This appendix presents data and methodologies for using the Simple Method (Schueler, 1987) to estimate pollutant load from a site or drainage area. This appendix is meant for planning purposes only, and should not be used for SMP design.

The Simple Method estimates stormwater runoff pollutant loads for urban areas. The technique requires a modest amount of information, including the subwatershed drainage area and impervious cover, stormwater runoff pollutant concentrations, and annual precipitation. With the Simple Method, the investigator can either break up land use into specific areas, such as residential, commercial, industrial, and roadway and calculate annual pollutant loads for each type of land, or utilize more generalized pollutant values for urban runoff. It is also important to note that these values may vary depending on other variables such as the age of development.

The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as:

$$L = 0.226 * R * C * A$$

Where:
L = Annual load (lbs)
R = Annual runoff (inches)
C = Pollutant concentration (mg/l)
A = Area (acres)
0.226 = Unit conversion factor

For bacteria, the equation is slightly different, to account for the differences in units. The modified equation for bacteria is:

$$L = 103 * R * C * A$$

Where:
L = Annual load (Billion Colonies)
R = Annual runoff (inches)
C = Bacteria concentration (1,000/ ml)
A = Area (acres)
103 = Unit conversion factor

A.1 Pollutant Concentrations

Stormwater pollutant concentrations can be estimated from local or regional data, or from national data sources. Table A.1 presents typical concentration data for pollutants in urban stormwater.

Table A.1 National Median Concentrations for Chemical Constituents in Stormwater

Constituent	Units	Urban Runoff
TSS	mg/l	54.5[1]
TP	mg/l	0.26[1]
TN	mg/l	2.00[1]
Cu	ug/l	11.1[1]
Pb	ug/l	50.7[1]
Zn	ug/l	129[1]
F Coli	1,000 col/ ml	1.5[2]

Source:
1: Pooled NURP/USGS (Smullen and Cave, 1998)
2: Schueler (1999)

In addition, some source areas appear to be particularly important for some pollutants. Table A.2 summarizes these data for several key source areas. It is important to note that, because the Simple Method computes runoff based on an impervious area fraction, it cannot be easily used to isolate pervious sources, such as lawns. However, a user can evaluate particular hotspots, such as auto recyclers, separately. In addition, a composite runoff concentration can be developed based on the fraction of lawn, driveway, and roof on a residential site, for example.

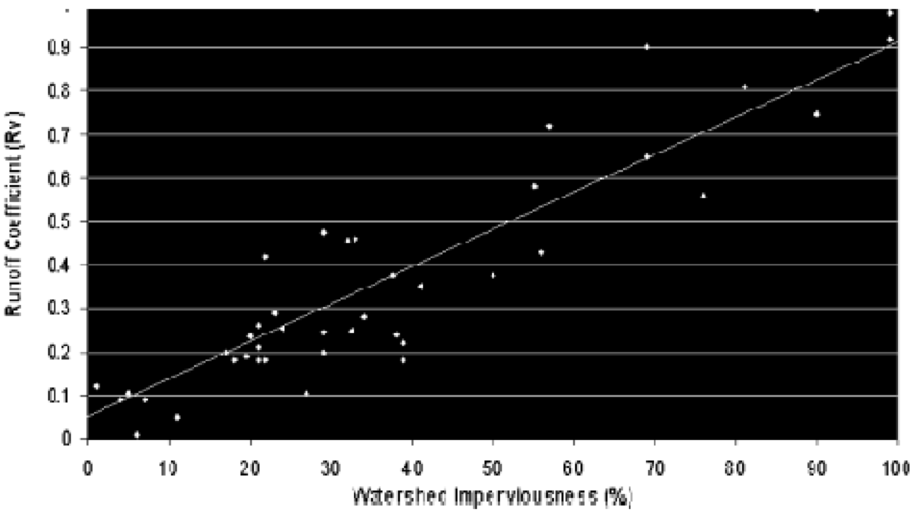
Table A.2 Pollutant Concentrations from Source Areas							
Constituent	**TSS[1]**	**TP[2]**	**TN[3]**	**F Coli[1]**	**Cu[1]**	**Pb[1]**	**Zn[1]**
	mg/l	mg/L	mg/l	1,000 col/ ml	ug/l	ug/l	ug/l
Resid Roof	19	0.11	1.5	0.26	20	21	312
Comm Roof	9	0.14	2.1	1.1	7	17	256
Indust Roof	17	-	-	5.8	62	43	1,390
C/R Parking	27	0.15	1.9	1.8	51	28	139
Indust Parking	228	-	-	2.7	34	85	224
Res Street	172	0.55	1.4	37	25	51	173
Comm Street	468	-	-	12	73	170	450
Rural Highway	51	-	22	-	22	80	80
Urban Highway	142	0.32	3.0	-	54	400	329
Lawns	602	2.1	9.1	24	17	17	50
Landscaping	37	-	-	94	94	29	263
Driveway	173	0.56	2.1	17	17	-	107
Gas Station	31	-	-	-	88	80	290
Auto Recycler	335	-	-	-	103	182	520
Heavy Industrial	124	-	-	-	148	290	1600

1: Claytor and Schueler (1996)

2: Average of Steuer et al. (1997),Bannerman (1993) and Waschbusch (2000)

3: Steuer et al. (1997)

Figure A.1 Relationship Between Watershed Imperviousness and the Stormwater Runoff Coefficient



A.2 Annual Runoff

The Simple Method calculates annual runoff as a product of annual runoff volume, and a runoff coefficient (Rv). Runoff volume is calculated as:

$$\mathbf{R = P * P_j * Rv}$$

Where:
- R = Annual runoff (inches)
- P = Annual rainfall (inches)
- P_j = Fraction of annual rainfall events that produce runoff (usually 0.9)
- Rv = Runoff coefficient

In the Simple Method, the runoff coefficient is calculated based on impervious cover in the subwatershed. This relationship is shown in Figure A.1. Although there is some scatter in the data, watershed imperviousness does appear to be a reasonable predictor of Rv.

The following equation represents the best fit line the dataset (N=47, R^2=0.71).

$$\mathbf{Rv=0.05+0.9Ia}$$

Where: Ia = Impervious fraction

A.3 Impervious Cover Data

The Simple Method uses different impervious cover values for separate land uses within a subwatershed. Representative impervious cover data, are presented in Table A.3. These numbers are derived from a recent study conducted by the Center for Watershed Protection under a grant from the U.S. Environmental Protection Agency to update impervious cover estimates for a variety of land uses. (Cappiella and Brown, 2001). In addition, some jurisdictions may have detailed impervious cover information if they maintain a detailed land use/land cover GIS database.

Table A.3 Land Use and Impervious Cover Estimates

Land Use Category	Mean Impervious Cover
Agriculture	**2**
Open Urban Land*	**9**
2 Acre Lot Residential	**11**
1 Acre Lot Residential	**14**
1/2 Acre Lot Residential	**21**
1/4Acre Lot Residential	**28**
1/8 Acre Lot Residential	**33**
Townhome Residential	**41**
Multifamily Residential	**44**
Institutional**	**31-38%**
Light Industrial	**50-56%**
Commercial	**70-74%**

* Open urban land includes developed park land, recreation areas, golf courses, and cemeteries.

** Institutional is defined as places of worship, schools, hospitals, government offices, and police and fire stations

A.4 Limitations of the Simple Method

The Simple Method should provide reasonable estimates of changes in pollutant export resulting from urban development activities. However, several caveats should be kept in mind when applying this method.

The Simple Method is most appropriate for assessing and comparing the relative stormflow pollutant load changes of different land use and stormwater management scenarios. The Simple Method provides estimates of storm pollutant export that are probably close to the "true" but unknown value for a development site, catchment, or subwatershed. However, it is very important not to over emphasis the precision of the results obtained. For example, it would be inappropriate to use the Simple Method to evaluate relatively similar development scenarios (e.g., 34.3% versus 36.9% Impervious cover). The simple method provides a general planning estimate of likely storm pollutant export from areas at the scale of a development site, catchment or subwatershed. More sophisticated modeling may be needed to analyze larger and more complex drainages.

In addition, the Simple Method only estimates pollutant loads generated during storm events. It does not consider pollutants associated with baseflow volume. Typically, baseflow is negligible or non-existent at the scale of a single development site, and can be safely neglected, unless wastewater sources such as illicit connections and wastewater treatment plans are significant. However, catchments and subwatersheds do generate baseflow volume. Pollutant loads in baseflow are generally low and can seldom be distinguished from natural background levels (NVPDC, 1980). Consequently, baseflow pollutant loads normally constitute only a small fraction of the total pollutant load delivered from an urban area. Nevertheless, it is important to remember that the load estimates refer only to storm event derived loads and should not be confused with the total pollutant load from an area. This is particularly important when the development density of an area is low. For example, in a large low density residential subwatershed (Imp. Cover < 5%), as much as 75% of the annual runoff volume may occur as baseflow. In such a case, the annual baseflow nutrient load may be equivalent to the annual stormflow nutrient load.

A.5 SMP Pollutant Removal

The removal efficiencies of various SMP practices also help determine final annual pollutant loads. Table A.4 provides estimates of the average pollutant removal efficiency of the five SMP categories.

Table A.4. Suggested Removal Rates for SMPs

	TSS	TP	TN	Metals[1]	Bacteria
Wet Ponds	80	50 (51)	35 (33)	60 (62)	70
Stormwater Wetlands	80[2] (76)	50 (49)	30	40 (42)	80 (78)
Filtering Practices	85 (86)	60 (59)	40 (38)	70 (69)	35 (37)
Infiltration Practices [4]	90[3] (95)	70	50 (51)	90[3] (99)	90[4]
Water Quality Swales	85 (84)	40 (39)	50[5] (84)	70	0 (-25)[6]

1. Average of zinc and copper. Only zinc for infiltration
2. Many wetland practices in the database were poorly designed, and we consequently adjusted sediment removal upward.
3. It is assumed that no practice is greater than 90% efficient.
4. Data inferred from sediment removal.
5. Actual data is based on only two highly performing practices.
6. Assume 0 rather than a negative removal.

Note: Data in parentheses represent median pollutant removal data reported in the *National Pollutant Removal Database - Revised Edition* (Winer, 2000). These data were adjusted for convenience and to reflect biases in the data.

These efficiencies represent ideal pollutant removal rates that cannot be achieved at all sites, or at a watershed level. Typically, they need to be "discounted" to account for site constraints, and other factors that reduce practice efficiency. For example, the removal rate should be adjusted to reflect the fraction of runoff captured by a practice on an annual basis (90% if this guidance is followed). For more detail on how to apply these discounts, consult Caraco (2001).

One particularly important consideration is how to account for practices applied in series (e.g., two ponds applied in sequence). If the volume within the practices adds up to the total water quality volume, they are assumed to act as a single practice with that volume. Otherwise, total pollutant removal should be determined by the following equation:

$$R = L\,[(E_1)+(1- E_1)E_2+(1-((E_1)+(1- E_1)E_2)E_3+\ldots]$$

Where:

R = Pollutant Removal (lbs)

L = Annual Load from Simple Method (lbs.)

E_i = Efficiency of the ith practice in a series

Another adjustment can be made to these removals to account for loss of effectiveness and "irreducible concentrations." Evidence suggests that, at low concentrations, SMPs can no longer remove pollutants.

Table A.5 depicts typical outflow concentrations for various SMPs. Another simplified way to account for this phenomenon is to reduce the efficiency of a second or third practice in a series. For example, the removal efficiency could be cut in half to reflect inability to remove fine particles.

Table A.5. Typical SMP Effluent Concentrations

	TSS	TP	TN	Cu	Zn
Wet Ponds	17	0.11	1.3	5.0	30
Wetlands	22	0.20	1.7	7.0	31
Filtering Practices	11	0.10	1.12	10	21
Infiltration Practices	17[2]	0.05[2]	3.8[2]	4.8[2]	39[2]
Open Channel Practices	14	0.19	1.12	10	53

1. Units for Zn and Cu are micrograms per liter
2. Data based on fewer than five data points

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