STORMWATER MANAGEMENT PLAN
FOR
WRANGLER RIDGE SUBDIVISION

Project Location:
Northeast Quadrant of SW Urish Rd. & SW 17th St.
Topeka, KS 66615

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February 14, 2014

SBB Project No. 13-177

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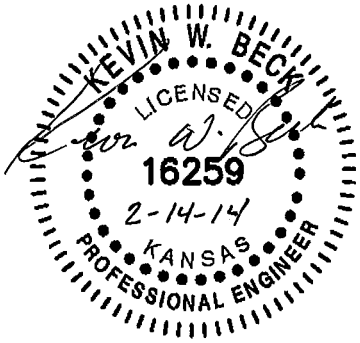
Submitted By:



Kari A. Bigham, EIT

Kevin W. Beck, PE, LEED AP, Principal

DRAINAGE REPORT (Category "A")

Subdivision Data

The proposed subdivision being platted is described as Lot 1 through 3, Block "A," and Lot 1 and 2, Block "B," Wrangler Ridge Subdivision. It is located in the northeast quadrant of SW Urish Rd. & SW 17th St. in Topeka, KS. It is found in the Southwest quarter of the Northwest quarter of Section 5, Township 12 South, and Range 15 East. The property consists of approximately 74.62 acres (m/l).

The existing property contains approximately 22.28 acres of wooded area and 52.26 acres of meadow or undeveloped grassland. An unnamed tributary enters the property in the southeast part of the property and continues in the northeasterly direction. A drainage swale begins in the north central part of the property and drains to the north and northeast. An existing detention pond is located in the extreme southwest corner of the property. A small portion of the west side of the property, approximately 16 acres, drains to the west. The remaining portion of the property drains to the north and northeast via overland flow. The average slope of the property is 4.5%.

Lot 1, Block "A" is intended to be zoned as C-2 for commercial development. Lot 2, Block "A" is intended to be zoned O & I-2 for development of office buildings. Lot 3, Block "A" and Lot 1, Block "B" is intended to be zoned as M-2 for multi-family homes. Finally, Lot 2, Block "B" is intended to be zoned as C-4 for commercial development.

Watershed Data

Existing Waterways

According to the City of Topeka Drainage Basin Map, the property lies within the Wanamaker and South Kansas Drainage Basin. As described in the previous section, an unnamed tributary runs through the southeast portion of the property, draining in the northeasterly direction. This tributary is located within the Wanamaker Drainage Basin. The tributary begins south of the property and conveys approximately 29.55 acres of runoff onto the property via a 42" CSP storm sewer pipe that crosses SW 17th Street. This pipe is located approximately 990 feet west of the east property line. The tributary also drains approximately 26.89 acres of the subject property. Additionally, a small portion of land to the north, 0.79 acre, and 0.51 acre to the east, drains onto the property and exits the property via the unnamed tributary.

A natural drainage swale begins in the north central part of the property and flows to the north and northeast. This swale is within the Wanamaker Drainage Basin. Stormwater runoff from approximately 27.52 acres exits the property via this swale. There is also 5.52 acres north of the property that drains onto the property and exits through the swale.

There are two smaller drainage areas found within the property boundaries that are within the Wanamaker Drainage Basin and exit the site via overland flow. One is found in the east corner of the property and drains 3.00 acres with 0.38 acres of it flowing across this site from the property to the east. The other is found in the northeast corner of the property and accounts for 1.71 acres of the runoff generated by the proposed subdivision.

Finally, there are two drainage areas located along the west side of the property that fall within the South Kansas Basin. One area found in the northwest corner of the property is 8.13 acres and includes 0.14 acres from the property to the north. The final drainage area is 7.89 acres and is located in the southwest corner of the property. There is an existing detention pond within the basin that receives 4.43 acres of off-site runoff via a 24" CSP storm sewer pipe (See Figure 1 in Appendix B for Existing Drainage Areas Map).

According to FEMA FIRM map no. 20177C0192E, the site is not within a designated floodplain. According to the USGS 7.5' Silver Lake quadrangle topographical map, the unnamed tributary is considered a dotted blue line or intermittent stream. Therefore, it is considered to be a Type II stream and the total required buffer width (per City of Topeka Ordinance) is 50 feet on each side perpendicular to the centerline of the stream.

Existing Hydrological Data

The Rational Method was utilized to determine the stormwater runoff from the site. All calculations include drainage that flows onto the subdivision as well as the drainage that is within the subdivision (See Figure 1 in Appendix B for Existing Drainage Areas Map).

Drainage data was used from the Street Improvement Project No. T-701006.00 for S.W. 17th Street (Phase II) for the City of Topeka, in Shawnee County, Kansas. The data used was for the 42" CSP storm sewer pipe (Headwaters Drainage Area) and for the 24" CSP storm sewer pipe (17th Street Drainage Area) that discharges stormwater onto the property. The 42" CSP storm sewer pipe discharge was added onto the final discharge for the Unnamed Tributary Drainage Area. The 24" CSP storm sewer pipe discharge was added onto the final discharge for the Detention Pond Drainage Area. The discharges of these pipes are shown in Tables I and II below.

Table I. 42" CSP Pipe Calculations – Headwaters

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)
2	29.55	0.38	20.0	3.34	1.00	37.5
10	29.55	0.38	20.0	4.62	1.00	51.9
100	29.55	0.38	20.0	6.59	1.25	92.5

Table II. 24" CSP Pipe Calculations – 17th Street

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)
2	4.43	0.49	11.0	4.35	1.00	9.4
10	4.43	0.49	11.0	5.89	1.00	12.8
100	4.43	0.49	11.0	8.30	1.25	22.5

Calculations using the Rational Method for the remaining drainage areas are summarized in Tables III-VIII below.

Table III. Existing Runoff Calculations – Unnamed Tributary

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Length of Travel (Ft.)	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)	Runoff Rate**, Combined (Q, cfs)
2	28.19	0.30	1934	21.4	3.23	1.00	27.3	60.0
10	28.19	0.30	1934	21.4	4.48	1.00	37.9	84.3
100	28.19	0.30	1934	21.4	6.41	1.25	67.8	151.1

** Includes runoff from 42" pipe (off-site) and based on the longest T_c of 23.8 min.

Table IV. Existing Runoff Calculations – Middle (Drainage Swale)

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Length of Travel (Ft.)	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)
2	33.04	0.30	1878	21.6	3.21	1.00	31.8
10	33.04	0.30	1878	21.6	4.47	1.00	44.3
100	33.04	0.30	1878	21.6	6.39	1.25	79.2

Table V. Existing Runoff Calculations – East

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Length of Travel (Ft.)	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)
2	3.00	0.30	657	13.8	3.98	1.00	3.6
10	3.00	0.30	657	13.8	5.39	1.00	4.9
100	3.00	0.30	657	13.8	7.61	1.25	8.6

Table VI. Existing Runoff Calculations – Northeast

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Length of Travel (Ft.)	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)
2	1.71	0.30	584	12.8	4.11	1.00	2.1
10	1.71	0.30	584	12.8	5.56	1.00	2.9
100	1.71	0.30	584	12.8	7.84	1.25	5.0

Table VII. Existing Runoff Calculations – Northwest

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Length of Travel (Ft.)	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)
2	8.13	0.30	742	21.0	3.26	1.00	8.0
10	8.13	0.30	742	21.0	4.52	1.00	11.0
100	8.13	0.30	742	21.0	6.46	1.25	19.7

Table VIII. Existing Runoff Calculations – Detention Pond

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Length of Travel (Ft.)	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)	Runoff Rate**, Combined (Q, cfs)
2	7.89	0.30	742	18.2	3.51	1.00	8.3	15.9
10	7.89	0.30	742	18.2	4.81	1.00	11.4	21.8
100	7.89	0.30	742	18.2	6.83	1.25	20.2	38.7

** Includes runoff from 24" pipe (off-site) and longest T_c = 18.2 min.

Future Hydrological Data

Currently, the extents of the proposed development for the site are not defined. A detailed drainage analysis should be required at the time of the Site Development Plan review. However, for the purpose of this drainage report, it is assumed that the future development of this site will contain a maximum of 80% of impervious surface in Lots 1 and 2, Block "A" and Lot 2, Block "B", 70% impervious surface in Lot 3, Block "A", and 60% impervious surface in Lot 1, Block "B". The planned city street that runs north and south in the middle of the subdivision will be assumed to have an impervious area of 70%. The future drainage areas remain the same as existing for the purpose of this report. The headwaters and 17th Street drainage areas will discharge the same amount as existing, as these drainage areas are located off the property. Once again, the headwater drainage area and the 17th Street drainage areas will be added to the unnamed tributary drainage area and the detention pond drainage area, respectively. The proposed runoff calculations, using the Rational Method, are provided in Table IX-XIV below.

Table IX. Proposed Runoff Calculations – Unnamed Tributary

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Length of Travel (Ft.)	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)	Runoff Rate**, Combined (Q, cfs)
2	28.19	0.70	1934	12.6	4.13	1.00	81.5	94.4
10	28.19	0.70	1934	12.6	5.59	1.00	110.3	132.6
100	28.19	0.70	1934	12.6	7.89	1.25	194.6	237.7

** Includes runoff from 42" pipe (off-site) and based on the longest T_c of 23.8 min.

Table X. Proposed Runoff Calculations – Middle (Drainage Swale)

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Length of Travel (Ft.)	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)
2	33.04	0.68	1878	13.0	4.08	1.00	91.7
10	33.04	0.68	1878	13.0	5.52	1.00	124.0
100	33.04	0.68	1878	13.0	7.79	1.25	218.8

Table XI. Proposed Runoff Calculations – East

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Length of Travel (Ft.)	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)
2	3.00	0.76	657	6.3	5.12	1.00	11.7
10	3.00	0.76	657	6.3	6.91	1.00	15.8
100	3.00	0.76	657	6.3	9.72	1.25	27.7

Table XII. Proposed Runoff Calculations – Northeast

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Length of Travel (Ft.)	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)
2	1.71	0.69	584	6.8	5.03	1.00	5.9
10	1.71	0.69	584	6.8	6.78	1.00	8.0
100	1.71	0.69	584	6.8	9.55	1.25	14.1

Table XIII. Proposed Runoff Calculations – Northwest

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Length of Travel (Ft.)	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)
2	8.13	0.75	742	10.2	4.47	1.00	27.3
10	8.13	0.75	742	10.2	6.04	1.00	36.8
100	8.13	0.75	742	10.2	8.52	1.25	64.9

Table XIV. Proposed Runoff Calculations – Detention Pond

Storm Event	Drainage Area (A, Ac.)	Runoff Coeff., C	Length of Travel (Ft.)	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Antecedent Moisture Constant, k	Runoff Rate (Q, cfs)	Runoff Rate**, Combined (Q, cfs)
2	7.89	0.82	742	7.4	4.92	1.00	31.8	37.5
10	7.89	0.82	742	7.4	6.64	1.00	43.0	50.8
100	7.89	0.82	742	7.4	9.36	1.25	75.7	89.2

** Includes runoff from 24" pipe (off-site) and longest T_c = 11.8 min.

Hydraulic Discussion

As previously discussed, an unnamed tributary enters the property in the southeast part of the property and continues in the northeasterly direction. A drainage swale begins in the north central part of the property and drains to the north and northeast. An existing detention pond is located in the extreme southwest corner of the property. A small portion of the west side of the property, approximately 16 acres, drains to the west. The remaining portion of the property drains to the north and northeast via overland flow.

The 16 acres that drains to the west is within the South Kansas Drainage Basin while the remainder of the property is within the Wanamaker Drainage Basin. The City of Topeka does not require detention within the South Kansas Basin but does require detention within the Wanamaker Drainage Basin.

Most likely stormwater will be conveyed through the property via interior swales and/or storm sewers. Therefore, drainage easements for these swales or pipes shouldn't be required.

In comparing the existing runoff amounts with the proposed runoff amounts for each drainage area, there is an increase in runoff with the proposed conditions. Because of this, it is recommended that detention should be provided for all drainage areas. The comparisons are shown in Tables XV-XX shown below.

Table XV. Existing vs. Proposed Runoff – Unnamed Tributary (w/ Headwaters)

Storm Event	Existing Runoff (cfs)	Proposed Runoff (cfs)	Difference (cfs)
2	60.0	94.4	+34.4
10	84.3	132.6	+48.3
100	151.1	237.7	+86.6

Table XVI. Existing vs. Proposed Runoff – Middle (Drainage Swale)

Storm Event	Existing Runoff (cfs)	Proposed Runoff (cfs)	Difference (cfs)
2	31.8	91.7	+59.9
10	44.3	124.0	+79.7
100	79.2	218.8	+139.6

Table XVII. Existing vs. Proposed Runoff – East

Storm Event	Existing Runoff (cfs)	Proposed Runoff (cfs)	Difference (cfs)
2	3.6	11.7	+8.1
10	4.9	15.8	+10.9
100	8.6	27.7	+19.1

Table XVIII. Existing vs. Proposed Runoff – Northeast

Storm Event	Existing Runoff (cfs)	Proposed Runoff (cfs)	Difference (cfs)
2	2.1	5.9	+3.8
10	2.9	8.0	+5.1
100	5.0	14.1	+9.1

Table XIX. Existing vs. Proposed Runoff – Northwest

Storm Event	Existing Runoff (cfs)	Proposed Runoff (cfs)	Difference (cfs)
2	8.0	27.3	+19.3
10	11.0	36.8	+25.8
100	19.7	64.9	+45.2

Because the northwest drainage area runoff flows to a drainage ditch that follows SW Urish Road, the amount of runoff that must be detained will be based on the current capacity of this drainage ditch.

Table XX. Existing vs. Proposed Runoff – Detention Pond (w/ 17th Street)

Storm Event	Existing Runoff (cfs)	Proposed Runoff (cfs)	Difference (cfs)
2	15.9	37.5	+21.6
10	21.8	50.8	+29.0
100	38.7	89.2	+50.5

The existing detention pond's outfall pipe size will determine the amount of runoff that will be detained and whether or not the existing detention pond will need to be re-sized.

Conclusions

Future stormwater discharges should be addressed with the submittal of the site plans as the property develops. A detailed Site Grading Plan along with stormwater quality calculations should be required with the site plan submittal for each lot or portion of lot development.

Stormwater Quality Report

The City of Topeka has established known principal pollutants of concern (PPCs) for the drainage basins through their stormwater monitoring program. These pollutants include biochemical oxygen demand (BOD), E. coli, lead, copper, phosphorus, suspended solids (sediment) and zinc. These PPCs are to be reduced by at least 30% through the design of best management practices.

Since a design has not been established yet for the subdivision, it is unknown what pollutants will be of concern for the subdivision. Because of this, it is also unknown what types of best management practices (BMPs) will be implemented, either detention and retention BMPs, conveyance BMPs, or a combination of both. Therefore, based on assumptions, both the water quality volume and the peak water quality discharge are calculated for each lot in the proposed Wrangler Ridge Subdivision.

Water Quality Volumes

Water quality volumes are used to design detention and retention BMPs. The City of Manhattan, KS BMP Manual (the manual) was utilized for calculating the water quality volume for the site. The volume is based on the amount of impervious area added to the site.

It is assumed, for this report, that the future development of this site will contain a maximum of 80% of impervious surface in Lots 1 and 2, Block "A" and Lot 2, Block "B", 70% impervious surface in Lot 3, Block "A", and 60% impervious surface in Lot 1, Block "B". The Water Quality Event for Topeka, KS is 1.20 inches. Using the Short-Cut Method for drainage areas where the percent site imperviousness is known, the water quality volumes were calculated for each lot, shown in Table XXI below.

Table XXI. Water Quality Volumes for Subdivision Lots

Block, Lot	Impervious Area (I, %)	Volumetric Runoff Coefficient (R_v)	Water Quality Rainfall Event (P_{WQ}, in.)	Tributary Area (A_T, ac.)	Water Quality Volume (WQ_v, ac-ft)
A, 1	80	0.77	1.20	11.04	0.85
A, 2	80	0.77	1.20	6.07	0.47
A, 3	70	0.68	1.20	19.24	1.31
B, 1	60	0.59	1.20	19.10	1.13
B, 2	80	0.77	1.20	14.02	1.08

Peak Water Quality Discharge

Conveyance BMPs should be able to handle the peak water quality discharge. The manual was utilized for calculating the peak water quality discharge for the site. The discharge is based on the amount of impervious area within the drainage area as well as rainfall intensity and travel time.

It is assumed, for this report, that the future development of this site will contain a maximum of 80% of impervious surface in Lots 1 and 2, Block "A" and Lot 2, Block "B", 70% impervious surface in Lot 3, Block "A", and 60% impervious surface in Lot 1, Block "B". Using the Rational Method given in the manual, the peak water quality discharges were calculated for each lot, shown in Table XXII below.

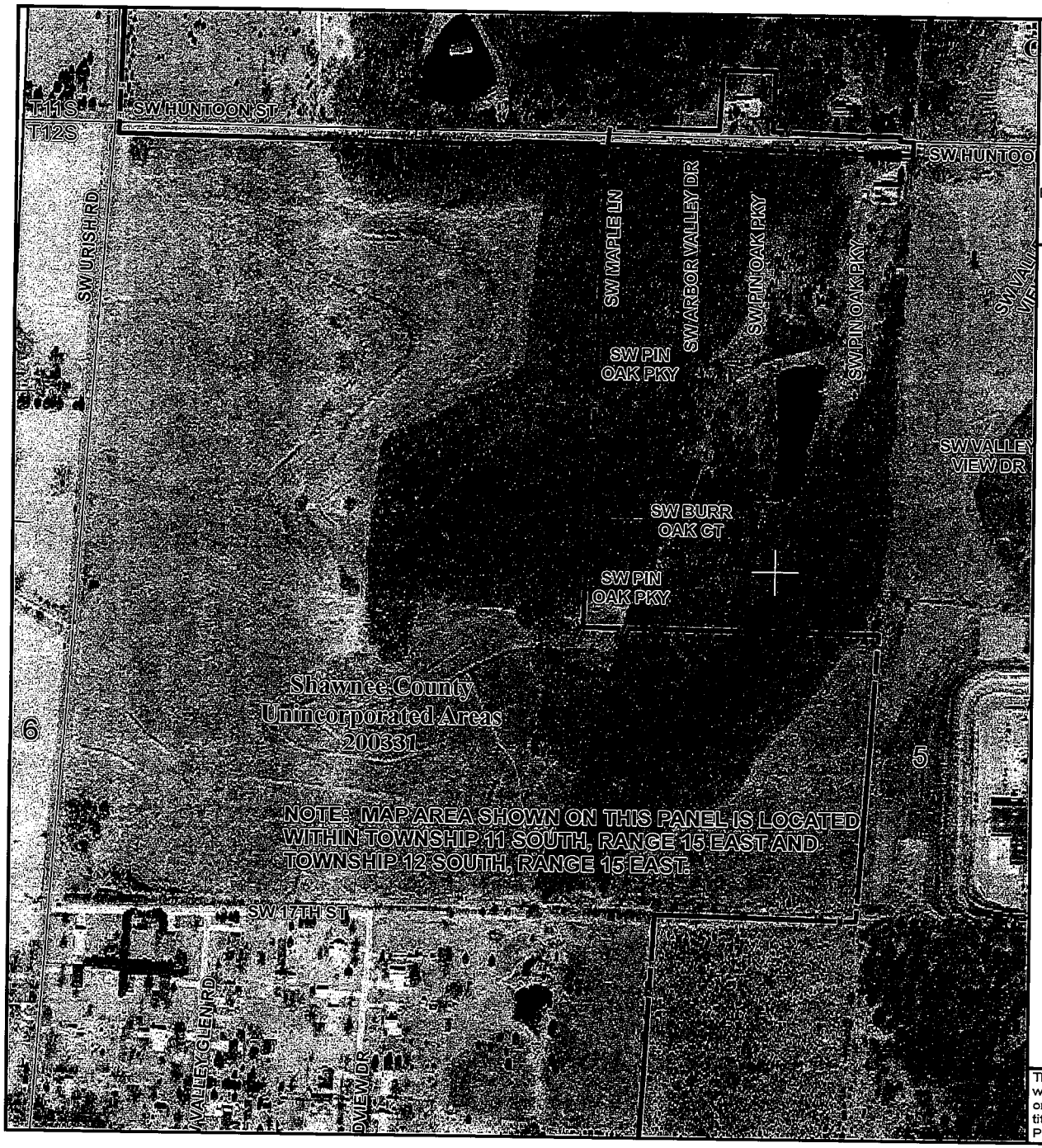
Table XXII. Peak Water Quality Discharge Calculations

Lot	Drainage Area (A, Ac.)	Impervious Area (I)	Runoff Coeff. (C)	Length of Travel (Ft.)	Time of Concentration (T_c, min.)	Rainfall Intensity (I, in/hr)	Runoff Rate (Q, cfs)
A, 1	11.04	0.8	0.78	744	8.2	1.54	13.3
A, 2	6.07	0.8	0.78	688	8.8	1.51	7.1
A, 3	19.24	0.7	0.72	742	10.9	1.41	19.5
B, 1	19.10	0.6	0.66	839	9.5	1.48	18.7
B, 2	14.02	0.8	0.78	776	7.6	1.57	17.2

Conclusions

Future stormwater BMPs should be addressed with the submittal of the site plans as the property develops. A detailed Site Grading Plan along with stormwater quality calculations should be required with the site plan submittal for each lot or portion of lot development.

APPENDIX A
DRAINAGE REPORT DATA



MAP SCALE 1" = 500'

250 0 250 500 750 1,000 FEET

METE

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0192E

FIRM

FLOOD INSURANCE RATE MAP

SHAWNEE COUNTY, KANSAS

AND INCORPORATED AREAS

PANEL 192 OF 450

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SHAWNEE COUNTY	200331	0192	E
TOPEKA, CITY OF	205187	0192	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
20177C0192E

EFFECTIVE DATE
SEPTEMBER 29, 2011

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

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Subject: Slopes — Sheet No. 1 of 1

Hutter — Job No. 13-177

By: KAB — Date: 2/3/14

Slopes

Unnamed Tributary ⇒ $\frac{1073.8 - 996.8}{1685} = 4.6\%$

Middle ⇒ $\frac{1073.8 - 1000}{1680} = 4.4\%$

East ⇒ $\frac{1052.2 - 1000}{652} = 8\%$

Northeast ⇒ $\frac{1054 - 1002}{555} = 9.4\%$

Northwest ⇒ $\frac{1006 - 1047.5}{705} = 2.6\%$

Detention ⇒ $\frac{1073.8 - 1045.2}{726} = 3.9\%$

Average Slopes:

$.046\left(\frac{26.89}{74.62}\right) + .044\left(\frac{27.52}{74.62}\right) + .08\left(\frac{2.02}{74.62}\right) + .044\left(\frac{1.71}{74.62}\right) + .026\left(\frac{7.99}{74.62}\right) + .039\left(\frac{2.89}{74.62}\right)$

$= 4.5\%$

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Subject: Combined Q for Pipes - Existing Hotter
Sheet No. 1 of 1
Job No. 13-177
By: KAB
Date: 2/3/14

Runoff Rate Combined ⇒ Unnamed Trib.

Largest T_c ⇒ 21.4

$i_2 = 3.23$

$i_{10} = 4.48$

$i_{100} = 6.41$

Headwaters:

$Q_2 = 29.55(0.38)(3.23) = 36.3$ cfs

$Q_{10} = 29.55(0.38(4.48) = 50.3$

$Q_{100} = 29.55(0.38)(6.41)(1.25) = 90$

Detention Pond

Largest T_c ⇒ 18.2

$i_2 = 3.51$

$i_{10} = 4.81$

$i_{100} = 6.83$

17th Street:

$Q_2 = 4.43(.49)(3.51) = 7.6$ cfs

$Q_{10} = 4.43(.49)(4.81) = 10.4$

$Q_{100} = 4.43(.49(6.83)(1.25) = 18.5$

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Subject Time of Concentration - Combined - Unnamed Trib - Exist. Sheet No. 1 of 1

Hilfer Job No. 13-177

By KAB Date 2/7/14

Time of Concentration → Headwaters → T_c = 20.0 min

Time of Concentration → Unnamed Trib

L = 242.88 + 908.96 = $\boxed{1151.84}$ → Channel Flow Only

Slope → $\frac{1043.32 - 995.9}{1047} = \boxed{4.5\%}$

See spreadsheet for T_c calcs

T_c = 3.8 min

$\boxed{T_c = 23.8 \text{ min}}$

i_2 = 3.05

i_{10} = 4.28

i_{100} = 6.14

Headwaters

Q_2 = .38(3.05)(29.55) = 34.2 cfs

Q_{10} = .38(4.28)(29.55) = 48.1

Q_{100} = .38(6.14)(29.55)(1.25) = 86.2

Unnamed Trib

Q_2 = .3(3.05)(28.19) = 25.8 cfs

Q_{10} = .3(4.28)(28.19) = 36.2

Q_{100} = .3(6.14)(28.19)(1.25) = 64.9

Total

Q_2 = 34.2 + 25.8 = 60 cfs

Q_{10} = 48.1 + 36.2 = 84.3 cfs

Q_{100} = 86.2 + 64.9 = 151.1 cfs

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Detention Pond
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.3	300	3.9	15.84534078

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
442	16.1345	0.039	3.186308447	2.311975

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
3.186308447	4.779462671		0

Total Time of Concentration

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

18.15731615 min

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	East
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.3	300	8	12.47076581

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
357	16.1345	0.08	4.563525744	1.303816

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
4.563525744	6.845288617		0

Total Time of Concentration

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

13.77458228 min

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Middle
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.3	300	4.4	15.22084958

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
700	16.1345	0.044	3.384401272	3.447188

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
3.384401272	5.076601908	878	2.882505581

Total Time of Concentration

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

21.55054293 min

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Northeast
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.3	300	9.4	11.81808661

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
284	16.1345	0.094	4.946744028	0.956858

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
4.946744028	7.420116043		0

Total Time of Concentration

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

12.77494496 min

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Northwest
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.3	300	2.6	18.13838727

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
442	16.1345	0.026	2.601609953	2.83158

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
2.601609953	3.902414929		0

Total Time of Concentration

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

20.96996725 min

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Unnamed Trib.
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.3	300	4.6	14.99698103

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
700	16.1345	0.046	3.460464731	3.371416

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
3.460464731	5.190697096	934	2.998954934

Total Time of Concentration

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

21.36735211 min

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Unnamed Trib. - Combined
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
20	16.1345	0.045	3.422644308	0.097391

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
3.422644308	5.133966462	1131.81	3.674254621

Total Time of Concentration

3.771645207 min

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

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Engineering / Surveying

Subject: Prop Runoff Coeff. Sheet No. 1 of 2

Holler Job No. 13-177

By: KAB Date: 2/3/14

Unnamed Trib

Undisturbed Acres = 1.3 acres + 2.49 = 3.79 acres ⇒ 0.3

80% impervious = 11.4 acres + 1.63 acres = ~~13.03 acres~~ ⇒ 13.1 acres

60% impervious = ~~8.49 acres~~ ⇒ 9.03 acres

70% impervious = 2.27 acres

~~28.08 acres~~ 28.19 acres

impervious area = .8(13.1) + .6(9.03) + .7(2.27) = 17.49 acres impervious

⇒ 0.95

10.7 acres undisturbed

~~$A = .3\left(\frac{3.79}{28.19}\right) + .95\left(\frac{17.49}{28.19}\right) = \boxed{0.63}$~~

$C = .3\left(\frac{10.7}{28.19}\right) + .95\left(\frac{17.49}{28.19}\right) = \boxed{0.70}$

Middle

Undisturbed Areas = 5.52 acres

80% impervious = 4.44 acres + 2.76 acres = ~~7.2 acres~~ ⇒ 7.18 acres

60% impervious = ~~8.40 acres~~ ⇒ 8.36 acres

70% impervious = 11.98 acres

~~33.1~~ 33.04 acres

impervious area = 7.18(.8) + 8.36(.6) + 11.98(.7) = 19.15 acres

13.89 acres undisturbed

$C = .3\left(\frac{13.89}{33.04}\right) + .95\left(\frac{19.15}{33.04}\right) = \boxed{0.68}$

East

Undisturbed Areas = 0.38 acres

80% impervious ⇒ 2.62 acres

.8(2.62) = 2.10 acres ⇒ impervious, 0.9 acres undisturbed

$C = \frac{2.1}{3}(.95) + \frac{.9}{3}(.3) = \boxed{0.76}$

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Subject Prop Runoff Coeff. Sheet No. 2 of 2

Hotter Job No. 13-177

By KAB Date 2/3/14

Northeast

60% impervious = 1.71 acres

.6(1.71) = 1.03 acres impervious, 0.68 acres undisturbed

$$C = \frac{1.03}{1.71}(.95) + \frac{0.68}{1.71}(.3) = \boxed{0.69}$$

Northwest

0.14 acres ⇒ undisturbed

70% impervious ⇒ 7.60 ac

80% impervious ⇒ 0.39 ac

8.13 ac

.7(7.6) + .8(.39) = 5.63 ac impervious

2.5 ac undisturbed

$$C = \frac{5.63}{8.13}(.95) + \left(\frac{2.5}{8.13}\right)(.3) = \boxed{0.75}$$

Detention Pond

7.89 acres ⇒ 80% impervious

.8(7.89) = 6.31 acres impervious

1.58 acre undisturbed

$$C = \frac{6.31}{7.89}(.95) + \frac{1.58}{7.89}(.3) = \boxed{0.82}$$

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Engineering / Surveying

Subject T_c - Combined - Detention - ~~Exist~~ Prop Sheet No. 1 of 1

Holter Job No. 13-177

By KAB Date 2/7/14

Time of Concentration ⇒ 17th St ⇒ 11.0 min

Time of Concentration ⇒ Detention Pond ⇒

Length = $\boxed{1119.08}$ ⇒ Shallow Concentrated

Slope = $\frac{1095.69 - 1042.75}{117}$ = $\boxed{2.5\%}$

See Spreadsheet for T_c

T_c = 0.78 min

$\boxed{T_c = 11.8 \text{ min}}$

i_2 = 4.24 in/hr

i_{10} = 5.74

i_{100} = 8.08

17th St

Q_2 = 4.24 (.49)(4.43) = 9.2 cfs

Q_{10} = 5.74 (.49)(4.43) = 12.5 cfs

Q_{100} = 8.08 (.49)(4.43)(1.25) = 21.9 cfs

Detention Pond

Q_2 = 4.24 (0.82)(8.13) = ~~10.3~~ 28.3 cfs

Q_{10} = 5.74 (0.82)(8.13) = ~~14.0~~ 38.3

Q_{100} = 8.08 (0.82)(8.13)(1.25) = ~~24.6~~ 67.3

Total

Q_2 = 9.2 + 28.3 = 37.5

Q_{10} = 12.5 + 38.3 = 50.8

Q_{100} = 21.9 + 67.3 = 89.2

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Engineering / Surveying

Subject: Combined Q → Unnamed Trib-Prop Sheet No. 1 of 1

Hotter Job No. 13-177

By: KAB Date: 7/7/14

T_c Prop = T_c Exist = 23.8 min

i_2 = 3.05 in/hr

i_{10} = 4.28

i_{100} = 6.14

Headwaters

Q_2 = 34.2 cfs

Q_{10} = 48.1

Q_{100} = 86.2

Unnamed Trib

Q_2 = 28.19 (.7)(3.05) = 60.2 cfs

Q_{10} = 28.19 (.7)(4.28) = 84.5 cfs

Q_{100} = 28.19 (.7) (6.14)(1.25) = 151.5 cfs

Total

Q_2 = 34.2 + 60.2 = 94.4 cfs

Q_{10} = 48.1 + 84.5 = 132.6 cfs

Q_{100} = 86.2 + 151.5 = 237.7 cfs

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Detention Pond - Proposed
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.82	300	3.9	5.545869272

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
442	20.3282	0.039	4.014497838	1.835016

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
4.014497838	6.021746758		0

Total Time of Concentration

7.380884999 min

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Detention Pond - Proposed
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
		2.5	0

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
119.08	16.1345	0.025	2.551088445	0.777969

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
2.551088445	3.826632668		0

Total Time of Concentration **0.777968584** min

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	East - Proposed
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.76	300	8	5.300075471

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
357	20.3282	0.08	5.749683228	1.03484

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
5.749683228	8.624524842		0

Total Time of Concentration **6.33491509** min

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Middle - Proposed
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.68	300	4.4	7.990946028

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
700	20.3282	0.044	4.264079205	2.736034

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
4.264079205	6.396118808	878	2.287845766

Total Time of Concentration **13.01482602** min

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Northeast - Proposed
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.69	300	9.4	6.056769385

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
284	20.3282	0.094	6.232508101	0.759459

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
6.232508101	9.348762152		0

Total Time of Concentration **6.816228219** min

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Northwest - Proposed
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.75	300	2.6	7.935544429

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
442	20.3282	0.026	3.277823759	2.247426

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
3.277823759	4.916735639		0

Total Time of Concentration **10.18297053** min

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Unnamed Trib. Proposed
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.7	300	4.6	7.498490517

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
700	20.3282	0.046	4.359913176	2.675894

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

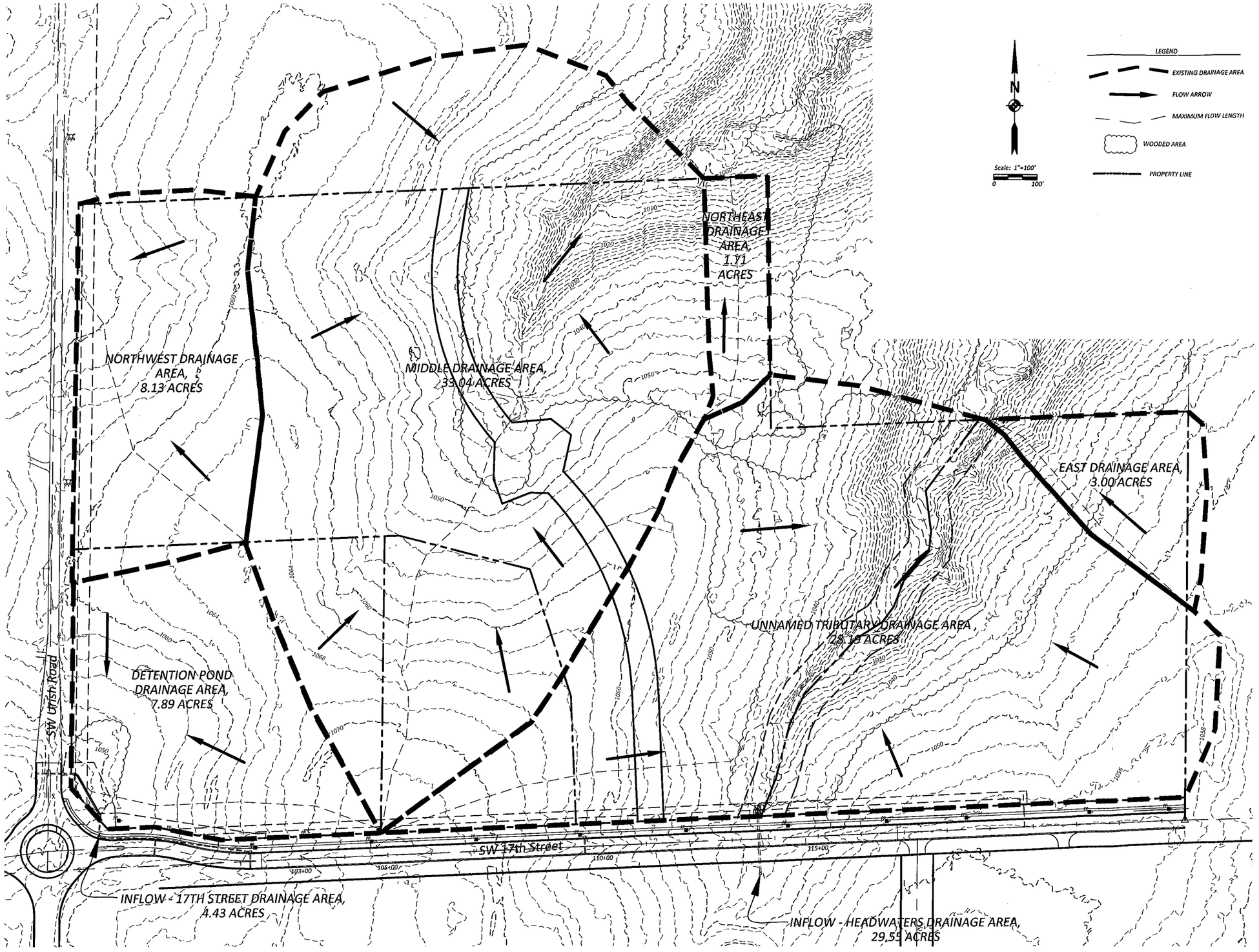
NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
4.359913176	6.539869764	934	2.380271661

Total Time of Concentration **12.55465644** min

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

APPENDIX B
DRAINAGE AREA FIGURES



Rev.	By	Date	Description

Prepared for:

JOHN P. & BARBARA R. HOFFER
4840 SW 69th ST.
AUBURN, KANSAS 66402

Schmidt, Beck & Boyd Engineering, LLC
1415 SW Topeka Blvd.
Topeka, KS 66612
Ph: (785) 215-8630

SBB

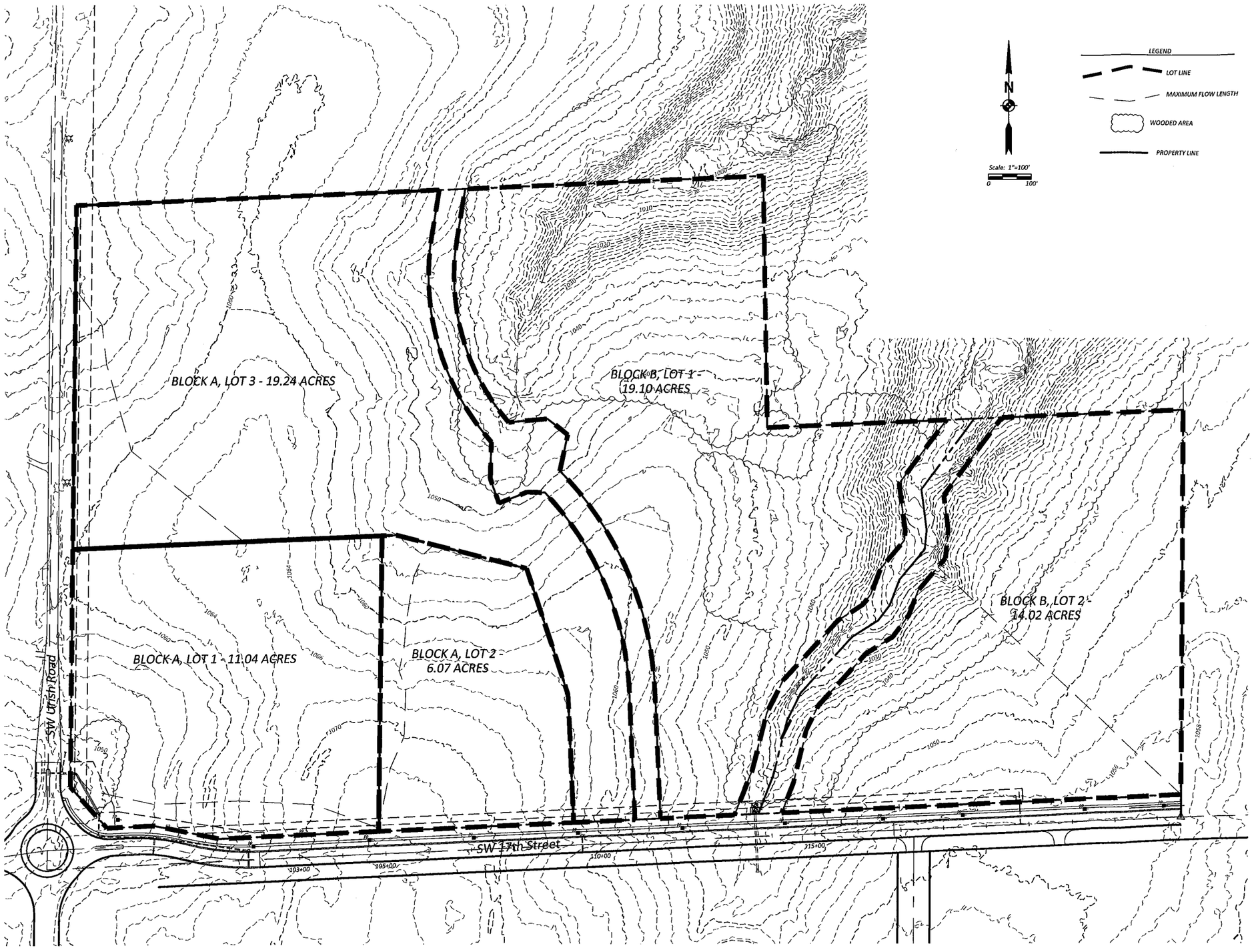
SHEET TITLE:

EXISTING DRAINAGE AREAS

SBB Proj. No.:	13-177
	–
Drawn by:	KAB
Checked by:	KWB
Date:	02/14/2014
Scale:	1"=100'
Drawing No.:	

FIGURE 1

APPENDIX C
STORMWATER MANAGEMENT
FIGURES, DATA AND PLANS



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Topeka, KS 66612
Ph: (785) 215-8530

SBB

SHEET TITLE:

WATER QUALITY VOLUMES & PEAK
WATER QUALITY DISCHARGE
DRAINAGE AREAS

SBB Proj. No.:	13-177
	-
Drawn by:	KAB
Checked by:	KWB
Date:	02/14/2014
Scale:	1"=100'
Drawing No.:	FIGURE 2

SBB
Schmidt, Beck & Boyd
Engineering / Surveying

Subject Areas Sheet No. 1 of 1

Hotter Job No. 13-177

By KAB Date 2/4/14

~~Block A~~

~~Lot 1 ⇒~~

Trib ⇒ 2.5 acres ⇒ total
− .01 acre ⇒ east
2.49 acres ⇒ unnamed

Block B, Lot 2 ⇒ 14.02 acres ⇒ total
80% − 2.62 acres ⇒ east
11.40 acres ⇒ unnamed

Block B, Lot 1 ⇒ 19.1 acres ⇒ total
60% 1.71 acres ⇒ Northeast
8.40 acres ⇒ middle
8.99 acres ⇒ unnamed

Block A, Lot 3 ⇒ 19.24 acres + 2.58 = 21.82 acres ⇒ total
70% − 2.27 acres ⇒ unnamed
− 7.57 acres ⇒ northwest
11.98 acres ⇒ middle

Block A, Lot 2 ⇒ 6.07 acres ⇒ total
80% − 1.63 acres ⇒ unnamed
4.44 acres ⇒ middle

Block A, Lot 1 ⇒ 11.04 acres ⇒ total
80% − 0.39 acres ⇒ northwest
− 2.76 acres ⇒ middle
7.89 acres ⇒ detention

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Block A, Lot 1
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.78	300	3.9	6.338136311

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
444	20.3282	0.039	4.014497838	1.843319

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
4.014497838	6.021746758		0

Total Time of Concentration **8.181455276** min

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Block A, Lot 2
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.78	300	3	6.917396862

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
388	20.3282	0.03	3.520947523	1.836627

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
3.520947523	5.281421284		0

Total Time of Concentration **8.754023686** min

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Block A, Lot 3
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.72	300	2.6	8.615733952

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
442	20.3282	0.026	3.277823759	2.247426

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
3.277823759	4.916735639		0

Total Time of Concentration

10.86316005 min

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Block B, Lot 1
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.66	300	5.8	7.635013532

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
539	20.3282	0.058	4.895678858	1.834952

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
4.895678858	7.343518287		0

Total Time of Concentration 9.469965046 min

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

Time of Concentration - Rational Method Calculations

Subject	Hoffer
Drainage ID	Block B, Lot 2
Job No.	13-177
By	KAB
Date	2/14/2014

Overland Flow

$$T_{OF} = 1.8\,(1.1 - C)\frac{\sqrt{L}}{\sqrt[3]{S}}$$

See pg. 1-30, Blue Book

Runoff Coeffienct, C	***Length, L (ft, max 300')***	***Slope, S (%, Avg.)***	***Time, T (min)***
0.78	300	5	5.834358472

Shallow Concentrated Flow

$$T_{sc} = \frac{L}{60 * V_{SC}} \qquad V_{sc} = K * \sqrt{S}$$

NRCS Method

Length, L (ft, max 700')	***K (16.1345 - non paved, 20.3282 - paved)***	***Slope, S (ft/ft, Avg.)***	***Velocity SC, V (ft/sec)***	***Time, T (min)***
476	20.3282	0.05	4.545523706	1.745307

Channel Flow

$$T_{ch} = \frac{L}{60 * V_{ch}} \qquad V_{ch} = 1.5 * V_{sc}$$

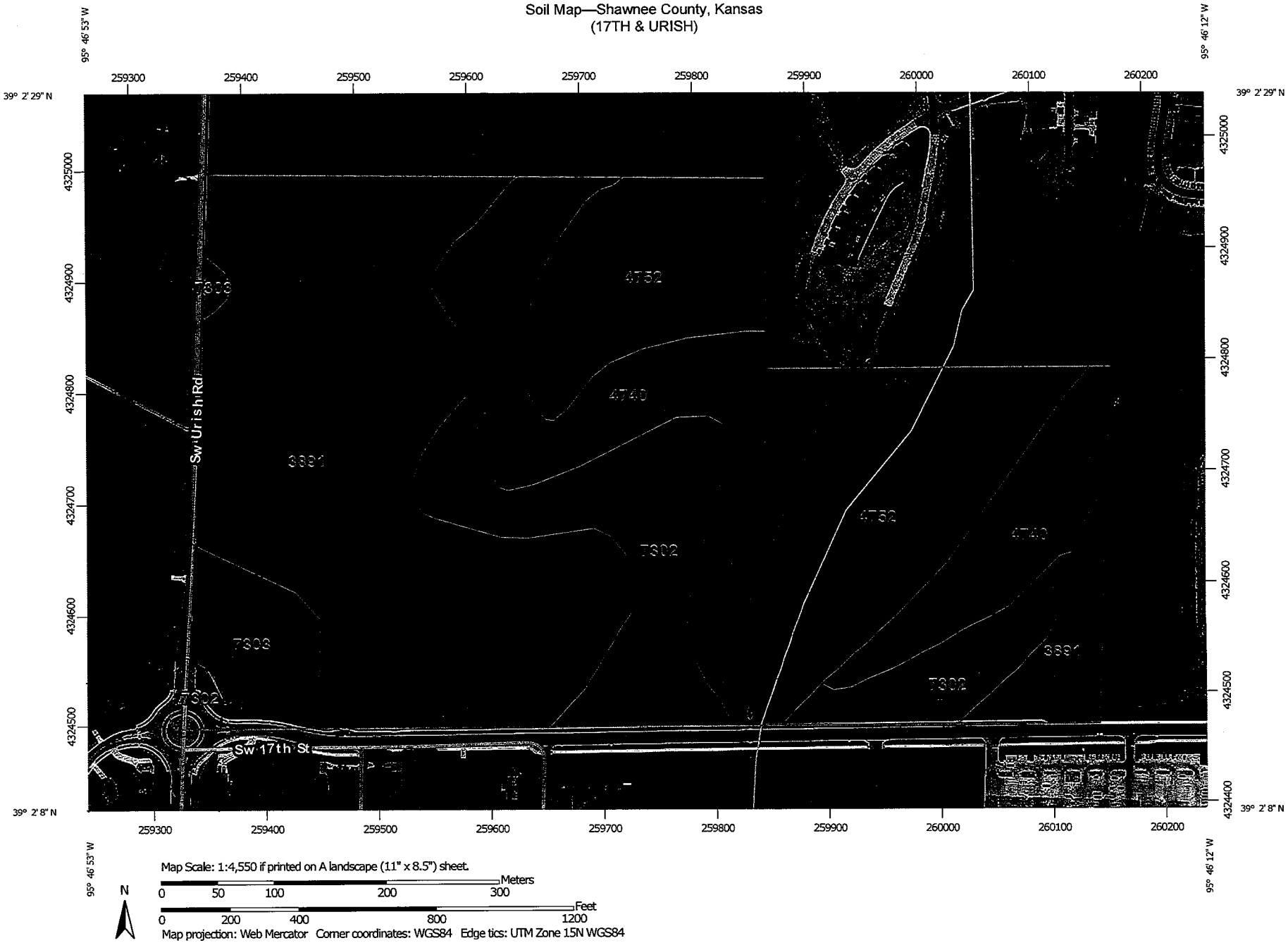
NRCS Method w/ Velocity Estimator (from Manning's Eqn)

Velocity SC, V (ft/sec)	**Velocity CH, (ft/sec)**	**Length, L (ft)**	**Time, T (min)**
4.545523706	6.818285559		0

Total Time of Concentration **7.57966525** min

$$T_c = T_{OF} + T_{SC} + T_{CH}$$

Soil Map—Shawnee County, Kansas
(17TH & URISH)



USDA **Natural Resources Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

1/31/2014
Page 1 of 3

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Shawnee County, Kansas
Survey Area Data: Version 12, Dec 10, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

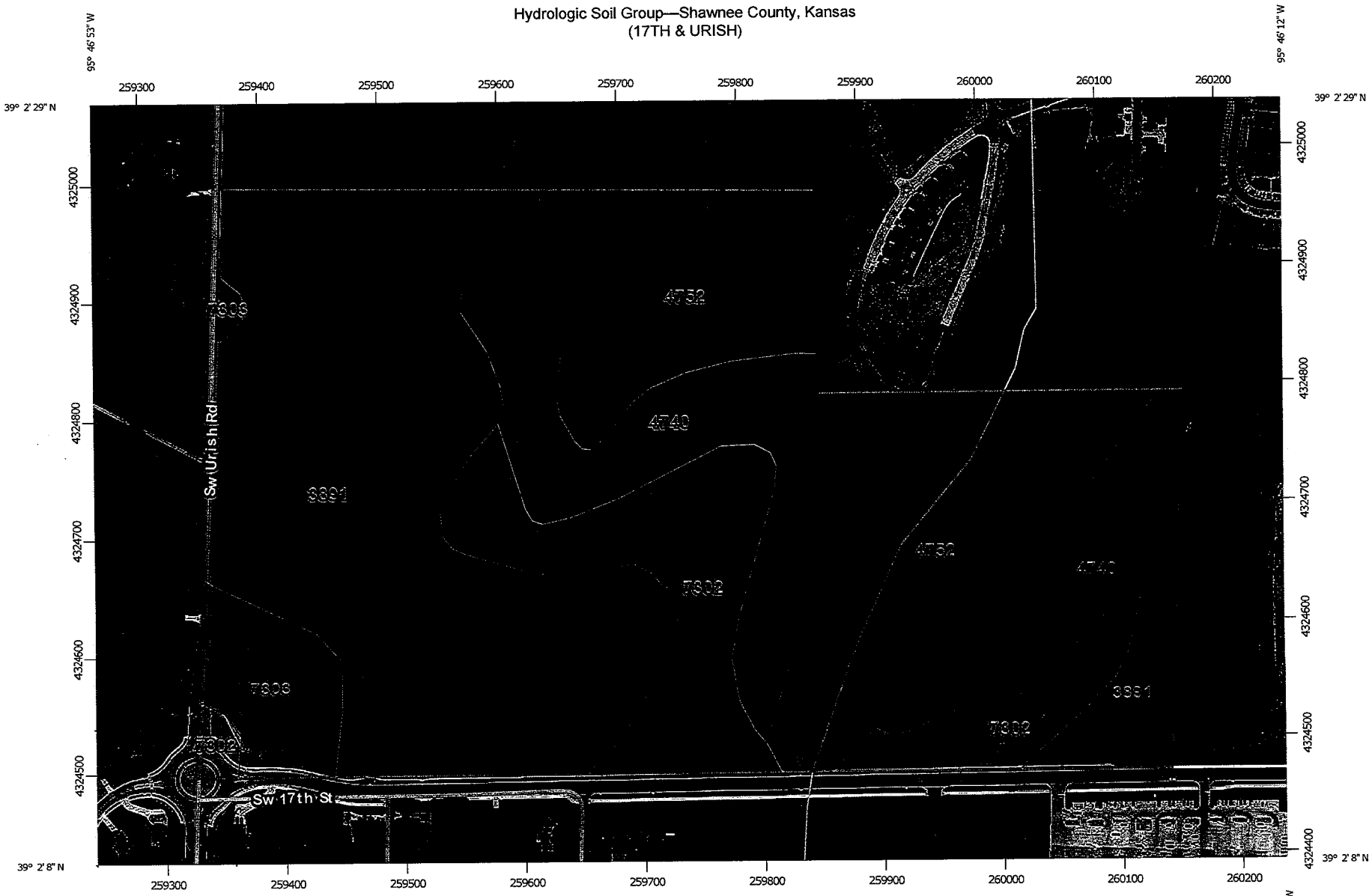
Date(s) aerial images were photographed: Jul 14, 2013—Aug 12, 2013

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Shawnee County, Kansas (KS177)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
3891	Ladysmith silty clay loam, 1 to 3 percent slopes	32.4	37.5%
4740	Labette silty clay loam, 1 to 3 percent slopes	17.6	20.3%
4752	Sogn-Vinland complex, 3 to 25 percent slopes	20.1	23.3%
7302	Martin silty clay loam, 3 to 7 percent slopes	12.4	14.4%
7303	Martin silty clay loam, 3 to 7 percent slopes, eroded	3.8	4.4%
Totals for Area of Interest		**86.4**	**100.0%**

Hydrologic Soil Group—Shawnee County, Kansas
(17TH & URISH)



Map Scale: 1:4,550 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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Date(s) aerial images were photographed: Jul 14, 2013—Aug 12, 2013

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Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Shawnee County, Kansas (KS177)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
3891	Ladysmith silty clay loam, 1 to 3 percent slopes	D	32.4	37.5%
4740	Labette silty clay loam, 1 to 3 percent slopes	D	17.6	20.3%
4752	Sogn-Vinland complex, 3 to 25 percent slopes	D	20.1	23.3%
7302	Martin silty clay loam, 3 to 7 percent slopes	C	12.4	14.4%
7303	Martin silty clay loam, 3 to 7 percent slopes, eroded	C	3.8	4.4%
Totals for Area of Interest			**86.4**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

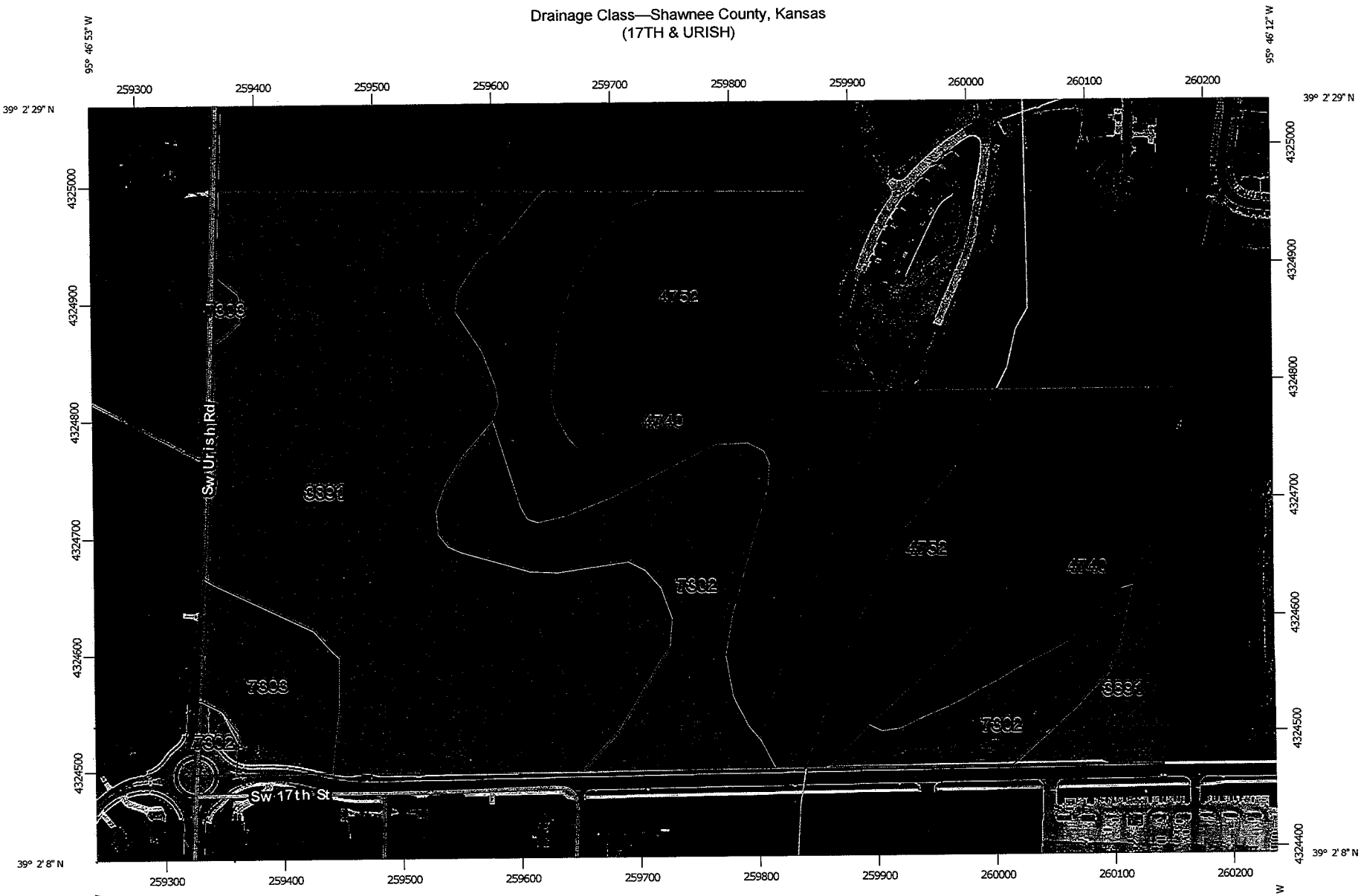
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Drainage Class—Shawnee County, Kansas
(17TH & URISH)



Map Scale: 1:4,550 if printed on A landscape (11" x 8.5") sheet.

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

Excessively drained

Somewhat excessively drained

Well drained

Moderately well drained

Somewhat poorly drained

Poorly drained

Very poorly drained

Subaqueous

Not rated or not available

Soil Rating Lines

Excessively drained

Somewhat excessively drained

Well drained

Moderately well drained

Somewhat poorly drained

Poorly drained

Very poorly drained

Subaqueous

Not rated or not available

Soil Rating Points

Excessively drained

Somewhat excessively drained

Well drained

Moderately well drained

Somewhat poorly drained

Poorly drained

Very poorly drained

Subaqueous

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

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Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

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Survey Area Data: Version 12, Dec 10, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 14, 2013—Aug 12, 2013

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Drainage Class

Drainage Class— Summary by Map Unit — Shawnee County, Kansas (KS177)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
3891	Ladysmith silty clay loam, 1 to 3 percent slopes	Somewhat poorly drained	32.4	37.5%
4740	Labette silty clay loam, 1 to 3 percent slopes	Well drained	17.6	20.3%
4752	Sogn-Vinland complex, 3 to 25 percent slopes	Somewhat excessively drained	20.1	23.3%
7302	Martin silty clay loam, 3 to 7 percent slopes	Moderately well drained	12.4	14.4%
7303	Martin silty clay loam, 3 to 7 percent slopes, eroded	Moderately well drained	3.8	4.4%
Totals for Area of Interest			**86.4**	**100.0%**

Description

"Drainage class (natural)" refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized-excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. These classes are defined in the "Soil Survey Manual."

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher