Robert E. Blevins

Revised Preliminary Drainage Plan

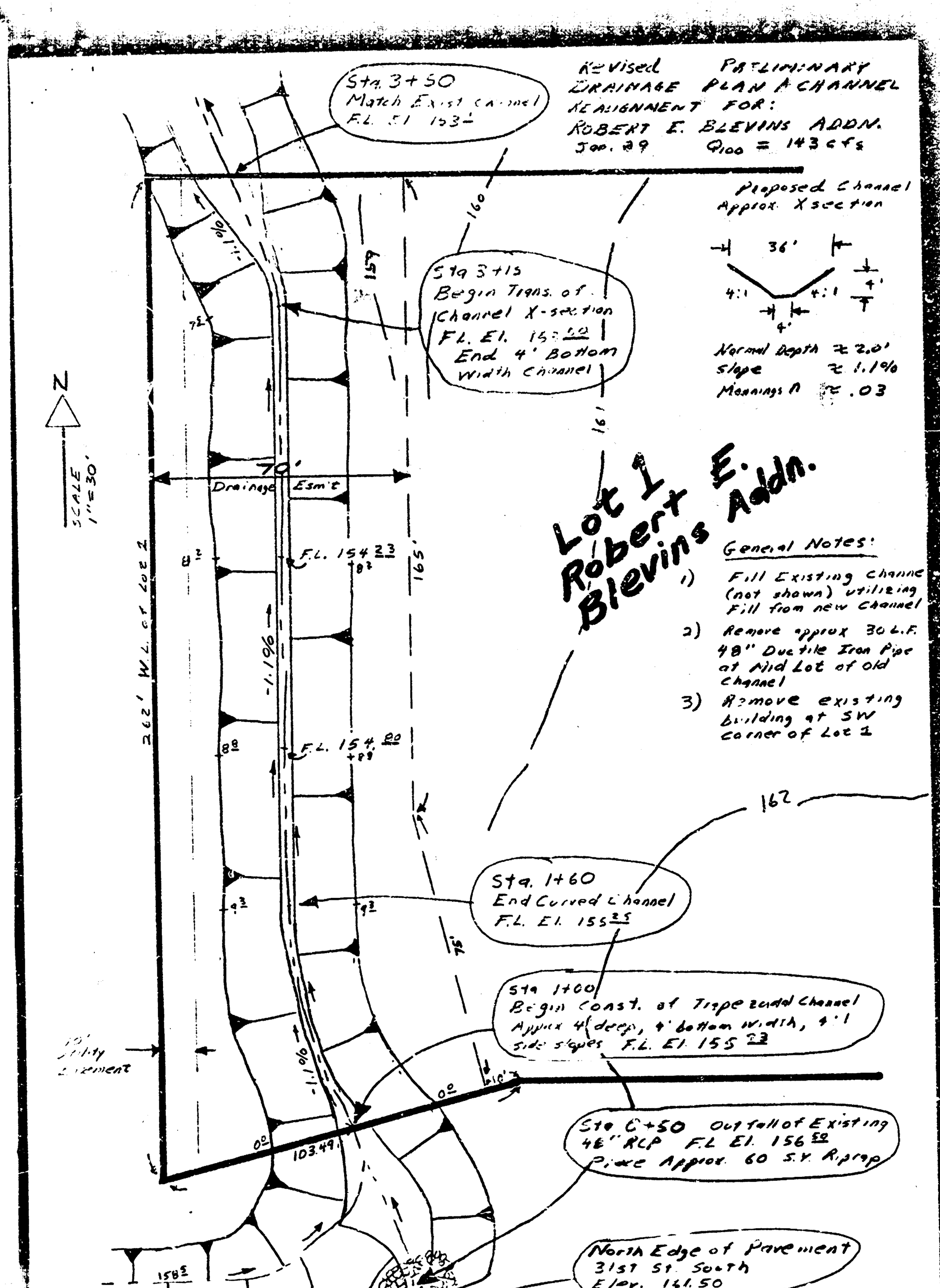
and Channel Realignment for:

Robert E. Blevins Addn. to Wichita,

Sedgwick County, Kansas

Prepared For: The City of Wichita -- Owner
Lowell D. High ------- Platting Surveyor

Prepared By: Robert A. Harrington, P.E.
January, 1989



Revised Preliminary Drainage Plan -- January 1989

Proposed Channel Realignment -- Robert E. Blevins Addition
From Sta. 0+50 to Sta. 3+50 (Approx. N.L. of Addn.)

The proposed channel is a grass lined trapezoid with a 4' bottom width and 4:1 side slopes.
The approximate channel depth is 4', which means the allowable maximum depth of flow is 3' if we want to have 1' of freeboard.

Open Channel Flow Calculations -------- DEPTH

Manning Equation - Trapezoidal Channels
Finding the normal depth of flow d, and the velocity v
Given discharge Q, base width b, side slope z, roughness n, slope s

$$Q = (1.486/n) * A * R^{2/3} * S^{1/2}$$

Enter the ditch flow slope: $s := .011$

Enter the base width in feet: $b := 4$

Enter the side slope ratio horizontal/vertical; $z := 4$

Enter the value of the roughness coefficient: $n := .05$

Enter the discharge flow rate in cfs:

$Q := 143$

The formula for velocity of flow is:

$$v(d) := \frac{Q}{(b + z\cdot d)\cdot d}$$

$$A(d) := (b + z\cdot d)\cdot d$$

$$P(d) := b + 2\cdot d\cdot\sqrt{1 + z^2}$$

$$R(d) := \frac{A(d)}{P(d)}$$

Proposed Channel Realignment -- Robert E. Blevins Addition
From Sta. 0+50 to Sta. 3+50 (Approx. N.L. of Addn.)

We will now find the normal depth of flow: 'd' and the average flow velocity 'v'

$$K_{AR}(d) := \left[\frac{1.486}{n}\right]\cdot A(d)\cdot R(d)^{\frac{2}{3}}\cdot s^{\frac{1}{2}}$$

Guess $d := 1$

Given

$Q \approx K_{AR}(d)$

$d_n := find(d)$

$d_n = 2.0285$ feet ✓OK Normal depth is O.K. Leaves approx. 2 feet of freeboard

$A[d_n] = 24.57332$ square feet $P[d_n] = 20.72747$ linear feet

$R[d_n] = 1.18554$ feet $v[d_n] = 5.81932$ feet per second ✓OK Velocity is permissible

Now compute the product of velocity and hydraulic radius -- this is mainly of use for grassy channels as a check on the appropriate Mannings n

$$R(d) := \frac{(b + z\cdot d)\cdot d}{b + \left[2\cdot d\cdot\sqrt{1 + z^2}\right]}$$

$VR := v[d_n]\cdot R[d_n]$ $VR = 6.89906$

For Petition Purposes Only, use an estimated construction cost of:

$13,500.00

Use $14,000

Preliminary Drainage Plan for:

Robert E. Blevins Addn. to Wichita,

Sedgwick County, Kansas

Prepared For: The City of Wichita -- Owner
Lowell D. High ------- Platting Surveyor

Prepared By: Robert A. Harrington, P.E.
December, 1988

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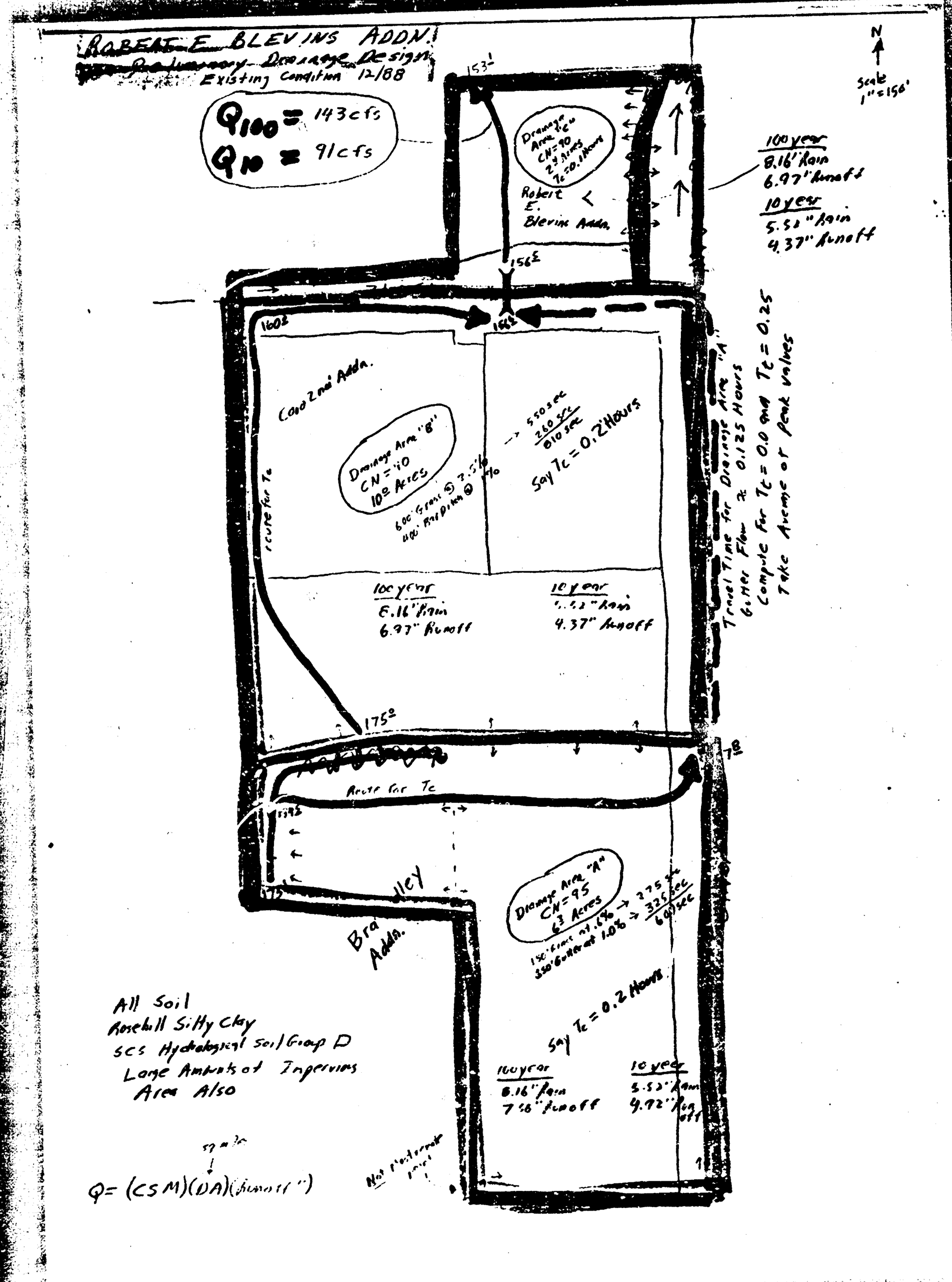
Preliminary Drainage Plan for:

Robert E. Blevins Addn. to Wichita,

Sedgwick County, Kansas

Condition of the Existing Drainage in

Blevins Addition



Robert E. Blevins Addition -- Preliminary Drainage Calculations
December, 1988 100 year storm
Calculation q100a

Area A Area = 6.3 Acres Runoff = 7.56 inches

Tabular Discharges for Type II Storm Distribution (csm/in)
Time of Concentration 0.20 Hours

Tt	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
0.00	23	47	208	509	796	641	424	245	170	138	121	104	85	75	71	68	56	49	40	34	29	24	18
Q (cfs)	2	3	15	38	59	48	32	18	13	10	9	8	6	6	5	5	4	4	3	3	2	2	1

Drainage
Area B: Area = 10.0 Acres Runoff = 6.97 inches

Tabular Discharges for Type II Storm Distribution (csm/in)
Time of Concentration 0.20 Hours

Tt	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
0.00	23	47	208	509	796	641	424	245	170	138	121	104	85	75	71	68	56	49	40	34	29	24	18
Q (cfs)	3	5	23	55	87	70	46	27	19	15	13	11	9	8	8	7	6	5	4	4	3	3	2

Drainage
Area C: Area = 2.4 Acres Runoff = 6.97 inches

Tabular Discharges for Type II Storm Distribution (csm/in)
Time of Concentration 0.10 Hours

Tt	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
0.00	24	51	299	991	746	477	233	152	132	121	111	85	74	70	68	65	52	48	39	33	29	24	18
Q (cfs)	1	1	8	26	19	12	6	4	3	3	3	2	2	2	2	2	1	1	1	1	1	1	0

Resultant Net Flows from the above through ditch in Robert E. Blevins Addition

	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
Q (cfs)	5	10	46	119	165	130	84	49	35	28	25	21	18	16	15	14	12	10	8	7	6	5	4

See next page for calculation using $T_t = 0.25$, Then average the $T_t = 0.00$ peak flow and $T_t = 0.25$ peak flow together to get an estimate of the actual $T_t \approx 0.125$ peak flow

Robert E. Blevins Addition -- Preliminary Drainage Calculations
December, 1988 100 year storm
Calculation q100b

Area A Area = 6.3 Acres Runoff = 7.56 inches

Tabular Discharges for Type II Storm Distribution (csm/in)
Time of Concentration 0.20 Hours

Tt	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
0.25	18	34	49	91	196	419	603	627	486	341	235	173	138	114	96	83	70	55	43	36	31	25	18
Q (cfs)	1	3	4	7	15	31	45	47	36	25	17	13	10	8	7	6	5	4	3	3	2	2	1

Drainage
Area B: Area = 10.0 Acres Runoff = 6.97 inches

Tabular Discharges for Type II Storm Distribution (csm/in)
Time of Concentration 0.20 Hours

Tt	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
0.00	23	47	208	509	796	641	424	245	170	138	121	104	85	75	71	68	56	49	40	34	29	24	18
Q (cfs)	3	5	23	55	87	70	46	27	19	15	13	11	9	8	8	7	6	5	4	4	3	3	2

Drainage
Area C: Area = 2.4 Acres Runoff = 6.97 inches

Tabular Discharges for Type II Storm Distribution (csm/in)
Time of Concentration 0.10 Hours

Tt	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
0.00	24	51	299	991	746	477	233	152	132	121	111	85	74	70	68	65	52	48	39	33	29	24	18
Q (cfs)	1	1	8	26	19	12	6	4	3	3	3	2	2	2	2	2	1	1	1	1	1	1	0

Resultant Net Flows from the above through ditch in Robert E. Blevins Addition

	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
Q (cfs)	4	9	34	88	121	113	97	77	58	44	34	26	21	18	17	15	13	11	9	7	6	5	4

$\frac{121+165}{2}$ = 143 cfs ← Expected 100 year peak flow Q_{100}

↑ 165 from previous page

Robert E. Blevins Addition -- Preliminary Drainage Calculations
December, 1988 10 year storm
Calculation q10a

Area A Area = 6.3 Acres Runoff = 4.32 inches

Tabular Discharges for Type II Storm Distribution (csm/in)
Time of Concentration 0.20 Hours

Tt	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
0.00	23	47	208	509	796	641	424	245	170	138	121	104	85	75	71	68	56	49	40	34	29	24	18
Q (cfs)	1	2	10	25	39	31	21	12	8	7	6	5	4	4	3	3	3	2	2	2	1	1	1

Drainage
Area B: Area = 10.0 Acres Runoff = 4.37 inches

Tabular Discharges for Type II Storm Distribution (csm/in)
Time of Concentration 0.20 Hours

Tt	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
0.00	23	47	208	509	796	641	424	245	170	138	121	104	85	75	71	68	56	49	40	34	29	24	18
Q (cfs)	2	3	14	35	54	44	29	17	12	9	8	7	6	5	5	5	4	3	3	2	2	2	1

Drainage
Area C: Area = 2.4 Acres Runoff = 4.37 inches

Tabular Discharges for Type II Storm Distribution (csm/in)
Time of Concentration 0.10 Hours

Tt	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
0.00	24	51	299	991	746	477	233	152	132	121	111	85	74	70	68	65	52	48	39	33	29	24	18
Q (cfs)	0	1	5	16	12	8	4	2	2	2	2	1	1	1	1	1	1	1	1	1	0	0	0

Resultant Net Flows from the above through ditch in Robert E. Blevins Addition

	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
Q (cfs)	3	6	29	76	105	83	53	31	22	18	16	14	11	10	9	9	7	7	5	5	4	3	2

Robert E. Blevins Addition -- Preliminary Drainage Calculations
December, 1988 10 year storm
Calculation q10b

Area A Area = 6.3 Acres Runoff = 4.92 inches

Tabular Discharges for Type II Storm Distribution (csm/in)
Time of Concentration 0.20 Hours

Tt	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
0.25	18	34	49	91	196	419	603	627	486	341	235	173	138	114	96	83	70	55	43	36	31	25	18
Q (cfs)	1	2	2	4	9	20	29	30	24	17	11	8	7	6	5	4	3	3	2	2	2	1	1

Drainage
Area B: Area = 10.0 Acres Runoff = 4.37 inches

Tabular Discharges for Type II Storm Distribution (csm/in)
Time of Concentration 0.20 Hours

Tt	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
0.00	23	47	208	509	796	641	424	245	170	138	121	104	85	75	71	68	56	49	40	34	29	24	18
Q (cfs)	2	3	14	35	54	44	29	17	12	9	8	7	6	5	5	5	4	3	3	2	2	2	1

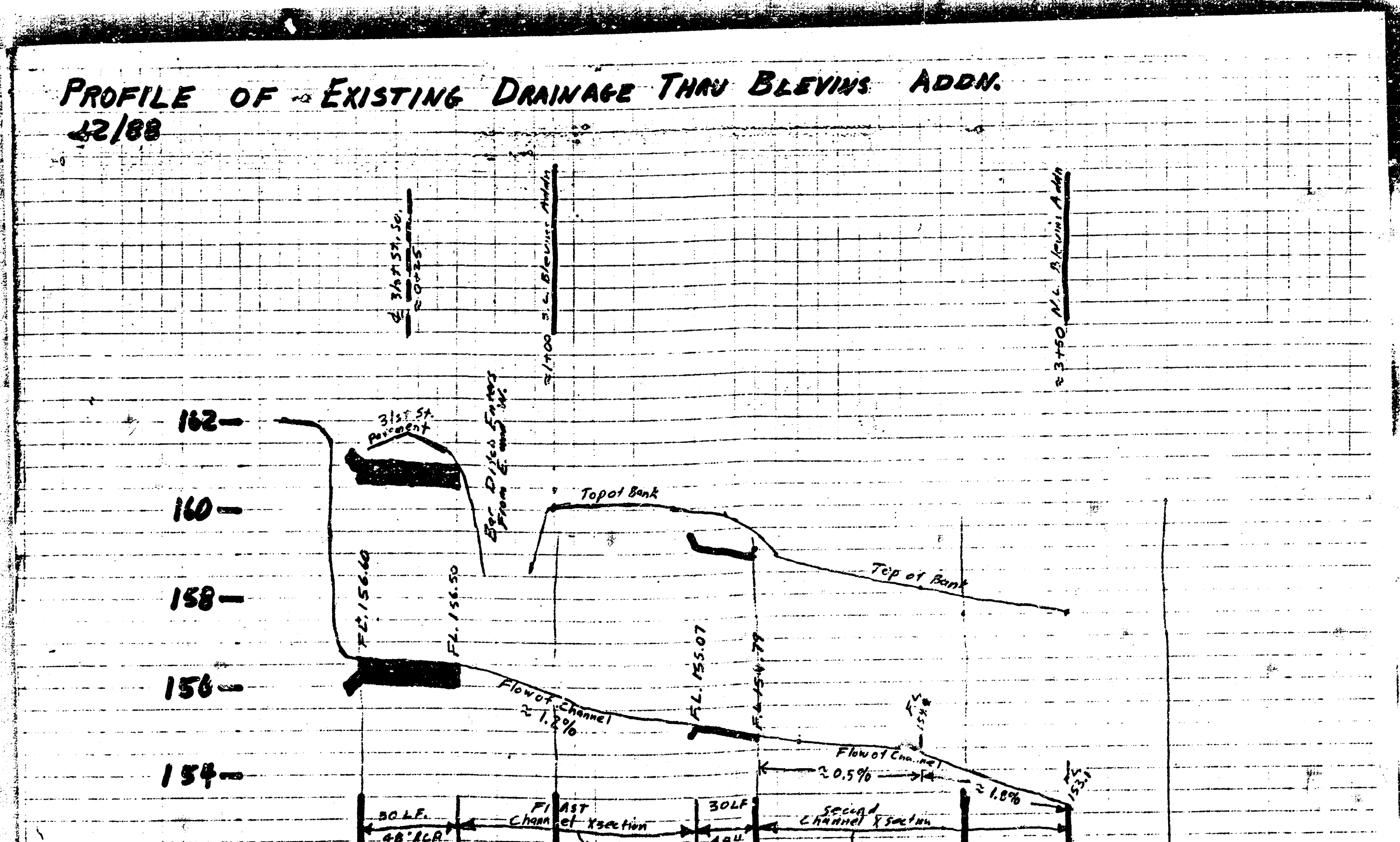
Drainage
Area C: Area = 2.4 Acres Runoff = 4.37 inches

Tabular Discharges for Type II Storm Distribution (csm/in)
Time of Concentration 0.10 Hours

Tt	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0
0.00	24	51	299	991	746	477	233	152	132	121	111	85	74	76	68	65	52	48	39	33	29	24	18
Q (cfs)	0	1	5	16	12	8	4	2	2	2	2	1	1	1	1	1	1	1	1	1	0	0	0

Resultant Net Flows from the above through ditch in Robert E. Blevins Addition

	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0



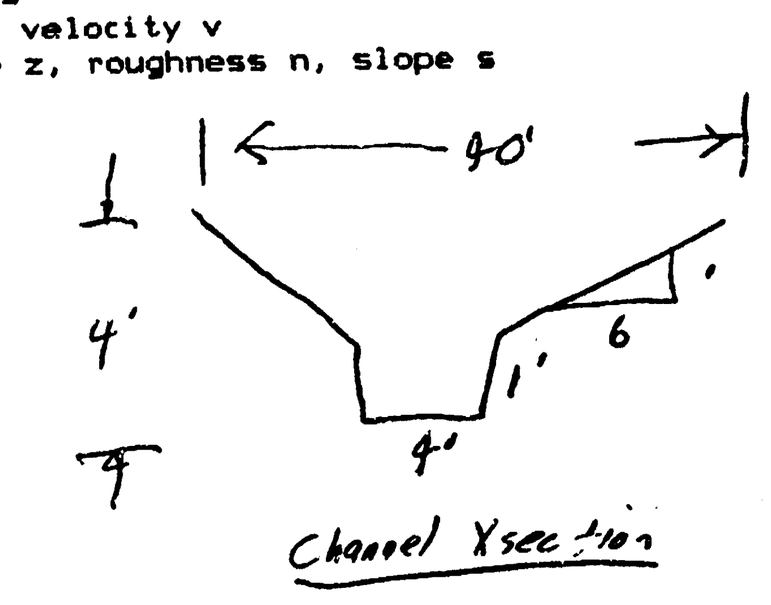
EXISTING 12/88

Blevins Addn. ≈ Sta 0+50 — Sta. 1+70

Open Channel Flow Calculations -------- DEPTH

Manning Equation - Semi Trapezoidal Channels
Finding the normal depth of flow d, and the velocity v
Given discharge Q, base width b, side slope z, roughness n, slope s

$$Q = (1.486/n) * A * R^{2/3} * S^{1/2}$$



Enter the ditch flow slope: $s := .012$

Enter the side slope ratio horizontal/vertical; $z := 6$

Enter the value of the roughness coefficient: $n := .05$

Enter the discharge flow rate in cfs:

$Q := 143$

$$A(d) := 4 + \left[\frac{8 + (d - 1)\cdot 12}{2}\right]\cdot(d - 1) \qquad P(d) := 6 + 2\cdot(d - 1)\cdot\sqrt{1 + z^2}$$

$$R(d) := \frac{A(d)}{P(d)}$$

The formula for velocity of flow is:

$$v(d) := \frac{Q}{A(d)}$$

We will now find the normal depth of flow: 'd' and the average flow velocity 'v'

Guess $d := 2$

Given

$$A(d)\cdot R(d)^{\frac{2}{3}} \approx \frac{n\cdot Q}{1.486\cdot\sqrt{s}}$$

$d_n := find(d)$

$d_n = 3.083$ feet

This number is probably irrelevant, actual depth will be determined by back water from culvert at Sta 1+70 - Sta 2+00

Otherwise, Approximately 1' of free board, probably adequate

$VR := v[d_n]\cdot R[d_n]$ $VR = 4.552$

Now compute the critical depth for this channel and discharge:

Top width T(d) is defined as follows:

$T(d) := 4 + 2\cdot z\cdot(d - 1)$

To find minimum specific energy, solve the following:

Guess $d := d_n$

Given

$$\frac{A(d)^3}{T(d)} \approx \frac{Q^2}{32.2}$$

$d_c := find(d)$ $d_c = 2.533$

Line 1258 Open Channel Flow Formula, McDermith 1984

Type I

Line 1258

Assume Area = 15707 (1 foot freeboard)

Be an optimist - neglect entrance friction losses $h_{f1-2} = 0$

Be an optimist - assume $C_D = 0.95$

At Area 15707 the typical channel will be flowing approximately full with a small constant area of 70 ft²

Velocity at approach = $\frac{Q}{A_1}$ = 1.43 ft/sec

Be an optimist - say $\bar{v}_2$ = 1.5 ft/sec

$z = 15707 - 15499 = 208$

$h_v = 15707 - 15499 = 9.76'$

Critical depth $d_c = y_c = 2.96$ feet

Critical Area A_c = 99.5 s.f. - call it 100 s.f. Level = 0

$$Q = C_D A_c \sqrt{2g\left(h_1 - z + \alpha_1 \frac{\bar{v}_1^2}{2g} - y_c - h_{f1-2}\right)}$$

$$Q = (0.95)(99.5)\sqrt{(2\cdot32.2)\left(9.26 - .28 + \frac{1.5^2}{2\cdot32.2} - 2.96 - 0\right)}$$

$$Q = (0.95)(99.5)\sqrt{69.026} = 78.6\ cfs$$

2nd Cut: Let $Q = 78.6$ cfs. Keep C_D at 0.95, allowing 5% on the smaller losses

$h_1 = 9.26'$ unchanged

$z = .28'$ unchanged

$h_v = 8.72'$

$d_c/y_c = 2.62'$

$\bar{v}_2 = \frac{78.6}{70} = 1.12$ fps

$$Q = (0.95)(8.72)\sqrt{(2\cdot32.2)\left(9.26 - .28 + \frac{1.12^2}{2\cdot32.2} - 2.62 - 0\right)}$$

$$Q = (0.95)(8.72)\sqrt{70.13}$$

$Q = 78.6$ cfs is far below what is required or allowable - need 143 cfs

CULVERT HAS INSUFFICIENT CAPACITY.

Conclusion: Existing Culvert is too small

Open Channel Flow Calculations -------- DEPTH

Blevins Addn

Sta. 2400 - 3400

Manning Equation - Trapezoidal Channels
Finding the normal depth of flow d, and the velocity v
Given discharge Q, base width b, side slope z, roughness n, slope s

$$Q = (1.486/n) * A * R^{2/3} * S^{1/2}$$

Enter the ditch flow slope: s := .005

Enter the base width in feet: b := 20

Enter the side slope ratio horizontal/vertical: z := 2.5

Enter the value of the roughness coefficient: n := .05

Enter the discharge flow rate in cfs:

Q := 143

$$K_{AR}(d) := \frac{((b + z\cdot d)\cdot d)^{\frac{5}{3}}}{(b + 2\cdot d\sqrt{1 + z^2})^{\frac{2}{3}}}$$

The formula for velocity of flow is:

$$v(d) := \frac{Q}{(b + z\cdot d)\cdot d}$$

We will now find the normal depth of flow: "d" and the average flow velocity "v"

Guess d := 2.

Given

$$K_{AR}(d) = \frac{n\cdot Q}{1.486\sqrt{s}}$$

d_n := find(d)

d_n = 1.983 feet ← Leaves 2' of freeboard plenty adequate

$v\left[\frac{d}{n}\right]$ = 2.89 feet per second

Now compute the product of velocity and hydraulic radius -- this is mainly of use for grassy channels as a check on the appropriate Mannings n

$$R(d) := \frac{(b + z\cdot d)\cdot d}{b + \left[2\cdot d\sqrt{1 + z^2}\right]} \qquad VR := v\left[\frac{d}{n}\right] R\left[\frac{d}{n}\right] \qquad VR = 4.662$$

Now compute the critical depth for this channel and discharge:

Top width T(d) is defined as follows:

T(d) := b + 2·d·z

Cross sectional area of a trapezoidal channel is defined as follows:

A(d) := (b + d·z)·d

To find minimum specific energy, solve the following:

Guess d := d_n ·.30

Given

$$\frac{A(d)^3}{T(d)} = \frac{Q^2}{32.2}$$

d_c := find(d) d_c = 1.112

Open Channel Flow Calculations -------- DEPTH

Blevins Addn

Sta 3400 - 3750

Manning Equation - Trapezoidal Channels
Finding the normal depth of flow d, and the velocity v
Given discharge Q, base width b, side slope z, roughness n, slope s

$$Q = (1.486/n) * A * R^{2/3} * S^{1/2}$$

Enter the ditch flow slope: s := .018

Enter the base width in feet: b := 20

Enter the side slope ratio horizontal/vertical: z := 2.5

Enter the value of the roughness coefficient: n := .05

Enter the discharge flow rate in cfs:

Q := 143

$$K_{AR}(d) := \frac{((b + z\cdot d)\cdot d)^{\frac{5}{3}}}{(b + 2\cdot d\sqrt{1 + z^2})^{\frac{2}{3}}}$$

The formula for velocity of flow is:

$$v(d) := \frac{Q}{(b + z\cdot d)\cdot d}$$

We will now find the normal depth of flow: "d" and the average flow velocity "v"

Guess d := 2'

Given

$$K_{AR}(d) = \frac{n\cdot Q}{1.486\sqrt{s}}$$

d_n := find(d)

d_n = 1.374 feet ← Leaves 2.6' of freeboard plenty adequate

$v\left[\frac{d}{n}\right]$ = 4.441 feet per second

Now compute the product of velocity and hydraulic radius -- this is mainly of use for grassy channels as a check on the appropriate Mannings n

$$R(d) := \frac{(b + z\cdot d)\cdot d}{b + \left[2\cdot d\sqrt{1 + z^2}\right]} \qquad VR := v\left[\frac{d}{n}\right] R\left[\frac{d}{n}\right] \qquad VR = 5.219$$

Now compute the critical depth for this channel and discharge:

Top width T(d) is defined as follows:

T(d) := b + 2·d·z

Cross sectional area of a trapezoidal channel is defined as follows:

Proposed x section is a trapezoid with 8' bottom width, 3:1 side slopes
Approximate channel depth is 4' (means maximum flow depth is 3', we have 1' of freeboard

Open Channel Flow Calculations -------- DEPTH

Manning Equation - Trapezoidal Channels
Finding the normal depth of flow d, and the velocity v
Given discharge Q, base width b, side slope z, roughness n, slope s

$$Q = (1.486/n) * A * R^{2/3} * S^{1/2}$$

Enter the ditch flow slope: s := .01133

Enter the base width in feet: b := 8

Enter the side slope ratio horizontal/vertical: z := 3

Enter the value of the roughness coefficient: n := .05

Enter the discharge flow rate in cfs:

Q := 143

$$K_{AR}(d) := \frac{((b + z\cdot d)\cdot d)^{\frac{5}{3}}}{(b + 2\cdot d\sqrt{1 + z^2})^{\frac{2}{3}}}$$

The formula for velocity of flow is:

$$v(d) := \frac{Q}{(b + z\cdot d)\cdot d}$$

$$A(d) := (b + z\cdot d)\cdot d$$

$$P(d) := b + 2\cdot d\sqrt{1 + z^2}$$

$$R(d) := \frac{A(d)}{P(d)}$$

We will now find the normal depth of flow: "d" and the average flow velocity "v"

$$K_{AR}(d) := \left[\frac{1.486}{n}\right] A(d)^{\frac{5}{3}} \cdot R(d)^{\frac{2}{3}} \cdot s^{\frac{1}{2}}$$

Guess d := 1

Given

$$Q = K_{AR}(d)$$

d_n := find(d)

d_n = 2.29745 feet Leaves approx. 1.7 feet of freeboard

$A\left[\frac{d}{n}\right]$ = 34.21455 square feet $P\left[\frac{d}{n}\right]$ = 22.53038 linear feet

$R\left[\frac{d}{n}\right]$ = 1.5186 feet $v\left[\frac{d}{n}\right]$ = 4.17951 feet per second

Now compute the product of velocity and hydraulic radius -- this is mainly of use for grassy channels as a check on the appropriate Mannings n

$$R(d) := \frac{(b + z\cdot d)\cdot d}{b + \left[2\cdot d\sqrt{1 + z^2}\right]} \qquad VR := v\left[\frac{d}{n}\right] R\left[\frac{d}{n}\right] \qquad VR = 6.34698$$

Now compute the critical depth for this channel and discharge:

Top width T(d) is defined as follows:

T(d) := b + 2·d·z

Cross sectional area of a trapezoidal channel is defined as follows:

A(d) := (b + d·z)·d

Cross sectional area of a trapezoidal channel is defined as follows:

A(d) := (b + d·z)·d

To find minimum specific energy, solve the following:

Guess d := d_n ·.30

Given

$$\frac{A(d)^3}{T(d)} = \frac{Q^2}{32.2}$$

d_c := find(d) d_c = 1.112

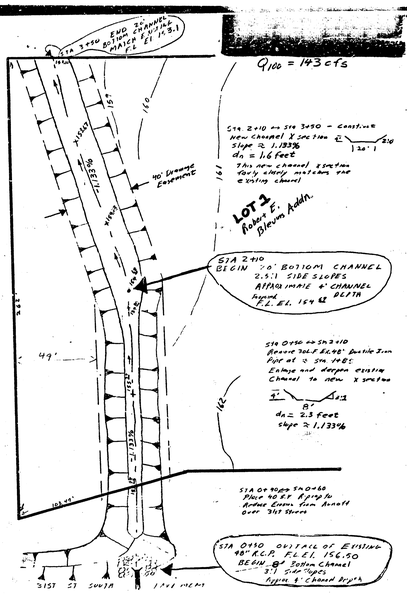
Preliminary Drainage Plan for:

Robert E. Blevins Addn. to Wichita,

Sedgwick County, Kansas

Proposed Drainage Plan

Blevins Addition



To find minimum specific energy, solve the following:

Guess d := d_n

Given

$$\frac{A(d)^3}{T(d)} = \frac{Q^2}{32.2}$$

d_c := find(d) d_c = 1.72152

Note that the normal depth is greater than the critical depth. However, this should not cause much of a problem, since there are (after removing the existing old Addn. 48" pipe) no significant flow obstructions, the velocity is within allowable limits for a grass lined channel on clay soil, and the flow is only intermittent.

Proposed x section closely matches the existing channel and is a trapezoid with 20' bottom width and 2.5:1 side slopes.
The approximate channel depth is 4', which means the allowable maximum depth of flow is 3' if we want to have 1' of freeboard.

Open Channel Flow Calculations -------- DEPTH

Manning Equation - Trapezoidal Channels
Finding the normal depth of flow d, and the velocity v
Given discharge Q, base width b, side slope z, roughness n, slope s

$$Q = (1.486/n) * A * R^{2/3} * S^{1/2}$$

Enter the ditch flow slope: s := .01133

Enter the base width in feet: b := 20

Enter the side slope ratio horizontal/vertical: z := 2.5

Enter the value of the roughness coefficient: n := .05

Enter the discharge flow rate in cfs:

Q := 143

The formula for velocity of flow is:

$$v(d) := \frac{Q}{(b + z\cdot d)\cdot d}$$

$$A(d) := (b + z\cdot d)\cdot d$$

$$P(d) := b + 2\cdot d\sqrt{1 + z^2}$$

$$R(d) := \frac{A(d)}{P(d)}$$

We will now find the normal depth of flow: "d" and the average flow velocity "v"

$$K_{AR}(d) := \left[\frac{1.486}{n}\right] A(d)^{\frac{5}{3}} \cdot R(d)^{\frac{2}{3}} \cdot s^{\frac{1}{2}}$$

Guess d := 1

Given

$$Q = K_{AR}(d)$$

d_n := find(d)

d_n = 1.57005 feet Leaves approx. 2.4 feet of freeboard

$A\left[\frac{d}{n}\right]$ = 37.56354 square feet $P\left[\frac{d}{n}\right]$ = 28.45496 linear feet

$R\left[\frac{d}{n}\right]$ = 1.32011 feet $v\left[\frac{d}{n}\right]$ = 3.80688 feet per second

Now compute the product of velocity and hydraulic radius -- this is mainly of use for grassy channels as a check on the appropriate Mannings n

$$R(d) := \frac{(b + z\cdot d)\cdot d}{b + \left[2\cdot d\sqrt{1 + z^2}\right]} \qquad VR := v\left[\frac{d}{n}\right] R\left[\frac{d}{n}\right] \qquad VR = 5.02549$$

Now compute the critical depth for this channel and discharge:

Top width T(d) is defined as follows:

T(d) := b + 2·d·z

Cross sectional area of a trapezoidal channel is defined as follows:

A(d) := (b + d·z)·d

To find minimum specific energy, solve the following:

Guess d := d_n

Given

$$\frac{A(d)^3}{T(d)} = \frac{Q^2}{32.2}$$

d_c := find(d) d_c = 1.11151

Note that the normal depth is greater than the critical depth. However, this should not cause much of a problem, since there are (after removing the exising old Addn. 48" pipe) no significant flow obstructions, the velocity is within allowable limits for a grass lined channel on clay soil, and the flow is only intermittent.

Cost Estimate (for Petition Purposes Only) for Drainage Improvements in Robert E. Blevins Addition

Quantity	Units	Item	Cost/Unit	Total
200.00	C.Y.	Excavation	2.50	500.00
150.00	C.Y.	Compacted Fill	2.50	375.00
40.00	S.Y.	Riprap	20.00	800.00
0.30	Acres	Grass Seeding, Mulch Etc.	1200.00	360.00
1.00	L.S.	Remove 36 L.F. 48" Ductile Iron Pipe	500.00	500.00
1.00	L.S.	Clear/Clean Drain. Cont., Remove Trash, Debris, Etc.	Incid.	0.00
		Subtotal		82,475.00
		Petition Contingency		371.25
		Engineering		990.00
		Administration		49.50
		Publication		$200.00
		Total		84,085.75

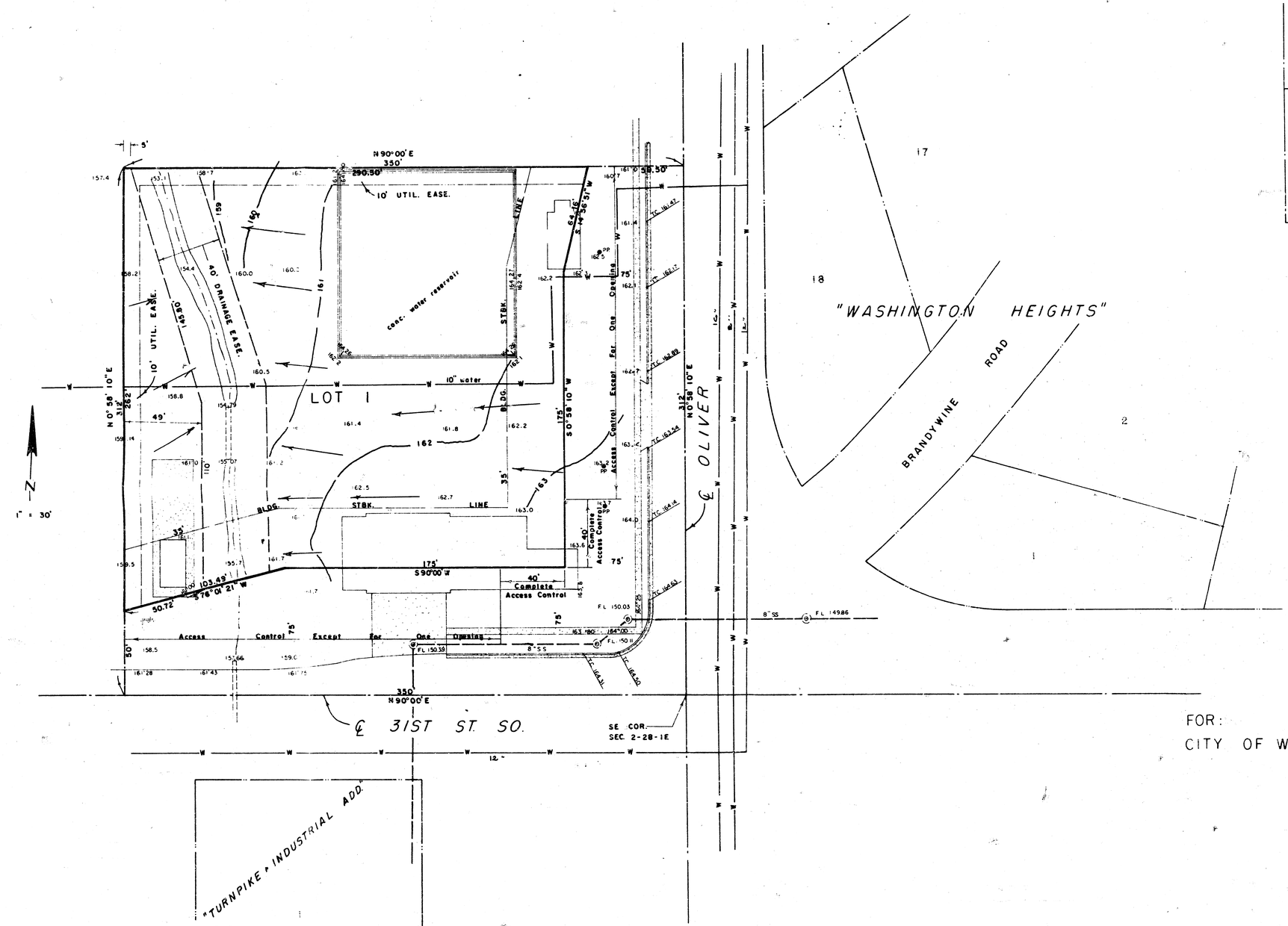
So, say for petition purposes only, call it $5,000.00

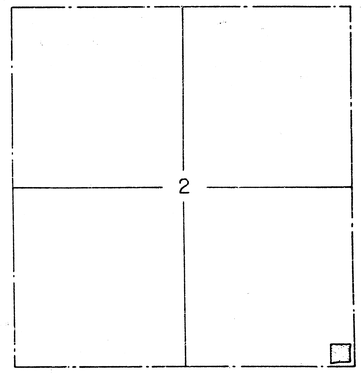
Robert E. Blevins

SKETCH PLAT

ROBERT E. BLEVINS ADDITION,

WICHITA, SEDGWICK COUNTY, KANSAS





VICINITY MAP
1" = 1000'

DRAINAGE PLAN

GRADE LOT TO DRAIN TO DRAINAGE DITCH BY METHOD APPROVED BY THE CITY OF WICHITA.

DRAIN LOT AS SHOWN BY ARROWS.

FOR:
CITY OF WICHITA

B.M. - ELEV. 161.22 - "□" on T.C. at NE cor. of property.

TOPO MADE JUNE, 1988.

LOWELL D. HIGH, L.S.
1542 S. ST. FRANCIS
WICHITA, KS 67211

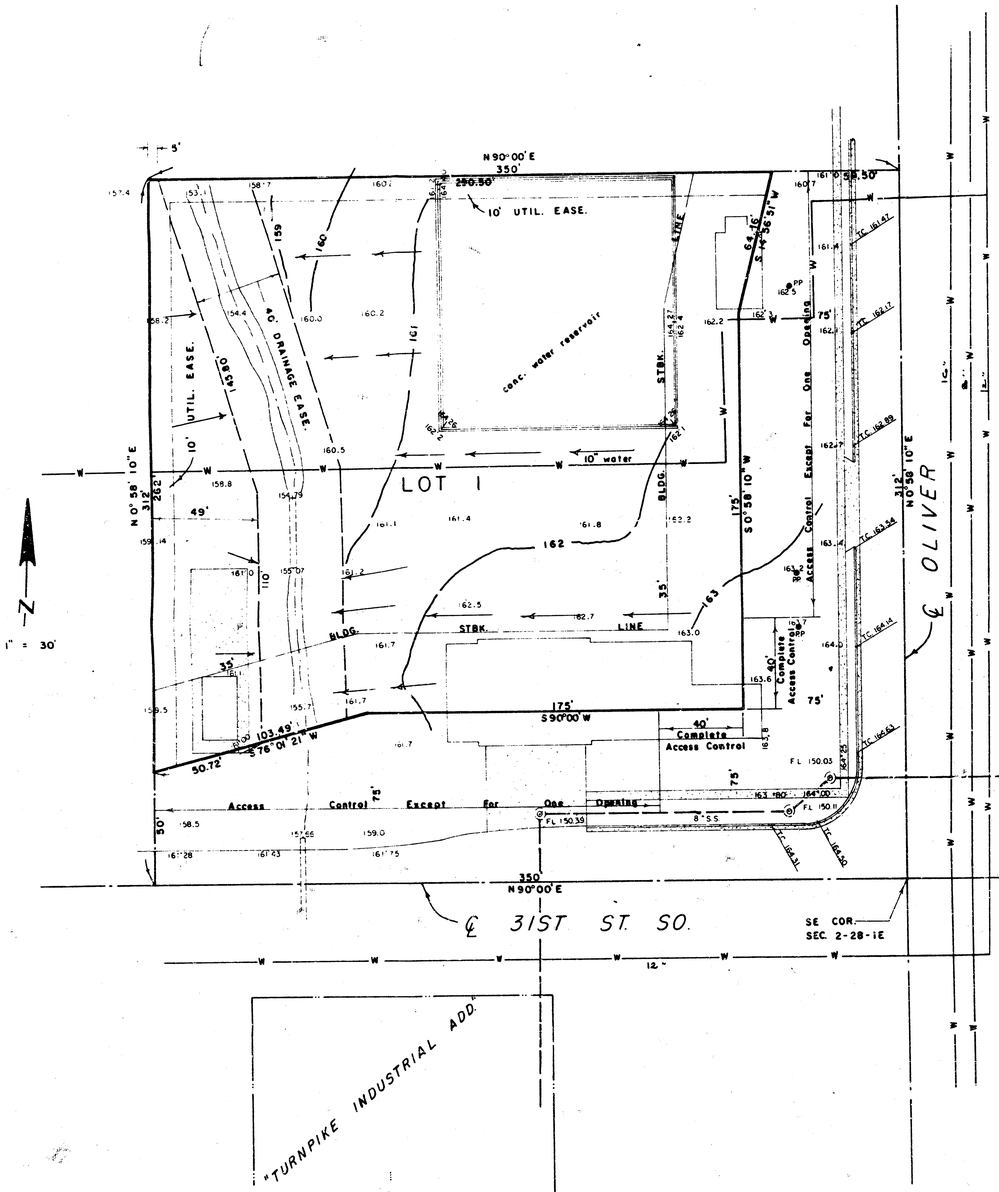
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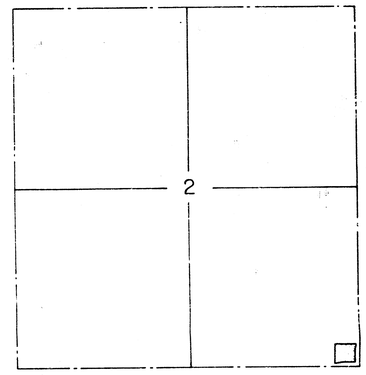
Robert E. Blevins

SKETCH PLAT

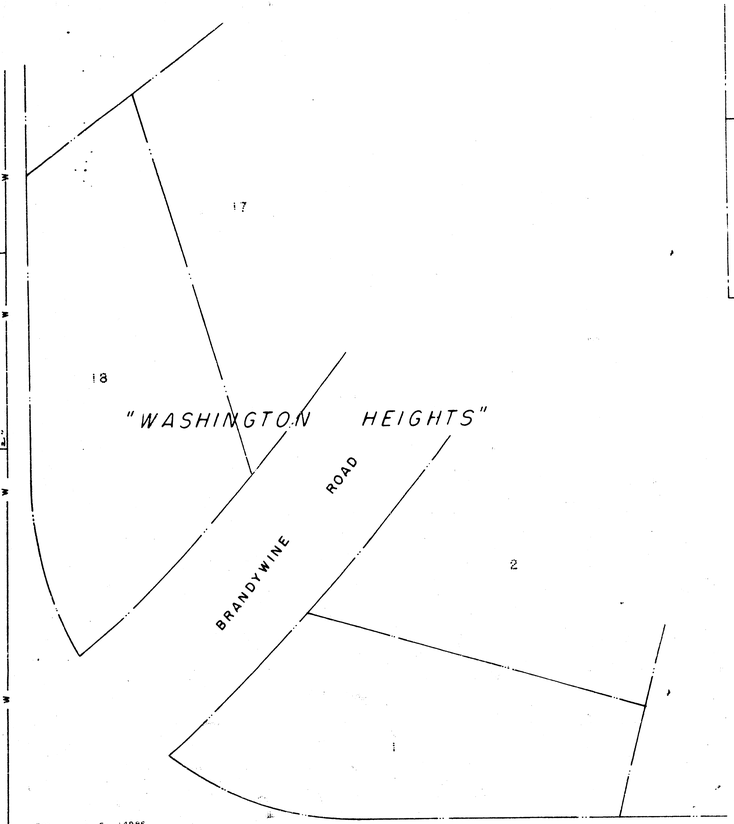
ROBERT E. BLEVINS ADDITION,

WICHITA, SEDGWICK COUNTY, KANSAS





VICINITY MAP
1" = 1000'



GRADE PLAN

GRADE LOT TO DRAIN TO DRAINAGE EASEMENT.

FOR:
CITY OF WICHITA

B.M. - ELEV. 161.22 - "□" on T.C. at NE cor. of property.

TOPO MADE JUNE, 1988.

LOWELL D. HIGH, L.S.
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WICHITA, KS 67211

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