Nondegradation Study

Loading Assessement

For Selected Municipal Separate Storm Sewer Systems (Selected MS4s)

City of Blaine, Minnesota

SEH No. A-BLAIN0701.00

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Prepared for City of Blaine, Minnesota

1.0 Introduction

1.1 MS4 Permit – General Requirements and Selected MS4

Minnesota Permit No. MNR040000 for Small Municipal Separate Storm Sewer Systems (MS4s) defines the conditions for discharging storm water by all small municipalities and other entities for which the permit is required. The main requirement for all permit applicants is to develop a Storm Water Pollution Prevention Program (SWPPP). Part X (Appendix D) of the permit includes non-degradation provisions for 30 Minnesota municipalities referred to as "Selected MS4s". The Selected MS4s are required to submit additional information to the MPCA Commissioner and "to determine whether additional control measures beyond those of the permit … can be reasonably taken to minimize the impacts of the discharges".

The permit stipulates that those "Selected MS4 that have significant New or Expanded Discharges" are required to complete a "Nondegradation Report". The additional information to be submitted consists of: 1. The Loading Assessment; 2. The Nondegradation Report; 3. The proposed Storm Water Pollution Prevention Program modifications to address non-degradation; 4. The public and local water authority comments on the proposed Storm Water

Pollution Prevention Program modifications to address non-degradation, with a Record of Decision on the comments; and 5. An application to modify the permit. According to the permit, the MPCA "will review the above submittals and will make a determination on the preliminary approval of the proposed Storm Water Pollution Prevention Program."

The loading assessment consists of determining the annual Runoff Volume (VOL), the Total Suspended Sediment (TSS), and the Total Phosphorus (TP) for three particular years: 1988 (past conditions), 2005 (present conditions), and 2020 (future conditions).

1.2 City of Blaine

The City of Blaine is one of the 30 Selected MS4s, presumably due to its significant increase in population in recent years. Located in the northern part of the Twin Cities Metropolitan Area, the City of Blaine has a total surface area of approximately 21,775 acres (34 square miles). Between 1988 and 2005 the population of Blaine increased from approximately 37,800 to approximately 54,000. At present growth rate the total population is expected to exceed 70,000 by 2020. However, recent housing data for 2006 and 2007 point to a slowdown in residential development, both across the region and within the City of Blaine.

The following list summarizes some of the City of Blaine's physical characteristics:

- Total surface: 21,775 acres (34 square miles)
- Approximate Limits: University Avenue NE (W), 133rd Avenue (N), Sunset Avenue (E), and 85th Avenue (S)
- Major Roads and Highways: I-35W, US Highway 10, Highway 65 (Central Avenue NE), Highway 14/242 (Main Street), Lexington Avenue (Highway 17)
- Home of Anoka County Regional Airport (1,700 acres)
- Home of National Sports Center (Approximately 430 acres)

2.0 Current (2005) Land Use - Discussion

An evaluation of the current (2005) land use has been done using the City of Blaine Comprehensive Land Use Plan and a 2005 high-resolution aerial map. There are approximately 20 zoning categories defined by the Comprehensive Land Use Plan. The Plan consists of large and mostly regular shaped polygons. A close examination of these polygons against the physical characteristics of the terrain reveals that land use polygons have been defined more from a zoning perspective. Therefore, discrepancies exist between the land use shown on the plan and actual physical land use. For example, several large areas depicted as "Low Density Residential" in the Comprehensive Land Use Plan are in fact, open space. This discrepancy is particularly common in the northern areas of the City (north of Main Street).

In order to create a true, physically based, land use map, the polygons defined in the Comprehensive Land Use Plan were adjusted based on the aerial map. Another important observation is that the polygons defined as "open space" cover only 2 percent of the total area as defined by the Comprehensive Land Use Plan. The Comprehensive Land Use Plan, however, represents more of a zoning type categorization of the City area. A close examination of the aerial map against the Comprehensive Land Use Plan shows that many of the polygons in various land use categories include large swaths of open space, much of which is largely undeveloped. For example, most of the land within the Rural Residential category is essentially open space. The aerial map indicates large, contiguous open space surfaces comprise approximately half of the City area. The open space surfaces consist primarily of croplands, wetlands, meadows, and woodland.

An average impervious percentage fraction was assigned for each of the land use categories. These percentages were verified against Landsat Remote Sensing Imagery data assembled by the University of Minnesota. The assigned impervious values may appear somewhat lower as they take into account the fact that within each polygon there is a certain amount of open space. A description of each land use category and the estimated average impervious fraction is provided in Table 1.

Table 1. Land Use / Zoning Summary (Year 2005)

Name	Index	Fraction of City's Total	Description	Assigned Imp % (2005)
Rural Residential	R	21.4%	Mostly open space (forest, pasture, wetlands, cropland), some buildings and private driveways	5%
Medium Density Residential	MDR	14.4%	Single Family Units – Standard size lots (0.5 acres), Includes large areas of open space, small parks, walking areas. Does not include street surfaces	25%
Low Density Residential	LDR	14.1%	Single Family Units - Large Lots (>0.5 acres), Includes large areas of open space, small parks, walking areas. Does not include street surfaces	20%
Right of Way	ROW	13.6%	Residential Streets and Public Roads, including the easement. For residential streets, the width of Right-of-way areas is approximately 60 feet	40%
Open Space	OS	12.0%	Meadows, forest, wetland, and some agricultural terrain. Isolated buildings and private driveways	2%
Airport	A	6.0%	Mostly open space, runways, taxi roads, building and adjacent pavement	20%
Heavy Industrial	HI	3.2%	Industrial Buildings and Parking Lots but also large swats of open space (wetlands, meadows, forest)	50%
Water	W	3.1%	Mostly ponds, man-made lakes, and natural lakes	0%
Community Commercial	CC	2.8%	Commercial Buildings and Parking Lots but also large swats of open space (wetlands, meadows, forest)	60%
Light Industrial	LI	2.7%	Industrial Buildings and Parking Lots but also large swats of open space (wetlands, meadows, forest)	50%
Mobile Home Residential	MHR	1.9%	Densely populated communities of mobile homes. Little open space areas	45%
Planned Industrial/Commercial	PIPC	1.3%	Presently little developed areas, consisting mostly of open space. Name designates a zoning category, not physical use	10%
Regional Recreation	REC	1.2%	Parks and Parks Buildings	20%
Planned Industrial	PI	1.1%	Presently little developed areas, consisting mostly of open space. Name designates a zoning category, not physical use	10%
High Density Residential	HDR	0.5%	Single Family Units - Smaller size lots (0.25 acres), Includes open space areas, small parks, walking areas. Does not include street surfaces	30%
Planned Commercial	PC	0.3%	Presently little developed areas, consisting mostly of open space. Name designates a zoning category, not physical use	10%
High Density Residential/Planned Commercial	HDRPC	0.2%	Single Family Units - Smaller size lots (0.25 acres), Includes open space areas, small parks, walking areas. Does not include street surfaces	30%
Neighborhood Commercial	NC	0.1%	Commercial areas with a large fraction of surrounding open space	30%
Office	O	0.1%	Office Buildings and Parking Lots but also large swats of open space (wetlands, meadows, forest)	50%
Medium Density Residential/Planned Commercial	MDRPC	0.03%	One occurrence only, consisting of commercial space and some open space	50%
TOTAL AREA (acres)	**21775**	**100%**		**20.6%**

The average impervious fractions for Low Density, Medium Density, and High Density Residential areas were determined to be 20%, 25%, and 30%, respectively. These fractions may seem lower than what is typically assumed for these types of development, reflecting the fact that the polygons described as "residential" include significant portions of open space. Furthermore, the street surfaces are captured separately, under the Right of Way category. For the same reasons, industrial and commercial categories have an average impervious fraction of 50%, lower than what is typically assumed for these categories. The impervious fraction for open water areas was assigned to be 0%. This is because the bodies of open water do not generate a net runoff since on evaporation slightly exceeds precipitation an average annual basis.

3.0 Drainage

3.1 General Characteristics

Formerly known as a predominantly agricultural area, the City of Blaine is located in a washout plain terrain. The overall relief is flat with land elevations throughout the City area ranging between 890 and 920 feet above mean sea level. The drainage system is characterized by an extensive system of ditches. Some of the ditches have been gradually replaced by a system of interconnected ponds. Other ditches have been re-aligned with segments replaced with storm sewer networks. A little over half of the total City area, representing portions located in the central, western and northern parts of the City, is part of the larger Coon Creek Watershed. The eastern and southeastern parts, covering a little over a third of the total City surface, belong to Rice Creek Watershed. Finally, the southwestern corner, comprising approximately 12% of the total City surface, falls under the jurisdiction of the Six-Cities Watershed Management Organization and drains into the Mississippi River.

There are only two natural lakes within the City limits: Loch Ness Lake, located in the central-eastern part of the City and Laddie Lake, located in the southwestern part of the City. In addition to these lakes there are numerous man-made lakes which are actually large storm water ponds, most of them constructed in conjunction with the residential development.

Large portions of open, undeveloped space exist within the City. Some of these portions are flat, marshy areas, many of which are delineated wetlands. Other open, undeveloped portions are covered by forests and meadows or pastures, although grazing is no longer common.

3.2 Watershed Delineation

The City has been divided into 48 watersheds along physical subwatersheds defined by the Coon Creek Watershed District and Rice Creek Watershed District. However, along the City limits the watershed boundaries follow the City's administrative boundaries rather than the physical subwatershed boundaries as defined by the two Watershed Districts. The southwestern portion of the City, which falls under the jurisdiction of the Six Cities Watershed Management Organization has been divided into 8 watersheds using a USGS contour mapping. The watershed delineation for the purpose of this study has consolidated over one hundred smaller subwatersheds defined by the Coon Creek Watershed Districts into 24 larger watersheds. The delineation was performed such that the major drainage boundaries were preserved. The delineation into fewer watersheds also served to minimize the number of watersheds in which land use changes have occurred between 1988 and 2005, or are expected to occur between 2005 and 2020. Delineating the watersheds on this basis was done in order to simplify the loading analysis and to identify those areas that may contribute to increased loading. Table 2 summarizes the breakdown of each watershed by land use category. It also shows the aggregate percentage of impervious surface based on the assumptions made for each land use category as discussed above (Table 1).

Table 2. Watershed Breakdown by Land-Use / Zoning

Land Use Code	CITY WIDE	RR	MDR	LDR	ROW	OS	AP	HI	W	CC	LI	MHR	PI/PC	REC	PI	HDR	PC	HDRPC	NC	O	MDRPC
Imp %:	20.6 %	5%	25%	20%	40%	2%	20%	50%	0%	60%	50%	45%	10%	20%	10%	30%	10%	30%	30%	50%	50%
AREA ID																					
CCWD-01	512	118	0	245	96				10	41				0					1		
CCWD-02	755	152	267	41	103			14	25	63		90							1		
CCWD-03	488	382			29	77															
CCWD-04	430	0	222	28	68					10		98				3			1		
CCWD-05	661	54	32	413	91				72	0											
CCWD-06	354	153	8	126	46	19															
CCWD-07	505	70	84	188	105	9			4	39						7					
CCWD-08	1362	243	196	389	186	27			219	3	33					47			19		
CCWD-09	344	160			15	169															
CCWD-10	955	282	218	224	142				2	13	18			56							
CCWD-11	301	0	28	152	77	0			3	40										0	
CCWD-12	1199		7		44	0	1106	13	4	3	22			0							
CCWD-13	187	100			4	83															
CCWD-14	503	83		105	54	159	1	34	6	5	9							49			
CCWD-15	854	115		210	58	465			5												
CCWD-16	358	6	30	152	67				8	33				29		21				7	6
CCWD-17	213	1	7	139	46				1	19											
CCWD-18	497	28	120	163	81				80	21			4								
CCWD-19	320	43			38	14	0	73	5		34		42	70				0			
CCWD-20	194				23		5	20	8	1	1		50	86							
CCWD-21	91				19			56		12			4								
CCWD-22	81				19			6		8	47										
CCWD-23	88				11			70			6										
CCWD-24	115		9	11	65		5	11	1		14										
RCWD-01	659	252	0		61	141		97	9	10	88										
RCWD-02	1276	748		25	99	225		32	25		11		6		105						
RCWD-03	246		138		61				3	1							44				
RCWD-04	551	360			30	161			1												
RCWD-05	453	176			19	258															
RCWD-06	982	363		38	36	535			10	1											
RCWD-07	521		252		112	17			2	53	57					4	25				
RCWD-08	95	89				5															
RCWD-09	304	129			16	146			11	2											
RCWD-10	139	135			3	1															
RCWD-11	107	45			12				5				45								
RCWD-12	163	91			26				13				33								
RCWD-13	557	6	31	57	36	95	182	68	5		77										
SIXC-01	777	61	323		152	17	3	61	30		99		32								
SIXC-02	554		8	4	110			129	3	10	22	135			132						
SIXC-03	358	177	12	94	46			1	21	6											
SIXC-04	239		7	102	100		3	0	3	12	13										
SIXC-05	147		2		41				0	103											
SIXC-06	816		453	6	214				39	70				23		3				8	
SIXC-07	317		41	49	60				2	11		74	67			13					
SIXC-08	105	26	42		12				0			10				15					
SIXC-09	437		281	34	113				4	2						3					
SIXC-10	545		316	85	94				28	18						3					
SIXC-11	62				24			3	2	7	26										
Total acres	**21775**	**4649**	**3134**	**3078**	**2961**	**2623**	**1305**	**690**	**668**	**617**	**577**	**406**	**283**	**265**	**238**	**119**	**69**	**49**	**21**	**15**	**6**

4.0 Runoff Evaluation

4.1 Precipitation Data

Weather estimate statistics are typically based on a 30-year interval of records. The rainfall distribution for Blaine has been assessed based on complete daily precipitation records from 1976 to 2005 for the Coon Creek weather station (Station No. 211785). The average total annual rainfall was determined to be 32 inches. It is generally assumed that only 90% of the total precipitation generates any significant runoff. The data record used for this study consists of all of the precipitation events greater than 0.15 inches. A summary of the annual rainfall averages is provided below.

Table 3. Coon Creek Annual Precipitation Summary from 1976 to 2005

	All Precipitation Events	**Runoff Generating Precipitation Events**
Average Annual Number of Rainy Days	97.0	47.3
Total Annual Average (inches)	32.0	28.9
Average Precipitation (inches)	0.33	0.61
Median Precipitation (inches)	0.15	0.44

4.2 Runoff Volume Estimates

Determining the runoff volume on an annual basis can fairly complex. For each watershed the annual runoff is a function of soil characteristics, rainfall distribution, amount of total impervious and the distribution of the impervious surfaces (i.e., connected versus disconnected). The issue is further complicated due to the fact that soil characteristics may vary seasonally and/or with the rainfall distribution (i.e., frozen, wet, moist or dry).

State-wide estimates for the annual runoff indicate that within the Blaine area the runoff is in the neighborhood of 6 inches. This state wide estimate of the runoff was derived from stream flow measurements, and it should be noted that not all of the runoff volume that reaches the stream represents surface water flow. Instead, a fraction of this volume reaches the streams as groundwater flow.

A common way to compute the runoff volume is the NRCS (formerly known as SCS) Curve Number (CN) Method. The Curve Number is a combined measurement of both soil infiltration capacity and surface coverage (i.e., land use). It ranges from a value of 30 for the most pervious natural surfaces such as sandy soils woods and meadows to 98 for impervious surfaces such as streets and parking lots. Soils are grouped into four hydrologic soil groups A, B, C, and D. Group A soils represents the most pervious soils (typically very sandy) and Group D soils the least pervious (typically organic soils with high clay content). In each soil group, cropland, high density residential, commercial, and industrial areas tend to have the highest CN values. At the opposite end, wooded areas and meadows have some of the lowest CN values.

Within the City of Blaine, over 99% of the soils belong to A, B, and D hydrologic groups. Group D soils cover a little over half of the total surface while Group A soils cover approximately one third. The 2005 aerial map shows that the pervious areas are fairly diverse. Woods and meadows represent approximately 10% to 15%, wetlands represent approximately 15% to 20%, croplands represent less than 10%, while the remaining pervious areas consist of lawns, right-of-way along streets and highways, recreational fields, and other grassy surfaces bordering commercial and industrial properties.

The aggregate curve number for all pervious surfaces within the City of Blaine is approximately 69, which is also a representative CN value for Group B lawns and pastures soils characterized by a “fair” (i.e. moderate) grass coverage.

The runoff depth (i.e., depth of surface water if the runoff were evenly distributed across the entire drainage area) was computed for each significant individual precipitation event between 1976 and 2005 using the same NRCS formula, and applied separately for pervious and impervious portions:

$$Q_p = \frac{[P - 0.2*(1000/CN_p - 10)]^2}{P + 0.8*(1000/CN_p - 10)} \quad Q_i = \frac{[P - 0.2*(1000/CN_i - 10)]^2}{P + 0.8*(1000/CN_i - 10)}$$

Where P represents the precipitation level expressed in inches.

Using CN = 98 for impervious surfaces and CN = 69 for pervious surfaces the average annual runoff depth was computed for both pervious and impervious surfaces by summing the results for all precipitation events and dividing the sum by 30 (years).

Table 4. Average annual runoff depth for pervious and impervious soils.

Date of Record	Precipitation Level (in)	Pervious Surfaces Runoff Depth (in) CN = 69	Impervious Surfaces Runoff Depth (in) CN = 98
01/02/76	0.44	0.00	0.26
01/10/76	0.28	0.00	0.13
02/15/76	0.33	0.00	0.17
03/01/76	0.31	0.00	0.15
03/05/76	0.37	0.00	0.20
03/12/76	0.60	0.00	0.41
03/25/76	0.21	0.00	0.08
03/29/76	0.62	0.00	0.43
…..	…..	…..	…..
…..	Coon Creek Rain Gauge	…..	…..
…..	30 years of record	…..	…..
…..	1976 to 2005	…..	…..
…..	…..	…..	…..
11/28/05	0.23	0.00	0.09
11/29/05	0.68	0.00	0.48
12/14/05	0.25	0.00	0.11
12/15/05	0.17	0.00	0.05
12/30/05	0.39	0.00	0.22
12/31/05	0.20	0.00	0.07
30-year Sum (in)	866.8	31.2	619.9
Annual Average (in)	28.89	1.04	20.66

The computations indicate that the vast majority of runoff is generated from impervious surfaces. Knowing the average annual runoff depths for both pervious and impervious surfaces, the total annual runoff depth of an area can be estimated by adding the pervious fraction runoff depth and impervious fraction runoff depth:

$$Q = Q_i \times i + Q_p \times (1 - i)$$

Where *i* is the impervious percentage of the area.

The impervious fraction for year 2005 for individual watersheds ranges between 4% and 50%, while the corresponding average annual runoff depth for the 48 watersheds considered varies from 1.9 inches to 11.6 inches. The aggregate City-wide value for year 2005 is approximately 5.1 inches.

5.0 Land Use Changes

5.1 Land Use Changes from 1988 to 2005

The most significant change between 1988 and 2005 has been the increase in residential units. As indicated above, during this 17-year time period the population of Blaine increased at an average rate of almost 1000 residents a year representing a net growth of almost 45 percent. Most of the residential developments that were built during this interval fall under the category of Low Density Residential in the form of single-family homes. Some of the multi-family home construction (i.e., town homes), may fit the medium or high density residential categories in terms of population density relative to the lot size. However, in terms of building space relative to the adjacent open space town homes better fit the low residential density category.

The storm water ponds constructed in conjunction with the residential developments contributed to a significant increase in the open water surface. Another land use change between 1988 and 2005 was the addition of commercial and office buildings, primarily along the Central Avenue corridor. A slight increase in light industrial land has occurred as well and since the right-of-way category includes all of the public streets, some increase in this category has also occurred, mainly in conjunction with the residential development which spurred the construction of new streets.

Based on comparison of detailed aerial photographs and discussions with the City, 29 areas were identified as having new or re-development between 1988 and 2005. A summary is provided below:

Table 6. Areas Developed between 1988 and 2005

ID	Total acres (GIS)	1988 Imp % estimate (1)	1988 Imp acres	2005 Imp. Acres (2)	Added Open Water Acres	2005 Imp %	1988-2005 Increase in Imp. Surface
01	194.6	6%	12	42	27.9	21.5%	30.2
02	101.4	2%	2	22	18.9	22.0%	20.2
03	31.0	2%	1	7	5.4	23.2%	6.6
04	73.5	2%	1	16	3.9	21.6%	14.4
05	5.9	15%	1	3	0.0	45.4%	1.8
06	46.1	8%	4	11	0.9	24.9%	7.8
07	16.5	12%	2	5	0.2	27.6%	2.6
08	48.7	10%	5	13	2.9	27.6%	8.6
09	48.7	5%	2	12	1.7	23.6%	9.1
10A	101.0	15%	15	24	0.8	23.5%	8.6
10B	622.6	6%	37	120	71.8	19.2%	82.2
10C	426.7	2%	9	90	79.3	21.2%	82.0
11A	25.8	20%	5	12	0.6	45.4%	6.6
11B	72.7	10%	7	10	1.8	14.1%	3.0
12	77.9	10%	8	14	3.9	18.4%	6.5
13	65.2	15%	10	16	0.0	24.6%	6.2
14	237.8	4%	10	54	3.5	22.7%	44.4
15	508.2	4%	20	103	116.0	20.3%	82.9
16	38.3	2%	1	12	1.0	31.4%	11.3
17A	47.5	2%	1	10	1.0	21.8%	9.4
17B	65.5	2%	1	14	4.6	21.7%	12.9
18A	21.3	2%	0	6	1.3	29.9%	5.9
18B	81.4	2%	2	40	1.4	48.8%	38.0
19	17.7	2%	0	9	0.0	49.4%	8.4
20	31.1	2%	1	7	3.3	22.4%	6.4
21	213.3	2%	4	50	23.4	23.6%	46.2
22	48.3	40%	19	22	2.1	45.6%	2.7
23	39.2	2%	1	5	3.7	12.3%	4.0
24	81.2	2%	2	10	6.8	12.0%	8.1
TOTAL	**3389**	**5.4%**	**183**	**759**	**388**	**22.4%**	**577**

(1) Based on Aerial Photograph Estimate
(2) Based on 2005 breakdown of each area by land use.

The table shows a net increase in impervious surface of 577 acres. Relative to the total surface of the City (21775 acres), this translates into a net relative increase of approximately 2.6 percent (i.e., from 18.0 to 20.6).

5.2 Land Use Changes from 2005 to 2020 (Projected)

The changes in land use between 1988 and 2005 are expected to continue at a similar pace and extent during the 2005 to 2020 interval. A considerable increase in residential units is expected. Most of the residential developments will fall under the category of low density residential (LDR) development. Some increase in commercial, office, and light industrial space is expected as well. Most of the new or re-development is expected to occur along Central Avenue Corridor and the Lexington Avenue corridor, primarily in the southeastern part of the City (I-35W, Lexington Avenue, 109th Avenue and 101st Avenue area). Based on discussions with the City, 19 areas to be developed or re-developed between 2005 and 2020 were identified and are shown in Figure 2. It should be noted that some of these areas have already been developed or the development is nearly complete. A summary of the areas subject to development between 2005 and 2020 is provided below:

Table 7. Areas anticipated to be re-developed between 2005 and 2020

Area ID	Total Area	Imp. Area in 2005	% Imp in 2005 (1)	2020 Projected Land Use	2020 Projected Imp % (2)	2020 Imp. Area Estimate	2005 to 2020 Increase in Imp. Area
A	273.4	18.7	6.8%	LDR	25.0%	68.4	49.7
B	158.9	13.6	8.6%	LDR	25.0%	39.7	26.1
C	55.4	6.2	11.2%	LDR	25.0%	13.8	7.7
D	72.7	19.6	27.0%	REC	30.0%	21.8	2.2
E	150.5	3.5	2.3%	MDR	35.0%	52.7	49.2
F	653.0	117.8	18.0%	LDR	25.0%	163.3	45.4
G	77.0	2.6	3.4%	RR	10.0%	7.7	5.1
H	79.9	4.0	5.0%	LDR	25.0%	20.0	16.0
I	77.4	3.3	4.2%	LI	60.0%	46.4	43.2
J	81.8	4.0	4.9%	COM	70.0%	57.2	53.2
K	50.0	2.5	5.1%	LDR	25.0%	12.5	10.0
L	32.9	2.0	6.1%	LDR	25.0%	8.2	6.2
M	70.0	4.7	6.7%	LDR	25.0%	17.5	12.8
N	55.0	2.7	5.0%	LDR	25.0%	13.7	11.0
O	40.8	3.2	7.9%	LDR	25.0%	10.2	7.0
P	42.0	2.1	4.9%	LDR	25.0%	10.5	8.4
R	30.3	2.8	9.2%	LDR	25.0%	7.6	4.8
S	36.6	3.7	10.0%	LDR	25.0%	9.2	5.5
T	25.0	2.5	10.0%	LDR	25.0%	6.3	3.8
Total	**2062**	**219**	**10.6%**		**28.4%**	**587**	**368**

(1) Based on 2005 breakdown of each area by land use
(2) Based on Planning Projections for year 2020

Table 7 shows a net projected increase in impervious surface by 364 acres. Relative to the total surface of the City (21,775 acres) this translates into a net relative increase of approximately 1.7 percent (i.e., from 20.6 to 22.3).

6.0 Loading Assessment of Annual Runoff Volume (VOL), Total Phosphorus (TP), and Total Suspended Sediment (TSS)

As explained above, for each watershed the annual runoff volume was estimated as a function of impervious fraction based on the precipitation distribution from 1976 to 2005, using an average curve number of 69 for pervious surfaces and a curve number of 98 for all impervious surfaces.

The TSS and TP loadings were computed using the constant concentration assumption. There are numerous TSS and TP storm water concentration data available based on measurements performed in the field. However, much of the data is not easily available. Furthermore, the measurements were performed in various locations, with different physical settings and following different procedures, making an accurate comparison difficult. To the best of our knowledge, there are only two sources that summarize storm water TSS and TP concentration measurement results in a structured and somewhat uniform way. One is the results of the National Urban Runoff Program (NURP) by USEPA (1983). The second data set is from the National Stormwater Quality Database (NSQD) assembled by Pitt et al (2003). Both studies show that storm water concentrations in both TSS and TP vary greatly with physical setting, climate, season, etc. However, the spatial and temporal averages of the measurements tend to converge within a relatively narrow range. The NURP average concentration values are listed as 100 mg/L for TSS and 0.33 mg/L for TP. The NSQD average concentration values are listed as 58 mg/L for TSS and 0.27 mg/L for TP. There is not enough information to determine which values are more suitable for this analysis. A significantly lower average TSS concentration in the NSQD database may be a reflection of improved sweeping practices and/or the implementation of cleaner construction practices. Because year 1988 was used as the baseline for the loading comparison, the 1983 NURP average concentration values of 100 mg/L for TSS and 0.33 mg/L for TP were used to determine the total TSS and TP loadings. The same concentration values were conservatively applied for years 2005 and 2020, although measures such as improved sweeping practices between 1988 and 2005 and the effect of the NPDES Phase II Permits adopted in September 2003 are likely to lower the overall TSS and TP average concentrations for years 2005 and 2020 as compared to year 1988.

CCWD monitoring data at a downstream station translate into average TSS and TP concentrations of 67 mg/L and 0.15 mg/L, respectively. These numbers lend credence to the concentration values of 100 mg/L for TSS and 0.33 mg/L for TP used in this report as the default at source concentration.

As specified in the MS4 Permit and MPCA guidance, the analysis is required to be in the form of a relative comparison and not a true representation of the loading from various sources or areas. Therefore, the values selected for this analysis are reasonable estimates of the load concentrations.

6.1 1988 Loading Assessment Evaluation

Year 1988 was used as the base for comparison. The runoff volume for each watershed and City wide was computed as explained above, by adding the runoff volume from pervious portions (average CN = 69) to the runoff volume from the impervious portions (CN = 98). The TSS and TP loadings were computed by multiplying the runoff volume by average concentration values of 100 mg/L for TSS and 0.33 mg/L for TP. Storm water treatment, such as ponds, that would result in TSS and TP retention were not considered in the 1988 analysis. Thus, the results for year 1988 serve as a base line for comparison and they represent an estimate of the TSS and TP loadings at the source and not the actual effluent loadings which are likely to be lower. Table 8 summarizes the loading levels for 1988 along with the changes in impervious area between 1988 and 2005.

Table 8. Year 1988 Loadings and Changes in Impervious Surface from 1988 to 2005.

Watershed	Total Area (ac)	1988 Imp Area (ac)	1988 Imp %	1988 Average Annual Runoff Depth (inches)	1988 Runoff Volume (ac-ft)	1988 Annual TSS (tons)	1988 Annual TP (tons)	Area(s) of Change from 1988 to 2005 (Table 6)	Imp area added from 1988 to 2005 (ac)	2005 Imp area (ac)	2005 Imp %
CCWD-01	511.9	104.0	20.3%	5.0	214.5	29.2	0.10	4	14.4	118.5	23%
CCWD-02	754.7	182.2	24.1%	5.8	363.3	49.4	0.16	2, 3	26.8	209.0	28%
CCWD-03	487.7	32.3	6.6%	2.3	95.1	12.9	0.04			32.3	7%
CCWD-04	430.3	139.7	32.5%	7.4	265.7	36.1	0.12			139.7	32%
CCWD-05	661.0	47.3	7.2%	2.4	134.6	18.3	0.06	10B	82.2	129.5	20%
CCWD-06	353.6	53.9	15.2%	4.0	118.7	16.1	0.05			53.9	15%
CCWD-07	505.0	114.5	22.7%	5.5	231.1	31.4	0.10	8, 13	14.8	129.3	26%
CCWD-08	1362.0	162.5	11.9%	3.4	383.7	52.2	0.17	15, 20	89.3	251.8	18%
CCWD-09	344.0	17.3	5.0%	2.0	58.1	7.9	0.03			17.3	5%
CCWD-10	955.4	195.8	20.5%	5.1	403.0	54.8	0.18	7	2.6	198.4	21%
CCWD-11	300.7	75.5	25.1%	6.0	149.5	20.3	0.07	9, 6	16.9	92.3	31%
CCWD-12	1199.3	260.0	21.7%	5.3	529.1	71.9	0.24			260.0	22%
CCWD-13	187.1	8.1	4.3%	1.9	29.4	4.0	0.01			8.1	4%
CCWD-14	502.9	68.4	13.6%	3.7	155.4	21.1	0.07	16, 17A	20.7	89.0	18%
CCWD-15	853.9	36.0	4.2%	1.9	132.9	18.1	0.06	14	44.4	80.4	9%
CCWD-16	358.3	101.0	28.2%	6.6	196.3	26.7	0.09	5	1.8	102.8	29%
CCWD-17	213.3	50.8	23.8%	5.7	101.6	13.8	0.05	10A	8.6	59.4	28%
CCWD-18	497.3	20.8	4.2%	1.9	77.1	10.5	0.03	10C, 11A	88.5	109.3	22%
CCWD-19	320.3	86.8	27.1%	6.4	169.8	23.1	0.08	11B	3.0	89.8	28%
CCWD-20	193.6	36.8	19.0%	4.8	77.0	10.5	0.03	12	6.5	43.3	22%
CCWD-21	90.8	42.9	47.2%	10.3	78.0	10.6	0.03			42.9	47%
CCWD-22	80.5	39.1	48.6%	10.6	71.0	9.6	0.03			39.1	49%
CCWD-23	87.7	42.8	48.8%	10.6	77.5	10.5	0.03			42.8	49%
CCWD-24	115.5	43.9	38.0%	8.5	81.8	11.1	0.04			43.9	38%
RCWD-01	659.0	92.1	14.0%	3.8	207.7	28.2	0.09	18B, 19	46.4	138.5	21%
RCWD-02	1275.7	109.2	8.6%	2.7	289.1	39.3	0.13	18A, 23	10.0	119.1	9%
RCWD-03	245.6	63.6	25.9%	6.1	125.3	17.0	0.06			63.6	26%
RCWD-04	550.7	33.1	6.0%	2.2	101.9	13.9	0.05			33.1	6%
RCWD-05	453.1	21.5	4.7%	2.0	74.3	10.1	0.03			21.5	5%
RCWD-06	982.0	51.4	5.2%	2.1	169.1	23.0	0.08			51.4	5%
RCWD-07	520.7	171.8	33.0%	7.5	326.1	44.3	0.15			171.8	33%
RCWD-08	95.0	4.6	4.8%	2.0	15.7	2.1	0.01			4.6	5%
RCWD-09	303.9	16.9	5.5%	2.1	53.9	7.3	0.02			16.9	6%
RCWD-10	139.1	8.1	5.9%	2.2	25.4	3.4	0.01			8.1	6%
RCWD-11	107.1	3.5	3.3%	1.7	15.1	2.0	0.01	24	8.1	11.6	11%
RCWD-12	162.8	18.2	11.2%	3.2	43.9	6.0	0.02			18.2	11%
RCWD-13	556.9	131.9	23.7%	5.7	264.0	35.9	0.12	17B	12.9	144.8	26%
SIXC-01	777.5	179.8	23.1%	5.6	361.4	49.1	0.16	21, 22	48.9	228.7	29%
SIXC-02	553.5	202.1	36.5%	8.2	378.4	51.5	0.17			202.1	37%
SIXC-03	357.9	53.5	15.0%	4.0	118.5	16.1	0.05			53.5	15%
SIXC-04	239.4	76.4	31.9%	7.3	145.6	19.8	0.07			76.4	32%
SIXC-05	146.6	78.9	53.8%	11.6	141.8	19.3	0.06			78.9	54%
SIXC-06	815.8	251.7	30.9%	7.1	482.3	65.6	0.22			251.7	31%
SIXC-07	316.7	94.3	29.8%	6.9	181.7	24.7	0.08			94.3	30%
SIXC-08	105.0	25.6	24.4%	5.8	51.0	6.9	0.02			25.6	24%
SIXC-09	437.5	124.4	28.4%	6.6	241.4	32.8	0.11			124.4	28%
SIXC-10	544.8	115.3	21.2%	5.2	235.7	32.1	0.11	1	30.2	145.5	27%
SIXC-11	61.7	28.2	45.7%	10.0	51.4	7.0	0.02			28.2	46%
Total	**21775**	**3918**	**18.0%**	**4.6**	**8295**	**1128**	**3.72**		**577**	**4495**	**20.6%**

6.2 2005 Loading Assessment Evaluation

The same procedure discussed in previous section was used to determine the runoff volume for 2005. The increase in impervious surface between 1988 and 2005 translates into an increase in the annual runoff volume. No reduction in runoff volume that would be occurring from infiltration BMPs was factored into the analysis. The TSS and TP loadings were assessed based on the same constant concentration assumptions used for year 1988. Thus, an increase in runoff volume would result in a proportional increase in TSS and TP that is generated at the source. However, due to construction of numerous storm water treatment ponds between 1988 and 2005 (some of which are relatively large) much of the TSS and TP, from both new impervious surfaces and some of the old impervious surfaces, is retained resulting in considerably reduce loadings.

Table 2 shows that between 1988 and 2005 the overall impervious surface increased by 577 acres from 18.0 to 20.6 percent. The storm water treatment ponds associated with new developments constructed during the same period cover a total area of 388 acres (Table 2). This represents roughly 2 acres of open water for every 3 acres of new impervious area. Assuming an average pond depth of 3 feet (typical and likely conservative), this translates into 2 acre-feet of pond (treatment) volume for each acre of additional impervious. This means that the new ponds constructed between 1988 and 2005 have a high capacity of treating the storm water runoff from the new impervious surfaces as well as the storm water runoff from the older adjacent impervious surfaces within the watershed whose runoff is routed through these ponds.

The effect of these ponds is a net reduction in the TSS and TP loadings for year 2005 as compared to year 1988. The reduction percentage in TSS and TP is based on particle settling dynamics. Results from numerous P8 models show a logarithmic relationship between the pond storage volume relative to the runoff level and the particle removal effectiveness. In short, ponds having a dead storage capacity that is equivalent to the runoff volume resulting from 0.5, 1.0, and 2.0 inches rainfall events can retain approximately 70, 80, and 90 percent of the TSS and approximately 40, 50, and 60 percent of the TP, respectively. However, the maximum TSS and TP reduction levels were assumed to be 95 and 65 percent respectively. Results are summarized in Table 9.

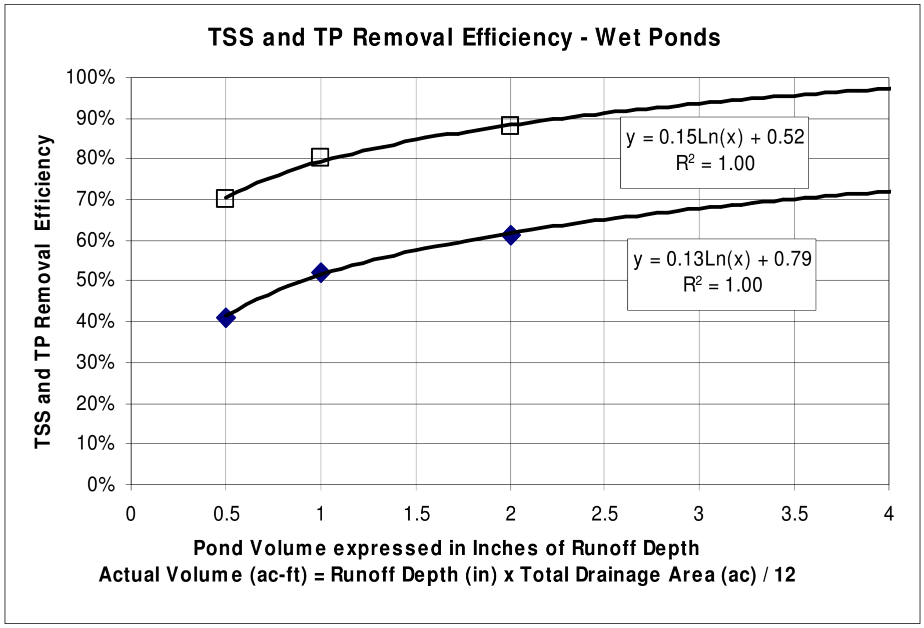

Table 9. Year 2005 Loadings, At Source and After Pond Treatment (Effluent).

Watershed	Total Area (ac)	2005 Imp area (ac)	2005 Imp %	2005 Average Annual Runoff Depth (inches)	2005 Runoff Volume (ac-ft)	2005 Annual TSS at source (tons)	2005 Annual TP at source (tons)	New Ponds 1988 2005 Volume (ac-ft)	New Ponds Vol. / All Imp Area (in)	TSS Ponds Removal Effic.	TP Ponds Removal Effic.	2005 Effluent TSS (tons)	2005 Effluent TP (tons)
CCWD-01	511.9	118.5	23%	5.6	238.1	32.4	0.11	11.8	1.2	83%	53%	5.1	0.05
CCWD-02	754.7	209.0	28%	6.5	407.2	55.4	0.18	72.8	4.2	95%	65%	2.8	0.06
CCWD-03	487.7	32.3	7%	2.3	95.1	12.9	0.04					12.9	0.04
CCWD-04	430.3	139.7	32%	7.4	265.7	36.1	0.12					36.1	0.12
CCWD-05	661.0	129.5	20%	4.9	269.0	36.6	0.12	215.5	20.0	95%	65%	1.8	0.04
CCWD-06	353.6	53.9	15%	4.0	118.7	16.1	0.05					16.1	0.05
CCWD-07	505.0	129.3	26%	6.1	255.2	34.7	0.11	17.7	1.6	87%	57%	4.5	0.05
CCWD-08	1362.0	251.8	18%	4.7	529.8	72.0	0.24	357.8	17.1	95%	65%	3.6	0.08
CCWD-09	344.0	17.3	5%	2.0	58.1	7.9	0.03					7.9	0.03
CCWD-10	955.4	198.4	21%	5.1	407.2	55.4	0.18	0.7	0.0	35%	5%	36.2	0.17
CCWD-11	300.7	92.3	31%	7.1	177.1	24.1	0.08	7.7	1.0	80%	50%	4.8	0.04
CCWD-12	1199.3	260.0	22%	5.3	529.1	71.9	0.24					71.9	0.24
CCWD-13	187.1	8.1	4%	1.9	29.4	4.0	0.01					4.0	0.01
CCWD-14	502.9	89.0	18%	4.5	189.2	25.7	0.08	6.0	0.8	77%	47%	5.9	0.05
CCWD-15	853.9	80.4	9%	2.9	205.4	27.9	0.09	10.5	1.6	86%	56%	3.8	0.04
CCWD-16	358.3	102.8	29%	6.7	199.2	27.1	0.09	0.4	0.0	36%	6%	17.3	0.08
CCWD-17	213.3	59.4	28%	6.5	115.6	15.7	0.05	2.5	0.5	70%	40%	4.7	0.03
CCWD-18	497.3	109.3	22%	5.4	221.9	30.2	0.10	239.8	26.3	95%	65%	1.5	0.03
CCWD-19	320.3	89.8	28%	6.5	174.6	23.7	0.08	5.3	0.7	75%	45%	5.9	0.04
CCWD-20	193.6	43.3	22%	5.4	87.7	11.9	0.04	11.7	3.2	95%	65%	0.6	0.01
CCWD-21	90.8	42.9	47%	10.3	78.0	10.6	0.03					10.6	0.03
CCWD-22	80.5	39.1	49%	10.6	71.0	9.6	0.03					9.6	0.03
CCWD-23	87.7	42.8	49%	10.6	77.5	10.5	0.03					10.5	0.03
CCWD-24	115.5	43.9	38%	8.5	81.8	11.1	0.04					11.1	0.04
RCWD-01	659.0	138.5	21%	5.2	283.6	38.6	0.13	4.5	0.4	67%	37%	12.9	0.08
RCWD-02	1275.7	119.1	9%	2.9	305.4	41.5	0.14	15.0	1.5	86%	56%	5.8	0.06
RCWD-03	245.6	63.6	26%	6.1	125.3	17.0	0.06					17.0	0.06
RCWD-04	550.7	33.1	6%	2.2	101.9	13.9	0.05					13.9	0.05
RCWD-05	453.1	21.5	5%	2.0	74.3	10.1	0.03					10.1	0.03
RCWD-06	982.0	51.4	5%	2.1	169.1	23.0	0.08					23.0	0.08
RCWD-07	520.7	171.8	33%	7.5	326.1	44.3	0.15					44.3	0.15
RCWD-08	95.0	4.6	5%	2.0	15.7	2.1	0.01					2.1	0.01
RCWD-09	303.9	16.9	6%	2.1	53.9	7.3	0.02					7.3	0.02
RCWD-10	139.1	8.1	6%	2.2	25.4	3.4	0.01					3.4	0.01
RCWD-11	107.1	11.6	11%	3.2	28.3	3.8	0.01	20.4	21.1	95%	65%	0.2	0.00
RCWD-12	162.8	18.2	11%	3.2	43.9	6.0	0.02					6.0	0.02
RCWD-13	556.9	144.8	26%	6.1	285.0	38.8	0.13	13.9	1.2	82%	52%	7.0	0.06
SIXC-01	777.5	228.7	29%	6.8	441.4	60.0	0.20	76.6	4.0	95%	65%	3.0	0.07
SIXC-02	553.5	202.1	37%	8.2	378.4	51.5	0.17					51.5	0.17
SIXC-03	357.9	53.5	15%	4.0	118.5	16.1	0.05					16.1	0.05
SIXC-04	239.4	76.4	32%	7.3	145.6	19.8	0.07					19.8	0.07
SIXC-05	146.6	78.9	54%	11.6	141.8	19.3	0.06					19.3	0.06
SIXC-06	815.8	251.7	31%	7.1	482.3	65.6	0.22					65.6	0.22
SIXC-07	316.7	94.3	30%	6.9	181.7	24.7	0.08					24.7	0.08
SIXC-08	105.0	25.6	24%	5.8	51.0	6.9	0.02					6.9	0.02
SIXC-09	437.5	124.4	28%	6.6	241.4	32.8	0.11					32.8	0.11
SIXC-10	544.8	145.5	27%	6.3	285.1	38.8	0.13	83.6	6.9	95%	65%	1.9	0.04
SIXC-11	61.7	28.2	46%	10.0	51.4	7.0	0.02					7.0	0.02
Total	21775	4495	20.6%	5.1	9238.1	1256	4.15	1174				691	2.97

6.3 2020 Loading Assessment Evaluation (Projection)

Impervious levels for year 2020 were determined by analyzing the areas where changes are expected to occur (Table 7). The overall increase in impervious surface between 2005 and 2020 is projected to be moderate. Without any infiltration and without any pollutant treatment, the increase of in runoff volume, TSS and TP is estimated in Table 10:

Table 10. Areas To Be Developed Between 2005 and 2020 - Projected Loadings WITHOUT any treatment.

Area to be developed	Total surface (acres)	2005 Imp%	2005 Imp. acres	2005 level Runoff Depth (inches)	2005 level Runoff Volume (ac-ft)	2005 level TSS (tons)	2005 level TP (tons)	Projected 2020 Land Use	2020 Assigned Imp%	2020 Imp. acres	2020 Average Runoff Depth (inches)	2020 At-Source Runoff Volume (ac-ft)	2020 At-Source TSS Level (tons)	2020 At-Source TP level (tons)
A	273	6.8%	18.7	2.38	54	7.4	0.024	LDR	25%	68.4	5.95	135	18.4	0.061
B	159	8.6%	13.6	2.72	36	4.9	0.016	LDR	25%	39.7	5.95	79	10.7	0.035
C	55	11.2%	6.2	3.23	15	2.0	0.007	LDR	25%	13.8	5.95	27	3.7	0.012
D	73	27.0%	19.6	6.33	38	5.2	0.017	REC	30%	21.8	6.93	42	5.7	0.019
E	150	2.3%	3.5	1.49	19	2.5	0.008	MDR	35%	52.7	7.91	99	13.5	0.044
F	653	18.0%	117.8	4.58	249	33.9	0.112	LDR	25%	163.3	5.95	324	44.0	0.145
G	77	3.4%	2.6	1.71	11	1.5	0.005	RR	10%	7.7	3.00	19	2.6	0.009
H	80	5.0%	4.0	2.01	13	1.8	0.006	LDR	25%	20.0	5.95	40	5.4	0.018
I	77	4.2%	3.3	1.87	12	1.6	0.005	LI	60%	46.4	12.81	83	11.2	0.037
J	82	4.9%	4.0	2.00	14	1.9	0.006	COM	70%	57.2	14.78	101	13.7	0.045
K	50	5.1%	2.5	2.04	9	1.2	0.004	LDR	25%	12.5	5.95	25	3.4	0.011
L	33	6.1%	2.0	2.23	6	0.8	0.003	LDR	25%	8.2	5.95	16	2.2	0.007
M	70	6.7%	4.7	2.35	14	1.9	0.006	LDR	25%	17.5	5.95	35	4.7	0.016
N	55	5.0%	2.7	2.02	9	1.3	0.004	LDR	25%	13.7	5.95	27	3.7	0.012
O	41	7.9%	3.2	2.59	9	1.2	0.004	LDR	25%	10.2	5.95	20	2.7	0.009
P	42	4.9%	2.1	2.00	7	1.0	0.003	LDR	25%	10.5	5.95	21	2.8	0.009
R	30	9.2%	2.8	2.84	7	1.0	0.003	LDR	25%	7.6	5.95	15	2.0	0.007
S	37	10.0%	3.7	3.00	9	1.3	0.004	LDR	25%	9.2	5.95	18	2.5	0.008
T	25	10.0%	2.5	3.00	6	0.9	0.003	LDR	25%	6.3	5.95	12	1.7	0.006
Total	2062	10.6%	**219.3**	3.13	**537**	**73.1**	**0.24**		28.4%	**586.6**	6.62	**1138**	**154.7**	**0.51**

Table 10 shows that within the areas to be developed, if no runoff and pollutant reduction is considered, the at-source levels are slightly more than double for year 2020 when compared to year 2005.

However, the net increase in runoff volume will likely be significantly diminished because of an anticipated change in storm water treatment practices. Rice Creek Watershed District is in the process of adopting new development rules which shift the focus of storm water treatment onto infiltration. The new rules seek to achieve no increase in runoff volume. Presently, Coon Creek Watershed District does not have mandated infiltration targets but encourages such practices where feasible. The City of Blaine intends to place more emphasis on storm water infiltration practices, such as rain water gardens in the future. The reduction in runoff volume due to infiltration will result in a commensurate reduction in TSS and TP loadings. Additional treatment will be obtained in more conventional practices such as ponds or grassed swales.

A better picture of how the revised watershed district rules will control the level of runoff and pollutant reduction will emerge later. For the time being, to ascertain the storm water treatment levels between 2005 and 2020 a scenario in which 50 percent of the runoff volume would be infiltrated was assumed. A 50 percent reduction in the runoff volume can be accomplished by designing an infiltration facility (BMP) that could retain and infiltrate a volume that is the equivalent to 0.4 inches of runoff from the entire (existing and proposed) impervious surface within the areas to be developed (i.e., 587 according to Table 10). Alternatively, the runoff volume to be retained and infiltrated can be looked upon as the equivalent of the 0.6 inches of runoff from the net additional impervious surface (i.e., 587 acres less 219 acres of existing impervious surface already in place within areas to be developed). An assumed 50 percent reduction in runoff volume would also result into a similar reduction in TSS and TP. It was further assumed that the remaining 50 percent of runoff would be routed through storm water ponds sized to retain at least 80 percent of the TSS and 50 percent of the TP. These levels of TSS and TP retention are conservative, given that during the 1988 to 2005 period the size of the ponds led to considerably higher removal rates.

Thus, given the assumption that 50 percent of the runoff volume would be infiltrated, the overall resulting removal percentage for TSS and TP would be 90 percent and 75 percent, respectively. Table 11 summarizes the results of the simulation.

Table 11. Areas To Be Developed Between 2005 and 2020 - Projected Loadings Assuming 50% Runoff Volume Reduction Through Infiltration and Further Treatment of Remaining Runoff

Area to be developed	Total surface (acres)	2005 Imp%	2005 Imp. acres	2005 level Runoff Depth (inches)	2005 level Runoff Volume (ac-ft)	2005 level TSS (tons)	2005 level TP (tons)	Projected 2020 Land Use	2020 Assigned Imp%	2020 Imp. acres	2020 Average Runoff Depth (inches)	2020 Runoff Volume after 50% reduction (ac-ft)	2020 TSS Level after 90% reduction* (tons)	2020 TP level after 75% reduction* (tons)
A	273	6.8%	18.7	2.38	54	7.4	0.024	LDR	25%	68.4	5.95	68	1.8	0.015
B	159	8.6%	13.6	2.72	36	4.9	0.016	LDR	25%	39.7	5.95	39	1.1	0.009
C	55	11.2%	6.2	3.23	15	2.0	0.007	LDR	25%	13.8	5.95	14	0.4	0.003
D	73	27.0%	19.6	6.33	38	5.2	0.017	REC	30%	21.8	6.93	21	0.6	0.005
E	150	2.3%	3.5	1.49	19	2.5	0.008	MDR	35%	52.7	7.91	50	1.3	0.011
F	653	18.0%	117.8	4.58	249	33.9	0.112	LDR	25%	163.3	5.95	162	4.4	0.036
G	77	3.4%	2.6	1.71	11	1.5	0.005	RR	10%	7.7	3.00	10	0.3	0.002
H	80	5.0%	4.0	2.01	13	1.8	0.006	LDR	25%	20.0	5.95	20	0.5	0.004
I	77	4.2%	3.3	1.87	12	1.6	0.005	LI	60%	46.4	12.81	41	1.1	0.009
J	82	4.9%	4.0	2.00	14	1.9	0.006	COM	70%	57.2	14.78	50	1.4	0.011
K	50	5.1%	2.5	2.04	9	1.2	0.004	LDR	25%	12.5	5.95	12	0.3	0.003
L	33	6.1%	2.0	2.23	6	0.8	0.003	LDR	25%	8.2	5.95	8	0.2	0.002
M	70	6.7%	4.7	2.35	14	1.9	0.006	LDR	25%	17.5	5.95	17	0.5	0.004
N	55	5.0%	2.7	2.02	9	1.3	0.004	LDR	25%	13.7	5.95	14	0.4	0.003
O	41	7.9%	3.2	2.59	9	1.2	0.004	LDR	25%	10.2	5.95	10	0.3	0.002
P	42	4.9%	2.1	2.00	7	1.0	0.003	LDR	25%	10.5	5.95	10	0.3	0.002
R	30	9.2%	2.8	2.84	7	1.0	0.003	LDR	25%	7.6	5.95	7	0.2	0.002
S	37	10.0%	3.7	3.00	9	1.3	0.004	LDR	25%	9.2	5.95	9	0.2	0.002
T	25	10.0%	2.5	3.00	6	0.9	0.003	LDR	25%	6.3	5.95	6	0.2	0.001
Total	2062	10.6%	**219.3**	3.13	**537**	**73.1**	**0.24**		28.4%	**586.6**	6.62	**569**	**15.5**	**0.13**

*Includes reduction in runoff volume through infiltration

The results show that within the areas projected to be developed between 2005 and 2020, given the assumptions discussed above, there is only a minor increase in runoff volume of 32 acre-feet (i.e. from 537 to 569). Given the City-wide annual runoff volume estimate of 9238 acre-feet, this increase is approximately 0.3 percent. For all practical purposes this represents essentially no runoff volume increase. This calculated small increase can be fully offset if, for example few rain gardens are built in places that are currently developed (i.e., retrofit).

7.0 Results Summary – Discussion

The loadings calculation results are summarized in Table 11.

Table 12. 1988, 2005, and 2020 Loadings Summary

Year	Imp. surface (acres)	Imp. %	Runoff Volume (ac-ft)	Annual TSS (tons)	Annual TP (tons)	Notes
1988	3918	18.0%	8295	1128	3.72	Assuming No Storm Water Treatment
2005	4495	20.6%	9238	691	2.97	Assuming Storm Water Treatment by Ponds Only - Based on NEW Ponds Size
1988 to 2005 relative changes	14.7%		11.4%	-38.7%	-20.2%	Increase in Runoff Volume level Reduction in TSS and TP levels
2020 without any treatment	*4863*		*9839*	*773*	*3.24*	*For Comparison Purposes Only Assuming No Reduction in Runoff Volume, TSS or TP Levels*
2020	4863	22.3%	9270	634	2.86	Assuming Half of Runoff Volume is Infiltrated and Half is Treated Using Other BMSs (Primarily Ponds)
2005 to 2020 relative changes	8.2%		0.3%	-8.3%	-3.8%	Runoff Volume level unchanged Reduction in TSS and TP levels

7.1 1988 to 2005 Evaluation

During the 1988 – 2005 period, the amount of impervious surface increased by 14.7 percent, or from an estimated 18.0 to 20.6 percent. The conversion from pervious to impervious surface resulted in a corresponding increase in runoff volume.

The increase in runoff volume is unlikely to cause significant degradation to water quality. One possible concern is that urban streams tend to show increased bank erosion due to increased peaks. In Blaine area most of the runoff is routed through ponds, wetlands, and numerous County Ditches prior to reaching receiving waters of Coon Creek, Rice Creek or Mississippi River. Thus, the peaks are largely attenuated. Most county ditches appear to be very well vegetated with little signs of erosion.

The effluent TSS and TP loadings for period 1988 – 2005 were determined to have decreased. This outcome is due to the fact that many storm water treatment ponds, some which very large in size, were constructed between 1988 and 2005. These ponds have the capacity to retain large amounts of TSS and TP.

A detailed assessment of the potential for impact to wetlands resulting from an increase in runoff volume or from an increased depth or duration of inundation was not completed. Based on the relative small increase in runoff volumes determined from these analyses and from early discussions with watershed representatives, there are no significant issues stemming from the increased runoff volumes.

7.2 2005 to 2020 Evaluation

During the 2005 – 2020 period the amount of impervious surface is projected to increase from 4495 acres to 4693 acres (8.2 percent). With a major shift in storm water treatment practices from the more traditional ponds to infiltration BMPs, the runoff volume is expected remain largely unchanged.

A simple simulation was performed in which half of the runoff volume could be infiltrated while the remaining half would be routed through ponds or detention basins, shows virtually no increase in the annual runoff volume and a decrease in the amounts of effluent TSS and TP.

7.3 Other Considerations

The benefits of street sweeping have not been factored in. City records indicate approximately 3,500 cubic yards of material being swept each year. This translates in approximately 4,700 tons of materials (assuming an average density of 100 pcf). Laboratory analyses on the swept material collected from the streets indicate a concentration in Total Phosphorus (TP) of 300 ppm. Combining these numbers, the total amount of TP removed through street sweeping annually is approximately 1.4 tons, or approximately one third of the TP generated at the source.

8.0 Storm Water Pollution Prevention Plan (MS4)

On May 31, 2006 the City of Blaine submitted the Storm Water Pollution Prevention Program (SWPPP) as required under MPCA General Permit MN R 040000. The document defines the main goal which is to preserve, protect, and improve the water resources impacted by storm water runoff. The document also defines in detail the specific BMPs in all of the six areas required by the permit: Public Education and Outreach, Public Involvement and Participation, Illicit Discharge Detection and Elimination, Construction Site Runoff Control, Post Construction Runoff Control, and Pollution Prevention and Good Housekeeping.

9.0 Storm Water Plans, Permits, Studies

9.1 City of Blaine - Comprehensive Water Resources Plan

Section IV of the Comprehensive Water Resources Plan (CWRP) summarizes the goals and policies adopted by the City of Blaine in nine critical areas: Water Quantity, Water Quality, Recreation Fish and Wildlife, Enhancement of Public Participation Information and Education, Public Ditch System, Groundwater, Wetlands, Erosion, and Shoreland Management. The CWRP, along with the City's NPDES SWPPP, form the basis for the overall storm water management program in the City. The City's CWRP was developed in accordance with Minnesota Rule, Chapter 8410 and is consistent with the Plans of the Six Cities WMO, Coon Creek WD and Rice Creek WD.

9.2 Coon Creek Watershed District Loading Analysis Study

A loading assessment was being prepared by Wenck Associates, Inc. for the entire Coon Creek Watershed District. Preliminary findings and data have been made available during a series of meetings hosted by the CCWD. The data includes a P8 model based assessment of runoff volume, TP, TSS loadings as function of the impervious percentage and loading reduction as a result of the district rules and policies. The assessment also factors in an estimated loading reduction due to sweeping practices. Approximately 25 percent of the entire CCWD swept impervious area is located in Blaine. At the same time, approximately half of the City of Blaine area is located within the CCWD district. Due to differences in the approaches the data from the CCWD study cannot be directly compared with the data presented in this report.

9.3 Rice Creek Anoka County Ditch 53-62 Resource Management Plan (RMP) and Golden Lake TMDL Study

The RMP for Anoka County Ditch 53-62 (ACD 53-62) was completed in December 2006. The RMP sets forth a special set of objectives for the drainage area along the ditch. Most of the ACD 52-63 watershed is located within the City of Blaine and, more importantly, it includes the area along Lexington Avenue corridor where a substantial portion of the future urban development is expected to take place. These objectives will be implemented through RCWD Rule. The purpose of the RMP was to protect, conserve, and enhance wetland areas and vegetated buffers. The RMP would also benefit the water quality within the ACD 53-62 which is particularly important given that the ditch is tributary to Golden Lake, a water body identified as impaired for Phosphorus by the Minnesota Pollution Control Agency. A TMDL study that assesses the Phosphorus load allocation and load reduction targets is being completed by the RCWD.

10.0 Public Participation and Review

A Public Hearing was held on September 20, 2007. The notice for this Public Hearing was published on August 17, 2007 in Blaine – Spring Life Newspaper. The text is reproduced below:

1012 LG Notice of Public Hearings

NOTICE OF PUBLIC HEARING BEFORE THE BLAINE CITY COUNCIL ANOKA COUNTY, MINNESOTA MS4 NON-DEGRADATION PLAN TO WHOM IT MAY CONCERN: NOTICE is hereby given that the City Council of the City of Blaine, Minnesota, will meet on Thursday, September 20, 2007, at 8:00 p.m. in the Council Chambers at the City Hall, 10801 Town Square Drive NE to consider the following document: MS4 Non-degradation Plan The Minnesota Pollution Control Agency (MPCA) has selected 30 cities, including the City of Blaine, and required that they perform an in-depth study *of the changes on pollution and volume of water contained in stormwater runoff resulting from the increased hard surfaces connected with development within the city since 1988. This study must be submitted to the MPCA by October 1, 2007. Such persons as desire to be heard with reference to the proposed document will be heard at this meeting. Hearing impaired persons planning to attend who need an interpreter or other persons with disabilities who require auxiliary aids should contact Rebecca Olson at (763) 785-6120 no later than September 14, 2007. For questions regarding the proposed project, contact Stormwater Manager Jim Hafner at (763) 785-6188. Jane M. Cross, CMC, City Clerk*

Published in Blaine / Spring Lake Park Life Aug. 17, 2007

A Draft copy of this Loading Assessment was sent for review and comments to Anoka Conservation District, Coon Creek Watershed District, Rice Creek Watershed District, and Six Cities Watershed Management Organization. Of these, only Coon Creek Watershed District provided comments and questions.

11.0 Conclusions

The assessment of storm water runoff volume and main pollutant loadings was conducted according to the requirements and guidelines of the permit. Overall, the assessment found no significant increase in these loadings between 1988 and 2005. While the assessment shows an increase in the runoff volume due to the expansion of impervious surface, the TSS and TP loadings decreased, chiefly because numerous storm water treatment ponds accompanied the new development and re-development that occurred between 1988 and 2005.

It should be noted that the evaluation of Runoff Volume, TSS and TP presented above is based on a series of conservative assumptions. For example, in computing the runoff volume, the entire impervious surface was considered connected. However, most of the new development between 1988 and 2005 consisted of Low Density Residential units. Thus, a large portion of the added impervious surface is disconnected. The TSS and TP loading estimate it is also conservative. The TSS and TP reduction was based exclusively on single wet basin retention assumptions. Given that many of the ponds were built in series, the pollutant load reduction is actually further enhanced by the treatment train concept. Furthermore, the effect of grassed swales and ditches on reducing the TSS and TP loadings has not been factored in. Nor has any credit been taken for improvements in street sweeping equipment or practices, or from the state law governing the use of phosphorus fertilizers.

It seems reasonable to conclude that the increase in Runoff Volume is commensurate with the size of the City. Runoff Volume reduction is a relatively new area to the storm water management arena while the potential adverse effects are still being studied and debated. The most common impacts cited in connection with the runoff volume increase are a pronounced degradation of the natural stream banks and more frequent inundation of the wetlands. Neither of these has been found to occur in Blaine to a level that would be considered significant.

Looking into the future, the projected level of development will continue to add impervious surface. However, the increase in impervious surface between 2005 and 2020 is expected to be less than that seen between 1988 and 2005. Runoff infiltration is expected to play in increasingly important role in storm water management.

Most of the City falls under the jurisdiction of the Rice Creek Watershed District (RCWD) and the Coon Creek Watershed District (CCWD) with the remaining part being fully developed. RCWD is currently in the process of adopting new rules for storm water management which will place the focus on infiltration. The proposed rules will essentially translate into runoff volume control for most development cases and runoff volume reduction in cases where site re-development would disturb more than half of the existing impervious surface. CCWD is currently conducting research to assess the levels of infiltration that could be expected in the future. The runoff infiltration practices have the potential to offset the increase in runoff volume caused by the expansion of impervious surfaces. Thus, the any future development will be screened by the City and either CCWD or RCWD, ensuring compliance with strict pollution loading targets.

Additionally, the City will play and active role in adopting specific policies aimed at enhancing the surface water quality. The current MS4 permit contains aggressive plans for Construction and Post Construction Runoff Control as well as Pollution Prevention (Good Housekeeping) sections. The City of Blaine has also an excellent tradition in engaging the public educative and informative programs.

In conclusion, the level of development the City of Blaine experienced between 1988 and 2005 did not result in significant new or expanded discharge. It is predicated that the advent of new storm water management rules and policies will result in improved water quality and control or reduction of the overall runoff volume. Therefore, at this point in time, the City of Blaine proposes no modification to the existing MS4 Storm Water Pollution Prevention Plan (SWPPP) previously submitted to Minnesota Pollution Control Agency.

List of Figures