

Britton Engineering & Land Surveying, Inc

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PROPERTY

Tract C-2 of McMahon Subdivision, located in the NE $\frac{1}{4}$ of the SW $\frac{1}{4}$ of Section 24, Township 2 North, Range 7 East, B.H.M., Rapid City, Pennington County, South Dakota.

PURPOSE

The purpose of this report is to estimate the potential change in existing and developed runoff for the 2-year, 10-year, and 100-year storm events for the proposed development on the property described above. The above listed property is currently grassy area.

DRAINAGE ANALYSIS

The following drainage analysis for the above listed property has estimated the potential change in runoff for the 2-year, 10-year, and 100-year storm events. Runoff totals for these storms were estimated using the rational method and referenced to methods described in Section 2 of the Rapid City Drainage Criteria Manual (RCDCM). Composite runoff coefficients are based on values taken from Table 2-1 and calculated based on Equation 2-2 (RCDCM).

The grading for the site directs the surface runoff to the west flow into a proposed 8 feet wide V-pan that will discharge into an existing detention pond. The flow from this pond is directed to the north into the existing drainage channel. Table 1 shows the estimated existing and developed flow rates from the site for the 2-year, 10-year, and 100-year storm events.

RECEIVED

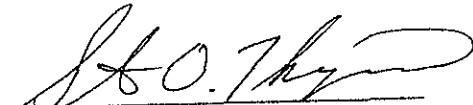
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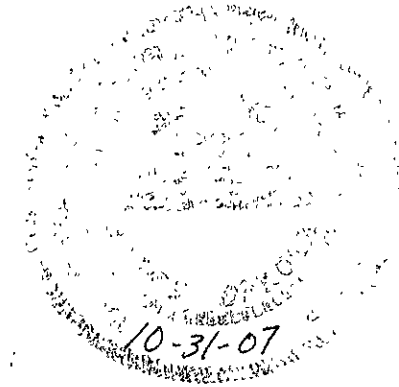
Table 1 - Estimated Total Flows from the above referenced project Rapid City Growth
Management Department

| Return Storm | Existing (cfs) | Developed (cfs) | Differences (cfs) |
|------------------|----------------|-----------------|-------------------|
| Q ₂ | 1.0 | 4.3 | 3.3 |
| Q ₁₀ | 1.8 | 6.6 | 4.8 |
| Q ₁₀₀ | 5.3 | 10.4 | 5.1 |

Temporary erosion control measures include the use of silt fence as shown on Sheet 4 of 5 of the corresponding plans. Enclosed with this report are maps showing the proposed developed conditions with site grading, modified rational calculations, and hand calculations used to estimate flows for the 2-year, 10-year, and 100-year storm events.

I hereby certify that the data herein being submitted was prepared by me or under my direct supervision and that to the best of my knowledge is true and correct.


Steven O. Thingelstad, PE/LS



Britton Engineering & Land Surveying, Inc.

PROJECT Tract C-2SHEET 1 OF 2DRAINAGE STUDYDATE 10/29/07

WT

| DEVELOPED FLOWS: | AREA (Ac) | C ₂ | C ₁₀ | C ₁₀₀ |
|------------------|-----------|----------------|-----------------|------------------|
| Building | 0.146 | 0.90 | 0.90 | 0.90 |
| CONCRETE | 0.964 | 0.87 | 0.88 | 0.89 |
| GRASS | 0.275 | 0.18 | 0.20 | 0.40 |
| | 1.385 | | | |

$$\text{Composite } C_2 = \frac{(0.146)(0.90) + (0.964)(0.87) + (0.275)(0.18)}{1.385} = 0.74$$

$$\text{Composite } C_{10} = \frac{(0.146)(0.90) + (0.964)(0.88) + (0.275)(0.20)}{1.385} = 0.75$$

$$\text{Composite } C_{100} = \frac{(0.146)(0.90) + (0.964)(0.89) + (0.275)(0.40)}{1.385} = 0.79$$

Assumed 5 min Storm

$$i_2 = 4.21$$

$$i_{10} = 6.37$$

$$i_{100} = 9.48$$

$$Q_2 = (1.385)(4.21)(0.74) = 4.3 \text{ cfs}$$

$$Q_{10} = (1.385)(6.37)(0.75) = 6.6 \text{ cfs}$$

$$Q_{100} = (1.385)(9.48)(0.79) = 10.4 \text{ cfs}$$

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PROJECT TRACT C-2

SHEET 2 OF 2

DRAINAGE STUDY

DATE 10/29/07
WT

| HISTORIC | AREA (A) | C ₂ | C ₀ | C ₁₀₀ |
|---|----------|----------------|----------------|------------------|
| GRASS | 1.385 | 0.18 | 0.20 | 0.40 |
| Assumed: | 5 min | | | |
| L ₂ = | 4.21 | | | |
| L ₁₀ = | 6.37 | | | |
| L ₁₀₀ = | 9.48 | | | |
| $Q_2 = (1.385)(4.21)(0.18) = 1.0 \text{ cfs}$ | | | | |
| $Q_{10} = (1.385)(6.37)(0.20) = 1.8 \text{ cfs}$ | | | | |
| $Q_{100} = (1.385)(9.48)(0.40) = 5.3 \text{ cfs}$ | | | | |
| | HISTORIC | Developed | Difference | |
| Q ₂ | 1.0 | 4.3 | +3.3 | |
| Q ₁₀ | 1.8 | 6.6 | +4.8 | |
| Q ₁₀₀ | 5.3 | 10.4 | +5.1 | |

8' Wide V-Pan @ 3" Depth
Worksheet for Triangular Channel

| Project Description | |
|---------------------|--------------------------------------|
| Project File | c:\haestad\academic\fmw\project4.fm2 |
| Worksheet | Tract C-2 |
| Flow Element | Triangular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | |
|----------------------|-----------------|
| Mannings Coefficient | 0.013 |
| Channel Slope | 0.208000 ft/ft |
| Left Side Slope | 16.000000 H : V |
| Right Side Slope | 16.000000 H : V |
| Discharge | 10.40 cfs |

| Results | | |
|------------------------|----------|-----------------|
| Depth | 0.23 | ft |
| Flow Area | 0.85 | ft ² |
| Wetted Perimeter | 7.37 | ft |
| Top Width | 7.35 | ft |
| Critical Depth | 0.48 | ft |
| Critical Slope | 0.003965 | ft/ft |
| Velocity | 12.31 | ft/s |
| Velocity Head | 2.35 | ft |
| Specific Energy | 2.58 | ft |
| Froude Number | 6.40 | |
| Flow is supercritical. | | |

8' Wide V-Pan @ 3" Depth @ Bottom
Worksheet for Triangular Channel

| Project Description | |
|---------------------|--------------------------------------|
| Project File | c:\haestad\academic\fmw\project4.fm2 |
| Worksheet | Tract C-2 |
| Flow Element | Triangular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | |
|----------------------|-----------------|
| Mannings Coefficient | 0.013 |
| Channel Slope | 0.005000 ft/ft |
| Left Side Slope | 16.000000 H : V |
| Right Side Slope | 16.000000 H : V |
| Discharge | 10.40 cfs |

| Results | | |
|------------------------|----------|-----------------|
| Depth | 0.46 | ft |
| Flow Area | 3.42 | ft ² |
| Wetted Perimeter | 14.82 | ft |
| Top Width | 14.80 | ft |
| Critical Depth | 0.48 | ft |
| Critical Slope | 0.003965 | ft/ft |
| Velocity | 3.04 | ft/s |
| Velocity Head | 0.14 | ft |
| Specific Energy | 0.61 | ft |
| Froude Number | 1.11 | |
| Flow is supercritical. | | |

Riprap Estimate

10/29/2007

100-Year

Q = 10.4
D = 2.25
Vc = 3
Vp = 12.3 From Figure 8-8 use 18 inch rock
Vc/Vp = 0.2 USE Fig. 8-4
Q/D^{2.5} = 1.37
d = 1.5
D/d = 1.5
L/D = 10.6
Length = 24
depth = 2
Width = 6.75
Volume (cy) = 13 of Class II Riprap Material.