Agenda Item 8

Memorandum

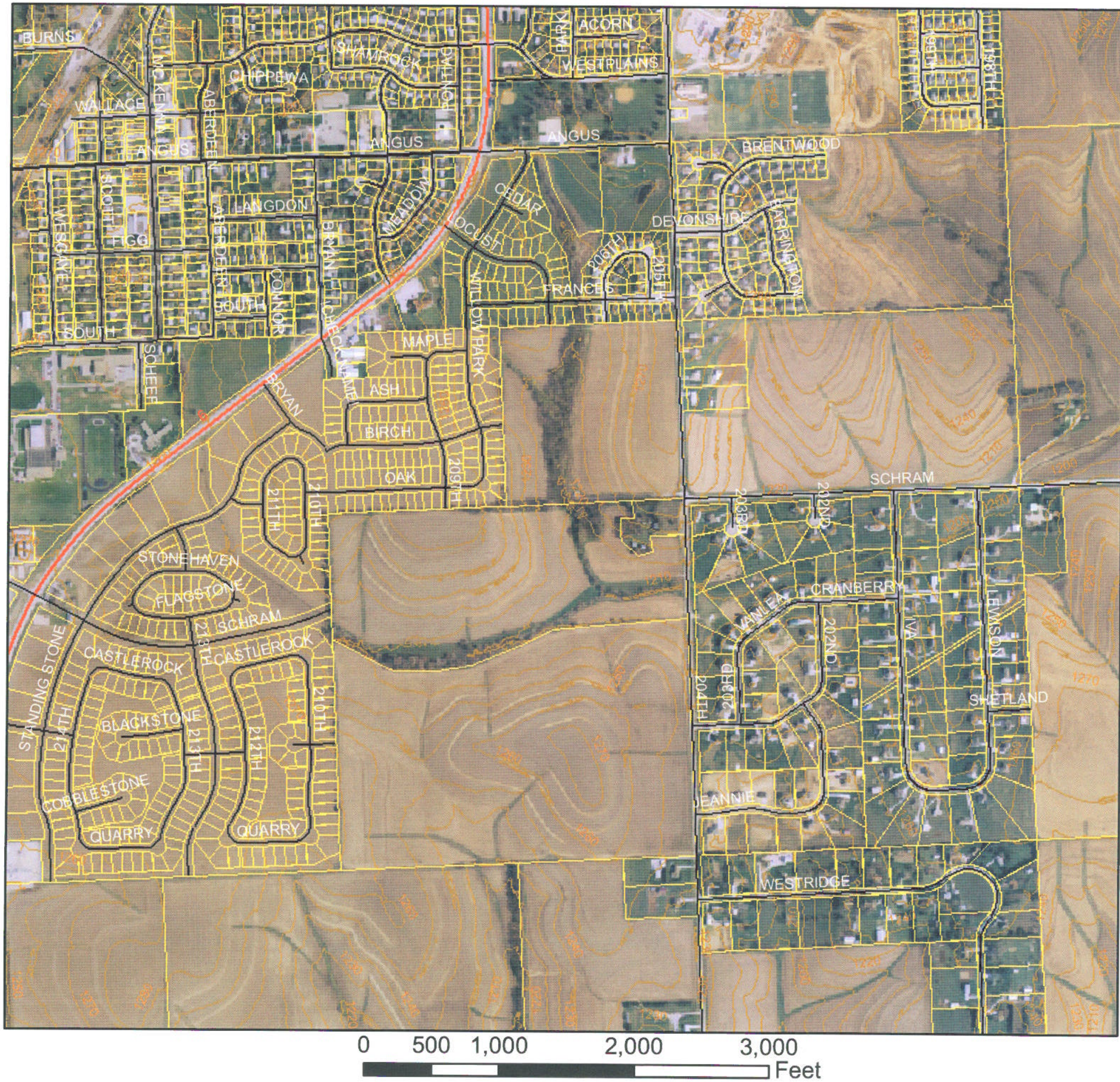
To: PPO Subcommittee
From: Paul Woodward, Water Resources Engineer
Date: November 8, 2006
Re: Flooding Issues in Forrest Run and Lyman Highlands Subdivisions near Gretna, NE

As a follow up to last month's discussion concerning flooding issues in the Forrest Run Subdivision near Gretna, NE (see attached map), District staff has meet with representatives from Lamp, Rynearson & Associates (LRA) to gather information on the existing flooding problems. LRA was able to provide valuable information as they had previously performed a drainage investigation of Forrest Run and Lyman Highlands as part of a study for the City of Gretna. The City had required this investigation in response to concerns that added drainage from the Covington subdivision (directly north of Forrest Run and Lyman Highlands) may increase flooding experienced in Forrest Run and Lyman Highlands. A copy of this drainage study report dated October 31, 2004 is enclosed.

As part of this study, the current and future 100-yr flood flow was modeled through the two subdivisions. A map showing the inundation area resulting from this modeling is attached. This map shows that several homes adjacent to the drainage way within Forrest Run and Lyman Highlands are subject to flooding during the current and future 100-year storm event. LRA concluded that this flooding problem is primarily caused by the nearly flat channel slope and impact of existing roadways and culverts. This means that potential solutions to the flooding problem must either improve the conveyance at the roadways or detain flood waters before entering the two subdivisions.

Based on this study, Gretna required the developer of Covington to incorporate detention on his site and modify the channel downstream of Iva Street in Lyman Highlands. However, these improvements provide little relief for the flooding which may occur within the two subdivisions.

After considering the results of prior investigations, District staff feels that it would be appropriate to further consider the proposed Regional Detention Basin proposed upstream of the two subdivisions (just upstream of 204th Street). As part of the conceptual Papillion Creek Watershed Drainage Plan, this basin will be further analyzed in upcoming studies of the drainage plan and associated Stormwater Management Policies. Therefore, it is management's recommendation that this basin be analyzed in greater detail as part of the Papillion Creek Watershed's future evaluation.



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100 Year Water Surface

Drainage Investigation

for

City of Gretna

for

Channel Improvement in Forest Run and Lyman Hylands

Lamp, Rynearson & Associates, Inc.

LRA # 04008.11
October 31th, 2004

INTRODUCTION

The purpose of this investigation is to determine the existing hydraulic conditions of the drainage channel located through the Forest Run and Lyman Hylands sub-divisions and to recommend improvements to the channel to accommodate increased flow due to future development upstream.

The portion of the drainage channel investigated in this report begins from 600 feet south of the intersection of 204th Street and Schram Road and ends where the stream crosses under Schram Road ½ mile east of 204th Street. The drainage basin for the channel is approximately 794 acres and includes a large portion of southern and central Gretna. The drainage basin extends south approximately one half mile south of Schram Road. The extents of the basin are shown in the Drainage Map included with this report.

It is anticipated that the majority of the agricultural land within the limits of the creek drainage basin will be developed in the future. As a result, an increase in flow can be expected in the channel. It may be necessary to improve the channel to accommodate the increase in flows. This report investigates the existing conditions of the channel and recommends appropriate improvements for the future developed conditions.

The computer programs used in this study include WinTR-55 distributed by the Natural Resource Conservation Service and HEC-HMS and HEC-RAS distributed by the US Army Corps of Engineers. These are widely accepted programs used in hydrologic and hydraulic analysis.

FIELD INVESTIGATION

A field investigation was conducted on October 8, 2004 to observe the existing conditions of the channel. The field observation began upstream at 204th Street. The channel crosses 204th Street through two 108" culverts. The channel on the west side of 204th Street is densely treed. Water ponds approximately six inches deep on this side of the road.

The channel on the east side of 204th Street has large weeds for approximately 300 feet and contains 1 to 3 inches of ponded water. Between 204th Street and Iva Street, the creek varies from an earth channel with maintained grass banks to a weedy channel with maintained grass banks. The longitudinal channel slope in this area is slight. There is little slope from the channel bank to the houses on the north. There is considerably more slope to the houses on the south. There are several features near the channel in this area including green utility boxes, gardens, and trees . See Picture 1.

Picture 1 – Channel at 204th Street Looking West

There are two 72" culverts under Iva Street. The south culvert is almost half filled in with silt and soil. It appears the culvert may have been intentionally filled.

The channel between Iva Street and Lewiston Lane varies from a clean earth bottom to weedy bottom. The width of the channel varies from 2 feet to 15 feet. The banks of the channel are maintained grass. There are several 6" to 10" size trees in the channel area. There is a newly built shed near the channel west of Lewiston Lane. See picture 2.

Picture 2 - Channel west of Lewiston Lane Looking West

There are two 72" culverts under Lewiston Lane. The south culvert is almost half filled in with silt and soil. It appears this culvert may also have been intentionally filled. See Picture 3.

Picture 3 - Double 72" Culverts under Lewiston Lane Looking at Outlet

The channel between Lewiston Lane and Schram Road contains weeds with maintained grass banks. The channel is approximately four feet wide and contains 2 inches of ponded water. There are 6" to 10" size trees in the channel at several areas.

There are two 72" culverts under Schram Road. The west culvert is half filled with silt and soil. See Picture 4. The channel on the North side of Schram Road is densely treed and weeded The field investigation concluded at this point.

Picture 4 : Double 72" Culverts Under Schram Road Looking at Inlet. West culvert silted in.

DESCRIPTION OF MODELS

A. Hydrology Models

The hydrological program used for this report is HEC-HMS distributed by the US Army Corp of Engineers http://www.hec.usace.army.mil/software/hec-hms/hechms-hechms.html. HEC-HMS uses rainfall data to determine surface water runoff rates and volumes. The rainfall distribution used in the model was taken from Technical Paper 40 as published the in the Omaha Stormwater Design Manual.

Rainfall losses are the difference in the volume of rainfall and the volume of surface runoff due to the rainfall. HEC-HMS has several methods available to model the rainfall loss rate. In this investigation, the SCS method was used to model the loss rate. This procedure uses a Curve Number or CN to represent the runoff potential for a particular land use. Curve Numbers can range from 0 to 100 with higher curve numbers indicating a higher runoff potential. Curve Numbers for typical land uses generally fall into the 60-95 range.

The SCS method uses a Lag Time to represent the delay in time after a heavy rain before the runoff reaches a maximum peak. Lag time in this report is calculated as 0.6 x Time of Concentration. Time of concentration is defined as the time for water to travel from the remotest part of a basin to the point of interest. Time of concentration is dependent on the land characteristics.

Initial abstraction is all the losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. Initial Abstraction was calculated In the model as $I_a = 0.2S$, where $S = 1000/CN - 10$.

HEC-HMS does not directly calculate CN values and Time of Concentration values; therefore, the model WinTR-55 distributed by the Natural Resource Conservation Service (NRCS), http://www.wcc.nrcs.usda.gov/hydro/hydro-tools-models-wintr55.html, was used to generate these values. WinTR-55 was also used as a check for the HEC-HMS model output. In addition, hand calculations using the Rational Method and regression equations developed by the United States Ge.

B. Hydraulic Model

HEC-RAS distributed by the US Army Corp of Engineers was used to model the drainage channel. This model uses cross-sections inputted by the user to determine channel flow profiles. Cross sections were determined using a topographic survey completed by Lamp, Rynearson & Associates. Other input parameters were determined from field investigations and from reference tables in Chow (1963). The topographic survey, cross section locations, and the cross sections used in the model are included in this report.

EXISTING CONDITIONS

The watershed basin was delineated using GIS aerial photographs and contours at 2' intervals interpolated from 10 meter USGS digital terrain model (DTM). The watershed basin was subdivided into five smaller basins designated Southwest Gretna, Gretna, West, Central, and East. Descriptions of the areas are shown in the following table:

Table 1.1 Watershed Basins - Existing Conditions

WATERSHED BASIN	AREA (Acres)	Curve Number (CN)	Lag Time (Minutes)	DESCRIPTION
Southwest Gretna	286	72	17.0	Includes portions of southwest Gretna and a future subdivision site.
Gretna	288	73	17.9	Includes portions of central Gretna, a future subdivision site and row crops.
West	88	70	7.8	Includes the Forrest Run subdivision and portions of the proposed Covington subdivision
Central	102	67	6.1	Includes central portions of the Lyman Hylands subdivision and the proposed Covington subdivision
East	30	71	5.6	Includes eastern portions of the Lyman Hylands subdivision and the proposed Covington subdivision and row crops.

The 10, 50 and 100-year runoff was calculated at Junction points A, B, C, and D as shown in the drainage map using HEC-HMS, WinTR-55. The 100-year runoff was also calculated at Junction D using the Rational Method and Regression Equations. The following table summarizes the calculated existing runoff:

Table 1.2 Summary of Runoff for 10, 50, and 100 Year Storm Events for Existing Conditions

Model	10 Year Runoff (cfs)	50 Year Runoff (cfs)	100 Year Runoff (cfs)
HEC-HMS			
Junction A	1,135	1,817	2,063
Junction B	1,216	1,956	2,301
Junction C	1,283	2,071	2,523
Junction D	1,300	2,109	2,588
WinTR-55			
Junction A	1,163	1,801	2,119
Junction B	1,267	1,968	2,317
Junction C	1,359	2,124	2,506
Junction D	1,391	2,175	2,569
Rational Method			
Junction D			2,160
Regression Equation			
Junction D	1,158	2,292	2,883

As shown in the above table, the runoff values calculated by each method are within a reasonable tolerance. The HEC-HMS values as shown in the above table are used in the study for the HEC-RAS anaylsis..

Note: Due to discrepancies in lag times with previous reports, the HEC-HMS program was also modeled using a Kinematic Wave transformation approach. Results from the kinematic wave model are consistent with the SCS lag time results in this report.

DEVELOPED CONDITIONS

In the developed conditions, it is anticipated that the majority of the undeveloped land will be developed by 2010. Developed conditions were modeled assuming all the existing seeded and agricultural land will be developed into 1/8-1/4 acre lots with a CN value of 80. It is anticipated that some of the land will be developed into other uses such as commercial areas and parks; however these are assumed to average to a composite CN near 80.

The developed condition lag time was determined using the same hydraulic length used in the existing conditions; however it is assumed that 75% of the hydraulic length will be either shallow gutter or sewer pipe flow with a velocity of 10 feet per second. The remaining 25% of the hydraulic length is assumed grass channel or creek flow with a velocity of 7 feet per second. The following table summarizes the developed conditions used in the model:

Table 1.1 Watershed Basins - Developed Conditions

WATERSHED BASIN	AREA (Acres)	Curve Number (CN)	Lag Time (Minutes)	DESCRIPTION
Southwest Gretna	286	80	10.6	Includes portions of southwest Gretna Stepping Stone subdivision.
Gretna	288	79	12.0	Includes portions of central Gretna and Willow Park subdivision.
West	88	73	7.0	Includes the Forrest Run and Covington subdivision
Central	102	71	5.8	Includes central portions of the Lyman Hylands and Covington subdivision
East	30	78	5.3	Includes eastern portions of the Lyman Hylands and Covington subdivisions..

The 100 year runoff was calculated at Junction points A,B,C, and D as shown in the drainage map using HEC-HMS, WinTR-55. The 100 year runoff was also calculated at Junction D using the Rational Method. The following table summarizes the calculated developed runoff:

Table 1.2 Summary of Runoff for 10, 50, and 100 Year Storm Events for Developed Conditions

Model	10 Year Runoff (cfs)	50 Year Runoff (cfs)	100 Year Runoff (cfs)
HEC-HMS			
Junction A	1,472	2,315	2,557
Junction B	1,570	2,484	2,794
Junction C	1,678	2,670	3,053
Junction D	1,711	2,726	3,131
WinTR-55			
Junction A	1,487	2,268	2,651
Junction B	1,604	2,452	2,879
Junction C	1,731	2,662	3,133
Junction D	1,776	2,732	3,217
Rational Method			
Junction D			3548
Regression Equation			
Junction D	1,657	3,050	3,829

APPENDIX A
OUTPUT FOR EXISTING RUNOFF

Section A	HEC-HMS
Section B	WINTR-55
Section C	RATIONAL METHOD
Section D	USGS REGRESSION EQUATIONS