



November 20, 2020

**City of Lee's Summit**  
**Development Services**  
220 SW Green Street  
Lee's Summit, MO, 64063

**RE: Hawthorn Ridge 3<sup>rd</sup> Plat**  
**Olsson Project #019-1605**

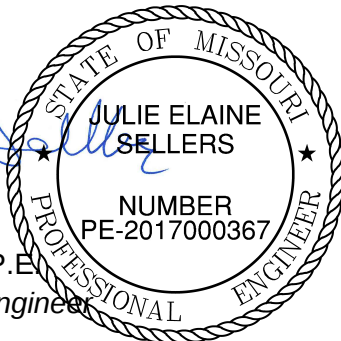
**To Whom It May Concern:**

Hawthorn 3<sup>rd</sup> plat is a proposed 19.00-acre residential development in Lee's Summit, Jackson County, Missouri. The residential development includes 45 single family homes. The property is located within the Hawthorn Ridge Development and bounded by SW Hook Road to the north, and between undeveloped private property to the east and west, between SW Pryor Road and SW Ward Road.

The impacts from the development of Hawthorn Ridge 3<sup>rd</sup> plat have been previously analyzed with the Hawthorn Ridge Macro and First Plat Micro Drainage Study, revised March 8, 2018. No changes to the overall development have been made since this study was prepared and approved. The approved Hawthorn Ridge Macro and First Plat Micro Drainage Study has been included with this memo, for reference. Since the overall plan has not changed from the previously approved study, we are requesting approval of this memo to satisfy stormwater drainage requirements for Hawthorn Ridge 3<sup>rd</sup> Plat development.

Should you have any questions regarding this submittal, or the plan moving forward, please do not hesitate to reach out to me for discussion at (816) 422-6044, or [jsellers@olsson.com](mailto:jsellers@olsson.com).

Sincerely,

  
  
Julie E. Sellers, P.E.  
*Olsson Project Engineer*

# **HAWTHORN RIDGE MACRO AND FIRST PLAT MICRO DRAINAGE STUDY**

Submitted: March 3, 2017

Revised: March 8, 2018

Proposed Residential Development located in:  
NW ¼ Section 25, Township 47N, Range 32W  
Lee's Summit, Jackson County, Missouri

Cedar Creek Watershed, Little Blue River Watershed

Prepared For:  
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## 1.) General Information:

Hawthorn Ridge is proposed as a 203-lot single family residential subdivision on the south side of SW Hook Rd approximately 1,300 feet east of SW Pryor Road. The first Plat of Hawthorn Ridge consists of 100 single family residential lots, two detention basins and club house. The site is bounded by SW Hook Rd to the north, estate lot residential on the west and east, and undeveloped land to the south. This locates the project in the NW ¼ of Section 25, Township 47 N, Range 32 W, Lee's Summit, Jackson County, Missouri.

Stormwater runoff from Hawthorn Ridge is conveyed into the Mouse Creek watershed, via several discharge points from the site. The majority of the site is discharged to the west, to an unnamed tributary to Mouse Creek. This drainage study will evaluate the hydrologic impact generated by the construction of the Hawthorn Ridge First Plat (Proposed Conditions). This study will also evaluate the future conditions which includes the full build-out of the Hawthorn Ridge property and includes the First and Second Plats.



Figure 1. Hawthorn Ridge Vicinity Map

### 1.1) FEMA Floodplain Classification:

FEMA Flood Boundary and Floodway Map Community Panel Number 29095C 0406F classifies the Hawthorn Ridge property as a "Zone X" Area. Zone X is the FEMA flood insurance rate zone that corresponds to "areas determined to be outside the 0.2% annual chance flood."

## 1.2) Soil Classifications

Soil Maps published on the NRCS Web Soil Survey, categorize soils on the Hawthorn Ridge property as:

| Symbol | Name                          | Slopes | HSG |
|--------|-------------------------------|--------|-----|
| 10000  | Arisburg silt loam            | 1-5%   | D   |
| 10082  | Arisburg-Urban land complex   | 1-5%   | D   |
| 10117  | Sampsel silty clay loam       | 5-9%   | C/D |
| 10128  | Sharpsburg-Urban land complex | 2-5%   | D   |

## 2.) Methodology

This drainage study has been prepared to evaluate the hydrologic impact generated by development of Hawthorn Ridge First Plat and full build-out conditions. The base data for the models prepared for this report has been obtained from available online maps and aerial imagery. This study was prepared in conformance with the “Hawthorn Ridge Preliminary Stormwater Drainage Study” submitted October 17, 2016.

The following methods were used in this study to model Existing, Proposed and Future Conditions for stormwater runoff:

- Haestad Methods, Inc. “PondPack” v8i
  - TR-55 Unit Hydrograph Method
    - 2-year, 10-year and 100-year Return Frequency storms
    - AMC II Soil Moisture conditions
    - 24-Hour SCS Type II Rainfall Distribution
    - SCS Runoff Curve Numbers per SCS TR-55 (Tables 2-2a – 2-2c)
    - SCS TR-55 Methods for determination of Time of Concentration and Travel Time. Where specific data pertaining to channel geometry is not available, “length & velocity” estimates for channel-flow Travel Time is utilized per Section 5600, Kansas City APWA Standard Specifications and Design Criteria.

## 3.) Existing Conditions Analysis

This section of the drainage study has been prepared to evaluate the Existing Conditions related to stormwater runoff. Section 4 will evaluate the site under Proposed Conditions. Section 5 will evaluate the site under Future Conditions. The purpose of this report is to evaluate the Proposed and Future Conditions stormwater discharge from the property and to ensure that there are no adverse conditions generated by the development. To quantify the effects of development of this project, the following areas and points of interest have been used for both Existing, Proposed and Future Conditions analyses.

**Watershed A** discharges to the north via an 18-inch culvert under NW Hook Road. Total modeled area within Watershed A is 7.62 acres under Existing Conditions, all of which is onsite. Small portions of the adjacent onsite watersheds will be redirected to Watershed A, increasing the total size of the watershed to 9.75 acres under Proposed and Future Conditions. A new detention facility will be constructed within Watershed A for the First Plat, which will be referred to in this report as *Basin A1*.

**Watershed B** lies directly west of Watershed A, and discharges to the north via a 24-inch culvert under NW Hood Rd. Total modeled area within Watershed B is 2.11 acres under Existing Conditions, 2.03 acres of which is onsite. A portion of Watershed B will be redirected to Watershed A, and a portion of Watershed C will be redirected to Watershed B under Proposed and Future Conditions. This will cause an overall increase in the area within Watershed B to 2.31 acres.

**Watershed C** lies directly south of Watershed C, and discharges to the west into a small existing farm pond. Total modeled area with Watershed C is 6.86 acres under Existing Conditions, 3.44 acres of which is onsite. Portions of Watershed C will be redirected to Watersheds B and D under Proposed and Future Conditions, reducing the modeled area to 5.52 acres.

**Watershed D** incorporates the majority of the Arborwalk Site, and discharges to the west to an unnamed tributary to Mouse Creek. The watershed has been divided into two subareas. Total modeled area within Watershed D is 83.76 acres under Existing Conditions, 64.52 acres of which is onsite. A portion of Watershed D will be redirected to Watershed A, and a portion of Watershed C will be redirected to Watershed D, resulting in a net decrease of area to 83.63 acres under Proposed and Future Conditions. Watershed D incorporates an additional point of interest **Point D2** at the western edge of the Hawthorn Ridge property. A new detention facility will be constructed with the First Plat within Subarea D2, which will be referred to in this report as **Basin D2**.

The following tables summarize the results of the Existing Conditions analysis. The intent of this report is to evaluate the hydrologic impact created by construction of Hawthorn Ridge. The Proposed and Future Conditions discharge data will be compared to these Existing Conditions results. The Existing Conditions stormwater runoff model simulates the 2, 10 and 100-year design storm events. Refer to the Existing Conditions Drainage Area Map (Exhibit 8-3.1) for subarea locations. Refer to Section 7.1 for output from the Existing Conditions model. The following tables contain input data and summarize the computed results from the PondPack model for Hawthorn Ridge Existing Conditions.

**Table 3-1 Hawthorn Ridge Existing Conditions Subarea Data**

| Subarea: | Area (ac.): | Composite CN | T <sub>c</sub> (hr.) |
|----------|-------------|--------------|----------------------|
| A1       | 7.62        | 84           | 0.181                |
| B1       | 2.11        | 84           | 0.181                |
| C1       | 6.86        | 85           | 0.190                |
| D1       | 24.79       | 81           | 0.169                |
| D2       | 58.96       | 85           | 0.313                |

**Table 3-2 Hawthorn Ridge Existing Conditions Runoff Data: Subarea Peak Discharge Rates**

| Subarea: | Q <sub>2</sub> (cfs) | Q <sub>10</sub> (cfs) | Q <sub>100</sub> (cfs) |
|----------|----------------------|-----------------------|------------------------|
| A1       | 20.58                | 35.54                 | 58.64                  |
| B1       | 5.72                 | 9.88                  | 16.29                  |
| C1       | 18.99                | 32.40                 | 53.01                  |
| D1       | 60.44                | 108.66                | 184.34                 |
| D2       | 133.67               | 229.89                | 378.62                 |

**Table 3-3 Hawthorn Ridge Existing Conditions Runoff Data: Point of Interest Peak Discharge Rates**

| Point of Interest: | Q <sub>2</sub> (cfs) | Q <sub>10</sub> (cfs) | Q <sub>100</sub> (cfs) |
|--------------------|----------------------|-----------------------|------------------------|
| Point A1           | 20.58                | 35.54                 | 58.64                  |
| Point B1           | 5.72                 | 9.88                  | 16.29                  |
| Point C1           | 18.99                | 32.4                  | 53.01                  |
| Point D1           | 175.98               | 308.32                | 513.94                 |
| Point D2           | 133.67               | 229.89                | 378.62                 |

Per APWA Section 5608.4 and City of Lee's Summit criteria, the performance criteria for detention is to provide detention to limit peak flow rates at downstream points of interest to maximum release rates:

- 50% storm peak rate less than or equal to 0.5 cfs per site acre
- 10% storm peak rate less than or equal to 2.0 cfs per site acre
- 1% storm peak rate less than or equal to 3.0 cfs per site acre

Allowable release rates were calculated for the points of interest, allowing that offsite peak discharges would be permitted to bypass the detention. Offsite bypass peak flow rates were calculated as a percentage of the existing conditions, relating to the percentage of offsite area flowing to each point. The release rates for the proposed development on the development site were calculated based on the detention criteria. The development release rates were added to the bypass peak flow rates to calculate an allowable peak flow rate for each point of interest as follows.

**Table 4-5 Hawthorn Ridge Point of Interest Offsite Area**

| Point of Interest: | Total Area (ac) | Onsite Area (ac) | Percent Onsite |
|--------------------|-----------------|------------------|----------------|
| Point A1           | 7.62            | 7.62             | 100.0%         |
| Point B1           | 2.11            | 2.03             | 96.1%          |
| Point C1           | 6.86            | 3.44             | 50.1%          |
| Point D1           | 83.76           | 64.52            | 77.0%          |
| Point D2           | 58.96           | 55.90            | 94.8%          |

**Table 4-6 Hawthorn Ridge Point of Interest Allowable Peak Flow Rates**

| Point of Interest: | Allowable Q <sub>2</sub> (cfs) | Allowable Q <sub>10</sub> (cfs) | Allowable Q <sub>100</sub> (cfs) |
|--------------------|--------------------------------|---------------------------------|----------------------------------|
| Point A1           | 3.81                           | 15.25                           | 22.87                            |
| Point B1           | 1.24                           | 4.44                            | 6.72                             |
| Point C1           | 11.19                          | 23.03                           | 36.74                            |
| Point D1           | 72.68                          | 199.86                          | 311.60                           |
| Point D2           | 34.90                          | 123.75                          | 187.38                           |

#### **4.) Proposed Conditions**

The Proposed Conditions section of analysis assumes completion of only Hawthorn Ridge First Plat, including construction of two new detention facilities in Watersheds A and D. The difference between the Existing Conditions model and the Proposed Conditions model is a direct result of the construction of Hawthorn Ridge First Plat.

As in the Existing Conditions section, this Proposed Conditions stormwater runoff model was created and run for the 2, 10 and 100-year design storm events. Refer to Section 7.2 for output from the Proposed Conditions model. The following tables contain input data and summarize the computed results from the PondPack model for Proposed Conditions. After the results of this Proposed Conditions model are presented, they will be compared to the Existing Conditions results. Any variation in computed discharge rates from Existing to Proposed Conditions will be a direct result of construction of Hawthorn Ridge First Plat.

**Table 4-1 Hawthorn Ridge Proposed Conditions Subarea Data**

| Subarea: | Area (ac.): | Composite CN | T <sub>c</sub> (hr.) |
|----------|-------------|--------------|----------------------|
| A1       | 6.95        | 85           | 0.123                |
| A1a      | 2.31        | 84           | 0.112                |
| B1       | 1.43        | 82           | 0.174                |
| C1       | 5.52        | 84           | 0.173                |
| D1       | 17.88       | 79           | 0.169                |
| D2       | 64.67       | 83           | 0.275                |
| D2a      | 1.54        | 79           | 0.141                |

**Table 4-2 Hawthorn Ridge Proposed Conditions Runoff Data: Subarea Peak Discharge Rates**

| Subarea: | Q <sub>2</sub> (cfs) | Q <sub>10</sub> (cfs) | Q <sub>100</sub> (cfs) |
|----------|----------------------|-----------------------|------------------------|
| A1       | 21.34                | 36.43                 | 59.61                  |
| A1a      | 6.92                 | 11.94                 | 19.68                  |
| B1       | 3.61                 | 6.41                  | 10.77                  |
| C1       | 15.07                | 25.98                 | 42.80                  |
| D1       | 39.98                | 74.12                 | 128.45                 |
| D2       | 146.03               | 257.11                | 430.06                 |
| D2a      | 3.53                 | 6.92                  | 11.94                  |

**Table 4-3 Hawthorn Ridge Proposed Conditions Runoff Data: Point of Interest Peak Discharge Rates**

| Point of Interest: | Q <sub>2</sub> (cfs) | Q <sub>10</sub> (cfs) | Q <sub>100</sub> (cfs) |
|--------------------|----------------------|-----------------------|------------------------|
| Point A1           | 7.15                 | 12.30                 | 20.60                  |
| Point B1           | 3.61                 | 6.41                  | 10.77                  |
| Point C1           | 15.07                | 25.98                 | 42.80                  |
| Point D1           | 44.57                | 117.14                | 240.05                 |
| Point D2           | 31.76                | 103.41                | 162.07                 |

**Table 4-4 Proposed Conditions Detention Basin Data**

|          | Peak Q In<br>(cfs) | T <sub>P</sub> In<br>(hr.) | Peak Q<br>Out (cfs) | T <sub>P</sub> Out<br>(hr.) | V <sub>R</sub><br>(ac-ft) | Peak<br>W.S.E. | Max. Storage<br>Volume (ac-ft) |
|----------|--------------------|----------------------------|---------------------|-----------------------------|---------------------------|----------------|--------------------------------|
| Basin A1 |                    |                            |                     |                             |                           |                |                                |
| 2-Year   | 21.34              | 11.95                      | 0.40                | 17.90                       | 1.22                      | 1,023.09       | 0.87                           |
| 10-Year  | 36.43              | 11.95                      | 1.12                | 14.65                       | 2.11                      | 1,023.79       | 1.47                           |
| 100-Year | 59.61              | 11.95                      | 7.76                | 12.35                       | 3.54                      | 1,024.38       | 2.00                           |
| Basin D2 |                    |                            |                     |                             |                           |                |                                |
| 2-Year   | 146.03             | 12.05                      | 31.29               | 12.45                       | 10.47                     | 1,001.85       | 4.77                           |
| 10-Year  | 257.11             | 12.05                      | 102.31              | 12.30                       | 18.57                     | 1,003.43       | 7.70                           |
| 100-Year | 430.06             | 12.05                      | 160.24              | 12.30                       | 31.69                     | 1,005.34       | 12.57                          |

All storm events, will see a decrease in flow rates from existing to proposed as a result of drainage area shifts and the construction of two new detention facilities. The following tables provide a comparison of runoff data between Existing and Proposed Conditions for Hawthorn Ridge First Plat. At Points B1 and C1, rates do not meet detention criteria but are kept at less than the Existing Conditions rates without detention as was outlined in the preliminary drainage study; therefore, additional detention facilities in those watersheds were not considered to be necessary. Where detention facilities are required, rates are reduced to less than the allowable peak flow rates, as shown in table 4-6, with the exception of the 2-year event at Point A1. However, that peak flow rate is drastically reduced from the Existing Conditions rate, so there will be no adverse effects on downstream systems.

**Table 4-5 Hawthorn Ridge Point of Interest Discharge Comparison**

|          |             | <b>Q<sub>2</sub> (cfs)</b> | <b>Q<sub>10</sub> (cfs)</b> | <b>Q<sub>100</sub> (cfs)</b> |
|----------|-------------|----------------------------|-----------------------------|------------------------------|
| Point A1 | Proposed    | 7.15                       | 12.3                        | 20.6                         |
|          | Existing:   | 20.58                      | 35.54                       | 58.64                        |
|          | Difference: | -13.43                     | -23.24                      | -38.04                       |
|          | Allowable:  | 3.81                       | 15.25                       | 22.87                        |
|          | Difference: | 3.34                       | -2.95                       | -2.27                        |
| Point B1 | Proposed    | 3.61                       | 6.41                        | 10.77                        |
|          | Existing:   | 5.72                       | 9.88                        | 16.29                        |
|          | Difference: | -2.11                      | -3.47                       | -5.52                        |
|          | Allowable   | 1.24                       | 4.44                        | 6.72                         |
|          | Difference: | 2.37                       | 1.97                        | 4.05                         |
| Point C1 | Proposed    | 15.07                      | 25.98                       | 42.8                         |
|          | Existing:   | 18.99                      | 32.4                        | 53.01                        |
|          | Difference: | -3.92                      | -6.42                       | -10.21                       |
|          | Allowable:  | 11.19                      | 23.03                       | 36.74                        |
|          | Difference: | 3.88                       | 2.95                        | 6.06                         |
| Point D1 | Proposed    | 44.57                      | 117.14                      | 240.05                       |
|          | Existing:   | 175.98                     | 308.32                      | 513.94                       |
|          | Difference: | -131.41                    | -191.18                     | -273.89                      |
|          | Allowable:  | 72.68                      | 199.86                      | 311.6                        |
|          | Difference: | -28.11                     | -82.72                      | -71.55                       |
| Point D2 | Proposed    | 31.76                      | 103.41                      | 162.07                       |
|          | Existing:   | 133.67                     | 229.89                      | 378.62                       |
|          | Difference: | -101.91                    | -126.48                     | -216.55                      |
|          | Allowable:  | 34.9                       | 123.75                      | 187.38                       |
|          | Difference: | -3.14                      | -20.34                      | -25.31                       |

In addition to mitigation of peak flow rates, APWA Section 5608.4 also requires 40 hour extended detention of runoff from the local 90% mean annual event (1.37"/24-hour rainfall). The two detention facilities will release the water quality event over a period of 40-72 hours. See Section 7.2 for the Time vs. Volume graph for the water quality event. The Water Quality Volume is released in approximately 57 hours from Basin A1 and approximately 40 hours from Basin D2.

## 5.) Future Conditions

The Future Conditions section of analysis assumes completion of Hawthorn Ridge First Plat and Second Plat, including construction of two new detention facilities in Watersheds A and D. The difference between the Existing Conditions model and the Proposed Conditions model is a direct result of the construction of Hawthorn Ridge First Plat.

As in the Existing Conditions section, this Future Conditions stormwater runoff model was created and run for the 2, 10 and 100-year design storm events. Refer to Section 7.3 for output from the Future Conditions model. The following tables contain input data and summarize the computed results from the PondPack model for Future Conditions. After the results of this Future Conditions model are presented, they will be compared to the Existing Conditions results. Any variation in computed discharge rates from Existing to Future Conditions will be a direct result of construction of Hawthorn Ridge.

**Table 5-1 Hawthorn Ridge Future Conditions Subarea Data**

| Subarea: | Area (ac.): | Composite CN | T <sub>c</sub> (hr.) |
|----------|-------------|--------------|----------------------|
| A1       | 6.95        | 85           | 0.123                |
| A1a      | 2.31        | 84           | 0.112                |
| B1       | 1.43        | 82           | 0.174                |
| C1       | 5.52        | 84           | 0.173                |
| D1       | 17.88       | 79           | 0.169                |
| D2       | 64.67       | 86           | 0.275                |
| D2a      | 1.54        | 79           | 0.141                |

**Table 5-2 Hawthorn Ridge Future Conditions Runoff Data: Subarea Peak Discharge Rates**

| Subarea: | Q <sub>2</sub> (cfs) | Q <sub>10</sub> (cfs) | Q <sub>100</sub> (cfs) |
|----------|----------------------|-----------------------|------------------------|
| A1       | 21.34                | 36.43                 | 59.61                  |
| A1a      | 6.92                 | 11.94                 | 19.68                  |
| B1       | 3.61                 | 6.41                  | 10.77                  |
| C1       | 15.07                | 25.98                 | 42.8                   |
| D1       | 39.98                | 74.12                 | 128.45                 |
| D2       | 164.03               | 276.78                | 449.52                 |
| D2a      | 3.53                 | 6.62                  | 11.58                  |

**Table 5-3 Hawthorn Ridge Future Conditions Runoff Data: Point of Interest Peak Discharge Rates**

| Point of Interest: | Q <sub>2</sub> (cfs) | Q <sub>10</sub> (cfs) | Q <sub>100</sub> (cfs) |
|--------------------|----------------------|-----------------------|------------------------|
| Point A1           | 7.15                 | 12.3                  | 20.6                   |
| Point B1           | 3.61                 | 6.41                  | 10.77                  |
| Point C1           | 15.07                | 25.98                 | 42.8                   |
| Point D1           | 44.62                | 131.25                | 247.98                 |
| Point D2           | 37.06                | 115.37                | 167.66                 |

**Table 5-4 Future Conditions Detention Basin Data**

|          | Peak Q In<br>(cfs) | T <sub>p</sub> In<br>(hr.) | Peak Q<br>Out (cfs) | T <sub>p</sub> Out<br>(hr.) | V <sub>R</sub><br>(ac-ft) | Peak<br>W.S.E. | Max. Storage<br>Volume (ac-ft) |
|----------|--------------------|----------------------------|---------------------|-----------------------------|---------------------------|----------------|--------------------------------|
| Basin A1 |                    |                            |                     |                             |                           |                |                                |
| 2-Year   | 21.34              | 11.95                      | 0.40                | 17.90                       | 1.22                      | 1,023.09       | 0.87                           |
| 10-Year  | 36.43              | 11.95                      | 1.12                | 14.65                       | 2.11                      | 1,023.79       | 1.47                           |
| 100-Year | 59.61              | 11.95                      | 7.76                | 12.35                       | 3.54                      | 1,024.38       | 2.00                           |
| Basin D2 |                    |                            |                     |                             |                           |                |                                |
| 2-Year   | 164.03             | 12.05                      | 36.58               | 12.45                       | 11.79                     | 1,002.26       | 5.44                           |
| 10-Year  | 276.78             | 12.05                      | 114.15              | 12.30                       | 20.20                     | 1,003.71       | 8.32                           |
| 100-Year | 449.52             | 12.05                      | 165.84              | 12.30                       | 33.61                     | 1,005.57       | 13.28                          |

All storm events, will see a decrease in flow rates as a result of drainage area shifts and the construction of two new detention facilities. The following tables provide a comparison of runoff data between Existing and Future Conditions for Hawthorn Ridge First and Second Plats. At Points B1 and C1, rates do not meet detention criteria but are kept at less than the Existing Conditions rates without detention as was outlined in the preliminary drainage study; rates are kept at less than the Existing Conditions rates without detention; therefore, additional detention facilities in those watersheds were not considered to be necessary. Where detention facilities are required, rates are reduced to less than the allowable peak flow rates, as shown in table 4-6, with the exception of the 2-year event at Point A1. However, that peak flow rate is drastically reduced from the Existing Conditions rate, so there will be no adverse effects on downstream systems.

Waivers are requested for the exceptions to the standard requirements.

**Table 5-5 Hawthorn Ridge Point of Interest Discharge Comparison**

|          |             | <b>Q<sub>2</sub> (cfs)</b> | <b>Q<sub>10</sub> (cfs)</b> | <b>Q<sub>100</sub> (cfs)</b> |
|----------|-------------|----------------------------|-----------------------------|------------------------------|
| Point A1 | Future      | 7.15                       | 12.3                        | 20.6                         |
|          | Existing:   | 20.58                      | 35.54                       | 58.64                        |
|          | Difference: | -13.43                     | -23.24                      | -38.04                       |
|          | Allowable:  | 3.81                       | 15.25                       | 22.87                        |
|          | Difference: | 3.34                       | -2.95                       | -2.27                        |
| Point B1 | Future      | 3.61                       | 6.41                        | 10.77                        |
|          | Existing:   | 5.72                       | 9.88                        | 16.29                        |
|          | Difference: | -2.11                      | -3.47                       | -5.52                        |
|          | Allowable:  | 1.24                       | 4.44                        | 6.72                         |
|          | Difference: | 2.37                       | 1.97                        | 4.05                         |
| Point C1 | Future      | 15.07                      | 25.98                       | 42.8                         |
|          | Existing:   | 18.99                      | 32.4                        | 53.01                        |
|          | Difference: | -3.92                      | -6.42                       | -10.21                       |
|          | Allowable:  | 11.19                      | 23.03                       | 36.74                        |
|          | Difference: | 3.88                       | 2.95                        | 6.06                         |
| Point D1 | Future      | 44.62                      | 131.25                      | 247.98                       |
|          | Existing:   | 175.98                     | 308.32                      | 513.94                       |
|          | Difference: | -131.36                    | -177.07                     | -265.96                      |
|          | Allowable:  | 72.68                      | 199.86                      | 311.6                        |
|          | Difference: | -28.06                     | -68.61                      | -63.62                       |
| Point D2 | Future      | 37.06                      | 115.37                      | 167.66                       |
|          | Existing:   | 133.67                     | 229.89                      | 378.62                       |
|          | Difference: | -96.61                     | -114.52                     | -210.96                      |
|          | Allowable:  | 34.9                       | 123.75                      | 187.38                       |
|          | Difference: | 2.16                       | -8.38                       | -19.72                       |

In addition to mitigation of peak flow rates, APWA Section 5608.4 also requires 40 hour extended detention of runoff from the local 90% mean annual event (1.37"/24-hour rainfall). The two detention facilities will release the water quality event over a period of 40-72 hours. See Section 7.3 for the Time vs. Volume graph for the water quality event. The Water Quality Volume is released in approximately 57 hours from Basin A1 and approximately 47 hours from Basin D2.

## **6.) Summary**

This Stormwater drainage study has been prepared to evaluate the hydrologic impact generated by the proposed development of Hawthorn Ridge First Plat and future development of Hawthorn Ridge First and Second Plat. Section 3 of this report determined the baseline conditions reflecting the Existing Conditions for the project site. Section 4 analyzes the site with the construction of the First Plat and the two detention facilities in Watersheds A and D. Section 5 analyzes the site under fully developed conditions. The results of these models were compared to evaluate the hydrologic impact generated by the project. Proposed and Future Conditions flow rates were also compared to the allowable maximum release rates per APWA Section 5600.

## **7.) Conclusions**

Hawthorn Ridge is proposed as a 203-lot single family residential subdivision on the south side of SW Hook Rd approximately 1,300 feet east of SW Pryor Road. This report has been prepared to evaluate the development to ensure that stormwater discharge from the site will not increase with development. Two detention facilities will be constructed in conjunction with development of Hawthorn Ridge First Plat to reduce peak discharge rates.

In conclusion, all points of interest exhibit Proposed Conditions peak discharges for all events that are at or below the Existing Conditions rates and/or allowable release rates. Waivers are requested for the exceptions to the standard requirements.

It is therefore requested that Lee's Summit, Missouri approve this "Hawthorn Ridge First Plat Drainage Study."

Figure 2 - Floodplain Map





MAP SCALE 1" = 500'

250 0 500 1000 FEET

250 0 500 1000 METERS



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0406F

**FIRM**

FLOOD INSURANCE RATE MAP

JACKSON COUNTY,  
MISSOURI  
AND INCORPORATED AREAS

PANEL 406 OF 480

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY                | NUMBER | PANEL | SUFFIX |
|--------------------------|--------|-------|--------|
| LEE'S SUMMIT,<br>CITY OF | 290174 | 0406  | F      |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.



MAP NUMBER  
29095C0406F

EFFECTIVE DATE  
SEPTEMBER 29, 2006

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at [www.msc.fema.gov](http://www.msc.fema.gov)

Soil Map—Jackson County, Missouri  
Figure 3 - Soils Map



## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service  
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>  
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

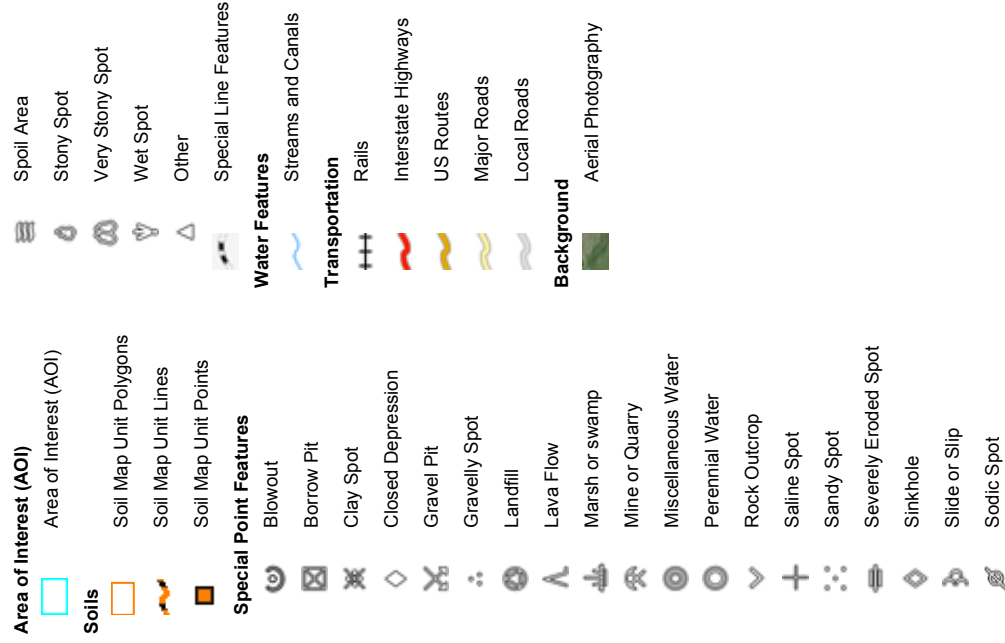
This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Jackson County, Missouri  
Survey Area Data: Version 15, Sep 11, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Feb 19, 2012—Mar 25, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.



## Map Unit Legend

| Jackson County, Missouri (MO095)   |                                                      |              |                |
|------------------------------------|------------------------------------------------------|--------------|----------------|
| Map Unit Symbol                    | Map Unit Name                                        | Acres in AOI | Percent of AOI |
| 10000                              | Arisburg silt loam, 1 to 5 percent slopes            | 32.9         | 39.4%          |
| 10082                              | Arisburg-Urban land complex, 1 to 5 percent slopes   | 11.4         | 13.7%          |
| 10117                              | Sampsel silty clay loam, 5 to 9 percent slopes       | 37.3         | 44.7%          |
| 10128                              | Sharpsburg-Urban land complex, 2 to 5 percent slopes | 1.8          | 2.1%           |
| <b>Totals for Area of Interest</b> |                                                      | <b>83.4</b>  | <b>100.0%</b>  |

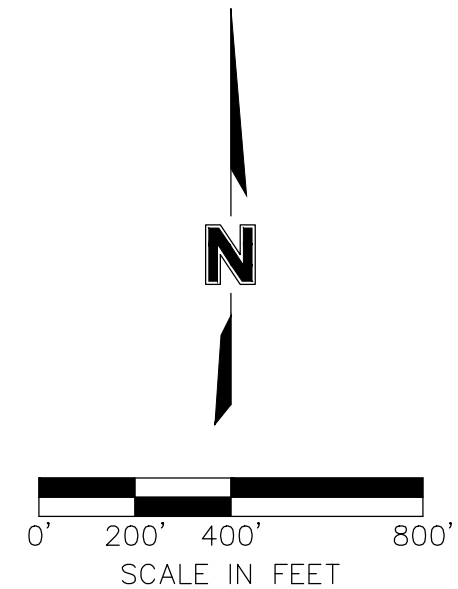
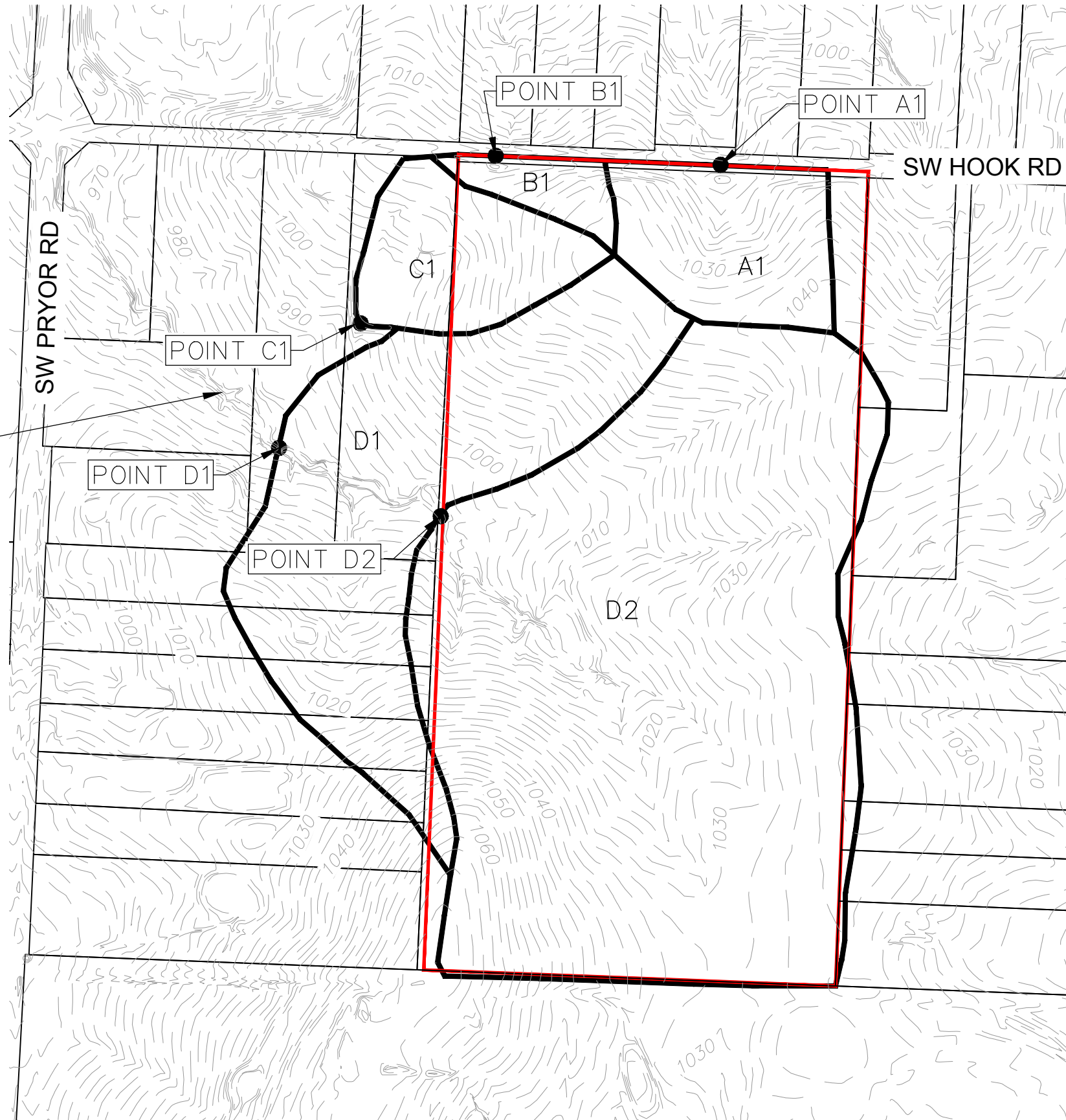
DWG: F:\2017\0001-0500\017-0188\40-Design\Exhibits\StmWtrStudy\W\_DAM\_EX\_70188.dwg  
DATE: Mar 08, 2018 11:40am  
USER: mdegonia  
XREFS:

LEGEND

RIDGE LINES

HAWTHORN RIDGE  
PROPERTY BOUNDARY

TRIBUTARY TO  
MOUSE CREEK



|                      |
|----------------------|
| PROJECT NO: 017-0188 |
| DRAWN BY: BHL        |
| DATE: 3.1.2017       |

## EXISTING CONDITIONS DRAINAGE AREA MAP

**MOLSSON**  
ASSOCIATES

7301 West 133rd Street  
Suite 200  
Overland Park, KS 66213-4750  
TEL 913.381.1170  
FAX 913.381.1174

|        |
|--------|
| FIGURE |
| 4      |

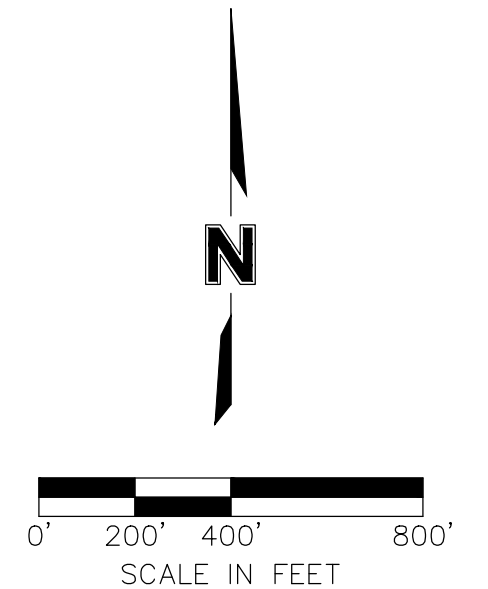
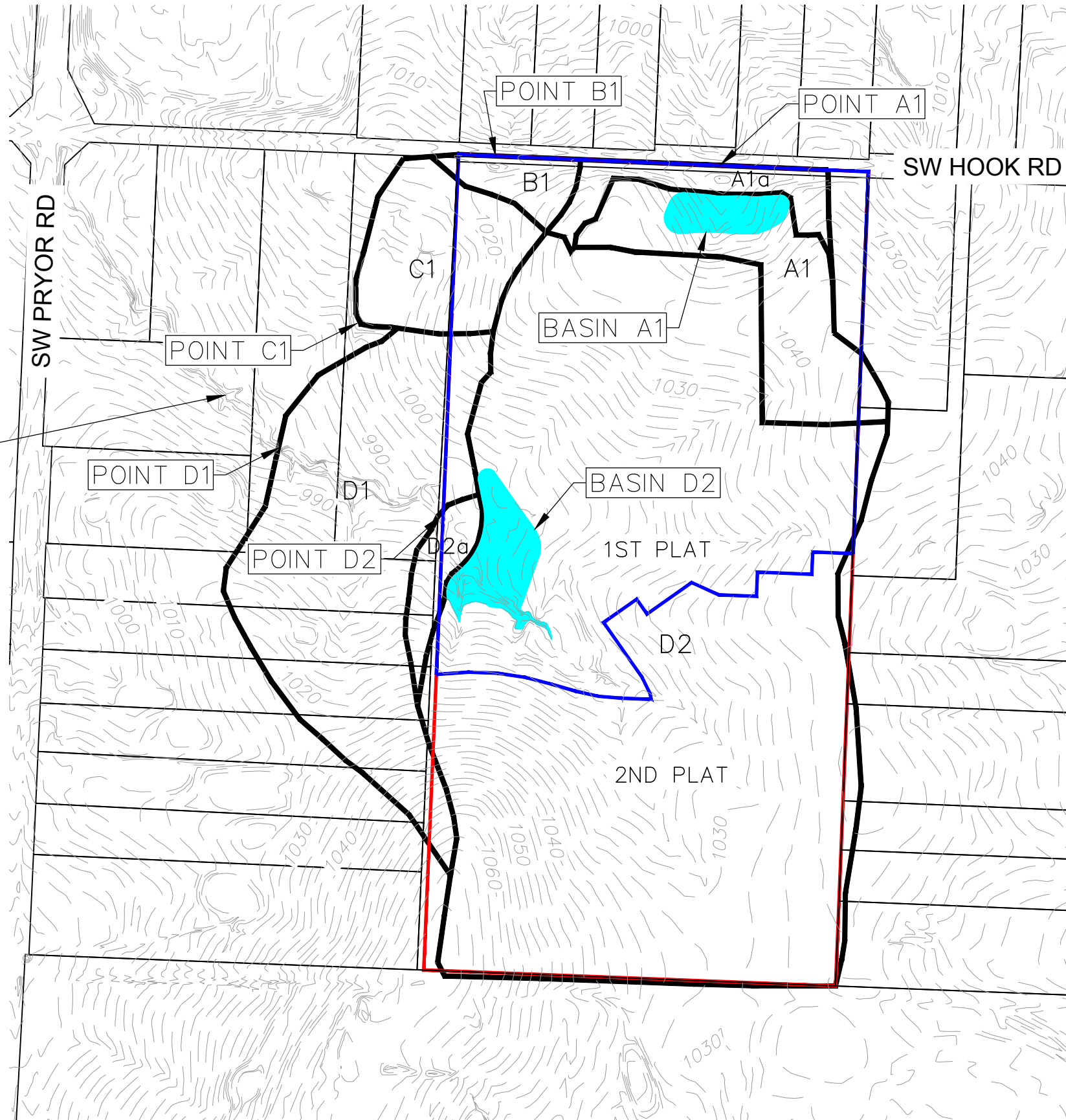
DWG: F:\2017\0001-0500\017-0188\40-Design\Exhibits\StmWtrStudy\W\_DAM\_PROP\_70188.dwg  
DATE: Mar 08, 2018 11:40am  
USER: mdgonia  
XREFS:

LEGEND

RIDGE LINES  
HAWTHORN RIDGE  
PROPERTY BOUNDARY  
PROPOSED DETENTION



TRIBUTARY TO  
MOUSE CREEK



PROJECT NO: 017-0188

DRAWN BY: BHL

DATE: 3.1.2017

PROPOSED AND FUTURE CONDITIONS DRAINAGE AREA MAP

**MOLSSON**  
ASSOCIATES  
7301 West 133rd Street  
Suite 200  
Overland Park, KS 66213-4750  
TEL 913.381.1170  
FAX 913.381.1174

FIGURE

5

## Section 7.1 Existing Conditions Model Summary

---

### Project Summary

---

|          |                   |
|----------|-------------------|
| Title    | Arborwalk         |
| Engineer | MGD               |
| Company  | Olsson Associates |
| Date     | 9/14/2016         |

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### Notes

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## Section 7.1 Existing Conditions Model Summary

Subsection: Master Network Summary

### Catchments Summary

| Label      | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft <sup>3</sup> /s) |
|------------|----------|----------------------|---------------------------|----------------------|--------------------------------|
| Subarea A1 | 2-Year   | 2                    | 1.281                     | 12.000               | 20.58                          |
| Subarea A1 | 10-Year  | 10                   | 2.246                     | 12.000               | 35.54                          |
| Subarea A1 | 100-Year | 100                  | 3.801                     | 12.000               | 58.64                          |
| Subarea B1 | 2-Year   | 2                    | 0.355                     | 12.000               | 5.72                           |
| Subarea B1 | 10-Year  | 10                   | 0.622                     | 12.000               | 9.88                           |
| Subarea B1 | 100-Year | 100                  | 1.053                     | 12.000               | 16.29                          |
| Subarea C1 | 2-Year   | 2                    | 1.200                     | 12.000               | 18.99                          |
| Subarea C1 | 10-Year  | 10                   | 2.080                     | 12.000               | 32.40                          |
| Subarea C1 | 100-Year | 100                  | 3.489                     | 12.000               | 53.01                          |
| Subarea D1 | 2-Year   | 2                    | 3.689                     | 12.000               | 60.44                          |
| Subarea D1 | 10-Year  | 10                   | 6.704                     | 12.000               | 108.66                         |
| Subarea D1 | 100-Year | 100                  | 11.645                    | 12.000               | 184.34                         |
| Subarea D2 | 2-Year   | 2                    | 10.291                    | 12.100               | 133.67                         |
| Subarea D2 | 10-Year  | 10                   | 17.845                    | 12.050               | 229.89                         |
| Subarea D2 | 100-Year | 100                  | 29.945                    | 12.050               | 378.62                         |

### Node Summary

| Label    | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft <sup>3</sup> /s) |
|----------|----------|----------------------|---------------------------|----------------------|--------------------------------|
| Point A1 | 2-Year   | 2                    | 1.281                     | 12.000               | 20.58                          |
| Point A1 | 10-Year  | 10                   | 2.246                     | 12.000               | 35.54                          |
| Point A1 | 100-Year | 100                  | 3.801                     | 12.000               | 58.64                          |
| Point B1 | 2-Year   | 2                    | 0.355                     | 12.000               | 5.72                           |
| Point B1 | 10-Year  | 10                   | 0.622                     | 12.000               | 9.88                           |
| Point B1 | 100-Year | 100                  | 1.053                     | 12.000               | 16.29                          |
| Point C1 | 2-Year   | 2                    | 1.200                     | 12.000               | 18.99                          |
| Point C1 | 10-Year  | 10                   | 2.080                     | 12.000               | 32.40                          |
| Point C1 | 100-Year | 100                  | 3.489                     | 12.000               | 53.01                          |
| Point D1 | 2-Year   | 2                    | 13.971                    | 12.050               | 175.98                         |
| Point D1 | 10-Year  | 10                   | 24.535                    | 12.050               | 308.32                         |
| Point D1 | 100-Year | 100                  | 41.570                    | 12.050               | 513.94                         |
| Point D2 | 2-Year   | 2                    | 10.291                    | 12.100               | 133.67                         |
| Point D2 | 10-Year  | 10                   | 17.845                    | 12.050               | 229.89                         |
| Point D2 | 100-Year | 100                  | 29.945                    | 12.050               | 378.62                         |

## Section 7.1 Existing Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea A1

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.020 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.18 ft/s   |
| Segment Time of Concentration               | 0.154 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 285.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.055 ft/ft |
| Average Velocity                            | 3.78 ft/s   |
| Segment Time of Concentration               | 0.021 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 230.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.006 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.181 hours |

## Section 7.1 Existing Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea A1

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
Lf= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
Aq= Flow area, square feet  
Wp= Wetted perimeter, feet  
V= Velocity, ft/sec  
Sf= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
Lf= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
Sf= Slope, ft/ft  
Tc= Time of concentration, hours  
Lf= Flow length, feet

## Section 7.1 Existing Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea B1

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.020 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.18 ft/s   |
| Segment Time of Concentration               | 0.154 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 180.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.030 ft/ft |
| Average Velocity                            | 2.79 ft/s   |
| Segment Time of Concentration               | 0.018 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 330.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.009 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.181 hours |

## Section 7.1 Existing Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea B1

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.1 Existing Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea C1

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.020 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.18 ft/s   |
| Segment Time of Concentration               | 0.154 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 410.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.050 ft/ft |
| Average Velocity                            | 3.61 ft/s   |
| Segment Time of Concentration               | 0.032 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 150.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.004 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.190 hours |

## Section 7.1 Existing Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea C1

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.1 Existing Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D1

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.050 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.26 ft/s   |
| Segment Time of Concentration               | 0.107 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 560.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.070 ft/ft |
| Average Velocity                            | 4.27 ft/s   |
| Segment Time of Concentration               | 0.036 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 945.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.026 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.169 hours |

## Section 7.1 Existing Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D1

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.1 Existing Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D2

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.015 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.16 ft/s   |
| Segment Time of Concentration               | 0.173 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 560.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.010 ft/ft |
| Average Velocity                            | 1.61 ft/s   |
| Segment Time of Concentration               | 0.096 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 1,590.00 ft |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.044 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.313 hours |

## Section 7.1 Existing Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D2

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
Lf= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
Aq= Flow area, square feet  
Wp= Wetted perimeter, feet  
V= Velocity, ft/sec  
Sf= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
Lf= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
Sf= Slope, ft/ft  
Tc= Time of concentration, hours  
Lf= Flow length, feet

## Section 7.1 Existing Conditions Model Summary

Subsection: Runoff CN-Area

Return Event: 2 years

Label: Subarea A1

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| Row crop Contoured HSG D          | 88.000 | 4.090           | 0.0      | 0.0       | 88.000      |
| Meadow HSG D                      | 78.000 | 3.280           | 0.0      | 0.0       | 78.000      |
| Impervious                        | 98.000 | 0.250           | 0.0      | 0.0       | 98.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 7.620           | (N/A)    | (N/A)     | 84.024      |

## Section 7.1 Existing Conditions Model Summary

Subsection: Runoff CN-Area

Label: Subarea B1

Return Event: 2 years

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| Row crop Contoured HSG D          | 88.000 | 0.750           | 0.0      | 0.0       | 88.000      |
| Meadow HSG D                      | 78.000 | 1.050           | 0.0      | 0.0       | 78.000      |
| Impervious                        | 98.000 | 0.230           | 0.0      | 0.0       | 98.000      |
| Offsite Meadow HSG D              | 78.000 | 0.070           | 0.0      | 0.0       | 78.000      |
| Offsite Impervious                | 98.000 | 0.010           | 0.0      | 0.0       | 98.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 2.110           | (N/A)    | (N/A)     | 83.829      |

## Section 7.1 Existing Conditions Model Summary

Subsection: Runoff CN-Area

Label: Subarea C1

Return Event: 2 years

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| Row crop Contoured HSG D          | 88.000 | 2.360           | 0.0      | 0.0       | 88.000      |
| Meadow HSG D                      | 78.000 | 1.030           | 0.0      | 0.0       | 78.000      |
| Impervious                        | 98.000 | 0.050           | 0.0      | 0.0       | 98.000      |
| Offsite Meadow HSG D              | 78.000 | 2.280           | 0.0      | 0.0       | 78.000      |
| Offsite Impervious                | 98.000 | 1.140           | 0.0      | 0.0       | 98.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 6.860           | (N/A)    | (N/A)     | 84.910      |

## Section 7.1 Existing Conditions Model Summary

Subsection: Runoff CN-Area

Return Event: 2 years

Label: Subarea D1

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| Row crop Contoured HSG D          | 88.000 | 7.040           | 0.0      | 0.0       | 88.000      |
| Meadow HSG D                      | 78.000 | 1.490           | 0.0      | 0.0       | 78.000      |
| Impervious                        | 98.000 | 0.090           | 0.0      | 0.0       | 98.000      |
| Offsite Meadow HSG D              | 78.000 | 15.690          | 0.0      | 0.0       | 78.000      |
| Offsite Impervious                | 98.000 | 0.480           | 0.0      | 0.0       | 98.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 24.790          | (N/A)    | (N/A)     | 81.300      |

## Section 7.1 Existing Conditions Model Summary

Subsection: Runoff CN-Area

Return Event: 2 years

Label: Subarea D2

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| Row crop Contoured HSG D          | 88.000 | 42.710          | 0.0      | 0.0       | 88.000      |
| Meadow HSG D                      | 78.000 | 13.190          | 0.0      | 0.0       | 78.000      |
| Offsite Meadow HSG D              | 78.000 | 3.020           | 0.0      | 0.0       | 78.000      |
| Offsite Impervious                | 98.000 | 0.040           | 0.0      | 0.0       | 98.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 58.960          | (N/A)    | (N/A)     | 85.257      |

## **Section 7.1 Existing Conditions Model Summary**

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## Section 7.2 Proposed Conditions Model Summary

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### Project Summary

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|          |                   |
|----------|-------------------|
| Title    | Hawthorn Ridge    |
| Engineer | MGD               |
| Company  | Olsson Associates |
| Date     | 3/8/2018          |

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### Notes

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## Section 7.2 Proposed Conditions Model Summary

Subsection: Master Network Summary

### Catchments Summary

| Label       | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft <sup>3</sup> /s) |
|-------------|----------|----------------------|---------------------------|----------------------|--------------------------------|
| Subarea A1  | 2-Year   | 2                    | 1.219                     | 11.950               | 21.34                          |
| Subarea A1  | 10-Year  | 10                   | 2.112                     | 11.950               | 36.43                          |
| Subarea A1  | 100-Year | 100                  | 3.543                     | 11.950               | 59.61                          |
| Subarea B1  | 2-Year   | 2                    | 0.222                     | 12.000               | 3.61                           |
| Subarea B1  | 10-Year  | 10                   | 0.399                     | 12.000               | 6.41                           |
| Subarea B1  | 100-Year | 100                  | 0.687                     | 12.000               | 10.77                          |
| Subarea C1  | 2-Year   | 2                    | 0.930                     | 12.000               | 15.07                          |
| Subarea C1  | 10-Year  | 10                   | 1.630                     | 12.000               | 25.98                          |
| Subarea C1  | 100-Year | 100                  | 2.759                     | 12.000               | 42.80                          |
| Subarea D1  | 2-Year   | 2                    | 2.448                     | 12.000               | 39.98                          |
| Subarea D1  | 10-Year  | 10                   | 4.559                     | 12.000               | 74.12                          |
| Subarea D1  | 100-Year | 100                  | 8.064                     | 12.000               | 128.45                         |
| Subarea D2  | 2-Year   | 2                    | 10.469                    | 12.050               | 146.03                         |
| Subarea D2  | 10-Year  | 10                   | 18.572                    | 12.050               | 257.11                         |
| Subarea D2  | 100-Year | 100                  | 31.694                    | 12.050               | 430.06                         |
| Subarea D2a | 2-Year   | 2                    | 0.211                     | 12.000               | 3.53                           |
| Subarea D2a | 10-Year  | 10                   | 0.393                     | 11.950               | 6.62                           |
| Subarea D2a | 100-Year | 100                  | 0.695                     | 11.950               | 11.58                          |
| Subarea A1a | 2-Year   | 2                    | 0.389                     | 11.950               | 6.92                           |
| Subarea A1a | 10-Year  | 10                   | 0.682                     | 11.950               | 11.94                          |
| Subarea A1a | 100-Year | 100                  | 1.154                     | 11.950               | 19.68                          |

### Node Summary

| Label    | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft <sup>3</sup> /s) |
|----------|----------|----------------------|---------------------------|----------------------|--------------------------------|
| Point A1 | 2-Year   | 2                    | 1.529                     | 11.950               | 7.15                           |
| Point A1 | 10-Year  | 10                   | 2.621                     | 11.950               | 12.30                          |
| Point A1 | 100-Year | 100                  | 4.515                     | 12.000               | 20.60                          |
| Point B1 | 2-Year   | 2                    | 0.222                     | 12.000               | 3.61                           |
| Point B1 | 10-Year  | 10                   | 0.399                     | 12.000               | 6.41                           |
| Point B1 | 100-Year | 100                  | 0.687                     | 12.000               | 10.77                          |
| Point C1 | 2-Year   | 2                    | 0.930                     | 12.000               | 15.07                          |
| Point C1 | 10-Year  | 10                   | 1.630                     | 12.000               | 25.98                          |
| Point C1 | 100-Year | 100                  | 2.759                     | 12.000               | 42.80                          |
| Point D1 | 2-Year   | 2                    | 13.129                    | 12.000               | 44.57                          |
| Point D1 | 10-Year  | 10                   | 23.525                    | 12.300               | 117.14                         |
| Point D1 | 100-Year | 100                  | 40.453                    | 12.050               | 240.05                         |
| Point D2 | 2-Year   | 2                    | 10.680                    | 12.450               | 31.76                          |
| Point D2 | 10-Year  | 10                   | 18.965                    | 12.300               | 103.41                         |
| Point D2 | 100-Year | 100                  | 32.389                    | 12.300               | 162.07                         |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Master Network Summary

### Pond Summary

| Label          | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft <sup>3</sup> /s) | Maximum Water Surface Elevation (ft) | Maximum Pond Storage (ac-ft) |
|----------------|----------|----------------------|---------------------------|----------------------|--------------------------------|--------------------------------------|------------------------------|
| Basin D2 (IN)  | 2-Year   | 2                    | 10.469                    | 12.050               | 146.03                         | (N/A)                                | (N/A)                        |
| Basin D2 (OUT) | 2-Year   | 2                    | 10.469                    | 12.450               | 31.29                          | 1,001.85                             | 4.766                        |
| Basin D2 (IN)  | 10-Year  | 10                   | 18.572                    | 12.050               | 257.11                         | (N/A)                                | (N/A)                        |
| Basin D2 (OUT) | 10-Year  | 10                   | 18.572                    | 12.300               | 102.31                         | 1,003.43                             | 7.700                        |
| Basin D2 (IN)  | 100-Year | 100                  | 31.694                    | 12.050               | 430.06                         | (N/A)                                | (N/A)                        |
| Basin D2 (OUT) | 100-Year | 100                  | 31.694                    | 12.300               | 160.24                         | 1,005.34                             | 12.573                       |
| Basin A1 (IN)  | 2-Year   | 2                    | 1.219                     | 11.950               | 21.34                          | (N/A)                                | (N/A)                        |
| Basin A1 (OUT) | 2-Year   | 2                    | 1.140                     | 17.900               | 0.40                           | 1,023.09                             | 0.870                        |
| Basin A1 (IN)  | 10-Year  | 10                   | 2.112                     | 11.950               | 36.43                          | (N/A)                                | (N/A)                        |
| Basin A1 (OUT) | 10-Year  | 10                   | 1.938                     | 14.650               | 1.12                           | 1,023.79                             | 1.474                        |
| Basin A1 (IN)  | 100-Year | 100                  | 3.543                     | 11.950               | 59.61                          | (N/A)                                | (N/A)                        |
| Basin A1 (OUT) | 100-Year | 100                  | 3.360                     | 12.350               | 7.76                           | 1,024.38                             | 1.999                        |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea A1

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 60.00 ft    |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.020 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.16 ft/s   |
| Segment Time of Concentration               | 0.102 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 250.00 ft   |
| Is Paved?                                   | True        |
| Slope                                       | 0.040 ft/ft |
| Average Velocity                            | 4.07 ft/s   |
| Segment Time of Concentration               | 0.017 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 140.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.004 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.123 hours |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea A1

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea A1a

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 50.00 ft    |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.020 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.16 ft/s   |
| Segment Time of Concentration               | 0.088 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 205.00 ft   |
| Is Paved?                                   | True        |
| Slope                                       | 0.060 ft/ft |
| Average Velocity                            | 4.98 ft/s   |
| Segment Time of Concentration               | 0.011 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 420.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.012 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.112 hours |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea A1a

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea B1

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.020 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.18 ft/s   |
| Segment Time of Concentration               | 0.154 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 180.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.030 ft/ft |
| Average Velocity                            | 2.79 ft/s   |
| Segment Time of Concentration               | 0.018 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 65.00 ft    |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.002 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.174 hours |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea B1

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea C1

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.020 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.18 ft/s   |
| Segment Time of Concentration               | 0.154 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 180.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.050 ft/ft |
| Average Velocity                            | 3.61 ft/s   |
| Segment Time of Concentration               | 0.014 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 195.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.005 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.173 hours |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea C1

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
Lf= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
Aq= Flow area, square feet  
Wp= Wetted perimeter, feet  
V= Velocity, ft/sec  
Sf= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
Lf= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
Sf= Slope, ft/ft  
Tc= Time of concentration, hours  
Lf= Flow length, feet

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D1

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.050 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.26 ft/s   |
| Segment Time of Concentration               | 0.107 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 560.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.070 ft/ft |
| Average Velocity                            | 4.27 ft/s   |
| Segment Time of Concentration               | 0.036 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 945.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.026 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.169 hours |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D1

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D2

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.015 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.16 ft/s   |
| Segment Time of Concentration               | 0.173 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 615.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.050 ft/ft |
| Average Velocity                            | 3.61 ft/s   |
| Segment Time of Concentration               | 0.047 hours |
| Segment #3: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 335.00 ft   |
| Is Paved?                                   | True        |
| Slope                                       | 0.040 ft/ft |
| Average Velocity                            | 4.07 ft/s   |
| Segment Time of Concentration               | 0.023 hours |
| Segment #4: Length and Velocity             |             |
| Hydraulic Length                            | 1,135.00 ft |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.032 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.275 hours |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D2

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{-0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D2a

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.050 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.26 ft/s   |
| Segment Time of Concentration               | 0.107 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 400.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.050 ft/ft |
| Average Velocity                            | 3.61 ft/s   |
| Segment Time of Concentration               | 0.031 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 125.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.003 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.141 hours |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D2a

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.2 Proposed Conditions Model Summary

Subsection: Runoff CN-Area

Label: Subarea A1

Return Event: 2 years

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| SFR HSG D                         | 87.000 | 4.957           | 0.0      | 0.0       | 87.000      |
| Open Space HSG D                  | 80.000 | 1.680           | 0.0      | 0.0       | 80.000      |
| Offsite Meadow HSG D              | 78.000 | 0.310           | 0.0      | 0.0       | 78.000      |
| Offsite Impervious                | 98.000 | 0.002           | 0.0      | 0.0       | 98.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 6.949           | (N/A)    | (N/A)     | 84.909      |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Runoff CN-Area

Return Event: 2 years

Label: Subarea A1a

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| SFR HSG D                         | 87.000 | 1.349           | 0.0      | 0.0       | 87.000      |
| Open Space HSG D                  | 80.000 | 0.960           | 0.0      | 0.0       | 80.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 2.309           | (N/A)    | (N/A)     | 84.090      |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Runoff CN-Area

Label: Subarea B1

Return Event: 2 years

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description            | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-------------------------------------|--------|-----------------|----------|-----------|-------------|
| SFR HSG D                           | 87.000 | 0.400           | 0.0      | 0.0       | 87.000      |
| Established Native Vegetation HSG D | 78.000 | 0.840           | 0.0      | 0.0       | 78.000      |
| Impervious                          | 98.000 | 0.110           | 0.0      | 0.0       | 98.000      |
| Offsite Meadow HSG D                | 78.000 | 0.070           | 0.0      | 0.0       | 78.000      |
| Offsite Impervious                  | 98.000 | 0.010           | 0.0      | 0.0       | 98.000      |
| COMPOSITE AREA & WEIGHTED CN --->   | (N/A)  | 1.430           | (N/A)    | (N/A)     | 82.196      |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Runoff CN-Area

Label: Subarea C1

Return Event: 2 years

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description            | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-------------------------------------|--------|-----------------|----------|-----------|-------------|
| SFR HSG D                           | 87.000 | 1.080           | 0.0      | 0.0       | 87.000      |
| Established Native Vegetation HSG D | 78.000 | 1.020           | 0.0      | 0.0       | 78.000      |
| Offsite Meadow HSG D                | 78.000 | 2.280           | 0.0      | 0.0       | 78.000      |
| Offsite Impervious                  | 98.000 | 1.140           | 0.0      | 0.0       | 98.000      |
| COMPOSITE AREA & WEIGHTED CN --->   | (N/A)  | 5.520           | (N/A)    | (N/A)     | 83.891      |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Runoff CN-Area

Return Event: 2 years

Label: Subarea D1

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| SFR HSG D                         | 87.000 | 0.830           | 0.0      | 0.0       | 87.000      |
| Open Space HSG D                  | 80.000 | 0.870           | 0.0      | 0.0       | 80.000      |
| Offsite Meadow HSG D              | 78.000 | 15.690          | 0.0      | 0.0       | 78.000      |
| Offsite Impervious                | 98.000 | 0.480           | 0.0      | 0.0       | 98.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 17.870          | (N/A)    | (N/A)     | 79.053      |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Runoff CN-Area

Label: Subarea D2

Return Event: 2 years

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| SFR HSG D                         | 87.000 | 23.890          | 0.0      | 0.0       | 87.000      |
| Open Space HSG D                  | 80.000 | 39.270          | 0.0      | 0.0       | 80.000      |
| Offsite Meadow HSG D              | 78.000 | 1.506           | 0.0      | 0.0       | 78.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 64.666          | (N/A)    | (N/A)     | 82.539      |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Runoff CN-Area

Label: Subarea D2a

Return Event: 2 years

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| Open Space HSG D                  | 80.000 | 0.620           | 0.0      | 0.0       | 80.000      |
| Offsite Meadow HSG D              | 78.000 | 0.920           | 0.0      | 0.0       | 78.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 1.540           | (N/A)    | (N/A)     | 78.805      |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Elevation-Area Volume Curve

Return Event: 2 years

Label: Basin A1

Storm Event: 2-YEAR

| Elevation<br>(ft) | Planimeter<br>(ft <sup>2</sup> ) | Area<br>(acres) | $A1+A2+\sqrt{A1 \cdot A2}$<br>(acres) | Volume<br>(ac-ft) | Volume (Total)<br>(ac-ft) |
|-------------------|----------------------------------|-----------------|---------------------------------------|-------------------|---------------------------|
| 1,022.00          | 0.0                              | 0.767           | 0.000                                 | 0.000             | 0.000                     |
| 1,024.00          | 0.0                              | 0.892           | 2.486                                 | 1.657             | 1.657                     |
| 1,026.00          | 0.0                              | 1.020           | 2.866                                 | 1.911             | 3.568                     |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Elevation-Area Volume Curve

Return Event: 2 years

Label: Basin D2

Storm Event: 2-YEAR

| Elevation<br>(ft) | Planimeter<br>(ft <sup>2</sup> ) | Area<br>(acres) | $A1+A2+\sqrt{A1 \cdot A2}$<br>(acres) | Volume<br>(ac-ft) | Volume (Total)<br>(ac-ft) |
|-------------------|----------------------------------|-----------------|---------------------------------------|-------------------|---------------------------|
| 992.50            | 0.0                              | 0.007           | 0.000                                 | 0.000             | 0.000                     |
| 994.00            | 0.0                              | 0.033           | 0.055                                 | 0.028             | 0.028                     |
| 996.00            | 0.0                              | 0.212           | 0.329                                 | 0.219             | 0.247                     |
| 998.00            | 0.0                              | 0.546           | 1.098                                 | 0.732             | 0.979                     |
| 1,000.00          | 0.0                              | 0.956           | 2.224                                 | 1.483             | 2.462                     |
| 1,002.00          | 0.0                              | 1.616           | 3.815                                 | 2.543             | 5.005                     |
| 1,004.00          | 0.0                              | 2.395           | 5.978                                 | 3.986             | 8.991                     |
| 1,006.00          | 0.0                              | 3.270           | 8.464                                 | 5.642             | 14.633                    |
| 1,008.00          | 0.0                              | 3.806           | 10.604                                | 7.069             | 21.702                    |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Outlet Input Data

Label: Basin A1

Return Event: 2 years

Storm Event: 2-YEAR

### Requested Pond Water Surface Elevations

|                       |             |
|-----------------------|-------------|
| Minimum (Headwater)   | 1,022.00 ft |
| Increment (Headwater) | 0.50 ft     |
| Maximum (Headwater)   | 1,026.00 ft |

### Outlet Connectivity

| Structure Type     | Outlet ID   | Direction | Outfall     | E1<br>(ft) | E2<br>(ft) |
|--------------------|-------------|-----------|-------------|------------|------------|
| Orifice-Circular   | Orifice - 2 | Forward   | Culvert - 1 | 1,022.00   | 1,026.00   |
| Orifice-Area       | Orifice - 1 | Forward   | Culvert - 1 | 1,023.75   | 1,026.00   |
| Culvert-Circular   | Culvert - 1 | Forward   | TW          | 1,012.00   | 1,026.00   |
| Tailwater Settings | Tailwater   |           |             | (N/A)      | (N/A)      |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Outlet Input Data

Label: Basin A1

Return Event: 2 years

Storm Event: 2-YEAR

|                                  |             |
|----------------------------------|-------------|
| Structure ID: Culvert - 1        |             |
| Structure Type: Culvert-Circular |             |
| Number of Barrels                | 1           |
| Diameter                         | 15.0 in     |
| Length                           | 100.00 ft   |
| Length (Computed Barrel)         | 100.02 ft   |
| Slope (Computed)                 | 0.020 ft/ft |
| Outlet Control Data              |             |
| Manning's n                      | 0.013       |
| Ke                               | 0.500       |
| Kb                               | 0.023       |
| Kr                               | 0.000       |
| Convergence Tolerance            | 0.00 ft     |
| Inlet Control Data               |             |
| Equation Form                    | Form 1      |
| K                                | 0.0098      |
| M                                | 2.0000      |
| C                                | 0.0398      |
| Y                                | 0.6700      |
| T1 ratio (HW/D)                  | 0.000       |
| T2 ratio (HW/D)                  | 1.297       |
| Slope Correction Factor          | -0.500      |

Use unsubmerged inlet control 0 equation below T1 elevation.

Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,  
interpolate between flows at T1 & T2...

|              |             |         |                         |
|--------------|-------------|---------|-------------------------|
| T1 Elevation | 1,012.00 ft | T1 Flow | 4.80 ft <sup>3</sup> /s |
| T2 Elevation | 1,013.62 ft | T2 Flow | 5.49 ft <sup>3</sup> /s |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Outlet Input Data

Label: Basin A1

Return Event: 2 years

Storm Event: 2-YEAR

|                                      |                           |
|--------------------------------------|---------------------------|
| Structure ID: Orifice - 1            |                           |
| Structure Type: Orifice-Area         |                           |
| Number of Openings                   | 1                         |
| Elevation                            | 1,023.75 ft               |
| Orifice Area                         | 2.0 ft <sup>2</sup>       |
| Top Elevation                        | 1,024.25 ft               |
| Datum Elevation                      | 1,023.75 ft               |
| Orifice Coefficient                  | 0.600                     |
| Structure ID: Orifice - 2            |                           |
| Structure Type: Orifice-Circular     |                           |
| Number of Openings                   | 1                         |
| Elevation                            | 1,022.00 ft               |
| Orifice Diameter                     | 4.0 in                    |
| Orifice Coefficient                  | 0.600                     |
| Structure ID: TW                     |                           |
| Structure Type: TW Setup, DS Channel |                           |
| Tailwater Type                       | Free Outfall              |
| Convergence Tolerances               |                           |
| Maximum Iterations                   | 30                        |
| Tailwater Tolerance (Minimum)        | 0.01 ft                   |
| Tailwater Tolerance (Maximum)        | 0.50 ft                   |
| Headwater Tolerance (Minimum)        | 0.01 ft                   |
| Headwater Tolerance (Maximum)        | 0.50 ft                   |
| Flow Tolerance (Minimum)             | 0.001 ft <sup>3</sup> /s  |
| Flow Tolerance (Maximum)             | 10.000 ft <sup>3</sup> /s |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Outlet Input Data

Label: Basin D2

Return Event: 2 years

Storm Event: 2-YEAR

### Requested Pond Water Surface Elevations

|                       |             |
|-----------------------|-------------|
| Minimum (Headwater)   | 992.50 ft   |
| Increment (Headwater) | 0.50 ft     |
| Maximum (Headwater)   | 1,008.00 ft |

### Outlet Connectivity

| Structure Type     | Outlet ID   | Direction | Outfall     | E1<br>(ft) | E2<br>(ft) |
|--------------------|-------------|-----------|-------------|------------|------------|
| Orifice-Circular   | Orifice - 3 | Forward   | Culvert - 1 | 992.50     | 1,008.00   |
| Orifice-Area       | Orifice - 1 | Forward   | Culvert - 1 | 1,000.75   | 1,008.00   |
| Orifice-Area       | Orifice - 2 | Forward   | Culvert - 1 | 1,002.50   | 1,008.00   |
| Culvert-Circular   | Culvert - 1 | Forward   | TW          | 991.28     | 1,008.00   |
| Tailwater Settings | Tailwater   |           |             | (N/A)      | (N/A)      |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Outlet Input Data

Label: Basin D2

Return Event: 2 years

Storm Event: 2-YEAR

|                                  |             |
|----------------------------------|-------------|
| Structure ID: Culvert - 1        |             |
| Structure Type: Culvert-Circular |             |
| Number of Barrels                | 1           |
| Diameter                         | 60.0 in     |
| Length                           | 101.84 ft   |
| Length (Computed Barrel)         | 101.85 ft   |
| Slope (Computed)                 | 0.010 ft/ft |
| Outlet Control Data              |             |
| Manning's n                      | 0.013       |
| Ke                               | 0.500       |
| Kb                               | 0.004       |
| Kr                               | 0.000       |
| Convergence Tolerance            | 0.00 ft     |
| Inlet Control Data               |             |
| Equation Form                    | Form 1      |
| K                                | 0.0098      |
| M                                | 2.0000      |
| C                                | 0.0398      |
| Y                                | 0.6700      |
| T1 ratio (HW/D)                  | 1.155       |
| T2 ratio (HW/D)                  | 1.302       |
| Slope Correction Factor          | -0.500      |

Use unsubmerged inlet control 0 equation below T1 elevation.

Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control, interpolate between flows at T1 & T2...

|              |           |         |                           |
|--------------|-----------|---------|---------------------------|
| T1 Elevation | 997.06 ft | T1 Flow | 153.67 ft <sup>3</sup> /s |
| T2 Elevation | 997.79 ft | T2 Flow | 175.62 ft <sup>3</sup> /s |

## Section 7.2 Proposed Conditions Model Summary

Subsection: Outlet Input Data

Label: Basin D2

Return Event: 2 years

Storm Event: 2-YEAR

---

Structure ID: Orifice - 1  
Structure Type: Orifice-Area

---

|                     |                     |
|---------------------|---------------------|
| Number of Openings  | 3                   |
| Elevation           | 1,000.75 ft         |
| Orifice Area        | 2.0 ft <sup>2</sup> |
| Top Elevation       | 1,001.25 ft         |
| Datum Elevation     | 1,000.75 ft         |
| Orifice Coefficient | 0.600               |

---

---

Structure ID: Orifice - 2  
Structure Type: Orifice-Area

---

|                     |                     |
|---------------------|---------------------|
| Number of Openings  | 3                   |
| Elevation           | 1,002.50 ft         |
| Orifice Area        | 4.0 ft <sup>2</sup> |
| Top Elevation       | 1,003.50 ft         |
| Datum Elevation     | 1,002.50 ft         |
| Orifice Coefficient | 0.600               |

---

---

Structure ID: Orifice - 3  
Structure Type: Orifice-Circular

---

|                     |           |
|---------------------|-----------|
| Number of Openings  | 1         |
| Elevation           | 992.50 ft |
| Orifice Diameter    | 4.0 in    |
| Orifice Coefficient | 0.600     |

---

---

Structure ID: TW  
Structure Type: TW Setup, DS Channel

---

|                |              |
|----------------|--------------|
| Tailwater Type | Free Outfall |
|----------------|--------------|

---

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### Convergence Tolerances

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|                               |                           |
|-------------------------------|---------------------------|
| Maximum Iterations            | 30                        |
| Tailwater Tolerance (Minimum) | 0.01 ft                   |
| Tailwater Tolerance (Maximum) | 0.50 ft                   |
| Headwater Tolerance (Minimum) | 0.01 ft                   |
| Headwater Tolerance (Maximum) | 0.50 ft                   |
| Flow Tolerance (Minimum)      | 0.001 ft <sup>3</sup> /s  |
| Flow Tolerance (Maximum)      | 10.000 ft <sup>3</sup> /s |

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## Section 7.3 Future Conditions Model Summary

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### Project Summary

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|          |                   |
|----------|-------------------|
| Title    | Hawthorn Ridge    |
| Engineer | MGD               |
| Company  | Olsson Associates |
| Date     | 3/8/2018          |

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### Notes

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## Section 7.3 Future Conditions Model Summary

Subsection: Master Network Summary

### Catchments Summary

| Label       | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft <sup>3</sup> /s) |
|-------------|----------|----------------------|---------------------------|----------------------|--------------------------------|
| Subarea A1  | 2-Year   | 2                    | 1.219                     | 11.950               | 21.34                          |
| Subarea A1  | 10-Year  | 10                   | 2.112                     | 11.950               | 36.43                          |
| Subarea A1  | 100-Year | 100                  | 3.543                     | 11.950               | 59.61                          |
| Subarea B1  | 2-Year   | 2                    | 0.222                     | 12.000               | 3.61                           |
| Subarea B1  | 10-Year  | 10                   | 0.399                     | 12.000               | 6.41                           |
| Subarea B1  | 100-Year | 100                  | 0.687                     | 12.000               | 10.77                          |
| Subarea C1  | 2-Year   | 2                    | 0.930                     | 12.000               | 15.07                          |
| Subarea C1  | 10-Year  | 10                   | 1.630                     | 12.000               | 25.98                          |
| Subarea C1  | 100-Year | 100                  | 2.759                     | 12.000               | 42.80                          |
| Subarea D1  | 2-Year   | 2                    | 2.448                     | 12.000               | 39.98                          |
| Subarea D1  | 10-Year  | 10                   | 4.559                     | 12.000               | 74.12                          |
| Subarea D1  | 100-Year | 100                  | 8.064                     | 12.000               | 128.45                         |
| Subarea D2  | 2-Year   | 2                    | 11.790                    | 12.050               | 164.03                         |
| Subarea D2  | 10-Year  | 10                   | 20.204                    | 12.050               | 276.78                         |
| Subarea D2  | 100-Year | 100                  | 33.609                    | 12.050               | 449.52                         |
| Subarea D2a | 2-Year   | 2                    | 0.211                     | 12.000               | 3.53                           |
| Subarea D2a | 10-Year  | 10                   | 0.393                     | 11.950               | 6.62                           |
| Subarea D2a | 100-Year | 100                  | 0.695                     | 11.950               | 11.58                          |
| Subarea A1a | 2-Year   | 2                    | 0.389                     | 11.950               | 6.92                           |
| Subarea A1a | 10-Year  | 10                   | 0.682                     | 11.950               | 11.94                          |
| Subarea A1a | 100-Year | 100                  | 1.154                     | 11.950               | 19.68                          |

### Node Summary

| Label    | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft <sup>3</sup> /s) |
|----------|----------|----------------------|---------------------------|----------------------|--------------------------------|
| Point A1 | 2-Year   | 2                    | 1.529                     | 11.950               | 7.15                           |
| Point A1 | 10-Year  | 10                   | 2.621                     | 11.950               | 12.30                          |
| Point A1 | 100-Year | 100                  | 4.515                     | 12.000               | 20.60                          |
| Point B1 | 2-Year   | 2                    | 0.222                     | 12.000               | 3.61                           |
| Point B1 | 10-Year  | 10                   | 0.399                     | 12.000               | 6.41                           |
| Point B1 | 100-Year | 100                  | 0.687                     | 12.000               | 10.77                          |
| Point C1 | 2-Year   | 2                    | 0.930                     | 12.000               | 15.07                          |
| Point C1 | 10-Year  | 10                   | 1.630                     | 12.000               | 25.98                          |
| Point C1 | 100-Year | 100                  | 2.759                     | 12.000               | 42.80                          |
| Point D1 | 2-Year   | 2                    | 14.449                    | 12.000               | 44.62                          |
| Point D1 | 10-Year  | 10                   | 25.157                    | 12.200               | 131.25                         |
| Point D1 | 100-Year | 100                  | 42.368                    | 12.050               | 247.98                         |
| Point D2 | 2-Year   | 2                    | 12.001                    | 12.450               | 37.06                          |
| Point D2 | 10-Year  | 10                   | 20.597                    | 12.250               | 115.37                         |
| Point D2 | 100-Year | 100                  | 34.304                    | 12.300               | 167.66                         |

## Section 7.3 Future Conditions Model Summary

Subsection: Master Network Summary

### Pond Summary

| Label          | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft <sup>3</sup> /s) | Maximum Water Surface Elevation (ft) | Maximum Pond Storage (ac-ft) |
|----------------|----------|----------------------|---------------------------|----------------------|--------------------------------|--------------------------------------|------------------------------|
| Basin D2 (IN)  | 2-Year   | 2                    | 11.790                    | 12.050               | 164.03                         | (N/A)                                | (N/A)                        |
| Basin D2 (OUT) | 2-Year   | 2                    | 11.790                    | 12.450               | 36.58                          | 1,002.26                             | 5.438                        |
| Basin D2 (IN)  | 10-Year  | 10                   | 20.204                    | 12.050               | 276.78                         | (N/A)                                | (N/A)                        |
| Basin D2 (OUT) | 10-Year  | 10                   | 20.204                    | 12.300               | 114.15                         | 1,003.71                             | 8.324                        |
| Basin D2 (IN)  | 100-Year | 100                  | 33.609                    | 12.050               | 449.52                         | (N/A)                                | (N/A)                        |
| Basin D2 (OUT) | 100-Year | 100                  | 33.609                    | 12.300               | 165.84                         | 1,005.57                             | 13.284                       |
| Basin A1 (IN)  | 2-Year   | 2                    | 1.219                     | 11.950               | 21.34                          | (N/A)                                | (N/A)                        |
| Basin A1 (OUT) | 2-Year   | 2                    | 1.140                     | 17.900               | 0.40                           | 1,023.09                             | 0.870                        |
| Basin A1 (IN)  | 10-Year  | 10                   | 2.112                     | 11.950               | 36.43                          | (N/A)                                | (N/A)                        |
| Basin A1 (OUT) | 10-Year  | 10                   | 1.938                     | 14.650               | 1.12                           | 1,023.79                             | 1.474                        |
| Basin A1 (IN)  | 100-Year | 100                  | 3.543                     | 11.950               | 59.61                          | (N/A)                                | (N/A)                        |
| Basin A1 (OUT) | 100-Year | 100                  | 3.360                     | 12.350               | 7.76                           | 1,024.38                             | 1.999                        |

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea A1

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 60.00 ft    |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.020 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.16 ft/s   |
| Segment Time of Concentration               | 0.102 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 250.00 ft   |
| Is Paved?                                   | True        |
| Slope                                       | 0.040 ft/ft |
| Average Velocity                            | 4.07 ft/s   |
| Segment Time of Concentration               | 0.017 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 140.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.004 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.123 hours |

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea A1

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea A1a

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 50.00 ft    |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.020 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.16 ft/s   |
| Segment Time of Concentration               | 0.088 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 205.00 ft   |
| Is Paved?                                   | True        |
| Slope                                       | 0.060 ft/ft |
| Average Velocity                            | 4.98 ft/s   |
| Segment Time of Concentration               | 0.011 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 420.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.012 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.112 hours |

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea A1a

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

$T_c = (L_f / V) / 3600$   
Where:  
 $T_c$ = Time of concentration, hours  
 $L_f$ = Flow length, feet  
 $V$ = Velocity, ft/sec

### ==== SCS Channel Flow

$T_c = (L_f / V) / 3600$   
Where:  
 $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{1/2}) / n$   
 $R$ = Hydraulic radius  
 $A_q$ = Flow area, square feet  
 $W_p$ = Wetted perimeter, feet  
 $V$ = Velocity, ft/sec  
 $S_f$ = Slope, ft/ft  
 $n$ = Manning's n  
 $T_c$ = Time of concentration, hours  
 $L_f$ = Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

$T_c = (L_f / V) / 3600$   
Where:  
Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
 $V$ = Velocity, ft/sec  
 $S_f$ = Slope, ft/ft  
 $T_c$ = Time of concentration, hours  
 $L_f$ = Flow length, feet

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea B1

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.020 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.18 ft/s   |
| Segment Time of Concentration               | 0.154 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 180.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.030 ft/ft |
| Average Velocity                            | 2.79 ft/s   |
| Segment Time of Concentration               | 0.018 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 65.00 ft    |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.002 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.174 hours |

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea B1

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea C1

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.020 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.18 ft/s   |
| Segment Time of Concentration               | 0.154 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 180.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.050 ft/ft |
| Average Velocity                            | 3.61 ft/s   |
| Segment Time of Concentration               | 0.014 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 195.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.005 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.173 hours |

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea C1

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
Lf= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
Aq= Flow area, square feet  
Wp= Wetted perimeter, feet  
V= Velocity, ft/sec  
Sf= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
Lf= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
Sf= Slope, ft/ft  
Tc= Time of concentration, hours  
Lf= Flow length, feet

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D1

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.050 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.26 ft/s   |
| Segment Time of Concentration               | 0.107 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 560.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.070 ft/ft |
| Average Velocity                            | 4.27 ft/s   |
| Segment Time of Concentration               | 0.036 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 945.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.026 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.169 hours |

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D1

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D2

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.015 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.16 ft/s   |
| Segment Time of Concentration               | 0.173 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 615.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.050 ft/ft |
| Average Velocity                            | 3.61 ft/s   |
| Segment Time of Concentration               | 0.047 hours |
| Segment #3: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 335.00 ft   |
| Is Paved?                                   | True        |
| Slope                                       | 0.040 ft/ft |
| Average Velocity                            | 4.07 ft/s   |
| Segment Time of Concentration               | 0.023 hours |
| Segment #4: Length and Velocity             |             |
| Hydraulic Length                            | 1,135.00 ft |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.032 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.275 hours |

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D2

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D2a

Return Event: 2 years  
Storm Event: 2-YEAR

### Time of Concentration Results

|                                             |             |
|---------------------------------------------|-------------|
| Segment #1: TR-55 Sheet Flow                |             |
| Hydraulic Length                            | 100.00 ft   |
| Manning's n                                 | 0.150       |
| Slope                                       | 0.050 ft/ft |
| 2 Year 24 Hour Depth                        | 3.6 in      |
| Average Velocity                            | 0.26 ft/s   |
| Segment Time of Concentration               | 0.107 hours |
| Segment #2: TR-55 Shallow Concentrated Flow |             |
| Hydraulic Length                            | 400.00 ft   |
| Is Paved?                                   | False       |
| Slope                                       | 0.050 ft/ft |
| Average Velocity                            | 3.61 ft/s   |
| Segment Time of Concentration               | 0.031 hours |
| Segment #3: Length and Velocity             |             |
| Hydraulic Length                            | 125.00 ft   |
| Velocity                                    | 10.00 ft/s  |
| Segment Time of Concentration               | 0.003 hours |
| Time of Concentration (Composite)           |             |
| Time of Concentration (Composite)           | 0.141 hours |

## Section 7.3 Future Conditions Model Summary

Subsection: Time of Concentration Calculations  
Label: Subarea D2a

Return Event: 2 years  
Storm Event: 2-YEAR

### ==== User Defined Length & Velocity

Tc =  $(L_f / V) / 3600$   
Where: Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet  
V= Velocity, ft/sec

### ==== SCS Channel Flow

Tc =  $R = Q_a / W_p$   
 $V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$   
  
 $(L_f / V) / 3600$   
Where: R= Hydraulic radius  
A<sub>q</sub>= Flow area, square feet  
W<sub>p</sub>= Wetted perimeter, feet  
V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
n= Manning's n  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

### ==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:  
 $V = 16.1345 * (S_f^{0.5})$   
  
Paved Surface:  
 $V = 20.3282 * (S_f^{0.5})$   
  
 $(L_f / V) / 3600$   
Where: V= Velocity, ft/sec  
S<sub>f</sub>= Slope, ft/ft  
Tc= Time of concentration, hours  
L<sub>f</sub>= Flow length, feet

## Section 7.3 Future Conditions Model Summary

Subsection: Runoff CN-Area

Return Event: 2 years

Label: Subarea A1

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| SFR HSG D                         | 87.000 | 4.957           | 0.0      | 0.0       | 87.000      |
| Open Space HSG D                  | 80.000 | 1.680           | 0.0      | 0.0       | 80.000      |
| Offsite Meadow HSG D              | 78.000 | 0.310           | 0.0      | 0.0       | 78.000      |
| Offsite Impervious                | 98.000 | 0.002           | 0.0      | 0.0       | 98.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 6.949           | (N/A)    | (N/A)     | 84.909      |

## Section 7.3 Future Conditions Model Summary

Subsection: Runoff CN-Area

Label: Subarea A1a

Return Event: 2 years

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| SFR HSG D                         | 87.000 | 1.349           | 0.0      | 0.0       | 87.000      |
| Open Space HSG D                  | 80.000 | 0.960           | 0.0      | 0.0       | 80.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 2.309           | (N/A)    | (N/A)     | 84.090      |

## Section 7.3 Future Conditions Model Summary

Subsection: Runoff CN-Area  
Label: Subarea B1

Return Event: 2 years  
Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description            | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-------------------------------------|--------|-----------------|----------|-----------|-------------|
| SFR HSG D                           | 87.000 | 0.400           | 0.0      | 0.0       | 87.000      |
| Established Native Vegetation HSG D | 78.000 | 0.840           | 0.0      | 0.0       | 78.000      |
| Impervious                          | 98.000 | 0.110           | 0.0      | 0.0       | 98.000      |
| Offsite Meadow HSG D                | 78.000 | 0.070           | 0.0      | 0.0       | 78.000      |
| Offsite Impervious                  | 98.000 | 0.010           | 0.0      | 0.0       | 98.000      |
| COMPOSITE AREA & WEIGHTED CN --->   | (N/A)  | 1.430           | (N/A)    | (N/A)     | 82.196      |

## Section 7.3 Future Conditions Model Summary

Subsection: Runoff CN-Area

Label: Subarea C1

Return Event: 2 years

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description            | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-------------------------------------|--------|-----------------|----------|-----------|-------------|
| SFR HSG D                           | 87.000 | 1.080           | 0.0      | 0.0       | 87.000      |
| Offsite Meadow HSG D                | 78.000 | 2.280           | 0.0      | 0.0       | 78.000      |
| Offsite Impervious                  | 98.000 | 1.140           | 0.0      | 0.0       | 98.000      |
| Established Native Vegetation HSG D | 78.000 | 1.020           | 0.0      | 0.0       | 78.000      |
| COMPOSITE AREA & WEIGHTED CN --->   | (N/A)  | 5.520           | (N/A)    | (N/A)     | 83.891      |

## Section 7.3 Future Conditions Model Summary

Subsection: Runoff CN-Area

Return Event: 2 years

Label: Subarea D1

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| SFR HSG D                         | 87.000 | 0.830           | 0.0      | 0.0       | 87.000      |
| Open Space HSG D                  | 80.000 | 0.870           | 0.0      | 0.0       | 80.000      |
| Offsite Meadow HSG D              | 78.000 | 15.690          | 0.0      | 0.0       | 78.000      |
| Offsite Impervious                | 98.000 | 0.480           | 0.0      | 0.0       | 98.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 17.870          | (N/A)    | (N/A)     | 79.053      |

## Section 7.3 Future Conditions Model Summary

Subsection: Runoff CN-Area

Label: Subarea D2

Return Event: 2 years

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| SFR HSG D                         | 87.000 | 56.860          | 0.0      | 0.0       | 87.000      |
| Open Space HSG D                  | 80.000 | 6.330           | 0.0      | 0.0       | 80.000      |
| Offsite Meadow HSG D              | 78.000 | 1.506           | 0.0      | 0.0       | 78.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 64.696          | (N/A)    | (N/A)     | 86.106      |

## Section 7.3 Future Conditions Model Summary

Subsection: Runoff CN-Area

Return Event: 2 years

Label: Subarea D2a

Storm Event: 2-YEAR

### Runoff Curve Number Data

| Soil/Surface Description          | CN     | Area<br>(acres) | C<br>(%) | UC<br>(%) | Adjusted CN |
|-----------------------------------|--------|-----------------|----------|-----------|-------------|
| Open Space HSG D                  | 80.000 | 0.620           | 0.0      | 0.0       | 80.000      |
| Offsite Meadow HSG D              | 78.000 | 0.920           | 0.0      | 0.0       | 78.000      |
| COMPOSITE AREA & WEIGHTED CN ---> | (N/A)  | 1.540           | (N/A)    | (N/A)     | 78.805      |

### Section 7.3 Future Conditions Model Summary

Subsection: Elevation-Area Volume Curve

Return Event: 2 years

Label: Basin A1

Storm Event: 2-YEAR

| Elevation<br>(ft) | Planimeter<br>(ft <sup>2</sup> ) | Area<br>(acres) | $A1+A2+\sqrt{A1 \cdot A2}$<br>(acres) | Volume<br>(ac-ft) | Volume (Total)<br>(ac-ft) |
|-------------------|----------------------------------|-----------------|---------------------------------------|-------------------|---------------------------|
| 1,022.00          | 0.0                              | 0.767           | 0.000                                 | 0.000             | 0.000                     |
| 1,024.00          | 0.0                              | 0.892           | 2.486                                 | 1.657             | 1.657                     |
| 1,026.00          | 0.0                              | 1.020           | 2.866                                 | 1.911             | 3.568                     |

### Section 7.3 Future Conditions Model Summary

Subsection: Elevation-Area Volume Curve

Return Event: 2 years

Label: Basin D2

Storm Event: 2-YEAR

| Elevation<br>(ft) | Planimeter<br>(ft <sup>2</sup> ) | Area<br>(acres) | $A1+A2+\sqrt{A1 \cdot A2}$<br>(acres) | Volume<br>(ac-ft) | Volume (Total)<br>(ac-ft) |
|-------------------|----------------------------------|-----------------|---------------------------------------|-------------------|---------------------------|
| 992.50            | 0.0                              | 0.007           | 0.000                                 | 0.000             | 0.000                     |
| 994.00            | 0.0                              | 0.033           | 0.055                                 | 0.028             | 0.028                     |
| 996.00            | 0.0                              | 0.212           | 0.329                                 | 0.219             | 0.247                     |
| 998.00            | 0.0                              | 0.546           | 1.098                                 | 0.732             | 0.979                     |
| 1,000.00          | 0.0                              | 0.956           | 2.224                                 | 1.483             | 2.462                     |
| 1,002.00          | 0.0                              | 1.616           | 3.815                                 | 2.543             | 5.005                     |
| 1,004.00          | 0.0                              | 2.395           | 5.978                                 | 3.986             | 8.991                     |
| 1,006.00          | 0.0                              | 3.270           | 8.464                                 | 5.642             | 14.633                    |
| 1,008.00          | 0.0                              | 3.806           | 10.604                                | 7.069             | 21.702                    |

## Section 7.3 Future Conditions Model Summary

Subsection: Outlet Input Data

Label: Basin A1

Return Event: 2 years

Storm Event: 2-YEAR

### Requested Pond Water Surface Elevations

|                       |             |
|-----------------------|-------------|
| Minimum (Headwater)   | 1,022.00 ft |
| Increment (Headwater) | 0.50 ft     |
| Maximum (Headwater)   | 1,026.00 ft |

### Outlet Connectivity

| Structure Type     | Outlet ID   | Direction | Outfall     | E1<br>(ft) | E2<br>(ft) |
|--------------------|-------------|-----------|-------------|------------|------------|
| Orifice-Circular   | Orifice - 2 | Forward   | Culvert - 1 | 1,022.00   | 1,026.00   |
| Orifice-Area       | Orifice - 1 | Forward   | Culvert - 1 | 1,023.75   | 1,026.00   |
| Culvert-Circular   | Culvert - 1 | Forward   | TW          | 1,012.00   | 1,026.00   |
| Tailwater Settings | Tailwater   |           |             | (N/A)      | (N/A)      |

## Section 7.3 Future Conditions Model Summary

Subsection: Outlet Input Data

Label: Basin A1

Return Event: 2 years

Storm Event: 2-YEAR

|                                  |             |
|----------------------------------|-------------|
| Structure ID: Culvert - 1        |             |
| Structure Type: Culvert-Circular |             |
| Number of Barrels                | 1           |
| Diameter                         | 15.0 in     |
| Length                           | 100.00 ft   |
| Length (Computed Barrel)         | 100.02 ft   |
| Slope (Computed)                 | 0.020 ft/ft |
| Outlet Control Data              |             |
| Manning's n                      | 0.013       |
| Ke                               | 0.500       |
| Kb                               | 0.023       |
| Kr                               | 0.000       |
| Convergence Tolerance            | 0.00 ft     |
| Inlet Control Data               |             |
| Equation Form                    | Form 1      |
| K                                | 0.0098      |
| M                                | 2.0000      |
| C                                | 0.0398      |
| Y                                | 0.6700      |
| T1 ratio (HW/D)                  | 0.000       |
| T2 ratio (HW/D)                  | 1.297       |
| Slope Correction Factor          | -0.500      |

Use unsubmerged inlet control 0 equation below T1 elevation.

Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control, interpolate between flows at T1 & T2...

|              |             |         |                         |
|--------------|-------------|---------|-------------------------|
| T1 Elevation | 1,012.00 ft | T1 Flow | 4.80 ft <sup>3</sup> /s |
| T2 Elevation | 1,013.62 ft | T2 Flow | 5.49 ft <sup>3</sup> /s |

## Section 7.3 Future Conditions Model Summary

Subsection: Outlet Input Data

Label: Basin A1

Return Event: 2 years

Storm Event: 2-YEAR

---

Structure ID: Orifice - 1  
Structure Type: Orifice-Area

---

|                     |                     |
|---------------------|---------------------|
| Number of Openings  | 1                   |
| Elevation           | 1,023.75 ft         |
| Orifice Area        | 2.0 ft <sup>2</sup> |
| Top Elevation       | 1,024.25 ft         |
| Datum Elevation     | 1,023.75 ft         |
| Orifice Coefficient | 0.600               |

---

---

Structure ID: Orifice - 2  
Structure Type: Orifice-Circular

---

|                     |             |
|---------------------|-------------|
| Number of Openings  | 1           |
| Elevation           | 1,022.00 ft |
| Orifice Diameter    | 4.0 in      |
| Orifice Coefficient | 0.600       |

---

---

Structure ID: TW  
Structure Type: TW Setup, DS Channel

---

|                |              |
|----------------|--------------|
| Tailwater Type | Free Outfall |
|----------------|--------------|

---

---

Convergence Tolerances

---

|                               |                           |
|-------------------------------|---------------------------|
| Maximum Iterations            | 30                        |
| Tailwater Tolerance (Minimum) | 0.01 ft                   |
| Tailwater Tolerance (Maximum) | 0.50 ft                   |
| Headwater Tolerance (Minimum) | 0.01 ft                   |
| Headwater Tolerance (Maximum) | 0.50 ft                   |
| Flow Tolerance (Minimum)      | 0.001 ft <sup>3</sup> /s  |
| Flow Tolerance (Maximum)      | 10.000 ft <sup>3</sup> /s |

---

## Section 7.3 Future Conditions Model Summary

Subsection: Outlet Input Data

Label: Basin D2

Return Event: 2 years

Storm Event: 2-YEAR

### Requested Pond Water Surface Elevations

|                       |             |
|-----------------------|-------------|
| Minimum (Headwater)   | 992.50 ft   |
| Increment (Headwater) | 0.50 ft     |
| Maximum (Headwater)   | 1,008.00 ft |

### Outlet Connectivity

| Structure Type     | Outlet ID   | Direction | Outfall     | E1<br>(ft) | E2<br>(ft) |
|--------------------|-------------|-----------|-------------|------------|------------|
| Orifice-Circular   | Orifice - 3 | Forward   | Culvert - 1 | 992.50     | 1,008.00   |
| Orifice-Area       | Orifice - 1 | Forward   | Culvert - 1 | 1,000.75   | 1,008.00   |
| Orifice-Area       | Orifice - 2 | Forward   | Culvert - 1 | 1,002.50   | 1,008.00   |
| Culvert-Circular   | Culvert - 1 | Forward   | TW          | 991.28     | 1,008.00   |
| Tailwater Settings | Tailwater   |           |             | (N/A)      | (N/A)      |

### Section 7.3 Future Conditions Model Summary

Subsection: Outlet Input Data

Label: Basin D2

Return Event: 2 years

Storm Event: 2-YEAR

|                                  |             |
|----------------------------------|-------------|
| Structure ID: Culvert - 1        |             |
| Structure Type: Culvert-Circular |             |
| Number of Barrels                | 1           |
| Diameter                         | 60.0 in     |
| Length                           | 101.84 ft   |
| Length (Computed Barrel)         | 101.85 ft   |
| Slope (Computed)                 | 0.010 ft/ft |
| Outlet Control Data              |             |
| Manning's n                      | 0.013       |
| Ke                               | 0.500       |
| Kb                               | 0.004       |
| Kr                               | 0.000       |
| Convergence Tolerance            | 0.00 ft     |
| Inlet Control Data               |             |
| Equation Form                    | Form 1      |
| K                                | 0.0098      |
| M                                | 2.0000      |
| C                                | 0.0398      |
| Y                                | 0.6700      |
| T1 ratio (HW/D)                  | 1.155       |
| T2 ratio (HW/D)                  | 1.302       |
| Slope Correction Factor          | -0.500      |

Use unsubmerged inlet control 0 equation below T1 elevation.

Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control, interpolate between flows at T1 & T2...

|              |           |         |                           |
|--------------|-----------|---------|---------------------------|
| T1 Elevation | 997.06 ft | T1 Flow | 153.67 ft <sup>3</sup> /s |
| T2 Elevation | 997.79 ft | T2 Flow | 175.62 ft <sup>3</sup> /s |

## Section 7.3 Future Conditions Model Summary

Subsection: Outlet Input Data

Label: Basin D2

Return Event: 2 years

Storm Event: 2-YEAR

|                                      |                           |
|--------------------------------------|---------------------------|
| Structure ID: Orifice - 1            |                           |
| Structure Type: Orifice-Area         |                           |
| Number of Openings                   | 3                         |
| Elevation                            | 1,000.75 ft               |
| Orifice Area                         | 2.0 ft <sup>2</sup>       |
| Top Elevation                        | 1,001.25 ft               |
| Datum Elevation                      | 1,000.75 ft               |
| Orifice Coefficient                  | 0.600                     |
| Structure ID: Orifice - 2            |                           |
| Structure Type: Orifice-Area         |                           |
| Number of Openings                   | 3                         |
| Elevation                            | 1,002.50 ft               |
| Orifice Area                         | 4.0 ft <sup>2</sup>       |
| Top Elevation                        | 1,003.50 ft               |
| Datum Elevation                      | 1,002.50 ft               |
| Orifice Coefficient                  | 0.600                     |
| Structure ID: Orifice - 3            |                           |
| Structure Type: Orifice-Circular     |                           |
| Number of Openings                   | 1                         |
| Elevation                            | 992.50 ft                 |
| Orifice Diameter                     | 4.0 in                    |
| Orifice Coefficient                  | 0.600                     |
| Structure ID: TW                     |                           |
| Structure Type: TW Setup, DS Channel |                           |
| Tailwater Type                       | Free Outfall              |
| Convergence Tolerances               |                           |
| Maximum Iterations                   | 30                        |
| Tailwater Tolerance (Minimum)        | 0.01 ft                   |
| Tailwater Tolerance (Maximum)        | 0.50 ft                   |
| Headwater Tolerance (Minimum)        | 0.01 ft                   |
| Headwater Tolerance (Maximum)        | 0.50 ft                   |
| Flow Tolerance (Minimum)             | 0.001 ft <sup>3</sup> /s  |
| Flow Tolerance (Maximum)             | 10.000 ft <sup>3</sup> /s |

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