CORRECTED FINAL REPORT

HIGH TEMPERATURE HOT WATER DISTRIBUTION SYSTEM STUDY

Prepared for

DIRECTORATE OF PUBLIC WORKS
FORT DRUM, NEW YORK

Under

CONTRACT NO. DACA01-94-D-0033
DELIVERY ORDER NO. 0013, MODIFICATION NO. 1

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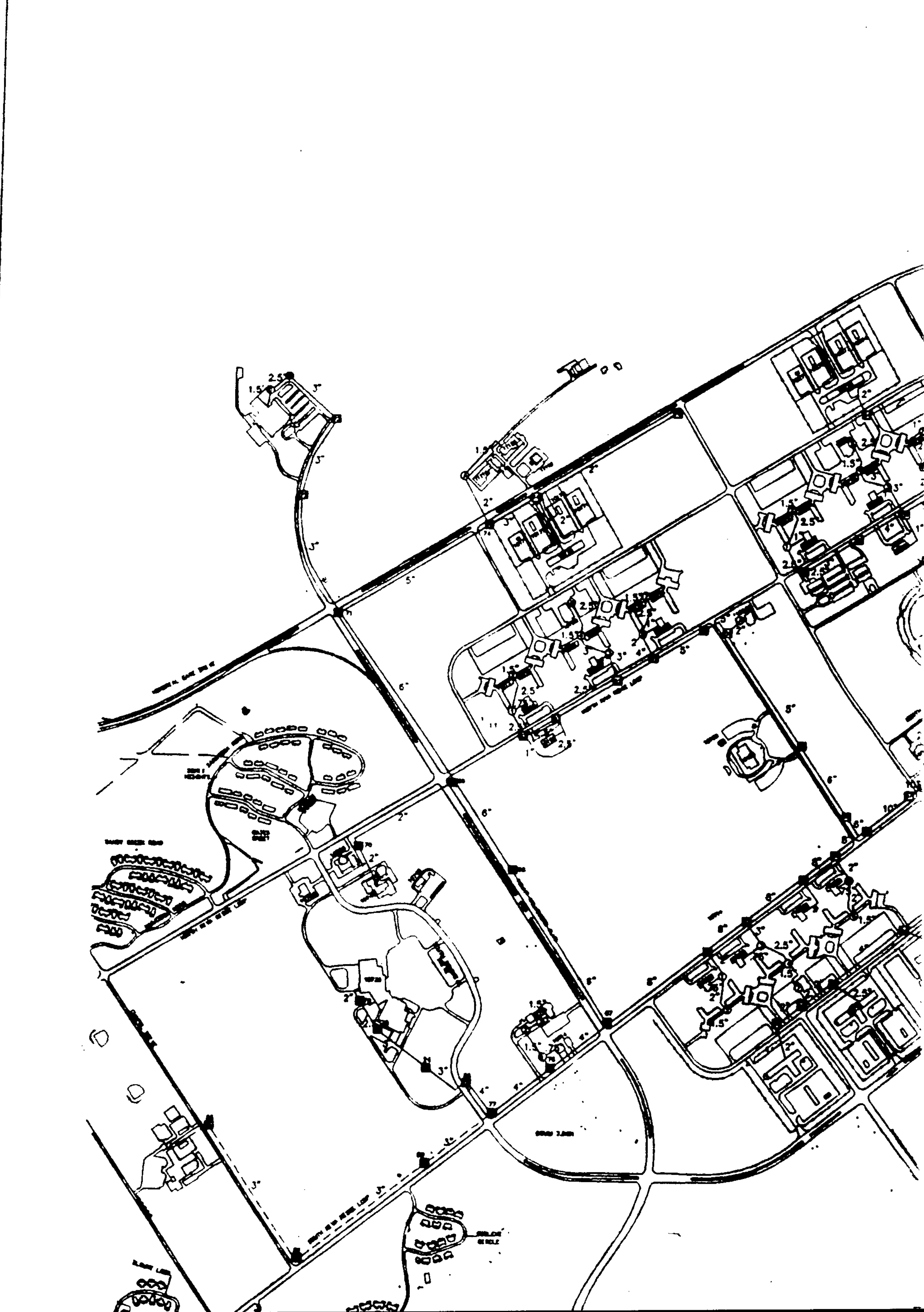

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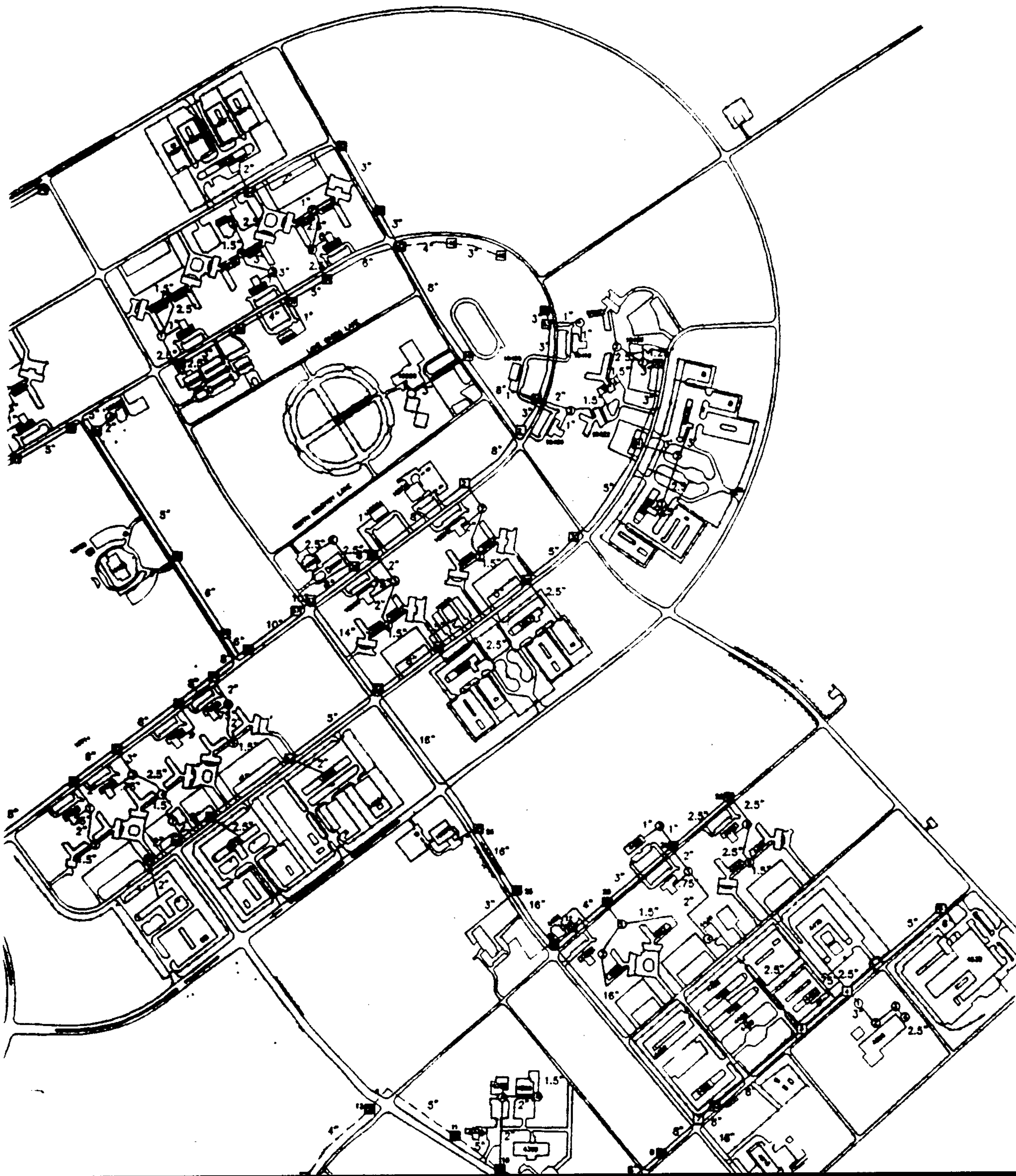

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SYMBOLS

———	HTHW LINE
- - - -	ABANDONED LINE
■	STEEL MANHOLES
□	CONCRETE MANHOLES
5"	PIPE SIZE WITH 2 PIPE PER LINE
○	SERVICE MANHOLES

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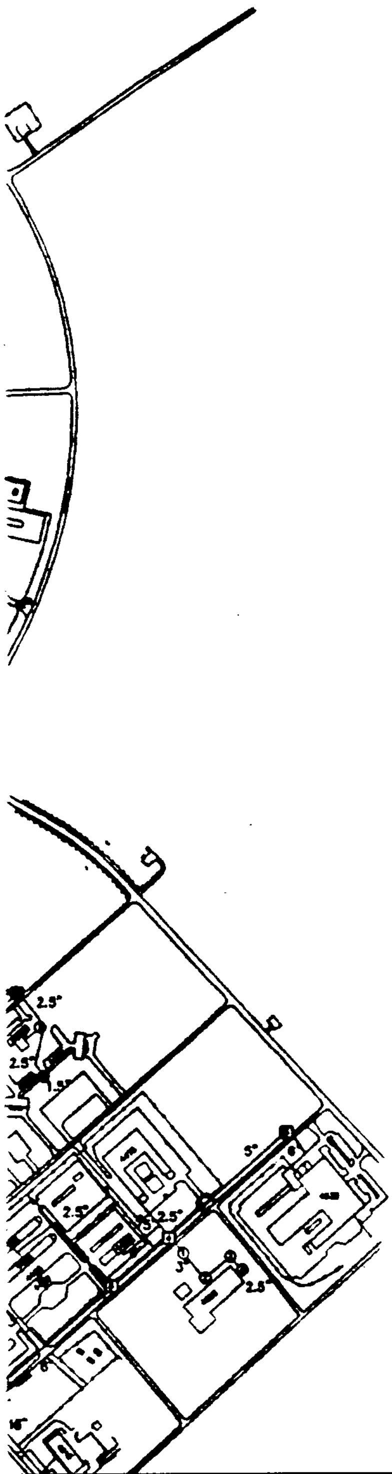

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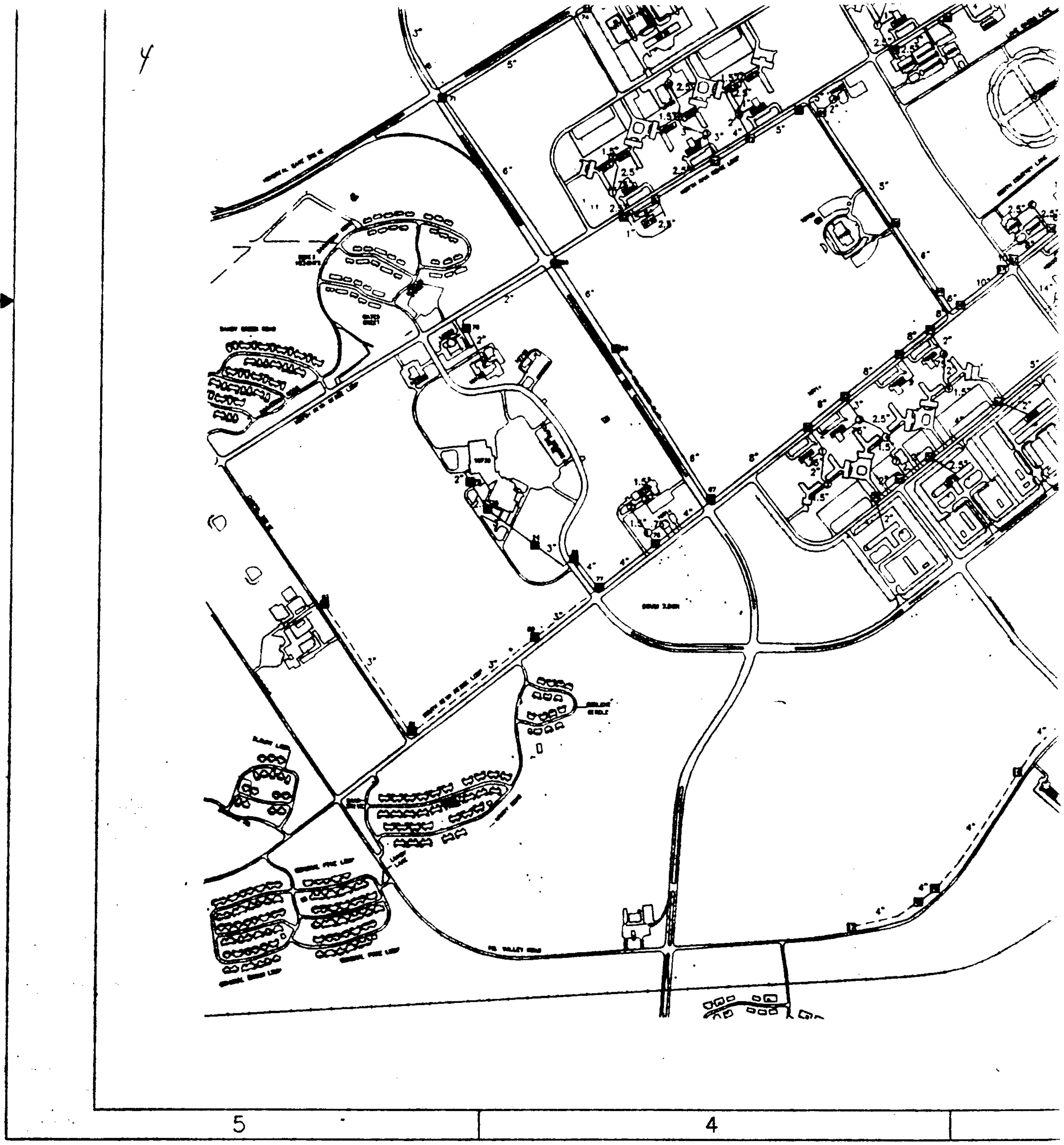
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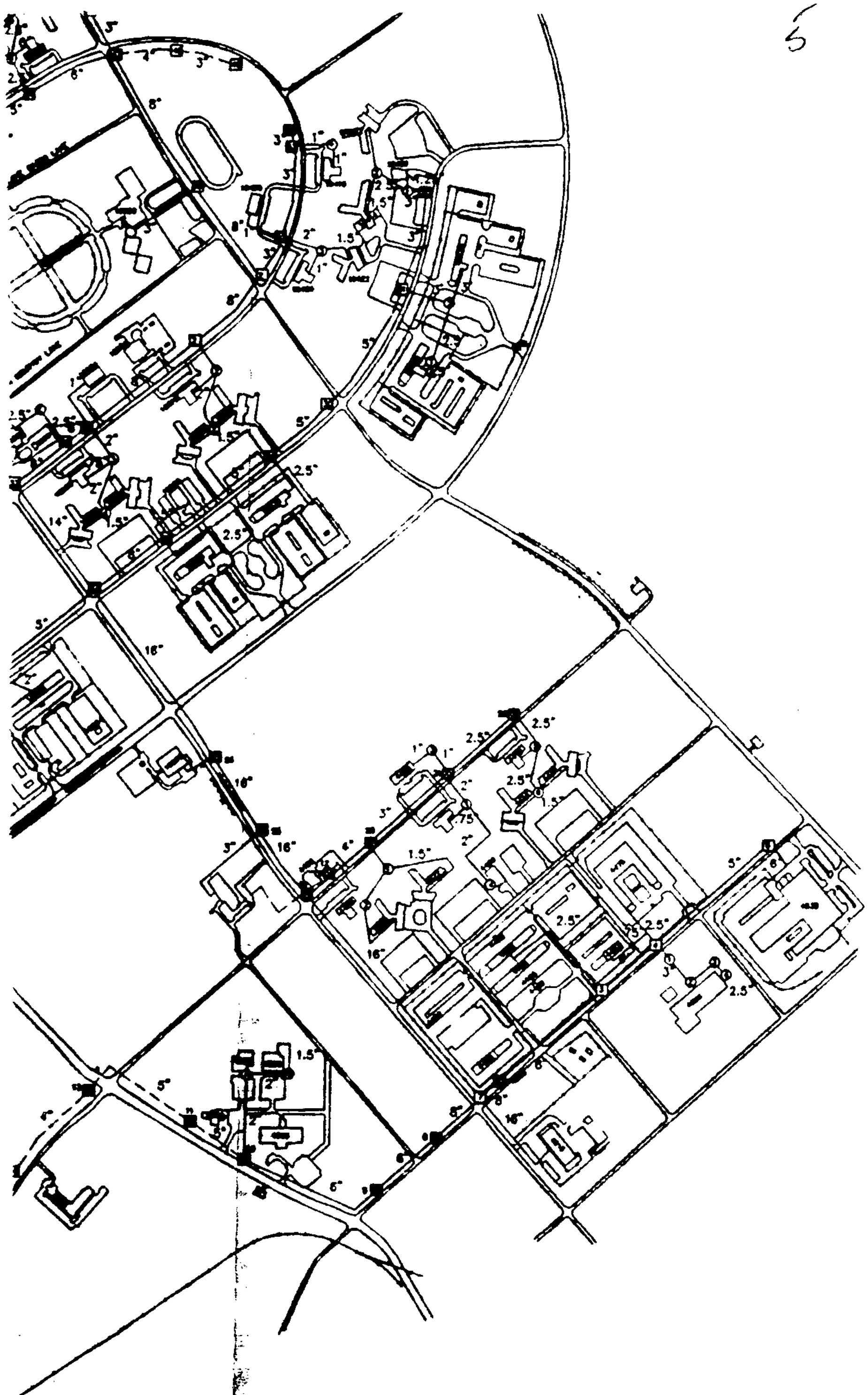
SERVICE MANHOLES



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EMC ENGINEERS, INC. EMC Engineers, Inc. •Denver •Atlanta

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US Army Corps of Engineers

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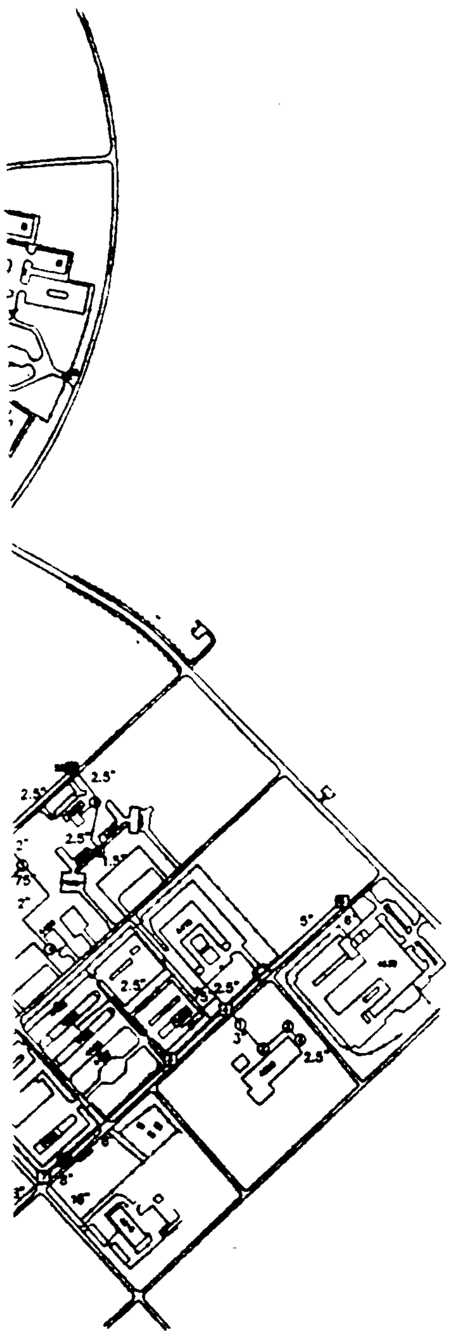

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Revisions

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HTHW DISTRIBUTION SYSTEM
FT. DRUM NY.

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This report has been prepared at the request of the client, and the observations, conclusions, and recommendations contained herein constitute the opinions of E M C Engineers, Inc. In preparing this report, EMC has relied on some information supplied by the client, the client's employees, and others, which we gratefully acknowledge. Because no warranties were given with this source of information, E M C Engineers, Inc. cannot make certification or give assurances except as explicitly defined in this report.

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Fort Drum HTHW Study

EXECUTIVE SUMMARY

INTRODUCTION

The existing High Temperature Hot Water (HTHW) Distribution System has been plagued with design and construction deficiencies since startup of the HTHW system, in October 1988. In October 1989, after one year of service, these deficiencies were outlined in a technical evaluation. The deficiencies included flooded manholes, sump pumps not hooked up, leaking valves, contaminated HTHW water, and no cathodic protection system.

This feasibility study of the High Temperature Hot Water (HTHW) Distribution System was performed under Contract No. DACA01-94-D-0033, Delivery Order 0013, Modification 1, issued to EMC Engineers, Inc. (EMC), by the Norfolk District Corps of Engineers, on 25 April 1996. The purpose of this study was to determine the existing conditions of the High Temperature Hot Water Distribution System, manholes, and areas of containment system degradation.

The study focused on two areas of concern, as follows:

- Determine existing conditions and areas of containment system degradation (leaks) in the underground carrier pipes and protective conduit.

- Document the condition of underground steel and concrete manholes.

To document the leaks, a site survey was performed, using state-of-the-art infrared leak detection equipment and tracer gas leak detection equipment. To document the condition of the manholes, color photographs were taken of the insides of 125 manholes, and notes were made on the condition of these manholes.

STUDY/SURVEY RESULTS

The survey revealed a system with some immediate problem areas, and also identified areas of future problems, which could be addressed now, to avoid major problems. A HTHW system failure occurring in the middle of winter could be disastrous, causing the new Post heating system to be shut down. The study revealed infiltration of ground water into conduits, wet insulation, and flooded manholes. Conduit and carrier pipes are corroded. Manholes are in desperate need of repair. The cathodic protection system is not fully functional.

ENERGY CONSERVATION ANALYSIS

The net heat loss calculated, based on the difference between a new thermally efficient system and the existing losses determined by field measurements, was 11,194,736 Btu/hour. From the study, Fort Drum developed 20 stand-alone projects, which will bring the existing failing system into a reliable working system. A summary of the projects follows:

Description	Estimated Construction Cost ($ Thousand)
Cathodic Protection (SIR 70)	$ 80.3
JOB #3 Mt. Belvedere (SIR 3.14)	$1,351.2
JOB #4 North Riva Ridge	$ 518.4
JOB #5 10600 Area	$ 367.1
JOB #6 P-10000	$ 96.1
JOB #7 Fire Station	$ 108.6
JOB #8 P-10100	$ 166.6
JOB #9 Second Street West	$ 324.8
JOB #10 Bowling Alley	$ 324.5
JOB #11 Guthrie Service	$ 145.1
JOB #12 Manhole 40-1, P-10510	$ 24.7
JOB #13 JA Jones, Manhole 19	$ 396.6
JOB #14 10100 Area	$ 219.6
JOB #15 10400 Area Conduit	$ 203.9
JOB #16 Manholes 10200 Area	$ 211.3
JOB #17 Manholes 4400 Area	$ 289.0
JOB #18 Manholes 10400,10500	$ 205.7
JOB #19 Manholes 10600 Area	$ 178.5
JOB #20 Manholes 10100/11000 Area	$ 188.7
JOB #21 Manholes 10700 Area	$ 119.0
TOTAL CONTRACT COST	$5,519.7
ESTIMATED CONTRACT COST (ROUNDED)	$5,520
CONTINGENCY PERCENT (6.00%)	$ 331
SUBTOTAL	$5,851
SIOH (6.00%)	$ 351
TOTAL (ROUNDED)	$6,200

CONCLUSIONS

An extensive investigation into alternate systems (such as natural gas) is not warranted. The cost of repairing of the existing system is much lower than the cost for a new natural gas system (estimated $19.2 Million). The existing HTHW distribution would not survive long enough to allow for the installation of an alternative system. The Government has a long-term commitment with a third party contract, to provide HTHW service to the new post. Where energy savings have been calculated, the results have been very favorable, with SIRs of 3.14 to 4.56.

SECTION 1
GENERAL DESCRIPTION

1.1 AUTHORITY FOR HTHW DISTRIBUTION SYSTEM STUDY

This study of the High Temperature Hot Water (HTHW) Distribution System was performed under Contract No. DACA01-94-D-0033, Delivery Order 0013, Modification 1, issued to EMC Engineers, Inc. (EMC) by the Norfolk District Corps of Engineers on 25 April 1996.

1.2 PURPOSE OF STUDY

The purpose of this feasibility study was to determine the existing conditions of the High Temperature Hot Water Distribution System, manholes, and areas of containment system degradation.

1.3 SCOPE OF WORK

The Scope of Work for this study is presented in Appendix A. The requirements outlined in the Scope of Work are summarized as follows:

- Perform a site survey of the existing underground piping/conduit system, using state-of-the-art infrared and tracer gas testing equipment.
- Take high-resolution color photographs of the inside conditions of 125 manholes.
- Prepare a report to document the work performed, the results, and the recommendations.

1.4 APPROACH

The High Temperature Hot Water Distribution System Study was focused on two areas of concern, as follows:

- Determine existing conditions and areas of containment system degradation (leaks) in the underground carrier pipes and protective conduit.
- Document the condition of underground steel and concrete manholes.

In order to document the leaks, a site survey was performed using state-of-the-art infrared leak detection equipment and tracer gas leak detection equipment. The infrared survey and tracer gas testing were conducted by Perma-Pipe in April and June 1996. Two copies of the reports and infrared video tapes were delivered to Mr. Steve Rowley at Ft. Drum in June and August 1996.

In order to document the condition of the manholes, color photographs were taken of the inside of 125 manholes, and notes were made on the condition of these manholes. The manhole survey was conducted by Lawman Heating and Cooling in April 1996. Two copies of the color photographs, negatives, and notes were delivered to Mr. Rowley, in June 1996. Six copies of a photo CD disc, containing all 500 photographs and notes, were delivered to Mr. Rowley in July 1996.

This compiled report contains the Perma-Pipe Infrared and Tracer Gas reports. No photographs are included in this report.

SECTION 2
INTRODUCTION AND TEST PROCEDURES

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Fort Drum HTHW IR Survey
1996 Report

INTRODUCTION

Infrared Thermography is a valuable tool in evaluating the thermal efficiency of insulated materials. The ability to see and record thermal anomalies allows for instant evaluation of the performance of the insulated structure. Thermal efficiencies can be measured, quantified, and compared against similar structures of differing designs. This comparison can be used to specify the most cost effective materials and identify thermal anomalies.

The use of thermography to evaluate buried thermal distribution systems is unique infrared application. Buried thermal distribution systems have been used for more than 85 years and has undergone many changes. The changes in design were a result of recognition of the need for more thermally efficient systems. With the introduction of video imaging thermography, there is now an economical procedure for evaluating the performance of a buried thermal distribution system.

It is accepted that the insulation must be maintained in a dry condition to be thermally efficient. Many different types of systems were designed to achieve this. However, there was no effective means of proving or evaluating the actual performance of the various designs. The introduction of video imaging thermography, for the first time afforded a method to see thermal losses from wet insulation and pipe leaks on buried thermal distribution systems. Infrared thermography provides a way to evaluate a buried piping system. Through the use of thermography and specially designed computer software, thermal efficiency can be proven. Potential failures can be avoided by scheduling maintenance to dry wet systems and repair leaks. Piping replacement schedules can be established based upon condition rather than age.

A thorough knowledge of all types of thermal distribution systems and the fundamental laws of thermography are required to properly evaluate a system. Different systems perform differently under similar conditions. Thermal imaging is affected by many environmental and surface conditions. There must be a thorough knowledge of the science of heat transfer as it relates to buried systems.

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Fort Drum HTHW IR Survey
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INTRODUCTION (cont.)

Pipeline Services has more than 85 years background experience to draw upon in the field of buried thermal distribution systems. More than 14 years have been dedicated to developing and using thermography as a useful tool for evaluating buried systems.

A soon as thermal inefficiencies are identified additional data is gathered to facilitate evaluating the system. Special software was developed to calculate BTU losses from temperatures gathered using contact measurement and temperature probes. Historical data and operating parameters are also used in the analysis. Factors such as pipe size, depth of bury, soil types, soil moisture content, surface cover, insulation thickness and type, conduit size, and operating temperature are taken into consideration when evaluating system performance.

PIPING INDICATING EXCESSIVE ENERGY LOSS

Excessive energy loss can be attributed to two primary causes: (1) lack of sufficient insulation; (2) wet or deteriorated insulation. New pipe is insulated and installed inside an outer steel jacket referred to as a conduit(recently non metallic jackets are also being used). The conduit is normally constructed from 10 gauge steel, coated with a water proof material, consisting of either reinforced asphalt or coal tar. The pipe and insulation are isolated from the wet soil by the outer conduit. This results in a thermal distribution system that is dry and thermally efficient. When this type of distribution system becomes wet, there are three primary causes. First, a loss of the outer jacket integrity. This can be a result of corrosion, or unreported mechanical damage from digging operations. Second, in manholes, water backing up into the conduit vents or drain plugs. Third, leaks from the interior carrier pipe.

When the interior of the conduit becomes wet, the thermal efficiency of the piping system is reduced and corrosion generally occurs on the interior of the conduit and the exterior of the carrier pipe. The solution is to locate the source of the water and take action to prevent the water from entering the conduit. Once the source of the water has been identified and the corrections made, the conduit can be dried. In the drying process, the insulation will be dried and returned to like new thermal efficiency.

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1996 Report

PROCEDURE

Check the affected conduit for water. Open vent and drain plugs at the low end of the run. Be prepared to collect a sample of the water for analysis. Test the water for boiler treatment using the boiler plant test procedure. The chemical test can be run on the water sample taken from the conduit. If water tests positive for boiler treatment, each pipe should be pressure tested to determine which pipe is leaking. Take the pipe out of service to conduct the pressure test. A hydrostatic pressure test will determine which pipe is leaking.

If the water tests negative for boiler treatment, pressure test the conduit. A conduit pressure test is conducted by connecting a compressor hose to the conduit vent opening through a pressure regulator. The conduit should hold five PSIG for 24 hours. The conduit end seals must not be corroded away and the vent and drain sockets must have good threads to insure an accurate air test. If gland seals were installed on the conduit, they should be repacked prior to pressure testing the conduit. During the pressure test, the end seals, vent and drain plugs, hose connections and gland seals should be soap tested to insure they are not leaking. If the conduit fails the pressure test, a Tracer Gas Survey is recommended to locate the breach in the conduit. An explanation of a Tracer Gas Survey is included in the Maintenance Guide section of this report.

A common problem associated with manholes is corrosion of the piping valves and fittings. Manholes generally are hot and wet most of the time which contributes to accelerated corrosion of metallic fittings inside the manhole. Conduit terminal ends, if they are not maintained, will be subject to corrosion. When the conduit end seal is corroded, water from flooded manholes will enter the conduit. New end seal plates should be welded in place to allow pressure testing of the conduit. If the conduit ends are corroded beyond the point where new end seal plates can be welded, strict manhole drying procedures will be required to insure that water does not back up into the conduit.

SECTION 3
REPORT OF SURVEY

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Fort Drum HTHW IR Survey

1996 Report

REPORT OF SURVEY

During the weeks of April 15 thru April 29, an **INFRARED EVALUATION SURVEY** was conducted for Fort Drum, New York. A list of runs surveyed including ratings can be found in section 4.00.

The survey was performed by **Inspection Services** Technicians using an Inframetrics Model 600 Radiometer for detection of infrared radiation from the buried distribution system. Contact and depth temperature measurements were made using a Beckman Model HD 110 Pyrometer Multimeter; in conjunction, with Omega Thermocouple probes.

A VHS format videotape recording of the entire survey was made. The times noted on the DETECTION REPORT page in Section 5.00 of this report that refers to the videotape recording. These times can be found in the upper right-hand corner of the video screen as the tape recording is being viewed. The thermal image represented on the sketch can be viewed by correlating these times with the time on the video tape. In addition a thermogram or thermograms are included preceding each report. The thermograms give the reader an idea of the energy loss noted with out the need to view the video tape.

The Infrared Survey was started at least two hours after sunset to minimize the possibility of solar thermal interference. The HTHW system had been in continuous service, assuring maximum transmission of infrared radiation from the buried distribution system. Trees, buildings, cars, structures, and machinery can all radiate or reflect infrared energy that can appear to be coming from the buried piping system. It is important to differentiate between infrared energy from the piping system and infrared energy from other sources. Only infrared energy from the buried Steam system is reported in this survey.

The system was at operating temperature while the survey was being conducted.

Recommendations given in the report are to be considered as a guide based upon nondestructive test methods used in the performance of the survey. They represent the best estimation of all values given and for corrective action based upon physical evidence and experience with similar piping systems.

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Fort Drum HTHW IR Survey
1996 Report

ANALYSIS

The infrared thermal analysis located several areas of excessive energy loss. These areas are noted below.

1. Piping from Manhole 19 to Manhole #25 along Second Ave.(16" Sup. Inside a 24" conduit, 16" Ret. Inside a 22" Conduit): The expansion loop area was loosing excessive energy. Two possible causes are: Water in the conduit which has saturated the insulation. Second, the loss of insulation from previous flooding and the action of boiling water. It is not possible to determine if one or both conduits are affected. The balance of the run of pipe appears to be loosing normal levels of energy. The expansion loops may not be laid at the proper angle to allow free flow of the water. This condition will trap water in the expansion loop. The conduit will be subject to corrosion. The insulation may be damaged and boil off the pipe. Recommend excavating the expansion loop and examining the condition of the conduit, pipe and insulation. If the conduit(s) is(are) found to be corroded, the expansion loop(s) can be replaced. Before replacement is considered inspect the conduit for some distance on either side of the "H" legs of the loop to insure the conduit is in weldable condition. The affected sections can be replaced. Once the replacement conduit has been installed an air test will confirm the balance of the conduit is tight.

2. Piping from Manhole #26 to Manhole #27 along Second Ave (16" Sup. Inside a 24" conduit, 16" Ret. Inside a 20" Conduit): Two expansion loops and one spot was noted loosing excessive energy. Two possible causes are: Water in the conduit which has saturated the insulation. Second, the loss of insulation from previous flooding and the action of boiling water. It is not possible to determine if one or both conduits are affected. The balance of the run of pipe appears to be loosing normal levels of energy. The expansion loops may not be laid at the proper angle to allow free flow of the water. This condition will trap water in the expansion loop. The conduit will be subject to internal corrosion. The insulation may be damaged and boil off the pipe. Recommend excavating the expansion loops and examining the condition of the pipe and insulation. Excavate the location along the run of pipe. If the conduit(s) is(are) found to be corroded, the expansion loop can be replaced. Before replacement is considered inspect the conduit for some distance on either side of the "H" legs of the loop to insure the conduit(s) is(are) in weldable condition. The affected section(s) can be replaced. Once the replacement conduit has been installed an air test will confirm the balance of the conduit is tight.

3. Piping from Manhole #27 to Manhole #37 along Second Ave.(14" Sup. Inside a 22" conduit, 14" Ret. Inside a 20" Conduit)::Two expansion loops were noted loosing excessive energy. Two possible causes are: Water in the conduit which has saturated the insulation.

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1996 Report

Second, the loss of insulation from previous flooding and the action of boiling water. It is not possible to determine if one or both conduits are affected. The balance of the run of pipe appears to be loosing normal levels of energy. The expansion loops may not be laid at the proper angle to allow free flow of the water. This condition will trap water in the expansion loop. The conduit will be subject to internal corrosion. The insulation may be damaged and boil off the pipe. Recommend excavating the expansion loops and examining the condition of the conduit, pipe and insulation. If the conduit(s) is(are) found to be corroded, the expansion loops can be replaced. Before replacement is considered inspect the conduit for some distance on either side of the "H" legs of the loop to insure the conduit is in weldable condition. The affected section(s) can be replaced. Once the replacement conduit has been installed an air test will confirm the balance of the conduit is tight.

4. Piping from Manhole #77 to Manhole #76 along South Riva Ridge Loop(4" Sup., 4" Ret. Inside an 18" Conduit): The expansion loop area was loosing excessive energy. Two possible causes are: Water in the conduit which has saturated the insulation. Second, the loss of insulation from previous flooding and the action of boiling water. It is not possible to determine if one or both conduits are affected. The balance of the run of pipe appears to be loosing normal levels of energy. The expansion loops may not be laid at the proper angle to allow free flow of the water. This condition will trap water in the expansion loop. The conduit will be subject to corrosion. The insulation may be damaged and boil off the pipe. Recommend excavating the expansion loop and examining the condition of the conduit, pipe and insulation. If the conduit is found to be corroded, the expansion loop can be replaced. Before replacement is considered inspect the conduit for some distance on either side of the "H" legs of the loop to insure the conduit is in weldable condition. The affected section can be replaced. Once the replacement conduit has been installed an air test will confirm the balance of the conduit is tight.

5. Piping from Manhole #41 to Manhole #46 along Fourth Street.(8" Sup. Inside a 16" conduit, 8" Ret. Inside a 14" Conduit): Three expansion loops were noted loosing excessive energy. Two possible causes are: Water in the conduit has saturated the insulation. Second is the loss of insulation from previous flooding and the action of boiling water. It is not possible to determine if one or both conduits are affected. The balance of the run of pipe appears to be loosing normal levels of energy. Recommend a tracer gas survey to determine the extent of damage to the conduit. The ends of the conduit inside the manholes may be corroded allowing water form flooded manholes to back-up into the conduit. The expansion loops may not be laid at the proper angle to allow free flow of the water. The water will stand in the expansion loops. The conduit will be subject to corrosion. The insulation may be damaged and boil off the pipe. The pipe may be protected from external corrosion from the operating temperature of the HTHW system. If the tracer gas survey determines the conduit is corroded for the majority of its length the piping should be replaced. Once corrosion has progressed along a run of conduit for the majority of its length it becomes impossible to predict remaining service life.

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If the conduit ends inside Manhole #41 and Manhole #46 are corroded beyond repair it will not be possible to test the conduit using a tracer gas. The expansion loops can be excavated and inspected. If the conduit(s) is(are) found to be corroded, the expansion loops can be replaced. Before replacement is considered inspect the conduit for some distance on either side of the "H" legs of the loop to insure the conduit is in weldable condition. The affected section(s) can be replaced. Second step is to excavate around the manholes and determine the condition of the conduit entries. It may be possible to replace the entry pieces and the expansion loops. This will allow an air test to insure the balance of the conduit is tight.

6. Piping from Manhole #46 to Manhole #47 along Fourth Street.(8" Sup. Inside a 16" conduit, 8" Ret. Inside a 14" Conduit): Two expansion loops were noted loosing excessive energy. This problem may have its origin in Manhole #46. The conduit ends may be corroded allowing water from flooding to enter the conduits. The expansion loops may not be laid at the proper angle to allow free flow of the water. The water will stand in the expansion loops. The conduit will be subject to corrosion. The insulation may be damaged and boil off the pipe. Recommend excavating the expansion loops and examining the condition of the conduit, pipe and insulation. If the conduit is found to be corroded, the expansion loop can be replaced. Before replacement is considered inspect the conduit for some distance on either side of the "H" legs of the loop to insure the conduit is in weldable condition. The affected section can be replaced. Once the replacement conduit has been installed an air test will confirm the balance of the conduit is tight.

7. Piping from Manhole #40-1 to Manhole #40-2 to Building 1051.(1.5" Sup., 1.5"" Ret. Inside a 12" Conduit): The piping between Manhole 40-1 and Manhole 40-2 should be replaced. The condition appears to be beyond economic repair.

The pipe between Manhole 40-2 and Building 10511 is loosing excessive energy from the manhole for a distance of approximately 56 feet. Manhole 40-2 is steaming and the steam may be getting inside the conduit either through open vents or a corroded conduit seal. Recommend pressure testing the conduit. A tracer gas survey is recommended if the conduit fails to hold pressure. The conduit can be repaired and returned to a dry thermally efficient condition.

8. Piping from Manhole #54 to Building 10270 along Fourth Armored Division Road.(2" Sup., 2"" Ret. Inside a 12 3/4" Conduit) The conduit has failed and as much as 66% of the run of pipe is indicating extremely poor thermal condition. A sink hole was found during the survey where it appeared that ground water was flooding the conduit. Recommend replacing the pipe.

9. Piping from Manhole #58 to Building 10000 at 10th Mountain Division Drive.(3" Sup.,3" Ret. Inside a 16" Conduit): One hot spot was identified along the run of pipe. Recommend a pressure test to determine if the conduit integrity has been lost. If the conduit fails the air test a tracer gas survey is recommended to locate conduit leaks. The hot spot is located in a swale and

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at a low point. Water from a flooded manhole may have collected in the area. The end seal on the conduit should be checked and vent and drain plugs checked inside the manhole.

SUMMARY

This completes the list of problem areas noted during the survey. The survey included approximately 10,000 feet of buried high temperature hot water distribution piping. Less than 2% of the buried piping is listed for replacement. Less that 7% of the total system was found to need repair. The piping system is in good condition. If repairs are made in a timely manner, the work on the cathodic protection is completed and manhole repair and maintenance is followed through, the system will offer many years of service.

The buried conduit system is like any other part of the heating distribution system. It must be maintained in order to continue to give trouble free service. A strict maintenance schedule, which includes the cathodic protection system testing, must be followed. Many procedures can be done in-house with the proper training and scheduling of work. Neglect maintenance on the underground piping system and future problems can be expected. Just as valves, pumps, seals, boilers and controls require maintenance and repair, the buried thermal distribution system must be maintained. The key to a long service life from a buried thermal distribution system is to keep the interior of the conduit dry.

The piping system is buried in a soil that contains deicing salts. The cathodic protection system will handle this threat. However, if the salt contaminated water is permitted to enter the conduit through manhole entries (corroded seals) the cathodic protection will not be of any value. Manhole maintenance is of primary importance.

PRIORITY FOR REPAIR

Priority One: Replacements

Manhole 40-1 to Manhole 40-2:
2" Supply w/1.5" insulation and 2" Return w/1" insulation inside a 12 3/4" Conduit.

Manhole 54 to Building 10270:
2" Supply w/1.5" insulation and 2" Return w/1" insulation inside a 12 3/4" Conduit.

Priority Two: Repairs

The following list is prepared based upon the importance of the pipe to the operation of the system as they affect the total operation of the base. The piping from Manhole #19 through Manhole #27 at Fifth Armored Div. Rd.. The noted expansion loops should be checked and

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repaired where needed. The piping is the main artery for the heating system on the base. It could be disastrous if a failure occurred in the middle of winter causing the base heating system to be shut down.

Included in this priority is the piping along Fourth Ave. between Manholes #41 to #46 and the two expansion loops beyond Manhole #46. These represent a main supply line that is responsible for heating a large portion of the base. It is also important to note that the manholes may be a contributor to these problems.

Priority Three Repairs include the expansion loop along Riva Ridge Loop down from Manhole #77 and the pipe from Manhole #58 to Building 10000. These are not as severe as the previously noted sections, however, now is the time to identify the problem and make the needed repairs.

SECTION 4
SURVEY RATINGS BY LINE

Fort Drum HTHW Infrared Survey Results

Location	Footage	Supply Size	Conduit Size S.	Insulation S.	Return Size	Conduit Size R.	Insulation R.	Survey Results: Good	Survey Results: Repair	Survey Results: Replace
MH 7 to MH 19	2395	16	24	2	16	22	1.5	X		
MH 19 to MH 25	707	16	24	2	16	22	1.5		X	
MH 25 to MH 26	874	16	24	2	16	22	1.5	X		
MH 26 to Bldg.	220	1 1/4	12	1 1/2	1 1/4		1	X		
MH 9 to MH 8	405	6	22	1 1/2	6		1	X		
MH 8 to MH 7	701	8	16	2	8	14	1.5	X		
MH 9 to MH 10	1454	6	22	1 1/2	6		1	X		
MH 19 to MH 12	226	4	18	2	4		1	X		
MH 12 to MH 20	412	4	18	2	4		1	X		
MH 20 to MH 21	858	3	16	1 1/2	3		1	X		
MH 21 to MH 22	736	2 1/2	14	1 1/2	2 1/2		1	X		
MH 67 to MH 68	1537	6	22	1 1/2	6		1			X *
MH 68 to MH 69	1633	6	22	1 1/2	6		1	X		
MH 69 to MH 71	2171	6	22	1 1/2	6		1	X		
MH 69 to MH 70	1464	2	12 3/4	1 1/2	2		1	X		
MH 67 to MH 76	806	4	18	2	4		1	X		
MH 76 to MH 77	801	4	18	2	4		1		X	
MH 77 to MH 86	470	4	18	2	4		1	X		
MH 86 to MH 24	232	3	16	1 1/2	3		1	X		
MH 24 to MH 78	965	3	16	1 1/2	3		1	X		
MH 78 to MH 79	476	2 1/2	14	1 1/2	2 1/2		1	X		
MH 71 to MH 74	2035	5	20	2	5		1	X		
MH 74 to MH 84	466	3	16	1 1/2	3		1	X		
MH 84 to MH 75	1661	2	12 3/4	1 1/2	2		1			***
MH 63 to MH 62	1358	2 1/2	14	1 1/2	2 1/2		1	X		
MH 62 to MH 61	602	4	18	2	4		1	X		
MH 61 to MH 60	602	5	20	2	5		1	X		
MH 67 to MH 66	1146	8	16	2	8	14	1.5	X		
MH 66 to MH 87	429	8	16	2	8	14	1.5	X		
MH 87 to MH 65	833	8	16	2	8	14	1.5	X		
MH 65 to MH 64	456	8	16	2	8	14	1.5	X		
MH 64 to MH 56	362	8	16	2	8	14	1.5	X		
MH 56 to MH 57	333	10	18	2	10	16	1.5	X		
MH 57 to MH 37	570	10	18	2	10	16	1.5	X		
MH 36 to MH 92	361	2	12 3/4	1 1/2	2		1	X		
MH 92 to MH 35	462	2	12 3/4	1 1/2	2		1	X		
MH 35 to MH 34	909	4	18	2	4		1	X		
MH 34 to MH 27	1031	5	20	2	5		1	X		
MH 7 to Heating Plant	421	16	24	2	16	22	1.5	X		
MH 27 to MH 37	1064	14	22	2	14	20	1.5		X	

Total Footage Page 1: 34644

* Scheduled for replacement
** Scaled from EMC supplied drawings
*** Abandoned

Fort Drum HTHW Infrared Survey Results

Location	Footage	Supply Size	Conduit Size S.	Insulation S.	Return Size	Conduit Size R.	Insulation R.	Survey Results		
								Good	Repair	Replace
MH 60 to MH 59	224	5	20	2	5		1	X		
MH 59 to MH 58	1449	5	20	2	5		1	X		
MH 58 to MH 90	514	6	22	1.5	6		1	X		
MH 90 to MH 56	690	6	22	1.5	6		1	X		
MH 37 to MH 39	474	8	16	2	8	14	1.5	X		
MH 39 to MH 38	192	8	16	2	8	14	1.5	X		
MH 38 to MH 40	1153	8	16	2	8	14	1.5	X		
MH 40 to MH 41	766	8	16	2	8	14	1.5	X		
MH 41 to MH 42	468	3	16	1.5	3		1	X		
MH 42 to MH 43	760	3	16	1.5	3		1	X		
MH 43 to MH 85	229	3	16	1.5	3		1	X		
MH 27 to MH 28	1014	8	16	2	8	14	1.5	X		
MH 28 to MH 29	867	5	20	2	5		1	X		
MH 29 to MH 30	587	5	20	2	5		1	X		
MH 30 to MH 31	1191	5	20	2	5		1	X		
MH 31 to MH 32	721	3	16	1.5	3		1	X		
MH 41 to MH 46	989	8	16	2	8	14	1.5		X	
MH 46 to MH 47	1224	8	16	2	8	14	1.5		X	
MH 47 to MH 89	289	3	16	1.5	3		1	X		
MH 89 to MH 53	771	3	16	1.5	3		1	X		
MH 53 to MH 54	879	2	12 3/4	1.5	2		1	X		
MH 52 to MH 88	363	3	16	1.5	3		1	X		
MH 88 to MH 51	795	4	12	2	4		1	X		
MH 51 to MH 50	468	5	20	2	5		1	X		
MH 50 to MH 47	753	6	22	1.5	6		1	X		
MH 72 to MH 73	646	3	16	1.5	3		1	X		
MH 7 to MH 82	234	8	16	2	8	14	1.5	X		
MH 82 to MH 3	1148	8	16	2	8	14	1.5	X		
MH 3 to MH 4	523	6	22	1.5	6		1	X		
MH 4 to MH 6	949	5	20	2	5		1	X		
MH 84 to 10170	634	2	12 3/4	1.5	2		1	X		
MH 63 to HW MH 1	214	2.5	14	1.5	2.5		1	X		
HW MH 1 to HW MH 2	391	2.5	14	1.5	2.5		1	X		
HW MH 1 to 10110	153	1	10 3/4	1.5	1		1	X		
HW MH 2 to 10114	167	2	12 3/4	1.5	2		1	X		
HW MH 2 to 10112	201	2	12 3/4	1.5	2		1	X		
MH 62 to HW MH 3	253	3	16	1.5	3		1	X		
HW MH 3 to 10120	316	1	10 3/4	1.5	1		1	X		
HW MH 3 to HW MH 4	296	3	16	1.5	3		1	X		
HW MH 4 to 10124	218	1.5	12	1.5	1.5		1	X		

Total Footage Page 2: 24173

* Scheduled for replacement
** Scaled from EMC supplied drawings
*** Abandoned

Fort Drum HTHW Infrared Survey Results

Location	Footage	Supply Size	Conduit Size S.	Insulation S.	Return Size	Conduit Size R.	Insulation R.	Survey Results		
								Good	Repair	Replace
HW MH 4 to 10122	171	1.5	12	1.5	1.5		1	X		
HW MH 4 to HW MH 5	436	2.5	14	1.5	2.5		1	X		
HW MH 5 to 10150	54	2.5	14	1.5	2.5		1	X		
MH 61 to HW MH 6	213	2	12 3/4	1.5	2		1	X		
HW MH 6 to 10130	154	1.5	12	1.5	1.5		1	X		
HW MH 6 to HW MH 7	433	2.5	14	1.5	2.5		1	X		
HW MH 7 to 10134	169	1.5	12	1.5	1.5		1	X		
HW MH 7 to 10132	200	1.5	12	1.5	1.5		1	X		
MH 66 to HW MH 1	265	2	12 3/4	1.5	2		1	X		
HW MH 1 to 10640	116	3/4	10 3/4	1.5	3/4		1	X		
HW MH 1 to HW MH 2	377	2	12 3/4	1.5	2		1	X		
HW MH 2 to 10644	167	1.5	12	1.5	1.5		1	X		
HW MH 2 to 10642	209	1.5	12	1.5	1.5		1	X		
MH 87 to HW MH 3	244	3	16	1.5	3		1	X		
HW MH 3 to 10630	156	3/4	10 3/4	1.5	3/4		1	X		
HW MH 3 to HW MH 4	403	2.5	14	1.5	2.5		1	X		
HW MH 4 to 10632	181	1.5	12	1.5	1.5		1	X		
HW MH 4 to 10622	226	1.5	12	1.5	1.5		1	X		
MH 65 to 10620	373	1	10 3/4	1.5	1		1	X		
MH 64 to HW MH 5	270	2	12 3/4	1.5	2		1	X		
HW MH 5 to 10610	109	3/4	10 3/4	1.5	3/4		1	X		
HW MH 5 to HW MH 6	370	2	12 3/4	1.5	2		1	X		
HW MH 6 to r10614	166	1.5	12	1.5	1.5		1	X		
HW MH 6 to 10612	204	1.5	12	1.5	1.5		1	X		
MH 36 to 10680	336	2	12 3/4	1.5	2		1	X		
MH 35 to 10670	295	2.5	14	1.5	2.5		1	X		
MH 34 to 10660	300	2	12 3/4	1.5	2		1	X		
MH 39 to MH 39E	231	2.5	14	1.5	2.5		1	X		
MH 39E to Bldg. 10506	425	2.5	14	1.5	2.5		1	X		
MH 52 to MH 52A	142	2.5	14	1.5	2.5		1	X		
MH 52A to 10205	84	2.5	14	1.5	2.5		1	X		
MH 38 to 10500?	544	1	10 3/4	1.5	1		1	X		
MH 38 to HW MH 3	297	2	12 3/4	1.5	2		1	X		
HW MH 3 to 10520	103	3/4	10 3/4	1.5	3/4		1	X		
HW MH 3 to HW MH 4	373	2	12 3/4	1.5	2		1	X		
HW MH 4 to 10524	169	1.5	12	1.5	1.5		1	X		
HW MH 4 to 10522	198	1.5	12	1.5	1.5		1	X		
MH 40 to HW MH 1	296	2	12 3/4	1.5	2		1	X		
HW MH 1 to 10510	97	3/4	10 3/4	1.5	3/4		1	X		
HW MH 1 to HW MH 2	374	2	12 3/4	1.5	2		1			X

Total Footage Page 3: 9930

* Scheduled for replacement
** Scaled from EMC supplied drawings
*** Abandoned

Fort Drum HTHW Infrared Survey Results

Location	Footage	Supply Size	Conduit Size S.	Insulation S.	Return Size	Conduit Size R.	Insulation R.	Survey Results: Good	Repair	Replace
HW MH 2 to 10511	172	1.5	12	1.5	1.5		1		X	
HW MH 2 to 10512	194	1.5	12	1.5	1.5		1	X		
MH 28 to 10550	156	1.5	12	1.5	1.5		1	X		
MH 28 to 10580	493	2.5	14	1.5	2.5		1	X		
MH 29 to 10570	426	2.5	14	1.5	2.5		1	X		
MH 46 to HW MH 1	579	3	16	1.5	3		1	X		
HW MH to 10050	21	3	16	1.5	3		1	X		
MH 42 to 10400	410	1	10 3/4	1.5	1		1	X		
MH 42 to HW MH 3	296	2	12 3/4	1.5	2		1	X		
HW MH 3 to 10420	137	1	10 3/4	1.5	1		1	X		
HW MH 3 to 10422	471	1.5	12	1.5	1.5		1	X		
MH 43 to HW MH 4	264	1	10 3/4	1.5	1		1	X		
HW MH 4 to 10410	210	1	10 3/4	1.5	1		1	X		
MH 32 to HW MH 1	249	3	16	1.5	3		1	X		
HW MH 1 to 10450	31	1 1/4	12	1.5	1 1/4		1	X		
HW MH 1 to HW MH 2	326	2.5	14	1.5	2.5		1	X		
HW MH 2 to 10414	282	2	12 3/4	1.5	2		1	X		
HW MH 2 to 10412	304	2	12 3/4	1.5	2		1	X		
MH 31 to MH 31A	445	3	16	1.5	3		1	X		
MH 31A to 10470	398	3	14	1.5	2.5		1	X		
MH 31A to MH 31B	494	2.5	14	1.5	2.5		1	X		
MH 31B to 10480	76	2.5	14	1.5	2.5		1	X		
MH 50 to HW MH 6	213	2.5	14	1.5	2.5		1	X		
HW MH 6 to 10230	155	1	10 3/4	1.5	1		1	X		
HW MH 6 to HW MH 7	404	2.5	14	1.5	2.5		1	X		
HW MH 7 to 10232	163	1.5	12	1.5	1.5		1	X		
HW MH 7 to 10234	195	1.5	12	1.5	1.5		1	X		
MH 51 to HW MH 3	331	3	16	1.5	3		1	X		
HW MH 3 to 10220	343	1	10 3/4	1.5	1		1	X		
HW MH 3 to HW MH 4	320	3	16	1.5	3		1	X		
HW MH 4 to 10222	169	1.5	12	1.5	1.5		1	X		
HW MH 4 to 10224	218	1.5	12	1.5	1.5		1	X		
HW MH 4 to HW MH 5	422	2.5	14	1.5	2.5		1	X		
HW MH 5 to 10250	51	2.5	14	1.5	2.5		1	X		
MH 51 to 10200	429	1	10 3/4	1.5	1		1	X		
MH 21 to HW MH 7	332	1	10 3/4	1.5	1		1	X		
HW MH 7 to 4400	118	1	10 3/4	1.5	1		1	X		
MH 52 to HW MH 1	241	2.5	14	1.5	2.5		1	X		
HW MH 1 to 10210	163	1	10 3/4	1.5	1		1	X		
HW MH 1 to HW MH 2	394	2.5	14	1.5	2.5		1	X		

Total Footage Page 4: 11095

* Scheduled for replacement
** Scaled from EMC supplied drawings
*** Abandoned

Fort Drum HTHW Infrared Survey Results

Location	Footage	Supply Size	Conduit Size S.	Insulation S.	Return Size	Conduit Size R.	Insulation R.	Survey Results			
								Good	Repair	Replace	
HW MH 2 to 10212	164	2	12 3/4	1.5	2		1	X			
HW MH 2 to 10214	199	2	12 3/4	1.5	2		1	X			
MH 54 to 10270	421	2	12 3/4	1.5	2		1			X	
MH 6 to 4530	389	5	20	2	5		1	X			
MH 73 to MH B	744	3	16	1.5	3		1	X			
MH B to MH C	200	3	16	1.5	3		1	X			
MH C to Clinic	205	2.5	14	1.5	2.5		1	X			
MH C to Med. Ops. Bldg.	226	1.5	12	1.5	1.5		1	X			
MH 20 to HW MH 1	316	2	12 3/4	1.5	2		1	X			
HW MH 1 to HW MH 2	283	2	12 3/4	1.5	2		1	X			
HW MH 2 to 4432	471	2	12 3/4	1.5	2		1	X			
HW MH 2 to 4430	141	3/4	10 3/4	1.5	3/4		1	X			
HW MH 1 to 4422	731	2	12 3/4	1.5	2		1	X			
MH 21 to HW MH 3	249	2	12 3/4	1.5	2		1	X			
HW MH 3 to 4420	169	3/4	10 3/4	1.5	3/4		1	X			
HW MH 3 to 4450	779	2	12 3/4	1.5	2		1	X			
MH 22 to HW MH 5	250	2.5	14	1.5	2.5		1	X			
HW MH 5 to 4410	133	1	10 3/4	1.5	1		1	X			
HW MH 5 to HW MH 6	432	2.5	14	1.5	2.5		1	X			
HW MH 6 to 4414	224	1.5	12	1.5	1.5		1	X			
HW MH 6 to 4412	231	1.5	12	1.5	1.5		1	X			
MH 3 to TEE	1045	3	16	1.5	3		1	X			
TEE to riser 74	79	2.5	14	1.5	2.5		1	X			
Tee to Maint. Bldg.	59	2	12 3/4	1.5	2		1	X			
MH 4 to TEE	133	2.5	14	1.5	2.5		1	X			
TEE to Direct Support Bldg.	229	2.5	14	1.5	2.5		1	X			
TEE to 4478	275	3/4	10 3/4	1.5	3/4		1	X			
MH 10 to MH A	648	2.5	14	1.5	2.5		1	X			**
MH A to Bldg. 4325	30	1.5	12	1.5	1.5		1	X			**
MH A to MH B	394	2.5	14	1.5	2.5		1	X			**
MH B to Bldg. 4320	450	1.5	12	1.5	1.5		1		X		**
MH 25 to Bldg.	929	3	16	1.5	3		1	X			**
MH 4 to HWMH 1	197	3	16	1.5	3		1	X			**
HWMH 1 to HWMH 2	281	3	16	1.5	3		1	X			**
HWMH 2 to HWMH 3	281	3	16	1.5	3		1	X			**
HWMH 3 to HWMH 4	140	3	16	1.5	3		1	X			**
HWMH 4 to Bldg. 4525	30	3	16	1.5	3		1	X			**
MH 26 to MH 27	1860	16	24	2	16	22	1.5		X		**
MH 58 to P-10,000.	1293	3	16	1.5	3		1		X		**
MH 74 to HWMH A	648	2	12 3/4	1.5	2		1	X			**

Total Footage Page 5: 15958

* Scheduled for replacement
** Scaled from EMC supplied drawings
*** Abandoned

Fort Drum HTHW Infrared Survey Results

Location	Footage	Supply Size	Conduit Size S.	Insulation S.	Return Size	Conduit Size R.	Insulation R.	Survey Results			
								Good	Repair	Replace	
HW MH A to 11115	56	1.5	12	1.5	1.5		1	X			**
HW MH A to 11120	648	1.5	12	1.5	1.5		1	X			**
MH 79 to 10730	225	2	12 3/4	1.5	2		1	X			**
MH 71 to MH 72	1180	3	16	1.5	3		1	X			
MH 70 to 10745	507	2	12 3/4	1.5	2		1	X			**
MH 76 to HWMH 1	169	1.5	12	1.5	1.5		1	X			**
HWMH 1 to HWMH 2	394	1.5	12	1.5	1.5		1	X			**
HWMH 2 to HWMH 3	197	1.5	12	1.5	1.5		1	X			**
HWMH 3 to 10715	112	1.5	12	1.5	1.5		1	X			**
HWMH 1 to Building	169	3/4	10 3/4	1.5	3/4		1	X			**

Total Footage Page 6: 3657

Total Footage : 99457

* Scheduled for replacement
** Scaled from EMC supplied drawings
*** Abandoned

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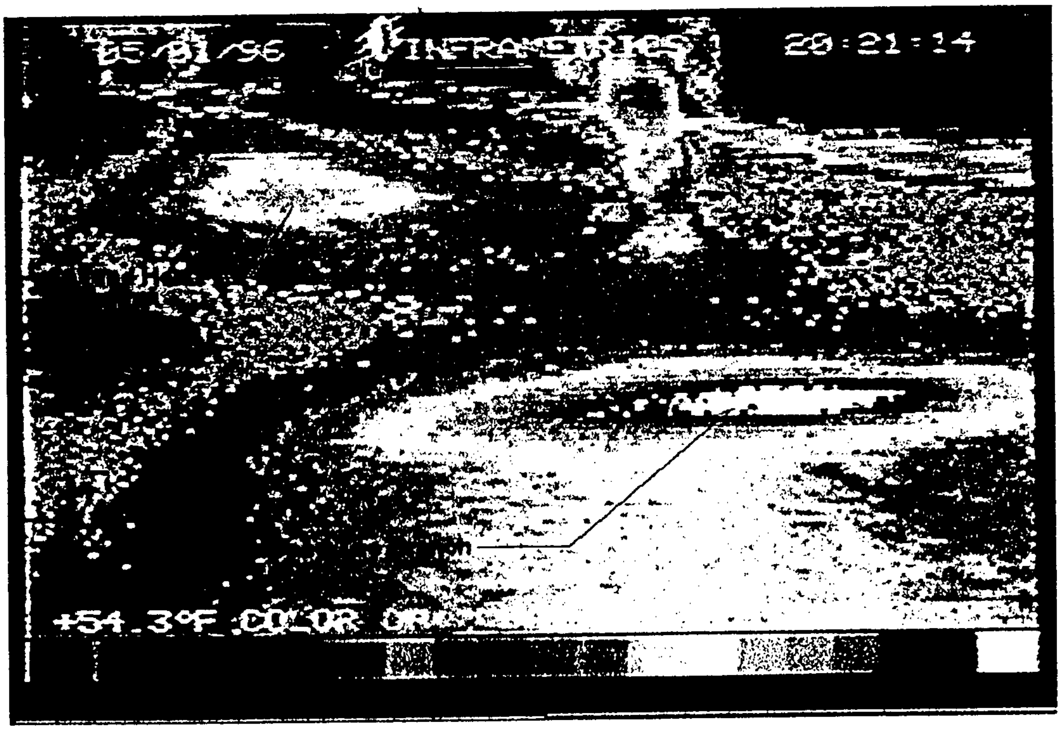
Fort Drum HTHW IR Survey

1996 Report.



Color Thermogram

Definition: A thermogram is a picture created by an infrared camera that records light in the infrared frequency range. Energy is emitted by all objects in the infrared frequency range where the objects are at a temperature greater than absolute zero. Infrared light is outside the frequency range that the eye detects as visible light. Interpretation of an infrared image requires a different way of viewing the picture. When the eye views an object, the eye records light that is reflected off the objects in the field of view. When there is no light source present, the eye does not record or send images to the brain. Infrared light has its source from the object itself. It requires no external source of light in order to be detected by an infrared scanner.

With out getting into deep physics, infrared light emits from objects with an intensity that is regulated by the temperature of the object. To understand this a little better, when any object is heated the molecules of that object move with increasing speed as the heat increases. This action causes energy waves to emit from the surface. These energy waves are in the frequency range of infrared light. This energy is what makes up the image seen in a thermogram. The infrared scanner sees these frequencies in black and white known as gray scales. Black is interpreted as cold and various levels of gray from black to white are the result of warmer and warmer temperatures. Theoretically white is the hottest temperature recorded based upon the scanner settings at the time the image was recorder.

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Fort Drum HTHW IR Survey
1996 Report

Color was added to aid in interpretation. The eye can only discern a certain number of levels of gray. False color is used to aid in the temperature separation. The thermograms used in this report use the colors blue for coldest, black through white for mid range temperatures, and red, the hottest setting for the image.

The scanner is computer controlled for creation of thermal images. It allows for adjusting the settings to achieve more contrast and facilitate interpretation. The temperature range can be adjusted to comply with temperature ranges of the subject under study. This feature was used during the conduct of this survey. Some areas will appear to be severe , however, the camera settings were adjusted differently from one area to another as the temperatures varied. This adjustment changes the temperature at which the color red and blue appear on the screen. Refer to the interpretation in the report, do not make judgments based upon the apparent thermal image.

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Evaluation Report
Energy Evaluation Buried Piping

Customer Name: EMC Engineers
Job Name: Fort Drum
Order Number: PLS-3014
Survey Date: April 27,28,29, 1996

Customer Contract No.: 1406.013

Location: Location of Thermal Image

Comments: Description of Thermal Image

Total Heat Loss for Thermal Images shown in sketch: 0000000 BTU/Hr.- Combined Heat Loss for each Thermal Image taken from Heat Loss Reports.

Line Segment Sketch:

Video Time Mark: 00:00
The time the Thermal Image was recorded on the Survey video.

Drawing of Thermal Image

Report Sketch No.

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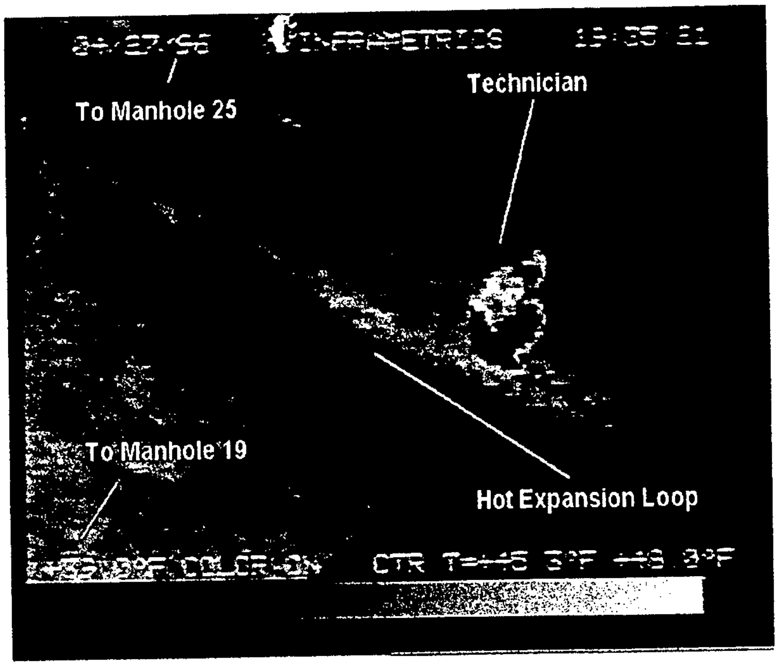
Fort Drum Infrared Survey



Manhole #19 to Manhole #25
Expansion Loop on MH #25 side.

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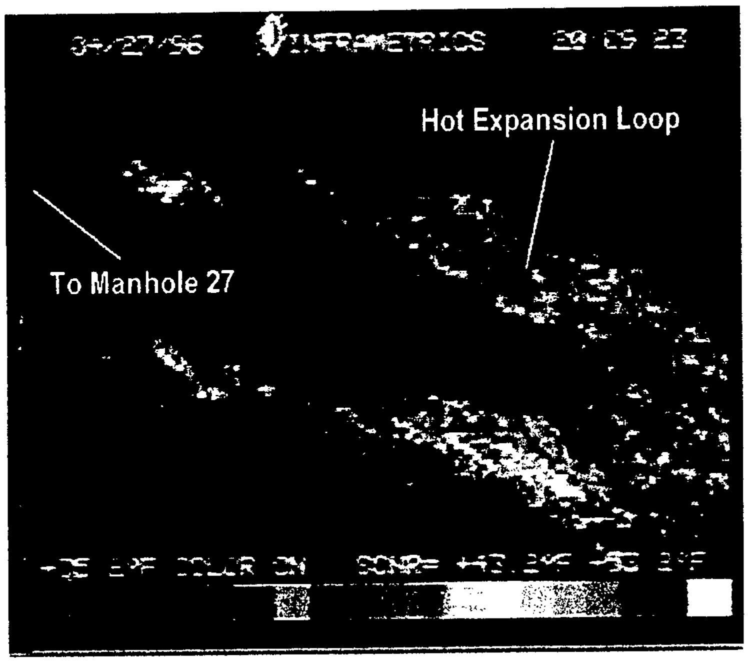
Fort Drum Infrared Survey



Manhole #26 to Manhole #27
Expansion Loop on MH #27 side.

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Evaluation Report
Energy Evaluation Buried Piping

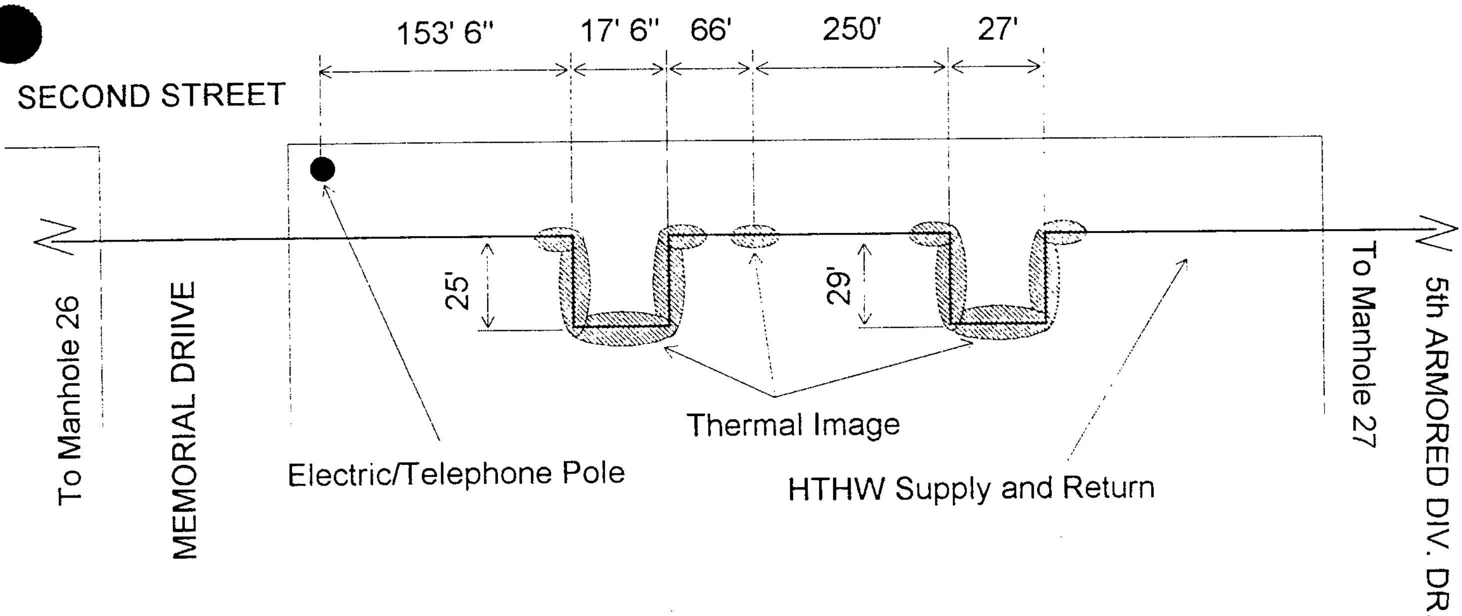
Customer Name:	EMC Engineers	
Job Name:	Fort Drum	
Order Number:	PLS-3014	**Customer Contract No.:** 1406.013
Survey Date:	April 27,28,29, 1996	

Location: Memorial Drive and 5th Armored Division Drive

Comments: Recommend excavating the expansion loops and examining the condition of the pipe and insulation. Excavate the location along the run of pipe. If the conduit(s) is (are) corroded, the expansion loop can be replaced. before replacement is considered inspect the conduit for some distance on either side of the "H" legs of the loop to insure the conduit(s) is (are) in weldable condition. The affected section(s) can be replaced. Once the replacement conduit has been installed an air test will confirm the balance of the conduit is tight.

Total Heat Loss for Thermal Images shown in sketch: 330774 BTU/Hr.

Line Segment Sketch: **Video Time Mark:** 19:44-20:02



Report Sketch No.2

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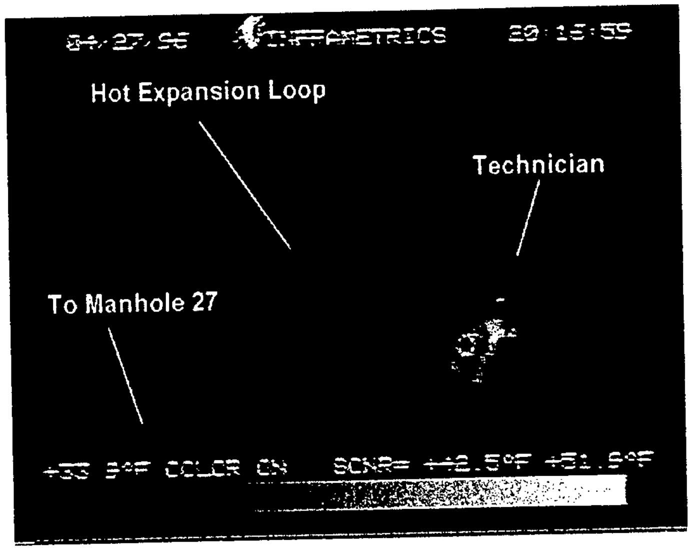
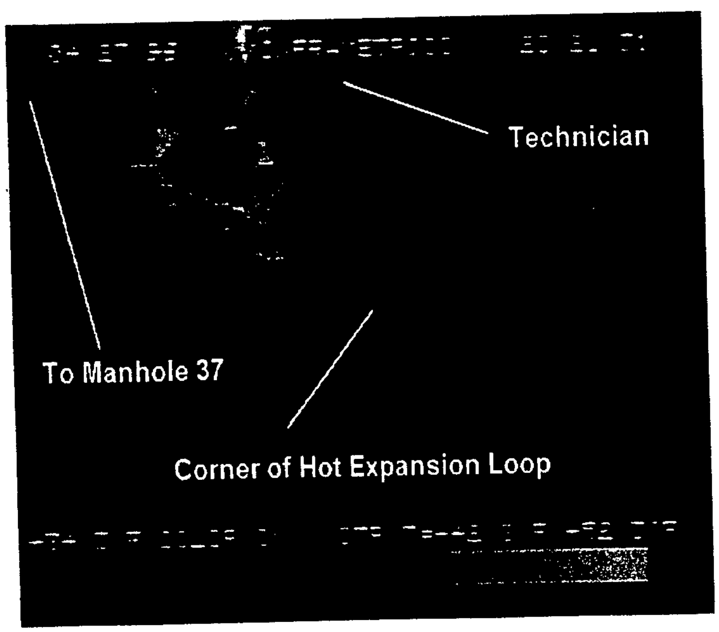
Fort Drum Infrared Survey



Manhole #27 to Manhole #37
Expansion Loop on MH #27 side.



Manhole #27 to Manhole #37
Expansion Loop on MH #37 side.

Perma-Pipe, Inc. - Inspection Services
2571 Medina Road; Medina, Ohio 44256 - (330) 725-3430 Fax (330) 725-3141

Evaluation Report
Energy Evaluation Buried Piping

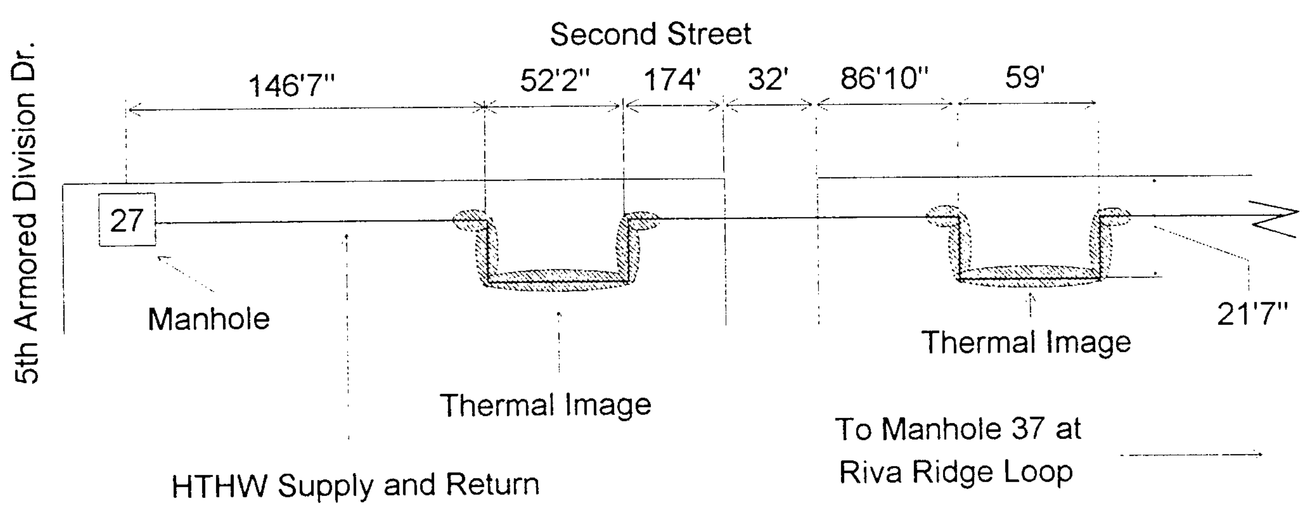
Customer Name:	EMC Engineers	
Job Name:	Fort Drum	
Order Number:	PLS-3014	**Customer Contract No.:** 1406.013
Survey Date:	April 27,28,29, 1996	

Location: Manhole 27 to Manhole 37

Comments: Recommend excavating the expansion loops and examining the condition of the conduit, pipe and insulation. If the conduit(s) is (are) found to be corroded, the expansion loops can be replaced. Before replacement is considered inspect the conduit for some distance on either side of the "H" legs of the loop to insure the conduit is in weldable condition. The affected section(s) can be replaced. Once the replacement conduit has been installed an air test will confirm the balance of the conduit is tight.

Total Heat Loss for Thermal Images shown in sketch: 327135 BTU/Hr.

Line Segment Sketch: **Video Time Mark:** 20:13-20:21



Report Sketch No.3

Perma-Pipe
Inspection Services

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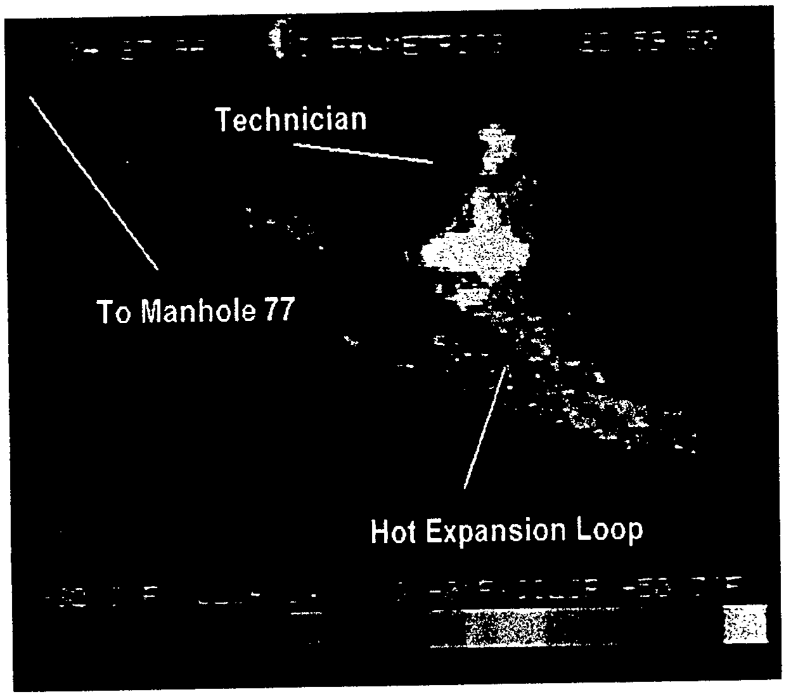
(216)725-3430 FAX (216)725-3141

Fort Drum Infrared Survey



Manhole #77 to Manhole #76
Expansion Loop on MH #77 side.

Perma-Pipe, Inc. - Inspection Services

2571 Medina Road; Medina, Ohio 44256 - (330) 725-3430 Fax (330) 725-3141

Evaluation Report
Energy Evaluation Buried Piping

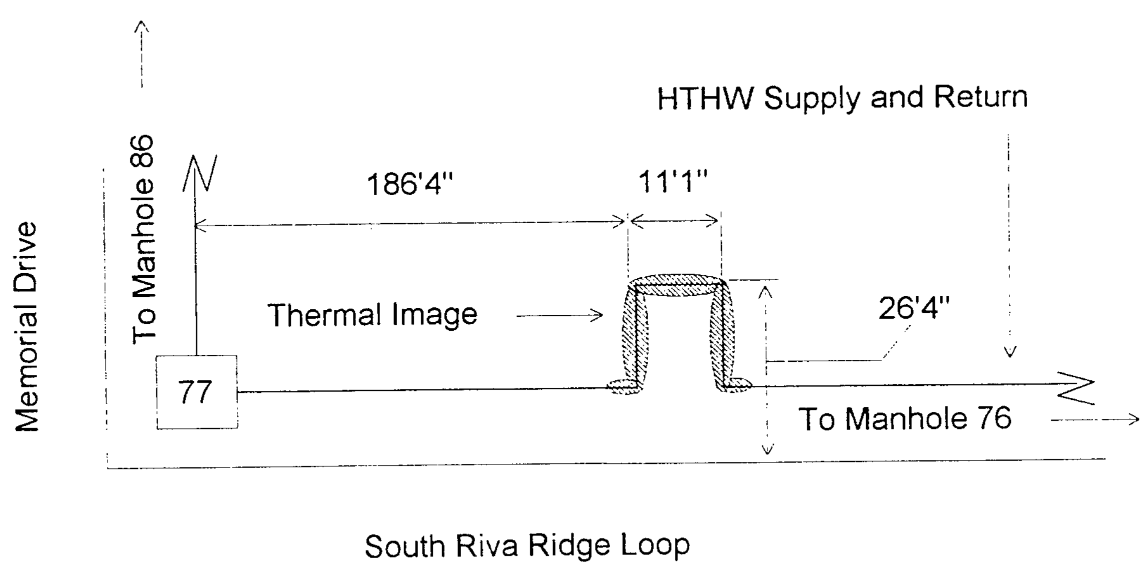
Customer Name:	EMC Engineers	
Job Name:	Fort Drum	
Order Number:	PLS-3014	**Customer Contract No.:** 1406.013
Survey Date:	April 27,28,29, 1996	

Location: Manhole 77 to Manhole 76- First Expansion Loop

Comments: Recommend excavating the expansion loop and examining the condition of the conduit, pipe and insulation. If the conduit is found to be corroded, the expansion loop can be replaced. Before replacement is considered inspect the conduit for some distance on either side of the "H" legs of the loop to insure the conduit is in weldable condition. The affected section can be replaced. Once the replacement conduit has been installed an air test will confirm the balance of the conduit is tight.

Total Heat Loss for Thermal Images shown in sketch: 62448 BTU/Hr.

Line Segment Sketch: **Video Time Mark:** 20:58



Report Sketch No.4

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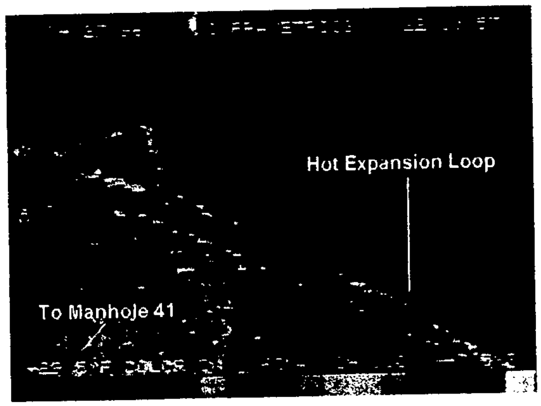
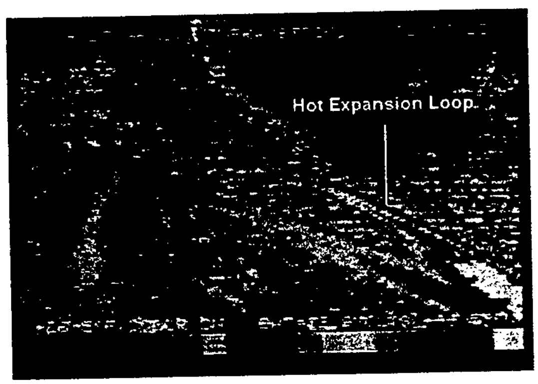
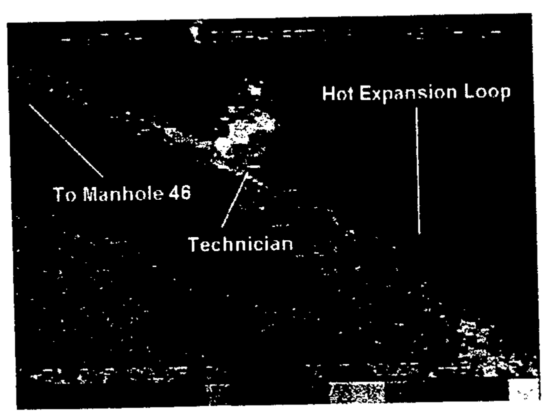
Fort Drum Infrared Survey



Manhole #41 to Manhole #46
Expansion Loop on MH #41 side.



Center Loop



Expansion Loop on MH #46 side.

Perma-Pipe, Inc. - Inspection Services

2571 Medina Road; Medina, Ohio 44256 - (330) 725-3430 Fax (330) 725-3141

Evaluation Report
Energy Evaluation Buried Piping

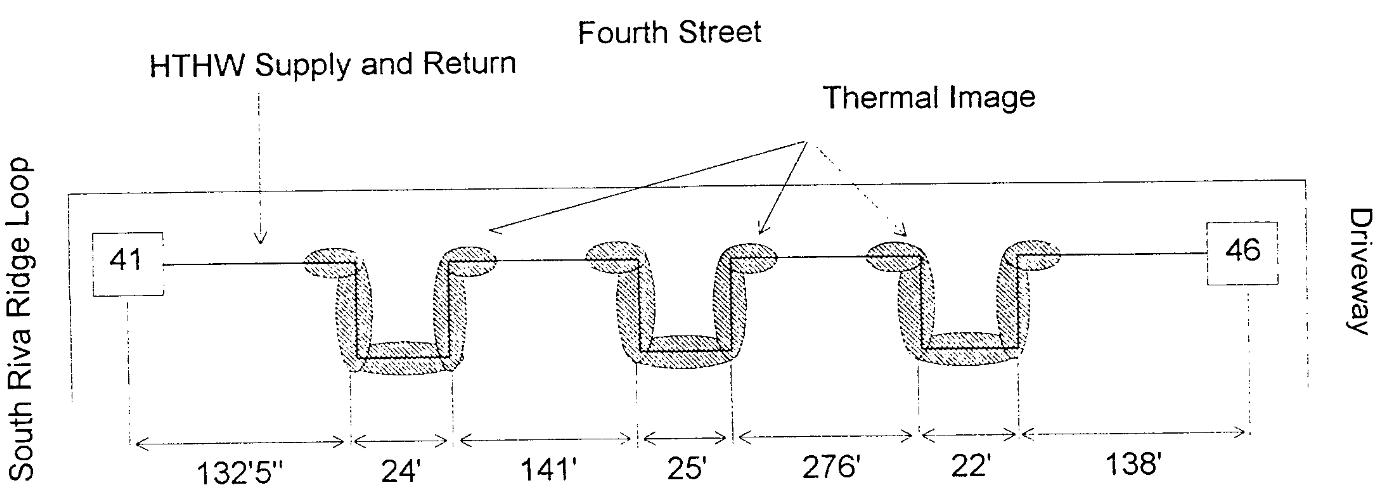
Customer Name:	EMC Engineers		
Job Name:	Fort Drum		
Order Number:	PLS-3014	**Customer Contract No.:**	1406.013
Survey Date:	April 27,28,29, 1996		

Location: Manhole 41 to Manhole 46

Comments: Recommend a tracer gas survey to determine the extent of damage to the conduit. The ends of the conduit inside the manholes may be corroded allowing water from flooded manholes to back-up into the conduit. The expansion loops may not be laid at the proper angle to allow free flow of the water. The water will stand in the expansion loops. The conduit will be subject to corrosion. The insulation may be damaged and boil off the pipe. The pipe may be protected from external corrosion from the operating temperature of the HTHW system. If the tracer gas survey determines the conduit is corroded for the majority of its length the piping should be replaced.

Total Heat Loss for Thermal Images shown in sketch: 307320 BTU/Hr.

Line Segment Sketch: **Video Time Mark:** 22:10-22:16-22:22



Report Sketch No.5

Perma-Pipe
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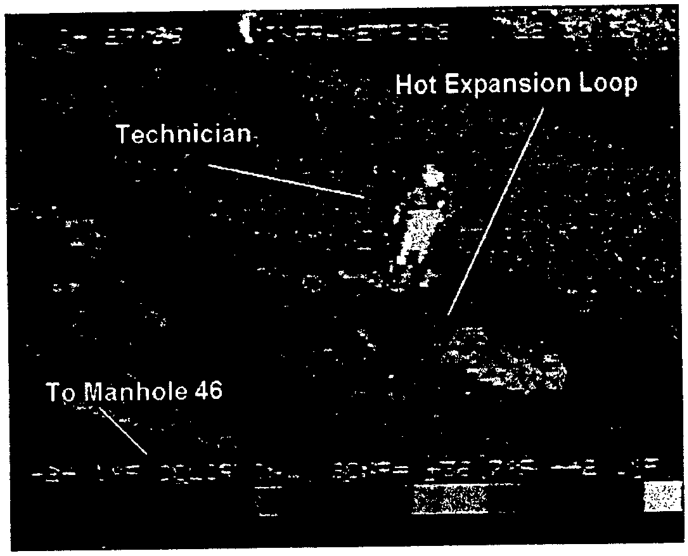
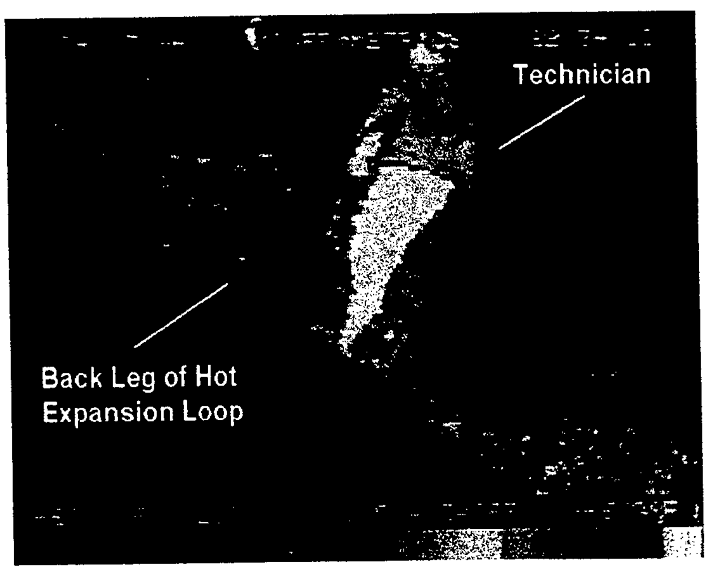
Fort Drum Infrared Survey



Manhole #46 to Manhole #47
Expansion Loop on MH #46 side.



Manhole #46 to Manhole #47
Expansion Loop on MH #47 side.

Perma-Pipe, Inc. - Inspection Services

2571 Medina Road; Medina, Ohio 44256 - (330) 725-3430 Fax (330) 725-3141

Evaluation Report
Energy Evaluation Buried Piping

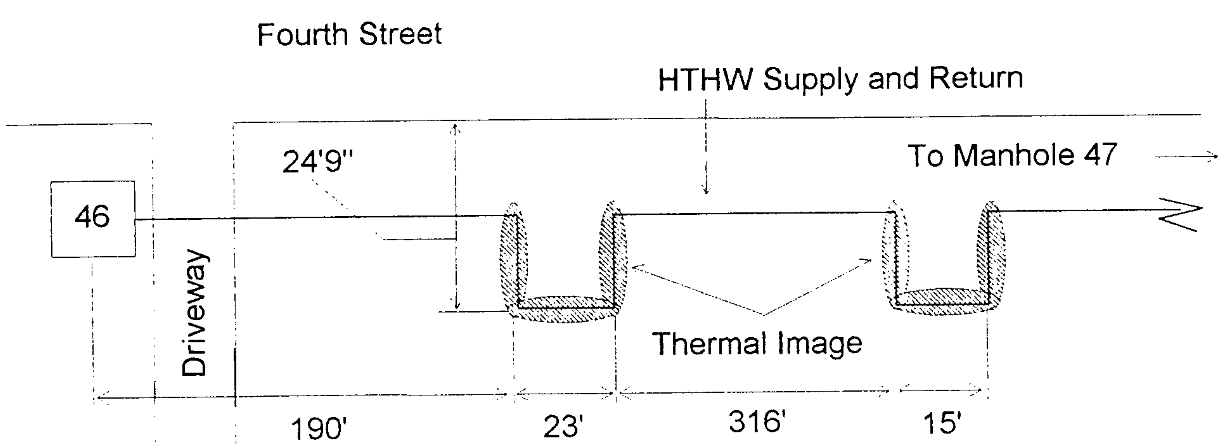
Customer Name:	EMC Engineers	
Job Name:	Fort Drum	
Order Number:	PLS-3014	**Customer Contract No.:** 1406.013
Survey Date:	April 27,28,29, 1996	

Location: Manhole 46 to Manhole 47

Comments: Recommend excavation the expansion loops and examining the condition of the conduit, pipe and insulation. If the conduit is found to be corroded, the expansion loop can be replaced. Before replacement is considered, inspect the conduit for some distance of either side of the "H" legs of the loop to insure the conduit is in weldable condition. The affected section can be replaced. Once the replacement conduit has been installed an air test will confirm the balance of the conduit is tight.

Total Heat Loss for Thermal Images shown in sketch: 172468 BTU/Hr.

Line Segment Sketch: **Video Time Mark:** 22:28-22:33



Report Sketch No.6

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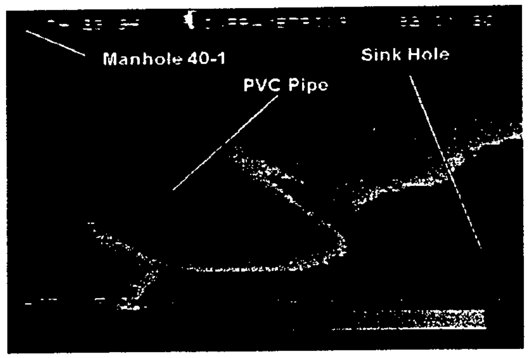
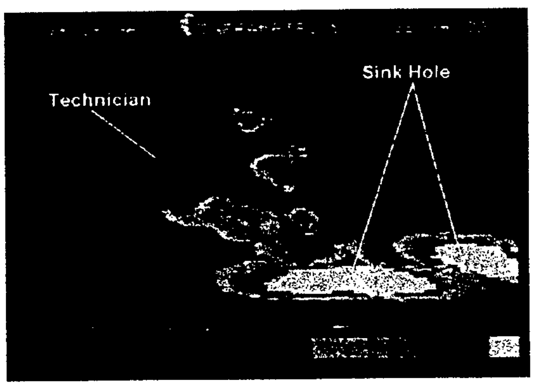
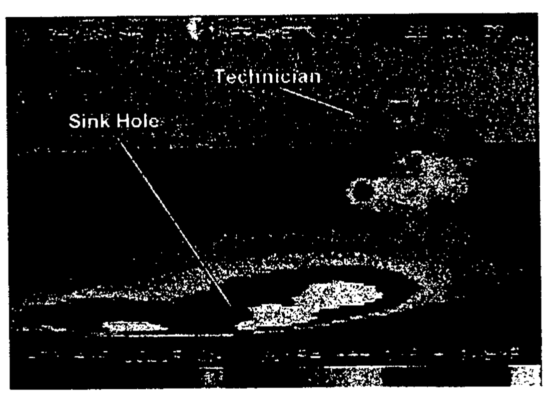
Fort Drum Infrared Survey



Manhole #40-1 to Manhole #40-2
Image #1, Sink Hole



Manhole #40-1 to Manhole #40-2
Image #2, Sink Hole



Manhole #40-1 to Manhole #40-2
Image #3, second sink hole

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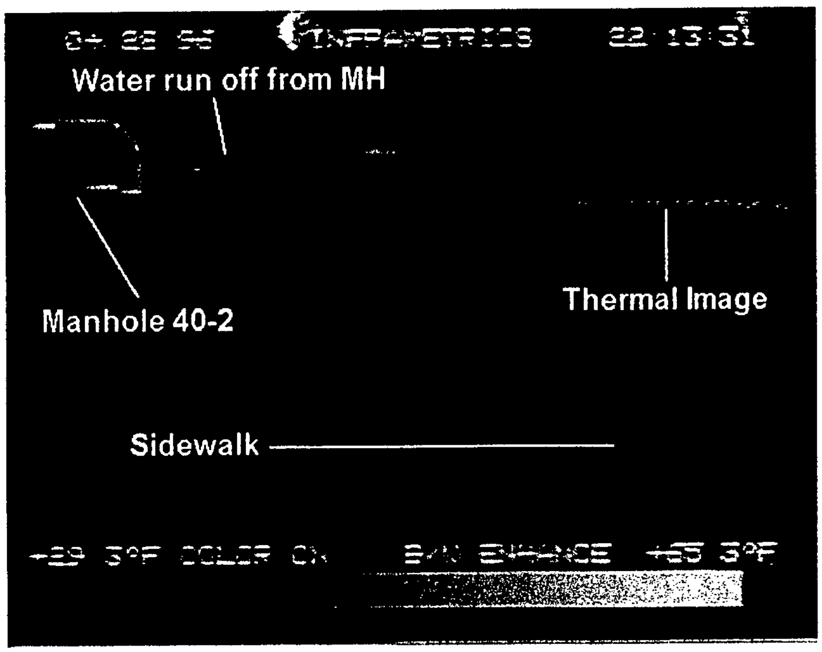
Fort Drum Infrared Survey



Manhole #40-2 to Building 10511

Perma-Pipe, Inc. - Inspection Services

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Evaluation Report
Energy Evaluation Buried Piping

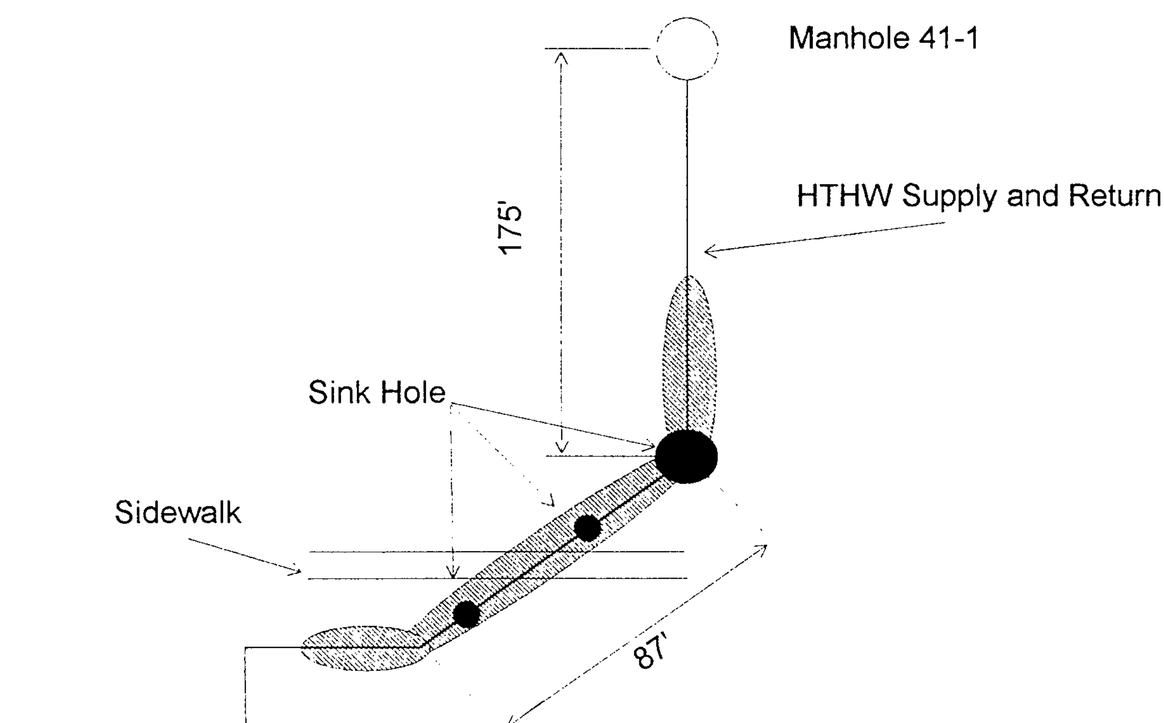
Customer Name:	EMC Engineers		
Job Name:	Fort Drum		
Order Number:	PLS-3014	**Customer Contract No.:**	1406.013
Survey Date:	April 27,28,29, 1996		

Location: Hot Water Manhole 40-1 to Hot Water Manhole 40-2 to Building 10511

Comments: The piping between Manhole 40-1 and 40-2 should be replaced. The condition appears to be beyond economic repair. The piping between 40-2 and building 10511 is loosing excessive energy from the manhole for a distance of approximately 56 feet. Manhole 40-2 is steaming and the steam may be getting inside the conduit either through open vents or a corroded conduit seal. Recommend pressure testing the conduit. A tracer gas survey is recommended if the conduit fails to hold pressure. The conduit can be repaired and returned to dry thermally efficient condition.

Total Heat Loss for Thermal Images shown in sketch: 7725285 BTU/Hr.

Line Segment Sketch: **Video Time Mark:** 22:01-22:15



Report Sketch No.7

Perma-Pipe
Inspection Services

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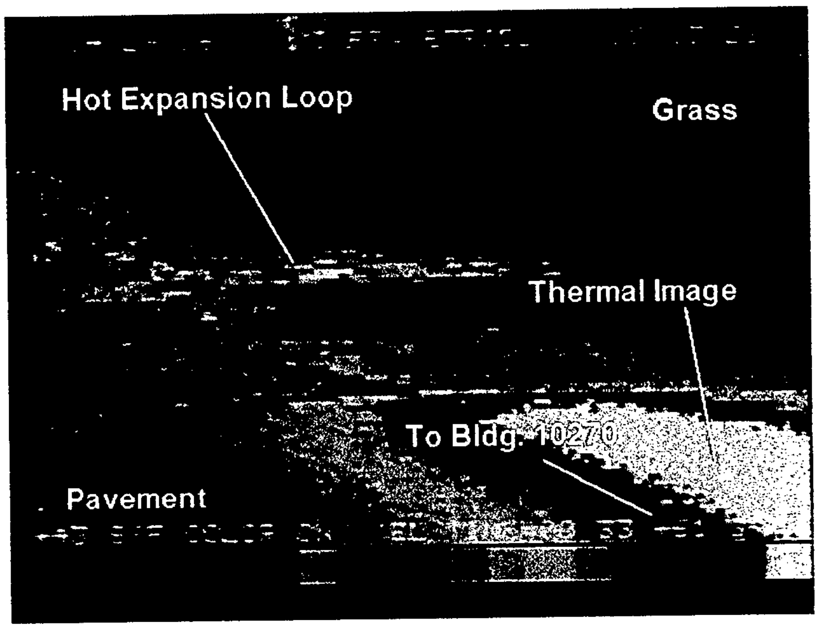
Fort Drum Infrared Survey



Manhole #54 to Building 10270

Perma-Pipe, Inc. - Inspection Services

2571 Medina Road; Medina, Ohio 44256 - (330) 725-3430 Fax (330) 725-3141

Evaluation Report
Energy Evaluation Buried Piping

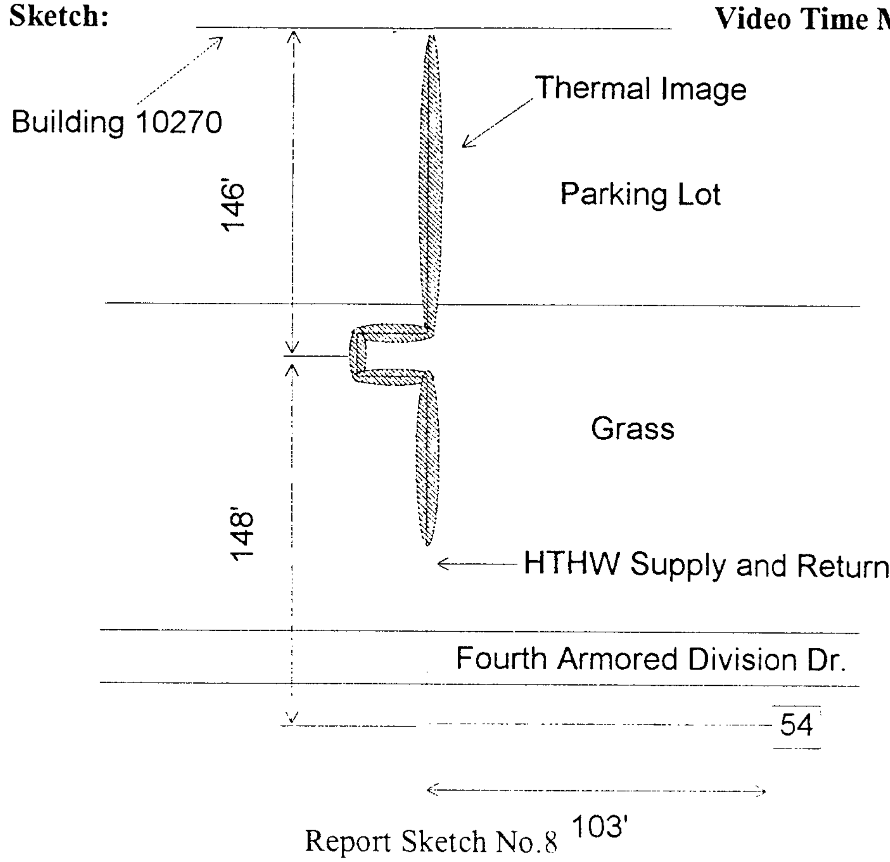
Customer Name:	EMC Engineers		
Job Name:	Fort Drum		
Order Number:	PLS-3014	**Customer Contract No.:**	1406.013
Survey Date:	April 27,28,29, 1996		

Location: Manhole 54 to Building 10270

Comments: The conduit has failed and as much as 66% of the run of pipe is indicating extremely poor thermal condition. A sink hole was found during the survey where it appeared that ground water was flooding the conduit. Recommend replacing the pipe.

Total Heat Loss for Thermal Images shown in sketch: 2522990 BTU/Hr.

Line Segment Sketch: **Video Time Mark:** 19:13



Report Sketch No.8

Perma-Pipe
Inspection Services

2571 Medina Road: Medina, Ohio 44256
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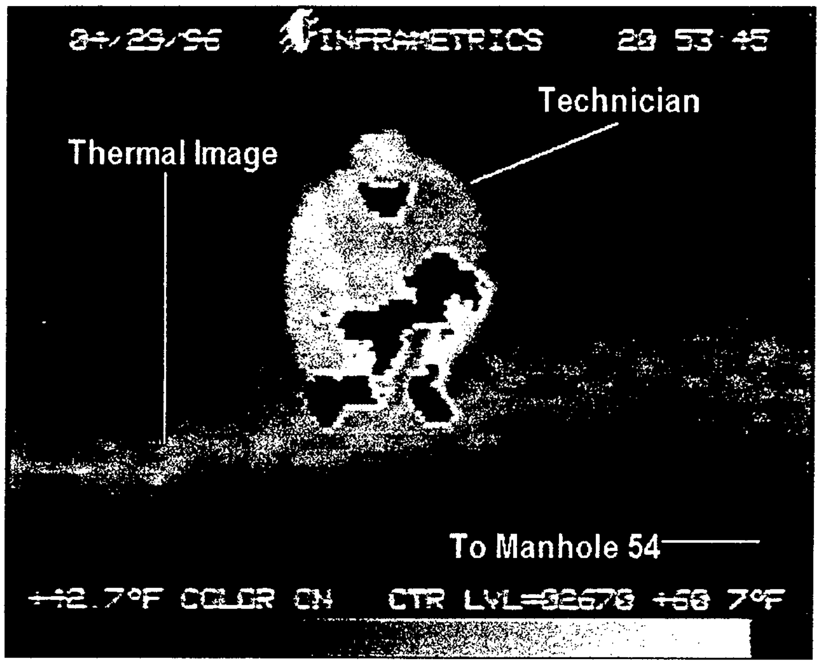
Fort Drum Infrared Survey



Manhole #58 to Building 10000

Perma-Pipe, Inc. - Inspection Services

2571 Medina Road; Medina, Ohio 44256 - (330) 725-3430 Fax (330) 725-3141

Evaluation Report
Energy Evaluation Buried Piping

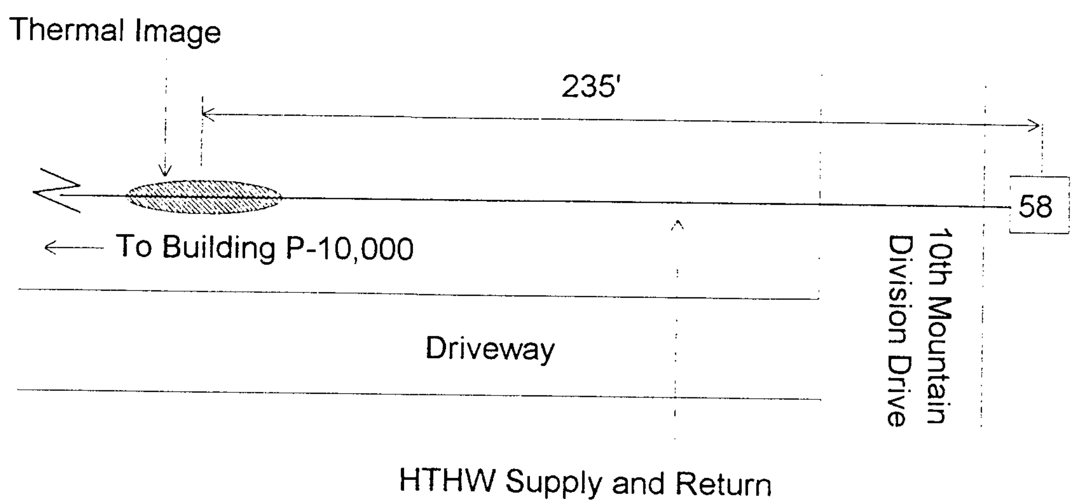
Customer Name:	EMC Engineers	
Job Name:	Fort Drum	
Order Number:	PLS-3014	**Customer Contract No.:** 1406.013
Survey Date:	April 27,28,29, 1996	

Location: Manhole 58 to Building P-10,000

Comments: Recommend a pressure test to determine if the conduit integrity has been lost. If the conduit fails the air test a tracer gas survey is recommended to locate conduit leaks. The hot spot is located in a ditch and at a low point. Water from a flooded manhole may have collected in the area. The end seal on the conduit should be checked and vent and drain plugs checked inside the manhole.

Total Heat Loss for Thermal Images shown in sketch: 46000 BTU/Hr.

Line Segment Sketch: **Video Time Mark:** 20:55



Report Sketch No.9

SECTION 6
HEAT LOSS SUMMARY, HEAT LOSS CALCULATIONS

Perma-Pipe, Inc. Inspection Services
Heatloss Summary

Fort Drum
Watertown, New York

Survey Data From: Aptil 27, 28, 29, 1996

Report Number	Location	Pipe and Insulation Data				** New System BTU/Hr-Ft.		Field Measured BTU/Hr-Ft.				Field Measured	
		Sup.	Ins.	Ret.	Ins.	Supply	Return	Combined		Footage		Total Heatloss	*NET Heatloss
1	MH19 to MH25 second Exp. Loop	16	2	16	1.5	118.5	136.3	513	x	209	=	107217	53963.8
2	Memorial Drive/5th Arm. Div. first Loop	16	2	16	1.5	118.5	136.3	1656	x	129	=	213624	180754.8
3	Memorial Drive/5th Arm. Div. second Loop	16	2	16	1.5	118.5	136.3	710	x	165	=	117150	75108
4	MH27 to MH37 first Loop	14	2	14	1.5	119.9	140.7	946	x	193	=	182578	132282.2
5	MH27 to MH37 second Loop	14	2	14	1.5	119.9	140.7	749	x	193	=	144557	94261.2
6	MH77 to MH76 first Loop	4	2	4	1	51.6	72.8	1301	x	48	=	62448	56476.8
7	MH41 to MH46 first Loop	8	2	8	1.5	81.2	97.5	1104	x	112	=	123648	103633.6
8	MH41 to MH46 second Loop	8	2	8	1.5	81.2	97.5	670	x	116	=	77720	56990.8
9	MH41 to MH46 third Loop	8	2	8	1.5	81.2	97.5	946	x	112	=	105952	85937.6
10	MH46 to MH47 first Loop	8	2	8	1.5	76.8	92.2	749	x	134	=	100366	77720
11	MH46 to MH47 second Loop	8	2	8	1.5	76.8	92.2	591	x	122	=	72102	51484
12	HWMH 40-1 to HWMH 40-2	2	1.5	2	1	40.4	48.1	20701	x	369	=	7638669	7606012.5
13	HWMH 40-2 to Building 10511	1.5	1.5	1.5	1	34.1	43.3	1203	x	72	=	86616	81043.2
14	MH54 to Building 10270	2	1.5	2	1	40.4	48.1	8035	x	314	=	2522990	2495201
15	MH58 to Building P-10000	3	1.5	3	1	50.8	61.2	920	x	50	=	46000	40400
16	HWMH B to Building 4320	1.5	1.5	1.5	1	34.1	43.3	424	x	10	=	4240	3466
								Totals		2348		11605877	11194736

** New system heatloss calculations are found in following this form.

* Note: Net Heatloss is the difference between a New thermally efficient system and the existing field measured heatloss.

PERMA PIPE INSPECTION SERVICES
2571 Medina Road; Medina, Ohio 44256; (330)725-3430

EVALUATION REPORT
ENERGY EVALUATION BURIED PIPING

JOB NAME: Ft. Drum
ORDER NO: PLS-3014 SURVEY DATE: April 27, 28, 29, 1996
LOCATION: Manhole 19 Exp. Loop

==

Soil Conductivity (BTU / Hr - Ft ^ 2 - F) ----------------------> 13
Temperature Difference (Over Pipe - Ambient) (F) ------------> 13
Distance (x) From Pipe Center (Ft) - Ambient) (F) ------------> 2
Pipe Depth of Bury (Ft) --> 5.00
Total Trench Footage (Losing Energy) (Ft) ---------------------> 209 Ft

==

Approximate System Heat Loss At This Location is 513 BTU/Hr-Ft.
Total Loss for 209 Feet is 107217 BTU/Hr. Report No. 1

==

Video Tape Time mk: 19:35

LOCATION: Memorial Dr. Exp. Loop

==

Soil Conductivity (BTU / Hr - Ft ^ 2 - F) ----------------------> 13
Temperature Difference (Over Pipe - Ambient) (F) ------------> 42
Distance (x) From Pipe Center (Ft) - Ambient) (F) ------------> 2
Pipe Depth of Bury (Ft) --> 5.00
Total Trench Footage (Losing Energy) (Ft) ---------------------> 129 Ft

==

Approximate System Heat Loss At This Location is 1656 BTU/Hr-Ft.
Total Loss for 129 Feet is 213624 BTU/Hr. Report No. 2

==

Video Tape Time mk: 19:44

LOCATION: 5th Arm. Div. Exp. Loop

==

Soil Conductivity (BTU / Hr - Ft ^ 2 - F) ----------------------> 13
Temperature Difference (Over Pipe - Ambient) (F) ------------> 18
Distance (x) From Pipe Center (Ft) - Ambient) (F) ------------> 2
Pipe Depth of Bury (Ft) --> 5.00
Total Trench Footage (Losing Energy) (Ft) ---------------------> 165 Ft

==

Approximate System Heat Loss At This Location is 710 BTU/Hr-Ft.
Total Loss for 165 Feet is 117150 BTU/Hr. Report No. 3

==

Video Tape Time mk: 20:02

PERMA-PIPE INSPECTION SERVICES
2571 Medina Road; Medina, Ohio 44256; (330)725-3430
EVALUATION REPORT
ENERGY EVALUATION BURIED PIPING

JOB NAME: Ft. Drum
ORDER NO: PLS-3014 **SURVEY DATE:** April 27, 28, 29, 1996
LOCATION: MH 27 to 37 1st Exp. Loop

===

Soil Conductivity (BTU / Hr - Ft ^ 2 - F) ————————> 13
Temperature Difference (Over Pipe - Ambient) (F) ————> 24
Distance (x) From Pipe Center (Ft) - Ambient) (F) ————> 2
Pipe Depth of Bury (Ft) ————————————> 5.00
Total Trench Footage (Losing Energy) (Ft) ——————> 193 Ft

===

Approximate System Heat Loss At This Location is 946 BTU/Hr-Ft.
Total Loss for 193 Feet is 182578 BTU/Hr. Report No. 4

===

Video Tape Time mk: 20:13

LOCATION: MH 27 2nd Exp. Loop

===

Soil Conductivity (BTU / Hr - Ft ^ 2 - F) ————————> 13
Temperature Difference (Over Pipe - Ambient) (F) ————> 19
Distance (x) From Pipe Center (Ft) - Ambient) (F) ————> 2
Pipe Depth of Bury (Ft) ————————————> 5.00
Total Trench Footage (Losing Energy) (Ft) ——————> 193 Ft

===

Approximate System Heat Loss At This Location is 749 BTU/Hr-Ft.
Total Loss for 193 Feet is 144557 BTU/Hr. Report No. 5

===

Video Tape Time mk: 20:21

LOCATION: MH 77 Exp. Loop

===

Soil Conductivity (BTU / Hr - Ft ^ 2 - F) ————————> 13
Temperature Difference (Over Pipe - Ambient) (F) ————> 33
Distance (x) From Pipe Center (Ft) - Ambient) (F) ————> 2
Pipe Depth of Bury (Ft) ————————————> 5.00
Total Trench Footage (Losing Energy) (Ft) ——————> 48 Ft

===

Approximate System Heat Loss At This Location is 1301 BTU/Hr-Ft.
Total Loss for 48 Feet is 62448 BTU/Hr. Report No. 6

===

Video Tape Time mk: 20:58

PERMA-PIPE INSPECTION SERVICES
2571 Medina Road; Medina, Ohio 44256; (330)725-3430

EVALUATION REPORT
ENERGY EVALUATION BURIED PIPING

JOB NAME: Ft. Drum
ORDER NO: PLS-3014 SURVEY DATE: April 27, 28, 29, 1996
LOCATION: MH 41 to MH 46 1st Loop

===

Soil Conductivity (BTU / Hr - Ft ^ 2 - F) ------------------------> 13
Temperature Difference (Over Pipe - Ambient) (F) ------------> 28
Distance (x) From Pipe Center (Ft) - Ambient) (F) ------------> 2
Pipe Depth of Bury (Ft) --------------------------------------> 5.00
Total Trench Footage (Losing Energy) (Ft) ------------------> 112 Ft

===

Approximate System Heat Loss At This Location is 1104 BTU/Hr-Ft.
Total Loss for 112 Feet is 123648 BTU/Hr. Report No. 7

===

Video Tape Time mk: 22:10

LOCATION: MH 41 to MH 46 2nd Loop

===

Soil Conductivity (BTU / Hr - Ft ^ 2 - F) ------------------------> 13
Temperature Difference (Over Pipe - Ambient) (F) ------------> 17
Distance (x) From Pipe Center (Ft) - Ambient) (F) ------------> 2
Pipe Depth of Bury (Ft) --------------------------------------> 5.00
Total Trench Footage (Losing Energy) (Ft) ------------------> 116 Ft

===

Approximate System Heat Loss At This Location is 670 BTU/Hr-Ft.
Total Loss for 116 Feet is 77720 BTU/Hr. Report No. 8

===

Video Tape Time mk: 22:16

LOCATION: MH 41 to MH 46 3rd Loop

===

Soil Conductivity (BTU / Hr - Ft ^ 2 - F) ------------------------> 13
Temperature Difference (Over Pipe - Ambient) (F) ------------> 24
Distance (x) From Pipe Center (Ft) - Ambient) (F) ------------> 2
Pipe Depth of Bury (Ft) --------------------------------------> 5.00
Total Trench Footage (Losing Energy) (Ft) ------------------> 112 Ft

===

Approximate System Heat Loss At This Location is 946 BTU/Hr-Ft.
Total Loss for 112 Feet is 105952 BTU/Hr. Report No. 9

===

Video Tape Time mk: 22:22

PERMA-PIPE INSPECTION SERVICES
2571 Medina Road; Medina, Ohio 44256; (330)725-3430

EVALUATION REPORT
ENERGY EVALUATION BURIED PIPING

JOB NAME: Ft. Drum
ORDER NO: PLS-3014
LOCATION: MH 46 to MH 47 1st Loop

SURVEY DATE: April 27, 28, 29, 1996

==

Soil Conductivity (BTU / Hr - Ft ^ 2 - F) ——————>	13
Temperature Difference (Over Pipe - Ambient) (F) ——————>	19
Distance (x) From Pipe Center (Ft) - Ambient) (F) ——————>	2
Pipe Depth of Bury (Ft) ——————>	5.00
Total Trench Footage (Losing Energy) (Ft) ——————>	134 Ft

==

Approximate System Heat Loss At This Location is 749 BTU/Hr-Ft.
Total Loss for 134 Feet is 100366 BTU/Hr. Report No. 10

==

Video Tape Time mk: 22:28

LOCATION: MH 46 to MH 47 2nd Loop

==

Soil Conductivity (BTU / Hr - Ft ^ 2 - F) ——————>	13
Temperature Difference (Over Pipe - Ambient) (F) ——————>	15
Distance (x) From Pipe Center (Ft) - Ambient) (F) ——————>	2
Pipe Depth of Bury (Ft) ——————>	5.00
Total Trench Footage (Losing Energy) (Ft) ——————>	122 Ft

==

Approximate System Heat Loss At This Location is 591 BTU/Hr-Ft.
Total Loss for 122 Feet is 72102 BTU/Hr. Report No. 11

==

Video Tape Time mk: 22:13

LOCATION: MH 40-1 to MH 40-2

==

Soil Conductivity (BTU / Hr - Ft ^ 2 - F) ——————>	13
Temperature Difference (Over Pipe - Ambient) (F) ——————>	152
Distance (x) From Pipe Center (Ft) - Ambient) (F) ——————>	10
Pipe Depth of Bury (Ft) ——————>	10.00
Total Trench Footage (Losing Energy) (Ft) ——————>	369 Ft

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Approximate System Heat Loss At This Location is 20701 BTU/Hr-Ft.
Total Loss for 369 Feet is 7638669 BTU/Hr. Report No. 12

==

Video Tape Time mk: 22:01

PERMA-PIPE INSPECTION SERVICES
2571 Medina Road; Medina, Ohio 44256; (330)725-3430

EVALUATION REPORT
ENERGY EVALUATION BURIED PIPING

JOB NAME: Ft. Drum
ORDER NO: PLS-3014 SURVEY DATE: April 27, 28, 29, 1996
LOCATION: MH 40-2 to 10511

===

Soil Conductivity (BTU / Hr - Ft^2 - F) ——————————> 13
Temperature Difference (Over Pipe - Ambient) (F) ————> 17
Distance (x) From Pipe Center (Ft) - Ambient) (F) ————> 2
Pipe Depth of Bury (Ft) ——————————————> 10.00
Total Trench Footage (Losing Energy) (Ft) ——————> 72 Ft

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Approximate System Heat Loss At This Location is 1203 BTU/Hr-Ft.
Total Loss for 72 Feet is 86616 BTU/Hr. Report No. 13

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Video Tape Time mk: 22:15

LOCATION: MH 54 to 10270

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Soil Conductivity (BTU / Hr - Ft^2 - F) ——————————> 13
Temperature Difference (Over Pipe - Ambient) (F) ————> 59
Distance (x) From Pipe Center (Ft) - Ambient) (F) ————> 10
Pipe Depth of Bury (Ft) ——————————————> 10.00
Total Trench Footage (Losing Energy) (Ft) ——————> 314 Ft

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Approximate System Heat Loss At This Location is 8035 BTU/Hr-Ft.
Total Loss for 314 Feet is 2522990 BTU/Hr. Report No. 14

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Video Tape Time mk: 19:13

LOCATION: MH 58 to P-10,000

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Soil Conductivity (BTU / Hr - Ft^2 - F) ——————————> 13
Temperature Difference (Over Pipe - Ambient) (F) ————> 13
Distance (x) From Pipe Center (Ft) - Ambient) (F) ————> 2
Pipe Depth of Bury (Ft) ——————————————> 10.00
Total Trench Footage (Losing Energy) (Ft) ——————> 50 Ft

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Approximate System Heat Loss At This Location is 920 BTU/Hr-Ft.
Total Loss for 50 Feet is 46000 BTU/Hr. Report No. 15

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Video Tape Time mk: 20:55

PERMA-PIPE INSPECTION SERVICES
2571 Medina Road; Medina, Ohio 44256; (330)725-3430

EVALUATION REPORT
ENERGY EVALUATION BURIED PIPING

JOB NAME: Ft. Drum
ORDER NO: PLS-3014 **SURVEY DATE:** April 27, 28, 29, 1996
LOCATION: HWMH B to Bldg. 4320

==

Soil Conductivity (BTU / Hr - Ft ^ 2 - F) ------------------------> 13
Temperature Difference (Over Pipe - Ambient) (F) -----------> 6
Distance (x) From Pipe Center (Ft) - Ambient) (F) -----------> 2
Pipe Depth of Bury (Ft) ------------------------------------> 10.00
Total Trench Footage (Losing Energy) (Ft) ----------------> 10 Ft

==

Approximate System Heat Loss At This Location is 424 BTU/Hr-Ft.
Total Loss for 10 Feet is 4240 BTU/Hr. Report No. 16

==

Video Tape Time mk: 00:01

drumener.rpt

‡Perma-Pipe, Inc.
PIPELINE SERVICES HEAT LOSS SURVEY REPORT

HEAT LOSS CALCULATIONS

Prepared By: James F Harley
Date: 05-31-1996 Order No. PLS-3014
Job Name: Fort Drum, IR SurveyCity,ST : Watertown, NY
Location: Manhole 19 to Manhole 25
Calculation Procedure 2

STRUCTURE 1 INPUT DATA
Steel Pipe Diameter = 16 inches, nominal
Insulation Thickness= 3.00 inches of Mineral Wool (2.00inches nominal)

Coat & Wrap Conduit
Diameter of Conduit= 24.000 inches
Coating Thickness= .25 inches
Depth of Burial= 60 inches
Insulation Conductivity= 0.31 BTU/hr-F-ft^2
Coating Conductivity= 1.20 BTU/hr-F-ft^2
Temperature of Fluid= 360 F

STRUCTURE 2 INPUT DATA
Steel Pipe Diameter = 16 inches, nominal
Insulation Thickness= 2.50 inches of Mineral Wool (1.50 inches nominal)

Coat & Wrap Conduit
Diameter of Conduit= 24.00 inches
Coating Thickness= .25 inches
Depth of Burial= 60 inches
Insulation Conductivity= 0.31 BTU/hr-F-ft^2
Coating Conductivity= 1.20 BTU/hr-F-ft^2
Temperature of Fluid= 360 F
Pipe Center to Center Spacing = 28.000 inches

SOIL DATA
Soil Temperature= 45 F
Soil Conductivity= 13.00 BTU/hr-F-ft^2

SYSTEM DATA OUTPUT
Struct. 1 Heat Trans. Fact.(KP1)= 0.4 BTU/hr-F-ft
Struct. 2 Heat Trans. Fact.(KP2)= 0.43 BTU/hr-F-ft
Fluid 1 Equiv. Temperature (TP1)= 360 F
Fluid 2 Equiv. Temperature (TP2)= 360 F
Struct. 1 Heat Loss (Q1)= 118.50 BTU/hr-ft
Struct. 2 Heat Loss (Q2)= 136.30 BTU/hr-ft
Total System Heat Loss (QT)= 254.80 BTU/hr-ft

‡Perma-Pipe, Inc.

PIPELINE SERVICES HEAT LOSS SURVEY REPORT

HEAT LOSS CALCULATIONS

Prepared By:	James F Harley		
Date:	05-31-1996	Order No.	PLS-3014
Job Name:	Fort Drum, IR SurveyCity,ST :		Watertown, NY
Location:	MH #26 to MH #27		

Calculation Procedure 2

STRUCTURE 1 INPUT DATA

Steel Pipe Diameter =	16 inches, nominal
Insulation Thickness=	3.00 inches of Mineral Wool (2.00inches nominal)
Coat & Wrap Conduit	
Diameter of Conduit=	24.000 inches
Coating Thickness=	.25 inches
Depth of Burial=	60 inches
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

STRUCTURE 2 INPUT DATA

Steel Pipe Diameter =	16 inches, nominal
Insulation Thickness=	2.50 inches of Mineral Wool (1.50 inches nominal)
Coat & Wrap Conduit	
Diameter of Conduit=	24.00 inches
Coating Thickness=	.25 inches
Depth of Burial=	60 inches
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Temperature of Fluid=	360 F
Pipe Center to Center Spacing =	28.000 inches

SOIL DATA

Soil Temperature=	45 F
Soil Conductivity=	13.00 BTU/hr-F-ft^2

SYSTEM DATA OUTPUT

Struct. 1 Heat Trans. Fact.	(KP1) =	0.4 BTU/hr-F-ft
Struct. 2 Heat Trans. Fact.	(KP2) =	0.43 BTU/hr-F-ft
Fluid 1 Equiv. Temperature	(TP1) =	360 F
Fluid 2 Equiv. Temperature	(TP2) =	360 F
Struct. 1 Heat Loss	(Q1) =	118.50 BTU/hr-ft
Struct. 2 Heat Loss	(Q2) =	136.30 BTU/hr-ft
Total System Heat Loss	(QT) =	254.80 BTU/hr-ft

‡Perma-Pipe, Inc.

PIPELINE SERVICES HEAT LOSS SURVEY REPORT

HEAT LOSS CALCULATIONS

Prepared By: James F Harley
Date: 05-31-1996 Order No. PLS-3014
Job Name: Fort Drum, IR SurveyCity,ST : Watertown, NY
Location: MH #27 to MH #37
Calculation Procedure 2

STRUCTURE 1 INPUT DATA

Steel Pipe Diameter =	14 inches, nominal
Insulation Thickness=	2.50 inches of Mineral Wool (2.00inches nominal)
Coat & Wrap Conduit	
Diameter of Conduit=	22.000 inches
Coating Thickness=	.25 inches
Depth of Burial=	60 inches
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

STRUCTURE 2 INPUT DATA

Steel Pipe Diameter =	14 inches, nominal
Insulation Thickness=	2.00 inches of Mineral Wool (1.50 inches nominal)
Coat & Wrap Conduit	
Diameter of Conduit=	20.00 inches
Coating Thickness=	.25 inches
Depth of Burial=	61 inches
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Temperature of Fluid=	360 F
Pipe Center to Center Spacing =	25.000 inches

SOIL DATA

Soil Temperature=	45 F
Soil Conductivity=	13.00 BTU/hr-F-ft^2

SYSTEM DATA OUTPUT

Struct. 1 Heat Trans. Fact.	(KP1) =	0.4 BTU/hr-F-ft
Struct. 2 Heat Trans. Fact.	(KP2) =	0.45 BTU/hr-F-ft
Fluid 1 Equiv. Temperature	(TP1) =	360 F
Fluid 2 Equiv. Temperature	(TP2) =	360 F
Struct. 1 Heat Loss	(Q1) =	119.90 BTU/hr-ft
Struct. 2 Heat Loss	(Q2) =	140.70 BTU/hr-ft
Total System Heat Loss	(QT) =	260.60 BTU/hr-ft

‡Perma-Pipe, Inc.
PIPELINE SERVICES HEAT LOSS SURVEY REPORT

HEAT LOSS CALCULATIONS

Prepared By: James F Harley
Date: 05-31-1996 Order No. PLS-3014
Job Name: Fort Drum, IR SurveyCity, ST : Watertown, NY
Location: MH #76 to MH #77
Calculation Procedure 3
STRUCTURE 1 INPUT DATA

Pipe 1

Steel Pipe Diameter =	4 inches, nominal
Insulation Thickness=	2.56 inches of Mineral Wool (2.00 inches nominal)
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

Pipe 2

Steel Pipe Diameter =	4 inches, nominal
Insulation Thickness=	1.56 inches of Mineral Wool (1.00 inches nominal)
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

Coat & Wrap Conduit

Diameter of Conduit=	19.00 inches
Coating Thickness=	.25 inches
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Depth of Burial=	60 inches

SOIL DATA

Soil Temperature=	45 F
Soil Conductivity=	%13 BTU/hr-F-ft^2

SYSTEM DATA OUTPUT

Pipe 1 Heat Trans. Fact.	(KP1) =	0.2 BTU/hr-F-ft
Pipe 2 Heat Trans. Fact.	(KP2) =	0.23 BTU/hr-F-ft
Fluid 1 Equiv. Temperature	(TP1) =	360 F
Fluid 2 Equiv. Temperature	(TP2) =	360 F
Pipe 1 Heat Loss	(Q1) =	51.60 BTU/hr-ft
Pipe 2 Heat Loss	(Q2) =	72.80 BTU/hr-ft
Total System Heat Loss	(QT) =	124.40 BTU/hr-ft

‡Perma-Pipe, Inc.
PIPELINE SERVICES HEAT LOSS SURVEY REPORT

HEAT LOSS CALCULATIONS

Prepared By: James F Harley
Date: 05-31-1996 Order No. PLS-3014
Job Name: Fort Drum, IR SurveyCity,ST : Watertown, NY
Location: MH #41 to MH #46
Calculation Procedure 2

STRUCTURE 1 INPUT DATA

Steel Pipe Diameter =	8 inches, nominal
Insulation Thickness=	2.69 inches of Mineral Wool (2.00inches nominal)
Coat & Wrap Conduit	
Diameter of Conduit=	16.000 inches
Coating Thickness=	.25 inches
Depth of Burial=	60 inches
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

STRUCTURE 2 INPUT DATA

Steel Pipe Diameter =	8 inches, nominal
Insulation Thickness=	2.06 inches of Mineral Wool (1.50 inches nominal)
Coat & Wrap Conduit	
Diameter of Conduit=	14.00 inches
Coating Thickness=	.25 inches
Depth of Burial=	61 inches
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Temperature of Fluid=	360 F
Pipe Center to Center Spacing =	19.000 inches

SOIL DATA

Soil Temperature=	45 F
Soil Conductivity=	13.00 BTU/hr-F-ft^2

SYSTEM DATA OUTPUT

Struct. 1 Heat Trans. Fact.	(KP1)=	0.3 BTU/hr-F-ft
Struct. 2 Heat Trans. Fact.	(KP2)=	0.31 BTU/hr-F-ft
Fluid 1 Equiv. Temperature	(TP1)=	360 F
Fluid 2 Equiv. Temperature	(TP2)=	360 F
Struct. 1 Heat Loss	(Q1)=	81.20 BTU/hr-ft
Struct. 2 Heat Loss	(Q2)=	97.50 BTU/hr-ft
Total System Heat Loss	(QT)=	178.70 BTU/hr-ft

‡Perma-Pipe, Inc.
PIPELINE SERVICES HEAT LOSS SURVEY REPORT

HEAT LOSS CALCULATIONS

Prepared By: James F Harley
Date: 05-31-1996 Order No. PLS-3014
Job Name: Fort Drum, IR SurveyCity,ST : Watertown, NY
Location: MH #46 to MH #47
Calculation Procedure 2

STRUCTURE 1 INPUT DATA

Steel Pipe Diameter =	8 inches, nominal
Insulation Thickness=	2.69 inches of Mineral Wool (2.00inches nominal)
Coat & Wrap Conduit	
Diameter of Conduit=	16.000 inches
Coating Thickness=	.25 inches
Depth of Burial=	120 inches
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

STRUCTURE 2 INPUT DATA

Steel Pipe Diameter =	8 inches, nominal
Insulation Thickness=	2.06 inches of Mineral Wool (1.50 inches nominal)
Coat & Wrap Conduit	
Diameter of Conduit=	14.00 inches
Coating Thickness=	.25 inches
Depth of Burial=	121 inches
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Temperature of Fluid=	360 F
Pipe Center to Center Spacing =	19.000 inches

SOIL DATA

Soil Temperature=	45 F
Soil Conductivity=	13.00 BTU/hr-F-ft^2

SYSTEM DATA OUTPUT

Struct. 1 Heat Trans. Fact.	(KP1)=	0.2 BTU/hr-F-ft
Struct. 2 Heat Trans. Fact.	(KP2)=	0.29 BTU/hr-F-ft
Fluid 1 Equiv. Temperature	(TP1)=	360 F
Fluid 2 Equiv. Temperature	(TP2)=	360 F
Struct. 1 Heat Loss	(Q1)=	76.80 BTU/hr-ft
Struct. 2 Heat Loss	(Q2)=	92.20 BTU/hr-ft
Total System Heat Loss	(QT)=	169.00 BTU/hr-ft

‡Perma-Pipe, Inc.
PIPELINE SERVICES HEAT LOSS SURVEY REPORT

HEAT LOSS CALCULATIONS

Prepared By: James F Harley
Date: 05-31-1996 Order No. PLS-3014
Job Name: Fort Drum, IR SurveyCity,ST : Watertown, NY
Location: HWMH #1 to HWMH #2
Calculation Procedure 3
STRUCTURE 1 INPUT DATA

Pipe 1
- Steel Pipe Diameter = 2 inches, nominal
- Insulation Thickness= 2.12 inches of Mineral Wool (1.50 inches nominal)
- Insulation Conductivity= 0.31 BTU/hr-F-ft^2
- Temperature of Fluid= 360 F

Pipe 2
- Steel Pipe Diameter = 2 inches, nominal
- Insulation Thickness= 1.59 inches of Mineral Wool (1.00 inches nominal)
- Insulation Conductivity= 0.31 BTU/hr-F-ft^2
- Temperature of Fluid= 360 F

Coat & Wrap Conduit
- Diameter of Conduit= 14.00 inches
- Coating Thickness= .25 inches
- Coating Conductivity= 1.20 BTU/hr-F-ft^2
- Depth of Burial= 60 inches

SOIL DATA
- Soil Temperature= 45 F
- Soil Conductivity= %13 BTU/hr-F-ft^2

SYSTEM DATA OUTPUT

Pipe 1 Heat Trans. Fact.	(KP1)=	0.1 BTU/hr-F-ft
Pipe 2 Heat Trans. Fact.	(KP2)=	0.15 BTU/hr-F-ft
Fluid 1 Equiv. Temperature	(TP1)=	360 F
Fluid 2 Equiv. Temperature	(TP2)=	360 F
Pipe 1 Heat Loss	(Q1)=	40.40 BTU/hr-ft
Pipe 2 Heat Loss	(Q2)=	48.10 BTU/hr-ft
Total System Heat Loss	(QT)=	88.50 BTU/hr-ft

‡Perma-Pipe, Inc.
PIPELINE SERVICES HEAT LOSS SURVEY REPORT

HEAT LOSS CALCULATIONS

Prepared By: James F Harley
Date: 05-31-1996 Order No. PLS-3014
Job Name: Fort Drum, IR SurveyCity,ST : Watertown, NY
Location: MH #54 to Bldg 10270
Calculation Procedure 3
STRUCTURE 1 INPUT DATA

Pipe 1

Steel Pipe Diameter =	2 inches, nominal
Insulation Thickness=	2.12 inches of Mineral Wool (1.50 inches nominal)
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

Pipe 2

Steel Pipe Diameter =	2 inches, nominal
Insulation Thickness=	1.59 inches of Mineral Wool (1.00 inches nominal)
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

Coat & Wrap Conduit

Diameter of Conduit=	14.00 inches
Coating Thickness=	.25 inches
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Depth of Burial=	60 inches

SOIL DATA

Soil Temperature=	45 F
Soil Conductivity=	%13 BTU/hr-F-ft^2

SYSTEM DATA OUTPUT

Pipe 1 Heat Trans. Fact.	(KP1) =	0.1 BTU/hr-F-ft
Pipe 2 Heat Trans. Fact.	(KP2) =	0.15 BTU/hr-F-ft
Fluid 1 Equiv. Temperature	(TP1) =	360 F
Fluid 2 Equiv. Temperature	(TP2) =	360 F
Pipe 1 Heat Loss	(Q1) =	40.40 BTU/hr-ft
Pipe 2 Heat Loss	(Q2) =	48.10 BTU/hr-ft
Total System Heat Loss	(QT) =	88.50 BTU/hr-ft

‡Perma-Pipe, Inc.
PIPELINE SERVICES HEAT LOSS SURVEY REPORT

HEAT LOSS CALCULATIONS

Prepared By: James F Harley
Date: 05-31-1996 Order No. PLS-3014
Job Name: Fort Drum, IR SurveyCity,ST : Watertown, NY
Location: HWMH #2 to Bldg # 10511
Calculation Procedure 3
STRUCTURE 1 INPUT DATA

Pipe 1

Steel Pipe Diameter =	1.5 inches, nominal
Insulation Thickness=	2.36 inches of Mineral Wool (1.50 inches nominal)
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

Pipe 2

Steel Pipe Diameter =	1.5 inches, nominal
Insulation Thickness=	1.55 inches of Mineral Wool (1.00 inches nominal)
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

Coat & Wrap Conduit

Diameter of Conduit=	14.00 inches
Coating Thickness=	.25 inches
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Depth of Burial=	60 inches

SOIL DATA

Soil Temperature=	45 F
Soil Conductivity=	%13 BTU/hr-F-ft^2

SYSTEM DATA OUTPUT

Pipe 1 Heat Trans. Fact.	(KP1)=	0.1 BTU/hr-F-ft
Pipe 2 Heat Trans. Fact.	(KP2)=	0.14 BTU/hr-F-ft
Fluid 1 Equiv. Temperature	(TP1)=	360 F
Fluid 2 Equiv. Temperature	(TP2)=	360 F
Pipe 1 Heat Loss	(Q1)=	34.10 BTU/hr-ft
Pipe 2 Heat Loss	(Q2)=	43.30 BTU/hr-ft
Total System Heat Loss	(QT)=	77.40 BTU/hr-ft

‡Perma-Pipe, Inc.
PIPELINE SERVICES HEAT LOSS SURVEY REPORT

HEAT LOSS CALCULATIONS

Prepared By: James F Harley
Date: 05-31-1996 Order No. PLS-3014
Job Name: Fort Drum, IR SurveyCity,ST : Watertown, NY
Location: MH #58 to Bldg P-10000
Calculation Procedure 3
STRUCTURE 1 INPUT DATA

Pipe 1

Steel Pipe Diameter =	3 inches, nominal
Insulation Thickness=	2.06 inches of Mineral Wool (1.50 inches nominal)
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

Pipe 2

Steel Pipe Diameter =	3 inches, nominal
Insulation Thickness=	1.56 inches of Mineral Wool (1.00 inches nominal)
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

Coat & Wrap Conduit

Diameter of Conduit=	16.00 inches
Coating Thickness=	.25 inches
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Depth of Burial=	60 inches

SOIL DATA

Soil Temperature=	45 F
Soil Conductivity=	%13 BTU/hr-F-ft^2

SYSTEM DATA OUTPUT

Pipe 1 Heat Trans. Fact.	(KP1)=	0.2 BTU/hr-F-ft
Pipe 2 Heat Trans. Fact.	(KP2)=	0.19 BTU/hr-F-ft
Fluid 1 Equiv. Temperature	(TP1)=	360 F
Fluid 2 Equiv. Temperature	(TP2)=	360 F
Pipe 1 Heat Loss	(Q1)=	50.80 BTU/hr-ft
Pipe 2 Heat Loss	(Q2)=	61.20 BTU/hr-ft
Total System Heat Loss	(QT)=	112.00 BTU/hr-ft

‡Perma-Pipe, Inc.
PIPELINE SERVICES HEAT LOSS SURVEY REPORT

HEAT LOSS CALCULATIONS

Prepared By: James F Harley
Date: 05-31-1996 Order No. PLS-3014
Job Name: Fort Drum, IR SurveyCity,ST : Watertown, NY
Location: MH B to Bldg 4320
Calculation Procedure 3
STRUCTURE 1 INPUT DATA

Pipe 1

Steel Pipe Diameter =	1.5 inches, nominal
Insulation Thickness=	2.36 inches of Mineral Wool (1.50 inches nominal)
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

Pipe 2

Steel Pipe Diameter =	1.5 inches, nominal
Insulation Thickness=	1.55 inches of Mineral Wool (1.00 inches nominal)
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

Coat & Wrap Conduit

Diameter of Conduit=	14.00 inches
Coating Thickness=	.25 inches
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Depth of Burial=	60 inches

SOIL DATA

Soil Temperature=	45 F
Soil Conductivity=	%13 BTU/hr-F-ft^2

SYSTEM DATA OUTPUT

Pipe 1 Heat Trans. Fact.	(KP1)=	0.1 BTU/hr-F-ft
Pipe 2 Heat Trans. Fact.	(KP2)=	0.14 BTU/hr-F-ft
Fluid 1 Equiv. Temperature	(TP1)=	360 F
Fluid 2 Equiv. Temperature	(TP2)=	360 F
Pipe 1 Heat Loss	(Q1)=	34.10 BTU/hr-ft
Pipe 2 Heat Loss	(Q2)=	43.30 BTU/hr-ft
Total System Heat Loss	(QT)=	77.40 BTU/hr-ft

‡Perma-Pipe, Inc.
PIPELINE SERVICES HEAT LOSS SURVEY REPORT

HEAT LOSS CALCULATIONS

Prepared By: James F Harley
Date: 05-31-1996 Order No. PLS-3014
Job Name: Fort Drum, IR SurveyCity,ST : Watertown, NY
Location: MH #67 TO MH #68
Calculation Procedure 3
STRUCTURE 1 INPUT DATA

Pipe 1

Steel Pipe Diameter =	6 inches, nominal
Insulation Thickness=	2.06 inches of Mineral Wool (1.50 inches nominal)
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

Pipe 2

Steel Pipe Diameter =	6 inches, nominal
Insulation Thickness=	1.50 inches of Mineral Wool (1.00 inches nominal)
Insulation Conductivity=	0.31 BTU/hr-F-ft^2
Temperature of Fluid=	360 F

Coat & Wrap Conduit

Diameter of Conduit=	24.00 inches
Coating Thickness=	.25 inches
Coating Conductivity=	1.20 BTU/hr-F-ft^2
Depth of Burial=	60 inches

SOIL DATA

Soil Temperature=	45 F
Soil Conductivity=	%13 BTU/hr-F-ft^2

SYSTEM DATA OUTPUT

Pipe 1 Heat Trans. Fact.	(KP1) =	0.2 BTU/hr-F-ft
Pipe 2 Heat Trans. Fact.	(KP2) =	0.30 BTU/hr-F-ft
Fluid 1 Equiv. Temperature	(TP1) =	360 F
Fluid 2 Equiv. Temperature	(TP2) =	360 F
Pipe 1 Heat Loss	(Q1) =	74.30 BTU/hr-ft
Pipe 2 Heat Loss	(Q2) =	94.80 BTU/hr-ft
Total System Heat Loss	(QT) =	169.10 BTU/hr-ft

PERMA-PIPE
Inspection Services

2571 Medina Road; Medina, Ohio 44256
(330) 725-3430 FAX (330) 725-3141

THERMAL DISTRIBUTION MAINTENANCE

PRODUCT DESCRIPTION

1. Terminology

a. Pipe: Used to describe the carrier of the heating medium.

b. Insulation: Thermal insulation that is placed on the carrier pipe.

c. Conduit: The 10 gauge coated, water-tight steel jacket that houses the pipe and insulation.

d. Dead Air Space: The air space between the outside surface of the insulation and the interior surface of the conduit.

e. Supports or Pipe Supports: Specially constructed pipe supports designed to keep the pipe and insulation centered inside the conduit. They are also designed to allow lateral movement of the pipe at elbows when the pipe expands or contracts.

f. End seal: A fully welded seal at the terminal end of the conduit where there is an anchor within five feet of a building or manhole entry.

g. Gland seal: A conduit seal that is welded to the conduit but not the pipe. The pipe is fitted with a water-tight packing gland to allow for longitudinal movement of the pipe through the seal where the pipe enters a building or manhole.

h. Prefabricated Manholes: Metal manholes prefabricated in a plant, shipped pre-piped ready to install.

2571 Medina Road; Medina, Ohio 44256
(330) 725-3430 FAX (330) 725-3141

PRIMARY CAUSES OF SYSTEM PROBLEMS

Water and Moisture

A. Causes corrosion

1. Accelerated corrosion is a result of moisture and elevated temperature.

2. Moisture source.

   * wet manholes,
   * flooded manholes,
   * leaks from valves, flanges and leaking manholes,
   * flooding from ground water after a storm,
   * flooding from melting snow during thaws,
   * water run-off from streets which carries de-icing salts during the winter months (this is the most corrosive form of water)

3. Elevated temperature of the manhole and moist atmosphere will cause accelerated corrosion of the metallic fittings and piping inside the manhole. The ends of the conduit are subject to the same corrosion from this atmosphere.

4. Water from flooded manholes can backup into the conduit if the drain plugs or vent plugs are not installed, or the vent risers are not raised above flood level.

5. When water enters the conduit interior the conduit components will corrode. In addition the insulation on the pipe becomes wet and reduces the thermal efficiency of the pipe. The decreased thermal efficiency increases the operating costs by increasing energy consumption to keep up with the heating demands of the buildings.

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MAINTENANCE:

A. Keep manholes dry

1. Maintain automatic sump pumps. The best way to insure that manholes do not flood is to maintain sump pumps. Sump pumps must be maintained to insure they work. Weak points are:

   * the electrical connections for the sump pumps inside the manhole. Elevated temperature and moist atmosphere causes oxidation of the electrical sockets and components if they are not water tight. The plugs must be inspected and kept clean to insure that the pumps will operate when the float switch is activated.

   * jamming of the float switch can cause a pump failure. The manhole should be maintained free of debris. Sumps should be inspected and cleaned. The sump pump float switch should be manually lifted to insure that the pump will operate. Faulty sump pumps should be repaired immediately.

2. Inspect manholes for:

   * leaking valve packing and repair as required.

   * inspect for leaking flanges and repair as required.

   * inspect trap assemblies and repair as required.

   * inspect and repair damaged insulation to maintain the thermal efficiency of the manhole, and to reduce the possibility of loose insulation from falling into the manhole sump and jamming the sump pump.

3. Inspect terminal ends of conduit and interior of manhole for loss of coating.

   * coat the ends of the conduit each year with a high melting point bitumastic compound. If the conduit terminal ends are not coated they will corrode and require repair or replacement.

   * if conduit terminal ends are allowed to corrode and the manhole floods, water will backup into the conduit and cause internal corrosion of the conduit, external corrosion of the pipe and loss of thermal efficiency.

   * touch-up coating on the interior of the manhole to prevent corrosion of manhole components.

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BURIED PIPING

The thermal distribution system is buried in a protective conduit. The pipe and insulation are isolated from ground water by an outer jacket. The jacket is coated with a protective high temperature reinforced bitumastic compound. The coating is designed to protect the outer conduit from external corrosion. The pipe and insulation will remain dry and thermally efficient as long as the integrity of the outer conduit is maintained. This includes the end seals and gland seals inside the manholes. Under normal undisturbed conditions, the outer conduit is designed to last for a minimum of 25 to 30 years.

Like any mechanical device the system is subject to damage from external forces, mechanical damage and neglect which can result in reduced service life. Some of the causes are corroded end seals and open conduit vent and plugs that allow water from flooded manholes to backup into the conduit. Other possibilities include:

* Mechanical damage from digging operations.
* Tree and shrubbery planting.
* Accelerated corrosion due to chemical attack.

WARNING SIGNS

An obvious warning sign is steam venting from conduit vent pipes. The second is water flowing from the conduit drain openings.

DETERMINING THE SOURCE OF THE WATER

There are certain procedures that should be followed to determine the source of the water and what action should be taken to make repairs.

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OBSERVATIONS

Steam venting from the conduit vent pipes will offer some clue as to the source of the water in the conduit.

* Fast venting steam will generally be a result of a pipe leak inside the conduit. This is mostly true when the vent at each end of the conduit is steaming at a high rate.

* Slow venting and intermittent venting of steam from the conduit vents generally are a result of an underground conduit leak or water entering the conduit from flooded manholes.

METHOD FOR LOCATING THE SOURCE

These procedures are:

* Obtaining a water sample from the conduit drain. The sample should be obtained from the low end of the run of piping. The sample should be stored in a clean glass container that has been rinsed with distilled water and allowed to air dry.

* Test the water for chemical treatment normally used in the corrosion prevention treatment. Test kits should be available in the boiler plant. The same test used to determine the level of chemical treatment can be used to test the water sample from the conduit.

INTERPRETATION

If the water sample contains chemical treatment, the cause of the steam venting is from a leak in the carrier pipe. If the water tests negative for chemical treatment, ground water is the cause for the venting steam.

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CORRECTIVE ACTION

PIPE LEAK

Infrared thermography, when properly applied and used with the proper tools and experience, can be applied to accurately locate leaks in buried thermal distribution piping.

When a pipe leak is suspected, infrared thermography is the only viable tool for locating. The technology must be applied by persons who have experience in the field and are familiar with thermal distribution systems. The technology to identify and classify thermal losses using specially designed computer software can and is being used in the location of buried pipe leaks.

Buried thermal distribution systems lose energy to the surrounding soil at a rate that is determined by the thermal efficiency of the insulation and by the various components that make-up the system. When these parameters are known, they can be compared to measured thermal losses obtained from a thermographic survey to determine if the noted thermal losses might be due to a pipe leak. Once all data is gathered and calculations completed, interpretation becomes fairly accurate for determining the location of the pipe leak. This method replaces the older method of Center Dig.

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CONDUIT LEAK

Locating a leak in buried conduit is more difficult than locating a pipe leak. A systematic approach would be:

1. Inspect conduit terminal ends for:

    * open vent or drain plugs,

    * corroded seals,

    * damaged gland seals or gland seals that need packing,

    * flooding from high water that may have entered through the vent or corroded end seal,

    * check construction records for any recent digging operation that may have been conducted where the conduit could have been damaged,

    * walk the line and look for recently disturbed soil where digging operations may have been performed or recently planted trees or shrubbery, or new signs installed.

2. Pressure test the conduit using a compressor. The conduit plugs must be installed and tight. Gland seal packing must be tight. Ends seals must be repaired where they have corroded through.

    The conduit is pressurized to a maximum 5 psig. The end seals, gland seals, conduit plugs and pressure fittings should be soap tested during the pressure test. Repairs must be made to insure an accurate test.

    If the conduit fails to hold an air test, a Tracer Gas Survey is recommended to locate the breech in the conduit wall.

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TRACER GAS SURVEY

A tracer gas survey is conducted to locate leaks in buried piping where the normal product can be replaced with a traceable gas. The most common application is for locating leaks in the protective jacket or conduit on thermal distribution systems.

The procedure for performing the survey is as follows:

A traceable gas is inserted into the pipe and pressurized to 5 psig. Normally the gas will escape from the holes in the buried pipe and surface over the leak area. A technician walks over the route of the piping using a detector that is sensitive to the gas. The leak is located by identifying the area of highest concentration of gas.

There are many factors that influence the accuracy of the test. However, using an experienced firm for testing will result in accurate leak locations with limited excavations.

Perma-Pipe, Inc.
Inspection Services

2571 Medina Road; Medina, Ohio 44256
(330) 725-3430 FAX (330) 725-3141

INTRODUCTION

A Tracer Gas Survey is conducted to locate leaks in buried piping where a traceable gas can be injected into the pipe. The gas used is P-10 (95% Nitrogen and 5% Methane) non-explosive, non-polluting type gas. The equipment used is a Detecto-Pak II Flame Ionization Gas Leak Detector.

Prior to injecting the gas into the pipe, holes are drilled approximately every 10 feet over the route of the pipe. These holes will allow the gas to escape to surface. A pre-survey is then conducted to check for natural gas in the soil. The gas is then injected into the pipe. The gas will escape from the breech in the pipe and surface over the leak area. With the Detecto-Pak, the technician then walks over the length of the line stopping at the pre-drilled holes to sample the atmosphere for escaping gas. The leak is located by identifying the area with the highest concentration of gas.

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Inspection Services

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REPORT OF SURVEY

On August 6th, 7th , and 8th, 1996, a Tracer Gas Survey was performed for Fort Drum 10th Mountain Division, Ft. Drum, New York. The runs of pipe tested consisted of:

1. Piping between HTWMH #26 and HTWMH #27 supply conduit.
2. Piping between HTWMH #41 and HTWMH #46 supply conduit.
3. Piping between HTWMH #7 and underground connection at property line of the Heating Plant supply conduit.

The survey was conducted by a Perma-Pipe Inspection Services technician using a Detecto-Pak II Flame Ionization Gas Leak Detector.

An air test was also conducted on the supply line going from manhole #58 to Building P-10,000.

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ANALYSIS OF TRACER GAS SURVEY

Piping between HTWMH #41 and HTWMH #46 supply conduit:

The conduit terminal end in manhole 41 is in poor condition. The vent connection on the conduit is corroded and a 12" piece of copper tubing attached to a hose was inserted into the conduit vent to insert the gas. The vent plug in manhole 46 is also corroded and the same application was used to vent the gas to the surface.

Once the connections were made the gas was injected into the conduit. While waiting for gas to arrive at the venting end of the conduit, steam and moisture rushed out of the vent hose indicating that the interior of the conduit is wet.

Once gas was detected coming from the vent hose the valve hose was closed and the line was walked several times with the Detecto-Pak Flame Ionization unit. Three areas of gas were detected.

1. Inside manhole # 41
2. Directly outside of manhole # 41
3. First expansion loop outside of manhole # 41

The dimensions and amounts of gas detected can be located report sketch No. 1.

Piping between HTWMH #26 and HTWMH #27 supply conduit:

The conduit terminal ends in manhole #26 and #27 appear to be in good condition. Proper connections were made to insert, and vent the traceable gas. Three areas of gas were detected during the survey.

1. Inside manhole #26
2. First expansion loop outside of manhole #26
3. 441' from the intersection of Memorial Drive and Second Street.

The gas found inside manhole #26 may be coming from a fitting. The gas was being inserted from the goose neck vent outside of the manhole. An air test will determine this. The dimensions and amounts of gas detected are located on report sketch No. 2.

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Piping between HTWMH #7 and underground connection at property line of the Heating Plant supply conduit:

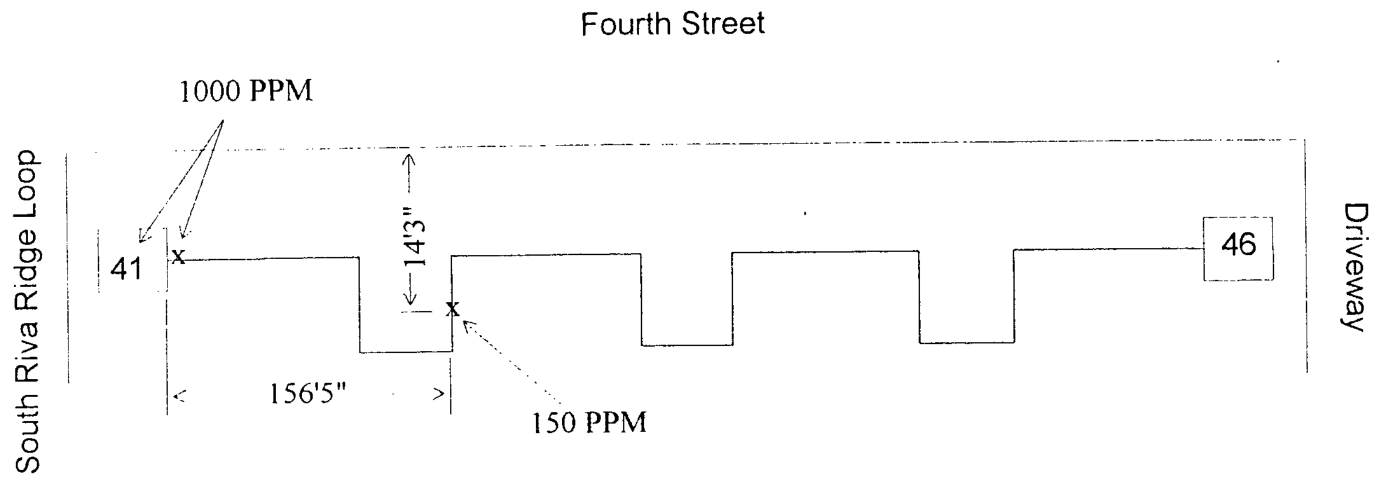
The conduit in manhole # 7 appears to be in good condition and proper connections were made to the conduit and the goose neck vent at the property line. Two areas of gas were located during the survey.

1. At the property line where the conduit begins.
2. 45'5" from manhole #7

Dimensions and amounts of gas detected are located on report sketch No. 3.

Air Test:

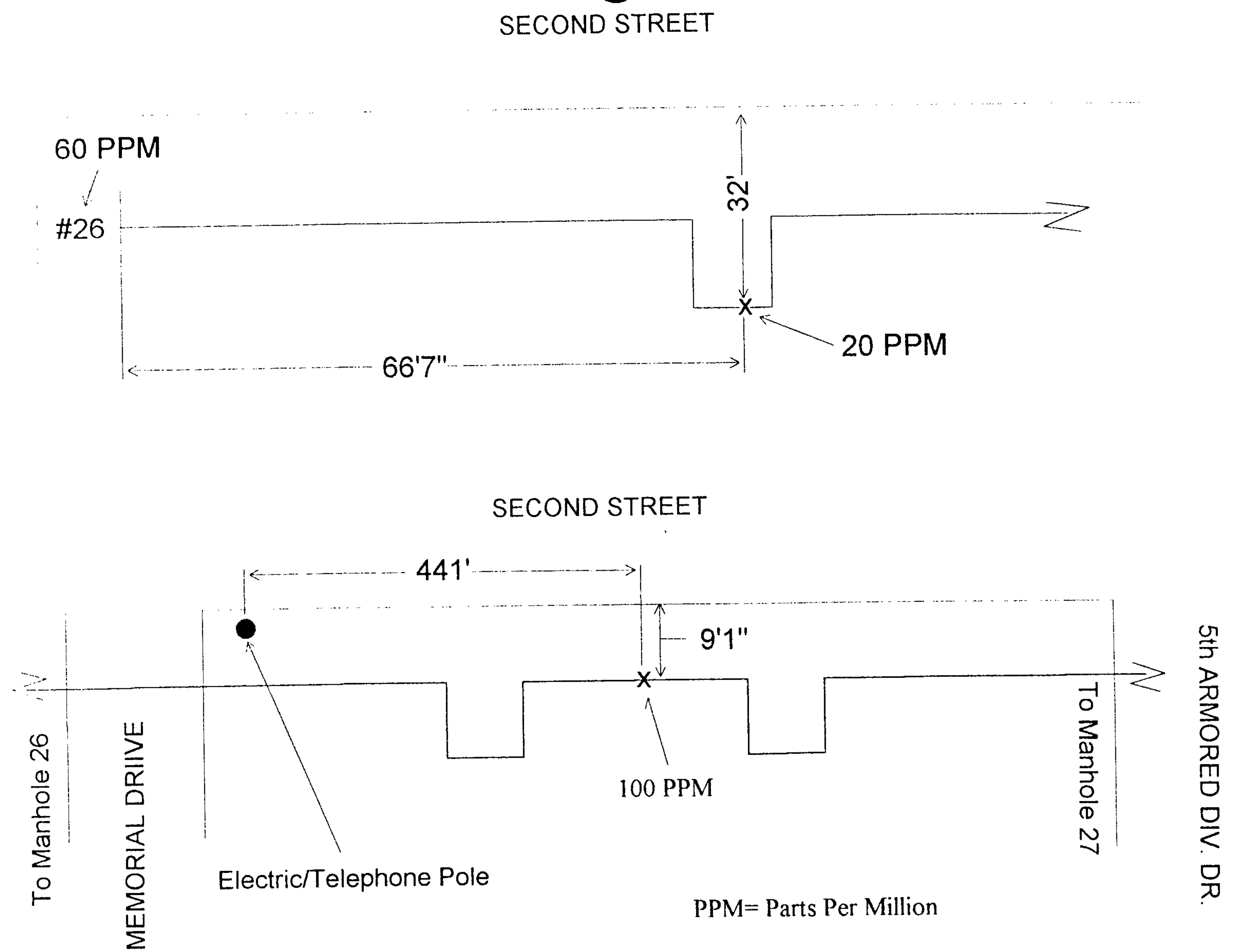
An air test was conducted on the supply line going from manhole #58 to Building P-10,000. Six PSI was placed into the conduit. The pressure dropped 1 PSI every 15 minutes. There was no indication of air escaping from the conduit in the manhole.



PPM= Parts Per Million

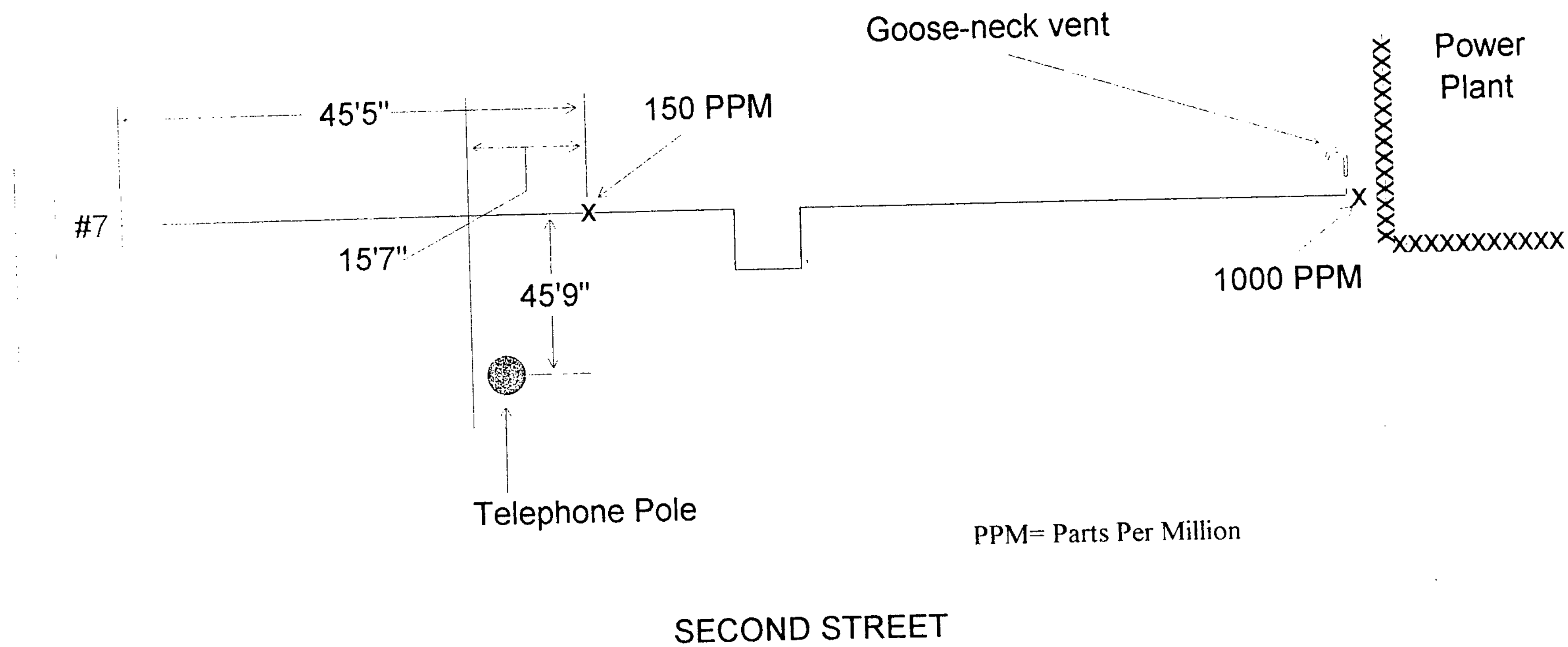
Report Sketch No. 1

Ft. Drum 10th Mountain Division
Ft. Drum, New York
Tracer Gas Survey PLS-3014
August 6, 1996



Report Sketch No. 2

Ft. Drum 10th Mountain Division
Ft. Drum, NY
Tracer Gas Survey PLS-3014
August 7, 1996



Ft. Drum 10th Mountain Division
Ft. Drum, New York
Tracer Gas Survey PLS-3014
August 8, 1996

Report Sketch No. 3

APPENDIX A

SCOPE OF WORK

MODIFICATION NO. 1
TO
Delivery Order No. 0013
CONTRACT NO. DACA01-94-D-0033
High Temperature Hot Water Distribution System Study
FORT DRUM, NY

STATEMENT OF REVISIONS

APPENDIX A
DETAILED SCOPE OF WORK
Paragraph 4. Completion and Payment Schedule

1. **Replace:**
"4. Completion and Payment Schedule: The following schedule shall be used as a guide in approving payments on this contract. The Contracting Officer's Representative (COR) will be Mr. Bryant Wilkins at the Norfolk District, COE

Interm Submittal	135 Calendar Days after Notice to Proceed
Pre-Final Submittal	150 Calendar Days after Notice to Proceed
Final Submittal	180 Calendar Days after Notice to Proceed"

With:
"4. Completion and Payment Schedule: The following schedule shall be used as a guide in approving payments on this contract. The Contracting Officer's Representative (COR) will be Mr. Bryant Wilkins at the Norfolk District, COE

Interm Submittal	150 Calendar Days after Notice to Proceed
Pre-Final Submittal	310 Calendar Days after Notice to Proceed
Final Submittal	385 Calendar Days after Notice to Proceed"

2. **Paragraph 9.1**

a. **Delete: (from INVESTIGATION OF EXISTING CONDITIONS)**
" Energy bills and summaries"

b. **Delete: (from INVESTIGATION OF EXISTING CONDITIONS)**
" Heating Load Profiles"

c. **Replace: (in INVESTIGATION OF EXISTING CONDITIONS)**
" Site Visits, Inspections. The AE shall perform a site survey of the existing High Temperature Hot Water System and perform a through survey using state of the art underground leak detection equipment such as infrared and tracer gas on piping 6 inch diameter and larger to determine existing conditions and areas of containment system degradation.. The AE shall also obtain a copy of any prior infrared surveys."

With:

" Site Visits, Inspections. The AE shall perform a site survey of the existing High Temperature Hot Water System and perform a through survey using state of the art underground leak detection equipment such as infrared and tracer gas on all piping to determine existing conditions and areas of containment system degradation.. The AE shall also obtain a copy of any prior infrared surveys."

d. Delete: (from INVESTIGATION OF EXISTING CONDITIONS)

" Nameplate data will be collected as well as observations of arrangements, physical condition and effectiveness. The following measurements will be normally collected:

Temperature levels at supply and return points
Electrical loads, voltage, amperage, kVA, and P.F.
High Temperature Hot Water flow rates
Schedules (where possible)
Dimensions"

e. Add: (at end of section INVESTIGATIONS OF EXISTING CONDITIONS)

"The AE shall take high resolution video tapess of the inside condition of 125 manholes as follows. Access to the manholes shall be provided by the AE. The original and one copy of the video tapes will bew provided to the Fort Drum DPW."

Steel Manholes Number:
8, 9, 10, 12, 19, 20, 21, 22, 24, 25, 26, 67, 68, 69, 70, 71, 74, 76, 77, 78, 79, 86.
Concrete Manholes Number:
3, 4, 6, 7, 27, 28, 29, 30, 31, 32, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 46, 47, 50, 51, 52, 53, 54, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 72, 73, 75, 82, 84, 85, 87, 88, 89, 90, 92.
Service Manholes Number:
10-A, 10-B, 4-1, 4-2, 4-3, 4-4, 20-1, 20-2, 21-3, 21-4, 21-7, 22-5, 22-6, 31-1, 31-2, 32-1, 32-2, 43-4, 42-3, 40-1, 40-2, 38-3, 38-4, 39-5, 64-5, 64-6, 87-3, 87-4, 87-7, 66-1, 66-2, 76-1, 76-2, 76-3, 46-1, 52-A, 52-1, 52-2, 73-B, 73-C, 51-3, 51-4, 51-5, 50-6, 50-7, 59-A, 61-6, 61-7, 62-3, 62-4, 62-5, 63-1, 63-2, 74-A

f. Replace: (from ANALYSIS OF SYSTEMS)

"The AE shall estimate the cost of modifications to correct the continuing deterioration of the HTHW containment system and the cost to repair existing deficiencies. The AE shall estimate energy savings and perform an LCCA for each modification considered."

With:

"The AE shall estimate the cost to repair existing deficiencies. The AE shall estimate energy savings and perform an LCCA for each modification considered."

f. Delete: (from ANALYSIS OF SYSTEMS)

"The energy savings resulting from these projects will include reduced pumping costs, water treatment costs, annual repair costs where piping is replaced or isolated, and any other savings resulting from reduced water consumption."

g. Delete: (from ANALYSIS OF SYSTEMS)
"The AE shall review information collected during the field survey to evaluate modifications currently being made to the cathodic protection system to determine if the modifications will eliminate the HTHW containment system deterioration. The AE shall also evaluate potential modifications which will correct existing HTHW containment system deficiencies."

h. Delete: (from ANALYSIS OF SYSTEMS)
" The analysis will also consider High Temperature Hot Water loads that are expected to increase or reduce in the future due to changes in facility use, change of mission, new additions, etc.

Other Miscellaneous Uses and Losses. The study will also consider costs and energy usage related to other High Temperature Hot Water usage not discussed above. Each miscellaneous use may include leaks, overheating, etc.

Utility Rate Analysis. A separate calculation will be performed for each type of energy conserved - gas, oil, and electric. The incremental cost of fuel will be used for all energy savings options."

h. Replace: (from ENERGY CONSERVATION OPPORTUNITY INVESTIGATIONS)

The Contractor will investigate all reasonable options of saving energy and energy-related costs in the operation of the High Temperature Hot Water production and distribution systems. The approach used to identify each option is briefly described below.

With:

The Contractor will investigate all areas of containment system degradation in the High Temperature Hot Water distribution systems. The approach used to identify each option is briefly described below.

h. Replace: (from REPORT PREPARATION PHASE)

<u>Facility Description - Section 3.</u> The report will briefly discuss the buildings and systems covered by the study. It will show floor plans, layout flow diagrams, facility age and condition, major equipment characteristics by system, hours of operation, and concerns expressed by occupants and managers.

<u>Energy Use and Costs - Section 4.</u> The report will describe individual and combined energy consumption for the past two years. The report will describe rate structures, incremental cost calculations, trends, and analysis of use by source. This section critically establishes baseline use of energy for later improvement possibilities.

With:

Facility Description - Section 3. The report will briefly discuss the systems covered by the study. It will show plans, layout flow diagrams, facility age and condition, operation, and concerns expressed by occupants and managers.

Energy Use and Costs - Section 4. The report will describe energy consumption and losses.. This section critically establishes baseline use of energy for later improvement possibilities.

APPENDIX D
HIGH TEMPERATURE HOT WATER ECOS

1. **Delete:**
" Prevention of further degradation of the HTHW distribution system.

2. **Delete:**
" Examination of ongoing cathodic protection program

3. **Delete:**
" Facilities which currently or will potentially utilize the High Temperature Hot Water"

APPENDIX A
DETAILED SCOPE OF WORK,
FY95 HIGH TEMPERATURE HOT WATER CONSERVATION STUDY
FORT DRUM, NEW YORK

1. All facilities to be investigated in this Study are located at Fort Drum, New York

2. The General Scope of Work outlines requirements for the Study and the Report; and the detailed scope of work lists the specific areas to be studied. If any conflicts arise between the General and the Detailed scopes of work, the Detailed Scope of Work shall govern.

3. The work consists of identifying and evaluating energy conservation opportunities (ECOs) for post wide High Temperature Hot Water System. A list of suggested ECOs is provided in APPENDIX D, HIGH TEMPERATURE HOT WATER SYSTEM ECOS. The ECOS in APPENDIX D, are to be evaluated as applicable for the area or facilities listed in APPENDIX D, LIST OF AREAS/FACILITIES TO BE STUDIED.

~~4. Completion and Payment Schedule: The following schedule shall be used as a guide in approving payments on this contract. The Contracting Officer's Representative (COR) will be Mr. Bryant Wilkins at the Norfolk District, COE~~

~~Interm Submittal~~	~~135 Calendar Days after Notice to Proceed~~
~~Pre-Final Submittal~~	~~150 Calendar Days after Notice to Proceed~~
~~Final Submittal~~	~~180 Calendar Days after Notice to Proceed~~

4. Completion and Payment Schedule: The following schedule shall be used as a guide in approving payments on this contract. The Contracting Officer's Representative (COR) will be Mr. Bryant Wilkins at the Norfolk District, COE

Interim Submittal	150 Calendar Days after Notice to Proceed
Pre-Final Submittal	310 Calendar Days after Notice to Proceed
Final Submittal	385 Calendar Days after Notice to Proceed

MILESTONE	PERCENT OF CONTRACT AMOUNT AUTHORIZED FOR PAYMENT
Entry Interview	10
Completion of Field Work	50
Receipt of Interim Submittal	75
Completion of Interim Presentation & Review	85
Receipt of Final Submittal	100

5. The installation representative for this contract will be Mr. Joe Ogiba Utilities Branch, Directorate of Public Works , FORT DRUM, New York. (315) 772-3322 FAX (315) 772-9613.

6. Government Furnished Information: The following documents are available for the use of the AE.

- As built drawings (as available) of buildings/systems
- Architectural and Engineering Instructions, Design Criteria, dated 9 December 1991, Revised 8 July 1992.
- TM5-785 Engineering Weather Data.
- AR5-4, Change No.1, dated 1 August 1982, Department of the Army Productivity Improvement Program.
- Energy Conservation Investment Program (ECIP) Guidance, dated 10 January 1994.
- AR415-15, dated 1 January 1994, Military Construction, Army (MCA) Program Development.
- Tri-Service Military Construction Program (MCP) Index, dated February 1991 for Cost Estimating

7. Direct Distribution of Submittals: The AE shall make direct distribution of correspondence, minutes, report submittals, and responses to comments as indicated by the following schedule:

AGENCY	CORRESPONDENCE	EXECUTIVE SUMMARIES	REPORTS	FIELD NOTES
Commander 10th Mountain Division (LI) and Ft. Drum 85 First Street West Fort Drum, NY 13603-5097 Attn: AFZS-EH-OM, Mr. Joe Ogiba	1	3	3	1*
Commander U. S. Army Engineer District, Norfolk ATTN: CENAO-EN-MP (Mr Mlecik) 803 Front Street Norfolk, VA 23510	1	3	3	1*
Commander USAED, North Atlantic ATTN: CENAD-EN-MM (Mr Wong) 90 Church Street New York, NY 10007	-	1	1	-

Commander USAED, Mobile ATTN: CESAM-EN-DM (Battaglia) PO Box 2288; Mobile, AL 36628-0001	1	1	1	-
Commander US Army Corps of Engineers ATTN: CEMP-ET (Mr Gentil) 20 Massachusetts Avenue NW Washington, DC, 20314 - 1000	-	1 (Final Only)	-	-
Headquarters, Forces Command Attn: FCEN-RDF, Mr. Naresh Kapur Energy Office, Building 200 Ft. McPherson, GA 30330-6000	-	1 (Final Only)	-	-

* Field Notes submitted in final form at interim submittal.

Progress reports will be prepared on a monthly basis to highlight the significant events of the prior month. This is especially true of actions completed, problems discovered, schedule changes and ECO developments. The progress reports will accompany monthly billings and will form the basis for progress meetings.

8. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977 or (800) 842-5278.

9. METHOD

9.1 INVESTIGATION OF EXISTING CONDITIONS

The Contractor will collect information on the existing High Temperature Hot Water system (approximately 40 miles of conduit containing 80 miles of pipe) and operations so as to have a reasonable understanding of operations, costs, energy use, problems, limitations, future needs, etc. This will be accomplished in the following steps.

<u>Data Gathering.</u> The Contractor will collect available data that will assist in energy use evaluations and recommendations. A partial list of data that will be sought are:

— ~~Energy bills and summaries~~

Prior studies and energy reports (if any)
Schedules
Piping drawings
Site plans
~~Maintenance records~~
Copies of other drawings needed
Proposals from vendors or contractors
~~Heating load profiles~~
~~High Temperature Hot Water plant operator logs~~
~~Temperature histories~~

~~Site Visits, Inspections. The AE shall perform a site survey of the existing High Temperature Hot Water System and perform a through survey using state of the art underground leak detection equipment such as infrared and tracer gas on piping 6 inch diameter and larger to determine existing conditions and areas of containment system degradation.. The AE shall also obtain a copy of any prior infrared surveys.~~

" Site Visits, Inspections. The AE shall perform a site survey of the existing High Temperature Hot Water System and perform a through survey using state of the art underground leak detection equipment such as infrared and tracer gas on all piping to determine existing conditions and areas of containment system degradation.. The AE shall also obtain a copy of any prior infrared surveys."

The AE shall confer with DPW personnel to determine operating conditions and planned projects which affect the system.

~~Nameplate data will be collected as well as observations of arrangements, physical condition and effectiveness. The following measurements will be normally collected:~~

~~Temperature levels at supply and return points~~
~~Electrical loads, voltage, amperage, kVA, and P.F.~~
~~High Temperature Hot Water flow rates~~
~~Schedules (where possible)~~
~~Dimensions~~

Photographs will be taken of key areas for later reference.

The AE shall take high resolution ~~video tapes~~ COLOR PHOTOGRAPHS of the inside condition of 125 manholes as follows. Access to the manholes shall be provided by the AE. The original and one copy of the ~~video tapes~~ PHOTOGRAPHS will bew provided to the Fort Drum DPW

Steel Manholes Number:
8, 9, 10, 12, 19, 20, 21, 22, 24, 25, 26, 67, 68, 69, 70, 71, 74, 76, 77, 78, 79, 86.
Concrete Manholes Number:
3, 4, 6, 7, 27, 28, 29, 30, 31, 32, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 46, 47, 50, 51, 52, 53, 54, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 72, 73, 75, 82, 84, 85, 87, 88, 89, 90, 92.

Service Manholes Number:
10-A, 10-B, 4-1, 4-2, 4-3, 4-4, 20-1, 20-2, 21-3, 21-4, 21-7, 22-5, 22-6, 31-1, 31-2, 32-1, 32-2, 43-4, 42-3, 40-1, 40-2, 38-3, 38-4, 39-5, 64-5, 64-6, 87-3, 87-4, 87-7, 66-1, 66-2, 76-1, 76-2, 76-3, 46-1, 52-A, 52-1, 52-2, 73-B, 73-C, 51-3, 51-4, 51-5, 50-6, 50-7, 59-A, 61-6, 61-7, 62-3, 62-4, 62-5, 63-1, 63-2, 74-A

ANALYSIS OF SYSTEMS

The Contractor will utilize standard methods of engineering calculations to understand current energy consumption in such detail as to permit identification of further improvement options.

HIGH TEMPERATURE HOT WATER SURVEY

Process water system maps for Fort Drum shall be developed showing the location and estimated flow of the leaks. The resulting maps shall be compared with Fort Drum's current mission, and a decision shall be made by Fort Drum DPW whether to repair, replace or isolate faulty piping sections. The Contractor shall confer with Fort Drum DPW and agree upon projects to develop for the water piping upgrades. ~~The energy savings resulting from these projects will include reduced pumping costs, water treatment costs, annual repair costs where piping is replaced or isolated, and any other savings resulting from reduced water consumption.~~

~~The AE shall review information collected during the field survey to evaluate modifications currently being made to the cathodic protection system to determine if the modifications will eliminate the HTHW containment system deterioration. The AE shall also evaluate potential modifications which will correct existing HTHW containment system deficiencies.~~

~~The AE shall estimate the cost of modifications to correct the continuing deterioration of the HTHW containment system and the cost to repair existing deficiencies. The AE shall estimate energy savings and perform an LCCA for each modification considered.~~

"The AE shall estimate the cost to repair existing deficiencies. The AE shall estimate energy savings and perform an LCCA for each modification considered."

~~The analysis will also consider High Temperature Hot Water loads that are~~ expected ~~to increase or reduce in the future due to changes in facility use, change of mission, new additions, etc.~~

~~Other Miscellaneous Uses and Losses. The study will also consider costs and energy usage related to other High Temperature Hot Water usage not discussed above. Each miscellaneous use may include leaks, overheating, etc.~~

~~Utility Rate Analysis. A separate calculation will be performed for each type of energy conserved - gas, oil, and electric. The incremental cost of fuel will be used for all energy savings options.~~

ENERGY CONSERVATION OPPORTUNITY INVESTIGATIONS

~~The Contractor will investigate all reasonable options of saving energy and energy-related costs in the operation of the High Temperature Hot Water production and distribution systems. The approach used to identify each option is briefly described below.~~

The Contractor will investigate all areas of containment system degradation in the High Temperature Hot Water distribution systems. The approach used to identify each option is briefly described below.

Existing Conditions. This section describes the nature of the existing operating system, its energy use, costs, advantages and disadvantages. Data is usually transferred to this section from the calculations.

Energy Conservation Opportunities. This section describes improvement ideas that are different from the existing conditions. They may describe a capital projects, modifications, or O&M procedures. The resulting improvements are described, energy costs, quantities and arrangements are briefly noted. Sufficient conceptual studies will be executed to determine feasibility, generate anticipated operational data and estimating values.

Construction Cost Estimate. A feasibility cost estimate in the format prescribed will be performed. The estimate breakdown will be included in the report showing known quantities and costs. Allowances for indirect costs and contingencies are included.

Annual Savings. The report will show the annual savings in energy, quantities, demand, costs, and BTU's. As the report is written, these savings are merely the difference between existing and proposed.

Discussion. This section of the report describes a number of relevant factors including payback period, impact on labor or non-energy costs, O&M concerns, appearances, comfort, life extension, etc. The intent of this section is to address normal impacts or uncertainties of various improvement ideas.

REPORT PREPARATION PHASE

The Contractor will prepare an Energy Analysis report which will fully document the steps previously described. The report will be prepared as follows.

Executive Summary - Section 1. The outline of the executive section is shown on Appendix B.

Methodology - Section 2. This part of the report describes the approach, sequence, assumptions, calculations methods, computer programs, sample outputs, etc. that were used for the study.

~~Facility Description - Section 3. The report will briefly discuss the buildings and systems covered by the study. It will show floor plans, layout flow diagrams, facility age and condition, major equipment characteristics by system, hours of operation, and concerns expressed by occupants and managers.~~

~~Energy Use and Costs - Section 4. The report will describe individual and combined energy consumption for the past two years. The report will describe rate structures, incremental cost calculations, trends, and analysis of use by source. This section critically establishes baseline use of energy for later improvement possibilities.~~

Facility Description - Section 3. The report will briefly discuss the systems covered by the study. It will show plans, layout flow diagrams, facility age and condition, operation, and concerns expressed by occupants and managers.

Energy Use and Costs - Section 4. The report will describe energy consumption and losses.. This section critically establishes baseline use of energy for later improvement possibilities.

ECOs Recommended - Section 5. This section describes in detail each of the Energy Conservation Opportunities (ECOs) that are recommended for adoption and funding. The approach to each ECO write-up is described in Section 5, Project Documentation

ECOs Not Recommended - Section 6. The report will also show ECOs that were investigated but not recommended for adoption due to economics, conflicts, with other ECOs or concerns of operations.

Discussion - Section 7. This part of the report will cover interesting findings of the study not related to other sections of the report. It may include recommendations for non-energy problems, further studies, O&M procedures, training, etc.

Attachments. As part of the report, there will be enclosures for photos, backup calculations, referenced materials such as rate tariffs, codes, etc.

Applications and Funding Requests. As part of this study, applications for project funding will be made in accordance with Section 5, Project Documentation and directions from local authorized persons. The exact level of funding and funding program (expected to be ECIP), will be at the direction of the facility manager.

Suggested Implementation Schedules. The report will also contain a suggested timetable for implementing various projects or programs. This recommendation will be made in consultation with various facility managers.

Operation and Maintenance Instructions. Where appropriate, the study will recommend the formation of procedures or changes to processes that relate to improved energy usage and costs through Operation and Maintenance.

APPENDIX B
EXECUTIVE SUMMARY GUIDELINE,

1. Introduction.

2. Building Data (types, number of similar buildings, sizes etc.)

3. Present Energy Consumption of Buildings or Systems Studied.

- Total Annual Energy Used.
- Source Energy Consumption.
  Electricity KWH, Dollars, BTU
  Fuel Oil GALS, Dollars, BTU
  Natural Gas THERMS, Dollars, BTU
  Propane GALS, Dollars, BTU
  Other QTY, Dollars, BTU

4. Reevaluated Projects Results.

5. Energy Conservation Analysis.

- ECOs Investigated.
- ECOs Recommended.
- ECOs Rejected. (Provide economics or reasons)
- ECIP Projects Developed. (Provide list)*
- Non-ECIP Projects Developed. (Provide list)*
- Operational or Policy Change Recommendations.

* Include the following data from the life cycle cost analysis summary sheet; the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple pay back period and the analysis date.

6. Energy and Cost Savings.

- Total Potential Energy and Cost Savings.
- Percentage of Energy Conserved.
- Energy Use and Cost Before and After the Energy Conservation opportunities are Implemented.

APPENDIX C,
REQUIRED FORM DD1391 DATA,

To facilitate ECIP project approval, the following supplemental data shall be provided:

1. In title block clearly identify projects as "ECIP."

2. Complete description of each item of work to be accomplished including quantity, square footage, etc.

3. A comprehensive list of buildings, zones, or areas including building numbers, square foot floor area, designated temporary or permanent, and usage (administration, patient treatment, etc.).

4. List references, and assumptions, and provide calculations to support dollar and energy savings, and indicate any added costs.

4.1. If a specific building, zone, or area is used for sample calculations, identify building, zone or area, category, orientation, square footage, floor area, window and wall area for each exposure.

4.2. Identify weather data source.

4.3. Identify infiltration assumptions before and after improvements

4.4. Include source of expertise and demonstrate savings claimed. Identify any special or critical environmental conditions such as pressure relationships, exhaust or outside air quantities, temperatures, humidity, etc.

5. Lighting retrofit projects must identify number and type of fixtures, and wattage of each fixture being deleted and installed. New lighting shall be only of the level to meet current criteria. Lamp changes in existing fixtures is not considered an ECIP type project.

6. An ECIP life cycle cost analysis summary sheet as shown in the ECIP Guidance shall be provided for the complete project and for each discrete part included in the project. The SIR is applicable to all segments of the project. Supporting documentation consisting of basic engineering and economic calculations showing how savings were determined shall be included.

7. The DD Form 1391 face sheet shall include, for the complete project, the annual dollar and MBTU savings, SIR, simple amortization period and a statement attesting that all buildings and retrofit actions will be in active use throughout the amortization period

8. The calendar year in which the cost was calculated shall be clearly shown on the DD Form 1391.

9. For each temporary building included in a project, separate documentation is required showing (1) a minimum 10 year continuing need, based on the

installation's annual real property utilization survey, for active building retention after retrofit,(2) the specific retrofit action applicable and (3) an economic analysis supporting the specific retrofit.

10. Non-appropriated funded facilities will not be included in an ECIP project without an accompanying statement certifying that utility costs are not reimbursable.

11. Any requirements required by ECIP guidance dated 10 Jan 1994 and any revisions thereto. Note that non-escalated costs and savings are to be used in the economic analyses.

12. The five digit category number for all ECIP projects except for Family Housing is 80000. The category code number for Family Housing projects is 71100.

APPENDIX D
HIGH TEMPERATURE HOT WATER ECOS

Energy Savings Opportunities include but are not necessarily limited to:

Replacement of failed elements of HTHW distribution system
Replacement of branches of the HTHW system
~~Prevention of further degradation of the HTHW distribution system.~~
~~Examination of ongoing cathodic protection program~~

LIST OF AREAS/FACILITIES TO BE STUDIED,

This study will include a thorough understanding of recommended improvements to the following:

High Temperature Hot Water Distribution system from the central plant to other buildings served by the system including piping, insulation, valves, controls, and associated structures.

~~Facilities which currently or will potentially utilize the High Temperature Hot Water~~

APPENDIX B

LIFE CYCLE COST ANALYSIS FOR ECIP

AND DD 1391 FORM

ARMY 96 23 Aug 1996

Fort Drum
New York

MAINT.REP
Repair HTHW Lines

822-20

PRIMARY FACILITY Repair High Temperature Hot Water (HTHW) and Cathodic Protection	LS	------	6200

ESTIMATED CONTRACT COST	(5520)
CONTINGENCY PERCENT (6.00%)	(331)
SUBTOTAL	(5851)
SUPERVISION,INSPECTION & OVERHEAD (6.00%)	(351)
TOTAL REQUEST	(6202)
TOTAL REQUEST (ROUNDED)	(6200)
ASSOCIATED CONSTRUCTION COST	(0)

Provide a Repair and Maintenance project to replace failed sections of underground HTHW line,repair leaking conduit of HTHW line ,layup of unneeded HTHW line, refurbish or repair 186 manholes, and repair the existing cathodic protection system

---

11. REQUIREMENT: N/A ADEQUATE: N/A SUBSTANDARD: N/A

PROJECT JUSTIFICATION:

This project is required to achieve a reliable HTHW service to the New Post. Utility,maintenance and future replacement costs will be reduced.Fort Drum has recently completed a complete survey of the HTHW system as part of the Energy Engineering Analysis Program (EEAP).The EEAP survey included infrared scanning,tracer gas testing and manhole inspection with photographs.The cathodic protection system was evaluated. The EEAP survey revealed a system with some immediate problem areas and identified future problem areas to address now so as to avoid major problems.From the study Fort Drum has developed 21 standalone projects that will bring the existing failing system into a reliable working system.If approved the projects can be obligated in FY-96 with construction completed in FY-97.The projects are as follows:

Description	Cost (000)
CATHODIC PROTECTION(SIR 70)	$ 80.3
JOB #3 MT BELVEDERE(SIR 3.14)	$ 1351.2
JOB #4 N RIVA RIDGE	$ 518.4
JOB #5 10600 AREA	$ 367.1
JOB #6 P-10000	$ 96.1
JOB #7 FIRE STATION	$ 108.6
JOB #8 P-10100	$ 166.6
JOB #9 2ND ST WEST	$ 324.8
JOB #10 BOWLING ALLEY	$ 324.5
JOB #11 GUTHRIE SERVICE	$ 145.1
JOB #12 MH40-1,P-10510	$ 24.7
JOB #13 JA JONES, MH 19	$ 396.6
JOB #14 10100 AREA	$ 219.6
JOB #15 10400 AREA CONDUIT	$ 203.9
JOB #16 MANHOLES 10200 AREA	$ 211.3
JOB #17 MANHOLES 4400 AREA	$ 289.0
JOB #18 MANHOLES 10400,10500	$ 205.7
JOB #19 MANHOLES 10600 AREAS	$ 178.5
JOB #20 MANHOLES 10100/11000	$ 188.7
JOB #21 MANHOLES 10700 AREAS	$ 119.0
TOTAL	$ 5519.7

DECISION ANALYSIS:

An extensive investigation into alternate systems (such as natural gas)is not warranted. The cost of repair of the existing system is much lower than a new natural gas system (est cost $19.2 M) The existing HTHW distribution would not survive long enough to allow for the installation of an alternative system. The government has a long term commitment for a third party contract to provide HTHW service to the new post.Where energy savings have been calculated the results have been very favorable SIR's of 3.14 to 4.56.

CURRENT SITUATION:

The entire existing HTHW distribution system has been plagued with design and construction deficiencies since startup of the HTHW system in Oct 1988.After one year of service these deficiencies were outlined in a technical evaluation in Oct 1989. These deficiencies included flooded manholes,sump pumps not hooked up,leaking valves,contaminated HTHW water and no cathodic protection system. Since startup Fort Drum has attempted to address the initial deficiencies as well as keep up with routine maintenance. Much has been accomplished, however more work is required.The EEAP study revealed infiltration of ground water in to conduits,insulation is wet and manholes flooded.Conduit and carrier pipes are corroded.Manholes are in desperate need of repair.The cathodic protection system is not fully functional.

FUNDING STATEMENT:
This project will be OMA funded.Portions can be funded subject to availability of OMA funds.

IMPACT IF NOT PROVIDED:

If this project is not provided the sections of HTHW line identified in the 20 jobs/areas will eventually fail with loss of HTHW service to all 88 new post facilities.This would effectively shutdown all barracks,dining facilities,motorpools,clinics,HQ and specialty buildings on the new post.Two sections have already failed and four buildings are without heat or hot water.They are presently being repaired under emergency conditions.Fort Drum's Public works would be unable to fulfill it's mission to provide adequate facilities for the 10th Mountain Division.The Division's Readiness would be adversely affected, including the ability to train, maintain military equipment and deploy within short notice

ADDITIONAL:

Fort Drum is not ,being considered for closure or realignment.

THOMAS N.BURNETTE JR.
MAJOR GENERAL, USA
COMMANDING

ESTIMATED CONSTRUCTION START:	APRIL 1997	INDEX:
ESTIMATED MIDPOINT OF CONSTRUCTION:	AUGUST 1997	INDEX:
ESTIMATED CONSTRUCTION COMPLETION:	NOVEMBER 1997	INDEX:

LIFE CYCLE COST ANALYSIS SUMMARY

\#1 ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT DRUM BY:ROWLEY 4/27/96 REGION NO. 1
PROJECT NO. EG-00008-5J
PROJ. NAME: HTHW REPAIR FEMP-97
DISCRETE PORTION NAME: REPLACE FAILED SECTION MH 67-69
ECONOMIC LIFE: 20

1.	INVESTMENT COST		
A.	CONSTRUCTION COST	$	$863,800
B.	SIOH	$	$51,828
C.	DESIGN COST	$	$51,828
D.	TOTAL COST (1A+1B+1C)	$	$967,456
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	$	$0
F.	PUBLIC UTILITY COMPANY REBATE	$	$0
G.	TOTAL INVESTMENT (1D-1E-1F)	$	$967,456

2. ENERGY SAVINGS (+)/ COST(-):
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS : 10/95,FY-96

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(	ANNUAL $ SAVINGS(	DISCOUNT FACTOR TABLE Ba-1	DISCOUNTED SAVINGS(5)
A. ELEC	$ 18.16	13.02	$ 236	13.86	$ 3,277
B. DIST	$ 0.00	0	$ 0	0.00	$ 0
C. RESID	$ 0.00	0	$ 0	0.00	$ 0
D. NG	$ 0.00	0	$ 0	0.00	$ 0
E. PPG	$ 0.00	0	$ 0	0.00	$ 0
F. COAL	$ 0.00	0	$ 0	0.00	$ 0
G. SOLAR	$ 0.00	0	$ 0	0.00	$ 0
H. GEOTH	$ 0.00	0	$ 0	0.00	$ 0
I. BIOMA	$ 0.00	0	$ 0	0.00	$ 0
J. REFUS	$ 0.00	0	$ 0	0.00	$ 0
K. WIND	$ 0.00	0	$ 0	0.00	$ 0
L. HTHW	$ 4.41	50,965	$ #######	13.56	$ 3,047,657
M. DEMAND SAVINGS 6 KW			$ 41	13.86	$ 572
N. TOTAL		50,978	$ #######		$ 3,051,507

3. NON ENERGY SAVINGS (+) OR COST (-):
A. ANNUAL RECURRING (+/-) : $ 0
(1) DICOUNT FACTOR (TABLE A) 13.47
(2) DISCOUNTED SAVINGS/COST (3A X 3A1) $ 0

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3	DISCOUNTED SAVINGS(+) COST(-)(4)
a.	MANDATORY	$ 967,456	7	0.76	$ 730,429

b.	REPAIRS	$ 0	0	0.00	$	0
c.		$ 0	0	0.00	$	0
d.	TOTAL	$ 967,456			$	730,429

. TOTAL NON ENERGY DISCOUNTED SAVINGS $ 730,429

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bd1/ECONOMIC LIFE)): 3.54

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $ 3,781,936

6 SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 3.91

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 11.34%

HTHW FEMP-97 REPAIR
SCOPE OF WORK

DATA TAKEN FROM RICKWELL SURVEY AND REPORT, JUNE 1991
AND ENERGY ECONOMICS INC REPORT OF DEC 1995
ESTIMATES FROM PAST PROJECTS OF HTHW INSTALLATION AND REPAIR

DISTRIBUTION SECTION	WORK REQUIRED	UNIT or LENGTH	PER UNIT MBTU/YR /UNIT	ANNUAL SAVINGS MBTU/YR	PER UNIT $/UNIT	CONSTRUCTIO COST
FROM MANHOLES 67-69(6" LINE)	REPLACE LINE	2800 FT	10.7	29960	$293	$820,400
MANHOLES 3 STEEL	WALL SEAL, PAINT VALVING, PREV MAINT	3 EA	468.17	1405	$7,800	$23,400
3 MANHOLES 67,68,69	ELECTRICAL WORK	3 EA		0	$4,800	$14,400
ROM MANHOLES 10-17(4" LINE)	LAYUP	5600 FT	3.5	19600	$1	$5,600
		TOTAL SAVINGS MBTU >		50965	SUBTOTAL	863800
			CONSTRUCTION COST ESTIMATE			$863,800

ELECTRIC SAVINGS IS DUE TO THE REDUCED RUN TIME OF 3 SUMP PUMPS

NON RECURRING SAVINGS IS THE ASSUMPTION OF MANDATORY REPAIRS OCCURRING IN YEAR 7 DUE TO COMPLETE FAILURE IF THIS WORK IS NOT PERFORMED NOW.

#2 ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT DRUM BY:ROWLEY 4/27/96 REGION NO. 1
PROJECT NO. EG-00002-6J
PROJ. NAME: HTHW REPAIR FEMP-97
DISCRETE PORTION NAME: REPLACE FAILED SECTION MH40 TO MH40-2
ECONOMIC LIFE: 20

1.	INVESTMENT COST		
A.	CONSTRUCTION COST	$	$302,036
B.	SIOH	$	$18,122
C.	DESIGN COST	$	$18,122
D.	TOTAL COST (1A+1B+1C)	$	$338,280
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	$	$0
F.	PUBLIC UTILITY COMPANY REBATE	$	$0
G.	TOTAL INVESTMENT (1D-1E-1F)	$	$338,280

2. ENERGY SAVINGS (+)/ COST(-):
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS : 10/95,FY-96

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(	ANNUAL $ SAVINGS(	DISCOUNT FACTOR TABLE Ba-1	DISCOUNTED SAVINGS(5)
A. ELEC	$ 18.16	13.02	$ 236	13.86	$ 3,277
B. DIST	$ 0.00	0	$ 0	0.00	$ 0
C. RESID	$ 0.00	0	$ 0	0.00	$ 0
D. NG	$ 0.00	0	$ 0	0.00	$ 0
E. PPG	$ 0.00	0	$ 0	0.00	$ 0
F. COAL	$ 0.00	0	$ 0	0.00	$ 0
G. SOLAR	$ 0.00	0	$ 0	0.00	$ 0
H. GEOTH	$ 0.00	0	$ 0	0.00	$ 0
I. BIOMA	$ 0.00	0	$ 0	0.00	$ 0
J. REFUS	$ 0.00	0	$ 0	0.00	$ 0
K. WIND	$ 0.00	0	$ 0	0.00	$ 0
L. HTHW	$ 4.41	21,487	$ 94,756	13.56	$ 1,284,887
M. DEMAND SAVINGS 6 KW			$ 41	15.04	$ 621
N. TOTAL		21,500	$ 95,033		$ 1,288,785

3. NON ENERGY SAVINGS (+) OR COST (-):
A. ANNUAL RECURRING (+/-) : $ 0
(1) DICOUNT FACTOR (TABLE A) 13.47
(2) DISCOUNTED SAVINGS/COST (3A X 3A1) $ 0

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3	DISCOUNTED SAVINGS(+) COST(-)(4)
a.	MANDATORY	$ 338,280	7	0.76	$ 255,401
b.	REPAIRS	$ 0	0	0.00	$ 0

c.	$	0	0	0.00	$	0
d. TOTAL	$	338,280			$	255,401

C. TOTAL NON ENERGY DISCOUNTED SAVINGS $ 255,401

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bd1/ECONOMIC LIFE)): 3.02

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $ 1,544,186

6 SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 4.56

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 12.20%

HTHW FEMP-96 REPAIR
SCOPE OF WORK

DATA TAKEN FROM RICKWELL SURVEY AND REPORT, JUNE 1991
AND ENERGY ECONOMICS INC REPORT OF DEC 1995
ESTIMATES FROM PAST PROJECTS OF HTHW INSTALLATION AND REPAIR

DISTRIBUTION SECTION	WORK REQUIRED	UNIT or LENGTH	PER UNIT MBTU/YR /UNIT	ANNUAL SAVINGS MBTU/YR	PER UNIT $/UNIT	CONSTRUCTIO COST
FROM MANHOLES 77-83(3" LINE)	LAYUP	4000 FT	2.83	11320	$1	$4,000
FROM MANHOLES 40-40-2(2"LINE)	REPLACE LINE	1281 FT	6.84	8762	$206	$263,886
NEW MANHOLE #40-2	NEW CONCRETE MANHOLE	1 EA	468.17	468	$12,350	$12,350
REHAB MANHOLES 40,40-1	CONDUIT/WALL SEAL VALVING, PREV MAINT	2 EA	468.17	936	$10,900	$21,800
		TOTAL SAVINGS MBTU >		21487	SUBTOTAL	$302,036
			CONSTRUCTION COST ESTIMATE			$302,036

ELECTRIC SAVINGS IS DUE TO THE REDUCED RUN TIME OF 3 SUMP PUMPS

NON RECURRING SAVINGS IS THE ASSUMPTION OF MANDATORY REPAIRS OCCURRING IN YEAR 7 DUE TO COMPLETE FAILURE IF THIS WORK IS NOT PERFORMED NOW.

#3 LIFE CYCLE COST ANALYSIS SUMMARY

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT DRUM BY:ROWLEY 4/27/96 REGION NO. 1
PROJECT NO. EG-00007-5J
PROJ. NAME: HTHW REPAIR FEMP-97
DISCRETE PORTION NAME: REPAIR OF THE HEAT DISTRIBUTION SYSTEM(PART 1)
ECONOMIC LIFE: 20

1.	INVESTMENT COST		
A.	CONSTRUCTION COST	$	$639,077
B.	SIOH	$	$38,345
C.	DESIGN COST	$	$38,345
D.	TOTAL COST (1A+1B+1C)	$	$715,766
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	$	$0
F.	PUBLIC UTILITY COMPANY REBATE	$	$0
G.	TOTAL INVESTMENT (1D-1E-1F)	$	$715,766

2. ENERGY SAVINGS (+)/ COST(-):
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS : 10/95,FY-96

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(	ANNUAL $ SAVINGS(	DISCOUNT FACTOR TABLE Ba-1	DISCOUNTED SAVINGS(5)
A. ELEC	$ 18.16	251.72	$ 4,571	13.86	$ 63,357
B. DIST	$ 0.00	0	$ 0	0.00	$ 0
C. RESID	$ 0.00	0	$ 0	0.00	$ 0
D. NG	$ 0.00	0	$ 0	0.00	$ 0
E. PPG	$ 0.00	0	$ 0	0.00	$ 0
F. COAL	$ 0.00	0	$ 0	0.00	$ 0
G. SOLAR	$ 0.00	0	$ 0	0.00	$ 0
H. GEOTH	$ 0.00	0	$ 0	0.00	$ 0
I. BIOMA	$ 0.00	0	$ 0	0.00	$ 0
J. REFUS	$ 0.00	0	$ 0	0.00	$ 0
K. WIND	$ 0.00	0	$ 0	0.00	$ 0
L. HTHW	$ 4.41	31,315	$ #######	13.56	$ 1,872,637
M. DEMAND SAVINGS 116 KW			$ 798	13.86	$ 11,061
N. TOTAL		31,567	$ #######		$ 1,947,055

3. NON ENERGY SAVINGS (+) OR COST (-):
A. ANNUAL RECURRING (+/-) : $ 6,000
(1) DICOUNT FACTOR (TABLE A) 13.47
(2) DISCOUNTED SAVINGS/COST (3A X 3A1) $ 80,820

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3	DISCOUNTED SAVINGS(+) COST(-)(4)
a.	MANDATORY	$ 715,766	7	0.76	$ 540,403
b.	REPAIRS	$ 0	0	0.00	$ 0
c.		$ 0	0	0.00	$ 0
d.	TOTAL	$ 715,766			$ 540,403

C. TOTAL NON ENERGY DISCOUNTED SAVINGS $ 621,223

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bd1/ECONOMIC LIFE)): 3.86

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $ 2,568,278

6 SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 3.59

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 10.86%

HTHW FEMP-96 REPAIR
SCOPE OF WORK

DATA TAKEN FROM RICKWELL SURVEY AND REPORT, JUNE 1991
AND ENERGY ECONOMICS INC REPORT OF DEC 1995
ESTIMATES FROM PAST PROJECTS OF HTHW INSTALLATION AND REPAIR

DISTRIBUTION SECTION	WORK REQUIRED	UNIT or LENGTH	PER UNIT MBTU/YR /UNIT	ANNUAL SAVINGS MBTU/YR	PER UNIT $/UNIT	CONSTRUCTIO COST
FROM MANHOLES PLANT TO MH7	REPAIR CONDUIT	258 FT	3.91	1008	$19	$4,938
FROM MANHOLES MH7 TO MH8	REPAIR CONDUIT	120 FT	11.17	1341	$19	$2,297
FROM MANHOLES MH13 TO MH14	REPAIR CONDUIT	60 FT	1.24	75	$19	$1,148
FROM MANHOLES MH17 TO MH15	REPAIR CONDUIT	120 FT	3.48	418	$19	$2,297
FROM MANHOLES MH19 TO MH7	REPAIR CONDUIT	120 FT	3.20	384	$19	$2,297
MANHOLES 9 STEEL	WALL SEAL, PAINT VALVING, PREV MAINT	9 EA	468.17	4214	$7,800	$70,200
MANHOLES 51 CONCRETE	CONDUIT/WALL SEAL VALVING, PREV MAINT	51 EA	468.17	23877	$10,900	$555,900
		TOTAL SAVINGS MBTU >		31315	SUBTOTAL	$639,077
				CONSTRUCTION COST ESTIMATE		$639,077

NON ENERGY SAVINGS IS THE AVOIDED MATERIAL COST OF REPLACING 15 SUMP PUMPS EACH YEAR AT $400/PUMP

ELECTRIC SAVINGS IS DUE TO THE REDUCED RUN TIME OF 58 SUMP PUMPS

NON RECURRING SAVINGS IS THE ASSUMPTION OF MANDATORY REPAIRS

OCCURRING IN YEAR 7 DUE TO COMPLETE FAILURE IF THIS WORK IS NOT PERFORMED NOW.

#4 LIFE CYCLE COST ANALYSIS SUMMARY

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT DRUM BY:ROWLEY 4/27/96 REGION NO. 1
PROJECT NO. EG-00003-6J
PROJ. NAME: HTHW REPAIR FEMP 97
DISCRETE PORTION NAME: REPAIR OF THE HEAT DISTRIBUTION SYSTEM (PART 2)
ECONOMIC LIFE: 20

1. INVESTMENT COST

A.	CONSTRUCTION COST	$	$635,642
B.	SIOH	$	$38,138
C.	DESIGN COST	$	$38,138
D.	TOTAL COST (1A+1B+1C)	$	$711,919
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	$	$0
F.	PUBLIC UTILITY COMPANY REBATE	$	$0
G.	TOTAL INVESTMENT (1D-1E-1F)	$	$711,919

2. ENERGY SAVINGS (+)/ COST(-):
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS : 10/95,FY-96

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(	ANNUAL $ SAVINGS(	DISCOUNT FACTOR TABLE Ba-1	DISCOUNTED SAVINGS(5)
A. ELEC	$ 18.16	256.06	$ 4,650	13.86	$ 64,450
B. DIST	$ 0.00	0	$ 0	0.00	$ 0
C. RESID	$ 0.00	0	$ 0	0.00	$ 0
D. NG	$ 0.00	0	$ 0	0.00	$ 0
E. PPG	$ 0.00	0	$ 0	0.00	$ 0
F. COAL	$ 0.00	0	$ 0	0.00	$ 0
G. SOLAR	$ 0.00	0	$ 0	0.00	$ 0
H. GEOTH	$ 0.00	0	$ 0	0.00	$ 0
I. BIOMA	$ 0.00	0	$ 0	0.00	$ 0
J. REFUS	$ 0.00	0	$ 0	0.00	$ 0
K. WIND	$ 0.00	0	$ 0	0.00	$ 0
L. HTHW	$ 4.41	32,892	$ #######	13.56	$ 1,966,943
M. DEMAND SAVINGS 118 KW			$ 812	13.86	$ 11,251
N. TOTAL		33,148	$ #######		$ 2,042,644

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) :	$ 6,000		
(1) DICOUNT FACTOR (TABLE A)	13.47		
(2) DISCOUNTED SAVINGS/COST (3A X 3A1)		$	80,820

B. NON RECURRING SAVINGS (+) OR COST (-)

ITEM		SAVINGS(+) COST(-)(1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3		DISCOUNTED SAVINGS(+) COST(-)(4)
a. MANDATORY	$	711,919	7	0.76	$	537,499
b. REPAIRS	$	0	0	0.00	$	0
c.	$	0	0	0.00	$	0
d. TOTAL	$	711,919			$	537,499

C. TOTAL NON ENERGY DISCOUNTED SAVINGS $ 618,319

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bd1/ECONOMIC LIFE)): 3.71

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $ 2,660,963

6 SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 3.74

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 11.09%

HTHW FEMP-96 REPAIR
SCOPE OF WORK

DATA TAKEN FROM RICKWELL SURVEY AND REPORT,JUNE 1991
AND ENERGY ECONOMICS INC REPORT OF DEC 1995
ESTIMATES FROM PAST PROJECTS OF HTHW INSTALLATION AND REPAIR

DISTRIBUTION SECTION	WORK REQUIRED	UNIT or LENGTH	PER UNIT MBTU/YR /UNIT	ANNUAL SAVINGS MBTU/YR	PER UNIT $/UNIT	CONSTRUCTIO COST
FROM MANHOLES P-4350 TO MH26	REPAIR CONDUIT	490 FT	3.62	1773	$19	$9,379
FROM MANHOLES MH30 TO MH31	REPAIR CONDUIT	140 FT	2.81	394	$19	$2,680
FROM MANHOLES MH58 TO MH59	REPAIR CONDUIT	120 FT	2.47	297	$19	$2,297
FROM MANHOLES MH77 TO MH76	REPAIR CONDUIT	60 FT	0.76	45	$19	$1,148
FROM MANHOLES P-4530 TO MH6	REPAIR CONDUIT	258 FT	10.70	2761	$19	$4,938
MANHOLES 9 STEEL	WALL SEAL,PAINT VALVING,PREV MAINT	9 EA	468.17	4214	$7,800	$70,200
MANHOLES 50 CONCRETE	CONDUIT/WALL SEAL VALVING,PREV MAINT	50 EA	468.17	23409	$10,900	$545,000
		TOTAL SAVINGS MBTU >		32892	SUBTOTAL	$635,642
				CONSTRUCTION COST ESTIMATE		$635,642

NON ENERGY SAVINGS IS THE AVOIDED MATERIAL COST OF REPLACING 15 SUMP PUMPS EACH YEAR AT $400/PUMP

ELECTRIC SAVINGS IS DUE TO THE REDUCED RUN TIME OF 59 SUMP PUMPS

NON RECURRING SAVINGS IS THE ASSUMPTION OF MANDATORY REPAIRS OCCURRING IN YEAR 7 DUE TO COMPLETE FAILURE IF THIS

#5 LIFE CYCLE COST ANALYSIS SUMMARY

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT DRUM BY:ROWLEY 4/27/96 REGION NO. 1

PROJECT NO. EG-00001-6J

PROJ. NAME: HTHW REPAIR

DISCRETE PORTION NAME: REPAIR OF THE FT DRUM CATHODIC PROTECTION SYSTEM

ECONOMIC LIFE: 20

1.	INVESTMENT COST		
A.	CONSTRUCTION COST	$	$715,000
B.	SIOH	$	$42,900
C.	DESIGN COST	$	$42,900
D.	TOTAL COST (1A+1B+1C)	$	$800,800
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	$	$0
F.	PUBLIC UTILITY COMPANY REBATE	$	$0
G.	TOTAL INVESTMENT (1D-1E-1F)	$	$800,800

2. ENERGY SAVINGS (+)/ COST(-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS : 10/95,FY-96

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(	ANNUAL $ SAVINGS(	DISCOUNT FACTOR TABLE Ba-1	DISCOUNTED SAVINGS(5)
A. ELEC	$ 18.16	0.00	$ 0	13.86	$ 0
B. DIST	$ 0.00	0	$ 0	0.00	$ 0
C. RESID	$ 0.00	0	$ 0	0.00	$ 0
D. NG	$ 0.00	0	$ 0	0.00	$ 0
E. PPG	$ 0.00	0	$ 0	0.00	$ 0
F. COAL	$ 0.00	0	$ 0	0.00	$ 0
G. SOLAR	$ 0.00	0	$ 0	0.00	$ 0
H. GEOTH	$ 0.00	0	$ 0	0.00	$ 0
I. BIOMA	$ 0.00	0	$ 0	0.00	$ 0
J. REFUS	$ 0.00	0	$ 0	0.00	$ 0
K. WIND	$ 0.00	0	$ 0	0.00	$ 0
L. HTHW	$ 4.41	60,984	$ #######	18.16	$ 4,883,940
M. DEMAND SAVINGS			$ 0	15.04	$ 0
N. TOTAL		60,984	$ #######		$ 4,883,940

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) : $ 0

(1) DICOUNT FACTOR (TABLE A) 13.47

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) $ 0

B. NON RECURRING SAVINGS (+) OR COST (-)

ITEM		SAVINGS(+) COST(-)(1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3	DISCOUNTED SAVINGS(+) COST(-)(4)
a.		$ 0	0	0.00	$ 0
b.		$ 0	0	0.00	$ 0
c.		$ 0	0	0.00	$ 0
d.	TOTAL	$ 0			$ 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS $ 0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bd1/ECONOMIC LIFE)): 2.98

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $ 4,883,940

6 SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 6.10

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 13.84%

SCOPE OF WORK ESTIMATES FROM PAST PROJECTS OF HTHW INSTALLATION AND REPAIR

WORK REQUIRED	UNIT or LENGTH	PER UNIT MBTU/YR /UNIT	ANNUAL SAVINGS MBTU/YR	PER UNIT $/UNIT	CONSTRUCTIO COST
PER REPORT FROM EEI DEC 1995	17424 FT	3.50	60984		$715,000
	TOTAL SAVINGS MBTU >		60984	SUBTOTAL	$715,000
			CONSTRUCTION COST ESTIMATE		$715,000

CATHODIC PROTECTION PROJECTED ENERGY SAVINGS IS BASED ON THE ASSUMPTION OF HEAT LOSSES OF INEVITABLE CONDUIT FAILURE DUE TO THE LACK OF CORRISION PROTECTION

#6 LIFE CYCLE COST ANALYSIS SUMMARY

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT DRUM BY:ROWLEY 3/25/96 REGION NO. 1

PROJECT NO. EG-00006-J

PROJ. NAME: BARRACKS REPAIR PROGRAM

DISCRETE PORTION NAME: REPAIR OF THE HEAT DISTRIBUTION SYSTEM 2 AREAS

ECONOMIC LIFE: 20

1.	INVESTMENT COST		
A.	CONSTRUCTION COST	$	$1,590,588
B.	SIOH	$	$95,435
C.	DESIGN COST	$	$95,435
D.	TOTAL COST (1A+1B+1C)	$	$1,781,458
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	$	$0
F.	PUBLIC UTILITY COMPANY REBATE	$	$0
G.	TOTAL INVESTMENT (1D-1E-1F)	$	$1,781,458

2. ENERGY SAVINGS (+)/ COST(-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS : 10/95,FY-96

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(	ANNUAL $ SAVINGS(	DISCOUNT FACTOR TABLE Ba-1	DISCOUNTED SAVINGS(5)
A. ELEC	$ 21.15	95	$ 2,019	13.86	$ 27,989
B. DIST	$ 0.00	0	$ 0	0.00	$ 0
C. RESID	$ 0.00	0	$ 0	0.00	$ 0
D. NG	$ 0.00	0	$ 0	0.00	$ 0
E. PPG	$ 0.00	0	$ 0	0.00	$ 0
F. COAL	$ 0.00	0	$ 0	0.00	$ 0
G. SOLAR	$ 0.00	0	$ 0	0.00	$ 0
H. GEOTH	$ 0.00	0	$ 0	0.00	$ 0
I. BIOMA	$ 0.00	0	$ 0	0.00	$ 0
J. REFUS	$ 0.00	0	$ 0	0.00	$ 0
K. WIND	$ 0.00	0	$ 0	0.00	$ 0
L. HTHW	$ 4.38	34,200	$ #######	13.56	$ 2,031,220
M. DEMAND SAVINGS 6 KW			$ 303	13.86	$ 4,195
N. TOTAL		34,295	$ #######		$ 2,063,404

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) : $ 0

(1) DISCOUNT FACTOR (TABLE A) 13.47

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) $ 0

B. NON RECURRING SAVINGS (+) OR COST (-)

ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3	DISCOUNTED SAVINGS(+) COST(-)(4)
a.	$ 0	0	0.00	$ 0
b.	$ 0	0	0.00	$ 0
c.	$ 0	0	0.00	$ 0
d. TOTAL	$ 0			$ 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS $ 0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bd1/ECONOMIC LIFE)): 11.71

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $ 2,063,404

6 SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.16

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 4.77%

DATA TAKEN FROM RICKWELL SURVEY AND REPORT, JUNE 1991
AND ENERGY ECONOMICS INC REPORT OF DEC 1995
ESTIMATES FROM PAST PROJECTS OF HTHW INSTALLATION AND REPAIR

BARRACKS REPAIR PROGRAM
10500 AREA, 10600 AREA
SCOPE OF WORK

DISTRIBUTION SECTION	WORK REQUIRED	UNIT or LENGTH	PER UNIT MBTU/YR /UNIT	ANNUAL SAVINGS MBTU/YR	PER UNIT $/UNIT	CONSTRUCTIO COST
10500 AREA						
REHAB MANHOLES 10 MANHOLES	CONDUIT/WALL SEAL VALVING, PREV MAINT	10 EA	468.17	4682	$10,900	$109,000
10500 AREA	REPAIR CONDUIT 10" LI	525 FT	0.76	399	$19	$10,049
	REPAIR CONDUIT 8" LIN	1750 FT	0.76	1330	$19	$33,495
	REPAIR CONDUIT 2" LIN	570 FT	0.76	433	$19	$10,910
	REPAIR CONDUIT 1.5" L	263 FT	0.76	199	$19	$5,034
	REPAIR CONDUIT 3/4" L	263 FT	0.76	199	$19	$5,034
FROM MANHOLES 40-40-2(2"LINE)	REPLACE 2" LINE	1281 FT	6.84	8762	$206	$263,886
NEW MANHOLE	NEW CONCRETE	1 EA	468.17	468	$12,350	$12,350
#40-2	REPLACE LINE	1281 FT	6.84	8762	$206	$263,886
						10500 area
10600 AREA						
REHAB MANHOLES 10 MANHOLES	CONDUIT/WALL SEAL VALVING, PREV MAINT	10 EA	468.17	4682	$10,900	$109,000
10600 AREA	REPAIR CONDUIT 8" LIN	1925 FT	0.76	1463	$19	$36,845
	REPAIR CONDUIT 3" LIN	175 FT	2.83	495	$19	$3,350
	REPAIR CONDUIT 2.5" L	175 FT	0.76	133	$19	$3,350
	REPAIR CONDUIT 2" LIN	1225 FT	0.76	931	$19	$23,447
	REPAIR CONDUIT 1.5" L	788 FT	0.76	596	$19	$15,082
	REPAIR CONDUIT 3/4" L	262 FT	0.76	198	$19	$5,015
NEW MANHOLE	NEW CONCRETE	1 EA	468.17	468	$12,350	$12,350

#87-4

34200	M	TOTAL	$922,080
SIEBE	MARKUP 15%		##########
	MARKUP 50%		##########

ELECTRIC SAVINGS IS DUE TO THE REDUCED RUN TIME OF 22 SUMP PUMPS

APPENDIX C

HTHW DISTRIBUTION PIPING\
MANHOLE SITE PLAN

(Please see binder pocket)