Appendix I-4
Results of FHWA Pollutant Loading and Toler Analysis
<table>
<thead>
<tr>
<th>POLUTANT</th>
<th>Copper (Cu)</th>
<th>Lead (Pb)</th>
<th>Zinc (Zn)</th>
<th>Total organic carbon (TOC)</th>
<th>Chemical oxygen demand (COD)</th>
<th>Nitrate + nitrite nitrogen (NO₂+NO₃)</th>
<th>Total kjeldahl nitrogen (TKN)</th>
<th>Phosphorus (PO₄-P)</th>
<th>Total suspended solids (TSS)</th>
<th>Volatile suspended solids (VSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.49</td>
<td>3.64</td>
<td>3.00</td>
<td>227.64</td>
<td>1038.03</td>
<td>6.92</td>
<td>16.66</td>
<td>3.64</td>
<td>1292.99</td>
<td>355.12</td>
</tr>
<tr>
<td>No Build</td>
<td>0.49</td>
<td>3.60</td>
<td>2.96</td>
<td>225.06</td>
<td>1026.27</td>
<td>6.84</td>
<td>16.47</td>
<td>3.60</td>
<td>1278.34</td>
<td>361.09</td>
</tr>
<tr>
<td>Proposed</td>
<td>-0.00%</td>
<td>-1.1%</td>
<td>-1.1%</td>
<td>-1.1%</td>
<td>-1.1%</td>
<td>-1.1%</td>
<td>-1.1%</td>
<td>-1.1%</td>
<td>-1.1%</td>
<td>-1.1%</td>
</tr>
<tr>
<td>Diff</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>% Diff</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Scaled % Diff</td>
<td>0.52</td>
<td>3.83</td>
<td>3.15</td>
<td>239.15</td>
<td>1090.53</td>
<td>7.29</td>
<td>17.51</td>
<td>3.83</td>
<td>1358.37</td>
<td>373.07</td>
</tr>
<tr>
<td>No Build</td>
<td>0.21</td>
<td>1.55</td>
<td>1.27</td>
<td>96.81</td>
<td>441.45</td>
<td>2.94</td>
<td>7.09</td>
<td>1.55</td>
<td>1296.86</td>
<td>356.18</td>
</tr>
<tr>
<td>Proposed</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Diff</td>
<td>0.02%</td>
<td>0.17%</td>
<td>0.14%</td>
<td>0.10%</td>
<td>0.17%</td>
<td>0.18%</td>
<td>0.18%</td>
<td>0.18%</td>
<td>0.17%</td>
<td>0.15%</td>
</tr>
<tr>
<td>% Diff</td>
<td>2%</td>
<td>11%</td>
<td>9%</td>
<td>11%</td>
<td>11%</td>
<td>11%</td>
<td>11%</td>
<td>11%</td>
<td>11%</td>
<td>11%</td>
</tr>
<tr>
<td>Scaled % Diff</td>
<td>0.27</td>
<td>2.90</td>
<td>1.64</td>
<td>124.30</td>
<td>569.54</td>
<td>3.80</td>
<td>9.14</td>
<td>3.80</td>
<td>729.19</td>
<td>194.94</td>
</tr>
<tr>
<td>No Build</td>
<td>0.28</td>
<td>2.95</td>
<td>1.69</td>
<td>128.38</td>
<td>585.41</td>
<td>3.90</td>
<td>9.40</td>
<td>3.90</td>
<td>729.19</td>
<td>200.27</td>
</tr>
<tr>
<td>Proposed</td>
<td>0.00%</td>
<td>0.06%</td>
<td>0.05%</td>
<td>0.04%</td>
<td>0.06%</td>
<td>0.04%</td>
<td>0.04%</td>
<td>0.04%</td>
<td>0.05%</td>
<td>0.06%</td>
</tr>
<tr>
<td>Diff</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>% Diff</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Scaled % Diff</td>
<td>0.24</td>
<td>1.91</td>
<td>1.49</td>
<td>113.42</td>
<td>517.21</td>
<td>3.45</td>
<td>9.14</td>
<td>3.45</td>
<td>729.19</td>
<td>194.94</td>
</tr>
<tr>
<td>No Build</td>
<td>0.26</td>
<td>1.91</td>
<td>1.57</td>
<td>119.35</td>
<td>544.25</td>
<td>3.63</td>
<td>9.40</td>
<td>3.63</td>
<td>729.19</td>
<td>200.27</td>
</tr>
<tr>
<td>Proposed</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Diff</td>
<td>0.01%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>% Diff</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Scaled % Diff</td>
<td>0.52</td>
<td>5.2%</td>
<td>5.2%</td>
<td>5.2%</td>
<td>5.2%</td>
<td>5.2%</td>
<td>5.2%</td>
<td>5.2%</td>
<td>5.2%</td>
<td>5.2%</td>
</tr>
</tbody>
</table>

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

#### Pollutant Concentration

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Lower Onondaga Creek</th>
<th>Lower Onondaga Creek</th>
<th>Middle Onondaga Creek</th>
<th>South Branch Bay Creek</th>
<th>Mud Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Build</td>
<td>Proposed</td>
<td>Scoured % off</td>
<td>No Build</td>
<td>Proposed</td>
</tr>
<tr>
<td><strong>Copper (Cu)</strong></td>
<td>58.03</td>
<td>58.34</td>
<td>-0.67 -1.1%</td>
<td>61.99</td>
<td>59.18 -59.19 -4.5% -0.01%</td>
</tr>
<tr>
<td><strong>Lead (Pb)</strong></td>
<td>437.07</td>
<td>432.11 -4.95 -1.1% -0.0024%</td>
<td>459.17 348.37 436.39 -4.5% -0.01%</td>
<td>185.87 185.87 0.00 0.0% 0.0%</td>
<td></td>
</tr>
<tr>
<td><strong>Zinc (Zn)</strong></td>
<td>359.46</td>
<td>355.41 -4.07 -1.1% -0.0024%</td>
<td>377.67 360.56 360.57 -4.5% -0.01%</td>
<td>152.88 152.88 0.00 0.0% 0.0%</td>
<td></td>
</tr>
<tr>
<td><strong>Total organic carbon (TOC)</strong></td>
<td>27916.62</td>
<td>27011.98 -309.44 -1.1% -0.0024%</td>
<td>28698.04 27386.49 27386.49 -4.5% -0.01%</td>
<td>11671.14 11671.14 0.00 0.0% 0.0%</td>
<td></td>
</tr>
<tr>
<td><strong>Chemical oxygen demand (COD)</strong></td>
<td>124563.80</td>
<td>123152.77 -1411.03 -1.1% -0.0024%</td>
<td>130863.05 124936.72 124936.73 -4.5% -0.01%</td>
<td>52974.14 52974.14 0.00 0.0% 0.0%</td>
<td></td>
</tr>
<tr>
<td><strong>Nitrate + nitrite nitrogen (NO2+3)</strong></td>
<td>830.43</td>
<td>821.02 -9.41 -1.1% -0.0024%</td>
<td>853.16 853.16 0.00 0.0% 0.0%</td>
<td>353.16 353.16 0.00 0.0% 0.0%</td>
<td></td>
</tr>
<tr>
<td><strong>Total kjeldahl nitrogen (TKN)</strong></td>
<td>1999.58</td>
<td>1976.93 -22.65 -1.1% -0.0024%</td>
<td>2050.70 2005.56 2005.57 -4.5% -0.01%</td>
<td>893.37 893.37 0.00 0.0% 0.0%</td>
<td></td>
</tr>
<tr>
<td><strong>Phosphorus (PO4-P)</strong></td>
<td>437.07</td>
<td>432.11 -4.95 -1.1% -0.0024%</td>
<td>459.17 438.37 436.39 -4.5% -0.01%</td>
<td>185.87 185.87 0.00 0.0% 0.0%</td>
<td></td>
</tr>
<tr>
<td><strong>Total suspended solids (TSS)</strong></td>
<td>155158.42</td>
<td>153400.82 -1757.60 -1.1% -0.0024%</td>
<td>163,004.85 156,220.93 156,220.94 -4.5% -0.01%</td>
<td>7331.70 7331.70 0.00 0.0% 0.0%</td>
<td></td>
</tr>
<tr>
<td><strong>Volatile suspended solids (VSS)</strong></td>
<td>42131.21</td>
<td>41213.21 -482.72 -1.1% -0.0024%</td>
<td>44741.51 42741.51 42741.52 -4.5% -0.01%</td>
<td>1812.73 1812.73 0.00 0.0% 0.0%</td>
<td></td>
</tr>
<tr>
<td><strong>Chloride annual average concentration</strong></td>
<td>2.65</td>
<td>3.12 0.47 17.7% -0.0377%</td>
<td>2.65 3.05 3.72 9.4% 0.0322%</td>
<td>34.64 36.09 1.4% 4.2% 0.08%</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** All Methods are calculated as annual average concentration. FHWA are calculated for annual mass loading.

Project: I-81 Viaduct Project

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>North Study Area</th>
<th>South Study Area</th>
<th>Central Study Area</th>
<th>North Study Area</th>
<th>South Study Area</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Copper (Cu)</strong></td>
<td>58.03</td>
<td>61.99</td>
<td>59.18</td>
<td>59.19</td>
<td></td>
</tr>
<tr>
<td><strong>Lead (Pb)</strong></td>
<td>432.11</td>
<td>185.87</td>
<td>185.87</td>
<td>185.87</td>
<td></td>
</tr>
<tr>
<td><strong>Zinc (Zn)</strong></td>
<td>355.41</td>
<td>152.88</td>
<td>152.88</td>
<td>152.88</td>
<td></td>
</tr>
<tr>
<td><strong>Total organic carbon (TOC)</strong></td>
<td>27011.98</td>
<td>11671.14</td>
<td>11671.14</td>
<td>11671.14</td>
<td></td>
</tr>
<tr>
<td><strong>Chemical oxygen demand (COD)</strong></td>
<td>123152.77</td>
<td>124936.72</td>
<td>124936.73</td>
<td>124936.73</td>
<td></td>
</tr>
<tr>
<td><strong>Nitrate + nitrite nitrogen (NO2+3)</strong></td>
<td>821.02</td>
<td>353.16</td>
<td>353.16</td>
<td>353.16</td>
<td></td>
</tr>
<tr>
<td><strong>Total kjeldahl nitrogen (TKN)</strong></td>
<td>1976.93</td>
<td>1812.73</td>
<td>1812.73</td>
<td>1812.73</td>
<td></td>
</tr>
<tr>
<td><strong>Phosphorus (PO4-P)</strong></td>
<td>432.11</td>
<td>1812.73</td>
<td>1812.73</td>
<td>1812.73</td>
<td></td>
</tr>
<tr>
<td><strong>Total suspended solids (TSS)</strong></td>
<td>153400.82</td>
<td>7331.70</td>
<td>7331.70</td>
<td>7331.70</td>
<td></td>
</tr>
<tr>
<td><strong>Volatile suspended solids (VSS)</strong></td>
<td>41213.21</td>
<td>1812.73</td>
<td>1812.73</td>
<td>1812.73</td>
<td></td>
</tr>
<tr>
<td><strong>Chloride annual average concentration</strong></td>
<td>3.12</td>
<td>36.09 1.4% 4.2% 0.08%</td>
<td>36.09 1.4% 4.2% 0.08%</td>
<td>36.09 1.4% 4.2% 0.08%</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** All Methods are calculated as annual average concentration. FHWA are calculated for annual mass loading.

Mud Creek (North Study Area)

Butternut Creek (East Study Area: Southern Section)

North-Branch Ley Creek (East Study Area: Northern Section)

Lower Onondaga Creek (Central Study Area)

Middle Onondaga Cr. (South Study Area)

**Note:** All Methods are calculated as annual average concentration. FHWA are calculated for annual mass loading.
### Table 9. Worksheet A - Site characteristics

1. Drainage Area of Highway Segment (section 2.1)
   - Total right of way (Analysis area) **AROW** 212.5 acres
   - Paved surface **AHWY** 146.2 acres
   - Percent Impervious (= 100 * AHWY/AROW) **IMP** 68.8%

2. Rainfall Characteristics (from section 2.2)
   - MEAN
     - Volume **MVP** 0.26 inch
     - Intensity **MIP** 0.051 inch/hour
     - Duration **MDP** 5.80 hour
     - Interval **MTP** 73.00 hour

3. Surrounding Area Type
   - ADT over 30,000 vehicles/day, urbanized area **URBAN**
   - ADT under 30,000 vpd, undeveloped to low density suburban **RURAL**

4. Select pollutant for analysis FHWA Volume I (section 2.4)
   - name
     - Cu
     - Zn
     - TOC
     - COD
     - NO₂⁻+₃
     - TKN
     - PO₄-P
     - TSS
     - VSS

5. Select receiving water target concentration (section 2.6)
   - surface water **TH**
     - STREAM - use table 4 for target concentrations
       - EPA Acute Criterion **CTA** 0.021 mg/l
       - suggested Threshold Effect Level **CTT** 0.045 mg/l
     - LAKE - use accepted level for average Phosphorus concentration
       - target concentration is 10 micrograms/liter **μg/l**
### FHWA Pollutant Loadings Analysis

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

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Watershed Drainage Area</td>
<td>ATOT</td>
</tr>
<tr>
<td></td>
<td>upstream of highway for a stream - total contributing area for a lake</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Average annual stream flow (section 2.3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a unit area flow rate per square mile (figure 3)</td>
<td>QSM</td>
</tr>
<tr>
<td></td>
<td>b Coef of variation of stream flows (section 2.3)</td>
<td>CVQS</td>
</tr>
<tr>
<td></td>
<td>c Average stream flow (QSM * ATOT)</td>
<td>MQS</td>
</tr>
</tbody>
</table>
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

4. Compute mass loads (section 3.2)
   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/l
   b. Mean event mass load = MCR * MVP * (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
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 NST 120 number
   b. Compute the probability (%) of the 3 year event PR 0.28 %

3. Enter value from Table 7 for MQS/MQR and frequency PR
   CU 2.089 mg/l

4. Select pollutant for analysis
   a. Site median concentration (table 3) TCR
   b. Soluble fraction (section 2.5) FSOL
   c. Acute Criteria Value (table 4) CTA
   d. Threshold effects level (table 4) CTT

5. Compute the once in 3 year stream pollutant concentration
   CO = CU * TCR * FSOL 0.045 0.084 0.275 mg/l

6. Compare with target concentration, CTA
   CRAT = CO / CTA 2.15 0.81 0.73 ratio

   a. If CRAT is less than about 0.75 A toxicity problem attributable to this pollutant is unlikely STOP
   b. If CRAT is greater than 5 reduction will definitely be required CONTROL

   Evaluate results
   c. If CRAT is still greater than 1 and greater reduction levels are not practical EVALUATE

   Estimate the potential for an adverse impact (as opposed to a criteria violation) by a comparison with the threshold effects level
   CRTE = CO / CTT 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.
### Constituent evaluation = Chloride

<table>
<thead>
<tr>
<th>Mean Annual Runoff</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.2 inches</td>
<td>8.37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drainage Area #</th>
<th>Drainage Area (sq.mi.)</th>
<th>Lane Miles, M</th>
<th>Salt Applied Rate, T (Ton/lane mile)</th>
<th>Annual Average Concentration, C (ppm)</th>
<th>Discharge Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>156</td>
<td>37.9</td>
<td>25</td>
<td>2.65</td>
<td>Lower Onondaga Creek</td>
</tr>
</tbody>
</table>
## 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 \(= 100 \times \frac{AHWY}{AROW}\) **IMP** | 67.9 %

2. **Rainfall Characteristics (from section 2.2)**
   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

3. **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 \(\frac{24 \times 365}{MTP}\) **NST** | 120 no. events

3. **Surrounding Area Type**
   - a. ADT over 30,000 vehicles/day, urbanized area **URBAN**
   - b. ADT under 30,000 vpd, undeveloped to low density suburban **RURAL**

4. **Select pollutant for analysis FHWA Volume I (section 2.4)**
   - name **Cu**  **Zn**  **TOC**  **COD**  **NO2+3**  **TKN**  **PO4-P**  **TSS**  **VSS**
   - and estimate runoff quality characteristics (use table 3)
   - a. site median concentration **TCR** | 0.054  0.400  0.329  25  114  0.76  1.83  0.400  142  39 mg/l
   - b. coef of variation \((0.71 \text{ Urban: 0.84 Rural: 0.75 Estimate})\) **CVCR** | 0.75 dimensionless

5. **Select receiving water target concentration (section 2.6)**
   - surface water **TH** | 120  120  120  120  120  120  120  120  120  120 mg/l
   - STREAM - use table 4 for target concentrations
   - a. EPA Acute Criterion **CTA** | 0.021  0.103  0.374 mg/l
   - b. suggested Threshold Effect Level **CTT** | 0.045  0.450  0.785 mg/l
   - LAKE - use accepted level for average Phosphorus concentration
   - c. target concentration is 10 micrograms/liter | 10 µg/l
<table>
<thead>
<tr>
<th></th>
<th>Watershed Drainage Area</th>
<th>ATOT</th>
<th>square miles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>upstream of highway for a stream - total contributing area for a lake</td>
<td>156.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Average annual stream flow (section 2.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>unit area flow rate per square mile (figure 3)</td>
</tr>
<tr>
<td>b</td>
<td>Coef of variation of stream flows (section 2.3)</td>
</tr>
<tr>
<td>c</td>
<td>Average stream flow (QSM * ATOT)</td>
</tr>
</tbody>
</table>
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

4. Compute mass Loads (section 3.2)
   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
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

NST 120 number

b. Compute the probability (%) of the 3 year event

PR 0.28 %

3. Enter value from table 7

for MQS/MQR and frequency PR

CU 2.071 mg/l

4. Select pollutant for analysis

<table>
<thead>
<tr>
<th>name</th>
<th>Heavy Metals</th>
<th>Oxygen Demand</th>
<th>Nutrients</th>
<th>Particulates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu</td>
<td>0.054</td>
<td>0.400</td>
<td>0.329</td>
<td>25</td>
</tr>
<tr>
<td>Pb</td>
<td>0.400</td>
<td>0.103</td>
<td>0.374</td>
<td>0.000</td>
</tr>
<tr>
<td>Zn</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOC</td>
<td></td>
<td></td>
<td></td>
<td>0.76</td>
</tr>
<tr>
<td>COD</td>
<td></td>
<td></td>
<td></td>
<td>1.83</td>
</tr>
<tr>
<td>NO2+3</td>
<td></td>
<td></td>
<td></td>
<td>0.400</td>
</tr>
<tr>
<td>TKN</td>
<td></td>
<td></td>
<td></td>
<td>142</td>
</tr>
<tr>
<td>PO4-P</td>
<td></td>
<td></td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>TSS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VSS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Compute the once in 3 year stream pollutant concentration

CO 0.045 0.083 0.273 mg/l

6. Evaluate results

a. If CRAT is less than about 0.75

A toxicity problem attributable to this pollutant is unlikely

STOP

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

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.
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

<table>
<thead>
<tr>
<th>Drainage Area #</th>
<th>Drainage Area (sq.mi.)</th>
<th>Lane Miles, M</th>
<th>Salt Applied Rate, T (Ton/lane mile)</th>
<th>Annual Average Concentration, C (ppm)</th>
<th>Discharge Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>156</td>
<td>44.7</td>
<td>25</td>
<td>3.12</td>
<td>Lower Onondaga Creek</td>
</tr>
</tbody>
</table>
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)
   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)
   name Cu Pb Zn TOC COD NO2+3 TKN PO4-P TSS VSS
   and estimate runoff quality characteristics (use table 3)
   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
**Project:** I-81 VIADUCT PROJECT  
**Project Number:** 20433  
**Alternate:** No Build for Community Grid Alternative

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Watershed Drainage Area</td>
<td>ATOT</td>
</tr>
<tr>
<td></td>
<td>upstream of highway for a stream - total contributing area for a lake</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Average annual stream flow (section 2.3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. unit area flow rate per square mile (figure 3)</td>
<td>QSM</td>
</tr>
<tr>
<td></td>
<td>b. Coef of variation of stream flows (section 2.3)</td>
<td>CVQS</td>
</tr>
<tr>
<td></td>
<td>c. Average stream flow (QSM * ATOT)</td>
<td>MQS</td>
</tr>
</tbody>
</table>
Table 10. Worksheet B - Highway runoff characteristics

1. Compute runoff coefficient ($R_v$) (see section 3.1)
   a. Percent Impervious (Worksheet A - Item 1c) IMP 66.5 \% 
   b. Runoff Coefficient ($= 0.007 \times IMP + 0.1$) $R_v$ 0.57 ratio

2. Compute runoff flow rates (section 3.1)
   a. Flow rate from mean storm $= R_v \times MIP \times AROW \times (3630 / 3600)$ 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 $= R_v \times MVP \times AROW \times 3630$ MVR 122543 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)
   a. Mean event concentration (MCR) $= TCR \times SQRT(1 + CVCR^2)$ MCR 0.07 0.50 0.41 31.25 142.50 0.95 2.29 0.50 177.50 48.75 mg/l 
   b. Mean event mass load $= MCR \times MVR \times (0.00006245)$ 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 $= M(MASS) \times NST$ 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
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
      NST: 120 number
   b. Compute the probability (%) of the 3 year event
      PR: 0.28 %

3. Enter value from table 7 for MQS/MQR and frequency PR
   CU: 1.082 mg/l

4. Select pollutant for analysis
   | Heavy Metals | Oxygen Demand | Nutrients | Particulates |
   | Cu | Pb | Zn | TOC | COD | NO2+3 | TKN | PO4-P | TiS | VSS |
   | 0.054 | 0.400 | 0.329 | 25 | 114 | 0.76 | 1.83 | 0.400 | 142 | 39 |
   | TCR | 0.400 | 0.100 | 0.400 |
   | FSOL | 0.021 | 0.103 | 0.374 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
   | CTA | 0.045 | 0.450 | 0.785 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

5. Compute the once in 3 year stream pollutant concentration
   CO: 0.023 0.043 0.142 mg/l

6. Compare with target concentration, CTA
   CRAT: 1.11 0.42 0.38 ratio
   a. If CRAT is less than about 0.75
      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
   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
      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.
**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

<table>
<thead>
<tr>
<th>Drainage Area #</th>
<th>Drainage Area (sq.mi.)</th>
<th>Lane Miles, M</th>
<th>Salt Applied Rate, T (Ton/lane mile)</th>
<th>Annual Average Concentration, C (ppm)</th>
<th>Discharge Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>156</td>
<td>37.9</td>
<td>25</td>
<td>2.65</td>
<td>Lower Onondaga Creek</td>
</tr>
</tbody>
</table>
1. **Drainage Area of Highway Segment (section 2.1)**
   - a. Total right of way (Analysis area) \( \text{AROW} = 229.5 \text{ acres} \)
   - b. Paved surface \( \text{AHWY} = 144.3 \text{ acres} \)
   - c. Percent Impervious \( \text{IMP} = 62.9\% \)

2. **Rainfall Characteristics (from section 2.2)**
   - Zone 1; Initial estimates from Figure 2.
     - a. Volume \( \text{MVP} = 0.26 \text{ inch} \)
     - b. Intensity \( \text{MIP} = 0.051 \text{ inch/hour} \)
     - c. Duration \( \text{MDP} = 5.80 \text{ hour} \)
     - d. Interval \( \text{MTP} = 73.00 \text{ hour} \)

   **COEF of VARIATION**
   - e. Volume \( \text{CVVP} = 1.46 \) dimensionless
   - f. Intensity \( \text{CVIP} = 1.30 \) dimensionless
   - g. Duration \( \text{CVDP} = 1.05 \) dimensionless
   - h. Interval \( \text{CVTP} = 1.07 \) dimensionless

   i. Number of storms per year \( \frac{24 \times 365}{\text{MTP}} \) \( \text{NST} = 120 \) no. events

3. **Surrounding Area Type**
   - a. ADT over 30,000 vehicles/day, urbanized area \( \text{URBAN} \)
   - b. ADT under 30,000 vpd, undeveloped to low density suburban \( \text{RURAL} \)

4. **Select pollutant for analysis FHWA Volume I (section 2.4)**
   - **name**
     - a. site median concentration \( \text{TCR} = 0.054 \text{ mg/l} \)
     - b. coef of variation \( 0.71 \text{ Urban} : 0.84 \text{ Rural} : 0.75 \text{ Estimate} \) \( \text{CVCR} = 0.75 \) dimensionless

5. **Select receiving water target concentration (section 2.6)**
   - a. surface water Total Hardness (figure 4) \( \text{TH} = 120 \text{ mg/l} \)
   - b. EPA Acute Criterion \( \text{CTA} = 0.021 \text{ mg/l} \)
   - c. suggested Threshold Effect Level \( \text{CTT} = 0.045 \text{ mg/l} \)
   - LAKE - use accepted level for average Phosphorus concentration
     - c. target concentration is 10 micrograms/liter \( 10 \text{ mg/l} \)

**Table 9. Worksheet A - Site characteristics**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total right of way</td>
<td>229.5 acres</td>
</tr>
<tr>
<td>Paved surface</td>
<td>144.3 acres</td>
</tr>
<tr>
<td>Percent Impervious</td>
<td>62.9%</td>
</tr>
<tr>
<td>Rainfall Volume</td>
<td>0.26 inch</td>
</tr>
<tr>
<td>Rainfall Intensity</td>
<td>0.051 inch/hour</td>
</tr>
<tr>
<td>Rainfall Duration</td>
<td>5.80 hour</td>
</tr>
<tr>
<td>Rainfall Interval</td>
<td>73.00 hour</td>
</tr>
<tr>
<td>Number of storms per year</td>
<td>120 no. events</td>
</tr>
<tr>
<td>Surrounding Area Type</td>
<td>URBAN/RURAL</td>
</tr>
<tr>
<td>Pollutant name</td>
<td>Heavy Metals</td>
</tr>
<tr>
<td>Cu</td>
<td>Pb</td>
</tr>
<tr>
<td>0.054</td>
<td>0.400</td>
</tr>
<tr>
<td>Coef of variation</td>
<td></td>
</tr>
<tr>
<td>CVVP</td>
<td>1.46</td>
</tr>
<tr>
<td>CVIP</td>
<td>1.30</td>
</tr>
<tr>
<td>CVDP</td>
<td>1.05</td>
</tr>
<tr>
<td>CVTP</td>
<td>1.07</td>
</tr>
<tr>
<td>Surface Water TH</td>
<td>120</td>
</tr>
<tr>
<td>Water Criteria</td>
<td></td>
</tr>
<tr>
<td>EPA Acute Criterion</td>
<td>0.021</td>
</tr>
<tr>
<td>Suggested Threshold</td>
<td>0.045</td>
</tr>
<tr>
<td>Lake concentration</td>
<td>10 μg/l</td>
</tr>
</tbody>
</table>
6  Watershed Drainage Area  
   ATOT  156.0  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 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
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
      \[ \text{flow rate from mean storm} = Rv \times MIP \times AROW \times \left(\frac{3630}{3600}\right) \]
      MQR 6.375 CFS
   b. coefficient of variation of runoff flows
      \[ \text{CVIP} \] (Worksheet A - Item 2f) CVOR 1.30 dimensionless

3. Compute runoff volumes (section 3.1)
   a. Volume from the mean storm
      \[ \text{Volume from the mean storm} = Rv \times MVP \times AROW \times 3630 \]
      MVR 116993 cubic feet
   b. coefficient of variation of runoff volumes
      \[ \text{CVVP} \] (Worksheet A - Item 2e) CVVR 1.46 dimensionless

4. Compute mass Loads (section 3.2)
   a. mean event concentration (MCR)
      \[ \text{mean event concentration (MCR)} = TCR \times \sqrt{1 + CVCR^2} \]
      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
      \[ \text{mean event mass load} = M(COSS) \times 0.00006245 \]
      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
      \[ \text{annual mass load from runoff} = M(MASS) \times NST \]
      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

Heavy Metals | Oxygen Demand | Nutrients | Particulates |
-------------|--------------|-----------|--------------|
Cu           | Pb           | Zn        | TOC          | COD          | NO2+3       | TKN         | PO4-P        | TSS          | VSS          |
TCR          | 0.054        | 0.400     | 0.329        | 25           | 114         | 0.76        | 1.83         | 0.400        | 142          | 39           |
CVCR         | 0.75         | 0.75      | 0.75         | 0.75         | 0.75        | 0.75        | 0.75         | 0.75         | 0.75         | 0.75         |
NST          | 120          | 120       | 120          | 120          | 120         | 120         | 120          | 120          | 120          | 120          |

mg/1         | dimensionless | number    |             | pounds         | pounds/year |

mg/1         | pounds        | pounds/year |
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
      \[ PR = 100 \times \left( \frac{1}{NST \times 3} \right) \] PR 0.28 %

3. Enter value from table 7 for MQS/MQR and frequency PR
   CU 2.093 mg/l

4. Select pollutant for analysis
   a. Site median concentration (table 3)
      TCR Cu 0.054 Pb 0.400 Zn 0.329 mg/l
      TOC COD NO2+3 TKN PO4-P TSS VSS
   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 mg/l
      0.000 0.000 0.000 0.000 0.000 0.000 0.000
   d. Threshold effects level (table 4)
      CTT 0.045 0.450 0.785 mg/l
      0.000 0.000 0.000 0.000 0.000 0.000 0.000

5. Compute the once in 3 year stream pollutant concentration
   \[ CO = CU \times TCR \times FSOL \] CO 0.045 0.084 0.275 mg/l

6. Compare with target concentration, CTA
   \[ CRAT = \frac{CO}{CTA} \] CRAT 2.15 0.81 0.74 ratio

   a. If CRAT is less than about 0.75
      A toxicity problem attributable to this pollutant is unlikely
      STOP

   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
      \[ CRTE = \frac{CO}{CTT} \] 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.
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

<table>
<thead>
<tr>
<th>Drainage Area #</th>
<th>Drainage Area (sq.mi.)</th>
<th>Lane Miles, M</th>
<th>Salt Applied Rate, T (Ton/lane mile)</th>
<th>Annual Average Concentration, C (ppm)</th>
<th>Discharge Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>156</td>
<td>41.5</td>
<td>25</td>
<td>2.90</td>
<td>Lower Onondaga Creek</td>
</tr>
</tbody>
</table>
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)
   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)
   name
   and estimate runoff quality characteristics (use table 3)
   a site median concentration TCR 0.054 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)
   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
FHWA POLLUTANT LOADINGS ANALYSIS

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

6 Watershed Drainage Area
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 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
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)
   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
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
   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 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
   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
      = 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.
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

<table>
<thead>
<tr>
<th>Drainage Area #</th>
<th>Drainage Area (sq.mi.)</th>
<th>Lane Miles, M</th>
<th>Salt Applied Rate, T (Ton/lane mile)</th>
<th>Annual Average Concentration, C (ppm)</th>
<th>Discharge Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>4.53</td>
<td>14.4</td>
<td>25</td>
<td>34.64</td>
<td>Middle Onondaga Creek</td>
</tr>
</tbody>
</table>
Table 9. Worksheet A - Site characteristics

1. Drainage Area of Highway Segment (section 2.1)
   a. Total right of way (Analysis area) \(\text{AROW} = 180.5\) acres
   b. Paved surface \(\text{AHWY} = 49.3\) acres
   c. Percent Impervious \(\text{IMP} = 27.3\%\)

2. Rainfall Characteristics (from section 2.2)
   Zone 1; Initial estimates from Figure 2.
   a. Volume \(\text{MVP} = 0.26\) inch
   b. Intensity \(\text{MIP} = 0.051\) inch/hour
   c. Duration \(\text{MDP} = 5.80\) hour
   d. Interval \(\text{MTP} = 73.00\) hour

   COEF of VARIATION
   e. Volume \(\text{CVVP} = 1.46\) dimensionless
   f. Intensity \(\text{CVIP} = 1.30\) dimensionless
   g. Duration \(\text{CVDP} = 1.05\) dimensionless
   h. Interval \(\text{CVTP} = 1.07\) dimensionless
   i. Number of storms per year \((24\times365 / \text{MTP})\) \(\text{NST} = 120\) no. events

3. Surrounding Area Type
   a. ADT over 30,000 vehicles/day, urbanized area \(\text{URBAN}\)
   b. ADT under 30,000 vpd, undeveloped to low density suburban \(\text{RURAL}\)

4. Select pollutant for analysis FHWA Volume I (section 2.4)
   name \(\text{Cu} \quad \text{Zn} \quad \text{TOC} \quad \text{COD} \quad \text{NO2+3} \quad \text{TKN} \quad \text{PO4-P} \quad \text{TSS} \quad \text{VSS}\)
   and estimate runoff quality characteristics (use table 3)
   a. site median concentration \(\text{TCR} = 0.054 \quad 0.400 \quad 0.329 \quad 25 \quad 114 \quad 0.76 \quad 1.83 \quad 0.400 \quad 142 \quad 39\) mg/l
   b. coef of variation \((0.71 \text{ Urban} : 0.84 \text{ Rural} : 0.75 \text{ Estimate})\) \(\text{CVCR} = 0.75\) dimensionless

5. Select receiving water target concentration (section 2.6)
   surface water Total Hardness (figure 4)
   STREAM -use table 4 for target concentrations
   a. EPA Acute Criterion \(\text{CTA} = 0.021 \quad 0.103 \quad 0.374\) mg/l
   b. suggested Threshold Effect Level \(\text{CTT} = 0.045 \quad 0.450 \quad 0.785\) mg/l
   or
   LAKE - use accepted level for average Phosphorus concentration
   c. target concentration is 10 micrograms/liter
      \(10\) \(\mu g/l\)
6 Watershed Drainage Area | ATOT | 4.5 | square miles
| | upstream of highway for a stream - total contributing area for a lake |

7 Average annual stream flow (section 2.3)

| | QSM | 1.70 | CFS/square mile |
| | CVQS | 1.10 | dimensionless |
| | MQS | 7.70 | CFS |
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)
   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 * MVP * (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
Table 11. Worksheet C - Stream impact analysis

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Calculation</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Define the flow ratio MQS/MQR (Worksheet B - 5a)</td>
<td>MQS/MQR</td>
<td>2.85 ratio</td>
</tr>
<tr>
<td>2</td>
<td>Compute the event frequency for a 3 year recurrence interval</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a Enter the average number of storms per year</td>
<td>NST</td>
<td>120 number</td>
</tr>
<tr>
<td></td>
<td>b Compute the probability (%) of the 3 year event</td>
<td>PR</td>
<td>0.28 %</td>
</tr>
<tr>
<td>3</td>
<td>Enter value from table 7 for MQS/MQR and frequency PR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Select pollutant for analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a Site median concentration (table 3)</td>
<td>TCR</td>
<td>0.054 0.400 0.329 mg/1</td>
</tr>
<tr>
<td></td>
<td>b Soluble fraction (section 2.5)</td>
<td>FSOL</td>
<td>0.400 0.100 0.400 fraction</td>
</tr>
<tr>
<td></td>
<td>c Acute Criteria Value (table 4)</td>
<td>CTA</td>
<td>0.021 0.103 0.374 mg/1</td>
</tr>
<tr>
<td></td>
<td>d Threshold effects level (table 4)</td>
<td>CTT</td>
<td>0.045 0.450 0.785 mg/1</td>
</tr>
<tr>
<td>4</td>
<td>Compute the once in 3 year stream pollutant concentration</td>
<td>CO</td>
<td>0.064 0.118 0.388 mg/1</td>
</tr>
<tr>
<td>5</td>
<td>Compare with target concentration, CTA</td>
<td>CRAT</td>
<td>3.04 1.15 1.04 ratio</td>
</tr>
<tr>
<td>6</td>
<td>Evaluate results</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a If CRAT is less than about 0.75</td>
<td>A toxicity problem attributable to this pollutant is unlikely</td>
<td>STOP</td>
</tr>
<tr>
<td></td>
<td>b If CRAT is greater than 5 reduction will definitely be required</td>
<td>Estimate the level of reduction possible and repeat the analysis with revised values for either concentration or flow or both</td>
<td>CONTROL</td>
</tr>
<tr>
<td></td>
<td>c If CRAT is still greater than 1 and greater reduction levels are not practical, ....</td>
<td>Estimate the potential for an adverse impact (as opposed to a criteria violation) by a comparison with the threshold effects level</td>
<td>EVALUATE</td>
</tr>
<tr>
<td></td>
<td>= CO / CTT</td>
<td>CRTE</td>
<td>1.42 ratio</td>
</tr>
</tbody>
</table>

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.
**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

<table>
<thead>
<tr>
<th>Drainage Area #</th>
<th>Drainage Area (sq.mi.)</th>
<th>Lane Miles, M</th>
<th>Salt Applied Rate, T (Ton/lane mile)</th>
<th>Annual Average Concentration, C (ppm)</th>
<th>Discharge Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>4.53</td>
<td>15</td>
<td>25</td>
<td>36.09</td>
<td>Middle Onondaga Creek</td>
</tr>
</tbody>
</table>
### 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)**
   - 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**
   - b. ADT under 30,000 vpd, undeveloped to low density suburban **RURAL**

4. **Select pollutant for analysis FHWA Volume I (section 2.4)**
   - Name
   - and estimate runoff quality characteristics (use table 3)
   - a. site median concentration **TCR**: 0.054
   - 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)**
   - **STREAM** - use table 4 for target concentrations
   - **LAKE** - use accepted level for average Phosphorus concentration
   - **surface water Total Hardness (figure 4)** **TH**: 120 mg/l
   - **EPA Acute Criterion** **CTA**: 0.021 mg/l
   - **suggested Threshold Effect Level** **CTT**: 0.045 mg/l
   - **target concentration is 10 micrograms/liter**

---

**Note:**
- The table and text content are extracted from the document as accurately as possible, ensuring the readability and coherence of the information presented.
FHWA POLLUTANT LOADINGS ANALYSIS

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

6 Watershed Drainage Area
ATOT 1.0 square miles
upstream of highway for a stream - total contributing area for a lake

7 Average annual stream flow (section 2.3)

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>QSM</td>
<td>unit area flow rate per square mile (figure 3)</td>
<td>1.70 CFS/square mile</td>
</tr>
<tr>
<td>b</td>
<td>CVQS</td>
<td>Coef of variation of stream flows (section 2.3)</td>
<td>1.10 dimensionless</td>
</tr>
<tr>
<td>c</td>
<td>MQS</td>
<td>Average stream flow (QSM * ATOT)</td>
<td>1.62 CFS</td>
</tr>
</tbody>
</table>
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

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

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

4. Compute mass Loads (section 3.2)
   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/l
   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

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
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
      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
   a. Site median concentration (table 3)
      TCR = 0.054 Cu 0.400 Pb 0.329 Zn 25 TOC 114 COD 0.76 NO2+3 1.83 TKN 0.400 PO4-P 142 mg/1
   b. Soluble fraction (section 2.5)
      FSOL = 0.400 fraction
   c. Acute Criteria Value (table 4)
      CTA = 0.021 mg/1
   d. Threshold effects level (table 4)
      CTT = 0.045 mg/1

4. Compute the once in 3 year stream pollutant concentration
   CO = CU * TCR * FSOL
   = 0.056 mg/1

5. Compare with target concentration, CTA
   CRAT = CO / CTA = 2.66 ratio

6. Evaluate results
   a. If CRAT is less than about 0.75
      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
   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
      CRTE = CO / CTT
      = 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.
**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

<table>
<thead>
<tr>
<th>Drainage Area #</th>
<th>Drainage Area (sq.mi.)</th>
<th>Lane Miles, M</th>
<th>Salt Applied Rate, T (Ton/lane mile)</th>
<th>Annual Average Concentration, C (ppm)</th>
<th>Discharge Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-North</td>
<td>0.95</td>
<td>2</td>
<td>25</td>
<td>22.94</td>
<td>North Branch Ley Creek</td>
</tr>
</tbody>
</table>
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)
   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)
   a site median concentration  TCR
   b coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)  CVCR

   | Heavy Metals | Oxygen Demand | Nutrients | Particulates |
   | Cu | Pb | Zn | TOC | COD | NO2+3 | TKN | PO4-P | TSS | VSS |
   | 0.054 | 0.400 | 0.329 | 25 | 114 | 0.76 | 1.83 | 0.400 | 142 | 39 | mg/l |
   | 0.75 | dimensionless |

5 Select receiving water target concentration (section 2.6)
   surface water Total Hardness (figure 4)
   STREAM - use table 4 for target concentrations
   a EPA Acute Criterion  CTA
   b suggested Threshold Effect Level  CTT

   LAKE - use accepted level for average Phosphorus concentration
   c target concentration is 10 micrograms/liter
   | nigeria | oil | mg/l |
   | 10 | µg/l |
6. Watershed Drainage Area
   ATOT: 1.0 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 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
**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  
\( K = 8.37 \)

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

The table above provides the necessary data for estimating chloride concentrations in the drainage areas specified.
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)
   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)
   name
   and
   estimate runoff quality characteristics (use table 3)
   a site median concentration TCR 0.054 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 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
FHWA POLLUTANT LOADINGS ANALYSIS

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

6 Watershed Drainage Area
   ATOT  68.9  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 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
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

4. Compute mass loads (section 3.2)
   a. Mean event concentration (MCR) = TCR * SQRT(1 + CVCR^2) MCR
   b. Mean event mass load = MCR * MVR * (0.00006245) M(MASS)
   c. Annual mass load from runoff = M(MASS) * NST ANMASS

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

<table>
<thead>
<tr>
<th>Heavy Metals</th>
<th>Oxygen Demand</th>
<th>Nutrients</th>
<th>Particulates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu</td>
<td>Pb</td>
<td>Zn</td>
<td>TOC</td>
</tr>
<tr>
<td>0.054</td>
<td>0.400</td>
<td>0.329</td>
<td>25</td>
</tr>
<tr>
<td>TCR</td>
<td>Coef of var. of site EMC's</td>
<td>Number of storms per year</td>
<td>mg/l</td>
</tr>
<tr>
<td>Site Median Conc (Worksheet A - Item 4a)</td>
<td>CVCRR</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>Coef of var. of site EMC's (Worksheet A - 4b)</td>
<td>NST</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Number of storms per year (Worksheet A - 2i)</td>
<td>M(MASS)</td>
<td>0.27</td>
<td>2.00</td>
</tr>
<tr>
<td>Number of storms per year</td>
<td>ANMASS</td>
<td>32.37</td>
<td>239.80</td>
</tr>
<tr>
<td>Project: I-81 VIADUCT PROJECT</td>
<td>Project Number: 20433</td>
<td>Area: East Study Area: Southern Region to Butternut Creek</td>
<td>Alternate: No Build Alternatives</td>
</tr>
</tbody>
</table>
Table 11. Worksheet C - Stream impact analysis

<table>
<thead>
<tr>
<th>MQS/MQR</th>
<th>33.59</th>
<th>ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST</td>
<td>120</td>
<td>number</td>
</tr>
<tr>
<td>PR</td>
<td>0.28</td>
<td>%</td>
</tr>
<tr>
<td>CU</td>
<td>1.246</td>
<td>mg/l</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Cu</th>
<th>Pb</th>
<th>Zn</th>
<th>TOC</th>
<th>COD</th>
<th>NO2+3</th>
<th>TKN</th>
<th>PO4-P</th>
<th>TSS</th>
<th>VSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site median concentration (table 3)</td>
<td>TCR</td>
<td>0.054</td>
<td>0.400</td>
<td>0.329</td>
<td>25</td>
<td>114</td>
<td>0.76</td>
<td>1.83</td>
<td>0.400</td>
<td>142</td>
</tr>
<tr>
<td>Soluble fraction (section 2.5)</td>
<td>FSOL</td>
<td>0.400</td>
<td>0.100</td>
<td>0.400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute Criteria Value (table 4)</td>
<td>CTA</td>
<td>0.021</td>
<td>0.103</td>
<td>0.374</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Threshold effects level (table 4)</td>
<td>CTT</td>
<td>0.045</td>
<td>0.450</td>
<td>0.785</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>CO</th>
<th>0.027</th>
<th>0.050</th>
<th>0.164</th>
<th>mg/l</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>CRAT</th>
<th>1.28</th>
<th>0.48</th>
<th>0.44</th>
<th>ratio</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>CRTE</th>
<th>0.60</th>
<th>ratio</th>
</tr>
</thead>
</table>

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.

A toxicity problem attributable to this pollutant is unlikely

Estimate the level of reduction possible and repeat the analysis with revised values for either concentration or flow or both

Evaluate results

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

= CO / CTT

CRTE  0.60  ratio

Alternate: No Build Alternatives

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

<table>
<thead>
<tr>
<th>Drainage Area #</th>
<th>Drainage Area (sq.mi.)</th>
<th>Lane Miles, M</th>
<th>Salt Applied Rate, T (Ton/lane mile)</th>
<th>Annual Average Concentration, C (ppm)</th>
<th>Discharge Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-South</td>
<td>68.9</td>
<td>9.8</td>
<td>25</td>
<td>1.55</td>
<td>Butternut Creek</td>
</tr>
</tbody>
</table>
### Table 9. Worksheet A - Site characteristics

<p>| | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drainage Area of Highway Segment (section 2.1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Total right of way (Analysis area)</td>
<td>AROW</td>
<td>221.0</td>
<td>acres</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Paved surface</td>
<td>AHWY</td>
<td>68.0</td>
<td>acres</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Percent Impervious ((= 100 \times AHWY/AROW))</td>
<td>IMP</td>
<td>30.8</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Rainfall Characteristics (from section 2.2)</td>
<td>MEAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Volume</td>
<td>MVP</td>
<td>0.26</td>
<td>inch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Intensity</td>
<td>MIP</td>
<td>0.051</td>
<td>inch / hour</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Duration</td>
<td>MDP</td>
<td>5.80</td>
<td>hour</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Interval</td>
<td>MTP</td>
<td>73.00</td>
<td>hour</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. Volume</td>
<td>CVVP</td>
<td>1.46</td>
<td>dimensionless</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f. Intensity</td>
<td>CVIP</td>
<td>1.30</td>
<td>dimensionless</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>g. Duration</td>
<td>CVDP</td>
<td>1.05</td>
<td>dimensionless</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>h. Interval</td>
<td>CVTP</td>
<td>1.07</td>
<td>dimensionless</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Number of storms per year ((24\times365 / MTP))</td>
<td>NST</td>
<td>120</td>
<td>no. events</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Surrounding Area Type</td>
<td></td>
<td>URBAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>or</td>
<td>RURAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Select pollutant for analysis FHWA Volume I (section 2.4) name</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>and</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>estimate runoff quality characteristics (use table 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. site median concentration</td>
<td>TCR</td>
<td>0.054</td>
<td>0.400</td>
<td>0.329</td>
<td>25</td>
<td>114</td>
<td>0.76</td>
<td>1.83</td>
<td>0.400</td>
<td>142</td>
</tr>
<tr>
<td></td>
<td>b. coef of variation (0.71 Urban : 0.84 Rural : 0.75 Estimate)</td>
<td>CVCR</td>
<td>0.75</td>
<td>dimensionless</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Select receiving water target concentration (section 2.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>surface water Total Hardness (figure 4)</td>
<td>TH</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>STREAM -use table 4 for target concentrations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. EPA Acute Criterion</td>
<td>CTA</td>
<td>0.021</td>
<td>0.103</td>
<td>0.374</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. suggested Threshold Effect Level</td>
<td>CTT</td>
<td>0.045</td>
<td>0.450</td>
<td>0.785</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LAKE - use accepted level for average Phosphorus concentration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. target concentration is 10 micrograms/liter</td>
<td></td>
<td>10</td>
<td>(\mu g/l)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Watershed Drainage Area</td>
<td>ATOT</td>
<td>68.9</td>
<td>square miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>------</td>
<td>------</td>
<td>--------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>upstream of highway for a stream - total contributing area for a lake</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Average annual stream flow (section 2.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Unit area flow rate per square mile (figure 3)</td>
<td>QSM</td>
<td>1.70</td>
<td>CFS/square mile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Coef of variation of stream flows (section 2.3)</td>
<td>CVQS</td>
<td>1.10</td>
<td>dimensionless</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Average stream flow (QSM * ATOT)</td>
<td>MQS</td>
<td>117.13</td>
<td>CFS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 (Rv = 0.007 * IMP + 0.1)
      Rv: 0.32 ratio

2. Compute runoff flow rates (section 3.1)
   a. Flow rate from mean storm
      \[ \text{MQR} = Rv \times \text{MIP} \times \text{AROW} \times \frac{3630}{3600} \]
      MQR: 3.584 CFS
   b. Coefficient of variation of runoff flows
      \[ \text{CVOR} = \text{CVIP} \] (Worksheet A - Item 2f)
      CVOR: 1.30 dimensionless

3. Compute runoff volumes (section 3.1)
   a. Volume from the mean storm
      \[ \text{MVR} = Rv \times \text{MVP} \times \text{AROW} \times 3630 \]
      MVR: 65782.9 cubic feet
   b. Coefficient of variation of runoff volumes
      \[ \text{CVVR} = \text{CVVP} \] (Worksheet A - Item 2e)
      CVVR: 1.46 dimensionless

4. Compute mass loads (section 3.2)
   a. Mean event concentration (MCR)
      \[ \text{MCR} = TCR \times \sqrt{1 + \text{CVCR}^2} \]
      MCR: 0.07 0.50 0.41 31.25 142.50 0.95 2.29 0.50 177.50 48.75 mg/l
   b. Mean event mass load
      \[ \text{MASS} = \text{MCR} \times \text{MVR} \times \frac{0.00006245}{0.00005} \]
      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
      \[ \text{ANMASS} = \text{MASS} \times \text{NST} \]
      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
      \[ \text{MQS/MQR} \]
      MQS/MQR: 32.68 ratio
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
      \[ PR = 100 \times \left( \frac{1}{NST \times 3} \right) \]
      PR: 0.28 %

3. Enter value from table 7 for MQS/MQR and frequency PR
   CU: 1.270 mg/l

4. Select pollutant for analysis
   a. Site median concentration (table 3)
      TCR: 0.054 Cu, 0.400 Pb, 0.329 Zn, 25 TOC, 114 COD, 0.76 NO2+3, 1.83 TKN, 0.400 PO4-P, 142 TSS, 39 VSS mg/l
   b. Soluble fraction (section 2.5)
      FSOL: 0.400 mg/l
   c. Acute Criteria Value (table 4)
      CTA: 0.021 Cu, 0.103 Pb, 0.374 Zn, 0.000 TOC, 0.000 COD, 0.000 NO2+3, 0.000 TKN, 0.000 PO4-P, 0.000 TSS, 0.000 VSS mg/l
   d. Threshold effects level (table 4)
      CTT: 0.045 Cu, 0.450 Pb, 0.785 Zn, 0.000 TOC, 0.000 COD, 0.000 NO2+3, 0.000 TKN, 0.000 PO4-P, 0.000 TSS, 0.000 VSS mg/l

4. Compute the once in 3 year stream pollutant concentration
   \[ CO = CU \times TCR \times FSOL \]
   CO: 0.027 Cu, 0.051 Pb, 0.167 Zn mg/l

5. Compare with target concentration, CTA
   \[ CRAT = \frac{CO}{CTA} \]
   CRAT: 1.31 Cu, 0.49 Pb, 0.45 Zn ratio

6. Evaluate results
   a. If CRAT is less than about 0.75
      A toxicity problem attributable to this pollutant is unlikely
      STOP
   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
      \[ CRTE = \frac{CO}{CTT} \]
      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.
**TOLER ANALYSIS FOR ESTIMATING CHLORIDES**

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

Constituent evaluation = Chloride

<table>
<thead>
<tr>
<th>Mean Annual Runoff</th>
<th>19.2 inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K$</td>
<td>8.37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drainage Area #</th>
<th>Drainage Area (sq.mi.)</th>
<th>Lane Miles, M</th>
<th>Salt Applied Rate, T (Ton/lane mile)</th>
<th>Annual Average Concentration, C (ppm)</th>
<th>Discharge Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-South</td>
<td>68.9</td>
<td>12</td>
<td>25</td>
<td>1.90</td>
<td>Butternut Creek</td>
</tr>
</tbody>
</table>
FHWA POLLUTANT LOADINGS ANALYSIS

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)
   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
   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
   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)
   a. site median concentration TCR 0.054 Cu 0.329 Zn 25 TOC 114 COD 0.76 NO2+3 1.83 TKN 0.400 PO4-P 142 TSS 39 VSS mg/l
   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)
   a. EPA Acute Criterion CTA 0.021 Pb 0.103 Zn 0.374 mg/l
   b. suggested Threshold Effect Level CTT 0.045 COD 0.450 NO2+3 0.785 mg/l
   or
   LAKE - use accepted level for average Phosphorus concentration
   c. target concentration is 10 micrograms/liter

   10 μg/l
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
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

4. Compute mass loads (section 3.2)
   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/l
   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
Table 11. Worksheet C - Stream impact analysis

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Define the flow ratio MQS/MQR (Worksheet B - 5a)</td>
<td>MQS/MQR = 2.86</td>
</tr>
<tr>
<td>2</td>
<td>Compute the event frequency for a 3 year recurrence interval</td>
<td>NST = 120, PR = 0.28%</td>
</tr>
<tr>
<td></td>
<td>a Enter the average number of storms per year</td>
<td>NST = 120 (from Worksheet A - Item 2i)</td>
</tr>
<tr>
<td></td>
<td>b Compute the probability (%) of the 3 year event</td>
<td>PR = 0.28% = 100 * (1 / (NST * 3))</td>
</tr>
<tr>
<td>3</td>
<td>Enter value from table 7 for MQS/MQR and frequency PR</td>
<td>CU = 2.950 mg/l</td>
</tr>
<tr>
<td>4</td>
<td>Select pollutant for analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a Site median concentration (table 3)</td>
<td>TCR = Cu = 0.054, Pb = 0.400, Zn = 0.329, TOC = 25, COD = 114, NO2+3 = 0.76, TKN = 0.183, PO4-P = 0.400, TSS = 142, VSS = 39 mg/l</td>
</tr>
<tr>
<td></td>
<td>b Soluble fraction (section 2.5)</td>
<td>FSOL = 0.400/0.100/0.400 fraction</td>
</tr>
<tr>
<td></td>
<td>c Acute Criteria Value (table 4)</td>
<td>CTA = 0.021/0.103/0.374 mg/l</td>
</tr>
<tr>
<td></td>
<td>d Threshold effects level (table 4)</td>
<td>CTT = 0.045/0.450/0.785 mg/l</td>
</tr>
<tr>
<td>5</td>
<td>Compute the once in 3 year stream pollutant concentration</td>
<td>CO = CU * TCR * FSOL = 0.064/0.118/0.388 mg/l</td>
</tr>
<tr>
<td>6</td>
<td>Evaluate results</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a If CRAT is less than about 0.75</td>
<td>CRAT = 3.03/1.15/1.04 ratio</td>
</tr>
<tr>
<td></td>
<td>A toxicity problem attributable to this pollutant is unlikely</td>
<td>STOP</td>
</tr>
<tr>
<td></td>
<td>b If CRAT is greater than 5 reduction will definitely be required</td>
<td>CONTROL</td>
</tr>
<tr>
<td></td>
<td>Estimate the level of reduction possible and repeat the analysis with revised values for either concentration or flow or both</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c If CRAT is still greater than 1 and greater reduction levels are not practical</td>
<td>CRTE = 1.42 ratio</td>
</tr>
<tr>
<td></td>
<td>Estimate the potential for an adverse impact (as opposed to a criteria violation) by a comparison with the threshold effects level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>= CO / CTT</td>
<td></td>
</tr>
</tbody>
</table>

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.
Constituent evaluation = Chloride

Mean Annual Runoff = 19.2 inches

<table>
<thead>
<tr>
<th>Drainage Area #</th>
<th>Drainage Area (sq.mi.)</th>
<th>Lane Miles, M</th>
<th>Salt Applied Rate, T (Ton/lane mile)</th>
<th>Annual Average Concentration, C (ppm)</th>
<th>Discharge Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>5.32</td>
<td>10.3</td>
<td>25</td>
<td>21.10</td>
<td>Mud Creek</td>
</tr>
</tbody>
</table>
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  AHWWY  59.2  acres
   c. Percent Impervious(= 100 * AHWWY/AROW)  IMP  25.3  %

2. Rainfall Characteristics (from section 2.2)
   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)
   name
   and
   estimate runoff quality characteristics (use table 3)
   a. site median concentration  TCR
      Cu  0.054
      Pb  0.400
      Zn  0.329
      TOC  25
      COD  114
      NO2+3  0.76
      TKN  1.83
      PO4-P  0.400
      TSS  142
      VSS  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  120  120  120  120  120  120  mg/1
   STREAM -use table 4 for target concentrations
   a. EPA Acute Criterion  CTA
      Cu  0.021
      Pb  0.103
      Zn  0.374
      0.021  0.103  0.374
      mg/1
   b. suggested Threshold Effect Level  CTT
      Cu  0.045
      Pb  0.450
      Zn  0.785
      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
### Watershed Drainage Area
- **Parameter**: ATOT
- **Value**: 5.3 square miles
- **Description**: upstream of highway for a stream - total contributing area for a lake

### Average Annual Stream Flow (section 2.3)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSM</td>
<td>1.70</td>
</tr>
<tr>
<td>CVQS</td>
<td>1.10</td>
</tr>
<tr>
<td>MQS</td>
<td>9.04</td>
</tr>
</tbody>
</table>

- **QSM**: unit area flow rate per square mile (figure 3)
- **CVQS**: Coef of variation of stream flows (section 2.3)
- **MQS**: Average stream flow (QSM * ATOT)
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 3.33 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 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)
   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/l
   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
Table 11. Worksheet C - Stream impact analysis

<table>
<thead>
<tr>
<th></th>
<th>MQS/MQR</th>
<th>Heavy Metals</th>
<th>Oxygen Demand</th>
<th>Nutrients</th>
<th>Particulates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cu</td>
<td>Pb</td>
<td>Zn</td>
<td>TOC</td>
</tr>
<tr>
<td>1</td>
<td>2.71</td>
<td>0.054</td>
<td>0.400</td>
<td>0.329</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>0.400</td>
<td>0.100</td>
<td>0.400</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>0.021</td>
<td>0.103</td>
<td>0.374</td>
<td>0.000</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>0.045</td>
<td>0.450</td>
<td>0.785</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**4. Compute the once in 3 year stream pollutant concentration**

\[ \text{CO} = \text{CU} \times \text{TCR} \times \text{FSOL} \]

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Heavy Metals</th>
<th>Oxygen Demand</th>
<th>Nutrients</th>
<th>Particulates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cu</td>
<td>Pb</td>
<td>Zn</td>
<td>TOC</td>
</tr>
<tr>
<td>5</td>
<td>CO</td>
<td>0.064</td>
<td>0.119</td>
<td>0.392</td>
<td></td>
</tr>
</tbody>
</table>

**6. Evaluate results**

- **If CRAT is less than about 0.75**
  A toxicity problem attributable to this pollutant is unlikely
- **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
- **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

\[ \text{CRTE} = \frac{\text{CO}}{\text{CTT}} \]

**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.
**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

\[ K = 8.37 \]

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