



Case No. 2010-00137 KENVIRONS

Kenvirons, Inc.

452 Versailles Road • Frankfort, KY 40601 • Phone: (502) 695-4357 • Fax: (502) 695-4363

Civil & Environmental Engineering and Laboratory Services

March 26, 2010

Kentucky Public Service Commission
Division of Engineering
211 Sower Blvd.
P.O. Box 615
Frankfort, Kentucky 40602-0615

RECEIVED

MAR 29 2010

PUBLIC SERVICE
COMMISSION

ATTN: MR. GEORGE W. WAKIM, MANAGER
Water and Sewer Branch

RE: Warrior Path Water Line Extension
Knox County Utility Commission

Dear Mr. Wakim:

Attached you will find the plans, specifications and hydraulic calculations for the above referenced proposed water line extension. As you will see the proposed line size is 2-inch for a distance of approximately 340 feet, which exceeds the Commission's 200 feet limit. Therefore, we are requesting a variance per 807 KAR 51066 Water Section 10(2)(a) minimum pipe size. With only one (1) initial customer and the anticipation of no more than three (3), the system pressure is more than adequate to provide service.

Should you have any questions please call.

Sincerely,

Kenneth D. Taylor, P.E.
Associate

KDT/pmw

Attachments

C: KCUC

KNOX COUNTY UTILITY COMMISSION

**P. O. Box 8
Artemus, KY 40903
606-546-5300
606-546-3099 fax**

March 24, 2010

Mr. Solitha Dharman, PE
Supervisor, Engineering Section
Water Infrastructure Branch
KY Division of Water
200 Fair Oaks, 4th Floor
Frankfort, KY 40601

RE: Warriors Path Water Line Extension

Dear Mr. Dharman:

Submitted herewith are four (4) sets of plans and specifications for the above referenced project.

The Commission has reviewed the plans and specifications and concurs with their content. Also attached are a water line submittal checklist, cost estimates, and hydraulic analysis results.

If you should have any questions or need additional information, please contact Ken Taylor, P.E. with Kenvirons, Inc. at (502) 695-4357.

Sincerely,



Marshall Ramey
Superintendent

Attachments

cc: Kentucky Public Service Commission

Page 1

DRINKING WATER DISTRIBUTION SYSTEMS CHECKLIST

PROJECT NAME: Warriors Path Water Line Extension
PWSID #: KY0610110 **Utility Name:** Knox County Utility Commission
County: Whitley

Utility Address: P. O. Box 8
City: Artemus **STATE:** KY **ZIP:** 40903

Engineer: Kenvirons, Inc. **Phone:** 502-695-4357
Fax: 502-695-4363 **E-mail Address:** ktaylor@kenvirons.com
Address: 452 Versailles Road
City: Frankfort **STATE:** KY **ZIP:** 40601

To improve the effectiveness of the DOW's review process, please respond to all the applicable questions that follow and provide all of the requested information.
Is this a federally funded project (i.e. SRF or SPAP)? **NO**

If yes, has an Environmental Information Document been reviewed and approved? n/a
If the project has been submitted to the State Clearinghouse for review, please provide the SAI number: **none**
Identify all funding sources: **private**

Provide a brief description for waterline projects with less than 10,000 linear feet (at a minimum identify the various line sizes, corresponding lengths and cost estimate): **The extension will consist of approximately 340 feet of 2" distribution line to initially serve one residence with the intent to add two additional residences in the near future. The cost estimate for this project is \$1,500 including labor, materials and equipment.**

All other Distribution projects should be accompanied with a detailed project description.

Is your system currently under any type of waterline or sewer sanctions? **no**
If yes, please submit an exception request and attach supporting documentation to justify its approval.

If another utility will serve the proposed project, provide the name and the PWSID No.
Utility: Pineville Water System **PWSID No.:** KY0070353

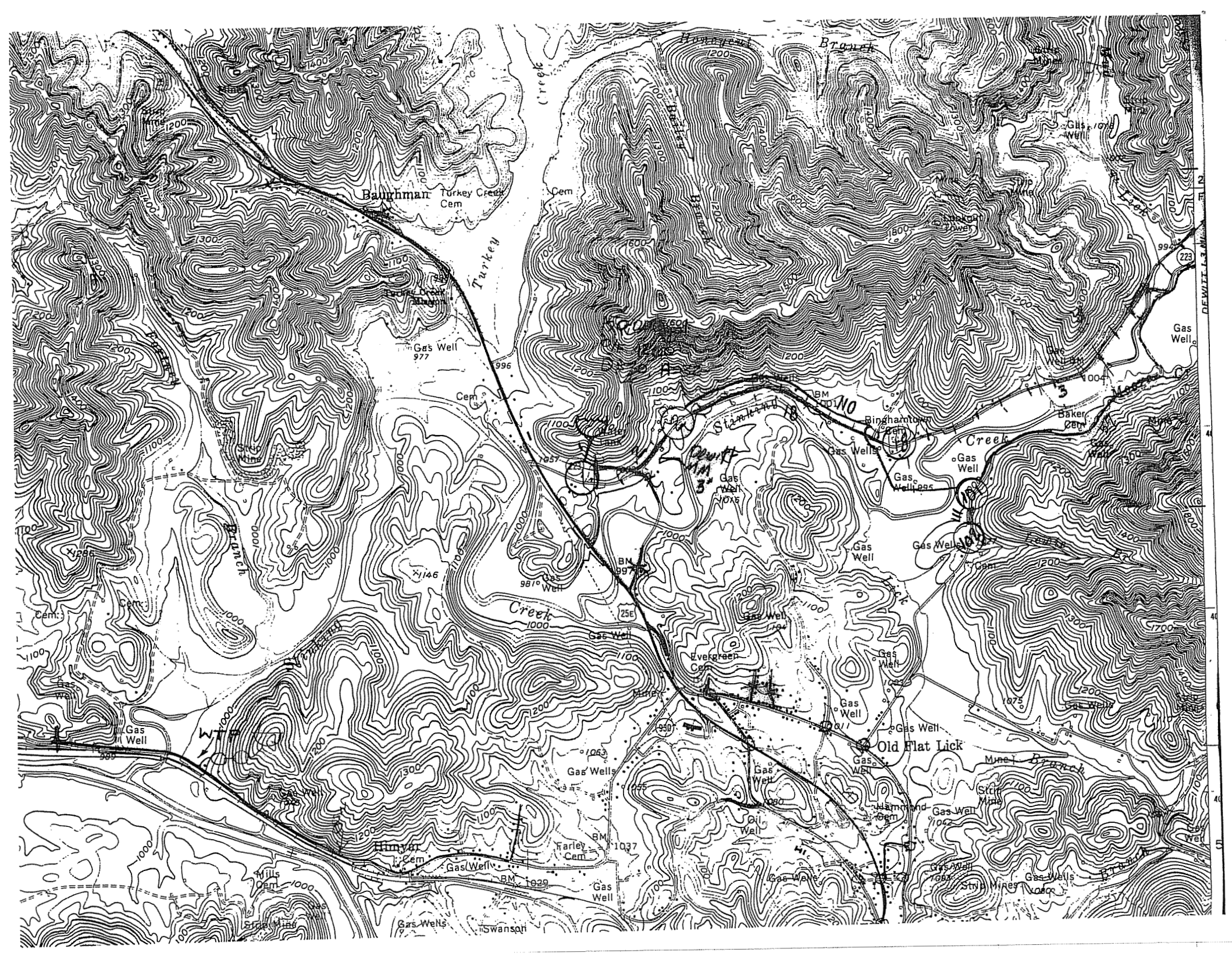
Identify the number of new customers and their projected demand? **3 new customers @ 7.5 gpm = 22.5 gpm peak demand**
Identify the number of existing residents; and their projected water demand, that may get served as a result of this project? **None**
Identify the total number of customers in your service area? **Approx. 2,800**



An Equal Opportunity Employer M/F/D

Warrior Path Water Line Extension
Knox County Utility Commission

Signed user: Mr. Michael Cox
P. O. Box 99
Flat Lick, KY 40935



NET SYSTEM INFLOW = 103.05
 NET SYSTEM OUTFLOW = .00
 NET SYSTEM DEMAND = 103.05

TANK STATUS REPORT (time = .0000 hours)

| TANK NUMBER (*) | PIPE NUMBER | NET FLOW (gpm) | WATER ELEVATION (ft) | TANK DEPTH (ft) | TANK VOLUME (gal) | TANK VOLUME (%) | TANK STATUS | PROJECTED DEPTH (ft) |
|-----------------|-------------|----------------|----------------------|-----------------|-------------------|-----------------|-------------|----------------------|
| 1-1 | 41 | -32.80 | 1459.00 | 60.00 | 42657. | 92.3 | DRAINING | 57.23 |
| 2-1 | 42 | -36.02 | 1325.00 | 23.00 | 121624. | 82.1 | DRAINING | 22.59 |
| 3-1 | 59 | .00 | 1398.00 | 22.00 | 94233. | 91.7 | | 22.00 |

* TANK TYPE: 1 - CONSTANT DIAMETER 2 - VARIABLE AREA

DATA CHANGES FOR NEXT SIMULATION

DEMAND CHANGES

DEMAND TYPE = 1 - GDF = 2.000

PEAK Demand
 $10\sqrt{3} = 17.3 \text{ GPM @ Jct } 102$

 SIMULATION RESULTS

TIME FROM INITIATION OF EPS = 1.0000 HOURS

THE RESULTS ARE OBTAINED AFTER 2 TRIALS WITH AN ACCURACY = .00000

PIPELINE RESULTS

STATUS CODE: XX -CLOSED PIPE FG -FIXED GRADE NODE PU -PUMP LINE

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 JOB NAME = 2010000

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CV -CHECK VALVE RV -REGULATING VALVE TK -STORAGE TANK

| PIPE NUMBER | NODE #1 | NODE #2 | FLOWRATE (gpm) | HEAD LOSS (ft) | PUMP HEAD (ft) | MINOR LOSS (ft) | LINE VELO. (ft/s) | HL/1000 (ft/ft) |
|-------------|---------|---------|----------------|----------------|----------------|-----------------|-------------------|-----------------|
|-------------|---------|---------|----------------|----------------|----------------|-----------------|-------------------|-----------------|

| | | | | | | | | |
|---------|----|----|--------|------|-----|-----|------|------|
| 1-FG | 0 | 1 | 68.46 | .11 | .00 | .00 | .44 | .11 |
| 2 | 1 | 2 | 68.46 | .99 | .00 | .00 | .78 | .45 |
| 3 | 18 | 3 | 13.13 | 1.30 | .00 | .00 | .34 | .15 |
| 4 | 3 | 17 | .05 | .00 | .00 | .00 | .00 | .00 |
| 5 | 4 | 5 | 4.70 | .03 | .00 | .00 | .12 | .02 |
| 6 | 5 | 6 | 2.48 | .03 | .00 | .00 | .06 | .01 |
| 7 | 6 | 42 | 1.20 | .01 | .00 | .00 | .03 | .00 |
| 8 | 7 | 8 | 21.60 | 4.36 | .00 | .00 | .98 | 1.56 |
| 9 | 8 | 87 | 12.00 | 2.13 | .00 | .00 | .31 | .13 |
| 10 | 87 | 10 | 6.00 | .04 | .00 | .00 | .07 | .00 |
| 11 | 10 | 20 | .00 | .00 | .00 | .00 | .00 | .00 |
| 12 | 12 | 99 | 28.62 | 2.58 | .00 | .00 | .73 | .65 |
| 13 | 12 | 13 | -35.20 | 6.63 | .00 | .00 | .90 | .95 |
| 14 | 14 | 74 | 41.66 | 4.14 | .00 | .00 | 1.06 | 1.29 |
| 15 | 83 | 15 | 3.50 | .24 | .00 | .00 | .16 | .05 |
| 16 | 67 | 16 | 11.60 | 1.48 | .00 | .00 | .53 | .49 |
| 17-XXPU | 41 | 26 | | | | | | |
| 18 | 2 | 18 | 18.93 | 1.35 | .00 | .00 | .48 | .30 |
| 19 | 40 | 19 | 6.40 | .18 | .00 | .00 | .16 | .04 |
| 20-XXPU | 11 | 9 | | | | | | |
| 21 | 4 | 21 | 24.60 | .41 | .00 | .00 | .28 | .07 |
| 22 | 79 | 22 | 17.60 | .18 | .00 | .00 | .20 | .04 |
| 23 | 22 | 38 | 15.80 | .13 | .00 | .00 | .18 | .03 |
| 24 | 38 | 23 | 13.36 | .05 | .00 | .00 | .15 | .02 |
| 25 | 23 | 24 | 6.28 | .02 | .00 | .00 | .07 | .01 |
| 26 | 24 | 25 | 2.88 | .00 | .00 | .00 | .03 | .00 |
| 27 | 25 | 41 | 1.28 | .00 | .00 | .00 | .01 | .00 |
| 28 | 26 | 27 | -14.64 | .19 | .00 | .00 | .17 | .03 |
| 29 | 43 | 14 | 51.00 | .68 | .00 | .00 | .58 | .26 |
| 30 | 26 | 28 | 7.00 | .38 | .00 | .00 | .18 | .05 |
| 31 | 28 | 29 | 2.76 | .07 | .00 | .00 | .13 | .03 |
| 32 | 76 | 34 | 3.08 | .05 | .00 | .00 | .08 | .01 |
| 33 | 34 | 35 | 2.02 | .02 | .00 | .00 | .05 | .00 |
| 34 | 24 | 36 | 1.28 | .02 | .00 | .00 | .03 | .00 |
| 35 | 85 | 30 | 2.20 | .01 | .00 | .00 | .06 | .01 |
| 36 | 38 | 33 | .64 | .01 | .00 | .00 | .03 | .00 |
| 37 | 13 | 37 | 2.12 | .08 | .00 | .00 | .10 | .02 |
| 38 | 21 | 31 | 2.76 | .04 | .00 | .00 | .07 | .01 |
| 39 | 31 | 32 | 1.48 | .01 | .00 | .00 | .04 | .00 |
| 40 | 23 | 39 | .96 | .01 | .00 | .00 | .04 | .00 |
| 41-TK | 88 | 0 | -65.60 | .67 | .00 | .00 | .74 | .42 |
| 42-TK | 0 | 62 | 72.04 | .28 | .00 | .00 | .46 | .12 |
| 43 | 70 | 40 | 11.20 | .95 | .00 | .00 | .29 | .11 |
| 44 | 17 | 4 | .05 | .00 | .00 | .00 | .00 | .00 |
| 45-XX | 42 | 7 | | | | | | |
| 46 | 62 | 44 | 5.12 | .01 | .00 | .00 | .06 | .00 |
| 47 | 44 | 45 | 3.20 | .01 | .00 | .00 | .04 | .00 |
| 48 | 45 | 46 | .96 | .00 | .00 | .00 | .02 | .00 |
| 49 | 45 | 47 | .64 | .00 | .00 | .00 | .03 | .00 |

| | | | | | | | | |
|---------|-----|----|--------|------|-----|-----|------|------|
| 50 | 44 | 48 | .64 | .00 | .00 | .00 | .03 | .00 |
| 51 | 14 | 49 | 8.06 | .03 | .00 | .00 | .09 | .01 |
| 52 | 49 | 52 | 2.22 | .03 | .00 | .00 | .06 | .00 |
| 53 | 52 | 53 | 1.06 | .02 | .00 | .00 | .05 | .01 |
| 54 | 49 | 50 | 5.30 | .01 | .00 | .00 | .06 | .00 |
| 55 | 50 | 51 | 2.12 | .02 | .00 | .00 | .05 | .00 |
| 56 | 43 | 27 | 15.92 | .03 | .00 | .00 | .18 | .03 |
| 57 | 101 | 4 | 31.33 | 1.40 | .00 | .00 | .36 | .09 |
| 58-XX | 46 | 54 | | | | | | |
| 59-TK | 54 | 0 | .00 | .00 | .00 | .00 | .00 | .00 |
| 60-XXPU | 41 | 26 | | | | | | |
| 61 | 4 | 55 | 2.08 | .07 | .00 | .00 | .09 | .02 |
| 62 | 55 | 56 | .64 | .01 | .00 | .00 | .03 | .00 |
| 63 | 55 | 57 | .80 | .00 | .00 | .00 | .04 | .00 |
| 64 | 3 | 58 | 5.80 | .34 | .00 | .00 | .26 | .12 |
| 65 | 58 | 59 | 4.80 | .19 | .00 | .00 | .12 | .02 |
| 66 | 59 | 60 | 1.60 | .06 | .00 | .00 | .07 | .01 |
| 67 | 3 | 61 | 1.28 | .04 | .00 | .00 | .06 | .01 |
| 68 | 43 | 62 | -66.92 | .76 | .00 | .00 | .76 | .38 |
| 69 | 91 | 63 | 4.00 | .25 | .00 | .00 | .18 | .06 |
| 70 | 64 | 67 | -10.40 | .05 | .00 | .00 | .12 | .01 |
| 71 | 67 | 69 | -24.40 | .18 | .00 | .00 | .28 | .06 |
| 72 | 69 | 88 | -37.60 | .39 | .00 | .00 | .43 | .13 |
| 73 | 16 | 68 | 10.40 | .70 | .00 | .00 | .27 | .09 |
| 74 | 93 | 73 | 11.20 | .60 | .00 | .00 | .29 | .10 |
| 75 | 67 | 66 | 2.00 | .15 | .00 | .00 | .09 | .02 |
| 76 | 70 | 96 | 14.00 | 1.09 | .00 | .00 | .36 | .15 |
| 77 | 40 | 72 | 2.40 | .03 | .00 | .00 | .11 | .02 |
| 78 | 64 | 65 | 1.20 | .03 | .00 | .00 | .05 | .01 |
| 79 | 88 | 70 | 28.00 | 1.20 | .00 | .00 | .71 | .55 |
| 80 | 13 | 74 | -39.54 | 3.72 | .00 | .00 | 1.01 | 1.03 |
| 81 | 74 | 75 | 1.06 | .01 | .00 | .00 | .05 | .01 |
| 82-XX | 25 | 76 | | | | | | |
| 83 | 76 | 77 | 1.06 | .02 | .00 | .00 | .05 | .01 |
| 84 | 35 | 78 | 1.06 | .00 | .00 | .00 | .03 | .00 |
| 85 | 21 | 79 | 19.72 | .17 | .00 | .00 | .22 | .04 |
| 86 | 79 | 80 | 1.06 | .02 | .00 | .00 | .05 | .01 |
| 87 | 28 | 81 | 1.48 | .02 | .00 | .00 | .07 | .01 |
| 88 | 8 | 82 | 2.00 | .07 | .00 | .00 | .09 | .02 |
| 89-RV | 12 | 83 | 3.50 | .00 | .00 | .00 | .16 | .05 |
| 90 | 50 | 84 | 1.06 | .01 | .00 | .00 | .05 | .01 |
| 91 | 85 | 86 | 1.06 | .01 | .00 | .00 | .05 | .01 |
| 92 | 23 | 85 | 4.32 | .04 | .00 | .00 | .11 | .02 |
| 93 | 42 | 11 | 1.20 | .00 | .00 | .00 | .01 | .00 |
| 94 | 9 | 64 | -8.80 | .05 | .00 | .00 | .10 | .01 |
| 95 | 26 | 76 | 5.20 | .10 | .00 | .00 | .13 | .02 |
| 96-XXPU | 11 | 9 | | | | | | |
| 97-RV | 68 | 89 | 1.20 | .02 | .00 | .00 | .05 | .01 |
| 98-RV | 68 | 90 | 1.60 | .02 | .00 | .00 | .07 | .01 |
| 99 | 9 | 91 | 4.00 | .20 | .00 | .00 | .18 | .06 |
| 100-RV | 63 | 92 | 1.20 | .03 | .00 | .00 | .05 | .01 |
| 101 | 69 | 93 | 12.80 | .41 | .00 | .00 | .33 | .13 |
| 102-RV | 73 | 94 | 2.80 | .12 | .00 | .00 | .13 | .03 |
| 103 | 72 | 95 | 1.20 | .02 | .00 | .00 | .05 | .01 |
| 104 | 96 | 71 | 9.60 | .18 | .00 | .00 | .25 | .08 |

| | | | | | | | | |
|----------|-----|-----|-------|------|-----|-----|------|------|
| 105-RV | 96 | 98 | .80 | .01 | .00 | .00 | .04 | .00 |
| 106-RV | 71 | 97 | .80 | .01 | .00 | .00 | .04 | .00 |
| 107 | 99 | 100 | 1.20 | .01 | .00 | .00 | .05 | .01 |
| 108 | 99 | 7 | 25.42 | 2.28 | .00 | .00 | .65 | .46 |
| 109-XXPU | 11 | 9 | | | | | | |
| 110 | 2 | 101 | 48.33 | 1.25 | .00 | .00 | .55 | .21 |
| 111 | 101 | 102 | 17.00 | 2.15 | .00 | .00 | 1.74 | 6.33 |

JUNCTION NODE RESULTS

| JUNCTION NUMBER | JUNCTION TITLE | EXTERNAL DEMAND (gpm) | HYDRAULIC GRADE (ft) | JUNCTION ELEVATION (ft) | PRESSURE HEAD (ft) | JUNCTION PRESSURE (psi) |
|-----------------|----------------|-----------------------|----------------------|-------------------------|--------------------|-------------------------|
| 1 | | .00 | 1249.89 | 1040.00 | 209.89 | 90.95 |
| 2 | | 1.20 | 1248.90 | 1020.00 | 228.90 | 99.19 |
| 3 | | 6.00 | 1246.25 | 1020.00 | 226.25 | 98.04 |
| 4 | | .00 | 1246.25 | 995.00 | 251.25 | 108.88 |
| 5 | | 2.22 | 1246.22 | 1040.00 | 206.22 | 89.36 |
| 6 | | 1.28 | 1246.18 | 1010.00 | 236.18 | 102.35 |
| 7 | | 3.82 | 1303.52 | 1003.00 | 300.52 | 130.23 |
| 8 | | 7.60 | 1299.16 | 1030.00 | 269.16 | 116.64 |
| 9 | | 4.80 | 1454.90 | 1072.00 | 382.90 | 165.92 |
| 10 | | 6.00 | 1296.99 | 1080.00 | 216.99 | 94.03 |
| 11 | | 1.20 | 1246.17 | 1072.00 | 174.17 | 75.47 |
| 12 | | 3.08 | 1308.38 | 1020.00 | 288.38 | 124.97 |
| 13 | | 2.22 | 1315.01 | 1041.00 | 274.01 | 118.74 |
| 14 | | 1.28 | 1322.87 | 1040.00 | 282.87 | 122.58 |
| 15 | | 3.50 | 1399.76 | 1280.00 | 119.76 | 51.90 |
| 16 | | 1.20 | 1453.52 | 1140.00 | 313.52 | 135.86 |
| 17 | | .00 | 1246.25 | 995.00 | 251.25 | 108.88 |
| 18 | | 5.80 | 1247.55 | 1030.00 | 217.55 | 94.27 |
| 19 | | 6.40 | 1453.23 | 1360.00 | 93.23 | 40.40 |
| 20 | | .00 | 1296.99 | 1160.00 | 136.99 | 59.36 |
| 21 | | 2.12 | 1245.84 | 1020.00 | 225.84 | 97.87 |
| 22 | | 1.80 | 1245.49 | 1020.00 | 225.49 | 97.71 |
| 23 | | 1.80 | 1245.30 | 1020.00 | 225.30 | 97.63 |
| 24 | | 2.12 | 1245.28 | 1040.00 | 205.28 | 88.95 |
| 25 | | 1.60 | 1245.27 | 1040.00 | 205.27 | 88.95 |
| 26 | | 2.44 | 1323.33 | 1040.00 | 283.33 | 122.78 |
| 27 | | 1.28 | 1323.52 | 1190.00 | 133.52 | 57.86 |
| 28 | | 2.76 | 1322.95 | 1050.00 | 272.95 | 118.28 |
| 29 | | 2.76 | 1322.88 | 1060.00 | 262.88 | 113.92 |
| 30 | | 2.20 | 1245.24 | 1080.00 | 165.24 | 71.61 |
| 31 | | 1.28 | 1245.80 | 1040.00 | 205.80 | 89.18 |
| 32 | | 1.48 | 1245.79 | 1050.00 | 195.79 | 84.84 |
| 33 | | .64 | 1245.35 | 1040.00 | 205.35 | 88.98 |
| 34 | | 1.06 | 1323.19 | 1040.00 | 283.19 | 122.71 |
| 35 | | .96 | 1323.16 | 1040.00 | 283.16 | 122.70 |
| 36 | | 1.28 | 1245.26 | 1070.00 | 175.26 | 75.95 |
| 37 | | 2.12 | 1314.93 | 1220.00 | 94.93 | 41.13 |
| 38 | | 1.80 | 1245.35 | 1005.00 | 240.35 | 104.15 |

39

.96

1245.29

1040.00

205.29

88.96

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| | | | | | |
|----|------|---------|---------|--------|--------|
| 40 | 2.40 | 1453.41 | 1260.00 | 193.41 | 83.81 |
| 41 | 1.28 | 1245.27 | 1040.00 | 205.27 | 88.95 |
| 42 | .00 | 1246.18 | 1000.00 | 246.18 | 106.68 |
| 43 | .00 | 1323.55 | 1057.00 | 266.55 | 115.51 |
| 44 | 1.28 | 1324.30 | 1070.00 | 254.30 | 110.20 |
| 45 | 1.60 | 1324.30 | 1080.00 | 244.30 | 105.86 |
| 46 | .96 | 1324.29 | 1180.00 | 144.29 | 62.53 |
| 47 | .64 | 1324.29 | 1120.00 | 204.29 | 88.53 |
| 48 | .64 | 1324.30 | 1080.00 | 244.30 | 105.86 |
| 49 | .54 | 1322.84 | 1080.00 | 242.84 | 105.23 |
| 50 | 2.12 | 1322.84 | 1100.00 | 222.84 | 96.56 |
| 51 | 2.12 | 1322.82 | 1240.00 | 82.82 | 35.89 |
| 52 | 1.16 | 1322.82 | 1100.00 | 222.82 | 96.55 |
| 53 | 1.06 | 1322.80 | 1160.00 | 162.80 | 70.55 |
| 54 | .00 | 1398.00 | 1300.00 | 98.00 | 42.47 |
| 55 | .64 | 1246.18 | 1000.00 | 246.18 | 106.68 |
| 56 | .64 | 1246.17 | 1080.00 | 166.17 | 72.01 |
| 57 | .80 | 1246.18 | 1000.00 | 246.18 | 106.68 |
| 58 | 1.00 | 1245.92 | 1010.00 | 235.92 | 102.23 |
| 59 | 3.20 | 1245.72 | 1040.00 | 205.72 | 89.15 |
| 60 | 1.60 | 1245.67 | 1080.00 | 165.67 | 71.79 |
| 61 | 1.28 | 1246.21 | 1120.00 | 126.21 | 54.69 |
| 62 | .00 | 1324.31 | 1080.00 | 244.31 | 105.87 |
| 63 | 2.80 | 1454.44 | 1360.00 | 94.44 | 40.93 |
| 64 | .40 | 1454.95 | 1080.00 | 374.95 | 162.48 |
| 65 | 1.20 | 1454.92 | 1320.00 | 134.92 | 58.47 |
| 66 | 2.00 | 1454.85 | 1240.00 | 214.85 | 93.10 |
| 67 | .40 | 1455.00 | 1110.00 | 345.00 | 149.50 |
| 68 | 7.60 | 1452.82 | 1360.00 | 92.82 | 40.22 |
| 69 | .40 | 1455.17 | 1110.00 | 345.17 | 149.58 |
| 70 | 2.80 | 1454.37 | 1170.00 | 284.37 | 123.23 |
| 71 | 8.80 | 1453.10 | 1360.00 | 93.10 | 40.34 |
| 72 | 1.20 | 1453.38 | 1280.00 | 173.38 | 75.13 |
| 73 | 8.40 | 1454.16 | 1382.00 | 72.16 | 31.27 |
| 74 | 1.06 | 1318.73 | 1040.00 | 278.73 | 120.78 |
| 75 | 1.06 | 1318.72 | 1160.00 | 158.72 | 68.78 |
| 76 | 1.06 | 1323.24 | 1060.00 | 263.24 | 114.07 |
| 77 | 1.06 | 1323.21 | 1080.00 | 243.21 | 105.39 |
| 78 | 1.06 | 1323.16 | 1120.00 | 203.16 | 88.04 |
| 79 | 1.06 | 1245.67 | 1000.00 | 245.67 | 106.46 |
| 80 | 1.06 | 1245.65 | 1020.00 | 225.65 | 97.78 |
| 81 | 1.48 | 1322.93 | 1080.00 | 242.93 | 105.27 |
| 82 | 2.00 | 1299.10 | 1040.00 | 259.10 | 112.28 |
| 83 | .00 | 1400.00 | 1020.00 | 380.00 | 164.67 |
| 84 | 1.06 | 1322.83 | 1100.00 | 222.83 | 96.56 |
| 85 | 1.06 | 1245.26 | 1080.00 | 165.26 | 71.61 |
| 86 | 1.06 | 1245.25 | 1060.00 | 185.25 | 80.28 |
| 87 | 6.00 | 1297.04 | 1072.00 | 225.04 | 97.52 |

| | | | | | |
|----|------|---------|---------|--------|--------|
| 88 | .00 | 1455.57 | 1160.00 | 295.57 | 128.08 |
| 89 | 1.20 | 1559.98 | 1440.00 | 119.98 | 51.99 |
| 90 | 1.60 | 1559.98 | 1440.00 | 119.98 | 51.99 |
| 91 | .00 | 1454.70 | 1280.00 | 174.70 | 75.70 |
| 92 | 1.20 | 1559.97 | 1440.00 | 119.97 | 51.99 |
| 93 | 1.60 | 1454.76 | 1200.00 | 254.76 | 110.40 |
| 94 | 2.80 | 1599.88 | 1480.00 | 119.88 | 51.95 |

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| | | | | | |
|-----|-------|---------|---------|--------|--------|
| 95 | 1.20 | 1453.36 | 1360.00 | 93.36 | 40.46 |
| 96 | 3.60 | 1453.28 | 1320.00 | 133.28 | 57.75 |
| 97 | .80 | 1579.99 | 1460.00 | 119.99 | 52.00 |
| 98 | .80 | 1579.99 | 1460.00 | 119.99 | 52.00 |
| 99 | 2.00 | 1305.80 | 1000.00 | 305.80 | 132.51 |
| 100 | 1.20 | 1305.79 | 1080.00 | 225.79 | 97.84 |
| 101 | .00 | 1247.65 | 1020.00 | 227.65 | 98.65 |
| 102 | 17.00 | 1245.50 | 1020.00 | 225.50 | 97.72 |

M A X I M U M A N D M I N I M U M V A L U E S

P R E S S U R E S

| JUNCTION NUMBER | MAXIMUM PRESSURES (psi) | JUNCTION NUMBER | MINIMUM PRESSURES (psi) |
|--------------------|-------------------------------|--------------------|-------------------------------|
| 9 | 165.92 | 73 | 31.27 |
| 83 | 164.67 | 51 | 35.89 |
| 64 | 162.48 | 68 | 40.22 |
| 69 | 149.58 | 71 | 40.34 |
| 67 | 149.50 | 19 | 40.40 |

V E L O C I T I E S

| PIPE NUMBER | MAXIMUM VELOCITY (ft/s) | PIPE NUMBER | MINIMUM VELOCITY (ft/s) |
|----------------|-------------------------------|----------------|-------------------------------|
| 111 | 1.74 | 4 | .00 |
| 14 | 1.06 | 44 | .00 |
| 80 | 1.01 | 93 | .01 |
| 8 | .98 | 27 | .01 |
| 13 | .90 | 48 | .02 |

| VALVE TYPE | POSITION NODE | CONTROLLED PIPE | VALVE SETTING (ft or gpm) | VALVE STATUS | UPSTREAM GRADE (ft) | DOWNSTREAM GRADE (ft) | THROUGH FLOW (gpm) |
|------------|---------------|-----------------|---------------------------|--------------|---------------------|-----------------------|--------------------|
| PRV-2 | 12 | 89 | 1400.00 | BOOSTED | 1308.38 | 1400.00 | 3.50 |
| PRV-2 | 68 | 97 | 1560.00 | BOOSTED | 1452.82 | 1559.98 | 1.20 |
| PRV-2 | 68 | 98 | 1560.00 | BOOSTED | 1452.82 | 1559.98 | 1.60 |
| PRV-2 | 63 | 100 | 1560.00 | BOOSTED | 1454.44 | 1559.97 | 1.20 |
| PRV-2 | 73 | 102 | 1600.00 | BOOSTED | 1454.16 | 1599.88 | 2.80 |
| PRV-2 | 71 | 106 | 1580.00 | BOOSTED | 1453.10 | 1579.99 | .80 |
| PRV-2 | 96 | 105 | 1580.00 | BOOSTED | 1453.28 | 1579.99 | .80 |

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S U M M A R Y O F I N F L O W S A N D O U T F L O W S

- (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
- (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

| PIPE NUMBER | FLOWRATE (gpm) |
|-------------|----------------|
| 1 | 68.46 |
| 41 | 65.60 |
| 42 | 72.04 |
| 59 | .00 |

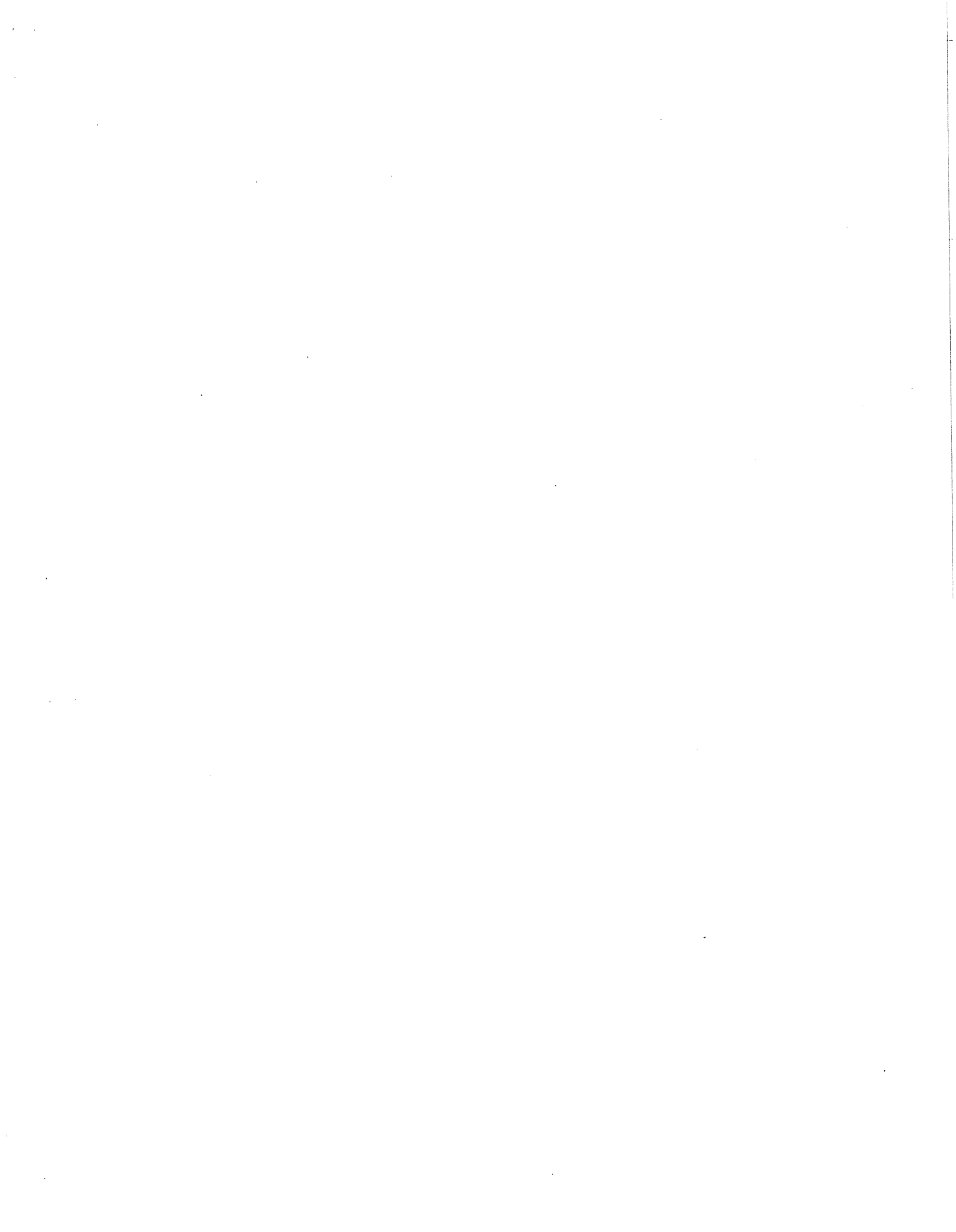
NET SYSTEM INFLOW = 206.10
NET SYSTEM OUTFLOW = .00
NET SYSTEM DEMAND = 206.10

T A N K S T A T U S R E P O R T (time = 1.0000 hours)

| TANK NUMBER (*) | PIPE NUMBER | NET FLOW (gpm) | WATER ELEVATION (ft) | TANK DEPTH (ft) | TANK VOLUME (gal) | TANK VOLUME (%) | TANK STATUS | PROJECTED DEPTH (ft) |
|-----------------|-------------|----------------|----------------------|-----------------|-------------------|-----------------|-------------|----------------------|
| 1-1 | 41 | -65.60 | 1456.23 | 57.23 | 40689. | 88.0 | DRAINING | 51.70 |
| 2-1 | 42 | -72.04 | 1324.59 | 22.59 | 119463. | 80.7 | DRAINING | 21.77 |
| 3-1 | 59 | .00 | 1398.00 | 22.00 | 94233. | 91.7 | | 22.00 |

* TANK TYPE: 1 - CONSTANT DIAMETER 2 - VARIABLE AREA

D A T A C H A N G E S F O R N E X T S I M U L A T I O N



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* * * * * K Y P I P E 2 * * * * *
* University of Kentucky Hydraulic Analysis Program *
* Distribution of Pressure and Flows in Piping Networks *
* 1300 PIPE VERSION - 1.10 (08/25/92) *
* * * * *

DATE: 3/23/2010
TIME: 13: 4:56

INPUT DATA FILENAME ----- DEWITT4.DAT
TABULATED OUTPUT FILENAME ----- DEWITT4.OUT
POSTPROCESSOR RESULTS FILENAME --- DEWITT4.RES

FLUSHING

Pipe III @ Jct 102
28 Gpm in 2" pipe

U N I T S S P E C I F I E D

FLOWRATE = gallons/minute
HEAD (HGL) = feet
PRESSURE = psig
METERED FLOW = gallons

*** GEOMETRIC VERIFICATION (*3*) SUCCESSFUL ***

O U T P U T O P T I O N D A T A

OUTPUT SELECTION: ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT
MAXIMUM AND MINIMUM PRESSURES = 5
MAXIMUM AND MINIMUM VELOCITIES = 5

E P S D A T A

TOTAL TIME FOR SIMULATION = 24.000
NORMAL TIME PERIOD = 1.000

V A R I A B L E H E A D T A N K D A T A

| TANK NUMBER (*) | PIPE NUMBER | MAXIMUM ELEVATION (ft) | MINIMUM ELEVATION (ft) | TANK CAPACITY (gal) | INITIAL VOLUME (gal) | EXTERNAL FLOW (gpm) |
|-----------------------|----------------|------------------------------|------------------------------|---------------------------|----------------------------|---------------------------|
| 1-1 | 41 | 1464.00 | 1399.00 | 46211. | 42657. | .00 |

2-1 42 1330.00 1302.00 148065. 121624. .00

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3-1 59 1400.00 1376.00 102799. 94233. .00

* TANK TYPE: 1 - CONSTANT DIAMETER 2 - VARIABLE AREA

P R E S S U R E S W I T C H D A T A

| REFERENCE PIPE | REFERENCE NODE | SWITCHING GRADES (ft) | | |
|-------------------|-------------------|-----------------------------|---|---------|
| 17 | 62 | 1320.00 | & | 1330.00 |
| 20 | 88 | 1454.00 | & | 1463.00 |
| 60 | 62 | 1310.00 | & | 1330.00 |
| 96 | 88 | 1444.00 | & | 1464.00 |
| 109 | 88 | 1448.00 | & | 1463.00 |

S Y S T E M C O N F I G U R A T I O N

NUMBER OF PIPES (p) = 111
 NUMBER OF JUNCTION NODES (j) = 102
 NUMBER OF PRIMARY LOOPS (l) = -1
 NUMBER OF FIXED GRADE NODES (f) = 11
 NUMBER OF SUPPLY ZONES (z) = 1

D A T A C H A N G E S F O R N E X T S I M U L A T I O N

D E M A N D C H A N G E S

THE FOLLOWING SPECIFIC DEMAND CHANGES ARE MADE :

| JUNCTION NUMBER | DEMAND (gpm) |
|--------------------|-----------------|
| 102 | 28.00 |

 S I M U L A T I O N R E S U L T S

TIME FROM INITIATION OF EPS = .0000 HOURS

THE RESULTS ARE OBTAINED AFTER 5 TRIALS WITH AN ACCURACY = .00017

S I M U L A T I O N D E S C R I P T I O N (L A B E L)

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DEWITT WATER DISTRICT
ROAD FORK AND ALL SIDEROADS
STINKING CK AND SIDE ROADS

P I P E L I N E R E S U L T S

STATUS CODE: XX -CLOSED PIPE FG -FIXED GRADE NODE PU -PUMP LINE
 CV -CHECK VALVE RV -REGULATING VALVE TK -STORAGE TANK

| PIPE NUMBER | NODE NOS. #1 #2 | FLOWRATE (gpm) | HEAD LOSS (ft) | PUMP HEAD (ft) | MINOR LOSS (ft) | LINE VELO. (ft/s) | HL/ 1000 (ft/ft) |
|----------------|-----------------------|-------------------|----------------------|----------------------|-----------------------|-------------------------|------------------------|
| 1-FG | 0 1 | 53.73 | .07 | .00 | .00 | .34 | .07 |
| 2 | 1 2 | 53.73 | .63 | .00 | .00 | .61 | .29 |
| 3 | 18 3 | 8.89 | .63 | .00 | .00 | .23 | .07 |
| 4 | 3 17 | 2.35 | .03 | .00 | .00 | .06 | .01 |
| 5 | 4 5 | 2.35 | .01 | .00 | .00 | .06 | .01 |
| 6 | 5 6 | 1.24 | .01 | .00 | .00 | .03 | .00 |
| 7 | 6 42 | .60 | .00 | .00 | .00 | .02 | .00 |
| 8 | 7 8 | 10.80 | 1.21 | .00 | .00 | .49 | .43 |
| 9 | 8 87 | 6.00 | .59 | .00 | .00 | .15 | .04 |
| 10 | 87 10 | 3.00 | .01 | .00 | .00 | .03 | .00 |
| 11 | 10 20 | .00 | .00 | .00 | .00 | .00 | .00 |
| 12 | 12 99 | 14.31 | .72 | .00 | .00 | .37 | .18 |
| 13 | 12 13 | -17.60 | 1.84 | .00 | .00 | .45 | .26 |
| 14 | 14 74 | 20.83 | 1.15 | .00 | .00 | .53 | .36 |
| 15 | 83 15 | 1.75 | .07 | .00 | .00 | .08 | .01 |
| 16 | 67 16 | 5.80 | .41 | .00 | .00 | .26 | .14 |
| 17-XXPU | 41 26 | | | | | | |
| 18 | 2 18 | 11.79 | .56 | .00 | .00 | .30 | .12 |
| 19 | 40 19 | 3.20 | .05 | .00 | .00 | .08 | .01 |
| 20-XXPU | 11 9 | | | | | | |
| 21 | 4 21 | 12.30 | .11 | .00 | .00 | .14 | .02 |
| 22 | 79 22 | 8.80 | .05 | .00 | .00 | .10 | .01 |
| 23 | 22 38 | 7.90 | .04 | .00 | .00 | .09 | .01 |
| 24 | 38 23 | 6.68 | .02 | .00 | .00 | .08 | .01 |
| 25 | 23 24 | 3.14 | .01 | .00 | .00 | .04 | .00 |
| 26 | 24 25 | 1.44 | .00 | .00 | .00 | .02 | .00 |

| | | | | | | | | |
|----|----|----|-------|-----|-----|-----|-----|-----|
| 27 | 25 | 41 | .64 | .00 | .00 | .00 | .01 | .00 |
| 28 | 26 | 27 | -7.32 | .05 | .00 | .00 | .08 | .01 |
| 29 | 43 | 14 | 25.50 | .19 | .00 | .00 | .29 | .07 |
| 30 | 26 | 28 | 3.50 | .11 | .00 | .00 | .09 | .01 |
| 31 | 28 | 29 | 1.38 | .02 | .00 | .00 | .06 | .01 |
| 32 | 76 | 34 | 1.54 | .01 | .00 | .00 | .04 | .00 |
| 33 | 34 | 35 | 1.01 | .01 | .00 | .00 | .03 | .00 |
| 34 | 24 | 36 | .64 | .00 | .00 | .00 | .02 | .00 |
| 35 | 85 | 30 | 1.10 | .00 | .00 | .00 | .03 | .00 |
| 36 | 38 | 33 | .32 | .00 | .00 | .00 | .01 | .00 |
| 37 | 13 | 37 | 1.06 | .02 | .00 | .00 | .05 | .01 |
| 38 | 21 | 31 | 1.38 | .01 | .00 | .00 | .04 | .00 |
| 39 | 31 | 32 | .74 | .00 | .00 | .00 | .02 | .00 |

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| | | | | | | | | |
|---------|-----|----|--------|-----|-----|-----|-----|-----|
| 40 | 23 | 39 | .48 | .00 | .00 | .00 | .02 | .00 |
| 41-TK | 88 | 0 | -32.80 | .18 | .00 | .00 | .37 | .12 |
| 42-TK | 0 | 62 | 36.02 | .08 | .00 | .00 | .23 | .03 |
| 43 | 70 | 40 | 5.60 | .26 | .00 | .00 | .14 | .03 |
| 44 | 17 | 4 | 2.35 | .00 | .00 | .00 | .06 | .01 |
| 45-XX | 42 | 7 | | | | | | |
| 46 | 62 | 44 | 2.56 | .00 | .00 | .00 | .03 | .00 |
| 47 | 44 | 45 | 1.60 | .00 | .00 | .00 | .02 | .00 |
| 48 | 45 | 46 | .48 | .00 | .00 | .00 | .01 | .00 |
| 49 | 45 | 47 | .32 | .00 | .00 | .00 | .01 | .00 |
| 50 | 44 | 48 | .32 | .00 | .00 | .00 | .01 | .00 |
| 51 | 14 | 49 | 4.03 | .01 | .00 | .00 | .05 | .00 |
| 52 | 49 | 52 | 1.11 | .01 | .00 | .00 | .03 | .00 |
| 53 | 52 | 53 | .53 | .00 | .00 | .00 | .02 | .00 |
| 54 | 49 | 50 | 2.65 | .00 | .00 | .00 | .03 | .00 |
| 55 | 50 | 51 | 1.06 | .00 | .00 | .00 | .03 | .00 |
| 56 | 43 | 27 | 7.96 | .01 | .00 | .00 | .09 | .01 |
| 57 | 101 | 4 | 13.34 | .29 | .00 | .00 | .15 | .02 |
| 58-XX | 46 | 54 | | | | | | |
| 59-TK | 54 | 0 | .00 | .00 | .00 | .00 | .00 | .00 |
| 60-XXPU | 41 | 26 | | | | | | |
| 61 | 4 | 55 | 1.04 | .02 | .00 | .00 | .05 | .00 |
| 62 | 55 | 56 | .32 | .00 | .00 | .00 | .01 | .00 |
| 63 | 55 | 57 | .40 | .00 | .00 | .00 | .02 | .00 |
| 64 | 3 | 58 | 2.90 | .09 | .00 | .00 | .13 | .03 |
| 65 | 58 | 59 | 2.40 | .05 | .00 | .00 | .06 | .01 |
| 66 | 59 | 60 | .80 | .02 | .00 | .00 | .04 | .00 |
| 67 | 3 | 61 | .64 | .01 | .00 | .00 | .03 | .00 |
| 68 | 43 | 62 | -33.46 | .21 | .00 | .00 | .38 | .11 |
| 69 | 91 | 63 | 2.00 | .07 | .00 | .00 | .09 | .02 |
| 70 | 64 | 67 | -5.20 | .01 | .00 | .00 | .06 | .00 |
| 71 | 67 | 69 | -12.20 | .05 | .00 | .00 | .14 | .02 |
| 72 | 69 | 88 | -18.80 | .11 | .00 | .00 | .21 | .04 |
| 73 | 16 | 68 | 5.20 | .19 | .00 | .00 | .13 | .02 |
| 74 | 93 | 73 | 5.60 | .17 | .00 | .00 | .14 | .03 |
| 75 | 67 | 66 | 1.00 | .04 | .00 | .00 | .05 | .00 |

| | | | | | | | | |
|-------|----|----|--------|------|-----|-----|-----|-----|
| 76 | 70 | 96 | 7.00 | .30 | .00 | .00 | .18 | .04 |
| 77 | 40 | 72 | 1.20 | .01 | .00 | .00 | .05 | .01 |
| 78 | 64 | 65 | .60 | .01 | .00 | .00 | .03 | .00 |
| 79 | 88 | 70 | 14.00 | .33 | .00 | .00 | .36 | .15 |
| 80 | 13 | 74 | -19.77 | 1.03 | .00 | .00 | .50 | .29 |
| 81 | 74 | 75 | .53 | .00 | .00 | .00 | .02 | .00 |
| 82-XX | 25 | 76 | | | | | | |
| 83 | 76 | 77 | .53 | .01 | .00 | .00 | .02 | .00 |
| 84 | 35 | 78 | .53 | .00 | .00 | .00 | .01 | .00 |
| 85 | 21 | 79 | 9.86 | .05 | .00 | .00 | .11 | .01 |
| 86 | 79 | 80 | .53 | .00 | .00 | .00 | .02 | .00 |
| 87 | 28 | 81 | .74 | .01 | .00 | .00 | .03 | .00 |
| 88 | 8 | 82 | 1.00 | .02 | .00 | .00 | .05 | .00 |
| 89-RV | 12 | 83 | 1.75 | .00 | .00 | .00 | .08 | .01 |
| 90 | 50 | 84 | .53 | .00 | .00 | .00 | .02 | .00 |
| 91 | 85 | 86 | .53 | .00 | .00 | .00 | .02 | .00 |
| 92 | 23 | 85 | 2.16 | .01 | .00 | .00 | .06 | .00 |
| 93 | 42 | 11 | .60 | .00 | .00 | .00 | .01 | .00 |
| 94 | 9 | 64 | -4.40 | .01 | .00 | .00 | .05 | .00 |

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| | | | | | | | | |
|----------|-----|-----|-------|------|-----|-----|------|-------|
| 95 | 26 | 76 | 2.60 | .03 | .00 | .00 | .07 | .01 |
| 96-XXPU | 11 | 9 | | | | | | |
| 97-RV | 68 | 89 | .60 | .01 | .00 | .00 | .03 | .00 |
| 98-RV | 68 | 90 | .80 | .01 | .00 | .00 | .04 | .00 |
| 99 | 9 | 91 | 2.00 | .06 | .00 | .00 | .09 | .02 |
| 100-RV | 63 | 92 | .60 | .01 | .00 | .00 | .03 | .00 |
| 101 | 69 | 93 | 6.40 | .11 | .00 | .00 | .16 | .04 |
| 102-RV | 73 | 94 | 1.40 | .03 | .00 | .00 | .06 | .01 |
| 103 | 72 | 95 | .60 | .01 | .00 | .00 | .03 | .00 |
| 104 | 96 | 71 | 4.80 | .05 | .00 | .00 | .12 | .02 |
| 105-RV | 96 | 98 | .40 | .00 | .00 | .00 | .02 | .00 |
| 106-RV | 71 | 97 | .40 | .00 | .00 | .00 | .02 | .00 |
| 107 | 99 | 100 | .60 | .00 | .00 | .00 | .03 | .00 |
| 108 | 99 | 7 | 12.71 | .63 | .00 | .00 | .32 | .13 |
| 109-XXPU | 11 | 9 | | | | | | |
| 110 | 2 | 101 | 41.34 | .93 | .00 | .00 | .47 | .16 |
| 111 | 101 | 102 | 28.00 | 5.42 | .00 | .00 | 2.86 | 15.95 |

JUNCTION NODE RESULTS

| JUNCTION NUMBER | JUNCTION TITLE | EXTERNAL DEMAND (gpm) | HYDRAULIC GRADE (ft) | JUNCTION ELEVATION (ft) | PRESSURE HEAD (ft) | JUNCTION PRESSURE (psi) |
|-----------------|----------------|-----------------------|----------------------|-------------------------|--------------------|-------------------------|
| 1 | | .00 | 1249.93 | 1040.00 | 209.93 | 90.97 |
| 2 | | .60 | 1249.30 | 1020.00 | 229.30 | 99.36 |
| 3 | | 3.00 | 1248.11 | 1020.00 | 228.11 | 98.85 |
| 4 | | .00 | 1248.07 | 995.00 | 253.07 | 109.67 |

| | | | | | |
|----|------|---------|---------|--------|--------|
| 5 | 1.11 | 1248.06 | 1040.00 | 208.06 | 90.16 |
| 6 | .64 | 1248.05 | 1010.00 | 238.05 | 103.16 |
| 7 | 1.91 | 1319.16 | 1003.00 | 316.16 | 137.00 |
| 8 | 3.80 | 1317.96 | 1030.00 | 287.96 | 124.78 |
| 9 | 2.40 | 1458.63 | 1072.00 | 386.63 | 167.54 |
| 10 | 3.00 | 1317.35 | 1080.00 | 237.35 | 102.85 |
| 11 | .60 | 1248.05 | 1072.00 | 176.05 | 76.29 |
| 12 | 1.54 | 1320.51 | 1020.00 | 300.51 | 130.22 |
| 13 | 1.11 | 1322.35 | 1041.00 | 281.35 | 121.92 |
| 14 | .64 | 1324.52 | 1040.00 | 284.52 | 123.29 |
| 15 | 1.75 | 1399.93 | 1280.00 | 119.93 | 51.97 |
| 16 | .60 | 1458.25 | 1140.00 | 318.25 | 137.91 |
| 17 | .00 | 1248.07 | 995.00 | 253.07 | 109.67 |
| 18 | 2.90 | 1248.73 | 1030.00 | 218.73 | 94.78 |
| 19 | 3.20 | 1458.17 | 1360.00 | 98.17 | 42.54 |
| 20 | .00 | 1317.35 | 1160.00 | 157.35 | 68.19 |
| 21 | 1.06 | 1247.96 | 1020.00 | 227.96 | 98.78 |
| 22 | .90 | 1247.86 | 1020.00 | 227.86 | 98.74 |
| 23 | .90 | 1247.81 | 1020.00 | 227.81 | 98.72 |
| 24 | 1.06 | 1247.80 | 1040.00 | 207.80 | 90.05 |
| 25 | .80 | 1247.80 | 1040.00 | 207.80 | 90.05 |
| 26 | 1.22 | 1324.65 | 1040.00 | 284.65 | 123.35 |
| 27 | .64 | 1324.70 | 1190.00 | 134.70 | 58.37 |
| 28 | 1.38 | 1324.55 | 1050.00 | 274.55 | 118.97 |
| 29 | 1.38 | 1324.53 | 1060.00 | 264.53 | 114.63 |

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| | | | | | |
|----|------|---------|---------|--------|--------|
| 30 | 1.10 | 1247.79 | 1080.00 | 167.79 | 72.71 |
| 31 | .64 | 1247.95 | 1040.00 | 207.95 | 90.11 |
| 32 | .74 | 1247.95 | 1050.00 | 197.95 | 85.78 |
| 33 | .32 | 1247.82 | 1040.00 | 207.82 | 90.06 |
| 34 | .53 | 1324.61 | 1040.00 | 284.61 | 123.33 |
| 35 | .48 | 1324.60 | 1040.00 | 284.60 | 123.33 |
| 36 | .64 | 1247.80 | 1070.00 | 177.80 | 77.05 |
| 37 | 1.06 | 1322.32 | 1220.00 | 102.32 | 44.34 |
| 38 | .90 | 1247.83 | 1005.00 | 242.83 | 105.22 |
| 39 | .48 | 1247.81 | 1040.00 | 207.81 | 90.05 |
| 40 | 1.20 | 1458.22 | 1260.00 | 198.22 | 85.89 |
| 41 | .64 | 1247.80 | 1040.00 | 207.80 | 90.05 |
| 42 | .00 | 1248.05 | 1000.00 | 248.05 | 107.49 |
| 43 | .00 | 1324.71 | 1057.00 | 267.71 | 116.01 |
| 44 | .64 | 1324.92 | 1070.00 | 254.92 | 110.47 |
| 45 | .80 | 1324.92 | 1080.00 | 244.92 | 106.13 |
| 46 | .48 | 1324.92 | 1180.00 | 144.92 | 62.80 |
| 47 | .32 | 1324.92 | 1120.00 | 204.92 | 88.80 |
| 48 | .32 | 1324.92 | 1080.00 | 244.92 | 106.13 |
| 49 | .27 | 1324.52 | 1080.00 | 244.52 | 105.96 |
| 50 | 1.06 | 1324.51 | 1100.00 | 224.51 | 97.29 |
| 51 | 1.06 | 1324.51 | 1240.00 | 84.51 | 36.62 |
| 52 | .58 | 1324.51 | 1100.00 | 224.51 | 97.29 |
| 53 | .53 | 1324.50 | 1160.00 | 164.50 | 71.29 |

| | | | | | |
|----|------|---------|---------|--------|--------|
| 54 | .00 | 1398.00 | 1300.00 | 98.00 | 42.47 |
| 55 | .32 | 1248.05 | 1000.00 | 248.05 | 107.49 |
| 56 | .32 | 1248.05 | 1080.00 | 168.05 | 72.82 |
| 57 | .40 | 1248.05 | 1000.00 | 248.05 | 107.49 |
| 58 | .50 | 1248.01 | 1010.00 | 238.01 | 103.14 |
| 59 | 1.60 | 1247.96 | 1040.00 | 207.96 | 90.12 |
| 60 | .80 | 1247.94 | 1080.00 | 167.94 | 72.78 |
| 61 | .64 | 1248.09 | 1120.00 | 128.09 | 55.51 |
| 62 | .00 | 1324.92 | 1080.00 | 244.92 | 106.13 |
| 63 | 1.40 | 1458.50 | 1360.00 | 98.50 | 42.69 |
| 64 | .20 | 1458.64 | 1080.00 | 378.64 | 164.08 |
| 65 | .60 | 1458.64 | 1320.00 | 138.64 | 60.08 |
| 66 | 1.00 | 1458.62 | 1240.00 | 218.62 | 94.73 |
| 67 | .20 | 1458.66 | 1110.00 | 348.66 | 151.09 |
| 68 | 3.80 | 1458.06 | 1360.00 | 98.06 | 42.49 |
| 69 | .20 | 1458.71 | 1110.00 | 348.71 | 151.11 |
| 70 | 1.40 | 1458.48 | 1170.00 | 288.48 | 125.01 |
| 71 | 4.40 | 1458.13 | 1360.00 | 98.13 | 42.52 |
| 72 | .60 | 1458.21 | 1280.00 | 178.21 | 77.22 |
| 73 | 4.20 | 1458.43 | 1382.00 | 76.43 | 33.12 |
| 74 | .53 | 1323.38 | 1040.00 | 283.38 | 122.80 |
| 75 | .53 | 1323.37 | 1160.00 | 163.37 | 70.80 |
| 76 | .53 | 1324.62 | 1060.00 | 264.62 | 114.67 |
| 77 | .53 | 1324.62 | 1080.00 | 244.62 | 106.00 |
| 78 | .53 | 1324.60 | 1120.00 | 204.60 | 88.66 |
| 79 | .53 | 1247.91 | 1000.00 | 247.91 | 107.43 |
| 80 | .53 | 1247.91 | 1020.00 | 227.91 | 98.76 |
| 81 | .74 | 1324.54 | 1080.00 | 244.54 | 105.97 |
| 82 | 1.00 | 1317.94 | 1040.00 | 277.94 | 120.44 |
| 83 | .00 | 1400.00 | 1020.00 | 380.00 | 164.67 |
| 84 | .53 | 1324.51 | 1100.00 | 224.51 | 97.29 |

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| | | | | | |
|-----|-------|---------|---------|--------|--------|
| 85 | .53 | 1247.80 | 1080.00 | 167.80 | 72.71 |
| 86 | .53 | 1247.80 | 1060.00 | 187.80 | 81.38 |
| 87 | 3.00 | 1317.37 | 1072.00 | 245.37 | 106.33 |
| 88 | .00 | 1458.82 | 1160.00 | 298.82 | 129.49 |
| 89 | .60 | 1559.99 | 1440.00 | 119.99 | 52.00 |
| 90 | .80 | 1559.99 | 1440.00 | 119.99 | 52.00 |
| 91 | .00 | 1458.57 | 1280.00 | 178.57 | 77.38 |
| 92 | .60 | 1559.99 | 1440.00 | 119.99 | 52.00 |
| 93 | .80 | 1458.59 | 1200.00 | 258.59 | 112.06 |
| 94 | 1.40 | 1599.97 | 1480.00 | 119.97 | 51.99 |
| 95 | .60 | 1458.21 | 1360.00 | 98.21 | 42.56 |
| 96 | 1.80 | 1458.18 | 1320.00 | 138.18 | 59.88 |
| 97 | .40 | 1580.00 | 1460.00 | 120.00 | 52.00 |
| 98 | .40 | 1580.00 | 1460.00 | 120.00 | 52.00 |
| 99 | 1.00 | 1319.79 | 1000.00 | 319.79 | 138.58 |
| 100 | .60 | 1319.79 | 1080.00 | 239.79 | 103.91 |
| 101 | .00 | 1248.36 | 1020.00 | 228.36 | 98.96 |
| 102 | 28.00 | 1242.94 | 1020.00 | 222.94 | 96.61 |

M A X I M U M A N D M I N I M U M V A L U E S

P R E S S U R E S

| JUNCTION NUMBER | MAXIMUM PRESSURES (psi) | JUNCTION NUMBER | MINIMUM PRESSURES (psi) |
|--------------------|-------------------------------|--------------------|-------------------------------|
| 9 | 167.54 | 73 | 33.12 |
| 83 | 164.67 | 51 | 36.62 |
| 64 | 164.08 | 54 | 42.47 |
| 69 | 151.11 | 68 | 42.49 |
| 67 | 151.09 | 71 | 42.52 |

V E L O C I T I E S

| PIPE NUMBER | MAXIMUM VELOCITY (ft/s) | PIPE NUMBER | MINIMUM VELOCITY (ft/s) |
|----------------|-------------------------------|----------------|-------------------------------|
| 111 | 2.86 | 93 | .01 |
| 2 | .61 | 27 | .01 |
| 14 | .53 | 48 | .01 |
| 80 | .50 | 84 | .01 |
| 8 | .49 | 36 | .01 |

R E G U L A T I N G V A L V E R E P O R T

| VALVE POSITION TYPE | CONTROLLED NODE | PIPE | VALVE SETTING (ft or gpm) | VALVE STATUS | UPSTREAM GRADE (ft) | DOWNSTREAM GRADE (ft) | THROUGH FLOW (gpm) |
|------------------------|--------------------|------|---------------------------------|-----------------|---------------------------|-----------------------------|--------------------------|
|------------------------|--------------------|------|---------------------------------|-----------------|---------------------------|-----------------------------|--------------------------|

DATE = 03-23-2010
JOB NAME = 2010000

PAGE NO. 8

| | | | | | | | |
|-------|----|-----|---------|---------|---------|---------|------|
| PRV-2 | 12 | 89 | 1400.00 | BOOSTED | 1320.51 | 1400.00 | 1.75 |
| PRV-2 | 68 | 97 | 1560.00 | BOOSTED | 1458.06 | 1559.99 | .60 |
| PRV-2 | 68 | 98 | 1560.00 | BOOSTED | 1458.06 | 1559.99 | .80 |
| PRV-2 | 63 | 100 | 1560.00 | BOOSTED | 1458.50 | 1559.99 | .60 |
| PRV-2 | 73 | 102 | 1600.00 | BOOSTED | 1458.43 | 1599.97 | 1.40 |
| PRV-2 | 71 | 106 | 1580.00 | BOOSTED | 1458.13 | 1580.00 | .40 |
| PRV-2 | 96 | 105 | 1580.00 | BOOSTED | 1458.18 | 1580.00 | .40 |

S U M M A R Y O F I N F L O W S A N D O U T F L O W S

**PLANS AND SPECIFICATIONS
WARRIORS PATH WATER LINE EXTENSIONS
KNOX COUNTY UTILITY COMMISSION
KNOX COUNTY, KENTUCKY**

RECEIVED

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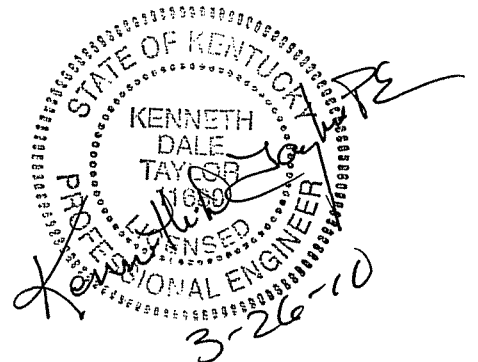
**PUBLIC SERVICE
COMMISSION**

Prepared By:

**Kenvirons, Inc.
452 VERSAILLES ROAD
FRANKFORT, KENTUCKY 40601**

PROJECT NO. 2009045

MARCH 2010



SECTION 15100

WATER LINES

1.0 GENERAL

The Contractor shall furnish all labor, materials, and equipment to install the water lines as shown on the plans and as specified herein.

The water lines may be either pressure-rated plastic pipe (PVC) using the ASTM or AWWA C-900 standard, or ductile iron (DI), all as specified hereinafter and as noted on the plans. The bid documents shall show the amounts of each type and class of pipe to be provided by the Contractor.

The Owner will obtain all rights-of-way for operations through private property. It will also secure building permits and the permits for all pipe laid in highway rights-of-way. Any charges for inspections or other fees required will be the responsibility of the Contractor since the amounts of these are dependent upon the operation of the Contractor.

1.1 KENTUCKY TRANSPORTATION CABINET BONDING

The Kentucky Transportation Cabinet will require that the Owner post a bond for all work accomplished on their right-of-way. Each contract on which work is to be performed will be a separate application and will require a separate bond. Each permit will have conditions attached and these conditions will vary depending on the area where work is to be performed. In areas where traffic control may pose a problem, working hours may be limited. A copy of the encroachment permit will be provided to the Contractor. The Contractor will be responsible for knowledge of the permit's content and conditions in order that the construction may be accomplished in accordance with the specified requirements.

Should any additional bonds or requirements be imposed by the Kentucky Transportation Cabinet, the Owner shall also be responsible for the bonding of the additional requirements.

2.0 MATERIALS

2.1 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

This specification covers rigid, pressure-rated, polyvinyl chloride pipe and fittings, hereinafter called PVC pipe and PVC fittings, for sizes 1/2 inch through 12-inch. Pipe shall be as manufactured by North American Diamond, J-M, or approved equal.

2.1.1 General.

2.1.1.1 Pipe Markings. Depending on the type of PVC pipe being used, the following shall be marked along the length of each joint of pipe: manufacturer's name, nominal pipe size and size base, material code (PVC 1120), dimension ratio or standard dimension ratio, pressure class or rating, production record code, certification seal (NSF logo), and, for C-900 PVC pipe, specification designation (i.e., AWWA C-900).

2.1.1.2 Underground Marking for PVC Pipe. Underground marking for either ASTM or C-900 PVC pipe shall be both of the following types.

2.1.1.2.1 Underground Marking Wire. At all locations where PVC pipe is utilized, a detectable underground marking wire shall be placed in the trench approximately 12-inches above the pipe. The wire used shall be No. 12 insulated copper wire. Extreme care shall be exercised in connecting and taping splices and joints to assure continuity. At each valve box the wire shall be looped to the surface extending 12-inches above the concrete valve box pad (see Std. Dwg. for valve). When the entire project or pipeline segment is complete, including meter installation and leak repairs, the locating wire system shall be checked for continuity.

2.1.1.2.2 Underground Marking Tape. At all locations where PVC pipe is utilized, a detectable underground marking tape shall be placed in the trench approximately twelve inches below the finished grade. The tape used shall be mylar encased aluminum foil with the printing "CAUTION - Buried Water Line Below". Printing shall be readable through the clear mylar and surface printing is not acceptable. Tape size shall be 2 inch width as provided by Lifeguard, Inc. or approved equal. Color of the tape shall be blue.

2.1.2 Polyvinyl Chloride (PVC) Pipe—ASTM Standard.

2.1.2.1 PVC Pipe. PVC pipe shall be extruded from Type 1, Grade 1, polyvinyl chloride material with a hydrostatic design stress of 2,000 psi for water at 73.4°F, designated as PVC 1120, meeting ASTM Specifications D-1784 for material and D-2241 for pipe, latest revisions. Pipe shall also meet all applicable provisions of the Product Standards and shall bear the National Sanitation Foundation (NSF) seal of approval in compliance with NSF Standard No. 14. PVC pipe having a maximum hydrostatic working pressure of 160 psi (SDR-26), 200 psi (SDR-21), 250 psi (SDR-17), or 315 psi (SDR-13.5) shall be used as shown in the Bid Documents and Plans.

Samples of pipe and physical and chemical data sheets shall be submitted to the Engineer for review and determination of compliance with these specifications before pipe is delivered to job. The pipe shall be homogeneous throughout and free from cracks, holes, foreign inclusions or other defects.

The workmanship, pipe dimensions and tolerances, outside diameters, wall thickness, eccentricity, sustained pressures (ASTM D-1598), burst pressures (ASTM D-1599), flattening, extrusion quality (ASTM D-2152), marking and all other requirements of the Product Standard PS 22-70 shall be conformed with in all respects. No pipe, 2 inches in diameter or larger, with a wall thickness less than 0.090 inches may be used.

Pipe shall be furnished in 20 feet or 40 feet lengths. The pipe may be double plain end or with bell on one end. Male ends of pipe must be beveled on the outside. Pipe shall have a ring painted around the male end or ends in such a manner as to allow field checking of setting depth of pipe in the socket. This requirement is made to assist construction superintendents and inspectors in visual inspection of pipe installation.

Pipe must be delivered to job site by means which will adequately support it, and not subject it to undue stresses. In particular, the load shall be so supported that the bottom rows of pipe are not damaged by crushing. Pipe shall be unloaded carefully and strung or stored as close to the final point of placement as is practical. Pipe must not be exposed to the direct rays of the sun for an extended period of time. If pipe is not to be installed shortly after delivery to the job site, it must be stored in a shaded location and strung as needed.

2.1.2.2 PVC Pipe Jointing. Pipe shall be joined with slip-type joints with rubber gaskets. Pipes with bells shall have all parts of the bell, including the gasket groove, made from the same extruded piece, integral with the pipe, and shall be thickened to meet standard dimension ratios of wall thickness to outside diameter. This manufacturing procedure shall be the normal practice of the pipe manufacturer and proven by past performance of pipe in service. The gasket groove shall be constructed such that gasket rollout will not occur. Rubber gasketing shall conform to ASTM D-3139.

Joint lubricant shall be of a type recommended by the manufacturer for their pipe subject to the Engineer approval. Lubricant shall be water soluble, non-toxic and have no objectionable properties.

Due to special requirements for special gaskets for use within 200 feet of underground fuel tanks, gas lines, and/or oil transport lines, PVC pipe shall not be used under these circumstances.

2.1.2.3 PVC Couplings. Where PVC couplings are used, they shall be of the same material as the pipe and may be of the moulded, or extruded type. PVC couplings shall have a minimum rating of 200 psi for continuous operation at 73.4 degrees F.

2.1.2.4 Fittings Ductile iron mechanical joint fittings with appropriate adapter as manufactured by Tyler, U.S. Pipe, Clow, Union Foundry or approved equal,

shall be used with PVC pipe. All such fittings shall be approved by the pipe manufacturer, and complete data sent to the Engineer, including the manufacturer's approval, for review. Fittings shall comply with AWWA C-110 or C-153 and shall be manufactured for the size and pressure class of the line on which they are used. Use of transition gaskets will not be allowed unless specifically approved by the pipe manufacturer. Coatings and lining shall be in accordance with section 2.2.7 of the Specifications.

2.1.2.5 Service Connections. All service connections on PVC lines shall be made by means of tees, factory tapped couplings, or bronze service clamps, manufactured specifically for use with PVC pipe as manufactured by Ford or approved equal, and appropriate corporation stop. Whenever possible, corporation steps shall be installed in plastic lines before conducting hydrostatic tests.

2.1.3 Polyvinyl Chloride (PVC) Pipe—AWWA C-900 Standard.

This specification covers the requirements for AWWA approved Polyvinyl Chloride Pressure Pipe for water supply and distribution systems.

2.1.3.1 PVC Pipe—AWWA C-900 Standard. PVC pipe shall meet the requirements of AWWA C-900 or C-905, latest revision and shall be furnished in cast-iron pipe equivalent outside diameters with rubber gasketed joints.

C-900 PVC pipe shall be made from Class 12454-A or Class 12454-B virgin compounds as defined in ASTM D-1784. The standard code designation shall be PVC 1120. The PVC compounds shall be tested and certified as suitable for potable water products by the NSF Testing Laboratory and shall carry the NSF approval marking.

Solvent-cement couplings or joints shall not be used. PVC joints using elastomeric gaskets shall be tested as assembled joints and shall meet the laboratory performance requirements specified in ASTM D-3139.

Pipe shall be DR (Dimension Ratio) 18, or DR 14 as shown on the plans or the bid form.

Pipe and couplings shall meet or exceed the following test requirements:

Hydrostatic Integrity - Each standard and random length of pipe shall be proof-tested at four times its rated class pressure for a minimum of 5 seconds. Bells or couplings shall be tested with pipe. The pipe and couplings shall further meet or exceed the pressure test requirements of ASTM D-1598 and D-1599.

Flattening - The pipe shall not split, crack, or break when tested by the parallel-plato method as specified by ASTM D- 2241.

Extrusion quality - The pipe shall not flake or disintegrate when tested by the acetone-immersion method as specified in ASTM D-2241.

Standard length - Pipe shall be furnished in standard laying lengths of 20 ft. \pm 1 in. A maximum of 15 percent of each pipe size may be furnished in random lengths of not less than 10 ft. each.

2.1.3.2 C-900 PVC Pipe Jointing. Pipe shall be joined with slip-type joints with rubber gaskets. Manufacturing and installation procedures shall be as recommended by the manufacturer and as described for PVC pipe in section 2.1.2 of this specification.

2.1.3.3 Fittings. Fittings for municipal PVC shall be ductile iron only. Fittings shall be mechanical joint. Fittings shall be manufactured for the size and pressure class of the line on which they are used and shall comply with AWWA C-110 or C-153. Coatings and lining shall be in accordance with section 2.2.7 of the Specifications. Fittings shall be as manufactured by Tyler, Clow, U.S. Pipe, Union Foundry or approved equal.

2.1.3.4 Service Connections. Service connections shall be made by means of bronze service clamps manufactured specifically for use with C-900 PVC pipe and appropriate corporation stops. Clamps shall be Mueller Catalog No. H-161 or approved equal.

2.2 DUCTILE IRON PIPE

These specifications cover ductile iron pipe (3-inch diameter and greater) to be used in water transmission systems with mechanical joints, rubber ring slip type joints or flanged joints.

2.2.1 General. Ductile iron pipe shall be designed in accordance with AWWA and for pressures and conditions as stated in these specifications or called for on the plans. Ductile iron pipe shall conform to AWWA C-151.

2.2.2 Minimum Nominal Thickness. The specified thickness will be determined for the given internal and external loading requirements in accordance with AWWA C-150. The class of pipe, wall thickness, and coatings required will be shown on the plans or the bid form and/or as specified herein for all ductile iron pipe installation.

2.2.3 River Crossing Pipe. River crossing pipe shall be ductile iron, Flex-Lok as manufactured by the American Cast Iron Pipe company or equal conforming to the appropriate requirements of AWWA C150/ANSI A21.50 and AWWA C151/ANSI A21.5 with a minimum thickness class of 54.

2.2.4 Lengths. Pipe may be furnished in 12, 16, 16 1/2, 18 or 20 feet nominal laying lengths.

2.2.5 Marking. The net weight, class or nominal thickness and sampling period shall be marked on each pipe.

2.2.6 Pipe Joints for Ductile Iron Pipe. Joints for buried pipe shall be either mechanical joint or push-on joint conforming to the requirements of AWWA C-111. Mechanical joint bolts and nuts shall be the low-alloy steel type conforming to AWWA C-111.

Interior piping of vaults, plants, etc. shall be supplied with flanged joints meeting the requirements of AWWA C-115. Special joints, such as the "locked" or "restrained" type, shall be as shown on the plans and/or called for in the bid schedule.

Gaskets resistant to hydrocarbon penetration shall be used within 200 feet of underground fuel tanks, gas lines, and/or oil transport lines. The gaskets shall be approved by the Engineer.

2.2.7 Coatings and Lining. All buried ductile iron pipe shall have manufacturer's outside coal tar or asphaltic base coating and a cement lining and bituminous seal coat on the inside. Cement mortar lining and a bituminous seal coat inside shall conform to AWWA C-104 latest revision.

Where specifically called for on the plans, pipe and fittings housed and in vaults shall be lined and coated on the inside as specified herein for buried ductile iron pipe and fittings, but shall be left uncoated on the outside so that it may be painted without the use of tar stop.

2.2.8 Fittings for Ductile Iron Pipe. Ductile iron mechanical, push-on and flanged joints shall conform to AWWA C-110 for centrifugally cast iron water pipe. Mechanical joints shall also conform in all respects to AWWA C-111. All fittings shall be manufactured for the size and pressure class of the pipeline in which they are to be used. All fittings shall be furnished complete with all joint accessories. All ductile iron pipe fittings for water, sewer, air, gas and force main service shall be coated outside and lined on the inside the same as the line on which they are installed.

3.0 EXECUTION

3.1 HAULING AND STORAGE

The Contractor shall notify the Engineer when pipe will be received on the job so that proper arrangements may be made for inspecting the unloading and stringing, as well as inspecting and examining the pipe materials.

All pipe shall be covered with tarpaulin during hauling from the manufacturer to the job site. It is acceptable for the front end only to be covered. The intent is to prevent diesel exhaust residue from coating the pipe and/or contaminating the gaskets.

Care must be exercised in the handling of all materials and equipment. The Contractor will be held responsible for all breakage or damage to items caused by his workmen, agents, or appliances for handling or moving. Pipes and other castings shall in no case be thrown or dropped from cars, trucks, or wagons to the ground, but shall be lowered gently and not allowed to roll against or strike other castings and unyielding objects violently.

Valves, castings, fabricated metal, reinforcing steel, etc. shall be yarded or housed in some convenient location by the Contractor and delivered at the construction site as required. All equipment and materials subject to damage from the weather, dampness, changes in temperature, or exposure shall be protected by a dry, weatherproof enclosure until ready for installation or use. The cost of all hauling, handling, and storage shall be included in the prices bid for equipment and materials in place. The Owner takes no risk or responsibility for fire, flood, theft, or damage until after the final acceptance of the work.

3.2 LINES AND GRADES

The Contractor will be required to accomplish any detailed layout, including that required for establishing the grade of the pipe line.

3.3 TRENCH EXCAVATION

3.3.1 General. This section describes the acceptable methods of trenching for the installation of pressure pipe and casing pipe in an open trench.

Trenching may be accomplished by means of a backhoe, trenching machine or by hand depending on the construction area.

At the Contractor's option, trenching, by a trenching machine or by backhoe is acceptable except as noted below:

Where the pipe line is being constructed close to other utilities, structures, building, or large trees, and it is reasonable to anticipate possible damage from the use of a backhoe, then trenching shall be made by hand methods.

The Contractor shall include in his unit price bid, all trenching necessary for installation of all pipelines as planned and specified. Trenching shall include all clearing and grubbing, including all weeds, briars, trees, stumps, etc. encountered in the trenching. The Contractor shall dispose of any such material by burning, burial, or hauling away (or as noted on the drawings), at no extra cost

to the Owner. It shall be the Contractor's responsibility to notify the appropriate State and local Air Pollution Control agencies when he conducts open burning of refuse. Ornamental shrubs shall be removed, protected, and replanted. Trenching also includes such items as minor street, road, sidewalk, pipe and small creek crossings, and cutting, moving or repairing damage to fences, poles, gates and/or other surface structures regardless of whether shown on the plans.

The Contractor shall protect existing facilities against danger or damage while pipeline is being constructed and backfilled, or from damage due to settlement of this backfill. In case of damage to any existing structures, repair and restoration shall be made at once and backfill shall not be replaced until this is done. In all cases, restoration and repair shall be such that the damaged structures will be in as good condition and serve its purpose as completely as before and such restoration and repair shall be done without extra cost to the Owner. The use of trench-digging machinery will be permitted except where its operations will cause damage to trees, buildings or existing structures above or below the ground. At such locations hand methods shall be employed to avoid such damage. All excavated material shall be piled in a manner that will not endanger the work and will avoid obstructing sidewalks and driveways. Gutters shall be kept clear or other satisfactory provisions made for street drainage.

All excavation shall be open trenches, except where the drawings call for tunnelling, boring, or jacking under structures, railroads, sidewalks and roads. The construction procedure for these types of excavation is described elsewhere in these specifications.

All trench excavation shall be termed unclassified and costs shall be included in the unit price bid for the pipe.

3.3.2 Clearing. The Contractor shall accomplish all clearing and/or grubbing as required for the construction under this contract. Clearing and grubbing shall include the cutting and removal of trees, stumps, brush, roots, logs, fences and other loose or projecting material and natural obstructions which, in the opinion of the Engineer, must be removed to properly construct and operate the facilities. Ornamental shrubs, plantings, fences, walls, etc. shall be removed and replanted or replaced or protected from the construction activity. Clearing and/or grubbing shall be incidental to the various bid items and no additional compensation will be paid for same.

3.3.3 Trench Depth. Trenches shall be excavated to the line and grade required for the installation of pipe at the elevations indicated on the plans. The minimum depth of cover shall be 30 inches above the top of the pipe, unless shown otherwise on the plans or on the Standard Details. When the pipe is laying in or on solid rock, the minimum depth of cover shall also be 30 inches above the top of the pipe. No additional compensation will be made for extra depth where required by the plans or due to Contractor error. Excavation, except as required

for exploration, shall not begin until the proposed work has been staked out. Materials which are not required for backfill and site grading shall be removed and disposed of as directed by the Engineer. Hauling, bedding, and backfilling shall be considered incidental to the various bid items and will not be paid for directly. Excavation shall be of sufficient depth to allow the piping to be laid on the standard pipe bedding in accordance with the section 3.4. The trenches shall be excavated to a minimum of six inches below the bottom of the pipe barrel in rock. In all cases where lines are under traffic a minimum cover of forty-two inches (42") shall be provided. Should it be necessary to avoid existing utilities, culverts, outlets, or other structures, the water line shall be carried deeper at no additional expense to the Owner.

Where the plans call for extra trench depth, this extra depth shall be provided at no extra cost.

3.3.4 Trench Width. Trench widths shall exceed the minimum width that will provide free working space on each side of the pipe and to permit proper backfilling around the pipe as shown in the accompanying table and unless specifically authorized by the Engineer, shall not be excavated to wider than two feet (2') plus the nominal diameter of the pipe at the top of the trench. Before laying the pipe, the trench shall be opened far enough ahead to reveal any obstruction that may necessitate changing the line and grade of the pipe. Should the Contractor fail to accomplish this, and changes are required, they shall be at his sole expense. In rock, all ledge rocks, boulders and large stones shall be removed to provide six inches (6") of clearance on each side and below all pipe and fittings.

Minimum Trench Width

| Size | Width |
|---------------|-------|
| Up to 4" Pipe | 1'-6" |
| 6" Pipe | 2'-0" |
| 8" Pipe | 2'-0" |
| 10" Pipe | 2'-4" |
| 12" Pipe | 2'-6" |
| 14" Pipe | 2'-6" |

| Size | Width |
|----------|-------|
| 15" Pipe | 2'-8" |
| 16" Pipe | 2'-8" |
| 18" Pipe | 3'-0" |
| 20" Pipe | 3'-2" |
| 21" Pipe | 3'-4" |
| 24" Pipe | 3'-8" |

3.3.5 Shoring, Sheet piling, and Bracing of Excavation. Where unstable material is encountered, or where the depth of the excavation in earth exceeds five feet (5'), the sides of the trench or excavation shall be supported by substantial sheet piling, bracing, or shoring. The design and installation of all sheet piling, sheet piling, bracing or shoring shall be based on computations of pressure exerted by the materials to be retained under retaining conditions. Adequate and proper shoring of all excavations will be the entire responsibility of the Contractor. The

Standards of the Federal Occupational Safety and Health Act and the Kentucky Department of Labor shall be followed.

The Engineer will not be responsible for determining requirements for bracing or sheeting.

3.3.6 Removal of Water. The Contractor shall provide for adequate removal of all water and the prevention of surface water from entering the excavation. The Contractor shall maintain dry conditions within the excavations until the backfill is placed. No additional compensation will be paid for replacement and/or stabilization of prepared excavations due to flooding and/or deterioration from extended exposure. All water pumped or drained from the excavation shall be disposed of in a suitable manner without damage to adjacent property or to other work under construction.

3.3.7 Pavement Removal. Pavement removal shall be as indicated on the plans or directed by the Engineer. When so required, or when directed by the Engineer, only one-half (1/2) of the street crossings or road crossings shall be excavated before placing temporary bridges over the side excavated, for the convenience of the traveling public. All backfilled ditches shall be maintained in such a manner that they will offer no hazard to the passage of traffic. The convenience of the traveling public and the property Owners abutting the improvements shall be taken into consideration. All public or private drives shall be promptly backfilled or bridged at the direction of the Engineer. Pavement replacement shall be in accordance with Section 02405 of these specifications. Excavated materials shall be disposed of so as to cause the least interference and in every case the disposition of excavated materials shall be satisfactory to the Engineer.

3.3.8 Traffic Maintenance. The Contractor shall be held responsible for any damage that may occur to persons or property by reason of the failure of the Contractor to properly guard and flag all open trenches or obstructions along the routes of the water lines. The Contractor at his own expense shall maintain warning signs, barricades and watchmen or flag men to control traffic at such times as his work would interfere with the flow of traffic. No excavation shall begin that may present a safety hazard unless the signs, barricades, lights, etc. are available to protect the open excavation at the conclusion of the day. The Contractor will comply with all Federal and State Occupational Safety and Health requirements for this type of construction. The Contractor shall also comply with all local and Kentucky Department of Highways requirements for signing and traffic control.

3.3.9 Line Location. The location of pipelines and their appurtenances as shown are those intended for the final construction. However, conditions may present themselves before construction on any line is started that would indicate desirable changes in location. In such cases, the Owner reserves the right to

make reasonable changes in line and structure locations without extra cost, except as may be determined by extra units of materials and construction actually involved. The Owner is under no obligation to locate pipelines so they can be excavated by machine.

3.4 BEDDING OF PIPELINE

In all cases the foundation for pipe shall be prepared so that the entire load of the backfill on top of the pipe will be carried uniformly on the barrel of the pipe. The bells of the pipe shall not carry any of the load of the backfill. The Contractor should refer to the Standard Details for pipe bedding shown in the plans. The bedding specifications shall govern the backfill from the bottom of the trench up to the centerline or spring line of the pipe.

All ductile iron pipe shall be installed in accordance with Standard ANSI/AWWA C150-A21.50 Laying Condition Type 3 unless otherwise noted.

3.4.1 Stable Earth Foundation. On all PVC pipelines, the trench bottoms shall be smooth and free of frozen material, clodded dirt and stones over 1/2" diameter. Bottom dirt left by trenching equipment will usually provide adequate material to level the trench bottom and provide bedding support for the pipe barrel. If the trench bottom is free of dirt, soft material may be shoveled off the side walls or shoveled under the pipe to insure proper pipe barrel bedding. In areas where the trench bottom is hard, a layer of soft backfill must be provided to insure the pipe barrel is properly cushioned. See the plans for proper bedding material depth.

If the foundation is good firm earth the pipe may be laid directly on the undisturbed earth provided the pipe barrel is supported for its full length.

Bedding of No. 9 stone, fine gravel, sand or compacted finely graded select earth shall be used to correct irregularities in the subgrade.

As an alternative to the above method, excavation may be undercut to a depth below the required invert elevation that will permit laying the pipe on a bed of granular material or finely graded select earth to provide continuous support for the pipe barrel. Bedding depth shall be as shown on the plans.

The bedding is not a separate pay item and shall be included as incidental expense in the unit price for the pipe bid per foot of pipe.

3.4.2 Trenches In Rock. All installation in rock will utilize the undercutting method. Bedding will be with 6 inches crushed stone or suitable earth material.

3.4.3 Unstable Trenches. If unstable material is encountered which may not provide a suitable foundation for the pipe, the unstable material will be removed

and an adequate layer of encasement concrete or other special bedding shall be placed for the pipe foundation in accordance with the Standard Details in the plans. Such "special pipe foundation" shall only be installed if directed by the Engineer in writing or on the plans.

3.5 PIPE LAYING

3.5.1 General. Proper instruments, tools and facilities satisfactory to the Engineer shall be provided and used by the Contractor for the safe and convenient prosecution of the work. Each pipe manufacturer shall have an experienced representative on the job for at least one day at the commencement of jointing and laying operations.

Before any length of pipe is placed in the trench, a careful inspection shall be made of the interior of the pipe to see that no foreign material is in the pipe. In order to properly remove any foreign materials, a swab of necessary length is to be available at all times.

All pipe shall be lowered carefully into the trench, properly aligned and properly jointed by use of suitable tools and equipment, in such a manner as to prevent damage to water line materials and protective coatings and linings. Excessive scratching of the exterior surface of the pipe will be cause for rejection of the pipe.

Under no circumstances shall pipeline materials be dropped or dumped into the trench. The pipe and fittings shall also be inspected for the purpose of determining if they are sound and free from cracks. Laying of pipe shall be commenced immediately after excavation is started. Pipe shall be laid with bell ends facing in the direction of laying.

When pipe laying is not in progress, the open ends of pipe shall be closed by approved means to prevent entrance of trench water into the line. Whenever water is excluded from the interior of the pipe, adequate backfill shall be deposited on the pipe to prevent floating. Any pipe which has floated shall be removed from the trench and relaid as directed by the Engineer. No pipe shall be laid in water or on frozen trench bottom, or whenever the trench conditions or the weather are unsuitable for such work.

If any defective pipe and fittings shall be discovered after the pipeline is laid, they shall be removed and replaced with a satisfactory pipe or fitting without additional charge to the Owner. Open ends of unfinished pipe lines shall be securely plugged or closed at the end of each day's work or when the line is left temporarily at any other time.

3.5.2 Laying Ductile Iron Pipe. Ductile iron pipe shall first be thoroughly cleaned at joints, then joined according to instructions and with tools

recommended by the manufacturer. Three (3) copies of instructions shall be furnished to the Engineer and one (1) copy shall be available at all times at the site of the work. The lining inside ductile iron pipe must not be damaged by handling.

All pipes must be forced and held together, or "homed" at the joints, before sealing or bolting. Pipe must be aligned as each joint is placed, so as to present as nearly true, straight lines and grades as is practical, and all curves and changes in grades must be laid in such a manner that the manufacturer's recommended maximum deflection is not exceeded at any joint.

Cutting of pipe may be done by wheeled pipe cutters or saws as the Contractor may elect, but the Contractor will be held responsible for breakage or damage caused by careless cutting or handling.

All ductile iron pipe shall be installed per AWWA C150 Laying Condition Type 3 unless otherwise noted, six inches (6") crushed stone bedding or suitable earth shall be used in rock. No pipe shall be laid resting on rock, blocking, or other unyielding objects. Jointing before placing in trench, and subsequent lowering of more than one section jointed together may be allowed, subject to the Engineer approval and direction.

When using pipe with push-on joints care must be exercised to make certain that the correct gasket is being used for the type of joint installed and that the gasket faces the proper direction. Before inserting the gasket, the groove and bell socket should be carefully cleaned of all dirt. If sand or dirt is permitted to remain in the groove, leaks may occur. Lubricant must be applied to bell socket, gasket and plain-end of pipe as required by manufacturer. Plain-end must be beveled before joint is made. Deflection required at the joint shall be obtained after the joint is made.

3.5.3 Laying Plastic Pipe. The trench bottom must be smooth and uniform and the alignment must conform with the plans. Bedding and cover as specified herein and shown in the Standard Details is required.

To make a clean and unobstructed joint, it is necessary to wipe the ring, groove and pipe spigot free from all foreign materials at the time of assembly. The ring must be positioned properly in the fitting to receive the pipe by a worker who is not in contact with the lubricant. In general, the lubricant is applied to the spigot (not the ring or groove). However, the manufacturer's instructions are to be followed in all cases. Only an approved lubricant may be used in accordance with the manufacturer's recommendations. All plastic pipe shall be joined by hand.

Where good bedding conditions are obtained PVC pipe smaller than 4 inches may be assembled outside the trench in longer sections (as conditions allow) and

then lowered into the trench. At any time when improper bedding is discovered or the pipe is severely deflected the pipe will be removed from the trench and the condition corrected. Pipe in sizes 4 inch and above may be assembled outside the trench but must be lowered into the trench as each joint is assembled. Regardless of installation methods all joints must be inspected after laying in trench for proper insertion and alignment. Field cuts and bevels will be allowed in accordance with the manufacturer's recommendations for these operations. A new reference mark shall be installed before joining any field cut pipe. The same requirements for clearance from rock or other objects, thrust blocking and deflections shall apply to PVC pipe as for other pipe materials.

C-900 PVC pipe of all sizes must be assembled in the trench in strict accordance with the manufacturer's requirements.

3.5.4 Installation of River Crossing Pipe. The ball joint pipe shall be assembled and installed in accordance with manufacturer's recommendations. Installation shall be made at time of low flow, using cofferdams as necessary to divert stream flow. The ball joint pipe shall be laid and allowed to settle before joining to the pipe on each side of the stream. The ball and joint pipes shall be tested separately once in place to detect any leaks or bad joints. After connecting to the land pipe, it shall be tested the same as specified for the other water mains. See the Drawings for additional installation requirements.

3.6 BACKFILLING

Backfilling must be started as soon as practicable after pipe has been laid. The ENGINEER shall be given a minimum of 8 hours for inspection before backfilling. The backfill shall be crushed rock, sand, or finely divided earth free from debris, organic material and stones, places simultaneously on both sides of pipe to the same level by hand.

In backfilling of the lower part of the trench beginning at the top of the bedding, the backfill material shall be carefully selected and walked-in around the pipe in 6" layers to a point 8 inches higher than the top of the pipe. The filling of the trench and the tamping of the backfill shall be carried on simultaneously on both sides of the pipe in such a manner that the completed pipe line will not be disturbed and injurious side pressures do not occur.

After the above specified backfill is hand placed, rock may be used in the backfill in pieces no larger than 18 inches in any dimension and to an extent not greater than one-half (1/2) the backfill materials used. If additional earth is required, it must be obtained and placed by the Contractor. Filling with rock and earth shall proceed simultaneously, in order that all voids between rocks may be filled with earth. Above the hand placed backfill, machine backfilling may be employed without tamping, (if not contrary to specified conditions for the location) provided caution is used in quantity per dump and uniformity of level of backfilling. Backfill

material must be uniformly ridged over trench and excess hauled away, with no excavated rock over 1-1/2 inch in diameter or pockets of crushed rock or gravel in top 6 inches of backfill. Ridged backfill shall be confined to the width of the trench and not allowed to overlap onto firm original earth and its height shall not be in excess of needs for replacement of settlement of backfill. All rock, including crushed rock or gravel from construction, must be removed from yards and fields. Streets, roadways and walks shall be swept to remove all earth and loose rock immediately following backfilling.

In the case of street, highway, railroad, sidewalk and driveway crossings or within any roadway paving or about manholes, valve and meter boxes, the backfill must be machine tamped in not over 4-inch layers, measured loose in accordance with the standard details. Where backfill is under paved driveways, streets, highways, railroads, sidewalks, paved parking areas and other areas where settlement is not allowed, crushed stone or coarse sand backfill only shall be used up to the paving surface. Crushed stone shall be Kentucky Department of Highways Standard Specification No. 57. Coarse sand backfill shall be spread in layers not over 4 inches thick and thoroughly compacted. Sand may be moistened to aide compaction. Tunnels shall be backfilled in not over 3-inch layers, measured loose, with selected material suitable for mechanically tamping. If material suitable for tamping cannot be obtained, sand, gravel or crushed rock shall be blown, packed or sluiced to complete fill all void spaces.

Where local conditions permit, pavement shall not be placed until 30 days have passed since placing backfill. Crushed stone is specified for roads and parking areas and sidewalks or their bases, shall be placed and compacted to the top of trench. Backfills shall be maintained easily passable to traffic at original ground level, until acceptance of project or replacement of paving or sidewalks.

Where the final surfacing is to be crushed stone, compacted earth backfill may be used in the trench to within 6 inches of the top as shown in the Standard Details.

The Kentucky Transportation Cabinet requires that water and sewer lines—when placed within the limits of the roadway embankment and/or beneath the roadway itself—be backfilled with sand, limestone sand (11's or smaller), or "flowable fill" as defined by Section 601.03.03.B(5) of their "Standard Specifications for Road and Bridge Construction". The Cabinet typically requires that sand, limestone sand, or flowable fill be used to backfill the trench and/or bore pit up to the subgrade elevation and extending to the outside edge of the shoulder.

Railroad Company and Highway Department requirements in regard to backfilling will take precedence over the above general specification where they are involved.

The Contractor shall protect all sewer, gas, electric, telephone, water and drain pipes or conduits, power and telephone poles and guy wires from danger of damage while pipelines are being constructed and backfilled, or from danger due to settlement of his backfill.

In case of damage to any such existing structures, repair and restoration shall be made at once and backfill shall not be replaced until this is done. In all cases, restoration and repair shall be such that the damaged structure will be in as good condition and serve its purpose as completely as before uncovering and such restoration and repair shall be done without extra charge.

No extra charge shall be made for backfilling of any kind, except as provided in the Bid. Backfilling shall be included as a part of the unit price bid for which it is subsidiary. No extra charge shall be made for supplying outside materials for backfill.

Before completion of contract, all backfills shall be reshaped, holes filled and surplus material hauled away, and all permanent walks, street, driveway and highway paving, and sod, replaced and reseeding performed.

The line Contractor shall be responsible for clean-up, grading, seeding, sodding or otherwise restoring all areas that he disturbs.

Any deficiency in the quantity of material for backfilling the trenches or for filling depressions caused by settlement, shall be supplied by the Contractor.

3.7 TIE-INS TO EXISTING PIPELINES

This work shall consist of connecting new water pipes to the existing system where shown on the plans and shall include the necessary fittings, tapping sleeves, valves and necessary equipment and material required to complete the connection.

Knowledge of pipe sizes in the existing system may not be accurate, therefore, it is recommended that the Contractor check outside diameters of existing pipe and types of pipe prior to ordering the required accessories. No additional payment will be allowed for matching pipe and/or accessories when the proper size is not ordered.

Neither the Owner nor the Engineer can guarantee the location of the existing lines. The Contractor shall verify the location of all existing water mains and valves pertaining to the proposed improvements before excavation is started.

The necessary regulation or operation of the valves on existing mains, to allow for the connections being made, shall be supervised by the Engineer. Before shutting down an existing water main or branch main for a proposed connection,

prior approval for a specific time and time interval shall be obtained from a representative of the Owner. At no time shall an existing main be shut down without the Owner's knowledge and permission.

Excavation to existing water mains shall be carefully made, care being exercised not to damage the pipe. The excavation shall not be of excessive size or depth beneath the pipe. The sides of the excavation shall be as nearly vertical as possible.

The Contractor shall be responsible for any damage to the existing system and any such damage shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

The Contractor shall verify, by field inspection, the necessary sizes, lengths and the types of fittings needed for each inter-connection. Typical connections are shown on the plans and any modifications or changes shall be subject to the approval of the Engineer. The exact length of the proposed water main needed for this work shall also be determined by field measurement as required.

The probing required to locate existing mains is not a separate pay item.

3.8 PIPE ENTERING STRUCTURES

Ductile iron, steel or PVC pressure pipe, 4-inch diameter or larger, entering structure below original earth level, unsupported by original earth for a distance of more than six feet (6'), shall be supported by #57 crushed stone. Costs for the support shall be included in the unit price for the pipe.

3.9 OWNERSHIP OF OLD MATERIALS

Pipe – Unless otherwise indicated, all existing pipe that is to be abandoned that interferes with construction or is easily removed shall become the property of the Contractor. All pipe that is not easily removed or not required to be removed as a result of the new construction, shall be abandoned in place by this Contractor.

Pipe Line Fittings and Appurtenances – All pipe line fittings, valves, hydrants and other like appurtenances that are removed as a result of new construction shall be removed by this Contractor but shall become the property of the Owner. All such fittings and appurtenances shall be delivered to a point by the Contractor. Said point shall be on the Owner's property and shall be designated by the Engineer.

Other Materials – All other materials or items that are to be removed, demolished, or abandoned as a part of this contract shall become the property of the Contractor and shall be disposed of by him.

3.10 THRUST BLOCKS AND ANCHORAGE

Thrust blocks shall be installed whenever the pipe line changes direction, as at tees, bends, crosses, stops, as at a dead end; or at valves. The locations of thrust blocks depend on the direction of thrust and type of fitting. Their size and type depends on pressure, pipe size, kind of soil, and the type of fitting. Where thrusts act upward (as at vertical curves) the weight of the pipe, the water in the pipe and the weight of the soil over the pipe should be determined to make certain that the total weight is sufficient to resist upward movement. If there is not enough soil or if it will not compact over the pipe or it is too soft to resist movement, then ballast or concrete may be placed around the pipe in sufficient weight and volume to counteract the thrust. Where a fitting is used to make a vertical bend, the fitting may be anchored to a concrete thrust block designed to key in to undisturbed soil and to have enough weight to resist upward and outward thrust, since the newplaced backfill may not have sufficient holding power.

Thrust blocks shall be constructed of not less than Class B concrete conforming to KTC Specification 601 and placed between the fitting and the trench wall. It is important to place the concrete so it extends to undisturbed (freshly cut) trench wall.

3.11 MAINTENANCE OF FLOW OF DRAINS AND SEWERS

Adequate provision shall be made for the flow of sewers, drains and water courses encountered during construction. Any structures which are disturbed shall be satisfactorily restored by the Contractor.

3.12 INTERRUPTION OF UTILITY SERVICES

No valve, switch or other control on any existing utility system shall be operated for any purpose by the Contractor without approval of the Engineer and the Utility. All consumers affected by such operations shall be notified by the Contractor as directed by the Engineer and utility before the operation and advised of the probable time when service will be restored.

3.13 FENCING

Where water supply line is being constructed in fields where stock is being grazed, Contractor shall provide temporary fence as approved by the Engineer around open trenches to prevent stock from falling in trenches. Where trenching operations should isolate grazing stock from their source of water, Contractor will either provide temporary bridging over trench or else provide water for such stock.

Where trench crosses near sound existing corner posts and existing fence is in good condition, fence may be taken loose, rolled back and stored until pipe line is completed at this point, then replaced by stretching tightly and thoroughly stapling. Additional posts will be provided and additional new fence shall be provided when it is necessary to place the fence crossed by the water line in a condition equal to existing fence before water line was constructed.

Where it is necessary to cut existing fence, new end posts shall be installed on each side of the water line and the old fence thoroughly stapled to these new posts before cutting. After pipe line is completed at this point, a new fence of galvanized wire (No. 9 gauge with No. 11 filler wires) shall be stretched between these new end posts and thoroughly stapled to existing posts and any new intermediate posts necessary to provide a good fence. Replacement of fences shall be on a replacement in-kind basis, and shall be considered incidental to laying of the lines and any additional cost shall be included in the unit price bid per lineal foot of pipe.

3.14 PROTECTION OF ADJACENT LANDSCAPE

Reasonable care shall be taken during construction of the water lines to avoid damage to vegetation. Ornamental shrubbery and tree branches shall be temporarily tied back, where appropriate, to minimize damage. Trees which receive damage to branches shall be trimmed of those branches to improve the appearance of the tree. Tree trunks receiving damage from equipment shall be treated with a tree dressing.

In the course of construction, the Contractor may deflect horizontal alignment of the water line to avoid trees and to keep from damaging their roots. The Contractor shall be fully responsible for settling all claims by private property owners concerning damage to trees and shrubs.

3.15 COORDINATION WITH UTILITIES

The Plans show the general location of existing utilities such information having been determined from the utilities. However, such information shall be considered general and is not guaranteed by Owner, Engineer or the Utility.

Prior to construction, the Contractor shall arrange to meet with representatives of all utilities, and provide them with his anticipated work schedule. The Contractor shall have the utilities make their best determination of utility locations in the areas in which he is working. Throughout the progress of the work, such field markings of utilities shall be kept current.

Repairs to any utilities damaged by the Contractor shall normally be performed by the utility at the Contractor's expense, unless the Contractor and the utility negotiate other understandings and/or procedures.

3.16 BLASTING AND ROCK EXCAVATION

The Contractor shall make his own investigation as he deems necessary to ascertain the sub-surface conditions to be encountered in the work.

All blasting operations shall be conducted in accordance with municipal ordinances, state and federal laws and Section 9, Explosives, of the "Manual of Accident Prevention in Construction", published by the Associated General Contractors of America, Inc. Soil particle velocity shall not exceed limit set by Kentucky law. All explosives shall be stored in conformity with said ordinances, laws and safety regulations. No blasting shall be done within five feet of any water mains, sewer lines, natural or manufactured gas lines, liquid petroleum product lines or other utilities. Any damage done by blasting is the responsibility of the Contractor and shall be promptly and satisfactorily repaired by him.

The Contractor shall use delay caps or other approved methods to reduce earth vibrations and noise. Mud capping, as defined in the above manual, will not be permitted as a method of breaking boulders. No blasting shall be permitted on Sundays or after dark.

Prior to commencing with the work, the Contractor shall, during a preconstruction conference with the Owner and the Engineer, state clearly his approach to performing the excavations on the project. He shall be familiar with the laws and ordinances covering blasting and shall also give consideration to the use of hydraulically operated rock breaking devices in lieu of blasting where considered necessary. If blasting is not handled in an expert manner at all times, the Engineer reserves the right to suspend blasting and require the work to proceed without it.

Prior to blasting, the Contractor shall make his own detailed preblast survey of adjacent walks, curbs, retaining walls, house foundations, etc. to determine conditions prior to the work. Such a file of information, including photographs, may be certified in such a manner as the Contractor believes necessary since this information that may stand in his defense.

4.0 PAYMENT

Payment for supplying, transporting and storing pipe, trenching, standard bedding, pipe installation, fittings, thrust-blocking, pipe locating wire and tape, testing, backfilling (including flowable fill, if required), disinfection, seeding, crop damage, regular stream crossings, clean-up, tie-ins to other structures and other incidental items in this section shall be made on the basis of the unit price per lineal foot for the type and size of pipe installed. Payment will include all those items not specifically covered by another proposal. Pipe will be measured along the centerline of the pipe as installed with no deduction for valves and fittings.

SECTION 15101

TESTING AND STERILIZATION

1.0 TESTING

1.1 After the pipe has been laid, all newly laid pipe or any valved section thereof shall be subjected to a hydrostatic pressure test of at least 1.5 times the working pressure at the point of testing, but in no case less than that required by other sections herein. In addition, a leakage test shall be conducted concurrently with the pressure test.

1.2 PRESSURE TEST

1.2.1 Test pressure shall:

1.2.1.1 Not be less than 1.25 times the working pressure at the highest point along the test section.

1.2.1.2 Not exceed pipe or thrust restraint design pressures at the lowest point along the test section.

1.2.1.3 Be of at least six (6) hour duration unless otherwise stipulated by owner.

1.2.1.4 Not vary by more than plus or minus 5 psi.

1.2.1.5 Not exceed twice the rated pressure of the valves or hydrants when the pressure of the test section includes closed gate valves or hydrants.

1.2.1.6 Not exceed the rated pressure of resilient seat butterfly valves when used.

1.2.2 Each valved section of pipe shall be filled with water slowly and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the ENGINEER.

1.2.3 Before applying the specified test pressure, air shall be expelled completely from the pipe, valves, and hydrants. If permanent air vents are not located at all high points, the contractor shall install corporation cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks

shall be removed and plugged, or left in place at the discretion of the ENGINEER.

1.2.4 All exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damage or defective pipe, fittings, valves or hydrants that are discovered following the pressure test shall be repaired or replaced with sound material and the test shall be repeated until it is satisfactory to the ENGINEER.

1.3 LEAKAGE TESTING

1.3.1 Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain pressure within 5 psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.

1.3.2 No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = ND(P \exp 1/2)/133,200$$

in which L is the allowable leakage, in gallons per hour; N is the length of pipeline tested in feet; D is the nominal diameter of the pipe, in inches; and P is the average test pressure during the leakage test, in pounds per square inch gauge.

1.3.2.1 Allowable leakage at various pressures is shown in TABLE K-1.

1.3.2.2 When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gal/hr/in of nominal valve size shall be allowed.

1.3.2.3 When hydrants are in the test section, the test shall be made against the closed hydrant.

1.3.3 Acceptance shall be determined on the basis of allowable leakage. If any test of pipe laid discloses leakage greater than that specified in Section 1.3.2 the contractor shall, at his own expense, locate and repair the defective material until the leakage is within the specified allowance.

1.3.3.1 All visible leaks are to be repaired regardless of the amount of leakage.

**Table K-1
Allowable Leakage Per 1,000 Ft. Of Pipeline (GPH)**

| Avg. Test Pressure psi | Nominal Pipe Diameter (Inches) | | | | | | | | |
|------------------------|--------------------------------|------|------|------|------|------|------|------|------|
| | 2 | 3 | 4 | 6 | 8 | 10 | 12 | 14 | 16 |
| 450 | 0.32 | 0.48 | 0.64 | 0.95 | 1.27 | 1.59 | 1.91 | 2.23 | 2.55 |
| 400 | 0.30 | 0.45 | 0.60 | 0.90 | 1.20 | 1.50 | 1.80 | 2.10 | 2.40 |
| 350 | 0.28 | 0.42 | 0.56 | 0.84 | 1.12 | 1.40 | 1.69 | 1.97 | 2.25 |
| 300 | 0.26 | 0.39 | 0.52 | 0.78 | 1.04 | 1.30 | 1.56 | 1.82 | 2.08 |
| 275 | 0.25 | 0.37 | 0.50 | 0.75 | 1.00 | 1.24 | 1.49 | 1.74 | 1.99 |
| 250 | 0.24 | 0.36 | 0.47 | 0.71 | 0.95 | 1.19 | 1.42 | 1.66 | 1.90 |
| 225 | 0.23 | 0.34 | 0.45 | 0.68 | 0.90 | 1.13 | 1.35 | 1.58 | 1.80 |
| 200 | 0.21 | 0.32 | 0.43 | 0.64 | 0.85 | 1.06 | 1.28 | 1.48 | 1.70 |
| 175 | 0.20 | 0.30 | 0.40 | 0.59 | 0.80 | 0.99 | 1.19 | 1.39 | 1.59 |
| 150 | 0.19 | 0.28 | 0.37 | 0.55 | 0.74 | 0.92 | 1.10 | 1.29 | 1.47 |
| 125 | 0.17 | 0.25 | 0.34 | 0.50 | 0.67 | 0.84 | 1.01 | 1.18 | 1.34 |
| 100 | 0.15 | 0.23 | 0.30 | 0.45 | 0.60 | 0.75 | 0.90 | 1.05 | 1.20 |

| Avg. Test Pressure psi | Nominal Pipe Diameter (Inches) | | | | | | | |
|------------------------|--------------------------------|------|------|------|------|------|------|------|
| | 18 | 20 | 24 | 30 | 36 | 42 | 48 | 54 |
| 450 | 2.87 | 3.18 | 3.82 | 4.78 | 5.73 | 6.69 | 7.65 | 8.60 |
| 400 | 2.70 | 3.00 | 3.60 | 4.50 | 5.41 | 6.31 | 7.21 | 8.11 |
| 350 | 2.53 | 2.81 | 3.37 | 4.21 | 5.06 | 5.90 | 6.74 | 7.58 |
| 300 | 2.34 | 2.60 | 3.12 | 3.90 | 4.68 | 5.46 | 6.24 | 7.02 |
| 275 | 2.24 | 2.49 | 2.99 | 3.73 | 4.48 | 5.23 | 5.98 | 6.72 |
| 250 | 2.14 | 2.37 | 2.85 | 3.56 | 4.27 | 4.99 | 5.70 | 6.41 |
| 225 | 2.03 | 2.35 | 2.70 | 3.38 | 4.05 | 4.73 | 5.41 | 6.03 |
| 200 | 1.91 | 2.12 | 2.55 | 3.19 | 3.82 | 4.46 | 5.09 | 5.73 |
| 175 | 1.79 | 1.98 | 2.38 | 2.98 | 3.58 | 4.17 | 4.77 | 5.36 |
| 150 | 1.66 | 1.84 | 2.21 | 2.76 | 3.31 | 3.86 | 4.41 | 4.97 |
| 125 | 1.51 | 1.68 | 2.01 | 2.52 | 3.02 | 3.53 | 4.03 | 4.53 |
| 100 | 1.35 | 1.50 | 1.80 | 2.25 | 2.70 | 3.15 | 3.60 | 4.05 |

2.0 STERILIZATION

2.1 GENERAL

It is the intent of this section to present essential procedures for disinfecting new and repaired water mains. The section is patterned after AWWA C651. The basic procedure comprises:

2.1.1 Preventing contaminating materials from entering the water mains during construction or repair and removing by flushing materials that may have entered the water main.

2.1.2 Disinfecting any residual contamination that may remain.

2.1.3 Determining the bacteriologic quality by laboratory test after disinfection.

2.2 PREVENTIVE MEASURES DURING CONSTRUCTION

2.2.1 Precautions shall be taken to protect pipe interiors, fittings, and valves against contamination. Pipe delivered for construction shall be strung so as to minimize entrance of foreign material. When pipe laying is not in progress, as, for example, at the close of the day's work, all openings in the pipe line shall be closed by water tight plugs. Joints of all pipe in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry.

If dirt, that, in the opinion of the ENGINEER, will not be removed by the flushing operation (section 2.3) enters the pipe, the interior of the pipe shall be cleaned and swabbed as necessary, with a five (5%) percent hypochlorite disinfecting solution.

2.2.2 Packing Materials and Joints—No contaminated material or any material capable of supporting prolific growth of micro-organisms shall be used for sealing joints. Packing material shall be handled in such a manner as to avoid contamination. Where applicable, packing materials must conform to AWWA standards. Packing material for cast iron pipe must conform to AWWA C600. Yarning or packing material shall consist of molded or tubular rubber rings, rope of asbestos or treated paper. Materials such as jute or hemp shall not be used. The lubricant used in the installation of sealing gaskets shall be suitable for use in potable water. It shall be delivered to the job in enclosed containers and shall be kept clean.

2.3 PRELIMINARY FLUSHING

The main shall be flushed prior to disinfection unless disinfected by the method in section 2.4.2.1. It is recommended that the flushing velocity be not less than

2.5 ft/sec. The rate of flow required to produce this velocity in various diameters is shown in Table K-2. No site for flushing should be chosen unless it has been determined that drainage is adequate at the site.

**Table K-2
Required Openings To Flush Pipelines
(40-PSI Residual Pressure)**

| Pipe Size (in) | Flow Required to Produce 2.5 fps Velocity (gpm) | Orifice Size (in) | Hydrants Required | |
|----------------|---|-------------------|--------------------|------------------|
| | | | Number of Hydrants | Nozzle Size (In) |
| 4 | 100 | 15/16 | 1 | 2 1/2 |
| 6 | 220 | 1 3/8 | 1 | 2 1/2 |
| 8 | 390 | 1 7/8 | 1 | 2 1/2 |
| 10 | 610 | 2 5/16 | 1 | 2 1/2 |
| 12 | 880 | 2 13/16 | 1 | 2 1/2 |
| 14 | 1,200 | 3 1/4 | 2 | 2 1/2 |
| 16 | 1,565 | 3 5/8 | 2 | 2 1/2 |
| 18 | 1,980 | 4 3/16 | 2 | 2 1/2 |

2.4 FORM OF CHLORINE FOR DISINFECTION

The most common forms of chlorine used in the disinfecting solutions are liquid chlorine (gas at atmospheric pressure), calcium hypochlorite granules, sodium hypochlorite solutions.

2.4.1 Liquid Chlorine

2.4.1.1 Use: Liquid chlorine shall be used only when suitable equipment is available and only under the direct supervision of a person familiar with the physiological, chemical, and physical properties of this element and who is properly trained and equipped to handle any emergency that may arise. Introduction of chlorine-gas directly from the supply cylinder is unsafe and shall not be permitted.

NOTE: The preferred equipment consists of a solution fed chlorinator in combination with a booster pump for injecting the chlorine-gas water mixture into the main to be disinfected. Direct feed chlorinators are not recommended because their use is limited to situations where the water pressure is lower than the chlorine cylinder pressure.

2.4.2 Hypochlorites

2.4.2.1 Calcium Hypochlorite: Calcium hypochlorite contains seventy (70%) percent available chlorine by weight. It is either granular or tabular in form. The tablets, 6-8 to the ounce, are designed to dissolve slowly in water. Calcium hypochlorite is packaged in containers of various types and sizes ranging from small plastic bottles to one hundred (100) pound drums.

A chlorine-water solution is prepared by dissolving the granules in water in the proportion requisite for the desired concentration.

2.4.2.2 Sodium Hypochlorite: Sodium hypochlorite is supplied in strengths from five and one-quarter (5.25%) to sixteen (16%) percent available chlorine. It is packaged in liquid form in glass, rubber, or plastic containers ranging in size from one (1) quart bottles to five (5) gallon carboys. It may also be purchased in bulk for delivery by tank truck.

The chlorine-water solution is prepared by adding hypochlorite to water. Product deterioration must be reckoned with in computing the quantity of sodium hypochlorite required for the desired concentration.

2.4.2.3 Application: The hypochlorite solutions shall be applied to the water main with a gasoline or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solutions may be fed with a hand pump, for example, a hydraulic test pump. Feed lines shall be of such material and strength as to withstand safely the maximum pressures that may be created by the pumps. All connections shall be checked for tightness before the hypochlorite solution is applied to the main.

2.5 METHODS OF CHLORINE APPLICATION

2.5.1 Continuous Feed Method: This method is suitable for general application.

2.5.1.1 Water from the existing distribution system or other approved sources of supply shall be made to flow at a constant, measured rate into the newly-laid pipe line. The water shall receive a dose of chlorine, also fed at a constant, measured rate. The two rates shall be proportioned so that the chlorine concentration in the water in the pipe is maintained at a minimum of 50 mg/L available chlorine. To assure that this concentration is maintained, the chlorine residual should be measured at regular intervals in accordance with the procedures described in the current edition of Standard Methods and AWWA M12—Simplified Procedures for Water Examination.

NOTE: In the absence of a meter, the rate may be determined either by placing a pitot gauge at the discharge or by measuring the time to fill a container of known volume.

TABLE K-3 gives the amount of chlorine residual required for each one hundred (100) feet of pipe of various diameters. Solutions of one (1%) percent chlorine may be prepared with sodium hypochlorite or calcium hypochlorite. The latter solution requires approximately one pound (1 lb.) of calcium hypochlorite in eight and five tenths (8.5) gallons of water.

Table K-3
Chlorine Required To Produce 50 mg/L Concentration
In 100 Ft. Of Pipe (By Diameter)

| Pipe Size (in) | 100 Percent Chlorine (lb) | 1 Percent Chlorine Solutions (gal) |
|----------------|---------------------------|------------------------------------|
| 4 | 0.027 | 0.33 |
| 6 | 0.061 | 0.73 |
| 8 | 0.108 | 1.30 |
| 10 | 0.170 | 2.04 |
| 12 | 0.240 | 2.88 |

2.5.1.2 During the application of the chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. Chlorine application shall not cease until the entire main is filled with the chlorine solution. The chlorinated water shall be retained in the main for at least twenty-four (24) hours during which time all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances. At the end of this twenty-four (24) hour period, the treated water shall contain no less than 25 mg/L chlorine throughout the length of the main.

2.5.2 Slug Method: This method is suitable for use with mains of large diameter for which, because of the volumes of water involved, the continuous feed method is not practical.

2.5.2.1 Water from the existing distribution system or other approved source of supply shall be made to flow at a constant, measured rate (see section 2.5.1.1) into the newly laid pipe line. The water shall receive a dose of chlorine also fed at a constant, measured rate. The two rates shall be proportioned so that the concentration in the water entering the pipe line is maintained at no less than 300 mg/L. The chlorine shall be applied continuously and for a sufficient period to develop a solid column or "slug" of chlorinated water that will, as it passes along the line, expose all interior surfaces to a concentration of at least 300 mg/L for at least three (3) hours. The application shall be checked at a tap near the upstream end of the line by chlorine residual measurements.

2.5.2.2 As the chlorinated water flows past tees and crosses, related valves and hydrants shall be operated as to disinfect appurtenances.

2.6 FINAL FLUSHING

After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the main is no higher than that generally prevailing in the system, or less than 1 mg/L. Chlorine residual determination shall be made to ascertain that the heavily chlorinated water has been removed from the pipe line.

2.7 BACTERIOLOGIC TESTS

2.7.1 After final flushing, and before the water main is placed in service, a sample or samples shall be collected from the end of the line and tested for bacteriologic quality and shall show the absence of coliform organisms. If the number and frequency of samples is not prescribed by the public health authority having jurisdiction, at least one sample shall be collected from chlorinated supplies where a chlorine residual is maintained throughout the new main. From unchlorinated supplies at least two samples shall be collected at least twenty-four (24) hours apart.

2.7.2 Samples for bacteriologic analysis shall be collected in sterile bottles treated with sodium thiosulphate. No hose or fire hydrant shall be used in collection of samples. A suggested sampling tap consists of a standard corporation cock installed in the main with a copper tube gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed, and retained for future use.

2.8 REPETITION OF PROCEDURE

If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory samples have been obtained. The tablet method cannot be used in these subsequent disinfections. When the sample tests indicate that disinfection has been effective, the main may be placed in service.

2.9 PROCEDURE AFTER CUTTING INTO OR REPAIRING EXISTING MAINS

The procedures outlined in this Section apply primarily when mains are wholly or partially dewatered. Leaks or breaks that are repaired with clamping devices while the mains remain full of water under pressure present little danger of contamination and require no disinfection.

2.9.1 Trench "Treatment": When an old line is opened, either by accident or by design, the excavation will likely be wet and may be badly contaminated from nearby sewers. Liberal quantities of hypochlorite applied to open trench areas will lessen the danger from such pollution. Tablets have the advantage in such a situation because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation.

2.9.2 Main Disinfection: The following procedure is considered as a minimum that may be used.

2.9.2.1 Swabbing With Hypochlorite Solution: The interior of all pipe and fittings used in making the repair (particularly couplings and tapping sleeves) shall be swabbed with a five (5%) percent hypochlorite solution before they are installed.

2.9.2.2 Flushing: Thorough flushing is the most practical means of removing contamination introduced during repairs. If valving and hydrant locations permit, flushing from both directions is recommended. Flushing shall be started as soon as the repairs are completed and continued until discolored water is eliminated.

2.9.2.3 Slug Method: Where practicable, in addition to the procedures of section 2.9.2.1, a section of main in which the break is located shall be isolated, all service connections shut off, and the section flushed and chlorinated as described in section 2.5.2, except that the dose may be increased to as much as 500 mg/L, and the contact time reduced to as little as one-half (1/2) hour. After chlorination, flushing shall be resumed and continued until discolored water is eliminated.

2.9.3 Sampling: Bacteriologic samples shall be taken after repairs to provide a record by which the effectiveness of the procedures used can be determined. If the direction of flow is unknown, samples shall be taken on each side of the main break.

3.0 PAYMENT

No separate payment shall be made for testing and sterilization of water lines. Items described in this section shall be incidental to the cost of installing the water line.

SECTION 15110

INSTALLATION OF WATER LINE ACCESSORIES

1.0 GENERAL

The Contractor is to supply and install all valves, hydrants, blowoffs and other equipment at the locations shown on the plans in complete accordance with these specifications.

2.0 MATERIALS

2.1 Fire Hydrant. All fire hydrants shall have a six inch bell connection, shall have two hose outlets and one pumper connection, shall be designed for 250 pounds working pressure or 300 pounds hydrostatic pressure and shall conform to the latest specifications of the AWWA C502. All working parts shall be bronze. Both hose outlets shall be 2 1/2 inch with NST threads and the pumper outlet shall be 4 1/2 inch with NST thread. Hydrants shall be designed so that no water will be lost when they are broken off and so they can be repaired with a repair kit. Design, materials, and workmanship shall be similar and equal to the latest stock pattern ordinarily produced by the manufacturer. Length of barrel shall be such to provide a 3 1/2 foot bury depth. Working drawings and full description of hydrants shall be submitted to the Engineer before ordering. All hydrants shall have a 5 1/4 inch valve opening against pressure. The hydrants shall be equal to Mueller Model A423 or equal. All hydrant extensions will be the responsibility of the Contractor.

2.1.1 Paint. Hydrants shall be painted one coat of red paint and two finish coats of approved paint of color directed by the Engineer. All hydrants are to receive the final coat of paint after field installation.

2.2 GATE VALVE

All gate valves shall be the resilient seat-type, iron body, non-rising stem, fully bronze mounted, and suitable for working water pressures of not less than 200 psi for installations on PVC pipe and not less than 250 psi for installations on DI pipe. Valves shall be of standard manufacture and of the highest quality both of materials and workmanship and shall conform to the latest revision of AWWA Specification C-509. Valves shall be furnished with flanged connections for exposed piping and push-on or mechanical joint connections for buried service. Gate valves shall have a clear water way equal to the nominal diameter, and shall be opened by turning counter-clockwise. The operating nut or wheel shall have an arrow cast in the middle, indicating the direction of opening. Each valve shall have the maker's initials, pressure rating and the year in which manufactured, cast on the body. Prior to shipment from the factory each valve shall be tested by hydraulic pressure of at least 300 pounds per square inch.

2.3 BUTTERFLY VALVE

All butterfly valves shall be of tight closing, resilient seat type with seats securely fastened to valve body. No metal-to-metal seating surfaces will be permitted. Valves shall be bubble tight at the rated pressure in either direction and shall be satisfactory for applications involving throttling service and/or frequent operation and for applications involving valve operation after long periods of inactivity.

Valves shall be suitable for working water pressure of 200 psi unless otherwise specified or noted on the plans.

Cast Markings: valve size, manufacturer's name, class, direction of opening, and year of casting.

The valve discs shall rotate 90° from the full open position to the tight shut position.

The valve discs shall be cast/ductile iron with a welded nickel edge free of ribbing or protrusions which may collect solids. The disc-to-shaft connections shall be via polished 316 SS pins. Sprayed or plated discs are not acceptable. All disc seating edges shall be smooth and polished.

The shafts shall be turned, ground and polished, and be of one-piece construction. The shafts shall also be constructed from stainless steel with diameters per AWWA C504, Class 75B.

The shaft seals shall be of Hycar or Hypalon and shall be provided to prevent leakage into the bearing chest areas.

The valve bearings shall be Teflon coated, self-lubricating, stainless steel design and construction.

The valve seats shall be Neoprene or Hypalon and shall be simultaneously molded, vulcanized and bonded to the valve body or a rigid reinforcing ring.

2.3.1 Operators. The valve operating mechanisms shall be for counterclockwise opening. There shall be no external moving parts on valve or operator except the operator input shaft. Input shaft is to be operated by a 2-inch square operating nut. Maximum required input force on the operator shaft to open and close the valve shall be 40 pounds. The total number of turns applied to the operating nut required to completely open the valve from a completely closed position shall be not less than twice the nominal valve diameter. An extension stem shall be furnished if required to bring the operating nut within 3 1/2 feet of finished grade. Extension stems shall be securely fastened to the valve stem. A stainless steel collar, 6-inches high, shall be welded to the operating gear box housing centered on the operating nut to hold

the valve box in place and seal it against dirt. The diameter of the collar shall be such that it will accept the valve box.

The valves shall be manufactured by M & H, Dresser, Dezurik or approved equal.

2.4 AIR RELEASE VALVES

A valve designed to allow exhaust of small pockets of air from the water main while in use shall be installed where shown on the plans or where directed by the Engineer. The air release valve shall have a 3/4" iron pipe thread inlet, cast iron body construction, bronze trim, with all internal parts of stainless steel. The valve shall have a minimum orifice size of 3/32". Valves shall be suitable for a working water pressure of 150 PSIG. The air release valve shall be mounted on 3/4" bronze riser pipe. The riser pipe shall be connected to the water main by use of a service clamp and a corporation stop. The riser shall also have a 3/4" bronze ball valve with stainless steel handle and be suitable for a 150 PSIG working water pressure. Air release valves shall be as manufactured by APCO Models 65 or 50, or approved equal.

Air release valves will be installed in the same type of box used for meter installation. The box must allow for adequate cover over the pipe at the installation.

In locations where the air release valve can not be placed directly above the water main, such as roadway drainage ditches, then a section of service tubing shall be used to locate the valve as directed by the Engineer. The service tubing shall be installed with a continuous upward slope to eliminate air pockets. Additional payment for the tubing shall be made based on the linear foot bid for service tubing. Tubing shall also be rodded through the box to support the valve. No additional payment will be made for the tubing supports.

2.5 VALVE BOXES

All valves (gate, air release, check, etc.) installed underground shall be installed in an approved valve box. Each gate valve shall be installed in a vertical position with a valve box. Valve boxes shall be of a cast iron, two or three-piece, slip-type consisting of a base, a center section and a top section with a cover marked "water". Where valve box is constructed in a paved area the box shall be a screw type box. The entire assembly shall be adjustable for elevation and shall be set vertically and be properly adjusted so that the cover will be in the same plane as the finished street surface (no more than 1/2" above ground in yards or pastures or 2" in unsodded areas). The assembly must provide for the required cover over the pipe at the installation site and shall rest on concrete pads as shown in the Standard Details. The Contractor shall furnish two (2) valve wrenches for the project.

2.6 BLOW-OFF VALVES

Blow-off valves shall be installed in accordance with the details and the specifications at locations shown on the plans and in other locations as directed by the Engineer. The Contractor should refer to the Standard Details for blow-off installation.

The blowoff pipe from the main to the flush valve shall be connected to the main by means of a tee. Do not use a corporation stop for this connection. The gate valve for the blow-off connection shall be a resilient seat gate valves in conformance with AWWA C509.

2.7 TAPPING SLEEVE AND VALVE

Tapping sleeves shall be as manufactured by Ford Meter Box Company, Inc., Model FTSC, or approved equal, and shall be rated for a minimum working water pressure of 150 psi. Contractor shall ascertain the type and size of pipe to which the connection is to be made prior to selection. The valve shall be as specified under section 2.2 or 2.3 of this specification.

3.0 EXECUTION

3.1 FIRE HYDRANTS

Under this Item, the Contractor shall provide all labor, tools, equipment and materials to furnish and install hydrants with gate valves as shown on the drawing and as directed by the Engineer.

Hydrants shall be set at such elevations that the connecting pipe will have the same depth of cover as the distribution main. The back of the hydrant opposite the pipe connection shall be firmly wedged against one and one-half square feet or enough of the vertical face of the trench with concrete to prevent the hydrants from blowing off the line. In addition, all fittings, valves and hydrants shall be joined by the use of all-thread rods, nuts and "DUC-LUG" offsets as shown on the attached drawing to prevent movement of the hydrant. If the character of the soil is such, in the opinion of the Engineer, that the hydrant cannot be securely wedged, bridle rod collars shall be used which shall be not less than three-fourths inch stock and shall be protected by a coat of acid resistant paint.

Not less than seven cubic feet of No. 9 stone shall be placed around the base of the hydrant to insure drainage. Before the No. 9 stone is placed and before it is backfilled the drain hole shall be inspected and thoroughly cleaned if necessary. The backfill around the hydrant shall be thoroughly compacted to the grade line in a manner satisfactory to the Engineer. Hydrants shall have the interior cleaned of all foreign matter before installation.

All hydrants will be installed with the pumper connection facing the main access road or as directed by the Engineer.

Stuffing boxes shall be tightened and the hydrants shall be inspected in open and closed position to see that all parts are in working condition.

3.2 VALVES

Underground valves shall be nut operated, unless otherwise shown on the plans. Valve supplier shall furnish two standard stem iron wrenches for turning nut operated valves. All underground valves which have nuts deeper than 30 inches below the top of valve box shall have extended stems with nuts located within 2 feet of valve box cap. Buried service valves shall have either epoxy-coated or tar-coated exteriors.

Exposed service valves shall be equipped with an AWWA approved handwheel operator. The exterior of exposed valves shall be epoxy-coated, tar-coated, or as specified on the DRAWINGS.

3.3 TIE IN CONNECTIONS

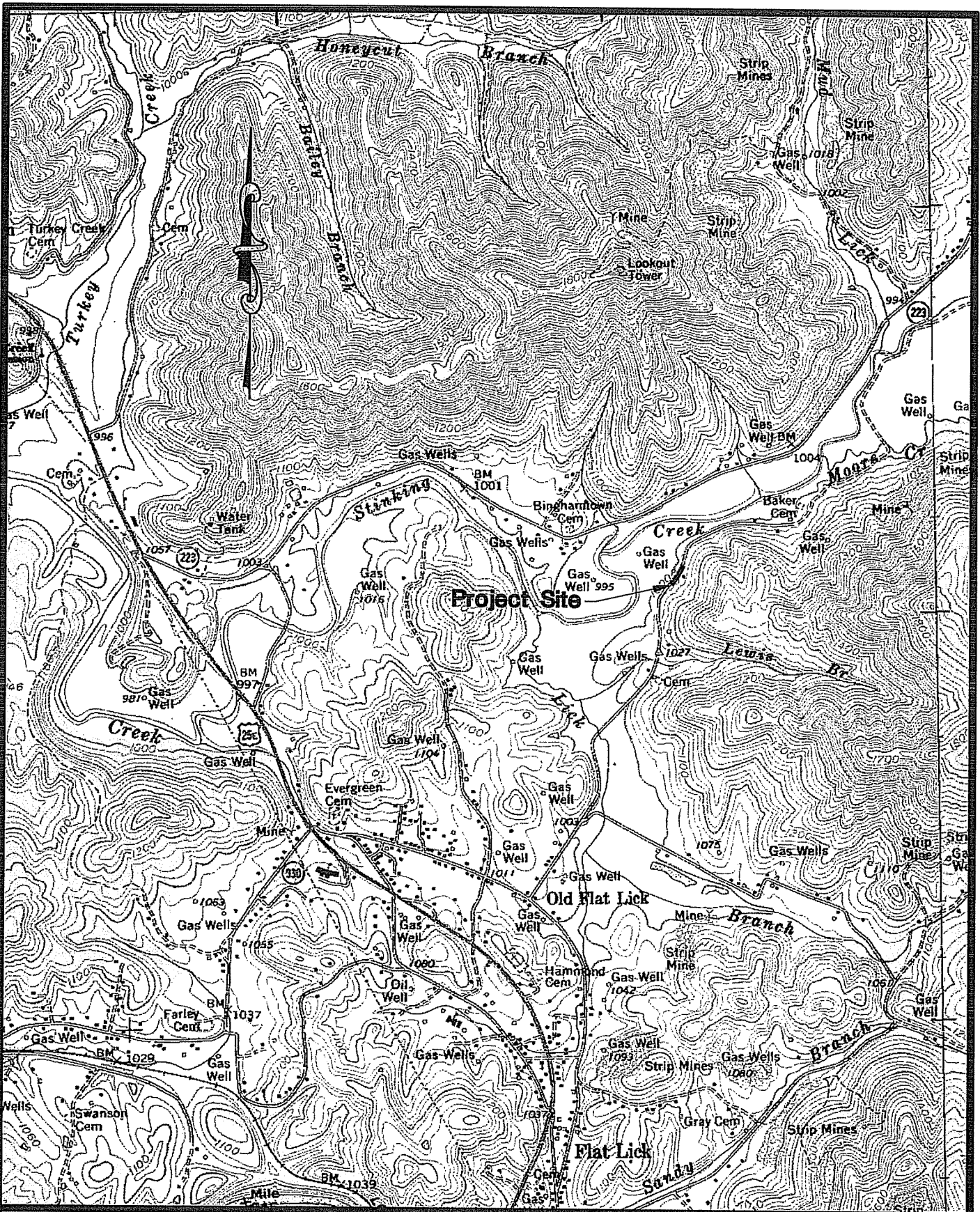
All tie in connections shall include a tapping sleeve and valve per Section 2.7 of this specification and any fittings suitable to make the required connection. The fittings shall be mechanical joint, ductile iron type as specified in other sections.

4.0 PAYMENT

Payment of the unit price bid for fire hydrants shall constitute full compensation for furnishing and installing the fire hydrants with associated tees, gate valve and incidental items as specified.

Payment for gate valves, air release valves, check valves and other special valves installed underground shall include all work necessary for a complete installation and shall include all valve stem boxes or other valve boxes and box covers. Payment will be made at the unit price bid for the type and size of valve installation.

Blowoff Assemblies will be paid for under their respective bid prices and such payment is to include the gate valve setting, boxes and six feet (6') of pipe. Any additional pipe required will be paid under bid price for pipe installed.

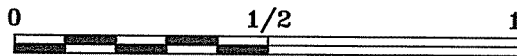


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ARTEMUS, KY. QUADRANGLE

KNOX COUNTY UTILITIES COMMISSION
 PROPOSED WATERLINE EXTENSION
 KNOX COUNTY, KENTUCKY

SCALE IN MILES

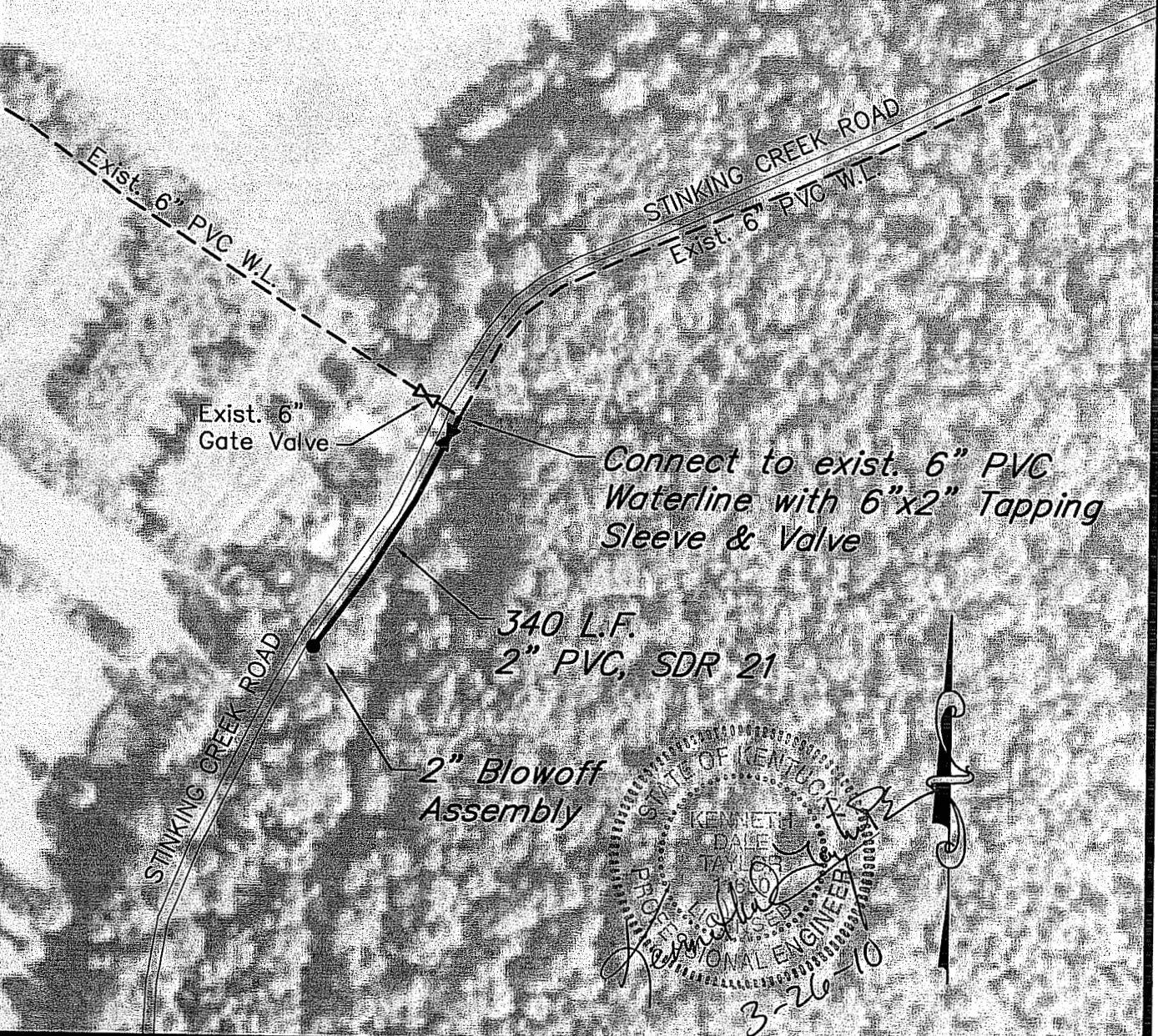


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KNOX COUNTY UTILITIES COMMISSION
 PROPOSED WATERLINE EXTENSION
 KNOX COUNTY, KENTUCKY
 SCALE: 1"=200'