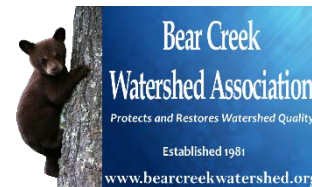


# Technical Memorandum BCWA



**Date:** February 9, 2018  
**To:** Bear Creek Watershed Association  
**From:** Russell N. Clayshulte, Manager

**Re:** BCWA TM 2017.03 Coyote Gulch

|          |                                                   |   |
|----------|---------------------------------------------------|---|
| Figure 1 | Coyote Gulch Project and Sample Sites .....       | 1 |
| Figure 3 | Estimated Annual Flows .....                      | 3 |
| Figure 4 | Total Phosphorus Removal by Project.....          | 3 |
| Figure 6 | Total Phosphorus Baseload Estimates .....         | 3 |
| Table 1  | Field Data .....                                  | 2 |
| Table 2  | Nutrient Data.....                                | 2 |
| Table 3  | Flow Data .....                                   | 2 |
| Table 4  | Nutrient Loads.....                               | 2 |
| Table 5  | Project Average Loading for Trade Estimates ..... | 4 |
| Table 6  | 2017 Annual Nutrient Loads.....                   | 4 |
| Table 7  | 2017 Trade Pound Estimates.....                   | 4 |

The Association coordinates with the City of Lakewood a sampling program on Coyote Gulch in the Bear Creek Park (Figure 1). The monitoring is done at two sampling sites: above the restoration project (Upper Coyote), and at the discharge into the reservoir (Lower Coyote). Beginning in 2013, the Association incorporated the nutrient sampling into the Association monitoring program as part of the P2 Supplemental Monitoring Program. The Association reduced the monitoring frequency to bi-monthly. Nutrient analyses are done at the Association's contract laboratory GEI Consultants Inc. The Association collects the chemistry data for total phosphorus and total nitrogen (Table 1). The Association takes bi-monthly flow measurements to determine nutrient loading. The Association also collects data for temperature, pH, specific conductance and Dissolved Oxygen. Data results are incorporated into the Association annual data summaries. The Association has pre-construction and post-construction loading data. This monitoring project has established a total phosphorus trade credit for use of the Association membership. Data maintained in the BCWA MSD11 Coyote Gulch Data Master spreadsheet.



**Figure 1** Coyote Gulch Project and Sample Sites

**Table 1      Field Data**

| Segment           | Site     | Location     | Date       | Time  | pH   | Water Temp °C | Air Temp °C | DO (mg/l) | SC (us/cm) | Flow (cfs) | Est Periphyton Coverage % | Water Clarity |
|-------------------|----------|--------------|------------|-------|------|---------------|-------------|-----------|------------|------------|---------------------------|---------------|
| <b>Segment 4a</b> | Site 47a | Upper Coyote | 2/13/2017  | 10:40 | 8.20 | 1.50          | 10          | 11.52     | 1492       | 0.17       | 10%                       | c             |
|                   |          |              | 4/17/2017  | 12:18 | 8.18 | 12.80         | 28          | 14.18     | 1310       | 0.37       | 10%                       | c             |
|                   |          |              | 6/26/2017  | 11:30 | 7.74 | 16.20         | 31          | 7.30      | 1261       | 0.26       | 10%                       | c             |
|                   |          |              | 8/8/2017   | 11:35 | 7.55 | 15.90         | 25.8        | 6.60      | 659        | 1.30       | 20%                       | c             |
|                   |          |              | 10/16/2017 | 12:45 | 8.22 | 7.20          | 19          | 10.73     | 1328       | 0.68       | 20%                       | c             |
|                   |          |              | 12/11/2017 | 12:25 | 8.57 | 0.10          | 16          | 13.01     | 1471       | 0.29       | 30%                       | c             |
|                   | Site 47b | Lower Coyote | 2/13/2017  | 10:48 | 8.32 | 3.20          | 10          | 13.26     | 1473       | 0.17       | 80%                       | c             |
|                   |          |              | 4/17/2017  | 12:28 | 8.32 | 13.80         | 28          | 13.40     | 1345       | 0.37       | 90%                       | c             |
|                   |          |              | 6/26/2017  | 11:40 | 8.12 | 17.60         | 31          | 9.62      | 1220       | 0.27       | 100%                      | c             |
|                   |          |              | 8/8/2017   | 11:45 | 7.57 | 16.70         | 29.0        | 7.70      | 612        | 1.53       | 60%                       | c             |
|                   |          |              | 10/16/2017 | 12:55 | 8.47 | 7.30          | 19          | 10.70     | 1250       | 0.74       | 25%                       | c             |
|                   |          |              | 12/11/2017 | 12:40 | 8.69 | 0.60          | 16          | 13.06     | 1153       | 0.44       | 45%                       | c             |

**Table 2      Nutrient Data**

| Segment           | Site     | Location     | Date       | Total Nitrogen | Total Phosphorus |
|-------------------|----------|--------------|------------|----------------|------------------|
| <b>Segment 4a</b> | Site 47a | Upper Coyote | 2/13/2017  | 2517           | 22               |
|                   |          |              | 4/17/2017  | 604            | 20               |
|                   |          |              | 6/26/2017  | 960            | 113              |
|                   |          |              | 8/8/2017   | 748            | 102              |
|                   |          |              | 10/16/2017 | 1463           | 35               |
|                   |          |              | 12/11/2017 | 2688           | 20               |
|                   | Site 47b | Lower Coyote | 2/13/2017  | 2400           | 20               |
|                   |          |              | 4/17/2017  | 552            | 16               |
|                   |          |              | 6/26/2017  | 896            | 120              |
|                   |          |              | 8/8/2017   | 725            | 101              |
|                   |          |              | 10/16/2017 | 1370           | 30               |
|                   |          |              | 12/11/2017 | 2564           | 16               |

**Table 3      Flow Data**

|              | Jan-Feb     | Mar-Apr | May-Jun | Jul-Aug | Sep-Oct | Nov-Dec |              |
|--------------|-------------|---------|---------|---------|---------|---------|--------------|
|              | cfs         |         |         |         |         |         |              |
| Upper Coyote | 0.17        | 0.37    | 0.26    | 1.30    | 0.68    | 0.29    |              |
| Lower Coyote | 0.17        | 0.37    | 0.27    | 1.53    | 0.74    | 0.44    |              |
|              | Ac-Ft/day   |         |         |         |         |         |              |
| Upper Coyote | 0.329       | 0.728   | 0.514   | 2.582   | 1.356   | 0.579   |              |
| Lower Coyote | 0.335       | 0.728   | 0.527   | 3.026   | 1.473   | 0.873   |              |
|              | Ac-ft/month |         |         |         |         |         | Annual ac-ft |
| Upper Coyote | 19.8        | 43.7    | 30.8    | 154.9   | 81.4    | 34.7    | 365.3        |
| Lower Coyote | 20.1        | 44.4    | 32.2    | 187.6   | 89.9    | 53.2    | 427.4        |

**Table 4      Nutrient Loads**

| Location     | Date    | Flow Estimate | Loading Pounds/Period |                  |
|--------------|---------|---------------|-----------------------|------------------|
|              |         |               | Total Nitrogen        | Total Phosphorus |
| Upper Coyote | Jan-Feb | 19.8          | 135.4                 | 1.2              |
|              | Mar-Apr | 43.7          | 71.8                  | 2.4              |
|              | May-Jun | 30.8          | 80.6                  | 9.5              |
|              | Jul-Aug | 154.9         | 315.5                 | 43.0             |
|              | Sep-Oct | 81.4          | 595.7                 | 4.4              |

| Location     | Date    | Flow Estimate | Loading Pounds/Period |                  |
|--------------|---------|---------------|-----------------------|------------------|
|              |         |               | Total Nitrogen        | Total Phosphorus |
| Lower Coyote | Nov-Dec | 34.7          | 227.0                 | 1.9              |
|              | Jan-Feb | 20.1          | 131.4                 | 1.1              |
|              | Mar-Apr | 44.4          | 66.7                  | 1.9              |
|              | May-Jun | 32.2          | 78.5                  | 10.5             |
|              | Jul-Aug | 187.6         | 370.4                 | 51.6             |
|              | Sep-Oct | 89.9          | 335.3                 | 7.3              |
|              | Nov-Dec | 53.2          | 371.6                 | 2.3              |

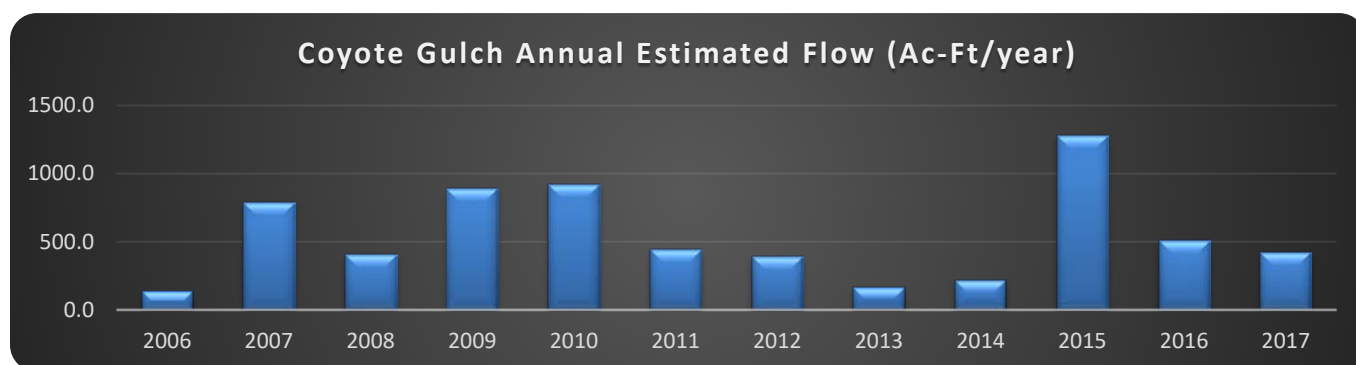


Figure 2 Estimated Annual Flows

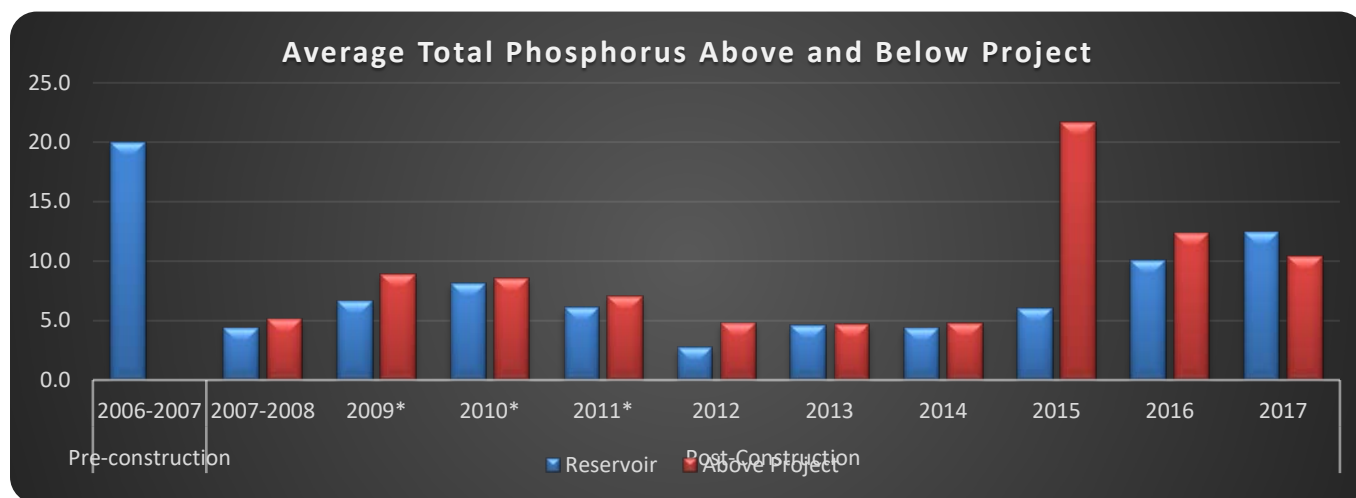


Figure 3 Total Phosphorus Removal by Project

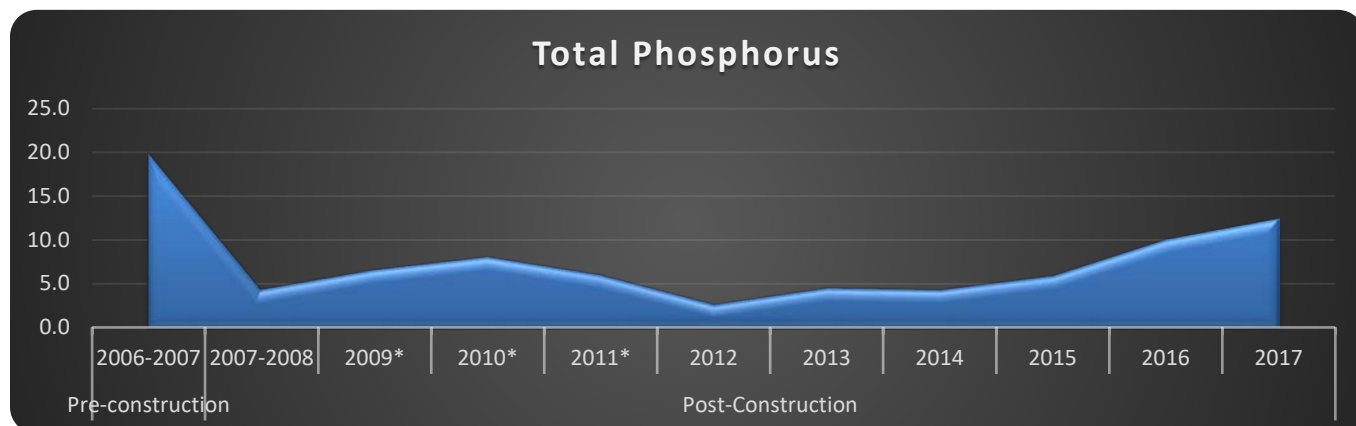


Figure 4 Total Phosphorus Baseload Estimates

**Table 5 Project Average Loading for Trade Estimates**

|                                                                               | Loading Pounds After Stable |         |               |        |
|-------------------------------------------------------------------------------|-----------------------------|---------|---------------|--------|
|                                                                               | Reservoir                   |         | Above Project |        |
|                                                                               | Nitrate                     | T. Phos | Nitrate       | T Phos |
| Total Pounds                                                                  | 11,167                      | 676     | 14,463        | 888    |
| Average                                                                       | 186                         | 11      | 241           | 15     |
| Median                                                                        | 91                          | 4       | 128           | 5      |
|                                                                               | T Nitrogen                  |         | T Nitrogen    |        |
| Total Pounds                                                                  | 955.9                       |         | 1341.8        |        |
| Average                                                                       | 319                         |         | 447           |        |
| 2009*/2010*/2011/2015 average loadings per year excludes April storm loadings |                             |         |               |        |

**Table 6 2017 Annual Nutrient Loads**

|              | Annual Pounds       |                |                  |
|--------------|---------------------|----------------|------------------|
|              | Flow Estimate ac-yr | Total Nitrogen | Total Phosphorus |
| Upper Coyote | 365.3               | 1426.0         | 62.4             |
| Lower Coyote | 427.4               | 1353.9         | 74.8             |
|              | Average Loading     |                |                  |
| Upper Coyote |                     | 237.7          | 10.4             |
| Lower Coyote |                     | 225.7          | 12.5             |

**Table 7 2017 Trade Pound Estimates**

| Total Phosphorus Trade Pounds                                     |                 |        |                     |             |
|-------------------------------------------------------------------|-----------------|--------|---------------------|-------------|
|                                                                   | Total Base Flow |        | Trade Ration Pounds |             |
|                                                                   | Monthly         | Annual | Monthly             | Annual      |
| Average                                                           | 6.6             | 78.8   | 6.7                 | <b>80.4</b> |
| Median                                                            | 6.0             | 72.5   | 7.0                 | <b>83.5</b> |
| Monthly TRP=PC Base Load-TBF Monthly Pounds/2                     |                 |        |                     |             |
| The base trade ratio is 2:1 for Association Trade Projects        |                 |        |                     |             |
| Base Flows Exclude April Storm Loadings                           |                 |        |                     |             |
| <b>Annual Trade Pounds Available = 80 pounds Total Phosphorus</b> |                 |        |                     |             |