WOODBURY COUNTY APPROXIMATE FLOOD STUDY
FARMER'S/GARRETSON DITCH
WOODBURY COUNTY, IOWA
PROJECT NO. 110.0660

SEPTEMBER 26, 2011

I hereby certify that this Engineering Document was prepared by me or under my direct personal supervision and that I am a duly Licensed Professional Engineer under the Laws of the State of Iowa.

Adam Bullerman 9/26/11

Adam R. Bullerman, P.E. Date

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Prepared by:

SNYDER & ASSOCIATES, INC.
2727 SW Snyder Blvd.
Ankeny, Iowa 50023
(515) 964-2020

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1. INTRODUCTION

1.1. Purpose

The following approximate hydrologic and hydraulic analysis was prepared to support a revision to the Zone A Special Flood Hazard Area (SFHA) determination within Woodbury County, Iowa. This analysis provides both scientific and technical corrections to the methods used to determine the Zone A SFHA shown in the effective FIRM panels dated September 29, 2011. Our justification for the revision can generally be classified into the following categories:

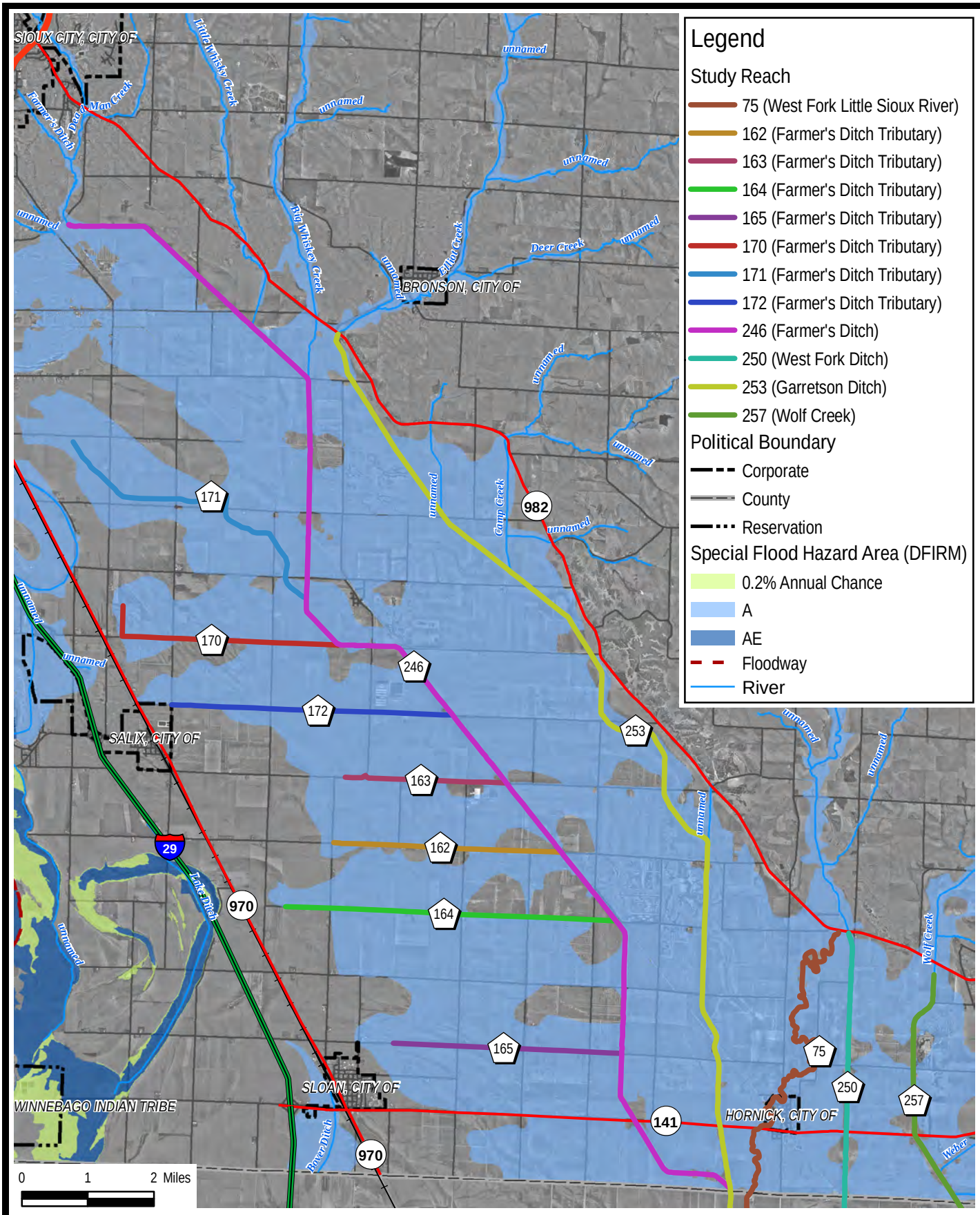
- Hydrologic modeling revisions using methods appropriate for the landform
- Updated hydraulic modeling based on hydrologic revisions and cross section data from more detailed topographic data using HEC-RAS
- Floodplain mapping based on more detailed topographic data

The Hydraulics Report[1] to perform new hydrologic and hydraulic analyses for Woodbury County, Iowa was reviewed in preparation of this report. In addition to this report, the FIRM panels, DFIRM data, and Flood Insurance Study dated September 29, 2011 was reviewed and incorporated in the revised mapping.

1.2. Study Reaches

This report covers the hydrologic and hydraulic modeling for the area east of Interstate 29 within the Missouri River Alluvial Plain of Woodbury County. Generally the revised modeling covers named rivers: Farmer's Ditch, Garretson Ditch, West Fork Little Sioux River, West Fork Ditch, Wolf Creek and all tributaries below the Loess Hills landform. The study reaches are covered by Woodbury County FIRM panels 212, 214, 225, 240, 400, 425, 450, 575, 576, 577, and 600. The individual reach identification numbers from the Hydraulics Report[1] were preserved and are shown in Figure 1.1.

[1] Hydraulics Report, Woodbury County, Iowa, AMEC Earth & Environmental, March 2, 2010



Study Reach Map
Woodbury County Approximate Flood Study
Farmer's/Garretson Ditch Woodbury County, Iowa

Figure 1.1
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2. HYDROLOGIC MODELING

2.1. Source of Error

We suggest that the hydrological analysis used to determine the 1% Annual Chance Flood discharge should be replaced due to the availability of better topographic data which allows for development of better hydrologic data. The mapping partner developed hydrologic data for this area using 10 meter DEM data from the USGS. Statewide LiDAR[2] data from the State of Iowa is now readily available for the state of Iowa and is much more detailed.

Discharges for this area were developed by the mapping partner using single variable regional regression equations for ungaged sites on ungaged streams presented in *USGS, Techniques for Estimating Flood-Frequency Discharges for Streams in Iowa, 2001*. This methodology is not necessarily inappropriate for this study area. However, the regression equations presented in the USGS report should only apply to watersheds that are "within the range or explanatory space of the characteristic values used to develop the regression equations."[3] The 2001 USGS regional regression equations place the study area watersheds entirely within Region 2. However, the study area watersheds include two distinct landforms, the low ground slope Missouri Alluvial Plain and the steep ground slope Loess Hills. Therefore, alternate methodology of the 2001 USGS report was used to determine the 1% annual chance flood discharges for the tributaries located within the Missouri Alluvial Plain.

2.2. Revised Hydrology

2.2.1. Methodology

To more accurately predict the discharges for the study area, the multi-variable region 2 regression equations were used since they "provide better predictive accuracies than the one-variable equations because slope and relief factors further define flood-frequency relations."[3] Due to the low Main Channel Slopes (MCS) of the tributary watersheds located in the Missouri Alluvial Plain, the multi-variable equations are more suited for the study area since the "MCS is positively related to flood runoff."[3]

2.2.2. Model Setup

Watersheds for the Missouri Alluvial Plain tributaries were delineated using LiDAR topography as shown in Figure 2.1. Flow change locations were identified for each reach from the digital data[4] used to generate the current approximate flood plain mapping. The modeled tributary watersheds were subdivided to reflect the flow change locations of the previous study. Larger watersheds such as Reach 75 (West Fork Little Sioux River) were further subdivided as needed to more accurately predict approximate flood boundaries. Since the community of Hornick is located within this watershed, additional flow change

[2] Iowa LiDAR Project: Iowa LiDAR Consortium, Flights: Spring 2008 – Spring 2010
[3] USGS, Techniques for Estimating Flood-Frequency Discharges for Streams in Iowa, 2001
[4] Woodbury County Approximate Flood Boundaries, Simulations and Spatial Files, Black & Veatch, November 2008

locations are justified to increase the accuracy of the approximate flood boundaries through the small community.

For each subwatershed located in the Missouri Alluvial Plain, the main channel length (MCL) and main channel slope (MCS) was determined using LiDAR topography and the techniques described in the 2001 USGS report. Generally the main channel slopes are very flat ranging between 1.62 and 2.61 feet per mile. For the 1% annual chance flood, the multi-variable region 2 regression equation is listed below:

$$Q_{100} = 531\ DA^{0.542}\ MCS^{0.313}\ (DML + 1)^{-0.549}$$

Q = 1% Annual Chance Flood Discharge [cfs]
DA= Drainage Area [Sq-Miles]
MCS = Main Channel Slope [ft/mile]
DML = Des Moines Lobe Ratio

Since all of the study area is located outside of the Des Moines Lobe region, the DML ratio equals zero.

2.2.3. Results

Table 1 summarizes the calculated multi-variable peak discharges for each Missouri Alluvial Plain tributary watersheds shown in Figure 2.1. The table also includes the previously determined 1% annual chance discharge and the percent reduction due to the alternate methodology.

Table 2.1 Summary of Discharges, Multi-Variable Regression Equation

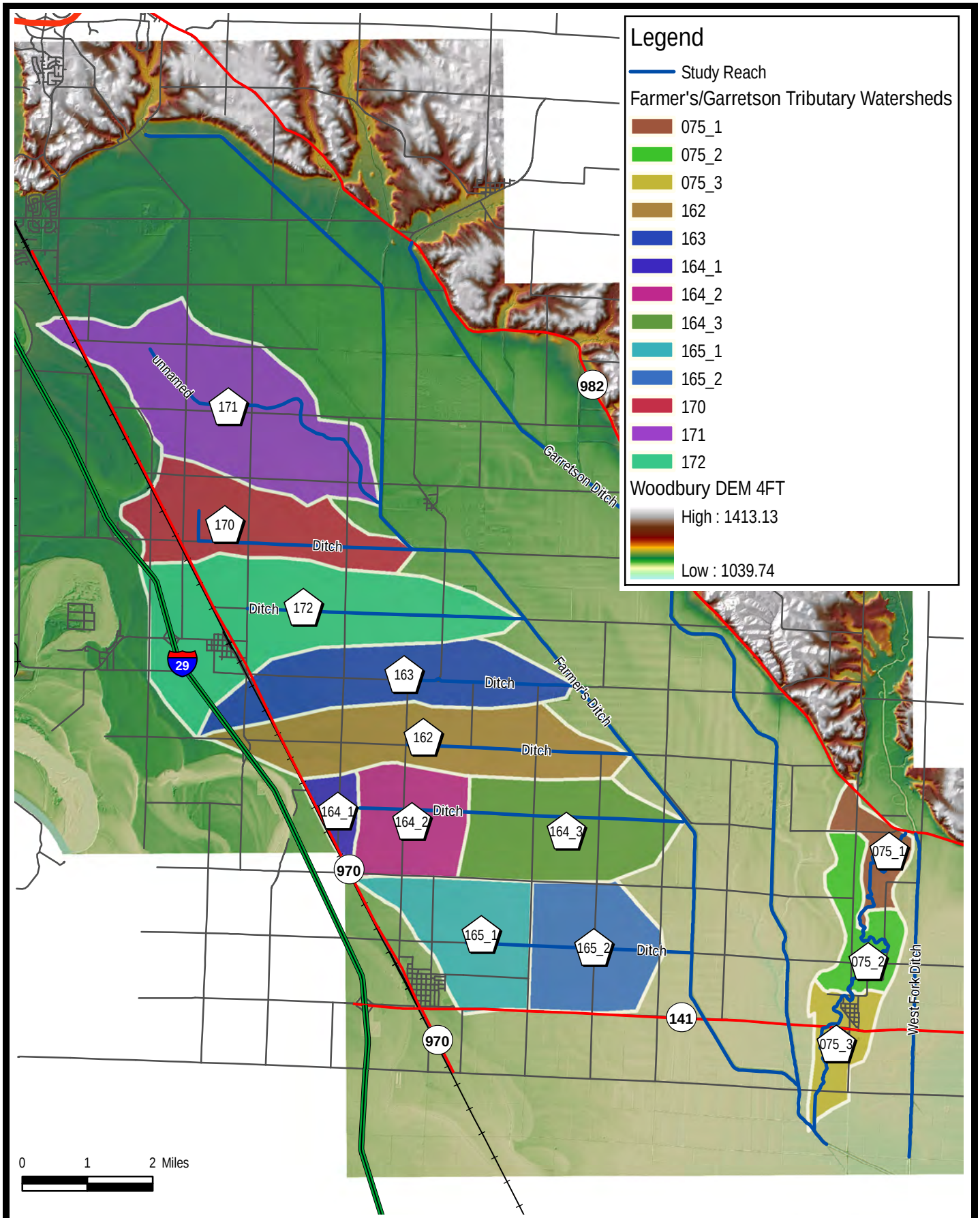
Subarea	*DA Cumulative (sq-mi)*	*MCS (ft/mi)*	*1% Annual Chance Discharge (cfs)*		
			Multi-Variable	*Original Approximate Study*	*Percent Reduction*
75_1	*1.17*	*1.78*	*693*	*3,652*	*81%*
75_2	*2.96*	*1.62*	*1,112*	*3,652*	*70%*
75_3	*4.47*	*1.80*	*1,437*	*3,652*	*61%*
162	*5.40*	*2.61*	*1,788*	*2,760*	*35%*
163	*4.61*	*2.57*	*1,634*	*3,539*	*54%*
164_1	*0.76*	*2.50*	*610*	*1,800*	*66%*
164_2	*3.55*	*2.50*	*1,406*	*2,188*	*36%*
164_3	*8.07*	*2.50*	*2,194*	*4,176*	*47%*
165_1	*3.46*	*2.50*	*1,386*	*3,166*	*56%*
165_2	*7.03*	*2.50*	*2,036*	*3,360*	*39%*
170	*4.36*	*2.53*	*1,577*	*2,760*	*43%*
171	*7.52*	*1.90*	*1,938*	*3,964*	*51%*
172	*7.83*	*2.38*	*2,125*	*2,633*	*19%*

Since the main waterways within the study area have a significant portion of their respective watersheds located within the Loess Hills land form where watershed slopes are much steeper, we concur with the previous study's choice to use the single variable regression equation to establish peak discharges. Generally, the main waterways would exhibit main channel slopes between 12 and 60 feet per mile. The calculated discharges using the multi-variable equation would not have a significant impact on the predictability over the single variable equation. Table 2.2 summarizes the previously determined 1% annual chance discharges at their respective flow change location within the hydraulic model.

Table 2.2 Summary of Discharges, Main Waterway Reaches

River	*Cross Section*	*1% Annual Chance Discharge (cfs)*
Farmer's Ditch (246)	*104990*	*5,185*
	85561	*8,320*
	81247	*12,315*
	73763	*12,453*
	68531	*12,646*
	63991	*12,961*
	60800	*13,142*
	46808	*13,491*
	39270	*13,711*
	31593	*13,830*
	25791	*14,145*
	20359	*14,340*
	13883	*14,518*
	6800	*14,651*
West Fork Ditch (250)	*26071*	*16,942*
	18183	*17,004*
	7603	*17,038*

River	*Cross Section*	*1% Annual Chance Discharge (cfs)*
Garretson Ditch (253)	*87069*	*9,845*
	79308	*10,013*
	68638	*10,408*
	63395	*11,162*
	60576	*11,617*
	47342	*11,814*
	39363	*11,981*
	32752	*12,073*
	26103	*12,280*
	16794	*12,379*
	10907	*12,506*
	5271	*18,324*
Wolf Creek (257)	*24657*	*12,737*
	12325	*12,793*
	7946	*12,980*
	5028	*13,297*



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Drainage Area Map
Woodbury County Approximate Flood Study
Farmer's/Garretson Ditch Woodbury County, Iowa

Figure 2.1
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3. HYDRAULIC MODELING

3.1. Source of Error

We suggest that the hydraulic analysis used to determine the 1% Annual Chance Flood elevations does not represent the best available topographic information for the study reach. The Mapping Partner utilized 10 meter DEM data from the USGS to develop cross section data for the approximate hydraulic analysis. The hydraulic model developed for this study reflects updated topographic data from Statewide LiDAR and the updated hydrologic analysis. The updated information will produce more accurate georeferenced floodplain mapping from the updated topographic mapping and more accurate floodplain extent with the updated hydrologic data.

3.2. Revised Hydraulics

3.2.1. Methodology

Approximate hydraulic analyses were performed with U.S Army Corps of Engineers Hydraulic Engineering Center River Analysis System (HEC-RAS) computer program (Version 4.1). Geometry data was generated using U.S. Army Corps of Engineers HEC-GeoRAS, GIS tools for support of HEC-RAS using ArcGIS. Cross sections were placed at critical locations with additional sections added where needed for model stability.

Cross section geometry was developed from Iowa Statewide LiDAR topography. The data is referenced to the North American Vertical Datum of 1988 (NAVD88). No field survey data was obtained for this approximate analysis. The hydraulic model is georeferenced to the North American Datum of 1983, Iowa State Plane North. Cross sections were drawn left to right looking downstream.

Overbank Manning's "n" values were determined from color aerial imagery of Woodbury County, 2009 and were set to a constant value of 0.06. As previously stated the land use and soil type is consistent throughout the studied area so the same overbank and channel "n" values were used. Channel "n" values are assumed to be 0.035 due to the straightened vegetated drainage ditches.

Boundary conditions for the study reach were selected in accordance with *Guidelines and Specifications for Flood Hazard Mapping Partners, C.3.3.1, page C-35, FEMA, November 2009*. Normal depth was assumed for all studied reaches.

HEC-GeoRAS geodatabases with corresponding feature classes for each study reach was included with the original simulation data files from the 2008 Black & Veatch study (included on attached disk). Original input feature classes were copied into new GeoRAS projects to maintain consistency with the original RAS models such as river lengths and cross section stationing. New cross section elevation data was extracted from the Iowa Statewide LiDAR digital elevation model using the cutlines from the original dataset. The original HEC-RAS models from the 2008 Black & Veatch study were then modified to include the elevation data derived from Iowa Statewide LiDAR. Reach and cross

section names were not modified. Bank station locations were appropriately adjusted to reflect the new elevation data. A copy of the LiDAR derived digital elevation model is included on the attached disk.

3.2.2. Results

The results of the revised hydraulic models for the 1% Annual Chance Flood are shown in Tables 3.1 through 3.12. Overall, the revised 1% Annual Chance Flood profiles were generally several feet lower than the Mapping Partner's approximate analysis. However some areas included slight increases. These differences (mostly lower) in profile elevations are a direct result of the updated hydrologic methods and using the best available topographic data. Digital copies of the HEC-RAS models are included on the attached disk.

Table 3.1 Hydraulic Results, Reach 075 (West Fork Little Sioux River)

Cross Section (Revised Analysis)	*1% Annual Chance Flood Profile* [1]		
	Black & Veatch Analysis [2]	*Revised Analysis*	*Difference*
0_1648	1,062.65	1,061.01	-1.64
10_1647	1,063.51	1,062.39	-1.12
20_1646	1,063.67	1,062.68	-0.99
30_1643	1,064.11	1,063.70	-0.41
40_1434	1,065.00	1,064.82	-0.18
50_1645	1,065.72	1,065.89	0.17
60_1644	1,065.97	1,066.72	0.75
70_1642	1,066.29	1,067.10	0.81
80_1437	1,068.76	1,068.18	-0.58
90_1641	1,071.47	1,070.29	-1.18
100_1436	1,072.21	1,071.43	-0.78
110_1435	1,072.25	1,071.19	-1.06

[1] Elevations in NAVD88

[2] Woodbury County Approximate Flood Boundaries, Simulations and Spatial Files, Black and Veatch, November 2008

Table 3.2 Hydraulic Results, Reach 162 (Farmer's Ditch Tributary)

Cross Section (Revised Analysis)	*1% Annual Chance Flood Profile* [1]		
	Black & Veatch Analysis [2]	*Revised Analysis*	*Difference*
4922	1,072.43	1,069.94	-2.49
10042	1,073.71	1,071.97	-1.74
15218	1,074.05	1,072.73	-1.32
17535	1,074.31	1,073.38	-0.93

[1] Elevations in NAVD88

[2] Woodbury County Approximate Flood Boundaries, Simulations and Spatial Files, Black and Veatch, November 2008

Table 3.3 Hydraulic Results, Reach 163 (Farmer's Ditch Tributary)

Cross Section (Revised Analysis)	*1% Annual Chance Flood Profile* [1]		
	Black & Veatch Analysis [2]	*Revised Analysis*	*Difference*
2339	1,073.78	1,071.11	-2.67
7661	1,074.39	1,074.03	-0.36
12699	1,075.01	1,074.88	-0.13

[1] Elevations in NAVD88

[2] Woodbury County Approximate Flood Boundaries, Simulations and Spatial Files, Black and Veatch, November 2008

Table 3.4 Hydraulic Results, Reach 164 (Farmer's Ditch Tributary)

Cross Section (Revised Analysis)	*1% Annual Chance Flood Profile* [1]		
	Black & Veatch Analysis [2]	*Revised Analysis*	*Difference*
0_1519	1,071.87	1,068.71	-3.16
10_9500	1,072.36	1,070.96	-1.40
20_9501	1,072.67	1,072.57	-0.10
30_1517	1,073.95	1,073.92	-0.03

[1] Elevations in NAVD88

[2] Woodbury County Approximate Flood Boundaries, Simulations and Spatial Files, Black and Veatch, November 2008

Table 3.5 Hydraulic Results, Reach 165 (Farmer's Ditch Tributary)

Cross Section (Revised Analysis)	*1% Annual Chance Flood Profile* [1]		
	Black & Veatch Analysis [2]	*Revised Analysis*	*Difference*
2634	1,067.87	1,065.80	-2.07
11869	1,068.58	1,068.81	0.23
17738	1,069.92	1,070.14	0.22

[1] Elevations in NAVD88

[2] Woodbury County Approximate Flood Boundaries, Simulations and Spatial Files, Black and Veatch, November 2008

Table 3.6 Hydraulic Results, Reach 170 (Farmer's Ditch Tributary)

Cross Section (Revised Analysis)	*1% Annual Chance Flood Profile* [1]		
	Black & Veatch Analysis [2]	*Revised Analysis*	*Difference*
9105.968	1,078.96	1,078.99	0.03
11677.22	1,079.39	1,079.53	0.14
14276.25	1,080.61	1,080.37	-0.24
19401.67	1,082.78	1,081.82	-0.96

[1] Elevations in NAVD88

[2] Woodbury County Approximate Flood Boundaries, Simulations and Spatial Files, Black and Veatch, November 2008

Table 3.7 Hydraulic Results, Reach 171 (Farmer's Ditch Tributary)

Cross Section (Revised Analysis)	*1% Annual Chance Flood Profile* [1]		
	Black & Veatch Analysis [2]	*Revised Analysis*	*Difference*
12923.1	1,080.67	1,080.73	0.06
16321.89	1,083.15	1,081.83	-1.32
18913.99	1,084.18	1,082.87	-1.31
21641.6	1,084.63	1,083.92	-0.71
26017.57	1,086.04	1,085.59	-0.45

[1] Elevations in NAVD88

[2] Woodbury County Approximate Flood Boundaries, Simulations and Spatial Files, Black and Veatch November 2008

Table 3.8 Hydraulic Results, Reach 172 (Farmer's Ditch Tributary)

Cross Section (Revised Analysis)	*1% Annual Chance Flood Profile* [1]		
	Black & Veatch Analysis [2]	*Revised Analysis*	*Difference*
2782	1,077.57	1,077.09	-0.48
7886	1,079.41	1,079.73	0.32

[1] Elevations in NAVD88

[2] Woodbury County Approximate Flood Boundaries, Simulations and Spatial Files, Black and Veatch, November 2008

Table 3.9 Hydraulic Results, Reach 246 (Farmer's Ditch)

Cross Section (Revised Analysis)	*1% Annual Chance Flood Profile* [1]		
	Black & Veatch Analysis [2]	*Revised Analysis*	*Difference*
829	1,066.28	1,064.74	-1.54
2200	1,066.77	1,065.24	-1.53
6800	1,067.27	1,066.20	-1.07
10599	1,067.46	1,066.50	-0.96
13883	1,067.70	1,066.89	-0.81
17015	1,067.84	1,067.41	-0.43
20359	1,068.09	1,067.80	-0.29
25791	1,069.21	1,068.65	-0.56
31593	1,070.80	1,070.09	-0.71
36685	1,072.69	1,070.98	-1.71
39270	1,073.37	1,071.40	-1.97
41955	1,073.75	1,072.19	-1.56
46808	1,074.22	1,073.50	-0.72
49831	1,074.56	1,074.63	0.07
52479	1,075.05	1,075.37	0.32
60800	1,078.58	1,077.93	-0.65
63991	1,079.64	1,079.23	-0.41
68531	1,080.09	1,080.12	0.03
71825	1,080.29	1,080.35	0.06
73763	1,080.50	1,080.45	-0.05
75684	1,081.17	1,080.64	-0.53
78674	1,082.04	1,081.76	-0.28
81247	1,083.64	1,082.60	-1.04
85561	1,084.37	1,083.28	-1.09
91657	1,085.12	1,084.60	-0.52
94625	1,086.83	1,084.95	-1.88
97428	1,090.17	1,085.24	-4.93
99936	1,090.17	1,085.86	-4.31
102574	1,090.19	1,086.90	-3.29
104990	1,090.49	1,088.18	-2.31

[1] Elevations in NAVD88

[2] Woodbury County Approximate Flood Boundaries, Simulations and Spatial Files, Black and Veatch, November 2008

Table 3.10 Hydraulic Results, Reach 250 (West Fork Ditch)

Cross Section (Revised Analysis)	*1% Annual Chance Flood Profile* [1]		
	Black & Veatch Analysis [2]	*Revised Analysis*	*Difference*
2400	1,065.01	1,061.44	-3.57
3359	1,065.97	1,062.21	-3.76
4175	1,066.01	1,062.54	-3.47
5068	1,066.02	1,062.72	-3.30
7603	1,066.05	1,063.10	-2.95
10307	1,066.13	1,063.76	-2.37
12942	1,068.01	1,064.70	-3.31
15567	1,068.18	1,066.03	-2.15
18183	1,068.54	1,067.36	-1.18
20875	1,069.11	1,068.46	-0.65
23530	1,070.34	1,070.66	0.32
26071	1,071.20	1,073.85	2.65

[1] Elevations in NAVD88

[2] Woodbury County Approximate Flood Boundaries, Simulations and Spatial Files, Black and Veatch, November 2008

Table 3.11 Hydraulic Results, Reach 253 (Garretson Ditch)

Cross Section (Revised Analysis)	*1% Annual Chance Flood Profile* [1]		
	Black & Veatch Analysis [2]	*Revised Analysis*	*Difference*
3849	1,065.87	1,063.82	-2.05
5271	1,067.31	1,065.01	-2.30
7835	1,067.72	1,065.68	-2.04
10907	1,067.85	1,065.94	-1.91
14369	1,068.01	1,066.17	-1.84
16794	1,068.13	1,066.55	-1.58
21930	1,068.20	1,067.04	-1.16
26103	1,068.35	1,068.23	-0.12
29547	1,068.86	1,069.02	0.16
32752	1,069.00	1,069.45	0.45
36471	1,069.16	1,069.91	0.75
38230	1,069.69	1,070.27	0.58
39363	1,071.41	1,070.80	-0.61
41152	1,072.73	1,071.00	-1.73
42847	1,074.00	1,071.12	-2.88
44392	1,074.54	1,071.76	-2.78
47342	1,074.68	1,072.15	-2.53
50039	1,074.90	1,072.65	-2.25
51107	1,077.59	1,072.83	-4.76
52899	1,080.01	1,073.16	-6.85
56616	1,080.05	1,074.89	-5.16
58268	1,080.43	1,075.23	-5.20
60576	1,080.50	1,075.67	-4.83
63395	1,080.54	1,076.76	-3.78
66114	1,080.60	1,077.73	-2.87
68638	1,080.64	1,078.18	-2.46
71428	1,080.67	1,078.44	-2.23
74032	1,080.69	1,078.78	-1.91
76677	1,080.73	1,079.59	-1.14
79308	1,081.68	1,080.48	-1.20
82323	1,084.28	1,082.53	-1.75
84650	1,085.73	1,086.49	0.76
87069	1,089.27	1,090.07	0.80

[1] Elevations in NAVD88

[2] Woodbury County Approximate Flood Boundaries, Simulations and Spatial Files, Black and Veatch, November 2008

Table 3.12 Hydraulic Results, Reach 257 (Wolf Creek)

Cross Section (Revised Analysis)	*1% Annual Chance Flood Profile* [1]		
	Black & Veatch Analysis [2]	*Revised Analysis*	*Difference*
1898	1,062.03	1,062.54	0.51
3544	1,065.01	1,062.78	-2.23
5028	1,068.10	1,063.26	-4.84
7946	1,068.32	1,064.15	-4.17
10148	1,068.61	1,064.55	-4.06
12325	1,068.80	1,065.03	-3.77
14189	1,068.96	1,065.59	-3.37
15486	1,069.04	1,065.89	-3.15
18154	1,071.01	1,066.32	-4.69
19870	1,071.07	1,066.68	-4.39
21572	1,071.18	1,067.94	-3.24
23324	1,071.27	1,070.46	-0.81
24657	1,072.31	1,073.41	1.10

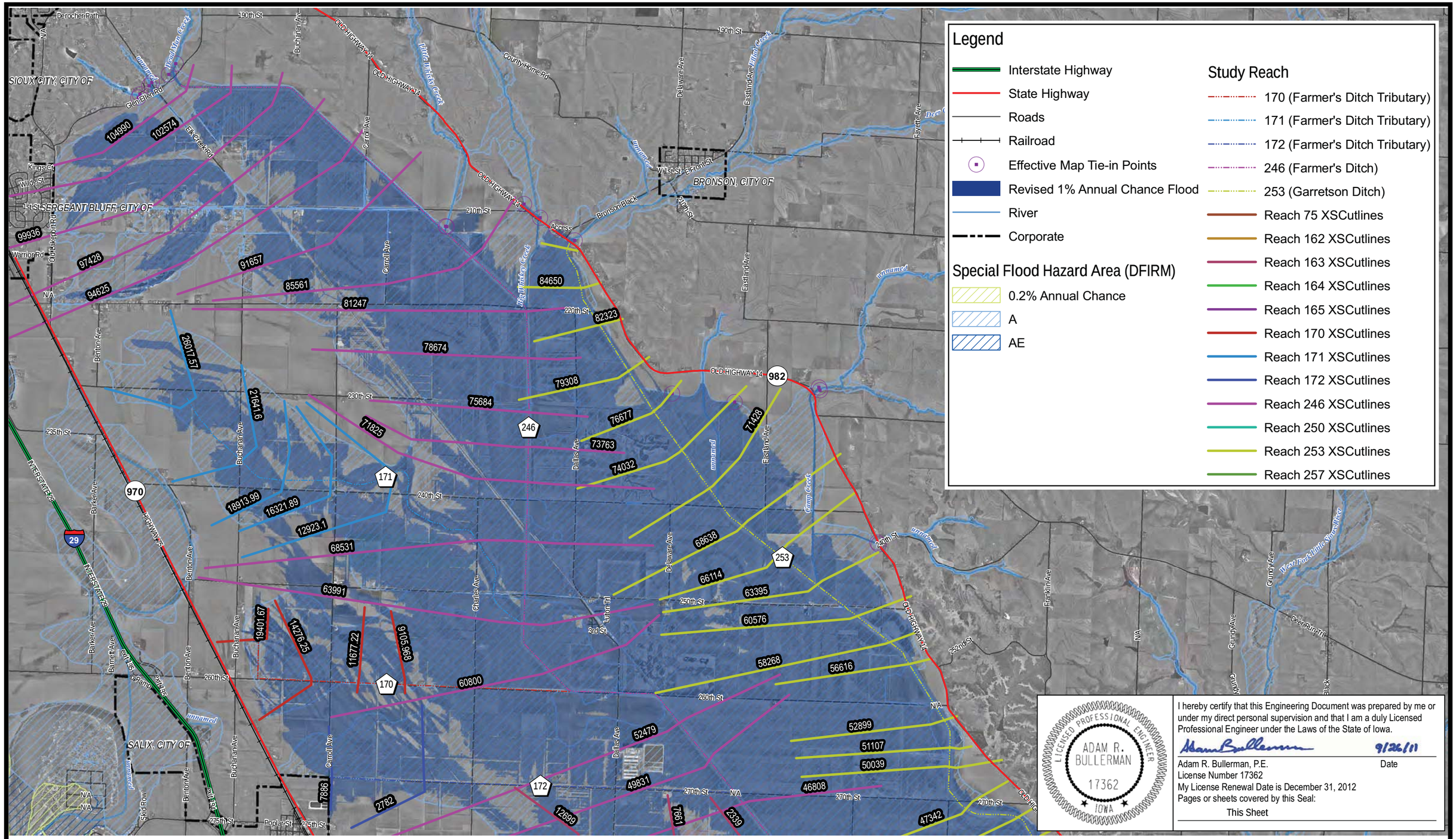
[1] Elevations in NAVD88

[2] Woodbury County Approximate Flood Boundaries, Simulations and Spatial Files, Black and Veatch, November 2008

4. MAPPING REVISIONS

Flood inundation mapping was generated using HEC-GeoRAS for the 1% Annual Chance Flood profile based on Iowa Statewide LiDAR data. The floodplain was delineated using the elevations at each cross section. In between cross sections the elevations were interpolated. Effective map tie-in locations were based on DFIRM data, September 29, 2011. For tributaries previously mapped using the N-FACT tool, new approximate boundaries were re-delineated with the Iowa Statewide LiDAR data to provide a seamless tie-in with the new HEC-RAS analysis. Depth results from the N-FACT analysis previously performed by Black & Veatch were available as attributes of the original spatial cross section data.

Several agricultural drainage ditch levees exist within this region. In accordance with FEMA mapping requirements, approximate flood inundation mapping was extended past these agricultural levees to natural grade. Approximate inundation mapping of modeled tributaries were then merged with the main drainage ditch mapping to form one dataset. A certified work map of the cross section locations and inundation mapping is included as Figure 4.1 and Figure 4.2. Digital shapefiles of the flood inundation mapping, stream centerlines, and hydraulic model cross sections, and map tie-in points are included on the attached disk.



I hereby certify that this Engineering Document was prepared by me or under my direct personal supervision and that I am a duly Licensed Professional Engineer under the Laws of the State of Iowa.

ADAM R. BULLERMAN — LICENSED PROFESSIONAL ENGINEER — 17362 — IOWA

Adam R. Bullerman, P.E. — Date 9/26/11
License Number 17362
My License Renewal Date is December 31, 2012
Pages or sheets covered by this Seal:
This Sheet

SNYDER & ASSOCIATES
Engineers and Planners

0 2,500 5,000 Feet
Map Elevations in NAVD88

Hydraulic Work Map (1 of 2)
Woodbury County Approximate Flood Study
Farmer's/Garretson Ditch Woodbury County, Iowa

Figure 4.1
Page 17

J:\2010_projects\110.0660\GIS\Fig4.1_Hydraulic Work Map.mxd

ADAM R. BULLERMAN
17362
LICENSED PROFESSIONAL ENGINEER
IOWA

I hereby certify that this Engineering Document was prepared by me or under my direct personal supervision and that I am a duly Licensed Professional Engineer under the Laws of the State of Iowa.

Adam Bullerman 9/26/11

Adam R. Bullerman, P.E. Date
License Number 17362
My License Renewal Date is December 31, 2012
Pages or sheets covered by this Seal:
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Legend

- Interstate Highway
- State Highway
- Roads
- Railroad
- Effective Map Tie-in Points
- Revised 1% Annual Chance Flood
- River

Political Boundary

- Corporate
- County

- A

Study Reach

- 75 (West Fork Little Sioux River)
- 162 (Farmer's Ditch Tributary)
- 163 (Farmer's Ditch Tributary)
- 164 (Farmer's Ditch Tributary)
- 165 (Farmer's Ditch Tributary)
- 170 (Farmer's Ditch Tributary)
- 172 (Farmer's Ditch Tributary)
- 246 (Farmer's Ditch)
- 250 (West Fork Ditch)
- 253 (Garretson Ditch)
- 257 (Wolf Creek)
- Reach 75 XSCutlines
- Reach 162 XSCutlines
- Reach 163 XSCutlines
- Reach 164 XSCutlines
- Reach 165 XSCutlines
- Reach 170 XSCutlines
- Reach 171 XSCutlines
- Reach 172 XSCutlines
- Reach 246 XSCutlines
- Reach 250 XSCutlines
- Reach 253 XSCutlines
- Reach 257 XSCutlines

SNYDER & ASSOCIATES
Engineers and Planners

0 2,500 5,000 Feet

Map Elevations in NAVD88

Hydraulic Work Map (2 of 2)
Woodbury County Approximate Flood Study
Farmer's/Garretson Ditch Woodbury County, Iowa

Figure 4.2
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J:\2010_projects\110.0660\GIS\Fig4.2_Hydraulic Work Map.mxd