Fort Dodge Stormwater Master Planning

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Project Location
Project Background

Flooding History

• Localized flooding and storm sewer pipe surcharging in the vicinity of the Crossroads Mall
  o The area consists of approx. 505 acres, which is comprised mainly of commercial and industrial land
  o Flooding problems attributed to large runoff volumes and high peak flows
  o Localized flooding and surcharged storm sewer are common within watershed and have occurred as recently as summers of 2007 and 2010
Locations of flooding are:

1) Vicinity of Veterans Bridge
2) West of Mall along S 25th St.
3) South of 5th Ave S and west of S 25th St
4) South of 5th Ave S and east of S 25th St
5) Along 8th Ave S between S 25th St and S 29th St
6) Along S 29th St just east of Mall
Project Background Cont’d

Flooding History

- In addition to flooding problems near the mall, much of total runoff volume is discharged to Gypsum Creek upstream of the existing 84” culvert just downstream of 5th Ave South
- City is concerned about capacity of the 84” culvert
HR Green prepared a Watershed Analysis Report in August, 2010, based on Hydrocad (rational method) which documented the source of the flooding and potential solutions. Based on this report the city approved the preparation of a more detailed analysis based on the following:

- Infiltration practices or storage to reduce storm sewer conveyance needs
- XP-SWMM modeling recommended to:
  - Account for existing storage in pipes and on surface
  - Pressure flow in pipes
  - Division of flow between multiple interlinked systems
Existing Data and Proposed Modeling Approach

• City provided HR Green the latest GIS data
  o Contained roadway and storm sewer alignments, contours, aerial imagery, and other relevant spatial information
• ArcView GIS was used to organize and view the data
• XP-SWMM was used to analyze existing conditions of:
  • Gypsum Creek & 84” culvert
  • Sewer System
• Proposed conditions XP-SWMM model used to evaluate proposed storage and sewer improvement options
Gypsum Creek Watershed

Lidar Watershed Area: 4537 acres

County Watershed Area: 4212 acres

84" Culvert I.E.: 1091.24

Modeled 84" Culvert

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Gypsum Creek Modeling

- The Geospatial hydrology toolkit from HEC-GeoHMS was used to determine the discharges from the Gypsum Creek watershed

  - HEC-GeoHMS is a public-domain extension for ArcGIS 9.2/9.3 and one must have an ArcView license and Spatial Analyst Extension
Data Assembly

Create a terrain DEM of the project derived from LIDAR data

- Cut a channel through the terrain
- Blue lines depict channels
- Darker areas = lower elevations
- Lighter areas = higher elevations
Build walls in order to correctly subdivide watersheds and direct water to a certain outlet

- Wall is shown by the white line
- Water does not flow across wall and the wall acts as a drainage divide
- Fill sinks
- Fill all depressions so that water flows through them and is not trapped
Stream and Watershed Characteristics

**Flow Direction**: Specify an outflow direction for each cell/sub-watershed

A color is assigned to each flow direction

**Flow Accumulation**: Program counts the number of cells tributary to each cell. Cells with large accumulated areas are shown in lighter grays or white (not shown).
Define Watersheds: Define the locations of the streams based upon the specified watershed area

- One can define the watershed area for a stream, which may be set at 1 sq. mi. area

Result is a colored map showing all of the individual sub-basins

- Can have multiple outlets in the same project
Watershed for Gypsum Creek

- Select the downstream outlet for Gypsum Creek, which is the upstream end of the 84” culvert.
- The overall watershed for the 84” culvert is shown in the red cross-hatching, which includes all of the individual sub-basins.
Sub-Basins comprising Gypsum Creek Watershed

- Each sub-basin is labeled and the flow path of each channel within the sub-basin is shown in blue
River Profile Tool

- Shows a profile for a specific river reach, which is shown in cyan at the top
Longest Flow Path

- Program determines longest flow path within each sub-basin, which is shown by the green polylines.
- To determine the cumulative flow path, add up the distances of the longest flow paths from all sub-basins so that you account for the most hydrologically remote point within the entire watershed.
Segment Flow Path

- Program will divide the longest flow path within each sub-basin into 3 components, sheet flow, shallow concentrated flow, and channel flow.
- Areas upstream of the blue dots consist of 100’ sheet flow.
- Areas downstream of blue dots and upstream of red dots, consist of shallow concentrated flow.
- Areas downstream of red dots are channel flow.
Interactive Longest Flow Path Tool

- If one does not like the way the program defines the longest flow path, you can modify it using the Interactive Longest Flow Path Tool.
- The modified longest flow path is in red.
Time of Concentration

- Tc calculations are done by utilizing the TR-55 Exporting Travel Time Parameters to Excel function in HEC-GeoHMS
- Blue = GIS provided data
- Green = User input
  - Mannings N
  - Paved/Unpaved
  - Channel Parameters
- Pink = Tc (hrs)
Soils Data

• Used County soils data available in the GIS database and applied it to the watershed area

• The closed polylines correspond to a particular soils type
Soils Attributes Table

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Land Use

- Various land uses are depicted with different colors of shading
Runoff Curve Number Tables

- Soils and Land Use GIS data is combined to create a RCN layer. Each color represents a different RCN value.
Sub-Basin Summary Spreadsheet

- Table is exported out of GIS
- Columns of importance are the watershed names, Tc, and areas
  - These 3 columns of data are then input into XP-SWMM for further analysis of the Gypsum Creek watershed and its impact on the storm sewer system in the main business district of Fort Dodge, IA
XP-SWMM Analysis

• Once we imported the hydrologic data from GIS into XP-SWMM, we found that the peak water surface elevation upstream of the existing 84” culvert was surcharging the pipe and overtopping 5th Avenue South.

• 10-yr peak water surface elevation is approx. 1108 using the Huff rainfall distribution.
XP-SWMM Analysis

- Based upon previous coordination with City staff, there were no reported incidents of overtopping associated with the existing 84” culvert
  - HR Green decided to add existing storage in the upstream watershed so as to reduce the peak flows
    - Existing storage below elevation 1108 was modeled
    - 10-year peak water surface elevation was found to be approximately 1105, about 3 ft lower than previously modeled without any storage
    - City will need to ensure that the existing storage is preserved if watershed is developed in the future
XP-SWMM Analysis

Node - G2001

- 10Yr 2Hr [Max 1103.729]
- 10Yr 3Hr [Max 1104.540]
- 10Yr 6Hr [Max 1105.262]
- 5yr Thpe II [Max 1105.428]
- 10yr Type II [Max 1106.127]
XP-SWMM Sewer Model Development

- Preparation of GIS data
- Import of Data into XP-SWMM
- Evaluation of Existing Conditions
- Evaluation of Alternatives
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XP-SWMM Analysis
Storage Alternative

City of Fort Dodge

Figure 4

Alternative # 1

- Proposed Storage BMP Alt #1
- Proposed Storm Sewer Alt #1
- Existing Storm Sewer Manholes
- Existing Storm Sewer
- Existing Sanitary Sewer Mains

Legend:

- 0 500 1,000 Feet

Map details:

- Volume: 9.3 ac-ft
  Invert: 1102
  HWL: 1105.1
- Diameter: 48"

- Volume: 7.2 ac-ft
  Invert: 1102
  HWL: 1106.8
- Diameter: 12"

- Volume: 6.4 ac-ft
  Invert: 1103
  HWL: 1107.9
- Diameter: 36"

- Volume: 6.8 ac-ft
  Invert: 1102
  HWL: 1108.2
- Diameter: 42"

- Volume: 6.8 ac-ft
  Invert: 1102
  HWL: 1108.2
Sewer Extended to Mall
Connection to 72” Outlet
Chosen Alternate
Phasing
Questions?

HR GREEN, INC.
420 N. Front Street, Suite 100
McHenry, IL 60050
Main: 815.385.1778
Fax: 815.385.1781
www.hrgreen.com