APPENDIX A

NOAA ATLAS 14 INFORMATION

Below is the depth-duration-frequency and intensity-duration-frequency data for the Spanish Fork Power House.

POINT PRECIPITATION
FREQUENCY ESTIMATES
FROM NOAA ATLAS 14

SPANISH FORK PWR HOUSE, UTAH (42-8119) 40.0797 N 111.6044 W 4806 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006
Extracted: Thu Jul 2 2009

Precipitation Depth Estimates (in)

AEP* (1-in-Y)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day
2	0.14	0.22	0.27	0.37	0.46	0.56	0.64	0.82	1.05	1.34	1.49	1.79	2.11
5	0.22	0.33	0.41	0.55	0.68	0.80	0.89	1.10	1.37	1.75	1.95	2.35	2.77
10	0.28	0.42	0.52	0.70	0.87	0.99	1.09	1.30	1.60	2.02	2.26	2.74	3.22
25	0.36	0.55	0.68	0.92	1.14	1.29	1.38	1.57	1.91	2.36	2.67	3.26	3.80
50	0.44	0.67	0.83	1.12	1.38	1.55	1.63	1.81	2.15	2.62	2.98	3.67	4.25
100	0.53	0.81	1.00	1.35	1.67	1.86	1.93	2.07	2.40	2.88	3.30	4.10	4.70
200	0.63	0.96	1.19	1.61	1.99	2.21	2.27	2.37	2.68	3.13	3.62	4.54	5.16
500	0.80	1.21	1.50	2.02	2.50	2.76	2.83	2.91	3.14	3.47	4.06	5.15	5.78
1000	0.94	1.43	1.78	2.39	2.96	3.27	3.33	3.39	3.56	3.73	4.40	5.63	6.27

* These precipitation frequency estimates are based on an annual maxima series. AEP is the Annual Exceedance Probability.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

SPANISH FORK PWR HOUSE, UTAH (42-8119) 40.0797 N 111.6044 W 4806 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006
Extracted: Tue Jul 21 2009

Precipitation Intensity Estimates (in/hr)

AEP* (1-in-Y)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day
2	1.74	1.32	1.09	0.74	0.46	0.28	0.21	0.14	0.09	0.06	0.03	0.02	0.01
5	2.60	1.98	1.64	1.10	0.68	0.40	0.30	0.18	0.11	0.07	0.04	0.02	0.02
10	3.31	2.51	2.08	1.40	0.87	0.50	0.36	0.22	0.13	0.08	0.05	0.03	0.02
25	4.34	3.31	2.74	1.84	1.14	0.65	0.46	0.26	0.16	0.10	0.06	0.03	0.02
50	5.28	4.02	3.32	2.24	1.38	0.78	0.54	0.30	0.18	0.11	0.06	0.04	0.03
100	6.36	4.83	4.00	2.69	1.67	0.93	0.64	0.35	0.20	0.12	0.07	0.04	0.03
200	7.59	5.78	4.77	3.22	1.99	1.10	0.76	0.40	0.22	0.13	0.08	0.05	0.03
500	9.55	7.27	6.01	4.05	2.50	1.38	0.94	0.49	0.26	0.14	0.08	0.05	0.03
1000	11.29	8.59	7.10	4.78	2.96	1.63	1.11	0.57	0.30	0.16	0.09	0.06	0.04

* These precipitation frequency estimates are based on an annual maxima series. AEP is the Annual Exceedance Probability.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

The storm depth varies over the City. Generally, the storm depth is greater to the east and lesser to the west, as can be observed in Figure A-1.

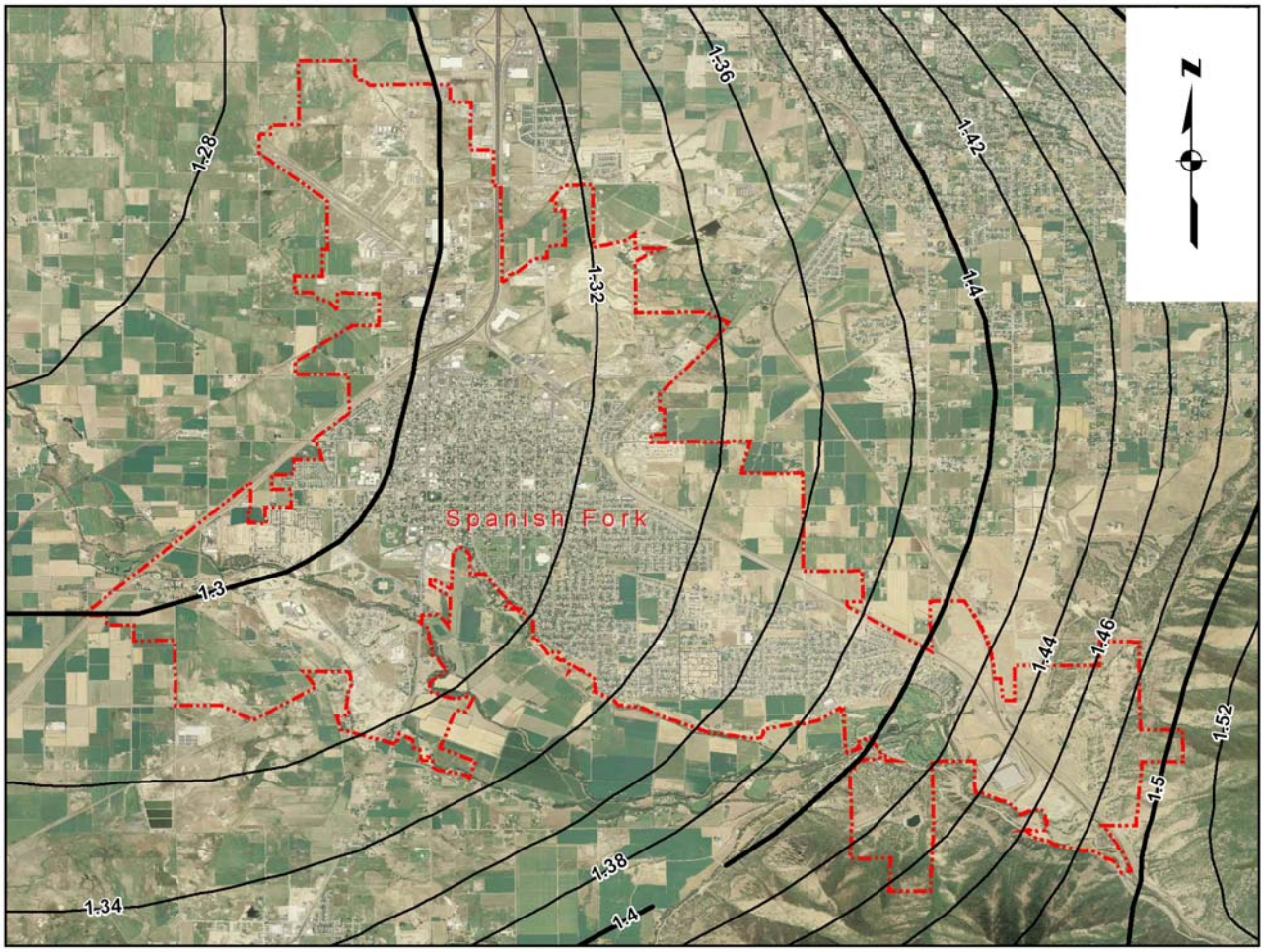


Figure A-1: Isopluvials of 3 hour precipitation (inches) with average recurrence interval of 25-years, from NOAA Atlas 14.

APPENDIX B

STORM DISTRIBUTIONS

APPENDIX B
STORM DISTRIBUTIONS

Below are the 25-year storm distributions for the 3-, 6-, and 24-hour storm durations. The total precipitation was obtained from the data shown in Appendix A. In order to apply these storm durations for other storm frequencies, multiply the incremental precipitation values by the ratio of the new storm frequency total depth to the 25-year total depth. The Farmer-Fletcher 3-hour modified storm distribution is the one exception to this rule. Below is an explanation of how that storm distribution was developed.

Salt Lake County developed the modified version of the Farmer-Fletcher distribution by nesting the one-hour (quartile 1) Farmer-Fletcher storm distribution, within the three hour period. The difference between the three-hour and the one-hour rainfall depths is divided equally and is distributed over the first 30 minutes of the storm and from hour 1.5 to 3.0 (see Table B-1).

Table B-1
Farmer-Fletcher Modified 3-Hour
Storm Distribution

Time (min)	Precipitation (Inches)
0	0.000
5	0.010
10	0.010
15	0.010
20	0.010
25	0.010
30	0.010
35	0.325
40	0.257
45	0.179
50	0.114
55	0.068
60	0.052
65	0.039
70	0.030
75	0.023
80	0.021
85	0.018
90	0.015

Time (min)	Precipitation (Inches)
95	0.010
100	0.010
105	0.010
110	0.010
115	0.010
120	0.010
125	0.010
130	0.010
135	0.010
140	0.010
145	0.010
150	0.010
155	0.010
160	0.010
165	0.010
170	0.010
175	0.010
180	0.010
Total:	1.38

* Nested 1-hour storm distribution

Table B-2
NOAA Atlas 14
General Precipitation Area
6-Hour Storm Distribution

Time (min)	Precipitation (Inches)
0	0.000
15	0.066
30	0.058
45	0.053
60	0.052
75	0.074
90	0.102
105	0.086
120	0.072
135	0.086
150	0.079
165	0.079
180	0.075
195	0.074
210	0.068
225	0.061
240	0.057
255	0.064
270	0.064
285	0.066
300	0.060
315	0.047
330	0.044
345	0.042
360	0.041
Total:	1.57

Table B-3
SCS Type II 24-Hour
Storm Distribution

Time (hours)	Precipitation (Inches)
0	0.000
0.5	0.013
1.0	0.013
1.5	0.013
2.0	0.014
2.5	0.014
3.0	0.015
3.5	0.016
4.0	0.016
4.5	0.017
5.0	0.018
5.5	0.019
6.0	0.020
6.5	0.021
7.0	0.023
7.5	0.025
8.0	0.027
8.5	0.030
9.0	0.033
9.5	0.037
10.0	0.043
10.5	0.055
11.0	0.073
11.5	0.114
12	0.897

Time (hours)	Precipitation (Inches)
12.5	0.170
13.0	0.088
13.5	0.063
14.0	0.049
14.5	0.043
15.0	0.037
15.5	0.033
16.0	0.029
16.5	0.027
17.0	0.025
17.5	0.023
18.0	0.021
18.5	0.020
19.0	0.019
19.5	0.018
20.0	0.017
20.5	0.016
21.0	0.015
21.5	0.015
22.0	0.014
22.5	0.014
23.0	0.013
23.5	0.013
24.0	0.013
Total:	2.36

APPENDIX C

TR-55 INFORMATION

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.
2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2]	Hydrologic condition [3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and I_a=0.2S
[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.
[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4]	48	65	73
Woods—grass combination (orchard or tree farm). [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.
2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.
3 *Poor*: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.
4 Actual curve number is less than 30; use CN = 30 for runoff computations.
5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.
6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 2-2d Runoff curve numbers for arid and semiarid rangelands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition [2]	A [3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and I_a, = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

Antecedent runoff condition

The index of runoff potential before a storm event is the antecedent runoff condition (ARC). ARC is an attempt to account for the variation in CN at a site from storm to storm. CN for the average ARC at a site is the median value as taken from sample rainfall and runoff data. The CN's in table 2-2 are for the average ARC, which is used primarily for design applications. See NEH-4 (SCS 1985) and Rallison and Miller (1981) for more detailed discussion of storm-to-storm variation and a demonstration of upper and lower enveloping curves.

Urban impervious area modifications

Several factors, such as the percentage of impervious area and the means of conveying runoff from impervious areas to the drainage system, should be considered in computing CN for urban areas (Rawls et al., 1981). For example, do the impervious areas connect directly to the drainage system, or do they outlet onto lawns or other pervious areas where infiltration can occur?

Connected impervious areas — An impervious area is considered connected if runoff from it flows directly into the drainage system. It is also considered connected if runoff from it occurs as concentrated shallow flow that runs over a pervious area and then into the drainage system.

Urban CN's (table 2-2a) were developed for typical land use relationships based on specific assumed percentages of impervious area. These CN vales were developed on the assumptions that (a) pervious urban areas are equivalent to pasture in good hydrologic condition and (b) impervious areas have a CN of 98 and are directly connected to the drainage system. Some assumed percentages of impervious area are shown in table 2-2a

If all of the impervious area is directly connected to the drainage system, but the impervious area percentages or the pervious land use assumptions in table 2-2a are not applicable, use figure 2-3 to compute a composite CN. For example, table 2-2a gives a CN of 70 for a 1/2-acre lot in HSG B, with assumed impervious area of 25 percent. However, if the lot has 20 percent impervious area and a pervious area CN of 61, the composite CN obtained from figure 2-3 is 68. The CN difference between 70 and 68 reflects the difference in percent impervious area.

Unconnected impervious areas — Runoff from these areas is spread over a pervious area as sheet flow. To determine CN when all or part of the impervious area is not directly connected to the drainage system, (1) use figure 2-4 if total impervious area is less than 30 percent or (2) use figure 2-3 if the total impervious area is equal to or greater than 30 percent, because the absorptive capacity of the remaining pervious areas will not significantly affect runoff.

When impervious area is less than 30 percent, obtain the composite CN by entering the right half of figure 2-4 with the percentage of total impervious area and the ratio of total unconnected impervious area to total impervious area. Then move left to the appropriate pervious CN and read down to find the composite CN. For example, for a 1/2-acre lot with 20 percent total impervious area (75 percent of which is unconnected) and pervious CN of 61, the composite CN from figure 2-4 is 66. If all of the impervious area is connected, the resulting CN (from figure 2-3) would be 68.

TR 55 Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project: _____ Designed By: _____ Date: _____

Location: _____ Checked By: _____ Date: _____

Check one: ☐ Present ☐ Developed

Check one: ☐ T_c ☐ T_t ☐ through subarea _____

NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to T_c only)	Segment ID				
1. Surface description (Table 3-1)					
2. Manning's roughness coeff., n (Table 3-1)					
3. Flow length, L (total L $\leq$ 100 ft) ..... ft					
4. Two-year 24-hour rainfall, P_2..... in					
5. Land slope, s ..... ft/ft					
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t ..... hr		+		=	

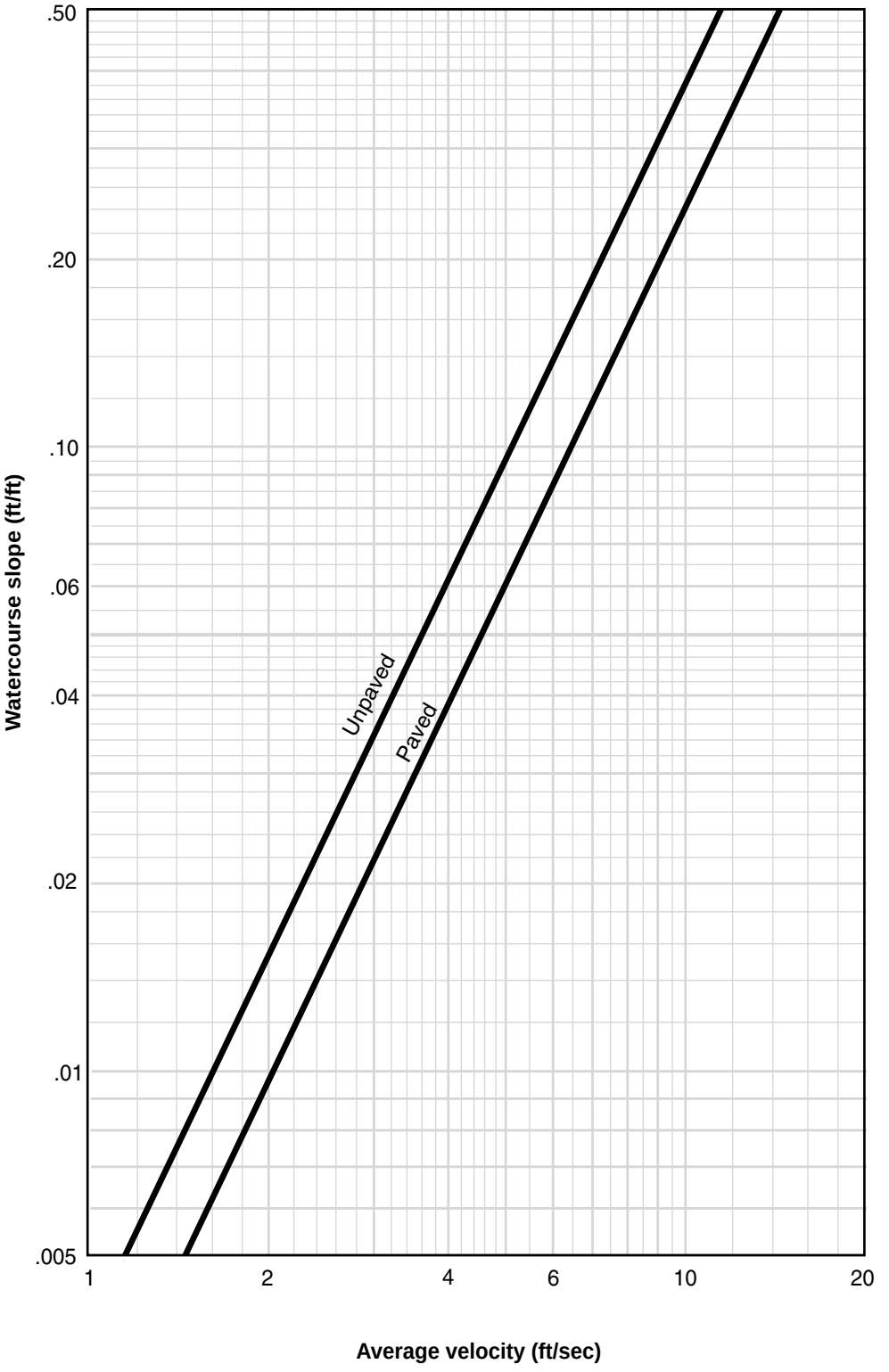
Shallow Concetrated Flow	Segment ID				
7. Surface description (paved or unpaved)					
8. Flow length, L ..... ft					
9. Watercourse slope, s ..... ft/ft					
10. Average velocity, V (Figure 3-1) ..... ft/s					
11. $T_t = \frac{L}{3600\,V}$ Compute T_t ..... hr		+		=	

Channel Flow	Segment ID				
12. Cross sectional flow area, a ..... ft^2					
13. Wetted perimeter, P_w ..... ft					
14. Hydraulic radius, $r = \frac{a}{P_w}$ Compute r ..... ft					
15. Channel Slope, s ..... ft/ft					
16. Manning's Roughness Coeff., n					
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V ..... ft/s					
18. Flow length, L ..... ft					
19. $T_t = \frac{L}{3600\,V}$ Compute T_t ..... hr		+		=	

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19 ..... hr ☐

Print Form | Reset Form | Save Form

Figure 3-1 Average velocities for estimating travel time for shallow concentrated flow



Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1] The n values are a composite of information compiled by Engman (1986).
[2] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3] When selecting n , consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \qquad \text{[eq. 3-3]}$$

where:

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bankfull elevation.

Tr 55 Worksheet 4: Graphical Peak Discharge Method

Project: _____ Designed By: _____ Date: _____

Location: _____ Checked By: _____ Date: _____

Check one: ____ Present _____ Developed

1. Data:

   Drainage area ..... A_m = _____ mi^2 (acres/640)

   Runoff curve number .... CN = _____ (From Worksheet 2)

   Time of concentration ..... T_c = _____ hr (From Worksheet 3)

   Rainfall distribution type ..... = _____ (II, III, DMVIII)

   Pond and swamp areas spread throughout watershed ..... = _____ percent of A_m (_____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency.....	yr			
3. Rainfall, P (24-hour).....	in			
4. Initial abstraction, I_a..... (Use CN with Table 4-1.)	in			
5. Compute I_a/P.....				
6. Unit peak discharge, q_u..... (Use T_c and I_a/P with exhibit 4- 10)	csm/in			
7. Runoff, Q ..... (From Worksheet 2)	in			
8. Pond and swamp adjustment factor, F_p..... (Use percent pond and swamp area with Table 4-2. Factor is 1.0 for zero percent pond and swamp area.)	in			
9. Peak discharge, q_p..... (Where $q_p = q_u A_m Q F_p$)	cfs			

Print Form Reset Form Save Form

APPENDIX D

SOIL MAP

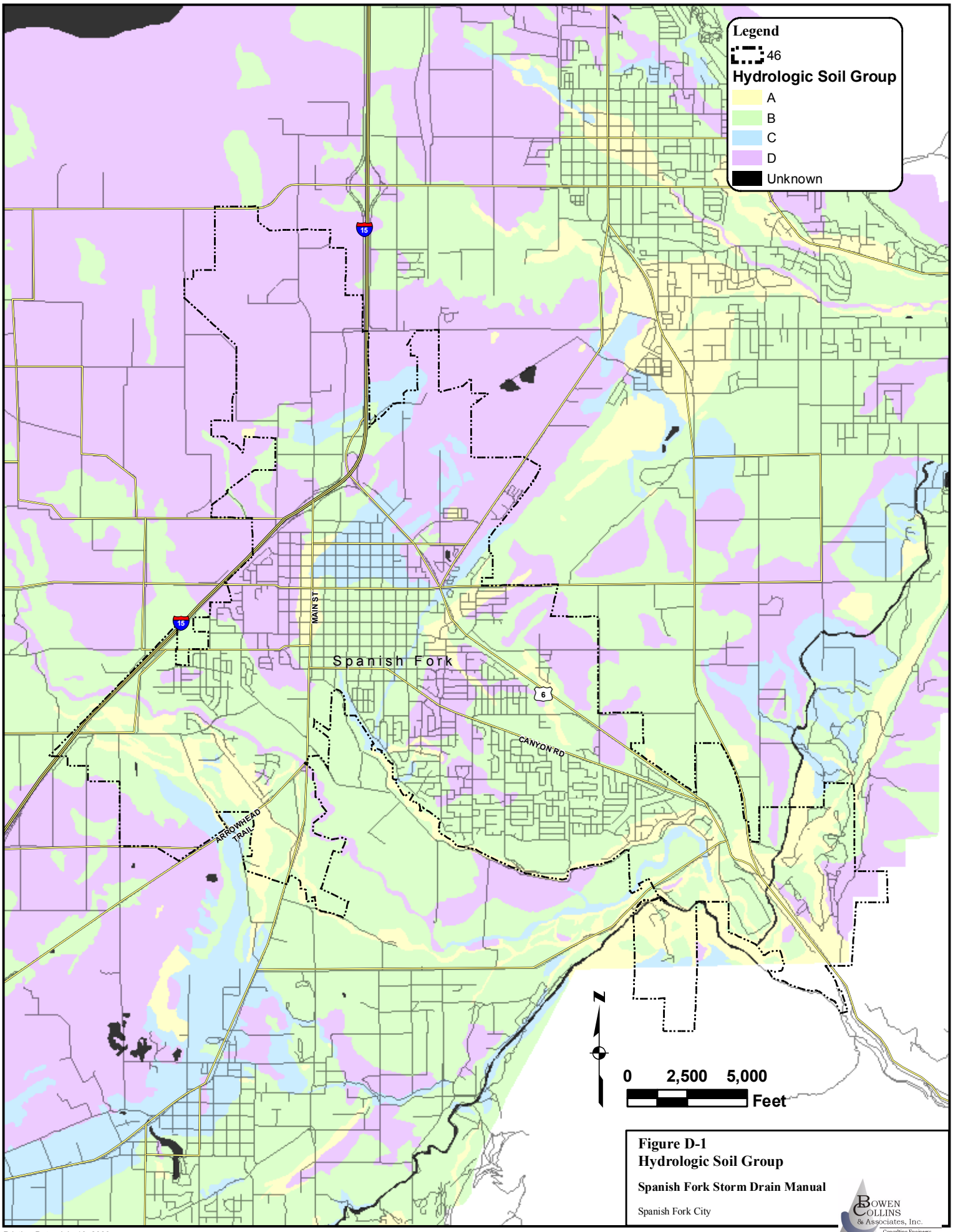


Figure D-1
Hydrologic Soil Group

Spanish Fork Storm Drain Manual

Spanish Fork City

Bowen Collins & Associates, Inc.
Consulting Engineers

Printing Date: July 16, 2009
File: P:\Spanish Fork City\Drainage Manual\Report\Figures\Isopluvials\Hydro Soil Class Map.mxd

APPENDIX E

FLOODPLAIN ORDINANCE

PART 4 DEVELOPMENT

CHAPTER 20 Flood Damage Prevention

15.4.20.010 Warning and Disclaimer of Liability

15.4.20.020 General Provisions

15.4.20.030 Administration

15.4.20.040 Provisions for Flood Hazard Reduction

15.4.20.050 Penalties for Violation

15.4.20.010 Warning and Disclaimer of Liability

The degree of flood protection required by this ordinance is considered reasonable for regulatory purposes and is based on scientific and engineering considerations. On rare occasions greater floods can and will occur and flood heights may be increased by man-made or natural causes. This ordinance does not imply that land outside the areas of special flood hazards or uses permitted within such areas will be free from flooding or flood damages. This ordinance shall not create liability on the part of the community or any official or employee thereof for any flood damages that result from reliance on this ordinance or any administrative decision lawfully made thereunder.

15.4.20.020 General Provisions

A. The ordinance shall apply to all areas with defined flood hazards within the jurisdiction of City.

B. The flood hazard areas for the purposes of this ordinance are those flood hazard areas in City that are identified by the current Federal Emergency Management Agency on Flood Insurance Rate Maps and Flood Boundary-Floodway Maps (FIRM and FBFMand any revisions thereto and any accompanying scientific and engineering Flood Insurance Study Report are hereby adopted by reference and declared to be a part of this ordinance.

C. Preliminary plat approval, site plan approval, or a building permit shall be required to ensure conformance with the provisions of this ordinance.

D. No structure or land shall hereafter be located, altered, or have its use changed without full compliance with the terms of this ordinance and other applicable regulations.

E. This ordinance is not intended to repeal, abrogate, or impair any existing easements, covenants, or deed restrictions. However, where this ordinance and another ordinance, easement, covenant, or deed restriction conflict or overlap, whichever imposes the more stringent restrictions shall prevail.

F. In the interpretation and application of this ordinance, all provisions shall be:

1. Considered as minimum requirements;
2. Liberally construed in favor of the governing body; and
3. Deemed neither to limit nor repeal any other powers granted under State statutes.

15.4.20.030 Administration

A. The Spanish Fork City Engineer or his/her appointee is hereby appointed the Floodplain Administrator to administer and implement the provisions of this ordinance and other appropriate sections of 44 CFR (National Flood Insurance Program Regulations) pertaining to floodplain management.

B. The duties and responsibilities of the Floodplain Administrator shall include, but not be limited to, the following:

1. Maintain and hold open for public inspection all records pertaining to the provisions of this ordinance.
2. Review permit application to determine whether proposed building site, including the placement of manufactured homes, will be reasonably safe from flooding from both surface and groundwater as well as from flood-related erosion.
3. Review, approve or deny all applications for development permits required by adoption of this ordinance.
4. Review permits for proposed development to assure that all necessary City permits have been obtained.
5. Where interpretation is needed as to the exact location of the boundaries of the areas of special flood hazards (for example, where there appears to be a conflict between a mapped boundary and actual field conditions) the Floodplain Administrator shall make the necessary interpretation.
6. Notify, in riverine situations, adjacent communities and the State Engineer's office prior to any alteration or relocation of a watercourse, and submit evidence of such notification to the Federal Emergency Management Agency.
7. Assure that the flood carrying capacity within the altered or relocated portion of any watercourse is maintained.
8. When base flood elevation data has not been provided in accordance with §030(B) the Floodplain Administrator shall obtain, review and reasonably utilize any base flood elevation data and floodway data available from a Federal, State or other source, in order to administer the provisions of §050.
9. When a regulatory floodway has not been designated, the Floodplain Administrator must require that no new construction, substantial improvements, or other development (including fill) shall be permitted within Zones A1-30 and AE on City's FIRM, unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within City.

C. Application for a preliminary plat, site plan, or building permit within a special floodplain hazard area shall be presented to the Floodplain

Administrator on forms furnished by him/her and may include, but not be limited to, plans in duplicate drawn to scale showing the location, dimensions, and elevation of proposed landscape alterations, existing and proposed structures, and the construction of fences, and the location of the foregoing in relation to areas of special flood hazard and areas of special erosion hazard. Additionally, the following information is required:

1. Elevation (in relation to mean sea level), of the lowest floor (including basement) of all new and substantially improved structures;
2. Elevation in relation to mean sea level to which any nonresidential structure shall be flood proofed;
3. A certificate from a licensed professional engineer or architect that the nonresidential flood proofed structure shall meet the flood proofing criteria of §050(B)(2);
4. Description of the extent to which any watercourse or natural drainage will be altered or relocated as a result of proposed development.
5. A bank stability/erosion hazard analysis performed by a licensed professional engineer, including site photographs, that evaluates potential flood-related erosion hazards and identifies appropriate erosion hazard mitigation measures to protect any structural improvements proposed in the area of special erosion hazard.
6. A geotechnical report that includes: at least one measurement of the ambient groundwater surface elevation on the site of proposed development collected between May 1 and May 31 (unless otherwise approved by the Floodplain Administrator); an engineer's estimate of the maximum anticipated groundwater elevation anticipated on the site during periods of flooding on the Spanish Fork River, referencing nearby base flood elevations on the current FIRM and all other available sources; and an engineer's recommendation with regard to the lowest elevation(s) that the lowest floor(s) (including basement) of all new and substantially improved structures should be constructed to be protected from flooding from groundwater and groundwater that could be influenced by surface water during periods of flooding.
7. A grading permit shall be obtained from the Floodplain Administrator before any excavation or fill work that could modify the flood hazards defined on the community's FIRM is completed in the area of special erosion hazard area.
8. Maintain record of all such information in accordance with §040(B)(1).

D. Approval or denial of a preliminary plat, site plan, or any permit required by City shall be based on all of the provisions of this ordinance and the following relevant factors:

1. The danger to life and property due to flooding or erosion damage;
2. The susceptibility of the proposed facility and its contents to flood and/or erosion damage and the effect of such damage on the individual owner;
3. The danger that materials may be swept onto other lands to the injury of others;
4. The safety of access to the property in times of flood for ordinary and emergency vehicles;
5. The costs of providing governmental services during and after flood conditions including maintenance and repair of streets and bridges, and public utilities and facilities such as sewer, gas, electrical and water systems;
6. The expected heights, velocity, duration, rate of rise and sediment transport of the flood waters and the effects of wave action, if applicable, expected at the site;
7. The necessity to the facility of a waterfront location, where applicable;
8. The availability of alternative locations, not subject to flooding or erosion damage, for the proposed use;
9. The relationship of the proposed use to the comprehensive general plan for that area

15.4.20.040 Provisions For Flood Hazard Reduction

A. General Standards.

1. In all areas of special flood hazards the following provisions are required for all new construction or substantial improvements:
   a. All new construction or substantial

improvements shall be designed (or modified) and adequately anchored to prevent flotation, collapse or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy;

b. All new construction or substantial improvements shall be constructed by methods and practices that minimize flood damage;

c. All new construction or substantial improvements shall be constructed with materials resistant to flood damage;

d. All new construction or substantial improvements shall be constructed with electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities that are designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding.

e. All new and replacement water supply systems shall be designed to minimize or eliminate infiltration of flood waters into the system;

f. All new construction shall be required to connect to City's sanitary sewer system.

g. On-site waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding.

h. No solid walls, solid fences, or other structures that could disrupt flowing water in an area of special flood hazard shall be constructed in a position or direction contrary to the direction of flowing water.

2. In all areas of special erosion hazards the following provisions are required for all new construction or substantial improvements:

a. No new construction or substantial improvements shall be designed or constructed until a licensed professional engineer certifies that no erosion hazard exists on the reach of open channel adjacent to or upstream from the proposed site for a distance of at least 150 feet or until any potential erosion hazard is mitigated by measures designed by a registered professional engineer and accepted by the Floodplain Administrator.

b. All permanent structures shall be set back a minimum of 60 feet from the top of bank of the nearest open channel that conveys runoff water.

c. No excavation or fill that could modify the flood hazards defined on the FIRM shall be performed without applying for and receiving a grading permit from the Floodplain Administrator.

d. No solid walls, solid fences, or other structures that could disrupt flowing water in an area of special erosion hazard shall be constructed in a position or direction contrary to the direction of flowing water.

3. In all areas of special flood hazard, all areas of special erosion hazard, and areas with potentially high groundwater levels, the following provisions are required for all new construction or substantial improvements:

a. As part of the building or development permit process, a geotechnical report shall be completed that includes a licensed professional engineer's recommendation with regard to the lowest elevation(s) that the lowest floor(s) (including basement) of all new and substantially improved structures should be constructed to be protected from flooding from groundwater and groundwater that could be influenced by surface water during periods of flooding, in accordance with §040(C)(6).

B. Specific Standards

In all areas of special flood hazards where base flood elevation data has been provided as set forth in (i) §030(B); (ii) §040(B)(8); or (iii) §050((C)(3), the following provisions are required:

1. Residential Construction - new construction or substantial improvement of any residential structure shall have the lowest floor (including basement), elevated a minimum of two feet above the base flood elevation. A licensed professional engineer or land surveyor shall submit a certification to the Floodplain Administrator that the standard of this subsection as proposed in §040(C)(1), is satisfied.

2. Nonresidential Construction - new construction or substantial improvements of any commercial, industrial or other nonresidential structure shall either have the lowest floor (including basement) elevated a minimum of two feet above the base flood level or together with attendant utility and sanitary facilities, be designed so that below the base flood level the structure is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy. A registered professional engineer or architect shall develop and/or review structural design, specifications, and plans for the construction, and shall certify that the design and methods of construction are in accordance with accepted standards of practice as outlined in this subsection. A record of such certification which includes the specific elevation (in relation to mean sea level) to which such structures are flood proofed shall be maintained by the Floodplain Administrator.

3. Enclosures - new construction or substantial improvements, with fully enclosed areas below the lowest floor that are usable solely for parking of vehicles, building access or storage in an area other than a basement, and which are subject to flooding shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters. Designs for meeting this requirement must either be certified by a licensed professional engineer or meet or exceed the following minimum criteria:
    a. A minimum of two openings having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding shall be provided.
    b. The bottom of all openings shall be no higher than one foot above grade.
    c. Openings may be equipped with screens, louvers, valves, or other coverings or devices provided that they permit the automatic entry and exit of floodwaters.
4. Manufactured Homes
    a. Require that all manufactured homes to be placed within Zone A on a community's FHBM or FIRM shall be installed using methods and practices which minimize flood damage. For the purposes of this requirement, manufactured homes must be elevated and anchored to resist flotation, collapse, or lateral movement. Methods of anchoring may include, but are not limited to, use of over-the-top or frame ties to ground anchors. This requirement is in addition to applicable State and local anchoring requirements for resisting wind forces.
    b. Require that manufactured homes that are placed or substantially improved on a permanent foundation such that the lowest floor of the manufactured home is elevated a minimum of two feet above the base flood elevation and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.
    c. Require that manufactured homes be placed or substantially improved on sites in an existing manufactured home park or subdivision with Zones A1-30, AH and AE on the community's FIRM that are not subject to the provisions of paragraph (4) of this section be elevated so that either:
        i. The lowest floor of the manufactured home is at least two feet above the base flood elevation, or
        ii. The manufactured home chassis is supported by reinforced piers or other foundation elements of at least equivalent strength that are no less than 36 inches in height above grade and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.
5. Recreational vehicles,trailers,or motor homes placed on sites within Zones A1-30**,** AH**,** and AE on the community's FIRM must meet one of the following criteria:
    a. Be on the site for fewer than 30 consecutive days,
    b. Be fully licensed and ready for highway use, or
    c. Meet the permit requirements of §040(C)(1), and the elevation and anchoring requirements for "manufactured homes" in paragraph (4) of this section. A recreational vehicle, trailer, or motor home is ready for highway use if it is on its wheels or jacking system, is attached to the site only by quick disconnect type utilities and security devices, and has no permanently attached additions.

C. Standards for Subdivision Proposals.
    1. All subdivision proposals shall be consistent with this ordinance.
    2. All proposals for the development of subdivisions including the placement of manufactured home parks and subdivisions shall meet Development Permit requirements of §030(C); §040(C); and the provisions of §050 of this ordinance.
    3. Base flood elevation data shall be generated for subdivision proposals and other proposed development (including the placement of manufactured home parks and subdivisions) greater than 50 lots or 5 acres, whichever is lesser, if not otherwise provided pursuant to §030(B), or §040(B)(8) of this ordinance.
    4. All subdivision proposals including the placement of manufactured home parks and subdivisions shall have adequate drainage provided to reduce exposure to flood hazards form both surface water and groundwater.
    5. All subdivision proposals including the placement of manufactured home parks and subdivisions shall have public utilities and facilities such as sewer, gas, electrical and water systems located and constructed to minimize or eliminate flood damage.

D. Standards for Areas of Shallow Flooding
    1. Located within the areas of special flood hazard established in §030(B), are areas designated as shallow flooding (AO and AH Zones). These areas have special flood hazards associated with base flood depths of 1 to 3 feet where a clearly defined channel does not exist and where

the path of flooding is unpredictable and where velocity flow may be evident. Such flooding is characterized by ponding or sheet flow; therefore, the following provisions apply:

a. All new construction or substantial improvements of residential structures shall have the lowest floor (including basement) elevated at least two feet above the base flood level.

b. All new construction or substantial improvements of non-residential structures;

i. Have the lowest floor (including basement) elevated at least two feet above the base flood level.

ii, Together with attendant utility and sanitary facilities be designed so that below the base flood level the structure is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads of effects of buoyancy.

c. A licensed professional engineer shall submit a certification to the Floodplain Administrator that the standards of this Section, as proposed in §040(C)(5) and §040(C)(6), are satisfied.

d. Require within Zones AH or AO adequate drainage paths around structures on sloping ground, to guide flood waters around and away from proposed structures.

2. City's FIRM may also identify areas of shallow flooding hazards with an average depth less than 1 foot deep (shaded Zone X), as established in §030(B). These areas may be between the flood hazard boundaries defined for the 1- and 0.2-percent-chance-annual-flood or associated with base flood depths less than 1 foot where a clearly defined channel does not exist and where the path of flooding is unpredictable and where velocity may be evident. Such flooding is generally characterized by sheet flow; therefore the following provisions apply:

a. All new construction or substantial improvements of residential and non-residential structures;

i. All new construction or substantial improvements have the lowest floor (including basement) elevated above the estimated depth of the base flood and above the highest groundwater level that is anticipated to occur during periods of flooding.

ii. Require within shaded X Zones positive ground slopes away from structures and adequate drainage paths around structures on sloping ground to guide flood water around and away from proposed structures.

iii. A registered professional engineer shall submit certification to the Floodplain Administrator that the standards of this Section, as proposed in §040(C)(5) and §040(C)(6)are satisfied.

E. Floodways

Floodways (located within areas of special flood hazard established in §030(B)) are areas designated as floodways. Since the floodway is an extremely hazardous area due to the velocity of flood waters which carry debris, potential projectiles and erosion potential, the following provisions shall apply:

1. Encroachments are prohibited, including fill, new construction, substantial improvements and other development within the adopted regulatory floodway *unless* it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base flood discharge.

2. If §050(A)(7) above is satisfied, all new construction or substantial improvements shall comply with all applicable flood hazard reduction provisions of Article 5.

F. Standards for Areas of Special Erosion Hazard

In order to prevent damage to structures in areas subject to special erosion hazards, the following provisions shall apply:

1. No structural development will be allowed to be constructed in an area of special erosion hazard unless the potential erosion hazards have been evaluated and mitigated and buildings meet minimum setback requirements in accordance with §050(A)(2).

2. No excavation or fill that could modify flood hazard boundaries defined on the FIRM shall be performed in areas of special erosion hazard without a grading permit, in accordance with §050(C)(7).

3. No solid walls, solid fences, or other structures that could disrupt flowing water in an area of special flood hazard or special erosion hazard shall be constructed in a position or direction contrary to

the direction of flowing water to create additional flooding and erosion hazards.

15.4.20.050. Penalties for Violation.

A. No structure or land shall hereafter be constructed, located, extended, converted, or altered without full compliance with the terms of this ordinance and other applicable regulations.

B. Violation of the provisions of this ordinance by failure to comply with any of its requirements (including violations of conditions and safeguards established in connection with conditions) shall constitute a class B misdemeanor. In addition to any fine, a violater shall pay all costs and expenses involved in the case.

C. Nothing herein contained shall prevent City from taking such other lawful action as is necessary to prevent or remedy any violation.

(Ord 07-09, Creating 02/20/2009)