Attachment 5

Precipitation Analysis

Stormceptor®

HYDROLOGY ANALYSIS

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of the Stormceptor System are based on the average annual removal of TSS for the selected site parameters.

Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

Rainfall Station

Rainfall Station	CHICAGO OHARE AP		
Rainfall File Name	IL1549.NDC	Total Number of Events	7233
Latitude	41°59'42"N	Total Rainfall (in.)	1490.1
Longitude	87°56'1"W	Average Annual Rainfall (in.)	33.9
Elevation (ft)		Total Evaporation (in.)	160.6
Rainfall Period of Record (y)	1962 - 2005	Total Infiltration (in.)	0.0
Total Rainfall Period (y)	44	Percentage of Rainfall that is Runoff (%)	92.2

Rainfall Event Analysis with Cumulative Totals

Rainfall Depth	No. of Events	Percentage of Total Events		Total Volume	Percentage of Annual Volume	
in.		%	Cumul.%	in.	%	Cumul.%
0.25	5605	77.5	77.5	345	23.1	23.1
0.50	771	10.7	88.2	278	18.7	41.8
0.75	370	5.1	93.3	229	15.4	57.2
1.00	195	2.7	96.0	169	11.3	68.5
1.25	109	1.5	97.5	122	8.2	76.7
1.50	72	1.0	98.5	98	6.6	83.3
1.75	35	0.5	99.0	57	3.8	87.1
2.00	17	0.2	99.2	32	2.1	89.2
2.25	18	0.2	99.4	38	2.6	91.8
2.50	12	0.2	99.6	28	1.9	93.7
2.75	8	0.1	99.7	21	1.4	95.1
3.00	5	0.1	99.8	14	1.0	96.1
3.25	4	0.1	99.9	12	0.8	96.9
3.50	4	0.1	100.	14	0.9	97.8
3.75	3	0.0	100.	11	0.7	98.5
4.00	1	0.0	100.	4	0.3	98.8
4.25	1	0.0	100.	4	0.3	99.1
4.50	2	0.0	100.	9	0.6	99.7
4.75	0	0.0	100.	0	0.0	99.7
5.00	0	0.0	100.	0	0.0	99.7
5.25	0	0.0	100.	0	0.0	99.7
5.50	0	0.0	100.	0	0.0	99.7
5.75	0	0.0	100.	0	0.0	99.7
6.00	1	0.0	100.	6	0.4	100.
6.25	0	0.0	100.	0	0.0	100.
6.50	0	0.0	100.	0	0.0	100.
6.75	0	0.0	100.	0	0.0	100.
7.00	0	0.0	100.	0	0.0	100.
7.25	0	0.0	100.	0	0.0	100.
7.50	0	0.0	100.	0	0.0	100.
7.75	0	0.0	100.	0	0.0	100.
8.00	0	0.0	100.	0	0.0	100.
8.25	0	0.0	100.	0	0.0	100.
>8.25	0	0.0	100.	0	0.0	100.

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Stormceptor®

HYDROLOGY ANALYSIS

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of the Stormceptor System are based on the average annual removal of TSS for the selected site parameters.

Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

Rainfall Station

Rainfall Station	CHICAGO MIDWAY AP 3SW		
Rainfall File Name	IL1577.NDC	Total Number of Events	8735
Latitude	41°44'14"N	Total Rainfall (in.)	1968.1
Longitude	87°46'39"W	Average Annual Rainfall (in.)	33.9
Elevation (ft)	620	Total Evaporation (in.)	183.7
Rainfall Period of Record (y)	1948 - 2005	Total Infiltration (in.)	0.0
Total Rainfall Period (y)	58	Percentage of Rainfall that is Runoff (%)	93.7

Rainfall Event Analysis

Rainfall Depth	No. of Events	Percentage of Total Events		Total Volume	Percentage of Annual Volume	
in.		%	Cumul.%	in.	%	Cumul.%
0.25	6677	76.4	76.4	536	27.2	27.2
0.50	1047	12.0	88.4	381	19.4	46.6
0.75	408	4.7	93.1	253	12.9	59.5
1.00	261	3.0	96.1	228	11.6	71.1
1.25	119	1.4	97.5	134	6.8	77.9
1.50	87	1.0	98.5	120	6.1	84.0
1.75	35	0.4	98.9	57	2.9	86.9
2.00	35	0.4	99.3	66	3.3	90.2
2.25	11	0.1	99.4	23	1.2	91.4
2.50	14	0.2	99.6	33	1.7	93.1
2.75	11	0.1	99.7	29	1.5	94.6
3.00	12	0.1	99.8	35	1.8	96.4
3.25	1	0.0	99.8	3	0.2	96.6
3.50	3	0.0	99.8	10	0.5	97.1
3.75	3	0.0	99.8	11	0.5	97.6
4.00	6	0.1	99.9	23	1.2	98.8
4.25	0	0.0	99.9	0	0.0	98.8
4.50	0	0.0	99.9	0	0.0	98.8
4.75	3	0.0	99.9	14	0.7	99.5
5.00	0	0.0	99.9	0	0.0	99.5
5.25	0	0.0	99.9	0	0.0	99.5
5.50	0	0.0	99.9	0	0.0	99.5
5.75	0	0.0	99.9	0	0.0	99.5
6.00	0	0.0	99.9	0	0.0	99.5
6.25	1	0.0	100.	6	0.3	99.8
6.50	0	0.0	100.	0	0.0	99.8
6.75	1	0.0	100.	7	0.3	100.
7.00	0	0.0	100.	0	0.0	100.
7.25	0	0.0	100.	0	0.0	100.
7.50	0	0.0	100.	0	0.0	100.
7.75	0	0.0	100.	0	0.0	100.
8.00	0	0.0	100.	0	0.0	100.
8.25	0	0.0	100.	0	0.0	100.
>8.25	0	0.0	100.	0	0.0	100.

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Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

OK-110 (sand only)								
Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s
1	0	2.65	0.0012					
53	3	2.65	0.0083					
75	15	2.65	0.0133					
88	25	2.65	0.0180					
106	40.8	2.65	0.0254					
125	15	2.65	0.0343					
150	1	2.65	0.0475					

Figure 1. Particle Size Distribution for 10 ac, 100% impervious. Pollutant load based on OK-110 (sand only) as charted above.

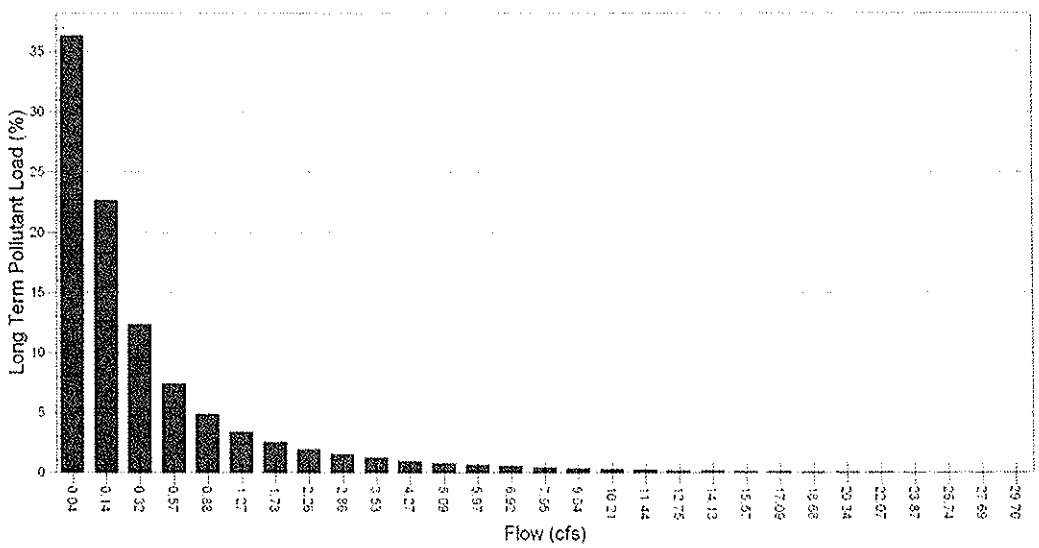


Figure 2. Long Term Pollutant Load by Flow Rate for CHICAGO OHARE AP – 1549, 1962 to 2005 for 10 ac, 100% impervious. The majority of the annual pollutant load is transported by small frequent storm events. Conversely, large infrequent events carry an insignificant percentage of the total annual pollutant load.

Stormceptor®

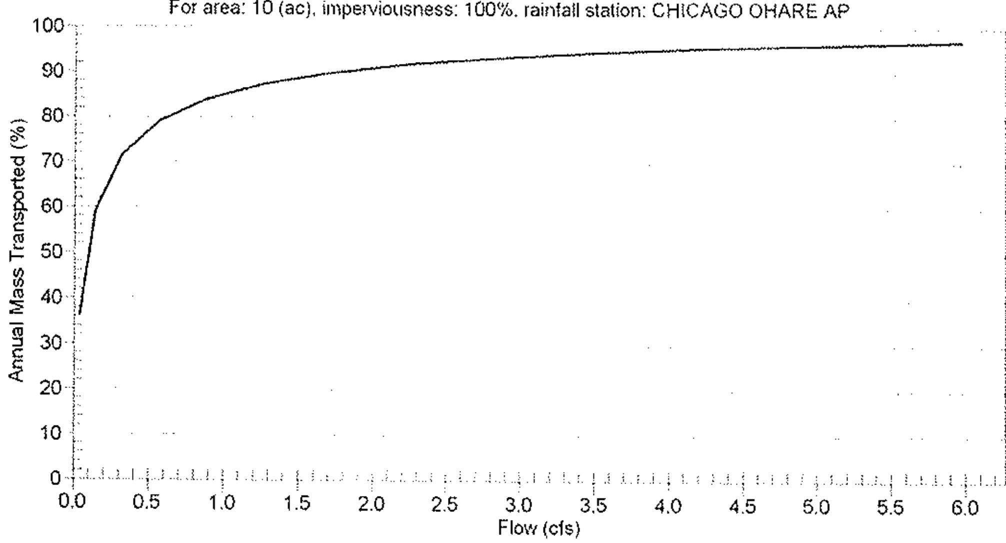
Pollutograph

"OK-110"

Flow Rate cfs	Influent Mass ton	Effluent Mass ton	Total Mass ton	Cumulative Mass %
0.035	8.2819	14.4573	22.7007	36.5
0.141	13.4466	9.2829	22.7007	59.2
0.318	16.2591	6.4713	22.7007	71.6
0.565	17.9465	4.7817	22.7007	79.1
0.883	19.0542	3.6663	22.7007	83.9
1.271	19.8319	2.8842	22.7007	87.4
1.73	20.4083	2.3034	22.7007	89.9
2.26	20.8516	1.8579	22.7007	91.9
2.86	21.2025	1.5048	22.7007	93.4
3.531	21.4841	1.2232	22.7007	94.6
4.273	21.7118	0.9955	22.7007	95.6
5.085	21.8933	0.8118	22.7007	96.4
5.968	22.0429	0.6622	22.7007	97.1
6.922	22.1661	0.5379	22.7007	97.6
7.946	22.2673	0.4356	22.7007	98.1
9.041	22.3487	0.3531	22.7007	98.4
10.206	22.4136	0.2871	22.7007	98.7
11.442	22.4675	0.2332	22.7007	99.0
12.749	22.5104	0.1903	22.7007	99.2
14.126	22.5467	0.154	22.7007	99.3
15.574	22.5753	0.1254	22.7007	99.4
17.092	22.5995	0.1012	22.7007	99.6
18.681	22.6204	0.0803	22.7007	99.6
20.341	22.6358	0.0649	22.7007	99.7
22.072	22.6479	0.0528	22.7007	99.8
23.873	22.6578	0.0429	22.7007	99.8
25.744	22.6655	0.0352	22.7007	99.8
27.687	22.6721	0.0286	22.7007	99.9
29.7	22.6776	0.0231	22.7007	99.9
31.783	22.682	0.0187	22.7007	99.9

Cumulative Mass Transported by Flow Rate

For area: 10 (ac), imperviousness: 100%, rainfall station: CHICAGO OHARE AP



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Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)								
Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s
20	20	1.3	0.0013					
60	20	1.8	0.0051					
150	20	2.2	0.0354					
400	20	2.65	0.2123					
2000	20	2.65	0.9417					

Figure 1. Particle Size Distribution for 10 ac, 100% impervious. Pollutant load based on EPA's ETV "FINE" as charted above.

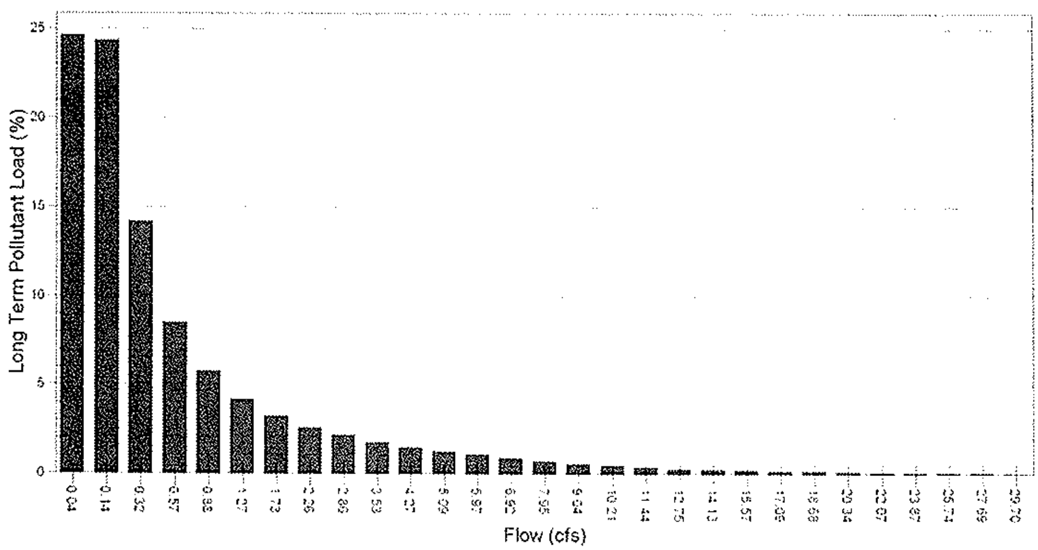


Figure 2. Long Term Pollutant Load by Flow Rate for CHICAGO OHARE AP – 1549, 1962 to 2005 for 10 ac, 100% impervious. The majority of the annual pollutant load is transported by small frequent storm events. Conversely, large infrequent events carry an insignificant percentage of the total annual pollutant load.

Stormceptor®

Pollutograph

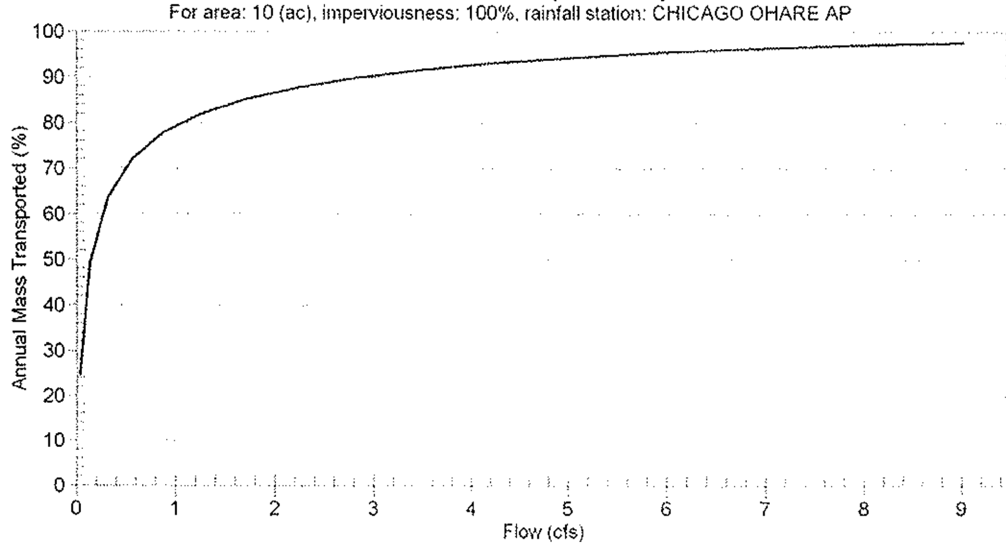
"Fine" EPA's ETV (recommended)

Flow Rate cfs	Influent Mass ton	Effluent Mass ton	Total Mass ton	Cumulative Mass %
0.035	116.9762	357.1007	472.4555	24.8
0.141	232.507	241.3642	472.4555	49.2
0.318	299.7841	173.9991	472.4555	63.5
0.565	340.1035	133.2716	472.4555	72.0
0.883	367.4242	105.7056	472.4555	77.8
1.271	387.2297	85.6955	472.4555	82.0
1.73	402.4999	70.2812	472.4555	85.2
2.26	414.7154	58.0096	472.4555	87.8
2.86	424.8178	47.8467	472.4555	89.9
3.531	433.1778	39.4526	472.4555	91.7
4.273	440.1771	32.4049	472.4555	93.2
5.085	446.0742	26.4616	472.4555	94.4
5.968	451.1111	21.4269	472.4555	95.5
6.922	455.2933	17.2403	472.4555	96.4
7.946	458.7132	13.8006	472.4555	97.1
9.041	461.4643	11.0396	472.4555	97.7
10.206	463.6148	8.8792	472.4555	98.1
11.442	465.3352	7.1368	472.4555	98.5
12.749	466.7124	5.7552	472.4555	98.8
14.126	467.8597	4.609	472.4555	99.0
15.574	468.798	3.6652	472.4555	99.2
17.092	469.568	2.8985	472.4555	99.4
18.681	470.1851	2.2781	472.4555	99.5
20.341	470.668	1.7864	472.4555	99.6
22.072	471.0343	1.4223	472.4555	99.7
23.873	471.3192	1.1341	472.4555	99.8
25.744	471.5436	0.9108	472.4555	99.8
27.687	471.7295	0.7249	472.4555	99.8
29.7	471.8824	0.5698	472.4555	99.9
31.783	472.0122	0.4411	472.4555	99.9

→ per 44 yrs

Cumulative Mass Transported by Flow Rate

For area: 10 (ac), imperviousness: 100%, rainfall station: CHICAGO OHARE AP



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Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

NJDEP (clay, silt, sand)								
Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s
1	5	2.65	0.0012					
4	15	2.65	0.0012					
29	25	2.65	0.0025					
75	15	2.65	0.0133					
175	30	2.65	0.0619					
375	5	2.65	0.1953					
750	5	2.65	0.4266					

Figure 1. Particle Size Distribution for 10 ac, 100% impervious. Pollutant load based on LEED recognized TARP protocol NJDEP as charted above.

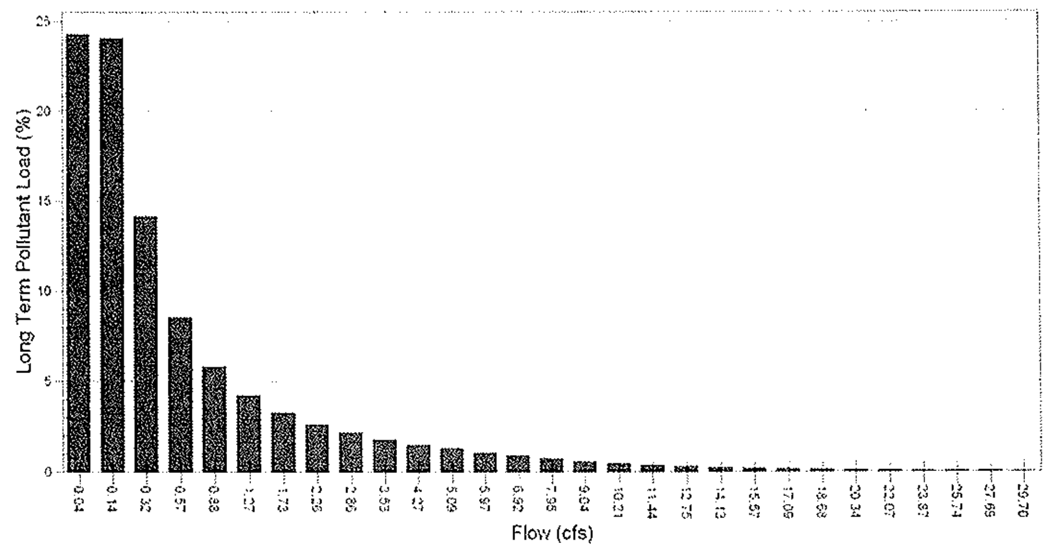

Figure 2. Long Term Pollutant Load by Flow Rate for CHICAGO OHARE AP – 1549, 1962 to 2005 for 10 ac, 100% impervious. The majority of the annual pollutant load is transported by small frequent storm events. Conversely, large infrequent events carry an insignificant percentage of the total annual pollutant load.

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Stormceptor®

Pollutograph

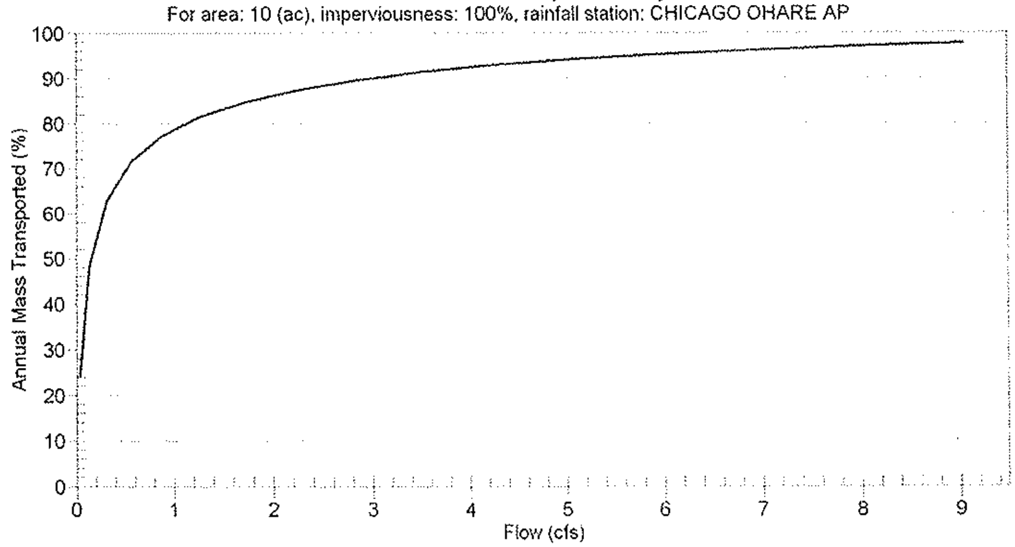
"NJDEP" as used in TARP (LEED approved)

Flow Rate cfs	Influent Mass ton	Effluent Mass ton	Total Mass ton	Cumulative Mass %
0.035	27.8366	86.6393	114.0755	24.4
0.141	55.4004	59.0304	114.0755	48.6
0.318	71.6133	42.8021	114.0755	62.8
0.565	81.4242	32.9054	114.0755	71.4
0.883	88.1056	26.1646	114.0755	77.2
1.271	92.9731	21.2465	114.0755	81.5
1.73	96.7362	17.4471	114.0755	84.8
2.26	99.7447	14.4144	114.0755	87.4
2.86	102.2417	11.902	114.0755	89.6
3.531	104.3053	9.8241	114.0755	91.4
4.273	106.0411	8.0795	114.0755	93.0
5.085	107.5063	6.6066	114.0755	94.2
5.968	108.7427	5.3625	114.0755	95.3
6.922	109.7822	4.323	114.0755	96.2
7.946	110.6237	3.4705	114.0755	97.0
9.041	111.3068	2.7819	114.0755	97.6
10.206	111.8447	2.2418	114.0755	98.0
11.442	112.2792	1.804	114.0755	98.4
12.749	112.6235	1.4575	114.0755	98.7
14.126	112.9084	1.1715	114.0755	99.0
15.574	113.1438	0.935	114.0755	99.2
17.092	113.3385	0.7425	114.0755	99.4
18.681	113.4958	0.5841	114.0755	99.5
20.341	113.6212	0.4587	114.0755	99.6
22.072	113.7125	0.3663	114.0755	99.7
23.873	113.7862	0.2926	114.0755	99.7
25.744	113.8412	0.2365	114.0755	99.8
27.687	113.8885	0.1892	114.0755	99.8
29.7	113.9281	0.1496	114.0755	99.9
31.783	113.9611	0.1166	114.0755	99.9

→ per 44 yrs

Cumulative Mass Transported by Flow Rate

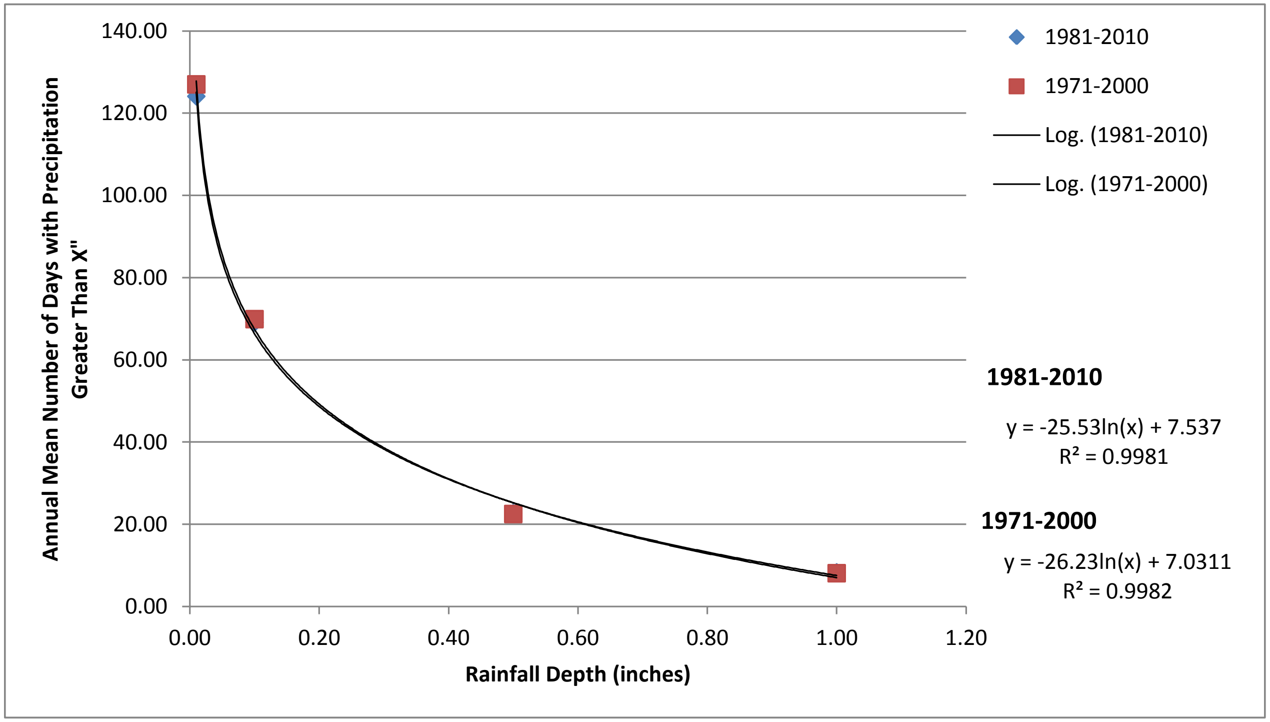
For area: 10 (ac), imperviousness: 100%, rainfall station: CHICAGO OHARE AP



Rainfall Depth, X (inches)	Annual Mean Number of Days with Precipitation Greater Than X"		Percent of Events Annually with Less Than X"	
	1981-2010	1971-2010	1981-2010	1971-2000
0.01	124.10	127.00	0.00%	0.00%
0.10	69.10	69.90	44.32%	44.96%
0.50	22.70	22.50	81.71%	82.28%
0.75[a]	14.88	14.64	88.01%	88.47%
1.00	8.30	8.10	93.31%	93.62%
1.25[a]	1.84	1.24	98.52%	99.03%

[a] The annual mean number of days with precipitation greater than 0.75" and 1.25" was interpolated using the regression equations below.

[b] The percent of events annually less than X", assumes that the annual mean number of events is equal to the number of events greater than 0.01" per year.



Water Quality Analysis of Elgin O'Hare–West Bypass Project

PREPARED BY: CH2M HILL

DATE: February 15, 2012

The Elgin O'Hare – West Bypass (EO-WB) project has been evaluated to determine the potential effects stormwater runoff may have on water quality in area waterways. The water quality in area waterways was analyzed using recommended approaches contained in the Illinois Department of Transportation's *Bureau of Design and Environment Manual, Chapter 26 Special Environmental Analyses* (IDOT, 2010). Changes in water quality attributable to total suspended solids (TSS) and metals (copper, lead, zinc) were evaluated using the methodology outlined in the Federal Highway Administration's *Pollutant Loadings and Impacts from Highway Stormwater Runoff Volume I: Design Procedure* (FHWA, 1990). The effect of chloride from deicing activities on water quality was made using the methodology outlined in the United States Geological Survey report developed by Frost, Pollock, and Wakelee (USGS, 1981). This memorandum outlines the use of the two methodologies, data sources, and findings. Chloride concentrations were subsequently evaluated further in a companion memo *Chloride Concentration Analysis,* which is included in Attachment 1.

Area of Interest

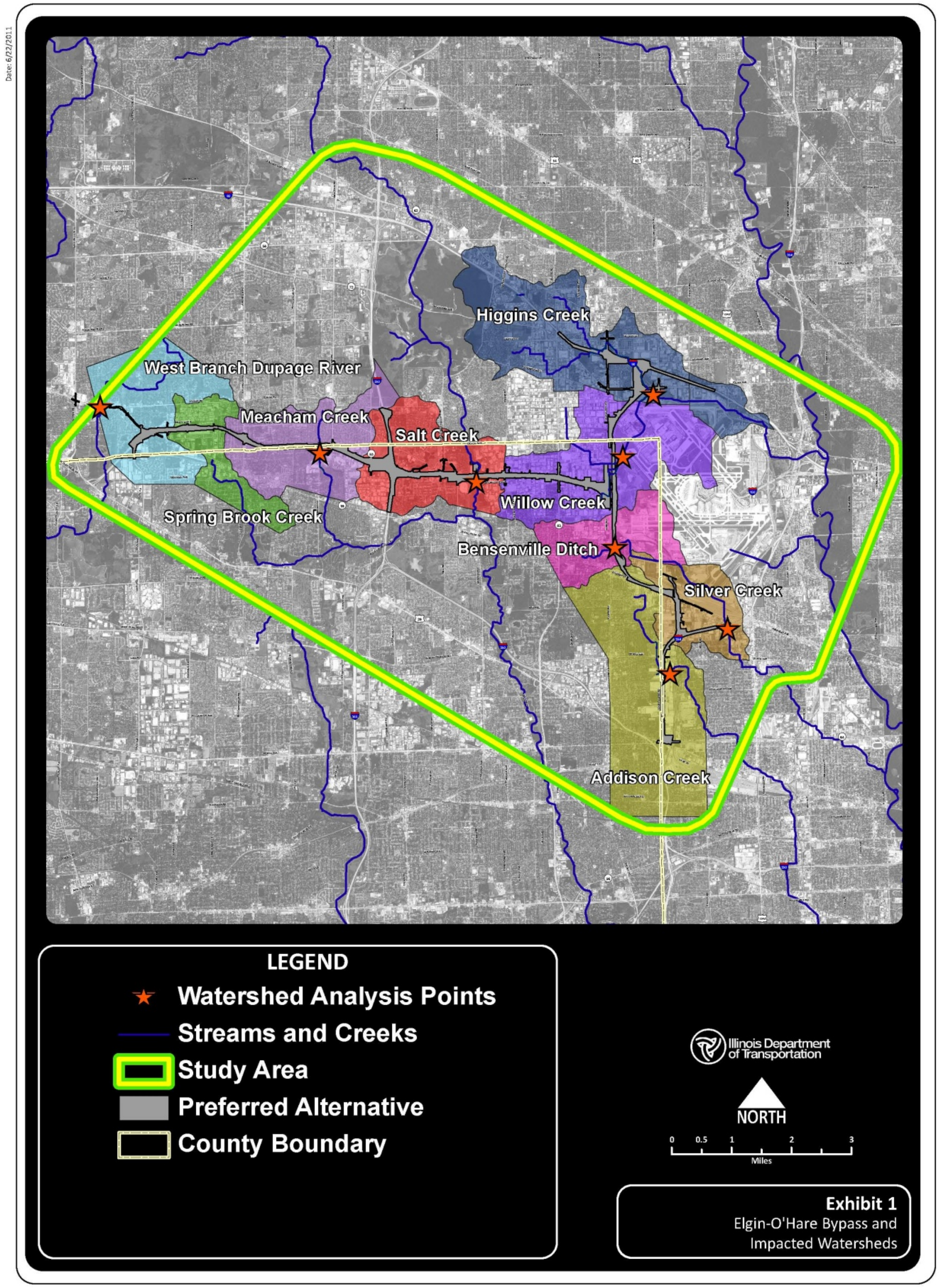
The EO-WB project crosses the following watersheds:

- West Branch DuPage River Watershed
  - West Branch DuPage River (main stem)
- Salt Creek Watershed
  - Spring Brook Creek
  - Meacham Creek
  - Salt Creek (main stem)
  - Addison Creek
- Des Plaines River Watershed
  - Higgins Creek
  - Willow Creek
  - Bensenville Ditch
  - Silver Creek

Exhibit 1 shows these watersheds within the EO-WB project area.

EXHIBIT 1

EO-WB and Impacted Watersheds



Background Data

The project study area is highly urbanized. The project results in an increase in impervious area within the study area and which varies from watershed to watershed. To put the additional impervious area into context, road lane-miles within the study area and individual watersheds were compared under existing conditions, a No-Build Alternative in which the EO-WB is not constructed but planned highway widening occurs, and the Build alternative (Table 1).

TABLE 1
Lane-Mile Changes in Project Area

Functional Class	2010 Existing Condition	2040 No-Build Condition	2040 Build Analysis
Freeway	421.3	445.9	642.7
Principal Arterial	414.7	414.7	393.9
Minor Arterial	496.1	496.1	504.9
Collector	278.5	278.5	309.1
Local Roads	1,140.0	1,140.0	1,140.0
Total	2,750.6	2,775.2	2,990.6
Increase from No-Build	NA	NA	215.4

The project results in a lane-mile increase of 7.2 percent across the study area. When looking at the individual watersheds shown in Exhibit 1, the lane-mile increase averaged 16.5 percent across all the watersheds, with individual watersheds having an increase in lane-miles ranging from 4 to 38 percent as shown in Table 2.

TABLE 2
Lane-Mile Increases in the Project Area

Watershed Name	2010 Existing Condition	2040 Build Total Lane Miles	Additional Lane Miles	Percentage Increase
West Branch DuPage River	161.4	168.1	6.7	4.2%
Spring Brook Creek	94.0	100.8	6.8	7.3%
Meacham Creek	206.2	228.3	22.0	10.7%
Salt Creek	153.7	204.2	50.6	32.9%
Willow Creek	130.2	179.5	49.3	37.9%
Higgins Creek	281.9	316.5	34.6	12.3%
Bensenville Ditch	90.9	106.3	15.4	16.9%
Silver Creek	70.4	93.6	23.2	32.9%
Addison Creek	293.4	329.1	35.7	12.2%
Total	1,482.1	1,726.4	244.3	16.5%

The study area is already significantly developed. For example, prior watershed studies have analyzed the West Branch DuPage River and Salt Creek watersheds. Overall, the West Branch DuPage River and Salt Creek watersheds were found to have 13 and 23 percent impervious area, respectively, with 49 and 75 percent urbanized area, respectively, based upon year 2000 land use data (CH2M HILL, 2003, 2004). Significant development in these watersheds has continued since that time. Land use within several watersheds affected by this project is shown in Table 3. With the level of development that has occurred in the watersheds, runoff is expected to exhibit storm water runoff pollution similar to other urbanized watersheds.

TABLE 3
Watershed Land Use Summary

	Watershed[a]									
	Addison Creek		Des Plaines River (main stem)		Salt Creek		West Branch DuPage River		Willow Creek	
Land Use	**acres**	**%**	**acres**	**%**	**acres**	**%**	**acres**	**%**	**acres**	**%**
Agricultural	0.6	0.0	46.4	0.1	295.9	0.6	940.6	4.4	69.6	0.5
Commercial	1,128.8	7.3	4,619.4	8.2	5,814.5	11.5	1,135.0	5.3	922.9	7.0
Industrial	2,466.4	16.0	4,371.1	7.8	2,448.6	4.9	296.6	1.4	5,071.1	38.3
Institutional	1,628.1	10.5	5,087.6	9.1	2,342.9	4.6	676.7	3.2	88.1	0.7
Open Space	1,021.7	6.6	7,170.4	12.8	9,237.2	18.3	4,670.3	22.0	652.7	4.9
Residential	7,233.4	46.8	28,879.8	51.4	24,464.7	48.5	11,047.9	51.9	1,525.8	11.5
Transportation	1,686.1	10.9	4,331.3	7.7	1,987.5	3.9	501.6	2.4	4,302.2	32.5
Vacant/ Wetlands/ Construction	237.3	1.5	1,050.7	1.9	2,636.9	5.2	1,521.5	7.2	559.4	4.2
Water	70.3	0.5	653.9	1.2	1,257.3	2.5	497.9	2.3	48.1	0.4

Source: CMAP, 2005

Note: Land use acreages are from CMAP and may vary from data provided by other sources found in other tables within this document.

[a] Includes the 12-digit HUC sub-watersheds that the project corridor is located in.

The additional lane-miles were evaluated by individual watershed. The analysis of each watershed included the drainage area tributary to each crossing, existing and proposed 2040 Build impervious areas within the highway right of way, and existing and proposed 2040 Build EO-WB lane miles within each watershed. Table 4 lists this information. Impervious areas within the project footprint for existing conditions were compared to the impervious area under the proposed 2040 Build condition. The water quality analysis was made at the farthest downstream crossing of each waterway.

Storm water pollution from urbanized watersheds has been summarized in A Compilation and Analysis of NPDES Stormwater Monitoring Information from The National Stormwater Quality Database, Version 1.1 (Center for Watershed Protection, 2005), which also reviewed several prior national studies. A summary of the urban stormwater runoff quality for TSS and metals is included in Table 5.

TABLE 4
Watershed Parameters

River	Drainage Area Tributary to Crossing (mi^2)	Highway Right-of-Way Impervious Area (acres)		Highway Lane Miles	
		2010 Existing Conditions[a]	2040 Build Conditions[b]	2010 Existing Conditions	2040 Build Conditions
Addison Creek	6.0	62.74	83.37	47.52	74.39
Silver Creek[c]	6.5	65.73	73.80	12.84	47.19
Bensenville Ditch	1.9	11.90	27.98	0.92	13.89
Willow Creek	6.0	98.35	163.06	0	50.29
Higgins Creek	7.0	121.76	184.59	44.87	78.99
Salt Creek	71	101.54	162.28	23.46	67.04
Meacham Creek	2.9	50.16	78.73	27.14	43.77
Spring Brook Creek[d]	0	19.16	23.70	6.21	11.34
West Branch DuPage River	4.5	31.82	37.87	6.89	10.62

[a] Total impervious area within the footprint of the proposed EO-WB 2040 Build
[b] Total impervious area of the EO-WB
[c] Silver Creek total highway miles includes upstream highway miles from Bensenville Ditch.
[d] For water quality analysis, the start of the IEPA stream layer was used for determining tributary area because Spring Brook Creek does not have a highway crossing.

TABLE 5
Urban Storm water Runoff Quality for TSS and Metals

Data Description	TSS (mg/L)	Copper, Total (mg/L)	Lead, Total (mg/L)	Zinc, Total (mg/L)
National Stormwater Database (average)	79	0.016	0.017	0.116
National Stormwater Database (maximum)	4,800	1.360	1.200	22.500
Prior study comparison range in National Stormwater Database (average)	78 to 174	0.0135 to 0.0666	0.0675 to 0.175	0.162 to 0.176

Based upon guidance provided in the Federal Highway Administration's *Pollutant Loadings and Impacts from Highway Stormwater Runoff Volume I: Design Procedure* (FHWA, 1990), a reasonable estimate of the soluble fraction of metals is suggested to be: 40 percent for copper, 10 percent for lead, and 40 percent for zinc. The analysis used in this memorandum calculates dissolved metal concentrations.

The water quality values to be calculated for the EO-WB project are expected to be higher for TSS and dissolved metals since they represent once in 3-year values instead of average values. As a result, the concentrations determined by this study are expected to be higher than the average values from those found in the National Stormwater Quality Database.

Data from numerous sources were used as inputs to the water quality analysis. In addition to the watershed- and project-specific data, other data such as precipitation data, flow data, water quality sampling data, and Illinois Environmental Protection Agency (IEPA) water quality criteria were used in the analysis.

Precipitation Data

Hourly precipitation data were from the NOAA Station 11-1549 gage at O'Hare airport. Historical data from June 1, 1962, through December 31, 2009, were available. The data were analyzed using the rainfall utility in the hydraulic modeling software XP-SWMM to determine individual storms within the period of record. The mean, standard deviation, and coefficient of variation were determined for the volume of rainfall, intensity, duration, and storm interval, all required inputs for the FHWA pollutant loading analysis procedure (FHWA, 1990). A 24-hour dry period was used as the minimum time between individual storms. Table 6 lists the precipitation parameters calculated from the historical rainfall data at O'Hare.

TABLE 6
Summary of Historical Rainfall

Parameter	Mean	Standard Deviation	Coefficient of Variation
Average volume (in.)	0.42	0.6	1.6
Average intensity (in./hr)	0.07	0.2	2.2
Average duration (hr)	14.1	19.4	1.4
Average interval (hr)	155.1	165.5	1.07

Because of the proximity of the project area to O'Hare airport, the precipitation data from the airport gage was used for the water quality analysis in all watersheds crossed by the project. For the chloride water quality analysis (USGS, 1981), the annual precipitation is needed. The annual precipitation for Station 11-1549 (O'Hare airport) is 36.27 inches. This average is based on historical data from 1971 through 2000.

Streamflow Data

Streamflow data were not available for specific rivers and creeks in the project area or for nearby sampling sites. Instead, streamflow data from several different USGS gages were used to determine the average flow rate per square mile for the area. Table 7 lists the USGS gages used in this analysis.

Water Quality Background Data

The Illinois Natural History Survey (INHS) conducted a series of two water quality sampling efforts for the project. The data obtained were used to determine background concentrations within the rivers for the analysis. Others also have conducted water quality sampling efforts within these watersheds. Some of the data available include data collected by the IEPA, the Metropolitan Water Reclamation District of Greater Chicago, and the DuPage River Salt Creek Workgroup. The Workgroup has conducted conductivity/chloride measurements on the West Branch DuPage River and Salt Creek, and other watersheds in the area. The Workgroup has actively sought to document chloride concentrations in the watersheds throughout the year, but especially during winter months when road deicing material contributes chlorides to the watersheds. A study in the 2007/2008 winter found chloride concentrations in winter months frequently exceeded the 500 mg/L water quality standard (CDM, 2008).

TABLE 7
Summary of USGS Gage Data

Gage	Location	Drainage Area (miles^2)	Average Annual Flow (cfs)	Average Annual Flow (cfs) / Drainage Area (miles^2)	Coefficient of Variation
5539900	West Branch Du Page River near West Chicago, IL	28.5	45.44[a]	1.59	1.35
5540275	Spring Brook at 87th Street near Naperville, IL	9.9	11.35 [b]	1.15	2.25
5530990	Salt Creek at Rolling Meadows, IL	30.5	33.63 [c]	1.10	1.98
5531044	Salt Creek near Elk Grove Village, IL	51.9	57.98 [d]	1.12	1.88
5531300	Salt Creek at Elmhurst, IL	91.5	149.71 [e]	1.64	1.13
5532000	Addison Creek at Bellwood, IL	17.9	21.38 [f]	1.19	1.47
		Average	**53.25**	**1.30**	**1.68**

[a] Data available from July 27, 1961, through April 19, 2011. Only years 1980 through 2011 were used for analysis. A review of the data showed increases in flow from 1961 through 1980, presumably from development.
[b] Data available from October 1, 1987, through April 19, 2011.
[c] Data available from July 12, 1973, through April 19, 2011.
[d] Data available from June 15, 1992, through April 19, 2011.
[e] Data available from June 1, 1989, through April 19, 2011.
[f] Data available from August 16, 1950, through April 19, 2011. Only years 1980 through 2011 were used for analysis. A review of the data showed increases in flows from 1950 through 1980, presumably from development.

A subsequent longer-term data collection effort at several locations along the Salt Creek watershed found the average chloride concentration over the winter season to be over 500 mg/L while the concentration outside of the winter season to be 200 to 300 mg/L. In the West Branch DuPage River, the winter season deicing chloride average concentration was 428 mg/L. A comparison of how the winter deicing season values compare to values throughout the year and outside of the deicing season is shown in Table 8.

TABLE 8
Variation in Chloride Concentration For Different Times of the Year

	Salt Creek at Busse Woods	Salt Creek at Wolf Road	Salt Creek at JFK Blvd	West Branch DuPage River at Arlington Drive
Annual Average (2010)	428.1	358.4	345.5	N/A
Winter Average (Jan–Mar, Nov– Dec) 2010	605.6	576.1	503.4	428.3
Average (Apr–Oct)	297.5	256.8	269.9	N/A
Average (2010 INHS flow monitoring period)[a]	312.9	269.0	299.0	N/A

Note: West Branch DuPage River data is from Jan–Feb 2010.
[a]INHS monitoring data May 27, 2010 and June 24, 2010. Average of May and June 2010 at Salt Creek monitoring station equals 266 mg/L.

The IEPA has also collected data within the watersheds. Data from 1999 to 2009 for locations within the Addison Creek, Salt Creek, and West Branch DuPage River watersheds are shown in Table 9. A comparison of the TSS, copper, lead, and zinc values in Table 9 to the National Stormwater Database averages shows the values in Salt Creek and the West Branch DuPage River are lower on average than the average found in the National Stormwater Database. The National Stormwater Database values represent wet weather runoff from urbanized areas while the IEPA values would include dry weather sampling. IEPA data were also requested for Higgins Creek, Bensenville Ditch, and Silver Creek, but no data were available for these parameters during this period.

TABLE 9
1999 to 2009 Water Quality Data for Locations Within the Addison Creek, Salt Creek, and West Branch DuPage River Watersheds

	TSS (mg/L)	Chloride (mg/L)	Copper (mg/L)	Lead (mg/L)	Zinc (mg/L)
Addison Creek Watershed (GLA-02)					
Average	23	389	0.008	0.003	0.062
Range	2 to 58	67 to 1,780	0.001 to 0.020	<0.001 to 0.007	0.007 to 0.100
Salt Creek Watershed (GL-09)					
Average	28	250	0.008	0.003	0.062
Range	2 to 150	19 to 890	0.002 to 0.010	<0.001 to 0.005	0.004 to 0.100
West Branch DuPage River (GBK-09)					
Average	32	226	0.007	0.003	0.060
Range	1 to 232	18 to 853	<0.001 to 0.019	<0.001 to 0.006	<0.001 to 0.100

In 2009 water quality samples were taken by INHS within Addison Creek, Higgins Creek, Meacham Creek, Salt Creek, and Willow Creek (INHS, 2009). Samples were taken June 16, August 10, and October 28, 2009. In 2010, water quality samples were taken within Spring Brook Creek and the tributary to the West Branch DuPage River. The samples were taken May 27 and June 24, 2010 (INHS, 2010). Hardness data from both sample sets were used to calculate IEPA water quality criteria when needed (described in the next section). The data used in this analysis are contained in Attachment 2 and summarized in Table 10. A review of USGS flow data in nearby streams indicates these data collection efforts represent dry weather conditions in the stream. The focus of this analysis is upon wet weather runoff. Consequently, values during wet runoff conditions are expected to vary from those collected for background conditions.

IEPA Water Quality Criteria

IEPA Part 302 Water Quality Standards were used to calculate acute and chronic standards for copper, lead, and zinc. The standards are based upon the hardness within each water body. The standard criterion for chloride is 500 mg/L. There is no IEPA numeric criterion for TSS. Table 11 lists the calculated acute and chronic criteria. The chronic zinc standard reflects the proposed Illinois Pollution Control Board change R2011-018.

TABLE 10
Summary of INHS Sampling Data

	Average and Range of Sampling Data						
Parameter (mg/L)	**Addison Creek**	**Willow Creek**	**Higgins Creek**	**Salt Creek**	**Meacham Creek**	**Spring Brook Creek**	**West Branch DuPage River**
TSS	Not Tested						
Copper average,	0.011	0.018	0.019	0.009	0.008	0.005	0.006
Copper range,	0.011–0.013	0.005–0.032	0.001–0.030	0.006–0.013	0.006–0.011	0.004–0.007	0.006–0.007
Lead average,	< 0.041	< 0.041	< 0.041	< 0.041	< 0.041	< 0.041	< 0.041
Lead range,	< 0.041	< 0.041	< 0.041	< 0.041	< 0.041	< 0.041	< 0.041
Zinc average,	0.062	0.063	**0.140**	**0.073**	0.043	0.013	0.030
Zinc range,	0.019–0.137	0.009–0.158	0.073–0.195	0.013–0.187	0.008–0.111	0.008–0.018	0.015–0.046
Chloride average,	179.3	203	161	226.3	198.7	183.0	178.5
Chloride range,	158–199	140–302	113–224	181–309	112–330	155–211	154–203
Sample Dates	June 16, August 10, and October 28, 2009					May 27 and June 24, 2010	

Note: Average values in **bold** exceed the chronic water quality standard.

Silver Creek and Bensenville Ditch were not sampled. The hardness data for all sampled rivers are similar, so the lowest value (229) was used for both Silver Creek and Bensenville Ditch. Using the lowest hardness value forces the criteria to be lower, and therefore the acute and chronic criteria threshold is more conservative.

Comparison of Chronic Water Quality Criteria to Background Data

A comparison of Tables 10 and 11 indicates the average background concentration of copper, lead, and zinc is less than the chronic water quality standard, except in Higgins Creek and Salt Creek. Higgins Creek is impaired for zinc and is being targeted for point source reductions after which it will be reassessed for meeting zinc water quality standards (AECOM, 2009). The Salt Creek zinc background concentration varied with two of the three samples being less than the chronic standard and one being greater than the chronic standard. A comprehensive list of background water quality data is contained in Attachment 2.

Event-Mean Concentration

The FHWA documents site median concentrations of pollutants (mg/L) for TSS, copper, lead, and zinc. For this water quality analysis, metals data from the National Cooperative Highway Research Program report no. 474 were used (NCHRP, 2002). The NCHRP report used site median concentrations from a Michigan Department of Transportation (CH2M HILL, 1998) study. The NCHRP report compared the more recent Michigan Department of Transportation (MDOT) data and the historical FHWA site mean concentrations. The NCHRP report notes that the historical FHWA report includes data

TABLE 11
Acute and Chronic Criteria Calculated from IEPA Part 302 Water Quality Standards

Pollutant	Acute Criteria (mg/L)	Chronic Criteria (mg/L)
Addison Creek (*Hardness = 290*)		
Copper	0.046	0.028
Lead	0.236	0.050
Zinc	0.295	0.077
Higgins Creek (*Hardness = 278*)		
Copper	0.045	0.027
Lead	0.226	0.047
Zinc	0.284	0.074
Meacham Creek (*Hardness = 308*)		
Copper	0.049	0.030
Lead	0.251	0.053
Zinc	0.310	0.081
Salt Creek (*Hardness = 248*)		
Copper	0.040	0.025
Lead	0.200	0.042
Zinc	0.258	0.067
West Branch DuPage River (*Hardness = 229*)		
Copper	0.037	0.023
Lead	0.184	0.039
Zinc	0.241	0.063
Willow Creek (*Hardness = 230*)		
Copper	0.037	0.023
Lead	0.185	0.039
Zinc	0.242	0.063
Spring Brook Creek (*Hardness = 316*)		
Copper	0.050	0.030
Lead	0.258	0.054
Zinc	0.317	0.083

from the era in which leaded gasoline was still in use and sampling techniques did not use "clean" techniques for metals. Consequently, the FHWA data are not representative of current conditions. As a result, the NCHRP data were used for the metals analysis. This NCHRP report does not include data for TSS, so the FHWA site median concentration was still used. Table 12 summarizes a comparison of the site median concentrations from NCHRP and the FHWA.

TABLE 12
Comparison of Site Median Concentrations from NCHRP Analysis and FHWA Procedure

	Average Daily Traffic Greater Than 30,000	
Pollutant (µg/L)	NCHRP (from MDOT study)	FHWA
Copper	41	54
Lead	25	400
Zinc	187	329

Average Daily Traffic

The average daily traffic (ADT) for the project is generally greater than 30,000 vehicles per day for any one highway direction. There are only two segments out of 40 highway segments analyzed with year 2040 traffic volumes less than 30,000. Consequently all traffic volumes are greater than 30,000 ADT for water quality analysis purposes. This places the project in an urban transportation setting for the FHWA water quality analysis procedure.

Slope of Stream Channel

The USGS chloride analysis methodology incorporates the slope of the river channel with other parameters. The slope used in this analysis is the slope of the main channel, in feet per mile, between points 10 percent and 85 percent along the stream from monitoring site to the topographic divide. The slope (ft/mi) was calculated using USGS quad maps showing the topographic data and the stream within the project watershed boundaries.

Applied Salt Loading

The amount of salt applied to the roadways is needed for the chloride analysis. Data from the Illinois Tollway and the Illinois Department of Transportation (IDOT) were used to determine the average salt usage per highway lane mile. The Illinois Tollway provided representative salt usage data for 2001–2002 through the 2010–2011 snow seasons. IDOT provided salt usage data for the 2006–2011 snow seasons. The average of the two sets of data was used to determine typical tons of chloride per mile per year (Table 13). The annual average was used in the analysis to be representative of recent seasonal variation. Table 13 lists the data used to determine tons/mile for the analysis. The average over the time period of 39.7 tons/lane-mile was selected for the analysis to represent average conditions.

TABLE 13
Yearly Salt Usage Data from Illinois Tollway and Illinois Department of Transportation (IDOT)

Snow Season	Tons of Salt Used	Lane Miles	Tons / Lane Mile
Illinois Tollway 05 Section			
2001–2002	4,265	154.6	27.6
2002–2003	5,534	154.6	35.8
2003–2004	5,727	154.1	37.2
2004–2005	7,443	155.6	47.8
2005–2006	4,832	155.6	31.1
2006–2007	7,210	155.6	46.3
2007–2008	10,389	155.6	66.8
2008–2009	6,540	155.6	42.0
2009–2010	5,801	161.6	35.9
2010–2011	5,976	161.6	37.0
10 Year Average.	6,371.7		40.7
IDOT Rodenburg Road Yard (Elgin O'Hare)			
2006	6,083	348	17.5
2007	10,951	348	31.5
2008	18,032	337	53.5
2009	12,101	337	35.9
2010	19,714	337	58.5
2011	11,973	337	35.5
6 Year Average.	7,885.4		38.7
Overall Average			**39.7**

Methodology

The data described in the previous sections are the inputs to the two methodologies used in this analysis. The FHWA procedure *Pollutant Loadings and Impacts from Highway Stormwater Runoff Volume I: Design Procedure* was used for the TSS, copper, lead, and zinc analysis. The USGS procedure developed by Frost, Pollock, and Wakelee (USGS, 1981) was used for the chloride analysis.

TSS and Metals Analysis Procedure

The FHWA procedure uses the percent imperviousness, rainfall characteristics, site median concentration, watershed drainage area, and streamflow to calculate the once in 3 year stream pollutant concentration; that concentration was compared to IEPA water quality criteria to determine how the stream may be affected by highway runoff. Only the impervious area within the highway right-of-way was used, because it represents the source area for urban highway pollutant runoff. The paved surface area and percent imperviousness was therefore 100 percent for the analysis.

Attachment 3 contains the FHWA procedure worksheets for each watershed, for both existing and 2040 Build conditions without BMPs.

Chloride Analysis Procedure

The FHWA procedure does not include an analysis for chloride. Therefore the 1981 USGS analysis procedure was used for the chloride analysis. This long-standing methodology has been used for other chloride water quality analysis for IDOT. The methodology uses the drainage area of each watershed, lane miles within each watershed, river slope, annual precipitation, and the tons per lane-mile salt applied to calculate the annual daily average chloride concentration and annual daily maximum chloride concentration.

Attachment 1 contains the memorandum of the chlorides analysis including results.

Pollutant Reduction through Best Management Practices

Best management practices (BMPs) will be implemented along the proposed project corridor. The BMPs will be wet ponds, dry ponds, grassed swales, bioswales, or similar. Wet pond BMP locations near O'Hare International Airport are being coordinated with the Federal Aviation Administration (FAA) because of the open water and habitat being a potential wildlife attractant. Numerous studies have been conducted to summarize pollutant reductions from BMPs. Several were reviewed as follows to determine a planning level pollutant load reduction when applied to the project:

- National Pollutant Removal Performance Database (September 2007)
  - Dry pond removal—median values: TSS (49 percent), Cu (29), Zn (29)
  - Wet pond removal—median values: TSS (80 percent), Cu (57), Zn (64)
  - Open channel—median values: TSS (81 percent), Cu (65), Zn (71)
- FHWA, Stormwater BMPs in an Ultra-Urban Setting: Selection and Monitoring (May 2000)
  - Dry detention pond removal: TSS (67–93 percent)
  - Extended detention wet pond removal: TSS (76 percent), metals (50–57 percent)
- FHWA, Evaluation and Management of Highway Runoff Water Quality (June 1996)
  - Extended detention dry pond removal: sediments (68–90 percent), metals (42–90)
  - Wet pond removal: sediments (90 percent), metals (n/a)
  - Grassed swales removal: sediments (70 percent), metals (50–90)

Other BMPs considered during the evaluation include a bioswale, which is defined as a grass swale with the bottom width containing an underdrain in an engineered soil media designed to encourage infiltration. The bioswale will encourage infiltration, thereby removing suspended solids through filtering and other mechanisms. The Illinois Tollway has constructed bioswale and other storm water BMPs to improve water quality and is active in monitoring the bioswale BMP performance. However, performance data for the Illinois Tollway bioswale are not expected to be available until mid-2012.

The International Stormwater BMP Database was reviewed for performance of similar BMPs. A BMP documented in the database [1]describes the performance of a BMP similar to the bioswale BMP envisioned for implementation on the EO-WB project. The report describes the BMP as an "ecology embankment" (renamed in June 2008 to "media filter drain") and documents the BMP performance between 2001 and 2005 from data collected and analyzed for contaminant removal efficiencies. The ecology embankment achieved the following removal efficiencies:

- TSS: 94 percent average; for modeling purposes 90 percent was used
- Total Zn: 85 percent average; for modeling purposes 85 percent was used
- Total Cu: 86 percent average; for modeling purposes 85 percent was used

Because the removal rates are very good with the ecology embankment and the performance of BMPs constructed by the Illinois Tollway are not yet known, to be conservative the bioswale performance was modeled using the average performance of a grass swale and the ecology embankment. Therefore, for bioswale water quality modeling purposes, the following were assumed:

- TSS: 80 percent average removal
- Total Metals (copper, lead, zinc): 68 percent average removal

As bioswale performance data become available from the Illinois Tollway, a revision to the potential performance expected with bioswales for the project may be considered.

For the purpose of this study, the following conservative BMP performance is used based upon averages from these literature sources for proposed BMP performance:

- Dry detention pond: 50 percent TSS removal, 30 percent metals removal
- Wet detention pond: 80 percent TSS removal, 50 percent metals removal
- Grassed swale: 70 percent TSS removal, 50 percent metals removal
- Bioswale: 80 percent TSS removal, 68 percent metals removal
- Ecology Embankment: 90 percent TSS removal, 85 percent metals removal

A visual review of the study area adjacent to the proposed 2040 Build condition highways indicated there are few BMPs under existing conditions. There are limited detention ponds along the transportation corridor treating highway runoff and grassed swales do not appear to have been designed specifically for pollutant removal. The exception appears to be the existing Elgin-O'Hare Expressway west of Illinois State Highway 53 where grassed medians and grassed ditches are present. Consequently, under existing conditions, it is assumed that existing detention ponds will provide the average removal efficiencies listed above, but grassed swales will only be assumed to provide one-third of the pollutant removal efficiency typically expected from well-designed swales for areas east of Illinois Highway 53

[1] The bioswale-type BMP is detailed in *Technology Evaluation and Engineering Report: WSDOT Ecology Embankments*, prepared for the State of Washington Department of Transportation by Herrera Environmental Consultants, Inc. (Seattle, WA), July 2006,

(Meacham Creek and West Branch DuPage River watersheds will assume existing grass swale performance with average removal efficiency). West of Highway 53, detention ponds treat stormwater runoff after the runoff is first treated by grassed swales. A value of one-third was selected to acknowledge some water quality benefit is expected with grassed swales, even though they may not perform at the level expected in the national stormwater quality studies.

For existing conditions, a review of percent treatment by grassed swales and ponds was conducted using available topographic information, aerials, and plans. Adjustments to the assumptions used in the analysis may be necessary after a more thorough analysis of the existing drainage patterns is completed as part of the planning process.

Results

The water quality analysis calculated existing and proposed 2040 Build water quality in the project area watersheds. The findings were compared to background sample data and water quality criteria to determine the effect of the EO-WB on water quality. The results for TSS and metals analysis are shown without BMPs in Table 14. The results from the chlorides analysis are included in Attachment 1-A.

BMPs were evaluated under existing and 2040 Build conditions. For existing conditions, the approximate percentage of the highway draining to grass swales and other BMPs was made for each watershed. For 2040 Build conditions, the percentage of highway draining to BMPs was estimated. Where the highway is treated by both grass swales and other BMPs, it was assumed that the grass swales first remove pollutants before the runoff enters the other BMPs. Table 15 lists BMP coverage by watershed for existing and 2040 Build conditions. The results for the TSS and metals analysis with BMPs are shown in Table 16.

The analysis completed for Spring Brook Creek is slightly different from the other watersheds. There is no waterway crossing of the highway with Spring Brook Creek, however, the watershed does span both sides of the highway. The 2040 Build condition increases the highway impervious area by 4.54 acres within the project footprint within the Spring Brook Creek watershed. The 2040 Build lane miles increase 5.13 lane miles. The water quality analysis was performed where the IEPA stream designation starts. Due to the small watershed size, the good BMP coverage present under existing conditions, and the limits on constructing BMPs with the expanded highway, water quality does not improve under the 2040 Build condition with planned BMPs. If bioswales were implemented instead of grass swales, the TSS and metals concentrations could improve compared to existing conditions.

TABLE 14
Water Quality Analysis Results (No BMPs)

	Evaluation Condition	Addison Creek	Silver Creek	Bensenville Ditch	Willow Creek	Higgins Creek	Salt Creek	Spring Brook Creek	Meacham Creek	West Branch DuPage River
TSS[b]	Criteria (mg/L)[a]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Existing condition without BMPs—once in 3 year stream concentration (mg/L)	257	307	274	355	361	171	352	360	284
	2040 Build condition without BMPs—once in 3 year stream concentration (mg/L)	337	313	344	412	407	204	372	412	296
	Percent increase[c] from existing conditions	31%	2%	25%	16%	13%	19%	6%	14%	4%
Copper[b]	Acute criteria (mg/L)	0.046	0.037	0.037	0.037	0.045	0.040	0.050	0.049	0.037
	Existing condition without BMPs—once in 3 year stream concentration (mg/L)	0.033	0.039	0.035	0.046	0.046	0.022	0.045	0.046	0.036
	2040 Build condition without BMPs—once in 3 year stream concentration (mg/L)	0.043	0.040	0.044	0.053	0.052	0.026	0.048	0.053	0.038
	Percent increase[c] from existing conditions	31%	2%	25%	16%	13%	19%	6%	14%	4%
Lead[b]	Acute criteria (mg/L)	0.236	0.184	0.184	0.185	0.226	0.200	0.258	0.251	0.184
	Existing condition without BMPs—once in 3 year stream concentration (mg/L)	0.005	0.006	0.005	0.007	0.007	0.003	0.007	0.007	0.006
	2040 Build condition without BMPs—once in 3 year stream concentration (mg/L)	0.007	0.006	0.007	0.008	0.008	0.004	0.007	0.008	0.006
	Percent increase[c] from existing conditions	31%	2%	25%	16%	13%	19%	6%	14%	4%

TABLE 14
Water Quality Analysis Results (No BMPs)

	Evaluation Condition	Addison Creek	Silver Creek	Bensenville Ditch	Willow Creek	Higgins Creek	Salt Creek	Spring Brook Creek	Meacham Creek	West Branch DuPage River
Zinc[b]	Acute criteria (mg/L)	0.295	0.241	0.241	0.242	0.284	0.258	0.317	0.310	0.241
	Existing condition without BMPs—once in 3 year stream concentration (mg/L)	0.151	0.180	0.161	0.208	0.211	0.100	0.206	0.211	0.166
	2040 Build condition without BMPs—once in 3 year stream concentration (mg/L)	0.197	0.183	0.201	0.241	0.238	0.119	0.218	0.241	0.173
	Percent increase[c] from existing conditions	31%	2%	25%	16%	13%	19%	6%	14%	4%

[a] No Numeric General Use Water Quality Standard is provided in the Illinois Administrative Code for TSS.

[b] Calculated using the FHWA Pollutant Loadings and Impacts from *Highway Stormwater Runoff Volume I: Design Procedure.*

[c] Percent increase values were rounded. Percentages were calculated prior to rounding.

TABLE 15
Existing and Proposed 2040 Build Conditions BMPs

	Existing Conditions							2040 Build Conditions						
	Dry pond	Wet pond	Low quality grass swale	Grass swale	Grass swale & dry pond	Grass swale & wet pond	Grass swale & dry pond & wet pond	Dry pond	Wet pond	Low quality grass swale	Grass swale	Grass swale & dry pond	Grass swale & wet pond	Grass swale & dry pond & wet pond
Addison Creek			50%							50%		50%		
Silver Creek			20%					50%				30%		
Bensenville Ditch			20%									90%		
Willow Creek			35%					10%			10%	70%		
Higgins Creek			70%					20%		30%		20%		
Salt Creek		15%	20%	10%							30%	25%	35%	
Spring Brook Creek				40%	35%						40%		40%	10%
Meacham Creek				15%	50%						5%	10%		75%
West Branch DuPage River					75%	80%							80%	

Note: No value represents no existing or proposed BMPs.

TABLE 16
Water Quality Analysis Results with Best Management Practices (BMPs)

		Addison Creek	Silver Creek	Bensenville Ditch	Willow Creek	Higgins Creek	Salt Creek	Spring Brook Creek	Meacham Creek	West Branch DuPage River
TSS[b]	Criteria (mg/L)[a]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Existing condition with BMPs—once in 3 year stream concentration (mg/L)	227	293	262	326	302	74			70
	2040 Build condition with BMPs—once in 3 year stream concentration (mg/L)	154	155			269	47 88	94 69	77	73
	Percent increase[c] in concentration	-32%	-47%	-69%	-64%	-11%	-36%	6%	12%	4%
Copper[b]	Acute criteria (mg/L)	0.046	0.037 81	0.037 117	0.037	0.045	0.040	0.050	0.049	0.037
	Existing condition with BMPs—once in 3 year stream concentration (mg/L)	0.030		0.034	0.043	0.041	0.013			0.015
	2040 Build condition with BMPs—once in 3 year stream concentration (mg/L)	0.038 0.026		0.018	0.025	0.040	0.019 0.010	0.017 0.020		0.015
	Percent increase[c] in concentration	-15% 0.026	-31%	-46%	-43%	-3%	-18%	6% 0.018	8%	4%
Lead[b]	Acute criteria (mg/L)	0.236	0.184	0.184	0.185	0.226	0.200	0.258	0.251	0.184
	Existing condition with BMPs—once in 3 year stream concentration (mg/L)	0.005		0.005	0.007	0.006	0.002			0.002
	2040 Build condition with BMPs—once in 3 year stream concentration (mg/L)	0.006 0.004		0.003	0.004	0.006	0.003 0.002	0.003 0.003		0.002
	Percent increase[c] in concentration	-15% 0.004	-31%	-46%	-43%	-3%	-18%	6% 0.003	8%	4%

TABLE 16
Water Quality Analysis Results with Best Management Practices (BMPs)

		Addison Creek	Silver Creek	Bensenville Ditch	Willow Creek	Higgins Creek	Salt Creek	Spring Brook Creek	Meacham Creek	West Branch DuPage River
Zinc[b]	Acute criteria (mg/L)	0.295	0.241	0.241	0.242	0.284	0.258	0.317	0.310	0.241
	Existing condition with BMPs—once in 3 year stream concentration (mg/L)	0.138	0.174	0.155	0.196	0.187	0.058	0.087	0.076	0.066
	2040 Build condition with BMPs—once in 3 year stream concentration (mg/L)	0.117	0.120	0.083	0.112	0.181	0.047	0.092	0.083	0.069
	Percent increase[c] in concentration	-15%	-31%	-46%	-43%	-3%	-18%	6%	8%	4%

[a] No Numeric General Use Water Quality Standard is provided in the Illinois Administrative Code for total suspended solids.

[b] Calculated using the FHWA Pollutant Loadings and Impacts from *Highway Stormwater Runoff Volume I: Design Procedure.*

[c] Percent increase values were rounded. Percentages were calculated prior to rounding.

TSS

With BMPs in place, the TSS concentration decreases in all watersheds from 11to 69 percent for the once in 3 year concentration, except for the Spring Brook Creek, Meacham Creek, and West Branch DuPage River watersheds. The decrease in TSS concentration is due to the limited amount of BMPs currently in place in these watersheds under existing conditions and the implementation of BMPs with the 2040 Build condition. In Meacham Creek and the West Branch DuPage River, a TSS increase of 12 and 4 percent is estimated. In Spring Brook Creek, a TSS increase of 6 percent is expected. The TSS concentrations in Spring Brook Creek, Meacham Creek, and West Branch DuPage River watersheds are generally smaller than the other watersheds. The increase in TSS occurs because of additional impervious area. There is no numeric water quality standard in Illinois for TSS.

Metals (Copper, Lead, Zinc)

With BMPs in place, the once in 3 year metals concentration improves by decreasing between 3 and 46 percent for all watersheds except Spring Brook Creek, Meacham Creek, and the West Branch DuPage River which increase from 4 to 8 percent. All of the watersheds have concentrations that are less than the acute metals criteria under 2040 Build conditions. The Willow Creek and Silver Creek copper concentrations under existing conditions were found to exceed the acute copper criteria, however under 2040 Build conditions, the copper concentrations were determined to improve and be less than the acute copper criteria due to the additional BMPs in place under 2040 Build conditions.

If bioswales were implemented instead of grass swales, the TSS and metals concentrations could improve for all watersheds compared to existing conditions.

Chloride

A detailed analysis of the chlorides pollutant concentrations from the project watersheds is included in the memorandum *Chloride Concentration Analysis*, which is included in Attachment 1.

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Attachment 1

Chloride Concentration Analysis Memorandum

Chloride Concentration Analysis of Elgin O'Hare – West Bypass Project

PREPARED BY: CH2M HILL

DATE: February 1, 2012

This memorandum summarizes the analysis of chloride and alternate methods to demonstrate compliance with the chloride water quality standard for the watersheds affected by the Elgin O'Hare – West Bypass (EO-WB) project. The Chloride water quality standard has often been exceeded in these watersheds and has led to the development of a chloride total maximum daily load (TMDL) for several watersheds. The presence of the TMDL and the additional chloride load anticipated with the EO-WB project provides both a challenge and unique opportunity for collaborative research with other chloride users in the watersheds to promote best principles for deicing.

Other pollutants such as TSS and metals were analyzed separately using a different methodology. The affected watersheds include parts of the West Branch DuPage River, Spring Brook Creek, Meacham Creek, Salt Creek, Willow Creek, Bensenville Ditch, Silver Creek, Addison Creek, and Higgins Creek.

Methodology

The methodology used to calculate potential chloride pollutant loading from the project area under existing, the initial construction phase, 2040 No-Build, and 2040 Build conditions was based on that outlined in the United States Geological Survey report developed by Frost, Pollock, and Wakelee (USGS, 1981). The methodology uses the drainage area of each watershed, lane miles within each watershed, river slope, annual precipitation, and tons per lane-mile salt applied to calculate the annual daily average chloride concentration and annual daily maximum chloride concentration. The data inputs that significantly drive the receiving water chloride concentration are lane miles and salt loading.

The initial construction phase condition reflects the portions of the EO-WB project that would be initially built providing sufficient capacity for approximately 20 to 25 years. The initial construction phase generally includes one less lane in either travel direction from what is envisioned with the 2040 Build scenario. The initial construction phase is being analyzed for chloride because it is a condition that is expected to occur for 20 to 25 years and advances in technology for deicing that develop over that time may be brought to bear to further reduce salt usage.

The 2040 No-Build condition reflects highway construction that is planned to occur regardless as to whether the EO-WB project occurs or not; and the 2040 Build condition reflects the complete project including additional travel lanes added to the initial construction phase for travel forecasted through 2040.

Area of Interest

The EO-WB project crosses the following watersheds:

- West Branch DuPage River Watershed
  - West Branch DuPage River (main stem)
- Salt Creek Watershed
  - Spring Brook Creek
  - Meacham Creek
  - Salt Creek (main stem)
  - Addison Creek
- Des Plaines River Watershed
  - Higgins Creek
  - Willow Creek
  - Bensenville Ditch
  - Silver Creek

Exhibit 1 shows these watersheds in the EO-WB project area. Only portions of the Salt Creek watershed are shown in this figure; additional areas are further upstream.

Applied Salt Loading

The amount of salt applied to the roadways is needed for the chloride analysis. Data from the Illinois Tollway and the Illinois Department of Transportation (IDOT) were used to determine the average salt usage per highway lane mile. The Illinois Tollway provided representative systemwide salt usage data for 2001–2002 through the 2010–2011 snow seasons. IDOT provided salt usage data for the 2006–2011 snow seasons. The average of the two sets of data was used to determine typical tons of salt per mile per year (Table 1). The annual average was used in the analysis to be representative of recent seasonal variation. Table 1 lists the data used to determine tons/mile for the analysis. The average over the time period of 39.7 tons/lane-mile was selected for the analysis to represent average conditions.

Calculated Chloride Loading

The USGS methodology was used to calculate the initial construction phase, 2040 No-Build, and 2040 Build conditions annual daily maximum chloride concentration attributed to highway runoff within each watershed. This methodology calculated the annual daily maximum chloride concentration assuming that all highway storm water reaches the area streams without any detention or storm water treatment practices in place. Table 2 summarizes the lane miles for the existing condition, initial construction phase, 2040 No-Build, and 2040 Build conditions, and Table 3 summarizes the existing and proposed chloride concentration. Concentrations exceeding the 500 mg/L water quality standard are highlighted in red. A table of all chloride concentration calculations and inputs is appended to this memorandum.

EXHIBIT 1
EO-WB and Impacted Watersheds

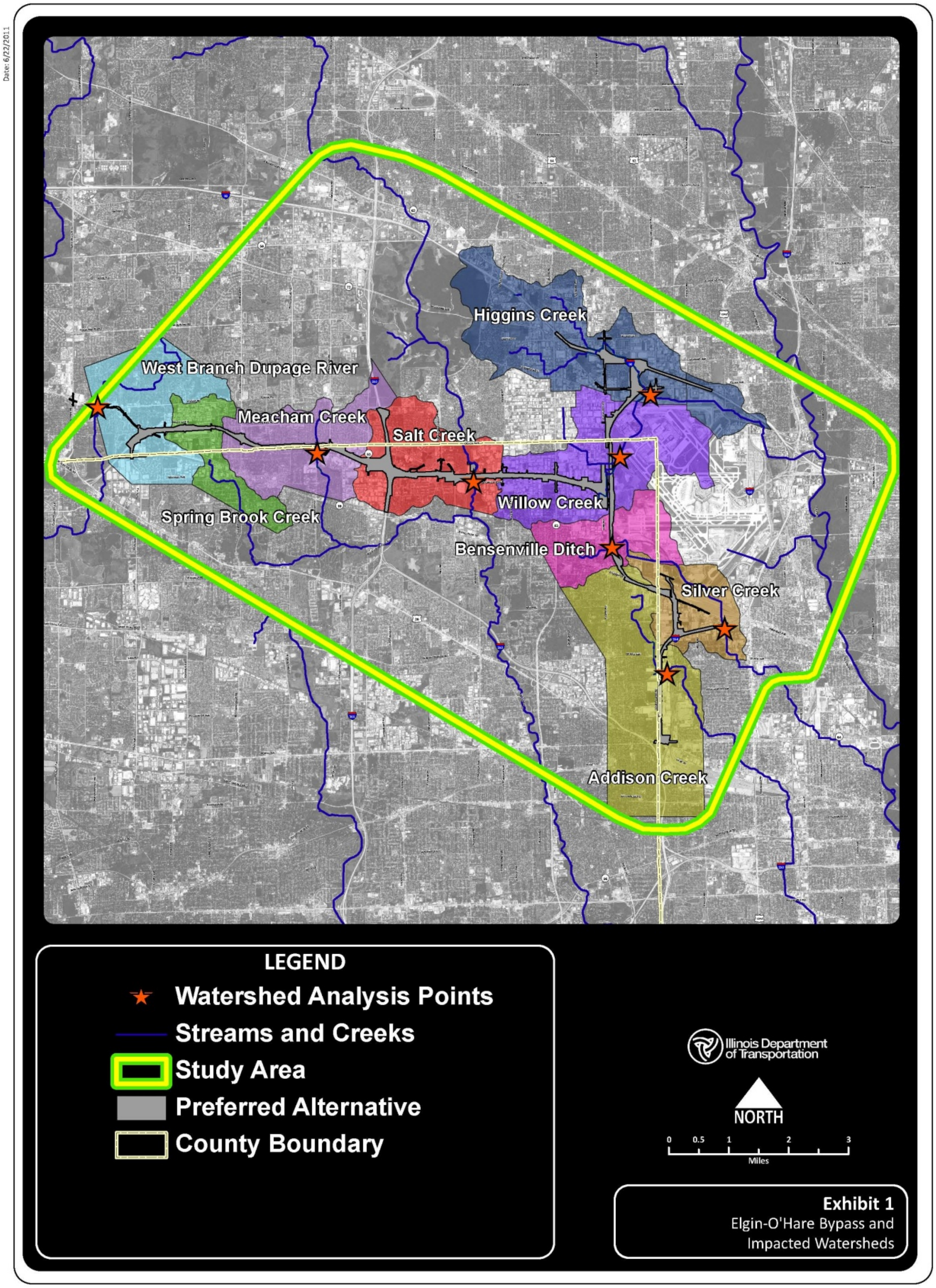

TABLE 1
Yearly Salt Usage Data from Illinois Tollway and IDOT

Snow Season	Tons of Salt Used	Lane Miles	Tons / Lane Mile
Illinois Tollway M-05 SECTION			
2001–2002	4,265	154.6	27.6
2002–2003	5,534	154.6	35.8
2003–2004	5,727	154.1	37.2
2004–2005	7,443	155.6	47.8
2005–2006	4,832	155.6	31.1
2006–2007	7,210	155.6	46.3
2007–2008	10,389	155.6	66.8
2008–2009	6,540	155.6	42.0
2009–2010	5,801	161.6	35.9
2010–2011	5,976	161.6	37.0
10 Year Average.	6,371.7		40.7
IDOT Rodenburg Road Yard (Elgin O'Hare)			
2006	6,083	348	17.5
2007	10,951	348	31.5
2008	18,032	337	53.5
2009	12,101	337	35.9
2010	19,714	337	58.5
2011	11,973	337	35.5
6 Year Average.	7,885.4		38.7
Overall Average			**39.7**

TABLE 2
Summary of Existing and Proposed Highway Miles

Watershed Name	2010 Existing Highway Lane Miles	Initial Construction Phase Highway Lane Miles	2040 No-Build Highway Lane Miles	2040 Build Highway Lane Miles
Salt Creek Watershed				
Spring Brook	6.2	10.1	6.2	11.3
Meacham Creek	27.1	39.6	27.1	43.8
Salt Creek (main stem)	23.5	56.2	23.5	67.0
Addison Creek	47.5	69.7	55.6	74.4
Des Plaines River Watershed				
Willow Creek	N/A	37.7	N/A	50.3
Higgins Creek	44.9	73.9	58.6	79.0
Bensenville Ditch	0.9	10.6	0.9	13.9
Silver Creek	11.9	28.0	11.9	33.3
West Branch DuPage River Watershed				
West Branch DuPage River	6.9	9.7	6.9	10.6
TOTAL	**168.9**	**335.4**	**190.7**	**383.6**

Note: There is no highway for Willow Creek Existing Conditions and 2040 No-Build Conditions

TABLE 3
Existing and Proposed Conditions Chloride Concentrations From Highway Deicing

	Salt Applied, tons/mi	Ann. Daily Max Chloride, mg/L			
		Existing	Initial Construction Phase	2040 No-Build	2040 Build
Salt Creek Watershed					
Spring Brook Creek	39.7	296	520	296	520
Meacham Creek	39.7	532	765	532	842
Salt Creek (main stem)	39.7	46	75	46	84
Addison Creek	39.7	467	716	541	716
Des Plaines River Watershed					
Willow Creek	39.7	N/A	376	N/A	492
Higgins Creek	39.7	385	658	495	658
Bensenville Ditch	39.7	52	415	52	415
Silver Creek	39.7	136	431	136	431
West Branch DuPage River Watershed					
West Branch DuPage River	39.7	110	156	110	156

Note: Silver Creek includes upstream loading from Bensenville Ditch.
Values shown in red exceed the chloride water quality standard of 500 mg/L.
There is no highway for Willow Creek Existing Conditions and 2040 No-Build Conditions.

Initial Chloride Concentration Evaluation

The Spring Brook Creek, Meacham Creek, Addison Creek, and Higgins Creek subwatersheds exceed the 500 mg/L chloride water quality standard under the initial construction phase and 2040 Build conditions. Reducing the salt application rate alone may not be acceptable because of the potential safety impacts of reducing salt for deicing the highway. Consequently, the following methods to demonstrate water quality standard compliance were investigated:

- Determining the salt loading required to meet water quality standards by subwatershed.
- Evaluating potential peak chloride concentration attenuation from directing runoff through storm water best management practices (BMPs).
- Identifying alternative deicer materials that could substitute for salt.

These approaches are discussed below.

Salt Usage Reduction Required to Achieve Water Quality Standards

An analysis of the salt application reduction required to lower the chloride concentration for the initial construction phase condition below 500 mg/L was done to determine how much of a reduction is necessary. Table 4 summarizes the reduction needed for the initial construction phase condition and for the 2040 Build condition within each watershed.

TABLE 4
Salt Usage Required to Meet Water Quality Standard

	Initial Construction Phase Conditions			2040 Build Conditions		
	Salt Applied, tons/ lane-mile	Reduction in Salt Application (tons/lane-mile)	Resulting Annual Daily Max Cl, mg/L	Salt Applied, tons/lane-mile	Reduction in Salt Application (tons/lane-mile)	Resulting Annual Daily Max Cl, mg/L
Salt Creek Watershed						
Spring Brook Creek	38.0	1.7	498	38.0	1.7	498
Meacham Creek	25.5	14.2	500	23.0	16.7	498
Salt Creek (main stem)	39.7	0.0	75	39.7	0.0	84
Addison Creek	27.0	12.7	495	27.0	12.7	495
Des Plaines River Watershed						
Willow Creek	39.7	0.0	376	39.7	0.0	492
Higgins Creek	29.5	10.2	495	29.5	10.2	495
Bensenville Ditch	39.7	0.0	415	39.7	0.0	415
Silver Creek	39.7	0.0	431	39.7	0.0	431
West Branch DuPage River Watershed						
West Branch DuPage River	39.7	0.0	156	39.7	0.0	156

Note: Silver Creek includes upstream loading from Bensenville Ditch.

Values shown in blue indicate watersheds that exceed the chloride water quality standards of 500 mg/L. Salt application rates in these locations need to be reduced by the value shown in order to meet the standard.

Reduction in salt usage would be required for the 2040 Build condition in Meacham Creek, Addison Creek, Higgins Creek, and Spring Brook Creek.

The salt application rates to achieve the chloride water quality standard in watersheds are highlighted in blue. If salt usage could be lowered to the annual application rates shown in Table 4, the chloride water quality standard would be met from highway runoff. However, because the required salt usage reductions vary from 4.2 – to 42 percent below the current usage rate, achieving these low application rates through salt reduction alone is unlikely without compromising safety expectations. Consequently, one or more alternative chloride compliance approaches described below could be pursued.

Chloride Application Best Management Practices

Two studies performed for the DuPage River Salt Creek Workgroup reviewed salt application and deicing programs at numerous communities in the Salt Creek watershed (CDM, 2007 and 2011). The workgroup has been focusing upon tracking chloride concentrations because there are chloride TMDLs in both the DuPage River and Salt Creek watersheds. These studies compiled results from community surveys and included potential salt reduction from alternative deicing programs. The 2007 study concluded that implementing the recommended measures could reduce chloride concentrations from 10 to 40 percent. The recommended measures include public education, staff training, and improved salt storage and handling practices; pre-wetting and anti-icing programs; consideration of alternative nonchloride products; and chloride monitoring in streams to demonstrate program effectiveness. The 2010 study, a follow-up of the 2007 study, determined that some communities had partially implemented some of the recommended deicing measures and had seen reductions in chloride applications.

A 2009 article published in *Stormwater* summarizes several different studies of chloride application and reduction programs. Chloride reductions of 20 to 30 percent could be attained through several equipment modifications and technologies (Talend, 2009).

The Tollway currently has a program for effective application of deicing materials using BMPs. Consequently achieving salt usage reduction as high as those documented in this study is unlikely.

Chloride Concentration Attenuation

Research has shown that chloride is not removed using traditional BMPs such as wet ponds, but chloride concentration can be reduced or increased as runoff flows through BMPs (USGS, 2001). The 2001 USGS study looked specifically at the concentration of chloride (and other pollutants) at the entrance and exit of a vegetated storm water detention basin. The study basin was a mixture of open water and vegetated areas. The report concluded that chloride concentration can be reduced during large winter storm events (up to 30 percent reduction), but then during smaller storm events in other seasons an increase in chloride concentration was observed (over 200 percent increase measured). The USGS study summarized chloride concentration changes from storm events year round. Since chloride is not absorbed in the ground or used by vegetation, any chloride that may temporarily reside in a pond or swale during large storms will be released during a subsequent storm.

Although the overall mass of chloride was not reduced, the chloride concentration was reduced during the peak times of the year that salt is applied (during the winter months).

During spring, summer, and fall, the concentration of chloride leaving the basin was higher than what was entering the basin. Therefore, if storm water is directed to a detention basin, the peak chloride concentration is reduced in winter but conveyed to waterways through the entire year. The observation that the storm water BMP stored chloride in the winter would have the net result of reducing the peak chloride concentration during the winter.

Table 4 summarizes the chloride concentrations in project subwatersheds with a 20 percent reduction in the peak annual daily concentration. A 20 percent reduction was selected to represent a conservative estimate of the reduction in peak chloride loading reported by the 2001 USGS study and is intended to provide a conservative assumption since BMPs planned for the project (dry ponds, swales, and wet ponds) are not the same as that found in the study. Use of a 20 percent reduction is conservative based on reductions of up to 30 percent seen during the winter storm events in the 2001 USGS study. The 20 percent reduction in the peak chloride loading will still enter the waterway during subsequent storms; most likely during non-winter months, when loading from other chloride sources is lower. Subwatersheds after assuming this 20 percent reduction that still exceed the chloride water quality standard of 500 mg/L are highlighted in red.

TABLE 4
Summary of Chloride Loading and 20 Percent Reduction in Peak Chloride Loading

	Initial Construction Phase Condition			2040 Build Condition		
	Salt Applied, tons/lane-mile	**Ann. Daily Max Cl, mg/L**	**20 Percent Reduction Max Cl, mg/L**	**Salt Applied, tons/mile**	**Ann. Daily Max Cl, mg/L**	**20 Percent Reduction Max Cl, mg/L**
Salt Creek Watershed						
Spring Brook Creek	39.7	520	416	39.7	520	416
Meacham Creek	39.7	765	612	39.7	842	674
Salt Creek (main stem)	39.7	75	60	39.7	84	67
Addison Creek	39.7	716	573	39.7	716	573
Des Plaines River Watershed						
Willow Creek	39.7	376	301	39.7	492	394
Higgins Creek	39.7	658	526	39.7	658	526
Bensenville Ditch	39.7	415	332	39.7	415	332
Silver Creek	39.7	431	345	39.7	431	345
West Branch DuPage River Watershed						
West Branch DuPage River	39.7	156	125	39.7	156	125

Note: Silver Creek includes upstream loading from Bensenville Ditch.

Values shown in red exceed the chloride water quality standard of 500 mg/L.

A peak reduction of 20 percent reduced the chloride concentration within the Spring Brook Creek subwatershed to less than the water quality standard of 500 mg/L for the initial construction phase and the 2040 Build Conditions. Addison Creek, Meacham Creek, and Higgins Creek subwatersheds still experience chloride concentrations that exceed the water quality standard for both initial construction phase and 2040 Build Conditions.

Consequently, considering peak chloride concentration attenuation from storm water BMPs by itself will not meet water quality standard.

Because the BMPs planned for this project are not always the same at that studied in the 2001 USGS study, adjustments to planned BMPs, especially in subwatersheds with predicted high chloride concentration may be needed to obtain the chloride concentration reductions observed in the study. As storm water BMPs are implemented and performance observed, additional information will be gained and opportunities to reduce peak chloride concentration watersheds could emerge. However, even with BMPs, the chloride water quality standard will be exceeded in some watersheds. Mitigation measures could be considered and advancements in deicing technology develop that may reduce the peak chloride concentration over time.

Mitigation

Deicing (e.g., salt application) of highways is necessary during the winter months for safety reasons. As a result, chloride water quality standards may be exceeded in some of the project corridor watersheds. The following measures will be used to minimize potential water quality impacts from deicing associated with the proposed improvements:

- Implementing stormwater BMPs (in accordance with FAA wildlife hazard guidelines, to the extent practicable) to reduce peak chloride concentrations consistent with the findings of USGS (Sherwood, 2001)
- Promoting weather-related data sharing between the Illinois Tollway and local communities to achieve more effective deicing material application based upon available pavement temperature and weather forecasts
- Strengthening watershed collaboration with the DRSCW by exploring opportunities for sponsoring research and assisting in a regional capital improvements for the reduction of chloride concentrations within the sub-watershed areas. By assisting with regional capital improvements through the DRSCW, member communities and groups will have the opportunity to receive assistance in up-grading salt application equipment to current standards thereby reducing application rates and chloride concentrations within the watersheds. Additionally, sponsoring research to explore the effectiveness of BMPs on reducing chloride concentrations in area watersheds, especially in the Meacham Creek watershed and west of I-290 where construction would commence as an initial phase of project implementation. Initially, pilot tests would be used to document the practicality of these chloride BMPs. The more promising findings will be considered further for implementation as part of subsequent phases of the EO-WB project. BMPs with successful test results would be implemented, where practical and feasible, with an emphasis on watersheds with chloride impairments.

Implementing these measures may help to mitigate the potential future impact from salt use and could provide guidance for future highway projects.

Through active participation in the DuPage River Salt Creek Workgroup the Tollway Authority will aid in the understanding of water quality issues in the entire watershed and will help disseminate information to numerous entities collaboratively working towards water quality improvement. Data from the DuPage River Salt Creek Workgroup chloride monitoring sites on the West Branch DuPage River and Salt Creek watersheds indicates the average chloride concentration during the winter deicing season can often exceed the water quality standard. Working collaboratively with other deicing agencies in the watershed could lead to more efficient salt usage over time.

Chloride total maximum daily loads have been developed for the West Branch DuPage River and Salt Creek watersheds and are in draft form for Higgins Creek. The Salt Creek watershed includes Meacham Creek, Spring Brook Creek, the Salt Creek main stem, and Addison Creek. BMPs for using best practices for roadway deicing have been disseminated through the DuPage River Salt Creek Workgroup and others to deicing organizations within the watersheds. Deicing BMPs will be used to minimize deicing material usage while balancing public safety. All entities conducting deicing activities in the watershed will benefit from working together to improve deicing management practices.

Sharing information between the Tollway Authority and local communities may help to reduce overall chloride loading within the watersheds. Shared information may include new deicing technology, weather forecasting, pavement temperature data, and chloride research findings.

Supporting research into new deicing technology effectiveness, measuring BMP performance, and resulting water quality will help mitigate the potential future impact from salt use and further inform future highway projects.

Alternate Deicers

Alternative deicers are described in detail in the report, *Total Maximum Daily Loads for West Branch DuPage River* (CH2M HILL, 2003) and summarized here to provide a context for the potential use of alternative deicers to reduce salt usage and meet the chloride water quality standard. Cost information was not updated to present day values. Use of alternatives such as calcium chloride and calcium magnesium acetate may be less environmentally harmful to sensitive ecosystems. These alternatives are more expensive than regular salt but less corrosive to bridges and overpasses (see Tables 5 and 6).

Conclusions

The chloride contribution from the EO-WB project will likely exceed the chloride water quality standard even when using BMPs. The additional chloride load anticipated with the EO-WB project provides both a challenge and unique opportunity for collaboration with other chloride users in the watersheds to promote sustainable deicing. A potential innovative approach includes taking a leadership role in conducting research and working with local collaborations with the goal of lowering chloride concentration over time in the watersheds crossed by the project.

TABLE 5
Alternative Road Deicers: Temperature, Cost, and Environmental Considerations

Check the Label For	Works Down to:	Cost is:	Environmental Impacts
Calcium magnesium acetate (CMA)	22°F to 25°F	20x more than rock salt	(+) less toxic but has dissolved oxygen impacts
Calcium chloride (CaCl)	-25°F	3x more than rock salt	(+) Can use lower doses (+) No cyanide (-) Chloride impact
Urea	20°F to 25°F	5x more than rock salt	(+) Less corrosion (-) Adds needless nutrients but has dissolved oxygen impacts
Sand	No melting effect	~$3 for a 50 lb bag	(-) Accumulates in streets and streams
Sodium chloride (NaCl; rock salt)	15°F	~$5 for a 50 lb bag	(-) Contains cyanide (-) Chloride Impact

Source: Envirocast Newsletter. Volume 1, No. 3. http://www.stormcenter.com/envirocast/2003-01-01. January 2003.

TABLE 6
Alternative Road Deicers: Temperature and Cost Considerations

Deicer	Minimum Operating Temperature	Cost ($/lane mile/season)
Sodium chloride	12°F	$6,371–6,909
Calcium chloride	-20°F	$6,977–7,529
CG-90 Surface Saver[a]	1°F	$5,931–6148
Calcium magnesium acetate	23°F	$12,958–16,319

[a]CG-90 is a combination of sodium and magnesium chloride with additives. *Source:* Center for Watershed Protection. *Stormwater BMP Design Supplement for Cold Climates.* Prepared for USEPA. December 1997.

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Attachment 1-A

Chloride Analysis Calculations

Chloride Concentration Inputs and Calculation Results

Condition	Drainage Area, sq mi	Lane Miles	Slope, ft/mi	Annual Precip, in	Salt Applied, tons/mi	Salt Applied, tons	Ann Avg Flow, cfs	Storage	Ann. Daily Avg Cl, mg/l	Ann. Daily Max Cl, mg/l	Chloride Load, tons
Addision Creek											
Existing	6	47.52	4.89	36.27	39.74	1888	9.00	0.00	255	467	1503
Proposed - ICP	6	74.39	4.89	36.27	39.74	2956	9.00	0.00	400	716	2374
Proposed 2040 NB	6	55.56	4.89	36.27	39.74	2208	9.00	0.00	299	541	1764
Proposed 2040 Build	6	74.39	4.89	36.27	39.74	2956	9.00	0.00	400	716	2374
Bensenville Ditch											
Existing	1.9	0.92	10.31	36.27	39.74	37	2.98	0.00	15	52	-8
Proposed - ICP	1.9	13.89	10.31	36.27	39.74	552	2.98	0.00	225	415	412
Proposed 2040 NB	1.9	0.92	10.31	36.27	39.74	37	2.98	0.00	15	52	-8
Proposed 2040 Build	1.9	13.89	10.31	36.27	39.74	552	2.98	0.00	225	415	412
Silver Creek											
Existing	6.5	12.84	6.93	36.27	39.74	510	9.72	0.00	64	136	379
Proposed - ICP	6.5	47.19	6.93	36.27	39.74	1875	9.72	0.00	235	431	1492
Proposed - ICP SILVER ONLY	6.5	33.30	6.93	36.27	39.74	1323	9.72	0.00	166	312	1042
Proposed 2040 NB	6.5	12.84	6.93	36.27	39.74	510	9.72	0.00	64	136	379
Proposed 2040 NB SILVER ONLY	6.5	11.92	6.93	36.27	39.74	474	9.72	0.00	59	128	349
Proposed 2040 Build	6.5	47.19	6.93	36.27	39.74	1875	9.72	0.00	235	431	1492
Proposed 2040 Build SILVER ONLY	6.5	33.30	6.93	36.27	39.74	1323	9.72	0.00	166	312	1042
Willow Creek											
Existing	6	0.00	4.56	36.27	39.74	0	9.00	0.00	not applicable	not applicable	-38
Proposed - ICP	6	37.72	4.56	36.27	39.74	1499	9.00	0.00	202	376	1185
Proposed 2040 NB	6	0.00	4.56	36.27	39.74	0	9.00	0.00	not applicable	not applicable	-38
Proposed 2040 Build	6	50.29	4.56	36.27	39.74	1999	9.00	0.00	270	492	1593
Higgins Creek											
Existing	7	44.87	16.44	36.27	39.74	1783	10.44	0.00	208	385	1417
Proposed - ICP	7	78.99	16.44	36.27	39.74	3139	10.44	0.00	367	658	2524
Proposed 2040 NB	7	58.63	16.44	36.27	39.74	2330	10.44	0.00	272	495	1863
Proposed 2040 Build	7	78.99	16.44	36.27	39.74	3139	10.44	0.00	367	658	2524
Salt Creek											
Existing	71	23.46	8.63	36.27	39.74	932	96.73	0.00	11	46	723
Proposed - ICP	71	56.15	8.63	36.27	39.74	2231	96.73	0.00	28	75	1783
Proposed 2040 NB	71	23.46	8.63	36.27	39.74	932	96.73	0.00	11	46	723
Proposed 2040 Build	71	67.04	8.63	36.27	39.74	2664	96.73	0.00	33	84	2136
Meacham Creek											
Existing	2.9	27.14	15.7	36.27	39.74	1079	4.48	0.00	294	532	842
Proposed - ICP	2.9	39.61	15.7	36.27	39.74	1574	4.48	0.00	429	765	1247
Proposed 2040 NB	2.9	27.14	15.7	36.27	39.74	1079	4.48	0.00	294	532	842
Proposed 2040 Build	2.9	43.77	15.7	36.27	39.74	1739	4.48	0.00	474	842	1381
Spring Brook Creek											
Existing	1.2	6.21	12.02	36.27	39.74	247	1.92	0.00	157	296	164
Proposed - ICP	1.2	11.34	12.02	36.27	39.74	450	1.92	0.00	286	520	330
Proposed 2040 NB	1.2	6.21	12.02	36.27	39.74	247	1.92	0.00	157	296	164
Proposed 2040 Build	1.2	11.34	12.02	36.27	39.74	450	1.92	0.00	286	520	330
West Branch DuPage River											
Existing	4.5	6.89	6.87	36.27	39.74	274	6.83	0.00	48	110	186
Proposed - ICP	4.5	10.62	6.87	36.27	39.74	422	6.83	0.00	75	156	307
Proposed 2040 NB	4.5	6.89	6.87	36.27	39.74	274	6.83	0.00	48	110	186
Proposed 2040 Build	4.5	10.62	6.87	36.27	39.74	422	6.83	0.00	75	156	307

Attachment 2

INHS Water Quality Summary Data

INHS Water Quality Summary Data

Site Number	Habitat	Constituent	June 16, 2009	August 10, 2009	October 28, 2009	May 27, 2010	June 24, 2010
ACGA	Addison Creek, at Grand Ave	TSS		Not tested for		NA	
		Copper, mg/L	0.01296	0.01079	0.01050		
		Lead, mg/L	< 0.041	< 0.041	< 0.041		
		Zinc, mg/L	0.01900	0.03080	0.13700		
		Chloride, mg/L	181	158	199		
WCYR	Willow Creek at York Road	TSS		Not tested for			
		Copper, mg/L	0.01782	0.03156	0.00536		
		Lead, mg/L	< 0.041	< 0.041	< 0.041		
		Zinc, mg/L	0.0219	0.009	0.158		
		Chloride, mg/L	302	140	167		
HC190	Higgins Creek upstream I-90	TSS		Not tested for			
		Copper, mg/L	0.01704	0.03006	0.00990		
		Lead, mg/L	< 0.041	< 0.041	< 0.041		
		Zinc, mg/L	0.07340	0.19540	0.15100		
		Chloride, mg/L	224	113	146		
SCTA	Salt Creek upstream Thorndale Ave.	TSS		Not tested for			
		Copper, mg/L	0.00853	0.01285	0.00606		
		Lead, mg/L	< 0.041	< 0.041	< 0.041		
		Zinc, mg/L	0.0133	0.02	0.187		
		Chloride, mg/L	309	181	189		
MCMR	Meacham Creek at Medinah Road	TSS		Not tested for			
		Copper, mg/L	0.00588	0.00717	0.01080		
		Lead, mg/L	< 0.041	< 0.041	< 0.041		
		Zinc, mg/L	0.00970	0.00770	0.11100		
		Chloride, mg/L	330	154	112		
2010-06	Spring Brook	TSS	NA			Not tested for	
		Copper, mg/L				0.00413	0.0068
		Lead, mg/L				< 0.041	< 0.041
		Zinc, mg/L				0.0082	0.0179
		Chloride, mg/L				211	155
2010-07	West Branch DuPage River	TSS				Not tested for	
		Copper, mg/L				0.0059	0.00686
		Lead, mg/L				< 0.041	< 0.041
		Zinc, mg/L				0.0147	0.0459
		Chloride, mg/L				203	154

Attachment 3
FHWA Methodology Worksheets

Site: Addison Creek

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	Copper	Lead	Zinc	TSS	Copper	Lead	Zinc	
Table 1. Worksheet A - Site Characteristics										
1. Drainage Area of Highway Segment (Section 2.1)										
a. Total right of way	AROW	62.74	62.74	62.74	62.74	83.37	83.37	83.37	83.37	Acres
b. Paved surface	AHWY	62.74	62.74	62.74	62.74	83.37	83.37	83.37	83.37	Acres
c. Percent Impervous	IMP	100	100	100	100	100	100	100	100	%
2. Rainfall Characteristics (section 2.2)	MEAN									
a. Volume	MVP	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	inch
b. Intensity	MIP	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	inch/hour
c. Duration	MDP	14.14	14.14	14.14	14.14	14.14	14.14	14.14	14.14	hour
d. Interval	MTP	155.11	155.11	155.11	155.11	155.11	155.11	155.11	155.11	hour
	COEF of VARIATION									
e. Volume	CVVP	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless
f. Intensity	CVIP	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
g. Duration	CVDP	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	dimensionless
h. Interval	CVTP	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	dimensionless
i. Number of storms per year (24*365/MTP)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	no. events
3. Surrounding Area Type										
a. ADT ususally over 30,000 vehicles/day	Urban	x	x	x	x	x	x	x	x	
or										
b. ADT usually under 30,000 vpd, undeveloped or suburban	Rural									
4. Select pollutant for analysis (section 2.4) and estimate runoff quality characteristics (use table 3)		**TSS**	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
a. site median concentration	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. coef of variation (0.71 urban, 0.84 Rural, 0.75 estimate for all sites)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
5. Select receiving water target concentration (section 2.6)										
Surface water Total Hardness (Figure 5)	TH	290	290	290	290	290	290	290	290	mg/l
STREAM -use table 4 for target concentration										
a. EPA Acute Criterion		1500	0.046	0.236	0.295	1500	0.046	0.236	0.295	mg/l
b. suggested Threshold Effect Level		none	0.028	0.050	0.077	none	0.028	0.050	0.077	mg/l
or										
LAKE - use accepted level for average Phosphorus concentration										
c. target concentration is 10 micrograms/liter		10	10	10	10	10	10	10	10	ug/l
6. Watershed Drainage Area	ATOT	6	6	6	6	6	6	6	6	square miles
upstream of highway for a stream - total contributing area for a lake										
7. Average annual stream flow (section 2.3)										
a. unit area flow rate per square mile (figure 4)	QSM	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	cfs/square miles
b. Coef of variation of stream flows (section 2.3)	CVQS	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	dimensionless
c. Average stream flow (QSM*ATOT)	MQS	7.79	7.79	7.79	7.79	7.79	7.79	7.79	7.79	cfs
Table 5. Worksheet B - Highway Runoff Characteristics										
1. Compute runoff coefficient (Rv) (section 3.1)										
a. Percent Impervious (Worksheet A - Item 1c)	IMP	100	100	100	100	100	100	100	100	%
b. Runoff Coefficient (=0.007*IMP+0.1)	Rv	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	ratio
2. Compute runoff flow rates (section 3.1)										
a. Flow rate from mean storm										
=Rv*MIP*AROW	MQR	3.505	3.505	3.505	3.505	4.657	4.657	4.657	4.657	cfs
b. Coefficient of variation of runoff flows										
=CVIP (worksheet A - Item 2f)	CVVR	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
3. Compute runoff volumes (section 3.1)										
a. Volume from the mean storm										
=Rv*MVP*AROW*3630	MVR	75754.4	75754.4	75754.4	75754.4	100663.7	100663.7	100663.7	100663.7	cubic feet
b. Coefficient of variation of runoff volumes										
=CVVP (worksheet A - Item 2e)	CVVR	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless

Site: Addison Creek
Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
4. Compute mass loads (section 3.2)										
Site Median Conc (worksheet A - Item 4a)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
Number of storms per year (Worksheet A - 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
a. mean event concentration (MCR)										
=TCR*SQRT(1+CVCR^2)	MCR	174.2	0.1	0.0	0.2	174.2	0.1	0.0	0.2	mg/l
b. mean event mass load										
=MCR*MVR*(0.00006245)	M(MASS)	823.885	0.238	0.145	1.085	1094.793	0.316	0.193	1.442	pounds
c. annual mass laod from runoff										
=M(MASS)*NST	ANMASS	46529.695	13.435	8.192	61.275	61829.465	17.852	10.885	81.423	pounds/year
5. Compute flow ratio (MQS/MQR) (section 3.3)										
a. ratio of average stream flow										
(worksheet A-7b) to MQR	MQS/MQR	2.223	2.223	2.223	2.223	1.673	1.673	1.673	1.673	ratio
Table 6. Worksheet C - Stream Impact Analysis										
1. Define the flow ratio MQS/MQR (Worksheet B-5a)	MQS/MQR	2.223	2.223	2.223	2.223	1.673	1.673	1.673	1.673	ratio
2. Compute the event frequency for a 3 year recurrence interval										
a. Enter the average number of storms per year										
(from Worksheet A - Item 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
b. Compute the probability (%) of the 3 year event										
=100*(1/(NST*3))	PR	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	%
3. Enter Value from Table 7 for MQS/MQR and frequency PR	CU	2.01	2.01	2.01	2.01	2.64	2.64	2.64	2.64	mg/l
4. Select pollutant for analysis										Name
a. Site median concentration (table 3)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. Soluble fraction (section 2.5)	FSOL	0.9	0.4	0.1	0.4	0.9	0.4	0.1	0.4	fraction
c. Acute Criteria (table 4)	CTA	1500	0.046	0.236	0.295	1500	0.046	0.236	0.295	mg/l
d. Threshold effects level (Table 4)	CTT	none	0.028	0.050	0.077	none	0.028	0.050	0.077	mg/l
5. Compute the once in 3 year stream pollutant concentration										
=CU*TCR*FSOL	CO	257.35	0.03	0.01	0.15	336.93	0.04	0.01	0.20	mg/l
6. Compare with Target Concentration, CTA										
=CO/CTA	CRAT	0.17	0.71	0.02	0.51	0.22	0.93	0.03	0.67	ratio
6a. Compare with background concentrations		n/a	0.011	< 0.041	0.062	n/a	0.011	< 0.041	0.062	mg/l
7. Evaluate Results										
a. If CRAT is less than about 0.75 a tocicity problem attributable to this pollutant is unlikely		STOP	STOP	STOP	STOP	STOP	STOP	STOP	STOP	
b. If CRAT is greater than 5 reduction will definitely be required. Estimate the level of reduction possible and repeat the analysis with revisted values for either concentration or flow or both		CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	
c. if CRAT is still greater than 1 and greater reduction levels are not practical, estimate the potential for an adverse impact (as opposed to a criteria violation) by a comparison with the threshold effects level)		EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	
=CO/CTT	CRTE	#VALUE!	1.17	0.10	1.96	#VALUE!	1.53	0.13	2.56	ratio

Site: Bensenville Ditch
Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	Copper	Lead	Zinc	TSS	Copper	Lead	Zinc	
Table 1. Worksheet A - Site Characteristics										
1. Drainage Area of Highway Segment (Section 2.1)										
a. Total right of way	AROW	11.9	11.9	11.9	11.9	27.98	27.98	27.98	27.98	Acres
b. Paved surface	AHWY	11.9	11.9	11.9	11.9	27.98	27.98	27.98	27.98	Acres
c. Percent Impervous	IMP	100	100	100	100	100	100	100	100	%
2. Rainfall Characteristics (section 2.2)	MEAN									
a. Volume	MVP	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	inch
b. Intensity	MIP	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	inch/hour
c. Duration	MDP	14.14	14.14	14.14	14.14	14.14	14.14	14.14	14.14	hour
d. Interval	MTP	155.11	155.11	155.11	155.11	155.11	155.11	155.11	155.11	hour
	COEF of VARIATION									
e. Volume	CVVP	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless
f. Intensity	CVIP	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
g. Duration	CVDP	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	dimensionless
h. Interval	CVTP	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	dimensionless
i. Number of storms per year (24*365/MTP)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	no. events
3. Surrounding Area Type										
a. ADT ususally over 30,000 vehicles/day	Urban	x	x	x	x	x	x	x	x	
or										
b. ADT usually under 30,000 vpd, undeveloped or suburban	Rural									
4. Select pollutant for analysis (section 2.4) and estimate runoff quality characteristics (use table 3)		**TSS**	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
a. site median concentration	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. coef of variation (0.71 urban, 0.84 Rural, 0.75 estimate for all sites)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
5. Select receiving water target concentration (section 2.6)										
Surface water Total Hardness (Figure 5)	TH	229	229	229	229	229	229	229	229	mg/l
STREAM -use table 4 for target concentration										
a. EPA Acute Criterion		1500	0.037	0.184	0.241	1500	0.037	0.184	0.241	mg/l
b. suggested Threshold Effect Level		none	0.023	0.039	0.063	none	0.023	0.039	0.063	mg/l
or										
LAKE - use accepted level for average Phosphorus concentration										
c. target concentration is 10 micrograms/liter		10	10	10	10	10	10	10	10	ug/l
6. Watershed Drainage Area	ATOT	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	square miles
upstream of highway for a stream - total contributing area for a lake										
7. Average annual stream flow (section 2.3)										
a. unit area flow rate per square mile (figure 4)	QSM	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	cfs/square miles
b. Coef of variation of stream flows (section 2.3)	CVQS	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	dimensionless
c. Average stream flow (QSM*ATOT)	MQS	2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.47	cfs
Table 5. Worksheet B - Highway Runoff Characteristics										
1. Compute runoff coefficient (Rv) (section 3.1)										
a. Percent Impervious (Worksheet A - Item 1c)	IMP	100	100	100	100	100	100	100	100	%
b. Runoff Coefficient (=0.007*IMP+0.1)	Rv	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	ratio
2. Compute runoff flow rates (section 3.1)										
a. Flow rate from mean storm										
=Rv*MIP*AROW	MQR	0.665	0.665	0.665	0.665	1.563	1.563	1.563	1.563	cfs
b. Coefficient of variation of runoff flows										
=CVIP (worksheet A - Item 2f)	CVVR	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
3. Compute runoff volumes (section 3.1)										
a. Volume from the mean storm										
=Rv*MVP*AROW*3630	MVR	14368.5	14368.5	14368.5	14368.5	33784.0	33784.0	33784.0	33784.0	cubic feet
b. Coefficient of variation of runoff volumes										
=CVVP (worksheet A - Item 2e)	CVVR	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless

Site: Bensenville Ditch
Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
4. Compute mass loads (section 3.2)										
Site Median Conc (worksheet A - Item 4a)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
Number of storms per year (Worksheet A - 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
a. mean event concentration (MCR)										
=TCR*SQRT(1+CVCR^2)	MCR	174.2	0.1	0.0	0.2	174.2	0.1	0.0	0.2	mg/l
b. mean event mass load										
=MCR*MVR*(0.00006245)	M(MASS)	156.268	0.045	0.028	0.206	367.426	0.106	0.065	0.484	pounds
c. annual mass laod from runoff										
=M(MASS)*NST	ANMASS	8825.364	2.548	1.554	11.622	20750.731	5.991	3.653	27.327	pounds/year
5. Compute flow ratio (MQS/MQR) (section 3.3)										
a. ratio of average stream flow										
(worksheet A-7b) to MQR	MQS/MQR	3.712	3.712	3.712	3.712	1.579	1.579	1.579	1.579	ratio
Table 6. Worksheet C - Stream Impact Analsysis										
1. Define the flow ratio MQS/MQR (Worksheet B-5a)	MQS/MQR	3.712	3.712	3.712	3.712	1.579	1.579	1.579	1.579	ratio
2. Compute the event frequency for a 3 year recurrence interval										
a. Enter the average number of storms per year										
(from Worksheet A - Item 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
b. Compute the probability (%) of the 3 year event										
=100*(1/(NST*3))	PR	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	%
3. Enter Value from Table 7 for MQS/MQR and frequency PR	CU	2.15	2.15	2.15	2.15	2.69	2.69	2.69	2.69	mg/l
4. Select pollutant for analysis										Name
a. Site median concentration (table 3)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. Soluble fraction (section 2.5)	FSOL	0.9	0.4	0.1	0.4	0.9	0.4	0.1	0.4	fraction
c. Acute Criteria (table 4)	CTA	1500	0.037	0.184	0.241	1500	0.037	0.184	0.241	mg/l
d. Threshold effects level (Table 4)	CTT	none	0.023	0.039	0.063	none	0.023	0.039	0.063	mg/l
5. Compute the once in 3 year stream pollutant concentration										
=CU*TCR*FSOL	CO	274.29	0.04	0.01	0.16	343.70	0.04	0.01	0.20	mg/l
6. Compare with Target Concentration, CTA										
=CO/CTA	CRAT	0.18	0.95	0.03	0.67	0.23	1.19	0.04	0.83	ratio
6a. Compare with background concentrations										mg/l
7. Evaluate Results										
a. If CRAT is less than about 0.75 a tocicity problem attributable to this pollutant is unlikely		STOP	STOP	STOP	STOP	STOP	STOP	STOP	STOP	
b. If CRAT is greater than 5 reduction will definitely be required. Estimate the level of reduction possible and repeat the analysis with revisted values for either concentration or flow or both		CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	
c. if CRAT is still greater than 1 and greater reduction levels are not practical, estimate the potential for an adverse impact (as opposed to a criteria violation) by a comparison with the threshold effects level)		EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	
=CO/CTT	CRTE	#VALUE!	1.53	0.14	2.55	#VALUE!	1.91	0.17	3.19	ratio

Site: Higgins Creek

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	Copper	Lead	Zinc	TSS	Copper	Lead	Zinc	
Table 1. Worksheet A - Site Characteristics										
1. Drainage Area of Highway Segment (Section 2.1)										
a. Total right of way	AROW	121.76	121.76	121.76	121.76	184.59	184.59	184.59	184.59	Acres
b. Paved surface	AHWY	121.76	121.76	121.76	121.76	184.59	184.59	184.59	184.59	Acres
c. Percent Impervous	IMP	100	100	100	100	100	100	100	100	%
2. Rainfall Characteristics (section 2.2)	MEAN									
a. Volume	MVP	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	inch
b. Intensity	MIP	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	inch/hour
c. Duration	MDP	14.14	14.14	14.14	14.14	14.14	14.14	14.14	14.14	hour
d. Interval	MTP	155.11	155.11	155.11	155.11	155.11	155.11	155.11	155.11	hour
	COEF of VARIATION									
e. Volume	CVVP	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless
f. Intensity	CVIP	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
g. Duration	CVDP	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	dimensionless
h. Interval	CVTP	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	dimensionless
i. Number of storms per year (24*365/MTP)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	no. events
3. Surrounding Area Type										
a. ADT ususally over 30,000 vehicles/day	Urban	x	x	x	x	x	x	x	x	
or										
b. ADT usually under 30,000 vpd, undeveloped or suburban	Rural									
4. Select pollutant for analysis (section 2.4) and estimate runoff quality characteristics (use table 3)		**TSS**	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
a. site median concentration	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. coef of variation (0.71 urban, 0.84 Rural, 0.75 estimate for all sites)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
5. Select receiving water target concentration (section 2.6)										
Surface water Total Hardness (Figure 5)	TH	278	278	278	278	278	278	278	278	mg/l
STREAM -use table 4 for target concentration										
a. EPA Acute Criterion		1500	0.045	0.226	0.284	1500	0.045	0.226	0.284	mg/l
b. suggested Threshold Effect Level		none	0.027	0.047	0.074	none	0.027	0.047	0.074	mg/l
or										
LAKE - use accepted level for average Phosphorus concentration										
c. target concentration is 10 micrograms/liter		10	10	10	10	10	10	10	10	ug/l
6. Watershed Drainage Area	ATOT	7	7	7	7	7	7	7	7	square miles
upstream of highway for a stream - total contributing area for a lake										
7. Average annual stream flow (section 2.3)										
a. unit area flow rate per square mile (figure 4)	QSM	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	cfs/square miles
b. Coef of variation of stream flows (section 2.3)	CVQS	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	dimensionless
c. Average stream flow (QSM*ATOT)	MQS	9.09	9.09	9.09	9.09	9.09	9.09	9.09	9.09	cfs
Table 5. Worksheet B - Highway Runoff Characteristics										
1. Compute runoff coefficient (Rv) (section 3.1)										
a. Percent Impervious (Worksheet A - Item 1c)	IMP	100	100	100	100	100	100	100	100	%
b. Runoff Coefficient (=0.007*IMP+0.1)	Rv	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	ratio
2. Compute runoff flow rates (section 3.1)										
a. Flow rate from mean storm										
=Rv*MIP*AROW	MQR	6.802	6.802	6.802	6.802	10.312	10.312	10.312	10.312	cfs
b. Coefficient of variation of runoff flows										
=CVIP (worksheet A - Item 2f)	CVVR	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
3. Compute runoff volumes (section 3.1)										
a. Volume from the mean storm										
=Rv*MVP*AROW*3630	MVR	147017.1	147017.1	147017.1	147017.1	222880.1	222880.1	222880.1	222880.1	cubic feet
b. Coefficient of variation of runoff volumes										
=CVVP (worksheet A - Item 2e)	CVVR	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless

Site: Higgins Creek

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
4. Compute mass loads (section 3.2)										
Site Median Conc (worksheet A - Item 4a)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
Number of storms per year (Worksheet A - 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
a. mean event concentration (MCR)										
=TCR*SQRT(1+CVCR^2)	MCR	174.2	0.1	0.0	0.2	174.2	0.1	0.0	0.2	mg/l
b. mean event mass load										
=MCR*MVR*(0.00006245)	M(MASS)	1598.921	0.462	0.282	2.106	2423.988	0.700	0.427	3.192	pounds
c. annual mass laod from runoff										
=M(MASS)*NST	ANMASS	90300.536	26.073	15.898	118.917	136896.977	39.527	24.102	180.280	pounds/year
5. Compute flow ratio (MQS/MQR) (section 3.3)										
a. ratio of average stream flow										
(worksheet A-7b) to MQR	MQS/MQR	1.336	1.336	1.336	1.336	0.882	0.882	0.882	0.882	ratio
Table 6. Worksheet C - Stream Impact Analysis										
1. Define the flow ratio MQS/MQR (Worksheet B-5a)	MQS/MQR	1.336	1.336	1.336	1.336	0.882	0.882	0.882	0.882	ratio
2. Compute the event frequency for a 3 year recurrence interval										
a. Enter the average number of storms per year										
(from Worksheet A - Item 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
b. Compute the probability (%) of the 3 year event										
=100*(1/(NST*3))	PR	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	%
3. Enter Value from Table 7 for MQS/MQR and frequency PR	CU	2.82	2.82	2.82	2.82	3.18	3.18	3.18	3.18	mg/l
4. Select pollutant for analysis										Name
a. Site median concentration (table 3)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. Soluble fraction (section 2.5)	FSOL	0.9	0.4	0.1	0.4	0.9	0.4	0.1	0.4	fraction
c. Acute Criteria (table 4)	CTA	1500	0.045	0.226	0.284	1500	0.045	0.226	0.284	mg/l
d. Threshold effects level (Table 4)	CTT	none	0.027	0.047	0.074	none	0.027	0.047	0.074	mg/l
5. Compute the once in 3 year stream pollutant concentration										
=CU*TCR*FSOL	CO	360.96	0.05	0.01	0.21	407.01	0.05	0.01	0.24	mg/l
6. Compare with Target Concentration, CTA										
=CO/CTA	CRAT	0.24	1.04	0.03	0.74	0.27	1.17	0.04	0.84	ratio
6a. Compare with background concentrations		n/a	0.019	< 0.041	0.140	n/a	0.019	< 0.041	0.140	mg/l
7. Evaluate Results										
a. If CRAT is less than about 0.75 a tocicity problem attributable to this pollutant is unlikely		STOP	STOP	STOP	STOP	STOP	STOP	STOP	STOP	
b. If CRAT is greater than 5 reduction will definitely be required. Estimate the level of reduction possible and repeat the analysis with revisted values for either concentration or flow or both		CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	
c. if CRAT is still greater than 1 and greater reduction levels are not practical, estimate the potential for an adverse impact (as opposed to a criteria violation) by a comparison with the threshold effects level)		EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	
=CO/CTT	CRTE	#VALUE!	1.70	0.15	2.84	#VALUE!	1.92	0.17	3.20	ratio
Background value			**0.011**	**<0.041**	**0.062**		**0.011**	**<0.041**	**0.062**	

Site: Meacham Creek

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
Table 1. Worksheet A - Site Characteristics										
1. Drainage Area of Highway Segment (Section 2.1)										
a. Total right of way	AROW	50.16	50.16	50.16	50.16	78.73	78.73	78.73	78.73	Acres
b. Paved surface	AHWY	50.16	50.16	50.16	50.16	78.73	78.73	78.73	78.73	Acres
c. Percent Impervous	IMP	100	100	100	100	100	100	100	100	%
2. Rainfall Characteristics (section 2.2)	MEAN									
a. Volume	MVP	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	inch
b. Intensity	MIP	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	inch/hour
c. Duration	MDP	14.14	14.14	14.14	14.14	14.14	14.14	14.14	14.14	hour
d. Interval	MTP	155.11	155.11	155.11	155.11	155.11	155.11	155.11	155.11	hour
	COEF of VARIATION									
e. Volume	CVVP	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless
f. Intensity	CVIP	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
g. Duration	CVDP	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	dimensionless
h. Interval	CVTP	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	dimensionless
i. Number of storms per year (24*365/MTP)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	no. events
3. Surrounding Area Type										
a. ADT ususally over 30,000 vehicles/day	Urban	x	x	x	x	x	x	x	x	
or										
b. ADT usually under 30,000 vpd, undeveloped or suburban	Rural									
4. Select pollutant for analysis (section 2.4) and estimate runoff quality characteristics (use table 3)		**TSS**	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
a. site median concentration	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. coef of variation (0.71 urban, 0.84 Rural, 0.75 estimate for all sites)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
5. Select receiving water target concentration (section 2.6)										
Surface water Total Hardness (Figure 5)	TH	308	308	308	308	308	308	308	308	mg/l
STREAM -use table 4 for target concentration										
a. EPA Acute Criterion		1500	0.049	0.251	0.310	1500	0.049	0.251	0.310	mg/l
b. suggested Threshold Effect Level		none	0.030	0.053	0.081	none	0.030	0.053	0.081	mg/l
or										
LAKE - use accepted level for average Phosphorus concentration										
c. target concentration is 10 micrograms/liter		10	10	10	10	10	10	10	10	ug/l
6. Watershed Drainage Area	ATOT	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	square miles
upstream of highway for a stream - total contributing area for a lake										
7. Average annual stream flow (section 2.3)										
a. unit area flow rate per square mile (figure 4)	QSM	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	cfs/square miles
b. Coef of variation of stream flows (section 2.3)	CVQS	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	dimensionless
c. Average stream flow (QSM*ATOT)	MQS	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	cfs
Table 5. Worksheet B - Highway Runoff Characteristics										
1. Compute runoff coefficient (Rv) (section 3.1)										
a. Percent Impervious (Worksheet A - Item 1c)	IMP	100	100	100	100	100	100	100	100	%
b. Runoff Coefficient (=0.007*IMP+0.1)	Rv	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	ratio
2. Compute runoff flow rates (section 3.1)										
a. Flow rate from mean storm										
=Rv*MIP*AROW	MQR	2.802	2.802	2.802	2.802	4.398	4.398	4.398	4.398	cfs
b. Coefficient of variation of runoff flows										
=CVIP (worksheet A - Item 2f)	CVVR	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
3. Compute runoff volumes (section 3.1)										
a. Volume from the mean storm										
=Rv*MVP*AROW*3630	MVR	60564.9	60564.9	60564.9	60564.9	95061.2	95061.2	95061.2	95061.2	cubic feet
b. Coefficient of variation of runoff volumes										
=CVVP (worksheet A - Item 2e)	CVVR	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless

Site: Meacham Creek

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
4. Compute mass loads (section 3.2)										
Site Median Conc (worksheet A - Item 4a)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
Number of storms per year (Worksheet A - 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
a. mean event concentration (MCR)										
=TCR*SQRT(1+CVCR^2)	MCR	174.2	0.1	0.0	0.2	174.2	0.1	0.0	0.2	mg/l
b. mean event mass load										
=MCR*MVR*(0.00006245)	M(MASS)	658.688	0.190	0.116	0.867	1033.862	0.299	0.182	1.361	pounds
c. annual mass laod from runoff										
=M(MASS)*NST	ANMASS	37200.024	10.741	6.549	48.989	58388.315	16.859	10.280	76.892	pounds/year
5. Compute flow ratio (MQS/MQR) (section 3.3)										
a. ratio of average stream flow										
(worksheet A-7b) to MQR	MQS/MQR	1.344	1.344	1.344	1.344	0.856	0.856	0.856	0.856	ratio
Table 6. Worksheet C - Stream Impact Analysis										
1. Define the flow ratio MQS/MQR (Worksheet B-5a)	MQS/MQR	1.344	1.344	1.344	1.344	0.856	0.856	0.856	0.856	ratio
2. Compute the event frequency for a 3 year recurrence interval										
a. Enter the average number of storms per year										
(from Worksheet A - Item 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
b. Compute the probability (%) of the 3 year event										
=100*(1/(NST*3))	PR	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	%
3. Enter Value from Table 7 for MQS/MQR and frequency PR	CU	2.82	2.82	2.82	2.82	3.22	3.22	3.22	3.22	mg/l
4. Select pollutant for analysis										Name
a. Site median concentration (table 3)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. Soluble fraction (section 2.5)	FSOL	0.9	0.4	0.1	0.4	0.9	0.4	0.1	0.4	fraction
c. Acute Criteria (table 4)	CTA	1500	0.049	0.251	0.310	1500	0.049	0.251	0.310	mg/l
d. Threshold effects level (Table 4)	CTT	none	0.030	0.053	0.081	none	0.030	0.053	0.081	mg/l
5. Compute the once in 3 year stream pollutant concentration										
=CU*TCR*FSOL	CO	360.42	0.05	0.01	0.21	411.71	0.05	0.01	0.24	mg/l
6. Compare with Target Concentration, CTA										
=CO/CTA	CRAT	0.24	0.94	0.03	0.68	0.27	1.08	0.03	0.78	ratio
6a. Compare with background concentrations		n/a	0.008	< 0.041	0.043	n/a	0.008	< 0.041	0.043	mg/l
7. Evaluate Results										
a. If CRAT is less than about 0.75 a tocicity problem attributable to this pollutant is unlikely		STOP	STOP	STOP	STOP	STOP	STOP	STOP	STOP	
b. If CRAT is greater than 5 reduction will definitely be required. Estimate the level of reduction possible and repeat the analysis with revisted values for either concentration or flow or both		CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	
c. if CRAT is still greater than 1 and greater reduction levels are not practical, estimate the potential for an adverse impact (as opposed to a criteria violation) by a comparison with the threshold effects level)		EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	
=CO/CTT	CRTE	#VALUE!	1.56	0.13	2.60	#VALUE!	1.78	0.15	2.97	ratio

Site: Salt Creek

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
Table 1. Worksheet A - Site Characteristics										
1. Drainage Area of Highway Segment (Section 2.1)										
a. Total right of way	AROW	101.54	101.54	101.54	101.54	162.28	162.28	162.28	162.28	Acres
b. Paved surface	AHWY	101.54	101.54	101.54	101.54	162.28	162.28	162.28	162.28	Acres
c. Percent Impervous	IMP	100	100	100	100	100	100	100	100	%
2. Rainfall Characteristics (section 2.2)	MEAN									
a. Volume	MVP	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	inch
b. Intensity	MIP	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	inch/hour
c. Duration	MDP	14.14	14.14	14.14	14.14	14.14	14.14	14.14	14.14	hour
d. Interval	MTP	155.11	155.11	155.11	155.11	155.11	155.11	155.11	155.11	hour
	COEF of VARIATION									
e. Volume	CVVP	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless
f. Intensity	CVIP	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
g. Duration	CVDP	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	dimensionless
h. Interval	CVTP	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	dimensionless
i. Number of storms per year (24*365/MTP)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	no. events
3. Surrounding Area Type										
a. ADT ususally over 30,000 vehicles/day	Urban	x	x	x	x	x	x	x	x	
or										
b. ADT usually under 30,000 vpd, undeveloped or suburban	Rural									
4. Select pollutant for analysis (section 2.4) and estimate runoff quality characteristics (use table 3)		**TSS**	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
a. site median concentration	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. coef of variation (0.71 urban, 0.84 Rural, 0.75 estimate for all sites)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
5. Select receiving water target concentration (section 2.6)										
Surface water Total Hardness (Figure 5)	TH	248	248	248	248	248	248	248	248	mg/l
STREAM -use table 4 for target concentration										
a. EPA Acute Criterion		1500	0.040	0.200	0.258	1500	0.040	0.200	0.258	mg/l
b. suggested Threshold Effect Level		none	0.025	0.042	0.067	none	0.025	0.042	0.067	mg/l
or										
LAKE - use accepted level for average Phosphorus concentration										
c. target concentration is 10 micrograms/liter		10	10	10	10	10	10	10	10	ug/l
6. Watershed Drainage Area	ATOT	71	71	71	71	71	71	71	71	square miles
upstream of highway for a stream - total contributing area for a lake										
7. Average annual stream flow (section 2.3)										
a. unit area flow rate per square mile (figure 4)	QSM	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	cfs/square miles
b. Coef of variation of stream flows (section 2.3)	CVQS	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	dimensionless
c. Average stream flow (QSM*ATOT)	MQS	92.20	92.20	92.20	92.20	92.20	92.20	92.20	92.20	cfs
Table 5. Worksheet B - Highway Runoff Characteristics										
1. Compute runoff coefficient (Rv) (section 3.1)										
a. Percent Impervious (Worksheet A - Item 1c)	IMP	100	100	100	100	100	100	100	100	%
b. Runoff Coefficient (=0.007*IMP+0.1)	Rv	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	ratio
2. Compute runoff flow rates (section 3.1)										
a. Flow rate from mean storm										
=Rv*MIP*AROW	MQR	5.672	5.672	5.672	5.672	9.065	9.065	9.065	9.065	cfs
b. Coefficient of variation of runoff flows										
=CVIP (worksheet A - Item 2f)	CVVR	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
3. Compute runoff volumes (section 3.1)										
a. Volume from the mean storm										
=Rv*MVP*AROW*3630	MVR	122602.8	122602.8	122602.8	122602.8	195942.3	195942.3	195942.3	195942.3	cubic feet
b. Coefficient of variation of runoff volumes										
=CVVP (worksheet A - Item 2e)	CVVR	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless

Site: Salt Creek

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
4. Compute mass loads (section 3.2)										
Site Median Conc (worksheet A - Item 4a)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
Number of storms per year (Worksheet A - 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
a. mean event concentration (MCR)										
=TCR*SQRT(1+CVCR^2)	MCR	174.2	0.1	0.0	0.2	174.2	0.1	0.0	0.2	mg/l
b. mean event mass load										
=MCR*MVR*(0.00006245)	M(MASS)	1333.397	0.385	0.235	1.756	2131.019	0.615	0.375	2.806	pounds
c. annual mass laod from runoff										
=M(MASS)*NST	ANMASS	75304.833	21.743	13.258	99.169	120351.273	34.749	21.189	158.491	pounds/year
5. Compute flow ratio (MQS/MQR) (section 3.3)										
a. ratio of average stream flow										
(worksheet A-7b) to MQR	MQS/MQR	16.255	16.255	16.255	16.255	10.171	10.171	10.171	10.171	ratio
Table 6. Worksheet C - Stream Impact Analsysis										
1. Define the flow ratio MQS/MQR (Worksheet B-5a)	MQS/MQR	16.255	16.255	16.255	16.255	10.171	10.171	10.171	10.171	ratio
2. Compute the event frequency for a 3 year recurrence interval										
a. Enter the average number of storms per year										
(from Worksheet A - Item 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
b. Compute the probability (%) of the 3 year event										
=100*(1/(NST*3))	PR	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	%
3. Enter Value from Table 7 for MQS/MQR and frequency PR	CU	1.33	1.33	1.33	1.33	1.59	1.59	1.59	1.59	mg/l
4. Select pollutant for analysis										Name
a. Site median concentration (table 3)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. Soluble fraction (section 2.5)	FSOL	0.9	0.4	0.1	0.4	0.9	0.4	0.1	0.4	fraction
c. Acute Criteria (table 4)	CTA	1500	0.040	0.200	0.258	1500	0.040	0.200	0.258	mg/l
d. Threshold effects level (Table 4)	CTT	none	0.025	0.042	0.067	none	0.025	0.042	0.067	mg/l
5. Compute the once in 3 year stream pollutant concentration										
=CU*TCR*FSOL	CO	170.54	0.02	0.00	0.10	203.71	0.03	0.00	0.12	mg/l
6. Compare with Target Concentration, CTA										
=CO/CTA	CRAT	0.11	0.55	0.02	0.39	0.14	0.65	0.02	0.46	ratio
6a. Compare with background concentrations		n/a	0.009	< 0.041	0.073	n/a	0.009	< 0.041	0.073	mg/l
7. Evaluate Results										
a. If CRAT is less than about 0.75 a tocicity problem attributable to this pollutant is unlikely		STOP	STOP	STOP	STOP	STOP	STOP	STOP	STOP	
b. If CRAT is greater than 5 reduction will definitely be required. Estimate the level of reduction possible and repeat the analysis with revisted values for either concentration or flow or both		CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	
c. if CRAT is still greater than 1 and greater reduction levels are not practical, estimate the potential for an adverse impact (as opposed to a criteria violation) by a comparison with the threshold effects level)		EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	
=CO/CTT	CRTE	#VALUE!	0.89	0.08	1.48	#VALUE!	1.06	0.09	1.77	ratio

Site: Silver Creek

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
Table 1. Worksheet A - Site Characteristics										
1. Drainage Area of Highway Segment (Section 2.1)										
a. Total right of way	AROW	65.73	65.73	65.73	65.73	73.8	73.8	73.8	73.8	Acres
b. Paved surface	AHWY	65.73	65.73	65.73	65.73	73.8	73.8	73.8	73.8	Acres
c. Percent Impervous	IMP	100	100	100	100	100	100	100	100	%
2. Rainfall Characteristics (section 2.2)	MEAN									
a. Volume	MVP	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	inch
b. Intensity	MIP	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	inch/hour
c. Duration	MDP	14.14	14.14	14.14	14.14	14.14	14.14	14.14	14.14	hour
d. Interval	MTP	155.11	155.11	155.11	155.11	155.11	155.11	155.11	155.11	hour
	COEF of VARIATION									
e. Volume	CVVP	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless
f. Intensity	CVIP	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
g. Duration	CVDP	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	dimensionless
h. Interval	CVTP	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	dimensionless
i. Number of storms per year (24*365/MTP)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	no. events
3. Surrounding Area Type										
a. ADT ususally over 30,000 vehicles/day	Urban	x	x	x	x	x	x	x	x	
or										
b. ADT usually under 30,000 vpd, undeveloped or suburban	Rural									
4. Select pollutant for analysis (section 2.4) and estimate runoff quality characteristics (use table 3)		**TSS**	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
a. site median concentration	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. coef of variation (0.71 urban, 0.84 Rural, 0.75 estimate for all sites)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
5. Select receiving water target concentration (section 2.6)										
Surface water Total Hardness (Figure 5)	TH	229	229	229	229	229	229	229	229	mg/l
STREAM -use table 4 for target concentration										
a. EPA Acute Criterion		1500	0.037	0.184	0.241	1500	0.037	0.184	0.241	mg/l
b. suggested Threshold Effect Level		none	0.023	0.039	0.063	none	0.023	0.039	0.063	mg/l
or										
LAKE - use accepted level for average Phosphorus concentration										
c. target concentration is 10 micrograms/liter		10	10	10	10	10	10	10	10	ug/l
6. Watershed Drainage Area	ATOT	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	square miles
upstream of highway for a stream - total contributing area for a lake										
7. Average annual stream flow (section 2.3)										
a. unit area flow rate per square mile (figure 4)	QSM	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	cfs/square miles
b. Coef of variation of stream flows (section 2.3)	CVQS	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	dimensionless
c. Average stream flow (QSM*ATOT)	MQS	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	cfs
Table 5. Worksheet B - Highway Runoff Characteristics										
1. Compute runoff coefficient (Rv) (section 3.1)										
a. Percent Impervious (Worksheet A - Item 1c)	IMP	100	100	100	100	100	100	100	100	%
b. Runoff Coefficient (=0.007*IMP+0.1)	Rv	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	ratio
2. Compute runoff flow rates (section 3.1)										
a. Flow rate from mean storm										
=Rv*MIP*AROW	MQR	3.672	3.672	3.672	3.672	4.123	4.123	4.123	4.123	cfs
b. Coefficient of variation of runoff flows										
=CVIP (worksheet A - Item 2f)	CVVR	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
3. Compute runoff volumes (section 3.1)										
a. Volume from the mean storm										
=Rv*MVP*AROW*3630	MVR	79364.6	79364.6	79364.6	79364.6	89108.6	89108.6	89108.6	89108.6	cubic feet
b. Coefficient of variation of runoff volumes										
=CVVP (worksheet A - Item 2e)	CVVR	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless

Site: Silver Creek

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	Copper	Lead	Zinc	TSS	Copper	Lead	Zinc	
4. Compute mass loads (section 3.2)										
Site Median Conc (worksheet A - Item 4a)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
Number of storms per year (Worksheet A - 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
a. mean event concentration (MCR)										
=TCR*SQRT(1+CVCR^2)	MCR	174.2	0.1	0.0	0.2	174.2	0.1	0.0	0.2	mg/l
b. mean event mass load										
=MCR*MVR*(0.00006245)	M(MASS)	863.149	0.249	0.152	1.137	969.122	0.280	0.171	1.276	pounds
c. annual mass laod from runoff										
=M(MASS)*NST	ANMASS	48747.160	14.075	8.582	64.195	54732.092	15.803	9.636	72.077	pounds/year
5. Compute flow ratio (MQS/MQR) (section 3.3)										
a. ratio of average stream flow										
(worksheet A-7b) to MQR	MQS/MQR	2.299	2.299	2.299	2.299	2.048	2.048	2.048	2.048	ratio
Table 6. Worksheet C - Stream Impact Analsysis										
1. Define the flow ratio MQS/MQR (Worksheet B-5a)	MQS/MQR	2.299	2.299	2.299	2.299	2.048	2.048	2.048	2.048	ratio
2. Compute the event frequency for a 3 year recurrence interval										
a. Enter the average number of storms per year										
(from Worksheet A - Item 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
b. Compute the probability (%) of the 3 year event										
=100*(1/(NST*3))	PR	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	%
3. Enter Value from Table 7 for MQS/MQR and frequency PR	CU	2.40	2.40	2.40	2.40	2.45	2.45	2.45	2.45	mg/l
4. Select pollutant for analysis										Name
a. Site median concentration (table 3)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. Soluble fraction (section 2.5)	FSOL	0.9	0.4	0.1	0.4	0.9	0.4	0.1	0.4	fraction
c. Acute Criteria (table 4)	CTA	1500	0.037	0.184	0.241	1500	0.037	0.184	0.241	mg/l
d. Threshold effects level (Table 4)	CTT	none	0.023	0.039	0.063	none	0.023	0.039	0.063	mg/l
5. Compute the once in 3 year stream pollutant concentration										
=CU*TCR*FSOL	CO	306.79	0.04	0.01	0.18	312.57	0.04	0.01	0.18	mg/l
6. Compare with Target Concentration, CTA										
=CO/CTA	CRAT	0.20	1.06	0.03	0.74	0.21	1.08	0.03	0.76	ratio
6a. Compare with background concentrations										mg/l
7. Evaluate Results										
a. If CRAT is less than about 0.75 a tocicity problem attributable to this pollutant is unlikely		STOP	STOP	STOP	STOP	STOP	STOP	STOP	STOP	
b. If CRAT is greater than 5 reduction will definitely be required. Estimate the level of reduction possible and repeat the analysis with revisted values for either concentration or flow or both		CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	
c. if CRAT is still greater than 1 and greater reduction levels are not practical, estimate the potential for an adverse impact (as opposed to a criteria violation) by a comparison with the threshold effects level)		EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	
=CO/CTT	CRTE	#VALUE!	1.71	0.16	2.85	#VALUE!	1.74	0.16	2.90	ratio

Site: Spring Brook

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
Table 1. Worksheet A - Site Characteristics										
1. Drainage Area of Highway Segment (Section 2.1)										
a. Total right of way	AROW	19.16	19.16	19.16	19.16	23.7	23.7	23.7	23.7	Acres
b. Paved surface	AHWY	19.16	19.16	19.16	19.16	23.7	23.7	23.7	23.7	Acres
c. Percent Impervous	IMP	100	100	100	100	100	100	100	100	%
2. Rainfall Characteristics (section 2.2)	MEAN									
a. Volume	MVP	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	inch
b. Intensity	MIP	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	inch/hour
c. Duration	MDP	14.14	14.14	14.14	14.14	14.14	14.14	14.14	14.14	hour
d. Interval	MTP	155.11	155.11	155.11	155.11	155.11	155.11	155.11	155.11	hour
	COEF of VARIATION									
e. Volume	CVVP	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless
f. Intensity	CVIP	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
g. Duration	CVDP	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	dimensionless
h. Interval	CVTP	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	dimensionless
i. Number of storms per year (24*365/MTP)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	no. events
3. Surrounding Area Type										
a. ADT ususally over 30,000 vehicles/day	Urban	x	x	x	x	x	x	x	x	
or										
b. ADT usually under 30,000 vpd, undeveloped or suburban	Rural									
4. Select pollutant for analysis (section 2.4) and estimate runoff quality characteristics (use table 3)		**TSS**	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
a. site median concentration	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. coef of variation (0.71 urban, 0.84 Rural, 0.75 estimate for all sites)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
5. Select receiving water target concentration (section 2.6)										
Surface water Total Hardness (Figure 5)	TH	316	316	316	316	316	316	316	316	mg/l
STREAM -use table 4 for target concentration										
a. EPA Acute Criterion		1500	0.050	0.258	0.317	1500	0.050	0.258	0.317	mg/l
b. suggested Threshold Effect Level		none	0.030	0.054	0.083	none	0.030	0.054	0.083	mg/l
or										
LAKE - use accepted level for average Phosphorus concentration										
c. target concentration is 10 micrograms/liter		10	10	10	10	10	10	10	10	ug/l
6. Watershed Drainage Area	ATOT	1.208	1.208	1.208	1.208	1.208	1.208	1.208	1.208	square miles
upstream of highway for a stream - total contributing area for a lake										
7. Average annual stream flow (section 2.3)										
a. unit area flow rate per square mile (figure 4)	QSM	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	cfs/square miles
b. Coef of variation of stream flows (section 2.3)	CVQS	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	dimensionless
c. Average stream flow (QSM*ATOT)	MQS	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	cfs
Table 5. Worksheet B - Highway Runoff Characteristics										
1. Compute runoff coefficient (Rv) (section 3.1)										
a. Percent Impervious (Worksheet A - Item 1c)	IMP	100	100	100	100	100	100	100	100	%
b. Runoff Coefficient (=0.007*IMP+0.1)	Rv	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	ratio
2. Compute runoff flow rates (section 3.1)										
a. Flow rate from mean storm										
=Rv*MIP*AROW	MQR	1.070	1.070	1.070	1.070	1.324	1.324	1.324	1.324	cfs
b. Coefficient of variation of runoff flows										
=CVIP (worksheet A - Item 2f)	CVVR	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
3. Compute runoff volumes (section 3.1)										
a. Volume from the mean storm										
=Rv*MVP*AROW*3630	MVR	23134.4	23134.4	23134.4	23134.4	28616.2	28616.2	28616.2	28616.2	cubic feet
b. Coefficient of variation of runoff volumes										
=CVVP (worksheet A - Item 2e)	CVVR	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless

Site: Spring Brook

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
4. Compute mass loads (section 3.2)										
Site Median Conc (worksheet A - Item 4a)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
Number of storms per year (Worksheet A - 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
a. mean event concentration (MCR)										
=TCR*SQRT(1+CVCR^2)	MCR	174.2	0.1	0.0	0.2	174.2	0.1	0.0	0.2	mg/l
b. mean event mass load										
=MCR*MVR*(0.00006245)	M(MASS)	251.604	0.073	0.044	0.331	311.222	0.090	0.055	0.410	pounds
c. annual mass laod from runoff										
=M(MASS)*NST	ANMASS	14209.578	4.103	2.502	18.713	17576.566	5.075	3.094	23.147	pounds/year
5. Compute flow ratio (MQS/MQR) (section 3.3)										
a. ratio of average stream flow										
(worksheet A-7b) to MQR	MQS/MQR	1.466	1.466	1.466	1.466	1.185	1.185	1.185	1.185	ratio
Table 6. Worksheet C - Stream Impact Analysis										
1. Define the flow ratio MQS/MQR (Worksheet B-5a)	MQS/MQR	1.466	1.466	1.466	1.466	1.185	1.185	1.185	1.185	ratio
2. Compute the event frequency for a 3 year recurrence interval										
a. Enter the average number of storms per year										
(from Worksheet A - Item 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
b. Compute the probability (%) of the 3 year event										
=100*(1/(NST*3))	PR	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	%
3. Enter Value from Table 7 for MQS/MQR and frequency PR	CU	2.75	2.75	2.75	2.75	2.91	2.91	2.91	2.91	mg/l
4. Select pollutant for analysis										Name
a. Site median concentration (table 3)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. Soluble fraction (section 2.5)	FSOL	0.9	0.4	0.1	0.4	0.9	0.4	0.1	0.4	fraction
c. Acute Criteria (table 4)	CTA	1500	0.050	0.258	0.317	1500	0.050	0.258	0.317	mg/l
d. Threshold effects level (Table 4)	CTT	none	0.030	0.054	0.083	none	0.030	0.054	0.083	mg/l
5. Compute the once in 3 year stream pollutant concentration										
=CU*TCR*FSOL	CO	351.75	0.05	0.01	0.21	371.76	0.05	0.01	0.22	mg/l
6. Compare with Target Concentration, CTA										
=CO/CTA	CRAT	0.23	0.90	0.03	0.65	0.25	0.95	0.03	0.69	ratio
6a. Compare with background concentrations		n/a	0.005	< 0.041	0.013	n/a	0.005	< 0.041	0.013	mg/l
7. Evaluate Results										
a. If CRAT is less than about 0.75 a tocicity problem attributable to this pollutant is unlikely		STOP	STOP	STOP	STOP	STOP	STOP	STOP	STOP	
b. If CRAT is greater than 5 reduction will definitely be required. Estimate the level of reduction possible and repeat the analysis with revisted values for either concentration or flow or both		CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	
c. if CRAT is still greater than 1 and greater reduction levels are not practical, estimate the potential for an adverse impact (as opposed to a criteria violation) by a comparison with the threshold effects level)		EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	
=CO/CTT	CRTE	#VALUE!	1.49	0.13	2.48	#VALUE!	1.57	0.13	2.63	ratio

Site: West Branch DuPage River

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	Copper	Lead	Zinc	TSS	Copper	Lead	Zinc	
Table 1. Worksheet A - Site Characteristics										
1. Drainage Area of Highway Segment (Section 2.1)										
a. Total right of way	AROW	31.82	31.82	31.82	31.82	37.87	37.87	37.87	37.87	Acres
b. Paved surface	AHWY	31.82	31.82	31.82	31.82	37.87	37.87	37.87	37.87	Acres
c. Percent Impervous	IMP	100	100	100	100	100	100	100	100	%
2. Rainfall Characteristics (section 2.2)	MEAN									
a. Volume	MVP	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	inch
b. Intensity	MIP	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	inch/hour
c. Duration	MDP	14.14	14.14	14.14	14.14	14.14	14.14	14.14	14.14	hour
d. Interval	MTP	155.11	155.11	155.11	155.11	155.11	155.11	155.11	155.11	hour
	COEF of VARIATION									
e. Volume	CVVP	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless
f. Intensity	CVIP	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
g. Duration	CVDP	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	dimensionless
h. Interval	CVTP	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	dimensionless
i. Number of storms per year (24*365/MTP)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	no. events
3. Surrounding Area Type										
a. ADT ususally over 30,000 vehicles/day	Urban	x	x	x	x	x	x	x	x	
or										
b. ADT usually under 30,000 vpd, undeveloped or suburban	Rural									
4. Select pollutant for analysis (section 2.4) and estimate runoff quality characteristics (use table 3)		**TSS**	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
a. site median concentration	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. coef of variation (0.71 urban, 0.84 Rural, 0.75 estimate for all sites)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
5. Select receiving water target concentration (section 2.6)										
Surface water Total Hardness (Figure 5)	TH	229	229	229	229	229	229	229	229	mg/l
STREAM -use table 4 for target concentration										
a. EPA Acute Criterion		1500	0.037	0.184	0.241	1500	0.037	0.184	0.241	mg/l
b. suggested Threshold Effect Level		none	0.023	0.039	0.063	none	0.023	0.039	0.063	mg/l
or										
LAKE - use accepted level for average Phosphorus concentration										
c. target concentration is 10 micrograms/liter		10	10	10	10	10	10	10	10	ug/l
6. Watershed Drainage Area	ATOT	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	square miles
upstream of highway for a stream - total contributing area for a lake										
7. Average annual stream flow (section 2.3)										
a. unit area flow rate per square mile (figure 4)	QSM	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	cfs/square miles
b. Coef of variation of stream flows (section 2.3)	CVQS	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	dimensionless
c. Average stream flow (QSM*ATOT)	MQS	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	cfs
Table 5. Worksheet B - Highway Runoff Characteristics										
1. Compute runoff coefficient (Rv) (section 3.1)										
a. Percent Impervious (Worksheet A - Item 1c)	IMP	100	100	100	100	100	100	100	100	%
b. Runoff Coefficient (=0.007*IMP+0.1)	Rv	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	ratio
2. Compute runoff flow rates (section 3.1)										
a. Flow rate from mean storm										
=Rv*MIP*AROW	MQR	1.778	1.778	1.778	1.778	2.116	2.116	2.116	2.116	cfs
b. Coefficient of variation of runoff flows										
=CVIP (worksheet A - Item 2f)	CVVR	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
3. Compute runoff volumes (section 3.1)										
a. Volume from the mean storm										
=Rv*MVP*AROW*3630	MVR	38420.5	38420.5	38420.5	38420.5	45725.5	45725.5	45725.5	45725.5	cubic feet
b. Coefficient of variation of runoff volumes										
=CVVP (worksheet A - Item 2e)	CVVR	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless

Site: West Branch DuPage River

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
4. Compute mass loads (section 3.2)										
Site Median Conc (worksheet A - Item 4a)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
Number of storms per year (Worksheet A - 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
a. mean event concentration (MCR)										
=TCR*SQRT(1+CVCR^2)	MCR	174.2	0.1	0.0	0.2	174.2	0.1	0.0	0.2	mg/l
b. mean event mass load										
=MCR*MVR*(0.00006245)	M(MASS)	417.852	0.121	0.074	0.550	497.299	0.144	0.088	0.655	pounds
c. annual mass laod from runoff										
=M(MASS)*NST	ANMASS	23598.580	6.814	4.155	31.077	28085.425	8.109	4.945	36.986	pounds/year
5. Compute flow ratio (MQS/MQR) (section 3.3)										
a. ratio of average stream flow										
(worksheet A-7b) to MQR	MQS/MQR	3.288	3.288	3.288	3.288	2.762	2.762	2.762	2.762	ratio
Table 6. Worksheet C - Stream Impact Analysis										
1. Define the flow ratio MQS/MQR (Worksheet B-5a)	MQS/MQR	3.288	3.288	3.288	3.288	2.762	2.762	2.762	2.762	ratio
2. Compute the event frequency for a 3 year recurrence interval										
a. Enter the average number of storms per year										
(from Worksheet A - Item 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
b. Compute the probability (%) of the 3 year event										
=100*(1/(NST*3))	PR	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	%
3. Enter Value from Table 7 for MQS/MQR and frequency PR	CU	2.22	2.22	2.22	2.22	2.32	2.32	2.32	2.32	mg/l
4. Select pollutant for analysis										Name
a. Site median concentration (table 3)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. Soluble fraction (section 2.5)	FSOL	0.9	0.4	0.1	0.4	0.9	0.4	0.1	0.4	fraction
c. Acute Criteria (table 4)	CTA	1500	0.037	0.184	0.241	1500	0.037	0.184	0.241	mg/l
d. Threshold effects level (Table 4)	CTT	none	0.023	0.039	0.063	none	0.023	0.039	0.063	mg/l
5. Compute the once in 3 year stream pollutant concentration										
=CU*TCR*FSOL	CO	284.04	0.04	0.01	0.17	296.12	0.04	0.01	0.17	mg/l
6. Compare with Target Concentration, CTA										
=CO/CTA	CRAT	0.19	0.98	0.03	0.69	0.20	1.02	0.03	0.72	ratio
6a. Compare with background concentrations		n/a	0.006	< 0.041	0.030	n/a	0.006	< 0.041	0.030	mg/l
7. Evaluate Results										
a. If CRAT is less than about 0.75 a tocicity problem attributable to this pollutant is unlikely		STOP	STOP	STOP	STOP	STOP	STOP	STOP	STOP	
b. If CRAT is greater than 5 reduction will definitely be required. Estimate the level of reduction possible and repeat the analysis with revisted values for either concentration or flow or both		CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	
c. if CRAT is still greater than 1 and greater reduction levels are not practical, estimate the potential for an adverse impact (as opposed to a criteria violation) by a comparison with the threshold effects level)		EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	
=CO/CTT	CRTE	#VALUE!	1.58	0.14	2.64	#VALUE!	1.65	0.15	2.75	ratio

Site: Willow Creek

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	Copper	Lead	Zinc	TSS	Copper	Lead	Zinc	
Table 1. Worksheet A - Site Characteristics										
1. Drainage Area of Highway Segment (Section 2.1)										
a. Total right of way	AROW	98.35	98.35	98.35	98.35	163.06	163.06	163.06	163.06	Acres
b. Paved surface	AHWY	98.35	98.35	98.35	98.35	163.06	163.06	163.06	163.06	Acres
c. Percent Impervous	IMP	100	100	100	100	100	100	100	100	%
2. Rainfall Characteristics (section 2.2)	MEAN									
a. Volume	MVP	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	inch
b. Intensity	MIP	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	inch/hour
c. Duration	MDP	14.14	14.14	14.14	14.14	14.14	14.14	14.14	14.14	hour
d. Interval	MTP	155.11	155.11	155.11	155.11	155.11	155.11	155.11	155.11	hour
	COEF of VARIATION									
e. Volume	CVVP	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless
f. Intensity	CVIP	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
g. Duration	CVDP	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	dimensionless
h. Interval	CVTP	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	dimensionless
i. Number of storms per year (24*365/MTP)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	no. events
3. Surrounding Area Type										
a. ADT ususally over 30,000 vehicles/day	Urban	x	x	x	x	x	x	x	x	
or										
b. ADT usually under 30,000 vpd, undeveloped or suburban	Rural									
4. Select pollutant for analysis (section 2.4) and estimate runoff quality characteristics (use table 3)		**TSS**	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
a. site median concentration	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. coef of variation (0.71 urban, 0.84 Rural, 0.75 estimate for all sites)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
5. Select receiving water target concentration (section 2.6)										
Surface water Total Hardness (Figure 5)	TH	230	230	230	230	230	230	230	230	mg/l
STREAM -use table 4 for target concentration										
a. EPA Acute Criterion		1500	0.037	0.185	0.242	1500	0.037	0.185	0.242	mg/l
b. suggested Threshold Effect Level		none	0.023	0.039	0.063	none	0.023	0.039	0.063	mg/l
or										
LAKE - use accepted level for average Phosphorus concentration										
c. target concentration is 10 micrograms/liter		10	10	10	10	10	10	10	10	ug/l
6. Watershed Drainage Area	ATOT	6	6	6	6	6	6	6	6	square miles
upstream of highway for a stream - total contributing area for a lake										
7. Average annual stream flow (section 2.3)										
a. unit area flow rate per square mile (figure 4)	QSM	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	cfs/square miles
b. Coef of variation of stream flows (section 2.3)	CVQS	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	dimensionless
c. Average stream flow (QSM*ATOT)	MQS	7.79	7.79	7.79	7.79	7.79	7.79	7.79	7.79	cfs
Table 5. Worksheet B - Highway Runoff Characteristics										
1. Compute runoff coefficient (Rv) (section 3.1)										
a. Percent Impervious (Worksheet A - Item 1c)	IMP	100	100	100	100	100	100	100	100	%
b. Runoff Coefficient (=0.007*IMP+0.1)	Rv	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	ratio
2. Compute runoff flow rates (section 3.1)										
a. Flow rate from mean storm										
=Rv*MIP*AROW	MQR	5.494	5.494	5.494	5.494	9.109	9.109	9.109	9.109	cfs
b. Coefficient of variation of runoff flows										
=CVIP (worksheet A - Item 2f)	CVVR	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	dimensionless
3. Compute runoff volumes (section 3.1)										
a. Volume from the mean storm										
=Rv*MVP*AROW*3630	MVR	118751.1	118751.1	118751.1	118751.1	196884.1	196884.1	196884.1	196884.1	cubic feet
b. Coefficient of variation of runoff volumes										
=CVVP (worksheet A - Item 2e)	CVVR	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	dimensionless

Site: Willow Creek

Cells to input data to

		EXISTING CONDITIONS				Proposed CONDITIONS				
		TSS	**Copper**	**Lead**	**Zinc**	**TSS**	**Copper**	**Lead**	**Zinc**	
4. Compute mass loads (section 3.2)										
Site Median Conc (worksheet A - Item 4a)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	dimensionless
Number of storms per year (Worksheet A - 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
a. mean event concentration (MCR)										
=TCR*SQRT(1+CVCR^2)	MCR	174.2	0.1	0.0	0.2	174.2	0.1	0.0	0.2	mg/l
b. mean event mass load										
=MCR*MVR*(0.00006245)	M(MASS)	1291.507	0.373	0.227	1.701	2141.262	0.618	0.377	2.820	pounds
c. annual mass laod from runoff										
=M(MASS)*NST	ANMASS	72939.042	21.060	12.841	96.054	120929.742	34.916	21.290	159.253	pounds/year
5. Compute flow ratio (MQS/MQR) (section 3.3)										
a. ratio of average stream flow										
(worksheet A-7b) to MQR	MQS/MQR	1.418	1.418	1.418	1.418	0.855	0.855	0.855	0.855	ratio
Table 6. Worksheet C - Stream Impact Analsysis										
1. Define the flow ratio MQS/MQR (Worksheet B-5a)	MQS/MQR	1.418	1.418	1.418	1.418	0.855	0.855	0.855	0.855	ratio
2. Compute the event frequency for a 3 year recurrence interval										
a. Enter the average number of storms per year										
(from Worksheet A - Item 2i)	NST	56.5	56.5	56.5	56.5	56.5	56.5	56.5	56.5	number
b. Compute the probability (%) of the 3 year event										
=100*(1/(NST*3))	PR	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	%
3. Enter Value from Table 7 for MQS/MQR and frequency PR	CU	2.78	2.78	2.78	2.78	3.22	3.22	3.22	3.22	mg/l
4. Select pollutant for analysis										Name
a. Site median concentration (table 3)	TCR	142	0.041	0.025	0.187	142	0.041	0.025	0.187	mg/l
b. Soluble fraction (section 2.5)	FSOL	0.9	0.4	0.1	0.4	0.9	0.4	0.1	0.4	fraction
c. Acute Criteria (table 4)	CTA	1500	0.037	0.185	0.242	1500	0.037	0.185	0.242	mg/l
d. Threshold effects level (Table 4)	CTT	none	0.023	0.039	0.063	none	0.023	0.039	0.063	mg/l
5. Compute the once in 3 year stream pollutant concentration										
=CU*TCR*FSOL	CO	355.13	0.05	0.01	0.21	411.88	0.05	0.01	0.24	mg/l
6. Compare with Target Concentration, CTA										
=CO/CTA	CRAT	0.24	1.22	0.04	0.86	0.27	1.42	0.04	1.00	ratio
6a. Compare with background concentrations		n/a	0.018	< 0.041	0.063	n/a	0.018	< 0.041	0.063	mg/l
7. Evaluate Results										
a. If CRAT is less than about 0.75 a tocicity problem attributable to this pollutant is unlikely		STOP	STOP	STOP	STOP	STOP	STOP	STOP	STOP	
b. If CRAT is greater than 5 reduction will definitely be required. Estimate the level of reduction possible and repeat the analysis with revisted values for either concentration or flow or both		CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	
c. if CRAT is still greater than 1 and greater reduction levels are not practical, estimate the potential for an adverse impact (as opposed to a criteria violation) by a comparison with the threshold effects level)		EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	EVALUATE	
=CO/CTT	CRTE	#VALUE!	1.97	0.18	3.28	#VALUE!	2.29	0.21	3.81	ratio