

BERWICK
Rochester Street Reconstruction
WIN 17328.00
HYDROLOGY AND HYDRAULICS REPORT

By
Sebago Technics, Inc.
Project 11309



June 2013

**Berwick
Rochester Street Improvements
WIN 17328.00
Hydrology and Hydraulics Report
June 2013**

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1. Introduction

WIN 17328.00 is a full reconstruction improvement project for Rochester Street in Berwick beginning at Annie Street and extending northwesterly a short distance beyond the northern entrance to Hall Brothers Roofing, approximately 0.44 miles. The project begins at Station 100+29 and ends at Station 123+75. See Figure 1.

Rochester Street in the area of the Project is two lanes with gravel shoulders and open ditches for control of surface drainage. The roadway generally runs northwest/southeast and parallel with the Salmon Falls River. The Project's high point is at the beginning of the Project, Station 100+29, at Elevation 216. The low point is located at approximately Station 118+75 at Elevation 175.1 (NAVD88). The roadway is frequently flooded during storm events at the existing low point. According to the latest FEMA Flood Insurance Study for the Town, the 100-year storm event has a water surface elevation of 177.8 (NAVD 1988). This is roughly 2.7' above the existing roadway surface elevation. Local residents attending the two public informational meetings held in Town for this Project confirmed that the roadway does flood during large storm events. Unfortunately, because of the impacts that would be caused to abutting properties it was not practical to raise the roadway surface above the 100-year flood level. Consequently, the river surface elevation at any given time has an overriding influence on the sizing of the two cross culverts that convey water beneath the roadway to the river at Stations 119+40 and 123+26.

2. Hydrology

Rochester Street is a Priority 4 roadway, so according to Chapter 12 of the Highway Design Guide we used the following Design Flood Frequency Criteria:

Roadway Cross Culverts	50 year
Driveway Culverts	10 year
Closed Systems	10 year/ 5 minute duration

Individual drainage basins along the project corridor were delineated based on site visits and the USGS Quadrangle for Berwick. These are shown on specific Watershed Area Maps included at the end of this Report. The proposed roadway design calls for a curbed section for much of the project length with a new sidewalk on the easterly side of the roadway. As such, a closed drainage system has been designed for much of the project using the Rational Method. In the remaining uncurbed portion of the project, existing cross culverts will be replaced and upgraded at existing locations. Given the size of the contributing watersheds for these culverts, both the Rational Method and HydroCad were used for these analyses. However, because of the controlling influence of the Salmon Falls River at these locations, these conduits act more like equalizer pipes than one-directional conveyances. Consequently, a traditional hydraulic

analysis was not appropriate for use at these locations. Instead we elected to increase the conveyance surface areas by one standard pipe size to insure smooth flows from one side of the road to the other.

3. Check Flood: 100-year recurrence interval

The two proposed cross culverts at Stations 119+40 and 123+26 have been checked for the 100-year flood event. The culvert at Station 119+40 will be fully submerged as the top of this conduit will be approximately 173.5 and the water surface generated by the river will be 177.8, or 4.3 feet above the culvert on both ends. The culvert at Station 123+26 is also fully submerged during this storm event. The top of the culvert is approximately 174.8 and the water surface will be 177.8, or 3 feet above the culvert.

4. Peak Discharge Estimation

The Rational Method was used for peak discharge estimation. Rainfall data and resulting IDF curves for the Project were obtained from the recent work by Cornell University and published on www.precip.net.

Specific Watershed Area Maps are included at the end of this Report. These maps illustrate the watershed boundaries, acreages, cover types, and time of concentrations, and incremental peak discharges.

5. Inlet Spacing, Spread Calculations, and Preliminary Closed System Sizing

Using the information contained on the Watershed Area Maps referenced above as input data, Sebago utilized the computer software, *HYDRAFLOW Storm Sewers 2003* by Intelisolve to:

- ☐ calculate inlet flows
- ☐ calculate grate interception rates
- ☐ calculate bypass flows
- ☐ check spread widths against project design criteria
- ☐ preliminarily size the enclosed pipe system

For this project, the design spread limit was assumed to be the shoulder width (3 feet) plus $\frac{1}{2}$ the travel lane width (or 5.5 feet) – for a total width of 8.5 feet. Because the shoulders are less than 4 feet, the catch basins will not be depressed and therefore the gutter cross section will be a simple trapezoid.

Other design criteria used by the software were:

- ☐ assume that the pipes will flow full
- ☐ minimum flow velocity equal to 2 fps
- ☐ minimum pipe slope of .003 ft./ft.
- ☐ outfall invert elevation for the closed system was established at the existing outfall invert elevation of 168.00
- ☐ the river elevation during the 10-year storm was assumed to be 174.7 (1988 NGVD), based upon the FEMA Flood Insurance Study
- ☐ the roughness coefficient for the pipes is assumed to be $n = 0.011$, assuming a smoothlined HDPE pipe and $n=0.013$ for the precast concrete box culvert

One system was created for the proposed closed drainage system with the outlet located at the proposed box culvert at Station 119+40. The data sheets developed from the model are appended to this Report.

In an effort to avoid conflicts between the proposed closed storm drainage system and existing utilities (water main, force main and gravity sanitary sewer), some unconventional drainage infrastructure is proposed. These unconventional measures include, underdrain located closer to the center of the roadway, underdrain located further away from the center of the roadway, underdrain more shallow than 3.4' below sub-base gravel, some cross pipes (between structures) are less than 18" diameter, only 0.1 foot difference in elevation is provided between the inlet and outlet pipe at some structures, some pipes have less than 2 feet of cover below subgrade, a trunk line (located within the left lane, Station 108+20 to Station 110+70) is proposed, and a F-basin is proposed within the roadway (station 121+00).

The results of the Hydraflow model show that, the lower end of the system will operate with a hydraulic grade line (HGL) above the crowns of the pipes between Station 113+50 and 121+00 because of the river elevation during the 10-year storm event. In fact, stormwater has the potential to be released from the catch basins during storm events larger than the 10-year storm onto the roadway surface between the low point at Station 117+81 and Stations 116+45 and 121+00. As such, we have provided catch basin grates on the structures at 115+32 and 116+50, which would normally be manholes with solid covers, to prevent the hydraulic pressure within the system from lifting these covers and causing a roadway safety condition. We were able to minimize the extent of this condition somewhat by upsizing the storm drain from Station 116+50 to Station 119+40 from 30" diameter to 36" diameter.

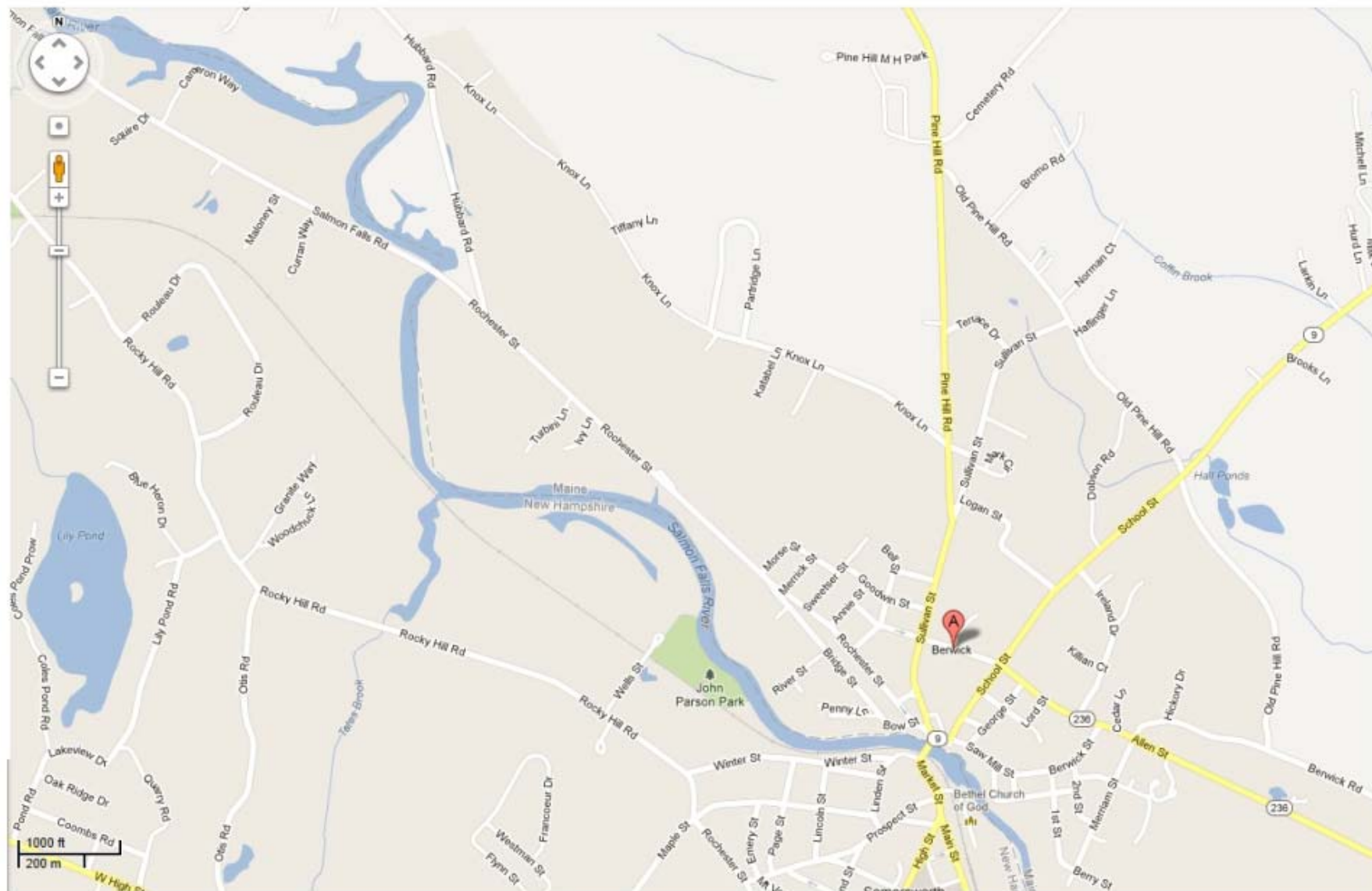
6. Cross Culverts

The proposed cross culverts were sized using the procedures contained in the Chapter 12 of the Highway Design Guide and HDS #5. HY-8 software was used to perform the sizing calculations. However, as stated previously, this standard methodology did not prove useful given the influence of the Salmon Falls River. Therefore, we elected to treat these conveyances as equalizers and provided additional surface opening area to facilitate cross flows. The results of this approach yielded the following:

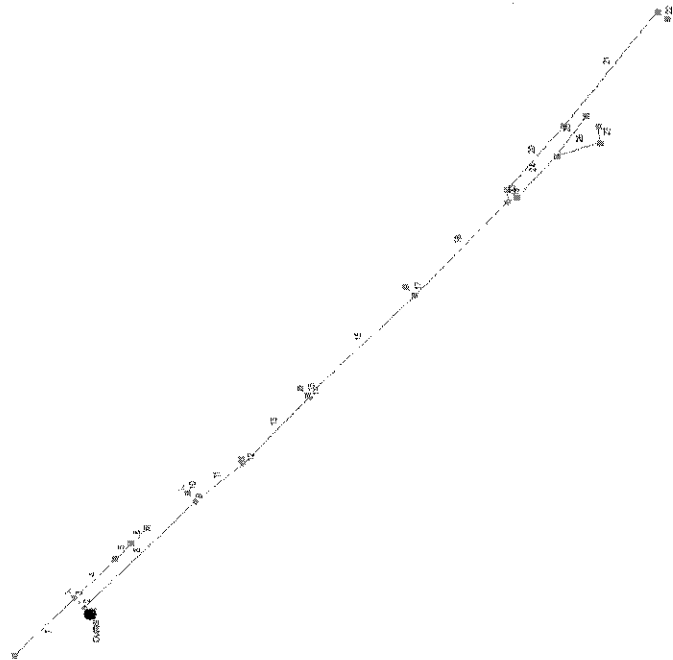
- ❑ Station 116+25 – existing 12" pipe upsized to 18" and connected to proposed closed system – eliminated one outfall
- ❑ Station 119+40 – existing 48" CMP upsized to a 7' wide by 5' high box culvert with the bottom 12" embedded below the streambed, if existing utilities will permit
- ❑ Station 123+26 – existing 30" CMP upsized to 36"

7. Underdrains

Because of the box cut nature of the proposed design, underdrains are proposed for both sides of the new roadway from Station 103+50 to Station 119+40. Underdrain is also included from Station 119+40, RT to Station 123+38, RT. From Station 119+40, LT to Station 123+75, LT the new subbase will daylight, so no underdrains are proposed. The proposed subsurface drainage collection system includes a mixture of Type B and Type C pipes.



Hydraflow Plan View



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	Dns line No.
1	Box Culv. 119+40	79.66	48 x 84 b	16.0	168.00	168.17	1.062	174.70*	174.71*	0.13	End
2	Box Culv. 119+40	54.95	48 x 84 b	26.0	168.17	168.45	1.077	174.83*	174.84*	0.06	1
3	Box Culv. 119+40	53.46	84 c	18.0	168.45	168.64	1.056	174.90	174.89	0.03	2
4	118+27 to 119+40	0.90	12 c	106.0	170.50	170.82	0.302	174.90*	174.95*	0.01	2
5	117+81 to 118+27	0.35	12 c	41.0	170.92	171.04	0.293	174.96*	174.96*	0.00	4
6	117+36 to 117+81	0.18	12 c	41.0	171.14	171.27	0.317	174.96*	174.96*	0.00	5
7	121+00 to 119+40	0.59	12 c	156.0	170.50	171.48	0.628	174.90*	174.93*	0.01	2
8	116+50 to 119+40	24.71	36 c	286.0	168.44	169.30	0.301	174.83*	175.11*	0.19	1
9	116+45 to 116+50	6.04	18 c	23.0	171.60	171.82	0.957	175.30*	175.36*	0.09	8
10	116+45	5.28	18 c	13.0	172.07	173.50	11.000	175.45*	175.47*	0.14	9
11	115+32 to 116+50	18.67	30 c	114.0	169.40	169.74	0.298	175.30*	175.47*	0.19	8
12	115+25 to 115+32	0.52	12 c	9.0	172.50	172.68	2.000	175.66*	175.67*	0.01	11
13	113+50 to 115+32	18.15	24 c	178.0	169.84	170.37	0.298	175.66*	176.49*	0.52	11
14	113+50	18.15	24 c	5.0	170.46	170.50	0.800	177.00*	177.03*	0.78	13
15	113+50	1.53	12 c	20.0	170.75	170.85	0.500	177.81*	177.83*	0.06	14
16	110+70 to 113+50	15.96	24 c	276.0	172.00	180.53	3.091	177.81*	183.06*	1.05	14
17	110+70	1.29	12 c	22.0	185.00	185.11	0.500	185.46	185.83	0.18	16
18	108+20 to 110+70	13.84	18 c	247.0	181.03	188.44	3.000	183.06*	191.81*	0.77	16
19	108+00 to 108+20	9.10	15 c	23.0	190.77	191.00	1.000	192.02*	193.85*	0.94	18
20	106+34 to 108+00	2.94	12 c	161.0	191.25	193.18	1.199	193.85*	194.63*	0.11	19
21	103+50 to 106+34	1.06	12 c	280.0	193.43	201.13	2.750	194.74	201.77	0.24	20
22	103+50	0.36	12 c	24.0	203.01	203.25	1.000	203.21	203.59	0.08	21
23	108+00 to 108+20	4.74	15 c	18.0	188.75	188.84	0.500	191.81*	191.88*	0.16	18
24	106+90 to 108+00	4.40	15 c	107.0	191.00	191.54	0.505	192.04*	192.97*	0.27	23
25	105+90 to 106+90	0.37	12 c	96.0	192.64	194.13	1.552	192.97	194.47	0.08	24
26	300+82 to 106+90	3.67	15 c	80.0	191.79	194.66	3.588	192.97*	195.92*	0.42	24
27	300+96 to 300+82	2.18	12 c	34.0	195.16	195.49	0.971	195.92*	196.52*	0.28	26
Project File: 11309ClosedDrainageSystem.6-4-13.stm						Number of lines: 27			Run Date: 06-14-2013		
NOTES: c = circular; e = elliptical; b = box; Return period = 10 Yrs.; * Indicates surcharge condition.											

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data							Line ID	
	Dnstr line No.	Line length (ft)	Defl angle (deg)	Junc type	Known Q (cfs)	Drng area (ac)	Runoff coeff (C)	Inlet time (min)	Invert El Dn (ft)	Line slope (%)	Invert El Up (ft)	Line size (in)	Line type	N value (n)	J-loss coeff (K)		Inlet/ Rim El (ft)
1	End	16.0	-42.0	MH	0.00	0.00	0.00	0.0	168.00	1.06	168.17	48 84	Box	0.013	1.00	176.12	Box Culv. 119+40
2	1	26.0	0.0	MH	0.00	0.00	0.00	0.0	168.17	1.08	168.45	48 84	Box	0.013	1.00	176.12	Box Culv. 119+40
3	2	18.0	0.0	Hdwl	53.46	0.00	0.00	0.0	168.45	1.06	168.64	84	Cir	0.013	1.00	176.12	Box Culv. 119+40
4	2	106.0	85.1	Comb	0.55	0.00	0.00	0.0	170.50	0.30	170.82	12	Cir	0.011	0.50	175.07	118+27 to 119+40
5	4	41.0	0.0	Comb	0.17	0.00	0.00	0.0	170.92	0.29	171.04	12	Cir	0.011	0.50	174.97	117+81 to 118+27
6	5	41.0	0.0	Comb	0.18	0.00	0.00	0.0	171.14	0.32	171.27	12	Cir	0.011	1.00	175.07	117+36 to 117+81
7	2	156.0	-94.9	Comb	0.59	0.00	0.00	0.0	170.50	0.63	171.48	12	Cir	0.011	1.00	176.40	121+00 to 119+40
8	1	286.0	85.1	MH	0.00	0.00	0.00	0.0	168.44	0.30	169.30	36	Cir	0.011	1.00	175.83	116+50 to 119+40
9	8	23.0	-79.0	Comb	0.76	0.00	0.00	0.0	171.60	0.96	171.82	18	Cir	0.011	0.50	175.80	116+45 to 116+50
10	9	13.0	-10.7	Hdwl	5.28	0.00	0.00	0.0	172.07	11.00	173.50	18	Cir	0.011	1.00	174.00	116+45
11	8	114.0	5.1	MH	0.00	0.00	0.00	0.0	169.40	0.30	169.74	30	Cir	0.011	0.85	176.90	115+32 to 116+50
12	11	9.0	-59.6	Comb	0.52	0.00	0.00	0.0	172.50	2.00	172.68	12	Cir	0.011	1.00	176.89	115+25 to 115+32
13	11	178.0	-5.4	MH	0.00	0.00	0.00	0.0	169.84	0.30	170.37	24	Cir	0.011	1.00	179.23	113+50 to 115+32
14	13	5.0	-89.0	Comb	0.66	0.00	0.00	0.0	170.46	0.80	170.50	24	Cir	0.011	1.50	179.00	113+50
15	14	20.0	0.1	Comb	1.53	0.00	0.00	0.0	170.75	0.50	170.85	12	Cir	0.011	1.00	179.00	113+50
16	14	276.0	90.4	Comb	0.83	0.00	0.00	0.0	172.00	3.09	180.53	24	Cir	0.011	1.50	189.34	110+70 to 113+50
17	16	22.0	-90.0	Comb	1.29	0.00	0.00	0.0	185.00	0.50	185.11	12	Cir	0.011	1.00	189.34	110+70
18	16	247.0	-2.6	MH	0.00	0.00	0.00	0.0	181.03	3.00	188.44	18	Cir	0.011	0.75	197.13	108+20 to 110+70
19	18	23.0	-44.3	Comb	6.16	0.00	0.00	0.0	190.77	1.00	191.00	15	Cir	0.011	1.10	197.12	108+00 to 108+20
20	19	161.0	40.5	Comb	1.88	0.00	0.00	0.0	191.25	1.20	193.18	12	Cir	0.011	0.50	199.40	106+34 to 108+00
Project File: 11309ClosedDrainageSystem.6-4-13.stm										Number of lines: 27							Date: 06-14-2013

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data							Line ID	
	Dnstr line No.	Line length (ft)	Defl angle (deg)	Junc type	Known Q (cfs)	Drng area (ac)	Runoff coeff (C)	Inlet time (min)	Invert EI Dn (ft)	Line slope (%)	Invert EI Up (ft)	Line size (in)	Line type	N value (n)	J-loss coeff (K)		Inlet/ Rim Ei (ft)
21	20	280.0	-1.3	Comb	0.70	0.00	0.00	0.0	193.43	2.75	201.13	12	Cir	0.011	1.50	207.33	103+50 to 106+34
22	21	24.0	90.2	Comb	0.36	0.00	0.00	0.0	203.01	1.00	203.25	12	Cir	0.011	1.00	207.27	103+50
23	18	18.0	21.4	Comb	0.34	0.00	0.00	0.0	188.75	0.50	188.84	15	Cir	0.011	0.70	197.12	108+00 to 108+20
24	23	107.0	-22.8	Comb	0.36	0.00	0.00	0.0	191.00	0.50	191.54	15	Cir	0.011	0.70	198.70	106+90 to 108+00
25	24	96.0	-6.8	Comb	0.37	0.00	0.00	0.0	192.64	1.55	194.13	12	Cir	0.011	1.00	200.27	105+90 to 106+90
26	24	80.0	30.9	Comb	1.49	0.00	0.00	0.0	191.79	3.59	194.66	15	Cir	0.011	1.25	198.97	300+82 to 106+90
27	26	34.0	-74.8	Comb	2.18	0.00	0.00	0.0	195.16	0.97	195.49	12	Cir	0.011	1.00	200.26	300+96 to 300+82
Project File: 11309ClosedDrainageSystem.6-4-13.stm										Number of lines: 27							Date: 06-14-2013

Hydraulic Grade Line Computations

Line	Size (in)	Q (cfs)	Downstream								Len (ft)	Upstream								Check		JL coeff (K)	Minor loss (ft)
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Energy loss (ft)		
1	48 84 b	79.66	168.00	174.70	4.00	28.00	2.85	0.13	174.83	0.045	16.0	168.17	174.71	4.00	28.00	2.85	0.13	174.83	0.045	0.045	0.007	1.00	0.13
2	48 84 b	54.95	168.17	174.83	4.00	28.00	1.96	0.06	174.89	0.021	26.0	168.45	174.84	4.00	28.00	1.96	0.06	174.90	0.021	0.021	0.006	1.00	0.06
3	84	53.46	168.45	174.90	6.45	37.07	1.44	0.03	174.93	0.006	18.0	168.64	174.89	6.25	36.28	1.47	0.03	174.93	0.006	0.006	0.001	1.00	0.03
4	12	0.90	170.50	174.90	1.00	0.79	1.15	0.02	174.92	0.046	106	170.82	174.95	1.00	0.79	1.15	0.02	174.97	0.046	0.046	0.048	0.50	0.01
5	12	0.35	170.92	174.96	1.00	0.79	0.45	0.00	174.96	0.007	41.0	171.04	174.96	1.00	0.79	0.45	0.00	174.96	0.007	0.007	0.003	0.50	0.00
6	12	0.18	171.14	174.96	1.00	0.79	0.23	0.00	174.96	0.002	41.0	171.27	174.96	1.00	0.79	0.23	0.00	174.96	0.002	0.002	0.001	1.00	0.00
7	12	0.59	170.50	174.90	1.00	0.79	0.75	0.01	174.91	0.020	156	171.48	174.93	1.00	0.79	0.75	0.01	174.94	0.020	0.020	0.031	1.00	0.01
8	36	24.71	168.44	174.83	3.00	7.07	3.50	0.19	175.02	0.098	286	169.30	175.11	3.00	7.07	3.50	0.19	175.30	0.098	0.098	0.281	1.00	0.19
9	18	6.04	171.60	175.30	1.50	1.77	3.42	0.18	175.49	0.237	23.0	171.82	175.36	1.50	1.77	3.42	0.18	175.54	0.237	0.237	0.054	0.50	0.09
10	18	5.28	172.07	175.45	1.50	1.77	2.99	0.14	175.59	0.181	13.0	173.50	175.47	1.50	1.77	2.99	0.14	175.61	0.181	0.181	0.024	1.00	0.14
11	30	18.67	169.40	175.30	2.50	4.91	3.80	0.22	175.53	0.148	114	169.74	175.47	2.50	4.91	3.80	0.22	175.70	0.148	0.148	0.169	0.85	0.19
12	12	0.52	172.50	175.66	1.00	0.79	0.66	0.01	175.67	0.015	9.0	172.68	175.67	1.00	0.79	0.66	0.01	175.67	0.015	0.015	0.001	1.00	0.01
13	24	18.15	169.84	175.66	2.00	3.14	5.78	0.52	176.18	0.461	178	170.37	176.49	2.00	3.14	5.78	0.52	177.00	0.461	0.461	0.821	1.00	0.52
14	24	18.15	170.46	177.00	2.00	3.14	5.78	0.52	177.52	0.461	5.0	170.50	177.03	2.00	3.14	5.78	0.52	177.55	0.461	0.461	0.023	1.50	0.78
15	12	1.53	170.75	177.81	1.00	0.79	1.95	0.06	177.87	0.132	20.0	170.85	177.83	1.00	0.79	1.95	0.06	177.89	0.132	0.132	0.026	1.00	0.06
16	24	15.96	172.00	177.81	2.00	3.14	5.08	0.40	178.21	n/a	276	180.53	183.06i	1.41	2.38	6.72	0.70	183.76i	n/a	n/a	4.854	1.50	n/a
17	12	1.29	185.00	185.46	0.46*	0.35	3.64	0.21	185.67	n/a	22.0	185.11	185.83i	0.48	0.38	3.42	0.18	186.01i	n/a	n/a	0.158	1.00	n/a
18	18	13.84	181.03	183.06	1.50	1.77	7.83	0.95	184.02	n/a	247	188.44	191.81i	1.38	1.70	8.14	1.03	192.84i	n/a	n/a	7.794	0.75	n/a
19	15	9.10	190.77	192.02	1.25*	1.23	7.42	0.86	192.88	n/a	23.0	191.00	193.85i	1.25	1.23	7.42	0.85	194.70i	n/a	n/a	0.974	1.10	n/a
20	12	2.94	191.25	193.85	1.00	0.79	3.74	0.22	194.07	0.488	161	193.18	194.63	1.00	0.79	3.74	0.22	194.85	0.488	0.488	0.786	0.50	0.11

Project File: 11309ClosedDrainageSystem.6-4-13.stm

Number of lines: 27

Run Date: 06-14-2013

NOTES: * Normal depth assumed., ** Critical depth assumed., i Under inlet control.

Hydraulic Grade Line Computations

Line	Size (in)	Q (cfs)	Downstream								Len (ft)	Upstream								Check		JL coeff (K)	Minor loss (ft)
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
21	12	1.06	193.43	194.74	1.00	0.79	1.35	0.03	194.77	n/a	280	201.13	201.77i	0.44	0.33	3.22	0.16	201.93i	n/a	n/a	6.995	1.50	n/a
22	12	0.36	203.01	203.21	0.20*	0.11	3.24	0.16	203.37	n/a	24.0	203.25	203.59i	0.25	0.16	2.29	0.08	203.67i	n/a	n/a	0.216	1.00	n/a
23	15	4.74	188.75	191.81	1.25	1.23	3.86	0.23	192.04	0.386	18.0	188.84	191.88	1.25	1.23	3.86	0.23	192.11	0.386	0.386	0.069	0.70	0.16
24	15	4.40	191.00	192.04	1.04	1.09	4.02	0.25	192.29	n/a	107	191.54	192.97i	0.84	0.88	5.00	0.39	193.36i	n/a	n/a	0.679	0.70	n/a
25	12	0.37	192.64	192.97	0.33	0.23	1.62	0.04	193.01	n/a	96.0	194.13	194.47i	0.26	0.16	2.31	0.08	194.56i	n/a	n/a	1.460	1.00	n/a
26	15	3.67	191.79	192.97	1.18	1.20	3.05	0.15	193.12	n/a	80.0	194.66	195.92i	0.77	0.79	4.65	0.34	196.25i	n/a	n/a	2.800	1.25	n/a
27	12	2.18	195.16	195.92	0.76	0.64	3.41	0.18	196.10	n/a	34.0	195.49	196.52i	0.63	0.52	4.21	0.28	196.80i	n/a	n/a	0.422	1.00	n/a

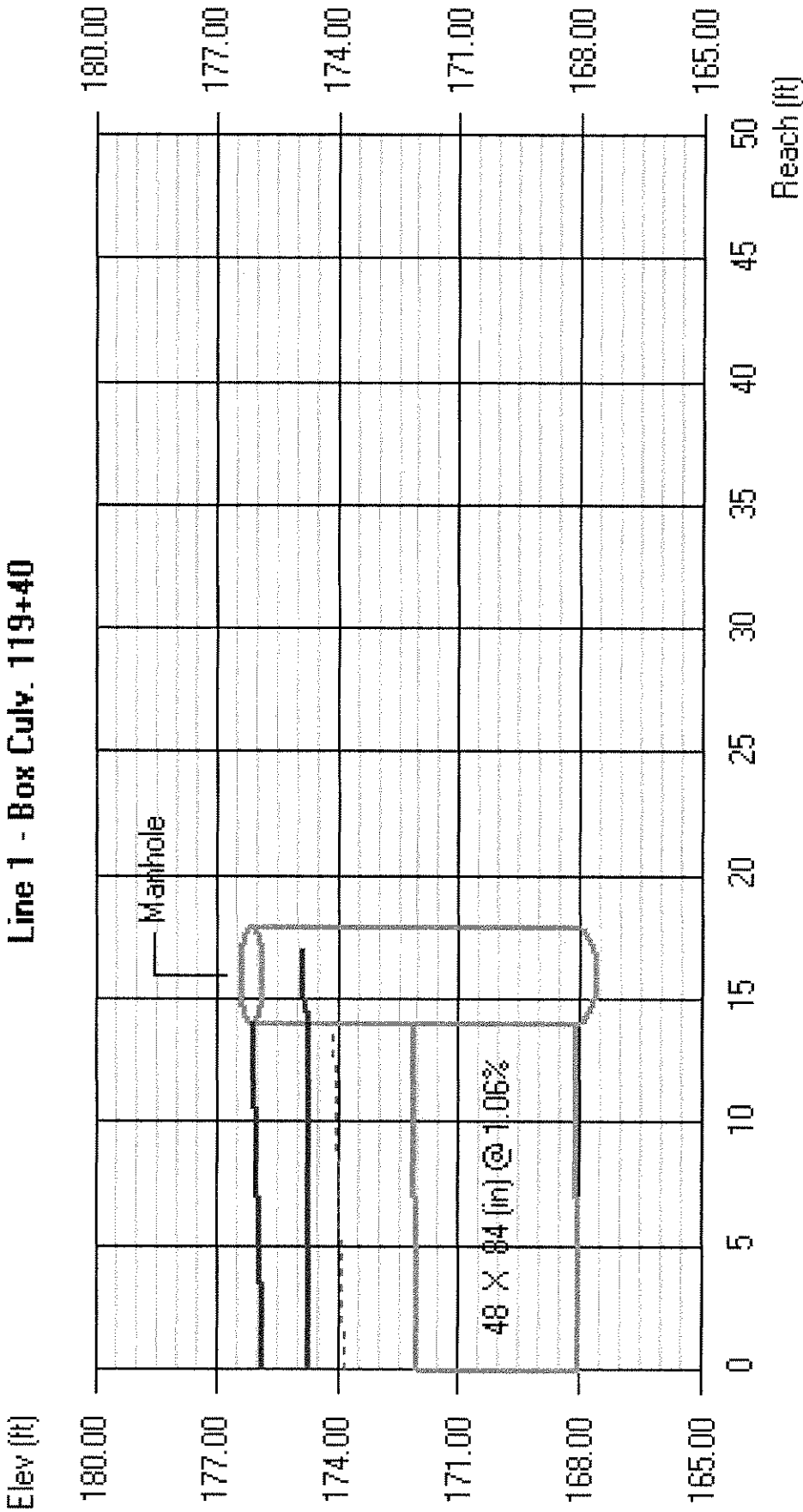
Project File: 11309ClosedDrainageSystem.6-4-13.stm

Number of lines: 27

Run Date: 06-14-2013

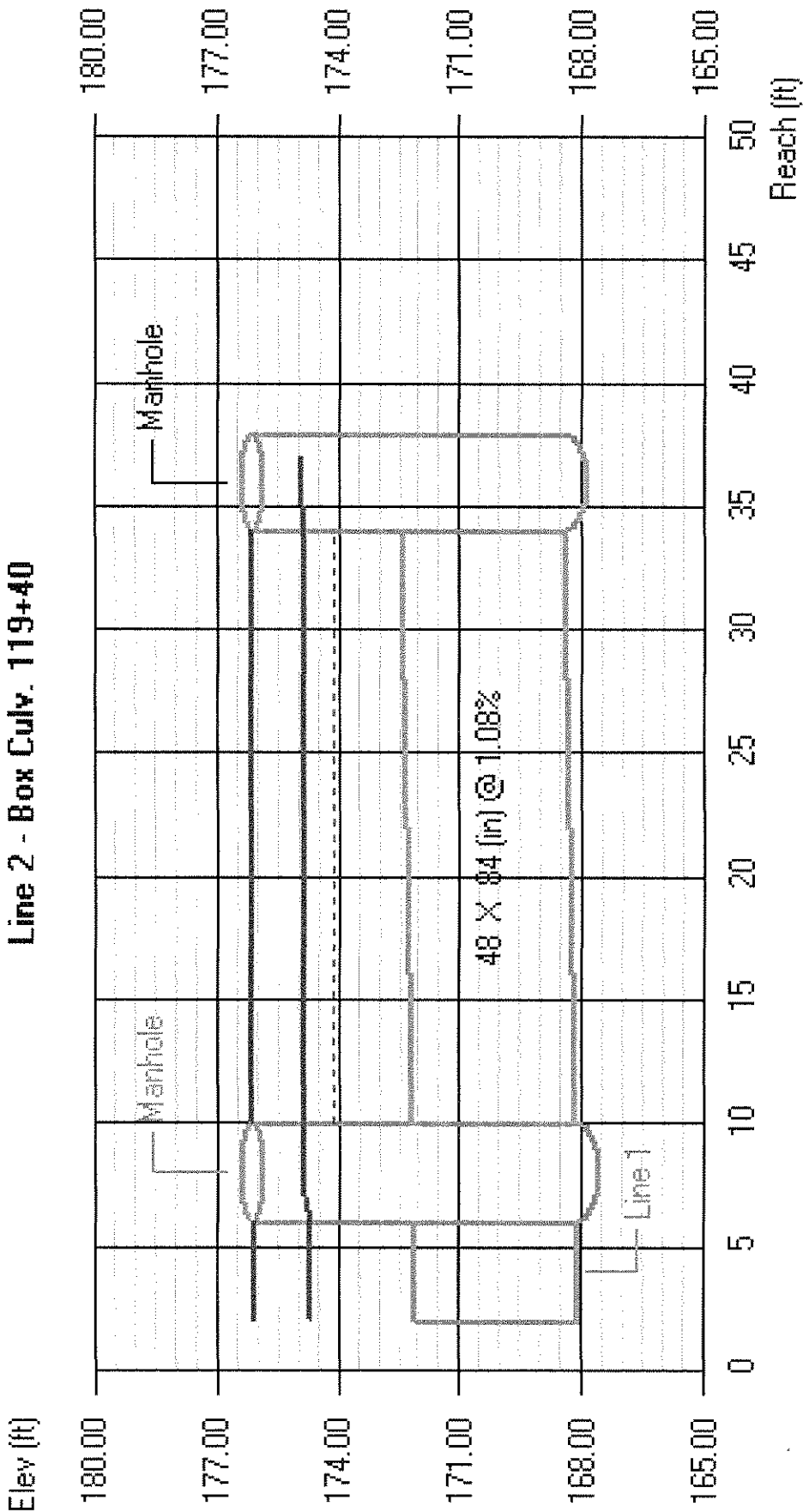
NOTES: * Normal depth assumed., ** Critical depth assumed., i Under inlet control.

Line 1 - Box Culv. 119+40



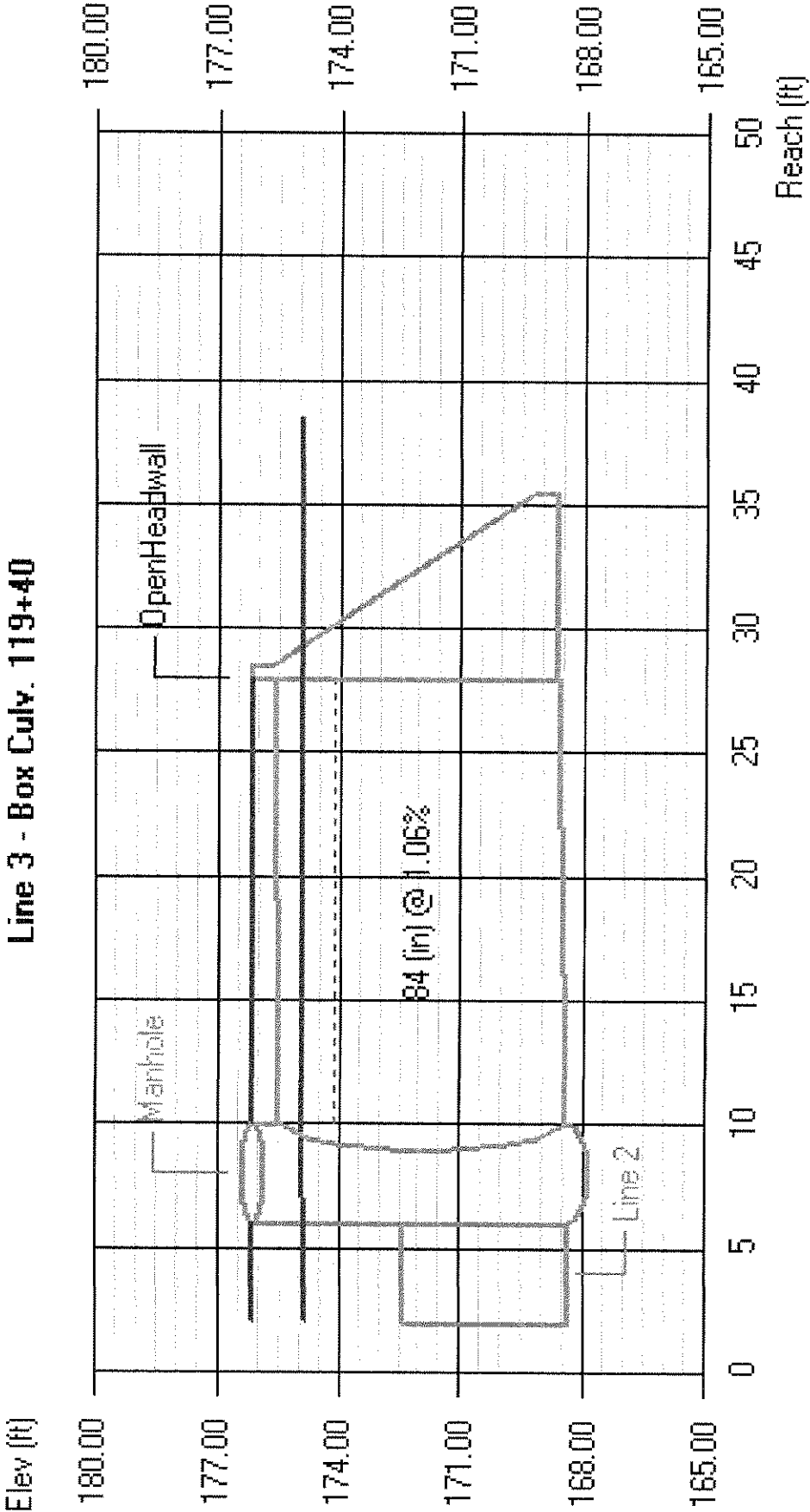
Storm Sewer Profile

Line 2 - Box Culv. 119+40

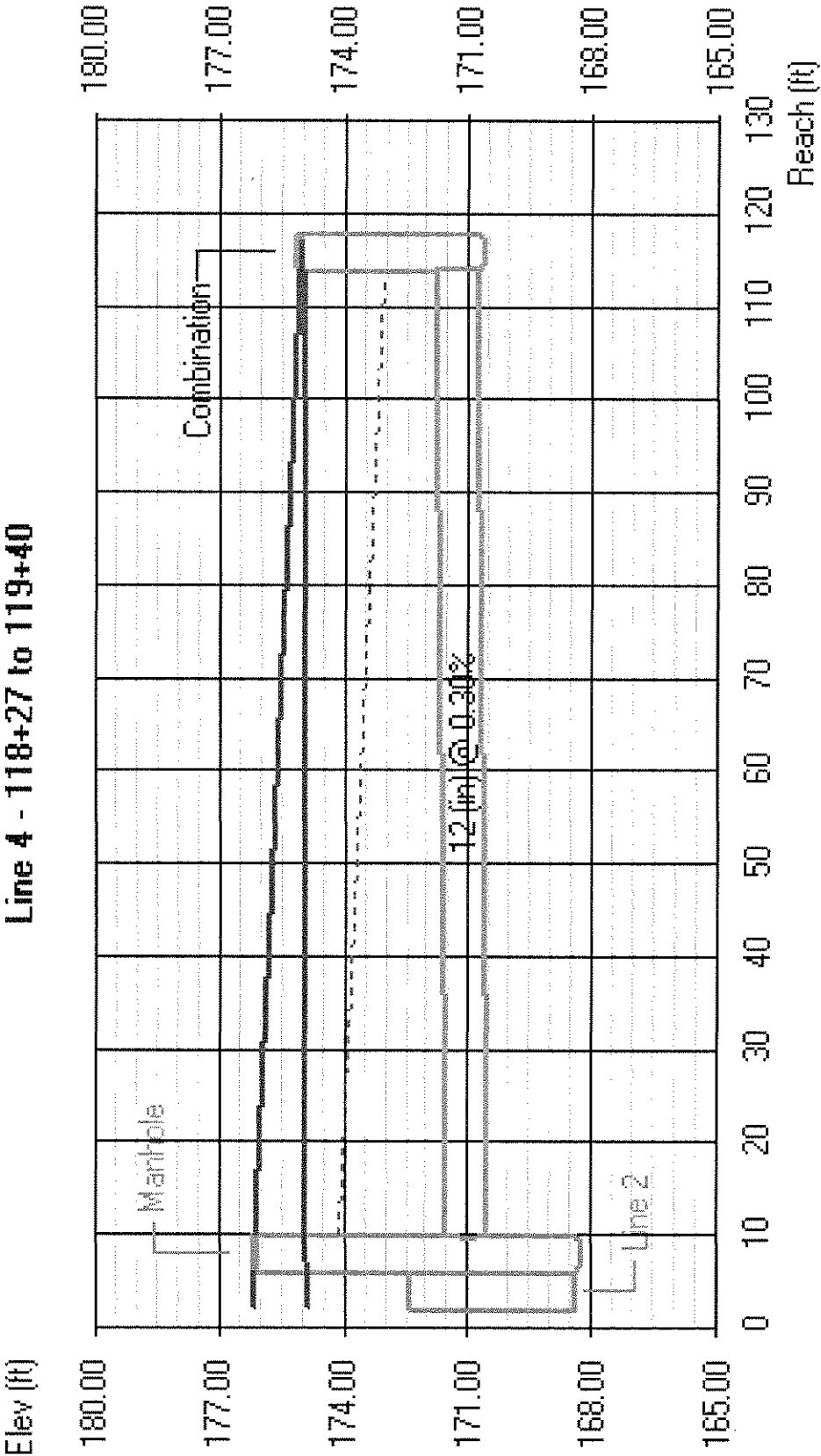


Storm Sewer Profile

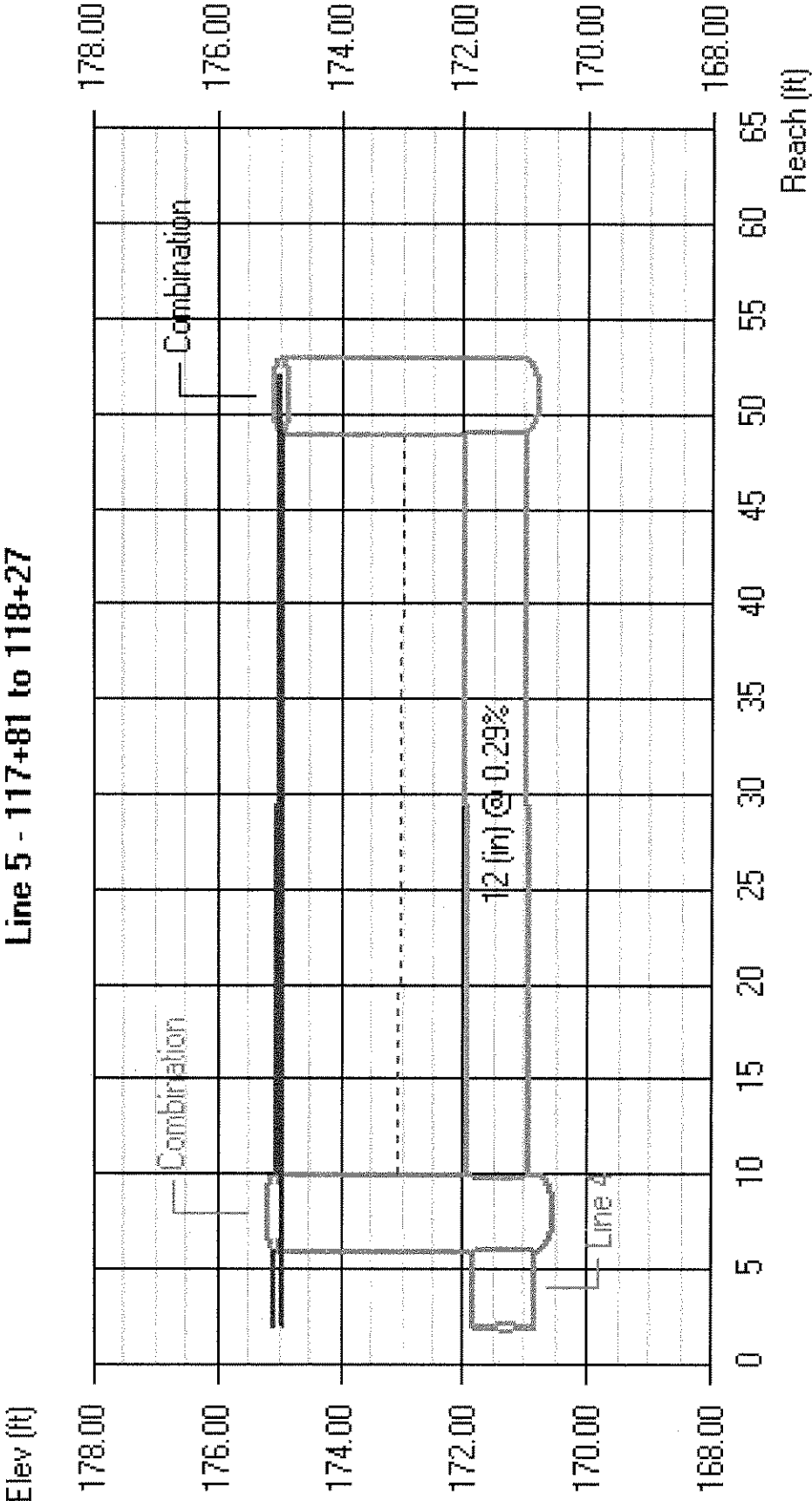
Line 3 - Box Culv. 119+40



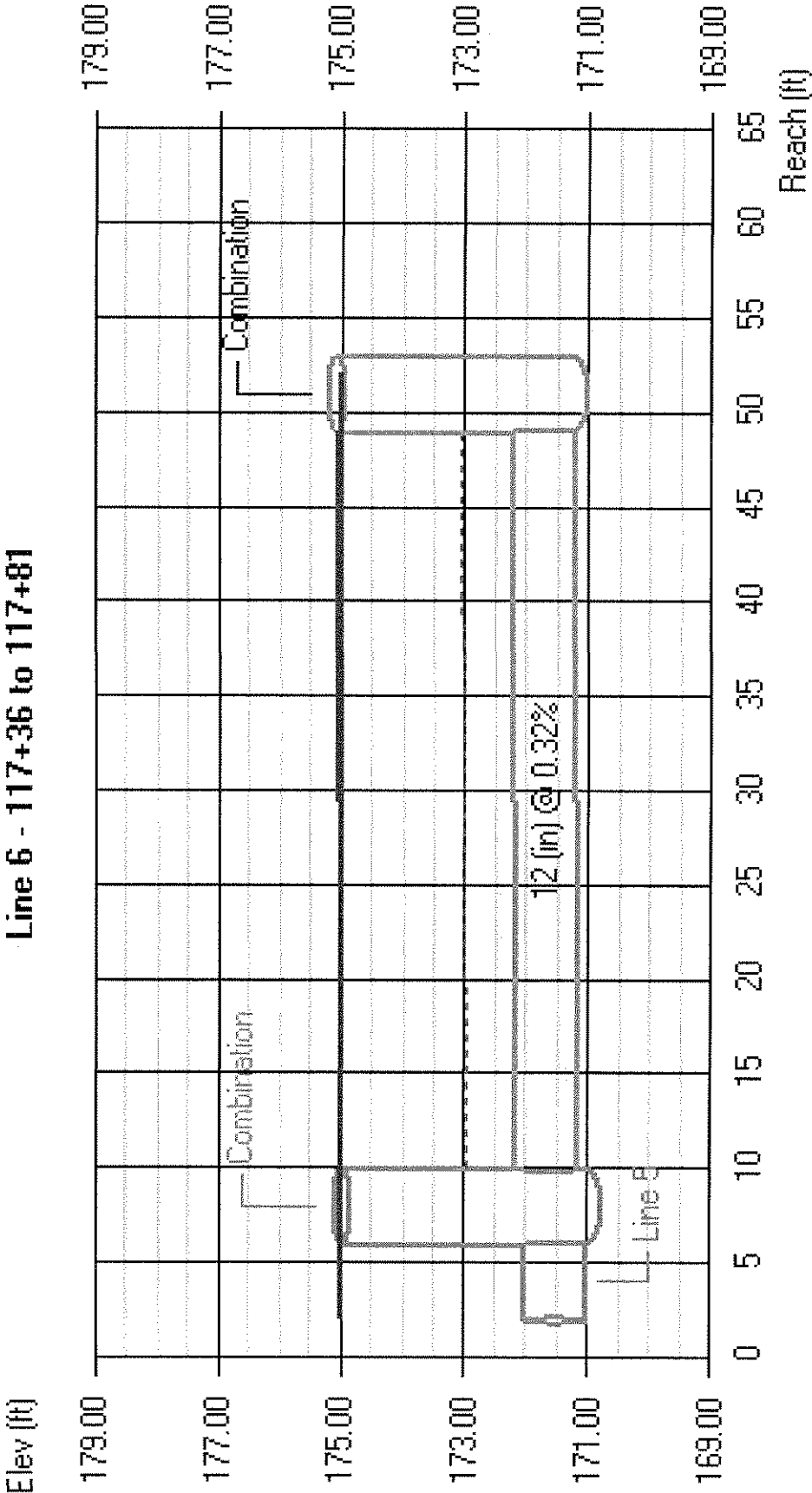
Storm Sewer Profile



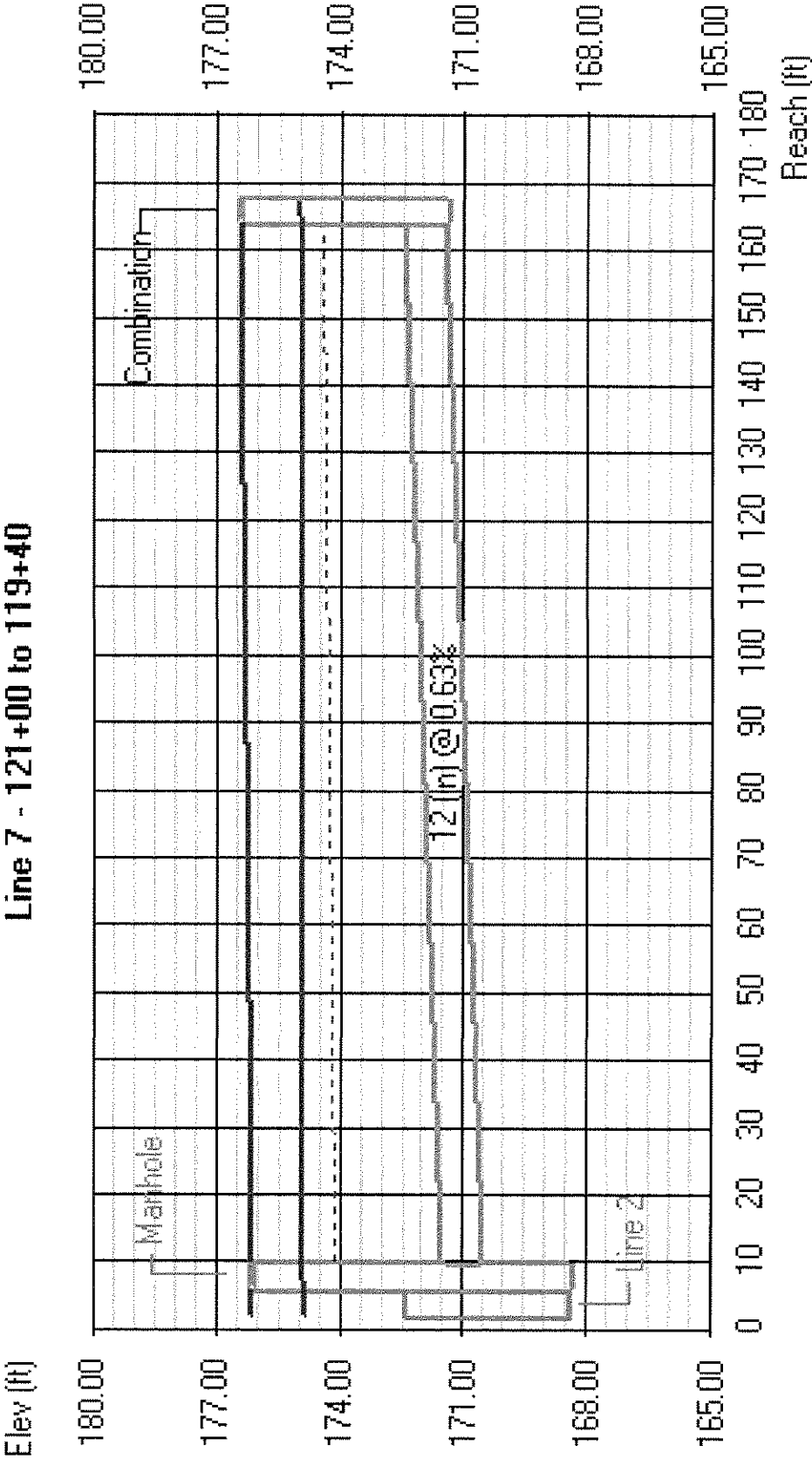
Line 5 - 117+81 to 118+27



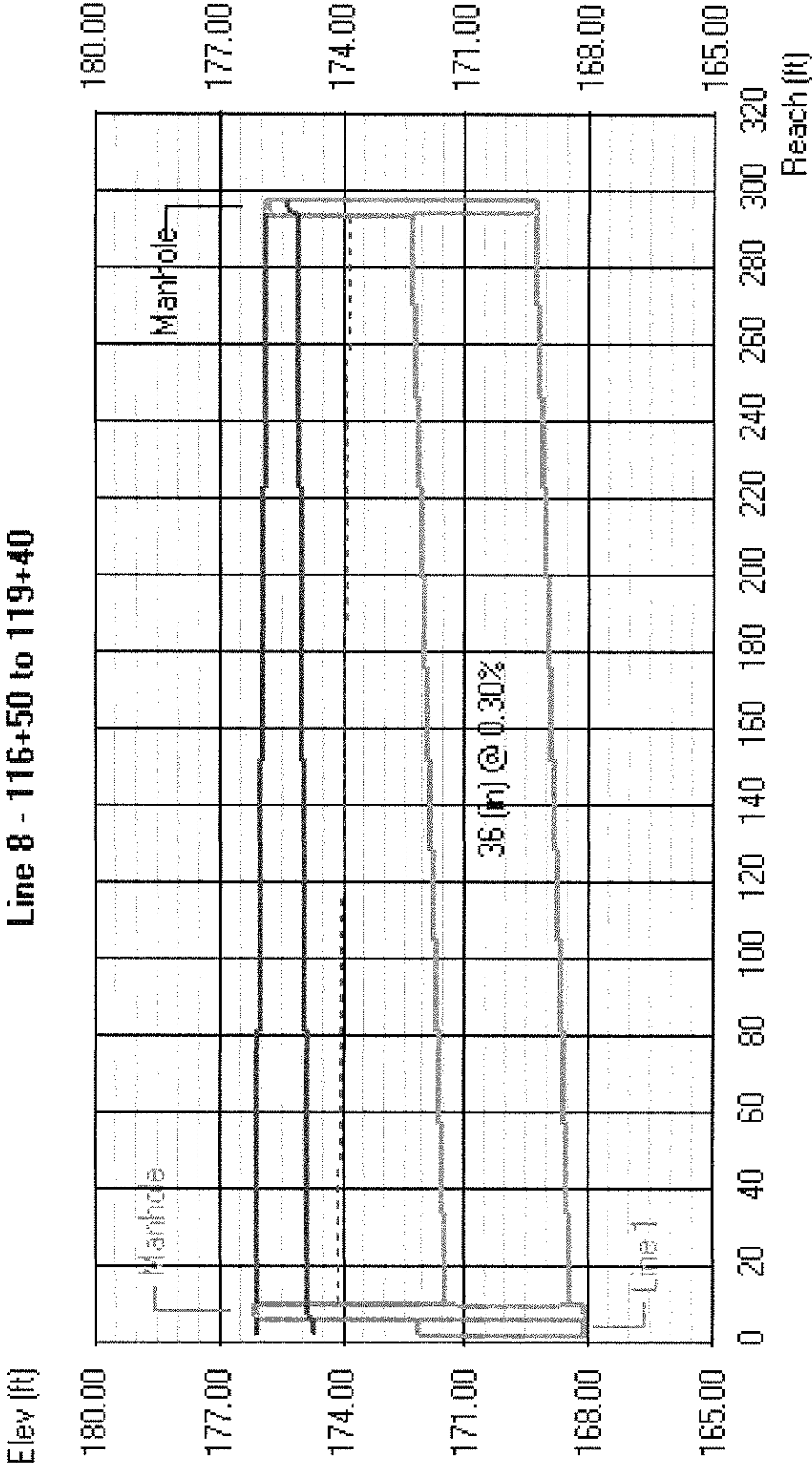
Line 6 - 117+36 to 117+81



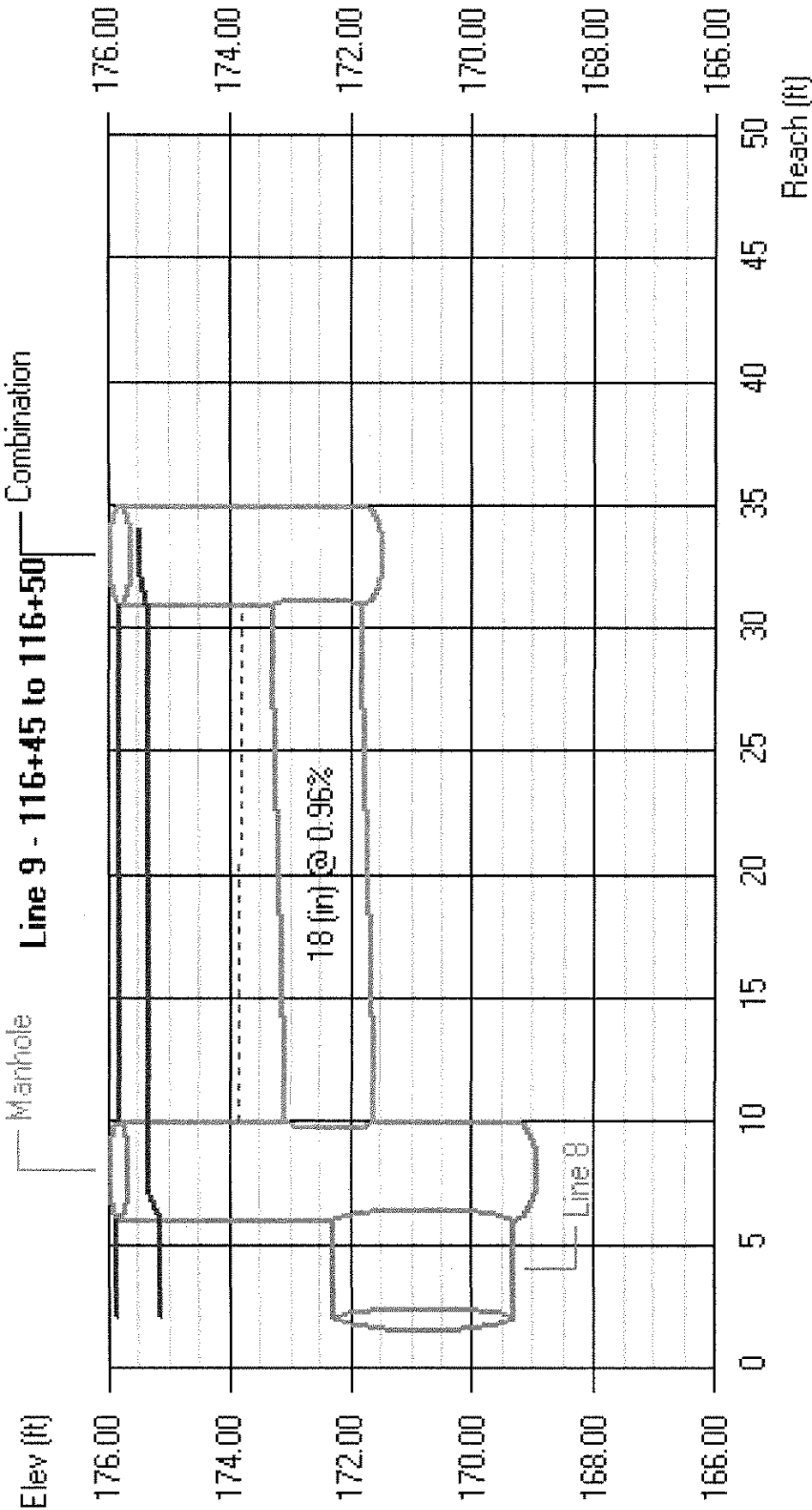
Line 7 - 121+00 to 119+40



Storm Sewer Profile

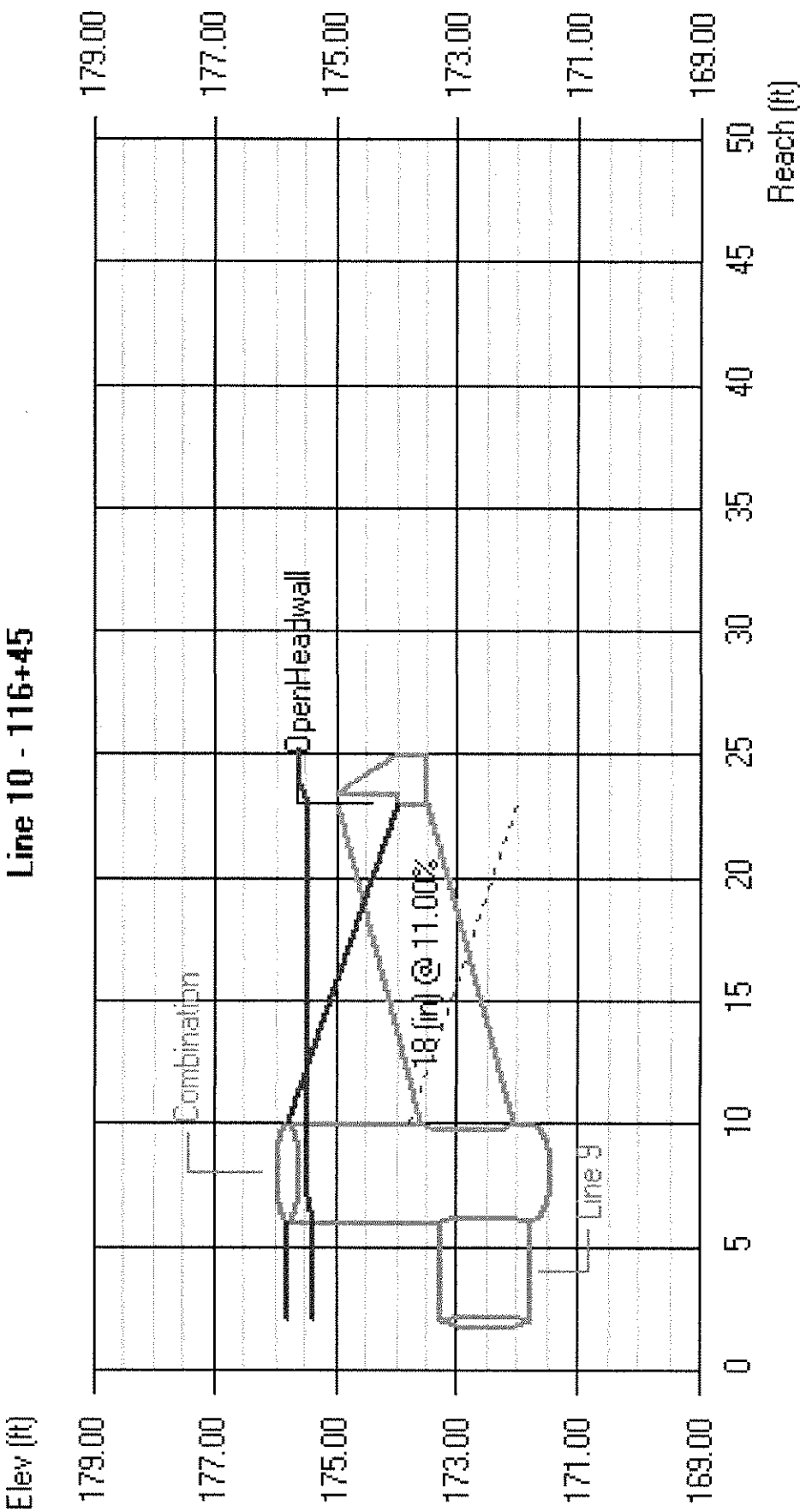


Storm Sewer Profile

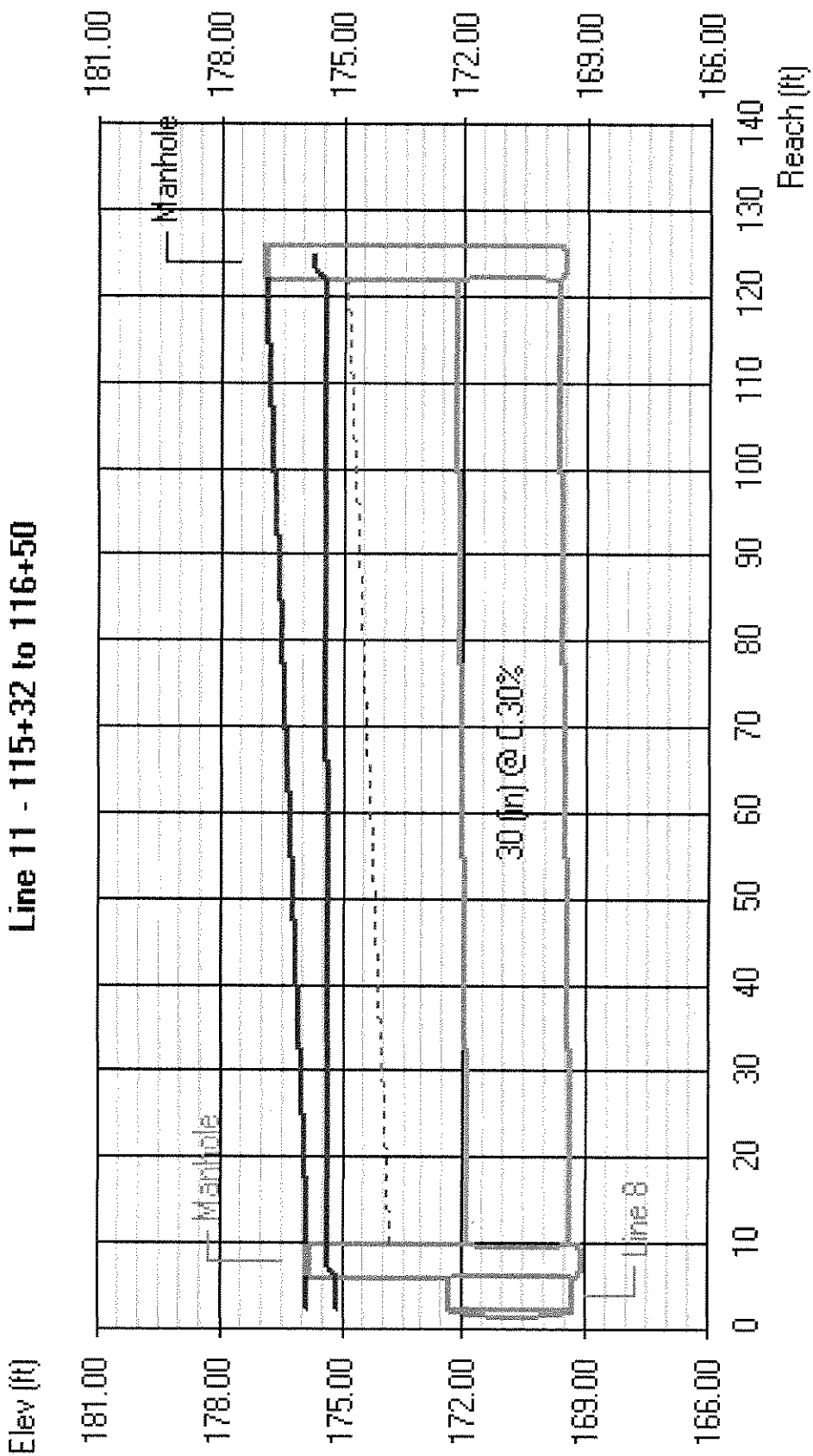


Storm Sewer Profile

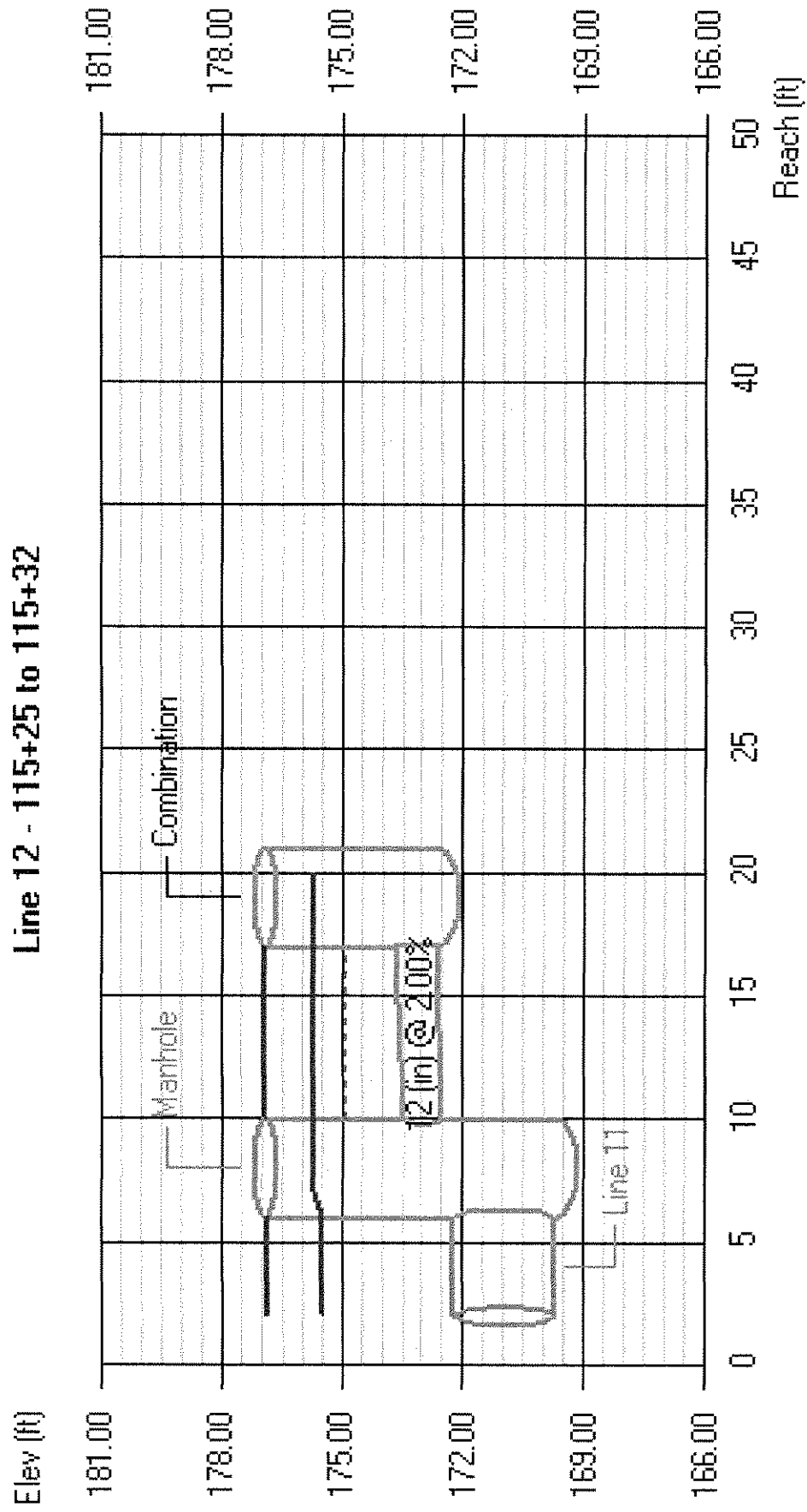
Line 10 - 116+45



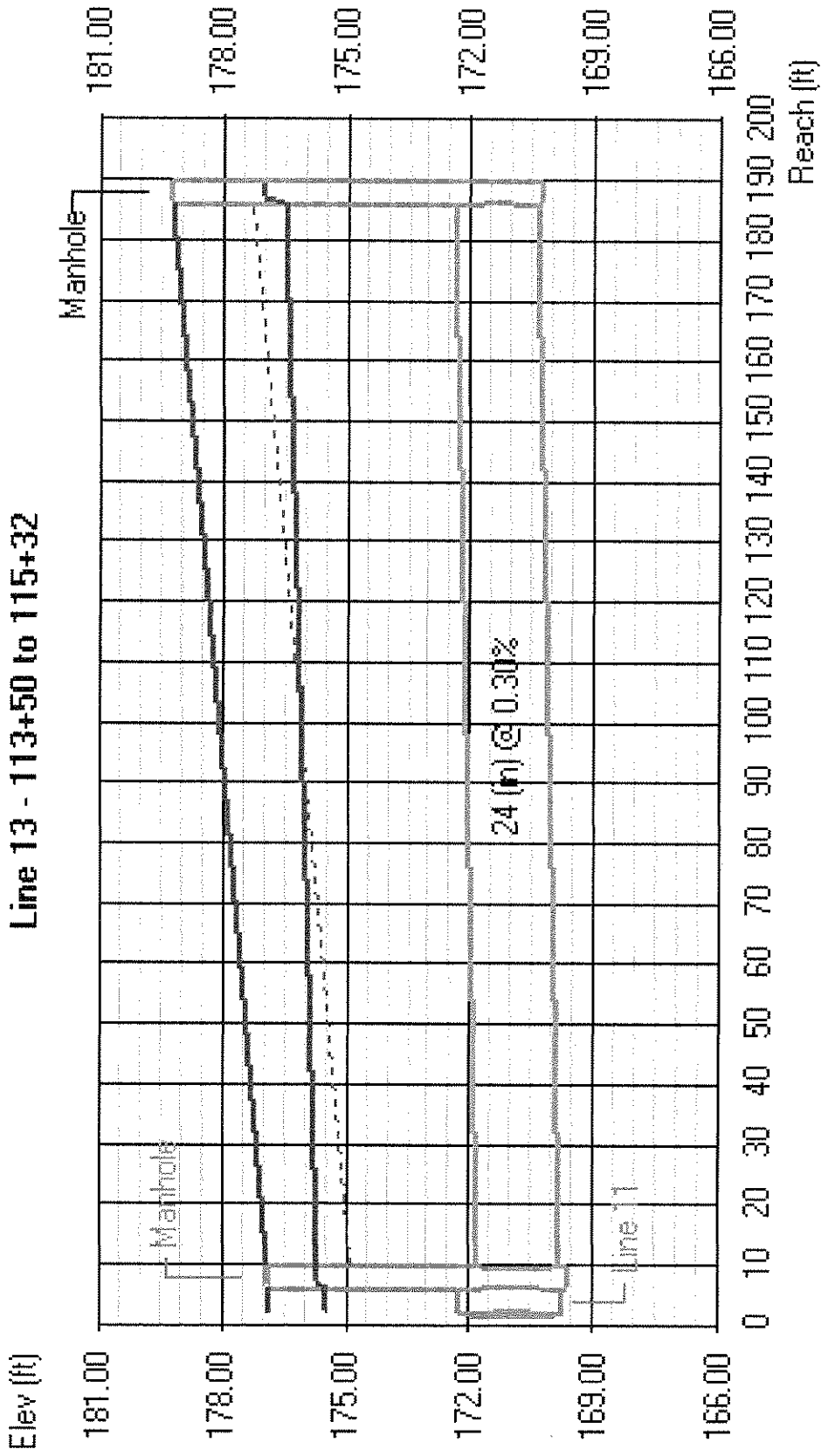
Storm Sewer Profile



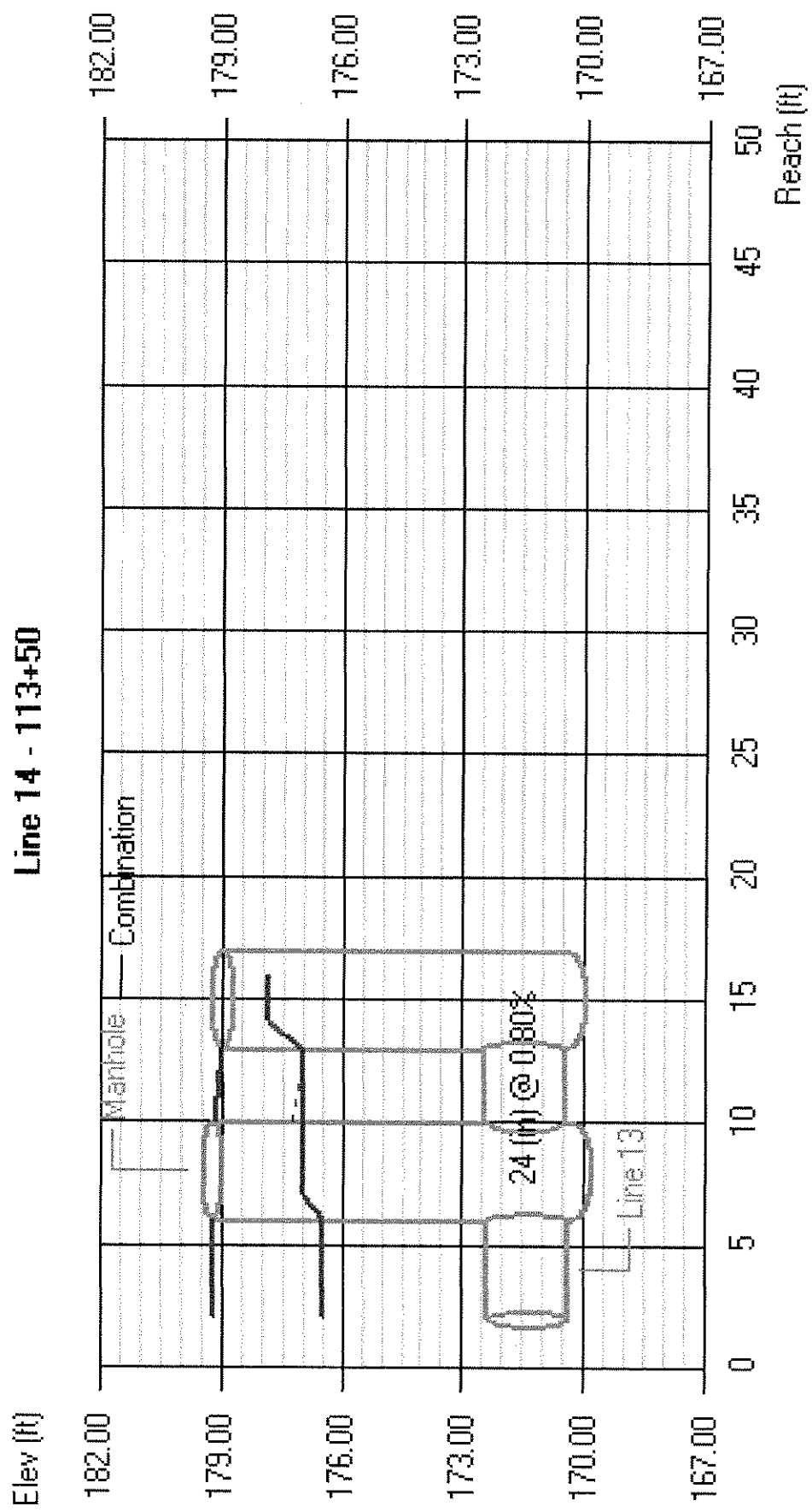
Line 12 - 115+25 to 115+32



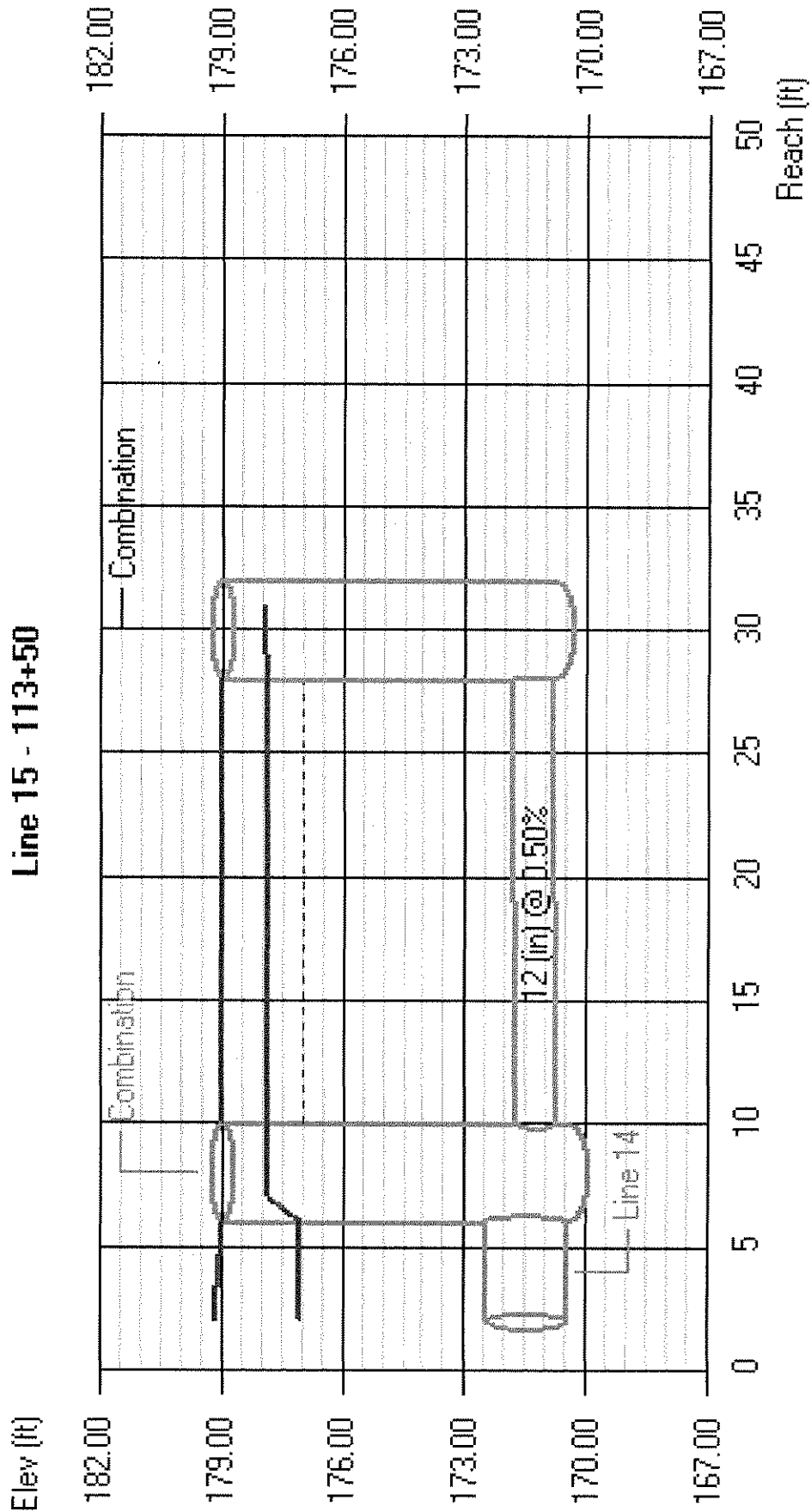
Storm Sewer Profile



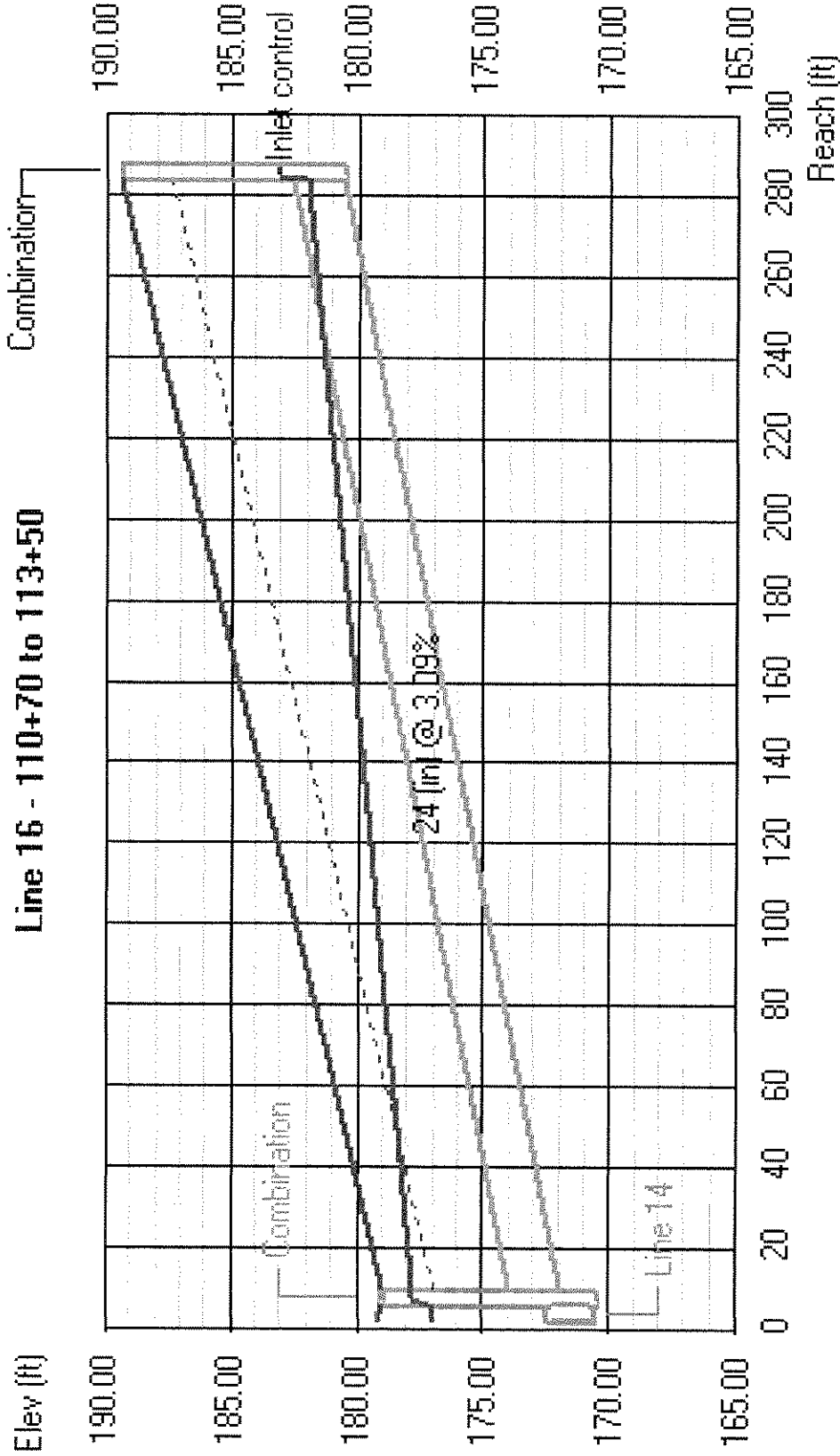
Line 14 - 113+50



Line 15 - 113+50

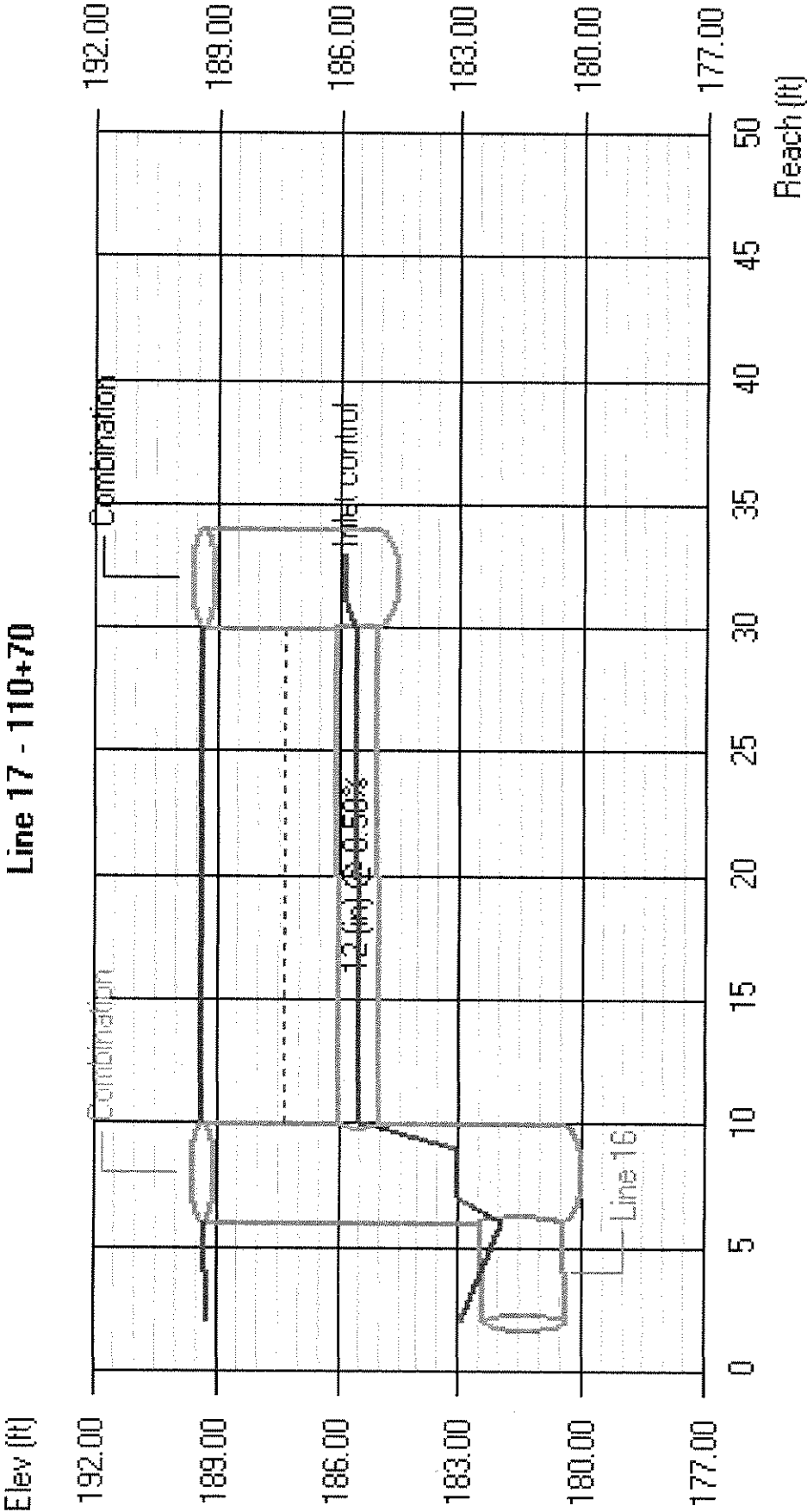


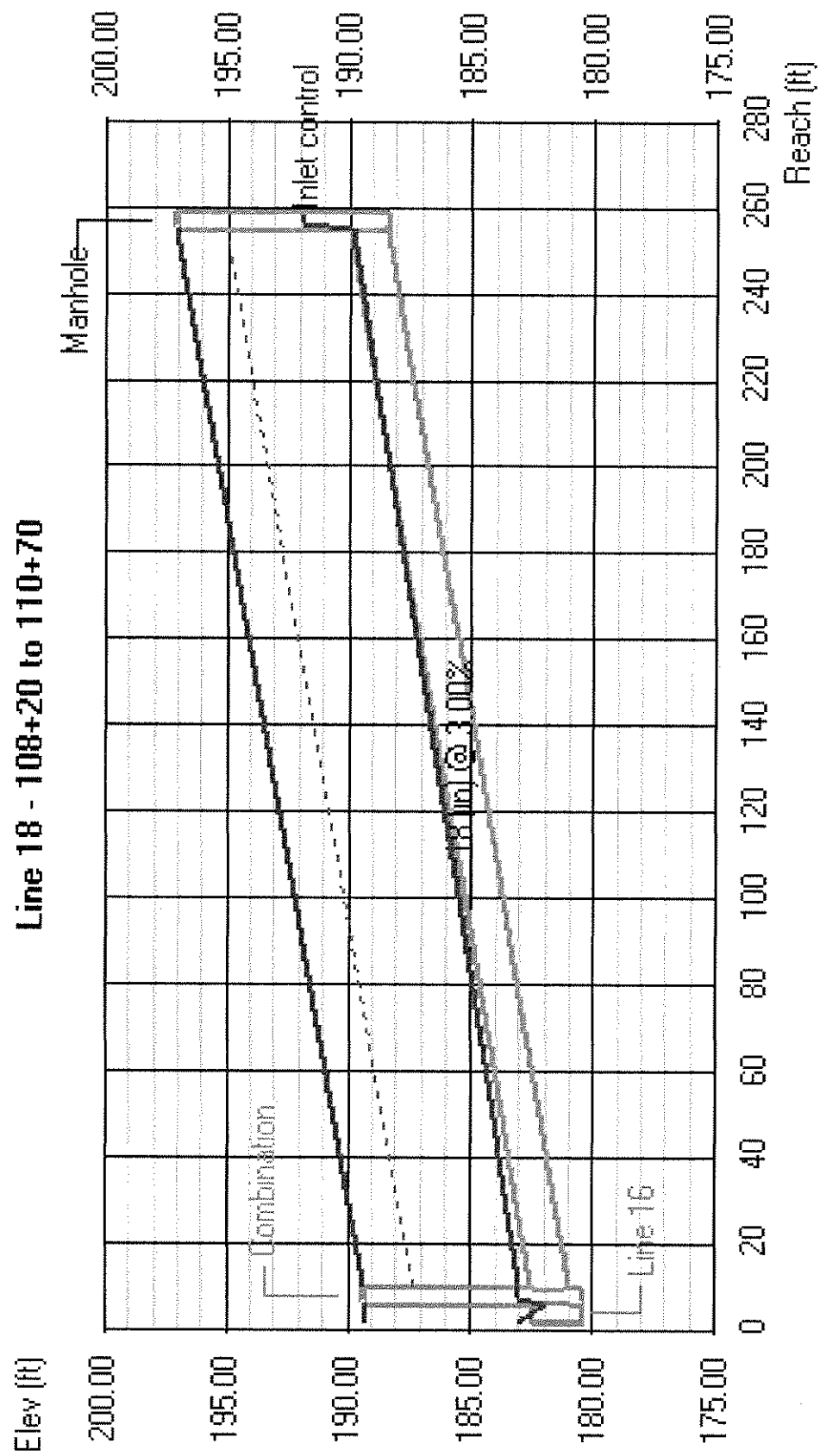
Storm Sewer Profile



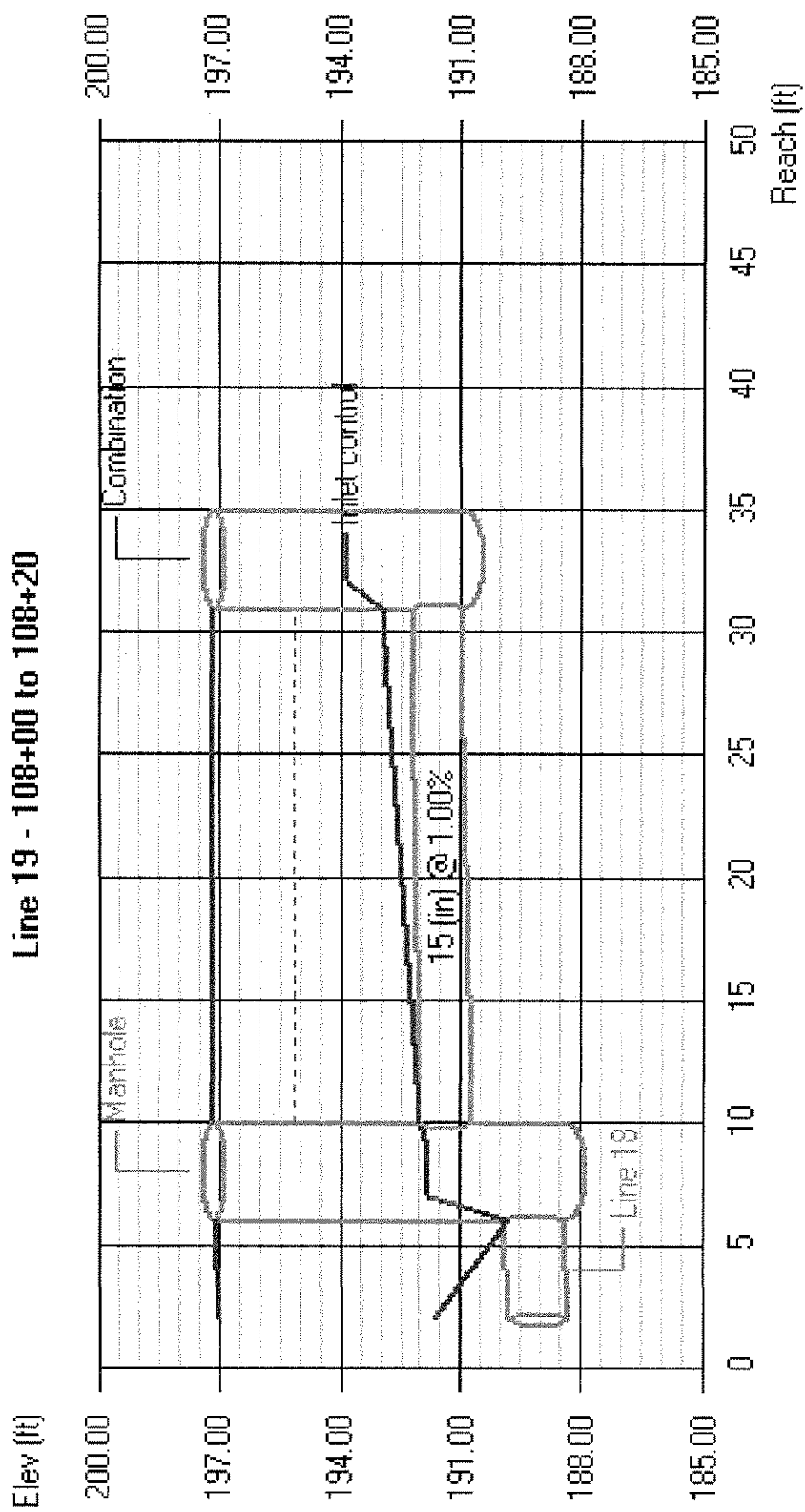
Storm Sewer Profile

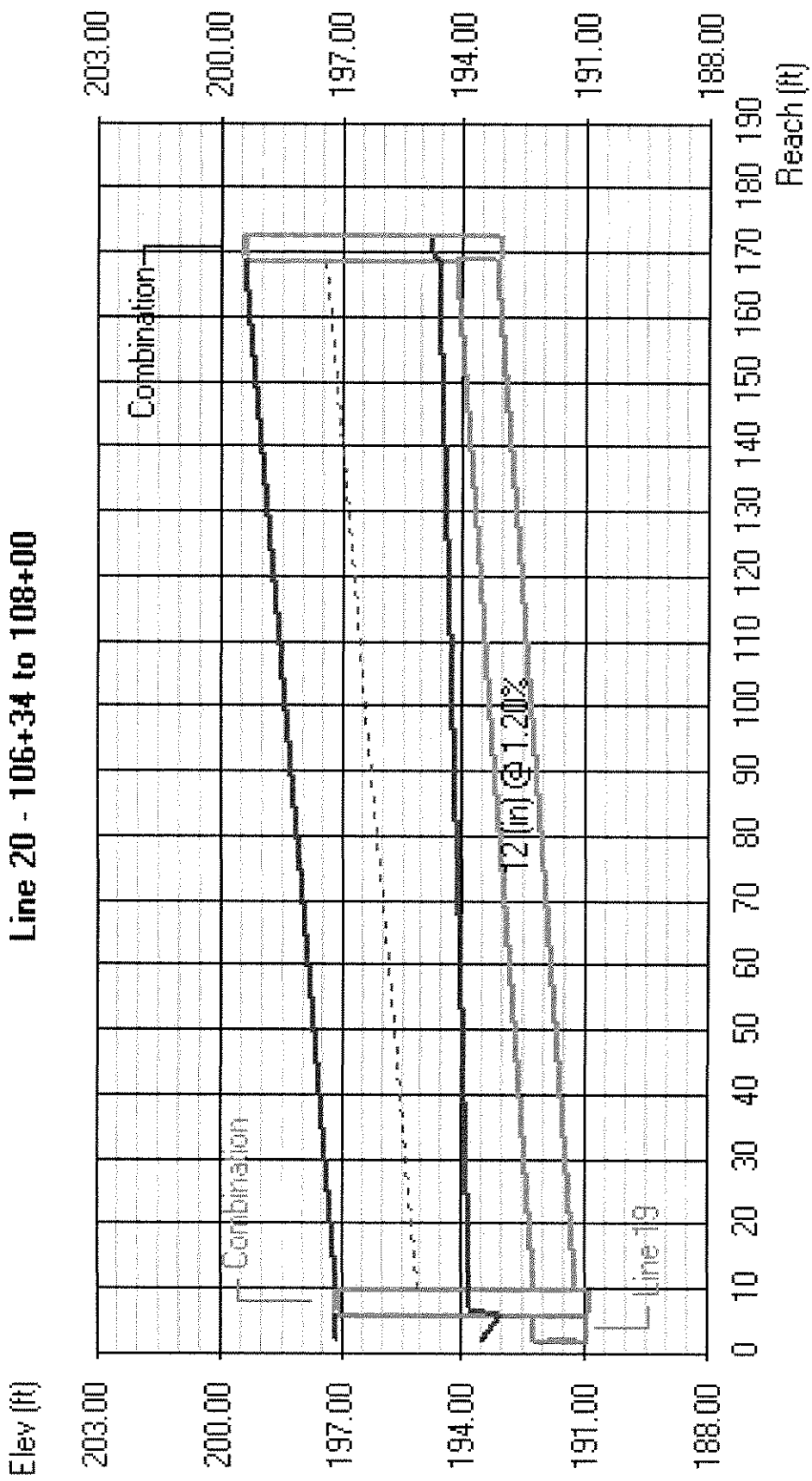
Line 17 - 110+70



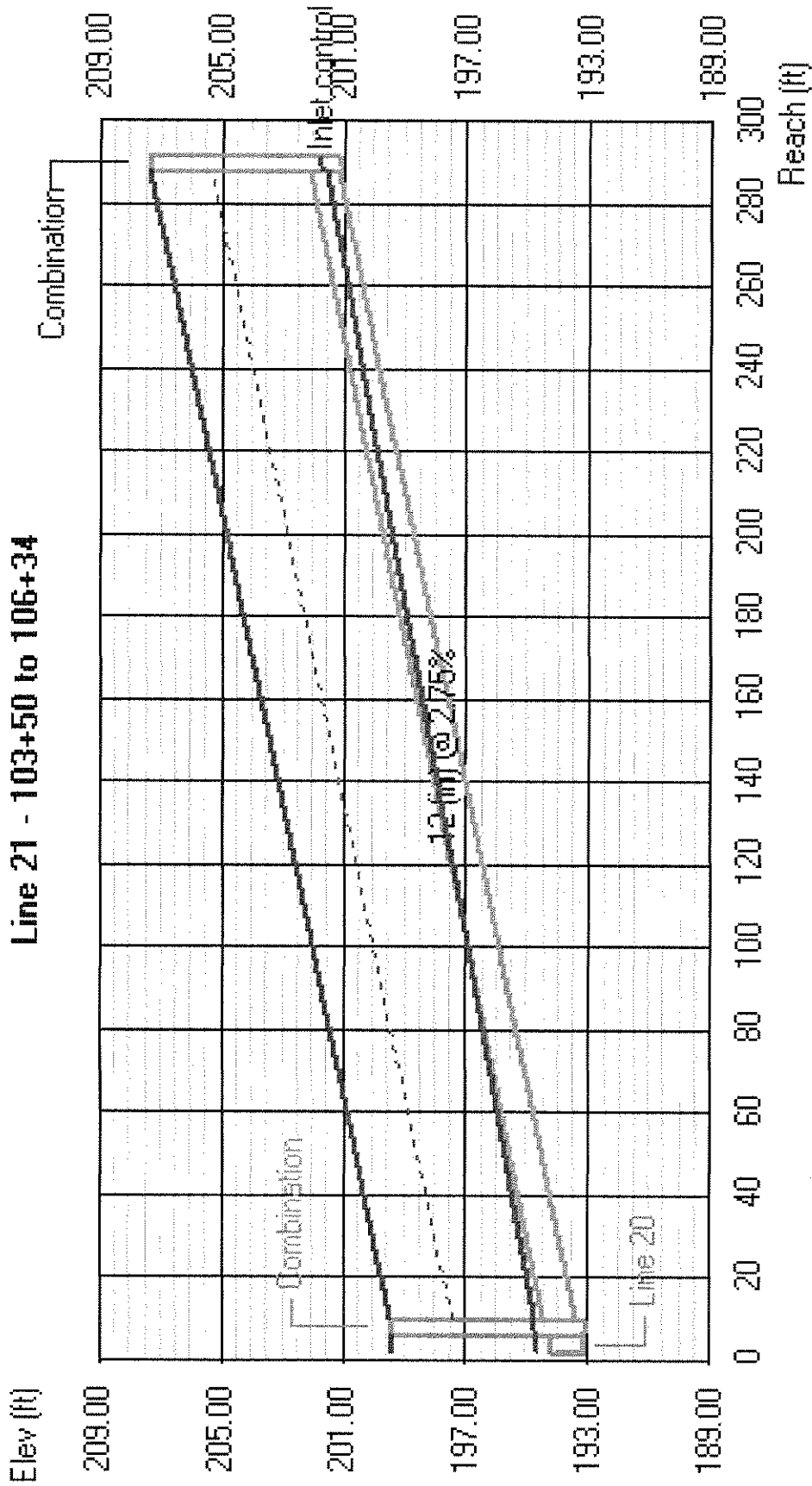


Line 19 - 108+00 to 108+20

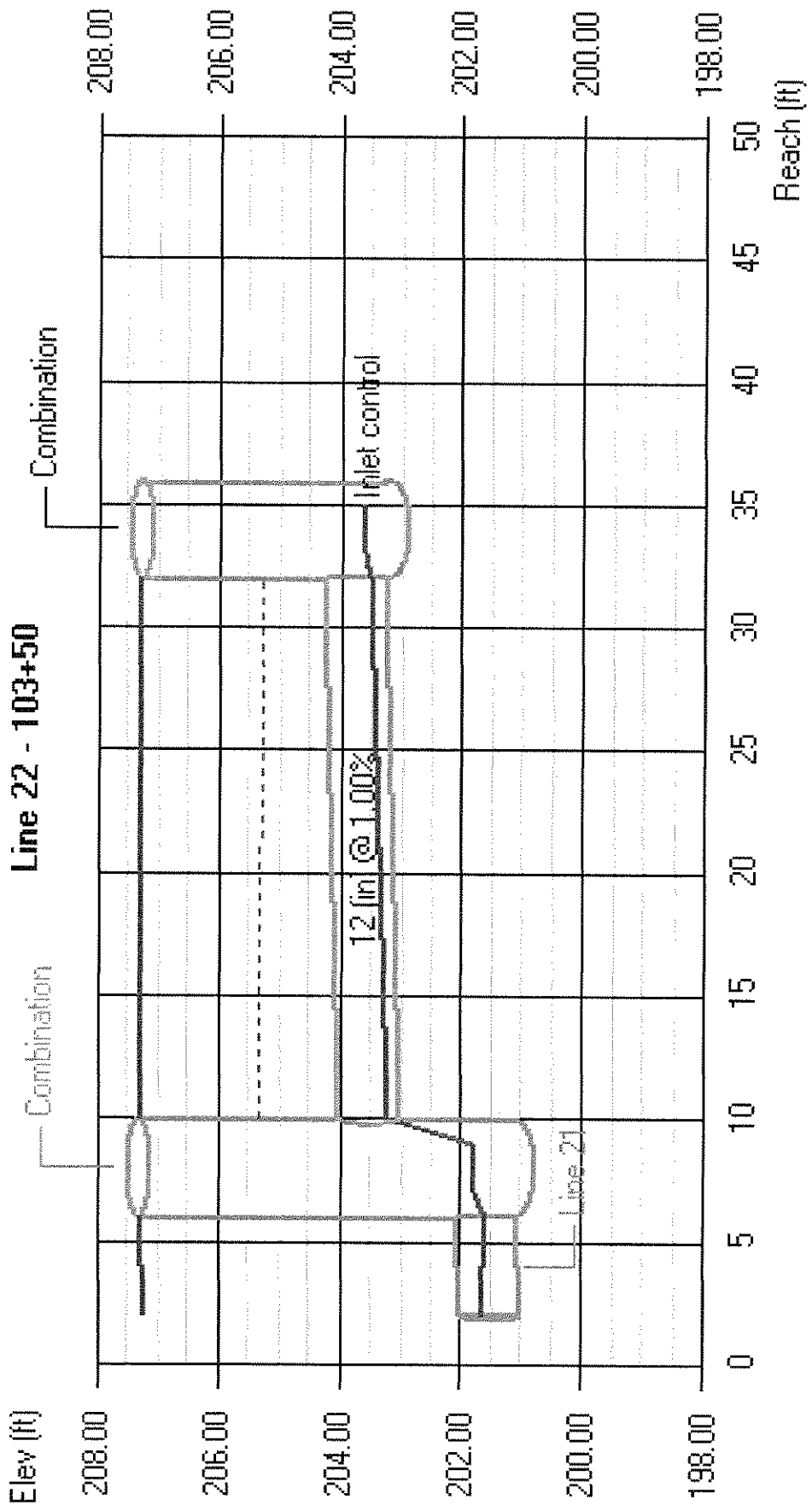




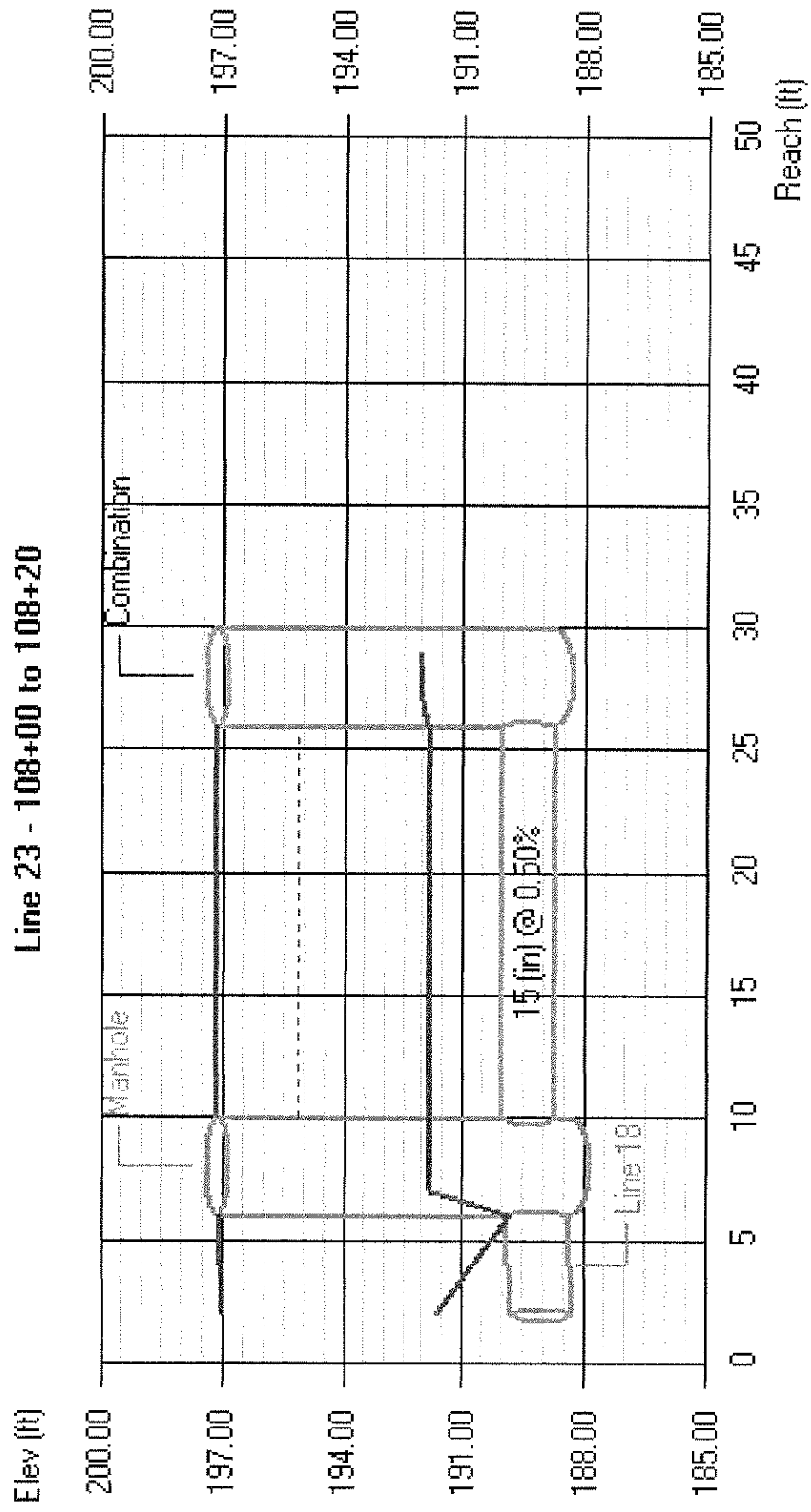
Storm Sewer Profile

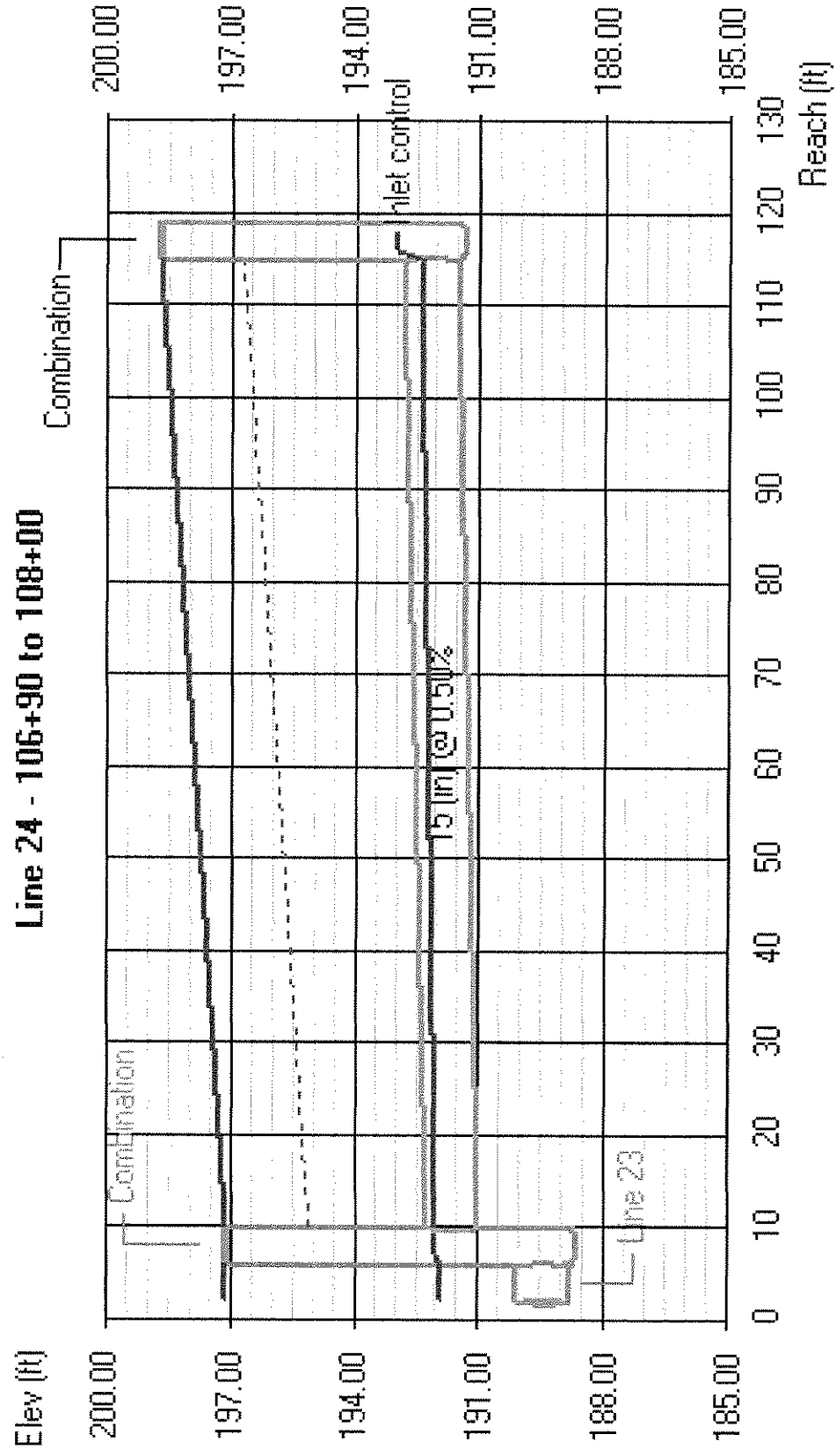


Storm Sewer Profile



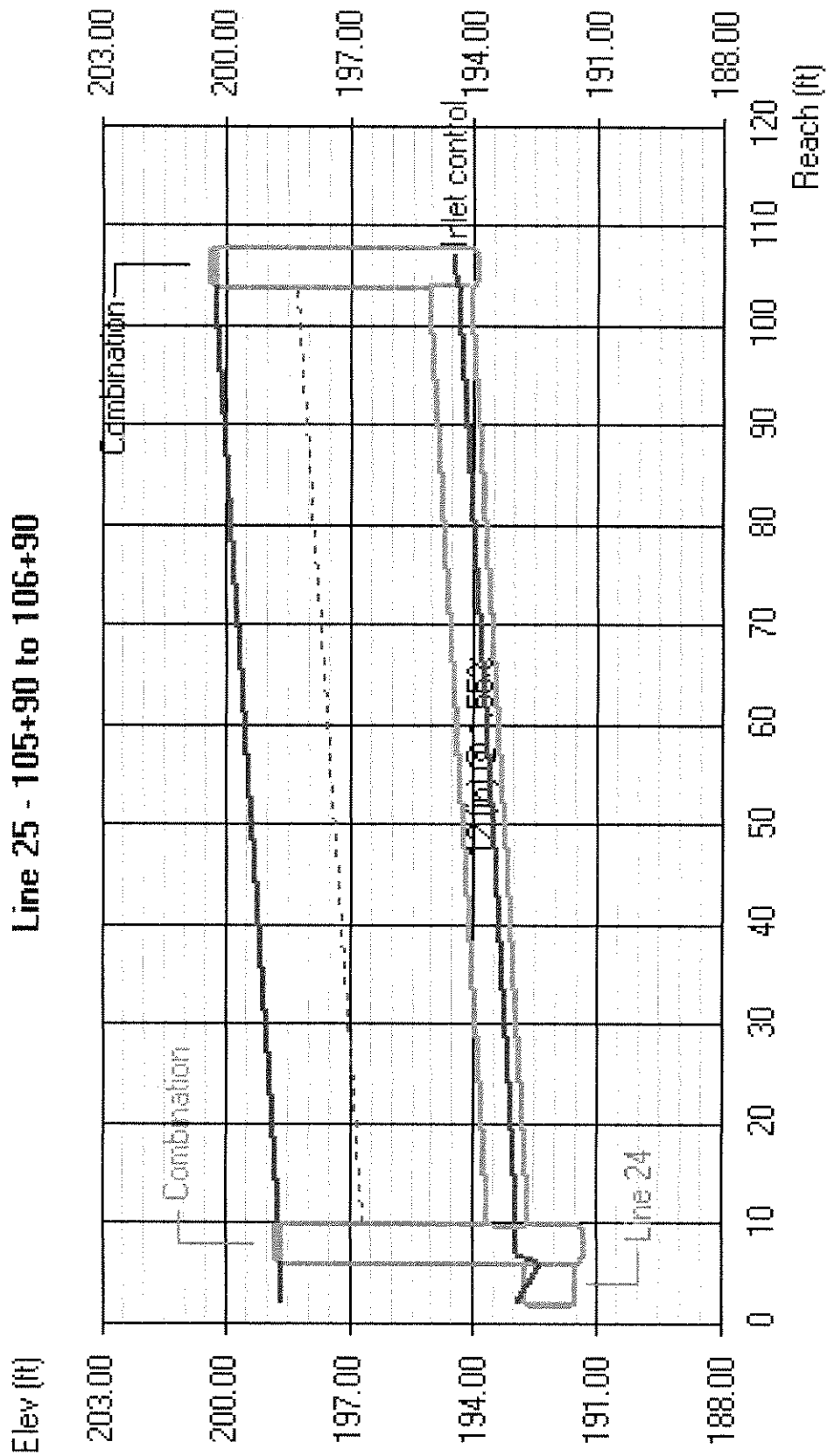
Line 23 - 108+00 to 108+20





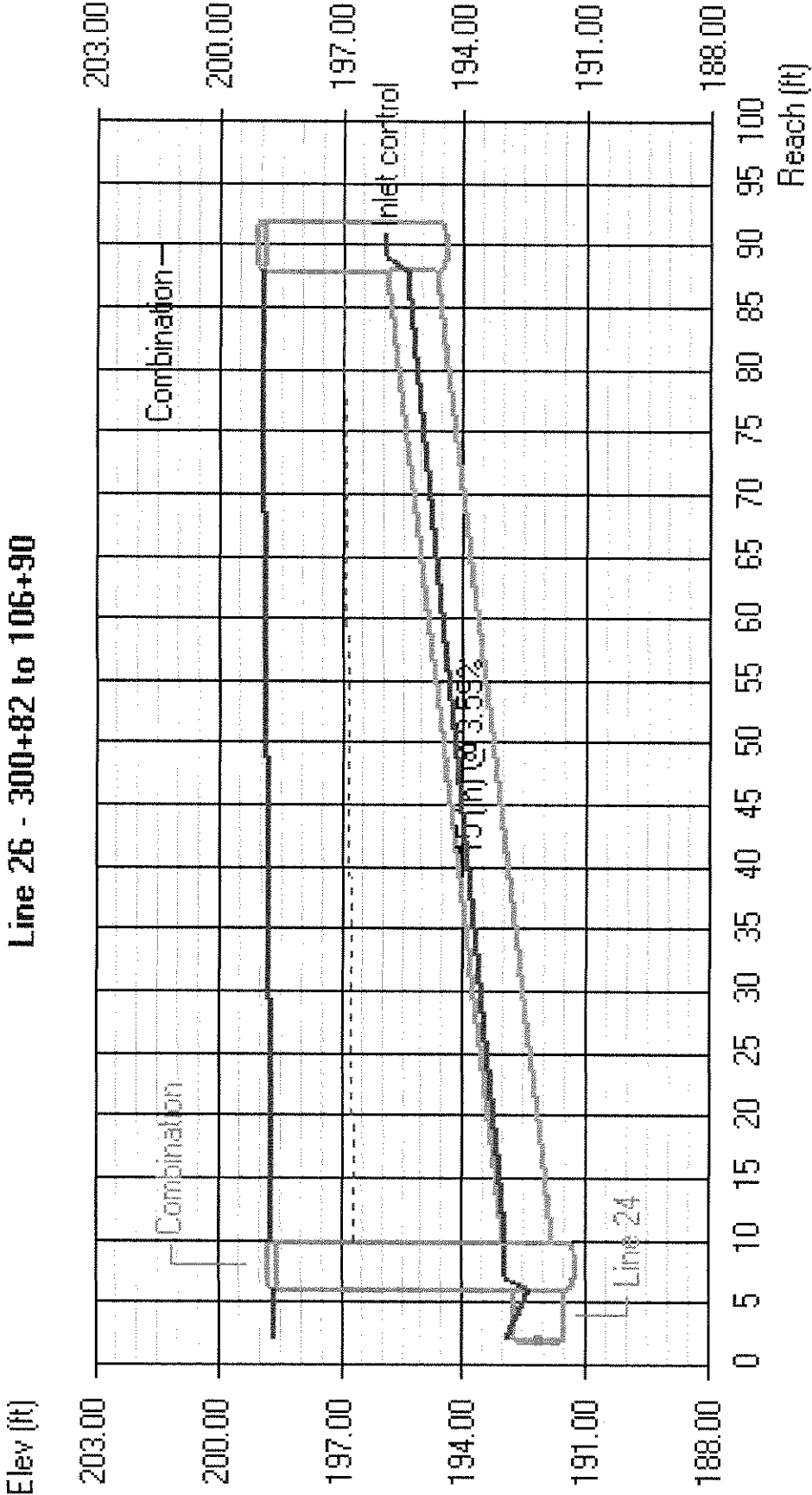
Storm Sewer Profile

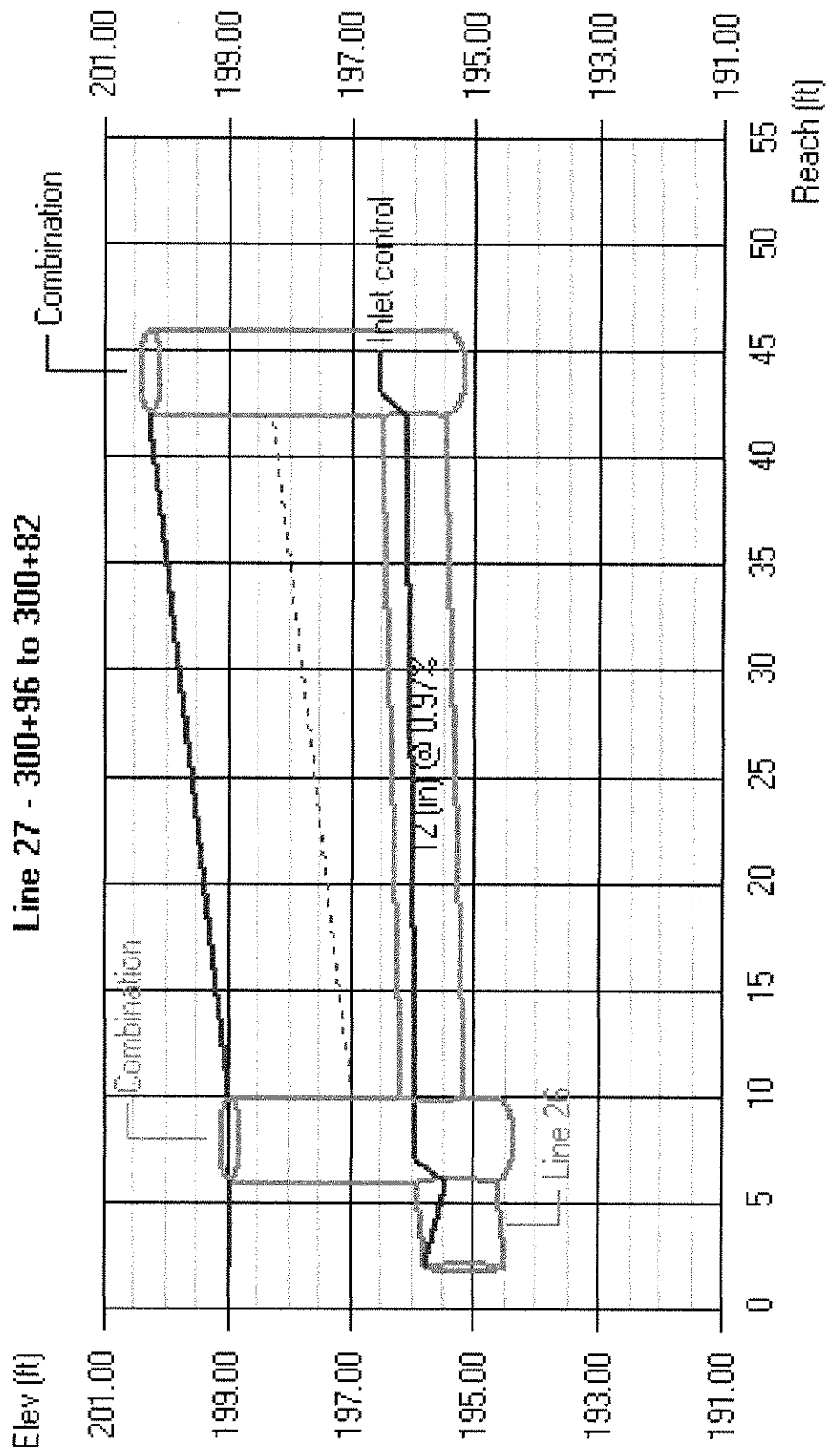
Proj. file: 11309ClosedDrainageSystem.6-4-13.stm



Storm Sewer Profile

Line 26 - 300+82 to 106+90







WATERSHED AREA 21

WATERSHED AREA 21 = 212,890 ACRES
C = 0.27 (44% 0.5 ACRE LOTS, 18% MEADOW, 38% WOODS)
TC = 112.0 MIN; 1 = 11.37
Q = 78.75 CFS

WATERSHED AREA 22 = 91,238 ACRES
C = 0.22 (39% 0.5 ACRE LOTS, 3% MEADOW, 58% WOODS)
TC = 81.8 MIN; 1 = 1.70
Q = 34.12 CFS

WATERSHED AREA 20 = 12,822 ACRES
C = 0.28 (83% 0.5 ACRE LOTS, 0% MEADOW, 17% WOODS)
TC = 60.2 MIN; 1 = 2.15
Q = 7.72 CFS



AREA 10 = 39,500 SF
C = 21% PAVEMENT(.85), 10% ROOF(.85),
7% TREES(.1) 61% GRASS(.15), 1% GRAVEL(.85)=0.371
TC = 10.4 MIN; i=3.84
Q = 1.292 CFS

AREA 14 = 25,600 SF
C = 24% PAVEMENT(.85), 1% ROOF(.85),
0% TREES, 73% GRASS(.15), 2% GRAVEL(.85)=0.339
TC = 10.3 MIN; i=3.807
Q = 0.758 CFS

AREA 8 = 13,500 SF
C = 37% PAVEMENT(.85), 12% ROOF(.85),
10% TREES(.1), 41% GRASS(.15), 1% GRAVEL(.85)=0.497
TC = 9.5 MIN; i=4.00
Q = 0.616 CFS

AREA 19 = 5,900 SF
C = 100% PAVEMENT(.85)=0.85
TC = 5.0 MIN; i=5.12
Q = 0.589 CFS

AREA 17 = 1,700 SF
C = 100% PAVEMENT(.85)=0.85
TC = 5.0 MIN; i=5.12
Q = 0.170 CFS

AREA 12 = 51,500 SF
C = 24% PAVEMENT(.85), 1% ROOF(.85),
0% TREES, 73% GRASS(.15), 2% GRAVEL(.85)=0.339
TC = 10.3 MIN; i=3.807
Q = 1.526 CFS

AREA 3 = 23,100 SF
C = 39% PAVEMENT(.85), 32% ROOF(.85),
21% GRASS(.15), 8% GRAVEL(.85)=0.703
TC = 5.3 MIN; i=5.05
Q = 1.883 CFS

AREA 4 = 6,800 SF
C = 42% PAVEMENT(.85), 18% ROOF(.85),
30% GRASS(.15), 10% GRAVEL(.85)=0.64
TC = 11.6 MIN; i=3.66
Q = 0.366 CFS

AREA 1 = 9,500 SF
C = 68% PAVEMENT(.85), 32% GRASS(.15)=0.626
TC = 5 MIN; i=5.12
Q = 0.699 CFS

AREA 18 = 5,500 SF
C = 100% PAVEMENT(.85)=0.85
TC = 5.0 MIN; i=5.12
Q = 0.549 CFS

AREA 2 = 9,100 SF
C = 34% PAVEMENT(.85), 3% ROOF(.85),
16% TREES(.1) 42% GRASS(.15), 5% GRAVEL(.85)=0.436
TC = 9.5 MIN; i=4.0
Q = 0.364 CFS

AREA 15 = 10,700 SF
C = 38% PAVEMENT(.85),
62% GRASS(.15) = 0.416
TC = 2.3 MIN; i = 5.12
Q = 0.523 CFS

AREA 13 = 13,500 SF
C = 38% PAVEMENT(.85),
62% GRASS(.15) = 0.416
TC = 2.3 MIN; i = 5.12
Q = 0.660 CFS

AREA 11 = 11,700 SF
C = 65% PAVEMENT(.85),
35% GRASS(.15) = 0.605
TC = 1.2 MIN; i = 5.12
Q = 0.832 CFS

AREA 7 = 6,900 SF
C = 66% PAVEMENT(.85),
33% GRASS(.15), 1% GRAVEL(.85)=0.619
TC = 11.6 MIN; i=3.66
Q = 0.359 CFS

AREA 5 = 50,800 SF
C = 25% PAVEMENT(.85), 19% ROOF(.85),
7% TREES(.1) 41% GRASS(.15), 8% GRAVEL(.85)=0.511
TC = 11.6 MIN; i=3.66
Q = 2.181 CFS

AREA 16 = 1,800 SF
C = 85% PAVEMENT(.85)=0.85
TC = 5.0 MIN; i=5.12
Q = 0.180 CFS

AREA 9 = 6,500 SF
C = 66% PAVEMENT(.85),
33% GRASS(.15), 1% GRAVEL(.85)=0.619
TC = 11.6 MIN; i=3.66
Q = 0.338 CFS

AREA 6 = 32,600 SF
C = 36% PAVEMENT(.85), 14% ROOF(.85),
44% GRASS(.15), 6% GRAVEL(.85)=0.542
TC = 11.6 MIN; i=3.66
Q = 1.485 CFS