# Mill Ditch Diversion Hydrologic Analysis - Bozeman Creek and Tributaries Digital Flood Insurance Rate Map Restudy Project

*prepared for*

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# 1.0 INTRODUCTION

## 1.1 Background

As part of the Mapping Activity Statement (MAS) contract for Bozeman Creek and Tributaries, Gallatin County, Montana (**Reference 5**), RESPEC is completing a detailed floodplain study for approximately 1.8 miles of Mill Ditch Diversion within Gallatin County, Montana. The Mill Ditch Diversion study limits extend from the confluence with the East Gallatin River at the downstream limit to the upstream limit at the point of diversion from Bozeman Creek, located southwest of the Church Avenue and Story Street intersection. The project area is displayed in **Figure 1-1**.

A Flood Insurance Study (FIS) has been completed for Gallatin County (**Reference 6**). Flood hazards are currently mapped as detailed Zone AE for the entire study area of Mill Ditch Diversion. The effective flooding for Mill Ditch Diversion is shown in **Figure 1-2**.

The hydrologic analysis for Mill Ditch Diversion is summarized in this report. The flood study will include the 10-, 4-, 2-, 1- and 0.2-percent-annual-chance (%AC) flood events.

## 1.2 Basin Description

The Mill Ditch Diversion watershed is located within the Bozeman Creek and East Gallatin watersheds (HUC 12 100200080904 and 100200080905) with Mill Ditch Diversion being a left bank tributary to East Gallatin River. Mill Ditch Diversion flows in a northwest direction from its point of diversion with Bozeman Creek. Mill Ditch Diversion watershed encompasses an area of 0.81 $mi^2$. The topography of the watershed ranges from mild and steep hill slopes in the upper reaches of the watershed to low sloping wetlands. The watershed is largely comprised of undeveloped areas with pockets of development consisting of residential and commercial areas.

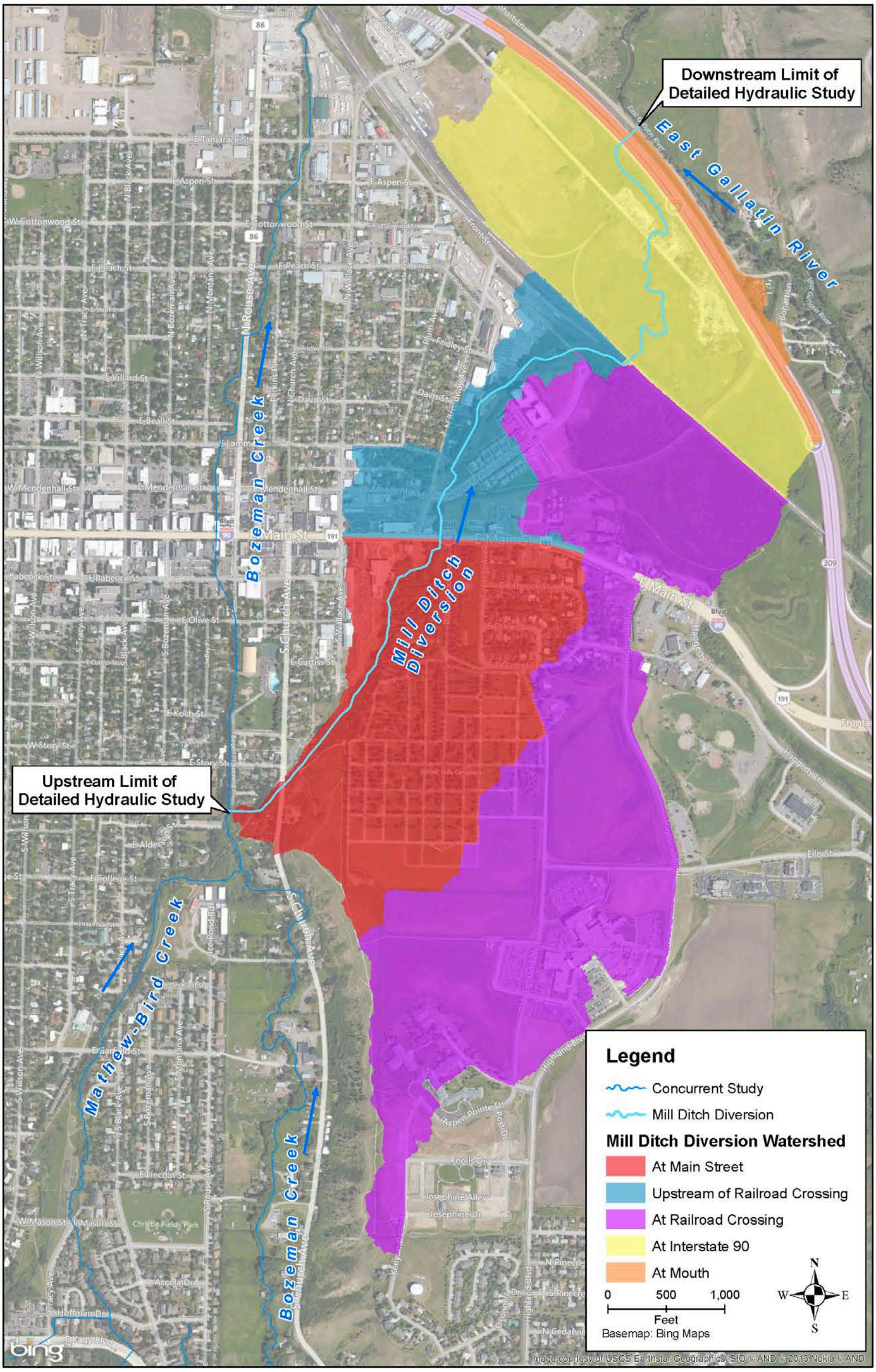


**Figure 1-1. Mill Ditch Diversion watershed**

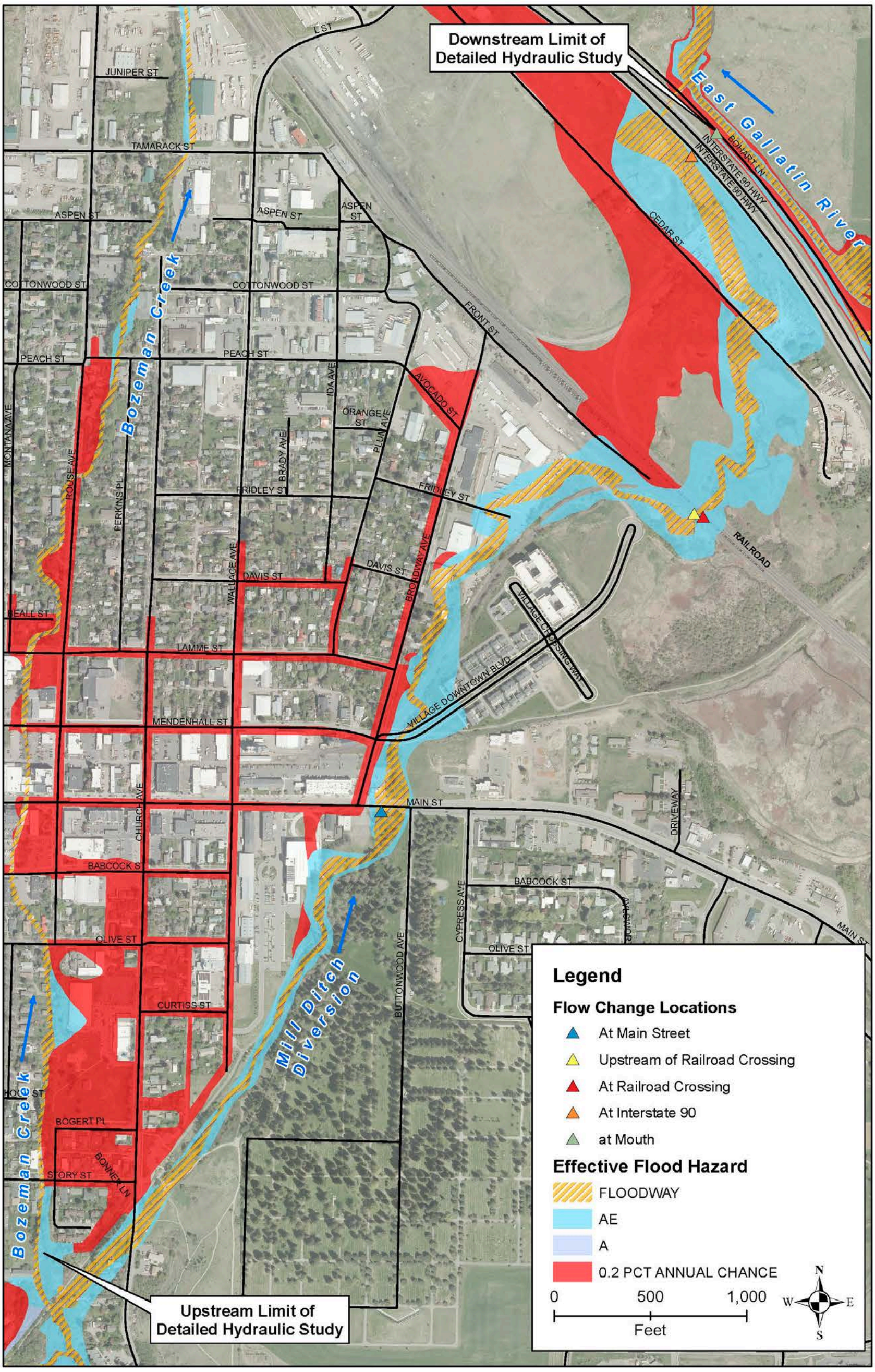


**Figure 1-2. Effective flood hazard areas for Mill Ditch Diversion**

## 1.3 Effective Hydrologic Analysis

As previously mentioned, flood hazards are currently mapped as detailed Zone AE for the entire study area of Mill Ditch Diversion. The Gallatin County FIS which went effective in 2011 does not mention if or when the effective hydrologic analysis of Mill Ditch Diversion was completed. Table 4 of the effective FIS states that peak discharges for Mill Ditch Diversion were due to the inflow "from overland flooding and from inflow from Bozeman Creek." Hence, the analyzed discharges of the effective Mill Ditch Diversion study were a result of the flooding and diverted flows of Bozeman Creek. Therefore it is assumed that the original analysis of Mill Ditch Diversion was completed with the Bozeman Creek study performed in June 1979 by the U.S. Department of Agriculture, Natural Resources Conservation Service. According to the FIS, later updates did not entail modifications to the analysis of Bozeman Creek or Mill Ditch Diversion.

## 1.4 Flooding History

Notable flooding within the Bozeman Creek watershed has been recorded in April 1893, April 1948, April 1977, and most recently in May of 2011. All of these events were produced from either high rate snowmelt or rain on snow events. The FIS states that the 1948 event was the largest event with flood waters entering Bozeman (the City) causing considerable damage. There is no reference as to the history of flooding along Mill Ditch Diversion within the FIS. Local accounts noted that the diversion was opened during the May 2011 event in an attempt to alleviate the flooding along Bozeman Creek.

## 1.5 Other Studies

The City was consulted for previous study information for the Bozeman Creek watershed and Mill Ditch Diversion. Unfortunately, the City didn't have any hydrologic data concerning the 100-yr event for the watershed outside of the aforementioned effective analysis. For development purposes the City requires that storm sewer facilities be sized for the 25-yr event and retention facilities be sized for the 10-yr 2-hr event. Since the focus of the present project is the 100-yr 24-hr event, these studies were considered negligible. However, the change in hydrologic characteristics due to the developments is accounted for in the land use information received from the City.

# 2.0 HYDROLOGIC ANALYSES

Because no gage data is available for Mill Ditch Diversion, regional regression equations along with an HEC-HMS model were used to calculate the peak discharges. Discharges were calculated at major road crossings and locations of significant drainage area increases. By dividing the basin at structures and locations of significant inflows, the discharges applied to upstream reaches during the hydraulic analysis are not overly conservative. For the present study, flow change locations are located at Main Street, upstream of the Northern Pacific Railroad, at the Northern Pacific Railroad, at Interstate 90, and at the mouth. Coincidentally, the effective FIS states that the effective discharges were also calculated at the mouth. The effective flow change location of Davis Street is approximate to the present flow change location at Main Street.

As previously stated, Mill Ditch Diversion originates at a diversion structure along Bozeman Creek, southwest of the intersection of Story Street and Church Avenue. For the present hydrologic study, it was assumed that no discharge was diverted from Bozeman Creek to Mill Ditch Diversion. It is recommended that a diversion of discharge analysis be conducted during the hydraulic analysis and the controlling discharges shall be utilized for hydraulic modeling and flood hazard mapping.

It should be noted that the Summary of Discharges table located in the effective FIS notes that the tabulated peak discharges are "due to inglow [*sic*] from overland flooding and from inflow from Bozeman Creek." It is assumed that the discharges listed within the FIS are a result of split flows analyzed during the hydraulic analysis rather than the hydrologic analysis.

## 2.1 Regional Regression Equation Analysis

Regional regression equations were used to compute the annual peak discharge values for the Mill Ditch Diversion drainage area. These equations are presented in *Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998: U.S. Geological Survey (USGS) Water-Resources Investigations Report (WRIR) 03-4308* (**Reference 11**). USGS WRIR 03-4308 separates Montana into eight different regions based on topography and climatic conditions. The entire drainage area for Mill Ditch Diversion is located in the Upper Yellowstone-Central Mountain Region.

USGS WRIR 03-4308 provides regression equations based on basin characteristics, active-channel width, bankfull width, and various weighted combinations of the methods. It also provides the Standard Error of Prediction (SEP) for all the methods. Smaller SEP percentages point to greater reliability of the regression equations used.

Prior to using the equations, the variables for the regression equations were estimated. All estimated variables for Mill Ditch Diversion at Northern Pacific Railroad and downstream were within the acceptable range of values used to generate the regression equations. The drainage areas for the flow locations upstream of the railroad have drainage areas less than the minimum area of 0.47 $mi^2$ recommended by the USGS. It should also be noted that the applicability of the channel characteristics regression estimates for Mill Ditch Diversion is considered to be less reliable. The active-channel and bankfull widths measured for Mill Ditch Diversion during field reconnaissance are likely inapplicable due to man-made alterations of the natural channel in the form of channel development, road crossings, bank protection and grade control structures. Therefore, the discharges for Mill Ditch Diversion derived from the regression equations based on channel characteristics should be used with caution. The range of values applied for the regression analyses are presented in **Table 2-1**.

ArcGIS 10.1 was used to estimate all variables for the basin characteristics equations in a manner consistent with the methods used by the USGS to formulate the regression equations. The drainage areas (A) were delineated using digital elevation models (DEM) developed from LiDAR developed by Photo Science, Inc. (**Reference 12**) and USGS Topographic Quadrangle Maps. Drainage area delineations utilized for the regression analysis are shown in **Figure 1-1** and the values are shown in **Table 2-1**.

The percentage of drainage area above elevation of 6000' ($E_{6000}$) was estimated by comparing the 6000' contour from the USGS Topographic Quadrangle maps with the delineated watershed. The delineated area above 6000' totals zero (0) $mi^2$.

The active-channel width and bankfull width for all basins were measured during field reconnaissance based on guidelines presented in USGS WRIR 03-4308. These values are presented in **Table 2-1**.

**Table 2-1. Regression parameters**

| Description | Drainage Area, A ($mi^2$) | Percentage of basin above 6,000 feet in elevation, $E_{6000}$ (%) | Active Channel Width $W_{ac}$ (ft) | Bankfull Channel Width $W_{bf}$ (ft) |
|---|---|---|---|---|
| **Upper Yellowstone-Central Mountain Region Range of Values Used to Develop Regression Equations** | 0.47 - 2,032 | 0 - 100 | 1.0 - 150 | 2.5 - 170 |
| **Confluence with East Gallatin River** | 0.81 | 0 | 5.0 | 11.5 |
| **At Interstate 90** | 0.78 | 0 | 5.0 | 11.5 |
| **At Northern Pacific Railroad** | 0.62 | 0 | 3.8 | 8.8 |
| **Upstream of Northern Pacific Railroad** | 0.27 | 0 | 3.5 | 8.8 |
| **At Main Street** | 0.20 | 0 | 2.5 | 6.0 |

Regression equations for basin characteristics, active-channel width, and bankfull width were calculated at Main Street, upstream of the Northern Pacific Railroad, at the Northern Pacific Railroad, at Interstate 90, and at the mouth independently. A weighted combination of the three methods was also computed for the three locations. All calculations were performed using the web-based USGS Flood Discharge at Ungaged Sites in Montana program. The program utilizes the equations presented in WRIR 03-4308. Results of the regression analyses are included below in **Section 3** of this report and the output data from the USGS web-based program is included in **Appendix A**.

## 2.2 Rainfall-Runoff Analysis

The Mill Ditch Diversion watershed was also analyzed using the rainfall-runoff method. This was done utilizing the U.S. Army Corps of Engineers' (USACE) HEC-HMS modeling program Version 3.5. The HEC-HMS modeling program is a graphical user interface designed to simulate a precipitation-runoff response in urban or natural watersheds. The model takes into account a user specified meteorological model, loss and transform method, and reach routing method for each individual subbasin entered into the program.

The meteorological model for Mill Ditch Diversion utilized a 24-hour design storm to simulate the rainfall over the watershed. The SCS Runoff Curve Number Method was used to model potential losses. The transform method used is the Curve Number Method described in National Engineering Handbook (**Reference 9**). The Muskingum-Cunge routing method was used to route the hydrograph through the watershed. Results of the HEC-HMS model are provided in **Section 3**.

### 2.2.1 Precipitation

Design storms used in the hydrologic analysis of Mill Ditch Diversion consisted of a 24-hour design storm distribution. Point precipitation depths for the 10-, 4-, 2-, and 1-percent-annual-chance storm events were taken from the isohyetal maps found in *NOAA Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume I – Montana* (**Reference 7**) for durations of 6 and 24 hours. All precipitation durations less than six hours were obtained using equations, figures and tables presented in *NOAA Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume I – Montana* and *Short Duration Rainfall Relations for the Western United States* (**Reference 1**). The 0.2-percent-annual-chance storm event precipitation values were extrapolated from a log-probability curve of the 10-, 4-, 2-, and 1-percent annual chance storm events. All point precipitation depths are displayed in **Table 2-2**. All pertinent data used to determine the depths are included in **Appendix B**.

**Table 2-2. Design storm rainfall depths**

| Duration | 50-Percent-Annual-Chance Depth (in) | 20-Percent-Annual-Chance Depth (in) | 10-Percent-Annual-Chance Depth (in) | 4-Percent-Annual-Chance Depth (in) | 2-Percent-Annual-Chance Depth (in) | 1-Percent-Annual-Chance Depth (in) | 0.2-Percent-Annual-Chance Depth (in)* |
|---|---|---|---|---|---|---|---|
| **5 min** | 0.17 | 0.26 | 0.33 | 0.42 | 0.49 | 0.57 | 0.72 |
| **15 min** | 0.31 | 0.49 | 0.61 | 0.77 | 0.92 | 1.06 | 1.35 |
| **1 hr** | 0.45 | 0.72 | 0.91 | 1.13 | 1.34 | 1.54 | 1.94 |
| **2 hr** | 0.52 | 0.79 | 0.98 | 1.22 | 1.42 | 1.60 | 2.04 |
| **3 hr** | 0.59 | 0.85 | 1.05 | 1.30 | 1.48 | 1.66 | 2.08 |
| **6 hr** | 0.75 | 1.00 | 1.20 | 1.50 | 1.65 | 1.80 | 2.25 |
| **12 hr** | 0.94 | 1.26 | 1.53 | 1.88 | 2.09 | 2.25 | 2.81 |
| **24 hr** | 1.20 | 1.60 | 1.90 | 2.30 | 2.60 | 2.80 | 3.37 |

**0.2-percent-annual-chance precipitation depths were extrapolated from 50- to 1-percent-annual-chance depths.*

It should be noted that the utilized rainfall values were compared with the values referenced in the City of Bozeman's (the City) *Design Standards and Specifications Policy* (**Reference 3**). Comparison of the City's rainfall depths shows close correlation with the isohyetal maps found in *NOAA Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume I – Montana*. However, the short duration values taken from *NOAA Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume I – Montana* and *Short Duration Rainfall Relations for the Western United States* were more conservative (larger) than those estimated utilizing the City's values.

### 2.2.2 Loss Rate

The SCS Curve Number Method was chosen to model potential runoff loss with respect to soil type and land use conditions. The subbasins utilized in the hydrologic modeling of Mill Ditch Diversion are shown in **Figure 2-1**. Drainage areas for the various subbasins are presented in **Table 2-3**. Soils coverage for the Mill Ditch Diversion watershed was obtained in Soil Survey Geographic (SSURGO) format from the Natural Resources Conservation Service (NRCS) Geospatial Data Gateway (**Reference 8**). The hydrologic soil groups present within the Mill Ditch Diversion watershed are displayed in **Figure 2-2**. Land use data was also obtained from the NRCS Geospatial Data Gateway as well as the City (**Reference 4**). The land use classifications present within the Mill Ditch Diversion watershed are displayed in **Figure 2-3**. Shapefiles containing the soils and land use data were intersected and clipped to the watershed boundary. This process resulted in a shapefile containing the land use associated to each soil type, along with the total area of each soil and land use combination within the watershed. The NRCS *Urban Hydrology for Small Watersheds Technical Release 55 (TR-55)* (**Reference 10**) was used to assign a set of curve numbers to each of the subbasins. When assigning curve

numbers all areas were considered to be in good hydrologic condition with an antecedent moisture condition of two (AMCII). An on-site evaluation of the watershed was conducted in addition to the examination of aerial imagery and land use coverage. This evaluation aided in assigning the most representative set of curve numbers to the different land use and vegetative cover types present in the watershed. The adopted land use curve numbers utilized for this study are shown in **Appendix C**.

Each subbasin's cumulative loss rate was determined by calculating an areal weighted-average curve number value. This final weighted-average curve numbers for the subbasins of Mill Ditch Diversion are shown in **Table 2-3** below. Calculations for the curve number method are included in **Appendix D**.

**Figure 2-1. Subbasins and longest flow paths utilized for the hydrologic model**

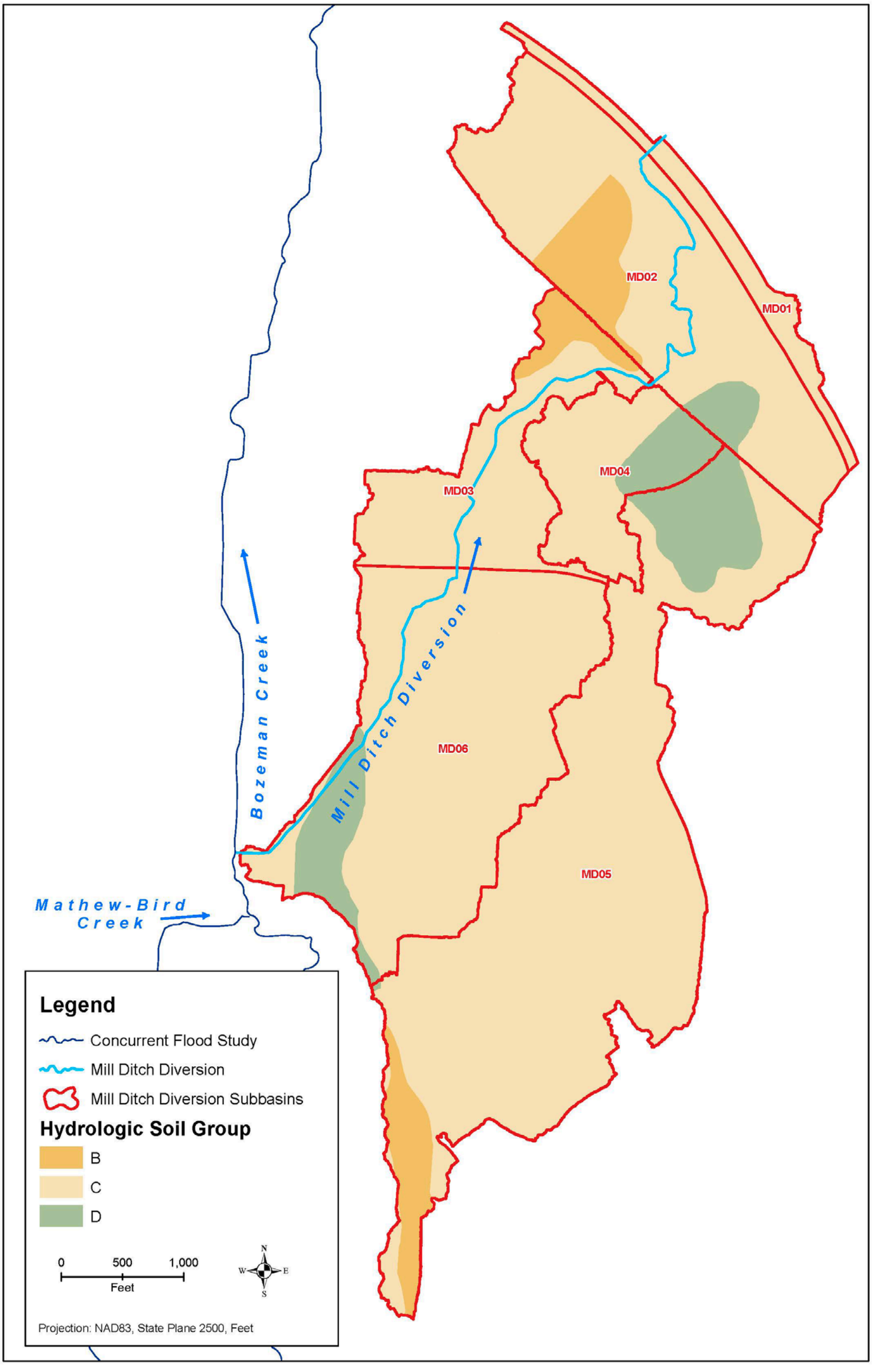


**Figure 2-2. Hydrologic soil groups present within the Mill Ditch Diversion watershed**

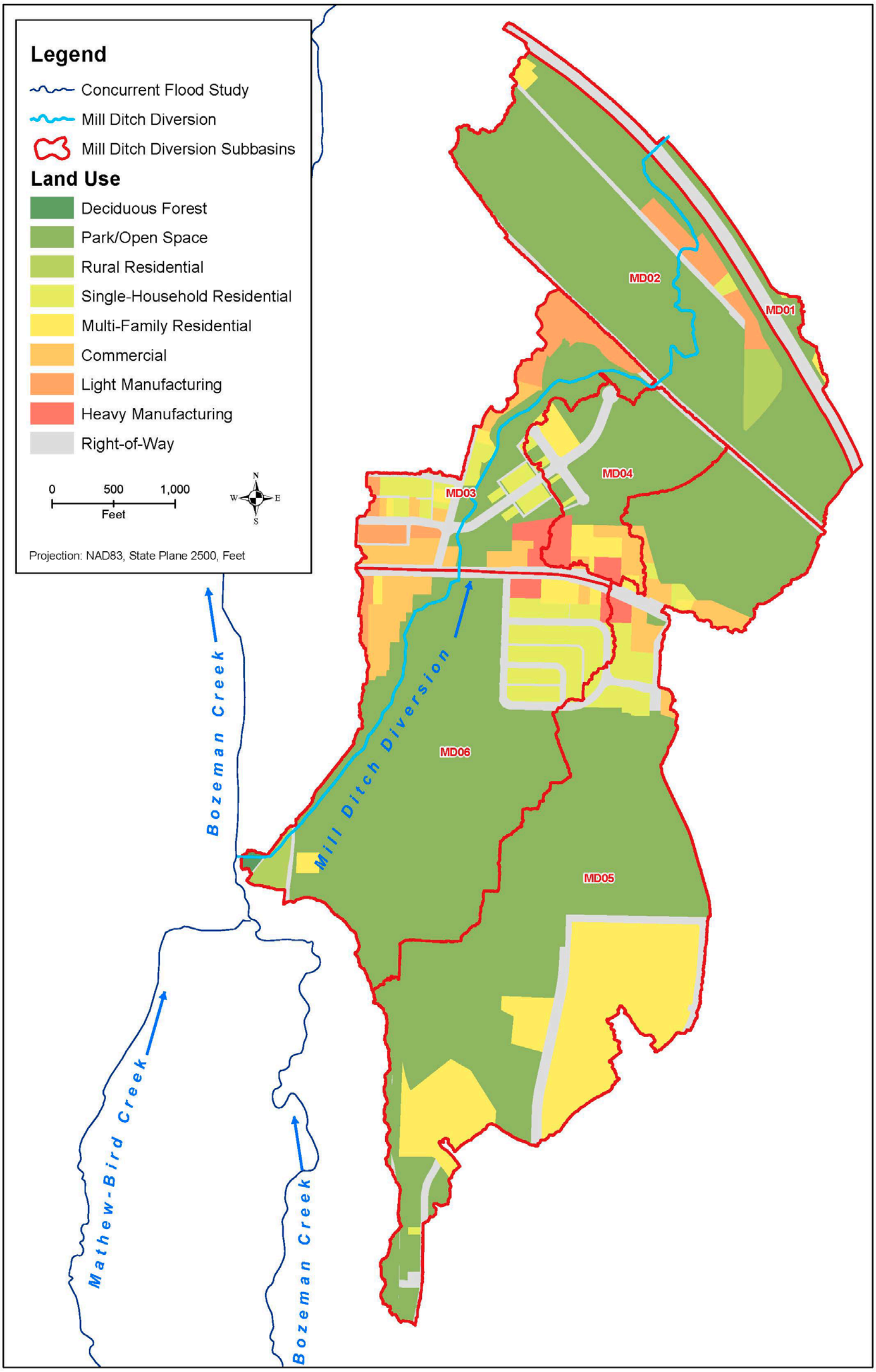


**Figure 2-3. Descriptions of land uses present within the Mill Ditch Diversion watershed**

### 2.2.3 Transform

In order to employ the SCS Dimensionless Unit Hydrograph method to distribute the runoff volume for the basin, the SCS lag time was required. The lag time for the basin was calculated using the Curve Number Lag Method described in the *National Engineering Handbook* (**Reference 8**). The lag time is calculated using the following equation:

$$L = (l^{0.8}(S+1)^{0.7}) / 1900Y^{0.5}$$

Where L equals the lag time in hours; l is defined as the hydraulic length of the catchment in feet; Y represents the average watershed land slope in percent; and

$$S = (1000 / CN) - 10$$

in which CN represents the dimensionless curve number described in **Section 2.2.2**.

Both the hydraulic length of the catchment and the average watershed land slope were calculated using ArcGIS 10.1. The path of the hydraulic length for each subbasin is shown in **Figure 2-1**.

HEC-HMS then uses the lag time parameter to internally calculate the time of concentration ($t_c$) for the watershed using the following equation:

$$t_c = L / 0.6$$

The results of the described calculations are provided in **Table 2-3**. Supplemental information and calculations are provided in **Appendix E**.

**Table 2-3. Summary of hydrologic parameters for each basin**

| HMS Basin | Area ($mi^2$) | Composite CN | Hydraulic Length (ft) | Average Watershed Land Slope (%) | Lag (min) | $t_c$ (min) |
|---|---|---|---|---|---|---|
| **MD01** | 0.0240 | 91.56 | 3246.2 | 1.6 | 25.61 | 42.69 |
| **MD02** | 0.1581 | 75.25 | 4405.0 | 1.8 | 53.42 | 89.04 |
| **MD03** | 0.0758 | 86.16 | 3837.4 | 3.0 | 26.20 | 43.66 |
| **MD04** | 0.0537 | 82.94 | 3293.5 | 5.2 | 19.70 | 32.83 |
| **MD05** | 0.2992 | 80.01 | 10627.7 | 5.0 | 56.71 | 94.52 |
| **MD06** | 0.1957 | 78.62 | 4372.7 | 5.8 | 26.95 | 44.91 |

### 2.2.4 Channel Routing

To computationally route the runoff hydrograph through the watershed, the Muskingum-Cunge routing method was chosen. This routing routine approximates the diffusion method, allowing the model to describe the physical nature of the basin and thus the attenuation potential. Within the HEC-HMS model the Muskingum-Cunge method allows the user to define an eight-point cross section to describe the channel and overbank geometries, roughness values, lengths and slopes for each reach. Routing reaches were delineated using ArcGIS 10.1. The eight-point channel cross sections, lengths and slopes were created for each reach of Mill Ditch Diversion using the best available topographic data for each subbasin. The Manning's *n* roughness values assigned within the HEC-HMS model were determined based on site visits, aerial photography, and engineering judgment. *Open Channel Hydraulics* by Ven Te Chow (**Reference 2**) provided tables of roughness coefficients for different surfaces. Assigned Manning's values throughout the simulated reaches varied from 0.040 – 0.045 for the channels to represent a meandering channel with stones and objects of variable form roughness. Manning's values of 0.06 – 0.07 were utilized in the overbanks to describe floodplains representing grasses to dense vegetation.

### 2.2.5 Reservoir Routing

An abandoned railroad embankment within the Mill Ditch Diversion watershed appears to provide storage-attenuation of peak discharge flows. Hence, this structure was defined within the HEC-HMS model. The structure is located at the downstream end of subbasin MD05 and called out in **Figure 2-4**. During the field reconnaissance, it was discovered that the discharge through the abandoned embankment is controlled by a 30" cast iron pipe. In order to best describe the storage available upstream of the culvert, an elevation-storage relationship was calculated from the aforementioned LiDAR. The elevation-storage relationship is listed in **Appendix F**. The invert of the pipe was also taken from the LiDAR data. By allowing HEC-HMS to calculate the discharge through the culvert based on the storage, the model more accurately depicts the realistic storage-discharge relationship located within the watershed.

**Figure 2-4. Location of abandoned railroad embankment**

# 3.HYDROLOGIC ANALYSES RESULTS

## 3.1 Summary of Discharges

The effective discharges used for Mill Ditch Diversion are shown in **Table 3-1**. Results of the various methods described in **Section 2** are summarized in **Table 3-2** through **Table 3-6**.

**Table 3-1. Effective discharges for Mill Ditch Diversion**

| Location | Drainage Area ($mi^2$) | 10-Percent-Annual-Chance Discharge (cfs) | 4-Percent-Annual-Chance Discharge (cfs) | 2-Percent-Annual-Chance Discharge (cfs) | 1-Percent-Annual-Chance Discharge (cfs) | 0.2-Percent-Annual-Chance Discharge (cfs) |
|---|---|---|---|---|---|---|
| **Near Davis Street** | --[1] | 145 | *N/A* | 265 | 340 | 290 |
| **At Interstate 90** | --[1] | 145 | *N/A* | 300 | 380 | 440 |

[1]*Drainage area not available due to inflow from overland flooding and from inflow from Bozeman Creek*

**Table 3-2. Resultant discharges for Mill Ditch Diversion at Main Street**

| Method | Description | 10%-Annual-Chance | 4%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|---|
| **2004 USGS Regional Regression Equations - Basin Characteristics[1]** | **Discharge (cfs)** | 12 | 25 | 39 | 58 | 125 |
| | **SEP** | 68.1% | 62.2% | 61.3% | 62.6% | 72.2% |
| **2004 USGS Regional Regression Equations - Active Channel Width** | **Discharge (cfs)** | 63 | 121 | 184 | 266 | 557 |
| | **SEP** | 71.9% | 78.0% | 84.6% | 92.2% | 114.2% |
| **2004 USGS Regional Regression Equations - Bankfull Width** | **Discharge (cfs)** | 81 | 150 | 222 | 315 | 632 |
| | **SEP** | 74.8% | 80.4% | 86.9% | 94.6% | 117.0% |
| **2004 USGS Regional Regression Equations - Weighted Basin, Active Channel & Bankfull Widths[1]** | **Discharge (cfs)** | 28 | 43 | 56 | 71 | 125 |
| | **SEP** | 54.3% | 56.2% | 58.9% | 61.5% | 72.2% |
| **HEC-HMS (HEC-HMS Element MD06)** | **Discharge (cfs)** | 35 | 61 | 84 | 105 | 158 |

[1]*Drainage area below range recommended by USGS.*

**Table 3-3. Resultant discharges for Mill Ditch Diversion upstream of Northern Pacific Railroad**

| Method | Description | 10%-Annual-Chance | 4%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|---|
| 2004 USGS Regional Regression Equations - Basin Characteristics[1] | Discharge (cfs) | 16 | 32 | 49 | 73 | 156 |
| | SEP | 67.6% | 61.7% | 60.8% | 62.1% | 71.5% |
| 2004 USGS Regional Regression Equations - Active Channel Width | Discharge (cfs) | 102 | 188 | 277 | 391 | 774 |
| | SEP | 70.9% | 76.8% | 83.3% | 90.6% | 112.0% |
| 2004 USGS Regional Regression Equations - Bankfull Width | Discharge (cfs) | 138 | 242 | 348 | 478 | 908 |
| | SEP | 73.8% | 79.3% | 85.6% | 93.1% | 114.9% |
| 2004 USGS Regional Regression Equations - Weighted Basin, Active Channel & Bankfull Widths[1] | Discharge (cfs) | 40 | 59 | 74 | 92 | 156 |
| | SEP | 53.6% | 55.5% | 58.2% | 60.9% | 71.5% |
| HEC-HMS (HEC-HMS Element J03) | Discharge (cfs) | 57 | 97 | 132 | 163 | 240 |

[1]*Drainage area below range recommended by USGS.*

**Table 3-4. Resultant discharges for Mill Ditch Diversion at Northern Pacific Railroad**

| Method | Description | 10%-Annual-Chance | 4%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|---|
| 2004 USGS Regional Regression Equations - Basin Characteristics | Discharge (cfs) | 30 | 59 | 90 | 130 | 273 |
| | SEP | 66.5% | 60.6% | 59.6% | 60.9% | 70.0% |
| 2004 USGS Regional Regression Equations - Active Channel Width | Discharge (cfs) | 102 | 188 | 277 | 391 | 774 |
| | SEP | 70.9% | 76.8% | 83.3% | 90.6% | 112.0% |
| 2004 USGS Regional Regression Equations - Bankfull Width | Discharge (cfs) | 138 | 242 | 348 | 478 | 908 |
| | SEP | 73.8% | 79.3% | 85.6% | 93.1% | 114.9% |
| 2004 USGS Regional Regression Equations - Weighted Basin, Active Channel & Bankfull Widths | Discharge (cfs) | 55 | 87 | 116 | 150 | 273 |
| | SEP | 53.3% | 55.0% | 57.5% | 59.9% | 70.0% |
| HEC-HMS (HEC-HMS Element J04) | Discharge (cfs) | 77 | 128 | 171 | 209 | 306 |

**Table 3-5. Resultant discharges for Mill Ditch Diversion at Interstate 90**

| Method | Description | 10%-Annual-Chance | 4%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|---|
| 2004 USGS Regional Regression Equations - Basin Characteristics | Discharge (cfs) | 35 | 69 | 105 | 152 | 318 |
| | SEP | 66.2% | 60.3% | 59.4% | 60.6% | 69.7% |
| 2004 USGS Regional Regression Equations - Active Channel Width | Discharge (cfs) | 141 | 251 | 363 | 502 | 961 |
| | SEP | 70.4% | 76.2% | 82.5% | 89.8% | 110.9% |
| 2004 USGS Regional Regression Equations - Bankfull Width | Discharge (cfs) | 201 | 339 | 475 | 641 | 1,170 |
| | SEP | 73.3% | 78.6% | 84.9% | 92.2% | 113.7% |
| 2004 USGS Regional Regression Equations - Weighted Basin, Active Channel & Bankfull Widths | Discharge (cfs) | 71 | 108 | 141 | 178 | 318 |
| | SEP | 53.0% | 54.6% | 57.1% | 59.6% | 69.7% |
| HEC-HMS (HEC-HMS Element J02) | Discharge (cfs) | 87 | 146 | 197 | 241 | 355 |

**Table 3-6. Resultant discharges for Mill Ditch Diversion at mouth**

| Method | Description | 10%-Annual-Chance | 4%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|---|
| 2004 USGS Regional Regression Equations - Basin Characteristics | Discharge (cfs) | 36 | 71 | 108 | 156 | 324 |
| | SEP | 66.2% | 60.3% | 59.3% | 60.5% | 69.6% |
| 2004 USGS Regional Regression Equations - Active Channel Width | Discharge (cfs) | 141 | 251 | 363 | 502 | 961 |
| | SEP | 70.4% | 76.2% | 82.5% | 89.8% | 110.9% |
| 2004 USGS Regional Regression Equations - Bankfull Width | Discharge (cfs) | 201 | 339 | 475 | 641 | 1,170 |
| | SEP | 73.3% | 78.6% | 84.9% | 92.2% | 113.7% |
| 2004 USGS Regional Regression Equations - Weighted Basin, Active Channel & Bankfull Widths | Discharge (cfs) | 72 | 110 | 143 | 182 | 324 |
| | SEP | 53.0% | 54.6% | 57.0% | 59.5% | 69.6% |
| HEC-HMS (HEC-HMS Element Mouth) | Discharge (cfs) | 92 | 155 | 209 | 256 | 377 |

## 3.2 Recommended Discharges

In review of the discharges listed in **Table 3-2** through **Table 3-6**, one can see that there is a vast difference in calculated discharges of those methods dependent upon basin characteristics (basin characteristic regression and HEC-HMS) versus those produced from channel characteristics (active-channel and bankfull widths). As previously discussed the active-channel width and bankfull width regression equations were deemed less reliable due to the aforementioned man-made development of the channel and further alterations to the flow path. Due to this, the regression estimates utilizing the channel characteristics were deemed inapplicable. Although the weighted regression estimates provide a slightly lower SEP than the basin characteristic regression estimates, it too is reliant on the channel characteristics and is therefore considered to be inapplicable. It should be noted that other weighted regression estimates based on channel characteristics were performed. However, due to the aforementioned lack of confidence in the channel variables, the results were not displayed in the above tables. The results of all performed regression analyses can be found in **Appendix A**.

Comparison of the basin characteristics regression estimates with the results of the hydrologic model shows a closer resemblance than the channel characteristics estimates. However, the basin characteristics regression is based off a regional data source while the hydrologic model describes the immediate conditions of the Mill Ditch Diversion watershed. Given that the HEC-HMS analysis better describes the hydrologic characteristics of the Mill Ditch Diversion watershed, the HEC-HMS model is considered the most appropriate hydrologic method for determining peak flow estimates for Mill Ditch Diversion. While it is recommended that the HEC-HMS results are the most appropriate hydrologic results, the results may not be the most appropriate discharges to utilize in the hydraulic analysis. During the hydraulic analysis of Bozeman Creek, the amount of discharge diverted to Mill Ditch Diversion should be calculated and compared to the HEC-HMS results with the larger discharges utilized in the final hydraulic analysis and floodplain mapping.

It is noted that the recommended discharges are less than the effective discharges for Mill Ditch Diversion. This is due to the difference in methods utilized to calculate the peak discharges. As previously stated, the effective FIS notes that the effective discharges are a result of "overland flooding and from inflow from Bozeman Creek."

Recommended 10-, 4-, 2-, 1- and 0.2-percent-annual-chance discharges for all flow change locations of Mill Ditch Diversion are presented below in **Table 3-7**. As previously mentioned, these discharges are proposed for comparison with the discharges calculated during the hydraulic analysis of Bozeman Creek.

**Table 3-7. Recommended discharges for Mill Ditch Diversion**

| Location | 10%-Annual-Chance Discharge (cfs) | 4%-Annual-Chance Discharge (cfs) | 2%-Annual-Chance Discharge (cfs) | 1%-Annual-Chance Discharge (cfs) | 0.2%-Annual-Chance Discharge (cfs) |
|---|---|---|---|---|---|
| **Confluence with East Gallatin River** | 92 | 155 | 209 | 256 | 377 |
| **At Interstate 90** | 87 | 146 | 197 | 241 | 355 |
| **At Northern Pacific Railroad** | 77 | 128 | 171 | 209 | 306 |
| **Upstream of Northern Pacific Railroad** | 57 | 97 | 132 | 163 | 240 |
| **At Main Street** | 35 | 61 | 84 | 105 | 158 |

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# APPENDIX A

# REGRESSION ANALYSES

# Montana Flood-Frequency and Basin-Characteristic Data

## Estimate Flood Discharges at Ungaged Sites in Montana – (continued)

---

### Summary of Estimation Parameters Selected:

| | |
|---|---|
| **Name for this estimation:** | **Mill Ditch at Main Street** |
| **Region:** | **Upper Yellowstone** |
| **Estimation method:** | **Weighted estimate based on Basin and Climatic Characteristics, Active-channel width, and Bankfull width** |
| **Drainage area in square miles:** | **0.1957** ← Area less than USGS recommended area |
| **Percent basin above 6,000 feet:** | **0** |
| **Width of active channel in feet:** | **2.5** |
| **Width of bank full channel in feet:** | **6** |

### Flood Discharge Estimation:

*(In the Flood Discharge table, RI is the Recurrence Interval, in years; STD ERR is the Standard Error; and 90% PRED. INTERVAL is the 90% Prediction Interval, in cubic feet per second)*

```
 METHOD: Regression on basin characteristics
 Flood frequency estimates for
 Mill Ditch at Main Street
Upper Yellowstone-Central Mountain Region: A =      0.20 E6 =     0.
 RI        DISCHARGE  STD ERR OF                90% PRED. INTERVAL
             (cfs)      PREDICTION(%)
     2          2.       100.3                0.4                 6.
     5          6.        77.4                1.9                19.
    10         12.        68.1                4.4                34.
    25         25.        62.2                9.7                65.
    50         39.        61.3               15.3               100.
   100         58.        62.6               22.2               150.
   200         82.        65.8               30.3               222.
   500        125.        72.2               42.6               366.
 WARNING: A outside of observed data range     0.47 to  2032.00
```

METHOD: Regression on active channel width
Flood frequency estimates for
Mill Ditch at Main Street
Upper Yellowstone-Central Mountain Region: WAC = 2.50

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 10. | 73.4 | 3.3 | 30. |
| 5 | 33. | 69.8 | 11.6 | 95. |
| 10 | 63. | 71.9 | 21.3 | 184. |
| 25 | 121. | 78.0 | 38.2 | 382. |
| 50 | 184. | 84.6 | 54.0 | 628. |
| 100 | 266. | 92.2 | 71.9 | 987. |
| 200 | 373. | 101.0 | 91.9 | 1510. |
| 500 | 557. | 114.2 | 121.2 | 2560. |

METHOD: Regression on bank full channel width
Flood frequency estimates for
Mill Ditch at Main Street
Upper Yellowstone-Central Mountain Region: WBF = 6.00

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 17. | 160.9 | 2.6 | 113. |
| 5 | 45. | 73.7 | 15.0 | 136. |
| 10 | 81. | 74.8 | 26.7 | 248. |
| 25 | 150. | 80.4 | 46.1 | 487. |
| 50 | 222. | 86.9 | 63.5 | 778. |
| 100 | 315. | 94.6 | 82.8 | 1200. |
| 200 | 432. | 103.5 | 103.9 | 1800. |
| 500 | 632. | 117.0 | 134.0 | 2980. |

METHOD: Combined methods 1, 2 and 3
Flood frequency estimates for
Mill Ditch at Main Street
Region 7

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 6. | 69.1 | 2.1 | 17. |
| 5 | 17. | 54.7 | 7.4 | 41. |
| 10 | 28. | 54.3 | 11.9 | 64. |
| 25 | 43. | 56.2 | 17.9 | 102. |
| 50 | 56. | 58.9 | 22.6 | 139. |
| 100 | 71. | 61.5 | 27.8 | 182. |
| 200 | 90. | 65.6 | 33.4 | 244. |
| 500 | 125. | 72.2 | 42.6 | 366. |

---

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# Montana Flood-Frequency and Basin-Characteristic Data

## Estimate Flood Discharges at Ungaged Sites in Montana – (continued)

---

### Summary of Estimation Parameters Selected:

| | |
|---|---|
| **Name for this estimation:** | **Mill Ditch upstream of RR crossi** |
| **Region:** | **Upper Yellowstone** |
| **Estimation method:** | **Weighted estimate based on Basin and Climatic Characteristics, Active-channel width, and Bankfull width** |
| **Drainage area in square miles:** | **0.2715** ← Area less than USGS recommended area |
| **Percent basin above 6,000 feet:** | **0** |
| **Width of active channel in feet:** | **3.8** |
| **Width of bank full channel in feet:** | **8.8** |

### Flood Discharge Estimation:

*(In the Flood Discharge table, RI is the Recurrence Interval, in years; STD ERR is the Standard Error; and 90% PRED. INTERVAL is the 90% Prediction Interval, in cubic feet per second)*

```
 METHOD: Regression on basin characteristics
 Flood frequency estimates for
 Mill Ditch upstream of RR crossi
Upper Yellowstone-Central Mountain Region: A =      0.27 E6 =     0.
 RI        DISCHARGE  STD ERR OF                90% PRED. INTERVAL
             (cfs)      PREDICTION(%)
     2          2.        99.6                0.5                 8.
     5          8.        76.9                2.5                24.
    10         16.        67.6                5.7                44.
    25         32.        61.7               12.4                82.
    50         49.        60.8               19.5               125.
   100         73.        62.1               28.1               187.
   200        103.        65.2               38.3               276.
   500        156.        71.5               53.5               452.
 WARNING: A outside of observed data range     0.47 to  2032.00
```

METHOD: Regression on active channel width
Flood frequency estimates for
Mill Ditch upstream of RR crossi
Upper Yellowstone-Central Mountain Region: WAC = 3.80

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 19. | 72.6 | 6.3 | 55. |
| 5 | 57. | 68.9 | 20.1 | 162. |
| 10 | 102. | 70.9 | 35.3 | 298. |
| 25 | 188. | 76.8 | 60.2 | 586. |
| 50 | 277. | 83.3 | 82.6 | 932. |
| 100 | 391. | 90.6 | 107.2 | 1420. |
| 200 | 533. | 99.2 | 133.9 | 2130. |
| 500 | 774. | 112.0 | 171.7 | 3490. |

METHOD: Regression on bank full channel width
Flood frequency estimates for
Mill Ditch upstream of RR crossi
Upper Yellowstone-Central Mountain Region: WBF = 8.80

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 34. | 160.1 | 5.1 | 221. |
| 5 | 81. | 72.9 | 27.2 | 240. |
| 10 | 138. | 73.8 | 46.0 | 416. |
| 25 | 242. | 79.3 | 75.5 | 777. |
| 50 | 348. | 85.6 | 100.8 | 1200. |
| 100 | 478. | 93.1 | 127.9 | 1790. |
| 200 | 640. | 101.8 | 156.6 | 2620. |
| 500 | 908. | 114.9 | 196.3 | 4200. |

METHOD: Combined methods 1, 2 and 3
Flood frequency estimates for
Mill Ditch upstream of RR crossi
Region 7

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 10. | 68.4 | 3.7 | 29. |
| 5 | 27. | 54.1 | 11.6 | 62. |
| 10 | 40. | 53.6 | 17.5 | 93. |
| 25 | 59. | 55.5 | 24.8 | 139. |
| 50 | 74. | 58.2 | 30.3 | 182. |
| 100 | 92. | 60.9 | 36.3 | 234. |
| 200 | 115. | 65.0 | 42.9 | 308. |
| 500 | 156. | 71.5 | 53.5 | 452. |

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# Montana Flood-Frequency and Basin-Characteristic Data

## Estimate Flood Discharges at Ungaged Sites in Montana – (continued)

---

### Summary of Estimation Parameters Selected:

| | |
|---|---|
| **Name for this estimation:** | **Mill Ditch at RR crossing** |
| **Region:** | **Upper Yellowstone** |
| **Estimation method:** | **Weighted estimate based on Basin and Climatic Characteristics, Active-channel width, and Bankfull width** |
| **Drainage area in square miles:** | **0.6244** |
| **Percent basin above 6,000 feet:** | **0** |
| **Width of active channel in feet:** | **3.8** |
| **Width of bank full channel in feet:** | **8.8** |

### Flood Discharge Estimation:

*(In the Flood Discharge table, RI is the Recurrence Interval, in years; STD ERR is the Standard Error; and 90% PRED. INTERVAL is the 90% Prediction Interval, in cubic feet per second)*

```
 METHOD: Regression on basin characteristics
 Flood frequency estimates for
 Mill Ditch at RR crossing
Upper Yellowstone-Central Mountain Region: A =      0.62 E6 =     0.
 RI        DISCHARGE  STD ERR OF                90% PRED. INTERVAL
             (cfs)      PREDICTION(%)
     2          4.        98.1                1.0                15.
     5         15.        75.7                4.9                46.
    10         30.        66.5               10.8                81.
    25         59.        60.6               23.1               148.
    50         90.        59.6               35.9               224.
   100        130.        60.9               51.2               330.
   200        182.        63.9               69.1               481.
   500        273.        70.0               95.6               778.
```

METHOD: Regression on active channel width
Flood frequency estimates for
Mill Ditch at RR crossing
Upper Yellowstone-Central Mountain Region: WAC = 3.80

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 19. | 72.6 | 6.3 | 55. |
| 5 | 57. | 68.9 | 20.1 | 162. |
| 10 | 102. | 70.9 | 35.3 | 298. |
| 25 | 188. | 76.8 | 60.2 | 586. |
| 50 | 277. | 83.3 | 82.6 | 932. |
| 100 | 391. | 90.6 | 107.2 | 1420. |
| 200 | 533. | 99.2 | 133.9 | 2130. |
| 500 | 774. | 112.0 | 171.7 | 3490. |

METHOD: Regression on bank full channel width
Flood frequency estimates for
Mill Ditch at RR crossing
Upper Yellowstone-Central Mountain Region: WBF = 8.80

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 34. | 160.1 | 5.1 | 221. |
| 5 | 81. | 72.9 | 27.2 | 240. |
| 10 | 138. | 73.8 | 46.0 | 416. |
| 25 | 242. | 79.3 | 75.5 | 777. |
| 50 | 348. | 85.6 | 100.8 | 1200. |
| 100 | 478. | 93.1 | 127.9 | 1790. |
| 200 | 640. | 101.8 | 156.6 | 2620. |
| 500 | 908. | 114.9 | 196.3 | 4200. |

METHOD: Combined methods 1, 2 and 3
Flood frequency estimates for
Mill Ditch at RR crossing
Region 7

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 12. | 68.2 | 4.4 | 34. |
| 5 | 35. | 53.9 | 15.0 | 81. |
| 10 | 55. | 53.3 | 24.2 | 127. |
| 25 | 87. | 55.0 | 37.2 | 205. |
| 50 | 116. | 57.5 | 47.9 | 282. |
| 100 | 150. | 59.9 | 59.8 | 376. |
| 200 | 193. | 63.8 | 73.1 | 508. |
| 500 | 273. | 70.0 | 95.6 | 778. |

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# Montana Flood-Frequency and Basin-Characteristic Data

## Estimate Flood Discharges at Ungaged Sites in Montana – (continued)

---

### Summary of Estimation Parameters Selected:

| | |
|---|---|
| **Name for this estimation:** | **Mill Ditch at I-90** |
| **Region:** | **Upper Yellowstone** |
| **Estimation method:** | **Weighted estimate based on Basin and Climatic Characteristics, Active-channel width, and Bankfull width** |
| **Drainage area in square miles:** | **.7825** |
| **Percent basin above 6,000 feet:** | **0** |
| **Width of active channel in feet:** | **5** |
| **Width of bank full channel in feet:** | **11.5** |

### Flood Discharge Estimation:

*(In the Flood Discharge table, RI is the Recurrence Interval, in years; STD ERR is the Standard Error; and 90% PRED. INTERVAL is the 90% Prediction Interval, in cubic feet per second)*

```
 METHOD: Regression on basin characteristics
 Flood frequency estimates for
 Mill Ditch at I-90
Upper Yellowstone-Central Mountain Region: A =      0.78 E6 =     0.
 RI        DISCHARGE  STD ERR OF                90% PRED. INTERVAL
             (cfs)      PREDICTION(%)
     2          5.        97.7                1.2                19.
     5         18.        75.4                5.9                54.
    10         35.        66.2               12.9                96.
    25         69.        60.3               27.4               174.
    50        105.        59.4               42.4               263.
   100        152.        60.6               60.3               386.
   200        213.        63.6               81.0               560.
   500        318.        69.7              111.8               902.
```

METHOD: Regression on active channel width
Flood frequency estimates for
Mill Ditch at I-90
Upper Yellowstone-Central Mountain Region: WAC = 5.00

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 28. | 72.1 | 9.6 | 84. |
| 5 | 81. | 68.4 | 28.9 | 229. |
| 10 | 141. | 70.4 | 49.0 | 408. |
| 25 | 251. | 76.2 | 81.1 | 776. |
| 50 | 363. | 82.5 | 108.9 | 1210. |
| 100 | 502. | 89.8 | 139.0 | 1810. |
| 200 | 674. | 98.2 | 170.9 | 2660. |
| 500 | 961. | 110.9 | 215.4 | 4290. |

METHOD: Regression on bank full channel width
Flood frequency estimates for
Mill Ditch at I-90
Upper Yellowstone-Central Mountain Region: WBF = 11.50

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 54. | 159.6 | 8.3 | 354. |
| 5 | 121. | 72.4 | 41.1 | 359. |
| 10 | 201. | 73.3 | 67.1 | 600. |
| 25 | 339. | 78.6 | 106.3 | 1080. |
| 50 | 475. | 84.9 | 138.9 | 1630. |
| 100 | 641. | 92.2 | 172.9 | 2380. |
| 200 | 843. | 100.8 | 208.1 | 3410. |
| 500 | 1170. | 113.7 | 255.7 | 5360. |

METHOD: Combined methods 1, 2 and 3
Flood frequency estimates for
Mill Ditch at I-90
Region 7

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 18. | 67.8 | 6.3 | 49. |
| 5 | 47. | 53.6 | 20.3 | 108. |
| 10 | 71. | 53.0 | 31.3 | 163. |
| 25 | 108. | 54.6 | 46.3 | 253. |
| 50 | 141. | 57.1 | 58.3 | 340. |
| 100 | 178. | 59.6 | 71.5 | 445. |
| 200 | 227. | 63.4 | 86.3 | 595. |
| 500 | 318. | 69.7 | 111.8 | 902. |

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# Montana Flood-Frequency and Basin-Characteristic Data

## Estimate Flood Discharges at Ungaged Sites in Montana – (continued)

---

### Summary of Estimation Parameters Selected:

| | |
|---|---|
| **Name for this estimation:** | **Mill Ditch at mouth** |
| **Region:** | **Upper Yellowstone** |
| **Estimation method:** | **Weighted estimate based on Basin and Climatic Characteristics, Active-channel width, and Bankfull width** |
| **Drainage area in square miles:** | **0.8065** |
| **Percent basin above 6,000 feet:** | **0** |
| **Width of active channel in feet:** | **5** |
| **Width of bank full channel in feet:** | **11.5** |

### Flood Discharge Estimation:

*(In the Flood Discharge table, RI is the Recurrence Interval, in years; STD ERR is the Standard Error; and 90% PRED. INTERVAL is the 90% Prediction Interval, in cubic feet per second)*

```
 METHOD: Regression on basin characteristics
 Flood frequency estimates for
 Mill Ditch at mouth
Upper Yellowstone-Central Mountain Region: A =      0.81 E6 =     0.
 RI        DISCHARGE  STD ERR OF                90% PRED. INTERVAL
             (cfs)      PREDICTION(%)
     2          5.        97.7                1.3                19.
     5         18.        75.4                6.0                56.
    10         36.        66.2               13.2                98.
    25         71.        60.3               28.0               178.
    50        108.        59.3               43.3               268.
   100        156.        60.5               61.6               394.
   200        217.        63.5               82.7               572.
   500        324.        69.6              114.1               920.
```

METHOD: Regression on active channel width
Flood frequency estimates for
Mill Ditch at mouth
Upper Yellowstone-Central Mountain Region: WAC = 5.00

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 28. | 72.1 | 9.6 | 84. |
| 5 | 81. | 68.4 | 28.9 | 229. |
| 10 | 141. | 70.4 | 49.0 | 408. |
| 25 | 251. | 76.2 | 81.1 | 776. |
| 50 | 363. | 82.5 | 108.9 | 1210. |
| 100 | 502. | 89.8 | 139.0 | 1810. |
| 200 | 674. | 98.2 | 170.9 | 2660. |
| 500 | 961. | 110.9 | 215.4 | 4290. |

METHOD: Regression on bank full channel width
Flood frequency estimates for
Mill Ditch at mouth
Upper Yellowstone-Central Mountain Region: WBF = 11.50

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 54. | 159.6 | 8.3 | 354. |
| 5 | 121. | 72.4 | 41.1 | 359. |
| 10 | 201. | 73.3 | 67.1 | 600. |
| 25 | 339. | 78.6 | 106.3 | 1080. |
| 50 | 475. | 84.9 | 138.9 | 1630. |
| 100 | 641. | 92.2 | 172.9 | 2380. |
| 200 | 843. | 100.8 | 208.1 | 3410. |
| 500 | 1170. | 113.7 | 255.7 | 5360. |

METHOD: Combined methods 1, 2 and 3
Flood frequency estimates for
Mill Ditch at mouth
Region 7

| RI | DISCHARGE (cfs) | STD ERR OF PREDICTION(%) | 90% PRED. INTERVAL | |
|---|---|---|---|---|
| 2 | 18. | 67.8 | 6.3 | 49. |
| 5 | 47. | 53.6 | 20.5 | 109. |
| 10 | 72. | 53.0 | 31.7 | 165. |
| 25 | 110. | 54.6 | 47.0 | 256. |
| 50 | 143. | 57.0 | 59.3 | 346. |
| 100 | 182. | 59.5 | 72.8 | 453. |
| 200 | 231. | 63.4 | 88.0 | 606. |
| 500 | 324. | 69.6 | 114.1 | 920. |

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# APPENDIX B

# RAINFALL DEPTH CALCULATIONS AND REFERENCES

| | 2YR | 5YR | 10YR | 25YR | 50YR | 100YR | 500YR |
|---|---|---|---|---|---|---|---|
| **5 min** | 0.17 | 0.26 | 0.33 | 0.42 | 0.49 | 0.57 | 0.72 |
| **15 min** | 0.31 | 0.49 | 0.61 | 0.77 | 0.92 | 1.06 | 1.35 |
| **1 hr** | 0.45 | 0.72 | 0.91 | 1.13 | 1.34 | 1.54 | 1.94 |
| **2 hr** | 0.52 | 0.79 | 0.98 | 1.22 | 1.42 | 1.60 | 2.04 |
| **3 hr** | 0.59 | 0.85 | 1.05 | 1.30 | 1.48 | 1.66 | 2.08 |
| **6 hr** | 0.75 | 1.00 | 1.20 | 1.50 | 1.65 | 1.80 | 2.25 |
| **12 hr** | 0.94 | 1.26 | 1.53 | 1.88 | 2.09 | 2.25 | 2.81 |
| **24 hr** | 1.20 | 1.60 | 1.90 | 2.30 | 2.60 | 2.80 | 3.37 |

Values taken from Figures 19-30 of *Precipitation-Frequency Atlas of the Western United States, Volume I - Montana*

Values calculated using Equations 3 & 5 of *Precipitation-Frequency Atlas of the Western United States, Volume I - Montana - East of the divide calcs*

Values interpolated between 2YR and 100YR using Figure 6 of *Precipitation-Frequency Atlas of the Western United States, Volume I - Montana*

Values calculated using Equations 7 & 8 of *Precipitation-Frequency Atlas of the Western United States, Volume I*

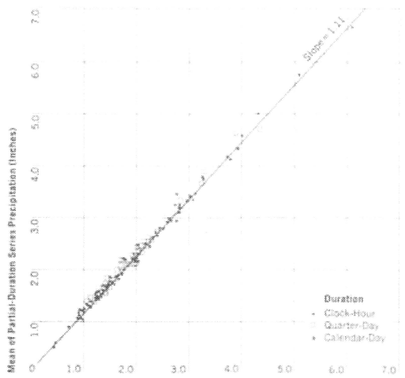
Values interpolated using Figure 17 of *Precipitation-Frequency Atlas of the Western United States, Volume I - Montana*

Values calculated using Table 11 of *Precipitation-Frequency Atlas of the Western United States, Volume I - Montana*

Values determined using ratios provided in *Short Duration Rainfall for the Western United States* (Arkell & Richards) - Front Face and High Plains North Region

Extrapolated using normal-probability relationship

**Figure 5.** *Relation between annual and partial-duration series.*



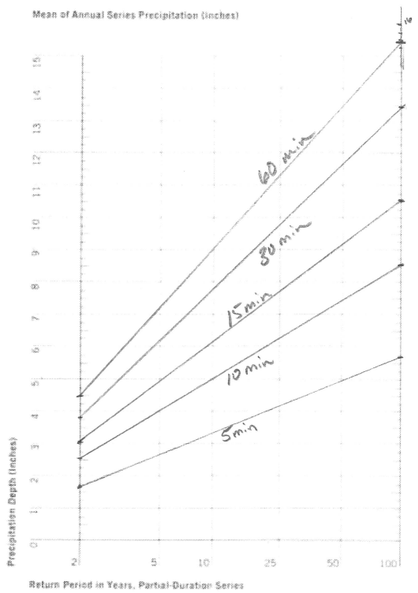
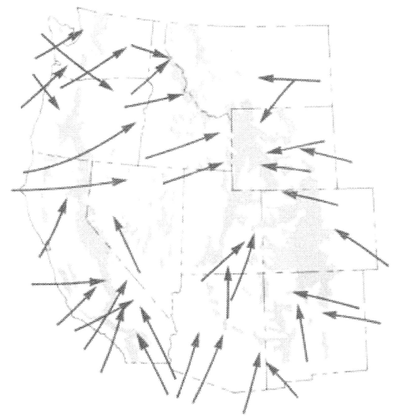




**Figure 6.** *Precipitation depth versus return period for partial-duration series.*

**Figure 7.** *Principal paths of moisture inflow in the western United States for storms producing large precipitation amounts. Timed areas are major orographic barriers.*



portant. Next, an examination was made of factors that combined topographic and meteorologic considerations, such as distance and direction to moisture sources. Each factor considered was a measure of some physical reality, and each was understandably related to variation in the precipitation-frequency regime.

Finally, various climatological and meteorological factors that could be indexes of variation of the precipitation-frequency values were considered. The procedure used for developing interpolating equations was a multiple-regression screening technique. This process was done by computer using a least-squares technique. The computer program was capable of accepting a total of 174 independent variables for as many locations as data were available. The number of variables screened for the various relations ranged between 60 and 100. This does not mean that 60 or more completely different factors could be identified. For example, several factors might involve different measures of slope. Moreover, these measures of slope might be over different distances or have different orientations. In each instance, the practice was to permit the computer to select the most critical of the various measures of each factor.

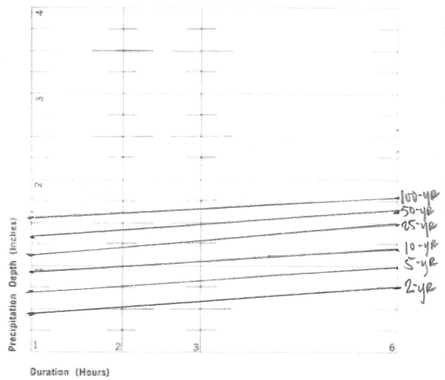
Although the computer program treated each variable as linear during the regression analysis, it was possible through internal computations to use logarithms, powers, roots, reciprocals, or combinations of any or all of the factors. The computer program selected the single variable most highly correlated with the precipitation-frequency value under investigation. The next step was to select the variable that, combined with the variable already selected, would explain the greatest variation in the precipitation-frequency values. The third, fourth, fifth, and further variables were selected in a similar manner. The program continued to select

| Region of applicability | Corr. coeff. | No. of stations | Mean of computed stn. values (inches) | Standard error of estimate (inches) |
|---|---|---|---|---|
| Gila, Williams, and lower Colorado River Basins (1) | 0.84 | 86 | 1.86 | 0.21 |
| Little Colorado, San Juan, and Virgin River Basins, except higher elevations of south-facing slopes (2)[1] | 0.81 | 105 | 1.36 | 0.20 |
| Higher elevations of south-facing slopes of Little Colorado, San Juan, and Virgin River Basins (2)[1] | 0.93 | 41 | 1.31 | 0.13 |
| Rio Grande Basin north of El Paso, Tex. (3) | 0.77 | 110 | 1.35 | 0.18 |
| Crest of Continental Divide and Sangre de Cristo Mountains to generalized 7,000-ft contour from southern Wyoming to southern tip of Sangre de Cristo Mountains (4) | 0.83 | 122 | 1.43 | 0.22 |
| Upper Colorado and Gunnison River Basins and Green River Basin below confluence of Green and Yampa Rivers (5) | 0.79 | 69 | 1.12 | 0.13 |
| Yampa River Basin, Green River Basin above confluence of Green and Yampa Rivers, and Bear River Basin east of Wasatch Mountains (6) | 0.83 | 29 | 1.03 | 0.08 |
| Mountains of central Utah (7) | 0.85 | 86 | 1.35 | 0.18 |
| Western Utah and Nevada, except Snake and Virgin River Basins and spillover zone east of Sierra Nevada Crest (8)[1] | 0.71 | 79 | 1.03 | 0.13 |
| Western Utah and Nevada, except Snake and Virgin River Basins and spillover zone east of Sierra Nevada crest (8)[1] | 0.71 | 55 | 1.04 | 0.15 |
| Big Horn River Basin above Saint Xavier and minor portions of North Platte, Powder, Tongue, and Yellowstone River Basins (9) | 0.78 | 55 | 1.25 | 0.21 |
| Upper Missouri River Basin above Holter Dam, Mont.; Snake River Basin above Alpine, Wyo.; and upper Yellowstone River Basin above Springdale, Mont. (10) | 0.76 | 57 | 1.19 | 0.16 |
| From generalized 4,000-ft contour on east to crests of Crazy and Little Belt Mountains and Lewis Range on west (11) | 0.80 | 52 | 1.67 | 0.26 |
| West of Continental Divide, but east of Bitterroot Range and Cabinet and Selkirk Mountains (12) | 0.85 | 44 | 1.36 | 0.12 |
| Mountainous region of eastern Washington and Oregon and of Idaho west of Bitterroot Range crest and Continental Divide, and north of southern boundary of Snake River Basin—excluding Snake River Valley below a generalized 5,000-ft contour (13) | 0.78 | 147 | 1.44 | 0.24 |
| Orographic region east of crest of Cascade Range and west of Snake River Basin (14) | 0.90 | 115 | 1.75 | 0.35 |
| Western slopes of Coast Ranges, Olympic Mountains, and Cascade Range (15) | 0.87 | 125 | 3.69 | 0.48 |
| Eel River Basin; southern portion of Klamath River Basin, and Cottonwood, Elder, Thomas, and Gladstone Creeks (16) | 0.91 | 39 | 4.19 | 0.50 |
| Russian River, Cache and Putah Creeks, and coastal drainages west of Russian River (17) | 0.84 | 63 | 5.31 | 0.78 |
| Santa Cruz Mountains and La Panza, Santa Lucia, and Coast Ranges (18) | 0.95 | 55 | 4.32 | 0.45 |
| Diablo, Gabilan, and Temblor Ranges (19) | 0.82 | 58 | 2.21 | 0.35 |
| San Rafael, San Bernardino, Santa Monica, and San Gabriel Mountains (20) | 0.88 | 149 | 3.98 | 0.59 |
| Santa Ana, Santa Rosa, Coyote, and other extreme southern coastal mountains (21) | 0.88 | 34 | 2.44 | 0.33 |
| Northern Sierra Nevada north of Mokelumne River Basin (22) | 0.92 | 84 | 4.56 | 0.53 |
| Southern Sierra Nevada south of Consumnes River Basin (23) | 0.88 | 61 | 3.43 | 0.53 |
| Southeastern desert region of California (24) | 0.89 | 41 | 1.07 | 0.16 |
| Spillover zone east of Sierra Nevada crest (25) | 0.94 | 41 | 2.05 | 0.27 |
| Spillover zone east of crest of coastal mountains of southern California (26) | 0.97 | 10 | 2.08 | 0.15 |

[1] Numbers in parentheses refer to geographic regions shown in figure 8.
[2] Two different equations were used in region 2. See text for explanation.
[3] Two different equations were used in region 8. See text for explanation.

**Table 3.** *Statistical parameters for relations used for interstation interpolation of 2-yr 24-hr precipitation values*

**Figure 16.** *Precipitation depth-duration diagram (1 to 6 hrs).*



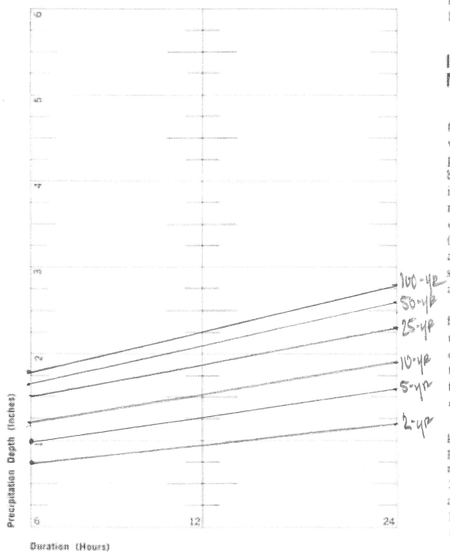




**Figure 17.** *Precipitation depth-duration diagram (6 to 24 hrs).*

**Estimates for 2- and 3-hr (120- and 180-min) precipitation-frequency values.** To obtain estimates of precipitation-frequency values for 2 or 3 hrs, plot the 6-hr value from the Atlas maps and the 1-hr value on the nomogram of figure 16. Then draw a straight line connecting the 1- and 6-hr values, and read the 2- and 3-hr values from the nomogram. This nomogram is independent of return period. It was developed using data from the same regions used to develop the 1-hr equations. The slight differences found in data from east and west of the Continental Divide were smaller than the sampling error inherent in the data, so one nomogram will serve for all sections of Montana. The mathematical solution from the data used to develop figure 16 gives the following equations for estimating the 2- and 3-hr values:

$$2\text{ hr} = 0.250\ (6\text{ hr}) + 0.750\ (1\text{ hr}), \qquad (7)$$

$$3\text{ hr} = 0.467\ (6\text{ hr}) + 0.533\ (1\text{ hr}). \qquad (8)$$

**Estimates for 12-hr (720-min) precipitation.** To obtain estimates for the 12-hr duration, plot values from the 6- and 24-hr maps on the nomogram of figure 17. The 12-hr estimates can then be read at the intersection of the line connecting these points with the 12-hr duration line of the nomogram.

**Estimates for less than 1 hr.** To obtain estimates for durations of less than 1 hr, the values in table 11 are applied to the 1-hr value for the return period of interest.

## Illustration of Use of Precipitation-Frequency Maps, Diagrams, and Equations.

To illustrate the use of these maps, values were read from figures 19 to 30 for the point at 47°00′ N. and 110°00′ W. These values are shown in boldface type in table 12. Because not all points are as easy to locate as latitude-longitude intersections, and because there may be some slight registration differences in printing, precise interpolation between isolines is difficult; the values read from the maps should be plotted on the return-period diagram of figure 6. This has been done for the 24-hr values in table 12 (fig. 18a). On this nomogram the 25-yr value appears somewhat above the line, so the value read from the maps is corrected (as shown by the strikeout in table 12); such corrected values are adopted in preference to the original readings.

The 2- and 100-yr 1-hr values for the point were computed from equations (3) and (5), since the point is east of the Continental Divide. The 2-yr 1-hr value is estimated at 0.50 in. from equation (3); using equation (5) (and an elevation of 4,400 ft), the 100-yr 1-hr value is 1.53 in. By plotting these 1-hr values on figure 6 and connecting them with a straight line, one can obtain estimates for return periods of 5, 10, 25, and 50 yrs.

The 2- and 3-hr values can be estimated by using the nomogram of figure 16. The 1- and 6-hr values for the desired return period are obtained as above. Plot these points on the figure 16 nomogram and connect them with a straight line; the estimates for 2 or 3 hrs can be read at the intersections of the connecting line and the 2- and 3-hr vertical lines. An example is shown in figure 18b for the 100-yr return period. The values of the 100-yr 2-hr (1.70 in.) and 100-yr 3-hr (1.85 in.) are in italics on table 12.

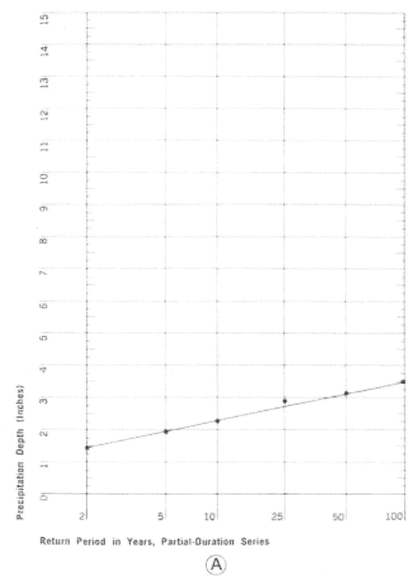
**Table 11.** *Adjustment factors to obtain n-minute estimates from 1-hr values*

| Duration (min) | 5 | 10 | 15 | 30 |
|---|---|---|---|---|
| Ratio to 1-hr | 0.29 | 0.45 | 0.57 | 0.79 |

(Adopted from *U.S. Weather Bureau Technical Paper* No. 40, 1961.)

**Table 12.** *Precipitation data for depth-frequency atlas computation point 47°00′ N., 110°00′ W.*

| | 1-hr | 2-hr | 3-hr | 6-hr | 24-hr |
|---|---|---|---|---|---|
| 2-yr | 0.50 | | | **0.88** | **1.47** |
| 5-yr | | | | **1.19** | **1.96** |
| 10-yr | | | | **1.42** | **2.30** |
| 25-yr | | | | **1.78** | **2.77** ~~**2.84**~~ |
| 50-yr | | | | **1.98** | **3.18** |
| 100-yr | *1.53* | *1.70* | *1.85* | **2.18** | **3.50** |



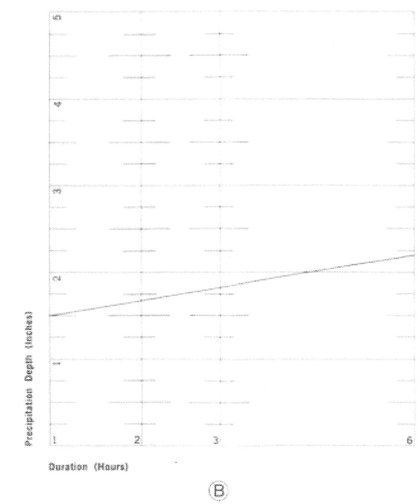




**Figure 18.** *Illustration of use of precipitation-frequency diagrams using values from precipitation-frequency maps and relations at 47°00′ N., 110°00′ W.*

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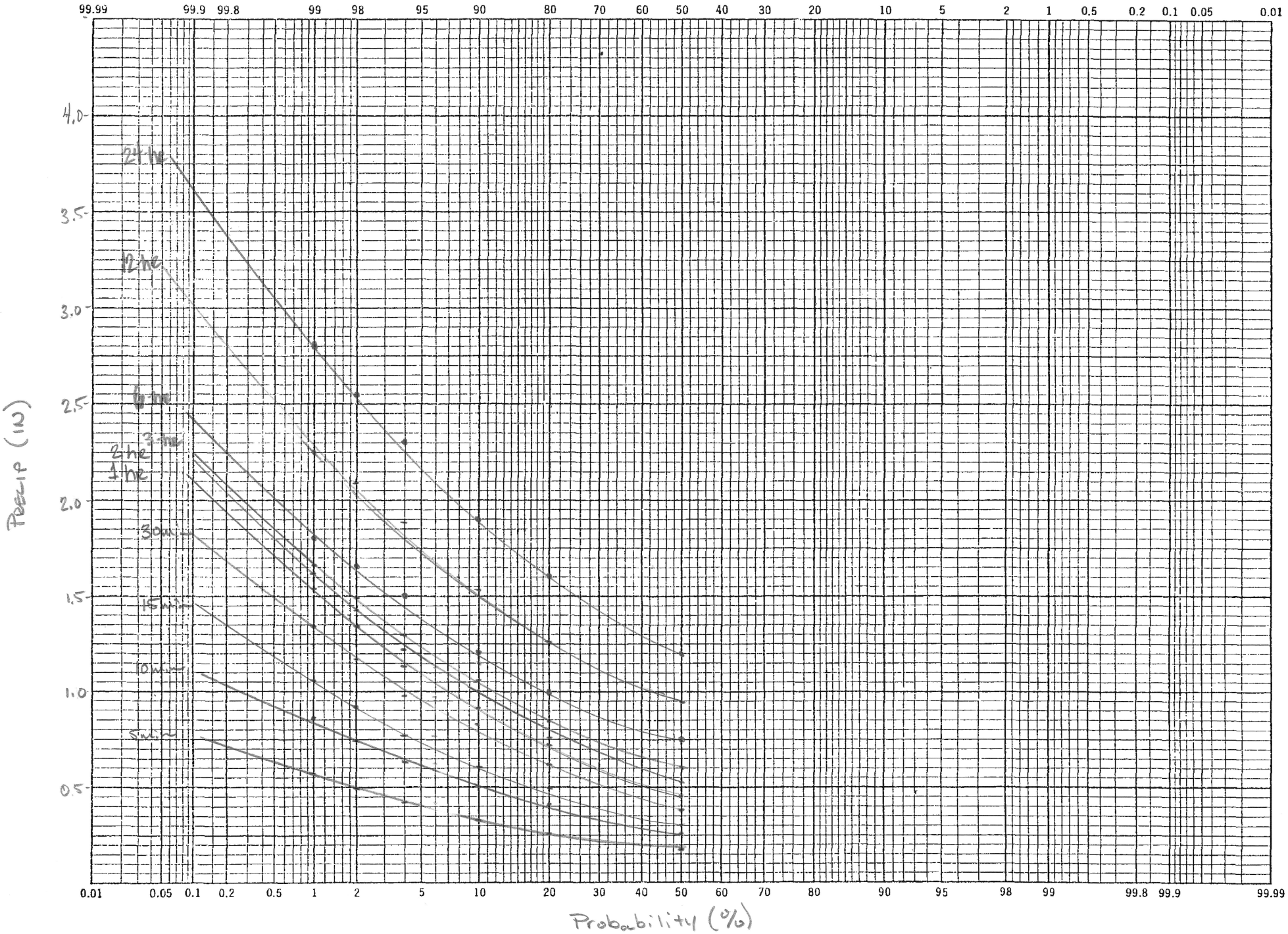

# APPENDIX C

# CURVE NUMBER LOOK-UP TABLE

| Land Use Category | Hydrologic Soil Group | | | | Description | Assumption | Reference | Source |
|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | | | | |
| Shrub/Scrub | 30 | 48 | 65 | 73 | Shrub/Scrub | Good hydrologic conditions | Engineering Hydrology - Principles and Practices (Ponce) | NLCD |
| Deciduous Forest | 30 | 55 | 70 | 77 | Deciduous Forest | Good hydrologic conditions | Engineering Hydrology - Principles and Practices (Ponce) | |
| Evergreen Forest | 30 | 55 | 70 | 77 | Evergreen Forest | Good hydrologic conditions | Engineering Hydrology - Principles and Practices (Ponce) | |
| Mixed Forest | 30 | 55 | 70 | 77 | Mixed Forest | Good hydrologic conditions | Engineering Hydrology - Principles and Practices (Ponce) | |
| Developed, Open Space | 39 | 61 | 74 | 80 | Developed, Open Space | Lawns, parks, cemeteries with vegetation established | Engineering Hydrology - Principles and Practices (Ponce) | |
| Hay/Pasture | 39 | 61 | 74 | 80 | Hay/Pasture | Pasture, grassland or range for grazing - Good hydrologic conditions | Engineering Hydrology - Principles and Practices (Ponce) | |
| Herbaceuous | | 62 | 74 | 85 | Herbaceous | Good hydrologic conditions | Engineering Hydrology - Principles and Practices (Ponce) | |
| Developed, Low Intensity | 60 | 70 | 80 | 85 | Developed, Low Intensity | 1/2 acre lots - vegetation established | Engineering Hydrology - Principles and Practices (Ponce) | |
| Developed, Medium Intensity | 61 | 75 | 83 | 87 | Developed, Medium Intensity | 1/4 acre lots - vegetation established | Engineering Hydrology - Principles and Practices (Ponce) | |
| Developed, High Intensity | 77 | 85 | 90 | 92 | Developed, High Intensity | Town houses | Engineering Hydrology - Principles and Practices (Ponce) | |
| Open Water | 98 | 98 | 98 | 98 | Open Water | | | |
| Cultivated Crops | 58 | 72 | 81 | 85 | Cultivated Crops | Close-seeded or broadcast legumes or rotation meadow straight row | Engineering Hydrology - Principles and Practices (Ponce) | |
| Emergent Herbaceous Wetlands | 78 | 78 | 78 | 78 | Emergent Herbaceous Wetlands | | Michigan DEQ | |
| Woody Wetlands | 78 | 78 | 78 | 78 | Woody Wetlands | | Michigan DEQ | |
| MFR | 77 | 85 | 90 | 92 | Multi-Household Residential - A building, or portion thereof, used for occupancy by four or more households living independently of each other, with the units completely separated by a common wall, floor and/or ceiling; apartments, condos. | Multi-family residential - Town houses | Engineering Hydrology - Principles and Practices (Ponce) | City of Bozeman |
| POS | 39 | 61 | 74 | 80 | Park or Open Space - Parks, trails, recreational areas and other places that are capable of being used by the public for recreation, relaxation and social purposes. May include private land serving a property owners association for similar purposes | Park/Open Space | Engineering Hydrology - Principles and Practices (Ponce) | |
| ROW | 98 | 98 | 98 | 98 | Rights-of-Way - A public way established or dedicated for public purposes by duly recorded plat, deed, grant, easement, governmental authority or by operation of law; roads; railroads. | Right-of-way/Paved roads: curbs and storm sewers | Engineering Hydrology - Principles and Practices (Ponce) | |
| RR | 59 | 74 | 82 | 86 | Rural Residential - Detached single-household residential property located outside of the City limits that does not have pasture. | Farmsteads - buildings, lanes, driveways, and surrounding lots | Engineering Hydrology - Principles and Practices (Ponce) | |
| SFR | 61 | 75 | 83 | 87 | Single-Household Residential - A building used for residential occupancy by one household, including multiple residences that share a common wall, as long as only one dwelling unit lies upon a single lot; townhomes. Also may include an accessory dwelling unit. | Single family residential - 1/4 acre lots - vegetation established | Engineering Hydrology - Principles and Practices (Ponce) | |
| AP | 77 | 85 | 90 | 92 | Administrative Professional - An establishment in which overall management functions occur and/or in which a recognized profession is maintained for the conduct of that profession. | Apartments - multi-family residential and town houses | Engineering Hydrology - Principles and Practices (Ponce) | |
| CA | 89 | 92 | 94 | 95 | Commercial Auto sales, rental, parts, storage, gas, service - Establishments primarily engaged in automotive related sale/services, fuels, repair, sales, washing, rental and leasing. | Commercial | Engineering Hydrology - Principles and Practices (Ponce) | |
| CR | 89 | 92 | 94 | 95 | Commercial Retail sales, services, Banks - Uses involving the sale of goods or services carried out for profit. | Commercial | Engineering Hydrology - Principles and Practices (Ponce) | |
| DTR | 77 | 85 | 90 | 92 | Duplex/Triplex Residential - A building, or a portion thereof, used for occupancy by two or three households living independently of each other, with the units completely separated by a common wall, floor and/or ceiling and reside on one lot; including apartments and condos. | Dual residential - multi-family residential and town houses | Engineering Hydrology - Principles and Practices (Ponce) | |
| HM | 89 | 92 | 94 | 95 | Hotel/Motel - A building or group of buildings, in which lodging is provided and offered to transient guests for compensation (not to include a boarding house, lodging house or rooming house)> | Heavy Manufacturing - Commercial | Engineering Hydrology - Principles and Practices (Ponce) | |
| LM | 89 | 92 | 94 | 95 | Light Manufacturing - Fabrication of and/or assembly of goods from previously prepared materials, to include storage, and mini-warehousing. | Light Manufacturing - Commercial | Engineering Hydrology - Principles and Practices (Ponce) | |
| MHMP | 77 | 85 | 90 | 92 | Manufactured Homes/Motor Parks | Multi-family residential | Engineering Hydrology - Principles and Practices (Ponce) | |
| MIXED | 89 | 92 | 94 | 95 | More than one principal use occurring on one lot. | For Mill Creek - Largely commercial | Engineering Hydrology - Principles and Practices (Ponce) | |
| PFP | 89 | 92 | 94 | 95 | Public Facility - A building, structure, facility or complex, used by or providing services to the general public and constructed by either the federal, state, county or municipal government agency. Also includes utilities serving the general public such as electrical service. | Commercial | Engineering Hydrology - Principles and Practices (Ponce) | |
| RB | 89 | 92 | 94 | 95 | Restaurant/Bar - A restaurant, coffee shop, cafeteria, grill, short order café, luncheonette, sandwich stand, drugstore, soda fountain, serving food; or an establishment where alcoholic beverages are served on premises. | Commercial | Engineering Hydrology - Principles and Practices (Ponce) | |
| UDV | 39 | 61 | 74 | 80 | Undeveloped - Land that is no longer, or has never been, in agricultural use and is not ready to be occupied by buildings (needs to be subdivided; needs infrastructure) | Mill Ditch - All undeveloped areas approximate the landuses for the Park/Open Space classification. | Engineering Hydrology - Principles and Practices (Ponce) | |
| VACANT | 39 | 61 | 74 | 80 | Vacant - Land that is currently developed and ready to be occupied by buildings but is unoccupied; no buildings or buildings requiring significant improvement in order to be used. | Mill Ditch - All vacant classified areas approximate the landuses for the Park/Open Space classification. | Engineering Hydrology - Principles and Practices (Ponce) | |

# APPENDIX D

# CURVE NUMBER CALCULATIONS

Mill Ditch Diversion Curve Number Calculations

| BASIN | LAND USE CATEGORY | SOIL MAP UNIT # | SUBREGION CN | SUBREGION AREA ($mi^2$) | SUBBASIN AREA ($mi^2$) | PERCENT OF SUBBASIN | CUMULATIVE PERCENT | AREA-WEIGHTED CN | CUMULATIVE CN | COMPOSITE CN |
|---|---|---|---|---|---|---|---|---|---|---|
| MD01 | MHMP | C | 90.0 | 0.00 | 0.02 | 1.58% | 1.6% | 1.4 | 1.4 | |
| MD01 | ROW | C | 98.0 | 0.02 | 0.02 | 71.94% | 73.5% | 70.5 | 71.9 | |
| MD01 | SFR | C | 83.0 | 0.00 | 0.02 | 0.46% | 74.0% | 0.4 | 72.3 | |
| MD01 | VACANT | C | 74.0 | 0.00 | 0.02 | 4.88% | 78.9% | 3.6 | 75.9 | |
| MD01 | VACANT | C | 74.0 | 0.00 | 0.02 | 0.00% | 78.9% | 0.0 | 75.9 | |
| MD01 | UDV | C | 74.0 | 0.01 | 0.02 | 21.15% | 100.0% | 15.6 | 91.6 | **91.6** |
| MD02 | AP | C | 90.0 | 0.00 | 0.16 | 0.26% | 0.3% | 0.2 | 0.2 | |
| MD02 | UDV | C | 74.0 | 0.01 | 0.16 | 4.53% | 4.8% | 3.4 | 3.6 | |
| MD02 | UDV | C | 74.0 | 0.00 | 0.16 | 1.04% | 5.8% | 0.8 | 4.3 | |
| MD02 | UDV | C | 74.0 | 0.02 | 0.16 | 14.70% | 20.5% | 10.9 | 15.2 | |
| MD02 | UDV | B | 61.0 | 0.00 | 0.16 | 2.73% | 23.3% | 1.7 | 16.9 | |
| MD02 | UDV | B | 61.0 | 0.00 | 0.16 | 0.22% | 23.5% | 0.1 | 17.0 | |
| MD02 | UDV | B | 61.0 | 0.02 | 0.16 | 9.69% | 33.2% | 5.9 | 22.9 | |
| MD02 | AP | C | 90.0 | 0.00 | 0.16 | 0.50% | 33.7% | 0.4 | 23.4 | |
| MD02 | LM | C | 94.0 | 0.01 | 0.16 | 3.39% | 37.0% | 3.2 | 26.6 | |
| MD02 | LM | C | 94.0 | 0.00 | 0.16 | 1.46% | 38.5% | 1.4 | 27.9 | |
| MD02 | UDV | C | 74.0 | 0.00 | 0.16 | 2.63% | 41.1% | 1.9 | 29.9 | |
| MD02 | UDV | C | 74.0 | 0.02 | 0.16 | 13.12% | 54.2% | 9.7 | 39.6 | |
| MD02 | RR | C | 82.0 | 0.00 | 0.16 | 2.42% | 56.7% | 2.0 | 41.6 | |
| MD02 | SFR | C | 83.0 | 0.00 | 0.16 | 0.45% | 57.1% | 0.4 | 41.9 | |
| MD02 | UDV | C | 74.0 | 0.01 | 0.16 | 8.85% | 66.0% | 6.6 | 48.5 | |
| MD02 | UDV | C | 74.0 | 0.03 | 0.16 | 17.32% | 83.3% | 12.8 | 61.3 | |
| MD02 | UDV | C | 74.0 | 0.00 | 0.16 | 0.11% | 83.4% | 0.1 | 61.4 | |
| MD02 | UDV | C | 74.0 | 0.01 | 0.16 | 5.52% | 88.9% | 4.1 | 65.5 | |
| MD02 | UDV | D | 80.0 | 0.00 | 0.16 | 2.06% | 91.0% | 1.6 | 67.1 | |
| MD02 | RR | D | 86.0 | 0.00 | 0.16 | 1.03% | 92.0% | 0.9 | 68.0 | |
| MD02 | UDV | D | 80.0 | 0.00 | 0.16 | 1.49% | 93.5% | 1.2 | 69.2 | |
| MD02 | ROW | C | 98.0 | 0.00 | 0.16 | 0.47% | 93.9% | 0.5 | 69.7 | |
| MD02 | ROW | C | 98.0 | 0.00 | 0.16 | 0.00% | 93.9% | 0.0 | 69.7 | |
| MD02 | ROW | C | 98.0 | 0.00 | 0.16 | 0.10% | 94.1% | 0.1 | 69.8 | |
| MD02 | ROW | C | 98.0 | 0.00 | 0.16 | 0.00% | 94.1% | 0.0 | 69.8 | |
| MD02 | ROW | C | 98.0 | 0.00 | 0.16 | 0.00% | 94.1% | 0.0 | 69.8 | |
| MD02 | ROW | C | 98.0 | 0.00 | 0.16 | 0.00% | 94.1% | 0.0 | 69.8 | |
| MD02 | ROW | C | 98.0 | 0.00 | 0.16 | 0.00% | 94.1% | 0.0 | 69.8 | |
| MD02 | ROW | B | 98.0 | 0.00 | 0.16 | 0.78% | 94.8% | 0.8 | 70.5 | |
| MD02 | ROW | D | 98.0 | 0.00 | 0.16 | 0.43% | 95.3% | 0.4 | 70.9 | |
| MD02 | UDV | C | 74.0 | 0.00 | 0.16 | 0.01% | 95.3% | 0.0 | 71.0 | |
| MD02 | UDV | C | 74.0 | 0.00 | 0.16 | 0.67% | 95.9% | 0.5 | 71.4 | |
| MD02 | UDV | B | 61.0 | 0.00 | 0.16 | 0.18% | 96.1% | 0.1 | 71.6 | |
| MD02 | UDV | C | 74.0 | 0.00 | 0.16 | 0.41% | 96.5% | 0.3 | 71.9 | |
| MD02 | ROW | C | 98.0 | 0.00 | 0.16 | 0.65% | 97.2% | 0.6 | 72.5 | |
| MD02 | ROW | C | 98.0 | 0.00 | 0.16 | 0.37% | 97.6% | 0.4 | 72.9 | |
| MD02 | ROW | C | 98.0 | 0.00 | 0.16 | 0.83% | 98.4% | 0.8 | 73.7 | |
| MD02 | ROW | B | 98.0 | 0.00 | 0.16 | 0.26% | 98.6% | 0.3 | 73.9 | |
| MD02 | ROW | C | 98.0 | 0.00 | 0.16 | 1.36% | 100.0% | 1.3 | 75.3 | **75.3** |
| MD03 | CA | C | 94.0 | 0.00 | 0.08 | 0.54% | 0.5% | 0.5 | 0.5 | |
| MD03 | CR | C | 94.0 | 0.00 | 0.08 | 0.01% | 0.5% | 0.0 | 0.5 | |
| MD03 | CR | C | 94.0 | 0.00 | 0.08 | 0.95% | 1.5% | 0.9 | 1.4 | |
| MD03 | CR | C | 94.0 | 0.00 | 0.08 | 0.40% | 1.9% | 0.4 | 1.8 | |
| MD03 | DTR | C | 90.0 | 0.00 | 0.08 | 0.60% | 2.5% | 0.5 | 2.3 | |
| MD03 | DTR | C | 90.0 | 0.00 | 0.08 | 0.71% | 3.2% | 0.6 | 3.0 | |
| MD03 | DTR | C | 90.0 | 0.00 | 0.08 | 0.40% | 3.6% | 0.4 | 3.3 | |
| MD03 | LM | C | 94.0 | 0.00 | 0.08 | 0.67% | 4.3% | 0.6 | 3.9 | |
| MD03 | LM | C | 94.0 | 0.00 | 0.08 | 0.58% | 4.8% | 0.5 | 4.5 | |
| MD03 | LM | C | 94.0 | 0.00 | 0.08 | 2.77% | 7.6% | 2.6 | 7.1 | |
| MD03 | LM | C | 94.0 | 0.00 | 0.08 | 0.92% | 8.5% | 0.9 | 8.0 | |
| MD03 | MFR | C | 90.0 | 0.00 | 0.08 | 0.09% | 8.6% | 0.1 | 8.0 | |
| MD03 | MIXED | C | 94.0 | 0.00 | 0.08 | 0.62% | 9.3% | 0.6 | 8.6 | |
| MD03 | MIXED | C | 94.0 | 0.00 | 0.08 | 1.69% | 10.9% | 1.6 | 10.2 | |
| MD03 | RB | C | 94.0 | 0.00 | 0.08 | 2.16% | 13.1% | 2.0 | 12.2 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 1.87% | 15.0% | 1.6 | 13.8 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.07% | 15.0% | 0.1 | 13.9 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 3.02% | 18.1% | 2.5 | 16.4 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.40% | 18.5% | 0.3 | 16.7 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.90% | 19.4% | 0.7 | 17.4 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.66% | 20.0% | 0.6 | 18.0 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.31% | 20.3% | 0.3 | 18.2 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 1.61% | 21.9% | 1.2 | 19.4 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.61% | 22.6% | 0.4 | 19.9 | |
| MD03 | CR | B | 92.0 | 0.00 | 0.08 | 0.00% | 22.6% | 0.0 | 19.9 | |
| MD03 | LM | B | 92.0 | 0.01 | 0.08 | 12.22% | 34.8% | 11.2 | 31.1 | |
| MD03 | ROW | B | 98.0 | 0.00 | 0.08 | 0.00% | 34.8% | 0.0 | 31.1 | |
| MD03 | ROW | B | 98.0 | 0.00 | 0.08 | 0.00% | 34.8% | 0.0 | 31.1 | |
| MD03 | ROW | B | 98.0 | 0.00 | 0.08 | 0.00% | 34.8% | 0.0 | 31.1 | |
| MD03 | ROW | B | 98.0 | 0.00 | 0.08 | 0.00% | 34.8% | 0.0 | 31.1 | |
| MD03 | ROW | B | 98.0 | 0.00 | 0.08 | 0.00% | 34.8% | 0.0 | 31.1 | |
| MD03 | ROW | B | 98.0 | 0.00 | 0.08 | 0.00% | 34.8% | 0.0 | 31.1 | |
| MD03 | VACANT | B | 61.0 | 0.00 | 0.08 | 0.90% | 35.7% | 0.6 | 31.7 | |
| MD03 | CA | C | 94.0 | 0.00 | 0.08 | 0.83% | 36.5% | 0.8 | 32.5 | |
| MD03 | CA | C | 94.0 | 0.00 | 0.08 | 0.24% | 36.8% | 0.2 | 32.7 | |
| MD03 | CR | C | 94.0 | 0.00 | 0.08 | 1.32% | 38.1% | 1.2 | 33.9 | |
| MD03 | CR | C | 94.0 | 0.00 | 0.08 | 1.44% | 39.5% | 1.4 | 35.3 | |
| MD03 | HM | C | 94.0 | 0.00 | 0.08 | 3.68% | 43.2% | 3.5 | 38.8 | |
| MD03 | HM | C | 94.0 | 0.00 | 0.08 | 0.00% | 43.2% | 0.0 | 38.8 | |
| MD03 | HM | C | 94.0 | 0.00 | 0.08 | 0.01% | 43.2% | 0.0 | 38.8 | |
| MD03 | HM | C | 94.0 | 0.00 | 0.08 | 0.00% | 43.2% | 0.0 | 38.8 | |
| MD03 | HM | C | 94.0 | 0.00 | 0.08 | 0.00% | 43.2% | 0.0 | 38.8 | |
| MD03 | HM | C | 94.0 | 0.00 | 0.08 | 0.00% | 43.2% | 0.0 | 38.8 | |
| MD03 | HM | C | 94.0 | 0.00 | 0.08 | 0.00% | 43.2% | 0.0 | 38.8 | |
| MD03 | HM | C | 94.0 | 0.00 | 0.08 | 0.01% | 43.2% | 0.0 | 38.8 | |
| MD03 | HM | C | 94.0 | 0.00 | 0.08 | 0.00% | 43.2% | 0.0 | 38.8 | |
| MD03 | LM | C | 94.0 | 0.00 | 0.08 | 0.53% | 43.8% | 0.5 | 39.3 | |
| MD03 | LM | C | 94.0 | 0.00 | 0.08 | 0.18% | 43.9% | 0.2 | 39.4 | |
| MD03 | UDV | C | 74.0 | 0.00 | 0.08 | 2.28% | 46.2% | 1.7 | 41.1 | |
| MD03 | MFR | C | 90.0 | 0.00 | 0.08 | 0.00% | 46.2% | 0.0 | 41.1 | |
| MD03 | MFR | C | 90.0 | 0.00 | 0.08 | 0.32% | 46.5% | 0.3 | 41.4 | |

Mill Ditch Diversion Curve Number Calculations

| BASIN | LAND USE CATEGORY | SOIL MAP UNIT # | SUBREGION CN | SUBREGION AREA ($mi^2$) | SUBBASIN AREA ($mi^2$) | PERCENT OF SUBBASIN | CUMULATIVE PERCENT | AREA-WEIGHTED CN | CUMULATIVE CN | COMPOSITE CN |
|---|---|---|---|---|---|---|---|---|---|---|
| MD03 | MFR | C | 90.0 | 0.00 | 0.08 | 0.00% | 46.5% | 0.0 | 41.4 | |
| MD03 | MFR | C | 90.0 | 0.00 | 0.08 | 0.00% | 46.5% | 0.0 | 41.4 | |
| MD03 | MFR | C | 90.0 | 0.00 | 0.08 | 0.00% | 46.5% | 0.0 | 41.4 | |
| MD03 | MIXED | C | 94.0 | 0.00 | 0.08 | 1.17% | 47.7% | 1.1 | 42.5 | |
| MD03 | POS | C | 74.0 | 0.00 | 0.08 | 2.44% | 50.1% | 1.8 | 44.3 | |
| MD03 | POS | C | 74.0 | 0.00 | 0.08 | 0.06% | 50.2% | 0.0 | 44.4 | |
| MD03 | POS | C | 74.0 | 0.00 | 0.08 | 0.03% | 50.2% | 0.0 | 44.4 | |
| MD03 | POS | C | 74.0 | 0.00 | 0.08 | 0.01% | 50.2% | 0.0 | 44.4 | |
| MD03 | POS | C | 74.0 | 0.00 | 0.08 | 0.06% | 50.3% | 0.0 | 44.4 | |
| MD03 | POS | C | 74.0 | 0.00 | 0.08 | 0.06% | 50.4% | 0.0 | 44.5 | |
| MD03 | POS | C | 74.0 | 0.00 | 0.08 | 2.97% | 53.3% | 2.2 | 46.7 | |
| MD03 | POS | C | 74.0 | 0.00 | 0.08 | 0.06% | 53.4% | 0.0 | 46.7 | |
| MD03 | RB | C | 94.0 | 0.00 | 0.08 | 1.23% | 54.6% | 1.2 | 47.9 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.00% | 54.6% | 0.0 | 47.9 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.15% | 54.8% | 0.1 | 48.0 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 1.54% | 56.3% | 1.3 | 49.3 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.11% | 56.4% | 0.1 | 49.4 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.00% | 56.4% | 0.0 | 49.4 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.03% | 56.5% | 0.0 | 49.4 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 1.53% | 58.0% | 1.3 | 50.7 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.44% | 58.4% | 0.4 | 51.1 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.00% | 58.4% | 0.0 | 51.1 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.43% | 58.9% | 0.4 | 51.4 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 4.23% | 63.1% | 3.1 | 54.5 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.55% | 63.7% | 0.4 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.01% | 63.7% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.03% | 63.7% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.02% | 63.7% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.01% | 63.7% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.00% | 63.7% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.00% | 63.7% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.00% | 63.7% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.00% | 63.7% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.00% | 63.7% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.00% | 63.7% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.00% | 63.7% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.00% | 63.7% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.00% | 63.7% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.05% | 63.8% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.00% | 63.8% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 0.00% | 63.8% | 0.0 | 55.0 | |
| MD03 | VACANT | C | 74.0 | 0.00 | 0.08 | 5.41% | 69.2% | 4.0 | 59.1 | |
| MD03 | ROW | C | 98.0 | 0.00 | 0.08 | 0.36% | 69.6% | 0.4 | 59.4 | |
| MD03 | UDV | C | 74.0 | 0.00 | 0.08 | 0.00% | 69.6% | 0.0 | 59.4 | |
| MD03 | UDV | C | 74.0 | 0.00 | 0.08 | 0.00% | 69.6% | 0.0 | 59.4 | |
| MD03 | UDV | C | 74.0 | 0.00 | 0.08 | 0.00% | 69.6% | 0.0 | 59.4 | |
| MD03 | UDV | C | 74.0 | 0.00 | 0.08 | 0.00% | 69.6% | 0.0 | 59.4 | |
| MD03 | UDV | C | 74.0 | 0.00 | 0.08 | 0.00% | 69.6% | 0.0 | 59.4 | |
| MD03 | UDV | C | 74.0 | 0.00 | 0.08 | 0.01% | 69.6% | 0.0 | 59.4 | |
| MD03 | UDV | C | 74.0 | 0.00 | 0.08 | 0.00% | 69.6% | 0.0 | 59.4 | |
| MD03 | UDV | C | 74.0 | 0.00 | 0.08 | 0.00% | 69.6% | 0.0 | 59.4 | |
| MD03 | UDV | C | 74.0 | 0.00 | 0.08 | 0.00% | 69.6% | 0.0 | 59.4 | |
| MD03 | UDV | C | 74.0 | 0.01 | 0.08 | 12.57% | 82.1% | 9.3 | 68.7 | |
| MD03 | ROW | C | 98.0 | 0.01 | 0.08 | 9.76% | 91.9% | 9.6 | 78.3 | |
| MD03 | ROW | C | 98.0 | 0.00 | 0.08 | 0.84% | 92.7% | 0.8 | 79.1 | |
| MD03 | ROW | C | 98.0 | 0.00 | 0.08 | 0.28% | 93.0% | 0.3 | 79.4 | |
| MD03 | ROW | C | 98.0 | 0.00 | 0.08 | 0.00% | 93.0% | 0.0 | 79.4 | |
| MD03 | UDV | C | 74.0 | 0.00 | 0.08 | 0.02% | 93.0% | 0.0 | 79.4 | |
| MD03 | ROW | C | 98.0 | 0.00 | 0.08 | 6.60% | 99.6% | 6.5 | 85.9 | |
| MD03 | SFR | C | 83.0 | 0.00 | 0.08 | 0.37% | 100.0% | 0.3 | 86.2 | **86.2** |
| MD04 | AP | C | 90.0 | 0.00 | 0.05 | 0.54% | 0.5% | 0.5 | 0.5 | |
| MD04 | CA | C | 94.0 | 0.00 | 0.05 | 0.67% | 1.2% | 0.6 | 1.1 | |
| MD04 | CA | C | 94.0 | 0.00 | 0.05 | 0.00% | 1.2% | 0.0 | 1.1 | |
| MD04 | CA | C | 94.0 | 0.00 | 0.05 | 0.00% | 1.2% | 0.0 | 1.1 | |
| MD04 | CA | C | 94.0 | 0.00 | 0.05 | 0.02% | 1.2% | 0.0 | 1.1 | |
| MD04 | CA | C | 94.0 | 0.00 | 0.05 | 0.00% | 1.2% | 0.0 | 1.1 | |
| MD04 | HM | C | 94.0 | 0.00 | 0.05 | 5.15% | 6.4% | 4.8 | 6.0 | |
| MD04 | HM | C | 94.0 | 0.00 | 0.05 | 2.66% | 9.0% | 2.5 | 8.5 | |
| MD04 | UDV | C | 74.0 | 0.00 | 0.05 | 5.77% | 14.8% | 4.3 | 12.7 | |
| MD04 | MFR | C | 90.0 | 0.00 | 0.05 | 5.95% | 20.8% | 5.4 | 18.1 | |
| MD04 | MIXED | C | 94.0 | 0.00 | 0.05 | 5.85% | 26.6% | 5.5 | 23.6 | |
| MD04 | POS | C | 74.0 | 0.00 | 0.05 | 0.00% | 26.6% | 0.0 | 23.6 | |
| MD04 | POS | C | 74.0 | 0.00 | 0.05 | 0.00% | 26.6% | 0.0 | 23.6 | |
| MD04 | POS | C | 74.0 | 0.00 | 0.05 | 0.01% | 26.6% | 0.0 | 23.6 | |
| MD04 | POS | C | 74.0 | 0.00 | 0.05 | 0.10% | 26.7% | 0.1 | 23.7 | |
| MD04 | POS | C | 74.0 | 0.00 | 0.05 | 0.12% | 26.8% | 0.1 | 23.8 | |
| MD04 | POS | C | 74.0 | 0.00 | 0.05 | 0.15% | 27.0% | 0.1 | 23.9 | |
| MD04 | POS | C | 74.0 | 0.00 | 0.05 | 0.97% | 28.0% | 0.7 | 24.6 | |
| MD04 | POS | C | 74.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.6 | |
| MD04 | POS | C | 74.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.6 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.6 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.6 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.01% | 28.0% | 0.0 | 24.6 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.01% | 28.0% | 0.0 | 24.6 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.6 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.6 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.6 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.01% | 28.0% | 0.0 | 24.6 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.6 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.6 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.01% | 28.0% | 0.0 | 24.6 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.01% | 28.0% | 0.0 | 24.7 | |

Mill Ditch Diversion Curve Number Calculations

| BASIN | LAND USE CATEGORY | SOIL MAP UNIT # | SUBREGION CN | SUBREGION AREA ($mi^2$) | SUBBASIN AREA ($mi^2$) | PERCENT OF SUBBASIN | CUMULATIVE PERCENT | AREA-WEIGHTED CN | CUMULATIVE CN | COMPOSITE CN |
|---|---|---|---|---|---|---|---|---|---|---|
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.00% | 28.0% | 0.0 | 24.7 | |
| MD04 | UDV | C | 74.0 | 0.00 | 0.05 | 0.12% | 28.1% | 0.1 | 24.8 | |
| MD04 | ROW | C | 98.0 | 0.00 | 0.05 | 0.65% | 28.8% | 0.6 | 25.4 | |
| MD04 | ROW | C | 98.0 | 0.01 | 0.05 | 9.53% | 38.3% | 9.3 | 34.7 | |
| MD04 | UDV | C | 74.0 | 0.00 | 0.05 | 0.12% | 38.4% | 0.1 | 34.8 | |
| MD04 | SFR | C | 83.0 | 0.00 | 0.05 | 0.58% | 39.0% | 0.5 | 35.3 | |
| MD04 | SFR | C | 83.0 | 0.00 | 0.05 | 0.47% | 39.5% | 0.4 | 35.7 | |
| MD04 | SFR | C | 83.0 | 0.00 | 0.05 | 0.27% | 39.8% | 0.2 | 35.9 | |
| MD04 | SFR | C | 83.0 | 0.00 | 0.05 | 0.31% | 40.1% | 0.3 | 36.2 | |
| MD04 | SFR | C | 83.0 | 0.00 | 0.05 | 0.02% | 40.1% | 0.0 | 36.2 | |
| MD04 | SFR | C | 83.0 | 0.00 | 0.05 | 0.04% | 40.1% | 0.0 | 36.2 | |
| MD04 | UDV | C | 74.0 | 0.00 | 0.05 | 0.00% | 40.1% | 0.0 | 36.2 | |
| MD04 | UDV | C | 74.0 | 0.00 | 0.05 | 1.04% | 41.2% | 0.8 | 37.0 | |
| MD04 | VACANT | C | 74.0 | 0.00 | 0.05 | 0.03% | 41.2% | 0.0 | 37.0 | |
| MD04 | VACANT | C | 74.0 | 0.00 | 0.05 | 0.00% | 41.2% | 0.0 | 37.0 | |
| MD04 | VACANT | C | 74.0 | 0.00 | 0.05 | 0.00% | 41.2% | 0.0 | 37.0 | |
| MD04 | VACANT | C | 74.0 | 0.00 | 0.05 | 0.00% | 41.2% | 0.0 | 37.0 | |
| MD04 | VACANT | C | 74.0 | 0.01 | 0.05 | 24.58% | 65.8% | 18.2 | 55.2 | |
| MD04 | VACANT | C | 74.0 | 0.00 | 0.05 | 0.89% | 66.7% | 0.7 | 55.9 | |
| MD04 | VACANT | C | 74.0 | 0.00 | 0.05 | 1.55% | 68.2% | 1.1 | 57.0 | |
| MD04 | UDV | D | 80.0 | 0.00 | 0.05 | 5.31% | 73.6% | 4.2 | 61.3 | |
| MD04 | VACANT | D | 80.0 | 0.01 | 0.05 | 16.93% | 90.5% | 13.5 | 74.8 | |
| MD04 | UDV | C | 74.0 | 0.00 | 0.05 | 3.32% | 93.8% | 2.5 | 77.3 | |
| MD04 | ROW | D | 98.0 | 0.00 | 0.05 | 1.25% | 95.1% | 1.2 | 78.5 | |
| MD04 | MFR | C | 90.0 | 0.00 | 0.05 | 4.95% | 100.0% | 4.5 | 82.9 | **82.9** |
| MD05 | MFR | B | 85.0 | 0.00 | 0.30 | 1.55% | 1.6% | 1.3 | 1.3 | |
| MD05 | POS | B | 61.0 | 0.00 | 0.30 | 0.00% | 1.6% | 0.0 | 1.3 | |
| MD05 | POS | B | 61.0 | 0.00 | 0.30 | 0.14% | 1.7% | 0.1 | 1.4 | |
| MD05 | POS | B | 61.0 | 0.00 | 0.30 | 0.20% | 1.9% | 0.1 | 1.5 | |
| MD05 | POS | B | 61.0 | 0.00 | 0.30 | 1.02% | 2.9% | 0.6 | 2.2 | |
| MD05 | POS | B | 61.0 | 0.00 | 0.30 | 0.00% | 2.9% | 0.0 | 2.2 | |
| MD05 | POS | B | 61.0 | 0.00 | 0.30 | 0.00% | 2.9% | 0.0 | 2.2 | |
| MD05 | POS | B | 61.0 | 0.00 | 0.30 | 0.22% | 3.1% | 0.1 | 2.3 | |
| MD05 | ROW | B | 98.0 | 0.00 | 0.30 | 0.68% | 3.8% | 0.7 | 3.0 | |
| MD05 | ROW | B | 98.0 | 0.00 | 0.30 | 0.00% | 3.8% | 0.0 | 3.0 | |
| MD05 | ROW | B | 98.0 | 0.00 | 0.30 | 0.00% | 3.8% | 0.0 | 3.0 | |
| MD05 | ROW | B | 98.0 | 0.00 | 0.30 | 0.00% | 3.8% | 0.0 | 3.0 | |
| MD05 | ROW | B | 98.0 | 0.00 | 0.30 | 0.00% | 3.8% | 0.0 | 3.0 | |
| MD05 | ROW | B | 98.0 | 0.00 | 0.30 | 0.04% | 3.9% | 0.0 | 3.0 | |
| MD05 | SFR | B | 75.0 | 0.00 | 0.30 | 0.07% | 3.9% | 0.1 | 3.0 | |
| MD05 | VACANT | B | 61.0 | 0.00 | 0.30 | 0.61% | 4.5% | 0.4 | 3.4 | |
| MD05 | VACANT | B | 61.0 | 0.00 | 0.30 | 0.12% | 4.7% | 0.1 | 3.5 | |
| MD05 | VACANT | B | 61.0 | 0.00 | 0.30 | 0.36% | 5.0% | 0.2 | 3.7 | |
| MD05 | VACANT | B | 61.0 | 0.00 | 0.30 | 0.09% | 5.1% | 0.1 | 3.8 | |
| MD05 | AP | C | 90.0 | 0.00 | 0.30 | 0.12% | 5.2% | 0.1 | 3.9 | |
| MD05 | AP | C | 90.0 | 0.00 | 0.30 | 0.00% | 5.2% | 0.0 | 3.9 | |
| MD05 | AP | C | 90.0 | 0.00 | 0.30 | 0.00% | 5.2% | 0.0 | 3.9 | |
| MD05 | AP | C | 90.0 | 0.00 | 0.30 | 0.15% | 5.4% | 0.1 | 4.0 | |
| MD05 | AP | C | 90.0 | 0.05 | 0.30 | 15.14% | 20.5% | 13.6 | 17.6 | |
| MD05 | CA | C | 94.0 | 0.00 | 0.30 | 0.43% | 20.9% | 0.4 | 18.0 | |
| MD05 | CA | C | 94.0 | 0.00 | 0.30 | 0.61% | 21.6% | 0.6 | 18.6 | |
| MD05 | CA | C | 94.0 | 0.00 | 0.30 | 0.18% | 21.7% | 0.2 | 18.8 | |
| MD05 | CR | C | 94.0 | 0.00 | 0.30 | 0.28% | 22.0% | 0.3 | 19.0 | |
| MD05 | CR | C | 94.0 | 0.00 | 0.30 | 0.57% | 22.6% | 0.5 | 19.6 | |
| MD05 | CR | C | 94.0 | 0.00 | 0.30 | 0.26% | 22.9% | 0.2 | 19.8 | |
| MD05 | HM | C | 94.0 | 0.00 | 0.30 | 0.00% | 22.9% | 0.0 | 19.8 | |
| MD05 | HM | C | 94.0 | 0.00 | 0.30 | 0.00% | 22.9% | 0.0 | 19.8 | |
| MD05 | HM | C | 94.0 | 0.00 | 0.30 | 0.39% | 23.2% | 0.4 | 20.2 | |
| MD05 | HM | C | 94.0 | 0.00 | 0.30 | 0.00% | 23.2% | 0.0 | 20.2 | |
| MD05 | POS | C | 74.0 | 0.03 | 0.30 | 9.35% | 32.6% | 6.9 | 27.1 | |
| MD05 | MIXED | C | 94.0 | 0.00 | 0.30 | 0.30% | 32.9% | 0.3 | 27.4 | |
| MD05 | MIXED | C | 94.0 | 0.00 | 0.30 | 0.00% | 32.9% | 0.0 | 27.4 | |
| MD05 | MIXED | C | 94.0 | 0.00 | 0.30 | 0.00% | 32.9% | 0.0 | 27.4 | |
| MD05 | MIXED | C | 94.0 | 0.00 | 0.30 | 0.00% | 32.9% | 0.0 | 27.4 | |
| MD05 | MIXED | C | 94.0 | 0.00 | 0.30 | 0.00% | 32.9% | 0.0 | 27.4 | |
| MD05 | MIXED | C | 94.0 | 0.00 | 0.30 | 0.00% | 32.9% | 0.0 | 27.4 | |
| MD05 | MIXED | C | 94.0 | 0.00 | 0.30 | 0.01% | 32.9% | 0.0 | 27.4 | |
| MD05 | POS | C | 74.0 | 0.10 | 0.30 | 33.94% | 66.8% | 25.1 | 52.5 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.48% | 67.3% | 0.4 | 52.9 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.13% | 67.5% | 0.1 | 53.0 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.00% | 67.5% | 0.0 | 53.0 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.00% | 67.5% | 0.0 | 53.0 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.05% | 67.5% | 0.0 | 53.0 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.00% | 67.5% | 0.0 | 53.0 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.02% | 67.5% | 0.0 | 53.0 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.09% | 67.6% | 0.1 | 53.1 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.21% | 67.8% | 0.2 | 53.3 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.00% | 67.8% | 0.0 | 53.3 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.31% | 68.1% | 0.2 | 53.5 | |

Mill Ditch Diversion Curve Number Calculations

| BASIN | LAND USE CATEGORY | SOIL MAP UNIT # | SUBREGION CN | SUBREGION AREA ($mi^2$) | SUBBASIN AREA ($mi^2$) | PERCENT OF SUBBASIN | CUMULATIVE PERCENT | AREA-WEIGHTED CN | CUMULATIVE CN | COMPOSITE CN |
|---|---|---|---|---|---|---|---|---|---|---|
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.00% | 68.1% | 0.0 | 53.5 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.06% | 68.2% | 0.0 | 53.5 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.2% | 0.0 | 53.5 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.01% | 68.2% | 0.0 | 53.5 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.2% | 0.0 | 53.5 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.01% | 68.2% | 0.0 | 53.5 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.2% | 0.0 | 53.5 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.2% | 0.0 | 53.6 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.2% | 0.0 | 53.6 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.06% | 68.3% | 0.1 | 53.6 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.05% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.01% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 68.3% | 0.0 | 53.7 | |
| MD05 | ROW | C | 98.0 | 0.01 | 0.30 | 3.26% | 71.6% | 3.2 | 56.9 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.01% | 71.6% | 0.0 | 56.9 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 71.6% | 0.0 | 56.9 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 71.6% | 0.0 | 56.9 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 71.6% | 0.0 | 56.9 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 71.6% | 0.0 | 56.9 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 71.6% | 0.0 | 56.9 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 71.6% | 0.0 | 56.9 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.00% | 71.6% | 0.0 | 56.9 | |
| MD05 | ROW | C | 98.0 | 0.01 | 0.30 | 1.96% | 73.6% | 1.9 | 58.8 | |
| MD05 | ROW | C | 98.0 | 0.00 | 0.30 | 0.35% | 73.9% | 0.3 | 59.2 | |
| MD05 | SFR | C | 83.0 | 0.00 | 0.30 | 0.14% | 74.1% | 0.1 | 59.3 | |
| MD05 | SFR | C | 83.0 | 0.00 | 0.30 | 0.27% | 74.4% | 0.2 | 59.5 | |
| MD05 | SFR | C | 83.0 | 0.00 | 0.30 | 1.34% | 75.7% | 1.1 | 60.6 | |
| MD05 | SFR | C | 83.0 | 0.00 | 0.30 | 0.22% | 75.9% | 0.2 | 60.8 | |
| MD05 | SFR | C | 83.0 | 0.00 | 0.30 | 0.97% | 76.9% | 0.8 | 61.6 | |
| MD05 | SFR | C | 83.0 | 0.00 | 0.30 | 0.02% | 76.9% | 0.0 | 61.6 | |
| MD05 | UDV | C | 74.0 | 0.01 | 0.30 | 4.75% | 81.7% | 3.5 | 65.1 | |
| MD05 | UDV | C | 74.0 | 0.00 | 0.30 | 0.01% | 81.7% | 0.0 | 65.1 | |
| MD05 | VACANT | C | 74.0 | 0.00 | 0.30 | 0.03% | 81.7% | 0.0 | 65.2 | |
| MD05 | VACANT | C | 74.0 | 0.00 | 0.30 | 0.00% | 81.7% | 0.0 | 65.2 | |
| MD05 | VACANT | C | 74.0 | 0.00 | 0.30 | 0.11% | 81.8% | 0.1 | 65.2 | |
| MD05 | VACANT | C | 74.0 | 0.00 | 0.30 | 0.44% | 82.3% | 0.3 | 65.6 | |
| MD05 | VACANT | C | 74.0 | 0.00 | 0.30 | 0.12% | 82.4% | 0.1 | 65.7 | |
| MD05 | UDV | D | 80.0 | 0.00 | 0.30 | 0.66% | 83.1% | 0.5 | 66.2 | |
| MD05 | UDV | D | 80.0 | 0.02 | 0.30 | 7.23% | 90.3% | 5.8 | 72.0 | |
| MD05 | VACANT | D | 80.0 | 0.00 | 0.30 | 0.75% | 91.0% | 0.6 | 72.6 | |
| MD05 | POS | D | 80.0 | 0.00 | 0.30 | 0.06% | 91.1% | 0.0 | 72.6 | |
| MD05 | UDV | C | 74.0 | 0.00 | 0.30 | 1.43% | 92.5% | 1.1 | 73.7 | |
| MD05 | ROW | D | 98.0 | 0.00 | 0.30 | 0.07% | 92.6% | 0.1 | 73.8 | |
| MD05 | POS | B | 61.0 | 0.00 | 0.30 | 0.88% | 93.5% | 0.5 | 74.3 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.33% | 93.8% | 0.2 | 74.5 | |
| MD05 | POS | C | 74.0 | 0.00 | 0.30 | 0.66% | 94.5% | 0.5 | 75.0 | |
| MD05 | MFR | C | 90.0 | 0.01 | 0.30 | 3.92% | 98.4% | 3.5 | 78.6 | |
| MD05 | AP | C | 90.0 | 0.00 | 0.30 | 1.61% | 100.0% | 1.5 | 80.0 | **80.0** |
| MD06 | AP | C | 90.0 | 0.00 | 0.20 | 0.30% | 0.3% | 0.3 | 0.3 | |
| MD06 | CR | C | 94.0 | 0.00 | 0.20 | 0.02% | 0.3% | 0.0 | 0.3 | |
| MD06 | CR | C | 94.0 | 0.00 | 0.20 | 0.01% | 0.3% | 0.0 | 0.3 | |
| MD06 | CR | C | 94.0 | 0.00 | 0.20 | 0.01% | 0.3% | 0.0 | 0.3 | |
| MD06 | LM | C | 94.0 | 0.00 | 0.20 | 0.81% | 1.2% | 0.8 | 1.1 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.13% | 1.3% | 0.1 | 1.2 | |
| MD06 | PFP | C | 94.0 | 0.01 | 0.20 | 2.70% | 4.0% | 2.5 | 3.7 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.10% | 4.1% | 0.1 | 3.8 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.02% | 4.1% | 0.0 | 3.8 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.00% | 4.1% | 0.0 | 3.8 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.00% | 4.1% | 0.0 | 3.8 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.98% | 5.1% | 0.7 | 4.5 | |
| MD06 | Deciduous Forest | C | 70.0 | 0.00 | 0.20 | 0.18% | 5.3% | 0.1 | 4.6 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.00% | 5.3% | 0.0 | 4.6 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.46% | 5.7% | 0.5 | 5.1 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 5.7% | 0.0 | 5.1 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.38% | 6.1% | 0.4 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |

Mill Ditch Diversion Curve Number Calculations

| BASIN | LAND USE CATEGORY | SOIL MAP UNIT # | SUBREGION CN | SUBREGION AREA ($mi^2$) | SUBBASIN AREA ($mi^2$) | PERCENT OF SUBBASIN | CUMULATIVE PERCENT | AREA-WEIGHTED CN | CUMULATIVE CN | COMPOSITE CN |
|---|---|---|---|---|---|---|---|---|---|---|
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.1% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.05% | 6.2% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.2% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.2% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.2% | 0.0 | 5.5 | |
| MD06 | ROW | C | 98.0 | 0.00 | 0.20 | 0.00% | 6.2% | 0.0 | 5.5 | |
| MD06 | RR | C | 82.0 | 0.00 | 0.20 | 1.70% | 7.9% | 1.4 | 6.9 | |
| MD06 | Deciduous Forest | C | 70.0 | 0.00 | 0.20 | 0.21% | 8.1% | 0.1 | 7.1 | |
| MD06 | AP | C | 90.0 | 0.00 | 0.20 | 1.05% | 9.1% | 0.9 | 8.0 | |
| MD06 | AP | C | 90.0 | 0.00 | 0.20 | 0.20% | 9.3% | 0.2 | 8.2 | |
| MD06 | CA | C | 94.0 | 0.00 | 0.20 | 0.24% | 9.6% | 0.2 | 8.4 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.54% | 10.1% | 0.4 | 8.8 | |
| MD06 | CR | C | 94.0 | 0.00 | 0.20 | 0.26% | 10.4% | 0.2 | 9.1 | |
| MD06 | HM | C | 94.0 | 0.00 | 0.20 | 0.72% | 11.1% | 0.7 | 9.7 | |
| MD06 | HM | C | 94.0 | 0.00 | 0.20 | 0.32% | 11.4% | 0.3 | 10.0 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.01% | 11.4% | 0.0 | 10.0 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.98% | 12.4% | 0.7 | 10.8 | |
| MD06 | POS | C | 74.0 | 0.01 | 0.20 | 6.23% | 18.6% | 4.6 | 15.4 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.94% | 19.6% | 0.7 | 16.1 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.86% | 20.4% | 0.6 | 16.7 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.63% | 21.0% | 0.5 | 17.2 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.86% | 21.9% | 0.6 | 17.8 | |
| MD06 | POS | C | 74.0 | 0.08 | 0.20 | 39.03% | 60.9% | 28.9 | 46.7 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 1.48% | 62.4% | 1.1 | 47.8 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.85% | 63.3% | 0.6 | 48.4 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.70% | 64.0% | 0.5 | 48.9 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.85% | 64.8% | 0.6 | 49.6 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.69% | 65.5% | 0.5 | 50.1 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 1.20% | 66.7% | 0.9 | 51.0 | |
| MD06 | SFR | C | 83.0 | 0.00 | 0.20 | 1.23% | 67.9% | 1.0 | 52.0 | |
| MD06 | SFR | C | 83.0 | 0.00 | 0.20 | 0.54% | 68.5% | 0.4 | 52.4 | |
| MD06 | SFR | C | 83.0 | 0.00 | 0.20 | 0.17% | 68.7% | 0.1 | 52.6 | |
| MD06 | SFR | C | 83.0 | 0.01 | 0.20 | 2.80% | 71.5% | 2.3 | 54.9 | |
| MD06 | SFR | C | 83.0 | 0.00 | 0.20 | 2.15% | 73.6% | 1.8 | 56.7 | |
| MD06 | SFR | C | 83.0 | 0.00 | 0.20 | 0.97% | 74.6% | 0.8 | 57.5 | |
| MD06 | SFR | C | 83.0 | 0.00 | 0.20 | 0.97% | 75.5% | 0.8 | 58.3 | |
| MD06 | SFR | C | 83.0 | 0.00 | 0.20 | 0.00% | 75.5% | 0.0 | 58.3 | |
| MD06 | UDV | C | 74.0 | 0.00 | 0.20 | 0.48% | 76.0% | 0.4 | 58.7 | |
| MD06 | DTR | D | 92.0 | 0.00 | 0.20 | 0.56% | 76.6% | 0.5 | 59.2 | |
| MD06 | POS | D | 80.0 | 0.02 | 0.20 | 9.14% | 85.7% | 7.3 | 66.5 | |
| MD06 | POS | D | 80.0 | 0.00 | 0.20 | 0.00% | 85.7% | 0.0 | 66.5 | |
| MD06 | POS | D | 80.0 | 0.00 | 0.20 | 0.31% | 86.0% | 0.2 | 66.7 | |
| MD06 | POS | D | 80.0 | 0.00 | 0.20 | 0.00% | 86.0% | 0.0 | 66.7 | |
| MD06 | POS | D | 80.0 | 0.00 | 0.20 | 0.00% | 86.0% | 0.0 | 66.7 | |
| MD06 | ROW | C | 98.0 | 0.01 | 0.20 | 5.63% | 91.7% | 5.5 | 72.3 | |
| MD06 | POS | C | 74.0 | 0.01 | 0.20 | 4.97% | 96.6% | 3.7 | 75.9 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 0.12% | 96.8% | 0.1 | 76.0 | |
| MD06 | POS | C | 74.0 | 0.00 | 0.20 | 2.22% | 99.0% | 1.6 | 77.7 | |
| MD06 | PFP | C | 94.0 | 0.00 | 0.20 | 0.61% | 99.6% | 0.6 | 78.2 | |
| MD06 | CR | C | 94.0 | 0.00 | 0.20 | 0.42% | 100.0% | 0.4 | 78.6 | **78.6** |

# APPENDIX E

# LAG TIME CALCULATIONS

Calculation of Lag Time

| Basin | CN | Avg Basin Slope (%) | Longest flow path (ft) | Tc (hr) | Tc (min) | Lag (min) |
|---|---|---|---|---|---|---|
| **MD01** | 91.6 | 1.58 | 3246.22 | 0.71 | 42.69 | 25.61 |
| **MD02** | 75.3 | 1.81 | 4405.00 | 1.48 | 89.04 | 53.42 |
| **MD03** | 86.2 | 3.01 | 3837.44 | 0.73 | 43.66 | 26.20 |
| **MD04** | 82.9 | 5.22 | 3293.47 | 0.55 | 32.83 | 19.70 |
| **MD05** | 80.0 | 4.96 | 10627.71 | 1.58 | 94.52 | 56.71 |
| **MD06** | 78.6 | 5.78 | 4372.74 | 0.75 | 44.91 | 26.95 |

# APPENDIX F

# ELEVATION-STORAGE RELATIONSHIP FOR HEC-HMS ELEMENT RESERVOIR-1

| Elevation (ft NAVD88) | Storage (ac-ft) |
|---|---|
| **4772.23** | 0.0000 |
| **4772.50** | 0.0005 |
| **4773.00** | 0.0124 |
| **4774.00** | 0.1765 |
| **4775.00** | 1.0048 |
| **4776.00** | 4.2125 |
| **4777.00** | 10.237 |
| **4778.00** | 19.192 |
| **4779.00** | 30.863 |
| **4780.00** | 45.350 |