Appendix I-4
Results of FHWA Pollutant Loading and Toler Analysis

Project: I-81 VIADUCT PROJECT

SUMMARY ESTIMATE RESULTS OF MEAN EVENT POLLUTANT LOADING ANALYSIS (WITHOUT BMPs) , pound per mean event

POLLUTANT	Viaduct Alternative					Community Grid Alternative																									
	Lower Onondaga Creek (Central Study Area)					Lower Onondaga Creek (Central Study Area)					Middle Onondaga Cr. (South Study Area)					North-Branch Ley Creek (East Study Area: Northern Section)					Butternut Creek (East Study Area: Southern Section)					Mud Creek (North Study Area)				
	No Builld	Proposed	Diff	% Diff	Scaled % Diff	No Build	Proposed	Diff	% Diff	Scaled % Diff	No Build	Proposed	Diff	% Diff	Scaled % Diff	No Build	Proposed	Diff	% Diff	Scaled % Diff	No Build	Proposed	Diff	% Diff	Scaled % Diff	No Build	Proposed	Diff	%Diff	Scaled % Diff
Copper (Cu)	0.49	0.49	0.00	0.0%	0.0000%	0.52	0.49	-0.02	-4.5%	-0.010%	0.21	0.21	0.00	0.0%	0.0%	0.02	0.02	0.00	0.0%	0.00%	0.27	0.28	0.01	2.8%	0.014%	0.24	0.26	0.01	5.2%	0.36%
Lead (Pb)	3.64	3.60	-0.04	-1.1%	-0.0024%	3.83	3.65	-0.17	-4.5%	-0.010%	1.55	1.55	0.00	0.0%	0.0%	0.17	0.18	0.01	7.2%	0.22%	2.00	2.05	0.06	2.8%	0.014%	1.81	1.91	0.09	5.2%	0.36%
Zinc (Zn)	3.00	2.96	-0.03	-1.1%	-0.0024%	3.15	3.00	-0.14	-4.5%	-0.010%	1.27	1.27	0.00	0.0%	0.0%	0.14	0.15	0.01	7.2%	0.22%	1.64	1.69	0.05	2.8%	0.014%	1.49	1.57	0.08	5.2%	0.36%
Total organic carbon (TOC)	227.64	225.06	-2.58	-1.1%	-0.0024%	239.15	228.32	-10.83	-4.5%	-0.010%	96.81	96.81	0.00	0.0%	0.0%	10.76	11.53	0.77	7.2%	0.22%	124.90	128.38	3.48	2.8%	0.014%	113.42	119.35	5.93	5.2%	0.36%
Chemical oxygen demand (COD)	1038.03	1026.27	-11.76	-1.1%	-0.0024%	1090.53	1041.14	-49.39	-4.5%	-0.010%	441.45	441.45	0.00	0.0%	0.0%	49.05	52.58	3.53	7.2%	0.22%	569.54	585.41	15.87	2.8%	0.014%	517.21	544.25	27.04	5.2%	0.36%
Nitrate + nitrite nitrogen (NO2+3)	6.92	6.84	-0.08	-1.1%	-0.0024%	7.27	6.94	-0.33	-4.5%	-0.010%	2.94	2.94	0.00	0.0%	0.0%	0.33	0.35	0.02	7.2%	0.22%	3.80	3.90	0.11	2.8%	0.014%	3.45	3.63	0.18	5.2%	0.36%
Total kjeldahl nitrogen (TKN)	16.66	16.47	-0.19	-1.1%	-0.0024%	17.51	16.71	-0.79	-4.5%	-0.010%	7.09	7.09	0.00	0.0%	0.0%	0.79	0.84	0.06	7.2%	0.22%	9.14	9.40	0.25	2.8%	0.014%	8.30	8.74	0.43	5.2%	0.36%
Phosphorus (PO4-P)	3.64	3.60	-0.04	-1.1%	-0.0024%	3.83	3.65	-0.17	-4.5%	-0.010%	1.55	1.55	0.00	0.0%	0.0%	0.17	0.18	0.01	7.2%	0.22%	2.00	2.05	0.06	2.8%	0.014%	1.81	1.91	0.09	5.2%	0.36%
Total suspended solids (TSS)	1292.99	1278.34	-14.65	-1.1%	-0.0024%	1358.37	1,296.86	-61.52	-4.5%	-0.010%	549.88	549.88	0.00	0.0%	0.0%	61.10	65.49	4.39	7.2%	0.22%	709.42	729.19	19.77	2.8%	0.014%	644.24	677.93	33.69	5.2%	0.36%
Volatile suspended solids (VSS)	355.12	351.09	-4.02	-1.1%	-0.0024%	373.07	356.18	-16.90	-4.5%	-0.010%	151.02	151.02	0.00	0.0%	0.0%	16.78	17.99	1.21	7.2%	0.22%	194.84	200.27	5.43	2.8%	0.014%	176.94	186.19	9.25	5.2%	0.36%

Project: I-81 VIADUCT PROJECT

SUMMARY ESTIMATE RESULTS OF ANNUAL MASS POLLUTANT LOADING ANALYSIS (WITHOUT BMPs)[1] , pound per annual

POLLUTANT	Viaduct Alternative					Community Grid Alternative																									
	Lower Onondaga Creek (Central Study Area)					Lower Onondaga Creek (Central Study Area)					Middle Onondaga Cr. (South Study Area)					North-Branch Ley Creek (East Study Area: Northern Section)					Butternut Creek (East Study Area: Southern Section)					Mud Creek (North Study Area)				
	No Build	Proposed	Diff	% Diff	Scaled % Diff	No Build	Proposed	Diff	% Diff	Scaled % Diff	No Build	Proposed	Diff	% Diff	Scaled % Diff	No Build	Proposed	Diff	% Diff	Scaled % Diff	No Build	Proposed	Diff	% Diff	Scaled % Diff	No Build	Proposed	Diff	%Diff	Scaled % Diff
Copper (Cu)	59.00	58.34	-0.67	-1.1%	-0.0024%	61.99	59.18	59.19	-4.5%	-0.010%	25.09	25.09	0.00	0.0%	0.0%	2.79	2.99	0.20	7.2%	0.22%	32.37	33.28	0.90	2.8%	0.014%	29.40	30.94	1.54	5.2%	0.36%
Lead (Pb)	437.07	432.11	-4.95	-1.1%	-0.0024%	459.17	438.37	438.39	-4.5%	-0.010%	185.87	185.87	0.00	0.0%	0.0%	20.65	22.14	1.49	7.2%	0.22%	239.80	246.49	6.68	2.8%	0.014%	217.77	229.16	11.39	5.2%	0.36%
Zinc (Zn)	359.49	355.41	-4.07	-1.1%	-0.0024%	377.67	360.56	360.57	-4.5%	-0.010%	152.88	152.88	0.00	0.0%	0.0%	16.99	18.21	1.22	7.2%	0.22%	197.24	202.74	5.50	2.8%	0.014%	179.12	188.48	9.37	5.2%	0.36%
Total organic carbon (TOC)	27316.62	27007.19	-309.44	-1.1%	-0.0024%	28698.04	27398.40	27398.41	-4.5%	-0.010%	11617.14	11617.14	0.00	0.0%	0.0%	1290.79	1383.62	92.83	7.2%	0.22%	14987.78	15405.52	417.74	2.8%	0.014%	13610.79	14322.50	711.70	5.2%	0.36%
Chemical oxygen demand (COD)	124563.80	123152.77	-1411.03	-1.1%	-0.0024%	130863.05	124936.72	124936.73	-4.5%	-0.010%	52974.14	52974.14	0.00	0.0%	0.0%	5886.02	6309.32	423.31	7.2%	0.22%	68344.30	70249.19	1904.89	2.8%	0.014%	62065.21	65310.58	3245.37	5.2%	0.36%
Nitrate + nitrite nitrogen (NO2+3)	830.43	821.02	-9.41	-1.1%	-0.0024%	872.42	832.91	832.92	-4.5%	-0.010%	353.16	353.16	0.00	0.0%	0.0%	39.24	42.06	2.82	7.2%	0.22%	455.63	468.33	12.70	2.8%	0.014%	413.77	435.40	21.64	5.2%	0.36%
Total kjeldahl nitrogen (TKN)	1999.58	1976.93	-22.65	-1.1%	-0.0024%	2100.70	2005.56	2005.57	-4.5%	-0.010%	850.37	850.37	0.00	0.0%	0.0%	94.49	101.28	6.80	7.2%	0.22%	1097.11	1127.68	30.58	2.8%	0.014%	996.31	1048.41	52.10	5.2%	0.36%
Phosphorus (PO4-P)	437.07	432.11	-4.95	-1.1%	-0.0024%	459.17	438.37	438.39	-4.5%	-0.010%	185.87	185.87	0.00	0.0%	0.0%	20.65	22.14	1.49	7.2%	0.22%	239.80	246.49	6.68	2.8%	0.014%	217.77	229.16	11.39	5.2%	0.36%
Total suspended solids (TSS)	155158.42	153400.82	-1757.60	-1.1%	-0.0024%	163,004.85	155,622.93	155622.94	-4.5%	-0.010%	65985.33	65985.33	0.00	0.0%	0.0%	7331.70	7858.98	527.28	7.2%	0.22%	85130.61	87503.37	2372.76	2.8%	0.014%	77309.29	81351.77	4042.48	5.2%	0.36%
Volatile suspended solids (VSS)	42613.93	42131.21	-482.72	-1.1%	-0.0024%	44768.94	42741.51	42741.52	-4.5%	-0.010%	18122.73	18122.73	0.00	0.0%	0.0%	2013.64	2158.45	144.82	7.2%	0.22%	23380.94	24032.62	651.67	2.8%	0.014%	21232.83	22343.09	1110.26	5.2%	0.36%
Chloride annual average concentration (Cl)[1] , ppm	2.65	3.12	0.47	17.7%	0.0377%	2.65	2.90	2.72	9.4%	0.022%	34.64	36.09	1.45	4.2%	0.26%	22.94	32.12	9.18	40.0%	1.22%	1.55	1.90	0.35	22.6%	0.113%	21.10	26.84	5.74	27.2%	1.87%

Note : 1 Toler Method are calculated as annual average concentration. FHWA are calculated for annual mass loading.

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FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build for Viaduct Alternative

Date: 12/03/2019
Area: Central Study Area

Table 9. Worksheet A - Site characteristics

1	Drainage Area of Highway Segment (section 2.1)			
a	Total right of way (Analysis area)	AROW	212.5	acres
b	Paved surface	AHWY	146.2	acres
c	Percent Impervious(= 100 * AHWY/AROW)	IMP	68.8	%
2	Rainfall Characteristics (from section 2.2)	MEAN		
	Zone 1; Initial estimates from Figure 2.			
a	Volume	MVP	0.26	inch
b	Intensity	MIP	0.051	inch / hour
c	Duration	MDP	5.80	hour
d	Interval	MTP	73.00	hour
		COEF of VARIATION		
e	Volume	CVVP	1.46	dimensionless
f	Intensity	CVIP	1.30	dimensionless
g	Duration	CVDP	1.05	dimensionless
h	Interval	CVTP	1.07	dimensionless
i	Number of storms per year (24*365 / MTP)	NST	120	no. events
3	Surrounding Area Type			
a	ADT over 30,000 vehicles/day, urbanized area	URBAN	☐	
	or			
b	ADT under 30,000 vpd, undeveloped to low density suburban	RURAL	☐	

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Select pollutant for analysis FHWA Volume I (section 2.4) and estimate runoff quality characteristics (use table 3)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a	site median concentration	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b	coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)	CVCR	0.75	dimensionless									
5	Select receiving water target concentration (section 2.6)												
	surface water Total Hardness (figure 4)	TH	120	120	120	120	120	120	120	120	120	120	mg/1
	STREAM -use table 4 for target concentrations												
a	EPA Acute Criterion	CTA	0.021	0.103	0.374								mg/1
b	suggested Threshold Effect Level	CTT	0.045	0.450	0.785								mg/1
	or												
	LAKE - use accepted level for average Phosphorus concentration												
c	target concentration is 10 micrograms/liter		10	µg/1									

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FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build for Viaduct Alternative

Date: 12/03/2019
Area: Central Study Area

6	Watershed Drainage Area upstream of highway for a stream - total contributing area for a lake	ATOT	156.0	square miles
7	Average annual stream flow (section 2.3)			
a	unit area flow rate per square mile (figure 3)	QSM	1.70	CFS/square mile
b	Coef of variation of stream flows(section 2.3)	CVQS	1.10	dimensionless
c	Average stream flow (QSM * ATOT)	MQS	265.20	CFS

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FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build for Viaduct Alternative

Date: 12/03/2019
Area: Central Study Area

Table 10. Worksheet B - Highway runoff characteristics

1	Compute runoff coefficient (Rv) (see section 3.1)			
a	Percent Impervious (Worksheet A - Item 1c)	IMP	68.8	%
b	Runoff Coefficient (= 0.007 * IMP + 0.1)	Rv	0.58	ratio
2	Compute runoff flow rates (section 3.1)			
a	flow rate from mean storm			
	= Rv * MIP * AROW * (3630 / 3600)	MQR	6.356	CFS
b	coefficient of variation of runoff flows			
	= CVIP (Worksheet A - Item 2f)	CVOR	1.30	dimensionless
3	Compute runoff volumes (section 3.1)			
a	Volume from the mean storm			
	= Rv * MVP * AROW * 3630	MVR	116644	cubic feet
b	coefficient of variation of runoff volumes			
	= CVVP (Worksheet A - Item 2e)	CVVR	1.46	dimensionless

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Compute mass Loads (section 3.2)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
	Site Median Conc (Worksheet A - Item 4a)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
	Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	dimensionless
	Number of storms per year (Worksheet A - 2i)	NST	120	120	120	120	120	120	120	120	120	120	number
a	mean event concentration (MCR)												
	= TCR * SQRT(1 + CVCR^2)	MCR	0.07	0.50	0.41	31.25	142.50	0.95	2.29	0.50	177.50	48.75	mg/1
b	mean event mass load												
	= MCR * MVR * (0.00006245)	M{MASS)	0.49	3.64	3.00	227.64	1038.03	6.92	16.66	3.64	1292.99	355.12	pounds
c	annual mass load from runoff												
	= M(MASS) * NST	ANMASS	59.00	437.07	359.49	27317	124564	830.43	1999.58	437.07	155158	42614	pounds/year

5	Compute flow ratio (MQS/MQR) (section 3.3)			
a	ratio of average stream flow (Worksheet A - 7b) to MQR	MQS/MQR	41.73	ratio

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FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build for Viaduct Alternative

Date: 12/03/2019
Area: Central Study Area

Table 11. Worksheet C - Stream impact analysis

1 Define the flow ratio MQS/MQR (Worksheet B - 5a)	MQS/MQR	41.73	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	120	number	
b Compute the probability {%) of. the 3 year event				
= 100 *(1 /(NST * 3))	PR	0.28	%	
3 Enter value from table 7				
for MQS/MQR and frequency PR	CU	2.089	mg/1	

4 Select pollutant for analysis		Heavy Metals			Oxygen Demand		Nutrients			Particulates		name
		Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a Site median concentration (table 3)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b Soluble fraction (section 2.5)	FSOL	0.400	0.100	0.400								fraction
c Acute Criteria Value (table 4)	CTA	0.021	0.103	0.374	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
d Threshold effects level (table 4)	CTT	0.045	0.450	0.785	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
4 Compute the once in 3 *year* stream pollutant concentration												
= CU * TCR * FSOL	CO	0.045	0.084	0.275								mg/1
5 Compare with target concentration, CTA												
= CO / CTA	CRAT	2.15	0.81	0.73								ratio

6 Evaluate results		
a If CRAT is less than about 0.75		STOP
A toxicity problem attributable to this pollutant is unlikely		
b If CRAT is greater than 5 reduction will definitely be required		CONTROL
Estimate the level of reduction possible and repeat the analysis with revised values for either concentration or flow or both		
c If CRAT is still greater than 1		EVALUATE
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		
=CO / CTT	CRTE	1.00 ratio

A further refinement in the analysis can be made using the procedure described in Appendix B.

Changes will usually be nominal, based on refined local estimates of variability of flows.

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TOLER ANALYSIS FOR ESTIMATING CHLORIDES

PROJECT: I-81 VIADUCT PROJECT
AREA: CENTRAL STUDY AREA
ALTERNATIVE: NO BUILD ALTERNATIVE

Constituent evaluation = Chloride
Mean Annual Runoff 19.2 inches
K = 8.37

Drainage Area #	Drainage Area (sq.mi.)	Lane Miles, M	Salt Applied Rate, T (Ton/lane mile)	Annual Average Concentration, C (ppm)	Discharge Location
A	156	37.9	25	2.65	Lower Onondaga Creek

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FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Viaduct Alternative

Date: 12/03/2019
Area: Central Study Area

Table 9. Worksheet A - Site characteristics

1	Drainage Area of Highway Segment (section 2.1)			
	a Total right of way (Analysis area)	AROW	212.5	acres
	b Paved surface	AHWY	144.2	acres
	c Percent Impervious(= 100 * AHWY/AROW)	IMP	67.9	%
2	Rainfall Characteristics (from section 2.2)	MEAN		
	Zone 1; Initial estimates from Figure 2.			
	a Volume	MVP	0.26	inch
	b Intensity	MIP	0.051	inch / hour
	c Duration	MDP	5.80	hour
	d Interval	MTP	73.00	hour
		COEF of VARIATION		
	e Volume	CVVP	1.46	dimensionless
	f Intensity	CVIP	1.30	dimensionless
	g Duration	CVDP	1.05	dimensionless
	h Interval	CVTP	1.07	dimensionless
	i Number of storms per year (24*365 / MTP)	NST	120	no. events
3	Surrounding Area Type			
	a ADT over 30,000 vehicles/day, urbanized area		URBAN	☐
	or			
	b ADT under 30,000 vpd, undeveloped to low density suburban		RURAL	☐

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Select pollutant for analysis FHWA Volume I (section 2.4) and estimate runoff quality characteristics (use table 3)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
	a site median concentration	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
	b coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)	CVCR	0.75	dimensionless									
5	Select receiving water target concentration (section 2.6) surface water Total Hardness (figure 4)	TH	120	120	120	120	120	120	120	120	120	120	mg/1
	STREAM -use table 4 for target concentrations												
	a EPA Acute Criterion	CTA	0.021	0.103	0.374								mg/1
	b suggested Threshold Effect Level	CTT	0.045	0.450	0.785								mg/1
	or												
	LAKE - use accepted level for average Phosphorus concentration												
	c target concentration is 10 micrograms/liter		10	µg/1									

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FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Viaduct Alternative

Date: 12/03/2019
Area: Central Study Area

6	Watershed Drainage Area upstream of highway for a stream - total contributing area for a lake	ATOT	156.0	square miles
7	Average annual stream flow (section 2.3)			
a	unit area flow rate per square mile (figure 3)	QSM	1.70	CFS/square mile
b	Coef of variation of stream flows(section 2.3)	CVQS	1.10	dimensionless
c	Average stream flow (QSM * ATOT)	MQS	265.20	CFS

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FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Viaduct Alternative

Date: 12/03/2019
Area: Central Study Area

Table 10. Worksheet B - Highway runoff characteristics

1	Compute runoff coefficient (Rv) (see section 3.1)			
a	Percent Impervious (Worksheet A - Item 1c)	IMP	67.9	%
b	Runoff Coefficient (= 0.007 * IMP + 0.1)	Rv	0.58	ratio
2	Compute runoff flow rates (section 3.1)			
a	flow rate from mean storm			
	= Rv * MIP * AROW * (3630 / 3600)	MQR	6.284	CFS
b	coefficient of variation of runoff flows			
	= CVIP (Worksheet A - Item 2f)	CVOR	1.30	dimensionless
3	Compute runoff volumes (section 3.1)			
a	Volume from the mean storm			
	= Rv * MVP * AROW * 3630	MVR	115323	cubic feet
b	coefficient of variation of runoff volumes			
	= CVVP (Worksheet A - Item 2e)	CVVR	1.46	dimensionless

			Heavy Metals			Oxygen Demand		Nutrients			Particulates		
4	Compute mass Loads (section 3.2)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
	Site Median Conc (Worksheet A - Item 4a)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
	Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	dimensionless
	Number of storms per year (Worksheet A - 2i)	NST	120	120	120	120	120	120	120	120	120	120	number
a	mean event concentration (MCR)												
	= TCR * SQRT(1 + CVCR^2)	MCR	0.07	0.50	0.41	31.25	142.50	0.95	2.29	0.50	177.50	48.75	mg/1
b	mean event mass load												
	= MCR * MVR * (0.00006245)	M{MASS)	0.49	3.60	2.96	225.06	1026.27	6.84	16.47	3.60	1278.34	351.09	pounds
c	annual mass load from runoff												
	= M(MASS) * NST	ANMASS	58.34	432.11	355.41	27007	123153	821.02	1976.93	432.11	153401	42131	pounds/year

5	Compute flow ratio (MQS/MQR) (section 3.3)			
a	ratio of average stream flow (Worksheet A - 7b) to MQR	MQS/MQR	42.20	ratio

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Viaduct Alternative

Date: 12/03/2019
Area: Central Study Area

Table 11. Worksheet C - Stream impact analysis

1 Define the flow ratio MQS/MQR (Worksheet B - 5a)	MQS/MQR	42.20	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	120	number
b Compute the probability {%) of. the 3 year event			
= 100 *(1 /(NST * 3))	PR	0.28	%
3 Enter value from table 7			
for MQS/MQR and frequency PR	CU	2.071	mg/1

4 Select pollutant for analysis		Heavy Metals			Oxygen Demand		Nutrients			Particulates		name
		Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a Site median concentration (table 3)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b Soluble fraction (section 2.5)	FSOL	0.400	0.100	0.400								fraction
c Acute Criteria Value (table 4)	CTA	0.021	0.103	0.374	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
d Threshold effects level (table 4)	CTT	0.045	0.450	0.785	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
4 Compute the once in 3 *year* stream pollutant concentration												
= CU * TCR * FSOL	CO	0.045	0.083	0.273								mg/1
5 Compare with target concentration, CTA												
= CO / CTA	CRAT	2.13	0.80	0.73								ratio

6 Evaluate results		
a If CRAT is less than about 0.75		STOP
A toxicity problem attributable to this pollutant is unlikely		
b If CRAT is greater than 5 reduction will definitely be required		CONTROL
Estimate the level of reduction possible and repeat the analysis with revised values for either concentration or flow or both		
c If CRAT is still greater than 1		EVALUATE
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		
=CO / CTT	CRTE	0.99 ratio

A further refinement in the analysis can be made using the procedure described in Appendix B.

Changes will usually be nominal, based on refined local estimates of variability of flows.

AKRF Engineering, P.C.

TOLER ANALYSIS FOR ESTIMATING CHLORIDES

PROJECT: I-81 VIADUCT PROJECT
AREA: CENTRAL STUDY AREA
ALTERNATIVE: VIADUCT ALTERNATIVES

Constituent evaluation = Chloride
Mean Annual Runoff 19.2 inches
K = 8.37

Drainage Area #	Drainage Area (sq.mi.)	Lane Miles, M	Salt Applied Rate, T (Ton/lane mile)	Annual Average Concentration, C (ppm)	Discharge Location
A	156	44.7	25	3.12	Lower Onondaga Creek

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build for Community Grid Alternative

Date: 12/03/2019
Area: Central Study Area

Table 9. Worksheet A - Site characteristics

1	Drainage Area of Highway Segment (section 2.1)			
a	Total right of way (Analysis area)	AROW	229.5	acres
b	Paved surface	AHWY	152.7	acres
c	Percent Impervious(= 100 * AHWY/AROW)	IMP	66.5	%
2	Rainfall Characteristics (from section 2.2)	MEAN		
	Zone 1; Initial estimates from Figure 2.			
a	Volume	MVP	0.26	inch
b	Intensity	MIP	0.051	inch / hour
c	Duration	MDP	5.80	hour
d	Interval	MTP	73.00	hour
		COEF of VARIATION		
e	Volume	CVVP	1.46	dimensionless
f	Intensity	CVIP	1.30	dimensionless
g	Duration	CVDP	1.05	dimensionless
h	Interval	CVTP	1.07	dimensionless
i	Number of storms per year (24*365 / MTP)	NST	120	no. events
3	Surrounding Area Type			
a	ADT over 30,000 vehicles/day, urbanized area		URBAN ☐	
	or			
b	ADT under 30,000 vpd, undeveloped to low density suburban		RURAL ☐	

4 Select pollutant for analysis FHWA Volume I (section 2.4) and estimate runoff quality characteristics (use table 3)		Heavy Metals			Oxygen Demand		Nutrients			Particulates		
	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a site median concentration	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)	CVCR	0.75	dimensionless									
5 Select receiving water target concentration (section 2.6) surface water Total Hardness (figure 4)	TH	120	120	120	120	120	120	120	120	120	120	mg/1
STREAM -use table 4 for target concentrations												
a EPA Acute Criterion	CTA	0.021	0.103	0.374								mg/1
b suggested Threshold Effect Level	CTT	0.045	0.450	0.785								mg/1
or												
LAKE - use accepted level for average Phosphorus concentration												
c target concentration is 10 micrograms/liter		10	µg/1									

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build for Community Grid Alternative

Date: 12/03/2019
Area: Central Study Area

6	Watershed Drainage Area upstream of highway for a stream - total contributing area for a lake	ATOT	156.0	square miles
7	Average annual stream flow (section 2.3)			
a	unit area flow rate per square mile (figure 3)	QSM	1.70	CFS/square mile
b	Coef of variation of stream flows(section 2.3)	CVQS	1.10	dimensionless
c	Average stream flow (QSM * ATOT)	MQS	265.20	CFS

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build for Community Grid Alternative

Date: 12/03/2019
Area: Central Study Area

Table 10. Worksheet B - Highway runoff characteristics

1	Compute runoff coefficient (Rv) (see section 3.1)			
a	Percent Impervious (Worksheet A - Item 1c)	IMP	66.5	%
b	Runoff Coefficient (= 0.007 * IMP + 0.1)	Rv	0.57	ratio
2	Compute runoff flow rates (section 3.1)			
a	flow rate from mean storm			
	= Rv * MIP * AROW * (3630 / 3600)	MQR	6.677	CFS
b	coefficient of variation of runoff flows			
	= CVIP (Worksheet A - Item 2f)	CVOR	1.30	dimensionless
3	Compute runoff volumes (section 3.1)			
a	Volume from the mean storm			
	= Rv * MVP * AROW * 3630	MVR	122543	cubic feet
b	coefficient of variation of runoff volumes			
	= CVVP (Worksheet A - Item 2e)	CVVR	1.46	dimensionless

			Heavy Metals			Oxygen Demand		Nutrients			Particulates		
4	Compute mass Loads (section 3.2)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
	Site Median Conc (Worksheet A - Item 4a)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
	Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	dimensionless
	Number of storms per year (Worksheet A - 2i)	NST	120	120	120	120	120	120	120	120	120	120	number
a	mean event concentration (MCR)												
	= TCR * SQRT(1 + CVCR^2)	MCR	0.07	0.50	0.41	31.25	142.50	0.95	2.29	0.50	177.50	48.75	mg/1
b	mean event mass load												
	= MCR * MVR * (0.00006245)	M{MASS)	0.52	3.83	3.15	239.15	1090.53	7.27	17.51	3.83	1358.37	373.07	pounds
c	annual mass load from runoff												
	= M(MASS) * NST	ANMASS	61.99	459.17	377.67	28698	130863	872.42	2100.70	459.17	163005	44769	pounds/year

5	Compute flow ratio (MQS/MQR) (section 3.3)			
a	ratio of average stream flow (Worksheet A - 7b) to MQR	MQS/MQR	39.72	ratio

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build for Community Grid Alternative

Date: 12/03/2019
Area: Central Study Area

Table 11. Worksheet C - Stream impact analysis

1 Define the flow ratio MQS/MQR (Worksheet B - 5a)	MQS/MQR	39.72	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	120	number	
b Compute the probability {%) of. the 3 year event				
= 100 *(1 /(NST * 3))	PR	0.28	%	
3 Enter value from table 7				
for MQS/MQR and frequency PR	CU	1.082	mg/1	

4 Select pollutant for analysis		Heavy Metals			Oxygen Demand		Nutrients			Particulates		name
		Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a Site median concentration (table 3)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b Soluble fraction (section 2.5)	FSOL	0.400	0.100	0.400								fraction
c Acute Criteria Value (table 4)	CTA	0.021	0.103	0.374	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
d Threshold effects level (table 4)	CTT	0.045	0.450	0.785	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
4 Compute the once in 3 *year* stream pollutant concentration												
= CU * TCR * FSOL	CO	0.023	0.043	0.142								mg/1
5 Compare with target concentration, CTA												
= CO / CTA	CRAT	1.11	0.42	0.38								ratio

6 Evaluate results		
a If CRAT is less than about 0.75		STOP
A toxicity problem attributable to this pollutant is unlikely		
b If CRAT is greater than 5 reduction will definitely be required		CONTROL
Estimate the level of reduction possible and repeat the analysis with revised values for either concentration or flow or both		
c If CRAT is still greater than 1		EVALUATE
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		
=CO / CTT	CRTE	0.52 ratio

A further refinement in the analysis can be made using the procedure described in Appendix B.

Changes will usually be nominal, based on refined local estimates of variability of flows.

AKRF Engineering, P.C.

TOLER ANALYSIS FOR ESTIMATING CHLORIDES

PROJECT: I-81 VIADUCT PROJECT
AREA: CENTRAL STUDY AREA
ALTERNATIVE: NO BUILD ALTERNATIVE

Constituent evaluation = Chloride
Mean Annual Runoff 19.2 inches
K = 8.37

Drainage Area #	Drainage Area (sq.mi.)	Lane Miles, M	Salt Applied Rate, T (Ton/lane mile)	Annual Average Concentration, C (ppm)	Discharge Location
A	156	37.9	25	2.65	Lower Onondaga Creek

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: Central Study Area

Table 9. Worksheet A - Site characteristics

1	Drainage Area of Highway Segment (section 2.1)			
	a Total right of way (Analysis area)	AROW	229.5	acres
	b Paved surface	AHWY	144.3	acres
	c Percent Impervious(= 100 * AHWY/AROW)	IMP	62.9	%
2	Rainfall Characteristics (from section 2.2)	MEAN		
	Zone 1; Initial estimates from Figure 2.			
	a Volume	MVP	0.26	inch
	b Intensity	MIP	0.051	inch / hour
	c Duration	MDP	5.80	hour
	d Interval	MTP	73.00	hour
		COEF of VARIATION		
	e Volume	CVVP	1.46	dimensionless
	f Intensity	CVIP	1.30	dimensionless
	g Duration	CVDP	1.05	dimensionless
	h Interval	CVTP	1.07	dimensionless
	i Number of storms per year (24*365 / MTP)	NST	120	no. events
3	Surrounding Area Type			
	a ADT over 30,000 vehicles/day, urbanized area		URBAN	☐
	or			
	b ADT under 30,000 vpd, undeveloped to low density suburban		RURAL	☐

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Select pollutant for analysis FHWA Volume I (section 2.4) and estimate runoff quality characteristics (use table 3)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
	a site median concentration	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
	b coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)	CVCR	0.75	dimensionless									
5	Select receiving water target concentration (section 2.6) surface water Total Hardness (figure 4)	TH	120	120	120	120	120	120	120	120	120	120	mg/1
	STREAM -use table 4 for target concentrations												
	a EPA Acute Criterion	CTA	0.021	0.103	0.374								mg/1
	b suggested Threshold Effect Level	CTT	0.045	0.450	0.785								mg/1
	or												
	LAKE - use accepted level for average Phosphorus concentration												
	c target concentration is 10 micrograms/liter		10	µg/1									

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: Central Study Area

6	Watershed Drainage Area upstream of highway for a stream - total contributing area for a lake	ATOT	156.0	square miles
7	Average annual stream flow (section 2.3)			
a	unit area flow rate per square mile (figure 3)	QSM	1.70	CFS/square mile
b	Coef of variation of stream flows(section 2.3)	CVQS	1.10	dimensionless
c	Average stream flow (QSM * ATOT)	MQS	265.20	CFS

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: Central Study Area

Table 10. Worksheet B - Highway runoff characteristics

1	Compute runoff coefficient (Rv) (see section 3.1)			
a	Percent Impervious (Worksheet A - Item 1c)	IMP	62.9	%
b	Runoff Coefficient (= 0.007 * IMP + 0.1)	Rv	0.54	ratio
2	Compute runoff flow rates (section 3.1)			
a	flow rate from mean storm			
	= Rv * MIP * AROW * (3630 / 3600)	MQR	6.375	CFS
b	coefficient of variation of runoff flows			
	= CVIP (Worksheet A - Item 2f)	CVOR	1.30	dimensionless
3	Compute runoff volumes (section 3.1)			
a	Volume from the mean storm			
	= Rv * MVP * AROW * 3630	MVR	116993	cubic feet
b	coefficient of variation of runoff volumes			
	= CVVP (Worksheet A - Item 2e)	CVVR	1.46	dimensionless

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Compute mass Loads (section 3.2)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P		TSS	VSS	
	Site Median Conc (Worksheet A - Item 4a)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400		142	39	mg/1
	Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75		0.75	0.75	dimensionless
	Number of storms per year (Worksheet A - 2i)	NST	120	120	120	120	120	120	120	120		120	120	number
a	mean event concentration (MCR)													
	= TCR * SQRT(1 + CVCR^2)	MCR	0.07	0.50	0.41	31.25	142.50	0.95	2.29	0.50		177.50	48.75	mg/1
b	mean event mass load													
	= MCR * MVR * (0.00006245)	M{MASS)	0.49	3.65	3.00	228.32	1041.14	6.94	16.71	3.65		1296.86	356.18	pounds
c	annual mass load from runoff													
	= M(MASS) * NST	ANMASS	59.18	438.37	360.56	27398	124937	832.91	2005.56	438.37		155623	42742	pounds/year

5	Compute flow ratio (MQS/MQR) (section 3.3)			
a	ratio of average stream flow (Worksheet A - 7b) to MQR	MQS/MQR	41.60	ratio

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: Central Study Area

Table 11. Worksheet C - Stream impact analysis

1 Define the flow ratio MQS/MQR (Worksheet B - 5a)	MQS/MQR	41.60	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	120	number									
b Compute the probability {%) of. the 3 year event												
= 100 *(1 /(NST * 3))	PR	0.28	%									
3 Enter value from table 7												
for MQS/MQR and frequency PR	CU	2.093	mg/1									
4 Select pollutant for analysis				Heavy Metals			Oxygen Demand		Nutrients			Particulates		name
				Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a Site median concentration (table 3)	TCR			0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b Soluble fraction (section 2.5)	FSOL			0.400	0.100	0.400								fraction
c Acute Criteria Value (table 4)	CTA			0.021	0.103	0.374	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
d Threshold effects level (table 4)	CTT			0.045	0.450	0.785	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
4 Compute the once in 3 *year* stream pollutant concentration														
= CU * TCR * FSOL	CO			0.045	0.084	0.275								mg/1
5 Compare with target concentration, CTA														
= CO / CTA	CRAT			2.15	0.81	0.74								ratio
6 Evaluate results														
a If CRAT is less than about 0.75		STOP												
A toxicity problem attributable to this pollutant is unlikely														
b If CRAT is greater than 5 reduction will definitely be required		CONTROL												
Estimate the level of reduction possible and repeat the analysis														
with revised values for either concentration or flow or both														
c If CRAT is still greater than 1		EVALUATE												
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														
=CO / CTT	CRTE	1.00	ratio											

A further refinement in the analysis can be made using the procedure described in Appendix B.

Changes will usually be nominal, based on refined local estimates of variability of flows.

AKRF Engineering, P.C.

TOLER ANALYSIS FOR ESTIMATING CHLORIDES

PROJECT: I-81 VIADUCT PROJECT
AREA: CENTRAL STUDY AREA
ALTERNATIVE: COMMUNITY GRID ALTERNATIVE

Constituent evaluation = Chloride
Mean Annual Runoff 19.2 inches
K = 8.37

Drainage Area #	Drainage Area (sq.mi.)	Lane Miles, M	Salt Applied Rate, T (Ton/lane mile)	Annual Average Concentration, C (ppm)	Discharge Location
A	156	41.5	25	2.90	Lower Onondaga Creek

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: South Study Area

Table 9. Worksheet A - Site characteristics

1	Drainage Area of Highway Segment (section 2.1)			
a	Total right of way (Analysis area)	AROW	180.5	acres
b	Paved surface	AHWY	49.3	acres
c	Percent Impervious(= 100 * AHWY/AROW)	IMP	27.3	%
2	Rainfall Characteristics (from section 2.2)	MEAN		
	Zone 1; Initial estimates from Figure 2.			
a	Volume	MVP	0.26	inch
b	Intensity	MIP	0.051	inch / hour
c	Duration	MDP	5.80	hour
d	Interval	MTP	73.00	hour
		COEF of VARIATION		
e	Volume	CVVP	1.46	dimensionless
f	Intensity	CVIP	1.30	dimensionless
g	Duration	CVDP	1.05	dimensionless
h	Interval	CVTP	1.07	dimensionless
i	Number of storms per year (24*365 / MTP)	NST	120	no. events

3 Surrounding Area Type

a	ADT over 30,000 vehicles/day, urbanized area	URBAN	☐
	or		
b	ADT under 30,000 vpd, undeveloped to low density suburban	RURAL	☐

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Select pollutant for analysis FHWA Volume I (section 2.4) and estimate runoff quality characteristics (use table 3)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a	site median concentration	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b	coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)	CVCR	0.75	dimensionless									
5	Select receiving water target concentration (section 2.6) surface water Total Hardness (figure 4)	TH	120	120	120	120	120	120	120	120	120	120	mg/1
	STREAM -use table 4 for target concentrations												
a	EPA Acute Criterion	CTA	0.021	0.103	0.374								mg/1
b	suggested Threshold Effect Level	CTT	0.045	0.450	0.785								mg/1
	or												
	LAKE - use accepted level for average Phosphorus concentration												
c	target concentration is 10 micrograms/liter		10	µg/1									

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: South Study Area

6	Watershed Drainage Area upstream of highway for a stream - total contributing area for a lake	ATOT	4.5	square miles
7	Average annual stream flow (section 2.3)			
a	unit area flow rate per square mile (figure 3)	QSM	1.70	CFS/square mile
b	Coef of variation of stream flows(section 2.3)	CVQS	1.10	dimensionless
c	Average stream flow (QSM * ATOT)	MQS	7.70	CFS

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: South Study Area

Table 10. Worksheet B - Highway runoff characteristics

1 Compute runoff coefficient (Rv) (see section 3.1)

a	Percent Impervious (Worksheet A - Item 1c)	IMP	27.3	%
b	Runoff Coefficient (= 0.007 * IMP + 0.1)	Rv	0.29	ratio

2 Compute runoff flow rates (section 3.1)

a	flow rate from mean storm			
	= Rv * MIP * AROW * (3630 / 3600)	MQR	2.703	CFS
b	coefficient of variation of runoff flows			
	= CVIP (Worksheet A - Item 2f)	CVOR	1.30	dimensionless

3 Compute runoff volumes (section 3.1)

a	Volume from the mean storm			
	= Rv * MVP * AROW * 3630	MVR	49606.1	cubic feet
b	coefficient of variation of runoff volumes			
	= CVVP (Worksheet A - Item 2e)	CVVR	1.46	dimensionless

4 Compute mass Loads (section 3.2)

		Heavy Metals			Oxygen Demand		Nutrients			Particulates		
	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
Site Median Conc (Worksheet A - Item 4a)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	dimensionless
Number of storms per year (Worksheet A - 2i)	NST	120	120	120	120	120	120	120	120	120	120	number
a mean event concentration (MCR)												
= TCR * SQRT(1 + CVCR^2)	MCR	0.07	0.50	0.41	31.25	142.50	0.95	2.29	0.50	177.50	48.75	mg/1
b mean event mass load												
= MCR * MVR * (0.00006245)	M{MASS}	0.21	1.55	1.27	96.81	441.45	2.94	7.09	1.55	549.88	151.02	pounds
c annual mass load from runoff												
= M(MASS) * NST	ANMASS	25.09	185.87	152.88	11617	52974	353.16	850.37	185.87	65985	18123	pounds/year

5 Compute flow ratio (MQS/MQR) (section 3.3)

a	ratio of average stream flow (Worksheet A - 7b) to MQR	MQS/MQR	2.85	ratio

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: South Study Area

Table 11. Worksheet C - Stream impact analysis

1	Define the flow ratio MQS/MQR (Worksheet B - 5a)	MQS/MQR	2.85										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	120										number
	b Compute the probability {%) of. the 3 year event												
	= 100 *(1 /(NST * 3))	PR	0.28										%
3	Enter value from table 7												
	for MQS/MQR and frequency PR	CU	2.951										mg/1
4	Select pollutant for analysis		Heavy Metals			Oxygen Demand		Nutrients			Particulates		name
			Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a	Site median concentration (table 3)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b	Soluble fraction (section 2.5)	FSOL	0.400	0.100	0.400								fraction
c	Acute Criteria Value (table 4)	CTA	0.021	0.103	0.374	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
d	Threshold effects level (table 4)	CTT	0.045	0.450	0.785	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
4	Compute the once in 3 *year* stream pollutant concentration												
	= CU * TCR * FSOL	CO	0.064	0.118	0.388								mg/1
5	Compare with target concentration, CTA												
	= CO / CTA	CRAT	3.04	1.15	1.04								ratio
6	Evaluate results												
a	If CRAT is less than about 0.75		STOP										
	A toxicity problem attributable to this pollutant is unlikely												
b	If CRAT is greater than 5 reduction will definitely be required		CONTROL										
	Estimate the level of reduction possible and repeat the analysis with revised values for either concentration or flow or both												
c	If CRAT is still greater than 1		EVALUATE										
	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												
	=CO / CTT	CRTE	1.42										ratio

A further refinement in the analysis can be made using the procedure described in Appendix B.

Changes will usually be nominal, based on refined local estimates of variability of flows.

AKRF Engineering, P.C.

TOLER ANALYSIS FOR ESTIMATING CHLORIDES

PROJECT: I-81 VIADUCT PROJECT
AREA: SOUTH STUDY AREA
ALTERNATIVE: NO BUILD ALTERNATIVE

Constituent evaluation = Chloride
Mean Annual Runoff 19.2 inches
K = 8.37

Drainage Area #	Drainage Area (sq.mi.)	Lane Miles, M	Salt Applied Rate, T (Ton/lane mile)	Annual Average Concentration, C (ppm)	Discharge Location
B	4.53	14.4	25	34.64	Middle Onondaga Creek

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: South Study Area

Table 9. Worksheet A - Site characteristics

1	Drainage Area of Highway Segment (section 2.1)			
a	Total right of way (Analysis area)	AROW	180.5	acres
b	Paved surface	AHWY	49.3	acres
c	Percent Impervious(= 100 * AHWY/AROW)	IMP	27.3	%
2	Rainfall Characteristics (from section 2.2)	MEAN		
	Zone 1; Initial estimates from Figure 2.			
a	Volume	MVP	0.26	inch
b	Intensity	MIP	0.051	inch / hour
c	Duration	MDP	5.80	hour
d	Interval	MTP	73.00	hour
		COEF of VARIATION		
e	Volume	CVVP	1.46	dimensionless
f	Intensity	CVIP	1.30	dimensionless
g	Duration	CVDP	1.05	dimensionless
h	Interval	CVTP	1.07	dimensionless
i	Number of storms per year (24*365 / MTP)	NST	120	no. events
3	Surrounding Area Type			
a	ADT over 30,000 vehicles/day, urbanized area	URBAN	☐	
	or			
b	ADT under 30,000 vpd, undeveloped to low density suburban	RURAL	☐	

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Select pollutant for analysis FHWA Volume I (section 2.4) and estimate runoff quality characteristics (use table 3)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a	site median concentration	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b	coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)	CVCR	0.75	dimensionless									
5	Select receiving water target concentration (section 2.6)												
	surface water Total Hardness (figure 4)	TH	120	120	120	120	120	120	120	120	120	120	mg/1
	STREAM -use table 4 for target concentrations												
a	EPA Acute Criterion	CTA	0.021	0.103	0.374								mg/1
b	suggested Threshold Effect Level	CTT	0.045	0.450	0.785								mg/1
	or												
	LAKE - use accepted level for average Phosphorus concentration												
c	target concentration is 10 micrograms/liter		10	µg/1									

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: South Study Area

6	Watershed Drainage Area upstream of highway for a stream - total contributing area for a lake	ATOT	4.5	square miles
7	Average annual stream flow (section 2.3)			
a	unit area flow rate per square mile (figure 3)	QSM	1.70	CFS/square mile
b	Coef of variation of stream flows(section 2.3)	CVQS	1.10	dimensionless
c	Average stream flow (QSM * ATOT)	MQS	7.70	CFS

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: South Study Area

Table 10. Worksheet B - Highway runoff characteristics

1	Compute runoff coefficient (Rv) (see section 3.1)			
a	Percent Impervious (Worksheet A - Item 1c)	IMP	27.3	%
b	Runoff Coefficient (= 0.007 * IMP + 0.1)	Rv	0.29	ratio
2	Compute runoff flow rates (section 3.1)			
a	flow rate from mean storm			
	= Rv * MIP * AROW * (3630 / 3600)	MQR	2.703	CFS
b	coefficient of variation of runoff flows			
	= CVIP (Worksheet A - Item 2f)	CVOR	1.30	dimensionless
3	Compute runoff volumes (section 3.1)			
a	Volume from the mean storm			
	= Rv * MVP * AROW * 3630	MVR	49606.1	cubic feet
b	coefficient of variation of runoff volumes			
	= CVVP (Worksheet A - Item 2e)	CVVR	1.46	dimensionless

			Heavy Metals			Oxygen Demand		Nutrients			Particulates		
4	Compute mass Loads (section 3.2)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
	Site Median Conc (Worksheet A - Item 4a)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
	Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	dimensionless
	Number of storms per year (Worksheet A - 2i)	NST	120	120	120	120	120	120	120	120	120	120	number
a	mean event concentration (MCR)												
	= TCR * SQRT(1 + CVCR^2)	MCR	0.07	0.50	0.41	31.25	142.50	0.95	2.29	0.50	177.50	48.75	mg/1
b	mean event mass load												
	= MCR * MVR * (0.00006245)	M{MASS)	0.21	1.55	1.27	96.81	441.45	2.94	7.09	1.55	549.88	151.02	pounds
c	annual mass load from runoff												
	= M(MASS) * NST	ANMASS	25.09	185.87	152.88	11617	52974	353.16	850.37	185.87	65985	18123	pounds/year

5	Compute flow ratio (MQS/MQR) (section 3.3)			
a	ratio of average stream flow (Worksheet A - 7b) to MQR	MQS/MQR	2.85	ratio

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: South Study Area

Table 11. Worksheet C - Stream impact analysis

1 Define the flow ratio MQS/MQR (Worksheet B - 5a)	MQS/MQR	2.85	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	120	number									
b Compute the probability {%) of. the 3 year event												
= 100 *(1 /(NST * 3))	PR	0.28	%									
3 Enter value from table 7												
for MQS/MQR and frequency PR	CU	2.951	mg/1									
4 Select pollutant for analysis				Heavy Metals			Oxygen Demand		Nutrients			Particulates		name
				Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a Site median concentration (table 3)	TCR			0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b Soluble fraction (section 2.5)	FSOL			0.400	0.100	0.400								fraction
c Acute Criteria Value (table 4)	CTA			0.021	0.103	0.374	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
d Threshold effects level (table 4)	CTT			0.045	0.450	0.785	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
4 Compute the once in 3 *year* stream pollutant concentration														
= CU * TCR * FSOL	CO			0.064	0.118	0.388								mg/1
5 Compare with target concentration, CTA														
= CO / CTA	CRAT			3.04	1.15	1.04								ratio
6 Evaluate results														
a If CRAT is less than about 0.75		STOP												
A toxicity problem attributable to this pollutant is unlikely														
b If CRAT is greater than 5 reduction will definitely be required		CONTROL												
Estimate the level of reduction possible and repeat the analysis														
with revised values for either concentration or flow or both														
c If CRAT is still greater than 1		EVALUATE												
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														
=CO / CTT	CRTE	1.42	ratio											

A further refinement in the analysis can be made using the procedure described in Appendix B.

Changes will usually be nominal, based on refined local estimates of variability of flows.

AKRF Engineering, P.C.

TOLER ANALYSIS FOR ESTIMATING CHLORIDES

PROJECT: I-81 VIADUCT PROJECT
AREA: SOUTH STUDY AREA
ALTERNATIVE: COMMUNITY GRID ALTERNATIVE

Constituent evaluation = Chloride
Mean Annual Runoff 19.2 inches
K = 8.37

Drainage Area #	Drainage Area (sq.mi.)	Lane Miles, M	Salt Applied Rate, T (Ton/lane mile)	Annual Average Concentration, C (ppm)	Discharge Location
B	4.53	15	25	36.09	Middle Onondaga Creek

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: Eastern Study Area- Northern Region to Ley Creek

Table 9. Worksheet A - Site characteristics

1	Drainage Area of Highway Segment (section 2.1)			
a	Total right of way (Analysis area)	AROW	18.5	acres
b	Paved surface	AHWY	5.7	acres
c	Percent Impervious(= 100 * AHWY/AROW)	IMP	30.8	%
2	Rainfall Characteristics (from section 2.2)	MEAN		
	Zone 1; Initial estimates from Figure 2.			
a	Volume	MVP	0.26	inch
b	Intensity	MIP	0.051	inch / hour
c	Duration	MDP	5.80	hour
d	Interval	MTP	73.00	hour
		COEF of VARIATION		
e	Volume	CVVP	1.46	dimensionless
f	Intensity	CVIP	1.30	dimensionless
g	Duration	CVDP	1.05	dimensionless
h	Interval	CVTP	1.07	dimensionless
i	Number of storms per year (24*365 / MTP)	NST	120	no. events
3	Surrounding Area Type			
a	ADT over 30,000 vehicles/day, urbanized area	URBAN	☐	
	or			
b	ADT under 30,000 vpd, undeveloped to low density suburban	RURAL	☐	

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Select pollutant for analysis FHWA Volume I (section 2.4) and estimate runoff quality characteristics (use table 3)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a	site median concentration	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b	coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)	CVCR	0.75	dimensionless									
5	Select receiving water target concentration (section 2.6) surface water Total Hardness (figure 4)	TH	120	120	120	120	120	120	120	120	120	120	mg/1
	STREAM -use table 4 for target concentrations												
a	EPA Acute Criterion	CTA	0.021	0.103	0.374								mg/1
b	suggested Threshold Effect Level	CTT	0.045	0.450	0.785								mg/1
	or												
	LAKE - use accepted level for average Phosphorus concentration												
c	target concentration is 10 micrograms/liter		10	µg/1									

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: Eastern Study Area- Northern Region to Ley Creek

6	Watershed Drainage Area upstream of highway for a stream - total contributing area for a lake	ATOT	1.0	square miles
7	Average annual stream flow (section 2.3)			
a	unit area flow rate per square mile (figure 3)	QSM	1.70	CFS/square mile
b	Coef of variation of stream flows(section 2.3)	CVQS	1.10	dimensionless
c	Average stream flow (QSM * ATOT)	MQS	1.62	CFS

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: Eastern Study Area- Northern Region to Ley Creek

Table 10. Worksheet B - Highway runoff characteristics

1	Compute runoff coefficient (Rv) (see section 3.1)			
a	Percent Impervious (Worksheet A - Item 1c)	IMP	30.8	%
b	Runoff Coefficient (= 0.007 * IMP + 0.1)	Rv	0.32	ratio
2	Compute runoff flow rates (section 3.1)			
a	flow rate from mean storm			
	= Rv * MIP * AROW * (3630 / 3600)	MQR	0.300	CFS
b	coefficient of variation of runoff flows			
	= CVIP (Worksheet A - Item 2f)	CVOR	1.30	dimensionless
3	Compute runoff volumes (section 3.1)			
a	Volume from the mean storm			
	= Rv * MVP * AROW * 3630	MVR	5511.79	cubic feet
b	coefficient of variation of runoff volumes			
	= CVVP (Worksheet A - Item 2e)	CVVR	1.46	dimensionless

			Heavy Metals			Oxygen Demand		Nutrients			Particulates		
4	Compute mass Loads (section 3.2)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
	Site Median Conc (Worksheet A - Item 4a)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
	Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	dimensionless
	Number of storms per year (Worksheet A - 2i)	NST	120	120	120	120	120	120	120	120	120	120	number
a	mean event concentration (MCR)												
	= TCR * SQRT(1 + CVCR^2)	MCR	0.07	0.50	0.41	31.25	142.50	0.95	2.29	0.50	177.50	48.75	mg/1
b	mean event mass load												
	= MCR * MVR * (0.00006245)	M{MASS)	0.02	0.17	0.14	10.76	49.05	0.33	0.79	0.17	61.10	16.78	pounds
c	annual mass load from runoff												
	= M(MASS) * NST	ANMASS	2.79	20.65	16.99	1291	5886	39.24	94.49	20.65	7332	2014	pounds/year

5	Compute flow ratio (MQS/MQR) (section 3.3)			
a	ratio of average stream flow (Worksheet A - 7b) to MQR	MQS/MQR	5.38	ratio

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: Eastern Study Area- Northern Region to Ley Creek

Table 11. Worksheet C - Stream impact analysis

1	Define the flow ratio MQS/MQR (Worksheet B - 5a)	MQS/MQR	5.38	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	120	number								
b	Compute the probability {%) of. the 3 year event											
	= 100 *(1 /(NST * 3))	PR	0.28	%								
3	Enter value from table 7											
	for MQS/MQR and frequency PR	CU	2.586	mg/1								
4	Select pollutant for analysis		Heavy Metals			Oxygen Demand		Nutrients			Particulates		name
			Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a	Site median concentration (table 3)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b	Soluble fraction (section 2.5)	FSOL	0.400	0.100	0.400								fraction
c	Acute Criteria Value (table 4)	CTA	0.021	0.103	0.374	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
d	Threshold effects level (table 4)	CTT	0.045	0.450	0.785	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
4	Compute the once in 3 *year* stream pollutant concentration												
	= CU * TCR * FSOL	CO	0.056	0.103	0.340								mg/1
5	Compare with target concentration, CTA												
	= CO / CTA	CRAT	2.66	1.00	0.91								ratio
6	Evaluate results												
a	If CRAT is less than about 0.75		STOP										
	A toxicity problem attributable to this pollutant is unlikely												
b	If CRAT is greater than 5 reduction will definitely be required		CONTROL										
	Estimate the level of reduction possible and repeat the analysis with revised values for either concentration or flow or both												
c	If CRAT is still greater than 1		EVALUATE										
	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												
	=CO / CTT	CRTE	1.24	ratio									

A further refinement in the analysis can be made using the procedure described in Appendix B.

Changes will usually be nominal, based on refined local estimates of variability of flows.

AKRF Engineering, P.C.

TOLER ANALYSIS FOR ESTIMATING CHLORIDES

PROJECT: I-81 VIADUCT PROJECT
AREA: EAST STUDY AREA - NORTHERN SECTION
ALTERNATIVE: NO BUILD ALTERNATIVE

Constituent evaluation = Chloride
Mean Annual Runoff = 19.2 inches
K = 8.37

Drainage Area #	Drainage Area (sq.mi.)	Lane Miles, M	Salt Applied Rate, T (Ton/lane mile)	Annual Average Concentration, C (ppm)	Discharge Location
C-North	0.95	2	25	22.94	North Branch Ley Creek

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: East Study Area- Northern Region to Ley Creek

Table 9. Worksheet A - Site characteristics

1	Drainage Area of Highway Segment (section 2.1)			
a	Total right of way (Analysis area)	AROW	18.5	acres
b	Paved surface	AHWY	6.3	acres
c	Percent Impervious(= 100 * AHWY/AROW)	IMP	34.1	%
2	Rainfall Characteristics (from section 2.2)	MEAN		
	Zone 1; Initial estimates from Figure 2.			
a	Volume	MVP	0.26	inch
b	Intensity	MIP	0.051	inch / hour
c	Duration	MDP	5.80	hour
d	Interval	MTP	73.00	hour
		COEF of VARIATION		
e	Volume	CVVP	1.46	dimensionless
f	Intensity	CVIP	1.30	dimensionless
g	Duration	CVDP	1.05	dimensionless
h	Interval	CVTP	1.07	dimensionless
i	Number of storms per year (24*365 / MTP)	NST	120	no. events
3	Surrounding Area Type			
a	ADT over 30,000 vehicles/day, urbanized area	URBAN	☐	
	or			
b	ADT under 30,000 vpd, undeveloped to low density suburban	RURAL	☐	

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Select pollutant for analysis FHWA Volume I (section 2.4) and estimate runoff quality characteristics (use table 3)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a	site median concentration	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b	coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)	CVCR	0.75	dimensionless									
5	Select receiving water target concentration (section 2.6)												
	surface water Total Hardness (figure 4)	TH	120	120	120	120	120	120	120	120	120	120	mg/1
	STREAM -use table 4 for target concentrations												
a	EPA Acute Criterion	CTA	0.021	0.103	0.374								mg/1
b	suggested Threshold Effect Level	CTT	0.045	0.450	0.785								mg/1
	or												
	LAKE - use accepted level for average Phosphorus concentration												
c	target concentration is 10 micrograms/liter		10	µg/1									

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: East Study Area- Northern Region to Ley Creek

6	Watershed Drainage Area upstream of highway for a stream - total contributing area for a lake	ATOT	1.0	square miles
7	Average annual stream flow (section 2.3)			
a	unit area flow rate per square mile (figure 3)	QSM	1.70	CFS/square mile
b	Coef of variation of stream flows(section 2.3)	CVQS	1.10	dimensionless
c	Average stream flow (QSM * ATOT)	MQS	1.62	CFS

AKRF Engineering, P.C.

TOLER ANALYSIS FOR ESTIMATING CHLORIDES

PROJECT: I-81 VIADUCT PROJECT
AREA: EAST STUDY AREA - NORTHERN SECTION
ALTERNATIVE: COMMUNITY GRID ALTERNATIVE

Constituent evaluation = Chloride
Mean Annual Runoff = 19.2 inches
K = 8.37

Drainage Area #	Drainage Area (sq.mi.)	Lane Miles, M	Salt Applied Rate, T (Ton/lane mile)	Annual Average Concentration, C (ppm)	Discharge Location
C-North	0.95	2.8	25	32.12	North Branch Ley Creek

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: East Study Area- Southern Region to Butternut Creek

Table 9. Worksheet A - Site characteristics

1	Drainage Area of Highway Segment (section 2.1)			
a	Total right of way (Analysis area)	AROW	221.0	acres
b	Paved surface	AHWY	65.3	acres
c	Percent Impervious(= 100 * AHWY/AROW)	IMP	29.5	%
2	Rainfall Characteristics (from section 2.2)	MEAN		
	Zone 1; Initial estimates from Figure 2.			
a	Volume	MVP	0.26	inch
b	Intensity	MIP	0.051	inch / hour
c	Duration	MDP	5.80	hour
d	Interval	MTP	73.00	hour
		COEF of VARIATION		
e	Volume	CVVP	1.46	dimensionless
f	Intensity	CVIP	1.30	dimensionless
g	Duration	CVDP	1.05	dimensionless
h	Interval	CVTP	1.07	dimensionless
i	Number of storms per year (24*365 / MTP)	NST	120	no. events
3	Surrounding Area Type			
a	ADT over 30,000 vehicles/day, urbanized area	URBAN	☐	
	or			
b	ADT under 30,000 vpd, undeveloped to low density suburban	RURAL	☐	

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Select pollutant for analysis FHWA Volume I (section 2.4) and estimate runoff quality characteristics (use table 3)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a	site median concentration	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b	coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)	CVCR	0.75	dimensionless									
5	Select receiving water target concentration (section 2.6) surface water Total Hardness (figure 4)	TH	120	120	120	120	120	120	120	120	120	120	mg/1
	STREAM -use table 4 for target concentrations												
a	EPA Acute Criterion	CTA	0.021	0.103	0.374								mg/1
b	suggested Threshold Effect Level	CTT	0.045	0.450	0.785								mg/1
	or												
	LAKE - use accepted level for average Phosphorus concentration												
c	target concentration is 10 micrograms/liter		10	µg/1									

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: East Study Area- Southern Region to Butternut Creek

6	Watershed Drainage Area upstream of highway for a stream - total contributing area for a lake	ATOT	68.9	square miles
7	Average annual stream flow (section 2.3)			
a	unit area flow rate per square mile (figure 3)	QSM	1.70	CFS/square mile
b	Coef of variation of stream flows(section 2.3)	CVQS	1.10	dimensionless
c	Average stream flow (QSM * ATOT)	MQS	117.13	CFS

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: East Study Area- Southern Region to Butternut Creek

Table 10. Worksheet B - Highway runoff characteristics

1	Compute runoff coefficient (Rv) (see section 3.1)			
a	Percent Impervious (Worksheet A - Item 1c)	IMP	29.5	%
b	Runoff Coefficient (= 0.007 * IMP + 0.1)	Rv	0.31	ratio
2	Compute runoff flow rates (section 3.1)			
a	flow rate from mean storm			
	= Rv * MIP * AROW * (3630 / 3600)	MQR	3.487	CFS
b	coefficient of variation of runoff flows			
	= CVIP (Worksheet A - Item 2f)	CVOR	1.30	dimensionless
3	Compute runoff volumes (section 3.1)			
a	Volume from the mean storm			
	= Rv * MVP * AROW * 3630	MVR	63999.1	cubic feet
b	coefficient of variation of runoff volumes			
	= CVVP (Worksheet A - Item 2e)	CVVR	1.46	dimensionless

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Compute mass Loads (section 3.2)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P		TSS	VSS	
	Site Median Conc (Worksheet A - Item 4a)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400		142	39	mg/1
	Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75		0.75	0.75	dimensionless
	Number of storms per year (Worksheet A - 2i)	NST	120	120	120	120	120	120	120	120		120	120	number
a	mean event concentration (MCR)													
	= TCR * SQRT(1 + CVCR^2)	MCR	0.07	0.50	0.41	31.25	142.50	0.95	2.29	0.50		177.50	48.75	mg/1
b	mean event mass load													
	= MCR * MVR * (0.00006245)	M{MASS)	0.27	2.00	1.64	124.90	569.54	3.80	9.14	2.00		709.42	194.84	pounds
c	annual mass load from runoff													
	= M(MASS) * NST	ANMASS	32.37	239.80	197.24	14988	68344	455.63	1097.11	239.80		85131	23381	pounds/year

5	Compute flow ratio (MQS/MQR) (section 3.3)			
a	ratio of average stream flow (Worksheet A - 7b) to MQR	MQS/MQR	33.59	ratio

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: East Study Area- Southern Region to Butternut Creek

Table 11. Worksheet C - Stream impact analysis

1 Define the flow ratio MQS/MQR (Worksheet B - 5a)	MQS/MQR	33.59	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	120	number									
b Compute the probability {%) of. the 3 year event												
= 100 *(1 /(NST * 3))	PR	0.28	%									
3 Enter value from table 7												
for MQS/MQR and frequency PR	CU	1.246	mg/1									
4 Select pollutant for analysis				Heavy Metals			Oxygen Demand		Nutrients			Particulates		name
				Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a Site median concentration (table 3)	TCR			0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b Soluble fraction (section 2.5)	FSOL			0.400	0.100	0.400								fraction
c Acute Criteria Value (table 4)	CTA			0.021	0.103	0.374	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
d Threshold effects level (table 4)	CTT			0.045	0.450	0.785	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
4 Compute the once in 3 *year* stream pollutant concentration														
= CU * TCR * FSOL	CO			0.027	0.050	0.164								mg/1
5 Compare with target concentration, CTA														
= CO / CTA	CRAT			1.28	0.48	0.44								ratio
6 Evaluate results														
a If CRAT is less than about 0.75		STOP												
A toxicity problem attributable to this pollutant is unlikely														
b If CRAT is greater than 5 reduction will definitely be required		CONTROL												
Estimate the level of reduction possible and repeat the analysis with revised values for either concentration or flow or both														
c If CRAT is still greater than 1		EVALUATE												
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														
=CO / CTT	CRTE	0.60	ratio											

A further refinement in the analysis can be made using the procedure described in Appendix B.

Changes will usually be nominal, based on refined local estimates of variability of flows.

AKRF Engineering, P.C.

TOLER ANALYSIS FOR ESTIMATING CHLORIDES

PROJECT: I-81 VIADUCT PROJECT
AREA: EAST STUDY AREA - SOUTHERN SECTION
ALTERNATIVE: NO BUILD ALTERNATIVE

Constituent evaluation = Chloride
Mean Annual Runoff = 19.2 inches
K = 8.37

Drainage Area #	Drainage Area (sq.mi.)	Lane Miles, M	Salt Applied Rate, T (Ton/lane mile)	Annual Average Concentration, C (ppm)	Discharge Location
C-South	68.9	9.8	25	1.55	Butternut Creek

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: East Study Area- Southern Region to Butternut Creek

Table 9. Worksheet A - Site characteristics

1	Drainage Area of Highway Segment (section 2.1)			
a	Total right of way (Analysis area)	AROW	221.0	acres
b	Paved surface	AHWY	68.0	acres
c	Percent Impervious(= 100 * AHWY/AROW)	IMP	30.8	%
2	Rainfall Characteristics (from section 2.2)	MEAN		
	Zone 1; Initial estimates from Figure 2.			
a	Volume	MVP	0.26	inch
b	Intensity	MIP	0.051	inch / hour
c	Duration	MDP	5.80	hour
d	Interval	MTP	73.00	hour
		COEF of VARIATION		
e	Volume	CVVP	1.46	dimensionless
f	Intensity	CVIP	1.30	dimensionless
g	Duration	CVDP	1.05	dimensionless
h	Interval	CVTP	1.07	dimensionless
i	Number of storms per year (24*365 / MTP)	NST	120	no. events
3	Surrounding Area Type			
a	ADT over 30,000 vehicles/day, urbanized area	URBAN	☐	
	or			
b	ADT under 30,000 vpd, undeveloped to low density suburban	RURAL	☐	

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Select pollutant for analysis FHWA Volume I (section 2.4) and estimate runoff quality characteristics (use table 3)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a	site median concentration	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b	coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)	CVCR	0.75	dimensionless									
5	Select receiving water target concentration (section 2.6) surface water Total Hardness (figure 4)	TH	120	120	120	120	120	120	120	120	120	120	mg/1
	STREAM -use table 4 for target concentrations												
a	EPA Acute Criterion	CTA	0.021	0.103	0.374								mg/1
b	suggested Threshold Effect Level	CTT	0.045	0.450	0.785								mg/1
	or												
	LAKE - use accepted level for average Phosphorus concentration												
c	target concentration is 10 micrograms/liter		10	µg/1									

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: East Study Area- Southern Region to Butternut Creek

6	Watershed Drainage Area upstream of highway for a stream - total contributing area for a lake	ATOT	68.9	square miles
7	Average annual stream flow (section 2.3)			
a	unit area flow rate per square mile (figure 3)	QSM	1.70	CFS/square mile
b	Coef of variation of stream flows(section 2.3)	CVQS	1.10	dimensionless
c	Average stream flow (QSM * ATOT)	MQS	117.13	CFS

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: East Study Area- Southern Region to Butternut Creek

Table 10. Worksheet B - Highway runoff characteristics

1	Compute runoff coefficient (Rv) (see section 3.1)			
a	Percent Impervious (Worksheet A - Item 1c)	IMP	30.8	%
b	Runoff Coefficient (= 0.007 * IMP + 0.1)	Rv	0.32	ratio
2	Compute runoff flow rates (section 3.1)			
a	flow rate from mean storm			
	= Rv * MIP * AROW * (3630 / 3600)	MQR	3.584	CFS
b	coefficient of variation of runoff flows			
	= CVIP (Worksheet A - Item 2f)	CVOR	1.30	dimensionless
3	Compute runoff volumes (section 3.1)			
a	Volume from the mean storm			
	= Rv * MVP * AROW * 3630	MVR	65782.9	cubic feet
b	coefficient of variation of runoff volumes			
	= CVVP (Worksheet A - Item 2e)	CVVR	1.46	dimensionless

			Heavy Metals			Oxygen Demand		Nutrients			Particulates		
4	Compute mass Loads (section 3.2)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
	Site Median Conc (Worksheet A - Item 4a)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
	Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	dimensionless
	Number of storms per year (Worksheet A - 2i)	NST	120	120	120	120	120	120	120	120	120	120	number
a	mean event concentration (MCR)												
	= TCR * SQRT(1 + CVCR^2)	MCR	0.07	0.50	0.41	31.25	142.50	0.95	2.29	0.50	177.50	48.75	mg/1
b	mean event mass load												
	= MCR * MVR * (0.00006245)	M{MASS)	0.28	2.05	1.69	128.38	585.41	3.90	9.40	2.05	729.19	200.27	pounds
c	annual mass load from runoff												
	= M(MASS) * NST	ANMASS	33.28	246.49	202.74	15406	70249	468.33	1127.68	246.49	87503	24033	pounds/year

5	Compute flow ratio (MQS/MQR) (section 3.3)			
a	ratio of average stream flow (Worksheet A - 7b) to MQR	MQS/MQR	32.68	ratio

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: East Study Area- Southern Region to Butternut Creek

Table 11. Worksheet C - Stream impact analysis

1	Define the flow ratio MQS/MQR (Worksheet B - 5a)	MQS/MQR	32.68	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	120	number									
b	Compute the probability {%) of. the 3 year event												
	= 100 *(1 /(NST * 3))	PR	0.28	%									
3	Enter value from table 7												
	for MQS/MQR and frequency PR	CU	1.270	mg/1									
4	Select pollutant for analysis		Heavy Metals			Oxygen Demand		Nutrients			Particulates		name
			Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a	Site median concentration (table 3)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b	Soluble fraction (section 2.5)	FSOL	0.400	0.100	0.400								fraction
c	Acute Criteria Value (table 4)	CTA	0.021	0.103	0.374	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
d	Threshold effects level (table 4)	CTT	0.045	0.450	0.785	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
4	Compute the once in 3 *year* stream pollutant concentration												
	= CU * TCR * FSOL	CO	0.027	0.051	0.167								mg/1
5	Compare with target concentration, CTA												
	= CO / CTA	CRAT	1.31	0.49	0.45								ratio
6	Evaluate results												
a	If CRAT is less than about 0.75		STOP										
	A toxicity problem attributable to this pollutant is unlikely												
b	If CRAT is greater than 5 reduction will definitely be required Estimate the level of reduction possible and repeat the analysis with revised values for either concentration or flow or both		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										
	=CO / CTT	CRTE	0.61	ratio									

A further refinement in the analysis can be made using the procedure described in Appendix B.

Changes will usually be nominal, based on refined local estimates of variability of flows.

AKRF Engineering, P.C.

TOLER ANALYSIS FOR ESTIMATING CHLORIDES

PROJECT: I-81 VIADUCT PROJECT
AREA: EAST STUDY AREA - SOUTHERN SECTION
ALTERNATIVE: COMMUNITY GRID ALTERNATIVE

Constituent evaluation = Chloride
Mean Annual Runoff = 19.2 inches
K = 8.37

Drainage Area #	Drainage Area (sq.mi.)	Lane Miles, M	Salt Applied Rate, T (Ton/lane mile)	Annual Average Concentration, C (ppm)	Discharge Location
C-South	68.9	12	25	1.90	Butternut Creek

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: North Study Area

Table 9. Worksheet A - Site characteristics

1	Drainage Area of Highway Segment (section 2.1)			
a	Total right of way (Analysis area)	AROW	233.6	acres
b	Paved surface	AHWY	54.6	acres
c	Percent Impervious(= 100 * AHWY/AROW)	IMP	23.4	%
2	Rainfall Characteristics (from section 2.2)	MEAN		
	Zone 1; Initial estimates from Figure 2.			
a	Volume	MVP	0.26	inch
b	Intensity	MIP	0.051	inch / hour
c	Duration	MDP	5.80	hour
d	Interval	MTP	73.00	hour
		COEF of VARIATION		
e	Volume	CVVP	1.46	dimensionless
f	Intensity	CVIP	1.30	dimensionless
g	Duration	CVDP	1.05	dimensionless
h	Interval	CVTP	1.07	dimensionless
i	Number of storms per year (24*365 / MTP)	NST	120	no. events
3	Surrounding Area Type			
a	ADT over 30,000 vehicles/day, urbanized area	URBAN	☐	
	or			
b	ADT under 30,000 vpd, undeveloped to low density suburban	RURAL	☐	

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Select pollutant for analysis FHWA Volume I (section 2.4) and estimate runoff quality characteristics (use table 3)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a	site median concentration	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b	coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)	CVCR	0.75	dimensionless									
5	Select receiving water target concentration (section 2.6)												
	surface water Total Hardness (figure 4)	TH	120	120	120	120	120	120	120	120	120	120	mg/1
	STREAM -use table 4 for target concentrations												
a	EPA Acute Criterion	CTA	0.021	0.103	0.374								mg/1
b	suggested Threshold Effect Level	CTT	0.045	0.450	0.785								mg/1
	or												
	LAKE - use accepted level for average Phosphorus concentration												
c	target concentration is 10 micrograms/liter		10	µg/1									

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: North Study Area

6	Watershed Drainage Area upstream of highway for a stream - total contributing area for a lake	ATOT	5.3	square miles
7	Average annual stream flow (section 2.3)			
a	unit area flow rate per square mile (figure 3)	QSM	1.70	CFS/square mile
b	Coef of variation of stream flows(section 2.3)	CVQS	1.10	dimensionless
c	Average stream flow (QSM * ATOT)	MQS	9.04	CFS

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: North Study Area

Table 10. Worksheet B - Highway runoff characteristics

1	Compute runoff coefficient (Rv) (see section 3.1)			
a	Percent Impervious (Worksheet A - Item 1c)	IMP	23.4	%
b	Runoff Coefficient (= 0.007 * IMP + 0.1)	Rv	0.26	ratio
2	Compute runoff flow rates (section 3.1)			
a	flow rate from mean storm			
	= Rv * MIP * AROW * (3630 / 3600)	MQR	3.167	CFS
b	coefficient of variation of runoff flows			
	= CVIP (Worksheet A - Item 2f)	CVOR	1.30	dimensionless
3	Compute runoff volumes (section 3.1)			
a	Volume from the mean storm			
	= Rv * MVP * AROW * 3630	MVR	58119.2	cubic feet
b	coefficient of variation of runoff volumes			
	= CVVP (Worksheet A - Item 2e)	CVVR	1.46	dimensionless

			Heavy Metals			Oxygen Demand		Nutrients			Particulates		
4	Compute mass Loads (section 3.2)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
	Site Median Conc (Worksheet A - Item 4a)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
	Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	dimensionless
	Number of storms per year (Worksheet A - 2i)	NST	120	120	120	120	120	120	120	120	120	120	number
a	mean event concentration (MCR)												
	= TCR * SQRT(1 + CVCR^2)	MCR	0.07	0.50	0.41	31.25	142.50	0.95	2.29	0.50	177.50	48.75	mg/1
b	mean event mass load												
	= MCR * MVR * (0.00006245)	M{MASS)	0.24	1.81	1.49	113.42	517.21	3.45	8.30	1.81	644.24	176.94	pounds
c	annual mass load from runoff												
	= M(MASS) * NST	ANMASS	29.40	217.77	179.12	13611	62065	413.77	996.31	217.77	77309	21233	pounds/year

5	Compute flow ratio (MQS/MQR) (section 3.3)			
a	ratio of average stream flow (Worksheet A - 7b) to MQR	MQS/MQR	2.86	ratio

AKRF Engineering, P.C.

FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: No Build Alternatives

Date: 12/03/2019
Area: North Study Area

Table 11. Worksheet C - Stream impact analysis

1 Define the flow ratio MQS/MQR (Worksheet B - 5a)	MQS/MQR	2.86	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	120	number	
b Compute the probability {%) of. the 3 year event				
= 100 *(1 /(NST * 3))	PR	0.28	%	
3 Enter value from table 7				
for MQS/MQR and frequency PR	CU	2.950	mg/1	

4 Select pollutant for analysis		Heavy Metals			Oxygen Demand		Nutrients			Particulates		name
		Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a Site median concentration (table 3)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b Soluble fraction (section 2.5)	FSOL	0.400	0.100	0.400								fraction
c Acute Criteria Value (table 4)	CTA	0.021	0.103	0.374	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
d Threshold effects level (table 4)	CTT	0.045	0.450	0.785	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
4 Compute the once in 3 *year* stream pollutant concentration												
= CU * TCR * FSOL	CO	0.064	0.118	0.388								mg/1
5 Compare with target concentration, CTA												
= CO / CTA	CRAT	3.03	1.15	1.04								ratio

6 Evaluate results			
a If CRAT is less than about 0.75		STOP	
A toxicity problem attributable to this pollutant is unlikely			
b If CRAT is greater than 5 reduction will definitely be required		CONTROL	
Estimate the level of reduction possible and repeat the analysis with revised values for either concentration or flow or both			
c If CRAT is still greater than 1		EVALUATE	
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			
=CO / CTT	CRTE	1.42	ratio

A further refinement in the analysis can be made using the procedure described in Appendix B.

Changes will usually be nominal, based on refined local estimates of variability of flows.

AKRF Engineering, P.C.

TOLER ANALYSIS FOR ESTIMATING CHLORIDES

PROJECT: I-81 VIADUCT PROJECT
AREA: NORTH STUDY AREA
ALTERNATIVE: NO BUILD ALTERNATIVE

Constituent evaluation = Chloride
Mean Annual Runoff = 19.2 inches
K = 8.37

Drainage Area #	Drainage Area (sq.mi.)	Lane Miles, M	Salt Applied Rate, T (Ton/lane mile)	Annual Average Concentration, C (ppm)	Discharge Location
D	5.32	10.3	25	21.10	Mud Creek

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FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: North Study Area

Table 9. Worksheet A - Site characteristics

1	Drainage Area of Highway Segment (section 2.1)			
a	Total right of way (Analysis area)	AROW	233.6	acres
b	Paved surface	AHWY	59.2	acres
c	Percent Impervious(= 100 * AHWY/AROW)	IMP	25.3	%
2	Rainfall Characteristics (from section 2.2)	MEAN		
	Zone 1; Initial estimates from Figure 2.			
a	Volume	MVP	0.26	inch
b	Intensity	MIP	0.051	inch / hour
c	Duration	MDP	5.80	hour
d	Interval	MTP	73.00	hour
		COEF of VARIATION		
e	Volume	CVVP	1.46	dimensionless
f	Intensity	CVIP	1.30	dimensionless
g	Duration	CVDP	1.05	dimensionless
h	Interval	CVTP	1.07	dimensionless
i	Number of storms per year (24*365 / MTP)	NST	120	no. events
3	Surrounding Area Type			
a	ADT over 30,000 vehicles/day, urbanized area		URBAN	☐
	or			
b	ADT under 30,000 vpd, undeveloped to low density suburban		RURAL	☐

			Heavy Metals			Oxygen Demand		Nutrients				Particulates		
4	Select pollutant for analysis FHWA Volume I (section 2.4) and estimate runoff quality characteristics (use table 3)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a	site median concentration	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b	coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)	CVCR	0.75	dimensionless									
5	Select receiving water target concentration (section 2.6) surface water Total Hardness (figure 4)	TH	120	120	120	120	120	120	120	120	120	120	mg/1
	STREAM -use table 4 for target concentrations												
a	EPA Acute Criterion	CTA	0.021	0.103	0.374								mg/1
b	suggested Threshold Effect Level	CTT	0.045	0.450	0.785								mg/1
	or												
	LAKE - use accepted level for average Phosphorus concentration												
c	target concentration is 10 micrograms/liter		10	µg/1									

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FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: North Study Area

6	Watershed Drainage Area upstream of highway for a stream - total contributing area for a lake	ATOT	5.3	square miles
7	Average annual stream flow (section 2.3)			
a	unit area flow rate per square mile (figure 3)	QSM	1.70	CFS/square mile
b	Coef of variation of stream flows(section 2.3)	CVQS	1.10	dimensionless
c	Average stream flow (QSM * ATOT)	MQS	9.04	CFS

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FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: North Study Area

Table 10. Worksheet B - Highway runoff characteristics

1 Compute runoff coefficient (Rv) (see section 3.1)

a	Percent Impervious (Worksheet A - Item 1c)	IMP	25.3	%
b	Runoff Coefficient (= 0.007 * IMP + 0.1)	Rv	0.28	ratio

2 Compute runoff flow rates (section 3.1)

a	flow rate from mean storm			
	= Rv * MIP * AROW * (3630 / 3600)	MQR	3.332	CFS
b	coefficient of variation of runoff flows			
	= CVIP (Worksheet A - Item 2f)	CVOR	1.30	dimensionless

3 Compute runoff volumes (section 3.1)

a	Volume from the mean storm			
	= Rv * MVP * AROW * 3630	MVR	61158.2	cubic feet
b	coefficient of variation of runoff volumes			
	= CVVP (Worksheet A - Item 2e)	CVVR	1.46	dimensionless

			Heavy Metals			Oxygen Demand		Nutrients			Particulates		
4	Compute mass Loads (section 3.2)	name	Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
	Site Median Conc (Worksheet A - Item 4a)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
	Coef of var. of site EMC's (Worksheet A - 4b)	CVCR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	dimensionless
	Number of storms per year (Worksheet A - 2i)	NST	120	120	120	120	120	120	120	120	120	120	number
a	mean event concentration (MCR)												
	= TCR * SQRT(1 + CVCR^2)	MCR	0.07	0.50	0.41	31.25	142.50	0.95	2.29	0.50	177.50	48.75	mg/1
b	mean event mass load												
	= MCR * MVR * (0.00006245)	M{MASS)	0.26	1.91	1.57	119.35	544.25	3.63	8.74	1.91	677.93	186.19	pounds
c	annual mass load from runoff												
	= M(MASS) * NST	ANMASS	30.94	229.16	188.48	14322	65311	435.40	1048.41	229.16	81352	22343	pounds/year

5 Compute flow ratio (MQS/MQR) (section 3.3)

a	ratio of average stream flow (Worksheet A - 7b) to MQR	MQS/MQR	2.71	ratio

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FHWA POLLUTANT LOADINGS ANALYSIS

Project: I-81 VIADUCT PROJECT
Project Number: 20433
Alternate: Community Grid Alternative

Date: 12/03/2019
Area: North Study Area

Table 11. Worksheet C - Stream impact analysis

1 Define the flow ratio MQS/MQR (Worksheet B - 5a)	MQS/MQR	2.71	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	120	number	
b Compute the probability {%) of. the 3 year event				
= 100 *(1 /(NST * 3))	PR	0.28	%	
3 Enter value from table 7				
for MQS/MQR and frequency PR	CU	2.977	mg/1	

4 Select pollutant for analysis		Heavy Metals			Oxygen Demand		Nutrients			Particulates		name
		Cu	Pb	Zn	TOC	COD	NO2+3	TKN	PO4-P	TSS	VSS	
a Site median concentration (table 3)	TCR	0.054	0.400	0.329	25	114	0.76	1.83	0.400	142	39	mg/1
b Soluble fraction (section 2.5)	FSOL	0.400	0.100	0.400								fraction
c Acute Criteria Value (table 4)	CTA	0.021	0.103	0.374	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
d Threshold effects level (table 4)	CTT	0.045	0.450	0.785	0.000	0.000	0.000	0.000	0.000	0.000	0.000	mg/1
4 Compute the once in 3 *year* stream pollutant concentration												
= CU * TCR * FSOL	CO	0.064	0.119	0.392								mg/1
5 Compare with target concentration, CTA												
= CO / CTA	CRAT	3.06	1.16	1.05								ratio

6 Evaluate results			
a If CRAT is less than about 0.75		STOP	
A toxicity problem attributable to this pollutant is unlikely			
b If CRAT is greater than 5 reduction will definitely be required Estimate the level of reduction possible and repeat the analysis with revised values for either concentration or flow or both		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	
=CO / CTT	CRTE	1.43	ratio

A further refinement in the analysis can be made using the procedure described in Appendix B.

Changes will usually be nominal, based on refined local estimates of variability of flows.

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TOLER ANALYSIS FOR ESTIMATING CHLORIDES

PROJECT: I-81 VIADUCT PROJECT
AREA: NORTH STUDY AREA
ALTERNATIVE: COMMUNITY GRID ALTERNATIVE

Constituent evaluation = Chloride
Mean Annual Runoff = 19.2 inches
K = 8.37

Drainage Area #	Drainage Area (sq.mi.)	Lane Miles, M	Salt Applied Rate, T (Ton/lane mile)	Annual Average Concentration, C (ppm)	Discharge Location
D	5.32	13.1	25	26.84	Mud Creek