**Revised Preliminary Drainage Plan**

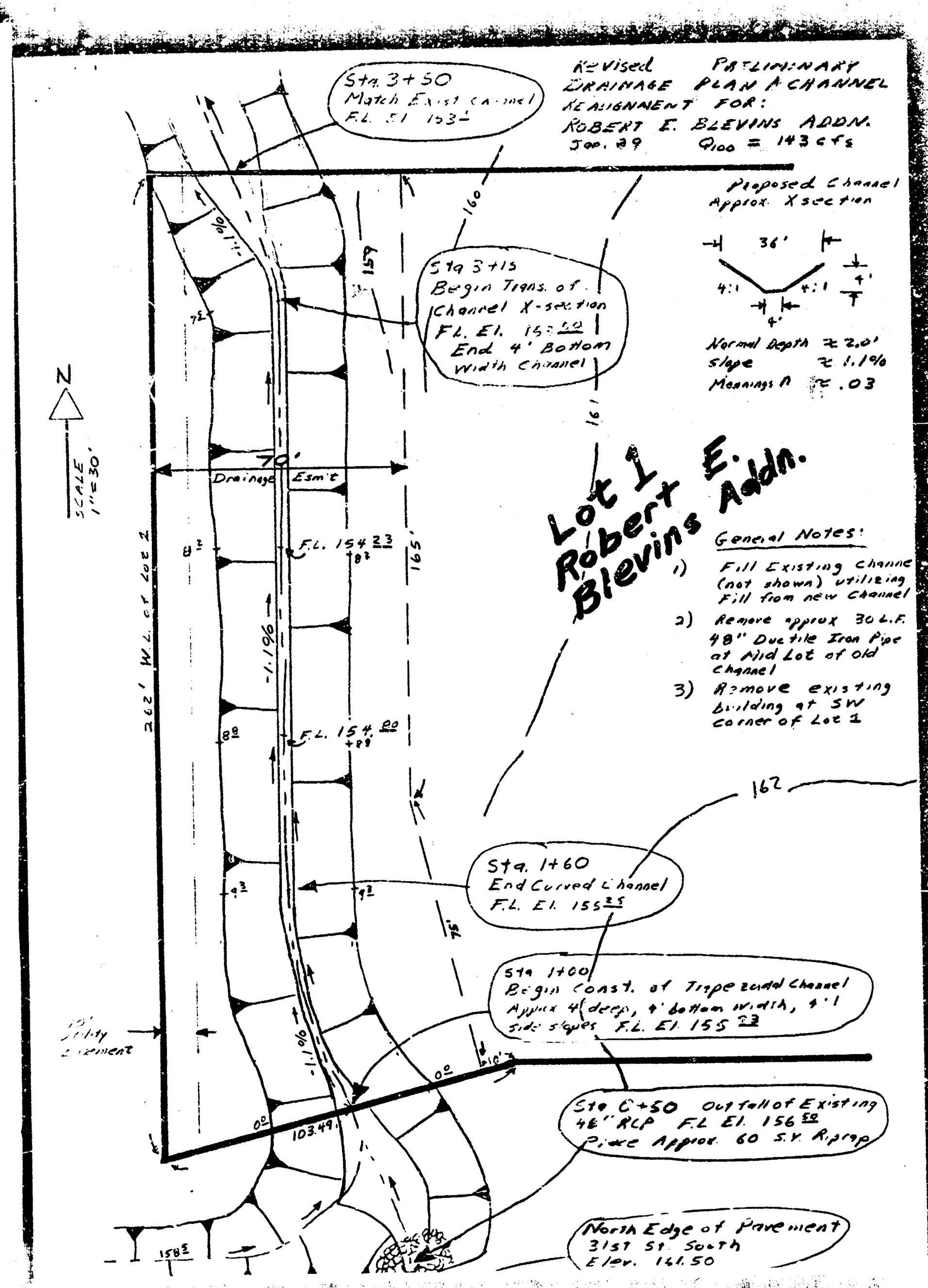
**and Channel Realignment for:**

**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: $n := .03$

Enter the discharge flow rate in cfs:

$Q := 143$

The formula for velocity of flow is:

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

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

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

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

Robert E. Blevins

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

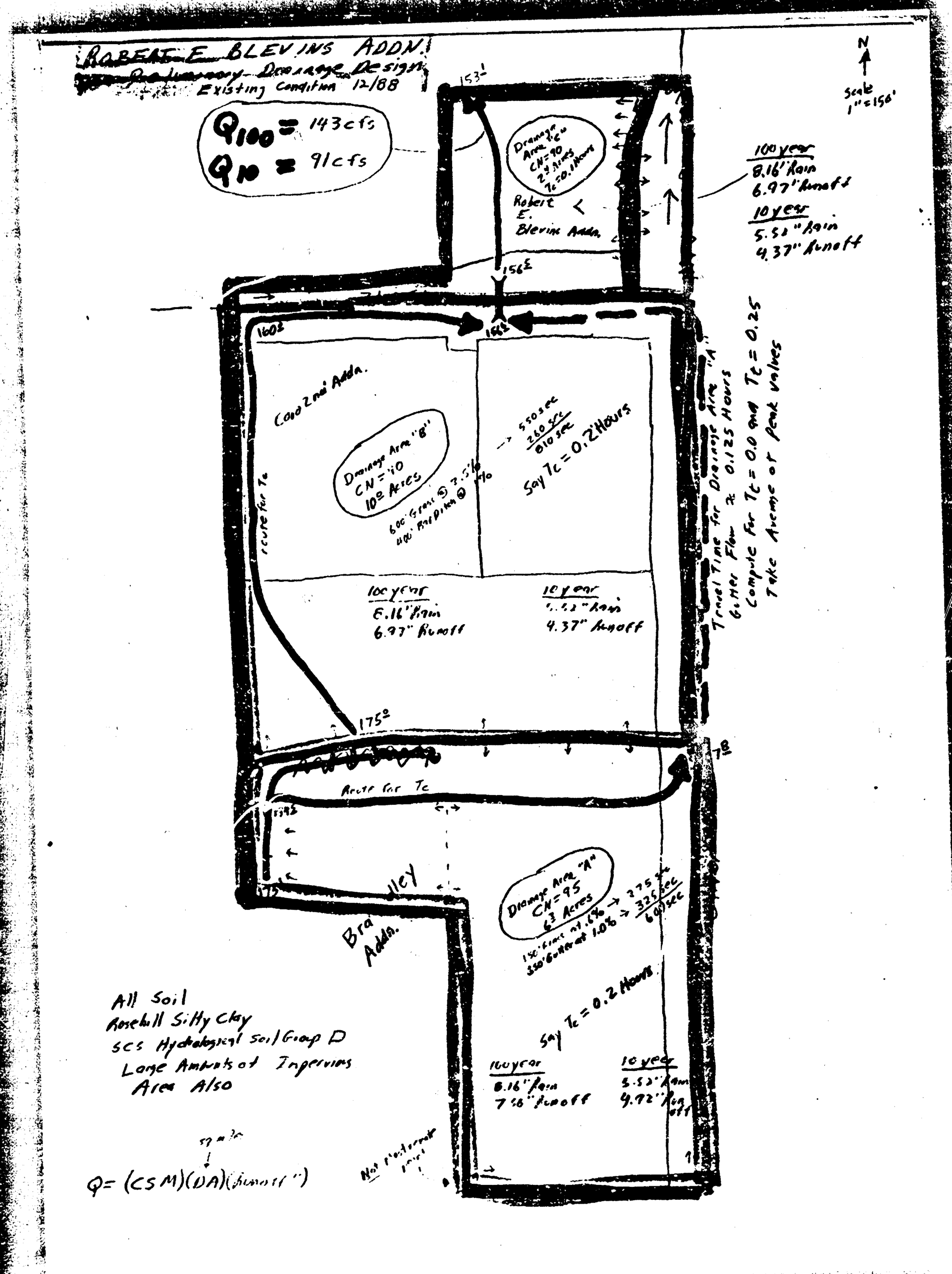
**Prepared By:** Robert A. Harrington, P.E.
December, 1988


**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 | 15.0 | 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 Tt = 0.25, then average the Tt = 0.00 peak flow and Tt = 0.25 peak flow together to get an estimate of the actual Tt ≈ 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 | 5 | 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 = 4.92 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 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 |

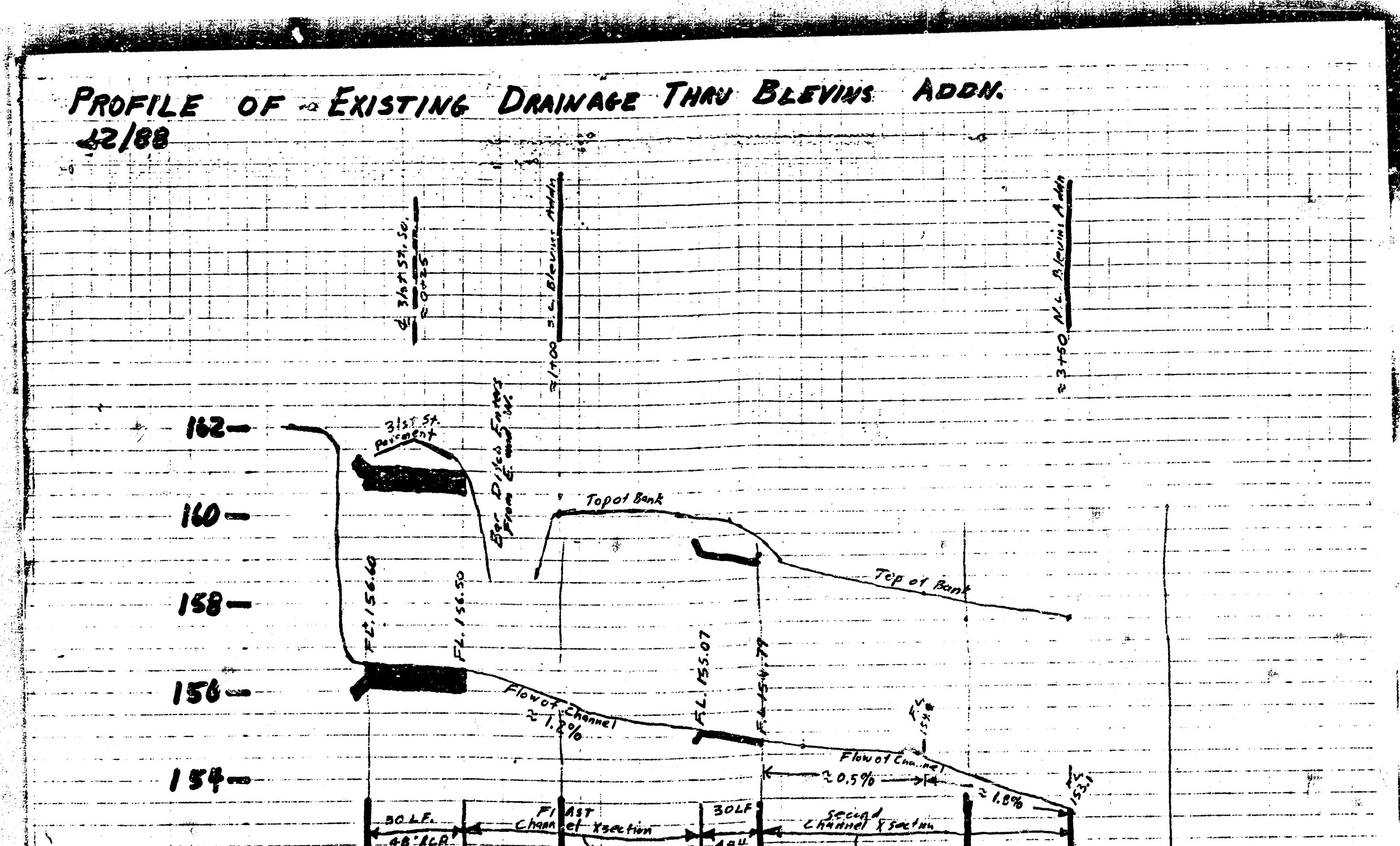
**Drainage Area C:  Area = 2.4 Acres  Runoff = 4.37 inches**

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 | 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




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

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

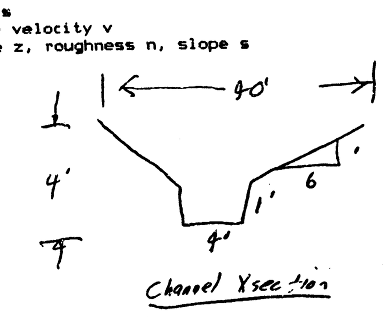
Enter the ditch flow slope: $s := .012$

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:

$Q := 143$




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

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

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

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

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

[redacted]

Assume $A_{Aw} = 15307$ (1' of freeboard)

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

Be an optimist – assume $C_p = 0.95$

Velocity of approach $= \frac{Q}{A} = 1.43$ ft/sec

$Q = C_p A_c \sqrt{2g\left(h_1 - z + \alpha_1 \frac{v_1^2}{2g} - y_c - h_{f1}\right)}$

$Q = (0.95)(9.95)\sqrt{(2\cdot 32.2)\left(4.28 - .28 + \frac{1.43^2}{2\cdot 32.2} - 2.96 - 0\right)}$

$Q = (0.95)(9.95)\sqrt{69.236} = 78.6$ cfs

2nd Cut: Let $Q = 78.6$ cfs. Keep $C_p = 0.95$

$h_1 = 4.26'$, $z = 0.28'$, $A_c = 8.72'$, $y_c = 2.62'$, $\bar{v}_1 = 1.12$ fps

Conclusion: Existing Culvert too small

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

CULVERT HAS INSUFFICIENT CAPACITY.

[redacted]

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Blevins Addn. Sta 2+00 – 3+00

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 := .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

Channel X-section (19', 20')

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

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

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

$d_n$ := find(d)

$d_n = 1.983$ feet — Leaves 2' of freeboard, plenty adequate

$v[d_n]$ = 3.89 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

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

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Blevins Addn. Sta 3+00 – 3+50

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 := .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

Channel X-section (20', 4')

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

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

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

$d_n$ := find(d)

$d_n$ = 1.374 feet — Leaves 2.6' of freeboard, plenty adequate

$v[d_n]$ = 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

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

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[redacted]

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') if we want 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

(32', 4', 8', 3:1)

The formula for velocity of flow is:

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

A(d) := (b + z·d)·d

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

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

---

[redacted]

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

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

Guess d := 1

Given

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

$d_n$ := find(d)

$d_n$ = 2.29746 feet — Leaves approx. 1.7 feet of freeboard

$A[d_n]$ = 34.21455 square feet  $P[d_n]$ = 22.53038 linear feet

$R[d_n]$ = 1.5186 feet  $v[d_n]$ = 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

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

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**Preliminary Drainage Plan for:**

**Robert E. Blevins Addn. to Wichita,**

**Sedgwick County, Kansas**

**Proposed Drainage Plan**

**Blevins Addition**

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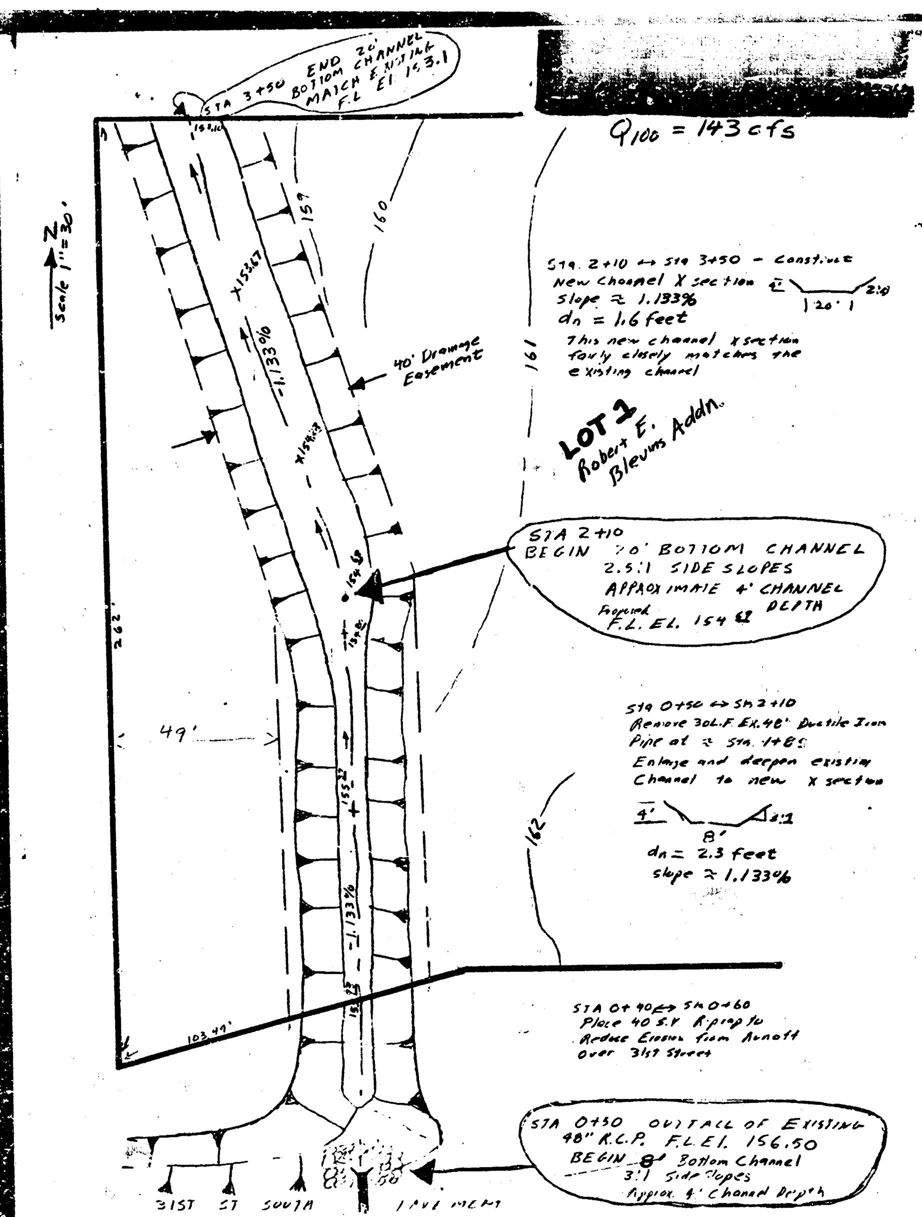


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[redacted]

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 mid 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.

---

[redacted]

Proposed x sec n 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

(40', 4', 20', 2.5:1)

The formula for velocity of flow is:

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

A(d) := (b + z·d)·d

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

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

---

[redacted]

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

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

Guess d := 1

Given

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

$d_n$ := find(d)

$d_n$ = 1.57005 feet — Leaves approx. 2.4 feet of freeboard

$A[d_n]$ = 37.56354 square feet  $P[d_n]$ = 28.45496 linear feet

$R[d_n]$ = 1.32011 feet  $v[d_n]$ = 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

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

---

[redacted]

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 existing mid 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**

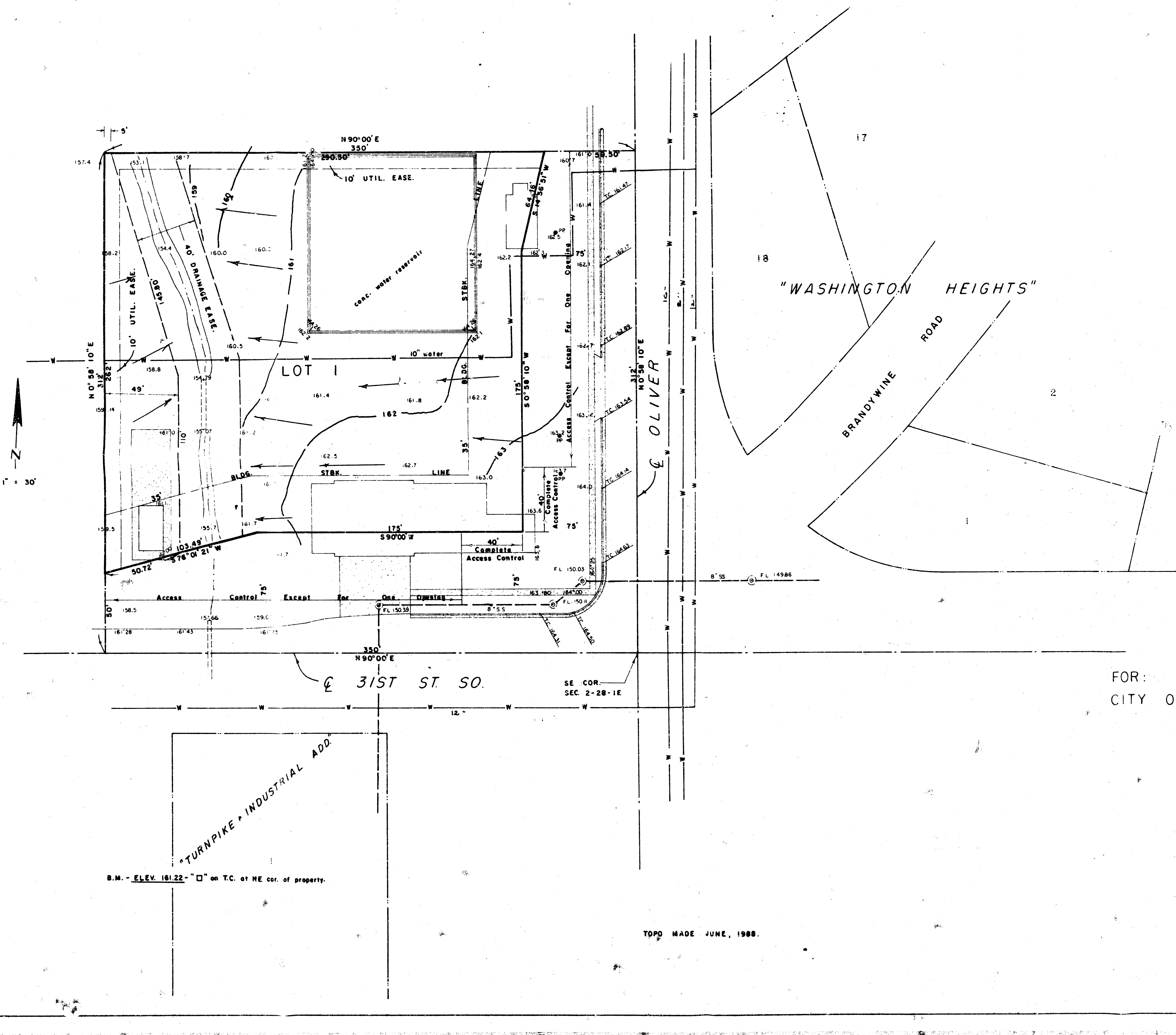
| Quantity | Units | Item | Cost/Unit | Total |
|---|---|---|---|---|
| 200.00 | C.Y. | Excavation | 2.50 | 500.00 |
| 150.00 | C.Y. | Compacted Fill | 2.50 | 375.00 |
| 40.00 | S.Y. | Riprap | 20.00 | 800.00 |
| 0.30 | Acres | Grass Seeding, Mulch Etc. | 1000.00 | 300.00 |
| 1.00 | L.S. | Remove 30 L.F. 48" Ductile Iron Pipe | 500.00 | 500.00 |
| 1.00 | L.S. | Clear/Clean Drain. Esmt., Remove Trash, Debris, Etc. | Incid. | 0.00 |
| | | Subtotal | | $2,475.00 |
| | | Petition Contingency | | 371.25 |
| | | Engineering | | 990.00 |
| | | Administration | | 49.50 |
| | | Publication | | $200.00 |
| | | Total | | $4,085.75 |

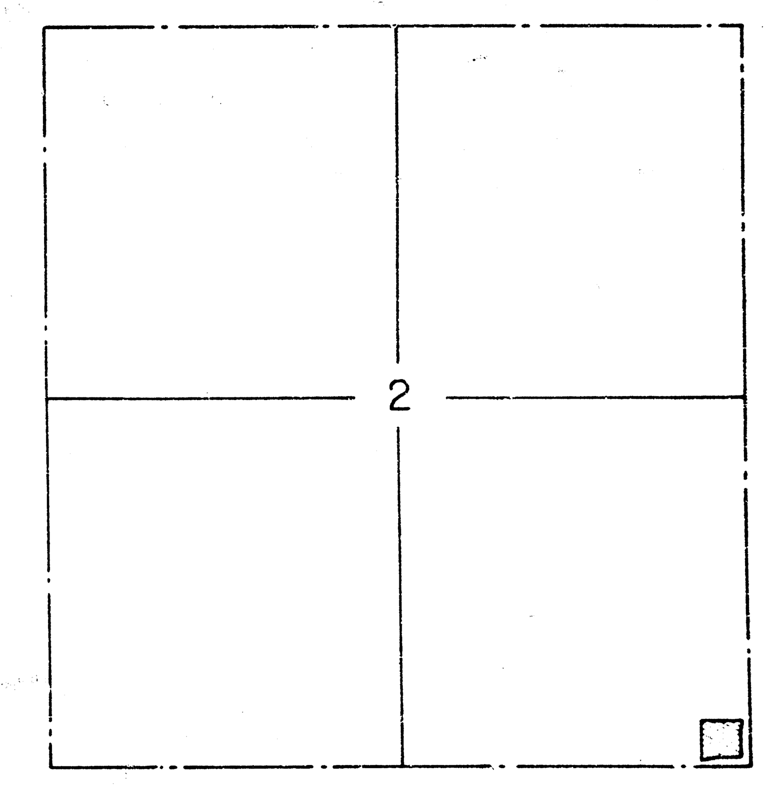
So, say for petition purposes only, call it $5,000.00

# SKETCH PLAT

## ROBERT E. BLEVINS ADDITION,

WICHITA, SEDGWICK COUNTY, KANSAS




VICINITY MAP
1" = 1000'

DRAINAGE PLAN

GRADE LOT TO DRAIN TO DRAINAGE PITCH BY METHOD APPROVED BY THE CITY OF WICHITA.
DRAIN LOT AS SHOWN BY ARROWS.

FOR:
CITY OF WICHITA

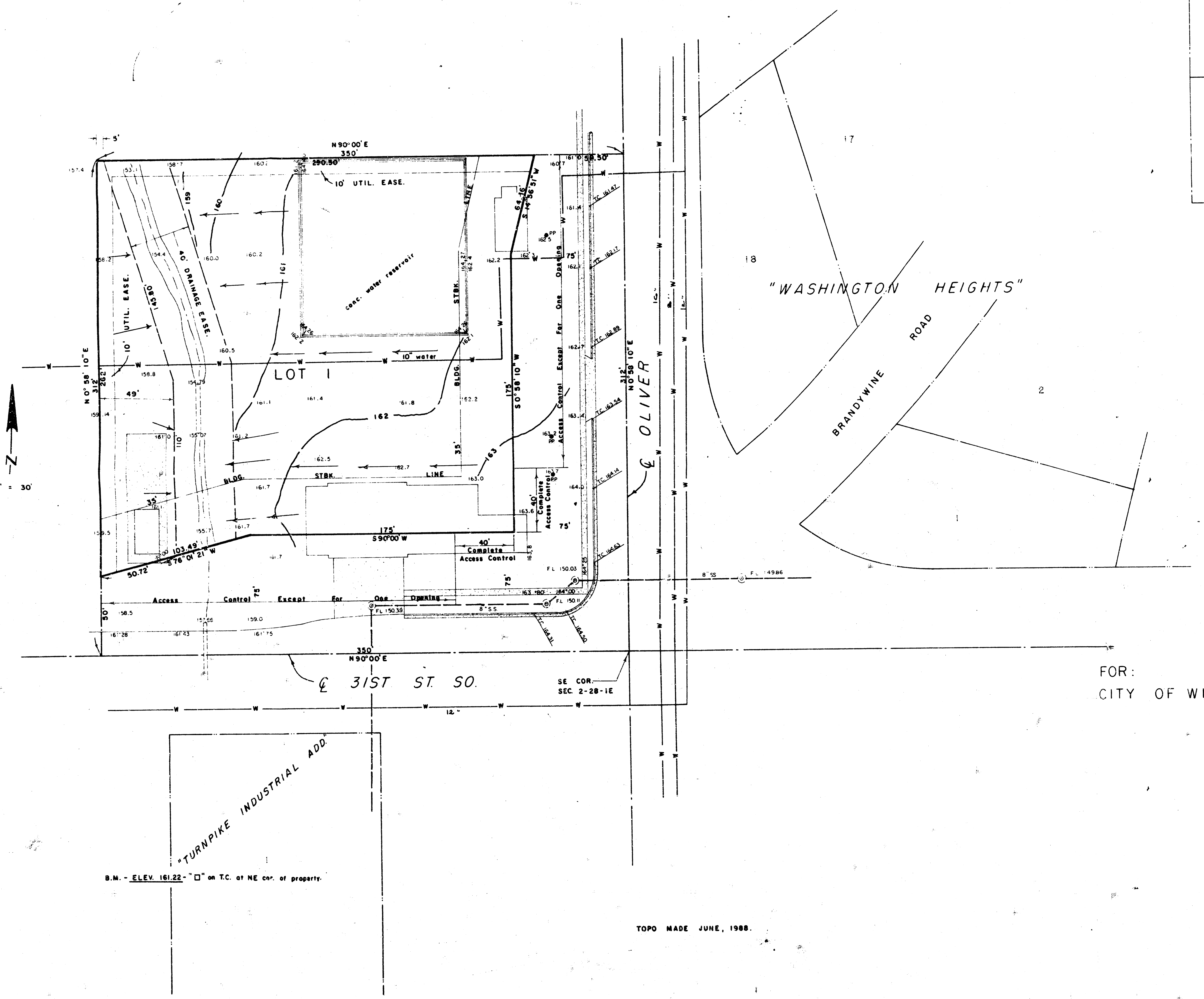
B.M. - ELEV. 161.22 - "□" on T.C. at NE cor. of property.

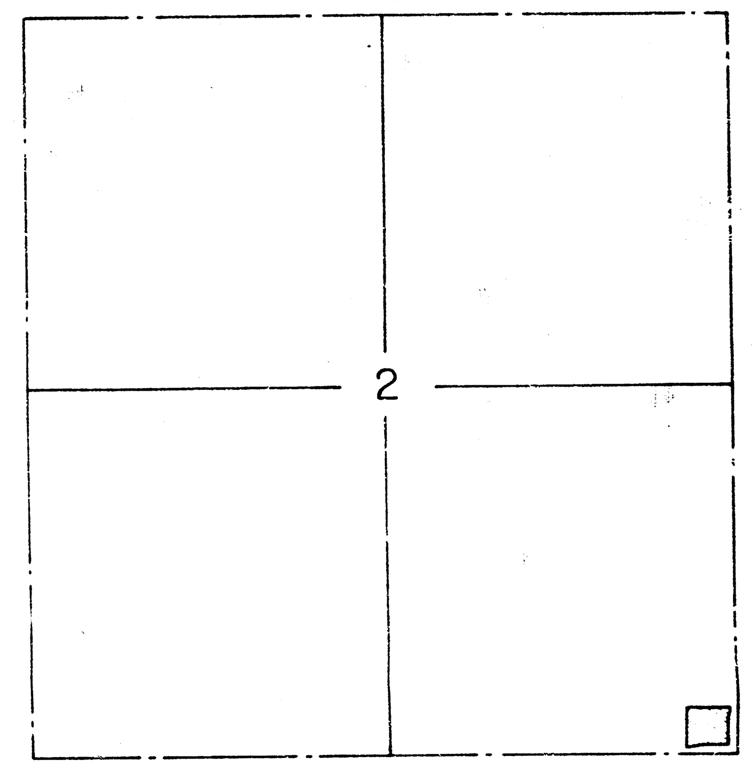
TOPO MADE JUNE, 1988.

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

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

TOPO MADE JUNE, 1988.


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