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Sewer Infiltration Investigation - Borough of Far Hills

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CFM INCORPORATED — ENVIRONMENTAL ENGINEERING SERVICES
628 ROUTE 10 WHIPPANY, NJ 07981 (201) 884-2111

June 8, 1983

Yannaccone, Murphy & Hollows, Inc.
52 Bernards Avenue
Bernardsville, New Jersey 07924

Attention: Mr. Thomas Murphy, P. E.

Re: SEWER INFILTRATION INVESTIGATION - BOROUGH OF FAR HILLS

Gentlemen:

In accordance with our proposal of May 6, 1983, we have undertaken a brief but thorough investigation of the Borough of Far Hills sanitary sewer system. Our investigation was directed to evaluate the extent of infiltration and inflow in the system; to identify the location of the majority of the infiltration and to evaluate the existing permanent flow meter servicing the Borough, expecially to determine its present accuracy.

The investigation was undertaken during the last two weeks of May 1983 and included the installation of a temporary flow monitoring system just upstream from the existing permanent meter; low flow measurements in the system to locate areas of significant infiltration; inspection of all system manholes (where possible); flow isolation and measurement of sewer reaches (between manholes) that exhibit high infiltration rates and limited dye water testing of a suspected cross connection in the system. The results of our investigation are summarized hereafter in tables for ease in evaluation. Flow meter data obtained during the two weeks of the investigation are also shown and compared to that recorded by the permanent meter. The following

is a brief description of the work undertaken and the results obtained:

TEMPORARY FLOW MONITORING

Temporary flow monitoring equipment was installed upstream of the present flow monitoring station to establish a basis for the investigation and to verify the accuracy of the permanent meter. The temporary installation included an 8" Palmer Bowlus flume, along with a portable battery-powered depth recorder, that produced a continuous record of the discharge through the flume. All flow was recorded on 7 day circular charts that could be readily compared to charts produced by the permanent meter. The permanent meter is a split six inch Kennison Nozzel, coupled with a float-operated recording system. Table I shows the recorded daily flow for both the temporary installation and the permanent flow meter for the two week period, May 13th through May 27th, 1983. The Table shows the average daily flow recorded by each installation, as well as the minimum and maximum flows.

In evaluating the flow data over the two week period, it was apparent that a significant percentage of the daily flow is leakage to the system. This is evident during the early morning hours when the minimum flow does not reduce below 50% of the daily average. A system the size of the Borough should have low flows below this, if no leakage was present.

During the two weeks of flow metering, the minimum flow also fluctuated in response to rainfall, which was plentiful during the investigation. Several storms during the period exceeded one half inch of rainfall (over 24 hours) and produced a corresponding increase in the average daily flow and minimum flow on the days following the storm. The response was so great so as to indicate that leakage to the system is especially sensitive to rainfall.

During the two weeks, the minimum flow recorded ranged between 26,000 and 70,000 gallons per day. Most of the time during non-rainfall periods, the minimum flow remained between 26,000 and 30,000 gallons per day. We feel that most of this low flow is leakage to the system and is probably prevalent through at least half of the year. Based on an evaluation of the data, we feel that there is approximately 25,000 gallons of leakage per day to the system on a continuous basis and that this leakage may increase to two or three times this flow immediately following rainfall event.

BOROUGH OF FAR HILLS

INFILTRATION INVESTIGATION

SUMMARY OF FLOW MONITORING DATA

(MAY 13-27, 1983)

RECORDED DAILY FLOW (IN MGD)

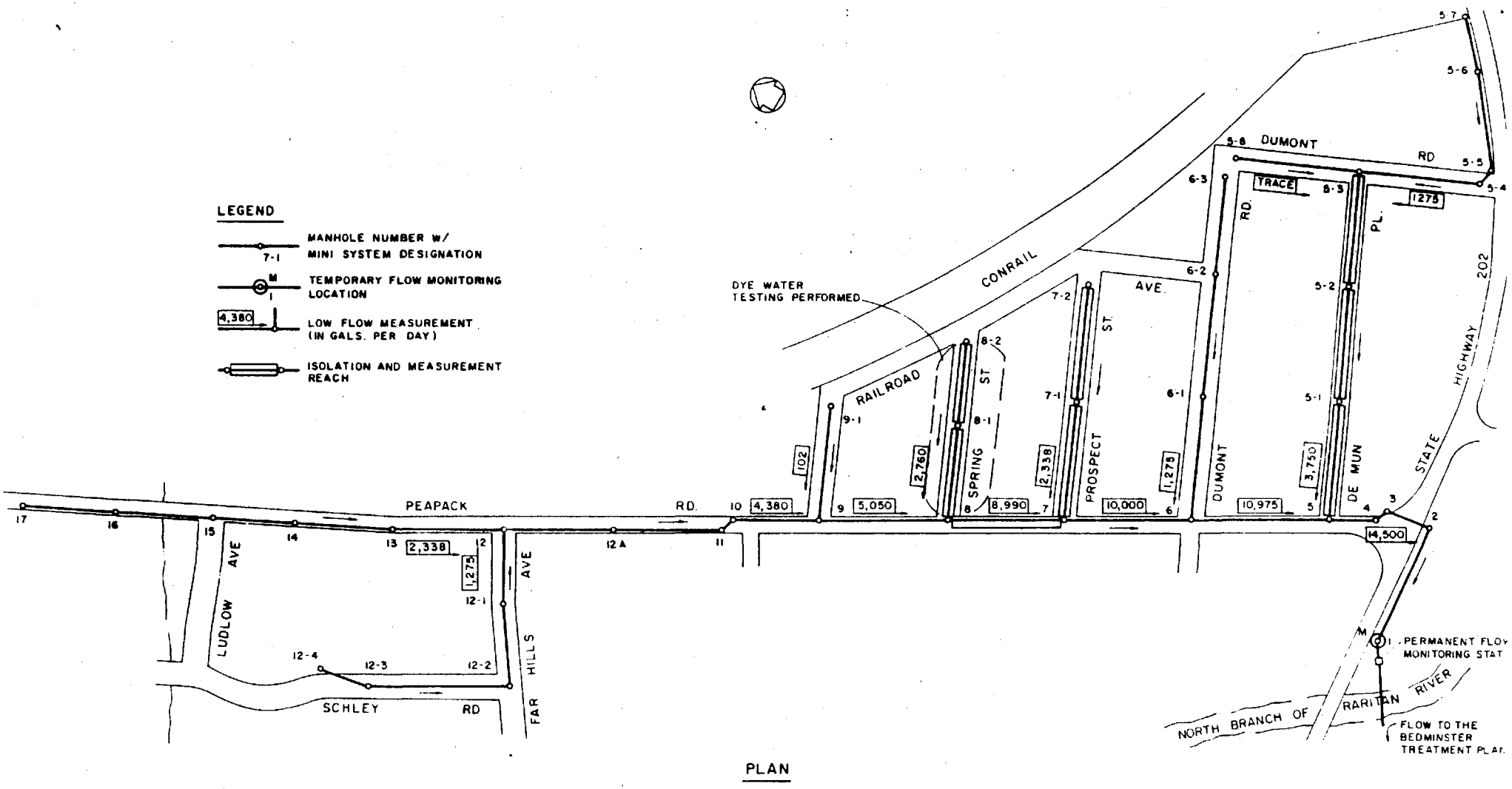
Date		Temporary Flow Meter[1] Avg.	Min.	Max.	Permanent Flow Meter[2] Avg.	Min.	Max.	Recorded Rainfall[3] (Inches)
5-13-83	(Friday)	0.049	0.026	0.064	0.036	0.022	0.066	
5-14	(Saturday)	0 051	0.030	0.081	0.036	0.022	0.050	
5-15	(Sunday)	0.049	0.033	0.065	0.035	0.022	0.050	0.21
5-16	(Monday)	0.065	0.033	0.087	0.045	0.022	0.070	0.62
5-17	(Tuesday)	0.062	0.050	0.093	0.044	0.034	0.080	-
5-18	(Wednesday)	0.063	0.046	0.093	0.041	0.026	0.065	-
5-19	(Thursday)	0.051	0.026	0.093	0.044	0.034	0.070	0.16
5-20	(Friday)	0.045	0.023	0.065	0.045	0.038	0.070	0.22
5-21	(Saturday)	0.074	0.041	0.194	0.055	0.034	0.125	0.31
5-22	(Sunday)	0.089	0.050	0.300	0.056	0.041	0.120	0.67
5-23	(Monday)	0.127	0.070	0.167	0.073	0.052	0.120	0.13
5-24	(Tuesday)	0.084	0.059	0.134	0.052	0.040	0.090	0.01
5-25	(Wednesday)	0.072	0.055	0.099	0.047	0.035	0.080	-
5-26	(Thursday)[4]	0.073	0.055	0.149	0.042	0.035	0.100	0.75
		0.454			0.651			

(1) 8" Palmer Bowlus Flume with Recorder in MH #1
(2) ½-6" Kennison Nozzle with Recorder
(3) 24 hour total rainfall
(4) Partial data only

LOW FLOW MEASUREMENTS

Low flow measurements were undertaken in the early morning hours of May 13, 1983 to identify those areas of the system contributing the majority of the leakage to the system. The measurements were made utilizing portable weirs, and the clarity of the flow was noted as an indication of groundwater leakage to the system.

The attached plan shows the Borough's sanitary sewer system with manholes assigned specific numbers for ease of identification. The plan also shows the results of the low flow measurements obtained on May 13th. The measurements were made in key manhole junctions in the system to identify those branches contributing leakage. Evaluation of the measurements obtained (considering the size and dimension of the sewer system upstream of the point of measurements), identified segments of the system to be investigated further with flow isolation techniques. Segments of the system that did not contain infiltration in a significant quantity were not investigated further. Of the total continuous infiltration to the system, approximately 70% was found to occur in nine segments (about 1900 L.F. of pipe). The length of these segments represented about twenty four percent of the total footage of the system, suggesting that the infiltration is not widespread but confined to specific locations.



PLAN

BOROUGH OF FAR HILLS

SOMERSET COUNTY NEW JERSEY

INFILTRATION INVESTIGATION

CFM INCORPORATED

ENVIRONMENTAL ENGINEERING SERVICES

MANHOLE INSPECTIONS

The majority of the manholes in the system were inspected during the two week period of the investigation. Manhole inspections were undertaken by skilled personnel to obtain data on the structural condition of the manholes and to catalog defects that were evident. A summary of the manhole inspections is shown on the attached Table, including information showing the structural condition of the manhole, observable defects in the piping system tributary to the manhole, sources of infiltration within the manhole, as well as possible inflow sources.

There are 38 manholes with the Borough's sewer system. Of these, 30 manholes were inspected in detail. Seven manholes were not inspected because they could not be opened or were covered with pavement, and one manhole could not be located. All manholes, with the exception of one, were found to be of brick construction with piping system being eight inch diameter vitrified clay pipe.

In reviewing the data obtained from the manhole inspection, it was found that about one third of the manholes contained defects that were allowing leakage into the system. Most of the leakage was in the form of seepage, rather than direct leakage. Possible source of inflow was generally found to be through the cover of the manhole, especially in areas where the frame was set lower than the pavement, allowing the collection of rainwater during rainfall. Observable defects

BOROUGH OF FAR HILLS

RESULTS OF MANHOLE INSPECTION

MANHOLE		CONST. MATERIAL	STRUCTURAL CONDITION				MANHOLE PIPING			INFILTRATION		POSSIBLE INFLOW SOURCE
No.	LOCATION		FRAME & COVER	RISER	JOINTS	BENCH & SLEEVE	SIZE (IN.)	MAT.	OBSERVED DEFECTS	SOURCE	EST. LEAKAGE (GPD)	
2	Route 202	Brick	Good	Good	Good	Worn	8"	VCP	None	None	-	None
5	Peapack & De Mun	"	"	"	"	Good	8"	"	Misaligned Jnts.	None		Frame & Cover
							8"	"	-	-		
5-1	De Mun Place	"	"	Loose	"	"	8"	"	Misaligned Jnts.	Riser Leak	25	None
5-2	" "	"	"	Worn	Worn	"	8"	"	-	Riser & Wall Leak	50	None
5-3	De Mun & Dumont	"	"	"	"	"	8"	"	None	None	-	None
							8"	"	"	"		-
				Note:	Ground water above Invert		monitor in MH 5-3 indicating no ground water (5-13-83)					
5-4	Dumont Road	"	"	Good	Loose	Good	8"	VCP	None	Wall Seepage	50	Cover
5-5	Dumont @ Rt.202	"	"	"	"	"	8"	"	None	"	50	None
5-6	Route 202	"	"	"	"	"	8"	"	Misaligned Deposits/Jnt	Wall Leak Joints	75 -	None
				Note:	Ground water ground water		monitor in MH 5-6 indicating 16" of above invert (5-20-83)					
5-7	Route 202	Cannot locate										
5-8	Dumont Road	Brick	Good	Good	Good	Good	8"	VCP	None	Riser leak	75	Cover
6	Peapack & Dumont	"	"	"	"	"	8"	"	"	None	-	Cover
							8"	"	"			
6-3	Dumont Road	Cannot open.	(Cover is broken.)									
7	Peapack @ Prospect	Brick	Good	Good	Good	Worn	8"	"	-			
							8"	"	Blockage (Removed)	None	-	None
7-1	Prospect Street	"	"	Loose	Worn	Good	8"	"	None	None	-	Cover & Riser
7-2	" "	"	"	Worn	Open	"	8"	"	None	-		Cover
8	Peapack @ Spring	"	"	Good	Good	Fair	8"	"	None	None		None
							8"	"	"	"		"
8-1	Spring Street	"	"	Loose	Loose	Good	8"	"	Misaligned	Pipe Sleeve	50	"
				Note:	Ground water above invert		monitor in MH 8-1 indicating no ground water (5-23-83)					
8-2	Spring Street	"	"	Loose	Loose	Good	8"	VCP	None	None	-	Cover
9	Peapack @ Railroad	"	"	Worn	Fair	"	8"	"	"	"		None
							8"	"	"	"		"
9-1	Railroad Ave.	"	"	"	Worn	"	8"	"	"	Riser Wall Leaks	300	"

BOROUGH OF FAR HILLS

RESULTS OF MANHOLE INSPECTION

MANHOLE		CONST. MATERIAL	STRUCTURAL CONDITION				MANHOLE PIPING			INFILTRATION		POSSIBLE INFLOW SOURCE
No.	LOCATION		FRAME & COVER	RISER	JOINTS	BENCH & SLEEVE	SIZE (IN.)	MAT.	OBSERVED DEFECTS	SOURCE	EST LEAKAGE (GPD)	
10	Peapack Raod	Brick	Good	Worn	Worn	Good	8"	VCP	None	Wall Leak	50	Cover
11	"	Paved Over - Cannot Open										
12-A	"	Brick	Good	Good	Worn	Good	8"	"	Roots in Manhole	None	-	Cover
12	Peapack @ Far Hills Ave.	"	"	Fair	Loose	Worn	8"	"	None	Wall leak	(T)	None
							8"	"	"			
				Note:	Ground water monitor indicating 27" of water over invert (5-11-83)							
12-1	Far Hills Ave.	"	"	Worn	Worn	Worn	8"	VCP	None	None		None
12-2	Far Hills @ Schley	"	"	"	"	Good	8"	"	Flow Stagnent	None		None
12-3	Schley Road	"	"	Good	Good	Good	8"	"	None	None		None
12-4	" "	"	"	"	"	"	8"	"	"	"		"
13	Peapack Road	Paved Over - Cannot Open.										
14	"	"	"	"	"							
15	"	"	"	"	"							
16	"	"	"	"	"							
17	"	"	"	"	"							

in the manholes included worn brick work and misaligned joints in the piping system immediately outside of the manhole wall.

FLOW ISOLATION AND MEASUREMENT

An evaluation of the low flow measurements indicates eight segments contributing a majority of the system leakage and warranting additional investigation utilizing flow isolation and measurement techniques. These techniques included use of a flow plug to stop the flow in the sanitary sewer before the segment to be investigated, while a flow measurement was made at the downstream manhole utilizing a weir. The plug is installed for a period of time sufficient to allow a proper measurement of the residual flow (presumed to be leakage to the pipe system between manholes). If usage of the system is observed during the measurement, the test is repeated so that only clear flow is measured.

The results of the flow isolation measurements are shown on the attached Table, including the size of the pipe, its length and residual rate of flow. For the most part, the flow isolation measurements were made approximately one week following the low flow measurements and after several significant rainstorms. The isolated measurements obtained during this higher groundwater period corresponded to the low flow measurement obtained the week before with the exception of the two reaches on Spring Street. The sewer reaches on Spring Street responded differently with a higher rate of flow measured

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RESULTS OF FLOW ISOLATION AND MEASUREMENT

MANHOLE NUMBER		LOCATION	PIPE REACH		FLOW MEASUREMENT				COMMENTS
UP STREAM	DOWN STREAM		SIZE (IN.)	LENGTH (FT.)	DATE	TIME	FLOW RATE (GPD)	FLOW CLARITY	
5-1	5	De Mun Place	8"	246	5/20/83	1130	764	CL	(Flow Isolation)
5-2	5-1	" "	8"	246	"	"	1588	CL	" "
5-3	5-2	" "	8"	246	"	"	1275	CL	" "
7-1	7	Prospect Street	8"	251	"	1445	1200	CL	" "
7-2	7-1	" "	8"	255	"	-	764	CL	" "
8-1	8	Spring Street	8"	201	5/23/83	1300	2338	-	-
8-2	8-1	" "	8"	180	"	"	2760	CL	Possible connection with storm sewer
8	7	Peapack Road	8"	250	5/26/83	1030	764	CL	-

after the significant rainfall than before. Observations by the field crew suggest a direct connection between the adjacent storm sewer and the sanitary sewer. As such, a test was undertaken on Spring Street to determine if a direct connection exists. Dyed water was introduced to the storm sewer (which is a box culvert along Spring Street) and the flow in the storm sewer was restricted to an elevation of approximately seven inches above the invert. Observations were made in the adjacent sanitary sewer and evidence of dye was observed. The cross connection was determined to be between Manhole 8-1 and 8-2 by this procedure. The investigation in the storm sewer was carried to Peapack Road, wherein the two systems separate. No further inflow investigations were attempted at this time since this was the only location where a possible cross connection was observed.

RESULTS OF INVESTIGATION

In reviewing the results of the investigation, the following results were determined:

a. Approximately 20 to 25,000 gallons of flow (which represents about half the average daily flow from the Borough) is thought to be infiltration to the system continuously during the period of the investigation.

b. About seventy percent of the leakage was confined to about twenty five percent of the piping system, specifically around De Mun Place, Prospect Street, Peapack Road and Spring Street.

c. The sewer on Spring Street contains a direct connection between the sanitary and storm sewers that contributes flow continually to the sanitary sewer and possibly significant flow during rainfall.

d. About one third of the manholes in the system presently contribute some degree of leakage (as seepage).

e. About one third of the manholes in the system may contribute inflow during storm events, especially through low-set covers and around the frames.

The results of these investigations were heavily influenced by the response time of the system. Infiltration builds quickly following rainfall events and diminishes over the next 24 to 48 hours. Flow measurements made during the investigation did not necessarily coincide with rainfall events since it had been suspected that infiltration was seasonal, rather than rainfall specific.

RECOMMENDATIONS

The investigation summarized above produced specific information on segments of the system which should be further investigated, utilizing internal television inspection. The sensitivity of the

system to rainfall events was such that further low flow measurements should be made immediately following significant rainfalls to identify if other areas of the system leak only during rainfall. The sewer on Spring Street, in particular, should be investigated in more detail since it appears to be heavily responsive to conditions in the adjacent storm sewer. Accordingly, we recommend the following:

a. Approximately 1400 feet of pipe should be inspected by internal television equipment. The sewers should be cleaned before the inspection to insure that the vision of the camera is not obstructed. Further, the sewer should be inspected at a time when flows are low enough to allow unobstructed view of the piping system and source of infiltration. The attached table shows those sewers to be inspected. These were selected by utilizing a minimum infiltration rate of 3000 GPD/in-mi as a basis. This value is a common limit utilized by the USEPA in evaluating sanitary sewer systems.

b. Rehabilitation of approximately one third of the manholes of the system should be considered to eliminate observed leakage. This work can be accomplished through exterior grouting around the outside of the manhole and/or coating inside the manhole.

c. Rehabilitation of manhole frames and covers be undertaken at those locations identified on the inspection summary to preclude

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INFILTRATION INVESTIGATION

RECOMMENDED INTERNAL INSPECTION

Manhole Reach	Location	Length (LF)	Isolated Flow (GPD)	Isolated Flow (GPD/In-Mi)	
1/2	Route 202 Row	260	8,000	20,500	*
5/5-1	De Mun Place	246	764	2,100	
5-1/5-2	" "	246	1,588	4,300	*
5-2/5-3	" "	246	1,275	3,500	*
7/7-1	Prospect Street	251	1,200	3,200	*
7-1/7-2	" "	255	764	2,000	
8/7	Peapack Road	251	764	2,000	
8/8-1	Spring Street	201	2,338	7,800	*
8-1/8-2	" "	180	2,760	10,200	*

* Recommended Internal Inspection Based Upon Minimum of 3,000 GPD/In-Mi Isolated Flow.

the entrance of rainfall during storm events. This work should include resetting the manhole frame and cover and in low areas, the installation of a restrictive device to prevent the entrance of runoff into the manhole.

d. Consideration be given to additional low flow investigation at times corresponding with significant rainfall, since it is apparent that the system responds directly to rainfall events. The results of these investigations may prompt further investigation in other sewer segments than those identified herein.

This investigation was undertaken at a time when groundwater was maximized in order to provide specific information upon leakage within the system. The results of the investigation show the leakage to be confined to only a percentage of the system in which rehabilitation measures should be considered. The internal television inspection recommended will provide the necessary data to structure an effective rehabilitation program for these segments. This, coupled with the manhole restoration, should reduce the amount of leakage occurring to the system and subsequent flow to the Bedminster Treatment Plan.

We trust this information is as requested. Should you have any questions, please advise.

Very truly yours,

CFM INCORPORATED

John J. Flood, P.E.

JJF:jp