III. PROCEDURES AND METHODS FOLLOWED

This section of the report provides the procedures and methods followed for the loading assessment and nondegradation analysis.

As required by the MPCA, the loading assessment estimates the changes in three parameters: annual average runoff volumes, total suspended solids loads, and phosphorus loads. This assessment is performed for two time frames: from 1990 to 2006, and from 2006 to 2020. The three years for the analysis were selected based on the most comprehensive data available that were nearest to the years suggested by the MPCA for the analysis (1988-1990, 2000-2005, and 2020). A method based on land use has been applied to determine the change in runoff volumes, phosphorus, and total suspended solids loadings as described in the Steps listed below.

In addition to the loading assessment, the Steps identified below describe procedures used to compare runoff volumes and pollutant runoff between the specified time periods. If it is identified that an increase of these runoff volumes or pollutant loadings have occurred or is projected to occur, then methods are identified that would mitigate degradation of downstream waters.

The approach used to complete the loading assessment and nondegradation analysis was developed and undertaken as generally outlined in **Figure 4.** A detailed description of these procedures and methods is provided below:

Step 1: Define land uses within the City for 1990 and 2006 conditions.

Under this step, aerial photography and City zoning maps from 1990 and 2006 were used to determine land use conditions in 1990 and the present, respectively. Land in the City was classified under one of the following land uses:

- **Agriculture:** The Agricultural land use category includes cultivated fields and the surrounding impervious surfaces such as farmstead buildings, farm roads, driveways, and roads.
- **Open Space:** This land use is defined as undeveloped land having vegetative cover such as parks, cemeteries, woods, brush, and non-agricultural open space. Access roads, small parking areas, and small structures that are within or adjacent to these areas may be included in this land use.
- **Single-Family Residential:** This land use is defined for single family residential lots that are 10,000 SF or larger, and is consistent with the City's land use maps.
- **Multi-family Residential:** This land use is defined as lots with multiple dwellings on one lot, or smaller lots associated with townhomes or condominiums. Areas are consistent with the City's land use mapping.
- **Industrial:** This land use is for developed industrial parcels as indicated on the City's land use and zoning maps and verified through visual inspection of aerial photographs.

- **Commercial:** This land use is for developed commercial parcels as indicated on the City's land use and zoning maps and verified through visual inspection of aerial photographs.
- **Institutional:** This land use is for parcels developed with schools and other uses typically associated with institutional land use including any ball fields, open spaces, and parking lots associated with the land use.
- **Gravel Pit:** This land use is for parcels with active or inactive gravel pit operations.
- **Right-of-Way:** This land use is for right-of-way corridors used for major highways.
- **Other:** Other land uses include Interstate right-of-way or large, open water bodies. Due to the unchanging presence of these land uses, they have been omitted from the analysis.

This land use information was compiled into a GIS database to be used for the loading assessment and nondegradation analysis.

Step 2. Compare 1990 and 2006 land uses.

After land uses were assigned, each parcel was reviewed to determine if a change has occurred since 1990. In areas of the City in which no land use change occurred, the analysis anticipates no change in loading values. In this case, the nondegradation standard has been met and no further analysis is needed. For parcels where land use changes have occurred, the analysis continued on to **Step 3**.

Step 3. Estimate annual runoff volume based on land use.

Runoff volumes were estimated for the 1990 and present land use conditions using the Natural Resource Conservation Service (NRCS) method for hydrology. Using this method, rainfall data, impervious surface mapping, soil types, land use and rainfall/runoff relationships were utilized to determine runoff volumes relative to land use.

Daily rainfall data was used to calculate daily runoff data for each land use using NRCS methodology. This daily runoff data was used to determine the annual average runoff volume based on cover type for the ten year period of rainfall data on a per acre basis. These per acre runoff volumes were used to generate City-wide runoff volumes based on land use and soils information**.**

The background information used in this analysis is identified below:

- **<u>Rainfall Analysis</u>**
  The average annual rainfall was estimated by using rain gauge data taken in Savage provided by the State Climatology Office. The ten years of daily rainfall data used spans from January of 1997 to December of 2006. See **Appendix A** for a tabulation of the rainfall data.

- **Soil Analysis**
  Data provided in the Scott County soil maps (see **Figure 5**) was used to assign hydrologic soil types to the undeveloped areas. Topsoil is typically placed on pervious areas when sites are developed and is classified as Type B soil. Therefore, for all developed areas Soil Type B was used. A moderate antecedent moisture condition (AMC II) was used for all calculations.

- **Land Use Analysis**
  Land uses were determined as described under **Step 1**.

- **Rainfall / Runoff Relationship**
  Using the *Hydrology Guide for Minnesota (1993),* Curve Numbers were assigned for areas based on soil types and land use. Curve Numbers used for the undeveloped land uses (Agriculture and Open Space) were determined by selecting appropriate curve numbers from the Hydrology Guide that could be associated with the land use of interest. Then the lowest and highest values (**Appendix G)** were documented and the average of the two numbers, rounded down, was used for the Curve Numbers in the analysis. See **Table 1** for a summary of Curve Numbers used for the analysis of undeveloped areas.

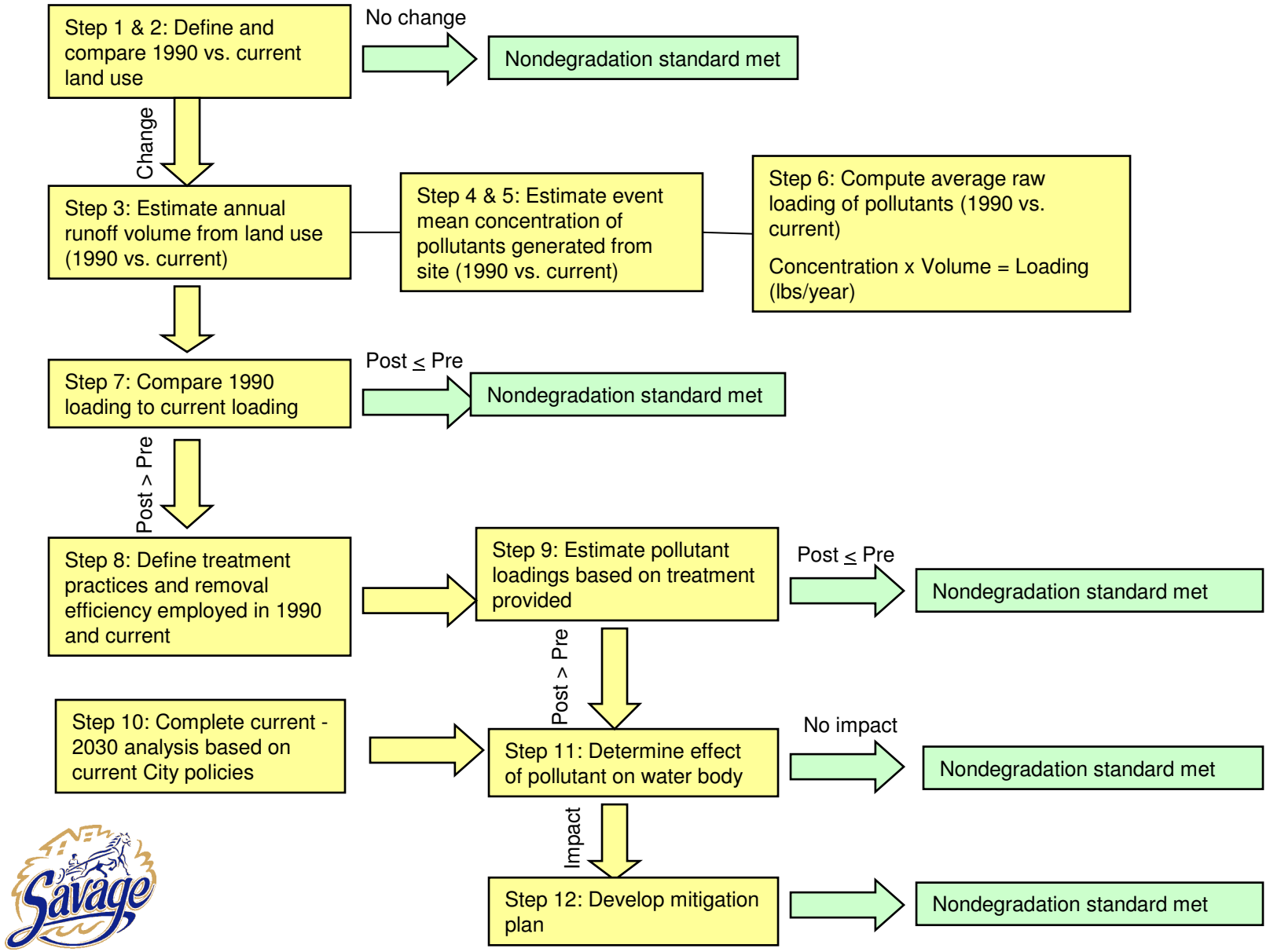
  All impervious surfaces were considered as directly connected. Estimates for runoff volumes in developed conditions are substantially higher when considering the impervious surfaces as directly connected. Therefore, the analysis performed will estimate higher runoff volumes in developed conditions than would be estimated if a portion of the impervious surfaces were not considered directly connected. This means that the changes in runoff volumes presented in the analysis are conservative. A Curve Number of 98 and 61 was used for developed impervious and pervious areas, respectively. These Curve Numbers are consistent with those recommended in the Minnesota Hydrology Guide for Type B soils.

  Impervious percentages for all land uses were based on several samples of impervious areas within each land use. These samples were analyzed using aerial photography and available planometric data to calculate a typical impervious percentage for each land use. Based on this information, the impervious percentage by land use was determined and applied to the same land uses within the City. The impervious percentages used in the analysis are shown below:

  1. Single Family Residential = 33% Impervious
  2. Multi-family Residential = 50% Impervious
  3. Industrial = 58% Impervious
  4. Commercial = 71% Impervious
  5. Institutional = 38% Impervious
  6. Open Space = 7% Impervious
  7. Agriculture = 6% Impervious
  8. Right-of-Way = 42% Impervious

FIGURE 4

Flow Chart Indicating Procedures and Methods Followed in the Savage Nondegradation Report



File: K:\01436-10\GIS\Maps\Figures\Fig5_soils.mxd, Nov 08, 2007 1:13:30 PM

Legend

A, A/D - These Soils have high infiltration rates even when thoroughly wetted. The infiltration rates range from .3 to .5 inches per hour. These soils consist chiefly of deep, well drained to excessively drained sands and gravel. These soils have a high rate of water transmission, therefore resulting in a low runoff potential.

B, B/D - These soils have a moderate infiltration rate ranging from .15 to .3 inches per hour when thoroughly wetted. These soils consist of deep moderately well to well drained soils with moderately fine to moderately coarse textures.

C/D- These soils have slow infiltration rates ranging from .05 to .15 inches per hour when thoroughly wetted.

D - These soils have very slow infiltration rates ranging from 0 to 0.05 inches per hour when thoroughly wetted. These soils are are typically clay soils with high swelling potential at or near the surface or shallow soils over nearly impercious material.

No Data

City Boundaries

Bloomington
Shakopee
Prior Lake
Savage
Burnsville
Lakeville
101
13
16
42
27
LYNN AVE
MCCOLL DR
DAKOTA AVE
GLENDALE RD
EGAN DR
154TH ST W
ALLEN BLVD
160TH ST SE

Source: Scott County Soils Survey
2006 Aerial Photographs

0 2,500 5,000 Feet

City of Savage

Nondegradation Analysis

Figure 5

Soils Map

WSB & Associates, Inc.

TABLE 1

Curve Numbers for Undeveloped Land Uses Within the City of Savage Based on Land Use and Soil Types

Undeveloped Land Use	Hydrologic Soil Type	Range of Curve Numbers from MN Hydrology Guide		Curve No. Used for Nondegradation Analysis (Mean)
		Low	High	
Agriculture	A	58	77	68
	B	69	86	78
	C	77	91	84
	D	80	94	87
Open Space	A	30	68	50
	B	48	79	63
	C	65	86	75
	D	73	89	81

Step 4. Review Research Documents for Event Mean Concentration Information Related to Total Phosphorus (TP) and Total Suspended Solids (TSS).

Research documents were reviewed to estimate TP and TSS event mean concentrations for the land uses defined under **Step 1**. Five primary sources were reviewed as a part of this step. A listing of these documents, along with a brief description of their content, is provided below:

1. **"Comments on the Simple Method for Determining Watershed Loads" published by the Minnesota Pollution Control Agency in May 2004.** (See **Appendix B**).
   This document identifies pollutant concentrations that were determined by several studies performed by others. The following is a list of tables contained in this document that were considered for review followed by the original source of the data.

   - Table 4: Nutrient Runoff Concentrations from Forested Watersheds [EPA, 1980].
   - Table 5: Runoff Nutrient Concentrations for Row Crops [US EPA, 1980].
   - Table 6: Runoff Nutrient Concentrations for Non-Row Crops [US EPA, 1980].
   - Table 7: Runoff Nutrient Concentrations for Pastured Watersheds [US EPA, 1980].
   - Table 8: Corn Field Runoff Suspended Sediment Concentrations [Gaynor and Findlay, 1995].
   - Table 9: Average Urban Runoff Pollutant Concentration Values for Use With the Simple Method [Scheuler, 1987].
   - Table 10: PLOAD Runoff Event Mean Concentrations [US EPA, 2001].
   - Table 11: Runoff Event Mean Pollutant Concentrations used in Wake County, North Carolina Study [CH2MHill, 2002].

2. **"Minnehaha Creek Watershed District H/H and Pollutant Loading Study," prepared by Emmons and Olivier Resources, Inc., 2003.** (See **Appendix C**).
   This document identifies recommended values that were determined based on literature review, knowledge of local water quality monitoring data, and professional assessment. This is the only publication reviewed specifically with recommended values for the Twin Cities area. Many of the values presented in this document for TP concentrations were adopted by the Minnesota Pollution Control Agency's "Minnesota Stormwater Manual", published in 2005.

3. **"The National Stormwater Quality Database (NSQD, version 1.1)" Pitt, et. al., 2004.** (See **Appendix D**).
   This paper recommends pollutant runoff concentrations based on review of several gauging stations and studies throughout the country. Some of the concentrations presented in this report were adopted by the MPCA's "Minnesota Stormwater Manual" published in 2005.

4. **"Protecting Water Quality in Urban Areas", MPCA, March 2000.** (See **Appendix E**).
   This paper recommends using mean pollutant concentrations that are presented in the USEPA's document entitled, "Results of the Nationwide Urban Runoff Program", 1983. The USEPA's document compiles information from across the country to calculate the mean concentrations for several pollutants, including TSS and TP. The results of the USEPA's document are presented within "Protecting Water Quality in Urban Areas".

5. **"Minnesota Stormwater Manual", MPCA 2005.** (See **Appendix F**).
   This document recommends using event mean concentrations as determined by the "Minnehaha Creek Watershed District H/H and Pollutant Loading Study" and "The National Stormwater Quality Database" papers listed above. Due to the authoritative source of the MPCA and because the document underwent extensive peer reviews in the Twin Cities Region, it has become a standard for use in the Twin Cities Metro Area.

Step 5. Estimate Event Mean Concentrations of TP and TSS for Each Land Use.

Information obtained from documents that were reviewed under **Step 4** was utilized to estimate the event mean concentrations of TP and TSS. The estimated concentrations and the basis for the estimates are presented below.

Total Phosphorus (TP) Event Mean Concentrations

The TP event mean concentrations found in the reviewed documents as well as values used in the nondegradation analysis are summarized in tables following this section. **Table 2-1** is a summary of concentrations by land use presented in documents reviewed under **Step 4** and those used in this nondegradation analysis. **Tables 2b to 2i** provide a detailed outline of this information for each specific land use. The concentrations by land use that were used in the analysis, along with their justification, are identified below:

1. **Agricultural Land Use**
   The event mean TP concentration for agricultural land use that was used in the nondegradation analysis is 0.75 mg/L. This was determined based on the following:

   - The concentrations of TP presented in the review documents ranged from 0.10 to 24.50 mg/L with mean and median values of 1.88 and 1.00 mg/L respectively. This information indicates that the concentration used in the analysis is within the range and is less than the mean and median values from the reviewed documents.

- The data presented in the Minnesota Stormwater Manual is taken from the Minnehaha Creek Watershed District (MCWD) Study and indicated concentrations of TP ranging from 0.32 to 0.46 mg/L. The concentration of 0.75 mg/L is slightly higher than the range presented in this document. However, gauge data taken in the MCWD Study appeared to be taken from pond outlets, and therefore is likely lower than concentrations prior to entering the pond. Furthermore, other reviewed documents indicated that the TP concentrations are much higher for agricultural land use and the nation-wide studies suggest that there is little regional variation between data. Instead, variations are contributed primarily to slope and specific site characteristics. Due to this, it appears that just as much weight should be placed on national and regional research data and the estimated concentration is a reasonable value between the two data sets.

- Concentrations presented in the documents reviewed under **Step 4** for agricultural land use were compared to concentrations presented for other land uses. The ratios of concentrations between land uses were noted and compared to the ratio of concentrations between land uses as used in this report. Based on this comparison, the concentration used for agricultural land use in the analysis is reasonable relative to the concentrations used for other land uses.

2. **Open Space Land Use**
   The TP runoff concentration for open space used in the nondegradation analysis is 0.10 mg/L. This was determined based on the following:

   - The concentrations of TP presented in the review documents ranged from 0.002 to 0.31 mg/L with mean and median values of 0.17 and 0.15 mg/L respectively. This information indicates that the concentration used in the analysis is within the range and is slightly less than the mean and median values from the reviewed documents.

   - The data presented in the Minnesota Stormwater Manual is taken from the Minnehaha Creek Watershed District (MCWD) Study and indicated concentrations of TP of 0.04 mg/L. The concentration of 0.10 mg/L is slightly higher than the range presented in this document. However, data taken in the MCWD Study was taken from pond outlets, and, therefore, would provide lower concentrations prior to entering the pond. Furthermore, other reviewed documents indicated that the TP concentrations are much higher for open space land use and the nation wide studies suggest that there is little regional variation between data. Instead, variations are contributed primarily to slope and specific site characteristics. As a result, more weight was placed on national and regional research data and the estimated concentration defined as a value between the two data sets.

3. **Single Family Residential Land Use**
   The TP runoff concentration for single family residential used in the nondegradation analysis is 0.30 mg/L. This estimation was determined based on the following:

   - The concentrations of TP presented in the review documents ranged from 0.20 to 0.46 mg/L with mean and median values of 0.33 and 0.29 mg/L respectively. The estimated concentration is within the range and is almost identical to the mean and median concentrations presented in reviewed documents.

   - The data presented in the Minnesota Stormwater Manual is taken from the NSQD which presents a TP concentration of 0.30 mg/L. This concentration is identical to the estimated concentration used in this analysis.

4. **Multi-family Residential Land Use**
   The TP runoff concentration for multi-family residential used in the nondegradation analysis is 0.32 mg/L. This estimation was determined based on the following:

   - The concentrations of TP presented in the review documents ranged from 0.10 to 1.08 mg/L with mean and median values of 0.42 and 0.31 mg/L respectively. The estimated concentration used in the analysis is within the range and between the mean and median values presented in reviewed documents.

   - The data presented in the Minnesota Stormwater Manual is taken from the NSQD and the Minnehaha Creek Watershed Study which present TP concentrations ranging from 0.27 to 0.32 mg/L. The estimated concentration used in the analysis is within the range of values presented in this document.

   - It has been observed in most reviewed documents that the TP concentration for multi-family residential land use is slightly higher than single family land use. The estimated concentration used in this analysis for single family and multi-family residential land use is 0.30 and 0.32 mg/L, respectively. Therefore the values estimated for the analysis follow the trend observed in reviewed documents.

5. **Industrial Land Use**
   The TP runoff concentration for industrial land use used in the nondegradation analysis is 0.26 mg/L. This estimation was determined based on the following:

   - The concentrations of TP presented in the reviewed documents range from 0.20 to 0.40 mg/L with mean and median values of 0.31 mg/L. The estimated value is within the range of concentrations and close to the mean and median values and is reasonable based on reviewed documents.

- The recommended concentration in the Minnesota Stormwater Manual is 0.26 mg/L. This value was derived from the NSQD and the Minnehaha Creek Watershed Study which present TP concentrations ranging from 0.20 to 0.28 mg/L and is the estimated concentration used in this analysis.

6. **Commercial Land Use**
   The TP runoff concentration for commercial land use used in the nondegradation analysis is 0.22 mg/L. This estimation was determined based on the following:

   - The concentrations of TP presented in the review documents ranged from 0.22 to 0.33 mg/L with mean and median values of 0.29 and 0.28 mg/L respectively. The estimated value is within the range of concentrations and close to the mean and median values and is reasonable based on reviewed documents.

   - The recommended concentration in the Minnesota Stormwater Manual is 0.22 mg/L. This value was derived from the NSQD and the Minnehaha Creek Watershed Study which present TP concentrations ranging from 0.22 to 0.28 mg/L. Although this concentration is slightly lower than that presented in other reviewed documents, the value is recommended by the MPCA and is equal to the estimated concentration used in this analysis.

7. **Institutional Land Use**
   The TP runoff concentration for institutional land use used in the nondegradation analysis is 0.18 mg/L. This estimation was determined based on the following:

   - The concentrations of TP presented in the review documents ranged from 0.18 to 0.30 mg/L with mean and median values of 0.25 and 0.28 mg/L respectively. The estimated value is within the range of concentrations and is reasonable based on reviewed documents.

   - Many of the reviewed documents did not have an institutional land use category. However, in the documents that had a specific institutional land use category it has been observed that the TP concentration is slightly lower than that experienced for Commercial land use. Therefore the estimated value for institutional land use was estimated at 0.18 mg/L, which is slightly lower than that estimated for commercial land use (0.22mg/L)

8. **Right-of-Way Land Use**
   The TP runoff concentration for right-of-way land use used in the nondegradation analysis is 0.25 mg/L. This estimation was determined based on the following:

   - Concentrations in observed documents range from 0.25 to 0.4 mg/L, with mean and median values of 0.33 mg/L. The concentration used in the report is within this range and is therefore a reasonable estimate.

- Based on reviewed documents, phosphorus concentrations for right-of-way should be similar to that found in industrial land use. The phosphorus concentration for right-of-way used in the report is very similar to that used for industrial land use and, therefore is a reasonable concentration to use.

9. Gravel Pit Land Use

The estimated runoff volume for gravel pit land use is zero. Because no runoff leaves this land use, a TP concentration for the land use was not needed for the analysis.

TABLE 2a

Summary of Total Phosphorus Concentration Data (mg/L) for Various Land Use Conditions Within the City of Savage

	Land Use								
	Agriculture	**Open Space**	**Single Family Residential**	**Multi-family Residential**	**Industrial**	**Commercial**	**Institutional**	**Right-of-Way**	**Gravel Pit**
Range of Concentrations *	0.100 - 24.50	0.002 - 0.31	0.20 - 0.46	0.10 - 1.08	0.20 - 0.40	0.22 - 0.33	0.18 - 0.30	0.18 - 0.30	N/A
Mean of Concentrations *	1.88	0.17	0.33	0.42	0.31	0.29	0.25	0.25	N/A
Median of Concentrations *	1.00	0.15	0.29	0.31	0.31	0.28	0.28	0.28	N/A
Concentration Used in Nondegradation Analysis	**0.75**	**0.10**	**0.30**	**0.32**	**0.26**	**0.22**	**0.18**	**0.18**	**N/A**

*** Taken from documents reviewed under Step 4 of Section III.**

TABLE 2b

Total Phosphorus Concentration (mg/L) Data for Agriculture Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 5: Row Crops, p10	0.652 - 24.500	6.523	1.486
Comments on the Simple Method for Determining Watershed Loads	Table 6: Non Row Crops, p11	0.100 - 1.792	0.767	0.493
Comments on the Simple Method for Determining Watershed Loads	Table 7: Pasture, p12	0.420 - 7.186	2.000	0.856
Comments on the Simple Method for Determining Watershed Loads	Table 10: Cropland and Pasture / Other Agricultural Land, p15	1 - 1	1.000	1.000
Comments on the Simple Method for Determining Watershed Loads	Table 11: Cultivated and Non-cultivated Agriculture, p16	0.5 - 4.0	2.250	2.250
MCWD H/H and Pollutant Loading Study	Table II.F.2-1: Cropland and Farmsteads	0.32 - 0.46	0.390	0.390
Protecting Water Quality in Urban Areas	Table 1.20-1: Open. Non-urban		0.230	
	Total	**0.100 - 24.50**	**1.880 ***	**1.000 ***

* Based on mean data of reviewed documents

Recommended Concentration 0.75 mg/L

Nondegradation Analysis
City of Savage

TABLE 2c

Total Phosphorus Concentrations (mg/L) Data for Open Space Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 4: Woods, p9	0.002 - 0.116	0.064	0.051
Comments on the Simple Method for Determining Watershed Loads	Table 9: Hardwood Forest		0.15	
Comments on the Simple Method for Determining Watershed Loads	Table 10: Various Forest, p15		0.14	
Comments on the Simple Method for Determining Watershed Loads	Table 11: Forest and Herbaceous Upland, p16	0.2 - 0.3	0.250	0.250
MCWD H/H and Pollutant loading Study	Table II.F.2-1: Forest/Shrub/Grassland		0.040	
The National Stormwater Quality Database (NSQD, Version 1.1)	Table 1: Open Space, Mixed Open Space	0.27 - 0.31	0.290	0.290
Protecting Water Quality in Urban Areas	Table 2-1: Open/non-urban		0.230	
	Totals	**0.002 - 0.31**	**0.166 ***	**0.150 ***

* Based on mean data of reviewed documents

Recommended Concentration 0.10 mg/L

Nondegradation Analysis
City of Savage

TABLE 2d

Total Phosphorus Concentration (mg/L) Data for Single Family Residential Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 9: New Suburban NURP Sites, p15		0.26	
Comments on the Simple Method for Determining Watershed Loads	Table 10: Residential, p15		0.28	
Comments on the Simple Method for Determining Watershed Loads	Table 11: Medium, Low and Single Family Residential, p16		0.2	
MCWD H/H and Pollutant loading Study	Table II.F.2-1: Single Family Residential		0.460	
The National Stormwater Quality Database (NSQD, Version 1.1)	Table 1: Residential		0.300	
Protecting Water Quality in Urban Areas	Table 1.20-1: Residential		0.460	
	Total	**0.20 - 0.46**	**0.327 ***	**0.290 ***

* Based on mean data of reviewed documents

Recommended Concentration 0.30 mg/L

TABLE 2e

Total Phosphorus Concentration (mg/L) Data for Multi-family Residential Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 9: Older Urban Areas		1.08	
Comments on the Simple Method for Determining Watershed Loads	Table 10: Mixed Urban or Built Up		0.1	
Comments on the Simple Method for Determining Watershed Loads	Table 11: High Density and Multi-family Residential		0.3	
MCWD H/H and Pollutant loading Study	Table II.F.2-1: Multi-family Residential		0.320	
The National Stormwater Quality Database (NSQD, Version 1.1)	Table 1: Mixed Residential		0.270	
Protecting Water Quality in Urban Areas	Table 1.20-1: Residential		0.460	
	Total	**0.10 - 1.08**	**0.422 ***	**0.310 ***

* Based on mean data of reviewed documents

Recommended Concentration 0.32 mg/L

TABLE 2f

Total Phosphorus Concentration (mg/L) Data for Industrial Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 10: Industrial and Commercial, p15		0.33	
Comments on the Simple Method for Determining Watershed Loads	Table 11: Industrial, p16		0.4	
MCWD H/H and Pollutant loading Study	Table II.F.2-1: Industrial		0.28	
Protecting Water Quality in Urban Areas	Table 1: Industrial, Mixed Industrial	0.20 - 0.26	0.230	0.230
	Total	**0.20 - 0.40**	**0.310 ***	**0.305 ***

* Based on mean data of reviewed documents

Recommended Concentration 0.26 mg/L

TABLE 2g

Total Phosphorus Concentration (mg/L) Data for
Commercial Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 10: Commercial and Services, Industrial and Commercial, p15	0.28 - 0.33	0.305	0.305
Comments on the Simple Method for Determining Watershed Loads	Table 11: Commercial, p16		0.4	
MCWD H/H and Pollutant Loading Study	Table II.F.2-1: Commercial		0.280	
The National Stormwater Quality Database (NSQD, Version 1.1)	Table 1: Commercial, Mixed Commercial	0.22 - 0.26	0.240	0.240
Protecting Water Quality in Urban Areas	Table 1.20-1: Commercial		0.240	
	Total	**0.22 - 0.33**	**0.293 ***	**0.280 ***

* Based on mean data of reviewed documents

Recommended Concentration 0.22 mg/L

TABLE 2h

Total Phosphorus Concentration (mg/L) Data for Institutional Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 11: Institutional, p16		0.3	
MCWD H/H and Pollutant Loading Study	Table II.F.2-1: Public/semi public		0.28	
The National Stormwater Quality Database (NSQD, Version 1.1)	Table 1: Institutional		0.18	
	Total	**0.18 - 0.30**	**0.253 ***	**0.280 ***

* Based on mean data of reviewed documents

Recommended Concentration 0.18 mg/L

TABLE 2i

Total Phosphorus Concentration (mg/L) Data for Right-of-Way Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 11: Institutional, p16		0.3	
MCWD H/H and Pollutant Loading Study	Table II.F.2-1: Public/semi public		0.28	
The National Stormwater Quality Database (NSQD, Version 1.1)	Table 1: Institutional		0.18	
	Total	**0.18 - 0.30**	**0.253 ***	**0.280 ***

* Based on mean data of reviewed documents

Recommended Concentration 0.18 mg/L

Total Suspended Solids (TSS) Event Mean Concentrations

The TSS event mean concentrations found in the reviewed documents as well as values used in the nondegradation analysis are summarized in tables following this section. **Table 3a** is a summary of concentrations by land use presented in documents reviewed under **Step 4** and those used in this nondegradation analysis. **Tables 3b to 3i** provide a detailed breakdown of this information for each specific land use. Concentrations estimated by land use as used in the analysis and justifications for the estimated values are identified below:

1. **Agricultural Land Use**
   The TSS runoff concentration for agriculture used in the nondegradation analysis is 215 mg/L. This estimation was determined based on the following:

   - The concentrations of TSS presented in the reviewed documents ranged widely from 100 to 1200 mg/L with mean and median values of 378 and 216 mg/L respectively. This information indicates that the estimated concentration used in the analysis is within the range and approximately equal to the median value from reviewed documents.

   - A recommended TSS concentration of 216 mg/L is presented in "Protecting Water Quality in Urban Areas." This value is taken from the Results of the Nationwide Urban Runoff Program for undeveloped areas and is based on actual monitoring data from many sites across the Country. The estimated value of 215 mg/L is nearly identical to the value presented in this document.

2. **Open Space Land Use**
   The TSS runoff concentration for open space used in the nondegradation analysis is 50 mg/L. This estimation was determined based on the following:

   - The concentrations of TSS presented in the review documents ranged from 10 to 216 mg/L with mean and median values of 82 and 66 mg/L respectively. This information indicates that the estimated concentration used in the analysis is within the range and is slightly less than the mean and median values from reviewed documents.

   - The NSQD document presents TSS concentrations for open space that range between 49 - 84 mg/L. The estimated TSS concentration used in this analysis is within, but near the low value in this range.

3. **Single Family Residential Land Use**
   The TSS runoff concentration for single family residential used in the nondegradation analysis is 140 mg/L. This estimation was determined based on the following:

   - The concentrations of TSS presented in the review documents ranged from 39 to 140 mg/L with mean and median values of 75 and 49 mg/L, respectively. The estimated concentration is the highest value observed in reviewed documents, but is within the range of values.

   - The data presented in Protecting Water Quality in Urban Areas is taken from the Results of the National Urban Runoff Program which presents a TSS concentration of 140 mg/L. Because this value has been recommended by the MPCA and the primary source data focuses on urban watersheds associated with residential developments it is a reasonable value to use for the nondegradation analysis.

4. **Multi-family Residential Land Use**
   The TSS runoff concentration for multi-family residential used in the nondegradation analysis is 140 mg/L. This estimation was determined based on the following:

   - The concentrations of TSS presented in the review documents ranged from 26 to 140 mg/L with mean and median values of 86 and 72 mg/L respectively. The estimated concentration is the highest value observed in reviewed documents, but is within the range of values.

   - The data presented in Protecting Water Quality in Urban Areas is taken from the Results of the National Urban Runoff Program which presents a TSS concentration of 140 mg/L for residential use. Because this value has been recommended by the MPCA and the primary source data focuses on urban watersheds associated with residential developments, it is a reasonable value to use for the nondegradation analysis.

   - The reviewed documents indicate that the concentration of TSS should be higher for multi-family use than single family use. Although 140 mg/L is the same as that used for single family residential, it is the highest number in the range of concentrations presented in reviewed documents. Therefore it is the highest concentration that could be justified and was the number used in this nondegradation analysis.

5. **Industrial Land Use**
   The TSS runoff concentration for industrial land use used in the nondegradation analysis is 100 mg/L. This estimation was determined based on the following:

   - The concentrations of TSS presented in the review documents ranged from 26 to 130 mg/L with mean and median values of 80 and 81 mg/L, respectively. The estimated concentration is within the range presented in reviewed documents and appears to be a reasonable estimate based on reviewed documents.

- The data presented in Protecting Water Quality in Urban Areas is taken from the Results of the National Urban Runoff Program which presents a TSS concentration of 101 mg/L for mixed land use. This value has been recommended by the MPCA and the primary source data focuses on urban watersheds associated with industrial developments. The estimated value of 100 mg/L is nearly identical to this value and is, therefore, consistent with this document's recommendations.

6. **Commercial Land Use**
   The TSS runoff concentration for commercial land use used in the nondegradation analysis is 90 mg/L. This estimation was determined based on the following:

   - The concentrations of TSS presented in the review documents ranged from 42 to 140 mg/L with mean and median values of 76 and 78 mg/L respectively. The estimated concentration is within this range and is close to mean and median values presented in the reviewed documents. Therefore, the estimate appears to be a reasonable concentration to use.

   - The data presented in Protecting Water Quality in Urban Areas is taken from the Results of the National Urban Runoff Program which presents a TSS concentration of 90 mg/L. This value has been recommended by the MPCA and the primary source data focuses on urban watersheds associated with industrial developments. The estimated value used in this analysis of 90 mg/L is identical to this value and is, therefore, consistent with this reviewed document's recommendations.

   - Concentrations presented in the documents reviewed under **Step 4** for commercial land use were compared to concentrations presented for other land uses. The ratios of concentrations between land uses were noted and compared to the ratio of concentrations between land uses as used in this report. Based on this comparison, it appears that the concentration used for commercial land use in the analysis is reasonable, relative to the concentrations used for other land uses.

7. **Institutional Land Use**
   The TSS runoff concentration for institutional land use used in the nondegradation analysis is 80 mg/L. This estimation was determined based on the following:

   - The concentrations of TSS presented in the review documents ranged from 66 to 82 mg/L with mean and median values of 74 and 75 mg/L, respectively. The estimated value is within the range of concentrations and is close to the mean and median values recommended in reviewed documents. Therefore, the estimated concentration used in this analysis is reasonable.

- Many of the reviewed documents did not have an institutional land use category. However, in the documents that had a specific institutional land use category it has been observed that the TSS concentration is slightly lower than that experienced for commercial land use. In addition, most of the institutional land use in the City of Savage has a higher percentage of pervious area than typical institutional land use and would result in lower TSS event mean concentrations. Therefore the estimated value for institutional land use was estimated at 80 mg/L, which is slightly lower than that estimated for commercial land use (90 mg/L).

8. Right-of-Way Land Use

The TSS runoff concentration for right-of-way land use used in the nondegradation analysis is 100 mg/L. This estimation was determined based on the following:

- Concentrations of TSS within the reviewed documents range from 81.6 to 104 mg/L with mean concentration of 94.9 mg/L. The estimated value is within the range of concentrations and similar to the mean concentration observed in documents. Therefore, the concentration of 100 mg/L is a reasonable concentration to use.

9. Gravel Pit Land Use

The estimated runoff volume for gravel pit land use is zero. Because no runoff leaves this land use, a TSS concentration for the land use was not needed for the analysis.

TABLE 3a

Summary of Total Suspended Solids Concetration Data (mg/L) for Various Land Use Conditions Within the City of Savage

	Agriculture	Open Space	Single Family Residential	Multi-family Residential	Industrial	Commercial	Institutional	Right-of-Way
Range of Concentrations *	100 - 1200	10 - 216	39 - 140	26 - 140	26 - 130	42 - 140	66 - 82	75 - 99
Mean of Concentrations *	378	82	75	86	80	76	74	85
Median of Concentrations *	216	66	49	72	81	78	75	85
Concentration Used in Nondegradation Analysis	**215**	**50**	**140**	**140**	**100**	**90**	**80**	**100**

*** Taken from documents reviewed under Step 4 of Section III.**

TABLE 3b

Total Suspended Solids Concentration (mg/L) Data for Agriculture Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 8: Corn Crops, Suspended Sediment, p13	170 - 910	468	400
Comments on the Simple Method for Determining Watershed Loads	Table 10: Cropland, Pasture, other Agricultural Land, p15		132	
Comments on the Simple Method for Determining Watershed Loads	Table 11: Agriculture, p16	688 - 1200	944	944
MCWD H/H and Pollutant Loading Study	Table II.F.2-5: Cropland, Farmsteads, Vacant/Agricultural	100 - 170	132	125
Protecting Water Quality in Urban Areas	Table 1.20-1: Open, Non-urban		216	
	Total	**100 - 1200**	**378** *	**216** *

* Based on mean data of reviewed documents

Recommended Concentration 215 mg/L

TABLE 3c

Total Suspended Solids Concentration (mg/L) Data for Open Space Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 10: Various Woods, other open spaces, p15		78	
Comments on the Simple Method for Determining Watershed Loads	Table 11: Forest, Herbaceous Upland, p15	39.3 - 40.0	40	40
MCWD H/H and Pollutant Loading Study	Table II.F.2-5: Forest/Shrub/Grassland		10	
The National Stormwater Quality Database (NSQD, Version 1.1)	Table 1: Open Space, Mixed Open Space	48.5 - 83.5	66	66
Protecting Water Quality in Urban Areas	Table 2.20-1: Open/non-urban		216	
	Total	**10 - 216**	**82** *	**66** *

* Based on mean data of reviewed documents

Recommended Concentration 50 mg/L

Nondegradation Analysis
City of Savage

TABLE 3d

Total Suspended Solids Concentration (mg/L) Data for
Single Family Residential Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 10: Residential, p15		39	
Comments on the Simple Method for Determining Watershed Loads	Table 11: Low, Medium and Single family residential, p16	44 - 54	49	49
MCWD H/H and Pollutant Loading Study	Table II.F.2-5: Single Family Residential		100	
The National Stormwater Quality Database (NSQD, Version 1.1)	Table 1: Residential		49	
Protecting Water Quality in Urban Areas	Table 1.20-1: Residential		140	
	Total	**39 - 140**	**75** *	**49** *

* Based on mean data of reviewed documents

Recommended Concentration 140 mg/L

TABLE 3e

Total Suspended Solids Concentration (mg/L) Data for Multi-family Residential Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 10: Mixed Urban or Built up, p15		26	
Comments on the Simple Method for Determining Watershed Loads	Table 11: Multi-famliy / High Density Residential, p16		72	
MCWD H/H and Pollutant Loading Study	Table II.F.2-5: Milti-family Residential		125	
The National Stormwater Quality Database (NSQD, Version 1.1)	Table 1: Mixed Residential		68	
Protecting Water Quality in Urban Areas	Table 1.20-1: Residential		140	
	Total	**26 - 140**	**86** *	**72** *

* Based on mean data of reviewed documents

Recommended Concentration 140 mg/L

TABLE 3f

Total Suspended Solids Concentration (mg/L) Data for Industrial Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 10: Industrial		26	
Comments on the Simple Method for Determining Watershed Loads	Table 11: Industrial		82	
MCWD H/H and Pollutant Loading Study	Table II.F.2-5: Industrial		130	
The National Stormwater Quality Database (NSQD, Version 1.1)	Table 1: Industrial, Mixed Industrial	78 - 82	80	80
	Total	**26 - 130**	**80** *	**81** *

* Based on mean data of reviewed documents

Recommended Concentration 100 mg/L

TABLE 3g

Total Suspended Solids Concentration (mg/L) Data for Commercial Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 10: Commercial, p15		26	
Comments on the Simple Method for Determining Watershed Loads	Table 11: Commercial and Services, p16		78	
MCWD H/H and Pollutant Loading Study	Table II.F.2-5: Commercial		140	
The National Stormwater Quality Database (NSQD, Version 1.1)	Table 1: Commercial, Mixed Commercial	42 -54	48	48
Protecting Water Quality in Urban Areas	Table 1.20-1: Commercial		90 *	*
	Total	**42 - 140**	**76** *	**78** *

* Based on mean data of reviewed documents

Recommended Concentration 90 mg/L

TABLE 3h

Total Suspended Solids Concentration (mg/L) Data for Institutional Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 11: Institutional, p16		66.1	
MCWD H/H and Pollutant Loading Study	Table II.F.2-5: Public/semi public		75	
The National Stormwater Quality Database (NSQD, Version 1.1)	Table 1: Institutional		82	
	Total	**66 - 82**	**74** *	**75** *

* Based on mean data of reviewed documents

Recommended Concentration 80 mg/L

TABLE 3i

Total Suspended Solids Concentration (mg/L) Data for Right-of-Way Land Use Within the City of Savage

SOURCE	DESCRIPTION	RANGE	MEAN	MEDIAN
Comments on the Simple Method for Determining Watershed Loads	Table 11: Transportation, p16		81.6	81.6
MCWD H/H and Pollutant Loading Study	Table II.F.2-5: Public/semi public		75	75
The National Stormwater Quality Database (NSQD, Version 1.1)	Table 1: Mixed Freeways		99	99
	Total		**85.2 ***	**81.6 ***

* Based on mean data of reviewed documents

Recommended Concentration 100 mg/L

Step 6: Compute annual loading of pollutants generated by land use.

The average loading of pollutants generated from each land use and time frame was computed based on the data generated from **Step 3** and **Step 5**. Annual loading is calculated using the following equation on a per acre basis:

Pollutant Event Mean Concentration x Annual Runoff Volume = Loading (lbs/year)

The pollutant loadings were calculated on a City-wide basis based on the acreages identified in **Step 1.** The results of this analysis were then used to calculate an estimated loading on a per acreage basis.

Step 7: Compare 1990 loadings to present loadings.

Based on the data generated from **Step 6**, the 1990 pollutant loadings were compared with present loadings by development. This calculation did not take into account any treatment or BMPs that were implemented as a part of development. Based on this comparison, if there was no increase in runoff volumes or pollutant loading, the nondegradation standard has been met. For areas where there was an increase in pollutants, the analysis continued on to **Step 8**.

Step 8: Define treatment practices and removal efficiencies employed in 1990 and present.

Treatment practices and BMPs that were in place in 1990 and the present were identified and evaluated for the nondegradation analysis. Identified below is a discussion of the BMPs considered for the analysis:

- **Stormwater Ponds**
  A review of past City policies and aerial photos indicated that construction of "NURP" storm water ponds have been required and constructed for new developments since 1990. These ponds will reduce runoff volumes through evaporation and infiltration and will also retain pollutants, thereby reducing pollutant loads discharged downstream.

  Pond areas were determined for the nondegradation analysis based on pond area information taken from the aerial photography and available planometric data. The sum of all of the ponds created since 1990 was divided by the areas that developed since 1990 to obtain a pond area to developed area ratio. This ratio was approximately 3% and was applied to areas that have developed since 1990 to estimate the area of new ponding in the new developments.

  Annual evaporation volumes, annual infiltration volumes, TP removal rates and TSS removal rates associated with newly constructed ponds were estimated for the nondegradation analysis. The values used in the analysis and justification for the values used are listed below:

1. **Annual Evaporation Volumes**

An annual average evaporation volume of 36 inches per acre of newly created pond areas was used for the nondegradation analysis. This is based on information provided in Figure 8-2 in the Hydrology Guide for Minnesota (**Appendix G**). The Figure indicates that approximately 36 inches of water will evaporate annually from each acre of surface water in the Savage region. This results in an annual evaporation volume of 3 acre-feet per acre of newly created pond.

2. **Annual Infiltration Volumes**

Based on available research documents, monitoring performed by WSB, and general observations, it has been determined that the infiltration rate of 0.03 inches per hour is reasonable to estimate the average infiltration rate occurring within stormwater ponds.

Research documents reviewed to determine an average infiltration rate in pond areas include the following:

- "Urban Hydrology for Small Watersheds" (TR-55), published by the USDA in June 1986.
- "BMP Modeling Concepts and Simulation", published by the USEPA in July 2006.
- "National Engineering Handbook", Part 630 Hydrology, Chapter 7 – Hydrologic Soil Groups, published by USDA in May of 2007.
- "Minnesota Stormwater Manual", published by the MPCA in September of 2006.
- "How Much Rain Enters the Soil?" written by G. W. Musgrave, published in the USDA Yearbook in 1955.

These documents were utilized to classify the soil type that would generally be found in ponds and to determine an infiltration rate to use for such a soil classification.

Soil Classification Within Pond Areas

Hydrologic Soil Types are classified as Type A, B, C, or D soils, with Type A soils having the highest infiltration capacity and Type D soils having the least. Based on County Soil Maps, the majority of the City has Type B soils, with some occurrences of other Soil Types.

Soil Types near the surface are primarily Type B soils throughout the City. However, it is expected that soils within pond areas may have a lower infiltration rate, and therefore, a differing Soil Type classification. This is due to several factors including sedimentation occurring within the pond, proximity to ground water elevations, and proximity to bedrock elevations.

Due to these factors, it is more appropriate to approximate an average Soil Type of C or D within such pond areas.

Many of the ponds within the City may have higher infiltration rates than that experienced with Type D soils. However, to simplify the analysis, and to conservatively estimate the infiltration capacity of the ponds, a Type D soil has been utilized for all of the pond areas.

Infiltration Rates for Type D Soils

Documents reviewed indicated a high variability of infiltration rates within Type D soils ranging from 0 to 0.2 inches per hour. Ranges indicated within each document and the average for the range was determined and have been summarized in the following table:

Infiltration Rates for Type D Soils		
	Infiltration Rate (in/hr)	
Source	Range	Average
Urban Hydrology for Small Watersheds	0 to 0.05	0.025
BMP Modeling Concepts and Simulation (Rawls et al 1983)	0.03	0.03
National Engineering Handbook	0 to 0.06	0.03
Minnesota Stormwater Manual	0 to 0.2	0.1

The average infiltration rate is 0.03 inches per hour in two of the four documents – "BMP Modeling Concepts and Simulation" and the "National Engineering Handbook." Of the remaining documents, "Urban Hydrology for Small Watersheds" presented an average rate of 0.025 inches per hour, which is very similar to the 0.03 inches per hour average presented in other documents. "Minnesota Stormwater Manual" presented a range that averaged to 0.1 inches per hour. This rate would be much higher than the rates suggested by other documents, and therefore, was not factored into the rate used in this analysis.

Based on these sources, and a Type D soil classification, the average infiltration rate utilized for pond areas in the analysis is 0.03 inches per hour.

Other Infiltration Considerations

General observations by City Staff support the 0.03 inches per hour rate used in this analysis. Most of the reviewed documents suggest that infiltration rates are increased when the air temperature is increased and decreased when soils are frozen. Due to these reasons, the infiltration rates within pond areas have been limited to 8 months of the year (240 days) for the purposes of this analysis.

Variability of infiltration rates is anticipated throughout the City. To account for areas where infiltration may not occur, and to apply a conservative

estimate to the infiltration occurring in ponds, the estimated infiltration volumes have been multiplied by 75% for the purposes of this analysis.

3. **Total Phosphorus (TP) Removal Rate**
   This analysis considers that newly created ponds will retain 60% of TP loads prior to discharging downstream. This TP removal rate is supported by information presented in "Phosphorus Removal by Urban Runoff Detention Basins" (Walker, **Appendix H**). Figure 5 in the document indicates that basins built to the NURP design standards that average four feet in depth provide TP removal efficiencies of 60% or greater. In addition, observations of water quality models support that NURP ponds are typically able to achieve a 60% TP removal rate. Therefore, the 60% removal rate used in the nondegradation report is a sensible value to use.

4. **Total Suspended Solids (TSS) Removal Rate**
   This analysis considers that newly created ponds will retain 85% of TSS loads prior to discharging downstream. This TSS removal rate is supported by information presented in "Phosphorus Removal by Urban Runoff Detention Basins" (**Appendix H**). Figure 2 in the document indicates that basins built to the NURP design standards that average 3.5 feet in depth provide TSS removal efficiencies of greater than 85%. In addition, observations of water quality models support that NURP ponds are typically able to achieve an 85% TSS removal rate. Therefore, the 85% removal rate used in the nondegradation report is a sensible value to use.

- **Other BMPs**
  In addition to storm water ponds, other BMPs may reduce volumes of runoff and pollutant loadings within the City. Some common BMPs that exist in the City are infiltration areas, sump catch basins, street sweeping, restrictions on phosphorus fertilizer, and vegetated buffers. These BMPs further reduce annual runoff volumes and pollutant loading discharges for present and future conditions and are discussed in the results of the loading assessment provided in **Section IV.**

Step 9. Estimate and compare annual runoff and pollutant loadings of each land use based on BMP treatments provided.

Runoff volumes and pollutant loadings leaving the site were estimated by taking the pollutant loading determined in **Step 5** and applying BMP removal efficiencies for BMPs that were determined in **Step 8**.

Pollutant loads and runoff volumes leaving the site were then compared for 1990 and present conditions. Based on this comparison, if there was no increase in runoff volumes or pollutant loading, it is considered that the nondegradation standard has been met. For areas where there was an increase, the analysis continued on to **Step 10**.

Step 10: Complete 2006 - 2020 Analysis

For all areas of the City where land use change is projected between 2006 and 2020, soil types, impervious surface mapping, land use and rainfall/runoff relationships were utilized to determine runoff volumes relative to land use change. The methods used for this were the same as those used for the 1990 to 2006 analysis described in **Steps 1 to 3**.

Once the new runoff volumes were determined, the event mean concentrations specified in **Step 5** were used to generate pollutant loadings on a per acre basis. These loadings were then used to estimate the pollutant loadings for 2006 to 2020 conditions in the same manner as calculated for 1990 to 2006 conditions outlined in **Step 6**.

BMPs identified and described in **Step 8** were then used to determine the projected changes in runoff volume, total phosphorus, and TSS loading for the period projected between 2006 and 2020.

Step 11: Determine impact on specific water bodies.

This step determined if an increase in runoff volumes, phosphorus loads or TSS loads was estimated to have occurred or projected to occur between 1990 and 2020 within major bodies of water or impaired waters within the City.

It is the intent of the Nondegradation Report to meet the MPCA's nondegradation requirements on a City-wide basis. However, this step may be useful in determining the origination of pollutants by watershed and may be utilized for future TMDL planning efforts.

Step 12: Develop mitigation plan.

For the areas where an increase in runoff volumes or pollutant loadings is estimated to have occurred or projected to occur from 1990 to 2020 under the City's current policies, a mitigation plan was developed to address the impact in conformance with the NPDES Phase II program. This plan included determining if action was necessary to mitigate impacts or if impacts would be managed in existing City policies.

If it was determined that new policies were necessary to mitigate impacts, new stormwater management policies and BMPs were identified to reduce impacts that have, or are projected to occur. This mitigation plan is provided in **Section V.**