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G-000-101.102

MANHOLE 180 OVERFLOW

05-26-1989

WMCO/WMCO
WMCO:LWE:89-022
26
LETTER

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~~R-001-101.8~~
G-000-101.102

From: D. J. Brettschneider/6101 WMCO:LWE:89-022

Date: May 26, 1989

Subject: **MANHOLE 180 OVERFLOW**

To : W. A. Weinreich

REFERENCES: 1) MEMO WMCO:R(RIFS):89-052, C.R. Connor to W.A. Weinreich, "Elevated Concentrations of Uranium in Offsite Soils," dated May 8, 1989.
2) MEMO WMCO:LWE:89-021, R.W. Kneip to D.J. Brettschneider, "FMPC Outfall Manhole Observations and Recommendations," dated May 8, 1989.
3) Presentation to EPA on South Plume Interim Action on April 25, 1989.
4) RI/FS Field Activity Daily Log from Video Industrial Services Inc. during Task 9.3, 1987 Main Effluent Outfall Line Cleanout, Grouting and Video Monitoring.

Task 5 of Reference 1 requests Environmental Engineering to perform an evaluation of the root cause of the Manhole 180 overflow which occurred on April 4, 1989. Attached is the requested Task 5 report. A summary of the field inspection of the manholes located along the low-pressure portion of the FMPC effluent sewer (Reference 2) is attached to the report.

The report also provides an analysis of the FMPC wastewater effluent low-pressure sewer under a flow condition of 2500 gallons per minute (gpm). This flow could be expected if the 1500 gpm South Plume flow (Reference 3) is added to the normal FMPC effluent sewer flow.

CONCLUSIONS

The April 4th overflow of the FMPC discharge line at Manhole 180 resulted from a combination of discharge flow rate, Great Miami River (GMR) flooding elevation, and the reduced flow capacity of the discharge line due to aging. The relationship between the existing conditions is shown in Figure 2 of the report.

Once the manhole covers at Manholes 178 through 181 are repaired, the effluent line from Manhole 181 to the GMR is cleaned, and the line is returned to its original pressurized design capability, the capacity of the sewer will be restored to over 2,500 gpm. Indeed, if the line were

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surcharged back to Manhole 178, a flow of ≅4486 gpm (see Appendix II calculation) could be achieved with the GMR at the 100-year flooding elevation.

The water from the April 4th overflow was trapped in an area southeast of Manhole 180.

RECOMMENDATIONS

The recommendations resulting from this study are as follows:

1) The pressure manhole covers and frames need to be replaced for Manholes 178, 179, 180 and 181.
2) Until the manhole covers and frames (Recommendation 1) have been replaced, the FMPC sewer discharge flow should be restricted when the river level would cause surcharging in the FMPC outfall sewer pipeline. Figure 2 of the report shows the safe maximum allowable flow in the pipeline as a function of the elevation of the GMR at the Outfall.
3) A routine inspection procedure for the effluent pipeline manhole covers needs to be established. If any problems are discovered, they should be resolved promptly.
4) A project should be initiated to clean the effluent sewer line from Manhole 180 to the GMR. The portion of the sewer from Manhole 181 to the GMR was not cleaned during the 1987 cleanout (Reference 4).
5) After cleanout, the effluent sewer will capable of handling the proposed 2500 gpm flow resulting from the addition of the water from the South Plume.
6) A new flow meter (Parshall Flume) is being installed at Manhole 175 under the General Plant Project "Effluent Monitoring Upgrades." This flow meter is capable of measuring a flow of 3470 gpm (5 million gallons per day) and is more than adequate for monitoring of the proposed future flow.

Please contact me if any additional information is required or if you would like me to discuss the report with you.

D. J. Brettschneider
Manager, Liquid Waste Engineering

DJB:PJD/pjd

Attachments

c:

M.F. Albert
C.R. Connor
P.J. Dolan
L. Elikan
M.J. Galper
Central File
R.C. Kispert
R.W. Kneip
J.R. McDonald
L. Pennington
R.S. Shirley

ENGINEERING ANALYSIS OF THE APRIL 4, 1989 MANHOLE 180 OVERFLOW

SUMMARY AND RECOMMENDATIONS

Liquid Waste Engineering (LWE) has investigated the April 4, 1989 overflow of the FMPC wastewater effluent low-pressure sewer at Manhole 180. A field inspection of the effluent sewer was made on May 3, 1989 when LWE was made aware of this problem. A summary report of the field inspection (WMCO:LWE:89-021) is attached to this report as Appendix I.

The recommendations resulting from this study are as follows:

#1) The pressure manhole covers and frames need to be replaced for manholes 178, 179, 180 and 181.

#2) Until the manhole covers and frames (Recommendation #1) have been replaced, the FMPC sewer discharge flow should be restricted when the river level would cause surcharging in the FMPC outfall sewer pipeline. Figure 2 of this report shows the safe maximum allowable flow in the pipeline as a function of the elevation of the Great Miami River at the Outfall.

#3) A routine inspection procedure for the effluent pipeline manhole covers needs to be established. If any problems are discovered, they should be resolved promptly.

#4) A project should be initiated to clean the effluent sewer line from Manhole 180 to the River. The portion of the sewer from Manhole 181 to the river was not cleaned during the 1987 cleanout.

#5) After cleanout, the effluent sewer will be capable of handling the proposed 2500 gpm flow resulting from the addition of the water from the South Plume.

#6) A new flow meter (Parshall Flume) is being installed at Manhole 175 under the General Plant Project "Effluent Monitoring Upgrades." This flow meter is capable of measuring a flow of 3470 gpm (5 million gallons per day) and is more than adequate for monitoring of the proposed future flow.

BACKGROUND

Plate 1 (FMPC Drawings 25x-1450-G-00014) presents a plan and profile of the FMPC Outfall Sewer built in 1951. The line is constructed of 16-inch diameter ductile iron pipe (AWWA Standard centrifugal cast iron pipe, bell and spigot fittings, Class 160, Federal Standard WW-P-421). From Manhole 177 (Station 7+55) out to the Great Miami River (GMR), the sewer is designed to function as a low-pressure pipeline, as can be seen from the hydraulic data on Plate 1. Plate 2 (FMPC Drawing 25X-1450-S-00010) presents the engineering details of Manholes 178, 179, 180, 181 and 182 as approved for construction in 1951. These manholes, while providing access to the sewer if necessary, were designed to operate under pressure.

Since installation of the effluent sewer in 1951, the GMR has eroded the bank at the sewer outfall. By 1959, more than 60 feet of the bank had been removed, exposing 90% of the Manhole 182 structure. From Plate 1, it can be seen that Manhole 182 was originally installed approximately 140 feet from the end of pipe. During a flood event in 1965, the Manhole 182 structure was toppled and the original discharge structure to the GMR was damaged.

A construction project was started in 1965 to rebuild the outfall; a second project in 1974 added riprap to the river bank and gravel to protect the discharge structure (Reference Construction Project file CP-65-29). Plate 3 (FMPC 25B-5500-G-00111) is the detail drawing for the revisions to the Outfall Sewer. Added to this plate is a hand sketch showing the estimated location of Manhole 182 in relation to the present outfall. The present outfall structure is estimated to be at this approximate location from review of the photographs taken during the 1965-66 reconstruction.

Plate 4 presents a plot of a portion of the Flood Insurance Rate Map (produced by the Federal Emergency Management Agency) which exhibits the 100-year and 500-year flood plain and the 100-year flooding elevations of the GMR near the discharge of the FMPC outfall sewer. The elevation for the 100-year GMR flood level at the FMPC outfall is at approximately 548.5 feet.

Plate 5 presents a one-foot interval contour map produced photometrically from the Roy F. Weston Inc.May 3, 1986 flyover. This map displays the effluent sewer from Manhole 175 at the Sewage Treatment Plant to just beyond Manhole 181 located east of State Route 128 in the field south of Stricker's Grove.

In August 1987, the FMPC's main effluent line was cleaned from Manhole 175 to Manhole 181. Observations and video records were made during RI/FS Task 9.3, "Main Effluent Outfall Line Cleanout, Grouting and Video Monitoring." The RI/FS Field Activity Daily Log kept during Task 9.3 by Video Industrial Services Inc. was reviewed for this report. Manhole 181 to the GMR was not cleaned. Access to the FMPC sewer discharge line was limited by the river level and riprap used to protect the outfall.

DISCUSSION

From the flood plain map, Plate 4, and the contour map, Plate 5, it can be seen that Manholes 180 and 181 are located in the 100-year GMR flood plain. Also, the tops of these two manholes (elevations 537 and 535 feet respectively) are well below the elevation of the 100-year flood (elevation 548.5 feet). A fairly sharp rise in grade upstream (west of Manhole 180) is evident on the contour map (Plate 5). From the profile on Plate 1, it can be seen that Manhole 179 was constructed well above the 100-year flood plain (top of manhole elevation is at 570 feet).

Area southeast of Manhole 180

The area just southeast of Manhole 180 is lower (elevation 527 feet) than any other point along the sewer until it reaches the river. From field observations, there is a drainage culvert at this low point under the roadway embankment which parallels the sewer. It is assumed that the sewer line downstream of Manhole 180 had to be installed below the flowline of this culvert. This caused the sewer from Manhole 180 to the GMR to be constructed on an extremely flat slope as can be seen on Plate 1 (slope = 0.0015 foot/foot or 1.5 feet drop per 1000 feet length). Because the sewer was constructed at such a flat slope, it was necessary to surcharge (to pressurize, or be able to create a hydraulic gradient elevation above the crown of the pipeline) the sewer upstream of Manhole 180 to achieve flow in the sewer greater than approximately 1624 gpm (see Appendix II). Note, a new 16 inch cast iron pipe can achieve a flow of 1624 gpm flow rate by gravity at a slope of 0.15%. The construction of pressure-type manholes along the lower portion of the sewer allows the whole system to be surcharged without uncontrolled wastewater escaping to the environment. The pressure manholes covers at the manholes are rated to hold 46 feet of water head pressure (20 psi).

From field observations, the north end of the culvert has been completely covered by an earthen embankment (Note - LWE was unable to determine which direction the culvert was constructed to flow). The contour lines on Plate 5 show this embankment to be at the approximate elevation of 536 feet, well above the estimated elevation 529 feet flowline of the culvert. Therefore, the area north of the sewer no longer has a natural surface drainage connection to the area south of the pipeline. From inspection of the Plate 5 contour lines, water ponded in the area would have to reach an approximate elevation of 536 feet before flowing over the top of this earthen embankment.

A review of the contour map south of Manhole 180 (only partially shown on Plate 5) indicates that a gentle rise in the topography occurs as you move southward. This rise continues upward as indicated by the concave shape of the contours as noted for elevations 528 through 531 feet on Plate 5. At the south end of this area, approximately 600 feet north of the State Route 128 and Willey Road junction, a second culvert was observed during field inspections. The existing ground at the culvert entrance is at the approximately elevation of 534 feet. A slight embankment (estimated elevation 535 feet) exists north of the culvert inlet which directs stormwater runoff from the south and west into the culvert. Therefore, any water which flows into the area southwest of Manhole 180 will be trapped in the area until the ponding level rises to the level of the roadway embankment or the level of the embankment north of the culvert at the southern end of the field. This ponded water, to leave this area, must either evaporate or seep into the ground.

Figure 1 is a sketch of the area where the higher than background levels of uranium in soil were detected as of May 3, 1989. With the above discussion in mind, it appears that the surcharge overflow experienced at Manhole 180 would have been trapped in this area. Therefore, it is assumed that as the water in this pool disappeared, either through evaporation or seepage into the ground, the uranium found in the soil was left behind. This would explain why the levels of uranium found in the soil (Table on Figure 1) were higher than the levels in the wastewater discharge (2.31 ppm on April 4). Since the culvert is blocked (sometime during the period of 1965 to 1974, based on examination of USGS maps), this process could have happened in the past with small amounts of uranium deposited each time.

HYDRAULIC ANALYSIS

Case 1 - April 4th Flow Conditions

From Case 1 of the attached calculations in Appendix II, the effluent pipeline as originally installed from Manhole 180 to the river could handle approximately 1624 gpm under full flow condition when the GMR was below elevation 527 feet (marked "Normal Gradient" on Plate 6). After 38 years of usage of the pipeline, the flow capacity of the pipeline would be expected to be reduced because of a build-up of scaling inside the pipe. This is reflected in the flow calculation by using a lower "C" value as shown in Table 1.

A "C" value of 60 to 80 would be reasonable to assume for a 38-year-old line. However, the 1987 cleanout of the main effluent line would have raised the "C" values for the pipe sections between Manholes 175 and 181. The effectiveness of the cleanout however is not known. Field tests would be necessary to determine the exact "C" values. To do this testing, it is also necessary to be able to accurately measure the flow and resulting hydraulic levels of the river and each manhole (180 and 181). As the Parshall Flume being installed at Manhole 175 to accurately measure the flow has not been calibrated, these "C" values cannot be field determined at this time.

For this report, it is assumed that the section of pipe from Manhole 181 to the river has a "C" value of 60 and the section from Manhole 180 to 181 was raised up to a least 90 with the cleanout. The "C" value of 60 in the line from Manhole 181 to the GMR results in a full flow capacity of 750 gpm as compared to the original installed capacity of 1624 gpm.

The "Normal Gradient" full pipe flow moves upward, surcharging the pipeline, as flooding of the GMR rises above elevation 527 feet. If the hydraulic raises above the top of any manhole, wastewater could overflow to the environment (if no pressurized cover is present). Manhole 180 top of manhole elevation is 537 feet, based on construction drawing Plate 2. With the two "C" values estimated above, the river would have to rise from normal elevation at 520.5 feet (as shown on Plate 1) to approximately elevation 531 feet to raise the hydraulic gradient at Manhole 180 to elevation 537 feet, thereby causing the wastewater to overflow the manhole.

On April 4th the overflow at Manhole 180 occurred at approxiamtely 10:00 am. A total composite discharge flow of 1.424 million gallons (989 gpm) was reported from Manhole 175 for April 4th. The Clearwell was being pumped at the time of the overflow, but was reportedly throttled back because of the observed overflow. Total volume discharged from the Clearwell was 250,000 gallons. Note that pumping of stormwater runoff directly from the Clearwell to the GMR is not a normal event. Unless an overflow from the Clearwell is threatened, the Clearwell is pumped to the Biodenitrification System for treatment before discharge toe the GMR. It should also be noted that the major contributions to the wastewater occur during the peak operating hours of 7:00 am to 5:00 pm at the FMPC (showers, sanitary sewer, manually controlled pumping operations, etc.)

Since the average flow was 989 gpm and the flow was reduce to stop the overflow at the Manhole 180, it can be assumed that a larger flow existed during the overflow. Without flow data from the Parshall Flume, it was assumed for this report that half the Clearwell pumping rate of 450 gpm added to the average would give the peak flow of approximately 1200 gpm.

Using the "C" values mentioned above, an average roughness coefficient was calculated for Manhole 180 to the GMR portion of the effluent line. The average roughness factor for this section of line would be 76.5. Plate 6 presents a plot of the hydraulic gradient for the sewer under a flow of 1200 gpm (slope = 0.0023) raised to an elevation of 537 feet at Manhole 180 (marked "Maximum Gradient Before Overflow" on Plate 6). The calculated river level to raise the hydraulic gradient to overflow (see Plate 6) would be approximately 11 feet (Elevation 531 - 520.5). This, then, would be the elevation of flooding necessary in the GMR to cause overflow surcharging at Manhole 180. Higher flooding levels in the GMR would cause the gradient to move upward still more. The 100-year flood elevation (548.5 ft.) and flow of 1200 gpm hydraulic gradient have been used to determine the expected net surcharge pressure on the Manhole 180 cover of 7 feet (3.0 psi) (internal pressure - external flood level pressure).

Figure 2 presents a plot of the GMR water level verses the flow in the effluent sewer under which Manhole 180 will be surcharged to the level of the manhole cover (Elevation 537 feet). From Figure 2, it can be seen that the flow from the FMPC required to surcharge Manhole 180 without an elevated water level in the GMR is approximately 1,595 gpm. As exhibited in Figure 2, the higher the river level, the lower the flow required to surcharge the pipeline. At elevations of 537 feet and above, any flow out of the sewer would cause Manhole 180 to be surcharged to overflow conditions. The arrow shown on Figure 2 is the estimated peak flow on April 4 as discussed above.

Figure 3 presents a distribution graph of the Manhole 175 NPDES discharge volumes for the period of January 1, 1987 through April 30, 1989. Figure 4 presents a plot of this daily average discharge flow (in gallons per minute) verses the number of days when the flow exceeded a given flowrate (in gallons per minute). From this figure, it can be seen that the flow rate of 1,595 gpm required to cause a surcharge overflow at Manhole 180 with no river flooding did not occur at the FMPC at any time during the plotted time frame.

Using the maximum flow of 1100 gpm from Figure 4, it can be implied that the suspect days for other possible overflow occurrences at Manhole 180 or 181 are those days when the river elevation was above elevation 532 feet. Table 2 is a tabulation of GMR data obtained from the Miami Conservancy District. The flow in the GMR as measured at Hamilton, Ohio on April 4, 1989 was 34,000 cfs. Assuming this to be the critical flow causing overflow, it would appear that no additional overflows would have occurred since at least 1985.

However, as the sewer was partially cleaned in 1987, a previously existing dirtier line could have raised the gradient slope and changed the above conditions and calculations. Another significant factor affecting surcharge of the Manhole 180 is peak flow. The effluent line can be surcharged at lower GMR levels when peak flows occur.

Case 2 - Propose Flow Conditions

Plate 7 presents a plot of the hydraulic gradient expected in the sewer at the proposed 2500 gpm future flow condition. The future flow of 2500 gpm is a combination of the normal flow of 1000 gpm and the anticipated 1500 gpm from the South Plume pumping project. The proposed cleanout of Manhole 180 to the river is anticipated to raise the "C" value to 100. The 2500 gpm flow hydraulic gradient when the GMR flow level is below elevation 525 feet produces a surcharge head pressure of 2.6 feet (1.1 psi) on the lid of Manhole 180. Manhole 180 surcharge pressure under 100-year GMR level is shown to be 14.2 feet (6.2 psi), which is less than the 20 psi rated pressure of the manhole covers. Note that the section of sewer upstream of Manhole 179 has a slope of 0.568% which is greater than the 2500 gpm gradient of 0.55%. Therefore, under this condition, maximum surcharging of the low-pressure sewer system would end just downstream of Manhole 179. No surcharging would be experienced at pressure manholes 177 and 178.

CONCLUSIONS

The April 4, 1989 overflow of the FMPC discharge line at Manhole 180 resulted from a combination of discharge flow rate, GMR flooding elevation, and the reduced flow capacity of the discharge line due to aging. The relationship between the existing conditions is shown in Figure 2 of the report.

Once the manhole covers at Manholes 178 through 181 are repaired, the effluent line from Manhole 181 to the GMR is cleaned and the line is returned to its original pressurized design capability, the capacity of the sewer will be restored to over 2,500 gpm. Indeed, if the line were surcharged back to Manhole 178, a flow of ≅4486 gpm (see Appendix II calculation) could be achieved with the GMR at the 100-year flooding elevation.

The water from the overflow was trapped in the area southeast of Manhole 180.

It is recommended that a revision to SOP 43-C-301 "Water Treatment Plant Operations and Sitewide Sampling Responsibilities" include the following:

6.7 River Rounds

6.7.5 Visually inspect manhole structures 175, 176, 177, 178, 179, 180, and 181 for damage or leakage as a minimum once a month, preferably when the Great Miami River is at a high level and the pipeline is surcharged. Report observations in Water Plant Log and immediately Water Plant Supervisor if damage or leakage is observed.

Appendix I

From: R. W. Kneip, Jr./6997

WMCO:LWE:89-021

Date: May 8, 1989

Subject: **FMPC OUTFALL MANHOLE OBSERVATIONS AND RECOMMENDATIONS**

To : D. J. Brettschneider

The following represents a summary of a field inspection of the manholes along the FMPC Outfall Line on May 3, 1989. This field inspection along with subsequent site drawing research was conducted in response to questions regarding the reported April 4, 1989 overflow of Manhole 180.

Background:

The FMPC's effluent line to the Great Miami River is a 16 inch Cast Iron pipeline that was originally designed as a partially pressurized system (Refer to site drawing 25X-1450-S-00010). This line is approximately 4400 feet long and originally contained eight manholes (MH's 175, 176, 177, 178, 179, 180, 181, and 182). Of these eight manholes, five (5) were designed to function as pressurized manholes. In the mid-1960's, the pressure type manhole closest to the Great Miami River (MH 182) was removed and the outfall structure was modified due to bank erosion, therefore leaving four (4) pressure type manholes in service.

The main difference between the pressure type manholes and the non-pressure type is that the pressure manholes are made of reinforced concrete vaults with gasketed and bolted (4 bolts each cover), pressure-tight manhole lids and rings. Typical non-pressure manholes are made up of precast concrete sections that are held in place by gravity and the manhole covers are simply placed on the rings.

Observations (5/3/89):

MH 177. This is a non-pressurized manhole that appears to be in good shape.

MH 178. This is the first of the pressurized manholes. This manhole is located at the bottom of the first slope in a crop field. This manhole is not specifically demarcated and was plowed under and had crops planted on and around it. After scraping approximately 1 inch of soil from the manhole cover it was observed that none of the bolts were in place to hold the cover on. Therefore this manhole cannot function as a pressure manhole as it was designed. No observation of the bolted connection between the manhole ring and the concrete vault could be made as it was not exposed.

MH 179. Pressure Type Manhole. This manhole is well marked and the top portion of the concrete vault is clean and visible. A yellow marker has been attached to this manhole by utilizing two of the four cover bolt holes, however they are not fastened securely. The remaining two bolt holes are empty. It was also observed that several of the anchor bolts that hold the manhole ring to the reinforced concrete vault were sheared off.

MH 180. Pressure Type Manhole. This is the manhole that was observed to overflow on April 4, 1989. Four new steel bolts were installed (Site drawings call for brass bolts) and new caulking was observed. It also appeared that the cover differed from the covers found on manholes 178, and 179. It was reported by Water Plant personnel that no gasket exists under the manhole cover. No observation of the bolted connection between the manhole ring and the concrete vault could be made as it was not exposed.

MH 181. Pressure Type Manhole. The cover of this manhole was demarcated by a yellow marker that was loosely bolted to one of the existing four cover bolt holes. The other three were empty and is could be seen that two of the four bolts had been sheared off, therefore this manhole could not be functioning as a pressurized manhole. With this in mind it should be noted that this manhole may have overflowed when Manhole 180 overflowed on April 4, 1989. No observation of the bolted connection between the manhole ring and the concrete vault could be made as it was not exposed.

Recommendations.

In order for Manholes 178, 179, 180, and 181 to function as pressurized manholes as originally designed, renovation of the manhole rings and lids will be required. Consultation with vendors have shown that the original manhole rings and covers are no longer produced, however suitable pressure-type manholes are available. It is recommended that the rings and covers of the four existing pressure-type manholes be completely removed and replaced with suitable substitutes in a fresh layer of non-shrinking grout to be placed over the existing concrete surface. The installation should meet the manufacturers specifications so that pressure-tight seals can be assured.

R. W. Kneip

RWK/dap

Appendix II
Calculations

Outfall 001 Pipeline Surcharge Analysis

Plates 1 and 2
Top of Manhole 180 = 537+/- feet at sta 18+18.68
Top of Manhole 181 = 535+/- feet at sta 32+41.88
Top of pipe at discharge = 527+/- feet at sta 44+02.84
(drawing shows Manhole 182 which the river removed during flooding in 1965)

Assumptions
1. River level ≤527 feet would not cause pipeline to surcharge.
2. River level > 527 feet causes back pressure on the pipeline.
3. Line between Manhole 181 and the River is relativity clean and not causing additional flow restriction.
4. Hazen-Williams roughness coefficient "C" equals 100 is assumed for existing effluent pipeline conditions (new pipe C = 140). This was used to reflect the pipeline condition taking into account the 1987 cleanout.

Hydraulic Gradient Calculations

Using Hazen-Williams equation
Q = 0.285 * C * d^2.63 * s^0.54
Q = flow rate, gallons per minute (gpm)
C = roughness coefficient = (See Table 1)
s = slope of hydraulic grade line, feet/feet
d = pipe diameter, inches = 16"

Case 1) Originally constructed full flow with no surcharge Manhole 180 to Manhole 181 (flattest section of sewer)
From Plate 1, slope = 0.0015 as built
Q = 0.285 * 130 * 16^2.63 * 0.0015^0.54
Q = ≅1624 gpm

Case 2) Flow expected in cast iron pipe after 38 years
Q = 0.285 * 60 * 16^2.63 * 0.0015^0.54
Q = ≅750 gpm

Case 3) Flow on April 4 of 1200 gpm
Manhole 180 to River (Manhole 182)
1200 = 0.285 * C * 16^2.63 * s^0.54
s^0.54 = 1200/(0.285 * 16^2.63 * C)

$$C\text{-(Manhole 180 to River)} = \frac{C\text{-(Manhole 180 to 181) distance}}{\text{Distance (Manhole 180 to River)}} + \frac{C\text{-(Manhole 181 to River) distance}}{\text{Distance (Manhole 180 to River)}}$$

C = 90*(3242-1819)/2584 + 60*(4403-3242)/2584 = 76.5

s^0.54 = 1200/(0.285 * 16^2.63 * 76.5) = 0.0375
s = 0.0375^(1/0.54) = 0.0023

Manhole 180 Elevation	=	537
River Elevation	= 537-((4403-1818)*0.0023)	531

Case 4) Hydraulic gradient at 2500 gpm

2500/(0.285 * 100 * 16^2.63) = s^0.54

0.060 = s^0.54 s = 0.0055

Case 5) Maximum flow in pipeline with surcharge from Manhole 177 to River

4402 - 765 = 3637 feet Length

584 - 525 = 59 feet Elevation

Slope = elevation/length = 59/3637 = 0.016 = 16 feet per 1000 feet

Q = 0.285 * 100 * 16^2.63 * 0.016^0.54

Q = ≅4486 gpm

Table 1

Hazen-Williams Coefficients for various pipe materials

Description of the Pipe	Values of C
Extremely smooth and straight cast iron	140
New	130
5 years old	120
10 years old	110
20 years old	90-100
30 years old	75-90
Old iron in bad condition	60-80

Sources: Water Supply and Sewerage, by Steel/McGee Fifth Edition, published by McGraw-Hill.
Elementary Fluid Mechanics, by Vennard & Street Sixth Edition, published by Wiley.

TABLE 2

The following Great Miami River flooding information was obtained during a telephone conversation with Keith Paston of the Miami Conservancy District (1-800-451-4932)

Maximum Recorded Event - January 22, 1959 - 108,000 cfs at Hamilton
- 113,000 cfs at New Baltimore

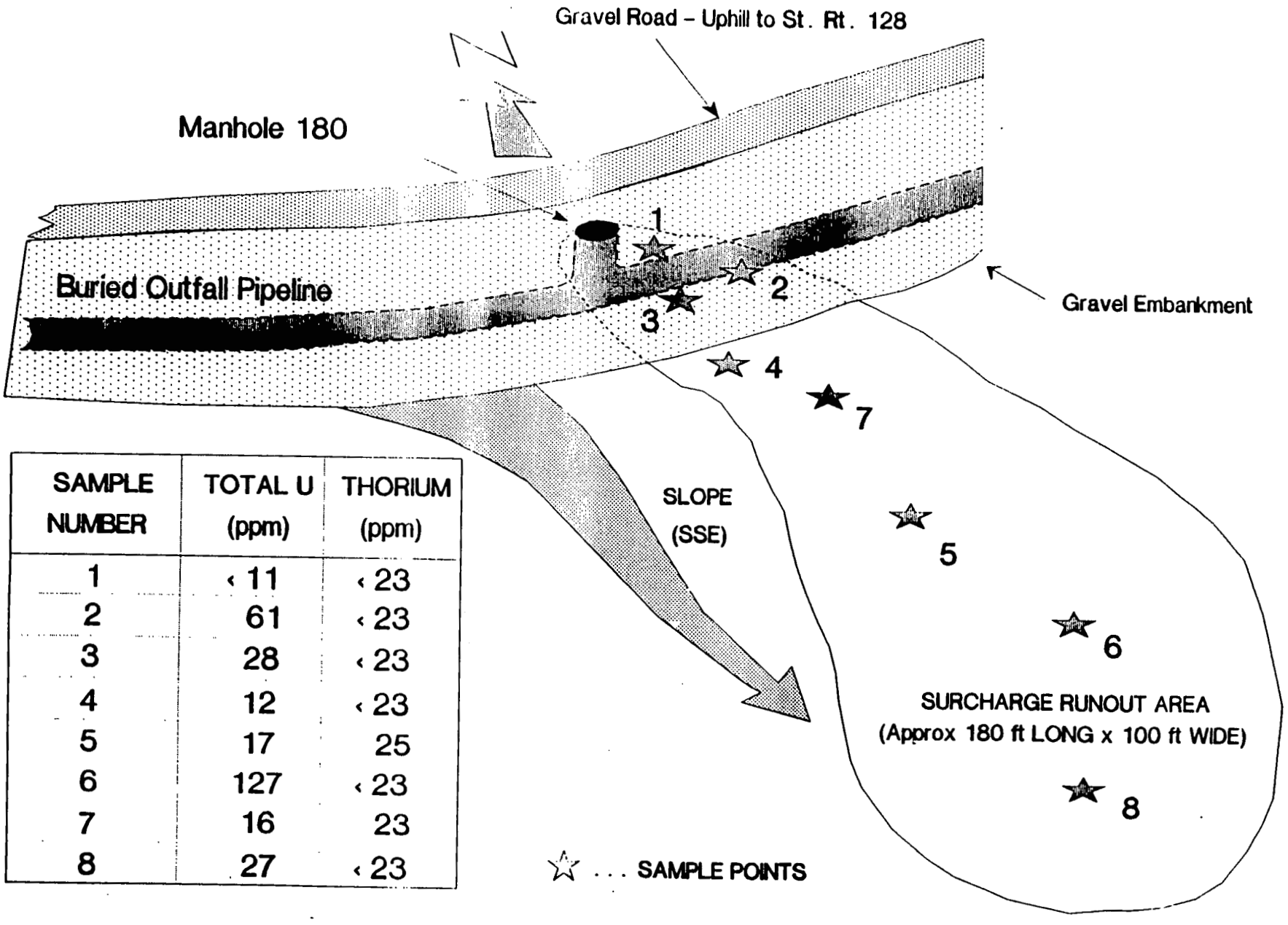
Maximum Yearly Flows at Hamilton

1986 -	30,700 cfs	
1987 -	18,000 cfs	
1988 -	26,200 cfs	
1989 -	34,000 cfs*	As of May 3, 1989

Daily Average Flow for April, 1989 in Cubic feet per second (cfs)

1	18,000	8	12,500	16	3,500	24	3,300
2	17,000	9	10,000	17	3,200	25	3,000
3	16,000	10	8,300	18	4,500	26	13,000
4	34,000*	11	7,000	19	6,000	27	28,000
5	26,000	12	5,800	20	7,600	28	24,000
6	20,000	13	5,000	21	5,400	29	21,000
7	16,000	14	4,400	22	4,500	30	18,000
		15	3,900	23	3,800		

*1989 maximum daily average flow (as of May 3) occurred on April 4, the day of the Manhole 180 overflow.



SAMPLE NUMBER	TOTAL U (ppm)	THORIUM (ppm)
1	< 11	< 23
2	61	< 23
3	28	< 23
4	12	< 23
5	17	25
6	127	< 23
7	16	23
8	27	< 23

Figure 1

FMPC Outfall 001 Pipeline Analysis

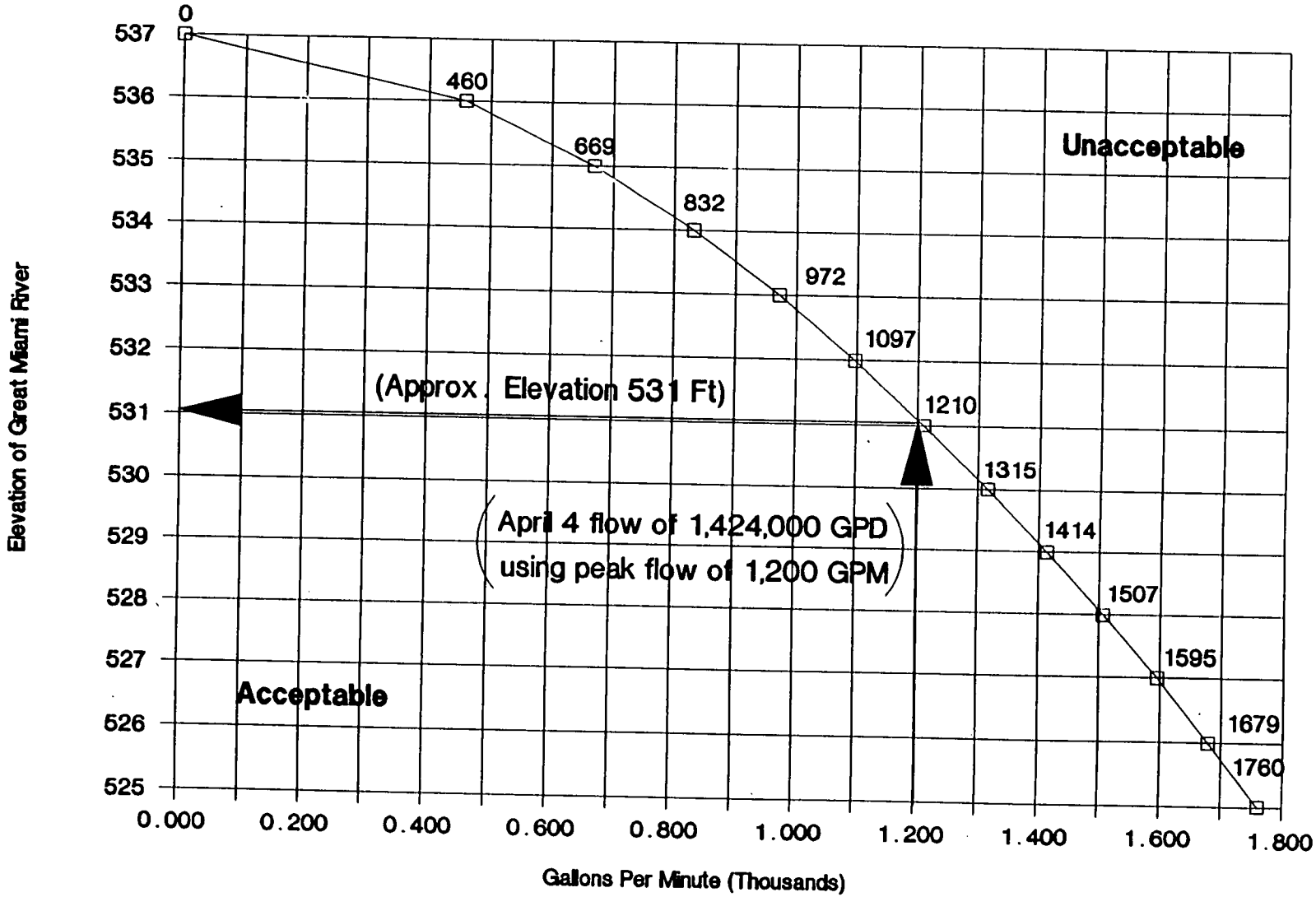


Figure 2

Manhole 175 Flow Distribution

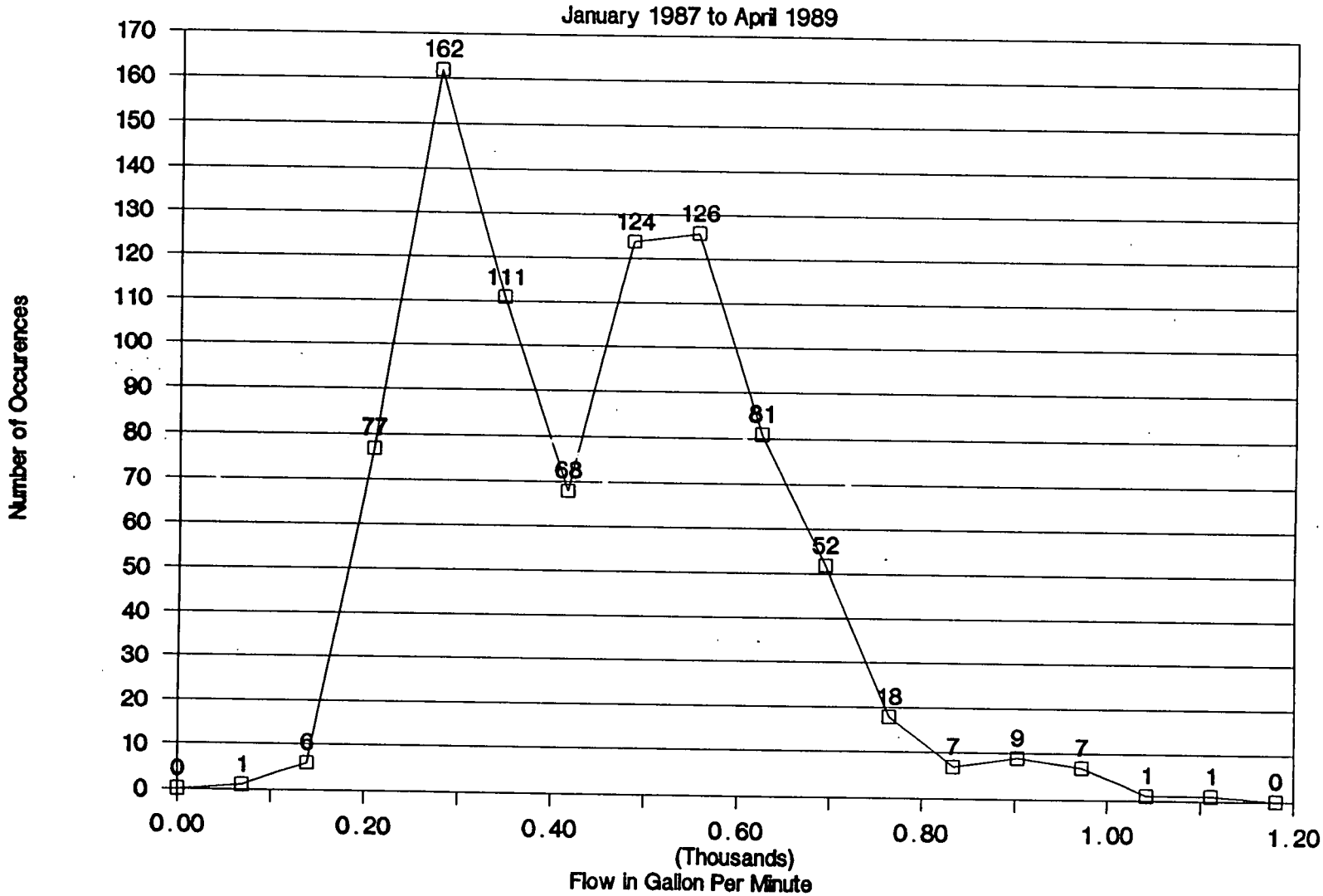


Figure 3

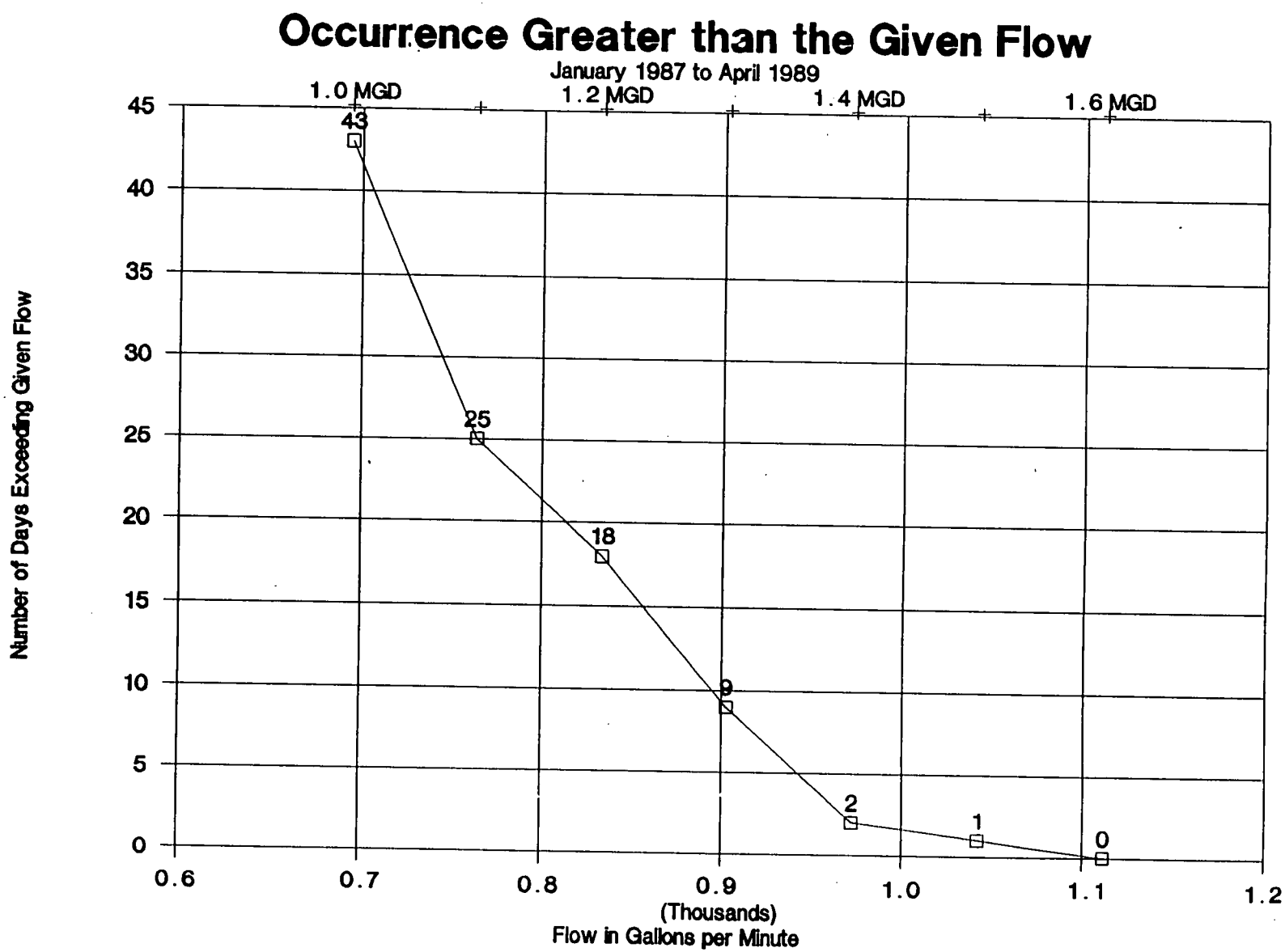
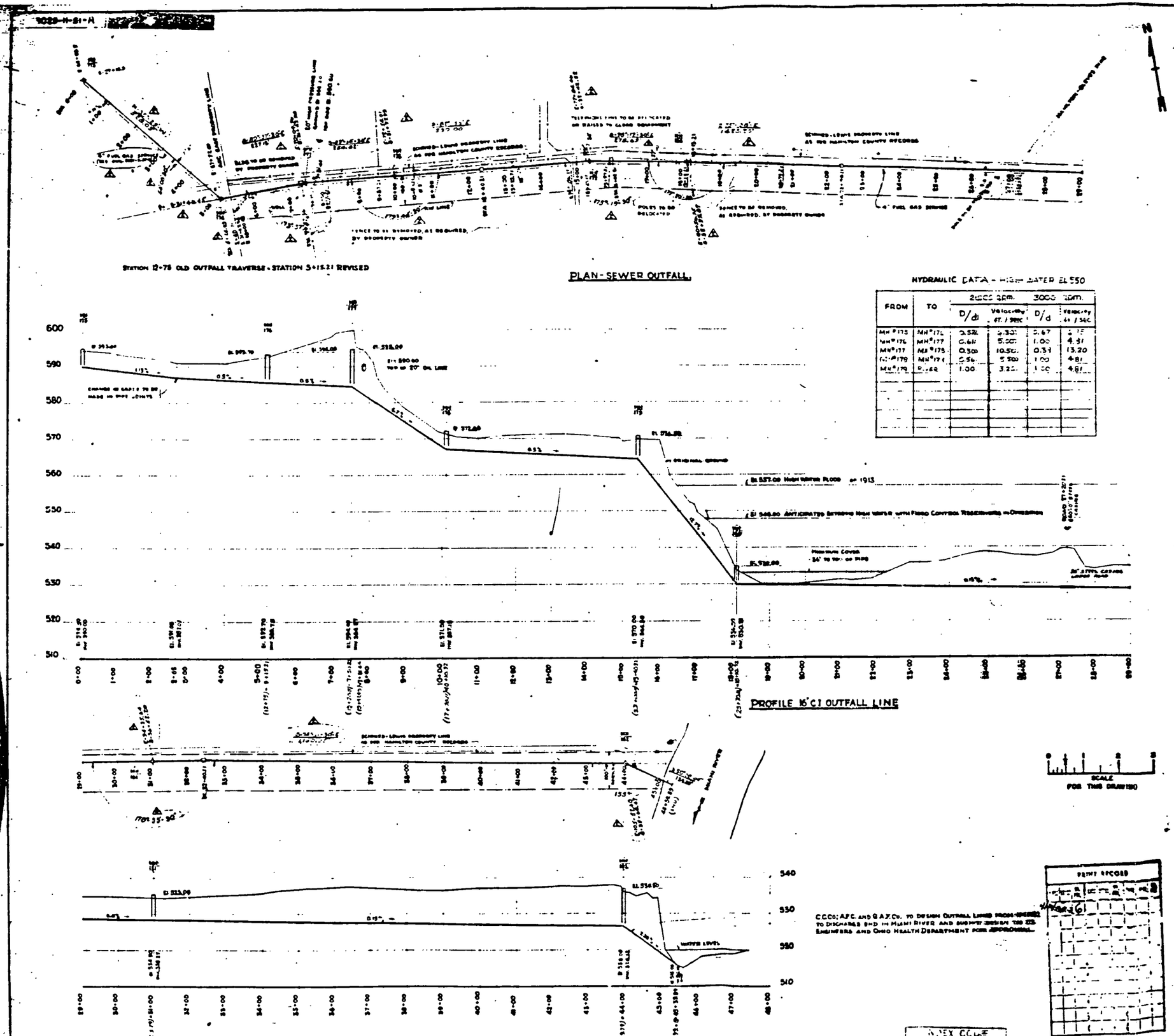

Occurrence Greater than the Given Flow
January 1987 to April 1989
1.0 MGD
1.2 MGD
1.4 MGD
1.6 MGD
Number of Days Exceeding Given Flow
45
40
35
30
25
20
15
10
5
0
43
25
18
9
2
1
0
0.6
0.7
0.8
0.9
1.0
1.1
1.2
(Thousands)
Flow in Gallons per Minute

Figure 4

PLATE 1

NOTE: OUTFALL SEWER TO BE LAID IN STRAIGHT LINE BETWEEN MANHOLE 176-177 AND 179-180



HYDRAULIC DATA - HIGH WATER EL 550

FROM	TO	2000 GPM. D/d	2000 GPM. Velocity ft./sec	3000 GPM. D/d	3000 GPM. Velocity ft./sec
MH #175	MH #176	0.52	5.30	0.67	5.15
MH #176	MH #177	0.61	5.00	1.00	4.91
MH #177	MH #178	0.50	10.50	0.31	13.20
MH #178	MH #179	0.56	5.50	1.00	4.81
MH #179	[illegible]	1.00	3.25	1.00	4.81

LEGEND

- INDICATES A GATE
- INDICATES A TREE
- INDICATES A FENCE

REFERENCE DRAWINGS

TITLE	DWG NUMBERS
GENERAL PLOT PLAN	3000-AA-02-A
SEWAGE TREATMENT PLANT PLOT PLAN	3025-S-980-A
PLOT PLAN	3000-AA-01-A
SITE IMPROVEMENTS SEWAGE DISPOSAL AREA	3025-S-30-A
PROFILE OUTFALL SEWER (SK)	3025-H-51-R, 3025-S-51-R
CONCRETE MANHOLES FOR 16" OUTFALL LINE - SANITARY SEWER SYSTEM	3025-A-12-A
SANITARY SEWER - LIFT STATION	3025-H-981-B

REVISED PLAN OF OUTFALL SEWER TO REFLECT PATH AS FIELD LAID FOR 16" CI PIPE - 3000 FEET OF 24" PVC PIPE, & PROFILE AS REQUIRED WITH SUBMITTALS

UNITED STATES ATOMIC ENERGY COMMISSION
NEW YORK OPERATIONS OFFICE

CONTRACT No. AT-30-1-1069

FEED MATERIALS PRODUCTION CENTER
FERNALD AREA

PLAN & PROFILE OF OUTFALL SEWER

CATALYTIC CONSTRUCTORS
PHILADELPHIA, PA

130

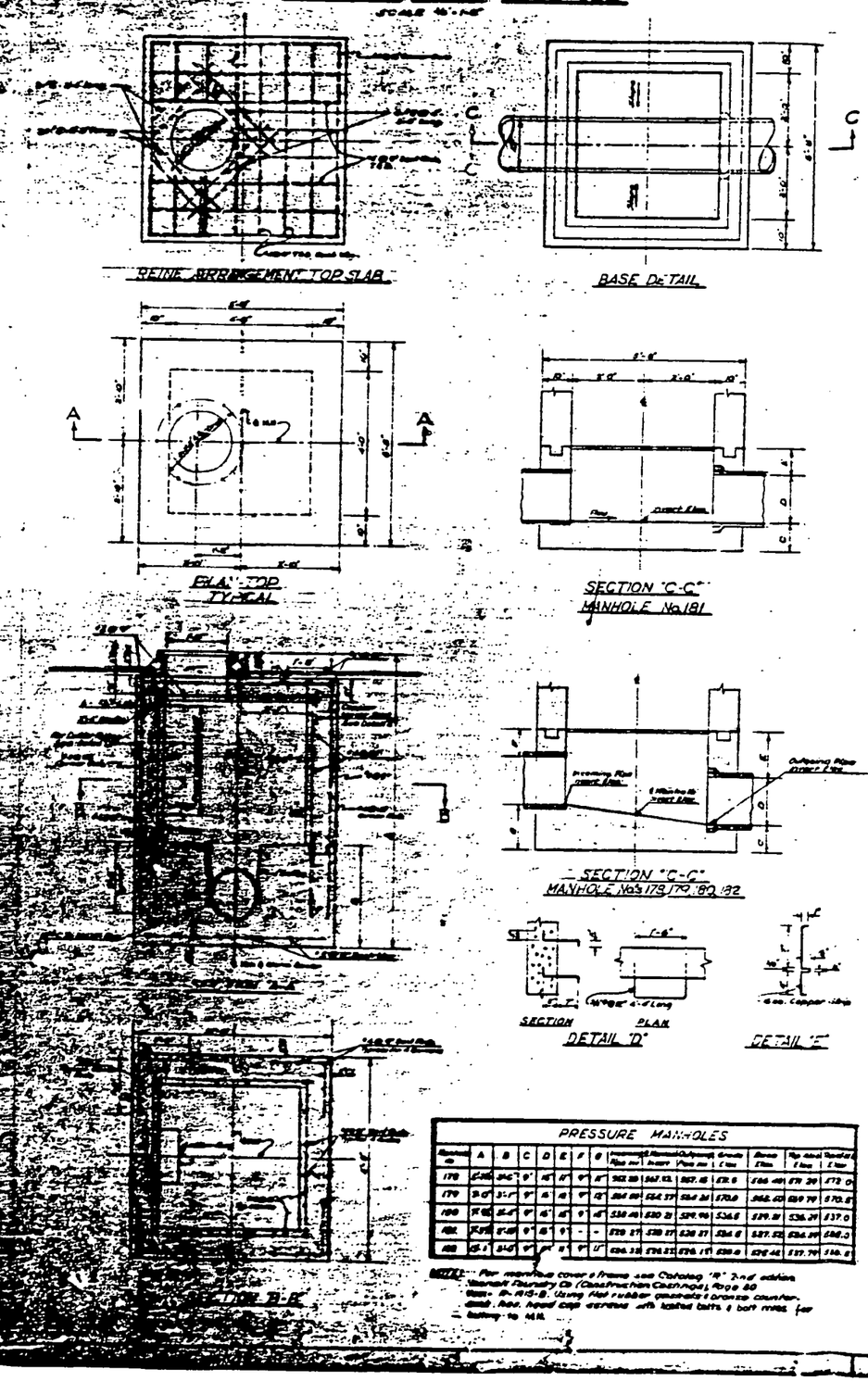
20

PLATE 2

130

PRESSURE TYPE MANHOLE

SCALE ½"=1'-0"



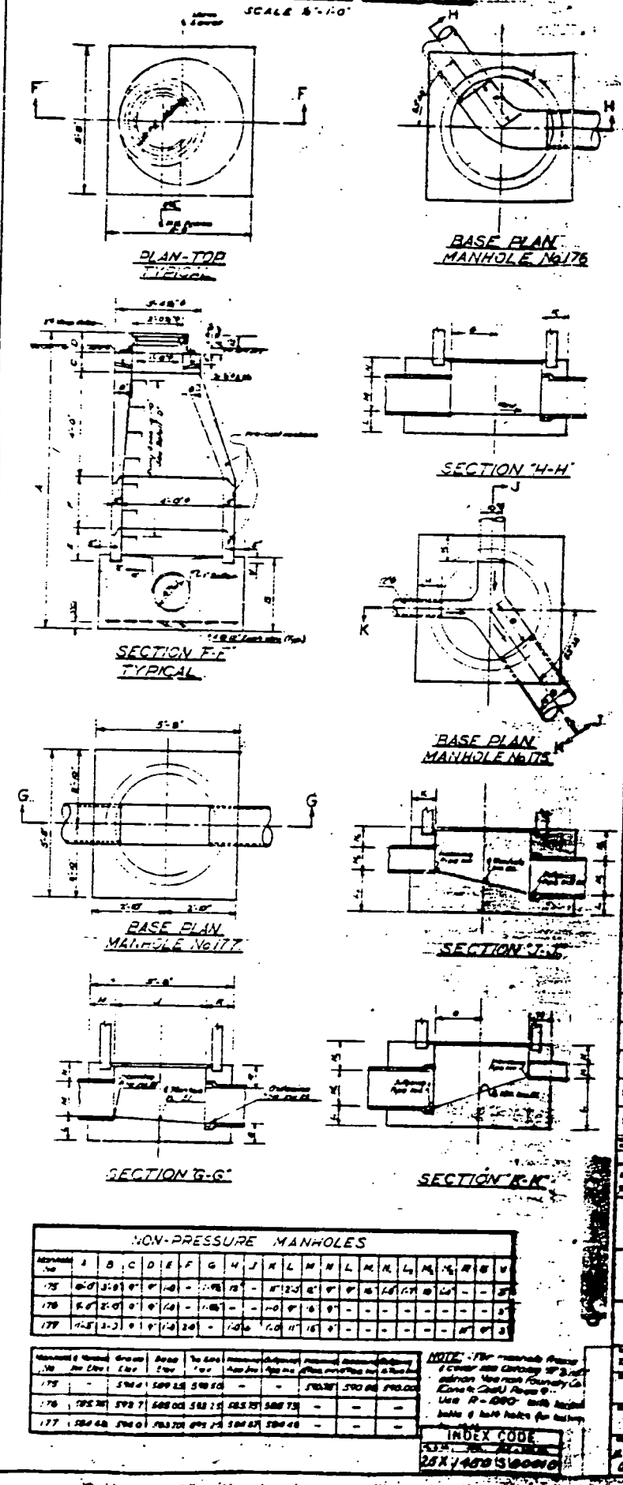
PRESSURE MANHOLES

Manhole No.	A	B	C	D	E	F	G	Invert Out Pipe Inv.	Invert In Pipe Inv.	Outfall Pipe Inv.	Ground Elev.	Top Slab Elev.	Top Slab Elev.
178	[illegible]	[illegible]	9"	18"	18"	9"	18"	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	572.0
179	[illegible]	[illegible]	9"	18	18	9"	18"	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	570.5
180	[illegible]	[illegible]	9"	18"	18"	9"	18"	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	537.0
181	[illegible]	[illegible]	9"	18	18	9	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
182	[illegible]	[illegible]	9"	18"	18"	9"	18"	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: For manhole cover & frame use Catalog "B" 2nd edition Neenah Foundry Co (Construction Castings), Page 80 Item R-1915-B. Using flat rubber gaskets & bronze countersunk, flat, hexed cap screws with locked bolts & bolt rings for bolting to M.H.

NON-PRESSURE TYPE MANHOLE

SCALE ½"=1'-0"



NON-PRESSURE MANHOLES

Manhole No.	A	B	C	D	E	F	G	H	J	K	L	M	N	L	M	K	L	M	K	M	N
175	[illegible]	[illegible]	9"	9"	[illegible]	-	[illegible]	18"	-	18"	[illegible]	6"	9"	9"	18	[illegible]	[illegible]	18	[illegible]	-	-
176	[illegible]	[illegible]	9	9"	[illegible]	-	[illegible]	-	-	[illegible]	9"	6	9"	-	-	-	-	-	-	-	-
177	[illegible]	[illegible]	9	9"	[illegible]	[illegible]	-	[illegible]	[illegible]	[illegible]	18"	6"	9"	-	-	-	-	-	-	18"	9"

Manhole No.	Invert Out Pipe Inv.	Invert In Pipe Inv.	Ground Elev.	Top Slab Elev.	Top Slab Elev.	Invert Out Pipe Inv.	Outfall Pipe Inv.	Ground Elev.	Top Slab Elev.	Top Slab Elev.
175	-	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]	[illegible]	[illegible]
176	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	-	-	-
177	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	-	-	-

NOTE: For manhole frame & cover use Catalog "B" 2nd edition Neenah Foundry Co (Construction Castings), Page 9. Use R-1080 with locked bolts & bolt holes for bolting.

INDEX CODE

25X/1489/S/00016

REDUCED DRAWING DO NOT SCALE

GENERAL NOTES

1. Reinforcing steel shall be intermediate grade billet steel bars in accordance with latest revision of A.S.T.M. Specifications A-615 & A-305.
2. Concrete to be Class "C" (3000 psi)
3. Floor concrete with adjustable steel steps [illegible]
4. Manhole frames & covers to be manufactured by the Neenah Foundry Co or equal. For castings number see note of schedule
5. Refer to the construction of manholes and sewers to be in accordance with Sanitary Sewer Specifications, Part II, Section 4
6. Pre-cast sections for non-pressure type manhole units "D & E" manufactured by the Cincinnati Concrete Pipe Co or approved equal.
7. Manhole rungs to be cast iron or aluminum

REFERENCE DRAWINGS

TITLE	DWG. No.
PLAN & PROFILE 6" C.T. SEWER OUTFALL LINE	3025-H-5-A
SITE IMPROVEMENTS - SEWAGE DISPOSAL AREA	3021-S-30-A
SEWAGE TREATMENT PLANT - PLOT PLAN	3025-S-990-A
SANITARY SEWERS - LIFT STATION	3025-H-981-A

PRINT RECORD

10-4-51							
8-1-52							
5-4-56							

REVISIONS

UNITED STATES ATOMIC ENERGY COMMISSION

FEED MATERIALS PRODUCTION CENTER
FERNALD AREA

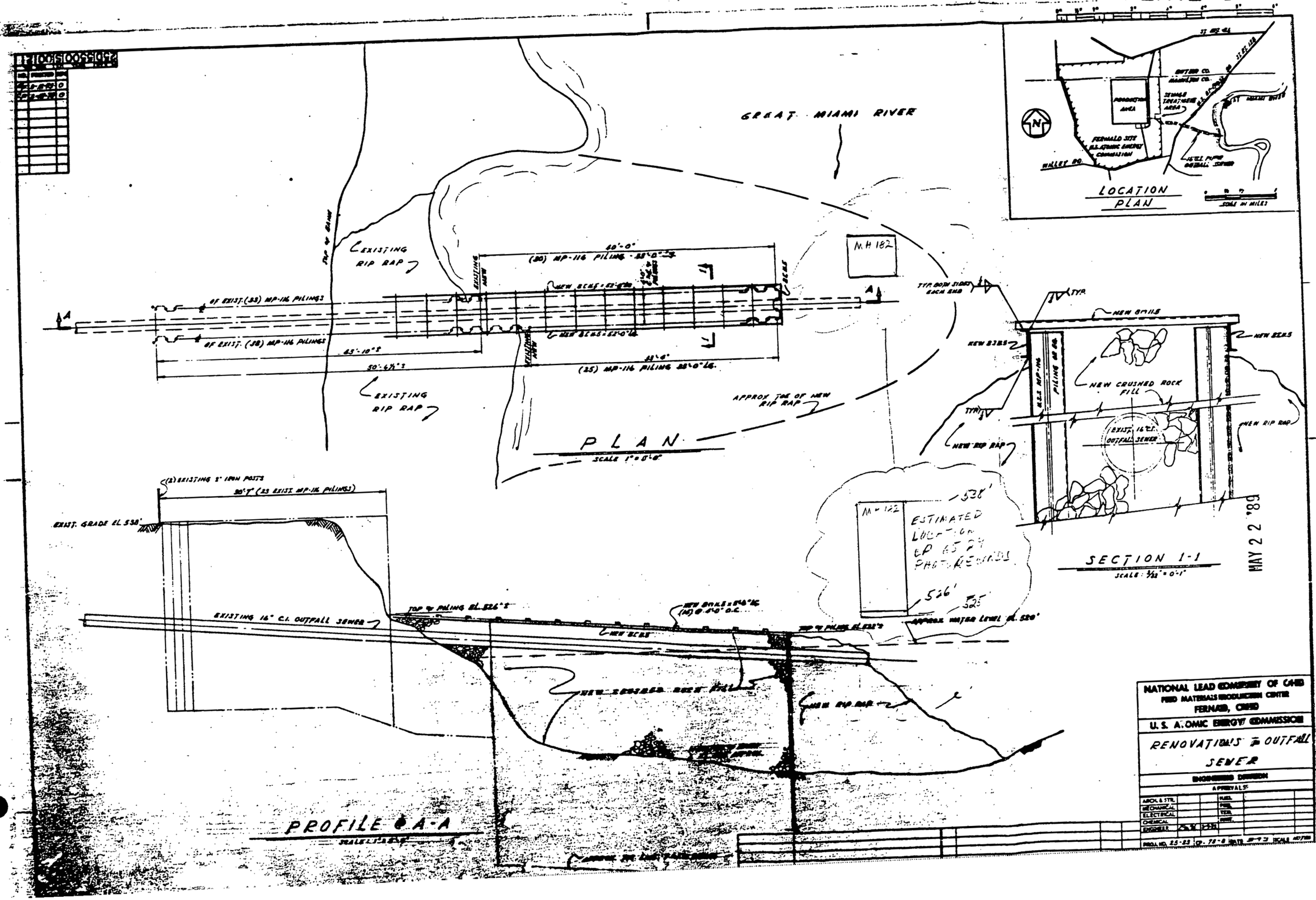
CONCRETE
MANHOLES FOR 16" CT. OUTFALL LINE
SANITARY SEWER SYSTEM

APPROVED FOR CONSTRUCTION

3025-A-12-A

MAY 22 '89

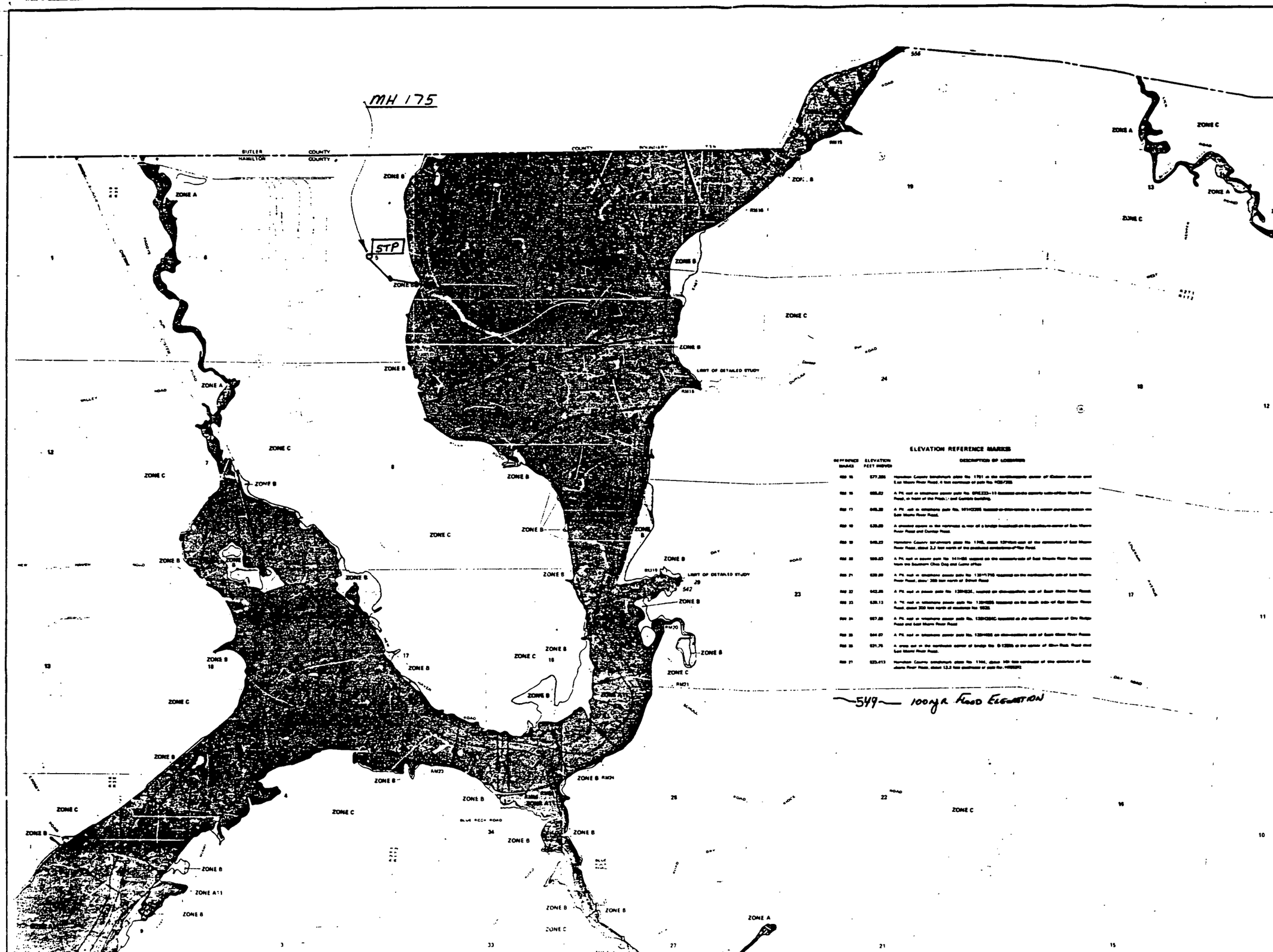
21


GREAT MIAMI RIVER
EXISTING RIP RAP
(30) MP-116 PILINGS
NEW BEAMS
OF EXIST. (33) MP-116 PILINGS
OF EXIST. (38) MP-116 PILINGS
(25) MP-116 PILING
M.H. 182
APPROX. TOE OF NEW RIP RAP
PLAN
SCALE 1"=8'-6"
LOCATION PLAN
SCALE IN MILES
NEW BEAMS
NEW CRUSHED ROCK FILL
NEW RIP RAP
EXIST. 16" C.I. OUTFALL SEWER
SECTION 1-1
SCALE: 3/32" = 0'-1"
(2) EXISTING 2" IRON POSTS
(25 EXIST. MP-116 PILINGS)
EXIST. GRADE EL. 538'
EXISTING 16" C.I. OUTFALL SEWER
TOP OF PILING EL. 526'±
NEW BEAMS
NEW CRUSHED ROCK FILL
NEW RIP RAP
APPROX. WATER LEVEL EL. 520'
ESTIMATED LOCATION OF 1945 PHOTO REMAINS
PROFILE @ A-A
MAY 22 '89
NATIONAL LEAD COMPANY OF OHIO
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
U.S. ATOMIC ENERGY COMMISSION
RENOVATIONS TO OUTFALL SEWER
ENGINEERING DIVISION
APPROVALS
ARCH. & STR.
MECHANICAL
ELECTRICAL
CHEMICAL
ENGINEER

22

PLATE 4

130



ELEVATION REFERENCE MARKS

REFERENCE MARKS	ELEVATION FEET (NGVD)	DESCRIPTION OF LOCATION
RM 15	577.355	Hamilton County benchmark plate No. 1761 in the northeastern corner of Dickson Avenue and East Miami River Road, 4 feet southeast of pole No. H25/720
RM 16	555.62	A PK nail in telephone power pole No. 6R6222-11 located on the south side of East Miami River Road, in front of the Pleasant and Gamble building.
RM 17	545.32	A PK nail in telephone pole No. 141H0295 located on the southeast corner of a vacant dwelling located on East Miami River Road.
RM 18	539.60	A chiseled square in the northeast corner of a bridge located on the southeastern corner of East Miami River Road and Dunlap Road.
RM 19	545.23	Hamilton County benchmark plate No. 1765, about 120 feet east of the intersection of East Miami River Road, about 3.2 feet north of the pavement centerline of Rex Road.
RM 20	555.63	A PK nail in power pole No. 141H1R6 located on the southwestern side of East Miami River Road across from the Beaumont Ohio Dog and Game office.
RM 21	539.89	A PK nail in telephone power pole No. 139H1790 located on the northwestern side of East Miami River Road, about 300 feet north of Dolwick Road.
RM 22	542.25	A PK nail in power pole No. 139H635, located on the southeastern side of East Miami River Road.
RM 23	539.13	A PK nail in telephone power pole No. 139H285 located on the south side of East Miami River Road, about 300 feet north of intersection No. 9535.
RM 24	557.88	A PK nail in telephone power pole No. 139H280C located on the northeastern corner of Dry Ridge Road and East Miami River Road.
RM 25	544.07	A PK nail in telephone power pole No. 139H1R6 on the southeastern side of East Miami River Road.
RM 26	531.76	A cross cut in the northeastern corner of bridge No. 0-12286 on the corner of Blue Rock Road and East Miami River Road.
RM 27	523.413	Hamilton County benchmark plate No. 1766, about 100 feet southeast of the intersection of East Miami River Road, about 13.3 feet southeast of pole No. H25/R2

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

COUNTY OF
HAMILTON,
OHIO
(UNINCORPORATED AREAS)

PANEL 10 OF 105

COMMUNITY-PANEL NUMBER
390284 0010 C

EFFECTIVE DATE:
JUNE 1, 1982

23

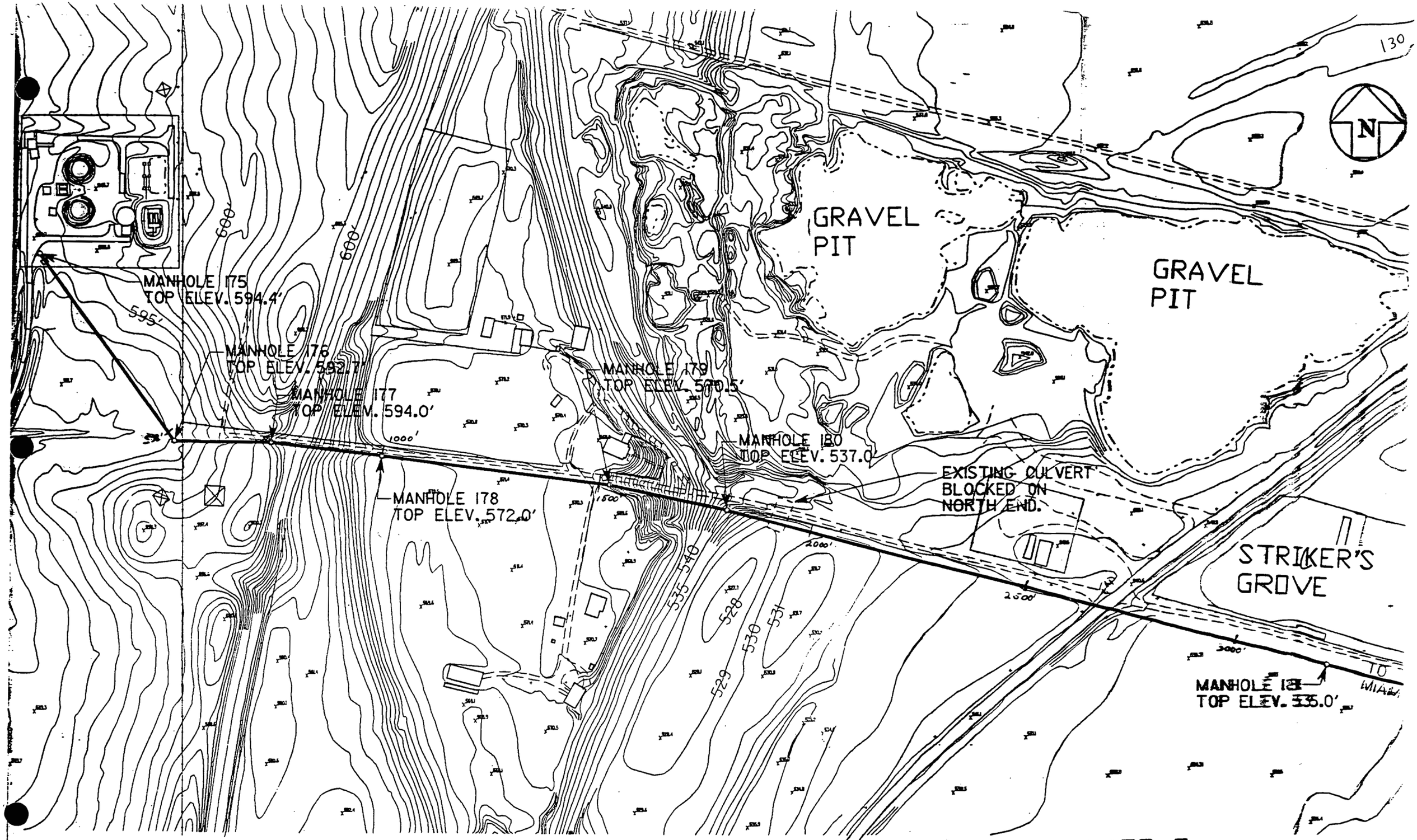
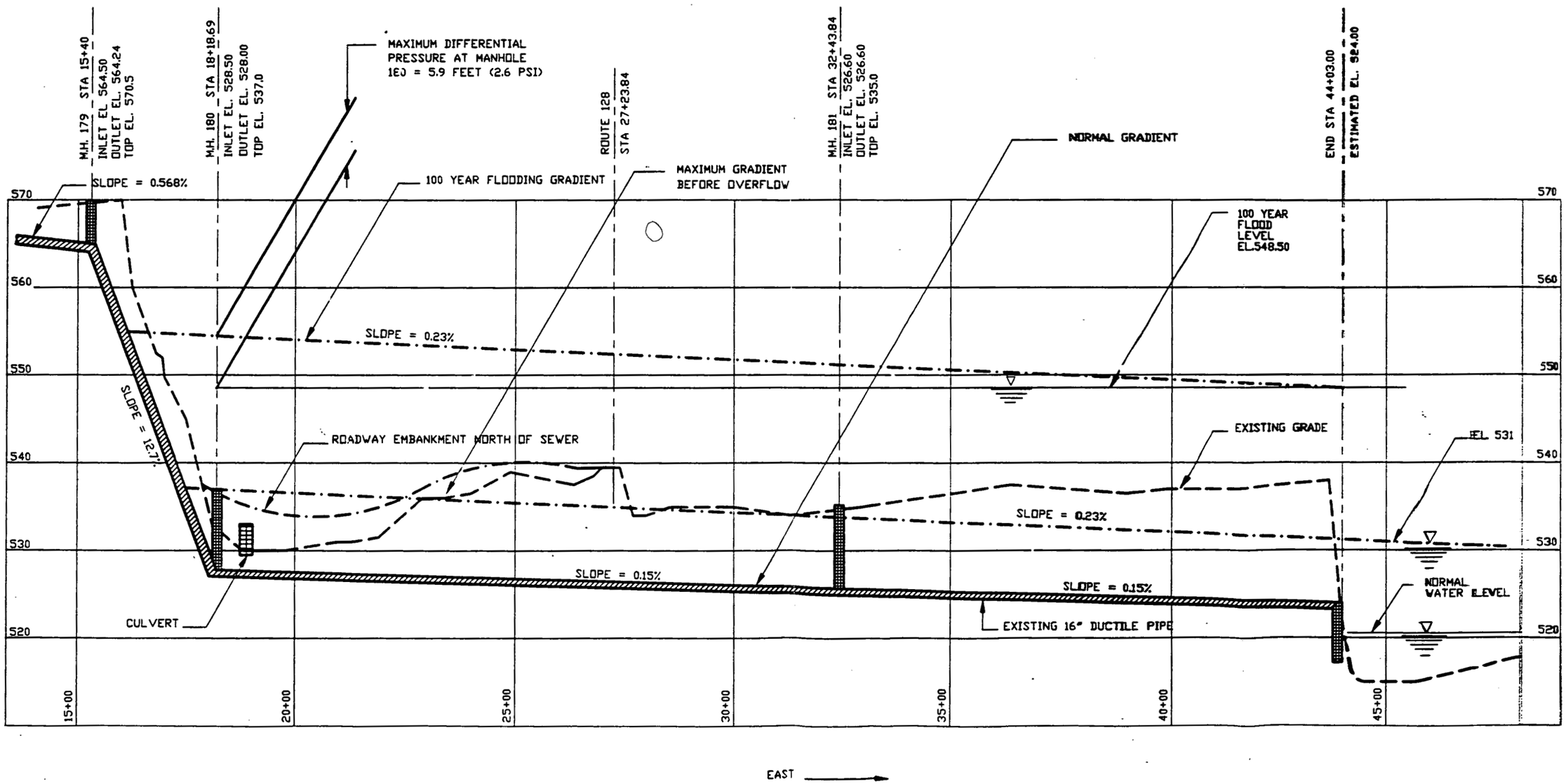


PLATE 5

SCALE 1"=200'

HYDRAULIC PROFILE UNDER APRIL 4, 1989 PIPE FLOW OF 1200 GPM

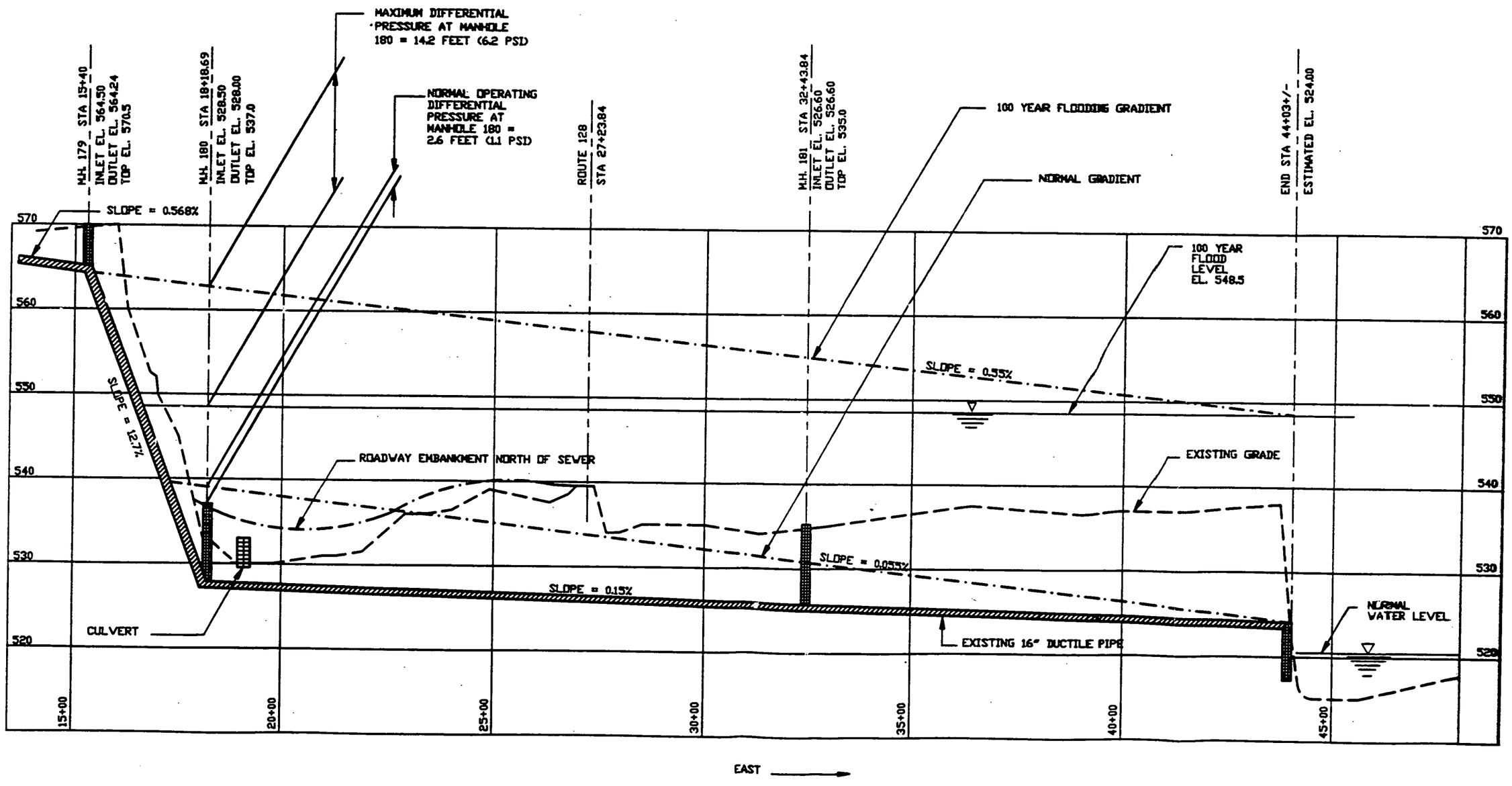


PROFILE FMPC OUTFALL SEWER

PLATE 6

HYDRAULIC PROFILE UNDER PROPOSED FLOW CONDITION OF 2500 GPM (3.6 MGD)

(NORMAL FLOW = 1000 GPM + SOUTH PLUME = 1500 GPM)



PROFILE FMPC OUTFALL SEWER

PLATE 7