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PRESSURE SEWER DEMONSTRATION AT THE BOROUGH OF PHOENIXVILLE, PENNSYLVANIA

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PRESSURE SEWER DEMONSTRATION AT THE BOROUGH OF PHOENIXVILLE, PENNSYLVANIA

by

George Mekosh
Daniel Ramos

Project No. 11050 FOU

Project Officer

James F. Kreissl
U.S. Environmental Protection Agency
National Environmental Research Center
Cincinnati, Ohio 45268

Prepared for

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ABSTRACT

A site was selected at the Borough of Phoenixville, Pennsylvania, which provided a maximum variable exercise of a pressure sewer system. The site consisted of five residences spread over more than one-half mile in hilly and predominantly shale-based terrain. The residences varied from a small house to a multiple-unit apartment house. The apartment house is more than half a mile in distance and 60 feet in elevation below the existing conventional gravity sewer inlet point.

The project proved over a six-month period that a multiple residence pressure sewer system can adequately store peak loads of wastewater and grind and pump wastewater through small-diameter plastic pipe to the existing conventional gravity sewer. During the project, data was collected which provided information concerning the installation, operation and maintenance of the system, its technical performance, the variations in that performance during the six-month period and the characteristics of the wastewater as delivered to the existing gravity sewer.

This report was submitted in fulfillment of Project Number 11050 FOU under the sponsorship of the Office of Research and Monitoring, United States Environmental Protection Agency by the Borough of Phoenixville, Pennsylvania

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SECTION I

CONCLUSIONS

1. The primary conclusion is that the project demonstrated over a six-month period that a multiple-residence, separate pressure sewer system can adequately store peak loads of household wastewater, comminute solids in the wastewater and pump this wastewater through small-diameter plastic pipe to the existing conventional gravity sewer.

2. The Pump Storage Grinder (PSG), which is the principal component of the pressure sewer system, easily handled the wastewater loads imposed on it at the five locations, representing a diverse sampling of home wastewater usage and location from the sewer main.

   All five PSG units operated satisfactorily including the two units located at the bottom of the hill which pumped waste to the main gravity sewer located ½ mile away and 60 ft. higher in elevation.

3. The pressure sewer system operated in an anaerobic (septic) mode with zero oxygen levels.

4. The project demonstrated the ease of installation of the pressure sewer system, including the PSG. The pressurized main was installed at a cost of less than $3.00 a linear foot. Operating costs averaged less than 50¢/month per living unit. The initial cost at each household installation, which included the storage tank, PSG, electrical and mechanical connections was $2050. This represents an average of approximately $850 per living unit (5 homes, 7 apartments). The cost of future installations will depend on their size, soil characteristics, existing systems, cost of labor and materials, type of equipment and options selected, etc.

SECTION II

RECOMMENDATIONS

It is recommended that, as a result of this demonstration, pressure sewer systems of this type be considered for use as an additional tool in the formulation of total sewerage system plans. In addition, it is recommended that additional cost factors for pressure sewers of this type be developed by expanding the demonstration at Phoenixville, including evaluation of its effects, if any, on the existing treatment plant.

The following recommendations arose from field experience:

(a) Provide an overflow sensor connected to a visual/audible alarm in the house to alert the occupants of PSG or system malfunction.

(b) Grade the vicinity of the storage tank such as to preclude the entry of surface water and run off into the tank.

SECTION III

INTRODUCTION

Pressure sewer systems are attractive for use in new housing or industrial complexes where their installation costs can be traded off against those of conventional sewers, or at existing sites where septic tanks have become overloaded or operate inefficiently and require either new tanks or the installation of sewers. Pressure sewers become even more attractive where hilly terrain makes conventional sewers extremely costly. Several locations in the Phoenixville area provided examples of the latter two cases.

This project afforded the opportunity to evaluate a pressure sewer system through actual field operation by connecting several homes to the terminus of the gravity sewer which was located uphill from the homes. The basic system design approach was to install a pump storage grinder unit in a holding tank at each dwelling and connect these to a branch pressure sewer line which tied into the existing gravity sewer. The farthest site from the gravity main was ½ mile away and it was 60 feet below the gravity main.

The General Electric Co. had designed a pump storage grinder (PSG) and was field testing one engineering prototype when the opportunity to design a pressure sewer serving multiple residences arose. The PSG comminutes solids in the wastewater, so that the mixture can be pumped thru smaller diameter pipe than is possible with conventional sewage pumps. The pump can deliver moderate flow against relatively high dynamic pressures (30-40 psig). Because the PSG is installed in a holding tank, the pump need not deliver the high flow rates required to keep up with high capacity flows such as toilet flushing. For this application, the pump selected delivered 15 gpm at zero head. Other capacities can be utilized depending on the application and system design.

SECTION IV

PROJECT OBJECTIVES

The objectives were to demonstrate over a six-month period, the feasibility of a multiple-unit, small-diameter pressure sewer system. It was required to determine if the PSG unit could adequately store peak loads of wastewater until processed and grind and pump this wastewater through small-diameter plastic pipes up to a discharge elevation of 60 feet into a conventional gravity sewer. The project provided an opportunity to make modifications based on field requirements and to obtain operating data for future system improvements. This was to be accomplished by recording a variety of parameters along a time base and by collecting samples of the wastewater for analysis and characterization.

SECTION V

SYSTEM LOCATION

A group of five residences located along Pennsylvania Highway #113, on the northern part of the Borough of Phoenixville was chosen as the test site as shown in Figure 1. A terminus of the gravity sewer was conveniently located above the first residence. The homes were spread out over a one-half mile section, with the lowest home being approximately 60 feet below the gravity sewer terminus. These homes had been utilizing septic tanks, which provided a suitable backup system to the proposed pressure sewer.

Other considerations for selecting this site were as follows:

1. The ground was mostly shale and percolation relatively poor.

2. The terrain was hilly, thereby making use of conventional gravity sewer systems impractical.

3. Sewers were needed immediately. However, the road was scheduled for filling and widening within the next few years. Any sewers installed would have been, in some areas, under 60 feet of fill within a few years, making access and maintenance very difficult. This would have required new sewers to be installed along with the road modifications. The problem was solved by using a pressure sewer since the major equipment cost, the Pump Storage Grinder (PSG), could remain intact with the house while the plastic pipes could be replaced very inexpensively along with the road modifications.

4. A recreational park along the river's edge was planned for this area. A pressure sewer appeared to be the only feasible means of getting sewage from the lowlands adjoining the river to the existing sewer. This addition could be combined with the existing pressure sewer system.

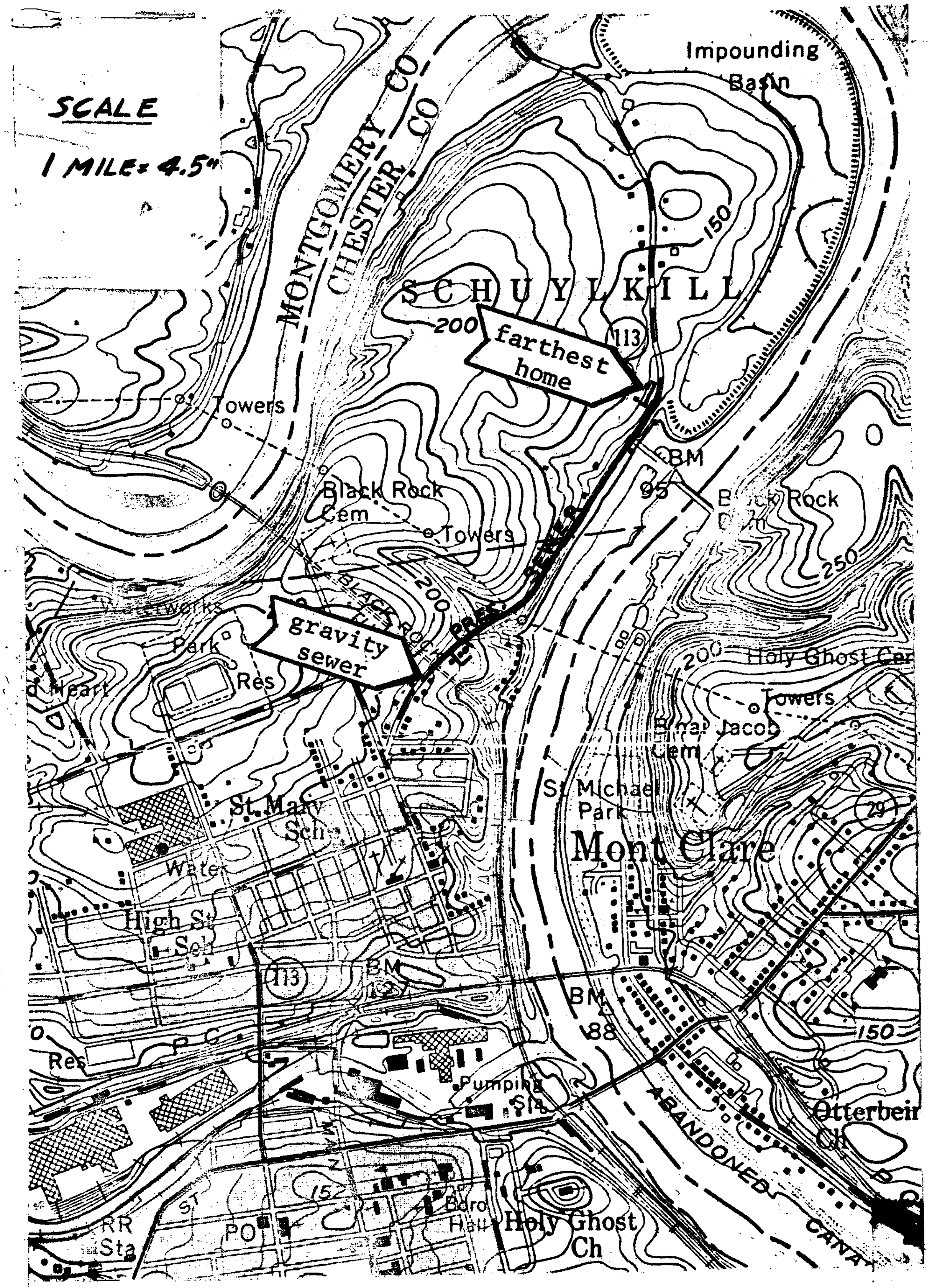


FIGURE 1. AREA MAP OF PHOENIXVILLE, PA.

SECTION VI

GENERAL PRESSURE SEWER COMPONENT DESCRIPTION

A typical pressure sewer system installation is shown in Figure 2. The existing house wastewater line is diverted from the septic tank to the Pump Storage Grinder (PSG). The existing septic tank is utilized as an overflow/emergency tank. The PSG and all piping are installed below the frost line to prevent freezing during winter operation. An access area is provided around the unit to allow for servicing and maintenance. A cover is placed over the access hole.

1. Pump Storage Grinder (PSG)

A sketch and additional details on the Pump Storage Grinder are contained in Appendix A. The unit operates in the following manner. A simple, rugged, diaphragm pressure switch serves as the primary control element. The closure of this switch energizes a relay which starts the motor, thereby starting the pump and the grinder. Water and solids pass through the grinder, where the solids are reduced to sizes less than ¼ inch, and then into the pump inlet line, through the pump, through a check valve, and into the discharge pipe. The check valve prevents back-flow from the pressurized main when the pump is not operating. As the water level drops while the tank is being emptied, the pressure switch is opened causing a relay to shut off the unit.

a. Motor

The motor is manufactured by the General Electric Company, General Purpose Motor Division, Fort Wayne, Indiana. It is described as a 1725 RPM, 1 HP, capacitor start, double shaft, drip-proof motor with built-in thermal overload protection.

b. Pump

The pump is a MOYNO Model FS-44 and is manufactured by Robbins and Myers of Springfield, Ohio. This is a progressing cavity pump with a hardened, corrosion-resistant rotor operating in a resilient stator. This pump has nearly vertical and linear flow characteristics as approximated in Figure 3 from data provided by the manufacturer.

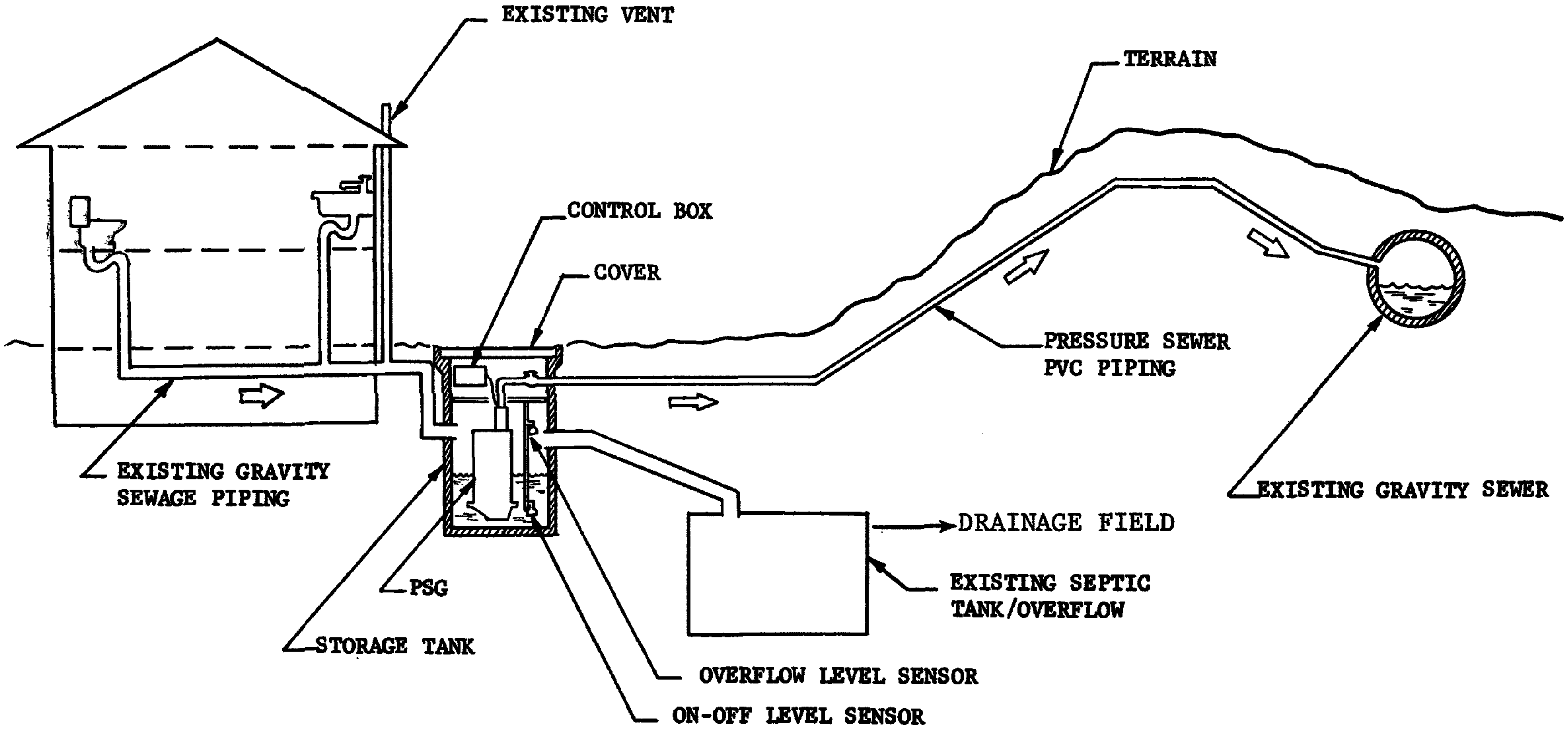


FIGURE 2. TYPICAL INSTALLATION

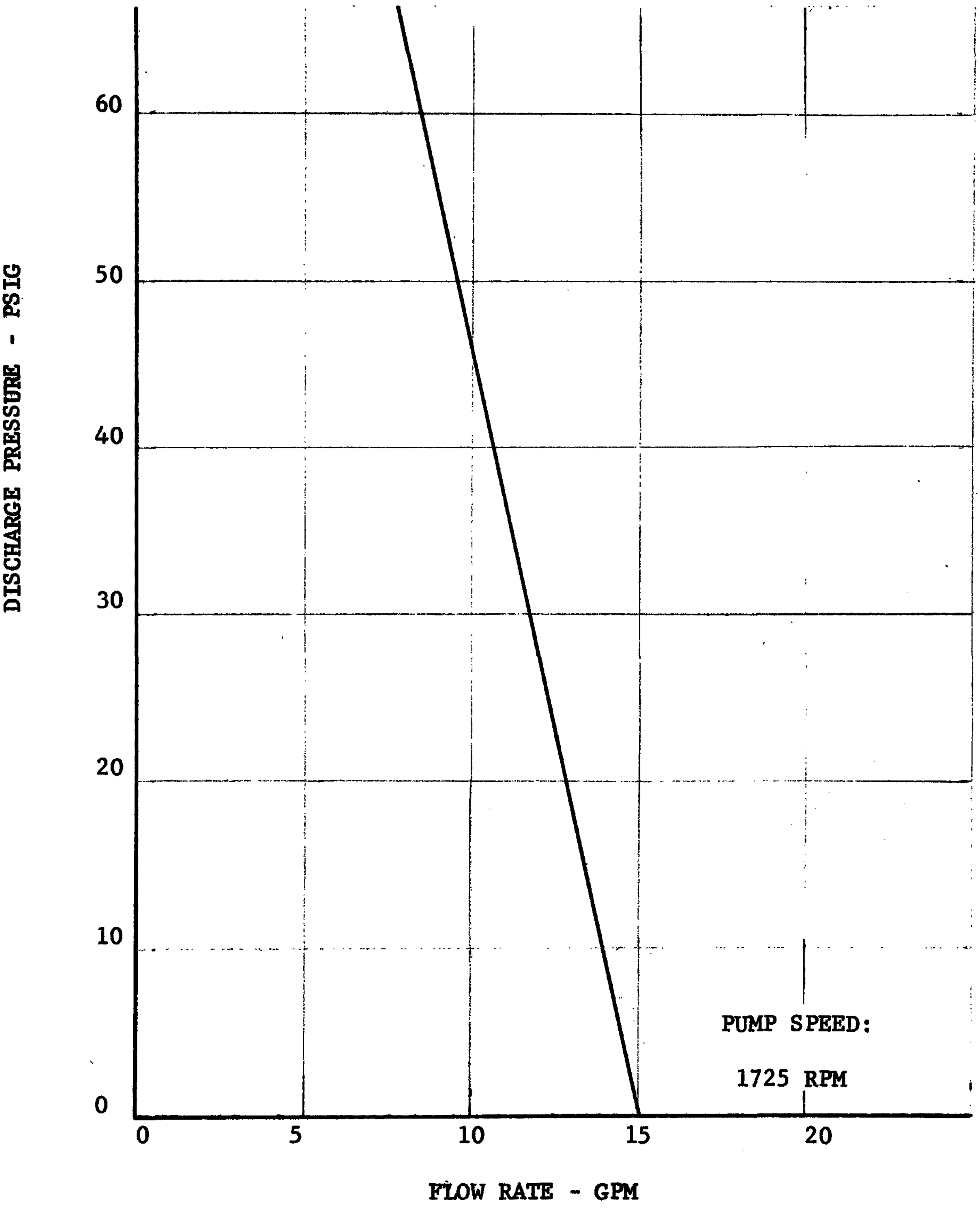
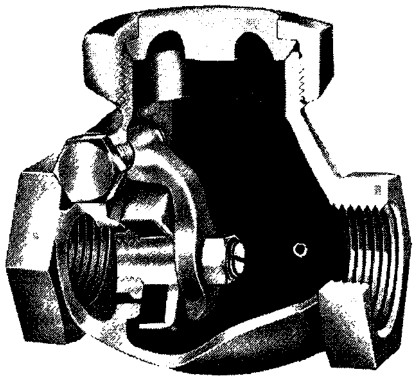


FIGURE 3. PUMP CHARACTERISTICS

c. Grinder

The grinder is very similar in operation to a standard household garbage disposal. It is directly driven by the motor at a speed of 1725 RPM. The flywheel is streamlined, i.e., all contours are smooth and the impellers (choppers) are reduced in size and made an integral part of the flywheel. This flywheel design at the above speed results in a sizeable reduction of viscous drag and operating power. Twenty-one separate materials have been successfully tested without stalling or damaging the grinder. The following general comments can be made: (1) The materials were handled at widely different rates. (2) Floating materials enter the grinder as the liquid surface drops to the level of the suction bell, (3) dense materials tend to settle to the bottom of the tank, (4) plastic film, rubber and cloth are worn away at rates which prevent cumulative build ups, and (5) mixtures of materials tend to be ground more readily than single items. Some of the tested materials include: toilet tissues, paper diapers, wooden pencils, plastic bags, plastic plates, and cups, sanitary napkins and elastomeric contraceptives.

d. Check Valve


0630 Sectional

The very nature of wastewater, i.e., its high solids content including stringy and fibrous materials, makes the reliable closure of a check valve extremely difficult. The check valve used in the pump storage grinder unit was selected with this in mind. The valve selected was a 3/4 inch bronze swing type, model number 0630, made by the Fairbanks Company. Its successful operation is largely dependent on the following subtle details: (1) the hinge point location with respect to the center of gravity of the swing disc, (2) the mass of the swing disc, (3) a smooth seat, (4) a self-aligning closure, (5) the eccentric body housing which provides a pocket for the swing disc when the valve is fully open, (6) oversize low friction passageways, and (7) an extra smooth and clean interior configuration.

e. Relief Valve

A pressure relief valve installed between the pump and the check valve is intended to prevent damage to the pump in the event of a system blockage. The relief valve is set to open between 70 and 75 psig allowing flow back into the storage tank. In order to minimize the effects of solids, the valve is mounted on a tee above the normal flow line. This prevents accumulation of solids in the area of the relief valve during normal unit operation.

f. Control Box

The control box is a customized electrical junction box which provides an environmental enclosure for joining the external power to the motor circuit. It can include the motor start capacitor, transfer relay used with the differential pressure switch, manual shut-off switch, instrumentation connections, etc.

2. Tank

The recommended storage tank is concrete and provides a reservoir to store peak inflows until they canbe ground and pumped out. The storage tank can be located so that an existing septic tank can be used as an overflow during emergency situations, such as electrical power failures. A tank 30 inches in diameter with a minimum depth of 36 inches below the overflow line has been selected as being compatible with a worst case minimum pumping rate of 8 gallons per minute (gpm) for any one PSG. The tank mentioned above can store 95 gallons of wastewater before overflowing into the septic tank. A 30-inch diameter storage tank equipped with a 7-inch differential level switch can store approximately 45 gallons of wastewater before actuation occurs. Upon actuation, the PSG will pump out approximately 20 gallons of wastewater before shut off, leaving a 25 gallon residual. The tank depth can be increased if a larger storage capacity is desired. The differential between actuation and shut-off can also be increased, if desired.

3. Pipe

Polyethylene pipe is considered to be ideal for both lateral and main sewer lines. All fittings and valves would then be polyethylene. This material produces a tough, flexible pipe which has excellent chemical resistance to a wide range of

3. Pipe (Cont'd)

corrosive fluids such as sodium hydroxide, hydrochloric acid, sulfuric acid, etc. Polyethylene is flexible enough to be plowed in. "Plowing-in" refers to the process that combines trenching, feeding of coiled tubing or cable from a spool into a trench and backfilling all in the same operation. This process makes it possible to rapidly bury long lengths of pipe in a trench.

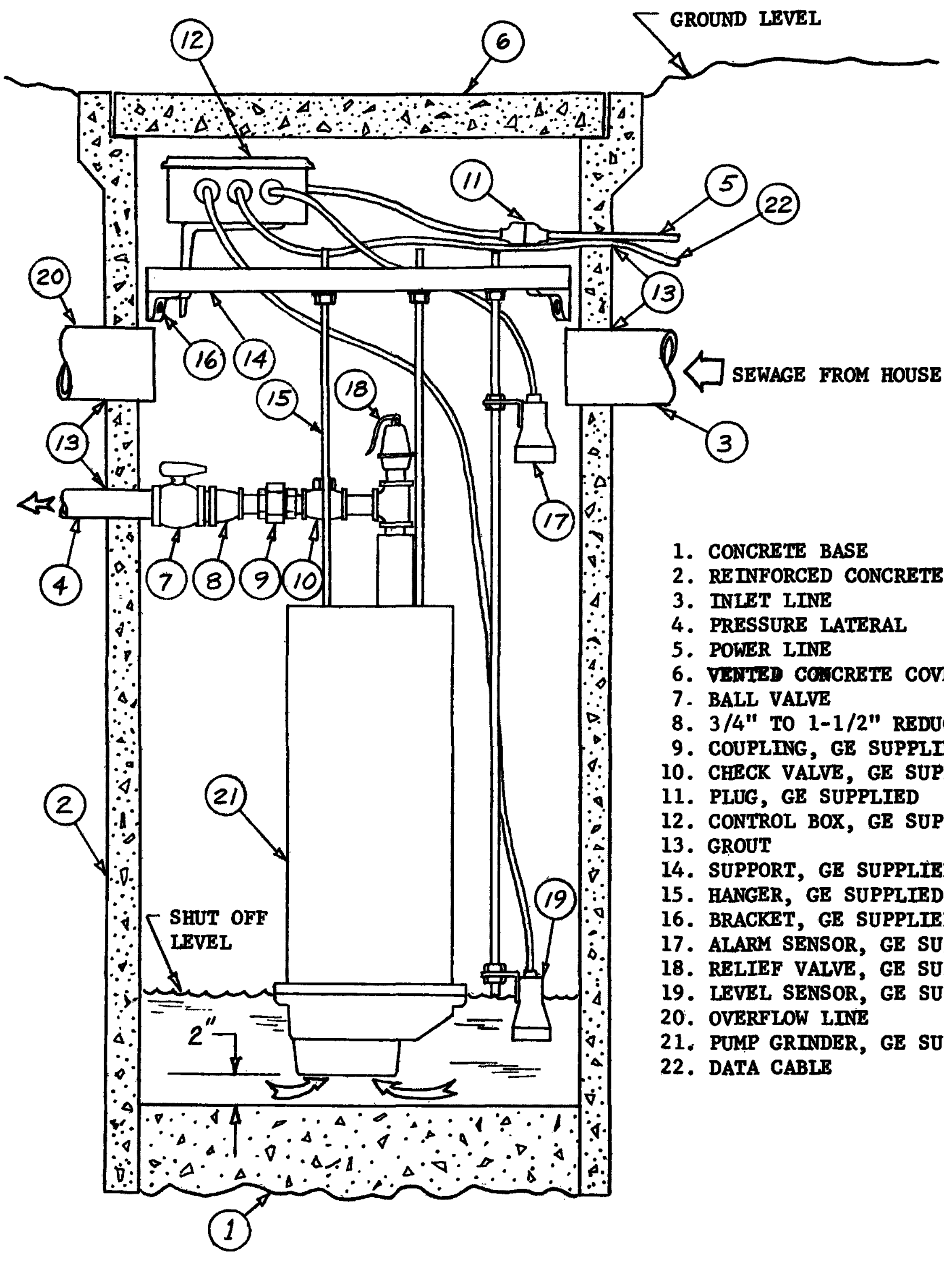
Polyethylene, schedule 40, two-inch pipe has a design pressure rating of 125 psig. The pipe may be cleaned in the event of blockage by flushing with chemicals, with high pressure water or by the introduction of a "rotating snake". A suitable alternate pipe is polyvinylchloride (PVC). This has the same desirable characteristics as polyethylene except it is not as flexible. PVC is not flexible enough to be coiled, therefore, it is not compatible with the "plowing-in" operation. The choice of pipe material depends on the terrain, distance and availability of "plowing-in" equipment.

SECTION VII

PHOENIXVILLE SYSTEM DESCRIPTION

Five residences were involved in the project. A storage tank with a Pump Storage Grinder installed in it, was interposed in each existing building sewer line at a convenient location between the residence and the septic tank. The existing septic tanks were used as emergency storage tanks in the event of overflows from the PSG tanks. The PSG outlets were fed into the pressure main, more than one half mile in length with a 70 -foot elevation differential (the lowest point in the system is 10 feet below the last home), which discharged to the existing gravity sewer. A bypass line was routed through a data collection station. Data cable was installed along with the pressure piping and connected each PSG and sensor to recording equipment in the central data station. The PSG units and all piping were installed below the frost line at a depth of 30 inches. The installation required approximately 2800 feet of 2-inch and approximately 700 feet of 1½-inch PVC pipe, 5 pump storage grinder units, and 5 storage tanks. Also included were electrical and mechanical tie-ins to existing facilities. Approximately 3000 feet of 52 pair data cable and approximately 500 feet of 13-pair data cable were also installed.

The electrical work included supplying and installing a 20 amp, 110 v. ac "slow blow" circuit breaker in the residences as well as a suitable 20 amp, 110v. ac power line from the circuit breaker to the pump storate grinder unit. The power cable was run underground. Figures 4, 5 and 6 show the PSG assembly as installed, the system layout (elevation) and the pipe and pump layout, respectively. The demonstration period extended for 6 months after system start-up. The data station was checked periodically by Phoenixville personnel. Data was collected by General Electric RESD personnel on a weekly basis and reviewed to determine any system changes or trends which might indicate future problems. The PSG units were also inspected on a weekly basis by General Electric RESD personnel. Until system safety was assured, these inspections included a check for objectionable gas formation. Inspection procedures are outlined in Appendix B.



1. CONCRETE BASE
2. REINFORCED CONCRETE PIPE
3. INLET LINE
4. PRESSURE LATERAL
5. POWER LINE
6. VENTED CONCRETE COVER
7. BALL VALVE
8. 3/4" TO 1-1/2" REDUCER
9. COUPLING, GE SUPPLIED
10. CHECK VALVE, GE SUPPLIED
11. PLUG, GE SUPPLIED
12. CONTROL BOX, GE SUPPLIED
13. GROUT
14. SUPPORT, GE SUPPLIED
15. HANGER, GE SUPPLIED
16. BRACKET, GE SUPPLIED
17. ALARM SENSOR, GE SUPPLIED
18. RELIEF VALVE, GE SUPPLIED
19. LEVEL SENSOR, GE SUPPLIED
20. OVERFLOW LINE
21. PUMP GRINDER, GE SUPPLIED
22. DATA CABLE

FIGURE 4. PUMP STORAGE GRINDER INSTALLATION

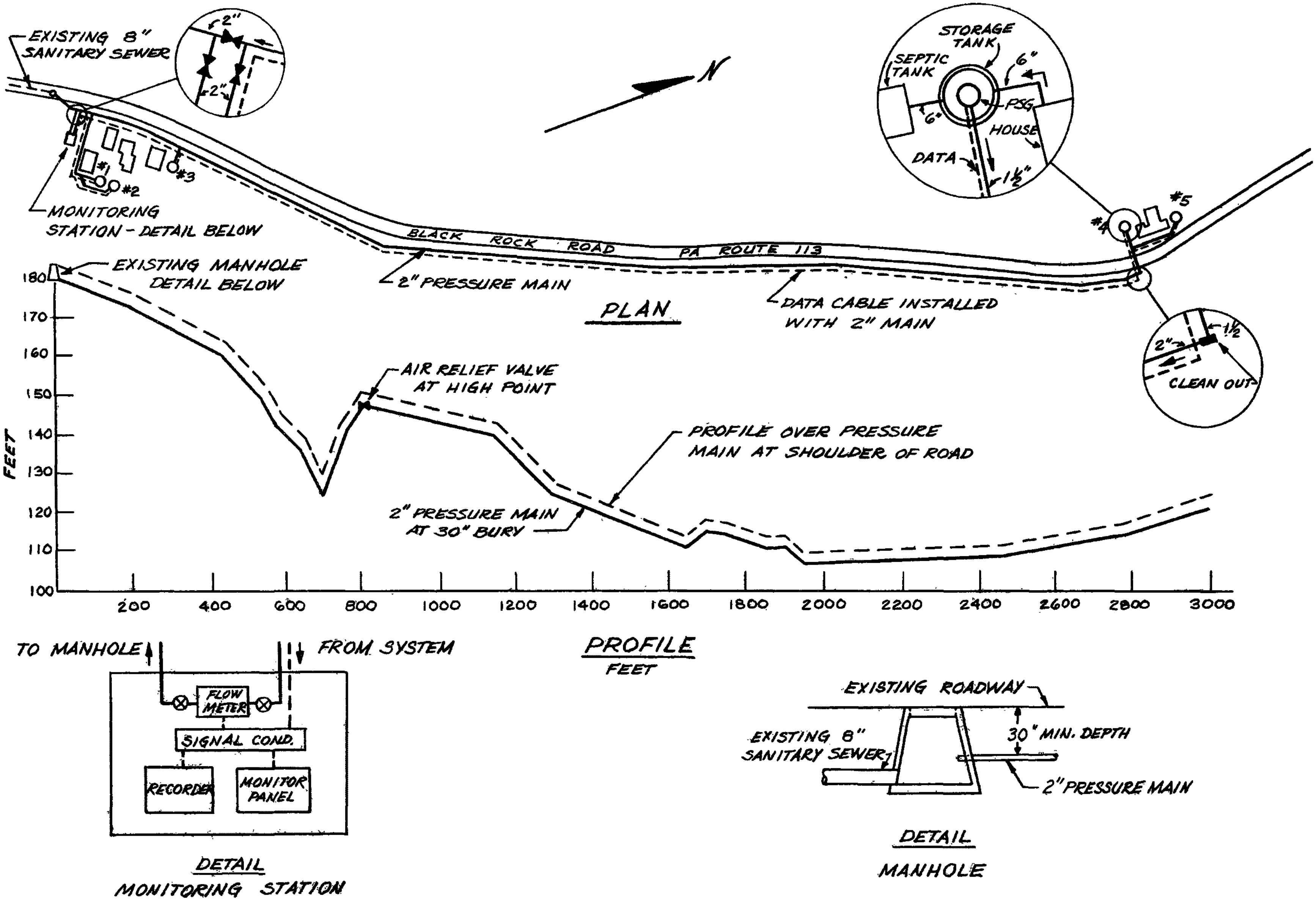


FIGURE 5. PRESSURE SEWER SYSTEM - PHOENIXVILLE

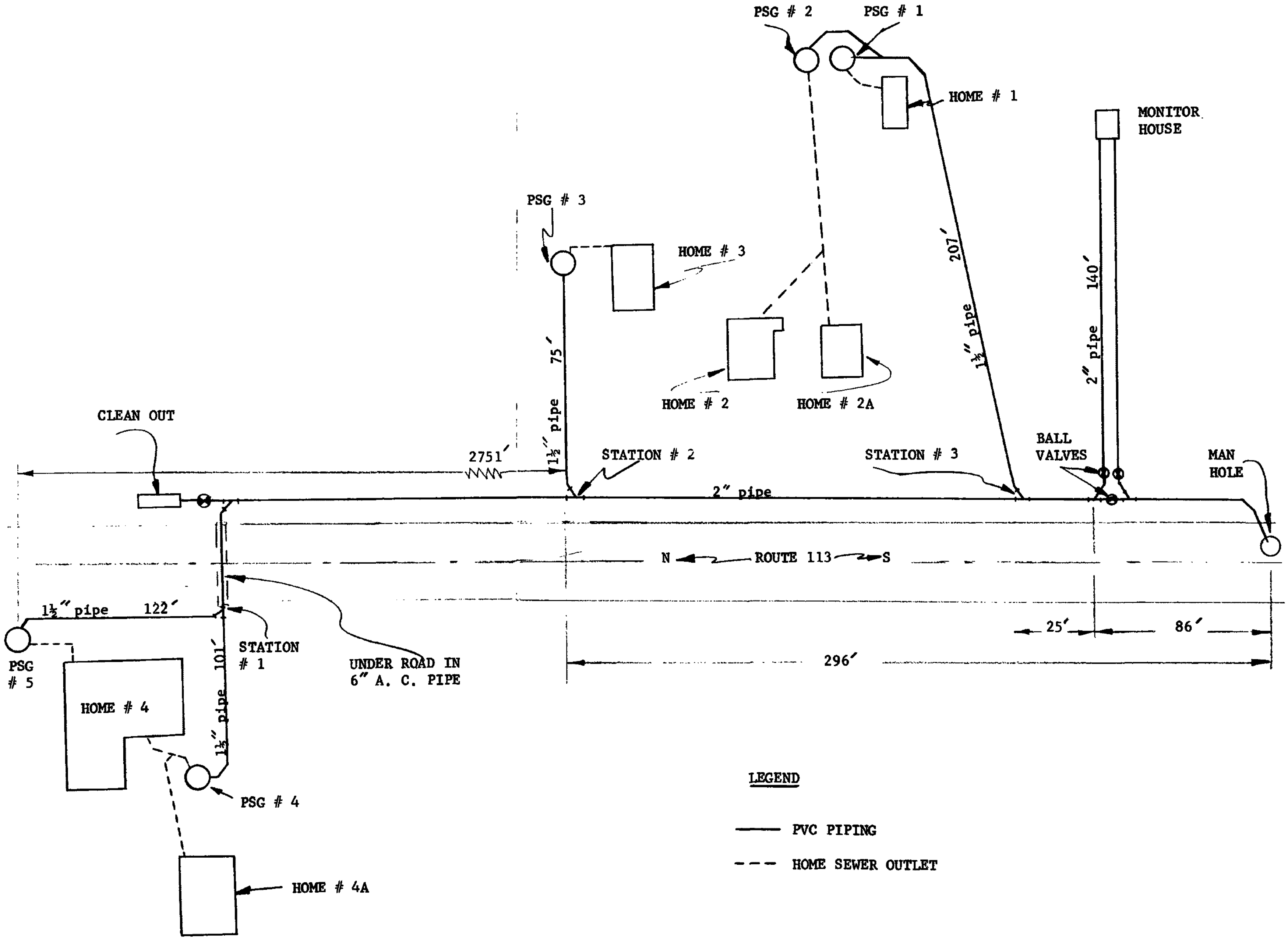


FIGURE 6. PIPE AND PUMP LAYOUT

The energy or hydraulic grade diagram for the system is shown in Figure 7. This diagram was developed by assuming that minimum system pressure would occur when only unit #4 was operating. From this "minimum" pressure line and the pump characteristic curve, (Figure 3), the actual flow from each storage grinder was calculated. A new "maximum" pressure line was then established based on all units operating simultaneously. A final calculation, utilizing this "maximum" pressure line, verified that the system would operate between the pressure limits shown in Figure 7.

Assuming that a maximum pressure of 60 psig can be developed by each unit, an "available" pressure line was plotted. Since the "available" pressure line is in every case above the maximum operating pressure, the design is shown to be practical. The minimum system velocity is 1.2 feet per second (fps) and occurs when PSG #4 is operating alone. This is compatible with the desired minimum scouring velocity of 1.0 fps. With units #4 & #5 operating together the velocity would be 2.2 fps.

A computer program was developed to further describe and analyze the Phoenixville pressure sewer system installation. The program (Phoenix) is a deskside digital computer program which calculates flows, velocities, friction head and pressures based on the provided input data. The input data required are the number of stations, pipe diameter, pipe length, and static head between stations. A station is defined as the junction of the road main and the laterals from the PSG units. Input data also required are the pipe diameter, pipe length and static head of the laterals. This also requires an initial pressure at Station 1 and the interface pressure with the connecting system. If the connecting system is a gravity sewer the interface pressure will nominally be zero.

The Program takes the input pressure at Station 1 and calculates the pump pressure and flow.

Summing pump flow at Station 1 the program calculates the friction head in the road main to Station 2. The program then calculates the pressure at Station 2. The process is repeated at each station until the interface or discharge pressure is calculated. If the discharge pressure is greater than 0.05 psi the program calculates a new input pressure and repeats the previous calculations. Several iterations are generally required for a solution.

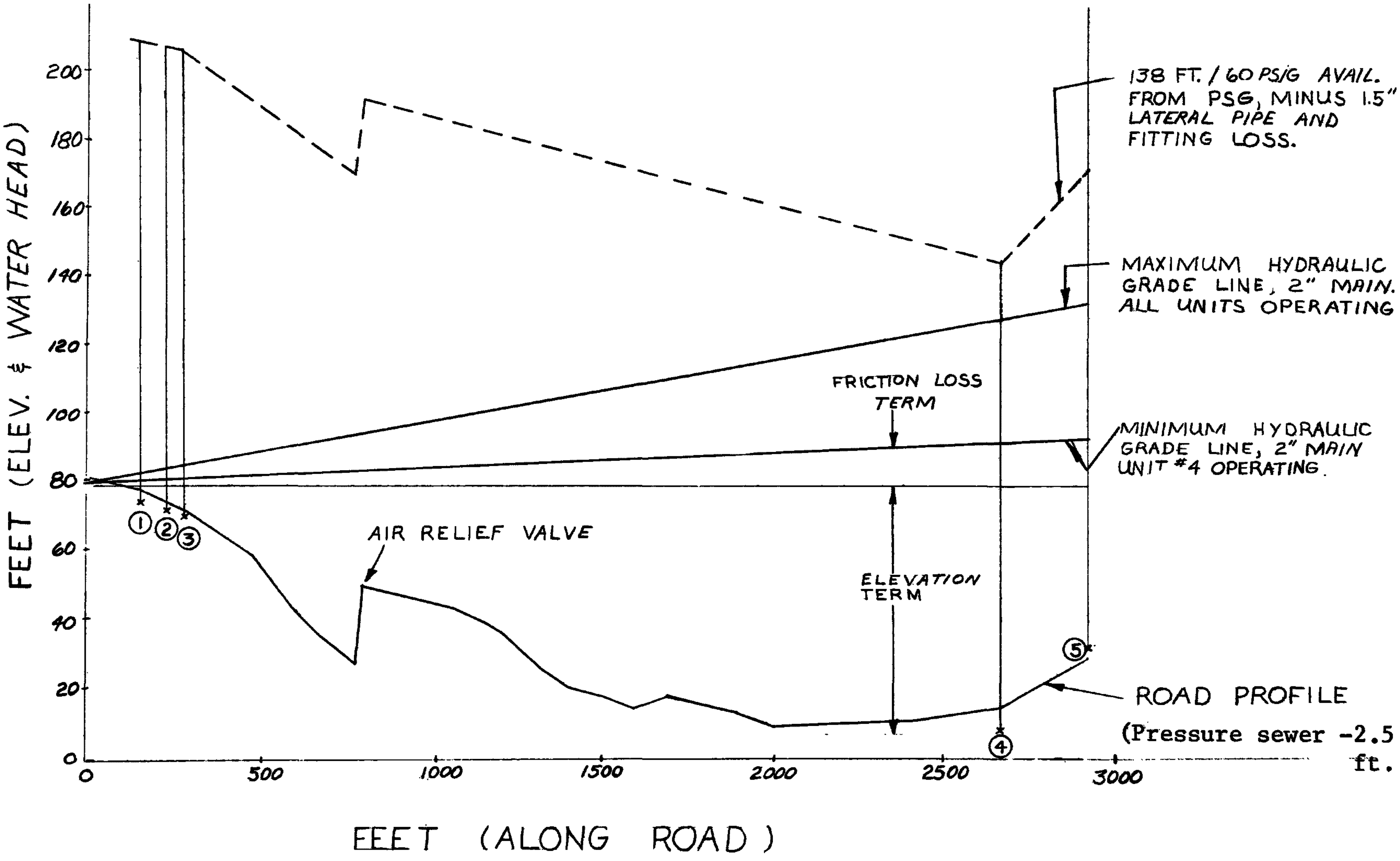


FIGURE 7. HYDRAULIC GRADE DIAGRAM

The equations used in the program are the pressure-flow characteristics of the pump and the friction head of the pipe. The equation of the progressive cavity pump characteristics is:

$$Q_o = 15.0 - 0.115\ P_o$$

Where: Q_o = Pump output flow, gpm
P_o = Pump output pressure, psig

The head loss due to fluid flow in the pipe is calculated using the empirical Hazen-Williams formula:

$$Hf = \frac{3.023}{D^{1.167}} \left(\frac{V}{C}\right)^{1.852}$$

Where: H_f = Friction head per foot, ft.

V = Fluid velocity, ft./sec.

D = Pipe diameter, ft.

C = Coefficient representing roughness pipe interior surface (C=150 for PVC pipe).

The characteristics of the equipment used at Phoenixville are listed below:

1. Pump Storage Grinder

The PSG units were of the design configuration shown in Appendix A . This particular design required that the uppermost part of the PSG, the electrical cable exit and potting, be above the overflow line. This requirement was necessary because the units were not completely submersible. Units # 3 and 4 were piped to allow for the incorporation of a temperature sensor and pressure transducer. The control box was mounted on brackets attached to the storage tank. Electrical power was supplied to the box from the home using #12-gage wire and connected with twist lock plugs, as shown in Figure 4. The control features included an on/off switch and the necessary circuitry to operate the unit and level sensing system. Since the overflow alarm sensor was for data only, it was not required to be routed through the control box. Electrical power was 110v. ac, single phase, 60 Hz.

1. Pump Storage Grinder (Cont'd)

The level sensing system used on the first pump storage grinders field tested by GE-RESD relied on a pressure differential switch that sensed the pressure buildup of an air column trapped in a dip tube. This method of level control was plagued with two problems: one, air leakage in the dip tube, and two, dip tube blockage caused by wastewater solids. The five pump storage grinders tested at Phoenixville, used a submersible pressure differential switch for level control. The switch consists of a snap action, double throw, micro switch that is activated by a rubber diaphragm. At the time of the demonstration, the submersible differential switch was available with only a few different operating pressure differential settings. The switch selected has a differential of 7 inches between actuation and cut-off level. When installed in a 30-inch diameter tank, the level sensing system would actuate the PSG when approximately 45 gallons of wastewater had accumulated and deactivate the unit after pumping approximately 20 gallons, leaving a residual of 25 gallons in the storage tank.

The choice of operating range for the switch is somewhat arbitrary, although dependent on other system parameters such as anticipated wastewater influx, tank size, operating cycles or system programming and pump capacity.

2. Piping

Polyvinylchloride (PVC) pipe was used at Phoenixville because of its availability. The PVC was schedule SDR-26; it was capable of withstanding hydrostatic working pressures of 160 psig at 73°F, and conformed to requirements set forth by ASTM-D 2241. All 2-inch pipe had an inside diameter of 2.2 inches. All 1½ inch pipe had an inside diameter of 1.75 inches. All fittings were PVC schedule 40. All pipe was installed at a depth of 30 inches. The trench did not exceed 4 inches in width except where necessitated by rock removal. Loose bed rock was removed by a backhoe. All of the PVC pipe was encased in 4 inch asbestos cement pipe where it crossed under public or private roads. The PVC pipe was handled and installed in strict accordance with the manufacturer's instructions. Care was taken during installation to prevent entry of foreign material which would have hindered flow through the pipe. The pressure system was leak-checked at a pressure of 100 psig at the completion of construction. As shown in Figure 7, the maximum system operating pressure analytically should have been below 60 psig.

2. Piping (Cont'd)

Access to the pipe lines was available through fittings at each pump storage grinder unit and through the clean-out box at the "bottom" of the system, illustrated on the right hand side of Figure 6.

3. PSG Storage Tank

The storage tanks were constructed from 8-foot sections of 30-inch inside diameter reinforced concrete sewer pipe. The pipe met the requirements set forth by ASTM and the Pennsylvania Department of Transportation for C76, Class 3 pipe. The 8-foot section of pipe was installed so that the top was level with the ground. The base of the tank was a minimum of 6 inches of poured concrete. A light duty cover was supplied by the construction contractor and was capable of withstanding the load of a home garden tractor or equivalent. The cover was 36 inches in diameter. The tank intercepted the existing home sewer line prior to its entry into the septic tank. The overflow line was a minimum of 36 inches from the bottom of the tank. The inlet line was higher than the overflow point. The actual tank depth was determined by the above requirements, as well as the depth of the existing home sewer line.

4. Data System

The data system supplied operating and chemical data. Electrical power (110 v. ac, single phase, 60 Hz) was available in the data station to operate the data system. A small electric heater was also used. The data system operated for the total 6-month demonstration period. All sensors were installed so that they were readily accessible for maintenance purposes, and the system contained calibration capabilities. The data station was approximately 8' x 10' x 6' high, was locked, and was sturdy enough to prevent vandalism. Data was transmitted from the individual sensors to the data station via the data cable.

The operating data included on time, overflow time and real time for each unit, and temperature and pressure readings at units # 3, # 4 and the data station, as shown in Table 1. The operating real times were determined from the recorder chart speed. Temperature was monitored with a thermistor probe attached to the outside of a section of pipe. This section of pipe was over-wrapped with insulation. The probe was located a minimum of 3 inches from either end of the insulation.

TABLE 1

PERFORMANCE DATA LIST

MEASUREMENT	FREQUENCY	LOCATIONS	TYPE OF SENSOR
On and overflow time	1/48 sec.	PSG #'s 1-5	Relay contacts level switch contacts
Total cycles	as occur	PSG #'s 1-5	Counter
Operating pressure	1/44 sec	PSG #'s 3 & 4 Data Station	Transducer
Temperature	1/44 sec	PSG #'s. 3 & 4 Data Station	Thermistor

4. Data System (Cont'd)

The pressure transducer was used in conjunction with a small diameter, silicone grease filled, interface tube between the transducer and the wastewater. All sensors which were installed in the storage tanks were capable of operating in high humidity environments at outdoor ambient temperatures. The recorder was the multiple (24) point type and was capable of running one week without the need to refill the chart paper. The monitor panel contained lights to indicate an "on" or an "overflow" condition for each unit. The data cable was a standard type used by utility companies for underground installation.

The wastewater characterization data was obtained from wastewater grab samples which were collected and analysed during 3 sample periods. The wastewater samples where obtained via a hand valve in the main pressure line in the data station. Composites were prepared by taking several grab samples over a period of time until a liter of solution was obtained. Each grab sample was approximately 200-300 ml. The following analyses were performed:

- Alkalinity
- Ammonia Nitrogen
- Bacterial Count (Coliform)
- Biochemical Oxygen Demand (BOD)
- Calcium
- Chemical Oxygen Demand
- Chloride
- Conductivity
- Detergents
- Dissolved Oxygen
- Magnesium
- Nitrate
- Oxidation-Reduction Potential (ORP)
- pH
- Phosphate
- Settleable Solids
- Sulfate
- Total Suspended Solids (TSS)

The oxidation reduction potential (ORP) was to be obtained by continuously recording the output of an ORP sensor located in the data station. However, an unprecedented long strike against the vendor (Leeds & Northrup) precluded us from obtaining this data continuously. Instead, the oxidation-reduction potential

4. Data System (Cont'd)

of the grab samples was measured using a portable, battery-powered ORP meter. The magnesium and calcium analyses were performed by the atomic absorption method. All other analyses were performed according to Standard Methods for Examination of Water and Wastewater, 13th Edition.

5. System Costs

Table 2 lists the material and installation costs of household related equipment, such as the PSG and its storage tank, used in the Phoenixville pressure sewer system. The PSG unit cost of $900.00 was based on prototype models. The total costs listed for item 2 through 6 were actual costs charged to the project by the contractor. The cost per unit, per foot or per installation was calculated by dividing the total cost by the actual quantity of material used in the system.

Table 3 lists material and installation costs related to the Phoenixville pressure sewer main. The total cost listed for the various items were costs charged to the project by the contractor. Once again, as in Table 2, the unit cost was calculated by dividing the total cost by the actual quantity in the system.

Table 4 lists the costs related to the data collection. It should be noted that a typical pressure sewer system would not require a data collection system.

It is difficult to provide meaningful cost estimates for future installations because they depend on such factors as the number of homes, total distance and piping runs, soil of conditions, type of equipment available, pipe sizes, new construction or converting present installations, whether or not any existing facilities are available.

TABLE 2

COST OF HOUSEHOLD RELATED EQUIPMENT FOR THE PHOENIXVILLE PROGRAM

ITEM	UNIT COST $/UNIT	QUANTITY	TOTAL COST $
PUMP STORAGE GRINDER (PSG) AND CONTROLLER	900.00 per UNIT	5 units + 1 spare	5,400.00
STORAGE TANK; EXCAVATE, SUPPLY AND INSTALL 30" DIA. 8' LONG SEWER PIPE SECTION; POUR CONCRETE BOTTOM, SUPPLY COVER; TIE-IN HOME SEWER IN-PUT LINE, OVERFLOW LINE, PRESSURE LATERAL; INSTALL PSG AND RESTORE AREA.	600.00 per INSTALLATION	5 INSTALLATIONS	3,000.00
PRESSURE LATERALS; SUPPLY 1½" PVC PIPE - SCHEDULE SDR-26, EXCAVATE, INSTALL AND RESTORE AREA.	2.50 per LINEAR FOOT	700 FEET TOTAL	1,750.00
HOME CIRCUIT BREAKER; SUPPLY AND INSTALL	60.00 per INSTALLATION	5 INSTALLATIONS	300.00
POWER CABLE; SUPPLY AND INSTALL SUITABLE UNDER-GROUND ELECTRICAL CABLE FROM HOME CIRCUIT BREAKER TO PSG STORAGE TANK.	3.00 per LINEAR FOOT	200 FEET TOTAL	600.00
MISCELLANEOUS PVC PIPE FITTINGS USED IN PRESSURE LATERAL TIE-IN TO PSG.	20.00 per INSTALLATION	5 INSTALLATIONS	100.00 (APPROX)
		TOTAL	$11,150.00

AVERAGE COST PER RESIDENCE, EXCLUDING COST OF SPARE UNIT $ 2,050.00

AVERAGE COST PER DWELLING UNIT (12) (LESS SPARE) $ 854.17

TABLE 3

COSTS RELATED TO PHOENIXVILLE PRESSURE SEWER MAIN

ITEM	UNIT COST $/UNIT	QUANTITY	TOTAL COST $
PRESSURE MAIN; SUPPLY 2" PVC SCHEDULE SDR-26 PIPE, EXCAVATE, INSTALL, TIE-IN TO PRESSURE LATERALS AND RESTORE AREA.	2.00 per LINEAR FOOT	2800 FEET	5,600.00
ROCK REMOVAL ON A PER CUBIC YARD BASIS	20.00 per CUBIC YARD	60 CUBIC YARDS	1,200.00
RESTORATION OF PAVED HIGHWAYS AND DRIVES ON A PER CUBIC YARD BASIS.	15.00 per CUBIC YARD	10 CUBIC YARDS	150.00
RESTORATION OR UNPAVED DRIVES ON A PER CUBIC YARD BASIS.	2.00 per CUBIC YARD	50 CUBIC YARDS	100.00
PROTECT ALL PRESSURE SEWER PIPE WHICH RUNS UNDER HIGHWAYS OR DRIVES BY ENCASING IT IN ASBESTOS CEMENT PIPE, 4-INCH DIAMETER; ON A PER LINEAR FOOT BASIS.	3.00 per LINEAR FOOT	40 FEET	120.00
AIR RELIEF VALVE: SUPPLY AND INSTALL IN PRESSURE MAIN; PROTECT IN BUFFALO BOX (6"), RISERS (30" HIGH X 4" DIAMETER)	350.00 per VALVE	1 REQUIRED	350.00
PROVIDE CLEANOUT; SUPPLY SHUT-OFF VALVE, PROTECT IN BUFFALO BOX (6"), RISERS (30" HIGH X 4" DIAMETER)	350.00 per INSTALLATION	1 REQUIRED	350.00
		TOTAL	$7,870.00

AVERAGE COST PER FOOT OF PHOENIXVILLE SEWER MAIN $2.82

TABLE 4

COSTS RELATED TO DATA COLLECTION

ITEM	QUANTITY	TOTAL COST $
DATA STATION STRUCTURE	1	1,100.00
DATA CABLE - 52 PAIR: ON A PER LINEAR FOOT BASIS : SUPPLY AND TIE-IN.	3000 FEET	5,500.00
DATA CABLE - 13 PAIR; ON A PER LINEAR FOOT BASIS, SUPPLY AND TIE-IN.	500 FEET	500.00
CONNECT PRESSURE SEWER SYSTEM TO DATA STATION: SUPPLY AND INSTALL VALVES, PROTECT IN BUFFALO BOXES (6"), RISERS (30" HIGH X 4" DIAMETER)	1	820.00
INSTRUMENTATION (MISC)	-	1,400.00

TOTAL COST OF PHOENIXVILLE DATA COLLECTION SYSTEM $9,320.00

SECTION VIII

DEMONSTRATION RESULTS

The following paragraphs present the data obtained from the demonstration, including operating cost. Reference to Appendix B will identify the typical check-off list used at the site for data collection.

1. PSG Use Characteristics

   The total operating time and cycles for each unit as well as the type of residence serviced is given in Table 5. Table 6 shows the average operating time per cycle for each unit by month. The average operating time per cycle is related to the operating differential of the level switch and to the pump output. The operating time per cycle of units #1, #2, #3, and #5 was lower than that expected. Investigation revealed that the level switch used on these units had a 4-inch differential instead of the 7-inch differential. Unit #4 did have a 7-inch differential level switch. Table 7 shows the average PSG operating time per day by month. Typical weekly use profiles were plotted for each unit and the system in Figures 8 (a) through 8 (f). Unit operating time in minutes per real time hour was plotted for a week. The intent of these profiles was to identify peak activity periods during the day and week. The use profile data was obtained by reducing the output of a continuous strip chart recorder, operating at a speed of 8 inches per hour, that was recording unit operating time. The use profile shown are representative of the beginning, middle and end of the demonstration period.

2. Flow and Pressure Data

   The flow and pressure characteristics of the system were initially described by the computer program. The computer program calculated pressure and flow characteristics at each of the five PSG locations and three station locations. The results of several computer runs are shown in Table 8. It can be seen from the data that PSG's #1, #2, and #3, which are at the higher elevation, operate at relatively low pressures, i.e., less that 12 psig. Units #4 and #5 which are at the lower elevation operate at roughly 35 psig when operating alone. The discharge pressure of each pump rises

TABLE 5

PSG USE CHARACTERISTICS

PUMP STORAGE GRINDER NO.	TOTAL HOURS	TOTAL CYCLES	TOTAL DAYS IN SERVICE	TYPE OF RESIDENCE SERVICED BY PSG	NO. PEOPLE
#1	50.9	4526	195	SINGLE HOME	2
#2	160.0	15306	195	5 APARTMENT UNITS (2 houses)	11
#3	102.8	6792	190	SINGLE HOME	3
#4	182.4	5016	189	4 APARTMENT UNITS + SINGLE HOME	10
#5	123.4	6946	189	3 APARTMENT UNITS	6

TABLE 6

PSG OPERATING TIME PER CYCLE*

PUMP STORAGE GRINDER

MONTH	#1	#2	#3	#4	#5
FEBRUARY	0.66	0.70	0.87	2.11	1.05
MARCH	0.66	0.58	0.87	2.02	1.22
APRIL	0.66	0.57	1.0	2.03	1.05
MAY	0.69	0.55	0.91	1.83	1.09
JUNE	0.67	0.68	0.92	2.29	1.06
JULY	0.71	0.66	0.96	1.97	1.04
AUGUST	0.67	0.73	0.93	----	0.91

*All values are expressed in minutes/cycle

TABLE 7

PSG AVERAGE OPERATING TIME PER DAY*

MONTH	#1	#2	#3	#4	#5
FEBRUARY	26.8	91.5	64.5	34.0	19.0
MARCH	23.8	67.5	38.0	38.6	39.3
APRIL	15.3	50.6	26.9	59.5	24.5
MAY	11.1	39.4	39.8	79.3	33.2
JUNE	12.3	39.0	26.1	74.6	36.5
JULY	8.15	23.2	4.2	68.2	51.4
AUGUST	14.2	43.6	49.5	-----	55.4

*All values expressed in minutes/day

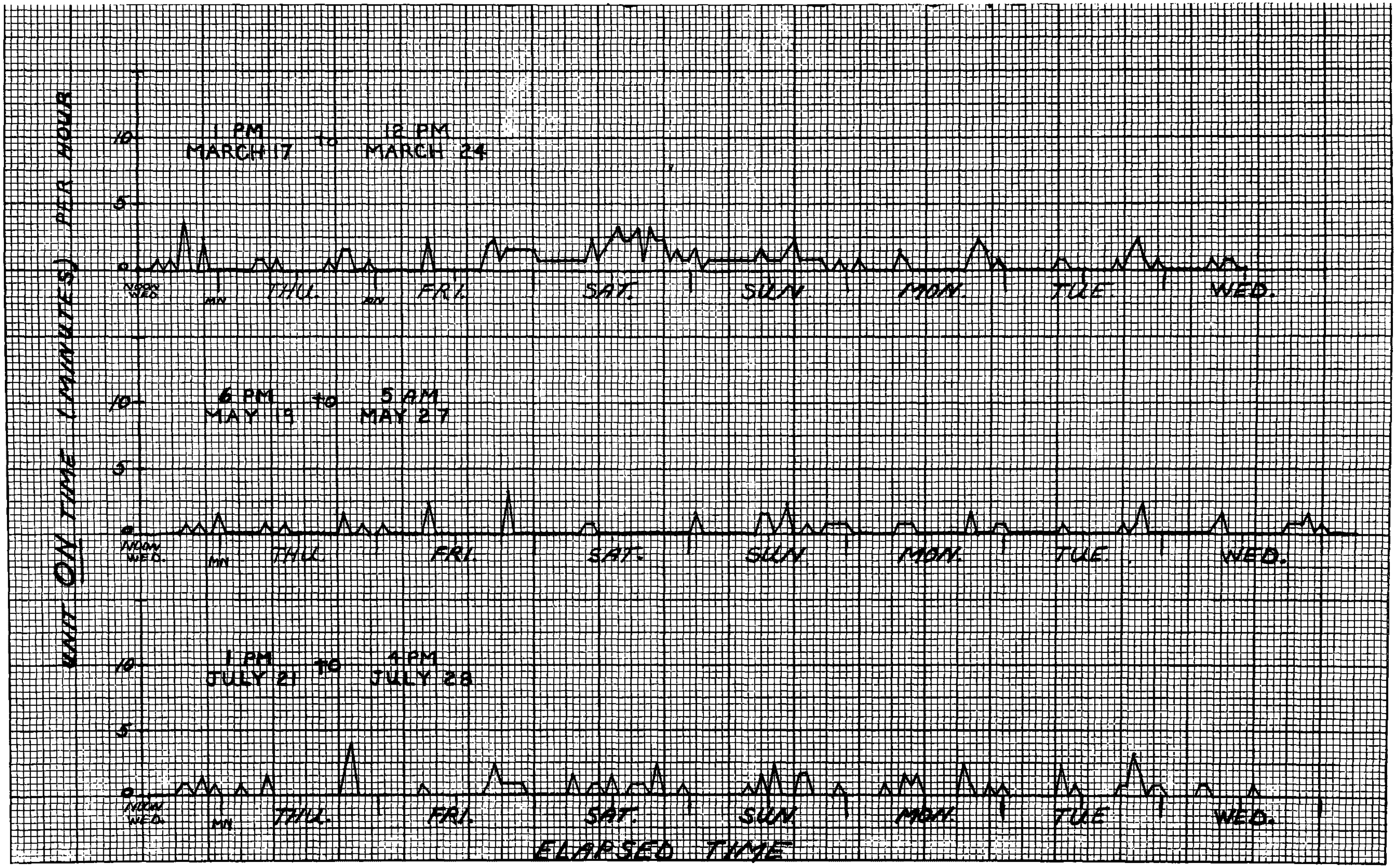


FIGURE 8A RSC #1 USE PROFILE

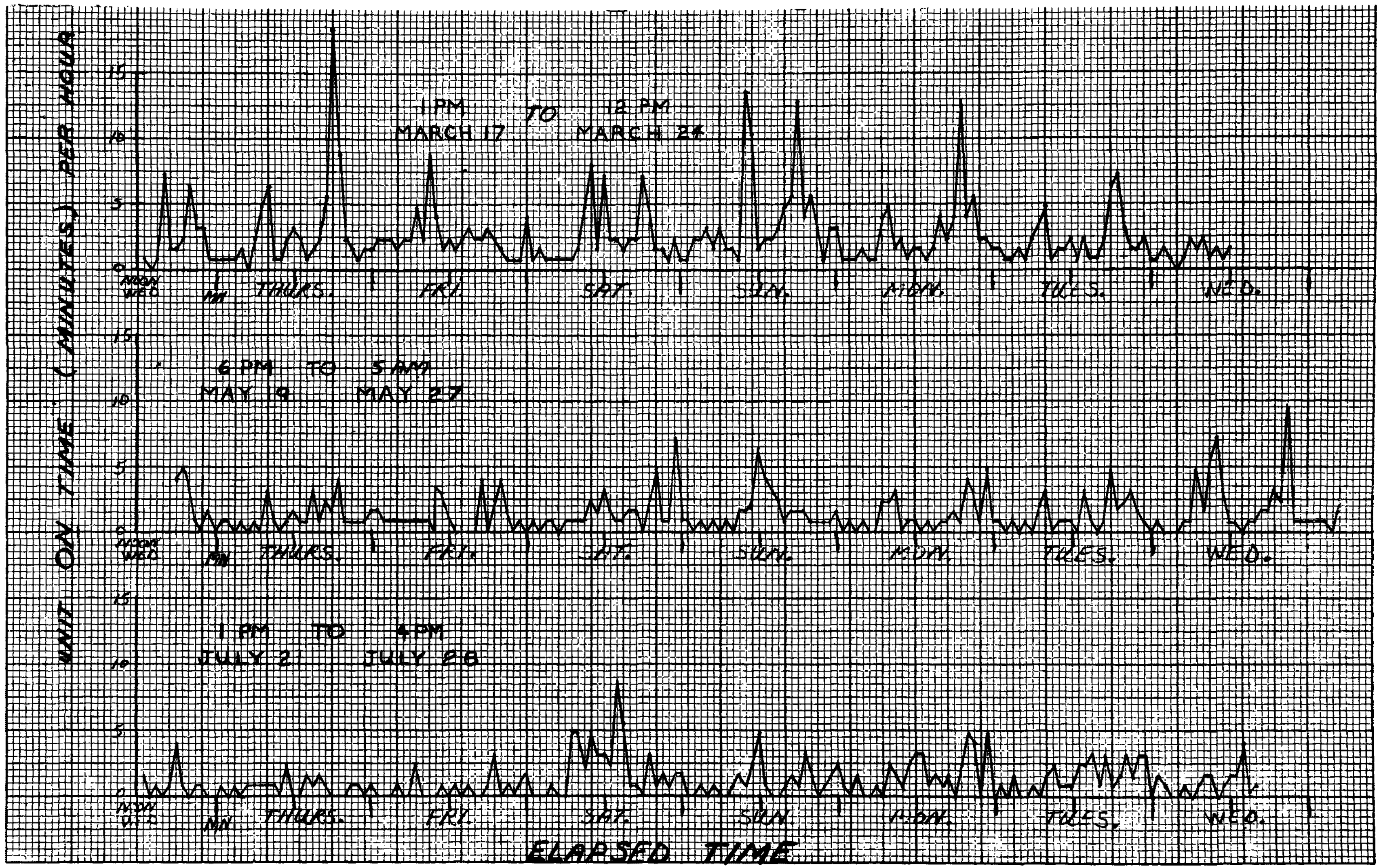


FIGURE 8B. PSG #2 USE PROFILE

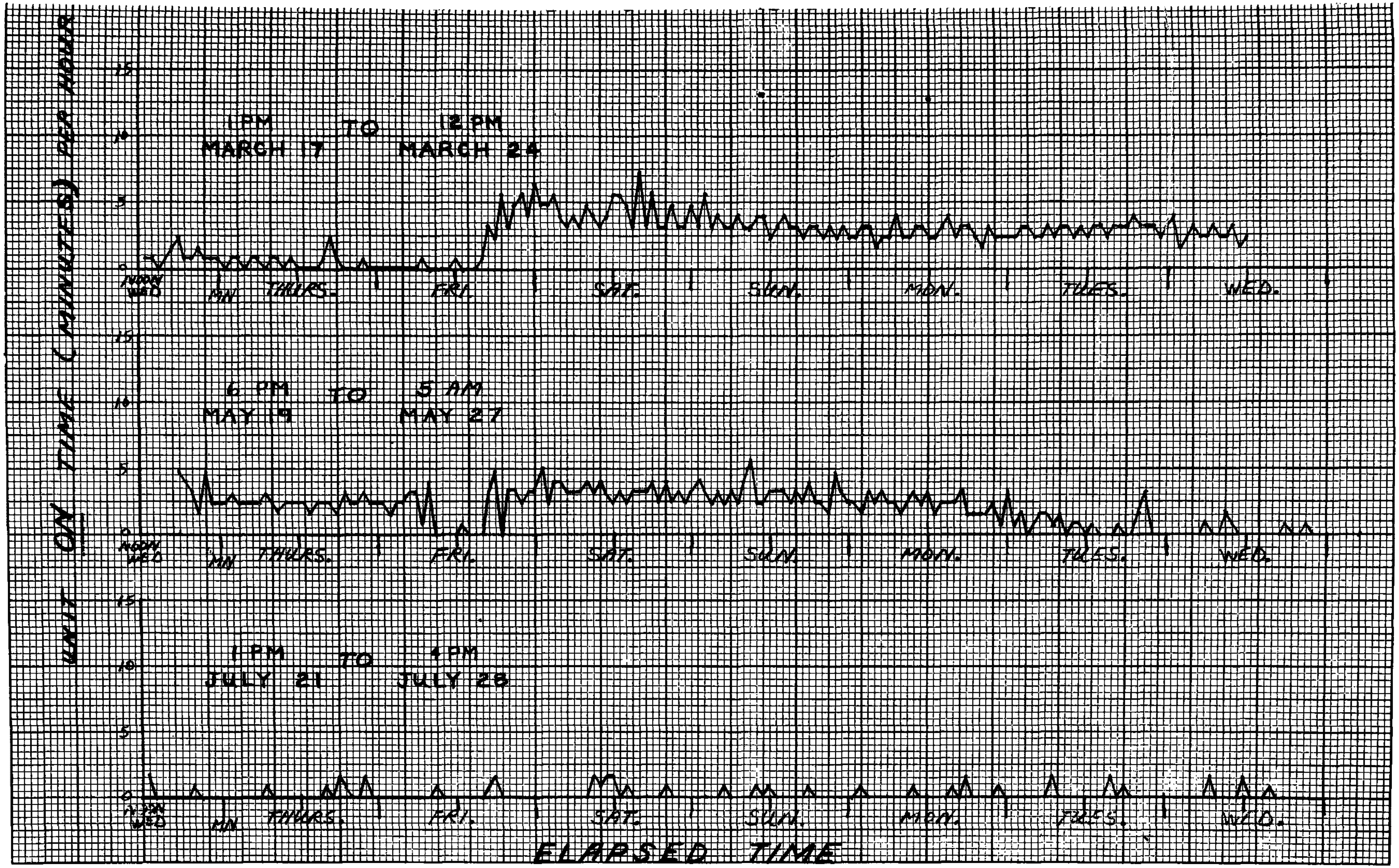


FIGURE 8C. PSG #3 USE PROFILE

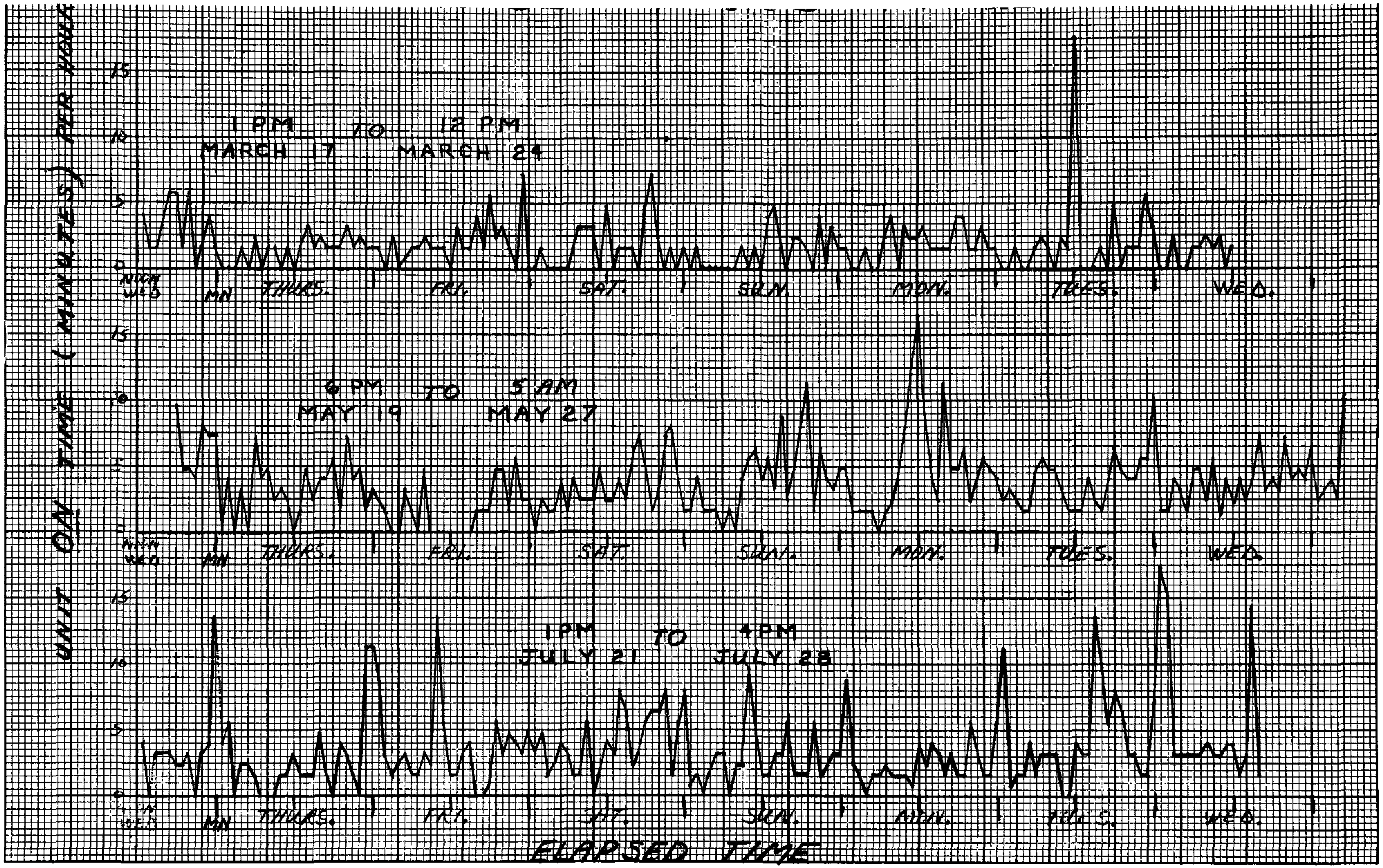


FIGURE 8D. PSG #4 USE PROFILE

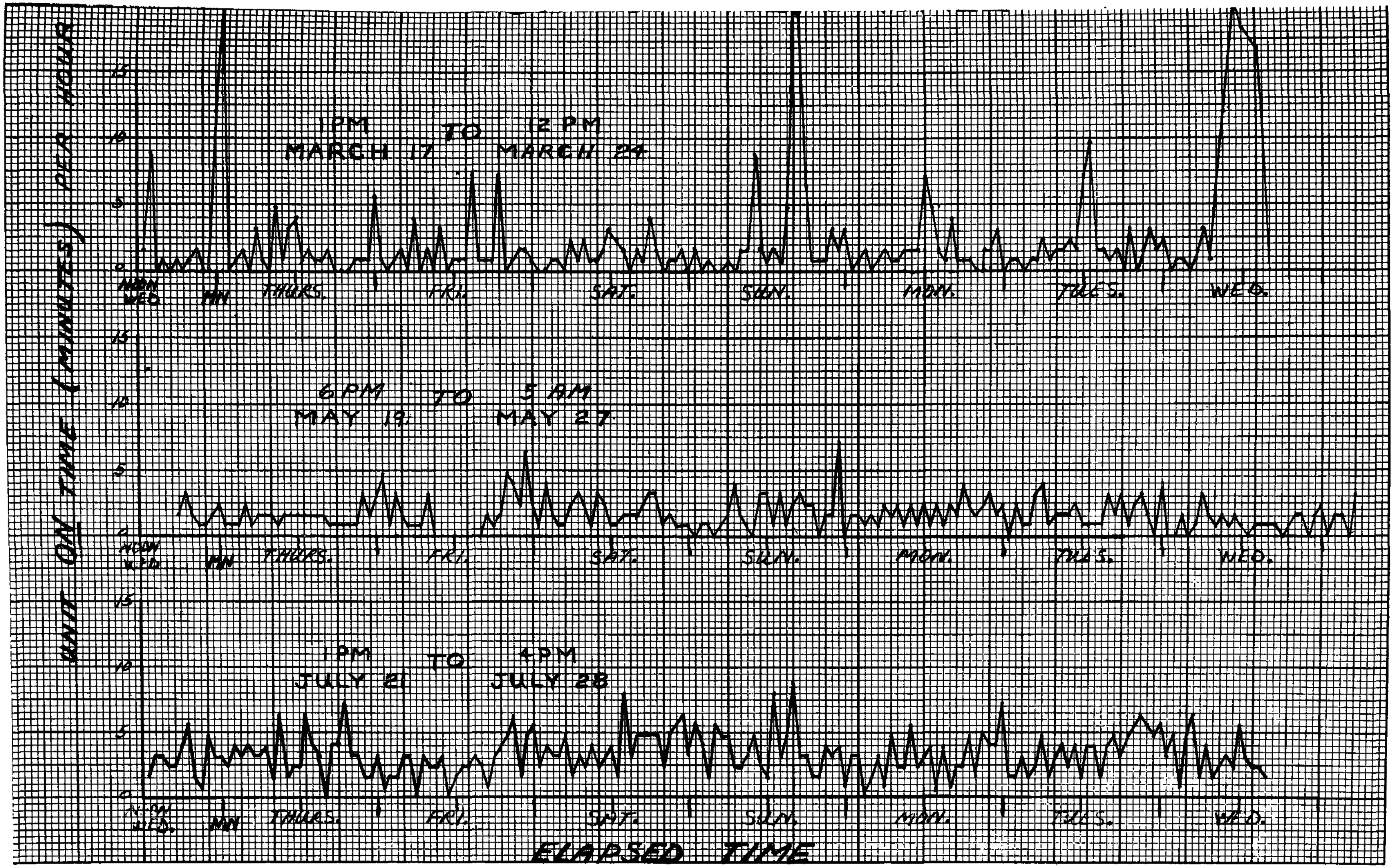


FIGURE 8E. PSG #5 USE PROFILE

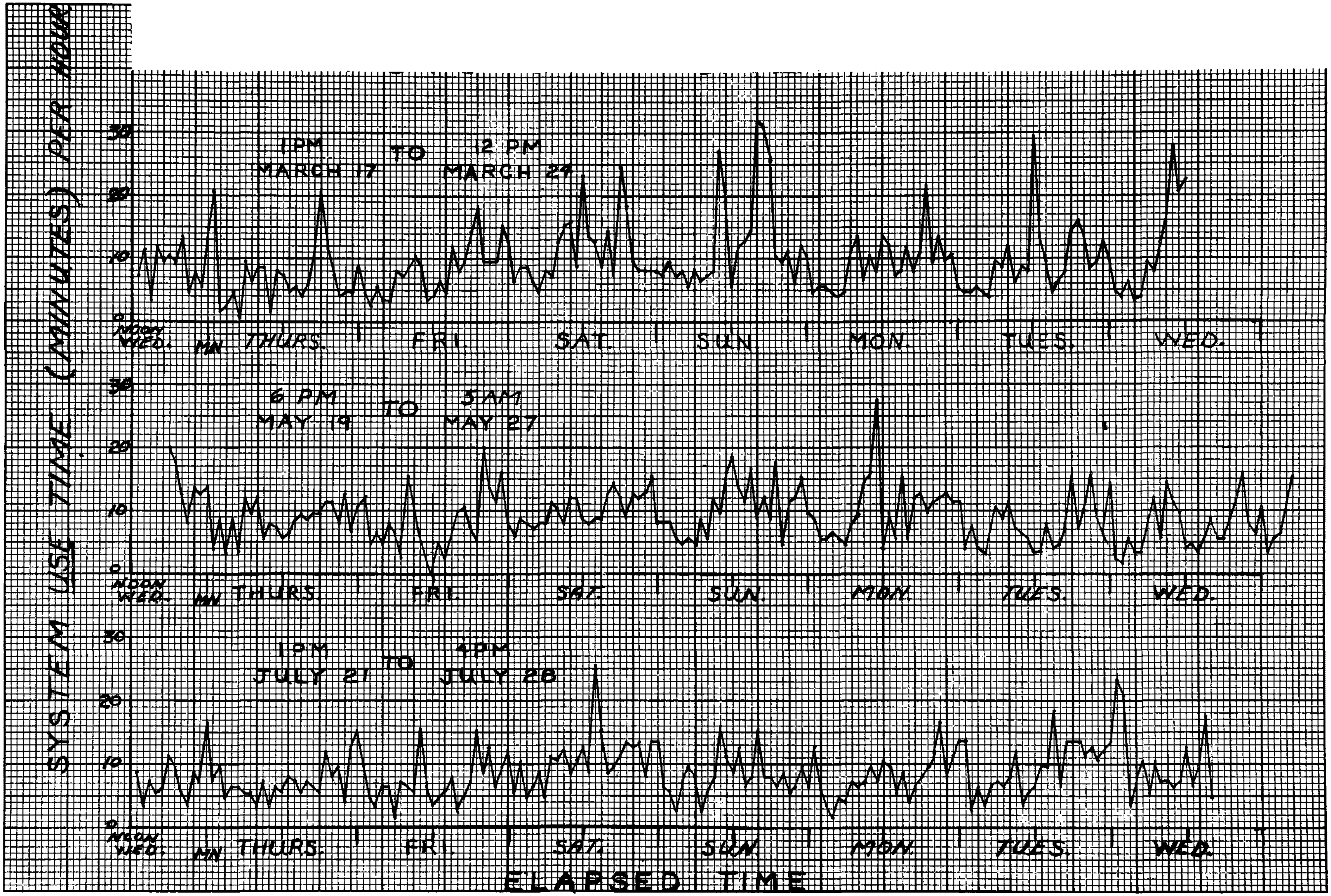


FIGURE 8F. USE PROFILE

TABLE 8

COMPUTER ANALYSIS OF SYSTEM

PSG UNITS OPERATING #	PUMP NUMBER #	PUMPS PRESSURE psig	PUMP FLOW gpm	STATION NUMBER #	STATION PRESSURE psig	STATION FLOW gpm	FRICTION HEAD feet	VELOCITY ft/sec	PIPE DIAMETER INCHES
1	1	10.3	13.8	3	3.5	13.8	2.1	1.5	1.94
2	2	10.6	13.8	3	3.4	13.8	2.0	1.5	1.94
3	3	11.7	13.7	2	6.0	13.7	2.9	1.5	1.94
4	4	34.9	11.1	1	31.0	11.1	10.7	1.2	1.94
5	5	35.1	11.1	1	31.0	11.1	10.6	1.2	1.94
1 & 2	1	23.4	12.4	3	19.1	24.7	10.7	4.5	1.50
	2	23.6	12.4	3	19.1	24.7	10.7	4.5	1.50
4 & 5	4	43.7	10.1	1	40.4	20.2	32.4	2.2	1.94
	5	43.9	10.1	1	40.4	20.2	32.4	2.2	1.94
All units	1	20.3	12.7	3	14.5	56.1	27.5	6.1	1.94
	2	20.5	12.7	3	14.5	56.1	27.5	6.1	1.94
	3	23.1	12.4	2	18.4	30.7	4.1	3.3	1.94
	4	52.3	9.1	1	49.7	18.3	21.9	2.0	1.94
	5	52.5	9.1	1	49.7	18.3	21.9	2.0	1.94

substantially when all units are running simultaneously, as illustrated by the data in Table 8.

The maximum pressure calculated by the computer is 52.5 psig which is the discharge pressure of PSG #5 when all units are operating. The maximum flow in the system, 56.1 gpm, is found at station #3 when all units are operating. The minimum flow in the system is 9.1 gpm. This flow represents the discharge flow rate of units 4 and 5 when all other units are operating as well. It should be noted that in all cases the fluid velocity is larger than the necessary 1.0 ft /sec scouring velocity. It should be noted that the measured discharge pressures of units #3 and #4, at the beginning of the demonstration were very close to that calculated by the computer program. This would indicate that the program described the Phoenixville system quite well.

As part of the data collection, pressure was monitored throughout the entire project at the data collection station, PSG #3 and PSG #4. Pressure transducers were installed in the exit piping of PSG #3 and PSG #4 and in the two-inch PVC piping which ran through the data collection station. The discharge pressure profiles of units #3 and #4, when they are operating alone, are shown in Figures 9 and 10. The slight reduction of discharge pressure shown in Figure 9 could be the result of a worn pump stator or possibly a calibration drift of the pressure transducers used. The increase in discharge pressure of PSG #4 shown in Figure 10 is too large to be caused by calibration drift. This trend could possibly be an indicator of a gradual reduction of cross-sectional flow area. At this time, however, a conclusive statement cannot be made. The piping system was provided with a clean-out if flushing became necessary.

It was not possible to correlate wastewater efflux with water inlet to each home because the borough does not individually meter water consumption.

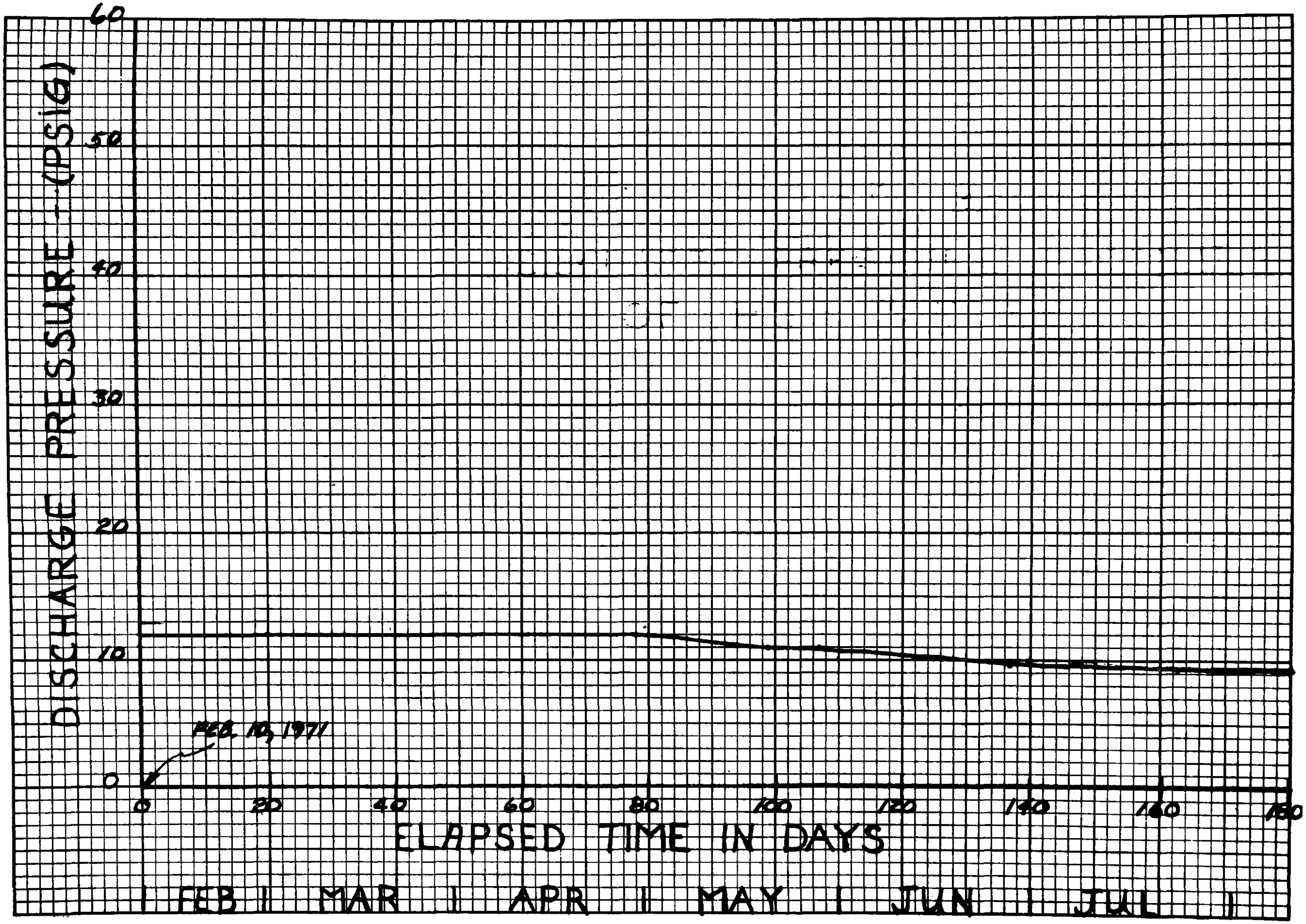


FIGURE 9. DISCHARGE PRESSURE PROFILE OF PSG #3

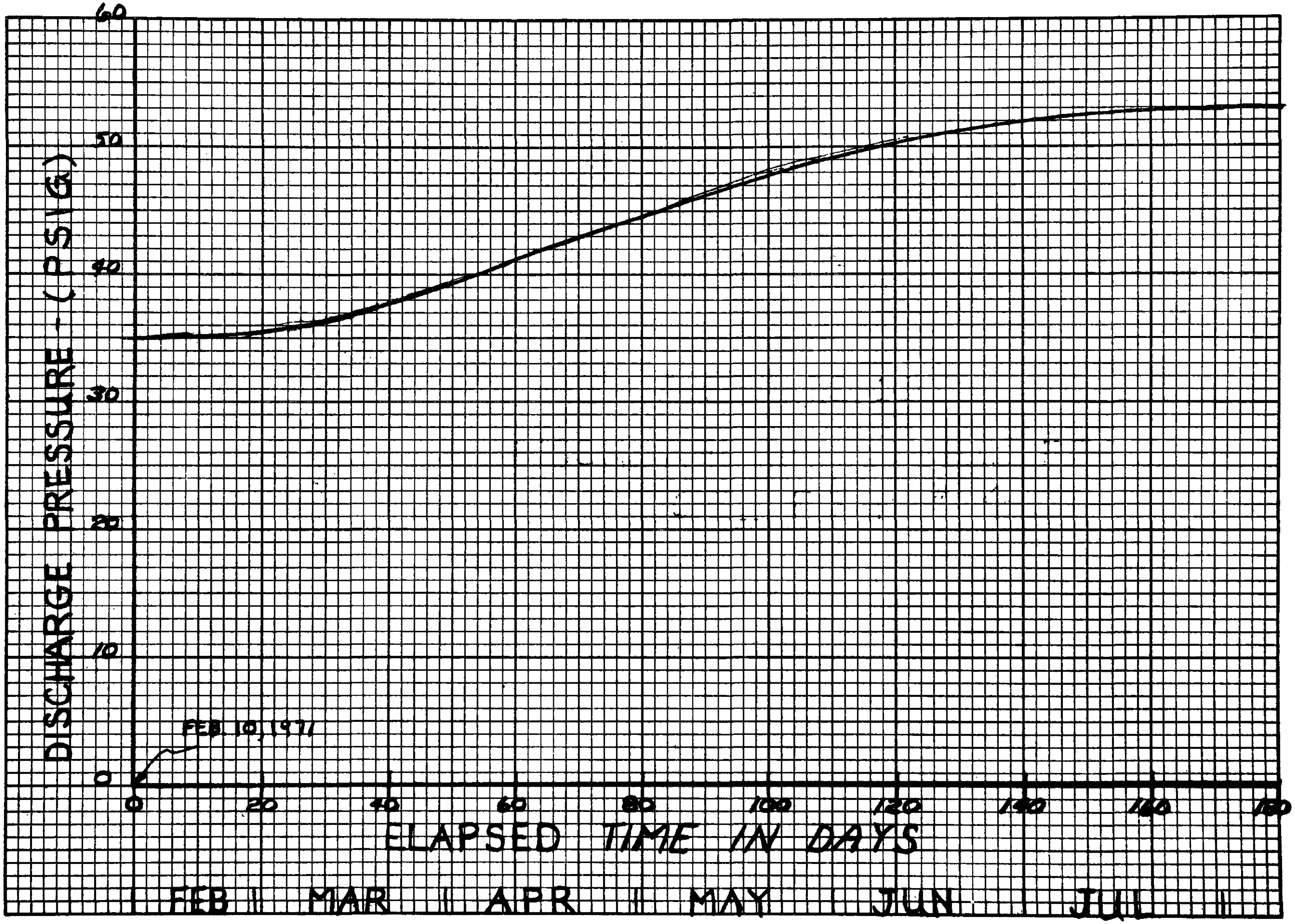


FIGURE 10. DISCHARGE PRESSURE PROFILE OF PSG #4

3. Wastewater Temperature Data

The temperature of the wastewater in the pressure sewer system was monitored at the data collection station, PSG #3 and PSG #4. In all three locations a thermistor probe was used. The temperature sensors were calibrated at GE-RESD and also at the test site to insure an accurate calibration. In the data collection station a temperature sensor was taped to the 2-inch PVC pipe with a special temperature insulating tape. At units #3 and #4 the temperature sensors were located on the brass pipe fitting nearest the PSG exits. The temperature insulating tape was used for attachment purposes as well as for insulation. Figures 11, 12 and 13 show the temperature profiles during the six-month demonstration period for these three locations.

4. Wastewater Characterization

The wastewater flowing through the pressure sewer was characterized by testing various grab samples taken from the sample port in the data collection station. The results of these tests are shown in Table 9. In the interpretation of this data it should be emphasized that sampling was limited both in number of samples and time of day when taken. Also, the wastewater is domestic waste and contains no industrial materials or significant storm water run-off as does municipal wastewater. Some surface water did enter the tanks because they were set level with the ground and the covers were not water tight.

The data presented shows the system to be operating in an anaerobic (septic) mode. This condition probably resulted from an excessive holding time, that is, the time elapsed from the moment the wastewater was introduced to the pressure sewer system to the time it was discharged into the gravity sewer line. There were no gases or odors noticed around the PSG installations.

5. Unit Operating Cost

The unit operating cost per day, month, and year is given in Table 10. The typical rate for the area, $0.03 per kilowatt-hour was used in the calculations. Units #1, #2, and #3 had an average current draw of 12.5 amps. Units #4 and #5 which operate at a high discharge pressure had an average current draw of 14.0 amps.

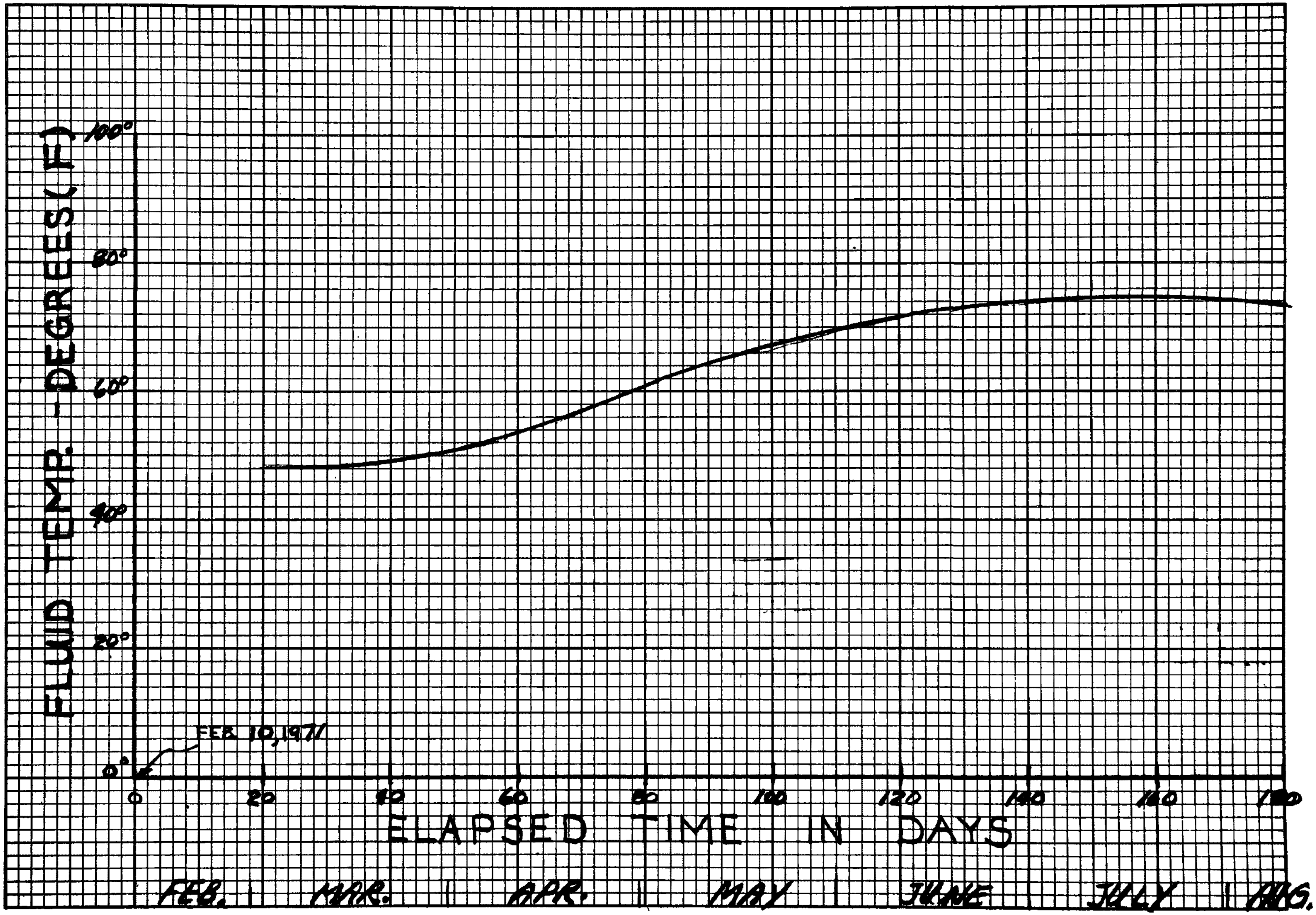


FIGURE 11. TEMPERATURE PROFILE OF FLUID FLOWING THROUGH DATA STATION

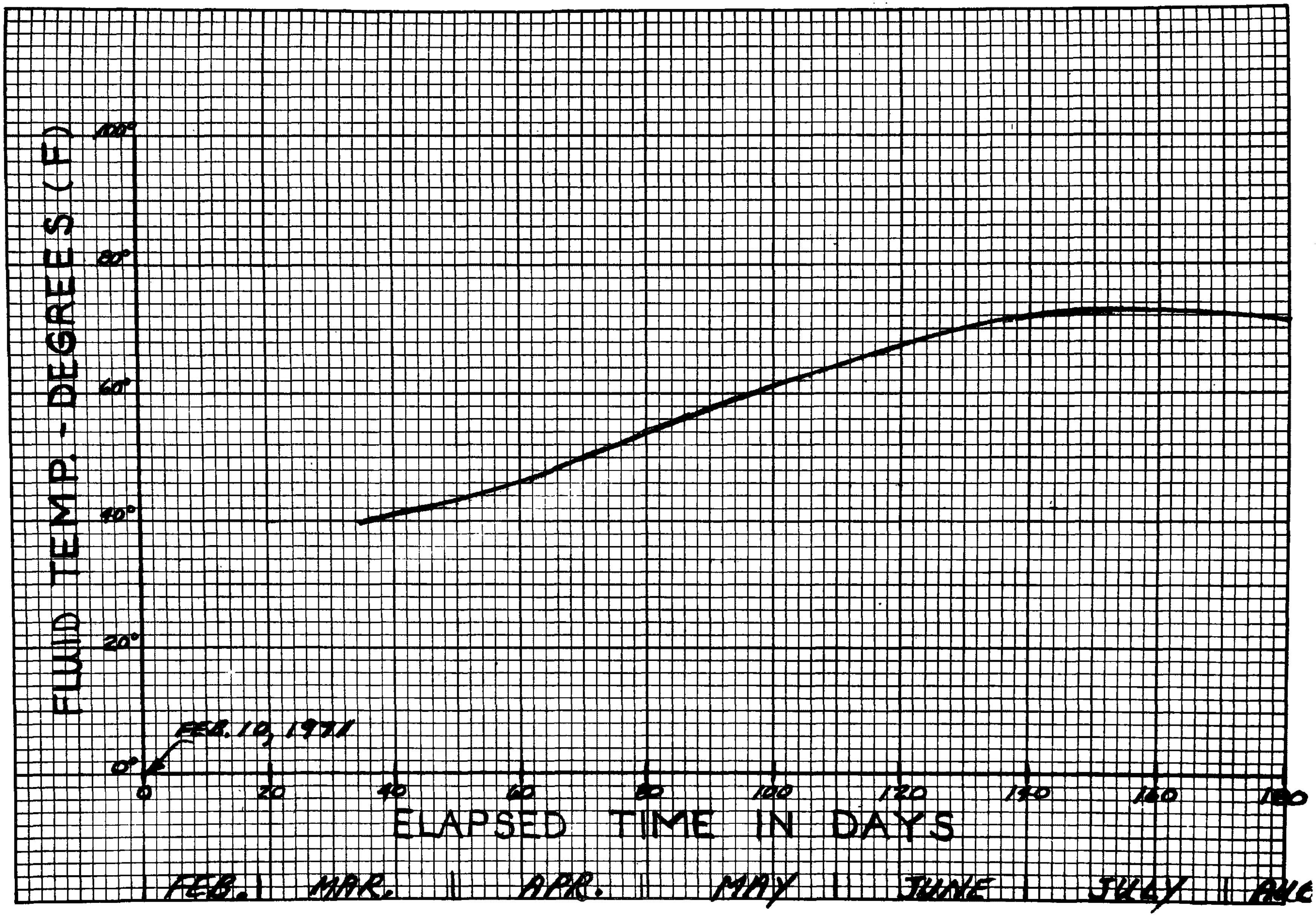


FIGURE 12. TEMPERATURE PROFILE OF PSG #3

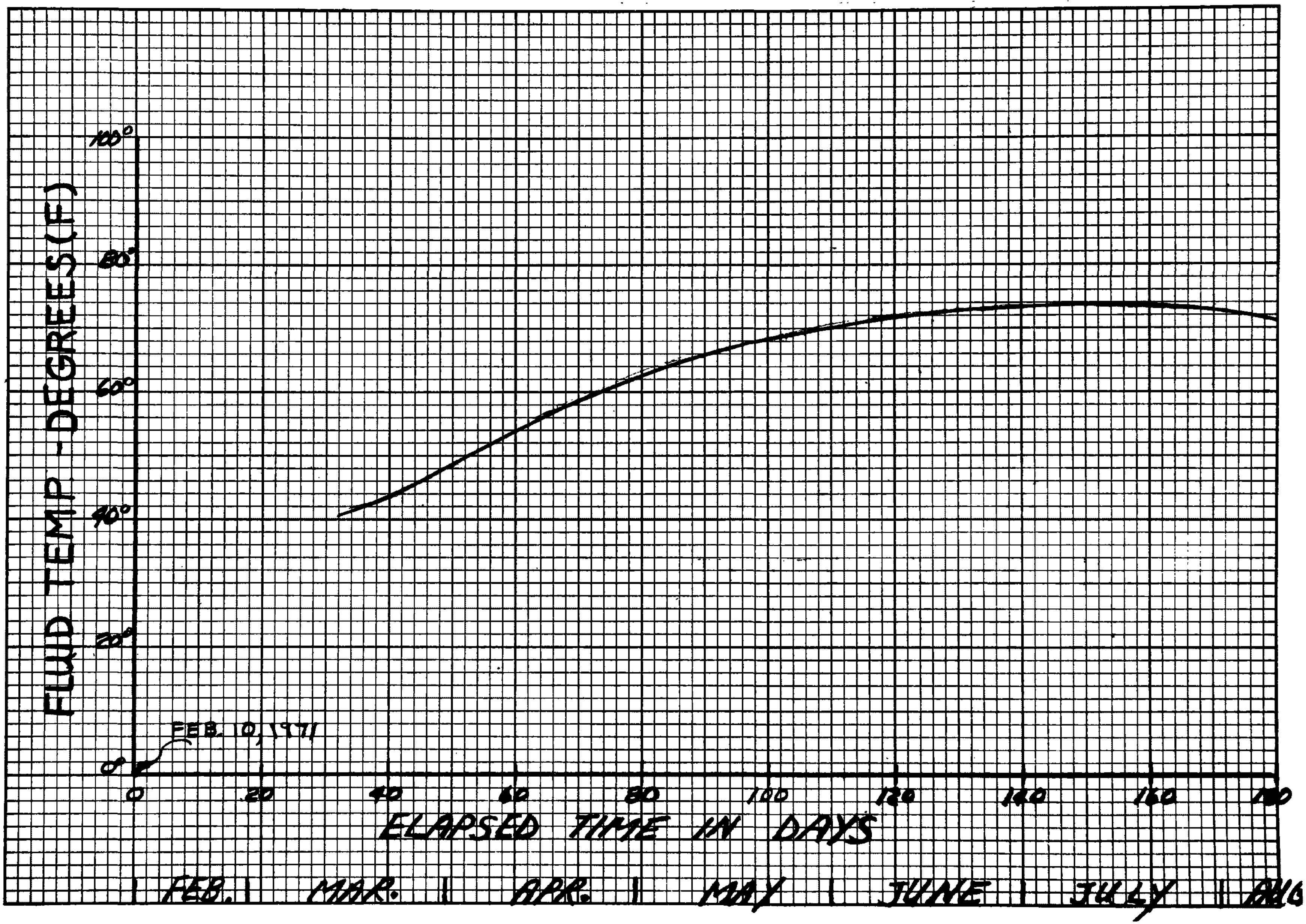


FIGURE 13. TEMPERATURE PROFILE OF PSG #4

TABLE 9

WASTEWATER CHARACTERIZATION

DATE PARAMETER SAMPLE TIME	6/8/71 12:00 noon 1:00 p.m.	6/17/71 9:00 a.m. 11:00 a.m.	6/28/71 12:00 noon	6/29/71 9:00 a.m. 9:15 a.m.	7/2/71 9:30 a.m.	7/6/71 9:30 a.m. 10:00 a.m.
pH	7.2	8.3	-	8.3	-	7.9
DISSOLVED OXYGEN (mg/1)	-	0	0	0	0	0
ORP (mv)	-	-	-200	-230 9:00 -160 9:15	-80	+60 9:30 +30 9:40 -10 9:50 -20 10:00
BOD (mg/1)	104	198	-	-	-	135
COD (mg/1)	311	524	-	-	-	343
SUSPENDED SOLIDS (mg/1)	108	224	-	514	-	146
SETTLEABLE SOLIDS (mg/1)	20	102	-	-	-	80
COLIFORMS (No/100 ml)	2.4×10^4	1.7×10^4	-	-	-	4.3×10^4
MAGNESIUM (mg/1)	6.3	6.6	-	-	-	110
CONDUCTIVITY (mhos/cm)	500	850	-	-	-	920
DETERGENTS (MBAS)	2	4.5	-	-	-	2.9

TABLE 9 (Cont.)

DATE PARAMETER SAMPLE TIME	6/8/71 12:00 noon 1:00 p.m.	6/17/71 9:00 a.m. 11:00 a.m.	6/28/71 12:00 noon	6/29/71 9:00 a.m. 9:15 a.m.	7/2/71 9:30 a.m.	7/6/71 9:30 a.m. 10:00 a.m.
AMMONIA NITROGEN (mg/1) as NH_3-N	36.3	66.5	-	-	-	74.1
TOTAL PHOSPHATE (mg/1) as PO_4-P	5.8	19	-	-	-	9.6
ALKALINITY (mg/1) as CaO_3	188	315	-	-	-	360
SULFATE (mg/1)	72	78	-	-	-	100
NITRATE (mg/1) as NO_3-N	2	2	-	-	-	2
CHLORIDE (mg/1)	42	68	-	-	-	92
CALCIUM (mg/1)	37	28	-	-	-	20.6

TABLE 10

UNIT AVERAGE OPERATING TIME AND COSTS

PSG NO.	HRS/DAY	$/DAY	HRS/MO.	$/MO.	HRS/YR.	$/YR.
1 - SINGLE HOME 2 PERSONS	.27	.012	8.1	.36	98	4.40
2 - 2 HOMES (5 APART.) 11 PERSONS	.87	.039	26.0	1.20	318	14.30
3 - SINGLE HOME 3 PERSONS	.55	.025	16.5	.75	200	9.10
4 - 4 APART. + 1 HOME 10 PERSONS	.98	.05	29.4	1.60	358	19.00
5 - 3 APARTMENTS 6 PERSONS	.57	.03	17.1	.90	208	11.00
TOTAL	3.24	.16	97.1	4.81	1182	57.80

6. Problems Encountered

During the check-out phase of the project, the holding tank for PSG #5 was filled with water when a valve coupling was inadvertently removed allowing the system to drain into the tank. Also during this phase, unit #3 was found to have a large chunk of concrete firmly wedged in the inlet hopper (throat). It is unclear how this occurred. The concrete could not have been sucked in since it was too heavy and too tightly wedged into the hopper. As a result of this, the two cutter blade retaining screws were sheared. These were replaced and the unit was returned to service.

On March 9, 1971, the control box in tank #3 was replaced with the spare control because of unpredictable circuit breaker operation. Investigations at GE-RESD found no problem with the rest of the control box equipment which performed properly with a new circuit breaker.

On April 1, 1971, the pump grinder in tank #4 became inoperative and was replaced with the spare pump grinder. The inoperative unit was found to be filled with water which caused the motor to electrically short. The water had entered the unit through a fracture in the stainless steel flexible outlet line. The fracture was in the line near the pump fitting end and was attributed to a defective part.

Some slight difficulty was experienced with the data station and air relief valve pipe. On March 9, 1971, it was determined that the power line to the data station and the air relief valve pipe needed repairs. The power line voltage was low and the relief valve pipe had been damaged, probably during routine snow removal by heavy equipment. The complete pressure sewer system was shut down during March 9 and 10 while repairs were quickly completed. Later, on April 12, 1971, the recorder print out drive line was found broken. The line was repaired, and the recorder was back in operation on April 16. This problem was found again on May 18, 1971 and repairs were completed on May 19.

6. Problems Encountered (Cont'd)

On July 29, the pump grinder in tank #4 became inoperative. The unit was brought back to GE-RESD for analysis. The failure analysis showed that the flywheel cutter assembly had backed off of the motor shaft slightly, thus reducing the necessary compression on the rotary shaft seal. Water had entered the unit via the shaft seal and electrically-shorted the motor. The unit was repaired and placed back into operation August 26.

On Oct. 21, 1971, during the final routine check of the system, units #3, #4, and #5 were found inoperative. Investigation revealed that there was no power at units #4 and #5 due to faulty cable splices installed by the contractor. Unit #3 had a ruptured flexible line. This deficiency had been previously experienced, and corrective action was instituted by changing to a rubber hose. All three units were updated by incorporating the flywheel lockwire, and replacing the steel flexible hose with rubber hose.

SECTION IX

ACKNOWLEDGEMENTS

Mr. John Kane, former manager of the Borough of Phoenixville, Pennsylvania, played a vital role in getting the project approved and underway. His support of the project and assistance during the construction phase and system start up is acknowledged with sincere thanks. The support of Mr. Stephen Ross, acting manager of the Borough of Phoenixville, Pennsylvania, during the demonstration period is acknowledged with sincere thanks.

The Re-Entry and Environmental Systems Division of the General Electric Company (RESD), Philadelphia, Pennsylavania, is credited with the design of the Phoenixville Pressure Sewer System and the implementation thereof, including the design and manufacture of the Pump Storage Grinder units and the design of the data monitoring system.

The engineering effort was conducted under the management of Mr. Gilbert E. DiSalle, manager of Actuation Equipment Engineering, RESD, and Mr. James F. Hall, Jr. former manager of Machine Design Engineering, RESD., and Mr. Daniel O. Ramos, Project Engineer, RESD.

Mr. George Mekosh, Jr., design engineer, RESD, was responsible for providing engineering support during system installation, monitoring the demonstration and writing this report.

The installation of the pressure sewer system was performed by the Altemose Construction Company, Norristown, Pennsylvania, under the direct supervision of Mr. Lester Horvath.

The support of the project by the Environmental Protection Agency and the help provided by Mr. James F. Kreissl, Project Officer, is acknowledged with sincere thanks.

SECTION X

APPENDICES

APPENDIX A

PUMP STORAGE GRINDER

OPERATION AND INSTALLATION

MANUAL

OPERATION

The basic function of the Pump Grinder is to mascerate and then transport wastewater under pressure. The primary control element of the Pump Grinder, as shown in Figure A-1, is a simple, rugged diaphragm switch. When the water level in the storage tank rises to a preset level, the diaphram switch closes and activates a set of relays. These relays which are located inside the control box start the motor which drives the pump and the grinder. During operation, water and solids pass through the grinder and the solids are reduced in size to less than 1/4 inch. After the mascerated wastewater leaves the grinder it enters the pump inlet line, passes through the pump, through a check valve, and into the discharge pipe. The check valve prevents back-flow. As the water level in the storage tank drops to a given level, the diaphragm switch opens and shuts off the motor. The pump grinder is also equipped with an overflow alert switch. This switch will send out a signal when the system is in an overflow condition.

PUMP GRINDER SPECIFICATION SHEET

1. Function:

Shred and pump wastewater through small diameter plastic pipes. Store peak loads until processed.

2. Grinder Performance:

Materials are ground to less than 1/4 inch in size before entering the small diameter piping. Heavy materials, such as metals, settle to the bottom of the tank for periodic removal. All materials can be handled (paper, wood, cloth, plastic, rubber, etc.).

3. Pump Performance:

8 gpm @ 60 psig

15 gpm @ 0 psig

4. Motor:

1 Hp, 1725 rpm, capacitor start, thermally protected, 115V. ac, single phase.

5. Dimensions:

Unit diameter : 11"

Unit Height : 32"

Tank diameter : 30"

Tank height : as required

6. Net Weight: (not including tank)

280 pounds

7. Safety:

The electrical system is protected by a circuit breaker. The motor is also thermally protected. The system has a check valve which prevents wastewater from flowing back into the unit when it is not operating. The pump itself, when not operating, serves as a check valve. The pump and discharge lines are protected by a relief valve. The relief valve is set to open at 70 to 75 psig. The tank is

7. Safety: (Cont'd)

equipped with an overflow pipe.

8. Material:

Materials in contact with sewage: Brass; Black Iron; 300 and 400 series Stainless Steel; Neoprene Rubber; Concrete.

PUMP GRINDER INSTALLATION (See Figure A-1)

The two support channels are attached to the pump grinder first. The channels initially are only hand tightened since a final adjustment will be needed. Note the channels should be 12 inches above the pump grinder. The check valve-relief valve assembly is attached next. Be sure to use a pipe joint compound on all threaded joints.

Next, install the diaphragm switch assembly. The on/off level switch and the overflow alert switch are suspended from a common threaded rod which is attached to one of the support channels. The on/off switch is located at the same level as the pump grinder inlet, two inches off the botton of the tank. The overflow alert switch is located 14 inches below the overflow line.

The tank brackets are installed next. The tank brackets serve as mounts for the two support channels. They are located 46 inches from the tank bottom. The pump grinder is lowered into the tank and secured to the tank brackets. To produce the two inch clearance necessary, adjust the pump grinder depth by means of the four threaded rods. The two inch clearance is necessary to insure proper scouring of the tank bottom.

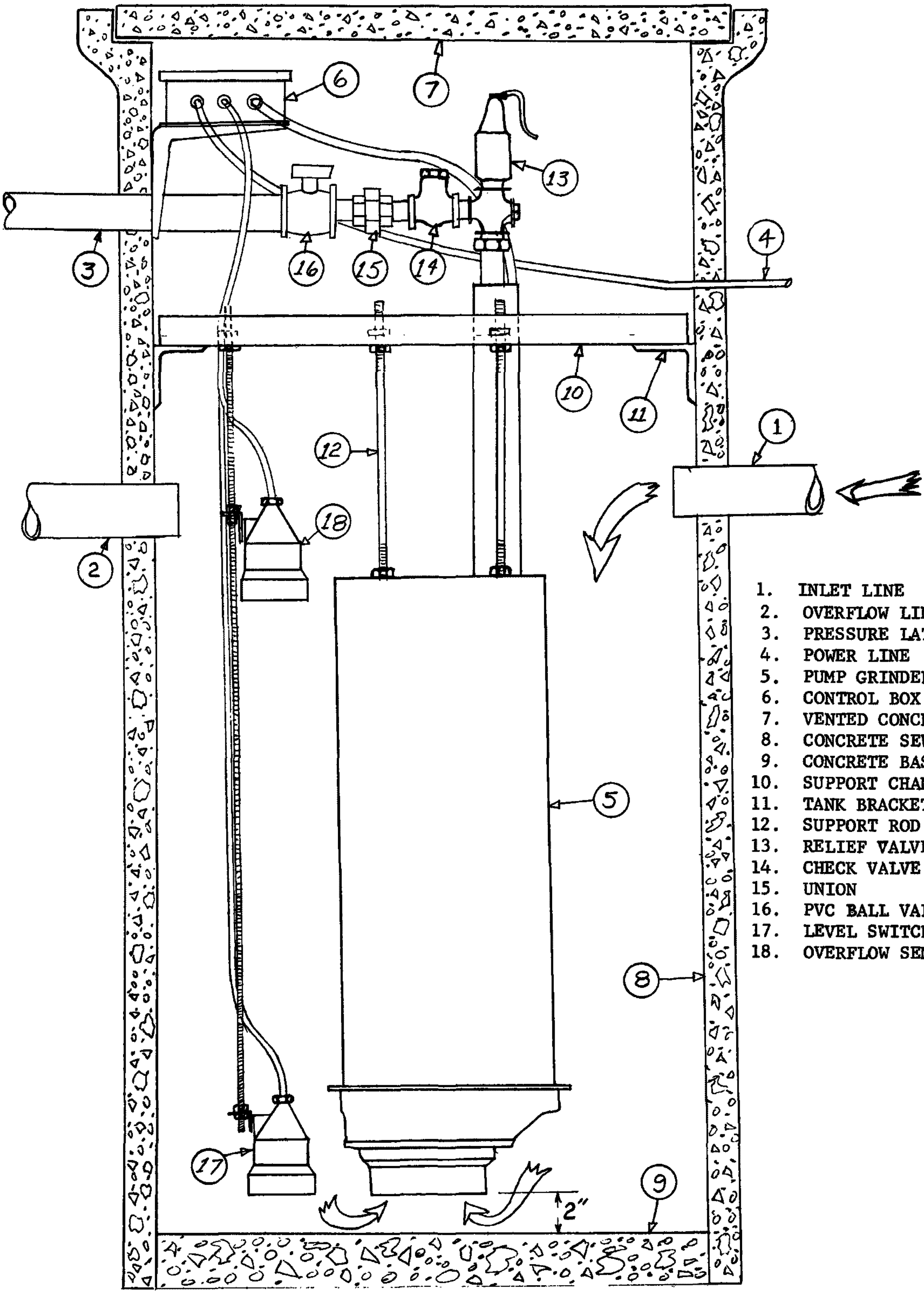
The discharge piping is connected next using as few bends and elbows as possible.

CONTROL BOX INSTALLATION

The control box is supported by two angles which are attached to the tank wall. The angles are located so that the control box can be attached to the angle by the rear hole of each control box flange. The control box is mounted far enough from the wall to permit the opening of its door.

ELECTRICAL CONNECTIONS

The pump grinder is equipped with two electrical cables which must be connected to the control box. The three conductor cable P4 coming from the motor carries motor current and is connected to P3 of the control box. The two conductor cable P6 coming from the motor goes to its capacitor which is located in the control box. P6 is connected to P5 of the control box.



1. INLET LINE
2. OVERFLOW LINE
3. PRESSURE LATERAL
4. POWER LINE
5. PUMP GRINDER
6. CONTROL BOX
7. VENTED CONCRETE COVER
8. CONCRETE SEWER PIPE
9. CONCRETE BASE
10. SUPPORT CHANNEL
11. TANK BRACKET
12. SUPPORT ROD
13. RELIEF VALVE
14. CHECK VALVE
15. UNION
16. PVC BALL VALVE
17. LEVEL SWITCH
18. OVERFLOW SENSOR

FIGURE A-1. PSG INSTALLATION

The on/off switch P1 is connected to J1 of the control box. Be sure the vent tube in the cable is pointing downward to prevent debris from entering. The power line from the house is labeled P8 and is connected to P7 of the control box.

The control box has a two conductor cable J2 which is connected to P2 of the data cable. This cable carries a signal indicating operating time. The overflow alert switch is also connected to the data cable. Be sure to have the vent tube in the switch cable pointing downward to prevent debris from getting into the vent tube.

SYSTEM START - UP

The Pump Grinder may require priming prior to the initial start-up. This is accomplished by manually opening the relief valve. Be sure there is enough water in the storage tank to warrant a start-up, approximately 16 inches. Turn the pump grinder on, operating it in the manual mode. This is accomplished by first opening the control box door. Then actuate the circuit breaker to the "ON" position. Next actuate the toggle switch to the manual position. The toggle switch is labeled "M" for manual operation and "A" for automatic operation. When water starts to come out of the relief valve exit, change the mode of operation to automatic and immediately close the relief valve. The pump grinder should begin pumping water through the discharge line. Let the pump grinder pump down and shut off automatically. Check to see that the residual water is 7 to 9 inches deep. If the water level is more than 9 inches deep lower the on/off switch by means of the threaded rod attached to the support channel. Next, let water enter the storage tank and note the level at which the pump grinder starts automatically. This level should be 14 to 16 inches high. Be sure that the overflow alert switch is 14 inches below the bottom of the overflow pipe. The control box door is closed and secured by the two clamps before completing the installation.

APPENDIX B

CHECK-OFF LIST PROCEDURE

FOR

PHOENIXVILLE PRESSURE SEWER INSPECTION

1. Record cycles and operating time for each unit on the data form provided.

2. Note overflow condition relative to alert lights.

3. Change Recorder paper and label used roll as to time and date removed also number of cycles and total operating minutes of each unit.

4. Install recorder paper and label new roll as to time started and date, number of cycles and total operating minutes of each unit.

5. Make gas level check on each installation.

6. Note general condition of each data station.

    a) Possible piping leaks

    b) Unusual operation of instruments

7. Make visual inspection of each unit (2 men required).

    a) Note possible overflow

    b) Excessive corrosion

    c) Sludge build up in the tank

    d) General condition of installation

DATA FORM

FOR

PHOENIXVILLE PRESSURE SEWER INSPECTION

CONDUCTED BY: ______________________

ACCOMPANIED BY: ______________________

DATE: ______________________ TIME: ______________________

LOCATION	OVERFLOW ALERT (ON/OFF) [1]	CYCLES (NUMBERS)	TOTAL OPERATING (MINUTES)	COMMENTS [2]

NOTE:

1. IF ANY OF THE OVERFLOW ALERT LIGHTS ARE ON, NOTE IN THE COLUMN LABELED OVERFLOW LOCATED ON THE DATA FORM. THEN PRESS THE RESET BUTTON. IF ANY OF THE LIGHTS STILL REMAIN ON, AN OVERFLOW CONDITION EXISTS. VERIFY OVERFLOW BY VISUAL INSPECTION. THEN CALL, AS SOON AS POSSIBLE, GENERAL ELECTRIC, PHILADELPHIA

2. COMMENT ON ANYTHING WHICH APPEARS UNUSUAL: VIBRATION, EXCESSIVE SLUDGE BUILDUP, SCALING, CORROSION, CONDENSATION, ETC.

SELECTED WATER RESOURCES ABSTRACTS

INPUT TRANSACTION FORM

1. Report No. | 2. | 3. Accession No. W

4. Title: PRESSURE SEWER DEMONSTRATION AT THE BOROUGH OF PHOENIXVILLE, PENNSYLVANIA

5. Report Date

6.

8. Performing Organization Report No.

7. Author(s): Mekosh, G., and Ramos, D.

9. Organization: General Electric Company
Philadelphia, Pennsylvania
Re-Entry and Environmental System Division

10. Project No. 11050 FOU

11. Contract/Grant No.

12. Sponsoring Organization

13. Type of Report and Period Covered

15. Supplementary Notes

Environmental Protection Agency report number, EPA-R2-73-270, July 1973.

16. Abstract

A site was selected at the Borough of Phoenixville, Pennsylvania, which provided a maximum variable exercise of a pressure sewer system. The site consisted of five residences spread over more than one-half mile in hilly and predominantly shale-based terrain. The residences varied from a small house to a multiple-unit apartment house. The apartment house is more than half a mile in distance and 60 feet in elevation below the existing conventional gravity sewer inlet point.

The project proved over a six-month period that a multiple residence pressure sewer system can adequately store peak loads of wastewater and grind and pump wastewater through small-diameter plastic pipe to the existing conventional gravity sewer. During the project, data was collected which provided information concerning the installation, operation and maintenance of the system, its technical performance, the variations in that performance during the six-month period and the characteristics of the wastewater as delivered to the existing gravity sewer.

17a. Descriptors

*Water pollution control, *Sewers, *Sewage disposal, Plastic pipes, Pressure conduits, Data Collections, costs.

17b. Identifiers

*Pump-grinders, *Pressure sewers, *System monitoring, Cost breakdown, Wastewater characterization.

17c. COWRR Field & Group

18. Availability

19. Security Class. (Report)

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Abstractor: James F. Kreissl

Institution: Environmental Protection Agency, National Environmental Research Center, Cinti, Ohio