are as follows:

- 48.08(1)(c) – Consider the amount of drainage required by, or provided to the assessed land.
- 48.08(1)(d) – Consider the thoroughness and reliability of drainage provided.
- 48.08(1)(e) – Consider the amount and frequency of flooding on the assessed land.
- 48.01(1)(f) – Consider the difficulty of draining the assessed land.

NMB is proposing to use runoff coefficient values as specified Attachment 5.2 in Chapter 13-10 of the Wisconsin Department of Transportation's Facilities Development Manual (FDM). The FDM has standard values for runoff coefficients based on land use, hydrologic soil group and land slope range. The vast majority of the land uses fall under one of these standard runoff coefficient values. However, the FDM does not have standard runoff coefficients for forest, agricultural-improved or swamp / wasteland. NMB used a commonly accepted average coefficient (0.13) for forested land and used the same value for agricultural-improved as residential greater than 1 acre (0.25). Swamp / wasteland was neglected from the assessment and assigned a runoff coefficient of 0.00 per ATCP 48.06(4). The FDM presents options for low intensity and high intensity design storm events. Low intensity design storm events have a 2 to 10 year design recurrence. High intensity design storm events have a 25 to 100 year design recurrence. Since the typical design storm for a study of this nature is a 10 year event, the low intensity option was used for the analysis. Current topographic data for the entire District was unavailable for this analysis. Therefore, an average slope range of 2% to 6% was assumed for the entire District.

Runoff coefficients for the remaining land uses within the District were generated based on individual calculations. This method was employed due to the land uses (and individual parcels) containing substantially different characteristics and levels of imperviousness. The land uses for which these individual runoff coefficients were calculated are commercial, institutional, municipal (County) and the properties with common ownership (condominium, common element and outlots). These parcel specific coefficients were calculated based on percentages of pervious and

impervious surface, agricultural use, road right-of-way, forest land and water surface. Impervious surfaces were assigned a runoff coefficient of 0.95 and pervious surfaces were assigned a runoff coefficient of 0.17. Water surfaces were treated the same as swamp / wasteland since water bodies accept runoff rather than generate it.

A breakdown of the District land uses by area and percentage as well as the standard runoff coefficients which were used is as follows:

Land Use Classifications for which Standard Runoff Coefficients were used

District-wide Land Use Classification	Land Use Classification Code	Total Area (Acres)	Percentage of Total Area	Runoff Coefficient
Residential less than 1/3 Acre (High-Density)	G1	46	5.6%	0.51
Residential 1/3 Acre to 1 Acre (Medium-Density)	G1	38	4.6%	0.33
Residential greater than 1 Acre (Low-Density)	G1	99	12.0%	0.25
Agricultural	G4	204	24.8%	0.19
Swamp/Wasteland	G5	37	4.5%	0.00
Forest Land	G6 / 5M	6	0.8%	0.13
Agricultural - Improved	G7	3	0.4%	0.25
Local Road Right of Way	R/W	65	7.9%	0.61
	Total	**498**	**60.5%**	

A breakdown of the District land uses by area and percentage for the individually calculated runoff coefficients is as follows:

Land Use Classifications for which Individual Runoff Coefficients were Calculated

District-wide Land Use Classification	Land Use Classification Code	Total Area (Acres)	Percentage of Total Area
Commercial	G2	149	18.1%
County	X3	2	0.3%
Local / Institutional	X4	79	9.6%
	Total	**230**	**28.0%**

In addition, several underlying soil conditions are more conducive than others to the absorption of storm water runoff. Sandy and gravelly soils with large particle sizes will absorb runoff quicker than clayey and silty soils with very small particle sizes. The National Resource Conservation Service (NRCS), a division of the United States Department of Agriculture (USDA), has defined four major soil groups which are explained as follows:

Group A soils have low runoff potential and high infiltration rates. They consist mainly of well drained sand and gravel.

Group B soils have moderate infiltration rates. They consist of moderately well drained soils with moderately fine to coarse textures.

Group C soils have low infiltration rates and have a moderately fine to fine texture.

Group D soils have high runoff potential and low infiltration rates. They consist mainly of clay soils.

Runoff coefficients were analyzed using the percentages of all four soil types in accordance with ATCP 48.08(1)(b).

NMB analyzed the soils within the entire District to determine the areas where each of the four soil types is present. This analysis was performed utilizing soils maps from the NRCS. The soils within the District break down into the four major soil groups as follows:

NRCS Soil Type	Percentage Within District
Type A	0.37%
Type B	14.62%
Type C	76.19%
Type D	7.76%
Water	1.06%

The soils within the District are predominately Type C soils. Therefore, the runoff coefficients for Type C soils specified in Attachment 5.2 of Chapter 13-10 of the WisDOT FDM were used to determine the total benefits for each parcel.

APPENDIX A
WISDOT FDM RATIONAL METHOD COEFFICIENT TABLE

FDM 13-10 Attachment 5.2 Runoff Coefficients (C), Rational Formula; and Runoff Coefficients for Specific Land Uses

Detail A - Runoff Coefficients (C), Rational Formula

Land Use	Percent Impervious Area	Hydrologic Soil Group A			B			C			D		
		Slope Range Percent			Slope Range Percent			Slope Range Percent			Slope Range Percent		
		0-2	2-6	6 & over	0-2	2-6	6 & over	0-2	2-6	6 & over	0-2	2-6	6 & over
Industrial	90	0.67 0.85	0.68 0.85	0.68 0.86	0.68 0.85	0.68 0.86	0.69 0.86	0.68 0.86	0.69 0.86	0.69 0.87	0.69 0.86	0.69 0.86	0.70 0.88
Commercial	95	0.71 0.88	0.71 0.89	0.72 0.89	0.71 0.89	0.72 0.89	0.72 0.89	0.72 0.89	0.72 0.89	0.72 0.90	0.72 0.89	0.72 0.89	0.72 0.90
High Density Residential	60	0.47 0.58	0.49 0.60	0.50 0.61	0.48 0.59	0.50 0.61	0.52 0.64	0.49 0.60	0.51 0.62	0.54 0.66	0.51 0.62	0.53 0.64	0.56 0.69
Med. Density Residential	30	0.25 0.33	0.28 0.37	0.31 0.40	0.27 0.35	0.30 0.39	0.35 0.44	0.30 0.38	0.33 0.42	0.38 0.49	0.33 0.41	0.36 0.45	0.42 0.54
Low Density Residential	15	0.14 0.22	0.19 0.26	0.22 0.29	0.17 0.24	0.21 0.28	0.26 0.34	0.20 0.28	0.25 0.32	0.31 0.40	0.24 0.31	0.28 0.35	0.35 0.46
Agriculture	5	0.08 0.14	0.13 0.18	0.16 0.22	0.11 0.16	0.15 0.21	0.21 0.28	0.14 0.20	0.19 0.25	0.26 0.34	0.18 0.24	0.23 0.29	0.31 0.41
Open Space	2	0.05 0.11	0.10 0.16	0.14 0.20	0.08 0.14	0.13 0.19	0.19 0.26	0.12 0.18	0.17 0.23	0.24 0.32	0.16 0.22	0.21 0.27	0.28 0.39
Freeways & Expressways	70	0.57 0.70	0.59 0.71	0.60 0.72	0.58 0.71	0.60 0.72	0.61 0.74	0.59 0.72	0.61 0.73	0.63 0.76	0.60 0.73	0.62 0.75	0.64 0.78

Detail B - Runoff Coefficients for Specific Land Use

Land Use	Hydrologic Soil Group A			B			C			D		
	Slope Range Percent			Slope Range Percent			Slope Range Percent			Slope Range Percent		
	0-2	2-6	6 & over	0-2	2-6	6 & over	0-2	2-6	6 & over	0-2	2-6	6 & over
Row Crops	.08 .22	.16 .30	.22 .38	.12 .26	.20 .34	.27 .44	.15 .30	.24 .37	.33 .50	.19 .34	.28 .41	.38 .56
Median Stripturf	.19 .24	.20 .26	.24 .30	.19 .25	.22 .28	.26 .33	.20 .26	.23 .30	.30 .37	.20 .27	.25 .32	.30 .40
Side Slopeturf			.25 .32			.27 .34			.28 .36			.30 .38
PAVEMENT												
Asphalt	.70 - .95											
Concrete	.80 - .95											
Brick	.70 - .80											
Drives, Walks	.75 - .85											
Roofs	.75 - .95											
Gravel Roads Shoulders	.40 - .60											

NOTE: The lower C values in each range should be used with the relatively low intensities associated with 2 to 10-year design recurrence intervals whereas the higher C values should be used for intensities associated with the longer 25 to 100 year deign recurrence intervals.

Detail A - Runoff Coefficients (C), Rational Formula

Land Use	Percent Impervious Area	Hydrologic Soil Group A Slope Range Percent 0-2	A 2-6	A 6 & over	B 0-2	B 2-6	B 6 & over	C 0-2	C 2-6	C 6 & over	D 0-2	D 2-6	D 6 & over
Industrial	90	0.67 0.85	0.68 0.85	0.68 0.86	0.68 0.85	0.68 0.86	0.69 0.86	0.68 0.86	0.69 0.86	0.69 0.87	0.69 0.86	0.69 0.86	0.70 0.88
Commercial	95	0.71 0.88	0.71 0.89	0.72 0.89	0.71 0.89	0.72 0.89	0.72 0.89	0.72 0.89	0.72 0.89	0.72 0.90	0.72 0.89	0.72 0.89	0.72 0.90
High Density Residential	60	0.47 0.58	0.49 0.60	0.50 0.61	0.48 0.59	0.50 0.61	0.52 0.64	0.49 0.60	0.51 0.62	0.54 0.66	0.51 0.62	0.53 0.64	0.56 0.69
Med. Density Residential	30	0.25 0.33	0.28 0.37	0.31 0.40	0.27 0.35	0.30 0.39	0.35 0.44	0.30 0.38	0.33 0.42	0.38 0.49	0.33 0.41	0.36 0.45	0.42 0.54
Low Density Residential	15	0.14 0.22	0.19 0.26	0.22 0.29	0.17 0.24	0.21 0.28	0.26 0.34	0.20 0.28	0.25 0.32	0.31 0.40	0.24 0.31	0.28 0.35	0.35 0.46
Agriculture	5	0.08 0.14	0.13 0.18	0.16 0.22	0.11 0.16	0.15 0.21	0.21 0.28	0.14 0.20	0.19 0.25	0.26 0.34	0.18 0.24	0.23 0.29	0.31 0.41
Open Space	2	0.05 0.11	0.10 0.16	0.14 0.20	0.08 0.14	0.13 0.19	0.19 0.26	0.12 0.18	0.17 0.23	0.24 0.32	0.16 0.22	0.21 0.27	0.28 0.39
Freeways & Expressways	70	0.57 0.70	0.59 0.71	0.60 0.72	0.58 0.71	0.60 0.72	0.61 0.74	0.59 0.72	0.61 0.73	0.63 0.76	0.60 0.73	0.62 0.75	0.64 0.78

Detail B - Runoff Coefficients for Specific Land Use

Land Use	Hydrologic Soil Group A Slope Range Percent 0-2	A 2-6	A 6 & over	B 0-2	B 2-6	B 6 & over	C 0-2	C 2-6	C 6 & over	D 0-2	D 2-6	D 6 & over
Row Crops	.08 .22	.16 .30	.22 .38	.12 .26	.20 .34	.27 .44	.15 .30	.24 .37	.33 .50	.19 .34	.28 .41	.38 .56
Median Stripturf	.19 .24	.20 .26	.24 .30	.19 .25	.22 .28	.26 .33	.20 .26	.23 .30	.30 .37	.20 .27	.25 .32	.30 .40
Side Slopeturf			.25 .32			.27 .34			.28 .36			.30 .38
PAVEMENT												
Asphalt	.70 - .95											
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Drives, Walks	.75 - .85											
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NOTE: The lower C values in each range should be used with the relatively low intensities associated with 2 to 10-year design recurrence intervals whereas the higher C values should be used for intensities associated with the longer 25 to 100 year deign recurrence intervals.