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FINAL
TECHNICAL PLAN
VERSION 3.1

November 1987

TASK NO. 10
SEWERS AND PROCESS WATER SYSTEM INVESTIGATIONS

CONTRACT NO. DAAK11-84-D-0017

EBASCO SERVICES INCORPORATED
R.L. STOLLAR AND ASSOCIATES
CALIFORNIA ANALYTICAL LABORATORIES, INC.
UBTL INC. TECHNOS INC. GERAGHTY & MILLER, INC.

DAAK11-84-D-0017

PREPARED FOR

**PROGRAM MANAGER'S
OFFICE FOR
ROCKY MOUNTAIN ARSENAL CLEANUP**

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Rocky Mountain Arsenal Information Center Commerce City, Colorado

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THIS FINAL TECHNICAL PLAN DESCRIBES THE WORK THAT WILL BE UNDERTAKEN TO ASSESS THE CONTAMINATION ASSOCIATED WITH THE SANITARY SEWER SYSTEM, THE CHEMICAL SEWER SYSTEM, AND THE PROCESS WATER SYSTEM. THESE SYSTEMS ARE LOCATED WITHIN SEVERAL DIFFERENT AREAS ON RMA. THE AREAS ARE GENERALLY DEFINED AS SOUTH PLANTS, NORTH PLANTS, ADMINISTRATION, THE BASINS, AND THE RAIL CLASSIFICATION YARD. TASK 10 WILL FOCUS ON THE POTENTIAL OF THE THREE SYSTEMS TO BE A CONTAMINATION SOURCE AND A CONTAMINANT PATHWAY.

THE SPECIFIC OBJECTIVES OF TASK 10 ARE TO:

1. DETERMINE WHICH SEGMENTS OF THE SEWER SYSTEMS AND THE PROCESS WATER SYSTEM ARE CONTAMINATED
2. IDENTIFY LEAK LOCATIONS IN THE SYSTEMS
3. EVALUATE THE EXTENT OF SOIL CONTAMINATION RESULTING FROM THE LEAKS
4. PROVIDE LITIGATION SUPPORT TO APPORTION CLEANUP COSTS BETWEEN THE ARMY AND SHELL.

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ABBREVIATIONS

AA	Atomic Absorption
CAL	California Analytical Laboratories
CFR	Code of Federal Regulations
CIP	Cast Iron Pipe
CRZ	Contaminant Reduction Zone
DBCP	Dibromochloropropane
Ebasco	Ebasco Services Inc.
EPA	Environmental Protection Agency
ESE	Environmental Science and Engineering, Inc.
FIS	Facility Information Sheet
ft	Feet
g	Gram
gal	Gallon
GC/MS	Gas Chromatograph/Mass spectrometry
GFD	Geotechnical Field Drilling
gpm	Gallons Per Minute
HASP	Health and Safety Program
H&S	Health and Safety
ICP	Inductively-coupled Argon Plasma Spectroscopy
IR-DMS	Installation Restoration - Data Management Systems
MKE	Morrison-Knudsen Engineers
ml	Milliliter
MRI	Midwest Research Institute
MS	Mass Spectral
N	Normality, Normal
NBS	National Bureau of Standards
NIH	National Institute of Health
NIOSH	National Institute of Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PMO	Program Manager's Office for the RMA Contamination Cleanup
ppb	Parts Per Billion

ABBREVIATIONS (Continued)

PPLV	Preliminary Pollution Limit Values
psi	Pounds Per Square Inch
PWS	Process Water System
QA	Quality Assurance
QC	Quality Control
RMA	Rocky Mountain Arsenal
RT	Retention Time
Shell	Shell Chemical Company
SI	International Standard Units
UBTL	UBTL Incorporated
USAMBRDL	U.S. Army Medical Bioengineering Research and Development Laboratory
USATHAMA	U.S. Army Toxic and Hazardous Materiels Agency
UTM	Universal Transverse Mercator
VCP	Vitrified Clay Pipe
yd^3	Cubic Yards
ug	Microgram
"	Inch

1.0 INTRODUCTION

1.1 BACKGROUND

The Program Manager's Office for the Rocky Mountain Arsenal Contamination Cleanup (PMO), is overseeing efforts by two contractor teams to identify the nature and extent of contamination at selected sites on Rocky Mountain Arsenal (RMA). This technical plan describes the work that the contractor team headed by Ebasco Services Incorporated (Ebasco) will undertake to assess the contamination associated with the sanitary sewer system, the chemical sewer system, and the process water system located on RMA. These systems are located within and interconnect several different areas on RMA. The areas are generally defined as the South Plants area, North Plants area, Administration area, Basins area, and the Rail Classification Yard area. This work has been awarded as Task Order Number 10.

This plan is one of a series that has been, and will continue to be, proposed by Ebasco to describe its planned activities at RMA. Ebasco's Final Technical Plan for Task 2, South Plants, (Ebasco, 1985a) was the first of these plans and serves as a reference document for all plans subsequently generated. The South Plants Technical Plan contains detailed background information on the general contamination problems at RMA and for this reason is referenced by this Sewer System Investigation Technical Plan.

1.2 TECHNICAL APPROACH

The overall objective of Task 10 is to provide an assessment of the nature and extent of soil contamination that may have resulted from the use or misuse of the RMA sewer systems and the process water system. Ebasco will also gather technical evidence of litigation quality on the conditions of the sanitary and chemical sewers and the process water system.

The specific objectives of this task are to:

- Determine which segments of the sanitary sewer system, the chemical sewer system, and the process water system are contaminated;

- o Identify specific and generic leak locations in the three systems;
- o Evaluate the extent of soil contamination resulting from leaks in the system; and
- o Provide litigation support to apportion cleanup costs between the U.S. Army and Shell Chemical Company.

Ebasco will conduct a detailed literature and document review to determine which segments of the three systems are or have been contaminated. Sediment samples will be collected from those segments where data are insufficient to determine if these have been contaminated. For the purposes of this investigation, "contaminated" soil or sewer lines refers to the detection of target analytes above the respective detection limits.

The sewer systems and the process water system are not "typical" contamination sources because they represent what may be termed as "linearized intermittent point sources of contamination," i.e., leakage, if it occurred, would most likely have taken place at discrete joints or connections rather than along the entire length of the lines. It is also possible that the systems could have acted not only as contamination sources, but also as contamination sinks and transport pathways, thus further complicating the issue. Task 10 will focus on the potential for each system to be a contamination source and a contaminant pathway.

The relative inaccessibility of the buried pipelines and the potential for leaks to occur over the 37 miles of pipeline eliminate the practicality of locating all leaks in the systems short of excavating all of the pipelines. The approach Ebasco will use will be to determine leakage along pipeline sections which have been identified in the literature and document review as being prime candidates for excessive leakage. For pressure lines, leakage will be evaluated with hydrostatic testing. For gravity flow lines, leaks will be located by detecting exfiltration of a dye injected into a limited number of pipeline segments, and by chemical analysis for contaminants in soil samples collected from beneath preselected manholes. In order to maximize the potential for locating leaks and subsequently evaluating the extent of soil contamination, the field investigation program will use, to the extent possible, the existing literature that documents pipeline segments known to contain leaks.

For those areas where the groundwater is below the sewer line invert, contaminants that may have leaked from the two sewer systems and the process water system would have contaminated soil beneath and around the leak. The volume of contaminated soil associated with a "typical" leak will be established by chemical analysis of soil samples collected laterally and vertically from an identified leak.

The overall extent of soil contamination will be evaluated based on the results of the leak location investigations and the extent of contamination associated with typical leaks. This contamination assessment evaluation will be based on a "worst-case" scenario, as the field investigation program of this task is focused primarily on portions of the systems suspected to contain leaks and, therefore, to have caused soil contamination. This is opposed to the random selection of investigation sites which could have produced an unbiased indication of the general integrity of the three systems.

Morrison-Knudsen Engineers (MKE) is currently conducting a similar investigation on behalf of Shell Chemical Company (Shell). The Army has permitted Shell and MKE to take the lead in investigating sewers located in or around the South Plants area. Ebasco is acting in an oversight capacity during all phases of the MKE field activities, and Ebasco's field investigation has been very closely coordinated with the MKE field survey. Considerable information has been acquired while overseeing the MKE field survey to date.

MKE field activities include field reconnaissance of manholes, low pressure testing of several sanitary and chemical sewer lines, sampling of sludge from manholes (if possible), and limited excavations and soil sampling to accurately assess the present conditions of each system and surrounding soils.

Ebasco's field investigation will continue to be closely coordinated with the MKE sewer survey. This close coordination will also involve taking duplicate samples of any MKE soil samples removed from excavations. Chemical analysis for target analytes of soil samples collected from MKE excavations and from Ebasco field activities will be used to identify contamination sources as well as to identify the nature and concentration of contaminants.

2.0 EVALUATION OF BACKGROUND DATA

2.1 LITERATURE REVIEW

Prior to any field investigation, a thorough examination of all data pertaining to the systems on RMA will be conducted. Background data to be examined include original RMA engineering drawings, memoranda of previous investigations and results, Army-Shell correspondence regarding each system, interrogatories, depositions, and Shell maps and drawings. This background information will be used to provide a working knowledge, as complete as possible, of the construction, nature, use, and history of the systems in question. Particular attention will be paid to any records of system modifications and alterations and their relation to possible sources of contamination. Due to the large volume of documents that will be reviewed and due to disparities in the presentation of the data, a computerized database will be developed to manage this information.

Information on system modifications and their relation to possible sources of contamination will be combined with building profiles and manufacturing and spill histories to ascertain localized probabilities of contamination sources. This information will then be compiled into a series of base maps to be used as reference material for subsequent Task 10 field investigations. This information will also be added to each system database to permit its rapid review and evaluation.

2.2 INITIAL SITE RECONNAISSANCE

There are conflicting reports and ambiguities as to the present configuration of the sanitary sewer, chemical sewer, and process water systems on RMA. There is no single reference which illustrates all of the manholes, connections, or modifications known to exist. Additionally, Shell began operating an above-ground system in the South Plants area in 1982 and prior connections to the abandoned buried chemical sewer system in that area are not readily observable. The abandoned chemical sewer in the vicinity of source area 36-5, southwest of the lime settling basins will be investigated as much as is practicable if it has not already been removed.

Detailed field reconnaissance will be conducted to corroborate various sources of information. The locations of all system manholes, documented and otherwise, will be plotted on a base map incorporating field observations and background information. A physical inspection of manholes will accompany this initial reconnaissance if there is a need to answer questions regarding connections to other systems or connections within undocumented systems. Inspections of the systems will include documentation of the condition of all components of the sewer including the lid, apron, corbels, inverts, and any weirs or flumes. Where possible, photographs will be taken to illustrate conditions in support of this permanent field documentation. This work will, whenever possible, be coordinated with similar activities being carried out by MKE for Shell.

3.0 FIELD INVESTIGATION PROGRAM

3.1 INTRODUCTION

The purpose of the field investigation program will be to obtain data which will permit an assessment of the sources and migration of contamination associated with the sewer systems and the process water system at RMA. This program has been divided into several phases designed to address the various conditions and uses of the systems. Previous field investigations have provided significant information on limited portions of the various systems. The sanitary sewer system in the South Plants and in portions of the Administration, Basins, and North Plants areas has been thoroughly investigated as recently as 1980. There is considerable documentation as to the structural integrity, use, and history of the sanitary sewer system in these areas.

There are, however, several areas on RMA where the sewer systems have not been thoroughly investigated and little is known of the integrity and possible contamination associated with them. The sanitary sewer system in the Rail Classification Yard area is an example of an area where very little is known about the structural integrity, use, or history of that system.

This system-wide disparity in information requires that this field investigation program incorporate all available findings from previous investigations, as well as obtain data from areas where little is known about the sewer conditions.

The first phase of this field program will involve a reconnaissance of selected manholes on RMA to document their integrity and the potential for the escape of contaminant vapor emissions. This reconnaissance will also provide information on the materials of construction and alignment of the sewer systems.

A manhole sampling program will be the second phase of the field program. Soil will be collected from immediately beneath the manholes using auger boring techniques, and sediment samples will be collected from the interior of the selected manholes. This will aid in identifying sewer segments that have been contaminated and the extent of vertical migration of any leaked contaminants.

The third phase of this program will evaluate the integrity of portions of the various systems suspected to be leaking. This phase will consist of hydrostatic pressure testing of the process water distribution lines and the pressure discharge lines from the sewer lift stations.

The fourth phase will focus on evaluating the potential for contaminants to leak from typical sewer line joint connections and the extent of soil contamination associated with any leaks. An inert tracer dye will be placed in selected segments of the sewer lines. The soil surrounding these segments will be excavated and the presence of the tracer determined. Soil samples will be collected at the excavation sites and the presence of target contaminants determined. Soil samples will also be collected from excavations opened by MKE on behalf of Shell.

Geophysical surveys will be conducted, where appropriate, to aid in clearing sites to be excavated or drilled where underground utilities may be present, but these surveys will generally not prove useful in locating sewers. There are no reliable geophysical methods for detecting vitrified clay pipe (VCP), the predominant type of sewer line on RMA, or other nonferrous pipes.

The field sampling programs will include a health and safety survey to assess the sampling team's exposure to potential hazards during excavating, drilling, and sampling.

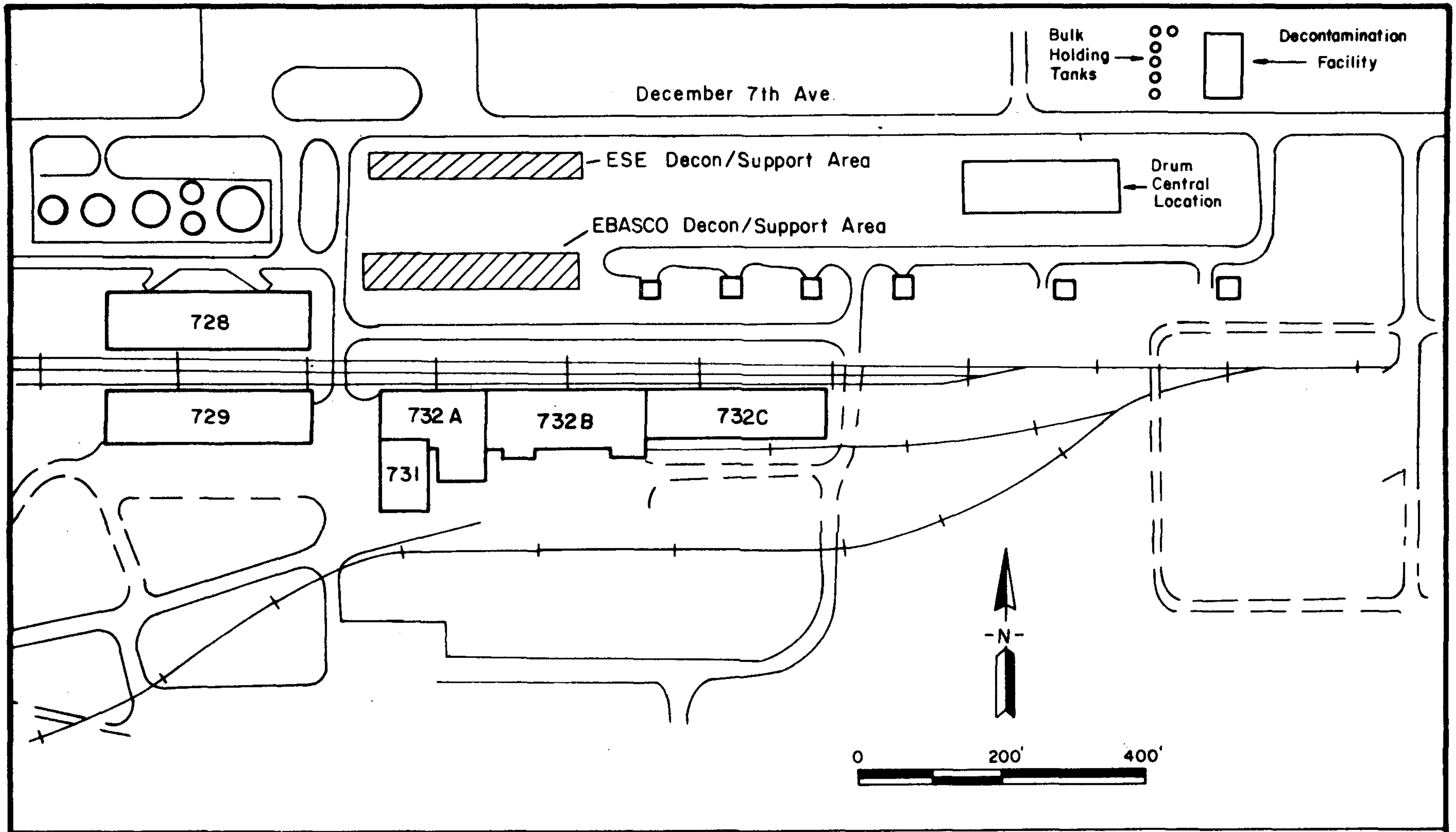
3.1.1 Support Facilities

During the mobilization meetings at RMA held the week of October 29 to November 2, 1984, the need for RMA support facilities was identified and initial discussions were held with RMA Installation Services personnel regarding the location and establishment of such facilities. The support facilities discussed included warehouse space, office space, provision of utilities (electric power, potable water, and sewer facilities) at warehouse and office facilities, and RMA's identification of a preferred location for decontamination activities.

During subsequent meetings involving Ebasco, Environmental Science and Engineering, Inc. (ESE), and RMA Facilities Engineering personnel, locations of the command center and support facilities were agreed upon. They are located along December 7th Avenue approximately 2,500 feet (ft) east of its intersection with "D" Street and north of Building 732 (Figure 3.1-1). RMA Facilities Engineering, with the support of Stearns Catalytic, has provided hookups for electricity, potable water, and sanitary sewer facilities for the Ebasco office trailer and ESE support facilities, as well as electricity and water supplies for the existing steam-cleaning area. Personnel decontamination activities and facilities are described further in the Health and Safety Plan located in Section V of the Rocky Mountain Arsenal Procedures Manual to the Technical Plan (Ebasco, 1985b).

Heated and lighted warehouse space has been provided by RMA for the use of both Ebasco and ESE. The eastern half of Building 728 (see Figure 3.1-1) has been made available for this purpose. This building has been divided in half by a firewall and RMA has further subdivided the eastern half into three approximately equal areas by chain link fences. The central area is being used by RMA for miscellaneous equipment storage. The two outer areas will be used by Ebasco and ESE. Each of these outer areas can be accessed through separate 12-ft doors from separate loading docks on the northern side of the building.

In addition to Building 728, RMA has provided warehouse space in Building 733-C for storage of some sample cores obtained during this task. Potentially hazardous solid materials such as used protective clothing are placed in drums, which are subsequently placed on pallets in Building 732.



Prepared for:

Program Manager's Office for
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

FIGURE 31-1
Support Facility Locations in the
South Plants Area
Rocky Mountain Arsenal, Task 10
Prepared by: Ebasco Services Incorporated

3.1.2 Support Activities

3.1.2.1 Surveys

Each sampled manhole and each excavation borehole will be surveyed to establish its elevation and map coordinates with respect to the Colorado State Plane Coordinate System. All elevations will be surveyed to the nearest 0.1 ft (3 centimeters) vertically and 3 ft (1 meter) horizontally, consistent with U.S. Army Toxic and Hazardous Materiels Agency (USATHAMA)/PMO requirements.

3.1.2.2 Decontamination of Equipment and Materials

The decontamination of equipment and materials will be in accordance with health and safety requirements and quality control requirements. Equipment such as sampling tools and boring equipment will be maintained and decontaminated to preclude cross-contamination between samples and from one site to another.

Some decontamination activities will take place at the sampling locations. These activities will utilize the mobile decontamination facilities discussed in the Health and Safety Plan of the Rocky Mountain Arsenal Procedures Manual (Ebasco, 1985b). Major decontamination of equipment, particularly the larger pieces of equipment, will take place at the regional steam-cleaning areas.

3.1.2.3 Waste Disposal

At the direction of the PMO, most contaminated wastes, including liquids, soils, and other solid wastes, will be containerized in drums and removed to controlled storage sites. Two exceptions to this general rule will be made. Excavated material from sewer line excavations will be removed in layers and subsequently returned to the excavation. Soil removed from the bottom of the excavation will be returned to the bottom of the excavation. Soils removed from mid-level will be returned to mid-level. Soils removed from the top of the excavation will be used to cap the excavation. Cuttings from the manhole borings will be returned to the borehole, as much as possible, and the borehole will be sealed with grout.

The following will be handled as potentially contaminated wastes, unless they are sampled and confirmed to be uncontaminated in accordance with Task Order 32 (Sampling Wastes Handing Protocols):

- o All wastes generated in sampling and decontamination areas,
- o Disposable sampling gear, and
- o Liquids generated at the steam-cleaning area.

Uncontaminated wastes will be disposed of in the sanitary sewer system or appropriate trash disposal facilities. Any portable or chemical toilet wastes generated will be disposed of according to normal protocols.

3.2 GEOPHYSICAL PROGRAM

3.2.1 Purpose

Geophysical surveys will be conducted to ensure, to the extent possible, that excavations and boring locations are clear of underground process lines or utilities. However, they have little utility in locating VCP, plastic, or other nonferrous sewers.

Surveys will be conducted at locations where boreholes or excavations are planned. All surveys will be conducted well in advance of drilling and excavation to allow for an assessment of the physical results and, if necessary, relocation or modification of the planned excavations.

3.2.2 Techniques

Potentially applicable geophysical techniques have been tested for their effectiveness at RMA. These tests and their results are described in Section I of the Rocky Mountain Arsenal Procedures Manual (Ebasco, 1985b).

Two geophysical techniques will be used to locate buried utilities (electrical lines, gas lines, water lines, steel sewers, etc.). If the buried utilities are within approximately 5 ft of the surface and are composed of ferrous and/or electrically conductive material, they may be detectable. Utilities are normally not buried below 10 ft. The first technique involves the use of a magnetic field gradiometer to detect magnetic fields. The second technique involves the use of a "pulse induction" metal detector which detects resistivity.

3.3 INVESTIGATIVE METHODS

The investigative methods incorporated as part of the field program are designed to provide information which will augment the existing information available from the literature and to provide information for the contamination assessment of the systems. Each method is specifically designed to evaluate the various aspects of the systems. The methods to be used will include manhole reconnaissance, manhole sampling, hydrostatic testing, and dye/excavation studies.

3.3.1 Manhole Reconnaissance

As it exists today, the combined chemical and sanitary sewer systems incorporate 363 manholes and over 21.5 miles of pipeline. Manholes are incorporated into gravity sewer systems to facilitate maintenance of the systems. The manholes will provide a means to access and investigate the internal portions of the sewer systems without excavating the sewer lines.

The objectives of the manhole reconnaissance survey are to:

- o Document the physical condition and evaluate the integrity of the manholes,
- o Document the configuration (connections and alignment) of the sewer systems and any modifications, and
- o Select manholes for the boring and sampling program.

The reconnaissance survey will consist of visual inspections and vapor emissions monitoring of selected manholes in both the chemical sewer, sanitary sewer, and process water return systems. The visual inspections of the manholes and sewer line connections will aid in determining the configuration and any modifications of the sewer system. The integrity and physical condition will be noted with special emphasis on the integrity of the manhole channel, the inlet and outlet connections, the bottom apron, and the manhole walls. This information will be used to determine which manholes are deteriorated and have a potential for exfiltration of wastewaters out of the sewer systems. The configuration of each of the manholes inspected will be documented and discrepancies with facility drawings will be noted. Vapor emissions from each manhole will be monitored with organic vapor analyzers, chemical agent detectors, explosimeters, and photoionization detectors. This monitoring will serve to more adequately assess the potential for localized areas of contamination, however, this monitoring will also detect typical sewer gases.

Many of the manholes selected for the field reconnaissance survey are documented in the literature as being associated with contamination and as being in poor condition. Additional information has been obtained while overseeing the ongoing MKE sewer survey and this information was incorporated into the selection process. Finally, several sanitary sewer manholes were selected to verify the absence of contamination in portions of the system where no contaminant documentation exists and where contamination is not anticipated.

3.3.2 Manhole Sampling

The objectives of the manhole sampling program are to:

- Verify that "uncontaminated" portions of the sanitary sewer system are indeed uncontaminated,

- Determine which segments of the various gravity sewer lines have leaked contaminants, and

- Estimate the vertical and horizontal migration depth of a "typical" leak of contaminants.

The manhole sampling program has two phases--sediment sampling and manhole drilling. Sediment samples will be collected from sections of the sanitary sewer and process water return systems where no contaminant documentation exists. The chemical analysis of these samples will be used to verify that these segments are uncontaminated.

The manhole drilling phase will aid in evaluating which segments of the sewer lines have leaked contaminants. This phase of the field investigation program will consist of drilling through the bottom of the manhole and collecting soil samples from beneath the manholes with hollow stem auger drilling equipment. As it is anticipated that th hollow stem auger will be unable to penetrate the manhole bottom, a solid drill bit will initially be used to drill through the manhole bottoms. Once this is accomplished, the hollow stem auger will be installed on the drill rig and standard auger procedures will be followed.

Soil samples will be collected from depths of 0-1 and 4-5 ft immediately below all manholes included in the drilling program. Analyses for target contaminants in these samples will indicate which sewer line segments have the potential to leak contaminants, and which segments are not associated with contamination. Many segments of the sanitary sewer system and all of the chemical sewer system are believed to have transported contaminants. Manholes in these segments will have additional samples collected at intervals below the 4-5 ft depth as indicated in Sections 3.4.2 and 3.5.2 of this report (sections addressing the specific field investigation programs). Data obtained will aid in estimating the vertical migration pattern of leaking contaminants.

Upon completion of the individual boreholes, as many of the auger cuttings as possible will be returned to the borehole, and the top of the borehole in the manhole bottom will be sealed with concrete grout. Before leaving a drilling site, the manhole flow channel for the sanitary sewers will be cleared to avoid maintenance problems. As the chemical sewer system is not in use, this restoration procedure is unnecessary; however, all boreholes will be sealed with the concrete grout.

3.3.3 Hydrostatic Testing

This testing procedure will be used on lift station discharge lines from the sanitary and chemical sewer systems and on the process water distribution system. As these systems transport liquids under pressure, the potential for contamination, even for small leaks, is high. The objectives of this test method are to identify leaking sections of the pressure lines and to quantify these leaks. The test method is based on American Water Works Association Standard C600-82, "Installation of Ductile-Iron Water Mains and their Appurtenances". This standard describes a hydrostatic testing procedure for pressure lines which will be used to assess the leakage potential of the various pressure lines. As stated in the standard, the leakage is defined as the quantity of water that must be supplied to the section of pipe under test to maintain the test pressure within 5.0 pounds per square inch (psi). The leakage values will be normalized by length of pipe under test, diameter of pipe, and test pressure. The normalization procedure is described in the standard. The test method to be used is described in Appendix B of this report.

3.3.4 Dye/Excavation Studies

The potential for contaminant leakage from pipe joints is judged to be high, based solely on the large number of joints in the systems. The relative inaccessibility of the buried lines and joints limits the investigative methods applicable for these sites. To assess the integrity and contamination potential of these joints, a tracer dye will be injected into selected sections of the gravity lines. These sections will be excavated and soil samples will be collected from beneath the joints for on-site analyses of the dye. The objectives of the dye/excavation studies are to:

- Determine the potential for pipe joints to leak,
- Determine the frequency of leaking joints,
- Identify possible contaminant migration patterns, and to

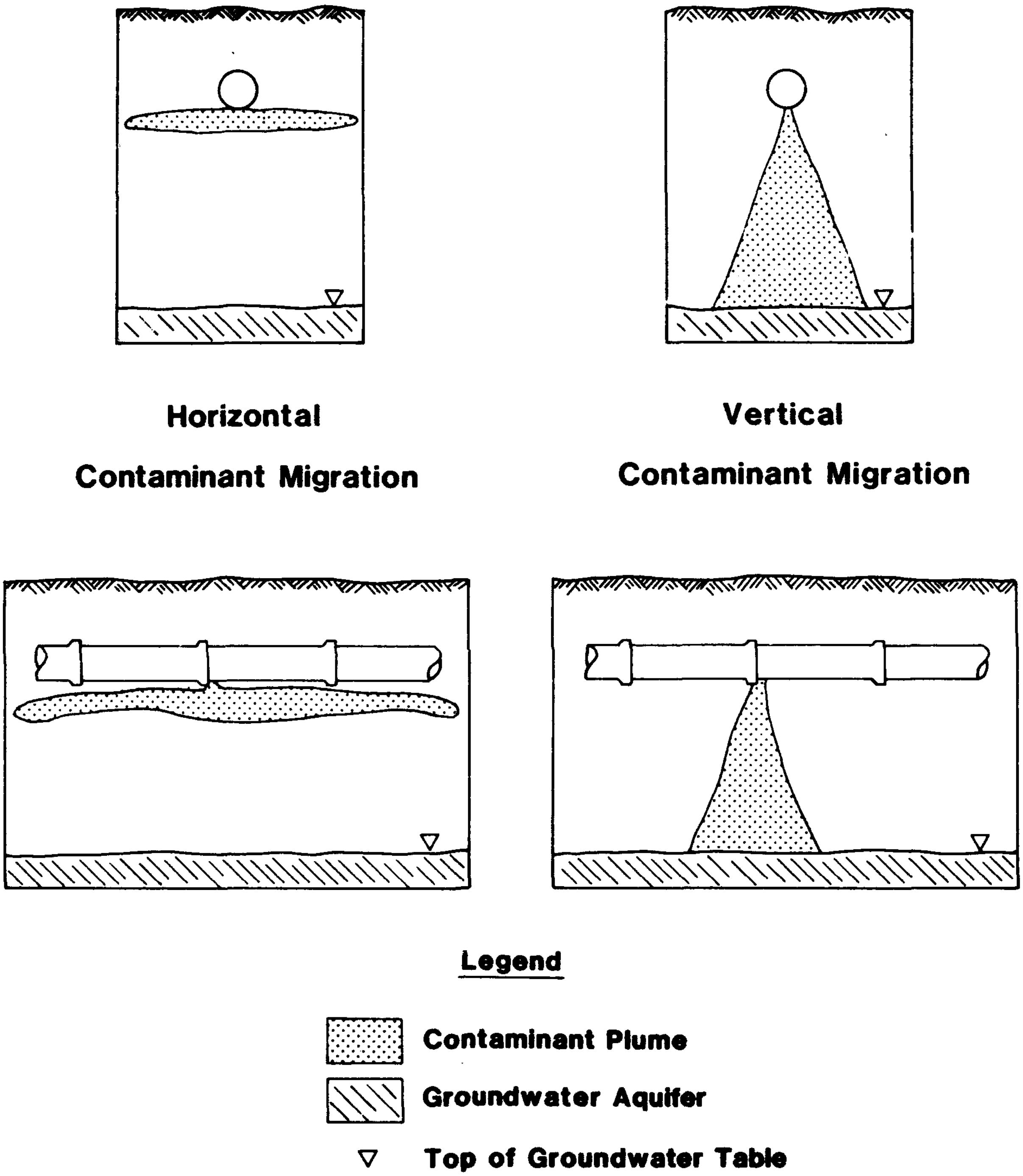
- Determine the extent of soil contaminated due to leaking joints.

The sections of pipeline selected for this test method will be sections identified in the literature as having a history of possible contamination and/or a history of documented or suspected exfiltration. Information from the manhole drilling program will be used in identifying sections that have leaked contaminants through the manholes and, thus, may have also leaked contaminants through bad pipe joints.

3.3.4.1 Dye Testing Procedures

The tracer to be used for the dye testing procedure will be Rhodamine B, a red dye which should visibly stain the soil. This staining will indicate possible migration patterns of liquids exfiltrating from the sewer lines. The migration pattern of the dye is not expected to follow the total migration pattern of leaking contaminants, but it is expected to give an indication of the contaminant migration pattern. These patterns are critical for understanding where the contaminants may have migrated. Possible patterns, as illustrated in Figure 3.3-1, include horizontal migration along the sewer lines and downward vertical migration away from the sewer lines. The dye stains will also indicate where soil samples should be taken to document contaminant exfiltration.

The test procedure will consist of installing sewer line plugs to isolate the line segment under test, followed by filling the line with a tracer dye solution. The line will be checked periodically to ensure the pipe remains full throughout the test. If the level of the dye solution decreases, additional solution will be added as needed to maintain a full pipe section. The liquid will be allowed to stand for a period of approximately 24 hours before the plugs are removed and the dye allowed to flow downstream in the sewer systems. The 24-hour test period should allow sufficient time for the tracer to leak through any cracks in the sewer lines and to establish local migration patterns around the sewer lines similar to contaminant migration patterns.



Prepared for:

Program Manager's Office for
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

FIGURE **3.3-1**
Possible Contaminant Migration Patterns
Rocky Mountain Arsenal, Task 10
Prepared by: Ebasco Services Incorporated

The dye testing procedure may prove to be an effective method to identify leak locations during any excavation and removal activities associated with remedial cleanup of the sewer systems and process water system. Dye could be injected into a pipeline prior to excavation. Any dye visibly noticed during excavation of the pipeline would indicate a leak location and an additional volume of soil, as determined by this task for a typical leak, would be removed and treated as contaminated soil. This procedure would minimize the amount of soil removed during cleanup and would aid in locating all leaks.

3.3.4.2 Excavation Procedures

The average depth for all the sewers to be investigated is 8 ft. Overburden soil will be removed with a backhoe to a depth of 6 inches above and 5 ft alongside the pipe to be examined. The remaining soil to the midline of the sewer will be removed manually with shovels and loaded into the bucket. A case 680H or equivalent backhoe will be required to expedite excavation.

Information reviewed to date indicates that most of the VCP sections used in the original construction are 5 ft long. Thus, an excavation 50 ft long will expose 10 pipe connections. If soil conditions dictate that the trench walls be laid back to a 45 degree angle of repose (1 to 1 ratio of horizontal to vertical), then approximately 163 cubic yards (yd^3) of soil will be removed per excavation. If soil conditions dictate that the trench walls be laid back to a 26 degree angle of repose (2 to 1 ratio of horizontal to vertical), then approximately 282 yd^3 of soil will be removed. Limited access at some sites may require the emplacement of vertical shoring or metal shields to stabilize the trench walls. The use of vertical shoring would reduce the volume of excavated soil to approximately 72 yd^3. Where pipelines comprised of 3 ft long pipe sections occur, the volumes of excavated soil would be approximately two-thirds of the volumes for 5 ft sections. All excavation work will be in strict compliance with all applicable Occupational Safety and Health Administration (OSHA) regulations.

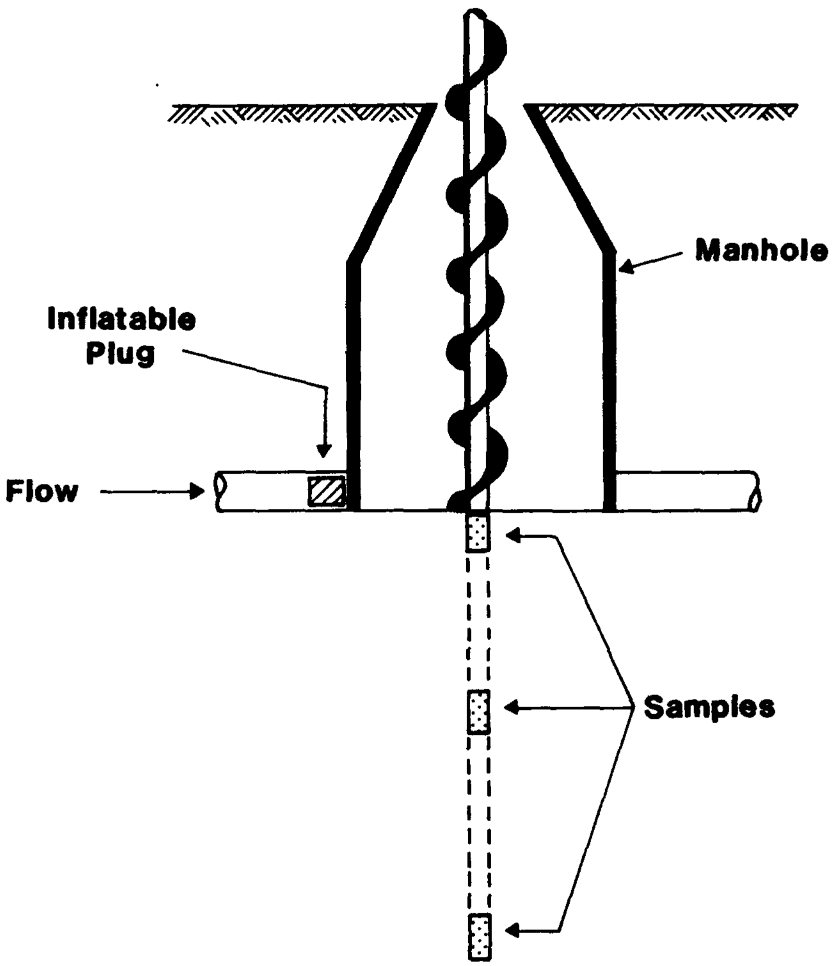
The last 6 inches of soil, above and beside the pipe in question, will be removed with hand shovels so as not to disturb the pipe. As the pipe and joints are exposed, Ebasco engineers will visually and photographically document the condition of the pipe. Information gathered by this method should show the type of pipe; horizontal or vertical deflections; separated or broken joints; circumferential or longitudinal cracks; crushed pipe; protruding, broken or leaking taps; and holes and corrosion in the pipe walls. Similarly, the bedding and backfill materials will be closely examined to determine the type and depth of bedding and backfill, as well as their compaction. Only the exposed pipe will be examined. The pipe will not be removed nor will it be subjected to any possibly damaging investigative procedures.

Excavated soil will be stockpiled on polyethylene sheeting and subsequently returned to the excavated site following completion of all investigative activities. The excavated material will be removed in layers and returned in reverse order of excavation. Thus, soils removed last will be returned first and those removed first will be returned last.

3.3.5 <u>Soil Sampling Methods</u>

Soil samples will be collected by several different methods. A hollow stem auger will be used to collect soil samples from beneath the manholes using procedures described in the RMA Procedures Manual (Ebasco, 1985b). The samples will be 1-ft borehole samples collected at prescribed depths, as outlined in Sections 3.4.2 and 3.5.2 of this Technical Plan. Figure 3.3-2 illustrates this sampling method. An Ebasco geologist will document all field observations pertaining to drilling parameters and soil characteristics. These samples will then be analyzed for target contaminants.

Soil samples from excavated trenches will be collected by means of a hammer-driven core barrel. This drilling mechanism consists of a hand-driven sliding hammer mounted on a guide rod connected to the core barrel. The samples will be collected in a 2-inch diameter, 1-ft long polybutyrate tube enclosed in the nonrotating core barrel. Soil above the desired sampling depth will be removed with a hand auger. The soil samples collected during excavation procedures will be analyzed for target contaminants and the results



Prepared for:	FIGURE 3.3-2
Program Manager's Office for Rocky Mountain Arsenal Cleanup Aberdeen Proving Ground, Maryland	**Manhole Soil Sampling** Rocky Mountain Arsenal, Task 10 Prepared by: Ebasco Services Incorporated

will aid in assessing the presence and migration patterns of contaminants near the exposed sewer line. Typical sample collection locations are illustrated in Figure 3.3-3.

The soil sampling method outlined above will also be used in any excavations made by MKE field staff on behalf of the Shell sewer investigation currently being conducted in the South Plants area. MKE has already started excavating six sanitary sewer lines and eight chemical sewer lines for investigation (refer to Sections 3.4 and 3.5, and Figures 3.4-6 and 3.5-3, respectively, of this document). It is believed that a total of 18 excavation sites will be investigated and sampled by MKE.

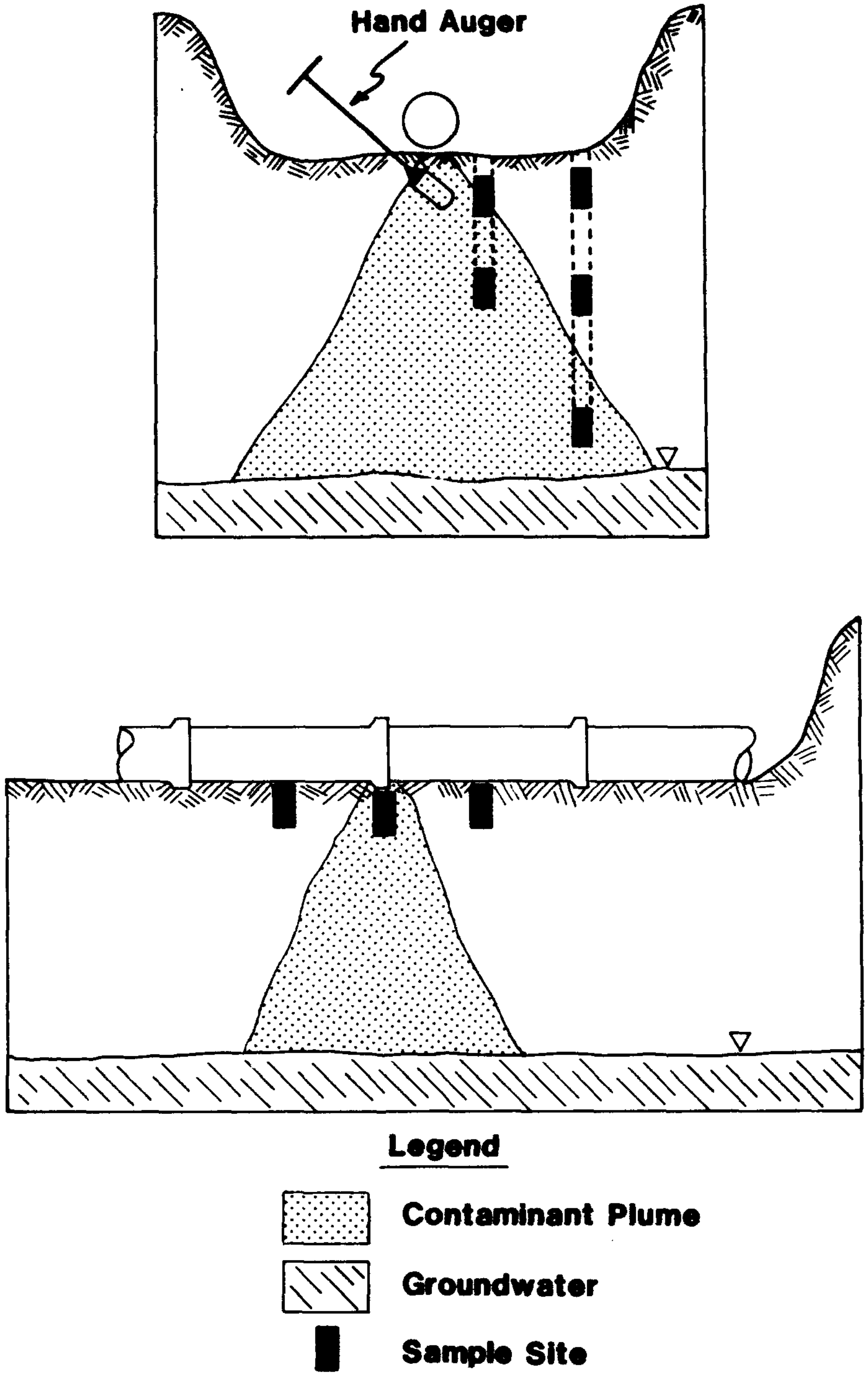
Soil samples for analysis of the tracer dye will be collected at the excavation sites using a stainless steel hand scoop. The analyses will document the presence of any dye that has exfiltrated from the pipe lines.

Sediment samples from manholes will be collected by using a stainless steel beaker connected to an aluminum extension rod. This sampling method will preclude the requirement to enter the manholes.

3.4 SANITARY SEWER SYSTEM

3.4.1 Sites to be Investigated

All of the sanitary sewers on RMA flow generally to the north and terminate at the RMA sanitary wastewater treatment plant. Figure 3.4-1 presents an overview of the sanitary sewer system on RMA. The Rail Classification Yard area, located near the southwestern corner of RMA, is situated in the far upstream reach of the sanitary sewer system. From the Rail Classification Yard area, wastes flow by gravity to the north, through two pump stations and force mains, and then eastward to the Administration area. Wastes from the Officers' Club and from the former housing area enter the second of the pump stations. Wastes from the Administration Building Complex flow by gravity to Manhole 65 where it combines with the wastes from the Rail Classification Yard and former housing areas. From Manhole 65, the wastes flow by gravity northeastward toward the Basins area and join the main sanitary sewer interceptor line at Manhole 46.



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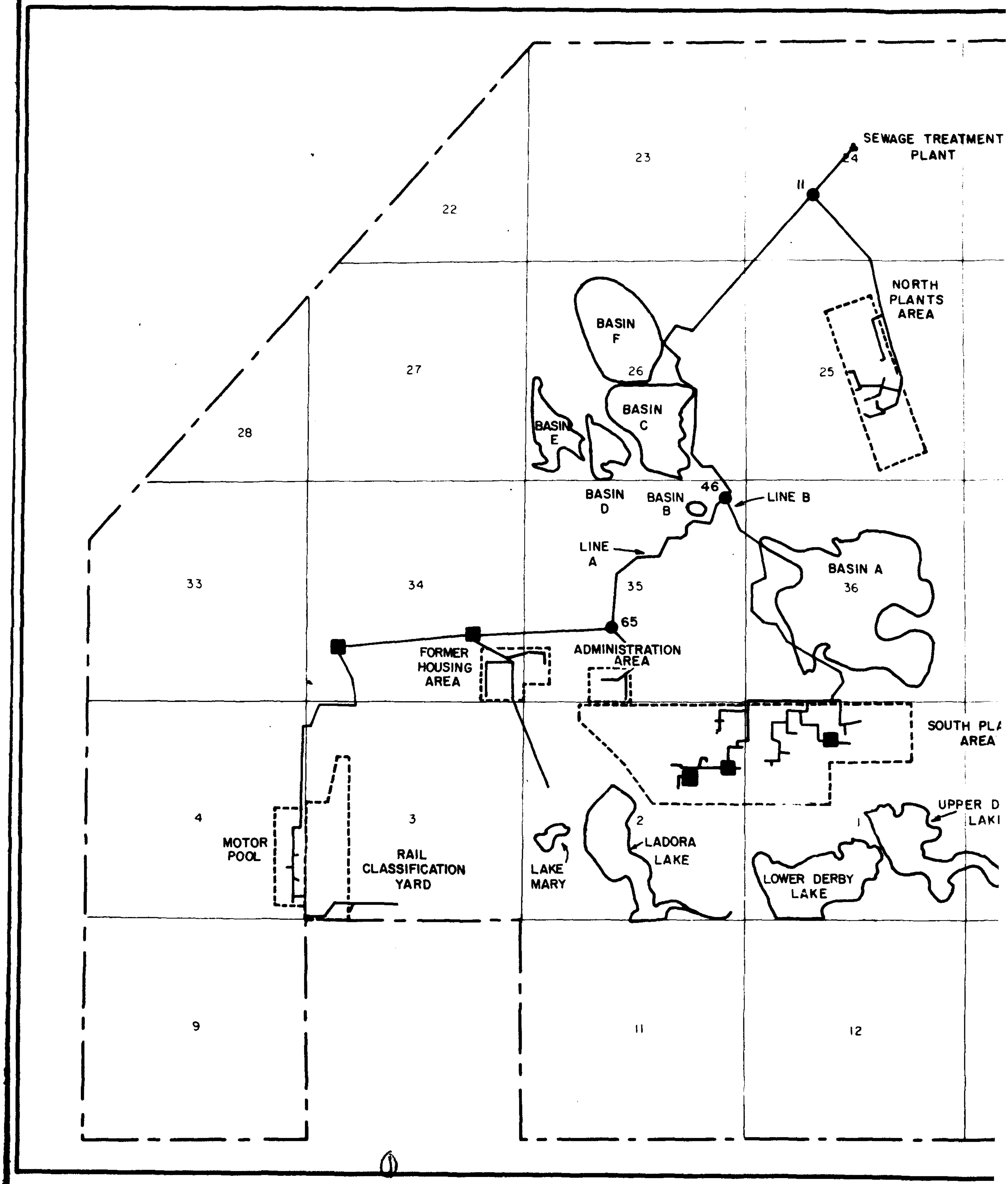
Program Manager's Office for
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

FIGURE **3.3-3**

Soil Sampling at Excavation Sites

Rocky Mountain Arsenal, Task 10

Prepared by: Ebasco Services Incorporated



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LINE B
LINE
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BASIN A
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FORMER
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ADMINISTRATION
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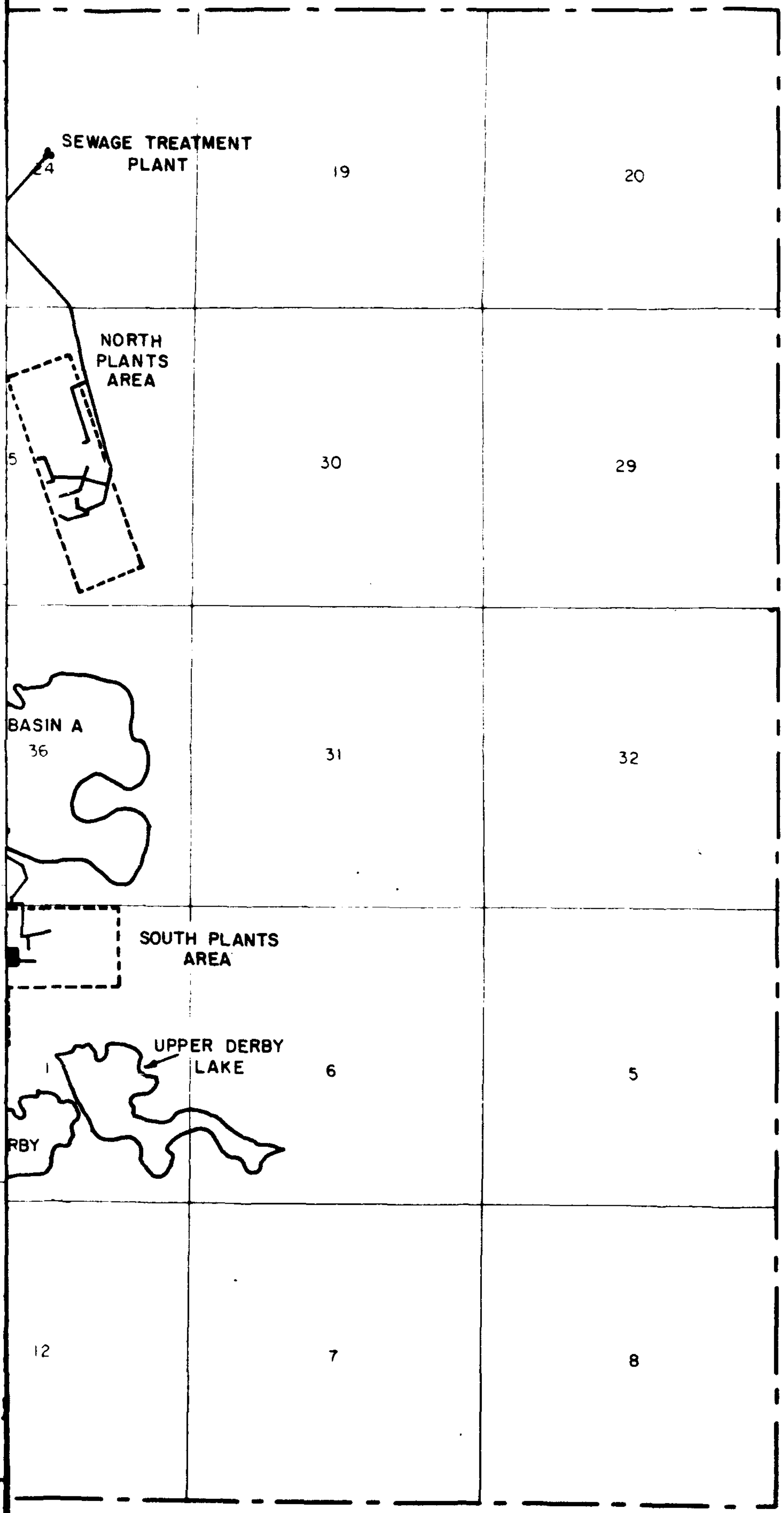

Legend

Sanitary Sewer Main

Lift Station

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Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

FIGURE **3.4-1**
Location Map for the Sanitary Sewer System
Rocky Mountain Arsenal, Task 10
Prepared by: Ebasco Services Incorporated

Sanitary waste originating in the South Plants area is collected in the South Plants sanitary sewer system and flows northwestward through the main interceptor line to the wastewater treatment plant located in Section 24. At Manhole 46, the line from the western areas (Line A) joins the main line from South Plants (Line B) which flows to the wastewater treatment plant.

The North Plants area is serviced by another branch of the sanitary sewer system. Sanitary flow from the North Plants is toward the north where it merges with the main interceptor line at Manhole 11, just upstream of the wastewater treatment plant.

Table 3.4-1 shows the length of sewer line servicing each area. The sewers are primarily constructed of bell and spigot VCP ranging in diameter from 4 to 18 inches. Approximately 70,000 ft of gravity sewers and 7,000 ft of steel and cast iron force mains are included in the RMA sanitary sewer system. Each of the major areas serviced by the sanitary sewer system will be investigated as part of this task. Areas are described in the following sections.

The sanitary sewer system was the subject of an intensive study prepared by Black and Veatch Engineers for the U.S. Army Corps of Engineers (Black and Veatch, 1980). This study focused on sanitary sewers in the South Plants, Sanitary Sewer Interceptor Lines A and B, and sewer lines from the North Plants. This study included flow metering, in-line video surveys, and sewer line excavations. Information gained from this Black and Veatch investigation will be used in the investigation outlined in this Technical Plan.

There are at least 12 small, on-site collection, treatment, and disposal systems located on RMA that are not connected to the main sewer system and designed to serve limited areas only. These systems apparently consist of isolated septic tank/tile field systems. Examples of these small capacity systems include those servicing the building at the West Gate, the abandoned officers' housing area near "C" Street, and an isolated building near the Rod and Gun Club. These systems generally serve only isolated areas and many are no longer in use. As these systems are not connected to the main sanitary

Table 3.4-1. RMA Sanitary Sewers.

Area	SANITARY SYSTEM Length (ft)	Sizes/Materials	Manholes
South Plants	16,362	4-12"/VCP	76
	680	4-6"/Steel	
North Plants	10,246	6-10"/VCP	35
Rail Classification Yard	10,225	6-8"/VCP	39
	3,200	6"/Steel	
Administration Area	14,755	4-12"/VCP	50
	3,600	8"/Steel	
Interceptor Sewer Line	16,204	18"/VCP	59
	1,075	18"/RC	
	300	24"/Concrete	
TOTALS	77,147		259

RC - Reinforced concrete, bell and spigot
VCP - Vitrified clay pipe, bell and spigot

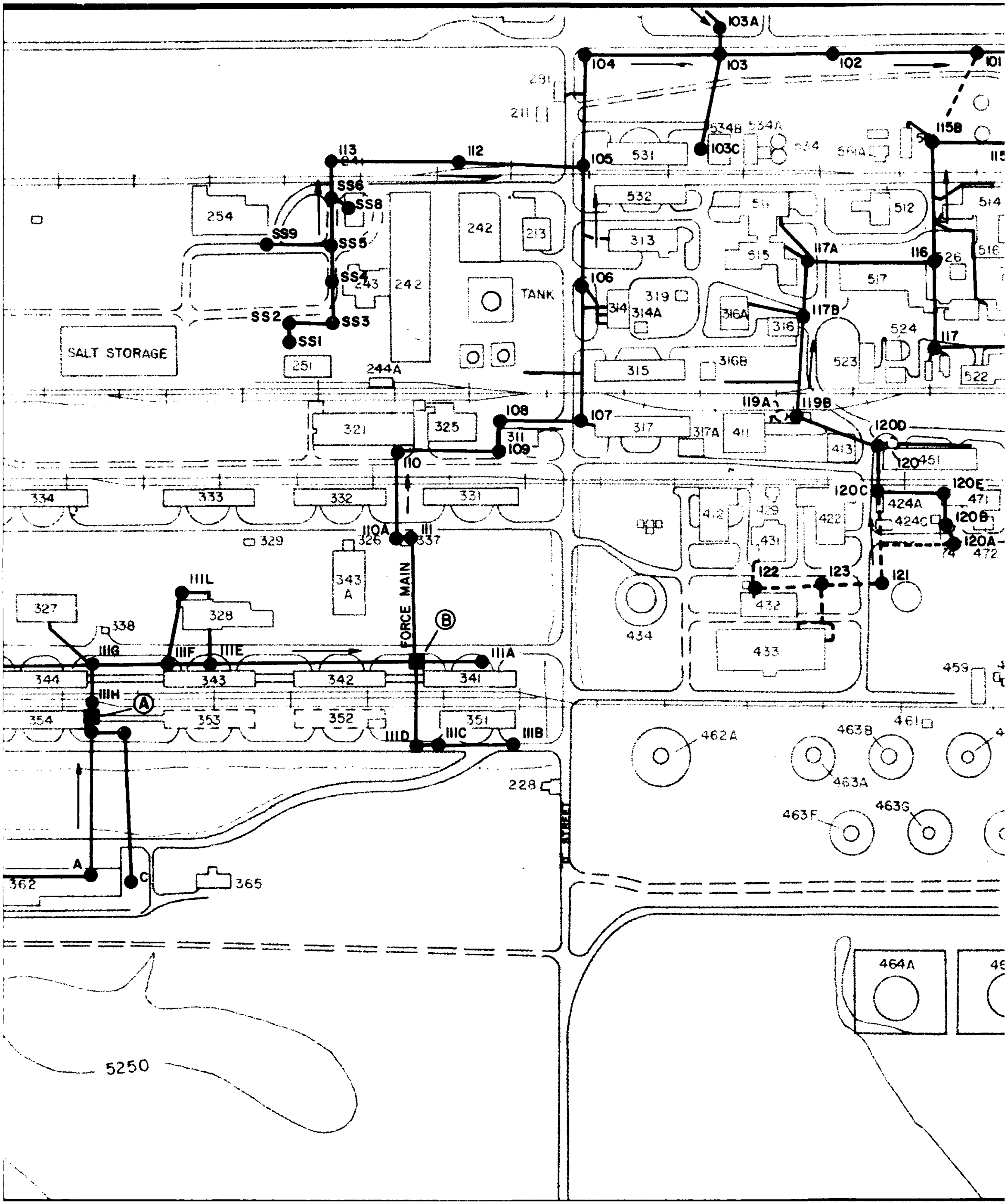
sewer system and there is no documented history that they are contaminated, they will not be studied in this Task 10 Sewer System Investigation.

3.4.1.1 Area 1 - South Plants

The sanitary sewer system in the South Plants area of RMA has been in use since 1942. The sanitary sewer system is constructed primarily of 3- to 5-ft lengths of 4- to 12-inch diameter VCP with oakum-cement joints. Although the sanitary sewer is primarily a gravity system in this area, there are three cast iron force mains from lift stations. The three lift stations serve the southeastern and southwestern portions of the South Plants and are designated Buildings 341B, 364, and 546. The sanitary sewer system serving the South Plants is illustrated in Figure 3.4-2. Most of the sanitary sewer system in this area is active.

Flow in the sanitary sewers in the South Plants area is directed generally toward the northeast. Buildings serviced west of "D" Street have sewers connected to a northward flowing trunkline located along the eastern side of "D" Street. This trunkline is connected at Manhole 104 to an eastward-flowing trunkline located parallel to and south of December 7th Avenue. This eastward-flowing branch also serves as the main collector line for most of the buildings located in the South Plants east of "D" Street. Another collector line serves the eastern South Plants buildings and enters Manhole 98 from the east. The sanitary sewer system exits the South Plants area at Manhole 98, where it turns northward under December 7th Avenue and enters Section 36.

Several areas of the sanitary sewer system have been modified since the initial construction. The most notable among these reconstructed areas involves the sewers formerly located near the northwestern corner of Building 451 in the South Plants area. In the fall of 1977, dibromochloropropane (DBCP, trade name NEMAGON) was found at levels in excess of 300 parts per billion (ppb) in the sanitary sewer lines between Manholes 120D and 119A. Various corrective activities were proposed and completed to reduce the concentration of DBCP in the sanitary sewer system. Completed projects included installation of a new building connection from



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TANK
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SS2
SS3
SS1
SALT STORAGE
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244A
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119A
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107
317
317A
411
120D
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451
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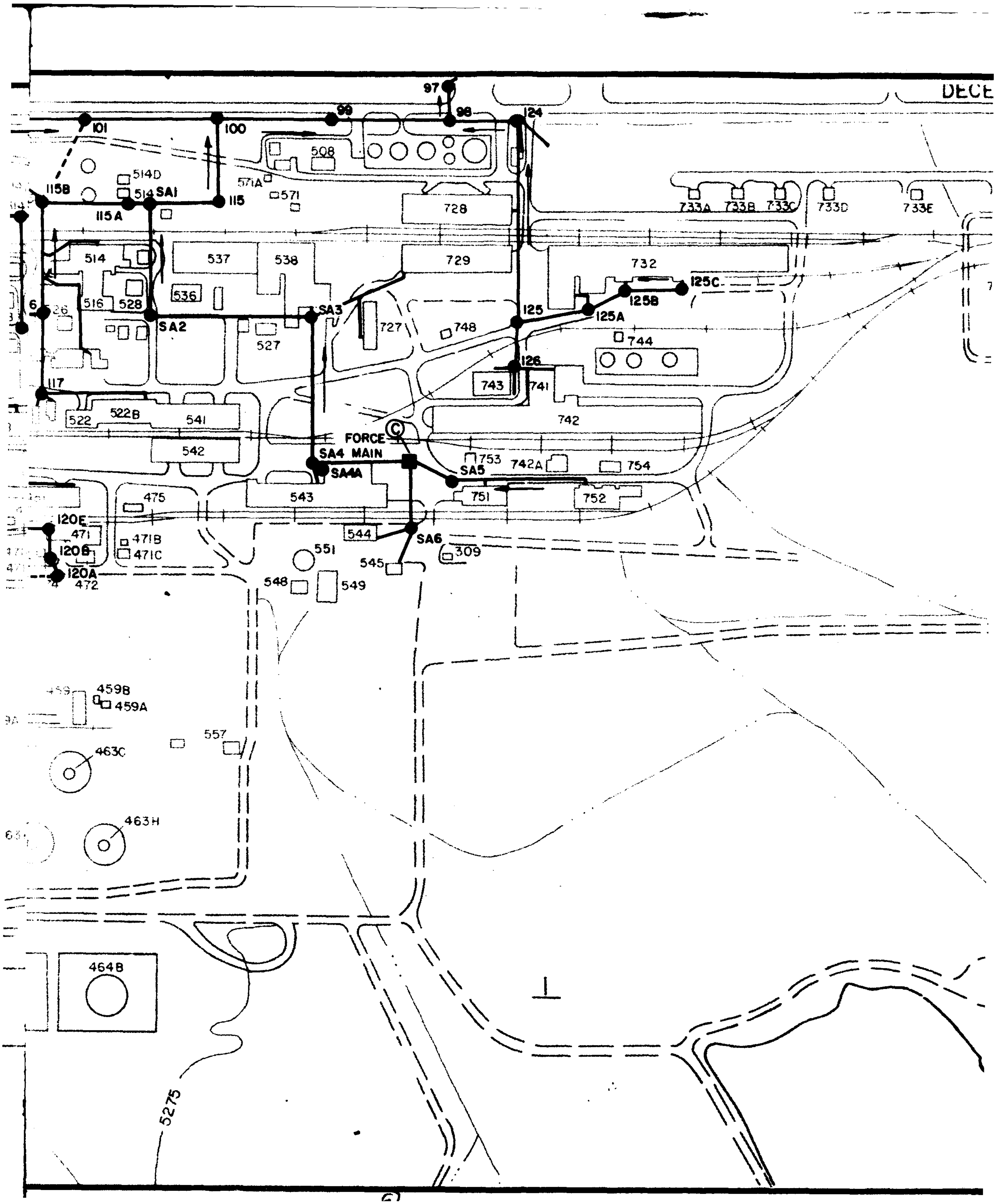
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SA3
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SA4 MAIN
SA4A
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SA6
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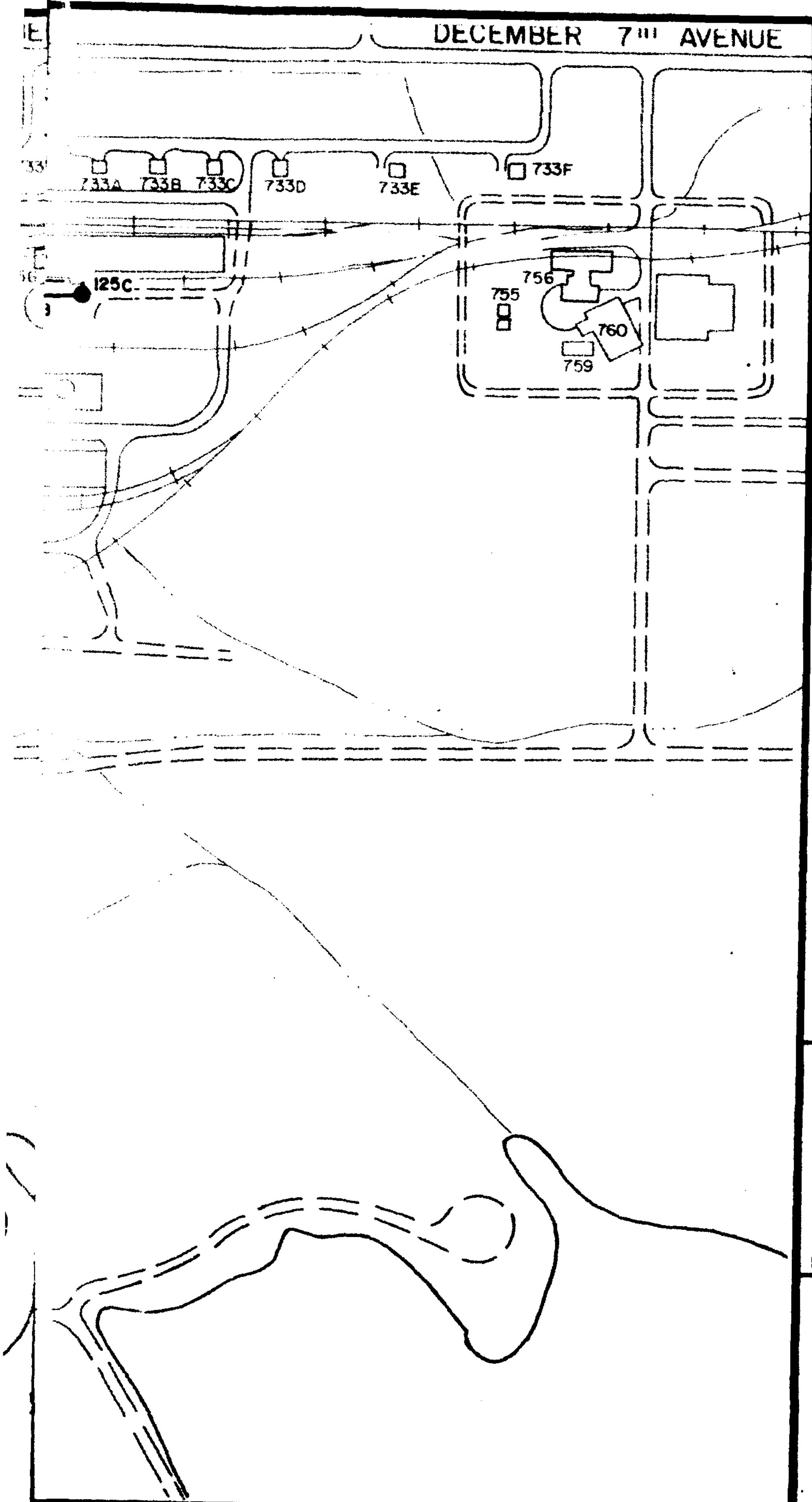

LEGEND

Sanitary Sewer Main

Manhole, with Number

Direction of Flow

Force Main — Force Main

Abandoned Manhole, with Number

Abandoned Sanitary Sewer Line

(A) Sewage Lift Station (Bldg. No. 364)

(B) Sewage Lift Station (Bldg. No. 341B)

(C) Sewage Lift Station (Bldg. No. 546)

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Prepared for:

Program Manager's Office for
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

Drafted: 10/22/86

FIGURE 3.4-2
Area 1 Sanitary Sewer System
South Plants Area

Rocky Mountain Arsenal, Task 10

Prepared by: Ebasco Services Incorporated

Building 451, cleaning of the sewer line with high pressure water jets, installation of two new manholes and connecting sewer lines, and finally, abandonment of the older manholes and sewer lines in the area.

3.4.1.2 Area 2 - North Plants

The North Plants manufacturing area is located in the center of Section 25 in the northern portion of RMA (Figure 3.4-3 in pocket). The sanitary sewer system serving this area can be subdivided into northern and southern collector lines. The northern collector services Buildings 1614, 1615, and 1616. This is a 4- and 6-inch VCP line which flows generally northward and connects to the main North Plants interceptor line north of Manhole S34. No manholes are incorporated into this collector line.

The southern collector line is the main sanitary sewer artery in the North Plants area and services Buildings 1501, 1601, 1606, 1607, 1611, 1701, 1703, 1704, and 1710. This collector is comprised of 8- and 10-inch VCP with several short lengths of 6- and 8-inch cast iron service laterals. The lines flow generally eastward to Manhole S30.

The North Plants interceptor line is a 10-inch VCP line starting at Manhole S30. This sewer line proceeds north-northwestward, passes under 9th Avenue, and connects with the main sanitary sewer interceptor line at Manhole 11, approximately 1,200 ft southwest of the wastewater treatment plant in Section 24. The total length of this 10-inch VCP line, from Manhole S30 to where the North Plants sewer joins the main 18-inch sanitary sewer line, is approximately 5,450 ft.

3.4.1.3 Area 3 - Rail Classification Yard Area

The Rail Classification Yard area is located along "B" Street, near the southwestern corner of Section 3 and the southeastern corner of Section 4. The sanitary sewer system services approximately 12 of the 30 buildings in this immediate area. Structures in the Rail Classification Yard area include numerous warehouse and storage facilities, the Rail Classification Yard itself, the motor pool area, and several office buildings and maintenance shops. The sanitary sewers in this area are illustrated in Figure 3.4-4 (in pocket).

The sanitary sewer system starts with an 8-inch VCP line that directs flows westward for approximately 2,200 ft into the southern end of the Rail Classification Yard area. Presently, no buildings are connected to this segment of the system. Near the intersection of "B" Street and 6th Avenue, the 8-inch sewer line turns northward and all flows are directed in a generally northward direction along the west side of "B" Street to the northeastern corner of Section 4. At about 650 ft south-southwest of the intersection of "B" Street and December 7th Avenue, the sewer line turns eastward under "B" Street and then trends northeastward to the southern side of December 7th Avenue. The line parallels December 7th Avenue for approximately 800 ft before turning northward under December 7th Avenue. The line continues northward toward Building 393, a sewage lift station. From Building 393, the wastewater is transported eastward via a 3,200-ft long, 6-inch steel force main to Building 392, another sewage lift station.

3.4.1.4 Area 4 - Administration Area

The Administration area is composed of two subareas, the former housing area and the Administration Building area. Figures 3.4-5A and 3.4-5B (in pocket) illustrate the sanitary sewer system in these subareas, respectively.

The Officers' Club, located along the western edge of Section 2, is serviced by a 2,500-ft long, 4-inch, VCP line. This line runs from Manhole H4B, located adjacent to the Officers' Club parking lot, to Manhole H3B, located in the southern section of the former housing area.

Many of the buildings in the former Army housing area have recently been demolished. With the exception of the recreational facilities, this subarea is presently unused. The sanitary sewer system in the former housing area is comprised of three collector laterals. A westward-flowing lateral provided service to a former trailer park area located in the southwestern quarter of Section 35. The western group of buildings is served by an 8-inch line that flows northward to the northwestern corner of the area, then eastward to Manhole 5A. The middle lateral collects wastewater from the Officers' Club in Manhole H3B, wastewater from the western lateral in Manhole 5A, wastewater from the former trailer park in Manhole 5, and also serves the eastern group of buildings in the area.

The combined wastewaters from the three laterals flow northwestward in a 8-inch line to the lift station at Building 392. This lift station also receives the discharge from the 6-inch steel force main originating at Building 393, as discussed earlier. From Building 392, an 8-inch steel force main carries waste directly eastward about 3,600 ft to Manhole 65, located approximately 1,200 ft north of Building 111.

The Administration Building area consists of a small group of buildings around Building 111, the Administration Building. Two laterals serve this area. One eastward-flowing line is located near the parking lot north of Building 111. The other sewer line services a small brick outbuilding located 300 ft southeast of Building 111. This line flows northward and is joined by the eastward-flowing line at Manhole 71 located 350 ft east of the Building 111 parking lot. At Manhole 65, this sewer line receives wastewater pumped through the 8-inch steel force main by the lift station in Building 392. The 12-inch main line then travels northeasterly to Manhole 46 near the northeastern corner of Section 35 where it joins the sanitary sewer interceptor line emanating from the South Plants area. This 4,850-ft length of line from Manhole 65 to Manhole 46 is designated Sanitary Sewer Line A.

3.4.1.5 Area 5 - Interceptor Sewer Line

The sanitary sewer interceptor line is the main line flowing to the sewage treatment plant which is located in the central portion of Section 24. The Interceptor Line is shown in Figures 3.4-6A and 3.4-6B (in pocket).

The interceptor line originates at Manhole 98 in the northeastern part of the South Plants area. The line crosses under December 7th Avenue and continues through Section 36 in a general northwesterly direction. The line crosses

"D" Street into Section 35 approximately 1,450 ft south of the intersection of "D" Street and 8th Avenue. The sewer line continues in a north-northwestward direction through Section 35. At Manhole 46 in Section 35, Sanitary Sewer Line A from the Administration and Rail Classification Yard areas joins Sanitary Sewer Line B, the interceptor line from the South Plants area.

The wastewater from the two sewer lines flows generally northward under 8th Avenue into Section 26, the Basins area. The interceptor line is located along the eastern edge of Basins C and F in this section. Just north of the Basin F skimmer ponds, the interceptor line continues in a northeasterly direction through the northeastern quadrant of Section 26 and the extreme northwestern corner of Section 25. The line proceeds northeastward through Section 24 to the sewage treatment plant in the middle of the section. The wastewater from the North Plants area joins the interceptor line at Manhole 11.

The interceptor line in Section 36 near Basin A has been modified at least twice. In 1952, a section of the line was replaced to reduce the influx of contaminated groundwater from the Basin A area. Later, the line segment in this area was abandoned and a new line installed to the west. The new line was intended to be installed above the high water level of Basin A.

3.4.2 Field Investigation Program

The field program for the sanitary sewer system is specifically designed to augment existing information available from the literature. This information will be used to assess the extent of contamination associated with the sanitary sewer system.

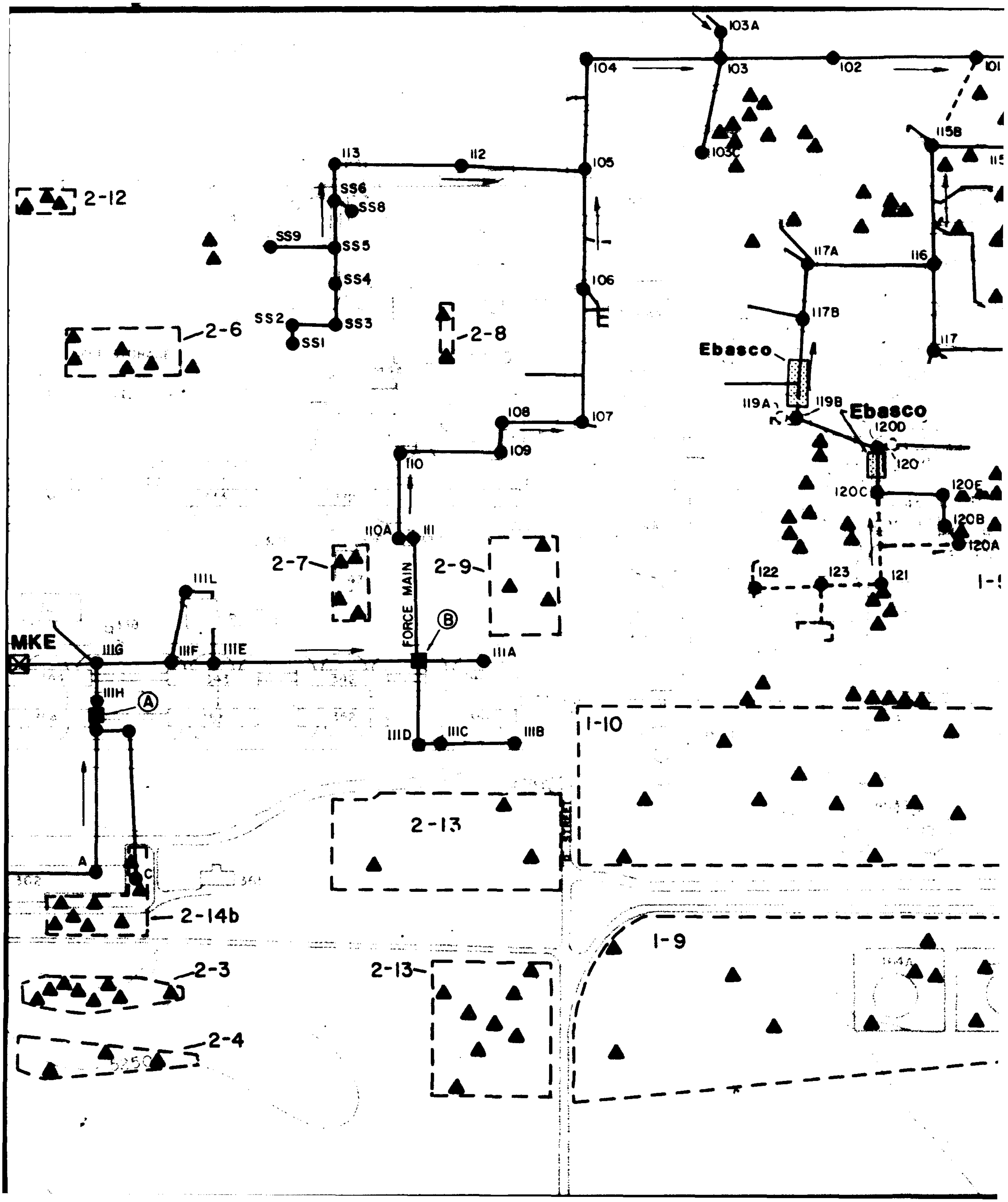
The first phase of the field program will involve a field reconnaissance of selected manholes in the sanitary sewer system. The reconnaissance will verify the condition of these manholes and will identify those manholes which are good candidates for the sampling program. The second phase will consist of sediment sampling and of manhole drilling and collection of soil samples immediately beneath manholes. The third phase of this program will be a high pressure test of lift station discharge lines to determine potential contaminant leakage from these lines. The last phase is a dye and excavation study of selected sewer line sections to assess the potential for leakage from pipe joints and cracks. A boring grid will be set up around the excavated pipe and samples will be taken to determine the extent of soil contamination caused by a leaking sewer line.

The specific investigative methods have been described in Section 3.3 of this report and are utilized for each of the separate sanitary sewer areas as described in the following sections.

3.4.2.1 Area 1 - South Plants

Information available in the literature indicates that the groundwater table in the South Plants area is high. MKE conducted an extensive manhole survey in the South Plants area. Ebasco monitored these activities which determined that some of the manholes were flooded and that sewer line was below the groundwater table. Present information indicates that the groundwater table elevation in this area is dropping. Manholes and sewer segments determined to be below the groundwater table will not be included in the manhole sampling program. Contaminants that may have leaked from these sewers are likely to have been dispersed by the general groundwater flow, thereby reducing the prospects of determining the exact source of the contaminants. Furthermore, infiltration of groundwater into these sewer segments is more likely than exfiltration of contaminants from the sewers.

Much of the sanitary sewer system in the South Plants is located in the "core" manufacturing zone where most of Army agent and Shell pesticide production occurred. Spills of contaminants are likely to have created such widespread contamination in this area that it will be impossible to distinguish sewer-related contamination from other possible sources of contamination. Task 2 and the follow-up Phase II investigation of Task 2 has, and will, concentrate on the "core" manufacturing area. Figure 3.4-7 identifies the locations of the boreholes associated with Task 2. For the purposes of this task, the sanitary sewer system in the South Plants area will be assumed to be contaminated.



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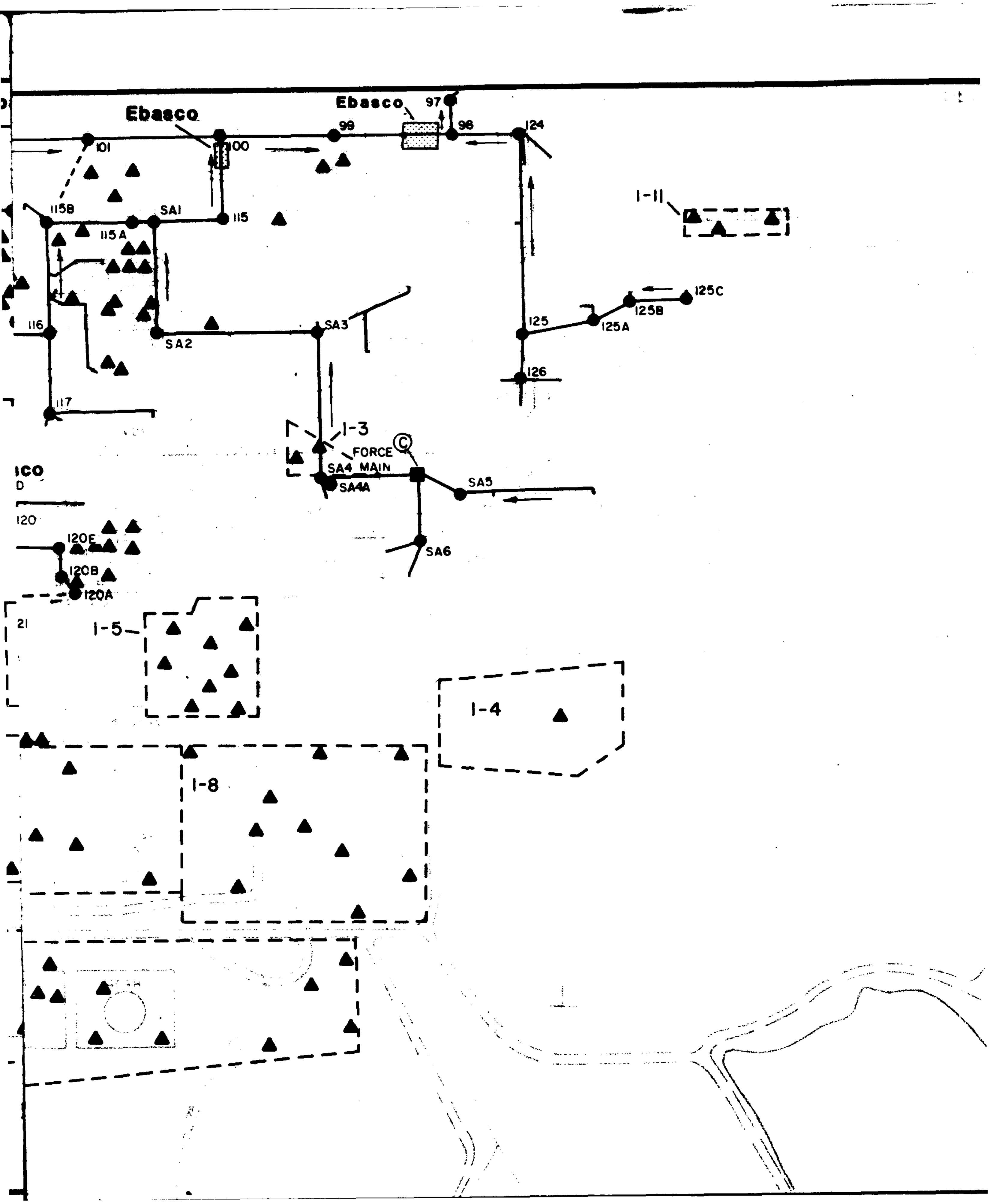

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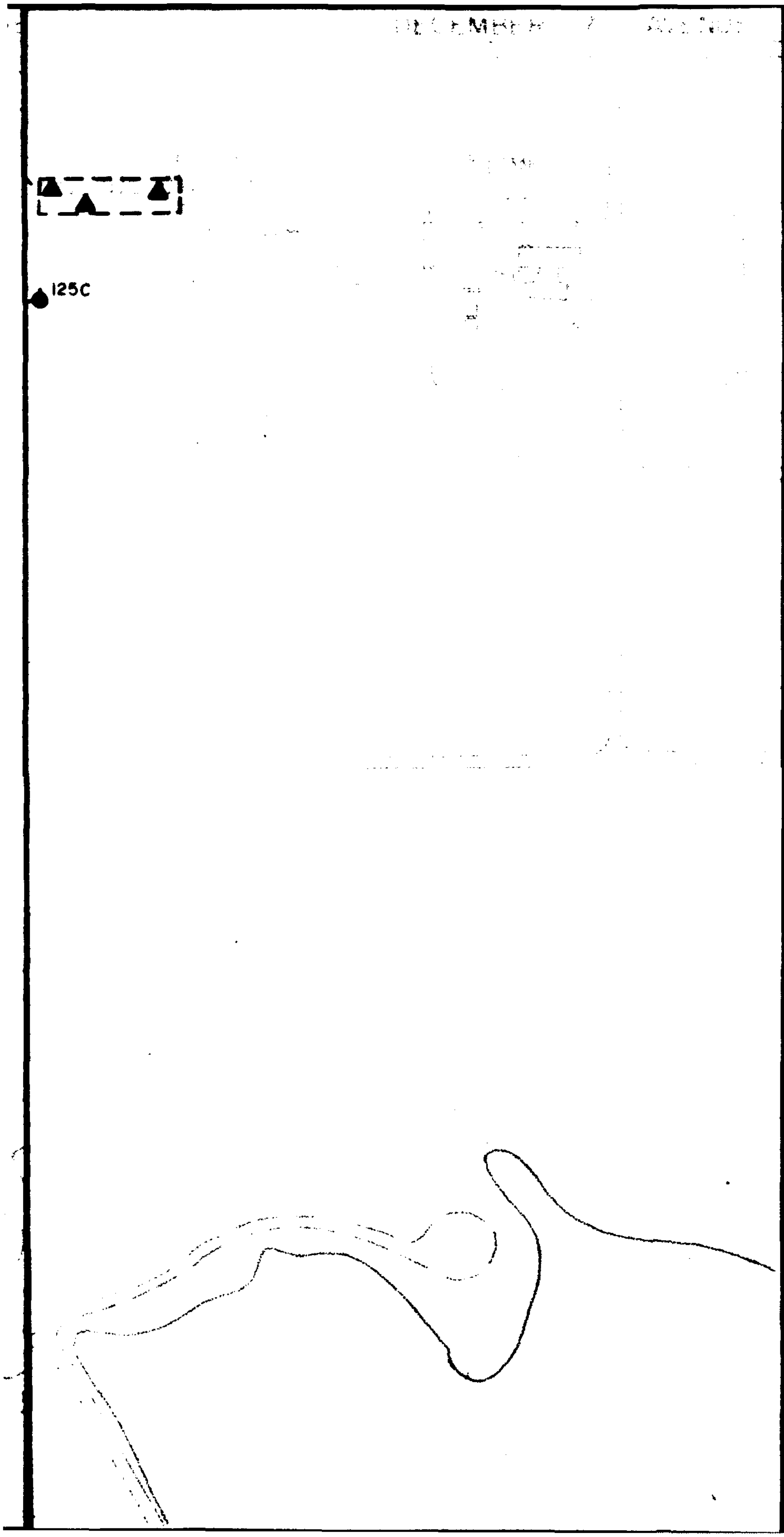

LEGEND

- Task 2 Bore Location
- Proposed Excavation Site
- MKE Excavation Site
- Sanitary Sewer Main
- Manhole With Number
- Direction of Flow
- Force Main — Force Main
- Abandoned Sanitary Sewer Line
- Abandoned Manhole, with Number
- Ⓐ Sewage Lift Station (Bldg. No. 364)
- Ⓑ Sewage Lift Station (Bldg. No. 341B)
- Ⓒ Sewage Lift Station (Bldg. No. 546)

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Prepared for:

Program Manager's Office for
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

Drafted: 10/22/86

FIGURE 3.4-7
Investigative Program South Plants Sanitary Sewer System

Rocky Mountain Arsenal, Task 10

Prepared by: Ebasco Services Incorporated

Selected manholes in the South Plants area will be investigated as part of the manhole sampling program. Soil samples will be collected at the 0-1, 4-5, and 9-10 ft depths below all manhole bottoms for manholes determined to have a potential to leak contaminants. These samples will provide some insight into the downward migration pattern of the contaminants. All boring activities will cease at either the 10 ft interval or the groundwater table, whichever is reached first. Sediment samples may be collected from manholes outside of the "core" manufacturing area where the potential for contaminated sewers is unknown. Table 3.4-2 is a list of manholes identified as primary candidates for the manhole reconnaissance survey. Criteria used for the selection of each manhole in Table 3.4-2 included strategic location of the manhole in the sewer system, documentation that the manhole is in poor condition, or location of the manhole in relation to known sources of contamination. Additions and/or deletions to this list may occur based on the results of the reconnaissance survey.

Dye/excavation studies will be conducted at two sites in the South Plants area. The two sites are described below.

Sanitary Sewer Between Manholes 98 and 99

The sewer line at this location is a 12-inch diameter VCP with bell and spigot joints sealed with cement. Most of the sanitary sewage emanating from the South Plants area passes through this section of pipe, including sewage from the "core" manufacturing zone. Contaminants entering the sanitary sewer system in the South Plants should be detected in any exfiltration from this segment of pipe. Possible contaminants include pesticides and military chemical agents.

Sanitary Sewer Between Manholes 117B and 119B

This segment of sewer line is an 8-inch diameter VCP with bell and spigot joints and cement joint sealant. This line is located downstream of the area used for manufacturing, packaging, handling, and storage of many pesticides, including NEMAGON. Several sections of new sewer lines and several new manholes have been installed upstream of this segment in an effort to reduce

Table 3.4-2. South Plants Sanitary Sewer Manholes to be Investigated.

Manhole No.	Materials of Contamination	Condition*	Possible Contaminants
97	unknown	unknown	most target analytes
98	brick	poor	most target analytes
99	brick	unknown	most target analytes
100	brick	poor	most target analytes
109	unknown	unknown	pesticides and white phosphorus
110	unknown	unknown	pesticides and white phorphorus
110A	unknown	unknown	pesticides and white phosphorus
112	brick	unknown	caustics and chlorine constituents
113	brick	unknown	caustics and chlorine constituents
124	unknown	poor	unknown
125	unknown	unknown	unknown

* Information indicating that manholes are in poor condition was obtained from the 1979 and 1980 Black and Veatch investigations (Black and Veatch Consulting Engineers, 1979; 1980).

NEMAGON concentrations in the sanitary sewage. Pesticides and NEMAGON are the primary potential contaminants expected in this area.

3.4.2.2 Area 2 - North Plants

The North Plants facility was constructed in 1951 and 1952 for the production of GB agent. This segment of the sanitary sewer system is not expected to be contaminated and no information has been found indicating that it has been contaminated. Therefore, the focus of the field program in this area will be to determine if contaminants that may have been in this sewer system have leaked. A manhole reconnaissance survey and a manhole sampling program will constitute the field investigation program for this area. Sediment samples will be collected from several manholes to determine if the sanitary sewe-line in this area is contaminated. Soil samples will be collected as part of a limited manhole drilling program designed to evaluate the potential for exfiltration of contaminants. Table 3.4-3 is a list of manholes to be investigated as likely candidates for the sampling program. Samples will be collected at 0-1 and 4-5 ft depths below the manholes. These manholes were selected primarily on the basis of their strategic location in the sewer system. Only Manhole S28 was reported to be in poor condition (Black and Veatch, 1979). The condition of the other manholes has not been reported. The contaminants of concern for this area are military chemical agents.

3.4.2.3 Area 3 - Rail Classification Yard Area

No information has been found which would indicate that contaminants would be associated with the sanitary sewer system in this area. The field investigation program for the Rail Classification Yard area will focus on verifying that the sewer lines in this area are uncontaminated and determining the existence or absence of contaminants migrating from the "worst-case" manholes in the system.

All sanitary sewage from this area collects in the sump at Building 393. The lift pumps in the building transfer the sewage through a 3,200-ft welded steel force main to lift station Building 392. As this line is pressurized, any leaks of contaminated liquid from this line could potentially be a major

Table 3.4-3. North Plants Sanitary Sewer Manholes to be Investigated.

Manhole No.	Material of Construction	Condition*
S14	concrete	unknown
S15	unknown	unknown
S23	concrete	unknown
S26	unknown	unknown
S27	unknown	unknown
S28	unknown	poor
S30	concrete	unknown
S31	concrete	unknown
S35	concrete	unknown
S36	concrete	unknown
S40	concrete	unknown
S41	concrete	unknown

* Information indicating that manholes are in poor condition was obtained from the 1979 and 1980 Black and Veatch investigations (Black and Veatch Consulting Engineers, 1979; 1980).

source of contamination. This line will be tested with the hydrostatic test method to assess its integrity.

The field investigation activities for the gravity sewers in this area will consist of a manhole reconnaissance survey and a manhole sampling program at selected manholes. Table 3.4-4 lists the manholes that are candidates for the sampling program, pending the results of the reconnaissance survey. These manholes were selected on the basis of their strategic location in this area.

As part of the sampling program, sediment samples will be collected from several manholes to determine if the sanitary sewer system in this area is contaminated. A limited manhole drilling program will collect soil samples from beneath manholes found to be in poor condition to determine if contaminants have exfiltrated from the system. Samples will be collected at depths of 0-1 and 4-5 ft below the manhole bottoms. Borings will also be made near the outfall of the overflow pipe at both lift stations and samples will be taken from the 0 to 1 and 4 to 5 ft depths.

The presence of the NEMAGON and trichloroethylene-contaminated groundwater plumes in this area indicates that portions of the area may have been contaminated by spills. However, the groundwater table is below the sanitary sewers in this region and the presence of these contaminants in the sewer system is not anticipated. To document the "uncontaminated" status of the sewer system in this area, samples collected from this area will be analyzed for all target analytes.

3.4.2.4 Area 4 - Administration Area

Based on available information from the literature, no contamination is expected to be associated with the sanitary sewer system in the Administration area. The field investigation program for the Administration area will focus on verifying the absence of contaminants in the sewer system and the absence of contaminant migration from the sewer system.

Table 3.4-4. Railroad Classification Yard Area Sanitary Sewer Manholes to be Investigated.

Manhole No.	Material of Construction	Condition*
RSA	brick	unknown
R6	brick	unknown
R12	brick	unknown
R13	brick	unknown
R19	unknown	unknown
R20	unknown	unknown
R28	unknown	unknown
R29	brick	unknown

* Information indicating that manholes are in poor condition was obtained from the 1979 and 1980 Black and Veatch investigations (Black and Veatch Consulting Engineers, 1979; 1980).

All sanitary wastewaters generated in the former housing section of this region are collected in the lift station sump of Building 392 where it joins the wastewaters from the Rail Classification Yard area. The lift station pumps the wastewater through a 3,600-ft long force main, constructed of welded steel, to Manhole 65. As with all force mains, any leaks could create a significant contaminant source. The integrity of this line will be checked by hydrostatic testing.

The manholes in the area selected to be included in the reconnaissance survey are listed in Table 3.4-5. Selection of these manholes was based primarily on their location in the system. A limited manhole sampling program will also be conducted. Sediment samples will be collected from several manholes to determine if the sewer system in this area is contaminated. A limited number of manholes will be included in the manhole drilling program to determine if contaminants have leaked out of the system. Soil samples will be collected at depths of 0-1 and 4-5 ft below the manholes.

3.4.2.5 Area 5 - Interceptor Sewer Line

The interceptor sewer line is the main sanitary sewer line which originates in the South Plants and terminates at the sanitary wastewater treatment plant in Section 24. Information from the literature search indicates that this line is contaminated with a variety of contaminants, including NEMAGON, Aldrin, chloroform, trichloroethylene, and carbon tetrachloride (Ebasco, 1986).

The interceptor sewer line passes around Basin A in Section 36. Although several manholes in the Basin A region were identified in the 1979 study as being in poor condition, no field investigation activities are planned for the majority of this segment. The line in this region is in close proximity to the contaminated groundwater under Basin A, and the reported infiltration of groundwater into the sanitary system in this region will make it difficult to distinguish soil contamination caused by leaking sewers from that caused by the groundwater.

Table 3.4-5. Administration Area Sanitary Sewer Manholes to be Investigated.

Manhole No.	Material of Construction	Condition*
H1	brick	unknown
H2	brick	unknown
48	unknown	unknown
49	unknown	unknown
50	brick	poor
64	unknown	unknown
65	brick	poor

* Information indicating that manholes are in poor condition was obtained from the 1979 and 1980 Black and Veatch investigations (Black and Veatch Consulting Engineers, 1979; 1980).

A manhole reconnaissance survey will be conducted at selected manholes along the length of the interceptor sewer line from the Basin A region to the wastewater treatment plant. Manholes to be included in the survey are listed in Table 3.4-6. Results of the survey will be used to assess a manhole drilling program to aid in determining the extent of soil contamination that may be associated with the sewer system. Manholes selected for the drilling program will be sampled at 0-1 ft, 4-5 ft, and 9-10 ft intervals below the bottom of the manhole to document any vertical migration of leaking contaminants. Contaminants of concern for this segment of the sanitary sewer system are all target analytes due to the suspected infiltration of Basin A groundwater.

Dye/excavation studies will be conducted at two locations along this line where reports indicate that problems with exfiltration have occurred. The two locations are described below.

Between Manholes 45 and 46

The sewer line is an 18-inch diameter VCP in 3-ft sections. An exfiltration source was found during an investigative excavation in 1980. Soil under the pipe was saturated and discolored, and dark sludge surrounded the pipe. The pipe was determined to have probably collapsed and was subsequently repaired by forming mortar around the pipe. Bells in both exposed joints were broken, cracked, and dripping during the investigation. The bottom of the pipe was also cracked. The pipe had poor slope--almost in the opposite direction of the gradient. The exact location was 81 ft downstream from Manhole 46.

Between Manholes 34 and 35

The sewer line is an 18-inch diameter VCP in 3-ft sections with bell and spigot ends. This pipe was found to be in good condition in 1980. However, examination found the mortar on the joints had cracks with some exfiltration. This exfiltration occurred 112 ft upstream of Manhole 34.

Table 3.4-6. Interceptor Sewer Line Manholes to be Investigated.

Manhole No.	Material of Construction	Condition*
10	brick	unknown
11	brick	poor
24	brick	poor
25	unknown	unknown
26	unknown	unknown
27	brick	poor
28	brick	poor
29	unknown	unknown
30	brick	unknown
35	unknown	unknown
36	unknown	unknown
37	brick	poor
38	brick	poor
39	brick	poor
40	brick	poor
41	unknown	unknown
44	brick	poor
45	brick	unknown
46	brick	unknown
78	brick	unknown
79	brick	poor
80	unknown	unknown

* Information indicating that manholes are in poor condition was obtained from the 1979 and 1980 Black and Veatch investigations (Black and Veatch Consulting Engineers, 1979; 1980).

3.5 CHEMICAL SEWER SYSTEM

3.5.1 <u>Sites to be Investigated</u>

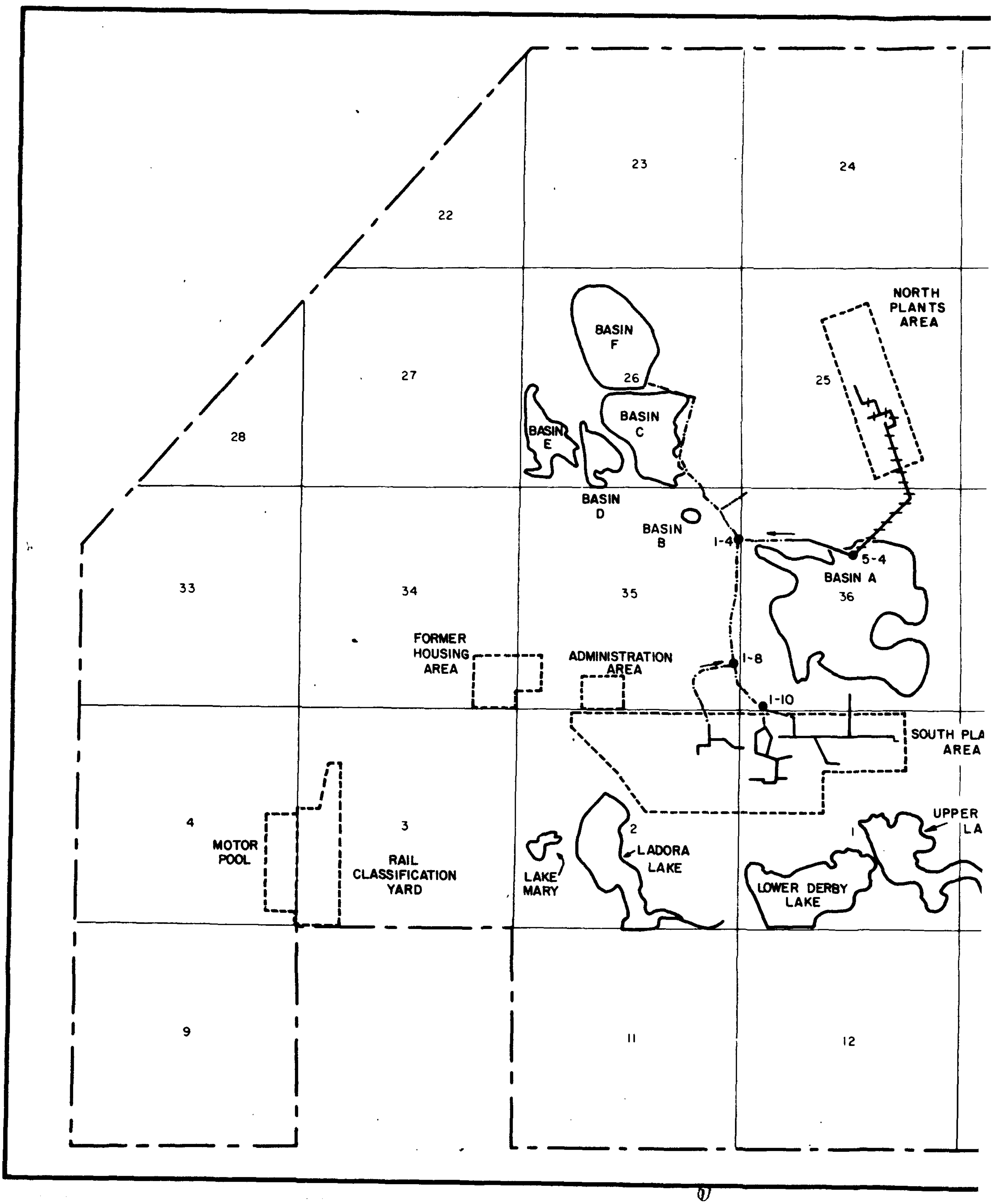
Only the North Plants and the South Plants areas are serviced by the chemical sewer system. Figure 3.5-1 presents an overview of the chemical sewer system on RMA. The two separate arteries serving these areas formerly merged in the northeastern corner of Section 35 and formed one chemical sewer line which discharged into Basin F. The Army removed the majority of these chemical lines in 1982. Manhole 5-1 on the sewer line from the North Plants manufacturing facility was plugged. Manholes and sumps in the South Plants were left in place, and the downstream ends of the sewer lines were plugged at December 7th Avenue.

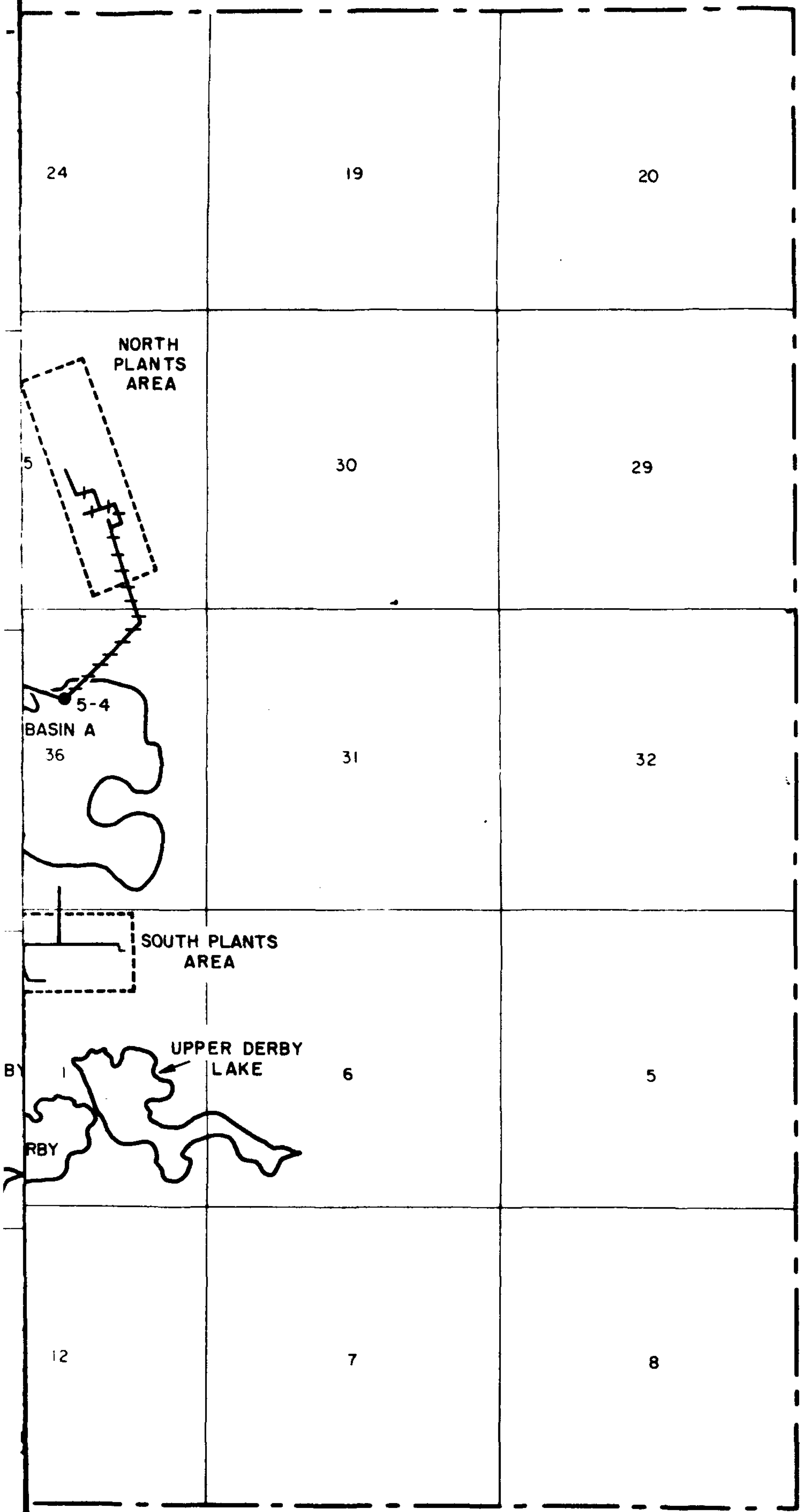
Over 36,500 ft of sewers remain in these areas. The majority of the system in the South Plants consists of VCP, while much of the chemical sewer system in the North Plants area was constructed of welded steel pipe. Each of the individual chemical sewer systems are discussed in more detail below.

3.5.1.1 South Plants

Most of the below-ground chemical sewer system was built in 1942. Figure 3.5-2 displays the South Plants area chemical sewer system. It is constructed primarily of 5-ft lengths of VCP varying from 4 to 12 inches in diameter with oakum-cement joints. Although the chemical sewers are primarily a gravity system, several force mains exist in the system. In the early 1980s, the Army stopped using the gravity system and constructed several steel force mains leading to a local waste treatment facility in the South Plants (the South Plants Laboratory Waste Treatment Facility).

Shell ceased discharging chemical wastewaters to Basin F in the late 1970s and subsequently plugged the chemical sewer lines leading from South Plants to Basin F. Shell abandoned use of the underground chemical sewer system in the South plants area in 1981 following the completion of an overhead collection system. The original system was abandoned in place.


23
24
22
NORTH
PLANTS
AREA
BASIN
F
27
26
25
BASIN
C
BASIN
E
28
BASIN
D
BASIN
B
1-4
5-4
BASIN A
33
34
35
36
FORMER
HOUSING
AREA
ADMINISTRATION
AREA
1-8
1-10
SOUTH PLA
AREA
UPPER
LA
4
MOTOR
POOL
3
RAIL
CLASSIFICATION
YARD
LAKE
MARY
2
LADORA
LAKE
1
LOWER DERBY
LAKE
9
11
12



Legend

- Contaminated Waste Main
- Waste Main Removed by the Army in 1982
- 1-8 Manhole with Number
- Direction of Flow
- Steel Sewer Lines

NOTE : All contaminated waste pipes are vitrified clay unless otherwise noted.

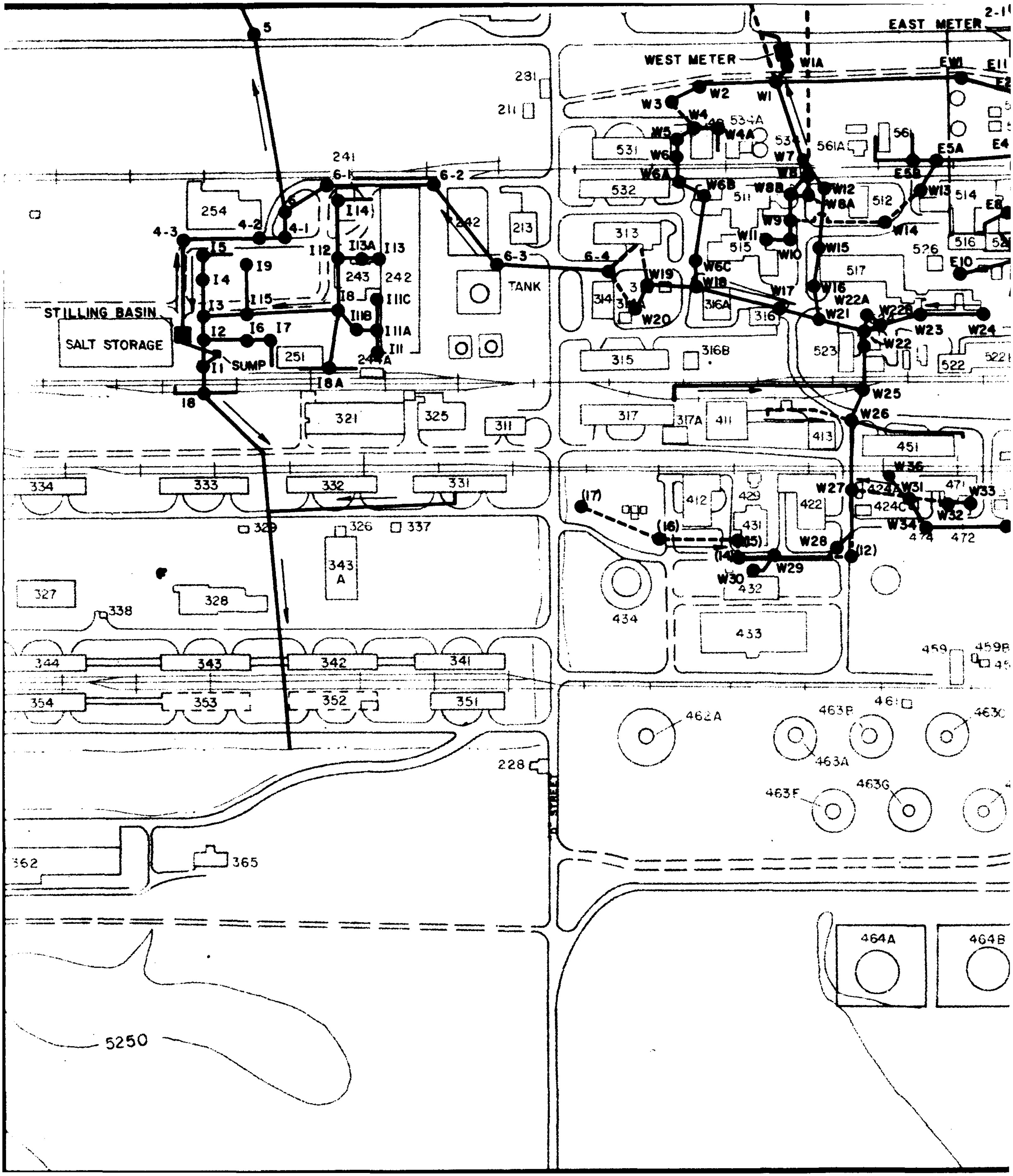
N

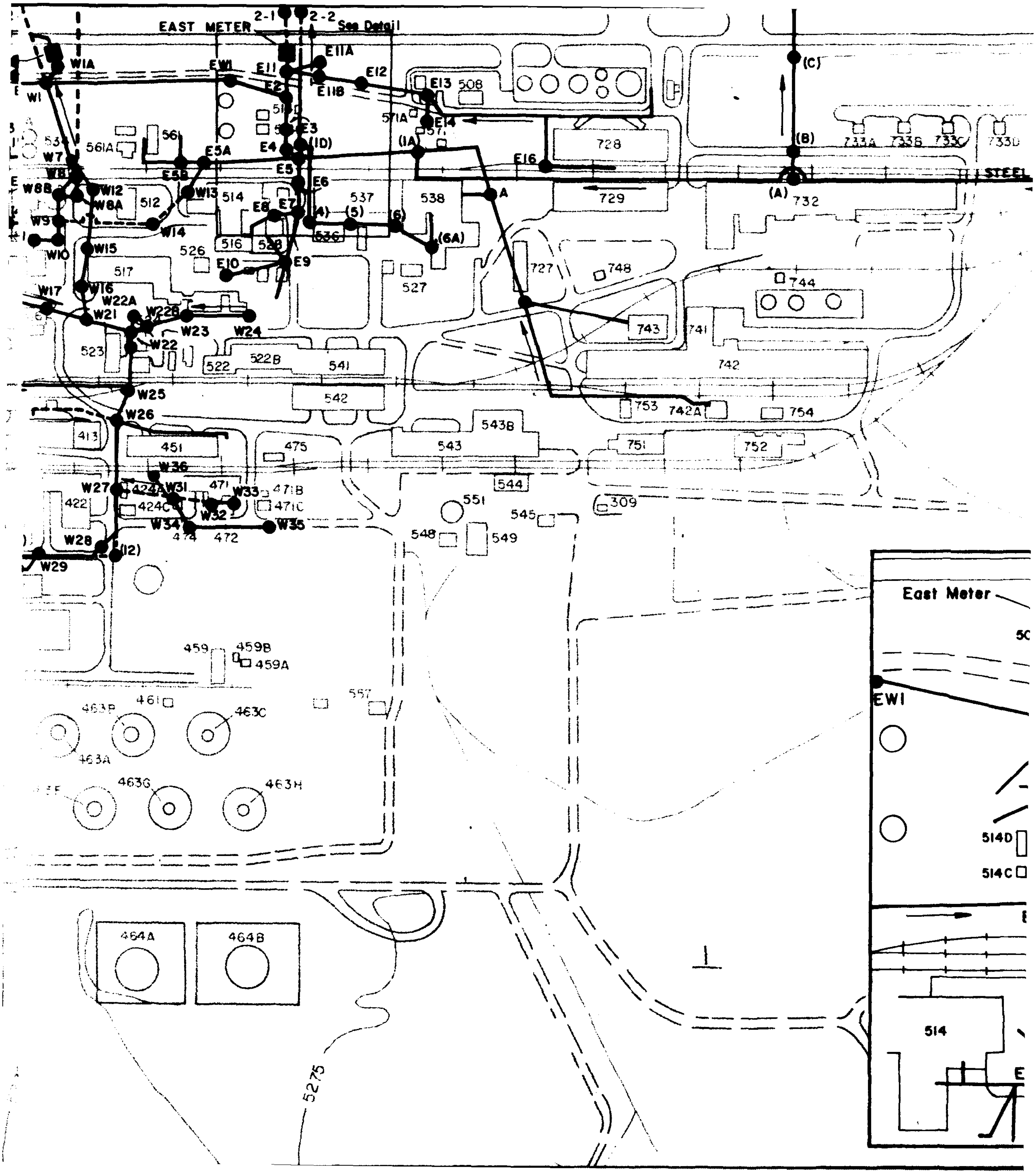
0 2000 4000 6000
FEET

Prepared for :

Program Manager's Office for
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

FIGURE **3.5-1**
Location Map for the Chemical Sewer System
Rocky Mountain Arsenal, Task 10
Prepared by: Ebasco Services Incorporated


EAST METER
WEST METER
STILLING BASIN
SALT STORAGE
SUMP
TANK
5250



EAST METER
2-1
2-2
See Detail
W1
W1A
W7
W8
W8B
W8A
W9
W10
W12
W13
W14
W15
W16
W17
W21
W22A
W22B
W22
W23
W24
W25
W26
W27
W28
W29
W31
W32
W33
W34
W35
W36
EW1
E11
E11A
E11B
E12
E13
E14
E16
E2
E3
E4
E5
E5A
E5B
E6
E7
E8
E9
E10
(1D)
(1A)
(4)
(5)
(6)
(6A)
(12)
A
(A)
(B)
(C)
STEEL
508
512
514
516
517
522
522B
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526
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543B
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561A
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571A
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424A
424C
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463A
463B
463C
463G
463H
464A
464B
471
471B
471C
472
474
475
727
728
729
732
733A
733B
733C
733D
741
742
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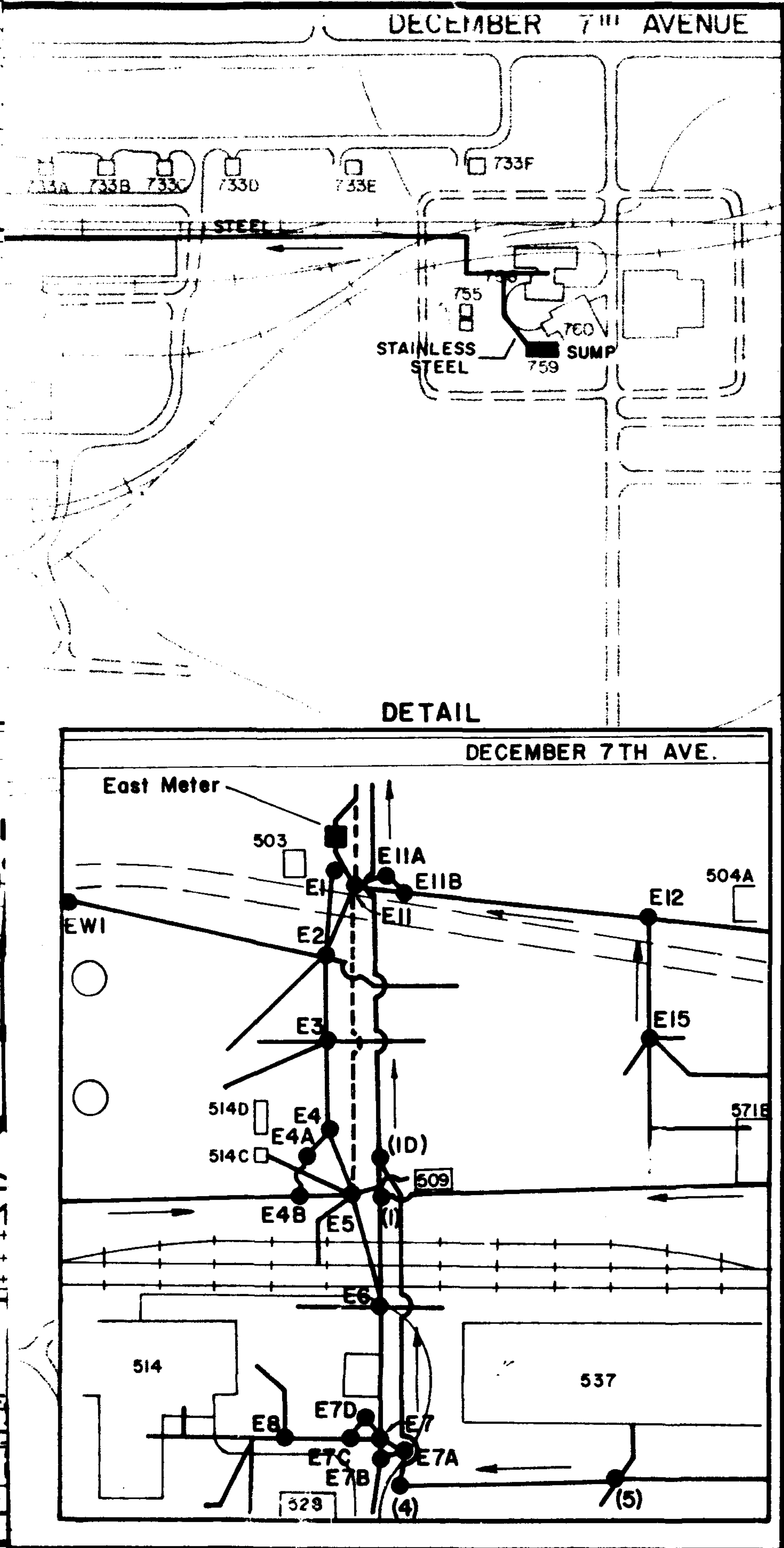
5275
East Meter
EW1
514D
514C
514



LEGEND

Sanitary Sewer Main

Manhole, With Number

Direction of Flow

N

0 300 600

FEET

Prepared for:

Program Manager's Office for
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

Drafted: 10/22/86

FIGURE 3.5-2

South Plants Area

Chemical Sewer System

Rocky Mountain Arsenal, Task 10

Prepared by: Ebasco Services Incorporated

(3)

There are approximately 19,000 ft of chemical sewer lines serving the entire South Plants area. Since its initial construction, extensive modifications to the chemical sewer system in the South Plants have taken place as a result of plugs, leaks, explosions, and other problems. Two areas in particular have been repeatedly repaired and/or rerouted. One is the north-south line east of Buildings 514 and 516. It was replaced from Manhole E7 to the east meter pit. Manholes E1 through E7 were also replaced. The sewers in the vicinity of Building 534B were also extensively modified. Sewer lines in this area connecting Manholes W4, W4A, W3, and W2 have been repeatedly replaced and/or rerouted. Unfortunately, many of these changes were made in the field with little apparent attention to adequate documentation of the date or details of the repairs.

Flow in the chemical sewers was generally northward. Portions of the chemical sewer system west of "D" Street formerly composed the caustic waste system. This area of the South Plants, west of "D" Street and south of December 7th Avenue, formerly contained the chlorine manufacturing facility. Caustic wastes from this facility were intended to flow northward to an evaporation basin (Caustic Waste Basin) in Section 35 for disposal. However, this line was never used (Donnelly, 1959). In 1956, this caustic waste system was connected to the chemical sewer line leading to Basin F. The outlet to the evaporation basin was then plugged and abandoned.

A nontoxic contaminated waste system, called the industrial system (I prefix manholes), was installed in the chlorine manufacturing area to collect surface water drainage and salt-contaminated wastes from the chlorine plant. Originally, this system discharged to the Sand Creek Lateral. In 1956, a baffle was installed in Manhole I1 which diverted low flows to a new sump and pump station. The pump station discharged the wastes to Manhole 4-3 and the chemical sewer system. High flows, such as those caused by intense rainstorms, would overflow the baffle to the Sand Creek Lateral.

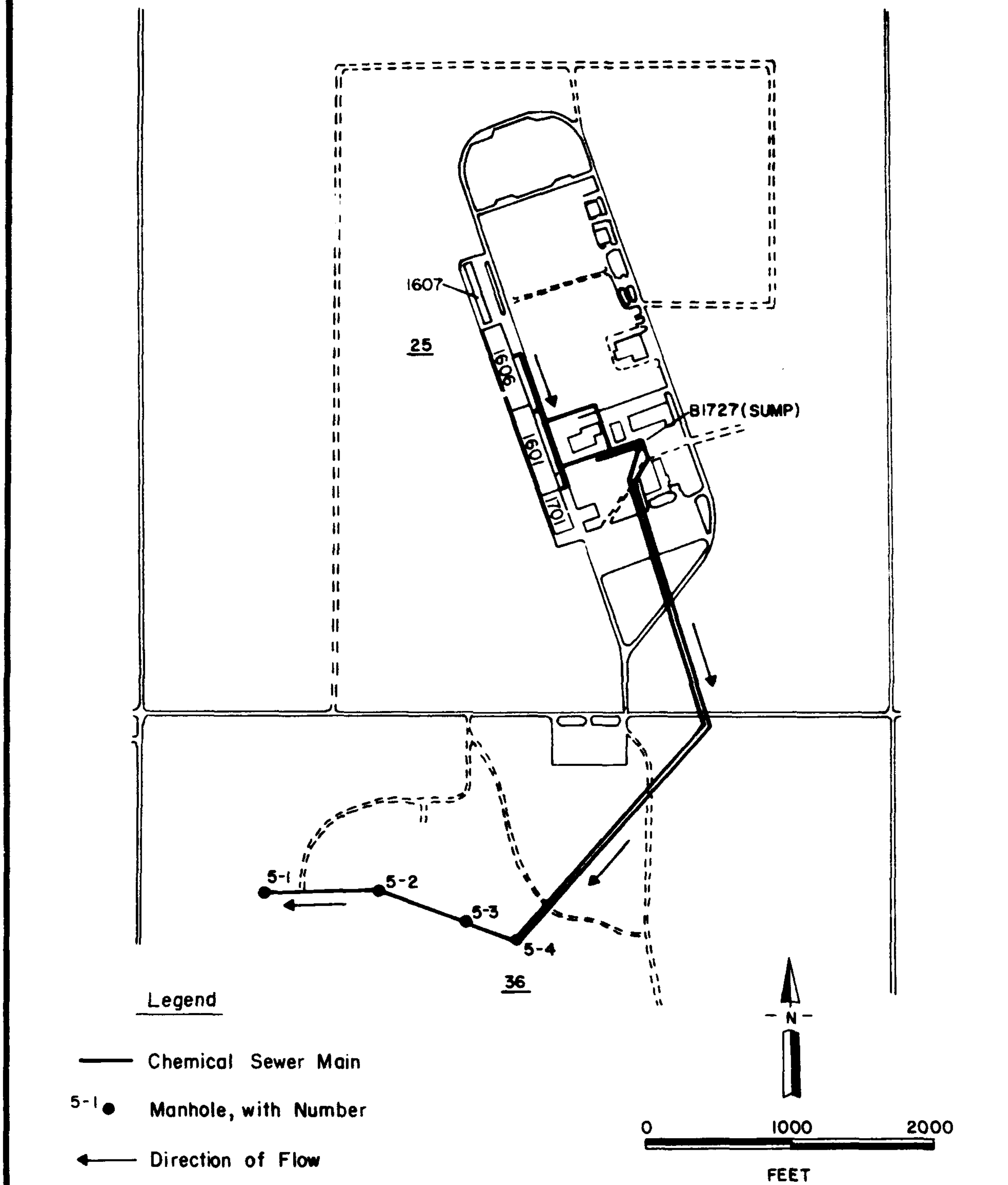
The chemical sewer system east of "D" Street can be roughly separated into two northward-flowing arteries. The western artery has manholes numbered with a

W prefix and includes Manholes W1 through W37. The lower the number following the letter prefix, the further that manhole is downstream. Thus, Manhole W1 is at the farthest downstream location on the artery and W37 is in the very upstream reach of the artery. Some segments of this line contain manholes without the W prefix. This western arterial formerly exited the South Plants approximately 400 ft east of the Fire Station. Today, the downstream terminus of the western arterial is plugged at the west meter pit in the vicinity of Building 502. The eastern artery of the chemical sewer system comprises sewer lines connecting Manholes E1 through E16 and some manholes without the E prefix. This eastern artery formerly exited the northern side of the South Plants with two lines approximately 900 ft east of the Fire Station. Today, the lines are plugged near the east meter pit in the vicinity of Building 503.

3.5.1.2 North Plants

The North Plants chemical sewer system was built in 1952 along with the initial construction of the GB Plant. Cast iron and steel piping, rather than VCP, were used to plumb the system in this area. The system is illustrated in Figure 3.5-3.

Chemical sewer lines in the North Plants originate from Buildings 1606, 1601, and 1701, located along the western margin of the facility. The lines proceed eastward for approximately 500 ft to the lift station sump in Building 1727. Two pressure discharge lines emanate from the lift station, a 6-inch diameter cast iron line and a 12-inch diameter steel line. The two parallel lines proceed southeastward and exit the facility. After the lines pass beneath Eighth Avenue and enter Section 36, they turn southwestward toward Basin A. These lines formerly discharged into Basin A. Following construction of Basin F in 1957, VCP extensions were added to the cast iron and steel pipes to redirect downstream discharges to the new basin. This 8-inch VCP line proceeded westward across the northern portion of Section 36 (north of Basin A) and merged with the chemical sewer line from the South Plants area directly west of "D" Street. Approximately 1,600 ft of this VCP line is still intact in Section 36. This line has been plugged at Manhole 5-1. The sewer lines remaining within the North Plants facility were likewise plugged.



Prepared for:

Program Manager's Office for
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

FIGURE 3.5-3
North Plants Area
Chemical Sewer System

Rocky Mountain Arsenal, Task 10

Prepared by: Ebasco Services Incorporated

3.5.1.3 Removed Chemical Sewer Lines

In 1982, the Army removed approximately 15,000 ft of 8-, 10-, and 12-inch diameter VCP in Sections 26, 35, and 36 (refer to Figure 3.5-1). Most of the removed lines were part of the chemical sewer system which transported contaminated wastewater from the South Plants area to Basin F. A portion of the VCP line on the North Plants chemical sewer line was also removed.

The removed sections of the chemical line are being investigated as Sites 26-9 and 35-2 under Task Order 14, and Site 36-20 under Task Order 1. No additional work for this section of the sewer system will be conducted as part of Task 10. However, information obtained from Tasks 1 and 14 will be integrated into the Task 10 contamination assessment report.

3.5.2 Field Investigation Program

The chemical sewer system's designated purpose was to collect and transport contaminated wastes to designated disposal sites. Any leaks in this system would definitely be sources of contamination for soil and possibly for groundwater. The field program will augment available information in the literature and will be used to assess the extent and the pattern of contaminant migration from the system.

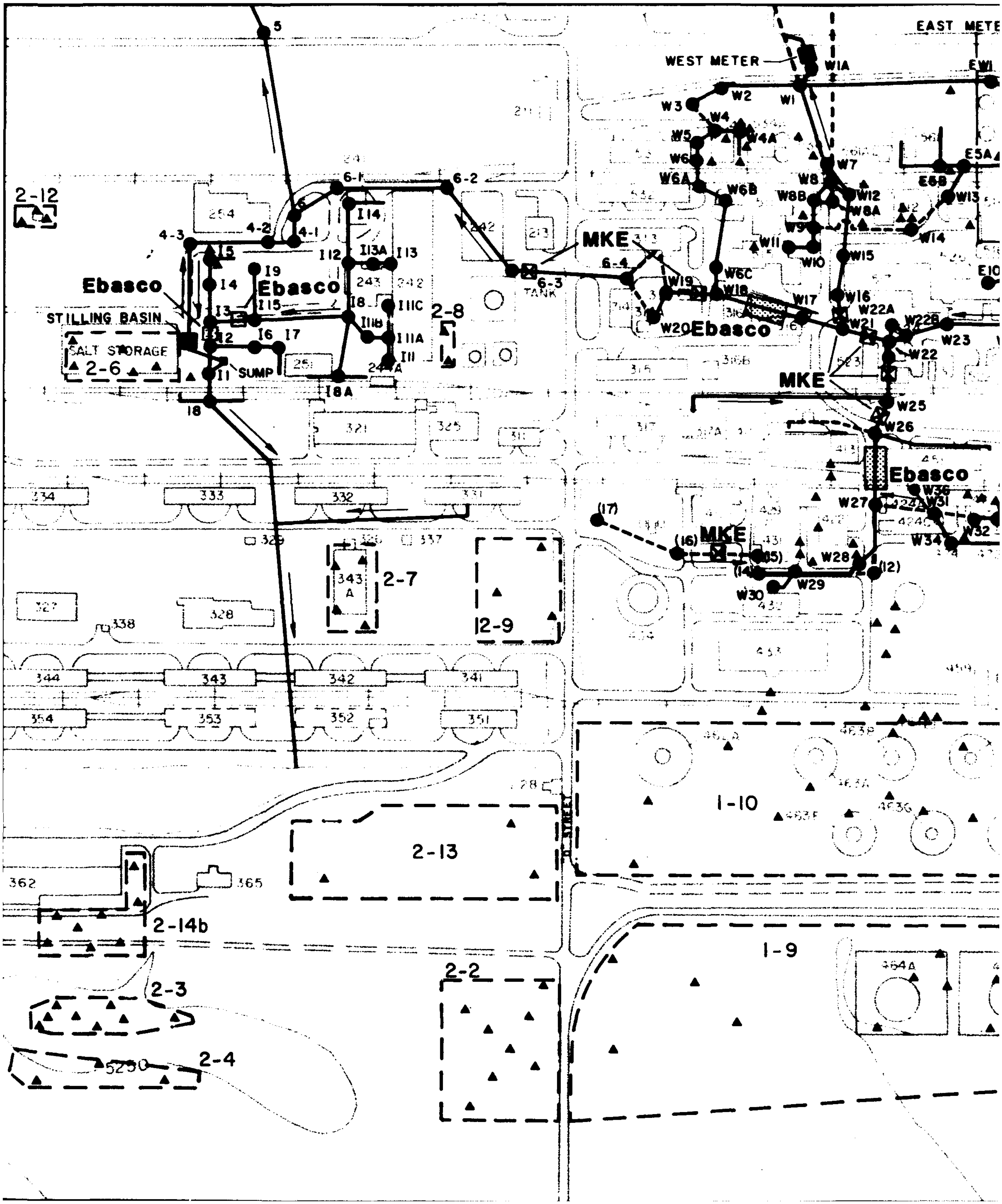
The program has four phases identical to the program used for the sanitary sewer system. However, all of the chemical system is considered contaminated, eliminating the need to determine if segments are uncontaminated. Phase 1 will consist of a manhole reconnaissance survey of selected manholes to determine candidate sites for the manhole sampling program. The manhole drilling program is the second phase and will consist of collecting soil samples from beneath the manhole bottoms. Hydrostatic testing of lift station pressure lines composes Phase 3. The last phase is a dye and excavation study of selected sewer line segments to assess the potential for leakage from pipe joints and cracks, and will aid in assessing the migration pattern of any leaked contaminants.

3.5.2.1 South Plants

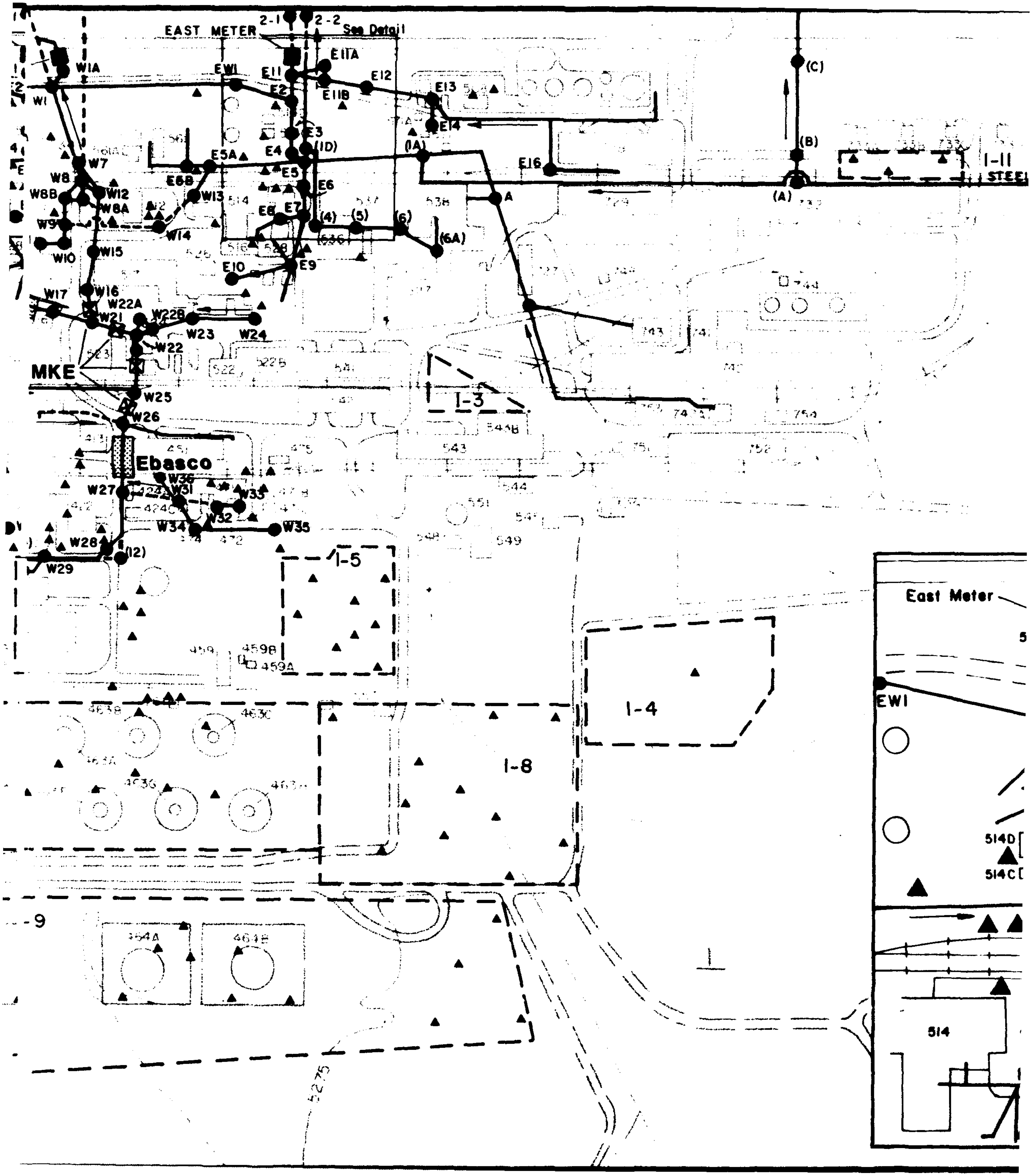
Information obtained as part of Ebasco's activities to monitor MKE's investigations indicate that a large segment of the chemical sewer lines in the South Plants, especially the "E" artery, was below the groundwater table. Recent information indicates that the groundwater table may be subsiding. Manholes and sewer segments below the groundwater table will be excluded from the field study, as the contaminated groundwater in the South Plants area will prevent determination of the exact source for the contaminated soils and water. Additionally, infiltration into these sewer sections is more likely than exfiltration of contaminants from the sewers.

Most of the chemical sewer system located in the "core" manufacturing zone of the South Plants will not be investigated. The widespread contamination in this zone, caused by numerous spills, makes it virtually impossible to distinguish sewer-related contamination from other sources of contamination. Task 2 and its follow-up Phase II investigation has concentrated, and will continue to concentrate, on the "core" manufacturing area. Figure 3.5-4 identifies the locations of boreholes associated with Task 2.

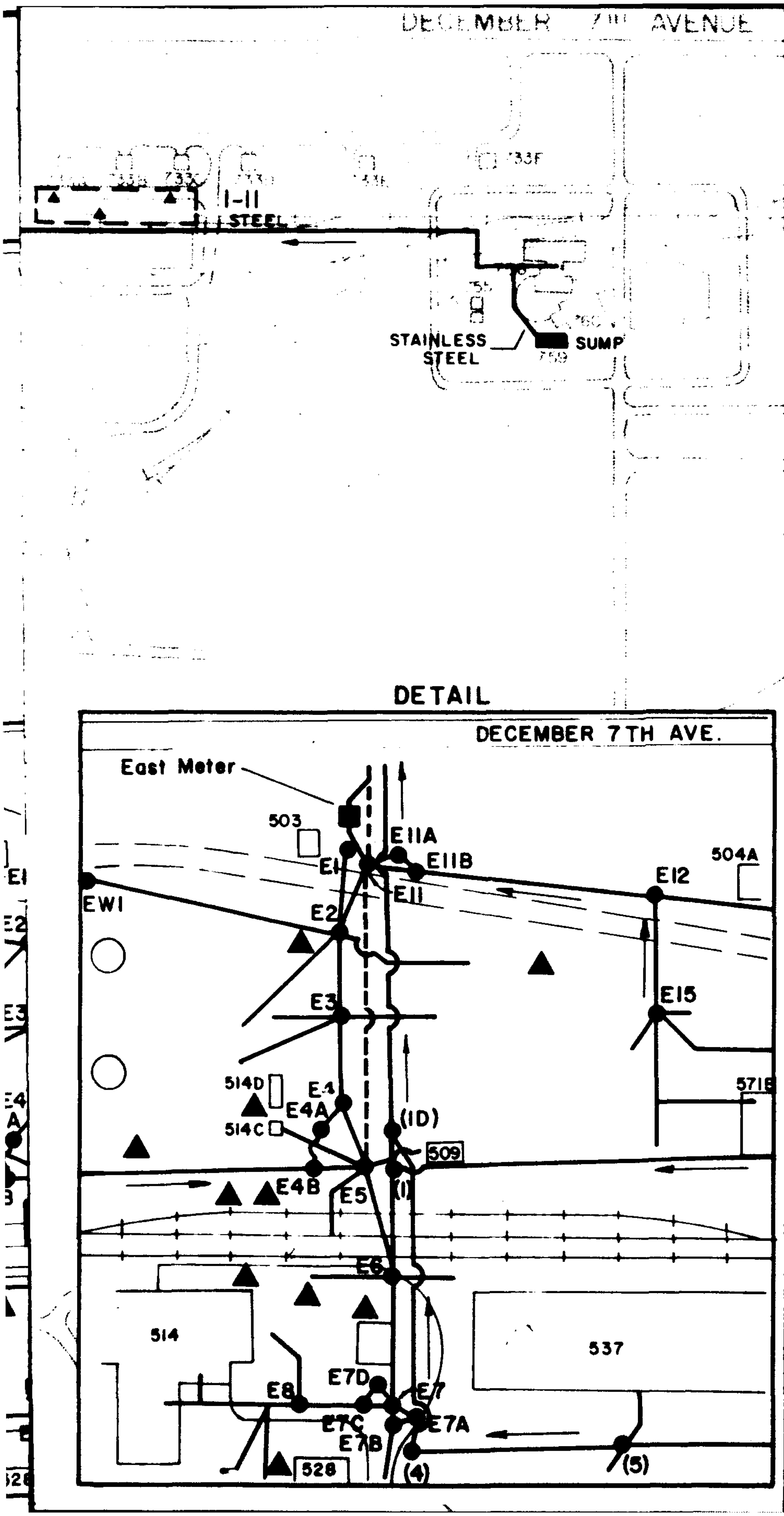
Selected chemical sewer manholes in the South Plants area will be investigated as part of the manhole reconnaissance survey. The manholes selected as part of this survey are listed in Table 3.5-1. Based on results of the reconnaissance survey, additional manholes may be added to this list. The results of this survey will be used to select manholes with the greatest potential for leakage. Selected manholes will be included in the manhole sampling program. Any leaks in the chemical sewer system would have resulted in contamination of the surrounding soil and possibly the groundwater. The "worst-case" manholes will be included in the sampling program. Soil samples will be collected at 5-ft intervals below the bottom of the manholes to the groundwater table. The intervals will be consistent with the intervals prescribed in Tasks 2, 7, 12, and 15 (intervals of 0-1 ft, 4-5 ft, 9-10 ft, 14-15 ft, etc.). The results of the chemical analyses of the soil samples will be used to assess the downward migration of any leaking contaminants.



EAST METE
WEST METER
W1A
EW1
Ebasco
STILLING BASIN
SALT STORAGE
2-6
2-12
SUMP
2-8
TANK
MKE
Ebasco
MKE
Ebasco
MKE
2-7
2-9
1-10
2-13
2-14b
1-9
2-3
2-2
2-4



EAST METER
2-1
2-2
See Detail
W1A
W1
EW1
E11
E11A
E12
E2
E11B
E13
E14
E3
(1D)
(1A)
E4
E5A
E5
E6B
W7
W8
W8B
W12
W8A
W13
E6
E7
E8
(4)
(5)
(6)
(6A)
W9
W14
W10
W15
E10
E9
W17
W16
W22A
W21
W22B
W23
W24
W22
MKE
W25
W26
Ebasco
W36
W27
W31
W33
W32
W34
W35
W28
(12)
W29
E16
(C)
(B)
(A)
A
1-11
STEEL
1-3
1-5
1-4
1-8
-9
East Meter
514D
514C
514



LEGEND

- ▲ Task 2 Bore Location
- ▦ Proposed Excavation Site
- ⊠ MKE Excavation Site
- —— Contaminated Waste Main
- ●° Manhole, With Number
- ←—— Direction of Flow

NOTE:

1. All contaminated waste mains are vitrified clay unless otherwise noted.

N

0 300 600

FEET

Prepared for:

Program Manager's Office for
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

Drafted: 10/22/86

FIGURE 3.5-4
Investigative Program South Plants Chemical Sewer System

Rocky Mountain Arsenal, Task 10

Prepared by: Ebasco Services Incorporated

Table 3.5-1. Manhole Investigation, Chemical Sewer System in South Plants.

Manhole No.	Material of Construction	Condition
(A)	unknown	unknown
(B)	unknown	unknown
(C)	unknown	unknown
4-1	unknown	unknown
6	unknown	unknown
6-1	unknown	unknown
6-2	unknown	unknown
I2	brick	unknown
I3	brick	unknown
I5	brick	unknown
W21	brick	unknown
W25	brick	unknown
W26	brick	unknown
W29	brick	unknown

Several lift stations and associated pressure force mains exist in the chemical sewer system in the South Plants. These include the 3-inch cast iron pipe (CIP) (approximately 60 ft) from Manhole I1, the 2 1/2-inch steel pipe (approximately 2,100 ft) from the hydrazine area, the 2-inch stainless steel line (approximately 180 ft) in the hydrazine facility, and the 3-inch lined steel pipe (approximately 600 ft) from Building 742A. These lines will be hydrostatically tested to determine their integrity and the possibility of these lines being sources for contamination.

Dye/excavation studies will be conducted at three sites in the South Plants area. The three sites are described below. Additional soil samples will be collected from the MKE pipeline excavation sites identified on Figure 3.5-4.

Chemical Sewer Between Manholes I2 and I3

The "I" line was initially installed as a storm water drainage system for the Series 200 buildings (the chlorine manufacturing area). This system originally discharged to the Sand Creek Lateral. In 1956 the flows were diverted to the chemical sewer system leading to Basin F by additions to the system including a diversion weir in Manhole I1. High flows, such as those caused by heavy rainfalls, could overflow the weir to the lateral.

Chemical Sewer Between Manholes W26 and W27

This section of the chemical sewer system is downstream of the Series 400 buildings which were used in the manufacturing, storage, and handling of military agents and several pesticides.

Chemical Sewer System Between Manholes W17 and W18

This segment of the chemical sewer is downstream of the laundry in Building 314 and downstream of Building 515, which was used for chlorinated pesticide production.

3.5.2.2 North Plants

The field program for the chemical sewer system serving North Plants is divided into two phases. The first phase will cover the dual-pressure lines from the lift station at Building 1727 to Manhole 5-4 in Section 36. The lines are approximately 4,000 ft long. One line is a 6-inch CIP and the other is a 12-inch steel line. The integrity of these lines will be checked with the hydrostatic test method. The second phase will involve collecting soil samples from the two MKE excavation sites on the VCP line between Manholes 5-1 and 5-4. The location of these excavations are indicated on Figure 3.5-5.

3.6 PROCESS WATER SYSTEM

3.6.1 Sites to be Investigated

The Process Water System (PWS), including distribution and return lines, was constructed in 1942 during the initial construction of RMA. The PWS was installed to remove heat from, and provide water to, various manufacturing processes. It also provided water for fire protection. The system originally took water from Ladora Lake, transported it to user buildings, and after passing through various pieces of heat exchange and cooling equipment, the water was returned to Upper Derby Lake and eventually back to Ladora Lake, with one exception. Process water passing through the overflow drain of the spray pond (Building 326) was discharged through a network of ditches and pipes to the Sand Creek Lateral. The system in use today (Figure 3.6-1) has undergone a major revision from the original design. A closed-loop cooling tower system for the East Plants section of South Plants was placed into operation in December 1964. This system did not include any of the lakes (Culley, 1971), except as makeup water. The closed system was designed to reduce the possibility of future contamination of the lakes. The PWS for the West Plants area of South Plants, the North Plants area, and the Administration area has remained relatively unchanged. In addition, the return system from South Plants has been rerouted to Lower Derby Lake.

Currently, the PWS supplies water only for fire protection and for the boiler operation. The entire PWS fire protection system consists of over 100 fire hydrants and several indoor sprinkler systems. A recent survey found that the PWS was in poor condition; corrosion problems were prevalent throughout the system (Harland Bartholomew, 1982).

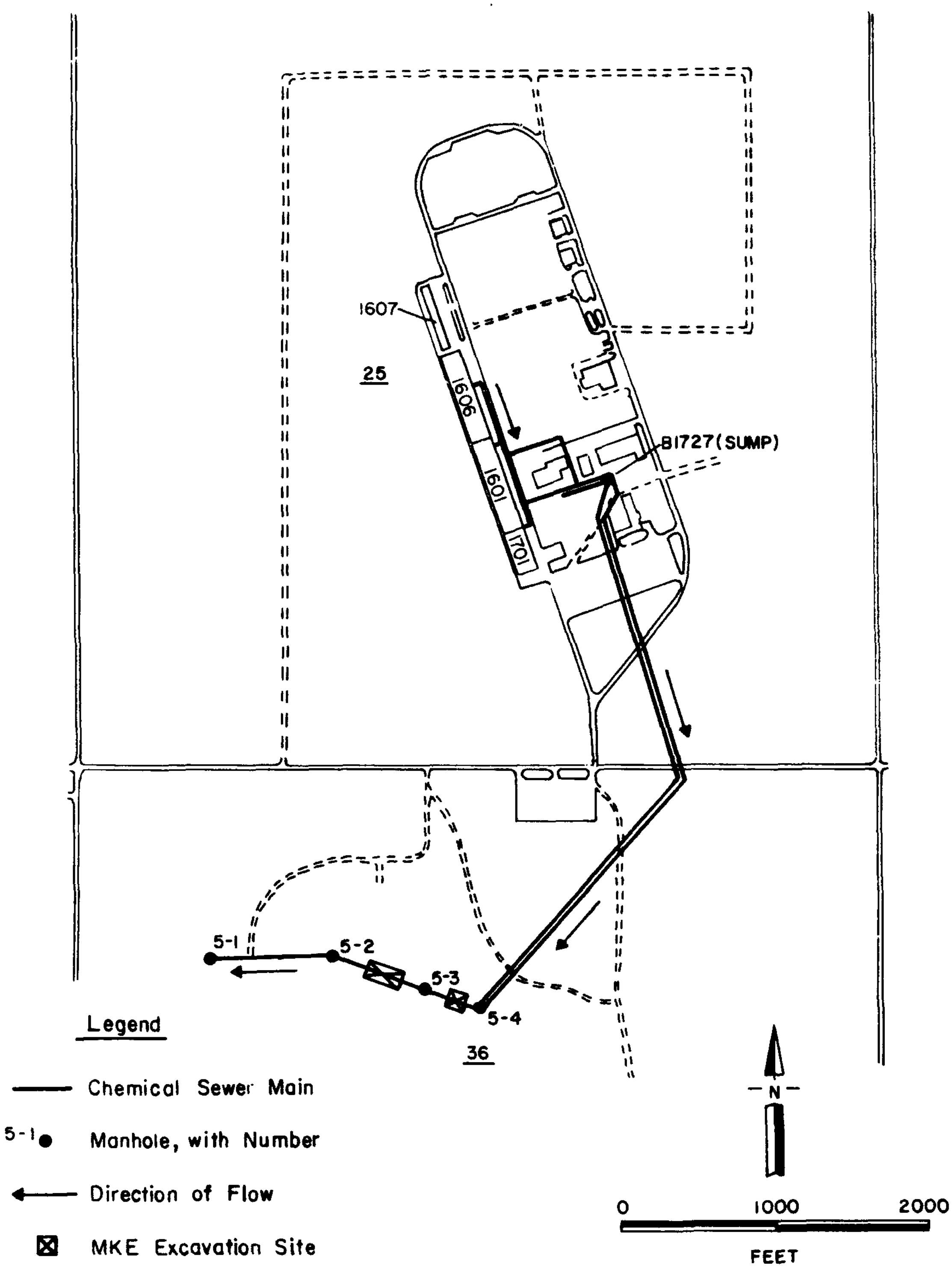


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FIGURE 3.5-5
North Plants Area - Chemical Sewer System Excavation Sites

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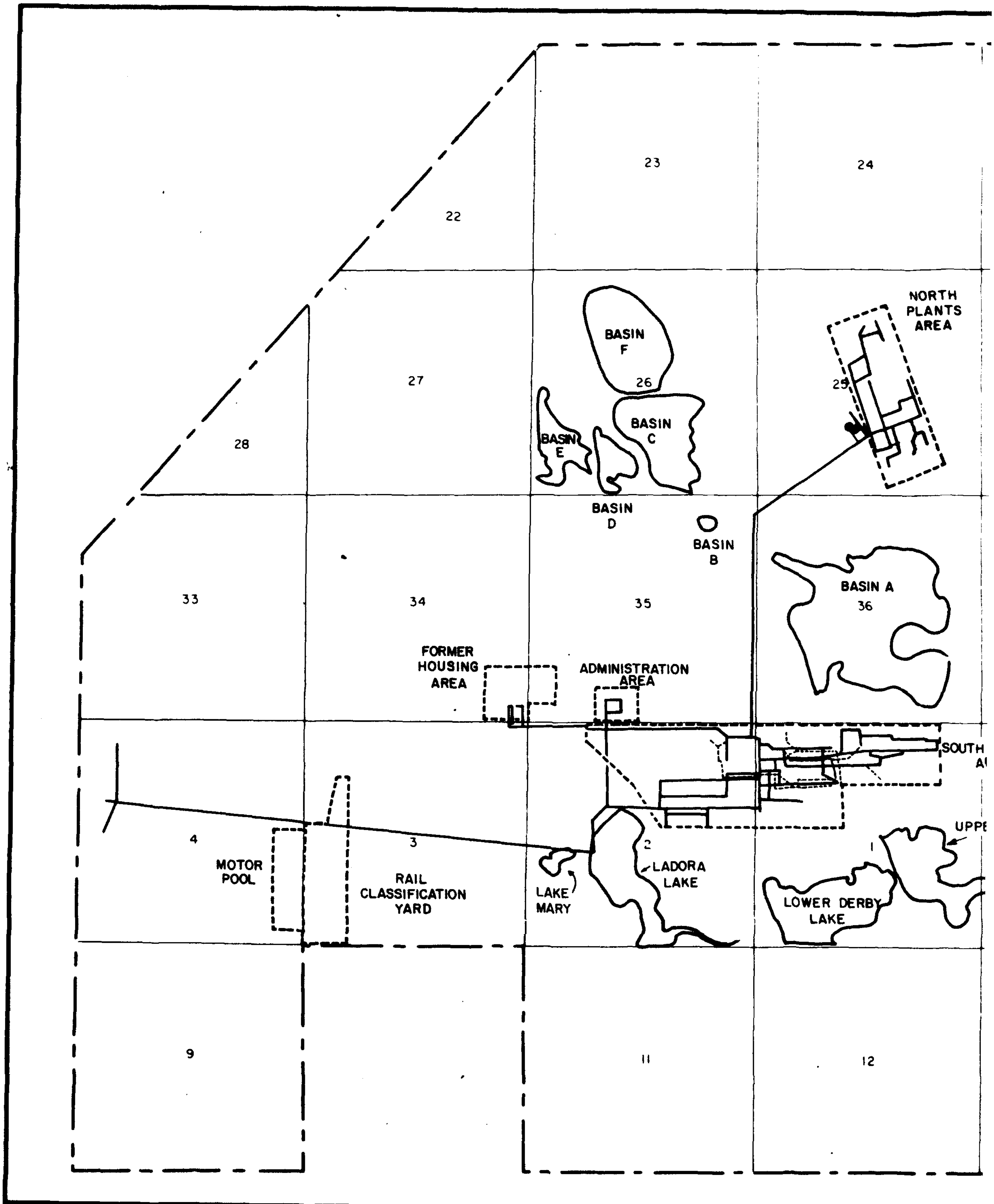
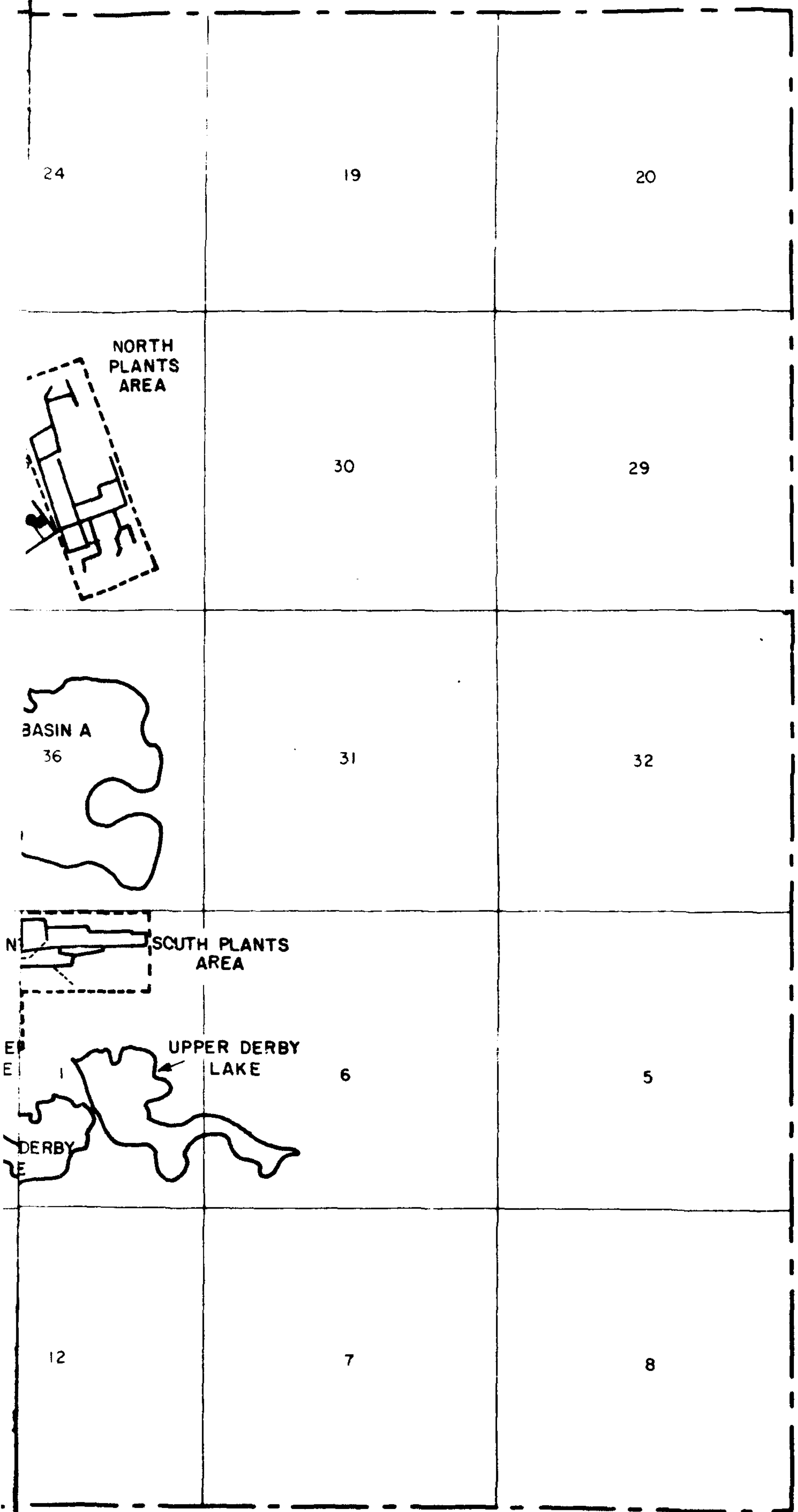

22
23
24
NORTH PLANTS AREA
BASIN F
27
26
25
28
BASIN C
BASIN E
BASIN D
BASIN B
BASIN A
36
33
34
35
FORMER HOUSING AREA
ADMINISTRATION AREA
SOUTH
4
3
2
1
MOTOR POOL
RAIL CLASSIFICATION YARD
LAKE MARY
LADORA LAKE
LOWER DERBY LAKE
9
11
12

(1)



Legend

Process Water Distribution System

Process Water Return System

-N-

0 2000 4000 6000
FEET

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FIGURE 3.6-1
General Location Map for the Process Water System

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For purposes of this investigation, the PWS is divided into four areas within the RMA: South Plants distribution and return, North Plants distribution, Administration distribution, and Sections 3 and 4 distribution.

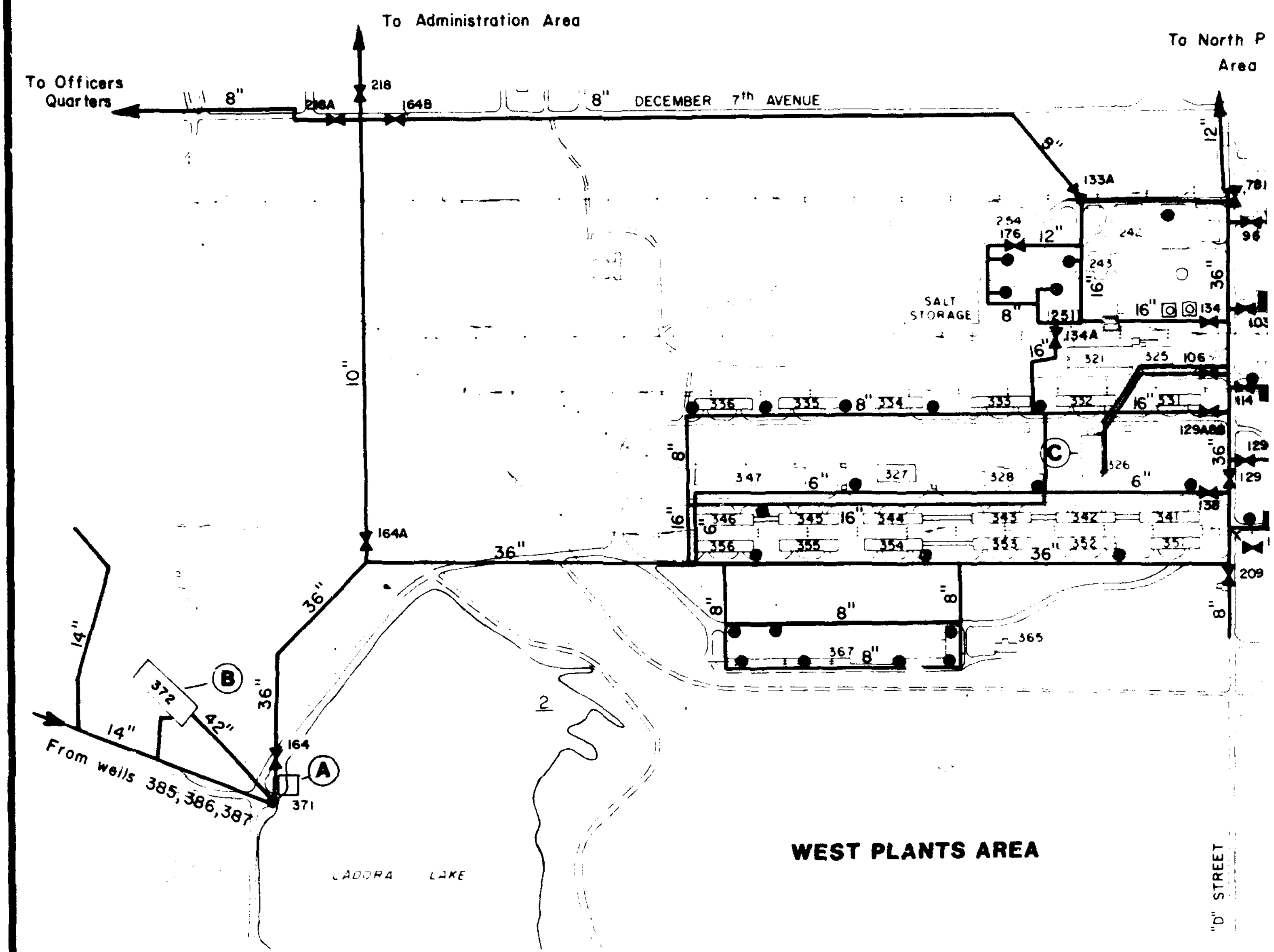
3.6.1.1 Area 1 - South Plants

The PWS in Area 1 provides cooling and process water for all manufacturing processes and fire protection water to the South Plants (Figure 3.6-2). In December 1964, the East Plants process water distribution system was converted to a closed system by Shell (Culley, 1971).

The new system uses the existing underground distribution and return piping, two 500,000 gallon storage tanks, a pumphouse, and a cooling tower. The system did not use the old "lakes" system for discharge of the used process water. The East Plants closed-loop system was separated from the old facility by four valves (96, 103, 114, and 130) connected to the 36-inch north-south main located along the eastern side of "D" Street within South Plants. Make-up water for the East Plants system is supplied through an 8-inch valve east of Building 431.

The return from the closed system discharges into a lift system instead of the lakes system (Figure 3.6-3). Two 4,000 gallons per minute (gpm) vertical turbine pumps, in the lift station, pump water to the wet well of the cooling tower pump house (Building 548). Three 3,500 gpm pumps, located in the pump house, lift process water into the cooling tower (Building 549). The cooling tower consists of a two-cell tower with a 7,000 gpm capacity. A 500,000 gallon reinforced concrete reservoir is located beneath the cooling tower. Three additional 3,500 gpm pumps, located in the cooling tower pump house, return process water from the concrete reservoir back into the process water distribution system. These pumps can also be used to lift process water into a 500,000 gallon elevated storage tank (Building 551).

The West Plants system, the facility west of "D" Street, has remained on the old "lakes" circulating system, wherein process water was pumped into the distribution system by three 7,000 gpm pumps located in the Ladora Lake pump house. In addition, the spray pond (Building 326) was designed to cool and



Legend

Ⓐ **Water Pump Station (Bldg. 371)**

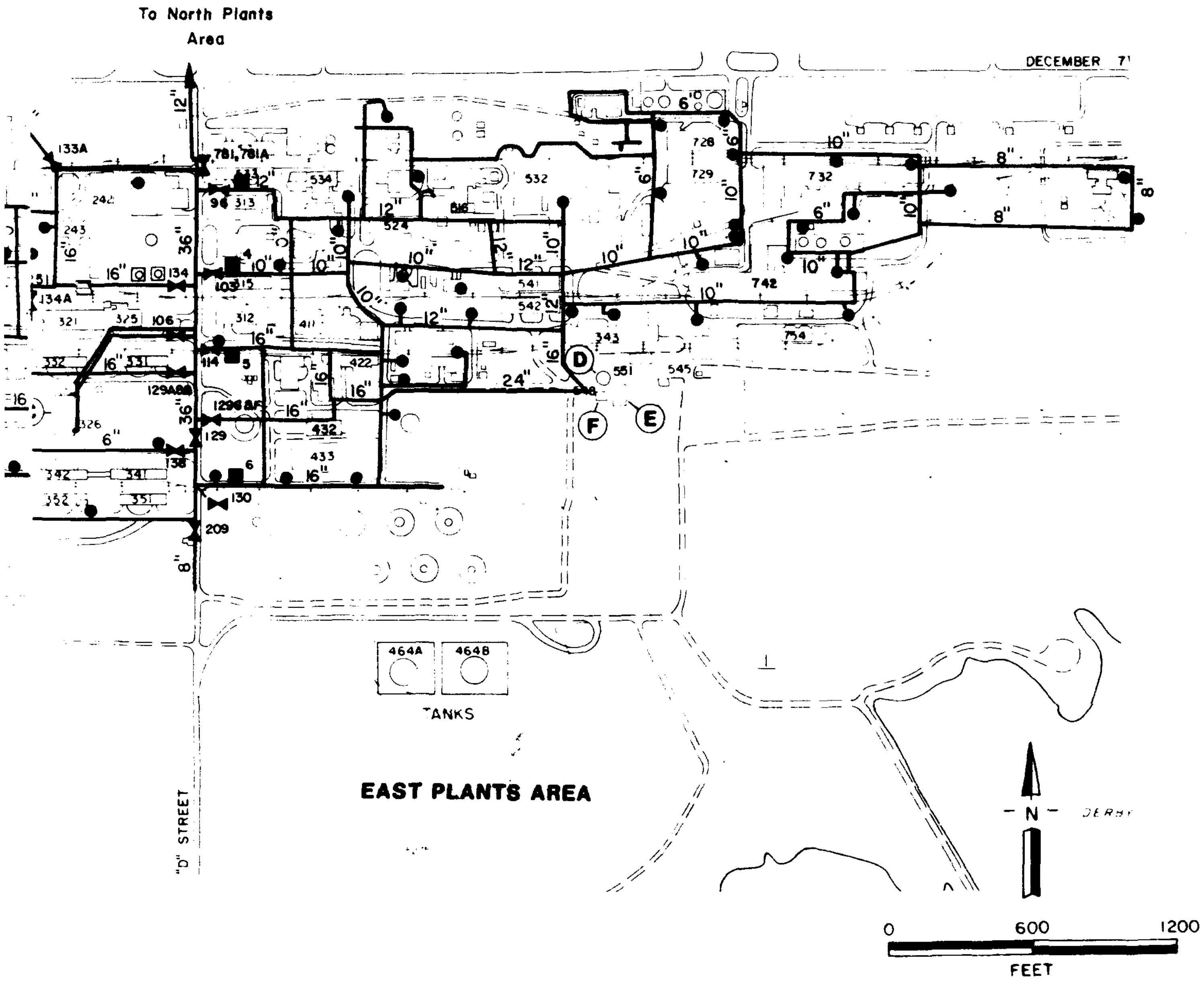
Ⓑ **Reservoir, 1,000,000 Gallon Capacity (Bldg. 372)**

Ⓒ **Spray Pond Structure and Spray House (Bldg. 326)**

Ⓓ **Elevated Water Storage Tank (Bldg. 551)**

Ⓔ **Cooling Tower (Bldg. 549)**

Ⓕ **Pump House (Bldg. 548)**



›nd

g Tower
549)

House
548)

———	**Process Water Line**
●	**Fire Hydrant**
⧗	**Valve**
■	**Meter**

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FIGURE 3.6-2

Area I Process Water System
South Plants Area

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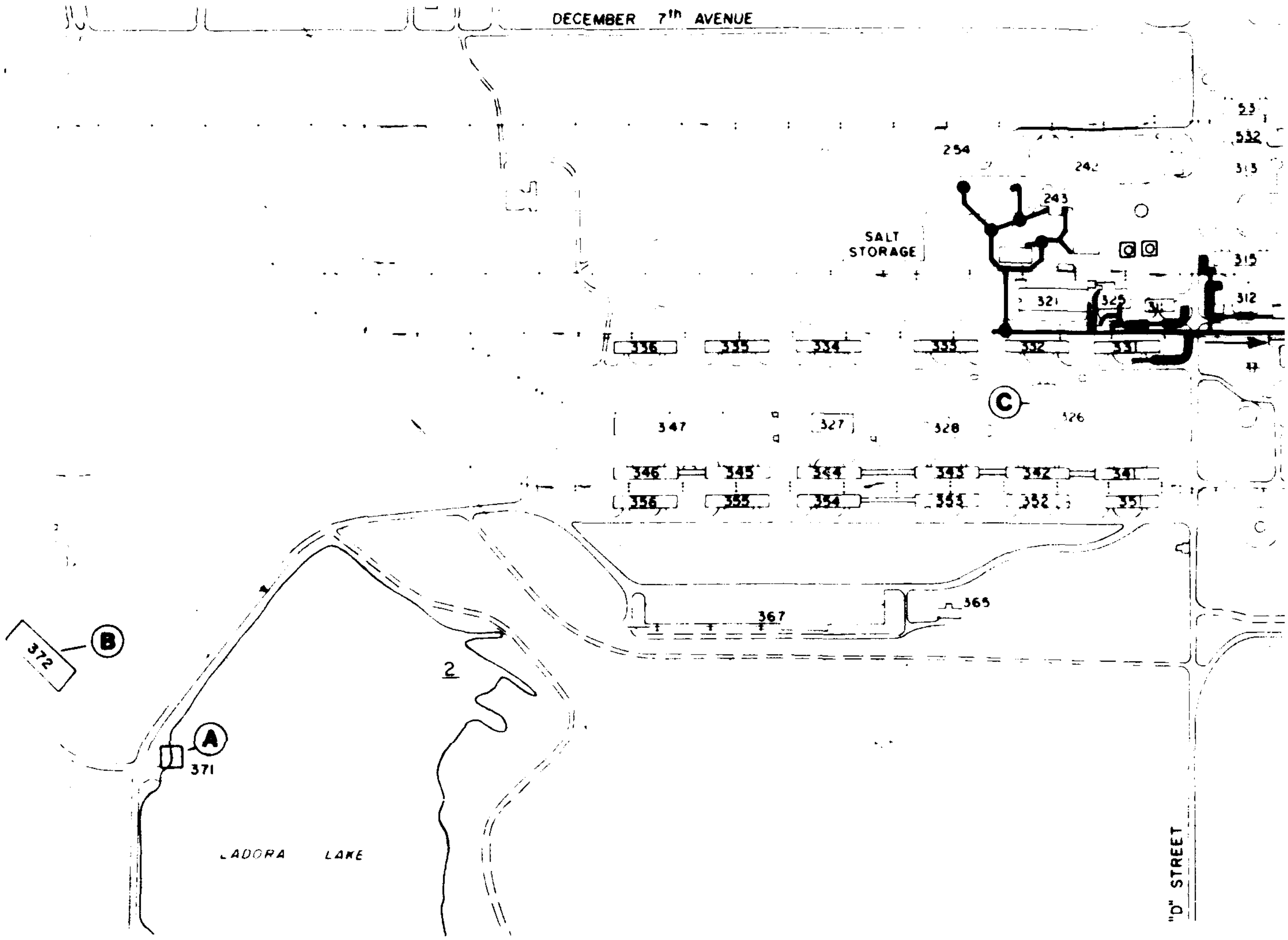


Legend

(A) Water Pump Station (Bldg. 371)

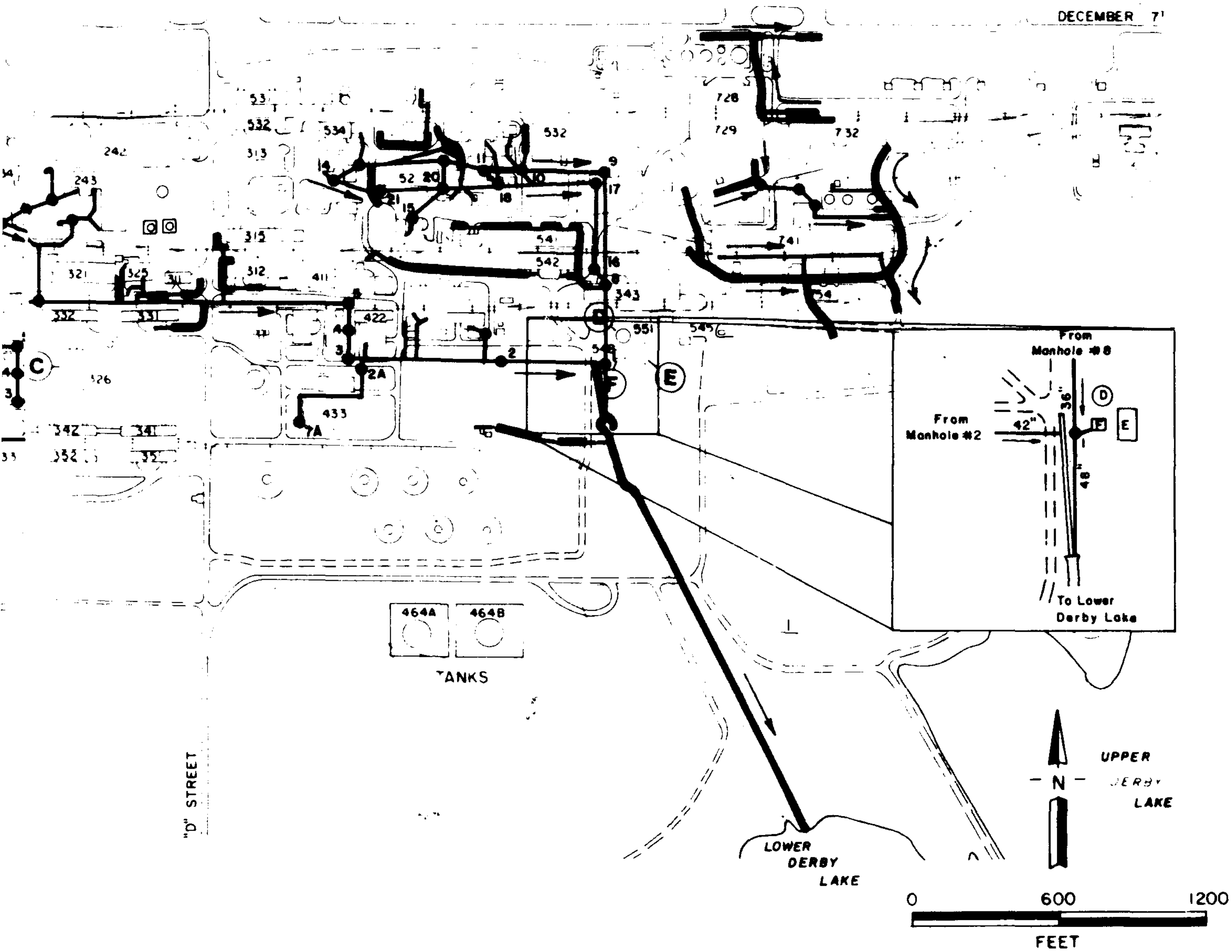
(B) Reservoir (Bldg. 372)

(C) Spray Pond Structure and Spray House (Bldg. 326)

(D) Elevated Water Storage Tank (Bldg. 551)

(E) Cooling Tower

(F) Pump House (Bldg. 548)



end

ng Tower

• Manhole

House

548)

Process Water Return System

Open Drainage Ditch

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FIGURE 3.6-3
Process Water Return System
South Plants Area
Rocky Mountain Arsenal, Task 10
Prepared by Ebasco Services Incorporated

recirculate process water used in the condensor to the turbine in the power plant (Building 325).

The return system in the West Plants restores water to the lakes system via the 42-inch main pipe which discharges to the return canal leading to Lower Derby Lake. In addition, an overflow return system located near the spray pond returns any overflow water to a drainage ditch which eventually ends up in the Sand Creek Lateral.

The South Plants complex has 62 fire hydrants and an unknown number of indoor sprinkler systems connected to the PWS (COE, 1984). A total number of 68 buildings are connected to the system. The type of process in each building connected to the system has not yet been determined.

3.6.1.2 Area 2 - North Plants

The PWS in Area 2 supplied water for fire protection and process cooling water to the North Plants facility during GB operations. The main line runs from the southeastern corner of Section 35 north, approximately 5,100 ft to the northeastern corner of the section. Near Building 831, the line runs northeastward across the northwestern corner of Section 36 for approximately 250 ft to the Section 25 boundary (Figure 3.6-4). From here the process water distribution system continues northeastward for approximately 3,000 ft to the GB operation facilities. Within North Plants, the system consists of 8-, 6-, and 4-inch pipes supplying water to 26 fire hydrants (Figure 3.6-5).

The process water used in the North Plants was not returned to the Lower Lakes but was either discharged to the GB Plant closed-loop system for reuse or to the chemical sewer system for disposal (Purcell, Undated). Blowdown from the North Plants cooling tower was discharged to storm sewer Manhole 10 which subsequently discharged to First Creek.

3.6.1.3 Area 3 - Adminstration Area

The PWS supplies water, through 8-, 6-, and 4-inch steel pipes, to six fire hydrants and an indoor sprinkler system (Building 111) for fire protection of the Administration area (Figure 3.6-6). The water is also used for irrigation.

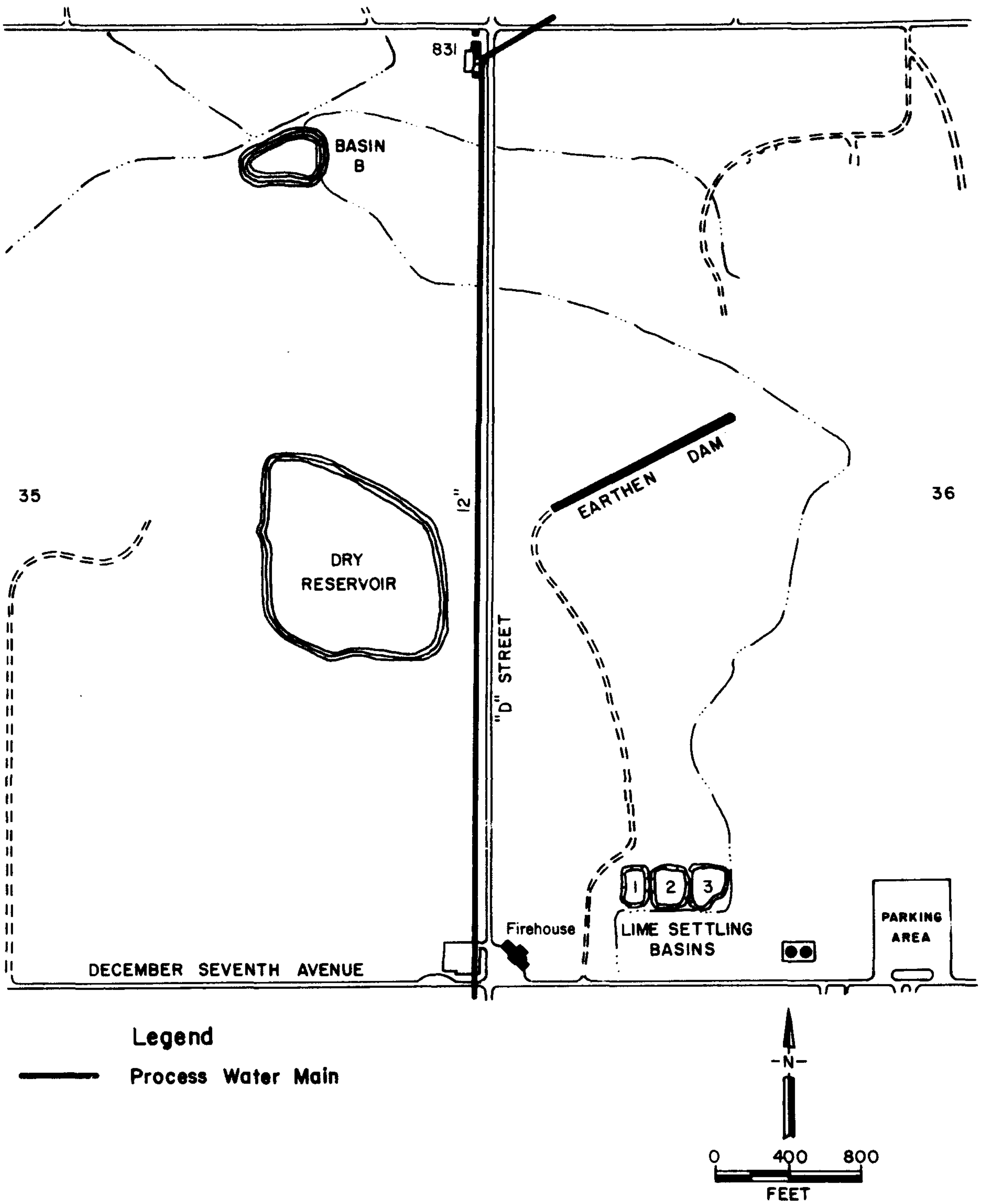

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FIGURE 3.6-4

Area 2 - Process Water System Sections 35 and 36

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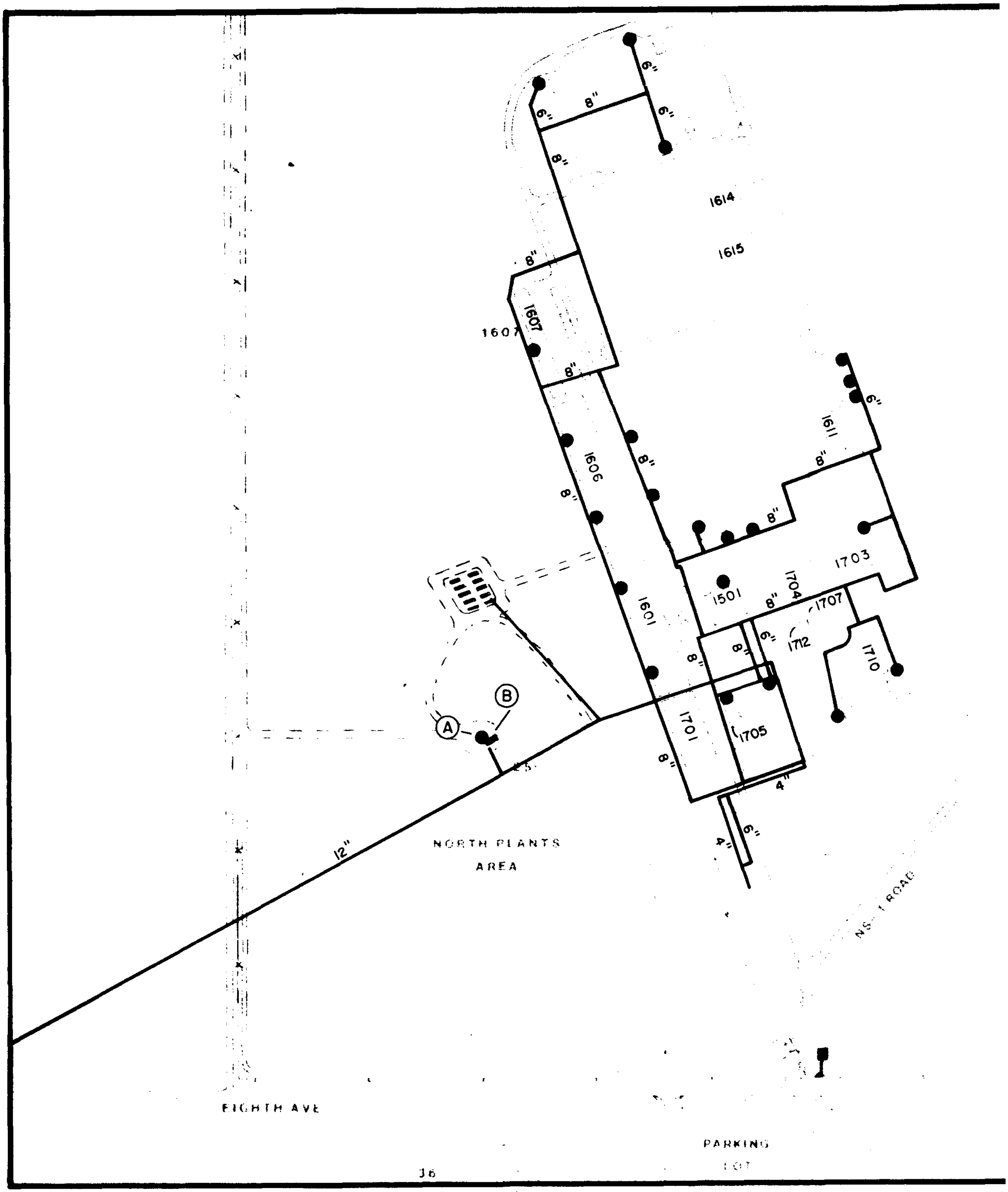
1614
1615
1607
1606
1611
1703
1704
1501
1707
1712
1710
1601
1701
1705
A
B
NORTH PLANTS
AREA
12"
8"
6"
4"
NS-1 ROAD
EIGHTH AVE
PARKING
36

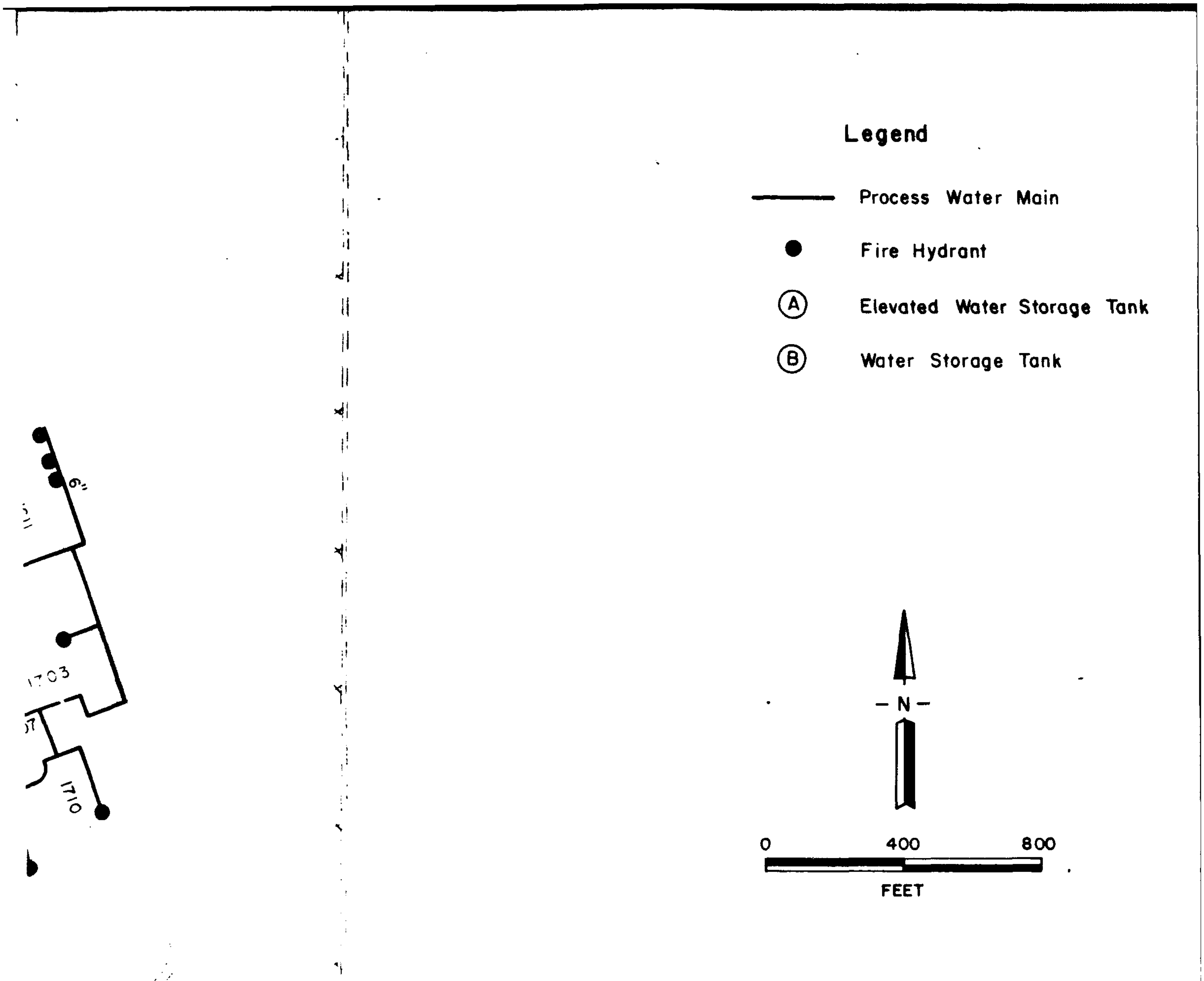

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FIGURE 3.6-5
Area 2 - Process Water System
North Plants

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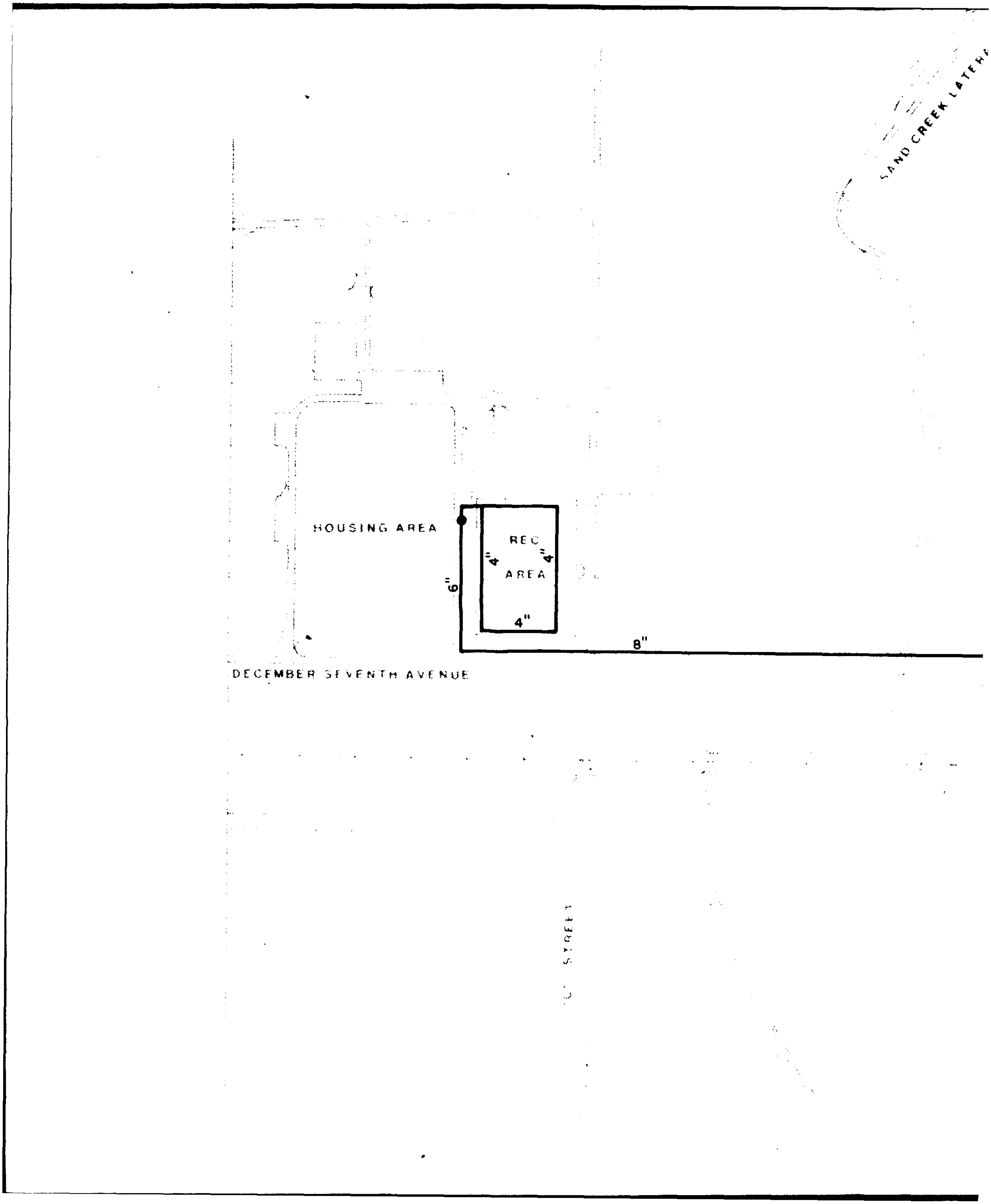
SAND CREEK LATERA
HOUSING AREA
REC
AREA
4"
4"
4"
6"
8"
DECEMBER SEVENTH AVENUE
STREET

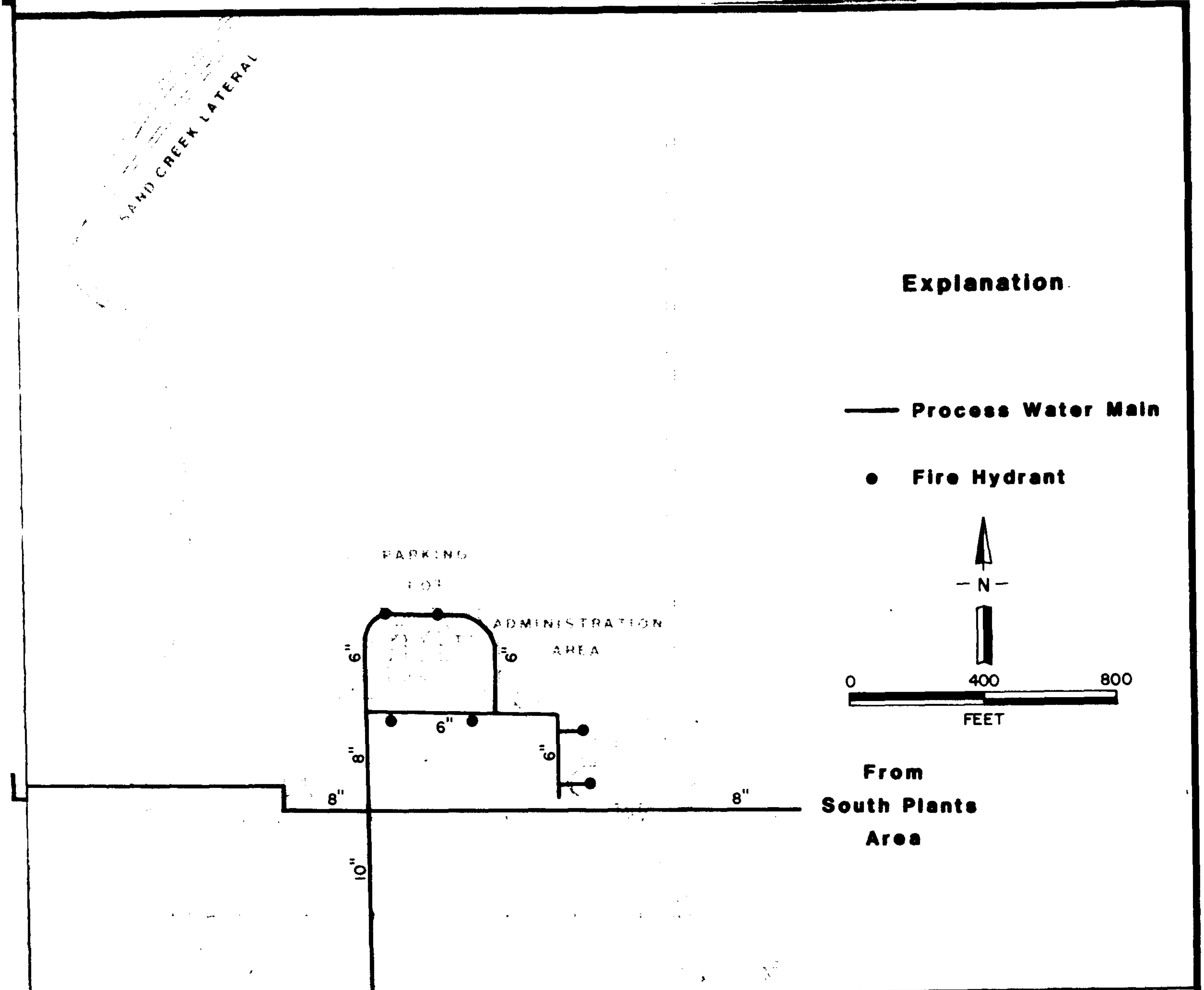

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FIGURE. 3.6-6
Area 3- Process Water System
Administration Area

Rocky Mountain Arsenal, Task 10
Prepared by: Ebasco Services Incorporated

Southwest of the Administration area an 8-inch asbestos cement main runs westward to the Officers' Quarters (former housing) area. This system supplies irrigation water to the recreation area through 6- and 4-inch asbestos cement pipes.

3.6.1.4 Area 4 - Sections 3 and 4

In order to provide additional process water for operations at RMA, the Army drilled three wells, (385, 386, and 387) near the western entrance to the Arsenal in 1954 (COE, 1954). A 14-inch steel line carries water from the three wells in western Section 4 to the process water wet wells at Building 371. Well Pump Stations 385, 386, and 387 have capacities of 900, 900, and 750 gpm, respectively. The wells provided supplemental water when needed in response to the projected additional daily process water requirements at the GB plant.

3.6.2 <u>Field Investigation Program</u>

Leakage in the process water distribution lines will be evaluated by means of the hydrostatic test procedure (Appendix B). Each area may be subdivided into sections for an initial investigation. Based on the results of this initial investigation, additional subsections within the main sections may be tested to more accurately locate lines with excessive leakage. Two areas of the process water return line located in South Plants will be investigated by dye testing and excavation to assess the potential for leakage from pipe joints or cracks.

3.6.2.1 Area 1 - South Plants

<u>Process Water Distribution System - West Plants</u>

This area is located in the South Plants area west of "D" Street in Section 2. The West Plants section contains the Chlorine Plant, the main pump house (Building 371), and the 300 series buildings. Pressure testing of the entire West Plants area process water distribution system will be conducted initially. In addition, the following two sections will be pressure tested within the West Plants area for greater delineation of any problems:

- o 300 series buildings, and

- o Chlorine Plant and surrounding areas.

Table 3.6-1 lists the valves that will be closed to conduct the pressure testing for the West Plants area; refer to Figure 3.6-2 for their locations. In addition, Tables 3.6-2 and 3.6-3 and Figure 3.6-7 show the valve closings for the 300 series buildings and the Chlorine Plant and surrounding areas.

Process Water Distribution System - East Plants

This area is located in the South Plants area east of "D" Street in Section 1. The East Plants region contains the 400 and 500 series buildings in which there have been several reported leaks near Buildings 422, 514, 515, 516, 543, and 548. Pressure testing of the entire East Plants area will be completed. In addition, the following two sections within the East Plants area will be pressure tested to provide additional details concerning any problems in these areas:

- o 400 series buildings, and

- o 500 series buildings.

Table 3.6-4 lists the valves that will be closed to conduct the pressure testing in the East Plants area. The location of these values are shown on Figure 3.6-2. In addition, Tables 3.6-5 and 3.6-6 and Figure 3.6-8 show the valve closings for the 400 and 500 series buildings.

Process Water Return Line - East Plants

Dye/excavation studies will be conducted at two sites in the South Plants area (Figure 3.6-9) to aid in assessing the extent of soil contamination associated with leaking PWS return lines. The 42-inch process water return line east of Building 548 between Manhole 2 and the process water return canal will be excavated. Contamination of the surrounding soil from this line is suspected because all used process water from West Plants was routed through the pipe to the return canal which discharges to the lakes.

Table 3.6-1. West Plants Area, Valve Closing for Pressure Testing.

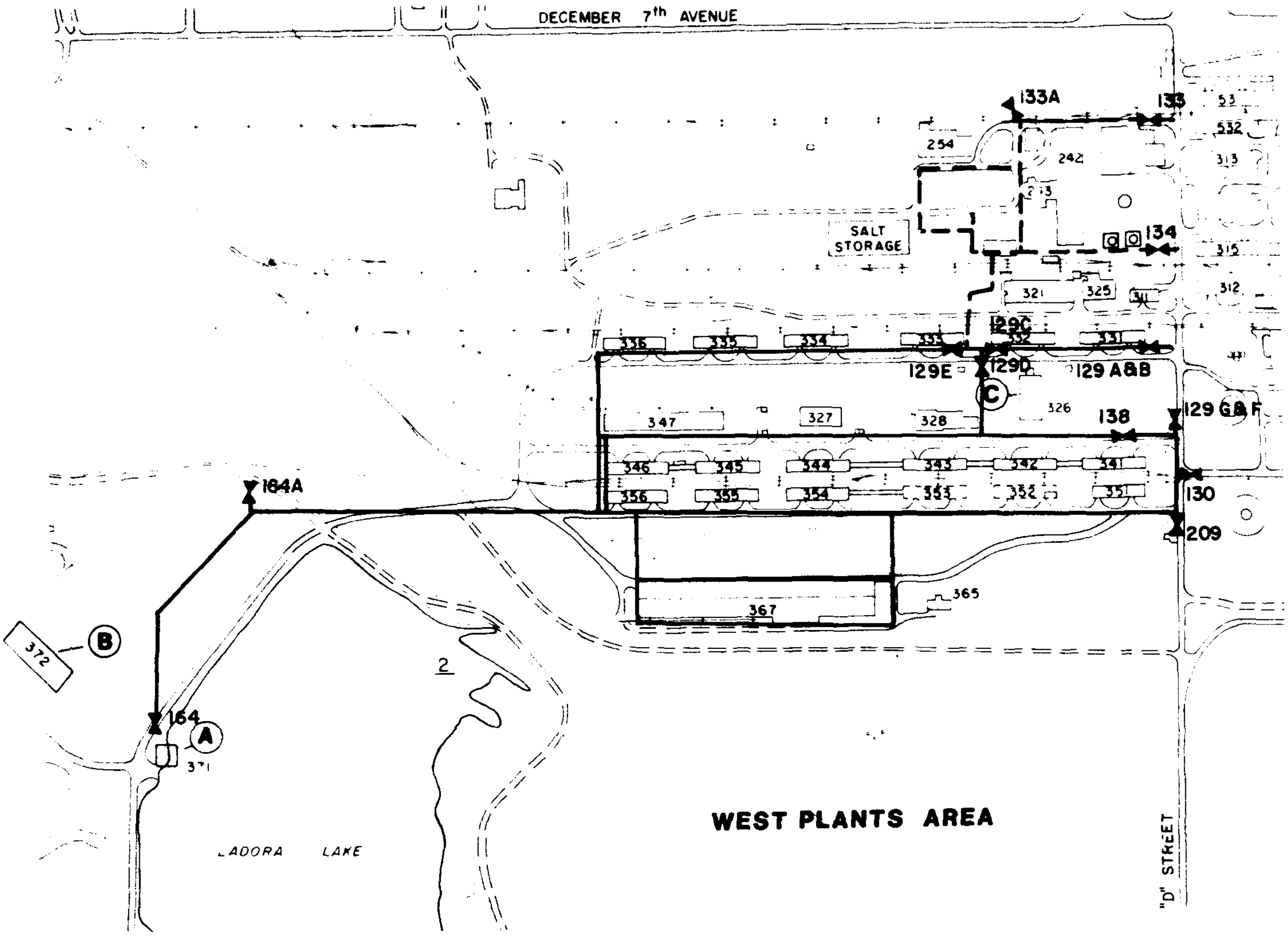
Valve	Location
V209	Southeast of Building 351
V130	Near Meter #6
V114	Near Meter #5
V103	Near Meter #4
V96	Near Meter #3
V781	East of Building 532
V781A	East of Building 532
V218	North of December 7th Ave.
V218A	South of Valve V218
V164	North of Building 371
V129F	Northeast of Building 341
V129G	Northeast of Building 341

Table 3.6-2. 300 Series Buildings, Valve Closings for Pressure Testing.

Valve	Location
V164	North of Building 371
V164A	300 ft North of Ladora Lake
V129A	Southeast of Building 331
V129B	Southeast of Building 331
V129G&F	East of Building 341
V130	East of Building 341
V209	Southeast of Building 331
129E	South of Buildings 332 and 332
129D	South of Buildings 332 and 333
129C	South of Buildings 332 and 333
138	South of Building 331

Table 3.6-3. Chlorine Plant and Surrounding areas, Valve Closings for Pressure Testing.

Valve	Location
V129E	South of Buildings 333 and 332
V129C	South of Buildings 333 and 332
V129D	South of Buildings 333 and 332
V133A	North of Building 241
V133	North of Building 213
V134	East of Buildings 321A and 321B



Legend

Ⓐ Water Pump Station

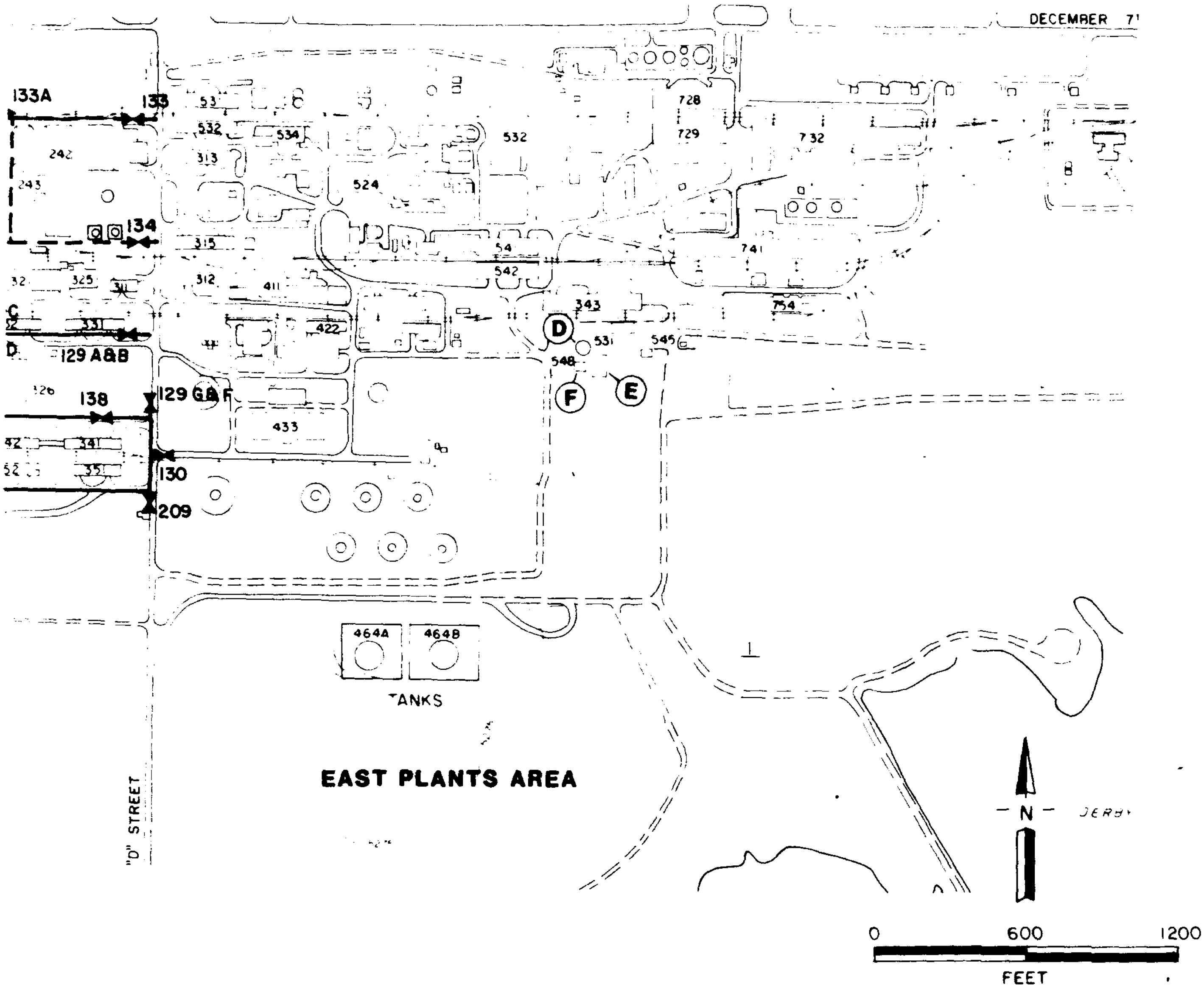
Ⓑ Reservoir

Ⓒ Spray Pond Structure and Spray House

Ⓓ Elevated Water Storage Tank

Ⓔ Cooling Tower

Ⓕ Pump House



ıd

, Tower

ꓤouse

- - - **Process Water System for the Chlorine Plant and Surrounding Area**

—— **Process Water System for the 300 Series Buildings**

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Drafted: 10/23/86

FIGURE 3.6-7

West Plants Area Inclading 300 Series Buildings Area and Chlorine Plants Area

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Table 3.6-4. East Plants Area, Valve Closings for Pressure Testing.

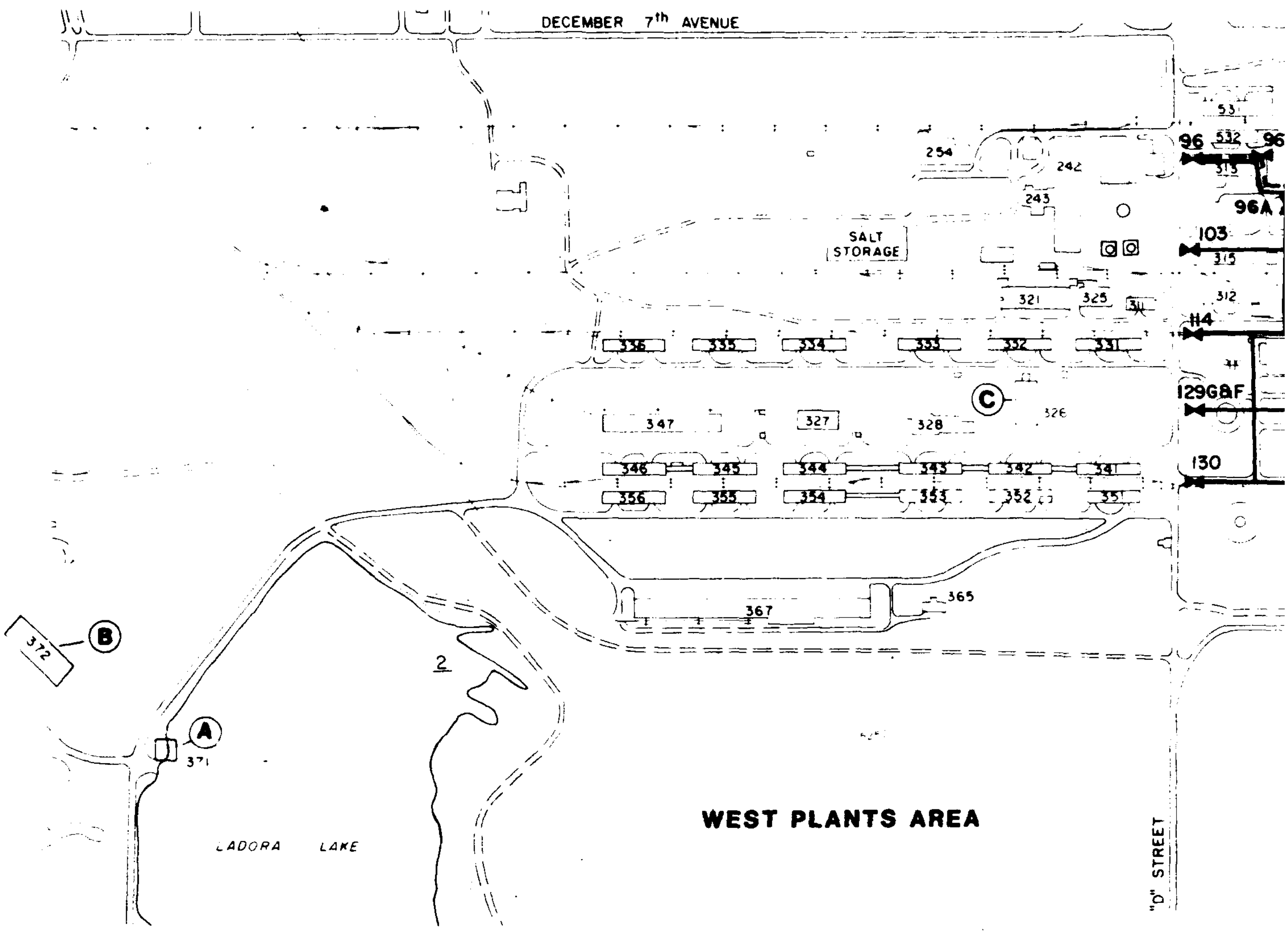
Valve	Location
V209	Southeast of Building 351
V138	Northeast of Building 341
V129B	Southeast of Building 331
V129A	Southeast of Building 331
V136	East of Building 311
V134	East of Building 321B
V781	West of Building 532
V781A	West of Building 532
V133	North of Building 213

Table 3.6-5. 400 Series Buildings, Valve Closings for Pressure Testing.

Valve	Location
V103	Near Meter #4
V96	South of Building 532
V99	North of Building 517
V119B	North of Building 543
V196	South of Building 451
V196A	South of Building 451
V130	Near Meter #6
V129G	500 ft East of Spray Pond
V129F	500 ft East of Spray Pond
V114	Near Meter #5
V105	East of Building 316

Table 3.6-6. 500 Series Buildings, Valve Closings for Pressure Testing.

Valve	Location
V211A	East of Building 541
V212	East of Building 542
V119C	West of Building 543
V118	Near Meter #7
V104	East of Building 523
V96A	West of Building 511A
V96B	North of Building 316A
V96	Near Meter #3
350	West of Building 728



Legend

Ⓐ **Water Pump Station**

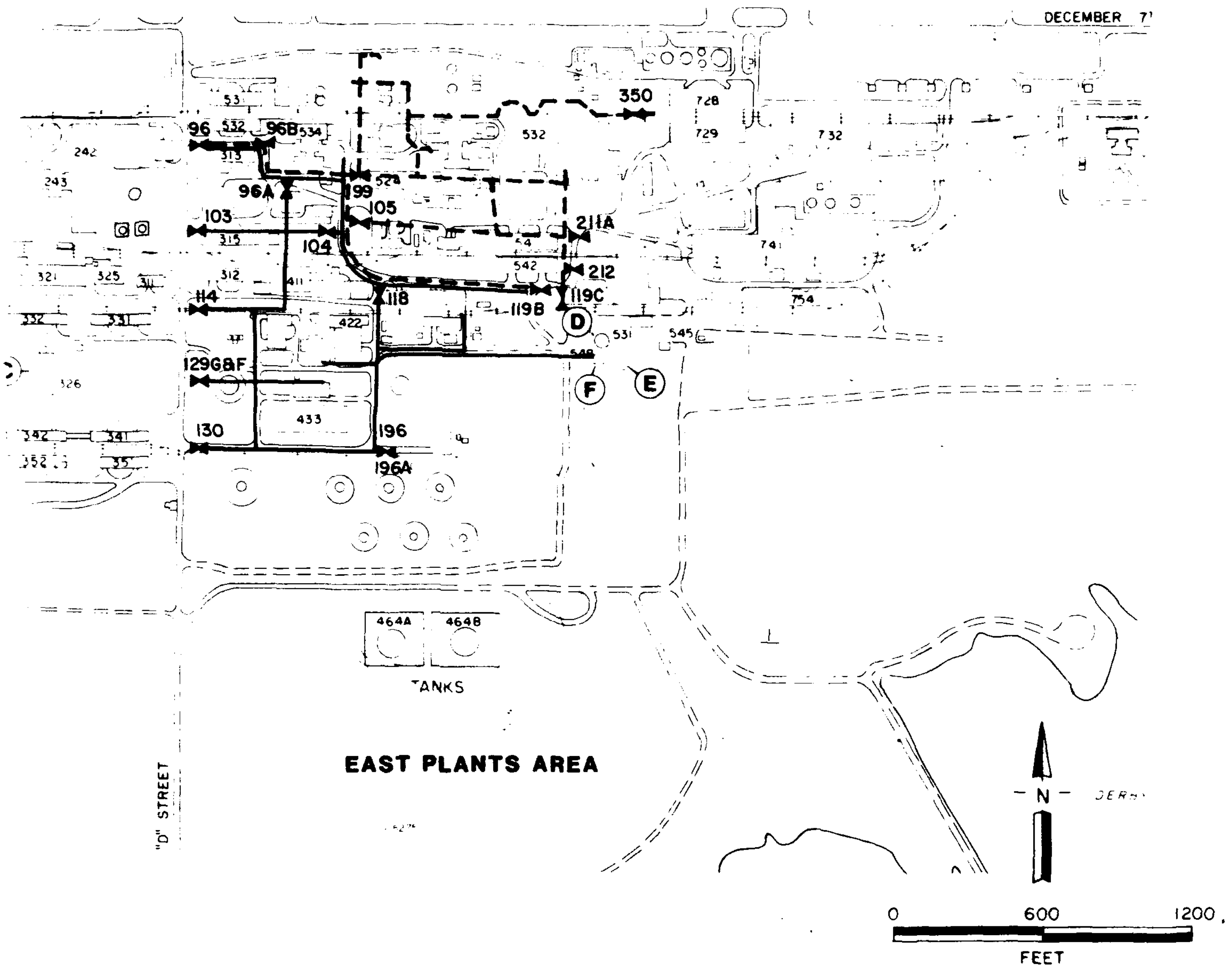
Ⓑ **Reservoir**

Ⓒ **Spray Pond Structure and Spray House**

Ⓓ **Elevated Water Storage Tank**

Ⓔ **Cooling Tower**

Ⓕ **Pump House**



ınd

'g Tower

, House

- - - Process Water System for the 500 Series Buildings

—— Process Water System for the 400 Series Buildings

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FIGURE 3.6-8
East Plants Area
Including 400 and 500 Series Buildings

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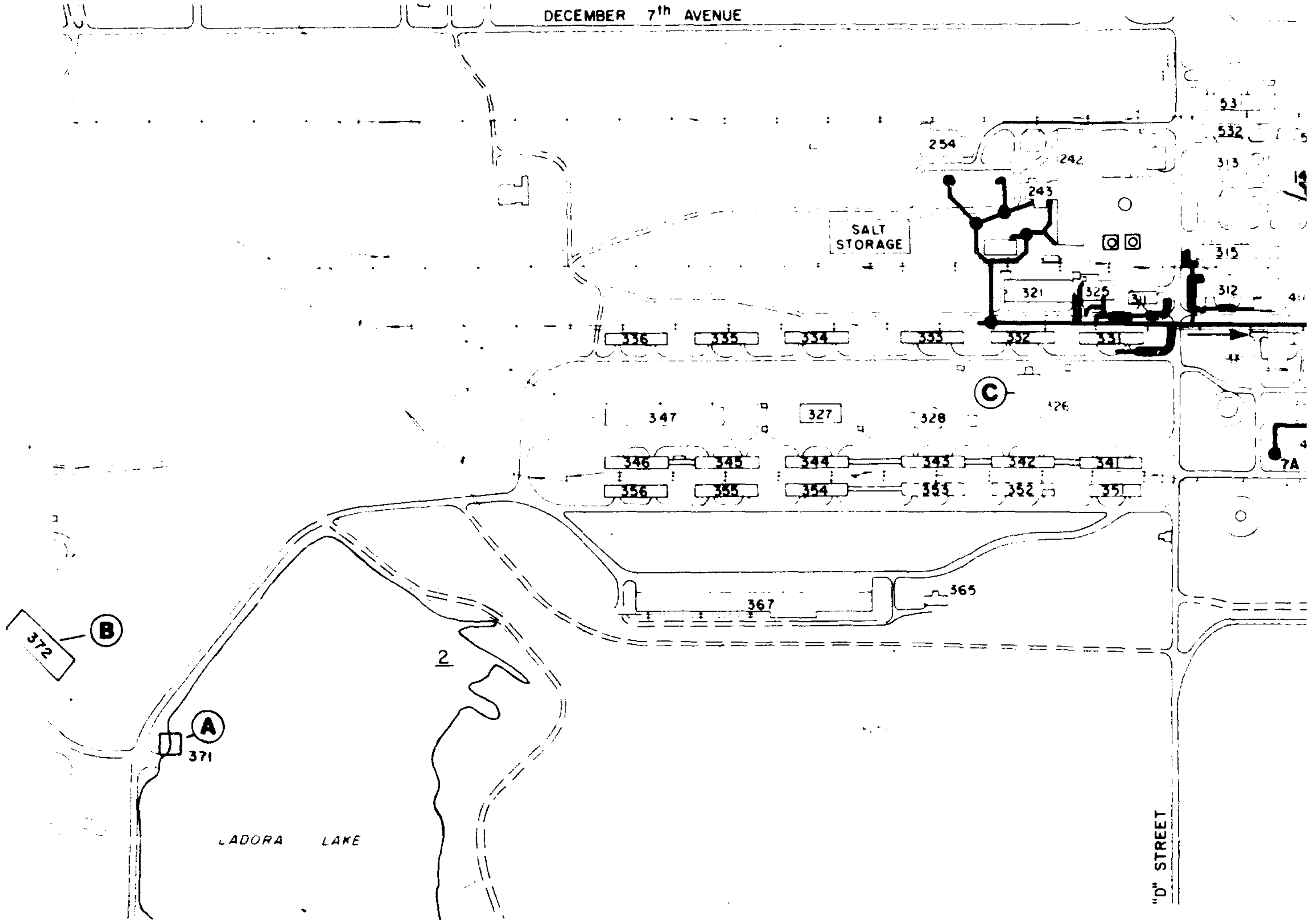


Legend

Ⓐ **Water Pump Station (Bldg. 371)**

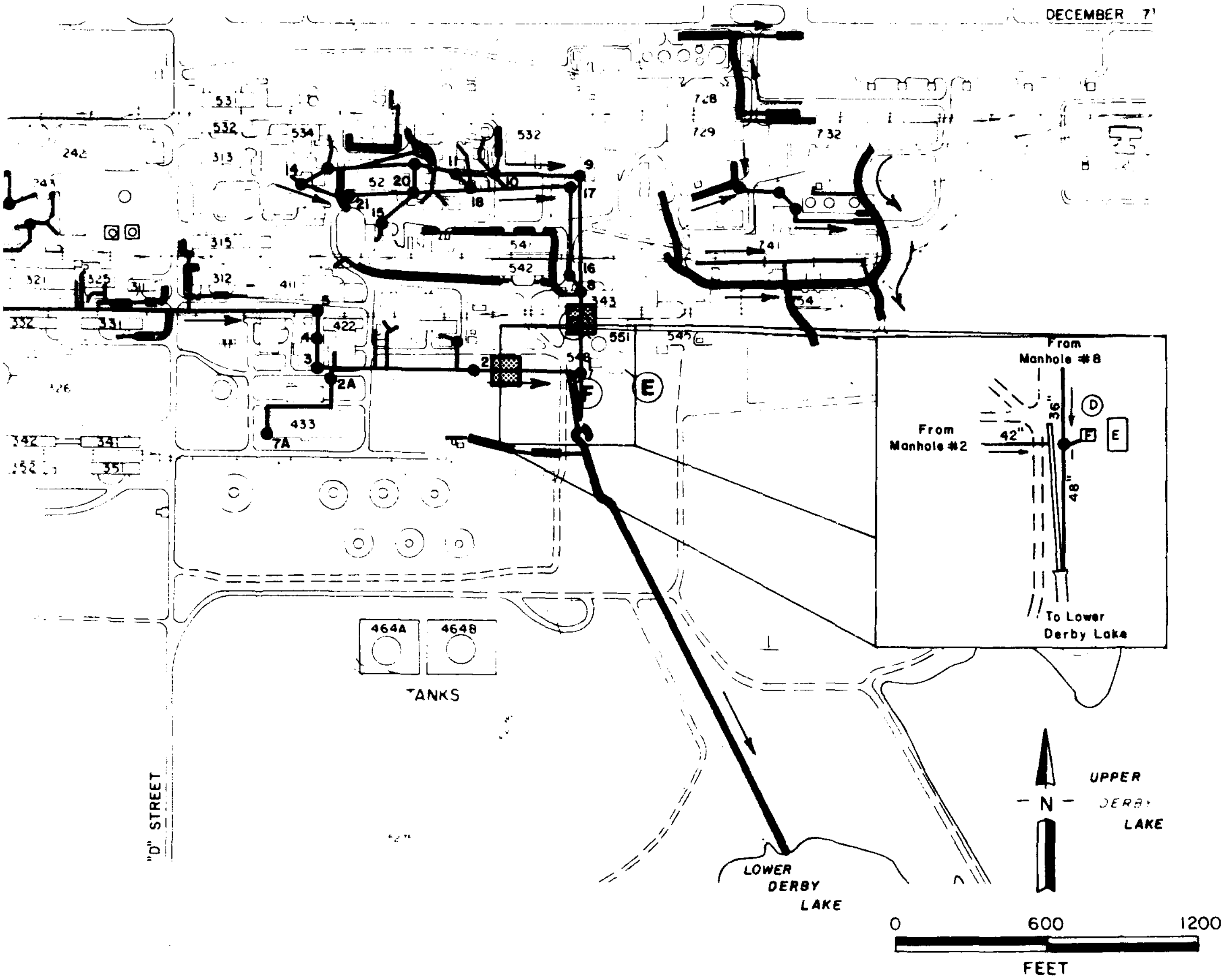
Ⓑ **Reservoir (Bldg. 372)**

Ⓒ **Spray Pond Structure and Spray House (Bldg. 326)**

Ⓓ **Elevated Water Storage Tank (Bldg. 551)**

Ⓔ **Cooling Tower**

Ⓕ **Pump House (Bldg. 548)**



nd

g Tower

House
548)

● Manhole

Process Water Return System

Open Drainage Ditch

Excavation Site

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FIGURE 3.6-9
Investigative Program South Plants
Process Water Return System
Rocky Mountain Arsenal, Task 10
Prepared by: Ebasco Services Incorporated

(2)

The 36-inch process water return line north of Building 548 between Manholes 1 and 8 will also be excavated. This line was initially installed to route all return water from the East Plants area to the return canal. Contamination of the surrounding soil from this line is also suspected.

3.6.2.2 Area 2 - North Plants

The PWS distribution lines in the North Plants area (Sections 25, 35, and 36) will be pressure tested for leakage. Valves 781 and 781A will be closed in South Plants; thus, all of the distribution lines north of December 7th Avenue and into the North Plants facility will be evaluated with one test (refer to Figures 3.6-3 and 3.6-4).

3.6.2.3 Area 3 - Administration Area

The Process Water Distribution System services two general subareas within Area 3. These are illustrated in Figure 3.6-5. The first of these is a group of buildings near Building 111 (Administration area). The second is the former housing area located one-quarter mile west of the Administration area (the Officers' Quarters area). The line in this area will be pressure tested by closing Valve 218A located just west of South Plants.

3.6.2.4 Area 4 - Sections 3 and 4

In Area 4, no testing will be done on the lines from the wells. These wells were used to supply makeup water to the "lakes" PWS, thus, they were not associated with any contaminated process return water.

3.7 TASK SCHEDULE

Figure 3.7-1 presents the estimated schedule for completing Task 10. Each of the major work elements associated with this task and the major components of the field investigation program are illustrated. No allowance is made for unexpected delays.

3.8 EVALUATION OF INVESTIGATION RESULTS

The information obtained as part of the Field Investigation Program will be used in assessing the nature and extent of soil contamination that may be

Figure 3.7-1

Project Schedule

Task 10

Rocky Mountain Ars

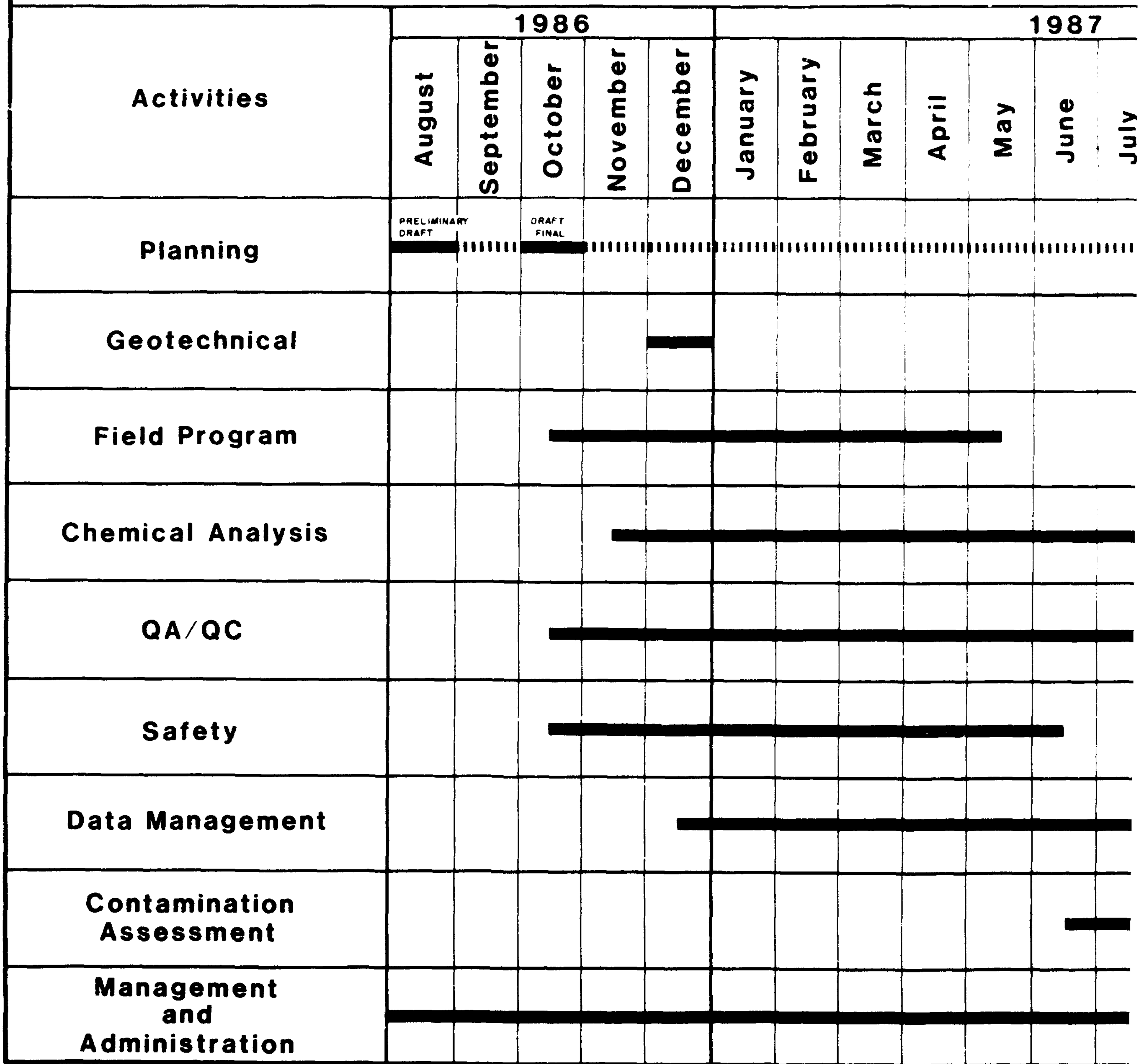
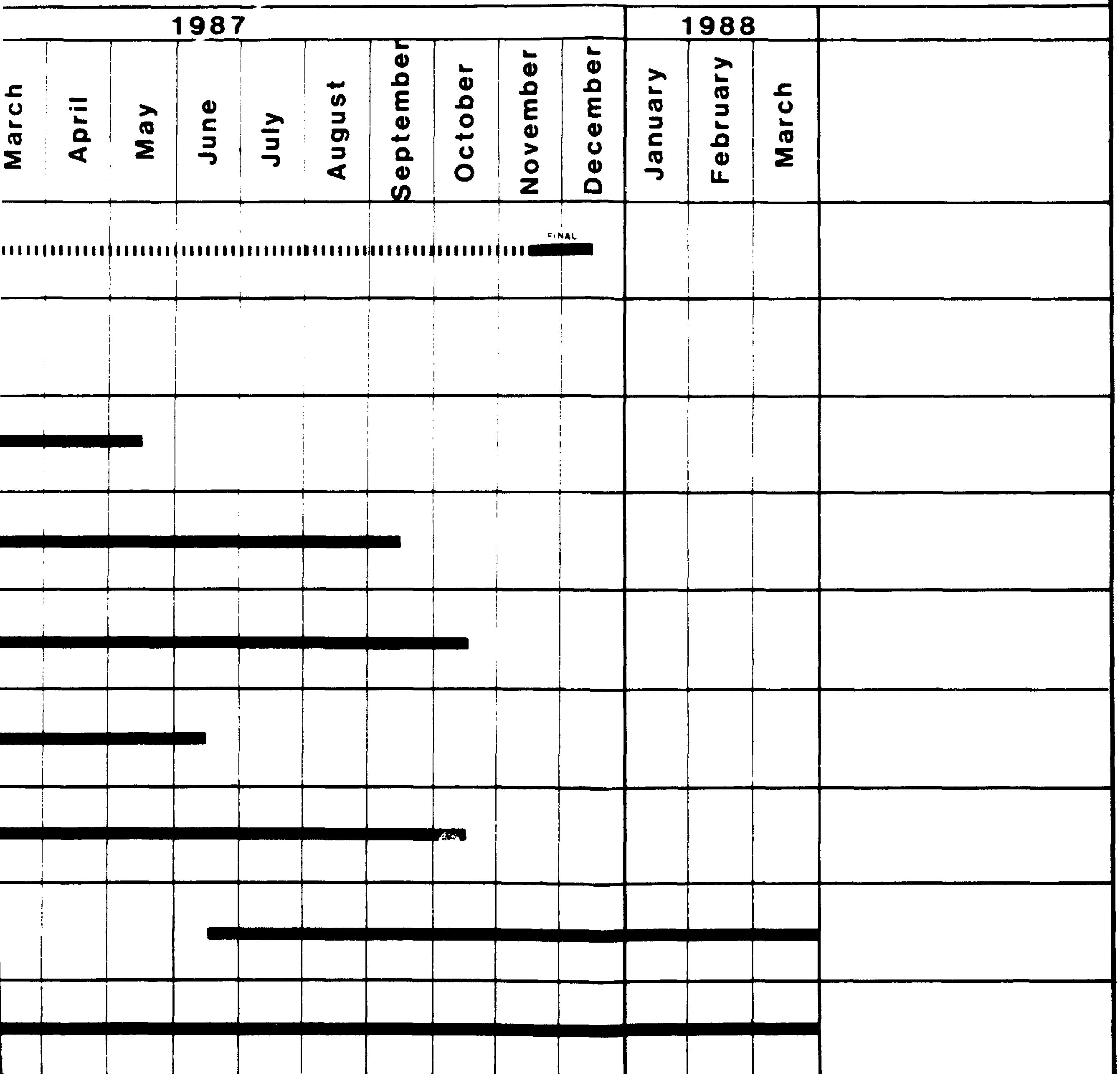


Figure 3.7-1

'oject Schedule

Task 10

.y Mountain Arsenal



associated with leaks in the three systems. The results will also be used to estimate the vertical and areal extent of soil contamination and to determine which segments of the various system are contaminated. Correlation of chemical analyses with sampling localities, and manufacturing and spill histories will facilitate an interpretation of probable contaminant sources.

Because it is not possible to investigate the sewer systems on the Arsenal in their entirety, only "worst case" leaks will be investigated. This approach will allow determination of the maximum possible extent of contaminant migration for each system in each area (North Plants, South Plants, Railyard/Administration Area, etc.). To ensure that all contamination resulting from the sewers is remediated, the maximum extent of contamination for each system in a given area, as determined in the field investigation, will be assumed for that entire system in that area.

Hydrostatic testing of the pressure lines will provide information on the general integrity of the PWS and lift station pressure lines. The information obtained from these results will also identify areas where leakage may have occurred.

The detailed inspections of the manholes will provide information on the methods of construction, the construction material, the general condition, and the presence or absence of maintenance of the manholes. The inspections will also determine which manholes have bottoms in poor condition that may have leaked liquids out of the sewer systems. These manholes will be chosen for the manhole boring program.

Chemical analyses of soil samples, collected from beneath the manholes as part of the manhole boring program, will aid in determining the extent of contamination along the sewers and the nature of any contaminants that have leaked from the sewers. These analyses will also facilitate a semi-quantitative evaluation of the vertical extent of contamination associated with leaking sewers. Sediment samples collected from manholes will provide information on which segments of the various systems are contaminated.

Detailed inspections of the tracer dye that has leaked from the sewers tested will aid in determining the local migration patterns of any leaked contaminants. Chemical analysis of soil samples, collected from the excavation sites at leak locations identified by the tracer dye, will define the vertical and areal extent of contamination caused by a typical leak. The results of the dye/excavation studies will also determine if the tracer will be useful as an aid to any remedial action program for the sewer systems.

4.0 CHEMICAL ANALYSIS PROGRAM

4.1 INTRODUCTION

The chemical analysis program was designed to be consistent with the sampling program for Task 10. Analytical methods for this task are described in more detail below. Most of the referenced analytical methods in this Technical Plan were those specified during meetings of the Analytical Services Teams for Tasks 1 and 2. These analytical methods were divided between the four Contractor laboratories for method development prior to the initiation of Task 2 field activities. Once a method was developed, it was distributed to all contractor laboratories for certification. Certification for all methods has been, or will be, completed prior to analysis of any Task 10 samples.

All samples collected will be screened for target analytes and nontarget contaminants. Analytical methods, detection level high range concentration, sample holding times, certification level, and reference method for all analytes are identified in Table 4.1-1.

Only soil and solid matrices (e.g., soil borings and sediments) will be sampled during Task 10. Soil and solid matrix samples will be assayed semi-quantitatively by gas chromatograph/mass spectroscopy (GC/MS) for volatile and semivolatile organic target analytes. An attempt will be made to identify other major unknown peaks present in the GC/MS total ion current profiles. Potential unknown analytes include those identified as: discarded commercial chemical products, off-specifications species, container residues, and spill residues thereof (40 CFR 261.33); and Appendix VIII Analytes (40 CFR 261) as amenable to the GC/MS methodology cited in this document. Collected samples will also be assayed quantitatively by graphite furnace atomic absorption spectroscopy for arsenic, by cold vapor atomic absorption spectroscopy for mercury, and for other target emission spectroscopy.

Sample shipping and holding temperatures are indicated in the Quality Assurance/Quality Control (QA/QC) plan of the RMA Procedures Manual (Ebasco, 1985b). Analytical methods for worker exposure (e.g., volatile organics in air) will not be USATHAMA/PMO Certified. Data from these samples will be used

Table 4.1-1. Analytical Methods/Solid Matrix (Soil, Solids, Sediment) for Task 10 (Page 1 of 4).

Analysis/Matrix/Analytes	Detection Limit (1)	High Range Concentration	Hold Time (2)	Level of Certification	Reference Methods (3)
Volatile Organics/Solids			7 days for	Semi-	USATHAMA N9
1,1-Dichloroethane	0.5 ug/g	25 ug/g	the solid	Quantitative (4)	for UBTL and
Dichloromethane	0.5 ug/g	25 ug/g	and 30 days		K9 for CAL
1,2-Dichloroethane	0.5 ug/g	25 ug/g	for the		
1,1,1-Trichloroethane	0.5 ug/g	25 ug/g	extract		
1,1,2-Trichloroethane	0.5 ug/g	25 ug/g			
Carbon tetrachloride	0.5 ug/g	25 ug/g			
Chloroform	0.5 ug/g	25 ug/g			
Tetrachloroethylene	0.5 ug/g	25 ug/g			
Trichloroethylene	0.5 ug/g	25 ug/g			
Trans-1,2-Dichloroethylene	0.5 ug/g	25 ug/g			
Benzene	0.5 ug/g	25 ug/g			
Toluene	0.5 ug/g	25 ug/g			
Xylene (3 isomers)	0.5 ug/g	25 ug/g			
Ethylbenzene	0.5 ug/g	25 ug/g			
Chlorobenzene	0.5 ug/g	25 ug/g			
Methylisobutyl ketone	0.5 ug/g	25 ug/g			
Dimethyldisulfide	0.5 ug/g	25 ug/g			
Bicycloheptadiene	0.5 ug/g	25 ug/g			
Dicyclopentadiene	0.5 ug/g	25 ug/g			
Semivolatile Organics/Solids			7 days for	Semi-	USATHAMA L9
Aldrin	0.5 ug/g	100 ug/g	the solid &	Quantitative (4)	for UBTL,
Endrin	0.5 ug/g	100 ug/g	30 days for		X9 for CAL and
Dieldrin	0.5 ug/g	100 ug/g	the extract		X9-A for HEA
Isodrin	0.5 ug/g	100 ug/g			
p,p'-DDT	0.5 ug/g	50 ug/g			
p,p'-DDE	0.5 ug/g	100 ug/g			
Chlorophenylmethyl sulfide	0.5 ug/g	100 ug/g			
Chlorophenylmethyl sulfoxide	0.5 ug/g	50 ug/g			
Chlorophenylmethyl sulfone	0.5 ug/g	100 ug/g			

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Table 4.1-1. Analytical Methods/Solid Matrix (Soil, Solids, Sediment) for Task 10 (Page 2 of 4).

Analysis/Matrix/Analytes	Detection Limit (1)	High Range Concentration	Hold Time (2)	Level of Certification	Reference Methods (3)
Hexachlorocyclopentadiene	0.5 ug/g	100 ug/g			
Oxathiane	0.5 ug/g	100 ug/g			
Dithiane	0.5 ug/g	100 ug/g			
Malathion	0.5 ug/g	100 ug/g			
Parathion	0.5 ug/g	100 ug/g			
Chlordane	0.5 ug/g	100 ug/g			
Azodrin	0.5 ug/g	100 ug/g			
Vapona	0.5 ug/g	100 ug/g			
Supona	0.5 ug/g	100 ug/g			
DIMP	0.5 ug/g	50 ug/g			
Atrazine	0.5 ug/g	100 ug/g			
1,2-Dibromo-3-chloropropane	0.5 ug/g	100 ug/g			USATHAMA S9 for UBTL and Z9 for CAL
ICP Metal Screen/Solids			6 mos	Quantitative (5)	USATHAMA P9 for UBTL and A9 for CAL
Cadmium	0.5 ug/g	500 ug/g			
Chromium	5 ug/g	500 ug/g			
Copper	5 ug/g	500 ug/g			
Lead	5 ug/g	500 ug/g			
Zinc	5 ug/g	500 ug/g			

Table 4.1-1. Analytical Methods/Solid Matrix (Soil, Solids, *Sediment*) for Task 10 (*Page* 3 *of* 4).

Analysis/Matrix/Analytes	Detection Limit (1)	High Range Concentration	Hold Time (2)	Level of Certification	Reference Methods (3)
Arsenic/Solids	1 ug/g	10 ug/g	6 mos	Quantitative (5)	USATHAMA B9 for UBTL and G9 for CAL
Mercury/Solids	0.1 ug/g	1 ug/g	28 days	Quantitative (5)	USATHAMA Y9 for UBTL and J9 for CAL
Thiodigylcol/solids	-	-	-	-	Method under development by ESE
Organics Screen/Air-Charcoal	-	-	4 weeks in freezer	None	UBTL method developed for NIOSH
Orgarics Screen/Air-Tenax	-	-	4 weeks in freezer	None	UBTL method developed for NIOSH

Table 4.1-1. Analytical Methods/Solid Matrix (Soil, Solids, Sediment) for Task 10 (Page 4 of 4).

NOTES:

(1) Actual detection limits for the certified methods are identified in Section IV of the Rocky Mountain Arsenal Procedures Manual, Section 12.4 and Appendix B. Detection limits for uncertified methods and for methods to be certified are desired detection limits.

(2) Sample holding times are identified in Section IV of the Rocky Mountain Arsenal Procedures Manual, Sections 8.4 and 10.3.

(3) Analytical methods are described in Section IV of the Rocky Mountain Arsenal Procedures Manual, Section 10.0 and Appendix B.

(4) Semi-Quantiative: See Section IV of the Rocky Mountain Arsenal Procedures Manual, Section 11.2.2.1.

(5) Quantitative: See Section IV of the Rocky Mountain Arsenal Procedures Manual, Section 11.2.2.2.

Reference:

Ebasco Services Inc. 1985. Section IV, Project Quality Assurance Plan, Rocky Mountain Arsenal Procedures Manual to the Technical Plan, August 1985, Contract NO. DAAK11-84-D-0017, Final Draft.

as an initial assessment and to identify the potential for worker exposure to organic vapors. A summary of laboratory analyses indicating preservation guidelines, analytical methods required, level of certifications, total analytical requirements, and weekly laboratory rates of analysis is given in the QA/QC Plan of the RMA Procedures Manual (Ebasco, 1985b).

4.2 SAMPLE MATRICES

All soil, sludge, sediment, and solid matrices were considered as soils for analytical purposes. All soil and solid analytical methods have been or will be USATHAMA/PMO Certified on a representative soil prior to sample collection. This representative soil is a background soil collected from the RMA area. Data for soil and solid matrices are initially reported on a dry weight basis and may be converted to a wet weight basis as required by the PMO. Table 4.2-1 identifies the chemical analyses to be performed on soil samples collected from the various segments of the three systms. Analyses were selected based on type of activities known to have been conducted at each site. For samples collected from segments where no information exists, the entire suite of analyses will be conducted.

4.3 ANALYTICAL METHODS FOR SOLID MATRICES

This section briefly describes the analytical methods listed in Table 4.1-1 for target analytes and their detection limits in the Task 10 survey. The specific protocol for each method may be reviewed in Section IV, Project Quality Assurance Plan, RMA Procedures Manual (Ebasco 1985b).

4.3.1 Volatile Organics

The volatile organics (VO) method in solids was based on EPA Method 8240 (EPA SW-846). This method was USATHAMA/PMO Certified for soils and solids at the semi-quantitative level. (See Section IV of the RMA Procedures Manual for method). Due to their volatility, analysis for these compounds will be restricted to deep soils obtained from excavations.

In this method, a 10 gram (g) portion of the sample will be obtained with minimum of handling and placed into 10 milliliter (ml) methanol in a volatile

Table 4.2-1. Sample Matrix.

Sample Locations	Analyses
Sanitary Sewer System	
South Plants	VO, SVO, Metals, As, Hg, TDG
North Plants	VO, Metals, As, Hg
Rail Classification Yard	VO, SVO, Metals, As, Hg, TDG
Administration Area	VO, SVO, Metals, As, Hg, TDG
Inteceptor Sewer Line	VO, SVO, Metals, As, Hg, TDG
Chemical Sewer System	
South Plants	VO, SVO, Metals, As, Hg, TDG
North Plants	VO, Metals, As, Hg
Process Water System	
South Plants	VO, SVO, Metals, As, Hg, TDG

As - arsenic
Hg - mercury
SVO - semivolatile organics
TDG - thiodigylcol
VO - volatile organics

organic acid (VOA) septum vial, spiked with the surrogates: methylene chloride-d_2; benzene-d_6; and ethyl benzene-d_{10}, capped with a Teflon-lined lid and shaken for four hours. A 20 microgram (ug) aliquot of the methanol extract will be removed, spiked with 200 ug of 1,2-dibromoethane-d_4 as an internal standard and injected into 5.0 ml of organics-free water contained in a syringe. The contents of the syringe will then be injected into a purging device, purged, and analyzed on a packed column (1 percent SP-1000 on Carbopack B) by GC/MS. Each sample will be assayed for target compounds at detection limits identified in Table 4.1-1.

In addition, the total ion current profile will be screened for all peaks. An attempt will be made to identify the major unknown peaks which are present in excess of 10 percent of the area of the internal standard peak. Each of these major unknown peaks will be reported as the purity, fit, and probability to match for the three most likely candidate compounds from the Environmental Protection Agency/National Bureau of Standards/National Institute of Health (EPA/NBS/NIH) Mass Spectral library computer program.

4.3.2 Semivolatile Organics

The analytical technique for semivolatile organics (SVO) was based on EPA Method 8270 in solids (EPA SW-846) and was USATHAMA/PMO Certified in soils and solids at the semi-quantitative level. (See Section IV of the RMA Procedures Manual for method).

Using this method, a 15 g portion of the sample will be obtained with a minimum of handling and spiked with the surrogates: 1,3-dichloro-benzene-d_4; diethylphthalate-d_4; 2-chlorophenol-d_4; and di-n-octylphthalate-d_4. The sample will be mixed with anhydrous sodium sulfate (30 g or more, depending on sample moisture content) then soxhelet extracted for eight hours with 300 ml methylene chloride. The extract is reduced to a final volume of 10 ml in a Kuderna-Danish (K-D) apparatus. An aliquot of this concentrate will be spiked with phenanthrene-d_{10} as an internal standard and analysed on a fused silica capillary column by GC/MS. Samples will be assayed for target analytes at the detection limits shown in Table 4.1-1.

4.3.3 Metals

The inductively-coupled argon plasma spectroscopy (ICP) method, based on USATHAMA Method 7S, is USATHAMA/PMO Certified at the quantitative level (See Section IV of the RMA Procedures Manual for method).

In this procedure, a 1.0 g portion of sample will be digested in a watch glass covered Griffin beaker with 3.0 ml of concentrated nitric acid. Contents of the beaker will be heated to near dryness and repeated portions of concentrated nitric acid added until the sample is completely digested. The digestion process is finished with 2.0 ml of 1:1 nitric acid and 2 ml of 1:1 hydrochloric acid. The sample digest will be filtered, the beaker and watch glass rinsed with deionized water, and rinsate passed through the filter. The digestate is brought to a final volume of 50 ml and assayed by ICP. Samples will be assayed for target metals at detection limits identified in Table 4.1-1.

4.3.4 Arsenic

The arsenic (As) method in soils and solids was developed from EPA Method 7060 (EPA-SW-846). Using this method, a 1.0 g sample will be digested with hydrogen peroxide and concentrated nitric acid. The digest will be filtered and assayed by graphite furnace atomic absorption spectrometry. The detection limit for arsenic is 1.0 micrograms per gram (ug/g). This method was USATHAMA/PMO Certified at the quantitative level (See Section IV of the RMA Procedures Manual for method).

4.3.5 Mercury

The mercury (Hg) method, developed from EPA Method 245.5 (EPA 600/4-82-057), was USATHAMA/PMO Certified at the quantitative level (See Section IV of the RMA Procedures Manual for method). In this method a 1.0 g sample portion will be digested with aqua regia followed by treatment with potassium permanganate. Excess permanganate will be reduced with hydroxylamine sulfate. Mercury will be reduced with stannous chloride and assayed by cold vapor AA. The target detection limit for mercury is 0.1 ug/g.

4.3.6 Thiodiglycol

The analytical method for thiodiglycol (TDG) is being developed by ESE and will be certified prior to the start of the Task 10 field investigation program. The method is designed to detect mustard surety agent products.

4.3.7 Volatile Organic Compounds in Air Using Activated Charcoal and Tenax

This method was designed by UBTL Incorporated (UBTL) for the National Institute of Occupational Safety and Health (NIOSH). It is designated for use in this program as a screening tool to identify the potential for each sampling team's exposure to volatile organic contaminants in air during the Task 10 program. The charcoal is desorbed with methylene chloride, and Tenax with isooctane. Extracts will be analyzed by packed column or fused silica capillary column GC/MS to identify significant unknown compounds. This method will not be USATHAMA/PMO Certified (See Section IV of the RMA Procedures Manual for method).

4.3.8 Nontarget Compounds

The total ion current profile will be screened for all major nontarget peaks. The laboratories will report (RT [Retention Time] Code, estimated concentrations and print MS [Mass Spectral] traces) all nontarget analytes with peaks greater than 10 percent of the internal standard response. Each of these major peaks greater than 10 percent of the internal standard response (excluding obviously meaningless peaks, e.g., column bleeds) will be reported as the purity, fit, and probability to match for the three most likely candidate compounds from the EPA/NBS/NIH Mass Spectral library computer program.

5.0 QUALITY ASSURANCE PROGRAM

5.1 PROJECT QA PLAN

An integral part of the Task 10 Technical Plan is the project-specific Quality Assurance (QA) Plan, describing the application of Ebasco's procedures to monitor and control field and analytical efforts at RMA. Ebasco has developed a Project QA Plan applicable to geotechnical, sampling, and analytical activities. For Task 10, Ebasco will adhere to, and comply with, the established QA requirements. The plan is presented in Section IV of the RMA Procedures Manual (Ebasco, 1985b). The specific objectives of the Ebasco Quality Assurance Plan for RMA are to:

- o Ensure adherence to established PMO QA Program guidelines and standards,
- o Ensure precision and accuracy for measurement data,
- o Ensure validity of procedures and systems used to achieve project goals,
- o Ensure that documentation is verified and complete,
- o Ensure that deficiencies affecting quality of data are quickly determined,
- o Perform corrective actions that are approved and properly documented,
- o Ensure that the data acquired will be sufficiently documented to be legally defensible, and
- o Ensure that the precision and accuracy levels attained during the PMO analytical certification program are maintained during the project.

The overall project QA responsibility rests with the Project Quality Assurance Coordinator. He will be assisted by the Field and Laboratory Quality Assurance/Quality Control (QA/QC) Coordinator.

The Field QA/QC Coordinator will assure that all quality control procedures are implemented for drilling, sampling, chain-of-custody, and documentation. Responsibilities are to:

- o Review all field data and documentation for completeness and accuracy;
- o Assure implementation of chain-of-custody procedures, sample security, and document security;
- o Determine deficiencies in implementation of drilling quality control protocols and seek corrective actions;
- o Prepare weekly reports of problems and corrective actions for the Project Quality Assurance Coordinator; and
- o Have available documentation for review by Ebasco Project Quality Assurance Coordinator or USATHAMA during audits.

Ebasco is using two laboratories for the performance of chemical analytical services. Both laboratories will comply with the Project QA plan. Each laboratory has appointed a Laboratory QA/QC Coordinator. Their responsibilities are to:

- o Monitor the quality control activities of the laboratory;
- o Recommend improvement in laboratory quality control protocol, when necessary;
- o Log in samples, introduce control samples in the sample train, and establish sample testing lot sizes;
- o Approve all data before submission to permanent storage;

- Maintain all quality control records and chain-of-custody documents;

- Assure document and sample security;

- Inform Ebasco's Project Quality Assurance Coordinator of non-compliance with the Project QA Plan; and

- Prepare and submit a weekly report of quality control data to the Ebasco Project Quality Assurance Coordinator.

Prior to the actual field program, QA/QC training will be conducted by the Project Quality Assurance Coordinator, or his designee, to indoctrinate field, laboratory, and project personnel in the specific procedures detailed in the Project QA Plan.

Also, prior to analysis of samples, the Project Quality Assurance Coordinator will visit the laboratories to review analytical procedures with chemical analysis personnel and instruct the Laboratory QA/QC Coordinators in the requirements of the Project QA Plan and data validation procedures. In addition, the Project Quality Assurance Coordinator will perform audits of field and laboratory work on a bi-monthly basis to ensure compliance with the Project QA Plan. Specific project QA/QC requirements are described in the following sections.

5.2 SPECIFIC PROJECT REQUIREMENTS

5.2.1 Geotechnical Requirements

The project geotechnical requirements are described in Section 7.0 of the Project QA Plan (Section IV of the RMA Procedures Manual). These requirements are based on the geotechnical guidelines established by PMO. Specifically, this chapter addresses the geotechnical requirements for well drilling operations, borehole logging, well installation and development, well diagrams, well acceptance, topographic surveying, selected data management entries, and geotechnical reports. Ebasco will have a geologist present and responsible at each operating drill rig for logging samples and monitoring drilling operations.

5.2.2 Field Sampling

The management of samples, up through the point of shipment from the field to the laboratory, will be under the supervision of Ebasco's Field QA/QC Coordinator. Samples must be collected in properly cleaned containers, properly labeled, preserved, and transported according to the prescribed methods. Section 8.0 of the Project QA Plan describes the procedures to monitor adherence to approved sampling protocol. If the Field QA/QC Coordinator determines that deviations from the sampling protocol have occurred, resulting in a compromise of the sample integrity, all samples taken prior to the inspection will be discarded and fresh samples will be taken. The Field QA/QC Coordinator is responsible for field chain-of-custody documentation and transfer and will supervise the strict adherence to chain-of-custody procedures.

5.2.3 Laboratory Quality Assurance Procedures

Section 10.0 of the Project QA Plan describes the Laboratory Quality Assurance Procedures. Both laboratories along with their internal quality assurance program will adhere to the Project QA Plan.

The Laboratory QA Program begins with the receipt of samples from the field. All samples will be shipped to UBTL for logging in, sample splitting, and distribution for analyses. The Laboratory QA/QC Coordinator is responsible for monitoring the laboratory activities. The Laboratory QA/QC Coordinator is also responsible for determining testing lot sizes and introducing laboratory control samples into the testing lot in an inconspicuous manner.

The samples must be analyzed within the prescribed holding time by the approved analytical methods. Analytical methods are described in Section 4.0 of this Technical Plan.

5.2.4 Laboratory Analytical Controls

Daily quality control of the analytical systems ensures accurate and reproducible results. Careful calibration and the introduction of the control samples are prerequisites for obtaining accurate and reliable results.

Procedures for instrument calibration and analytical controls are described in Section 12.0 of the Project QA Plan.

The Laboratory QA/QC coordinator for each laboratory will monitor the analytical controls. The out-of-control situation can be detected by the control charts. When an out-of-control situation is detected, efforts will be initiated to determine the cause. Corrective actions will be taken to bring the process under control. Full documentation of an out-of-control situation and the subsequent corrective action will be recorded by the Laboratory QA/QC Coordinator.

5.2.5 Laboratory Data Management, Review, Validation, and Reporting Procedures

Sections 13.0 through 16.0 of the Project QA Plan detail the procedures for laboratory data review, validation, and reporting procedures. The laboratories utilize highly automated systems for analytical data collection and reduction. The analytical supervisor along with the Laboratory QA/QC Coordinator review all analytical data after data reduction and prior to the transfer of the data report to Ebasco. The laboratory data reporting procedure is described in Section 15.0 of the Project QA Plan which is based on the established PMO reporting procedures for analyses performed at quantiative and semi-quantitative levels. The laboratories will adhere to these reporting procedures.

6.0 DATA MANAGEMENT PROGRAM

6.1 PLAN OVERVIEW

This plan presents the data management procedures to be used by Ebasco for the Environmental Program at RMA. As specified in the contract, all data will be presented to PMO in appropriate format and entered into the IR-DMS UNIVAC 1100/60. PMO has provided a Tektronix 4051 system and IR Data Management User's Guide, Version 85.6 (PRI, 1985) to Ebasco for this purpose. Data will be controlled as necessary. Presentation of project management data and report communication is discussed in Ebasco's Management Plan.

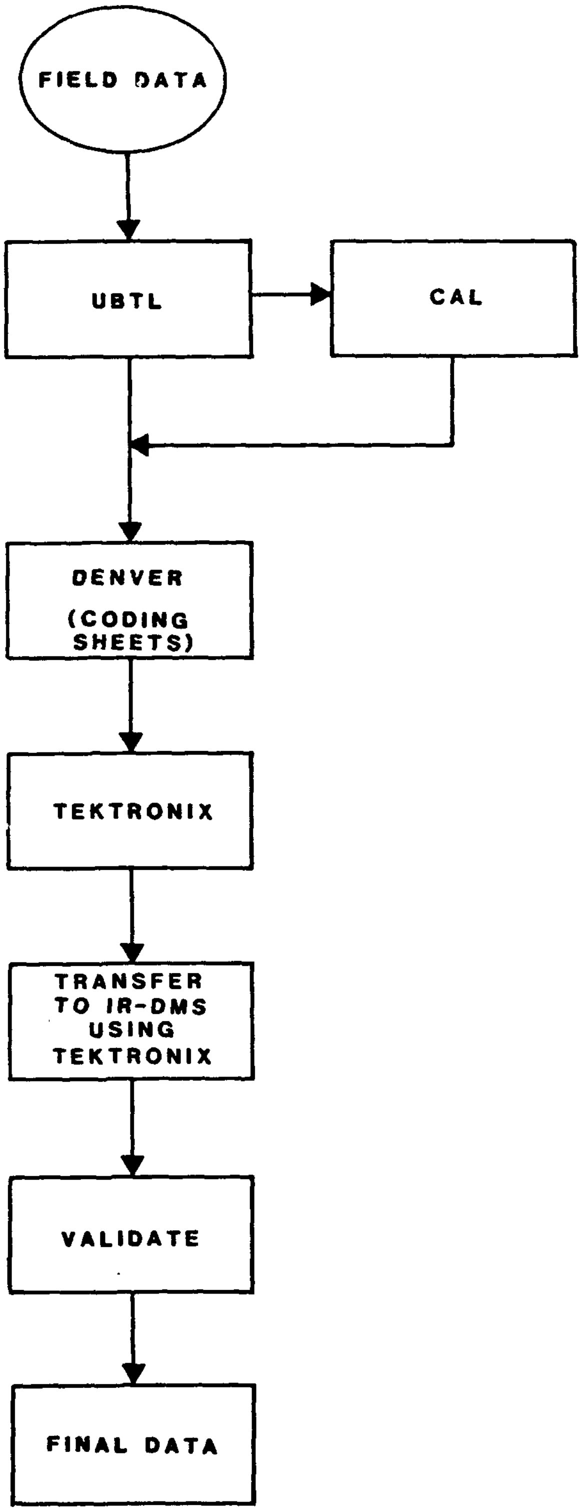
re 6.1-1 schematically shows the process Ebasco will use to coordinate ata management activities between itself and UBTL Incorporated (UBTL), California Analytical Laboratories (CAL), and Installation Restoration-Data Management Systems (IR-DMS). This is detailed in Section 6.3 of this report. As shown in Figure 6.1-1, Ebasco's primary data entry terminal for the IR-DMS will be through the Army-owned Tektronix terminal in Ebasco's Denver office. A second Army-owned terminal is maintained in Ebasco's Santa Ana office for backup data entry purposes. Specifics of data collection, data entry, data validation, and data analysis are discussed herein.

6.2 FIELD ACTIVITIES

6.2.1 Sample Handling

The Sample Coordinator is responsible for field documentation and logging of the samples. In addition, the Sample Coordinator will assure that all field data are properly accounted for and transferred to the Field QA/QC Coordinator for review.

To accomplish this, the Sample Coordinator will assure that proper sample collection procedures, sample control identification procedures, and proper chain-of-custody procedures are followed. (Specific procedures and reporting forms to be used for the management of field data are detailed in Appendix A of Section IV of the RMA Procedures Manual.)



Prepared for:

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Aberdeen Proving Ground, Maryland

FIGURE 6.1-1

Data Flow Between Ebasco, UBTL, CAL and IR-DMS

Rocky Mountain Arsenal, Task 10

Prepared by: Ebasco Services Incorporated

Sample control identification numbers will be assigned by the Ebasco geologist to each sample collected in the field. These sample identifiers will be recorded on the sample tag, in the field data log book, and on the sample chain-of-custody record at the time of sample collection. The chain-of-custody record will also serve as the analytical request form, verifiable by the analytical request list on the sample tag. The Sample Coordinator will check sample tags, chain-of-custody forms, and field data logs to assure complete and correct field data entry. Field identification numbers will remain with each sample throughout the data collection, shipment, analysis, and report phases of the program.

As part of the logging in of the samples, the Sample Coordinator will copy pertinent information from the chain-of-custody form into the sample control log book, package and seal the samples for shipment to the laboratory, and assure the shipment of these samples. The Sample Coordinator will forward the necessary written field records to the Field QA/QC Coordinator for review. The Field QA/QC coordinator will transfer the appropriate information to the Data Manager at Ebasco's Denver office for entry into the computer.

6.2.2 Geotechnical Program

Geotechnical boring logs, containing pertinent data regarding borehole lithology, will be coded within two weeks of borehole completion onto PMO data coding sheets. These data will be entered into the Geotechnical Field Drilling (GFD) Files at the Ebasco Denver office.

Upon completion of the drilling of borings at each site, a surveying crew will determine map coordinates and ground elevations for each boring. These survey data will be coded immediately onto PMO data coding sheets, and will be entered into the IR-DMS Map Files at the Ebasco Denver office. These files will be entered into the data management system before the completion of chemical analyses, as each sample location must be associated with a map location.

6.2.3 Laboratory

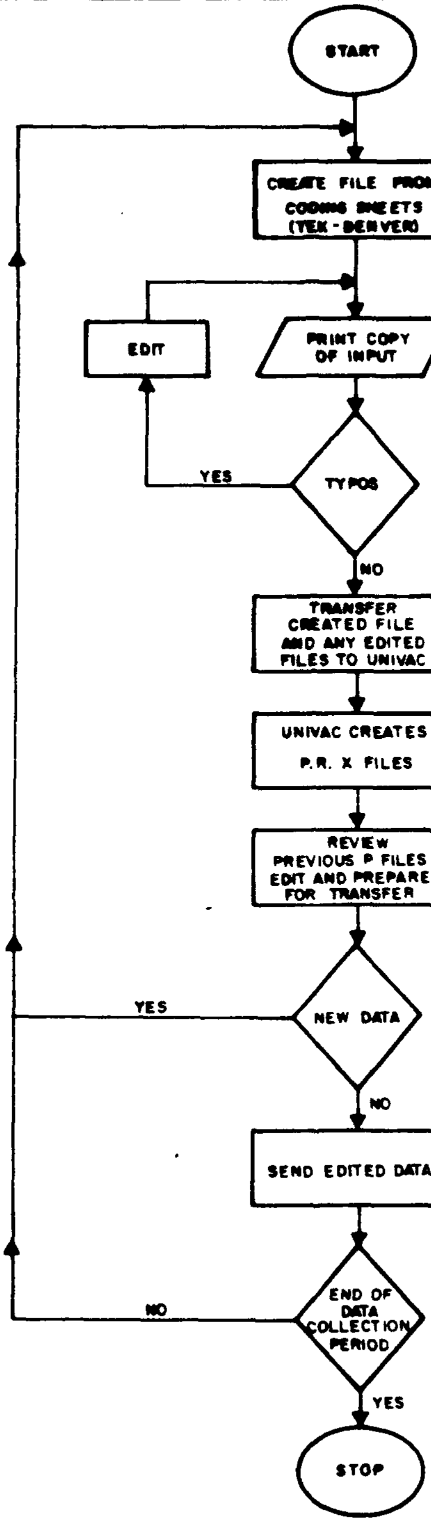
When samples are received at UBTL, the Sample Receipt Officer will sign the chain-of-custody record, log in sample shipment, verify sample integrity, assign sample lots, prepare split samples, and identify samples to be sent to CAL or to be retained by UBTL for chemical analysis. Each laboratory, UBTL and CAL, will submit weekly sample status reports to Ebasco's Data Manager. This weekly status report will be used to aid in planning the rate of field sampling and the distribution of laboratory workloads.

Field and laboratory sample control identification and chemical analysis data will be transcribed to the data coding sheet by UBTL and CAL, then verified using the program's laboratory control procedures. The verified data coding sheets will then be delivered, by courier, to Ebasco's Data Manager for entry into the IR-DMS database.

6.3 DATA ENTRY AND VALIDATION

Figure 6.3-1 illustrates the flow of data to enter laboratory results into the IR-DMS UNIVAC 1199/60. The first step in data entry is to create a magnetic tape copy of the coding sheets on the Tektronix 4051 terminal by keypunching. The Tektronix operator will enter only a subset of a complete file at one time. These file subsets will later be merged to a single file using the UNIVAC. After keypunching, the operator will obtain a printed copy of the data subset using the Tektronix printer, and will verify that the data in the Tektronix tape file is identical to that on the coding sheets. The operator will correct any data entry typographic errors using the Tektronix editor, then obtain a second printing of the file to confirm that the changes were properly made. Methods certification data and map location data will be entered first because validation routines make use of it.

Once the operator is certain that there are no remaining data entry errors on the Tektronix tape, the operator will use the Tektronix 4051 as a remote terminal to transfer the data to the UNIVAC 1100/60. To do this, the operator will load the data entry software, catalog a Level 1 (pre-acceptance) file on



Prepared for:

Program Manager's Office for
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

FIGURE 6.3-1
Laboratory Data Flow to the IR-DMS UNIVAC 1100/61 System
Rocky Mountain Arsenal, Task 10
Prepared by: Ebasco Services Incorporated

the UNIVAC, and transmit the data over the telephone lines using a modulator-demodulator (modem). Ebasco's operators will transfer Tektronix entry tape files to Level 1 UNIVAC files at least once per week, and will maintain a log of terminal usage and communication with the UNIVAC.

Once data are transferred, the operator will make use of IR-DMS utilities provided to convert English units of measurement to International Standard (SI) units. State Planar or Universal Transverse Mercator (UTM) grid system coordinates will also be converted to local origin coordinates, if necessary.

Next, the operator will invoke the IR-DMS data acceptance routines to perform the final data verification and create a Level 2 (temporary read-only) file. The acceptance routines will identify any errors in format or coding and any inconsistencies with previously loaded corresponding map records. If the acceptance routine does find errors at this stage, the operator will check the "R" file. The "R" file contains the rejected records that the acceptance routine creates. The UNIVAC editor is used to correct the verified entries, then they are resubmitted to the UNIVAC for acceptance. After acceptance, the IR-DMS automatically creates chemical and geological Level 2 files. Ebasco's operators will run the Level 1 data files through the data acceptance routines within seven days of their transfer to the UNIVAC system. They will delete Level 1 files once this data is accepted at Level 2.

Once the Level 2 file is created, the data processing operator will create a printed copy of the data set on the UNIVAC 1100/60 and submit, within ten working days of the Level 2 transfer, this copy to PMO.

The final step in the data entry and validation process, the creation of a Level 3 (final version, read-only) file, is undertaken by the PMO data processing staff at Aberdeen Proving Ground, Maryland.

6.4 ANALYSIS AND PRESENTATION

Ebasco scientists will access the PMO IR database and will perform analyses, as required, to support all contamination assessment work. The data analysis efforts may include graphic representations of data using data gridding, contouring, and three-dimensional surface representations. (Specifics of the contamination assessment work are presented in Section 8.0 of this report.) Several techniques will be used to access the data. If possible, IBM PCs will be used in terminal emulation mode to capture Level 3 data from the IR database to perform analyses and prepare material for presentation. The Tektronix 4051 terminals in Denver and Santa Ana will also be used in a direct link to the UNIVAC to prepare analyses and graphic representations. Ebasco scientists may establish communication links between IBM PCs to interchange data and facilitate data analysis.

7.0 HEALTH AND SAFETY PROGRAM

7.1 GENERAL

7.1.1 Project Health and Safety Plan

The purpose of this section is to provide an overview of the safety program Ebasco will employ to ensure the safety of its employees and that of subcontractors engaged in the field investigation activities at RMA. All employees involved in on-site downrange work undergo a complete Tox II Baseline physical and are continuously monitored in Ebasco's Medical Surveillance Program, per Occupational Safety and Health Act (OSHA) regulations (29 CFR 1910.20).

A draft of the project Health and Safety Plan (HASP), prepared according to the Ebasco Corporate Health and Safety Program, is included in Section V of the RMA Procedures Manual. All personnel working at RMA are familiar with this document and have been indoctrinated in all aspects of the safety program.

Overall responsibility for safety during the site investigation activities rests with the Project Health and Safety (PHS) Officer. The PHS Officer is responsible for developing the site-specific HASP at RMA and, through the on-site Health and Safety Coordinator, assumes its implementation responsibility. Specifically, the PHS staff are responsible for:

- Characterizing the potential specific chemical and physical hazards to be encountered,
- Developing all safety procedures and operations for on-site activities,
- Ensuring that adequate and appropriate safety training and equipment are available for project personnel,
- Arranging for medical examinations for specified project personnel,

- o Arranging for the availability of on-site emergency medical care and first aid, as necessary,
- o Determining and posting locations and routes to site work zones,
- o Notifying installation emergency officers (i.e., police and fire departments) of the nature of the team's operations and making emergency telephone numbers available to all team members, and
- o Indoctrinating all team members in safety procedures.

In implementing this safety program, the PHS Officer will be assisted by an on-site Health and Safety (HS) Coordinator. The HS Coordinator's function is to ensure that the established health and safety procedures are properly followed for all on-site activities. The details of the safety organization, administration, and responsibilities are described in Section I of the project HASP (Section V, RMA Procedures Manual).

In particular, the following specifics of the project HASP are especially important to the Task 10 investigation activity:

- o Safety organization, administration, and responsibilities;
- o Initial assessment and procedures for hazard assessment;
- o Safety training;
- o Safety operations procedures;
- o Monitoring procedures;
- o Safety considerations for sampling; and
- o Emergency procedures.

7.1.2 Task 10 Health Hazards

The sewer systems on RMA were used to transport both contaminated and uncontaminated wastewaters to disposal and treatment facilities. Information from the literature indicates that sections of the sanitary sewer and process water systems designed to handle uncontaminated wastes have been contaminated. Contaminants in the chemical sewer, sanitary sewer, and process water systems may include manufacturing products and byproducts of chemical and incendiary munitions and a variety of pesticides, insecticides, fungicides, and herbicides; including chlorinated benzenes, dibromochloropropane (DBCP), dichlorodiphenyltrichloroethane (DDT), and dicyclopentadiene (DCPD). These products and wastes are known to be toxic and hazardous to human health.

The conclusion of the RMA hazard assessment, based on historical evidence, is that the overall hazard assessment is extremely variable and is entirely dependent upon location and operation. Section VI of the project HASP describes the procedures to be employed to determine hazard of a specific building, or a sampling location for the identification of the preliminary level of protection requirement.

7.1.3 Training

Section VII of the HASP explains the training program for the RMA project. The training focuses on the general health and safety considerations and provides site-specific safety instructions.

7.1.4 Safety

Section VIII describes in detail the safety operations procedures. The important aspects of the safety operations procedures are:

- Zone approach for field work,
- Personnal protection, and
- Communications.

A three-zone approach (Support Zone, Contamination Reduction Zone, and Exclusion Zone) will be utilized, where possible, for all field work at RMA. The Support Zone will contain the Command Post with appropriate facilities such as communications, first aid, safety equipment, support personnel, hygiene facilities, etc. This zone will be manned at all times when field teams are operating downrange. Adjacent to the Support Zone will be the Contamination Reduction Zone (CRZ), which will contain the contamination reduction corridor for the decontamination of equipment and personnel (the actual decontamination procedures are discussed in Section XI of the HASP). All areas beyond the CRZ will be considered the Exclusion Zone. For pipeline excavations or soil boring operations the Exclusion Zone will be established at a 30-ft radius from the excavation site or drill rig. These support facilities are discussed and illustrated in Section VIII of the HASP.

The level of protection to be worn by field personnel will be defined and controlled by the on-site HS Coordinator and will be specifically defined for each operation in an information sheet (Facility Information Sheet, FIS). The preliminary FIS will be developed based upon historical information and data. This will be upgraded and utilized for future operations based upon the results of the Health and Safety portion of the soil and water sampling programs. For these programs, Level "C" type protection will generally be provided for investigation team members, however, Level "D" type protection may also be utilized as appropriate based on assessment by the PHS Officer and the on-site HS Coordinator. If determined necessary, changing from Level "C" to "B" protection can be easily achieved in the field. This can be accomplished in a matter of hours. Basic level of protection (i.e., Levels "A", "B", "C", or "D") for general operations are defined in Section VIII of the project HASP.

Maintaining proper communications among team members (investigation team, support team, and Health and Safety team members) during field investigation work is of utmost importance for the protection of investigation team members. The methods of communication that will be employed are:

- o Walkie talkies,
- o Air horns,
- o Hand signals, and
- o Voice amplification systems.

For external communication, telephones and sirens will be utilized.

7.1.5 Monitoring

Section IX of the HASP explains the health and safety monitoring procedures. A continuous monitoring of the working environment will be performed to ensure the adequacy of the level of personnel protection. Depending on the history of the sampling location, the presence of the following parameters will be monitored:

- o Army agents,
- o Oxygen levels,
- o Explosive conditions,
- o Organic vapor levels, and
- o Inorganic gas levels.

The type of on-site monitoring instruments to be utilized includes, but is not limited to, the following and will be based on the potential for the instrument specific contaminants to be present:

- o M18A2 Chemical Agent Kit for Army Agents;

- o M8 Alarm for nerve agents;
- o Oxygen meter for oxygen levels;
- o Combustible gas indicator for explosive conditions;
- o Photoionization Detector (PID) and Flame Ionization Detector (FID) for organic vapors; and
- o For inorganic gases, a gold film mercury monitor, a chlorine monitor, a carbon monoxide monitor, and a hydrogen sulfide monitor.

In addition, air samples will be collected at the breathing zone with charcoal and Tenax sample tubes and analyzed for volatile contaminants, as described in Section 4.0 of this Technical Plan. Based on the monitoring results (real time and field or laboratory analyses of the health and safety samples) the on-site Health and Safety Field Specialist can stop field investigation work. The upgrading and/or downgrading of the level of personal protection must be approved by the on-site HS Coordinator.

7.1.6 Sampling

Section X of the HASP explains the safety considerations during the actual sampling event. It describes the safety procedures to be followed for drilling operations, soil, surface water and liquid waste sampling, building sampling, and sampling in a confined space.

7.1.7 Emergency Procedures

The emergency procedures are described in Sections XIII to XV of the HASP. Section XIII explains the basic emergency situations; Section XIV describes how to get emergency services (i.e., medical, fire protection, ambulance, etc.) and Section XV outlines the evacuation procedures in case of emergency such as fire, explosion, and/or a significant release of toxic gases.

7.2 TASK 10 SITE-SPECIFIC HEALTH AND SAFETY CONSIDERATIONS

7.2.1 Manholes

Employees engaged in the opening of manholes will use Level "B" protective equipment and complete monitoring of the manhole vault will be undertaken. The information gained from the complete monitoring may be used to alter the level of protection as specified in the HASP. Monitoring requirements will be as described in the RMA HASP and will consist of organic vapor monitoring with a FID and PID, monitoring for the presence of combustible gases and oxygen levels, chemical agent monitoring, and other specific monitoring, as appropriate, and when indicated by the H&S Supervisor.

Sampling in the manhole vaults is expected to be conducted remotely. Because of the potential for direct contact with contaminants, maximum dermal protection must be provided. The dermal protection may extend to aprons, face shields, etc. in order to provide sufficient protection. Level "B" will be employed until sufficient data has been obtained to indicate that it is appropriate to change levels, but under no circumstances will sampling be conducted in less than full Level "C". All other personnel in the vicinity and supporting this sampling will remain in an upwind position and use appropriate protective equipment. If the sampling presents a potential for fall hazards, lifelines and safety harness will be employed. After sample collection and before shipment to the laboratory, the outside of all sample containers will be fully decontaminated by the decon technician; the containers will also be subject to monitoring and inspection by H&S personnel.

7.2.2 Hydrostatic Testing

Assuming these operations can be conducted remotely, protective equipment and measures, as previously described in this document and in the HASP, will be employed. However, if a confined space must be entered to conduct these or other functions, the Project H&S Officer shall be notified and a formal confined space entry program shall be implemented at his direction.

7.2.3 Excavation

Where excavations exceed 4 ft in depth, all aspects of currently applicable OSHA standards and NIOSH recommendations will be employed. Confined space entry protocol will be followed in the event that any excavation below 4 ft is to be entered. In any confined space entry, sufficient support or backup services must be provided.

The anticipated level of protection for excavation operations is Level "B", with special emphasis placed on the potential for dermal hazards and provisions for continuous monitoring. The action level criteria for monitoring, as defined for other sampling operations in the HASP, apply to excavation operations as well.

In light of the fact that the excavation locations around the sewers present the worst-case scenario for potential presence and contact with contamination, a Level "C" with heavy dermal protection will be permitted only after extended monitoring.

- Backhoe Operator

  The backhoe operator is expected to be somewhat remote from the source of any exposure. However, the unit shall be of an enclosed cab design and operated in an upwind condition. The level of protection employed will be based on monitoring of existing conditions and will be specified by the H&S Supervisor.

- Excavated Materials

  Excavated materials are the most likely to be contaminated with agents, pesticides, or other chemicals and, thus, present a potential risk to all personnel in the vicinity of the operation. They must be handled in such a manner so as to preclude airborne release, direct contact, and/or uncontrolled spread of contamination. In order to achieve these goals, the following practices are to be used:

1) A plastic liner shall be laid down on which excavated material is to be placed.

2) Additional cover will be used for excavated materials if they are to remain "open" or uncovered for long periods.

3) Excavated material should be placed downwind relative to the operations.

4) Soils removed from excavations will be stored in 3 layers (each covered with plastic) before being returned to the hole as described in Section 3.3.4 of this Technical Plan. It would be inappropriate to attempt to drum large volumes of contaminated soil until the final remedial action.

o <u>Soil Sampling</u>

The level of protection will be based on monitoring results, but must always account for dermal protection. Special cautions will be required to assure the selection and use of the appropriate level of protection for this activity.

8.0 CONTAMINATION ASSESSMENT

8.1 OBJECTIVES

The objectives of the Sewer System Investigation are to quantify the contaminants present, assess the extent of contamination, evaluate the factors that govern contaminant distribution, determine the severity and significance of the contamination, assess the structural integrity of the sewers, and apportion contamination by source (where possible). Due to the size and relative inaccessibility of the sewers and process water system, a complete and detailed contamination assessment is not possible. The field investigation program for this task will entail collecting samples from approximately 8 percent of the existing manholes and expose approximately 0.2 percent of the buried systems during the proposed excavations. However, the information obtained from this investigation will provide a "first-cut" estimate of the relative magnitude of problems associated with these systems. The need for additional studies and the specific areas for further studies will also be determined.

Investigations for this study will be conducted principally at potential source areas to evaluate whether the areas are contaminated, and if so, the types of contaminants present at each site. The studies will be accomplished through a limited number of borings and excavations from which samples will be screened for contaminants. In order to accomplish objectives of the overall program, the contamination assessment will consist of the following subtasks:

- Determination of the integrity of the different sewer lines;
- Determination of which sewer line and process system segments are contaminated;
- Determination of which sewer lines and process lines have the potential to leak contaminants;
- Estimation of the type, magnitude, distribution patterns, and extent of contaminant leakage to the subsurface environment around the lines;

- o Examination of the geologic and hydrogeologic influence on the spatial distribution of contaminants;
- o Determination of the relationship between the contamination of the sewer lines and the historical and current contamination of the surrounding area; and
- o Estimation of the significance of soil contamination (criteria development).

8.2 TYPE, MAGNITUDE, DISTRIBUTION, AND EXTENT OF CONTAMINATION

The results of the chemical analyses of the soil and sediment samples will be examined to determine the presence, quantities, and extent of contamination along the various lines. Compilation of soil-contaminant data by source, location, and depth will provide estimations of the areal and vertical extent of contamination associated with "typical" leak patterns. The chemical data will be integrated with the soils and geohydrologic data as described in Section 8.3 of this report. From this information, preliminary estimates of the lateral and vertical extent of the contaminants and definition of contaminant boundaries will be prepared. Maps and cross-sections will be prepared to illustrate the spatial distribution of contaminated and uncontaminated lines, and to delineate the existence of distinct contaminant concentration gradients in the proximity of sources and within the overall study areas.

8.3 FACTORS INFLUENCING CONTAMINANT DISTRIBUTION AND MOBILIZATION

8.3.1 Geologic and Hydrologic Conditions

Hydrological data from other task orders will be analyzed in conjunction with the historical information to determine the influence of the subsurface geology and hydrology in the distribution of contaminants in the ambient soils within the study areas.

Borehole logs of both cuttings and cores from the Task 10 program and from nearby bores installed under other task orders will be compiled, integrated, and interpreted to formulate a site-specific evaluation of geologic conditions. Hydrogeologic conditions of the Task 10 areas will be assessed following the evaluation of previously generated hydrogeologic data and data collected during this investigation. The groundwater impacts of infiltration into and exfiltration from the sewer systems will be assessed.

8.3.2 Contaminant Properties and Geochemistry of Ambient Soils

The distribution and mobilization of contaminants are functions of the molecular characteristics of the target chemicals, the physical/chemical properties of the soils, and the availability of transport pathways such as the sewer lines. These variables will be examined, as applied to the contaminants of concern and soil characteristics observed during sampling, and used in the data analyses to evaluate the contribution of these factors to the observed concentration gradients.

8.4 RELATIONSHIP OF CONTAMINATION SOURCES TO PAST AND PRESENT SOIL CONTAMINATION

The analysis of the contamination sources and soils data will be used to identify relationships between ambient soil and source contamination. These methods will allow for a preliminary estimate of the spatial extent of contamination and definition of the areas which may require cleanup.

8.5 SIGNIFICANCE OF SOIL CONTAMINATION (CRITERIA DEVELOPMENT)

Action levels for the target chemicals are currently being developed by the U.S. Army Medical Bioengineering Research and Development Laboratory (USAMBRDL) in coordination with the "How Clean is Clean" Committee. The approach being used is the Preliminary Pollution Limit Values (PPLV) method applied to five contaminant transport pathways consistent with the proposed land use scenarios. The pathways are: 1) drinking of groundwater, 2) inhalation of soil particles (dust), 3) soil ingestion by children, 4) ingestion of vegetables, and 5) uptake by fish and wildlife.

To date, physical/chemical and toxicological summaries of 55 target chemicals have been prepared by USAMBRDL. These summaries and the overall PPLV methodology are currently being reviewed by the members of the "How Clean is Clean" Committee.

APPENDIX A

REFERENCES

REFERENCES

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APPENDIX B

HYDROSTATIC TEST PROCEDURE

HYDROSTATIC TEST PROCEDURE

This test procedure is a modified version of the hydrostatic test method for new ductile-iron water lines as presented in the American Water Works Association (AWWA) Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances (Standard No. AWWA C600-82) (AWWA, 1977). This test method is a water-pressure test method and is not applicable for air-pressure testing due to serious safety hazards involved with air-pressure testing. This modified test method is applicable for determining the leakage of pressure lines under typical operating conditions. Leakage is measured as loss of water and can be compared to a standard leakage table for new pipe.

The following restrictions apply:

- The test pressure shall not exceed the pipe or thrust-restriant design pressures,
- The test pressure shall not vary by more than ±5 pounds per square inch (psi) for the duration of the test,
- The test pressure shall be applied for a minimum of 2 hours,
- The test pressure shall not exceed the rated pressure of any values,
- No value shall be operated in either the opening or closing direction at a differential pressure exceeding the rated pressure, and
- The test pressure shall equal the estimated maximum operating pressure.

The section of pipe to be tested shall be isolated by closing off all valves connected to lines external to the section under the test. For lift station pressure lines, temporarily installed valves may be required for the test if such are not permanently installed on the line. Make-up water to be added to the test section should be added with an appropriate pump and water meter.

The test is initiated by isolating the section to be tested as described above. Water is slowly added to the line until the line is completely filled. Any air in the line shall be completely expelled from the pipe, valves, and hydrants using either existing air vents or corporation cocks specifically installed at all high points for the test. After all air has been removed, the corporation cocks shall be closed and the designed test pressure applied with the pump. The system shall be allowed to stabilized at the test pressure before starting the 2 hour test duration. During the test period, water is added with the pump to maintain the test pressure to within the $\pm$ 5 psi test limits.

Leakage is defined as the quantity of water added to the test section during the test period. The leakage can be compared to standard new pipe leakage using Table 6 of AWWA C600-82 and the following:

$$L = \frac{SD \quad P}{133,200}$$

where: L = the allowable leakage, gallons per hour

S = length of pipe under test, feet

D = nominal diameter of the pipe, inches

P = average test pressure, psi gauge

The above equation is based on an allowable leakage of 11.65 gallons per day, per mile of pipe, per inch of nominal diameter at a pressure of 150 psi. Table B-1 presents allowable leakage at other test pressures.

Table B-1. Allowable Leakage per 1,000 ft (305 m) of Pipeline * -- gph**.

Avg. Test Pressure psi (Bar)	Nominal Pipe Diameter - in. 3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54
450 (31)	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60
400 (28)	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11
350 (24)	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58
300 (21)	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02
275 (19)	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72
250 (17)	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41
225 (16)	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03
200 (14)	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73
175 (12)	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36
150 (10)	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97
125 (9)	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53
100 (7)	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05

* - If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

** - To obtain leakage in litres/hour, multiply the values in the table by 3.785.

Task 10
0050U
Rev. 11/19/87

APPENDIX C

LETTER TECHNICAL PLANS

EBASCO SERVICES INCORPORATED EBASCO

143 Union Boulevard, Suite 1010, Lakewood, CO 80228-1824, (303) 988-2202

December 18, 1986
RMA10-EDEN-USA-M-020

Commander, Office of the Program Manager
for Rocky Mountain Arsenal Contamination Cleanup
ATTN: AMXRM-EE/(K. Blose)
Building E4585 - DBL Trailer
Aberdeen Proving Ground
Maryland 21010-5401

SUBJECT: Changes to the Draft Final Technical Plan for Task 10, Sewer System Investigation

Dear Kevin:

The manhole reconnaissance survey conducted as part of the field work for Task 10 has provided additional information on the sanitary and chemical sewer systems at the Rocky Mountain Arsenal. This information indicates that modifications to the Field Investigation Program for Task 10 are necessary to meet the objectives of this task. These modifications are described below.

1. Chemical Sewer Manhole 4-1 could not be located in the field. Alternative manholes for investigations and possible sampling include Manholes 4-2 and 4-3.

2. Overhead powerlines will prevent any drilling activities in Manhole W26. Alternate manholes for investigation and possible sampling are Manholes W27 and W28.

3. Several sites chosen for pipeline excavation will present access problems for the backhoe. Alternate sites are being evaluated. The locations of alternate sites will be sent to you after accessibility has been field-verified.

0090M

Please call if you have any questions.

Sincerely,

Dale D. Gabel, P.E.
Task Manager

DDG/jmj
cc: D. Campbell
J. Silvey
P. Chiaro
K. Knirsch
T. Bick
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E. McGrath
C. Hahn
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T. Lobby
C. Sutton
R. Duprey
DCC/Denver
Chron File
DCC/Santa Ana

0090M

EBASCO SERVICES INCORPORATED EBASCO

143 Union Boulevard, Suite 1010, Lakewood, CO 80228-1824, (303) 988-2202

February 5, 1987
RMA10-EDEN-USA-M-032

Commander, Office of the Program Manager
for Rocky Mountain Arsenal Contamination Cleanup
AMXRM - EE/K. Blose
Building E4585 - DBL Trailer
Aberdeen Proving Ground
Maryland 21010 - 5401

SUBJECT: Proposed Changes to Task 10 Sewer Line Excavation Sites

Dear Kevin:

The proposed pipeline excavations to be conducted on various sections of the chemical sewer system, the sanitary sewer system, and the process water return system as part of Task Order 10 have been reevaluated. Modifications to the proposed sites as identified in the Technical Plan are identified below.

1. Sanitary sewer line between Manholes 34 and 35.
   No change in this proposed location.

2. Sanitary sewer line between Manholes 45 and 46.
   No change in this proposed location.

3. Sanitary sewer line between Manholes 98 and 99.
   Due to potential groundwater problems in this region, as identified by Morrison-Knudsen Engineers (MKE), this site has been moved to the sanitary sewer line between Manholes 100 and 115. Groundwater problems are not anticipated at this site.

4. Sanitary sewer line between Manholes 117B and 119B.
   Steam lines located directly over this line will severely limit equipment access to this site for excavation. A replacement site is the sanitary sewer line between Manholes 120C and 120D.

5. Chemical sewer line between Manholes I-2 and I-3.
   No change in this proposed location.

6. Chemical sewer line between Manholes W26 and W27.
   No change in this proposed location.

7. Chemical sewer line between Manholes W17 and W18.
   No change in this proposed location.

8. Process water return between Manhole 2 and the process water return diversion box.
   A 12 inch cast iron or steel line has been laid in the invert of this 42 inch concrete line severely limiting access to the line for dye addition. A proposed alternative site is the process water return system between Manholes 4 and 5.

9. Process water return line between Manholes 1 and 8.
   No change in this proposed location.

After review of these changes, please call me if you have any questions.

Sincerely,

Dale Gabel

Dale D. Gabel, P.E.
Task Manager

DDG/bm

cc: T. Bick
Maj. Boonstoppel
F. McGrath
C. Hahn
A. Notary
J. Looby
C. Sutton
R. Duprey
J. Silvey
I. Chiaro
J. Keithley
K. Knirsch
DCC/Denver
DCC/Santa Ana
C. File

EBASCO SERVICES INCORPORATED EBASCO

143 Union Boulevard, Suite 1010, Lakewood, CO 80228-1824, (303) 988-2202

March 6, 1987
RMA10-EDEN-USA-T-011

Commander, Office of the Program Manager
for Rocky Mountain Arsenal Contamination Cleanup
ATTN: AMXRM-EE/K. Blose
Building E4585 - DBL Trailer
Aberdeen Proving Ground
Maryland 21010-5401

Dear Kevin:

As you know, the proposed technical approach to evaluate the nature and extent of soil contamination resulting from the Process Water Distribution System (PWDS) does not appear to be possible because the RMA Facility Engineer's office has said pressure testing of the active sections of the system will not be permitted. Approximately 95 percent of the total PWDS is active at the present time. Only a few sections in South Plants are inactive. The inactive sections include lines north and south of the tank farm area, lines south of Building 742, and lines in the chlorine area, as shown in Figure 1. In addition, the status of lines within the Shell leasehold area (500 series buildings) is not known. To pressure test less than 5 percent of the total system will not provide an adequate assessment of the system.

Proposed alternate activities to pressure testing are as follows:

1. Conduct a flow mass balance analysis of the entire PWDS to provide an assessment of the existing system;
2. Conduct a literature search of past contamination and operational and repair documents of the PWDS to identify past problem areas;
3. Locate existing leaks in the PWDS using source leak detectors and locators; and
4. Conduct a soil boring program in areas of the PWDS identified as "worst case" areas.

0056U
Rev. 3/6/87

The best solution in assessing the PWDS's integrity and the soil contamination in the vicinity of the PWDS will be to complete a three-step program. In Step 1, Ebasco shall complete a literature search to develop an overall understanding of the entire PWDS, past and present, and conduct a flow mass balance analyses of the PWDS. Step 2 will consist of detecting and locating existing leaks using leak locators and detectors. Step 3 will be an extensive soil boring program to assess the soil contamination in the vicinity of identified leak sites. Summaries of the advantages and disadvantages of each method are presented in more detail in the following paragraphs.

In step 1, a literature search will be completed to assess past leak locations and contamination of the PWDS at the time of the leaks. Research will focus on design, construction, operational and repair documents. In addition, several maps will be drawn to show past leak locations, spill locations, and possible assessment interferences from past leaks of the chemical and sanitary sewer system. Operational documents will be used to complete flow mass balances (if possible) for prior years which may suggest which past years have had water loss problems.

In addition, a flow mass balance analysis of the system will be computed to give a gross estimation of the total leakage under existing operational conditions. All intake and discharge lines, including Denver City Water and lake water, are shown in Figure 2. At the present time, only the line coming from the pump house (Building 371) has a flow meter. The intake lines into the boiler house have no flow meters connected. The boiler intake flows will be measured using ultasonic flowmeters. All discharge lines from the boiler house will be measured by open-channel flow meters.

In Step 2, leak detectors and locators will be used to create a distribution map of all potential existing leak locations. Leak detectors will be connected to valves and hydrants to assess whether a leak is occurring near a particular valve or hydrant. Leak locators will then be used to pin point the approximate location of the leak in question.

After all "worst case" situations (areas where past and present leaks overlap) have been identified during Steps 1 and 2, a soil boring program will then be initiated to identify soil contamination in the areas of past and present leaks.

For the Process Water Return System (PWRS) the field approach will be as presented in the Technical Plan, i.e., dye/excavation studies in two areas. However, the location of these sites has been changed because of access and safety problems which might be encountered in Manholes 1 and 2. The areas in which investigations will be completed are between Manholes 4 and 5 and Manholes 16 and 17.

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Rev. 3/6/87

In addition, a soil boring program will be conducted at all PWRS discharge points, the cooling tower blowdown evaporation pond, and several open return ditches in the South Plants area to identify past soil contamination. The literature search will also focus on identifying possible PWRS contamination assessment interferences from spills or sewer system leaks. Proposed boring locations for Task 10 and proposed and existing boring locations for other tasks in Sections 1 and 2, are shown in Figure 3. The borings will be hand augered to a depth of five feet and sampled at the 0-1 and 4-5 foot intervals for Phase I target compounds.

If you have any questions, please give either Carolyn Crosson or me a call.

Sincerely,

Dale Gabel

Dale D. Gabel, P.E.
Task Manager

DDG:jah

cc: Don Campbell
T. Bick
Maj. Boonstoppel
E. McGrath
C. Hahn
A. Notary
T. Looby
C. Sutton
R. Duprey
J. Silvey
K. Knirsch
P. Chiaro
J. Keithley
C. Crosson
S. Turner
DCC/Denver
DCC/Santa Ana
Chron File

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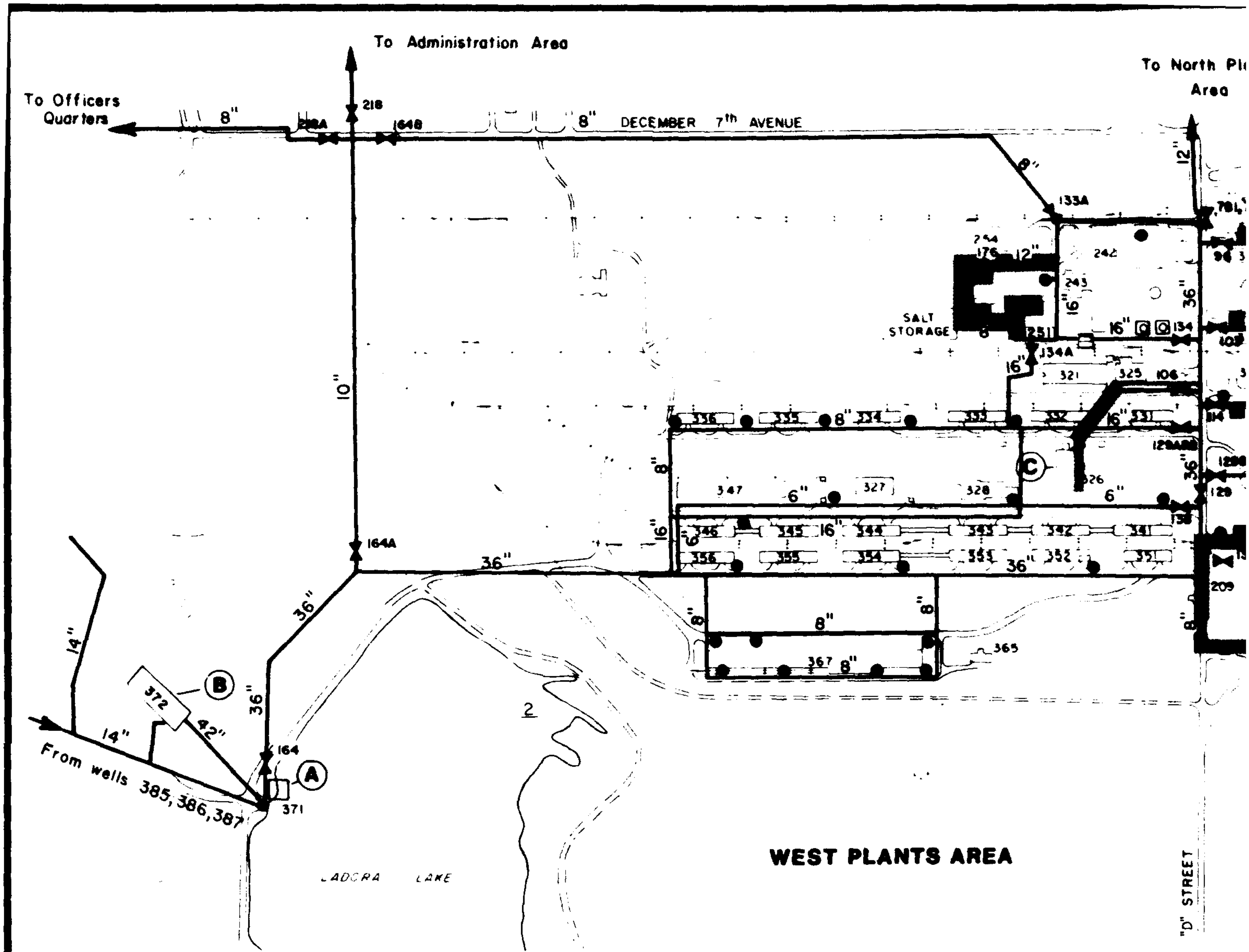


Legend

Ⓐ **Water Pump Station (Bldg. 371)**

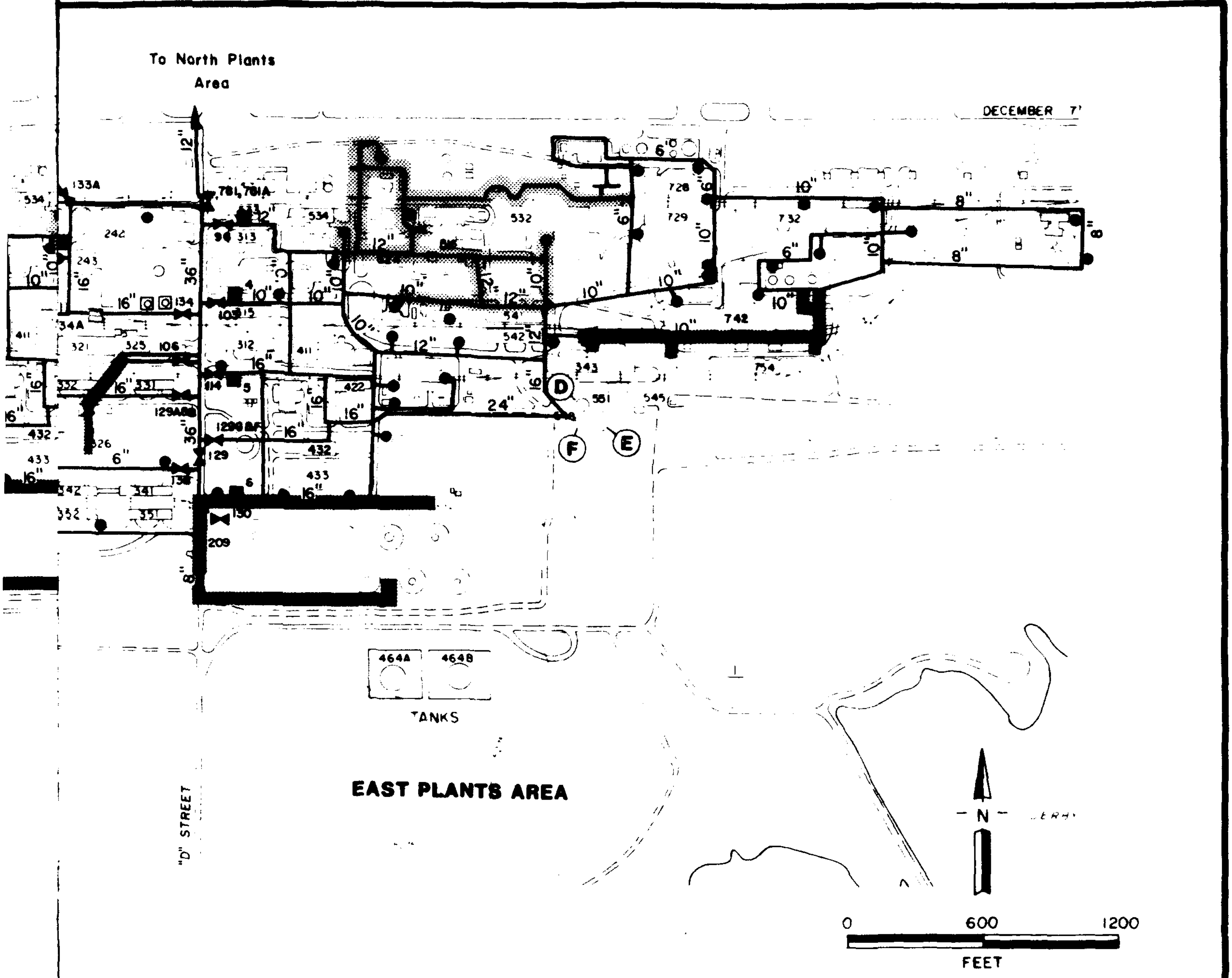
Ⓑ **Reservoir, 1,000,000 Gallon Capacity (Bldg. 372)**

Ⓒ **Spray Pond Structure and Spray House (Bldg. 326)**

Ⓓ **Elevated Water Storage Tank (Bldg. 551)**

Ⓔ **Cooling Tower (Bldg. 549)**

Ⓕ **Pump House (Bldg. 548)**



nd

Tower
49)

ouse
48)

Process Water Line

Fire Hydrant

Valve

Meter

Inactive System

Shell Leasehold Area (System Unknown)

Prepared for:

Program Manager's Office for
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

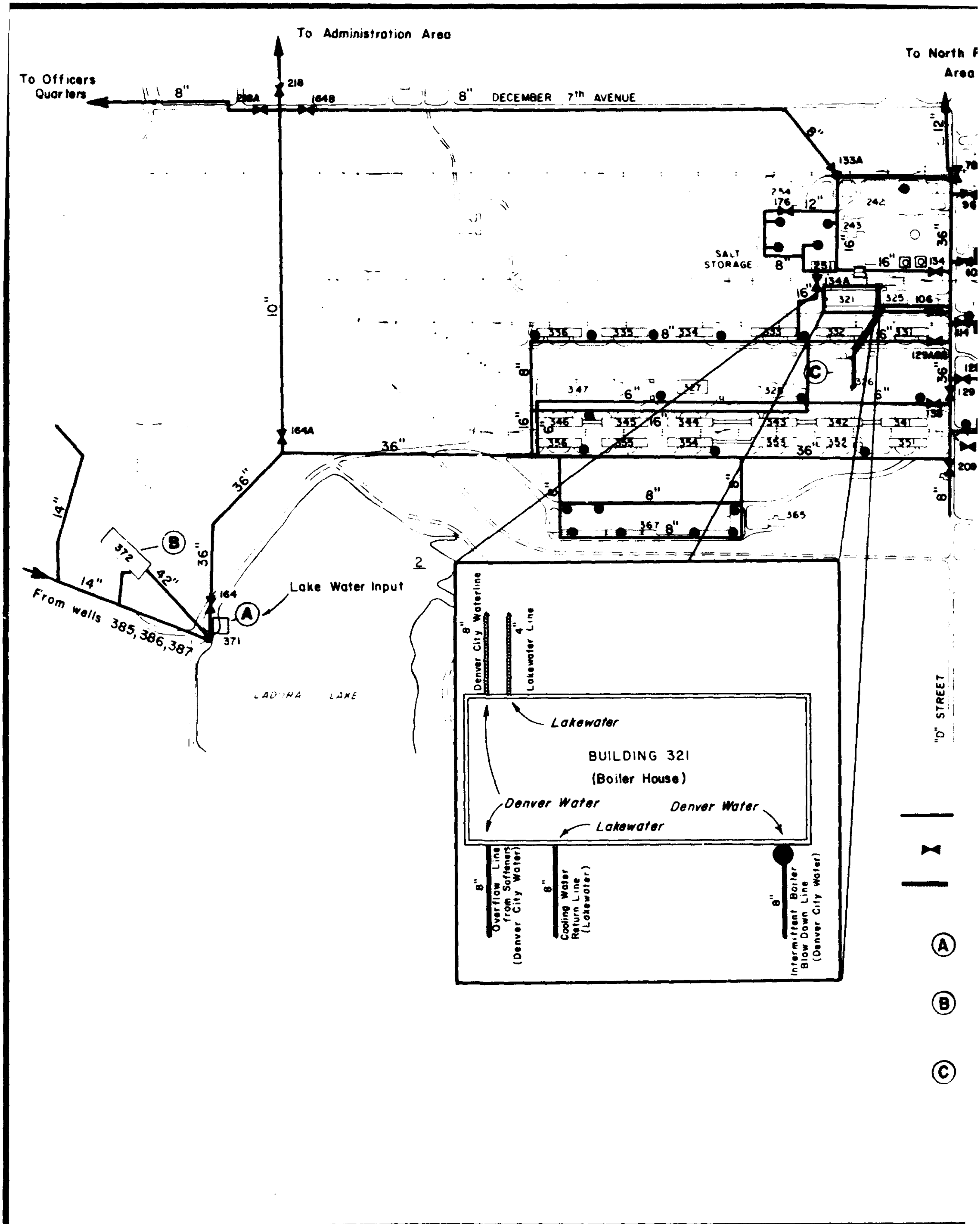
FIGURE 1

Process Water Distribution

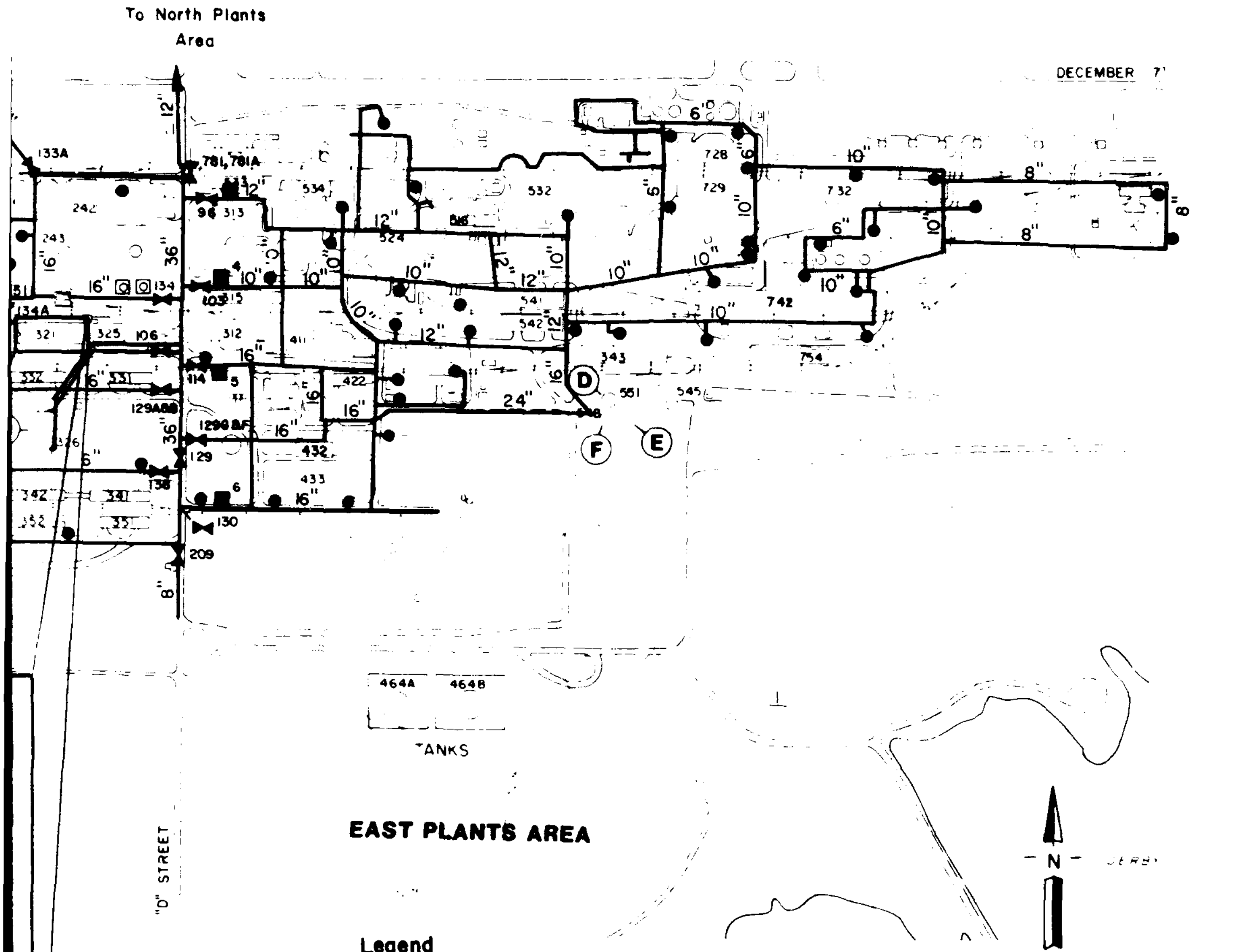
South Plants Area

Rocky Mountain Arsenal, Task 10

Prepared by Ebasco Services Incorporated



To Administration Area
To Officers Quarters
To North Area
8"
DECEMBER 7th AVENUE
218
218A
164B
133A
242
243
176
12"
16"
36"
SALT STORAGE
8"
134
134A
321
325
106
336
335
334
333
332
331
129A&B
C
326
347
6"
327
328
129
346
345
344
343
342
341
356
355
354
353
352
351
164A
10"
36"
200
365
367
14"
372
B
42"
164
A
Lake Water Input
From wells 385, 386, 387
371
LADORA LAKE
Denver City Waterline
Lakewater Line
4"
Lakewater
BUILDING 321
(Boiler House)
Denver Water
Denver Water
Lakewater
Overflow Line from Softeners (Denver City Water)
Cooling Water Return Line (Lakewater)
Intermittent Boiler Blow Down Line (Denver City Water)
"D" STREET
A
B
C



Legend

Process Water Distribution Line		Fire Hydrant	
Valve		Meter	
Discharge Lines from Boiler House		Input Lines to Boiler House	
(A)	Water Pump Station (Bldg. 371)	(D)	Elevated Water Storage Tank (Bldg. 551)
(B)	Reservoir, 1,000,000 Gallon Capacity (Bldg. 372)	(E)	Cooling Tower (Bldg. 549)
(C)	Spray Pond Structure and Spray House (Bldg. 326)	(F)	Pump House (Bldg. 548)

Prepared for:

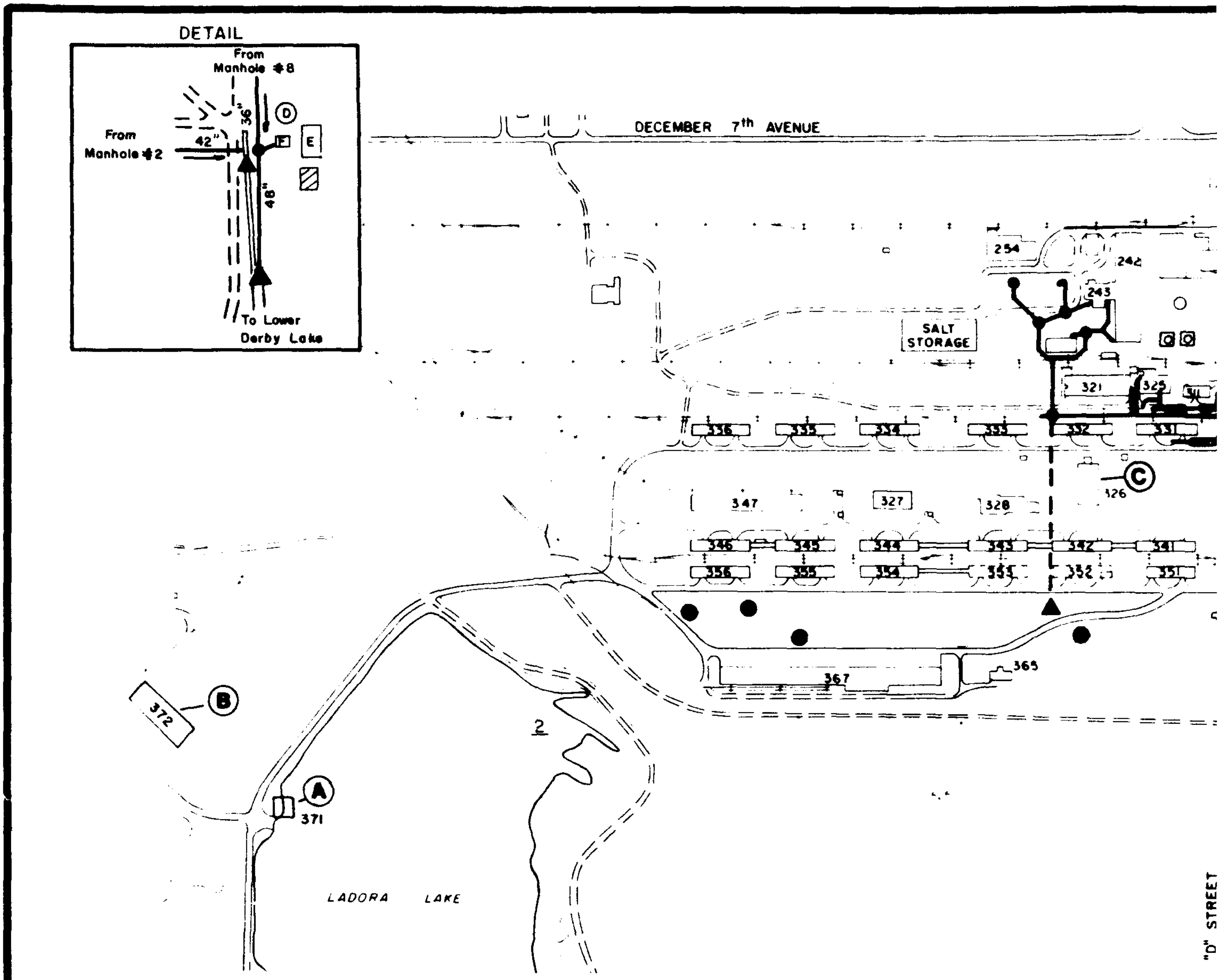
Program Manager's Office for
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

FIGURE 2

Process Water Distribution System South Plants Area

Rocky Mountain Arsenal, Task 10

Prepared by Ebasco Services Incorporated



Legend

Ⓐ **Water Pump Station (Bldg. 371)**

Ⓑ **Reservoir (Bldg. 372)**

Ⓒ **Spray Pond Structure and Spray House (Bldg. 326)**

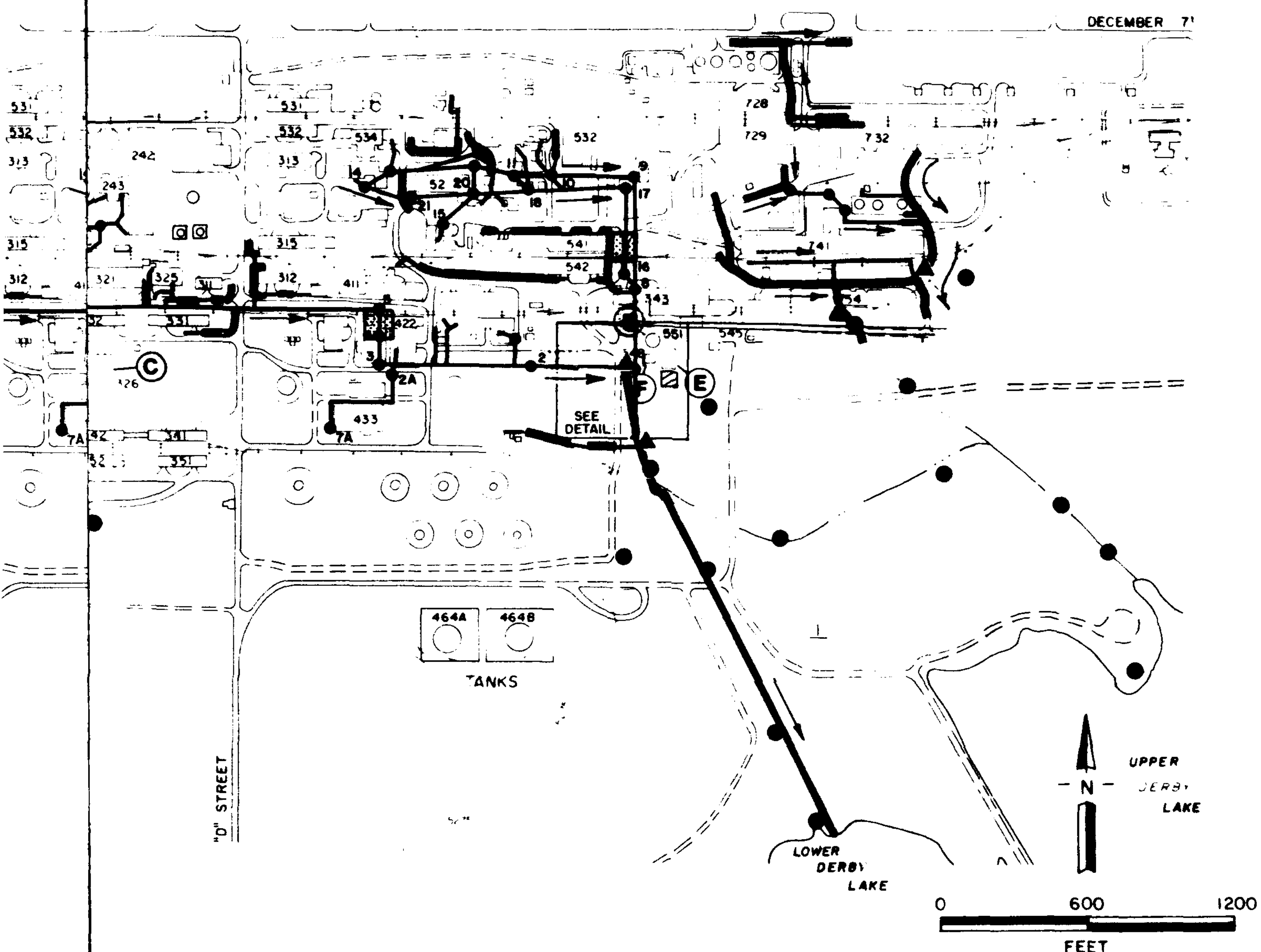
Ⓓ **Elevated Water Storage Tank (Bldg. 551)**

Ⓔ **Cooling Tower**

Ⓕ **Pump House (Bldg. 548)**

▲ **Proposed Boring Locations**

● **Task 7 Boring Loc**



d

Tower	•	Manhole
ouse		Process Water Return System
8)		Open Drainage Ditch
		Blowdown Line from Boiler House
d Boring		Excavation Site
s		
on / oring Location		Cooling Tower Evaporation Pond Boring Location

Prepared for:

Program Manager's Office for
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

FIGURE 3
Investigative Program South Plants Process Water Return System

Rocky Mountain Arsenal, Task 10
Prepared by Ebasco Services Incorporated

APPENDIX D

COMMENTS AND RESPONSES

COMMENTS AND RESPONSES

Specific written comments by MOA parties along with written responses are included in this appendix.

COLORADO DEPARTMENT OF HEALTH

Richard D. Lamm
Governor

Thomas M. Vernon, M.D.
Executive Director

January 13, 1987

RECEIVED
9 1987
DENVER REGIONAL OFFICE

Colonel W. Quintrell
Deputy Program Manager
AMXRM-EE, Bldg. 4585
Aberdeen Proving Ground
Maryland 21010-5401

Dear Colonel Quintrell:

Consistent with Section II E 2 of the 1982 MOA, enclosed are the State's comments on the Draft Final Technical Plan, Task #10, Sewer System Investigation. These comments were verbally transmitted to Ebasco, your contractor conducting the investigation within several weeks of receipt of the report.

If there are any questions please contact Mr. Chris Sutton with this Division.

Sincerely,

Terry Biberstine for R.K.

Rick Karlin, P.E.
Section Chief
Drinking Water/Ground Water Section
WATER QUALITY CONTROL DIVISION

RK/CS/lc

Enclosure

cc. Howard Kenison, Colo. Attorney General Office
Robert Duprey, U.S. Environmental Protection Agency
Chris Hahn, Shell Oil Company

4210 EAST 11TH AVENUE DENVER COLORADO 80220 PHONE (303) 320-8333

RESPONSES TO COLORADO
DEPARTMENT OF HEALTH
ON THE TECHNICAL PLAN FOR TASK 10
SEWERS AND PROCESS WATER SYSTEM INVESTIGATIONS

Comment 1: Page 1-1
The task should be designed to evaluate the chemical nature of any liquid wastes encountered within either the chemical, sanitary and process water sewer systems to aid in the correlation with chemical contaminants found in the surrounding soils.

Response: The task is designed to determine the presence and extent of soil contamination associated with the systems. If the systems are to be investigated as potential contamination sources, the pertinent information is whether or not contaminants escaped from the systems, what contaminants were involved and how far they have migrated through the soil. Past operations and associated liquids, not present operations, will be the source of any soil contamination found. Soil samples from around the pipes and manholes will best supply the needed information. Liquid samples taken from within any of the piping systems will tell what is currently present and not what was present previously. Sediment samples may be collected from inside selected manholes as the sediments may have been present for a long period of time. However, no water samples will be collected.

Comment 2: Page 1-1
The first objective listed should not include the chemical sewer as it is assumed that the entire chemical sewer is already "contaminated."

Response: We agree that the chemical sewer system can be "assumed" to be contaminated, however, there is no need to change the text.

Comment 3: Page 1-3
The identification of the extent of soil contamination in the vicinity of "identified" leaks should include an evaluation of the known worst cases (e.g., where the sewers have required extensive repair or re-routing) such as between man holes 120 D and 119 A of the sanitary sewer and between manhole E7 and the East Meter Pit or near Building 534B for the chemical sewer. The contamination of soils surrounding these known "worst cases" could then be utilized to represent the actual worst case soils contamination caused by sewer leaks.

Response: The investigative techniques described in the Technical Plan are designed to provide a "worst case" situation estimate of the extent of contamination associated with the pipelines. However, problems such as high groundwater and flooded sewers in some areas may prevent investigations at known leak locations. This is the case for the chemical sewer between Manhole E7 and the East Meter Pit, and near Building 534B (MKE, 1986). Changes to the sanitary sewer line excavation sites were proposed in the Letter Technical Plan dated February 5, 1987 and included areas where extensive repair or re-routing occurred. Potential access problems eliminated excavating the sewer line between Manholes 119A and 120D, however, the excavation between Manholes 120C and 120D should provide equivalent information.

Comment 4: Page 2-1
The buried chemcial sewer identified in the vicinity of source area 36-5 should be included in this investigation.

Response: The chemical sewer in the vicinity of Source Area 36-5 is assumed to be removed and will be investigated under Task 1, Section 36 Contamination Survey, by ESE. Existing lines are the focus of Task 10. As part of the Task 10 field investigations, the area around Source 36-5 will be investigated for the presence of any non-removed chemical sewers.

Comment 5: Page 3-11
During the tracer dye testing program, the dye liquid level within the segment of sewer being tested should be maintained (not allowed to drop substantially) during the entire test period (24 hours) to ensure that all leaks along a tested section are identified.

Response: To ensure a "worst case" scenario is developed for the sections to be tested, the dye testing method will be modified as suggested. The sewer pipe sections to be tested will be completely filled with dye solution instead of 1/2 filled as originally proposed. However, the large diameter lines (process water return lines) will be filled on 1/2 full to avoid possible safety hazards associated with plugging the large lines. The section being tested will be checked periodically to ensure the pipe remains full throughout the test. If the level of the dye solution decreases, additional solution will be added as needed to maintain a full pipe section. The Technical Plan has been modified to reflect this change.

Comment 6: Page 3-19
Which task will evaluate the extent of contamination from the 12 on-site leach field systems? These systems should be assessed since they provide a direct discharge of contaminants to soil and ground water.

Response: As stated in the Technical Plan, page 3-19, "These systems generally serve only isolated areas and many are no longer in use. As these systems are not connected to the main sanitary sewer system and there is no documented history that they are contaminated, they will not be studied in the Task 10" investigations. Task 24 will be evaluating the contamination potential for all structures.

Comment 7: A minimum number of borings should be designated in the Technical Plan and collected for all manhole and sewer investigations. The program as described calls for samples being collected only when it is "determined to have a potential to leak contaminants."

Response: As stated in the Technical Plan, we will collect samples when it is "determined to have a potential to leak contaminants" near manholes or sewer and process lines. It is anticipated that each trench will yield a minimum of 7 borings and 12 to 14 samples, however, the actual number is a case-by-case situation and can only be determined in the field. The number of sediment samples will depend on the amount of available sediment in the manholes and could not be determined at the time the Technical Plan was developed. There will be no change in the text.

Comment 8: Page 3-35
All areas where the three sewer systems are at or near the ground water table should be identified. No investigations are proposed for these areas. Therefore, these areas are presumed to be contaminated if contaminants are or were known to be present in the shallow aquifer.

Response: As stated on page 3-35 of the Technical Plan, areas where the systems are at or near the groundwater table are not to be sampled due to the difficulty of determining the source of contamination in soils contacted by the contaminated groundwater. If appropriate, the depth to ground water for all three systems will be considered in the contamination assessment section of the Contamination Assessment Reports for these systems.

Comment 9: Page 3-69
It is not clear in the report how the "worst case" leak scenarios are to be extrapolated to the sewers located over the entire Arsenal. The relationship of the soils beneath the entire sewer system needs to be explicitly defined in Section 3.8.

Response: A paragraph has been added to Section 3.8 (page 3-71) which reads, "Because it is not possible to investigate the sewer systems on the Arsenal in their entirety, only "worst case" leaks will be investigated. Using this approach, estimates of the maximum possible extent of contaminant migration for each system in each area (South Plants, North Plants, Railyard/Administration Area, etc.) will be made. To assure that all contamination resulting from the sewers is remediated, the maximum extent of contamination for each system in a given area will be assumed for the entire system in that area."

Comment 10: The soils programs analytic methodologies are presently being reviewed by the PMO for surety compounds and other arsenal contaminants to identify if lower analytic detection limits can be obtained. The Task 10 program should utilize the revised analytic program to the extent possible.

Response: When the analytic methodologies have been reviewed and approved by PMO for surety compounds and other Arsenal contaminants, these methodologies will be used on all soil samples.

Shell Oil Company

One Shell Plaza
P.O. Box 4320
Houston, Texas 77210

November 25, 1986

FEDERAL EXPRESS

USATHAMA
Office of the Program Manager
Rocky Mountain Arsenal Contamination Cleanup
ATTN: AMXRM-EE: Chief: Mr. Donald L. Campbell
Bldg. E4585, Trailer
Aberdeen Proving Ground, MD 21010-5401

Dear Mr. Campbell:

Enclosed are our comments on the October 1986 Draft Final Technical Plan for Task 10, "Sewer System Investigation". As indicated by the comments, we have serious concerns about this program.

It appears that a primary program objective is to quantify the extent of contaminated soils associated with the buried pipeline systems at RMA (p. 8-1). This being so, we believe that the program is deficient for the principal following reasons:

- The plan proposes to quantify pipeline-generated contamination on the basis of investigating 0.2 percent of the existing pipelines and 8 percent of the sewer manholes. Not only is such an extrapolation technically indefensible, but the techniques employed are suspect.
- The proposed 24 hour dye testing technique will not provide adequate definition of contaminant distributions that occurred over decades of continuous operation. As stated in the attached comments, a "typical" leak will not be simulated.
- Manhole drilling and sampling of the underlying soils will not provide meaningful data that correlates to adjacent pipeline leakage.

BRHT8632901

Mr. Donald L. Campbell
Page 2
November 25, 1986

- The interpretation of the hydrostatic testing of process water lines will be complicated by the age of the system and existence of leaky valves.

In addition to the above, the technical plan does not recognize the possibility of the disturbed soils adjacent to the pipe acting as a contaminant transport conduit. Also, it ignores the known fact that, even at the present time, infiltration of contaminated groundwater into the sanitary sewer results in the rapid transport of contaminants over great distances.

Based on the infirmities described in this letter and in the enclosed comments, we do not believe that this program will produce information that will benefit the RI/FS process.

We would be willing to discuss any questions you have on this issue.

Very truly yours,

W. E. Alcock
for C. K. Hahn
Denver Site Project

WEA/mtm

Enclosure

cc: Mr. Thomas Bick
Environmental Enforcement Section
Land & Natural Resources Division
U.S. Department of Justice
P.O. Box 23896
Benjamin Franklin Station
Washington, DC 20026

USATHAMA
Office of the Program Manager
Rocky Mountain Arsenal Contamination Cleanup
ATTN: AMXRM-EE: Mr. Kevin T. Blose
Bldg. E4585, Trailer
Aberdeen Proving Ground, MD 21010-5401

BRHT8632901

Major Robert J. Boonstoppel
Headquarters - Department of the Army
ATTN: DAJA-LTS
Washington, DC 20310-2210

BRHT8632901

DEPARTMENT OF THE ARMY
PROGRAM MANAGER, ROCKY MOUNTAIN ARSENAL CONTAMINATION CLEANUP
ABERDEEN PROVING GROUND, MARYLAND 21010-5401

REPLY TO ATTENTION OF

March 2, 1987

Environmental Engineering Division

Mr. Edward McGrath
Holme, Roberts & Owen
1700 Broadway
Denver, Colorado 80290

Dear Mr. McGrath:

This letter responds to your letter dated November 25, 1986 providing Shell's comments on Ebasco's October 1986 Draft Final Technical Plan for Task 10 - Sewer System Investigation.

Your letter presents four principal reasons why Shell believes the Technical Plan is deficient. Thirty-four specific comments are enclosed. Our response follows that format.

Shell's overall conclusion is that the Technical Plan will not "produce information that will benefit the Remedial Investigation/ Feasibility Study (RI/FS) process." We disagree. The goal of this program is to obtain useful data on potential contamination caused by leakage from the Arsenal sewer systems. Once these data (together with the sewer survey data collected by Shell) have been collected and evaluated, we can determine whether and to what extent conclusions can be drawn regarding other, unsampled segments of the sewer system. With input from the other Memorandum of Agreement Parties, we will decide at that time what additional information may be needed to characterize adequately the extent of contamination from the three systems. As such, we believe the Draft Task 10 Technical Plan presents a reasonable, cost-effective methodology in the remedial investigation process.

We agree with Shell's observation that only 0.2 percent of the existing pipelines and 8 percent of the sewer manholes will be investigated under our program. The rationale for this approach is that a comprehensive investigation of every segment of the 35 miles of sewers under conditions presented at the Arsenal is simply unnecessary and impractical. We opted for a pragmatic and practical approach, concentrating on certain segments of pipelines which have two characteristics: (1) based on a comprehensive literature search, we believe the segment to have had a history of leakage, and (2) based on site reconnaissance, we believe the segment to be presently accessible. Sections of pipeline which meet these two screening factors will be tested for leaks using the dye technique. Subsequently, "worst-case" sites, as identified by the dye testing program, will be investigated in greater detail in an effort to quantify the extent to which adjacent soils have been contaminated by the leakage. For "worst-case" planning purposes, we will assume that this approximate level of contamination may be associated with other segments of the pipeline systems.

It is important to emphasize that an exact determination of the quantity of contaminated soil associated with the buried pipeline systems can only be obtained during remediation activities. That is, only at the time sewer segments are actually excavated as part of a long-term remedial action will we be able to develop a precise estimate of the extent of remedial action needed for that segment. We believe this approach will be more efficient and far more cost-effective than a massive sampling effort this early in the RI/FS process.

As explained in greater detail in the attachment, our investigation will identify "worst-case" scenarios of leaks rather than "typical" leaks. We agree with Shell's observation that a "typical" leak will not be simulated. However, this is not the intent of our investigation. It is also true, as Shell notes, that 24-hour dye testing will not provide a precise definition of contaminant distribution that occurs over decades of continuous operations. However, this is not the objective of the dye tests. The primary purpose of the dye tests is to identify locations of "worst-case" leaks from the sewers. The extent of contaminant distributions will then be established by collecting soil samples from borings, or excavations at these sites.

Manhole investigation and pipeline investigation, as proposed in the Technical Plan, are two separate and independent activities. Detailed responses to Shell's comments regarding the manhole drilling/soil sampling proposals are included in the enclosure.

We agree with Shell's observation that hydrostatic testing of process water lines will be complicated. However, we feel that every effort should be made to perform such tests. The advantage of pressure testing is that, if successful, it can provide a practical, low-cost means of eliminating relatively long segments of a pipeline system from further study. A more detailed rationale for this testing effort is also included in the enclosure.

We hope that the insights into our sewer survey program provided by this letter and the enclosed detailed responses better clarify the scope and intent of this program. As noted previously, the results of this initial program will be used to the extent possible to estimate an appropriate quantity of soil which may require excavation or other type of remediation. An early "order of magnitude" estimate is necessary to enable the feasibility study group to develop remedial approaches to contamination from Arsenal sewer systems. We must reiterate that a precise determination of the soil contamination associated with these systems can only be made at the time pipelines are excavated.

Finally, it is my understanding that the Army has been, and will continue, splitting soil samples with Shell as requested by Morrison-Knudsen Engineering, Inc. Please let me know if you have additional concerns or would like to discuss this task further.

Sincerely,

Donald L. Campbell
Litigation Team Member

Enclosure

Copies Furnished

Mr. Chris Hahn, Shell Oil Company, c/o Holme Roberts & Owen, 1700 Broadway, Suite 1800, Denver, Colorado 80290
Mr. Preston Chiaro/Mr. Dale Gable, Envirosphere Company, 143 Union Boulevard, Number 1010, Lakewood, Colorado 80228
Mr. Tom Bick, Department of Justice, Environmental Enforcement Section, Land and Natural Resources Division, P.O. Box 7415, Benjamin Franklin Station, Washington, D.C. 20044-7415
Department of the Army, Office of the Judge Advocate General, Attention: Major R. Boonstoppel, The Pentagon, Washington, D.C. 20310-2200

RESPONSES TO SHELL COMMENTS
ON THE TECHNICAL PLAN FOR TASK 10
SEWERS AND PROCESS WATER SYSTEM INVESTIGATIONS

1. Comment: Title Page
The title of Task 10 should reflect that the process water system is also covered by this investigation.

Response: The title has been changed to: "Sewers and Process Water System Investigations."

2. Comment: Page 1-1, first objective statement.
The text should define what (for puposes of this investigation) constitutes "contamination" as applied to sewer systems.

Response: The first paragraph on page 1-2 has been modified as follows: "... Sediment samples will be collected from those segments where data are insufficient to determine if these have been contaminated. For the purposes of this investigation, "contaminated" soil or sewer lines refers to the detection of target analytes above the respective detection limits."

3. Comment: Page 1-2, last paragraph.
It is difficult to characterize a line as "typical" without considering age, construction materials, construction methods, the construction contractor, historical operating methods, and local soil conditions. Not much is "typical", actually. Extrapolating "typical" results over 37 miles of sewer line will be misleading. Other variables include: pipe gradient, bedding materials, and historic high groundwater impacts at certain areas.

Response: The use of the word "typical" is a generic term for pipeline sections and it is probably inappropriate. The intent of Task 10 is to identify "worst case" scenarios for a "contamination assessment evaluation," (as noted in the second sentence of the third paragraph on page 1-3); the second sentence of the last paragraph on page 1-2 has been rewritten and now reads: "The approach Ebasco will use, will be to determine leakage along pipeline sections which have been identified in the literature and document review as being prime candidates for excessive leakage." The investigative techniques described in the Technical Plan are designed to provide a "worst case" estimate of the extent of contamination associated with the pipelines. An exact determination of this extent of contamination can only be obtained during remediation activities. Additionally, as stated in the first paragraph on page 3-13, some of the techniques proposed for this task may prove effective during remediation activities.

Cost estimates and contaminated volume estimates for remediation of the various pipelines are required for integration into the overall Rocky Mountain Arsenal contamination cleanup. Investigations previously conducted did not determine the extent (either vertical or horizontal) of contaminated soil associated with leaks. Thus, even crude estimates without this type of information would be inappropriate. Using "worst case" scenarios as proposed for these investigations, will probably provide estimates greater than actual values, thus, the error associated with these estimates will be on the side of safety.

4. Comment: Page 1-3, second full paragraph.
See Comment 3.
The text should note that this approach to contamination assessment will provide only a crude estimate of the volume of contaminated soil caused by sewer and process water system leaks but will not provide knowledge as to the location of all such contaminated soil along the length of the entire sewer systems.

Response: As stated in the Response to Comment No. 3 and in the last paragraph on page 1-2, this task will not identify the location of and the extent of soil contamination associated with all leaks in the sewer systems as such a determination is not cost-effective for a study and is only applicable during remediation activities. As stated in the first paragraph on page 8-1, "... the information obtained from this investigation will provide a 'first cut' estimate of the relative magnitude of problems associated with these systems."

5. Comment: Page 3-6, first sentence.
The text should describe the standards which will be used ot determine whether wastes are "free of any contamination."

Response: The standards for determination if wastes are "free of any contamination" are being developed under Task Order No. 32, Sampling Wastes Handling. Task 32 is developing protocols for the handling and disposition of all wastes. The technical plan for this task will be provided for your information in the near future. The first sentence on page 3-6 has been modified as follows: "The following will be handled as potentially contaminated wastes, unless they are sampled and confirmed to be uncontaminated in accordance with Task Order 32 (Sampling Wastes Handling) protocols: ...."

6. Comment: Page 3-7, paragraph 3.3.1.
As determined by MKE field investigations, much of the abandoned South Plants contaminated sewer system is flooded. This is true even above the water table due to open area drains, sumps, etc.

Response: The existence of flooded chemical sewer lines in South Plants as documented in the April 1986 report of Morrison-Knudsen Engineers, Inc. (MKE) entitled, "Interim Report: Phase I of Rocky Mountain Arsenal Sewer Investigations," was used in the manhole and sewer segment investigative selection process.

7. Comment: Page 3-8, last sentence.
See Comment 3.

Response: See Response to Comment No. 3.

8. Comment: Page 3-9, paragraph 2, first sentence.
Leak mechanisms for manholes are different than for sewer pipes. The absence or presence of contamination under a manhole will provide insufficient data to make conclusions on adjacent pipelines. Also, it is quite possible that a leaking pipeline from an adjacent system could contaminate soils under a manhole that never leaked, thereby resulting in misleading conclusions about the manhole.

Response: The focus of the manhole drilling program is not to use leaking manholes as an indicator for the condition of adjacent pipelines or even to determine if adjacent pipelines leak. The purpose of the manhole sampling program is two-fold: 1) The presence of any contaminants detected in the soil samples collected from beneath the manholes may indicate that contaminants have been in the pipeline at one time and would infer that the pipeline should be classified as "contaminated," 2) Leaks emanating from leaking manholes will possess similar vertical migration potentials as leaks from adjacent pipelines. The depth sampling will "... aid in estimating the vertical migration pattern of leaking contaminants," as stated in paragraph 3 on page 3-9.

The exact sources (pipeline vs. manhole) of all contamination is beyond the scope of the study. However, the potential for the manholes included in the manhole drilling program to leak is greater than for randomly selected manholes as the manholes selected for the drilling program" ... are deteriorated and have a potential for exfiltration of wastewaters out of the sewer systems" (paragraph on top of page 3-8). Selecting the "worst case" manholes greatly increases the potential of locating contaminant leaks and enables information on contaminant vertical migration to be obtained.

9. Comment: Page 3-10, next to last line.
The frequency of leaking joints is dependent on a multitude of variables. (See Comment 3). A critical variable is that of flow rate. The dye testing methodology does not adequately reflect this. For example, some portions of the

gravity sewers are known to have flowed full and under pressure due to the infiltration/inflow associated with storm events. Conversely, upstream reaches carrying relatively low flows would react quite differently.

Response: A partial response to this comment is included in the Response to Comment No. 3. Additionally, flow rate is indeed a critical variable. No testing methodology will duplicate exactly all possible flow conditions that a section of gravity pipe will be exposed to over a 40 year period. However, the dye testing method is the best method available for approximating actual conditions. To ensure a "worst case" scenario is developed for the sections to be tested, the dye testing method has been modified slightly. The sewer pipe sections to be tested will be completedly filled with the dye solution instead of 1/2 filled as originally proposed. However, the large diameter process water return lines will be filled only 1/2 full to avoid safety hazards associated with plugging the large diameter (36 inch) lines. The section under test will be checked periodically to ensure the pipe remains full throughout the test. With the possible exception of surcharged conditions, this improved method will provide a "worst case" condition for identifying leaking joints.

It should be noted that detection of the dye outside of the pipelines does not necessarily document that the section of pipeline being tested has leaked contaminants. As the test method is a "worst case" scenario, the presence of the dye in the soil surrounding the pipeline only indicates the presence of possible contaminant leaks. As stated in the second paragraph on page 3-11 "The dye stains will also indicate where soil samples should be taken to document contaminant exfiltration." Thus, as stated in the Technical Plan, the analysis of soil samples for target contaminants will provide the documentation of contaminant leakage and the dye is merely used to identify sample bore locations.

10. Comment: Page 3-11, third paragraph, second sentence. The reasoning is flawed here, being based on the assumptions that: 1) the system was designed properly, and 2) design flow rates were close to actual flow rates.

Response: Information evaluated to-date does not refute the assumptions that 1) the systems were designed properly and 2) the actual flow rates for most pipeline sections did not exceed maximum design flow rates. However, the changes to the test procedure as outlined in the Response to Comment No. 9, should eliminate the need for these assumptions.

11. Comment: Page 3-11, third paragraph.
The 24-hour test of a gravity sewer segment one-half full will skew the results toward the downstream end. In a situation where all joints are damaged (as often observed by MKE in the field) this test would enhance leakage at the downstream end of the section. The upper end would receive less contact with the liquid.

Response: The changes in the test procedure as summarized in the Response to Comment No. 9 should eliminate the concerns express in this comment. In addition, the results of MKE field activities associated with exposed pipelines have not been made available to the Army or its contractors to aid in our evaluation.

12. Comment: Page 3-13, first paragraph.
Again, this places undue emphasis on the concept of a "typical" leak pattern. See Comment 3.

Response: As stated in Response to Comment No. 3, the "typical leak" as described in the Technical Plan is a "worst case" situation which will provide error on the side of safety.

13. Comment: Page 3-14, second complete sentence.
Will geotechnical lab testing (e.g., sieve analyses, etc.) be used to make these determinations? These rarely can be accurately assessed in the field.

Response: Geotechnical laboratory testing will be utilized on an "as needed" basis. However, it is anticipated that at least one sample will be collected from each excavation site with possible analytes being grain size analysis, soil density, and soil compaction.

14. Comment: Page 3-21, first full paragraph, second sentence.
Hot poured bituminous joints have also been observed in the sanitary sewers in the southwest warehouse area in the South Plants.

Response: The phrase "...constructed primarily of 3 to 5 ft lengths of 4 to 12 inch diameter VCP with oakum-cement joints: is not intended to be an all encompassing statement. Use of the term "primarily" implies that other materials of construction such as cast iron and plastic pipe, and rubber gasket and bituminous joints may also be present. The sentence is designed to provide the reader with an overview of the system and not an in-depth breakdown of the system components. However, if Shell has prepared a breakdown of system components to include pipe material, joint material, pipe size, year of construction, etc. this information should be provided to the Army to aid in our evaluation of the system.

15. Comment: Page 3-26, last paragraph.
What criteria will be used to determine which of the sewer manholes will be selected for sampling?

Response: Sediment samples will be collected "...from sections of the sanitary sewer and process water return systems where no contaminant documentation exists" (first paragraph on page 3-9). Obviously, sediment samples can only be collected at manholes containing sediment. Soil samples will be collected at manholes which are found to be "...deteriorated and have a potential for exfiltration of waste waters out of the sewer systems: (paragraph at top of page 3-8).

16. Comment: Page 3-27, third paragraph.
Field observations by MKE do not confirm that the water table in the South Plants area is dropping at all locations. Much of the sanitary sewer piping in the northern half of the South Plants is under groundwater.

Response: Presentation of this information is appreciated as it was not included in the MKE "Interim Report: Phase I of Rocky Mountain Arsenal Sewer Investigations" dated April, 1986. The Army would appreciate obtaining all MKE field observations.

17. Comment: Page 3-29, second paragraph, and Figure 3.4-7.
The two sanitary sewer sites proposed for dye/excavation study may prove to be difficult. The site between Manholes 117B and 119B is in line with an above ground steam line that will interfere with excavation, and the site between Manholes 98 and 99 will either be below the groundwater table or very close to it.

Response: The proposed locations for the two sanitary sewer line excavations in South Plants have been moved for the reasons stated in Shell's comments. The new proposed locations are between Manholes 120C and 120D and between Manholes 100 and 115 and the field activities have been coordinated with MKE.

18. Comment: Table 3.4-2, Page 3-30, and Figure 3.4-7.
The bottoms of Manholes 97, 98, 99, 100, 124 and possibly 125 have been under groundwater historically and probably are presently either below the water table or close to it. As stated on page 3-35 of the Technical Plan, Section 36 sanitary sewer manholes are not to be sampled due to the difficulty of determining the source of contamination in soils contacted by contaminated groundwater. If this is true, the same rationale should be applied to the South Plants manholes in close proximity to the contaminated groundwater mound.

Also, in April, 1985, MKE observed that the sanitary sewer located along the ditch line between Manholes 98 and 124 was excavated down to the pipe grade and water was pumped out of the flooded trench and discharged across December 7th Avenue into Section 36. Such recent disturbance of this area will make soil sampling results difficult to interpret. It is not known if the trench was flooded due to leaking pipes, high groundwater, surface water or a combination of these potential contaminant sources.

Response: As noted in the first paragraph on page 3-29, "Table 3.4-2 is a list of manholes identified as primary candidates for the manhole reconnaissance survey. ...Additions and/or deletions to this list may occur based on the results of the reconnaissance survey." These statements do not indicate that Manholes 97, 98, 100, and 124 will be sampled, only that they will be investigated. The statement in the first paragraph of Section 3.4.2.1 on page 3-27, "Manholes and sewer segments determined to be below the groundwater table will not be included in the investigation program" has been corrected to "Manholes and sewer segments determined to be below the groundwater table will not be included in the investigation program" has been corrected to "Manholes and sewer segments determined to be below the groundwater table will not be included in the manhole sampling program.: This change should clarify any misunderstandings and verify that the same rationale is being applied to all sewers in close proximity to groundwater.

19. Comment: Page 3-31, second paragraph, second sentence, and Table 3.4-3, page 3-32.
Although no data has been discovered that indicates that the North Plants sanitary sewer is contaminated, an Army contractor (Guildner Pipeline Maintenance) was kept out of certain areas in this sewer in 1980 due to safety concerns (RMA 060/0746-0748). the implication is that, at least in 1980, there was a concern for contamination in the North Plant sanitary system. Therefore, the manholes declared "off limits" in 1980 (in the vicinity of Building 1606) should be investigated. These would be S1, S2, S3, S4, S5, S6 and S7).

Response: Information Ebasco has obtained from RMA Facilities Engineering personnel indicate that Guildner Pipeline Maintenance was kept out of certain areas in the North Plants complex for security reasons and not due to concerns for potential exposure to contamination. Ebasco personnel will be permitted to investigate Manholes S1, S2, S3, S4, S5, S6, and S7. The manhole reconnaissance survey may be expanded to include some of these manholes if sufficient information cannot be obtained from manholes presently selected for investigation.

20. Comment: Page 3-31, last full paragraph, first sentence. Field observation and interviews with Army maintenance personnel indicate that the lift station receiving sanitary sewage from the Rail Classification Yards (Building 398) routinely overflows (due to electrical or mechanical failure) into a ditch running northwesterly from Building 393. Soils should be sampled in this ditch.

Response: Sampling of the soils from the lift station (Building 393) overflow will be included in the sampling program. One boring with soil samples taken from the 0 to 1 and 4 to 5 ft depths, will be located near the outfall of the overflow pipe. Analytes will be consistent with Section 4.2 (Sample Matrices) of the Technical Plan.

21. Comment: Page 3-35, first paragraph, first sentence. As with the lift station at Building 393, the station at Building 392 also has overflowed regularly. Soils should be sampled in the water course from Building 392.

Response: Information available fromthe literature (Microfilm RSA008, Frames 0597-0613) indicates that any overflows from the lift station at Building 392 discharged to a septic tank and drain field located north of the lift station. However, if the field investigation of the sanitary sewer in this region indicates that overflows discharged to the surface, the soils in the overflow area will be sampled. The sampling activities will consist of one boring with soil samples collected from the 0 to 1 and 4 to 5 ft depths. Analytes will be consistent with Section 4.2 (Sample Matrices) of the Technical Plan. Potential contamination of the septic tank systems at RMA is being addressed as part of Task 24.

22. Comment: Page 3-39, third paragraph. Portions of the chemical sewer were built in the years following 1942. Also, the hydrazine sewer carried Army effluents into the early 1980s and discharged into the gravity sewer which ultimately discharged to Basin F.

Response: The first sentence in Section 3.5.1.1 on page 3-39 has been corrected to "Most of the below ground chemical sewer system was built in 1942." The last sentence in the first paragraph of Section 3.5.1.1 on page 3-39 has been corrected to "In the early 1980s, the Army stopped using the gravity system and constructed several steel force mains leading to a local waste treatment facility in the South Plants (the South Plants Laboratory Waste Treatemnt Facility)."

23. Comment: Page 3-39, last paragraph.
Shell ceased discharging into the contaminated sewer system going to Basin F in March, 1978, not 1979.

Response: The first sentence of the last paragraph on page 3-39 has been corrected to "Shell ceased discharging chemical waste waters from its operations to Basin F in the late 1970s and subsequently plugged the chemical sewer lines leading from South Plants to Basin F." A letter by the Plant Manager for Shell Chemical Company's operations at RMA to the Commander of RMA indicates that Shell ceased discharging chemical waste waters to "Lake F" by March 31, 1978 (Microfilm RDA002, Frame 0560). However, documentation as to the exact date of this proposed activity could not be found in the literature.

24. Comment: Page 3-46, last paragraph.
Why is sampling of contaminated sewer manhole borings done at five foot intervals to the groundwater table but only to the 10 foot interval in sanitary sewer manholes?

Response: The migration of contaminants through a soil medium is strongly influenced by concentration gradients, as well as other variables. Contaminants migrating from the chemical sewer system would be expected to be at higher concentrations than those migrating fromt he sanitary sewer system. The total mass of contaminants in the chemical sewer system would also be expected to be much greater than the mass in the sanitary sewer system as the purpose of the chemical sewer system was to collect and transport contaminants whereas the purpose of the sanitary sewer system was to collect and transport domestic waste waters. Thus, the potential for vertical migration of contaminants would be greater for contaminants emanating from the chemical sewer system. If contaminants are found at the 10 foot interval in the sanitary sewer system, additional investigative activities will be required to determine the depth of vertical migration of leaking contaminants.

25. Comment: Page 3-46, second paragraph.
It is not believed to be impossible to distinguish between spill sources. Comparison of soil samples taken immediately below a sewer joint with those taken away from the joint can show high contaminant concentrations below the joint and increasingly lower concentrations away from the joint, indicating that leakage had occurred.

Response: The scenario described in the comment would indicate leakage from a joint. However, if the contaminant concentration of the soil sample taken immediately below a sewer line joint is not significantly greater than contaminant concentrations of soil samples taken away from the joint, the source of the contamination cannot be assumed to be the sewer line.

26. Comment: Page 3-47, Figure 3.5-4, and Page 3-48, Table 3.5-1.
The Technical Plan proposes to investigate beneath manholes (A), (B), and (C) north of Building 732. These manholes are of precast concrete construction dated in 1953, and according the George Donnelly, were never used. They are not representative of the significantly more numerous deteriorated contaminated sewer manholes in the South Plants and will mislead investigators if they are considered in any way "typical."

This same problem exists to a greater degree with proposed Manholes 6-1 and 6-2, which are precast concrete construction dated 1976. They too are not representative of the overall South Plants system.

Manhole 6 (Chlorine Plant area) has been observed by MKE to be filled full-depth with concrete.

Considering the toxic nature of Army agents handled in Buildings 536, 537, 538, and 540, Manholes (4), (5), (6), (6A) and (A) should be investigated. It is possible that they are not flooded at the upper reaches. Army document RMA 035/1267-1270 described mustard contamination in these lines as recently as August 1979.

Response: As stated in the third paragraph on page 3-46: "Selected chemical sewer manholes in the South Plants area will be investigated as part of the manhole reconnaissance survey. The manholes selected as part of this survey are listed in Table 3.5.1. ... The results of this survey will be used to select manholes with the greatest potential for leakage. Selected manholes will be included in the manhole sampling program." Manholes (A), (B), (C), 6, 6-1, and-2 are included in the manhole reconnaissance survey. However, as with all manholes, regardless of the year constructed or the type of construction, only those with a potential for leakage will be included in the manhole drilling program.

Manholes (4), (5), (6), (6A), and (A) were not included in the manhole reconnaissance program as MKE "Interim Report: Phase I of the Rocky Mountain Arsenal Sewer Investigations" indicated these manholes were flooded. This same rationale was utilized for excluding the "E" series chemical sewer manholes from investigations.

27. Comment: Page 3-49, third paragraph, third sentence.
What contaminants were discovered in the contaminated sewer serving the Chlorine Plant, and when?

Response: The statement in the Technical Plan "...contaminants were detected in the system..." is incorrect. No documentation of any sampling and analysis of water in this system has been found. The first sentence in Paragraph 3 on Page 3-49 has been changed to: "The "I" line was initially installed as a storm water and contaminated waste system for the Series 200 buildings (the chlorine manufacturing area)." The third sentence in this paragraph has been changed to: "In 1956, the flows were diverted to the chemical sewer system leading to Basin F by additions to the system incl_ding a diversion weir in Manhole II."

28. Comment: Page 3-49, Section 3.5.2.2 North Plants
Apparently, no North Plant chemical sewer manholes are intended to be investigated. This is inconsistent with the methods being employed in teh South Plants, Rail Classification Yards and other areas. A system with a known historical use of transporting GB-related contaminants should be thoroughly investigated. Is this an oversight or a misunderstanding of the text?

Response: As shown on Drawing No. 18-02-01 sheet no. 29 of 71 of the Master Plan of Rocky Mountain Arsenal, Colorado, Basic Information Maps, U.S. Army Corps. of Engineers, 1 June 1984, the chemical sewer system in North Plants contains no manholes. However, a manhole reconnaissance survey of Manholes 5-2, 5-3, and 5-4 in Section 36 will be added to the field program. Soil sampling beneath these manholes will be conducted if it is determined that a significant potential for leakage from those manholes exists. No further investigation of the chemical sewer system will be done in North Plants.

29. Comment: Page 3-56, fifth paragraph.
Also, the closed loop cooling system blowdown was discharged to the North Plants storm sewer and ultimately to First Creek.

Response: The following sentence has been added to the end of the fifth paragraph on page 3-56: "Blowdown from the North Plants cooling tower was discharged to storm sewer Manhole 10 which subsequently discharged to First Creek."

30. Comment: Page 3-61, last sentence, and Page 3-68, Figure 3.6-9.
It does not necessarily follwo that contamination should be suspected in the soils underlying the process water return lines simply because water was routed through them. More importantly, however, these two large diameter lines (36 to 42 inches) are not representative of the overall system, and therefore, any leakage patterns determined by the dye method could not be considered "typical."

Response: Information from several documents indicates that the water in the process water return system was contaminated (RSH927, Frames 0331-0343, RLA006, Frames 1072-1074, RLA006, Frame 1077, deposition of George Donnelly pages 1555-1557) and that the process water return system leaked (RSH834, Frames 1075-1084, RSH813, FRAMES 0722-0723, RSH879, Frames 0537-0538). Additionally, the majority of the piping in the process water return system is large diameter (greater than 18 inch) piping, thus, these two lines are representative of the system.

31. Comment: Page 4-1, third paragraph.
Degradation compounds of Army chemical agents should be added to the list in this paragraph.

Response: The paragraph is not an all encompassing paragraph. As noted in Table 4.1-1, the analytical method for thiodiglycol was not certified when this document was issued, thus, general information on methodology for this analyte would have been premature. However, the analytical method for thiodiglycol has now been certified.

32. Comment: Page 8-1, section 8.0.
Refer to Comment 3 concerning use of the term "typical." This rationale, coupled with so few sites investigated, can result in misleading conclusions.

Response: The Response to Comment No. 3 explains in detail the use of the word "typical." Additionally, as stated in the first paragraph of page 8-1: the information obtained fromthis investigation will provide a "first cut" estimate of the relative magnitude of problems associated with these systems."

33. Comment: Page B-1, last paragraph, first sentence.
Due to the age of the process water system, it is highly probable that the valves will not completely close, thereby providing misleading data during hydrostatic testing. This has been confirmed by discussions with Stearns-Catalytic personnel.

Another concern regards the hydrostatic testing program. If lines showing significant leaks are detected, do plans exist to conduct soil sampling? If not, what conclusions can be drawn from the program?

Response: Ebasco has also determined in discussions with Stearns-Catalytic personnel, that problems with completely closing many of the valves may exist. However, the small number of valves to be closed for any section to be tested (no more than 8) will enable the investigators to monitor these valves. Although some sections may not provide adequate test results, it is highly probable that many will. The hydrostatic testing program is designed to identify which areas of the process water system distribution have significant leaks and therefore, require additional investigations. These investigations may include soil sampling.

34. General Comment:

The technical plan does not address the possibility of the bedding and backfill materials acting as preferential pathways for contamination. This is especially true in areas where low permeability soils underlie the pipes, as is often the case in South Plants.

Response: The Technical Plan does recognize and address the possibility of backfill material acting as a preferential pathway for contaminant migration. As shown in Figure 3.3-1 on page 3-12, a horizontal contaminant migration pattern is one of the two major types of patterns anticipated. This horizontal pattern may result from low permeable bedding material and/or preferential pathway migration through the backfill. Figure 3.3-3 on page 3-17 shows a typical soil sampling pattern for an excavation site. This sampling pattern is specifically designed to aid in identifying contaminant migration patterns (i.e., horizontal, vertical, others) from a leaking joint.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
999 18th STREET—SUITE 500
DENVER, COLORADO 80202-2405

JUN 0 8 1987

REF: 8HWM-SR

Colonel W. N. Quintrell
Deputy Program Manager
AMXRM-EE Department of the Army
U.S. Army Toxic and Hazardous Materials Agency
Building 4585
Aberdeen Proving Ground, MD 21010-5401

Re: Rocky Mountain Arsenal (RMA),
Comments on March 6, 1987 Revision
to Technical Plan for Task 10

Dear Colonel Quintrell:

We have reviewed the March 6, 1987 revision to the Task 10 Technical Plan. Our consultants have prepared the attached comments, which we request you respond to before undertaking the revised action.

Our contact on this matter is Mr. Connally Mears at FTS 564-1523.

Sincerely yours,

Robert L. Duprey, Director
Waste Management Division

enclosure

cc: Thomas P. Looby, CDH
Joan Sowinski, CDH
Chris Hahn, Shell Oil Company
R. D. Lundahl, Shell Oil Company
Thomas Bick, Department of Justice
Elliott Laws, Department of Justice

RESPONSE TO ENVIRONMENTAL PROTECTION AGENCY COMMENTS
ON THE TECHNICAL PLAN FOR TASK 10
SEWERS AND PROCESS WATER SYSTEM INVESTIGATIONS

1. Comment: The inactive portion of the PWDS should still be pressure and dye tested as the flow mass balance analysis alternative will not provide any information about the integrity of this portion of the system or its contribution to past contamination problems.

Response: No field activities will be conducted on the inactive portions of the Process Water Distribution System (PWDS) as these portions comprise less than 5 percent of the total system and all information reviewed to date indicates no construction, operations, or maintenance differences between what is now inactive and active sections of the system. Therefore, the 95 percent of the system included in the flow mass balance analysis should provide an adequate assessment of the entire system. Dye testing for identification of possible leak locations was intended to be used for gravity pipe systems and have never been part of the investigative activities for pressure systems. It will be utilized for the Process Water Return System (PWRS) and for the gravity sewer systems.

2. Comment: The revision states that the excavation sites proposed in the Technical Plan need to be changed due to "access and safety problems". The nature and extent of the problems should be noted.

Response: The access and safety problems referred to on page 2 of the letter are as follows:

- o Manhole 1 is a large concrete sump which serves as a wet well for the lift station pumps. The pumps transfer water discharged from the 36-inch PWRS line to the closed loop cooling system. The invert of the 36-inch line is located approximately 7 feet from the bottom of the sump. The total depth of the sump is approximately 20 feet. At the time the manhole was investigated, it contained approximately 7 feet of standing water, thus posing a potential safety problem. Additionally, a metal grate has been installed over the outlet of the pipe, inhibiting access for plugging the pipe.

- o Manhole 2 is on the 42-inch PWRS line from the "west plants" area of South Plants. When the manhole was investigated, it was discovered that a sealed 12-inch pipe had been installed in the invert of the PWRS line from Manhole 5 to the discharge point at Derby Canal,

2. cont. located southwest of Manhole 1. This pipe would inhibit plugging of the larger PWRS line. Additionally, the 12-inch pipe at Manhole 2 was covered by standing water and the organic vapor analyzer (OVA) readings in the manhole were above Level B Action Limits. The standing water and high OVA readings presented significant health and safety concerns for further investigative work at this manhole.

3. Comment: The last sentence states that "the borings will be hand augured to be a depth of five feet". Are there any portions of the PWDS or PWRS that are deeper than this? The depths of the PWDS should be ascertained either by as-built drawings or field verification to assure that the sampling intervals of 0-1 ft and 4-5 ft are appropriate for evaluating PWPS contamination. It is possible that the smaller lines could straddle the sampling intervals or that a pipe could be below the bottom sampling interval.

Response: The borings which are to be hand augered to a depth of 5 feet are at the discharge points of the PWRS to the ditch and canal systems which return used cooling water and storm water to the lakes recirculation system. Data obtained from Tasks 2 and 7 indicate that no contamination exists below 5 feet in any of the return ditches investigated, thus, Ebasco will auger to a depth of 5 feet. If contamination is found at the 5 foot depth, additional follow-on work will be required to determine vertical extent of contamination.

4. Comment: The proposed revision states that "after all 'worst case' situations (areas where past and present leaks overlap) have been identified during steps 1 and 2, a soil boring program will then be initiated to identify soil contamination in the areas of past and present leaks". Yet Figure 3 shows proposed boring locations for Task 10. How have these locations been determined before steps 1 and 2 have been completed?

Response: The proposed boring locations shown on Figure 3 are for the process water <u>return</u> system discharge points to the return ditches. These locations were chosen because these canals have, at some time, been used for returning used cooling water to the lakes storage system for recirculation. The borings to be chosen "after all 'worst cases' situations have been identified" are for the process water <u>distribution</u> system lines in the South Plants area.

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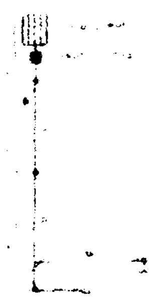

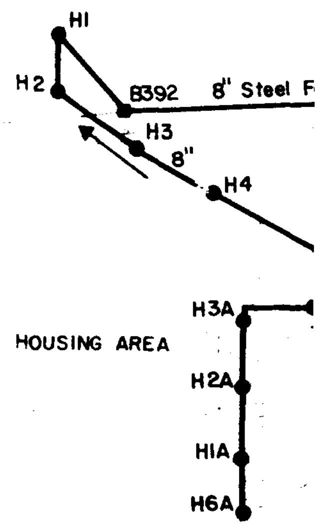
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HOUSING AREA
H2A
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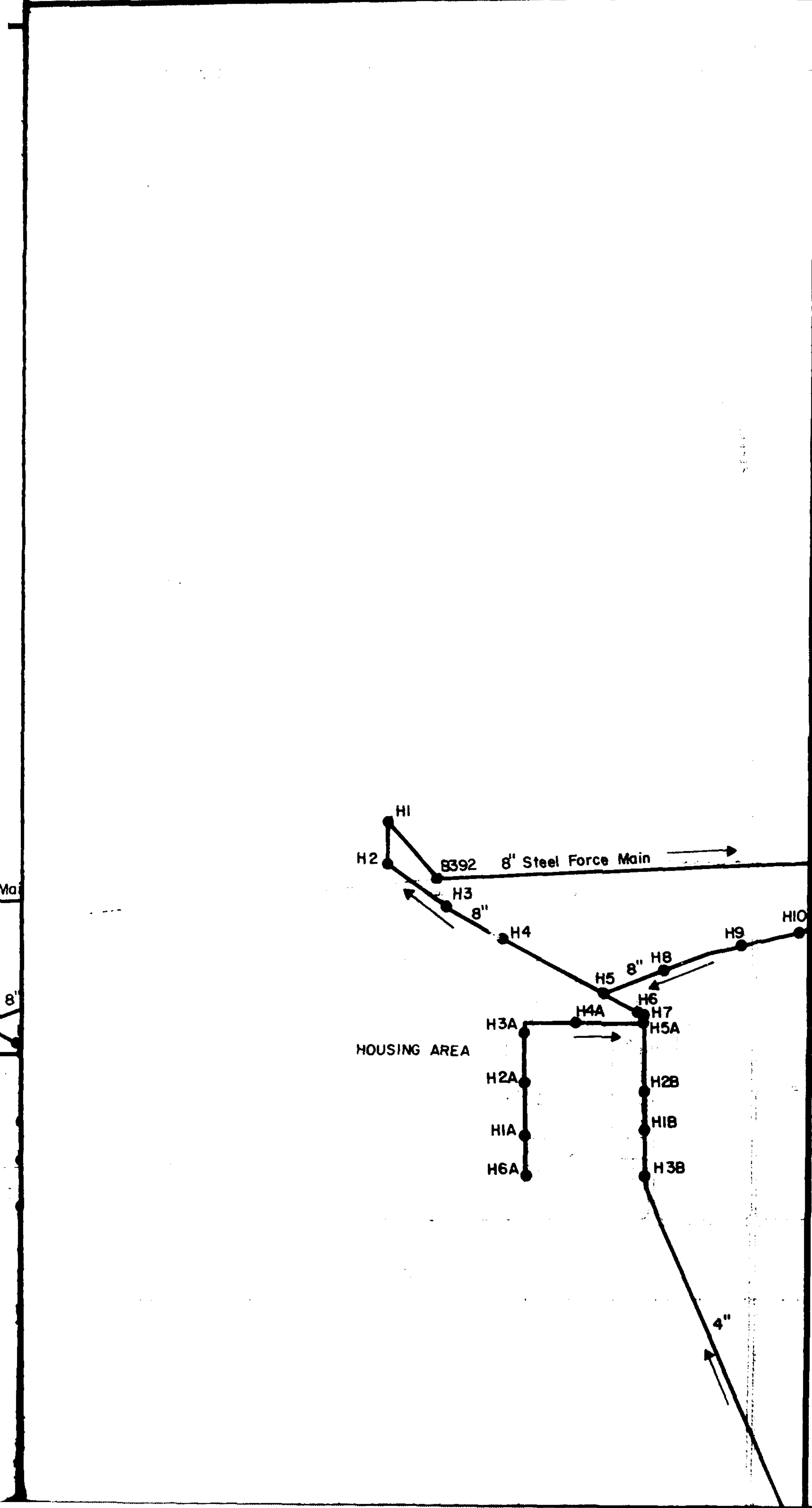


EXPLANATION

BUILDING, EXISTING

BUILDING, REMOVED

ROAD, PAVED

ROAD, UNPAVED

RAILROAD

SECTION NUMBER

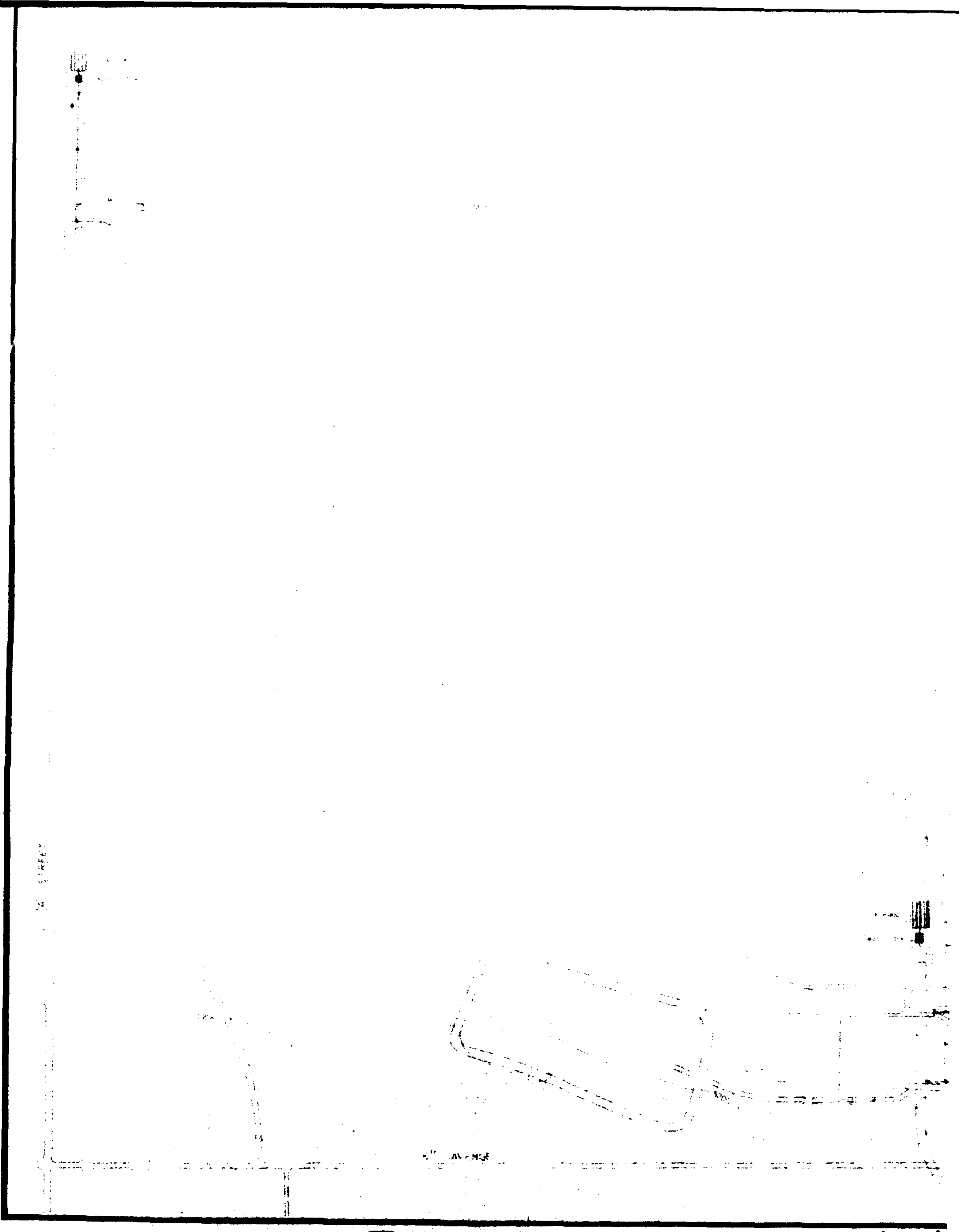
SANITARY SEWER SYSTEM

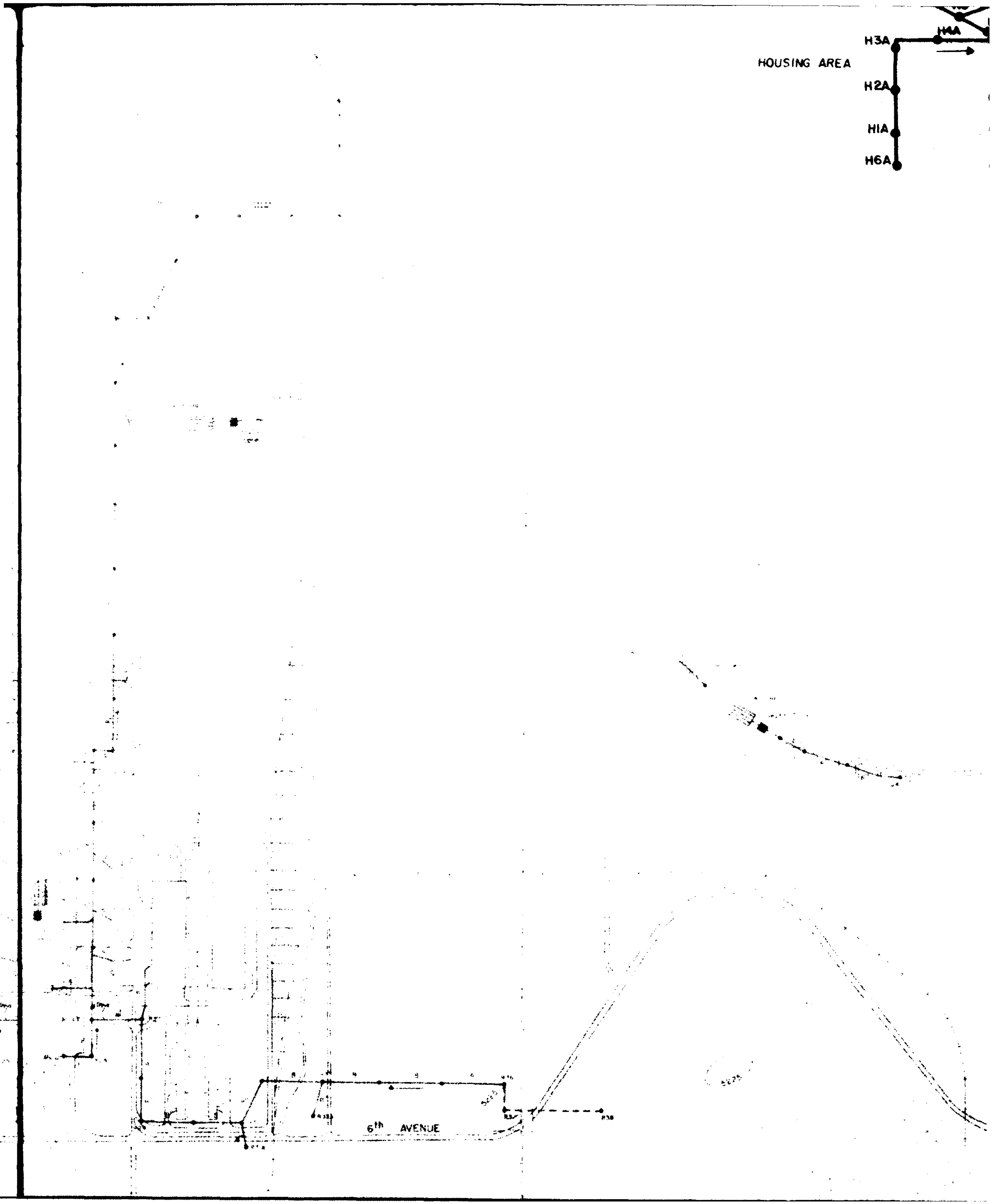
8" SEWER MAIN, WITH SIZE

H5 MANHOLE, WITH NUMBER

B311 LIFT STATION, WITH BUILDING NUMBER

INLET

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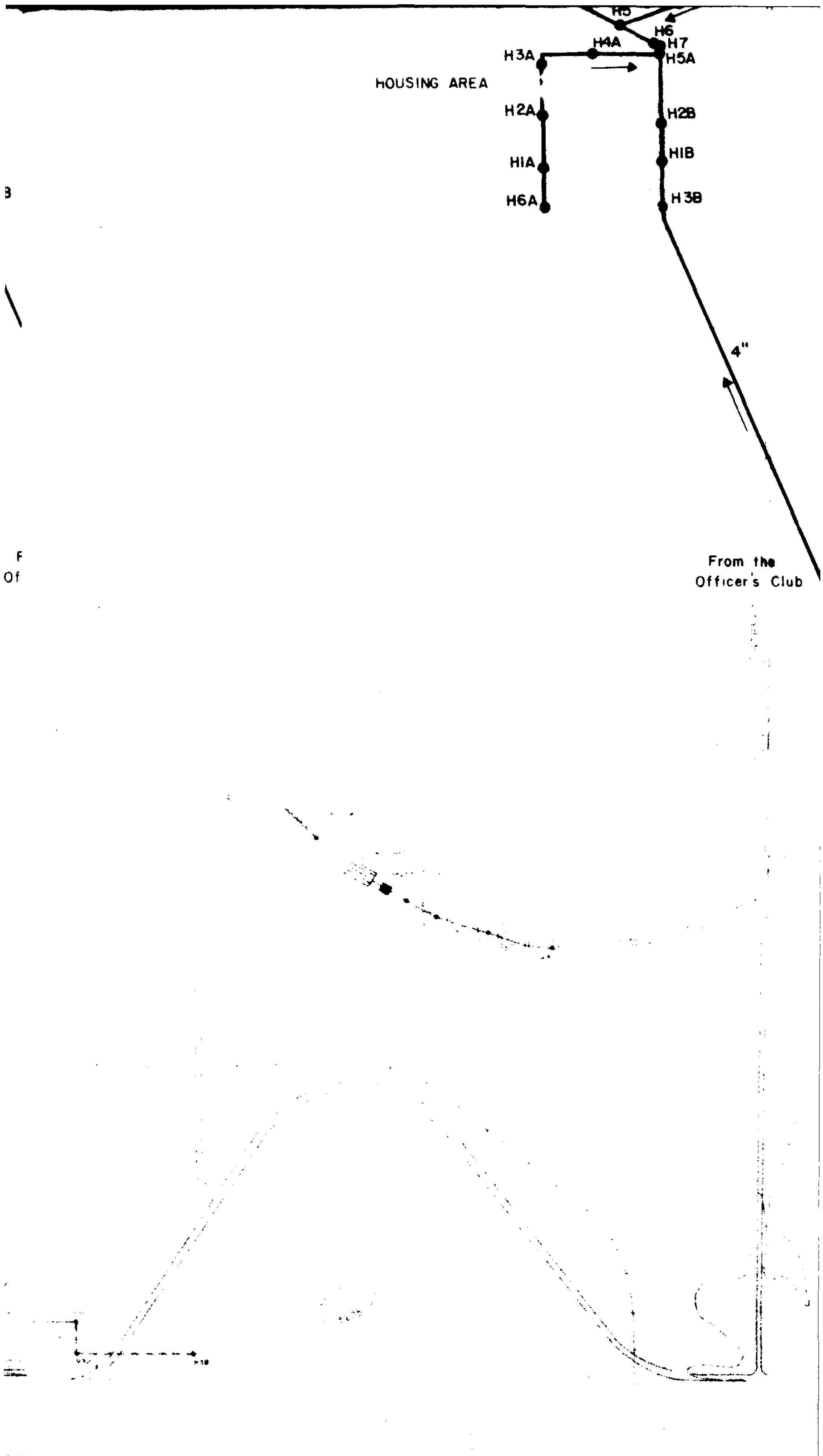
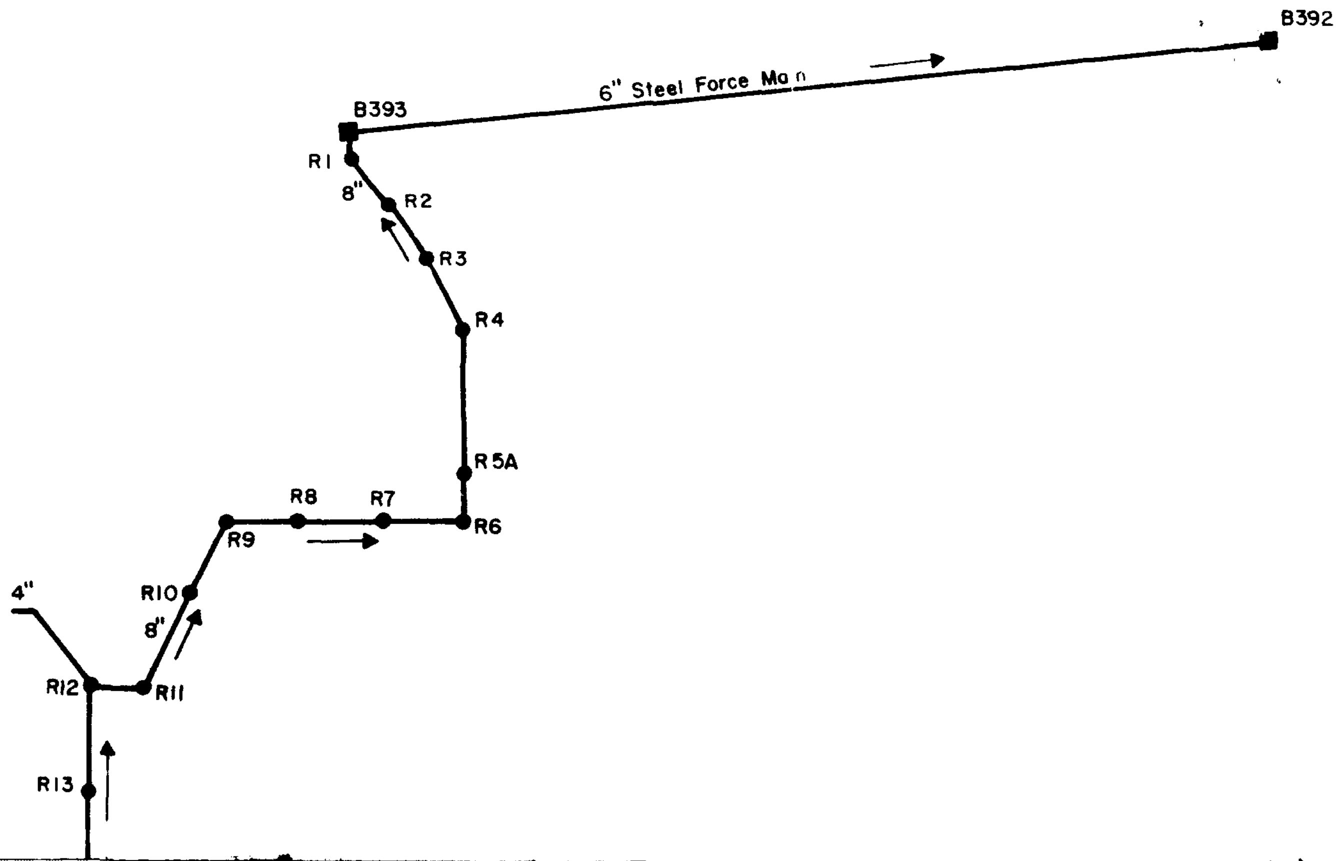
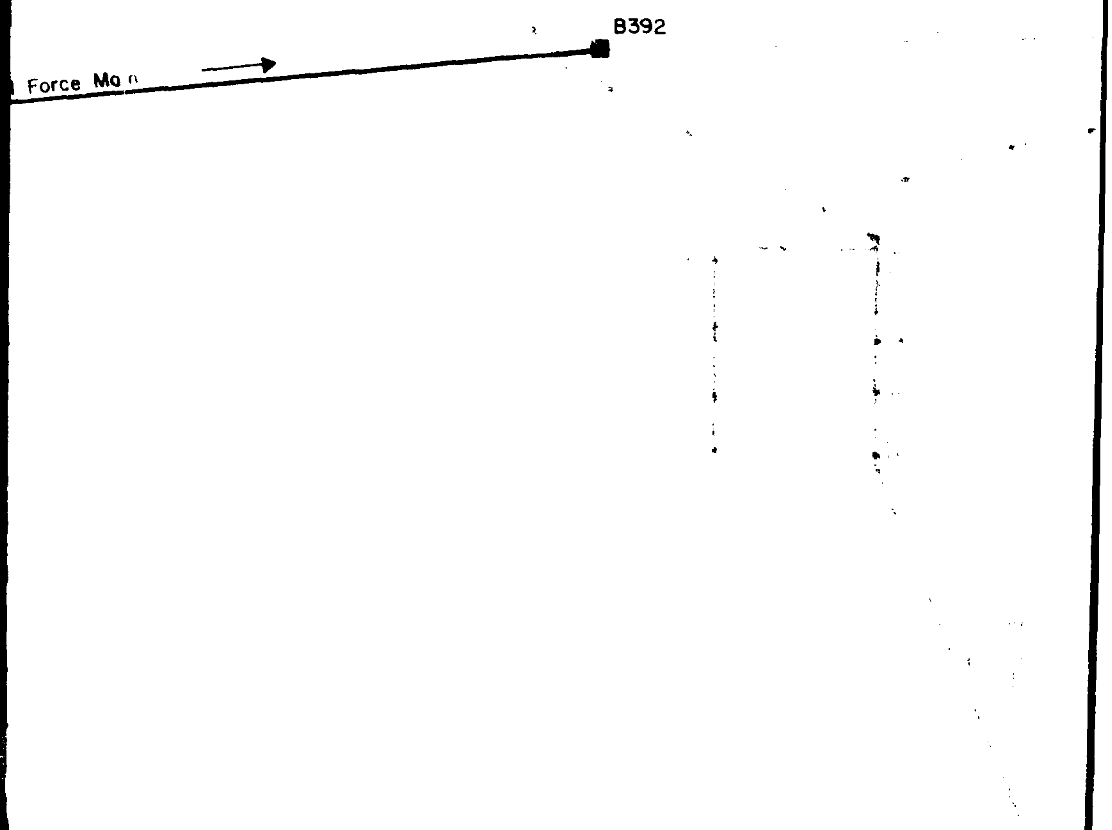
H4A
H2A
H1A
H6A
6th AVENUE


H5
H6
H7
H3A
H4A
H5A
HOUSING AREA
H2A
H2B
H1A
H1B
H6A
H3B
4"
From the
Officer's Club

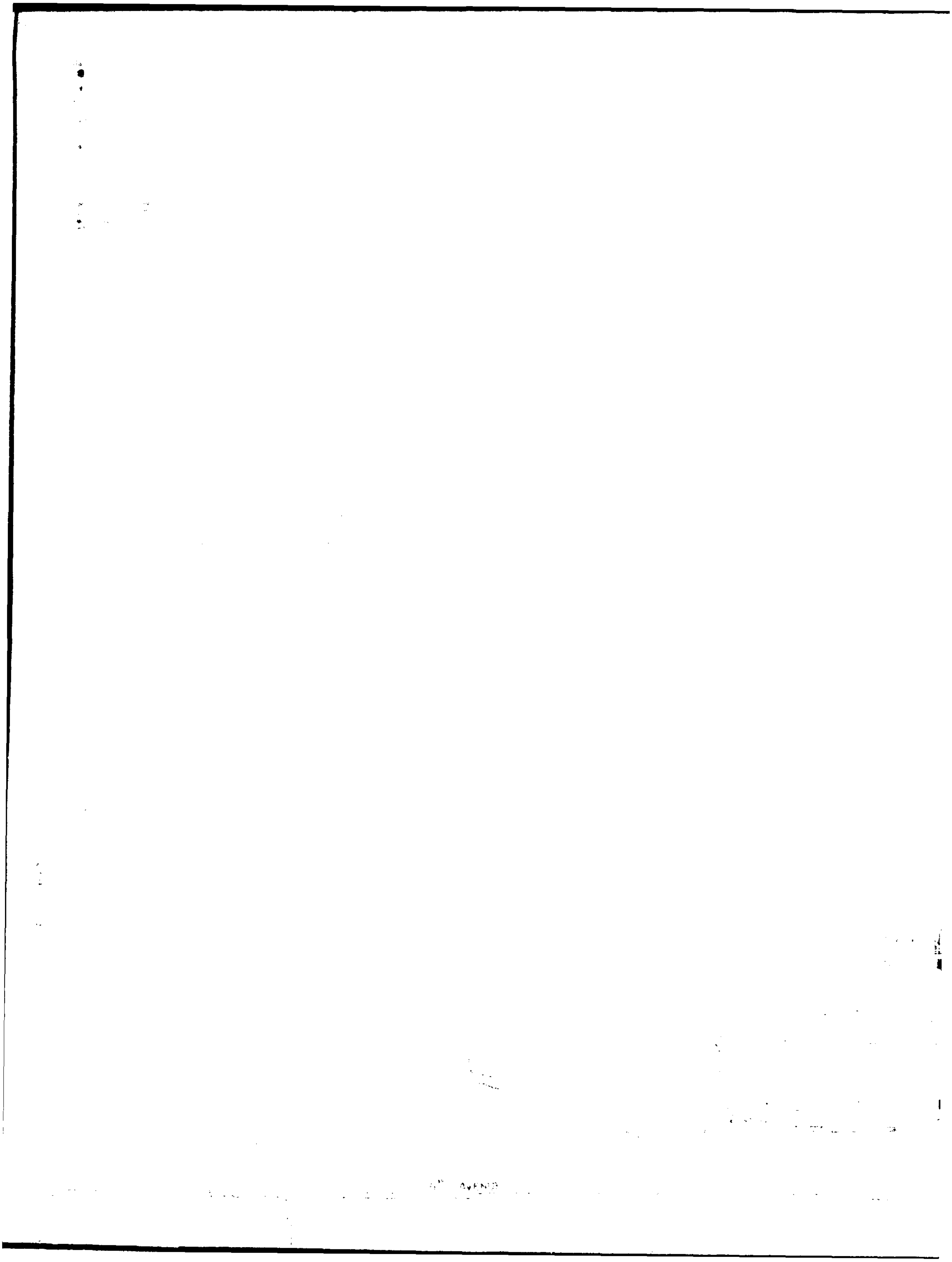
4"

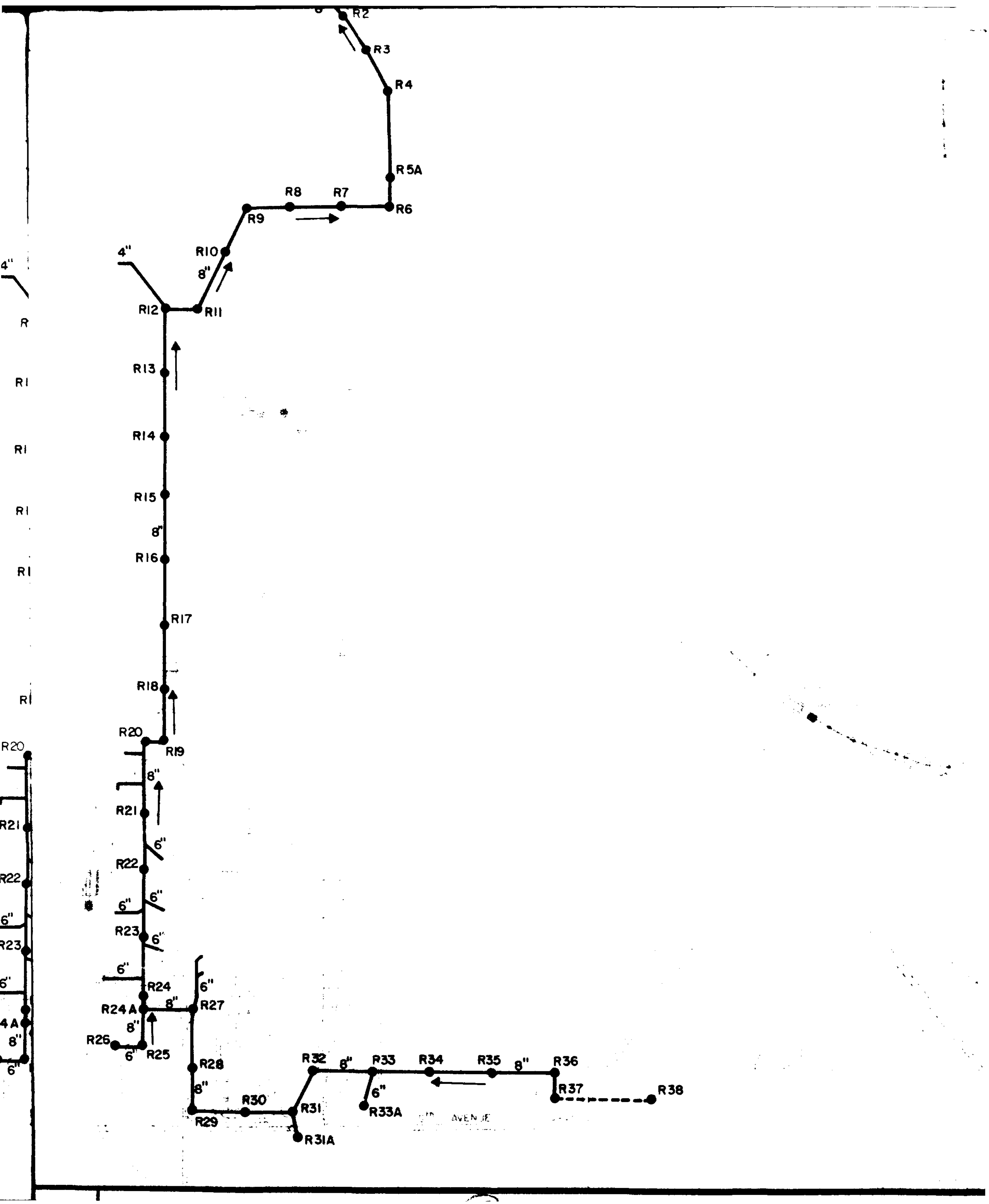


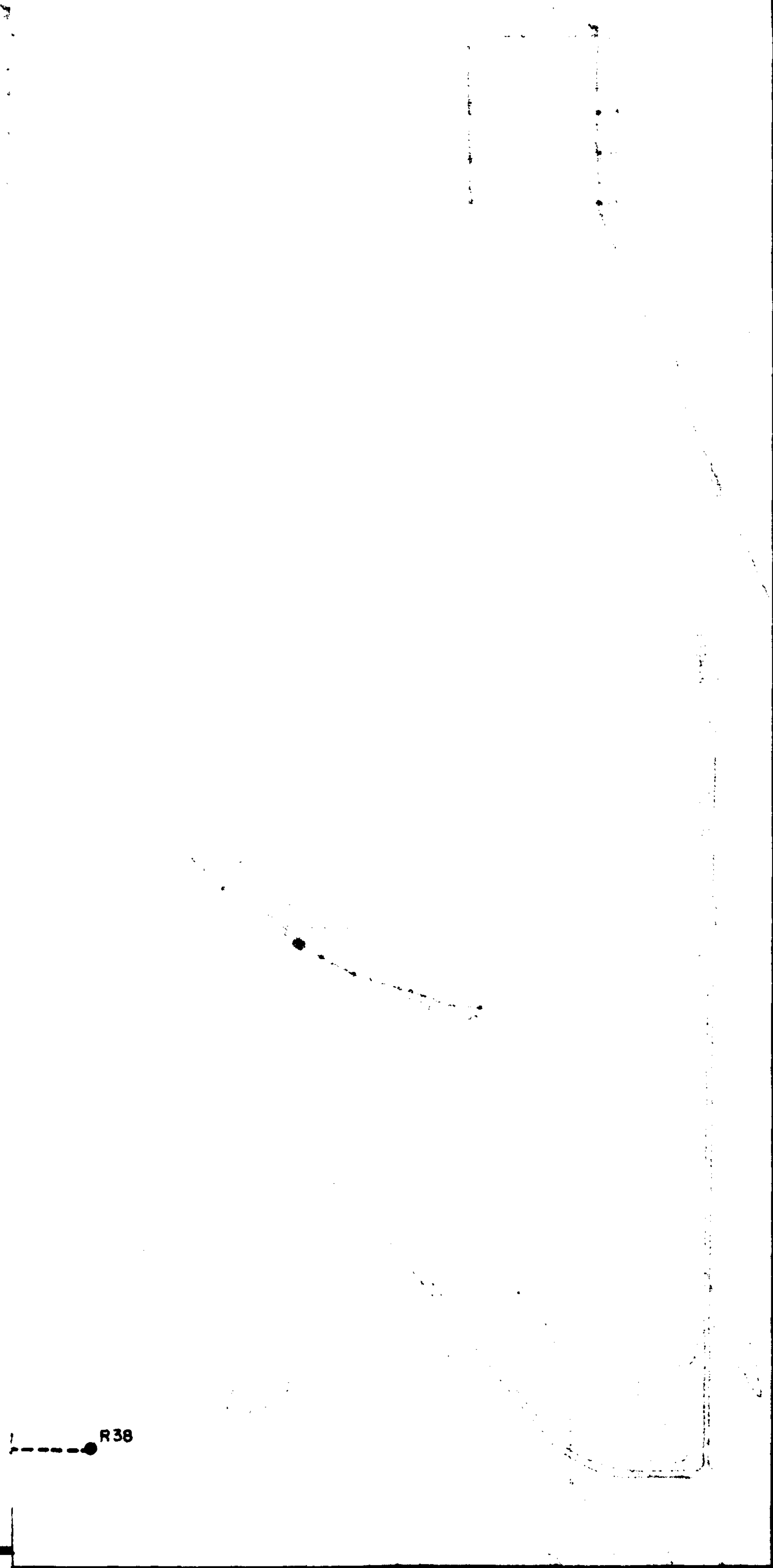
B392
6" Steel Force Main
B393
R1
8"
R2
R3
R4
R5A
R6
R7
R8
R9
R10
8"
4"
R12
R11
R13



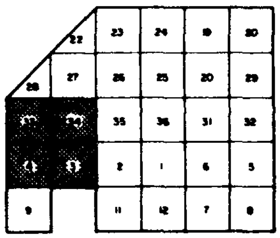
Force Ma n
B392




R2
R3
R4
R5A
R6
R7
R8
R9
R10
8"
4"
R11
R12
R13
R14
R15
8"
R16
R17
R18
R19
R20
8"
R21
6"
R22
6"
6"
R23
6"
6"
R24
6"
R24A
8"
R27
8"
R26
6"
R25
R28
8"
R29
R30
R31
R31A
R32
8"
R33
6"
R33A
R34
R35
8"
R36
R37
R38
AVENUE
R20
R21
R22
6"
R23
6"
4A
8"
6"



ROCKY MOUNTAIN ARSENAL
LOCATION



N

0 300 600
FEET

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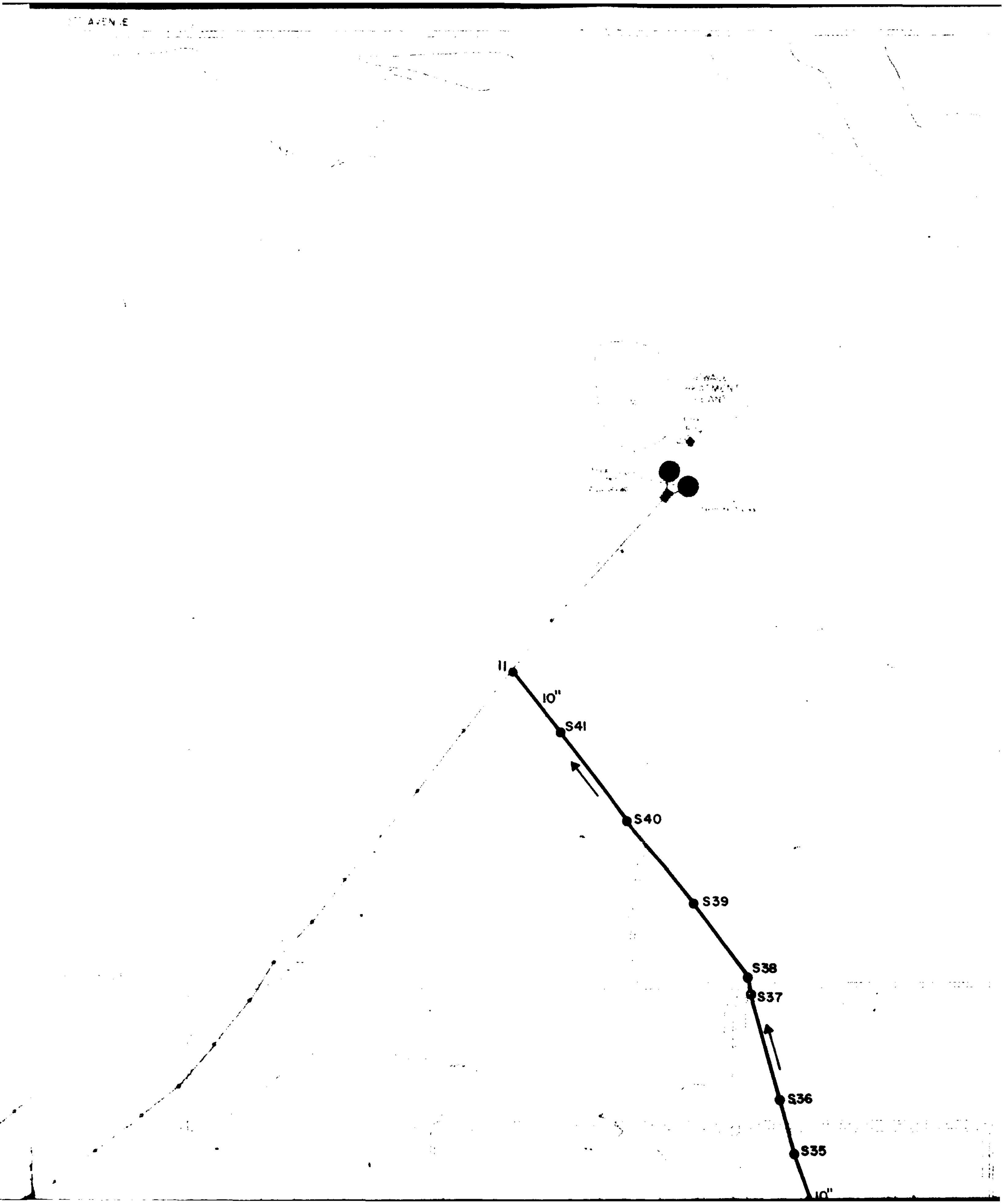
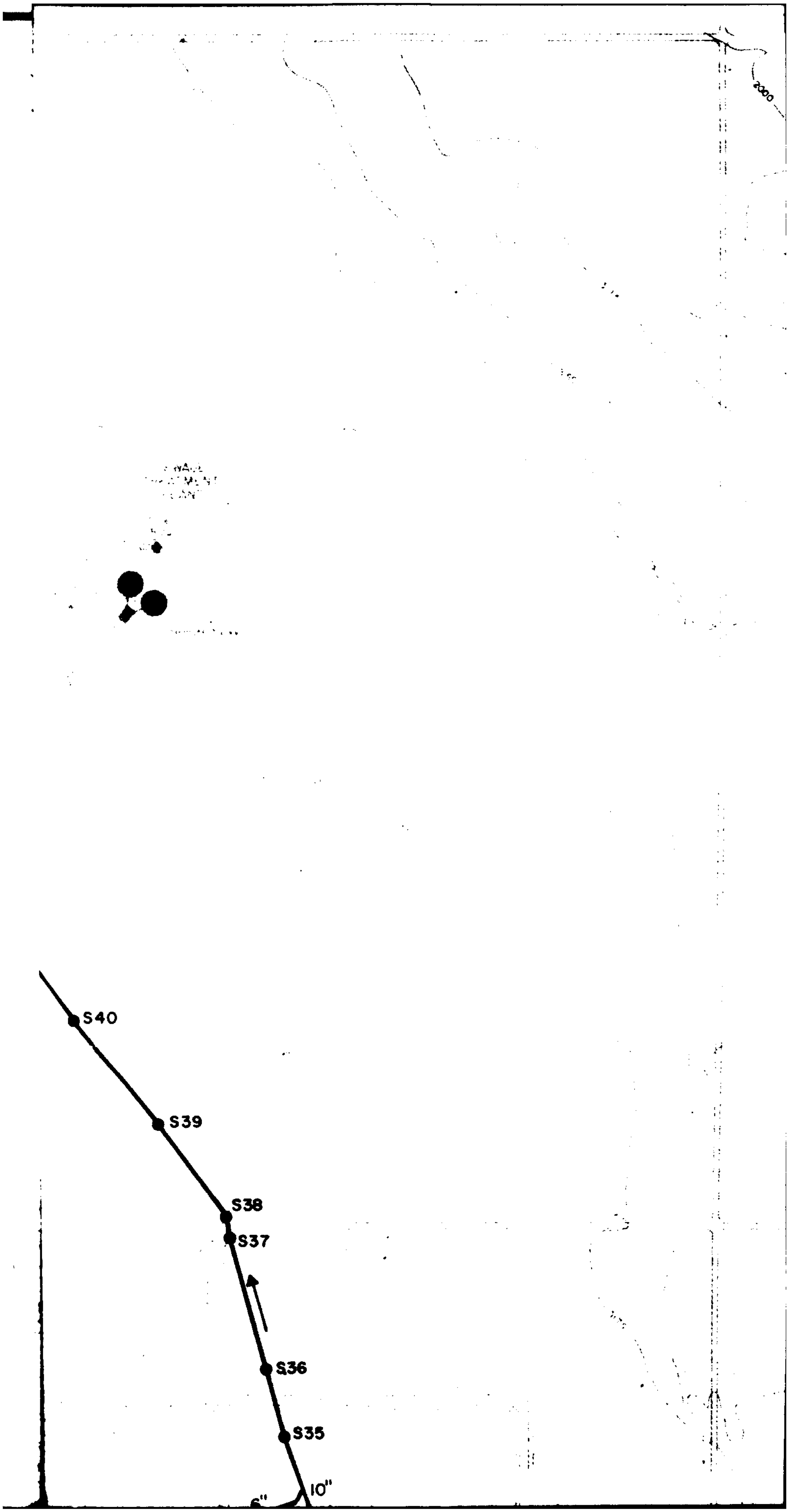
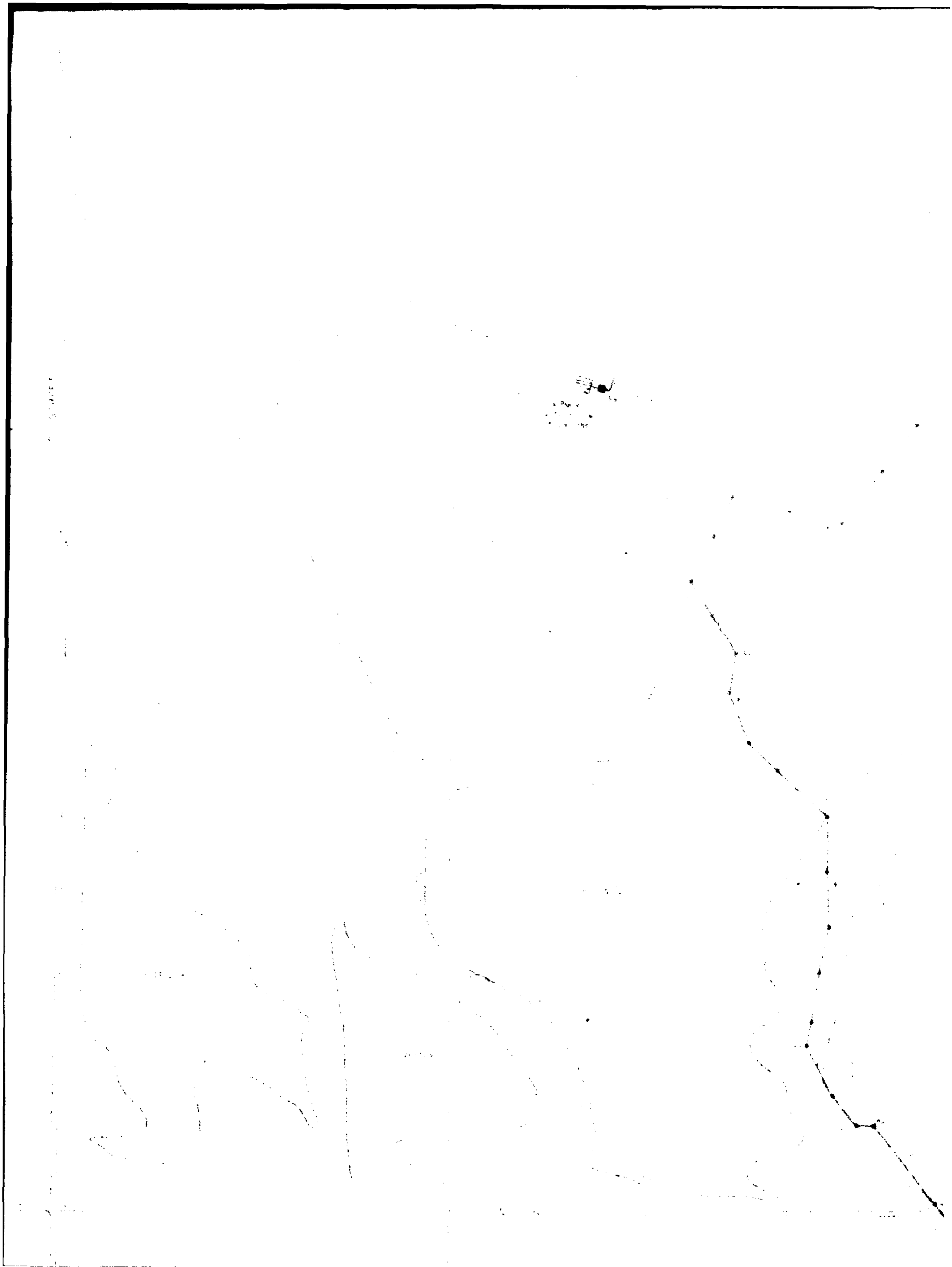
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

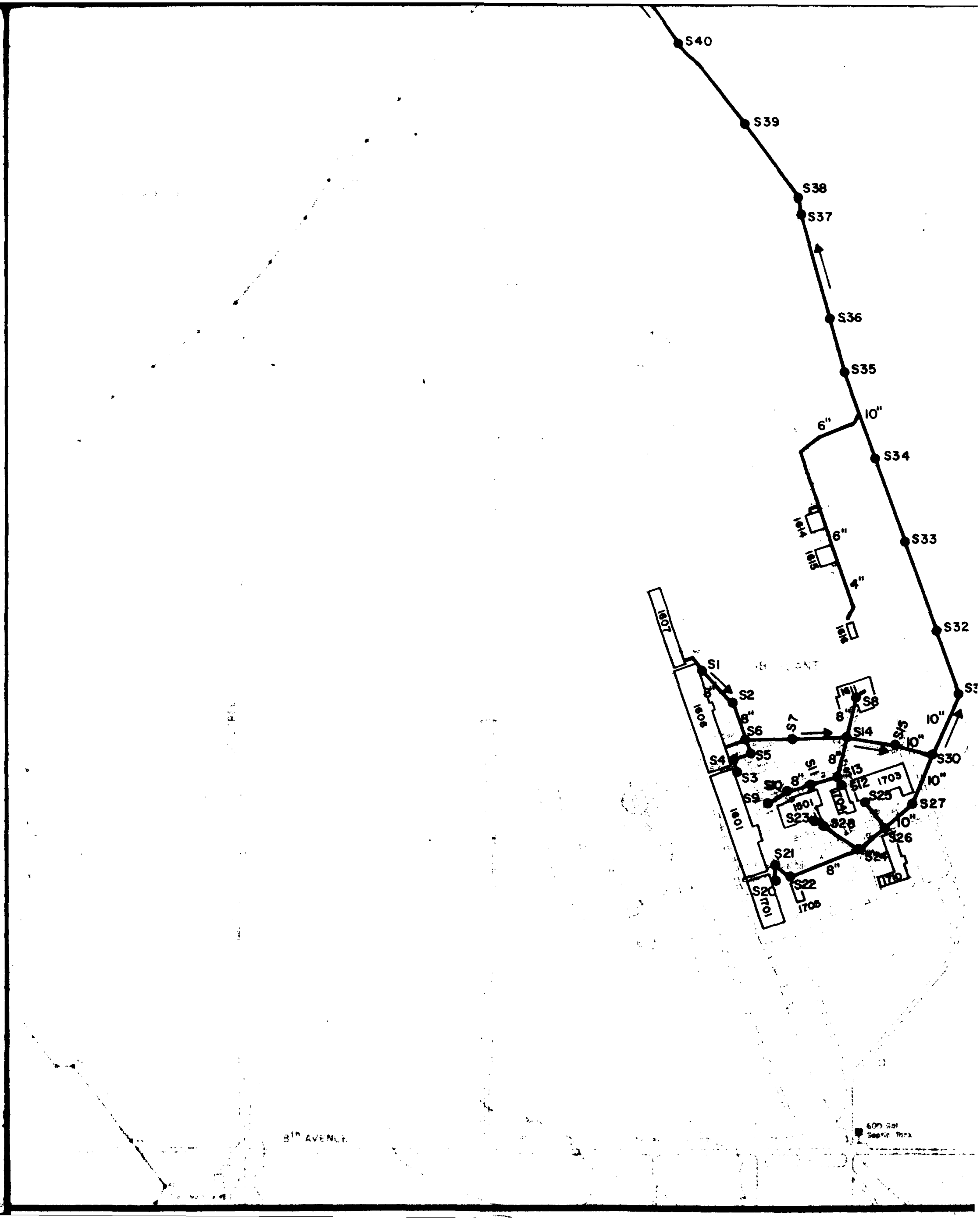
By Ebasco Services Incorporated

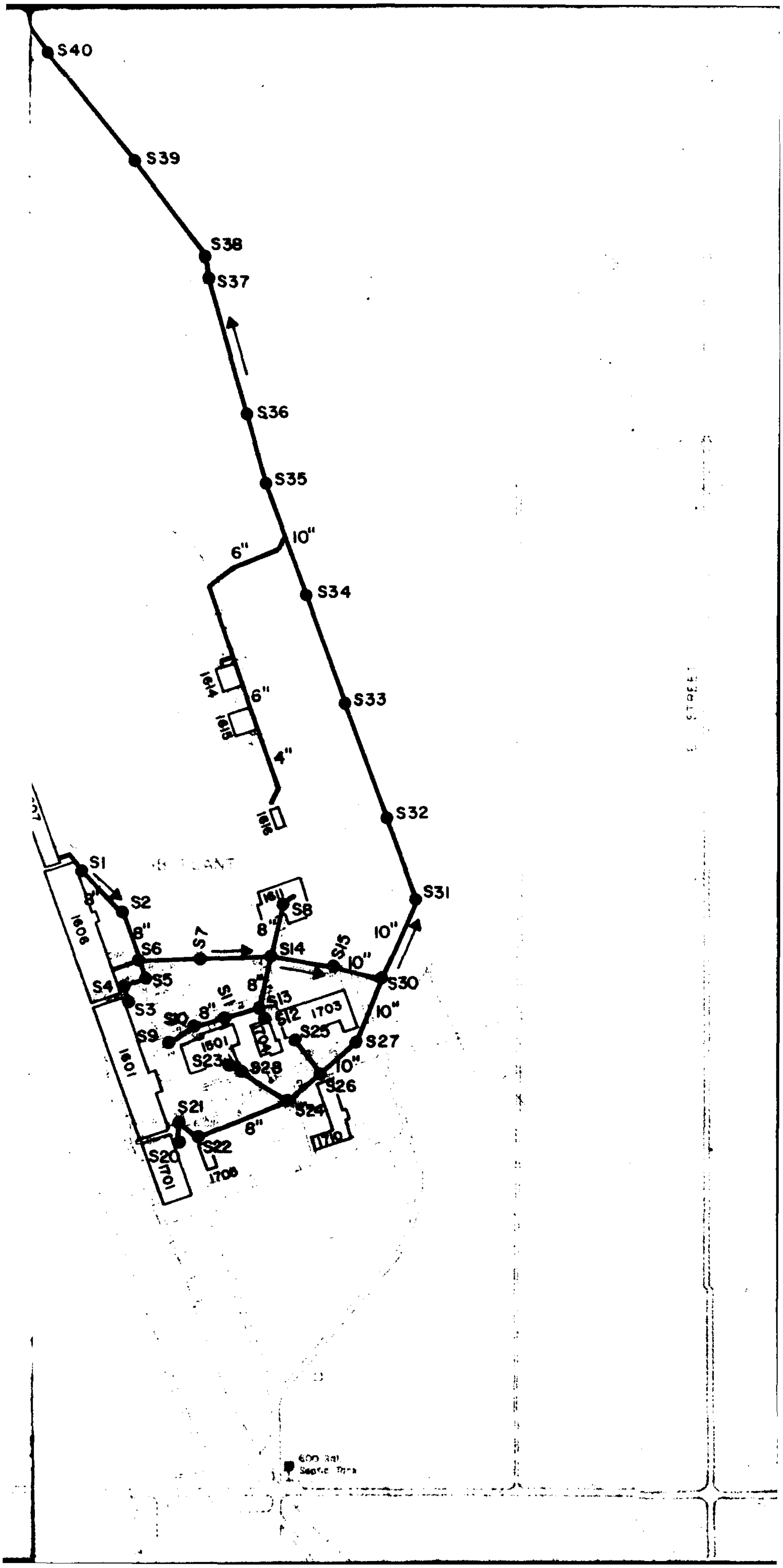
FIGURE 3.4-4
Area 3
Rail Classification Yard
Sanitary Sewer System

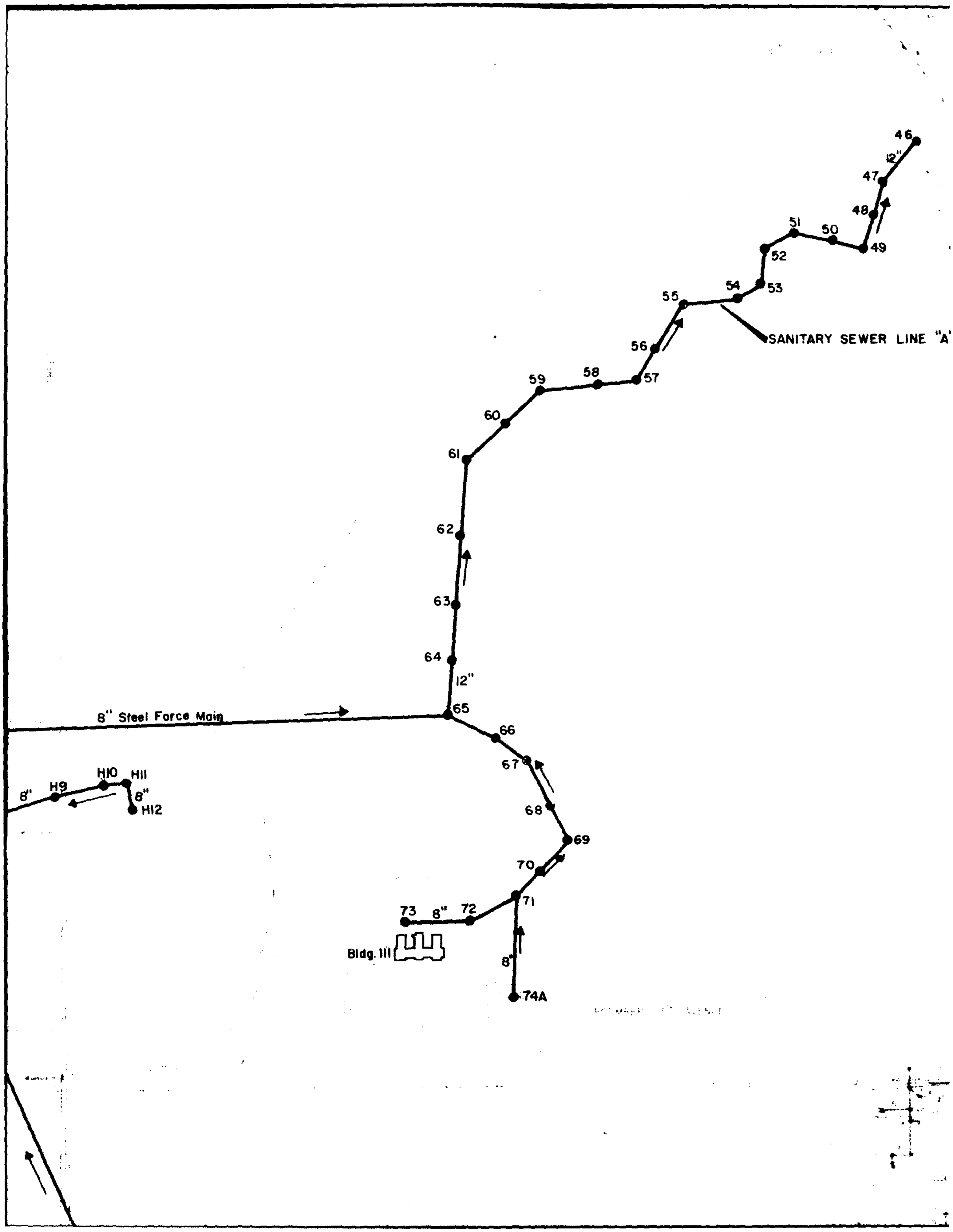

11
10"
S41
S40
S39
S38
S37
S36
S35
10"


2000
S40
S39
S38
S37
S36
S35
10"
6"

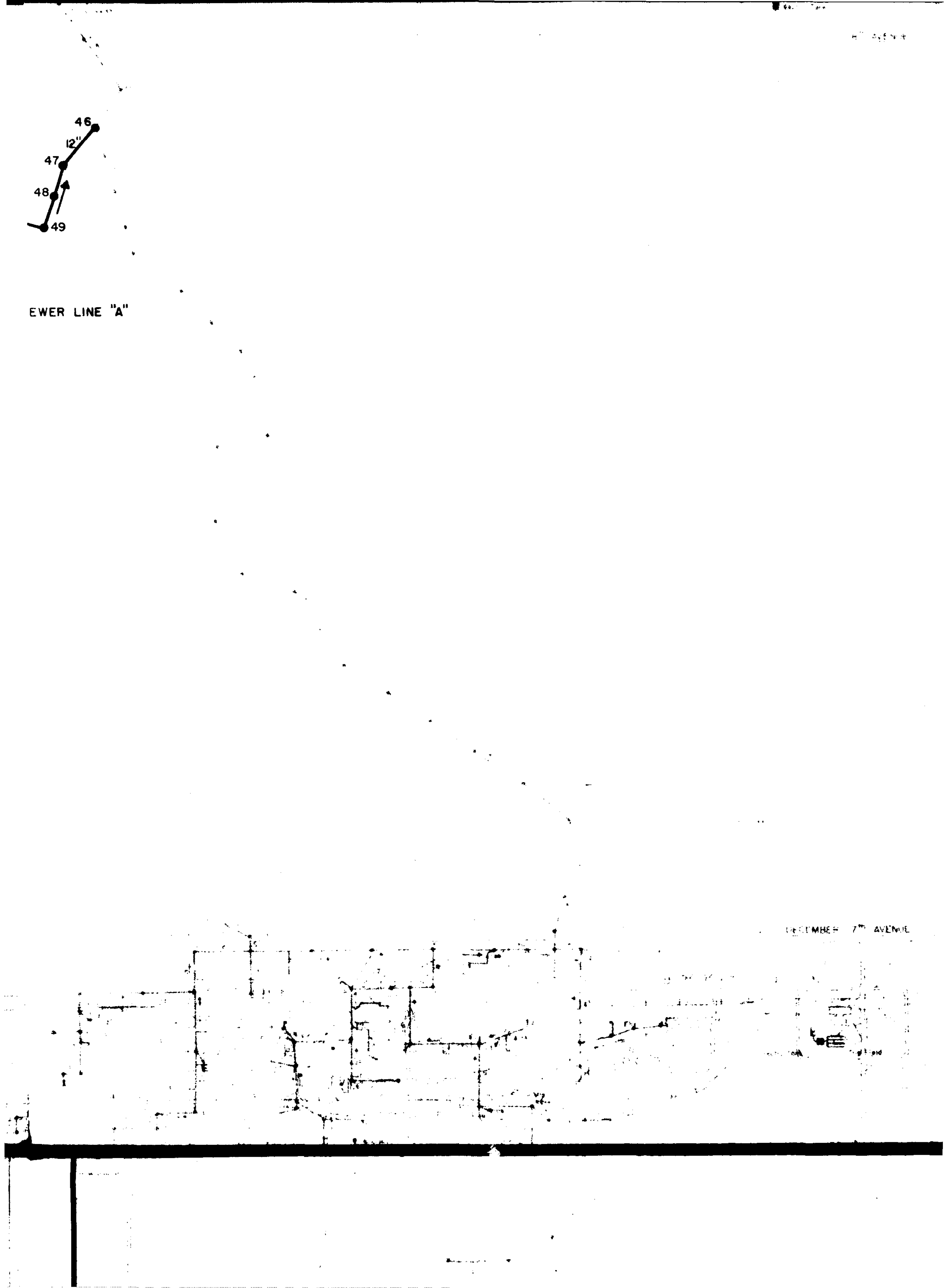



S40
S39
S38
S37
S36
S35
10"
6"
S34
1614
6"
S33
1615
4"
1616
S32
1607
S1
S2
1606
8"
S6
S7
S14
S15
10"
1611
S8
8"
S5
S4
S3
S30
S13
S12
1703
S10
S9
8"
1801
1704
S25
S27
S23
S28
10"
S26
1601
S21
S24
8"
S22
S20
1701
1705
1710
8th AVENUE
600 Gal
Septic Tank

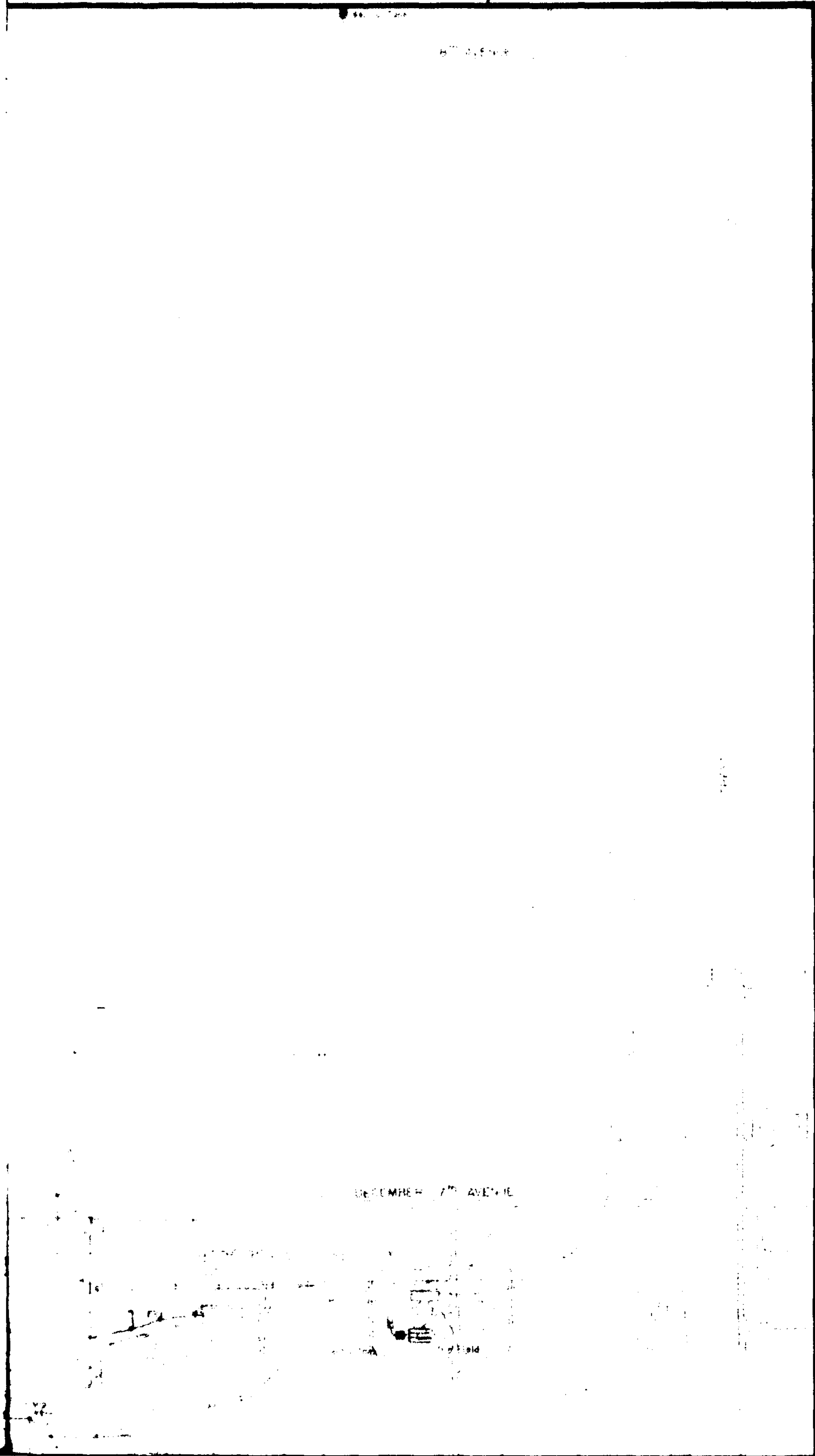

S40
S39
S38
S37
S36
S35
10"
6"
S34
S33
1614
6"
1615
4"
1616
S32
S31
S1
S2
8"
8"
1606
S6
S7
S14
1611
S8
8"
S15
10"
10"
S30
S4
S5
S3
8"
S13
S12
1703
S11
S10
8"
S9
1601
S25
S27
S23
S28
10"
S26
1801
S24
S21
8"
S22
1710
S20
1701
1708
600 gal.
Septic Tank



46
12"
47
48
51
50
49
52
54
53
55
SANITARY SEWER LINE "A'
56
59
58
57
60
61
62
63
64
12"
8" Steel Force Main
65
66
67
68
69
70
71
72
73
8"
Bldg. 111
8"
74A
H10
H11
H9
8'
8"
H12



46
12"
47
48
49
EWER LINE "A"



EXPLANATION

BUILDING, EXISTING

BUILDING, REMOVED

ROAD, PAVED

ROAD, UNPAVED

RAILROAD

SECTION NUMBER

SANITARY SEWER SYSTEM

8" SEWER MAIN, WITH SIZE

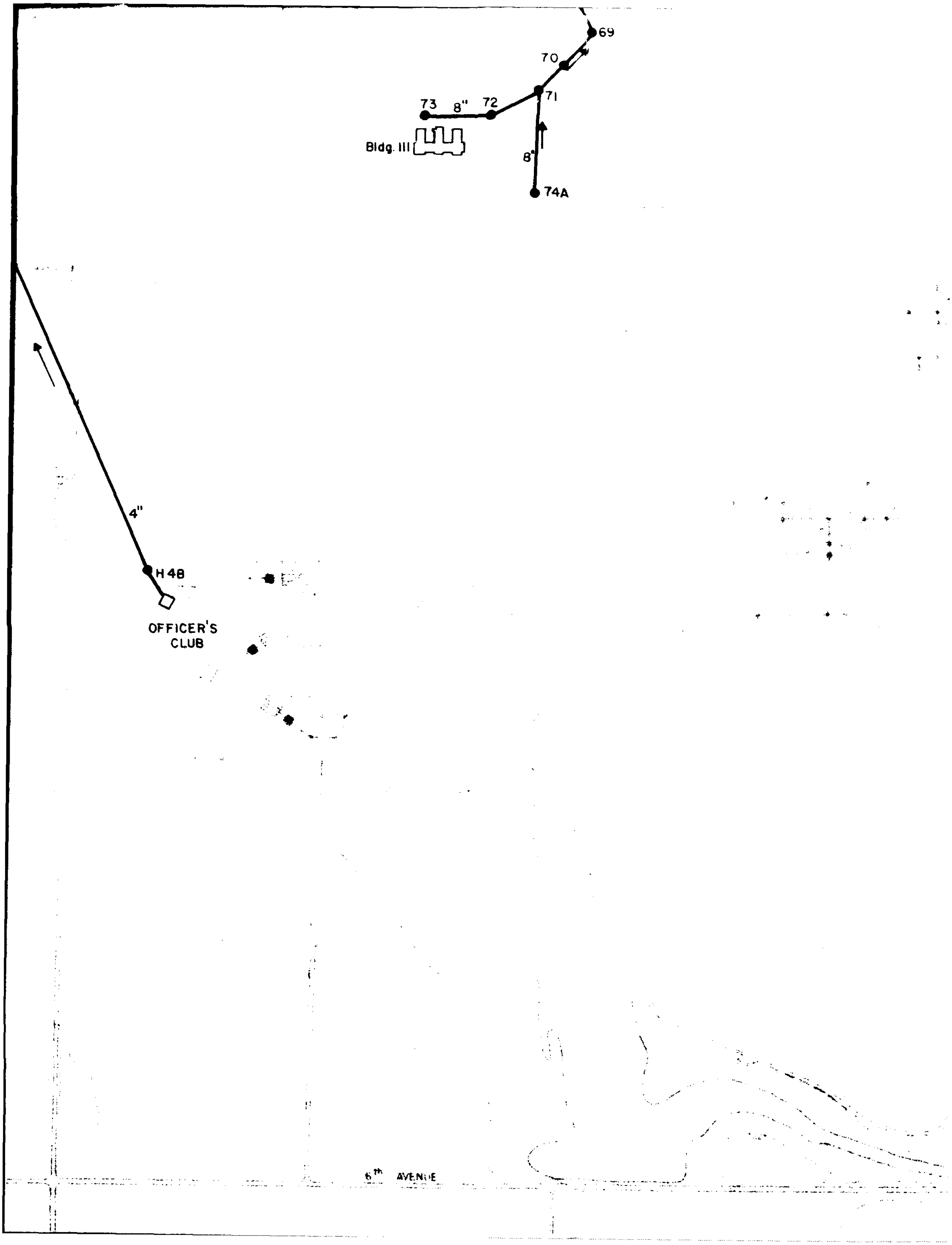
91 MANHOLE, WITH NUMBER

ABANDONED SEWER MAIN

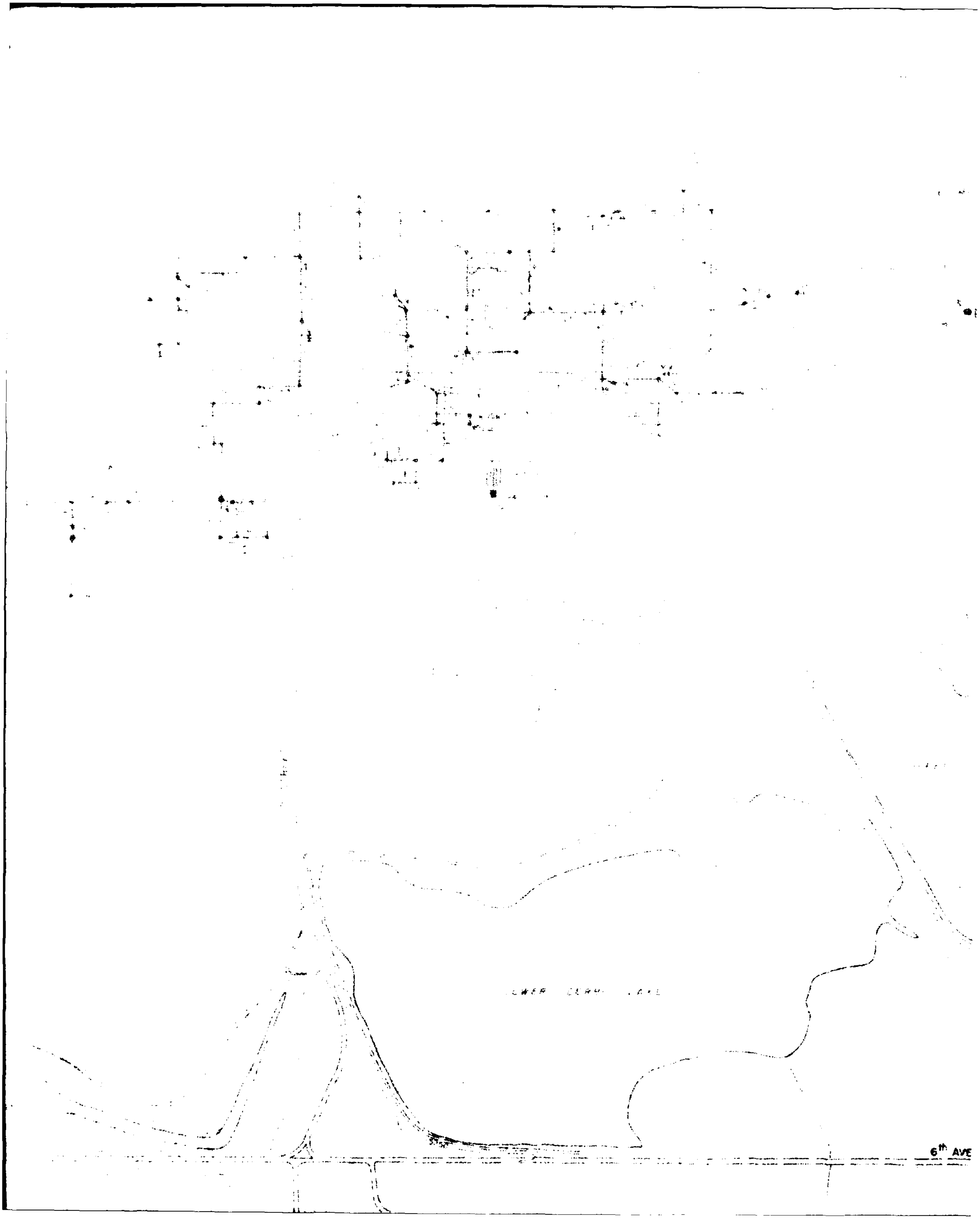
LIFT STATION, WITH BUILDING NUMBER

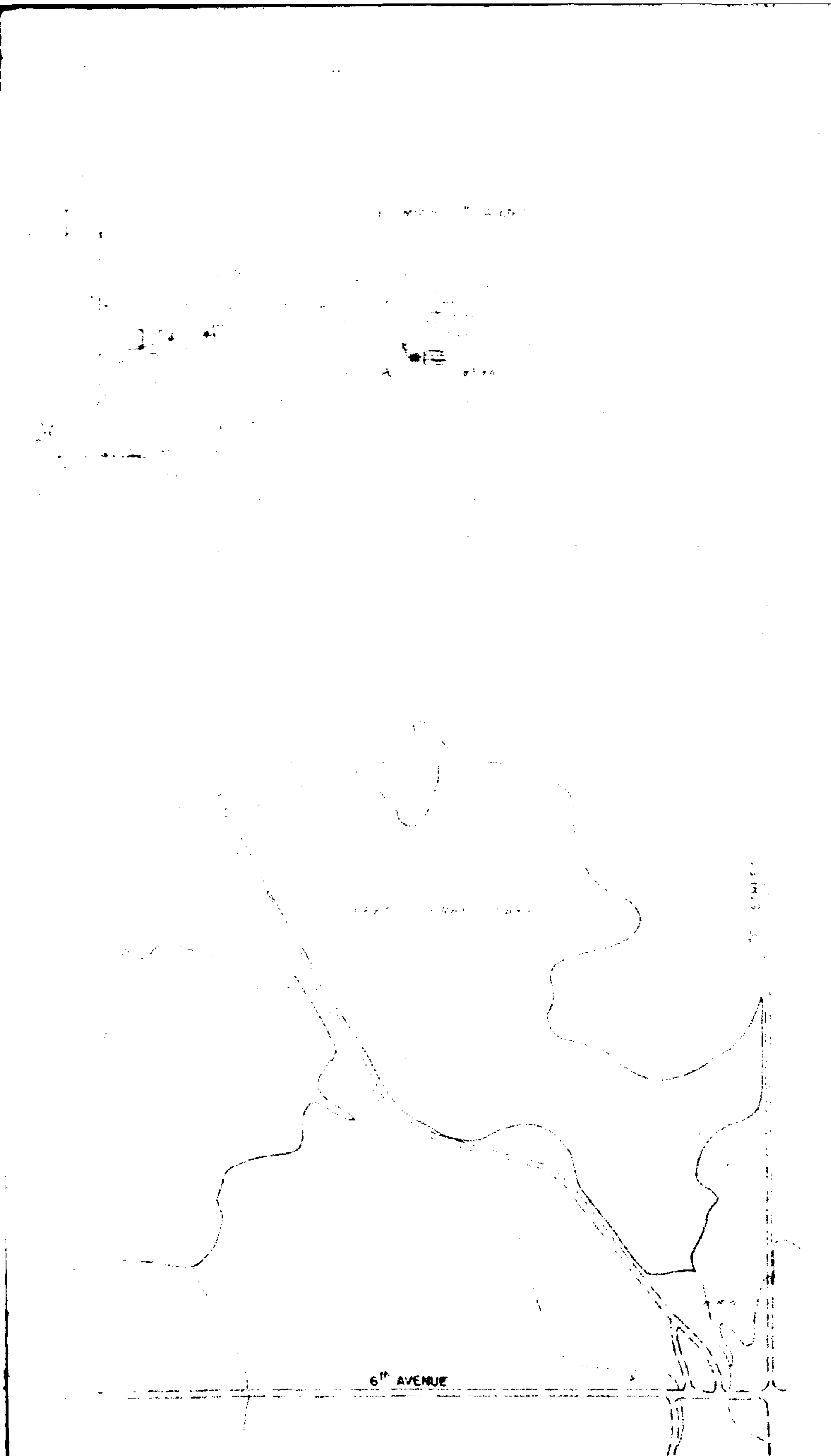
INLET

CLEANOUT

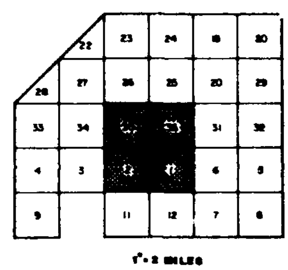


69
70
73
8"
72
71
Bldg. 111
8"
74A
4"
H48
OFFICER'S CLUB
6th AVENUE


6th AVE



ROCKY MOUNTAIN ARSENAL
LOCATION



N

0 300 600
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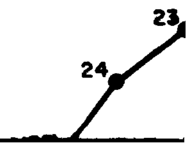
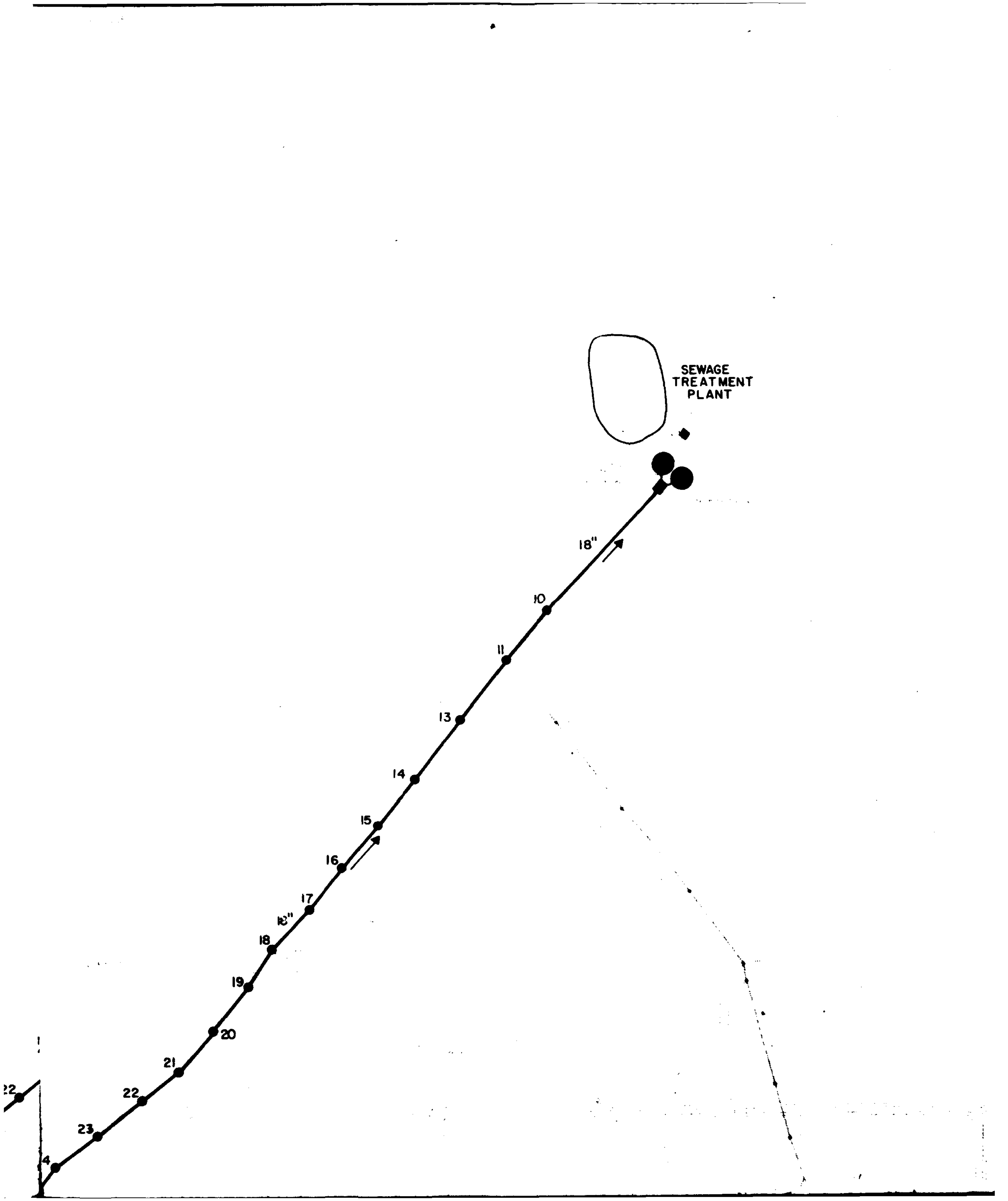
Aberdeen Proving Ground, Maryland
By Ebasco Services Incorporated

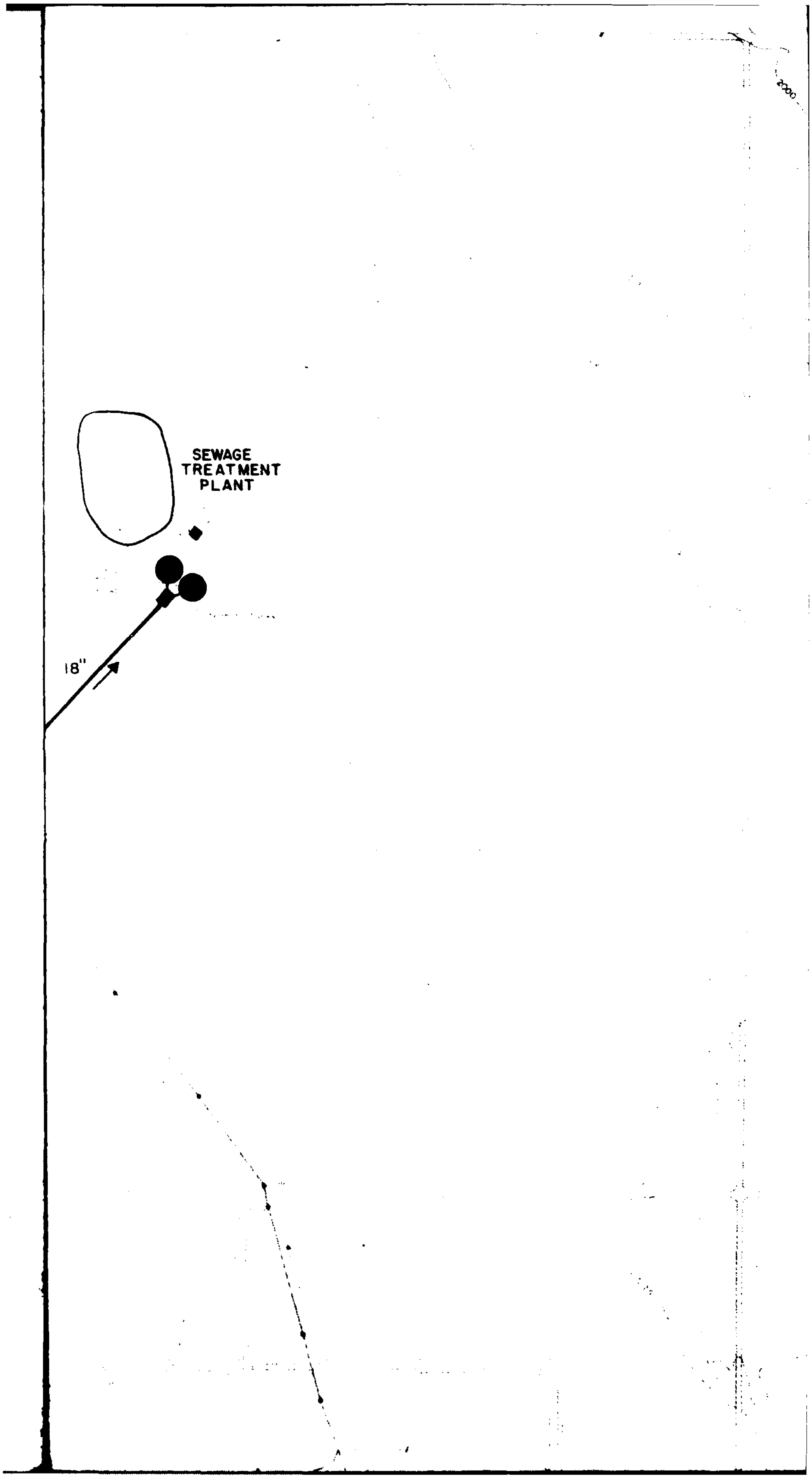
FIGURE 3.4-5B

Area 4
Administration Area and
Officers' Quarters
Sanitary Sewer System

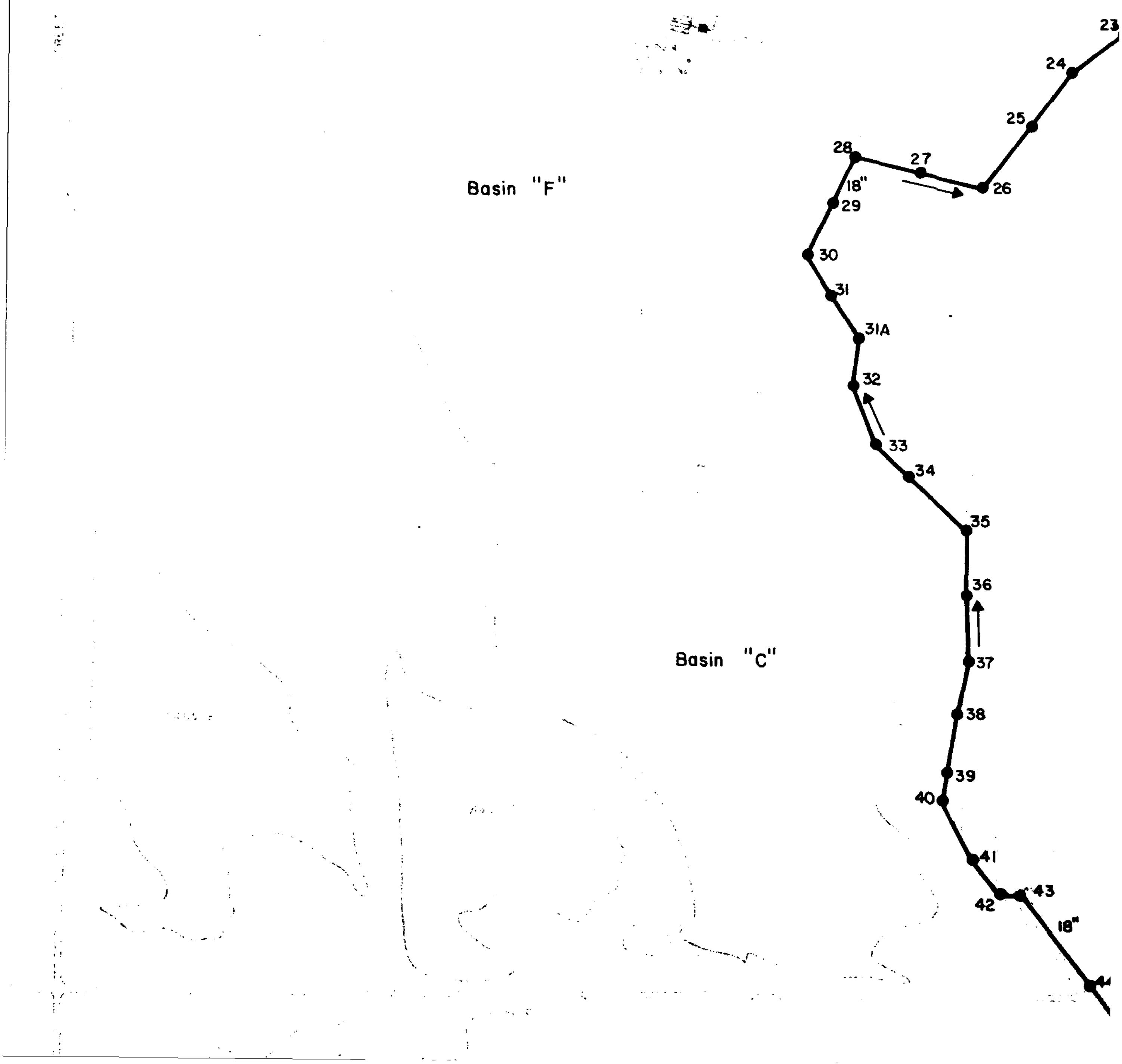

23
24



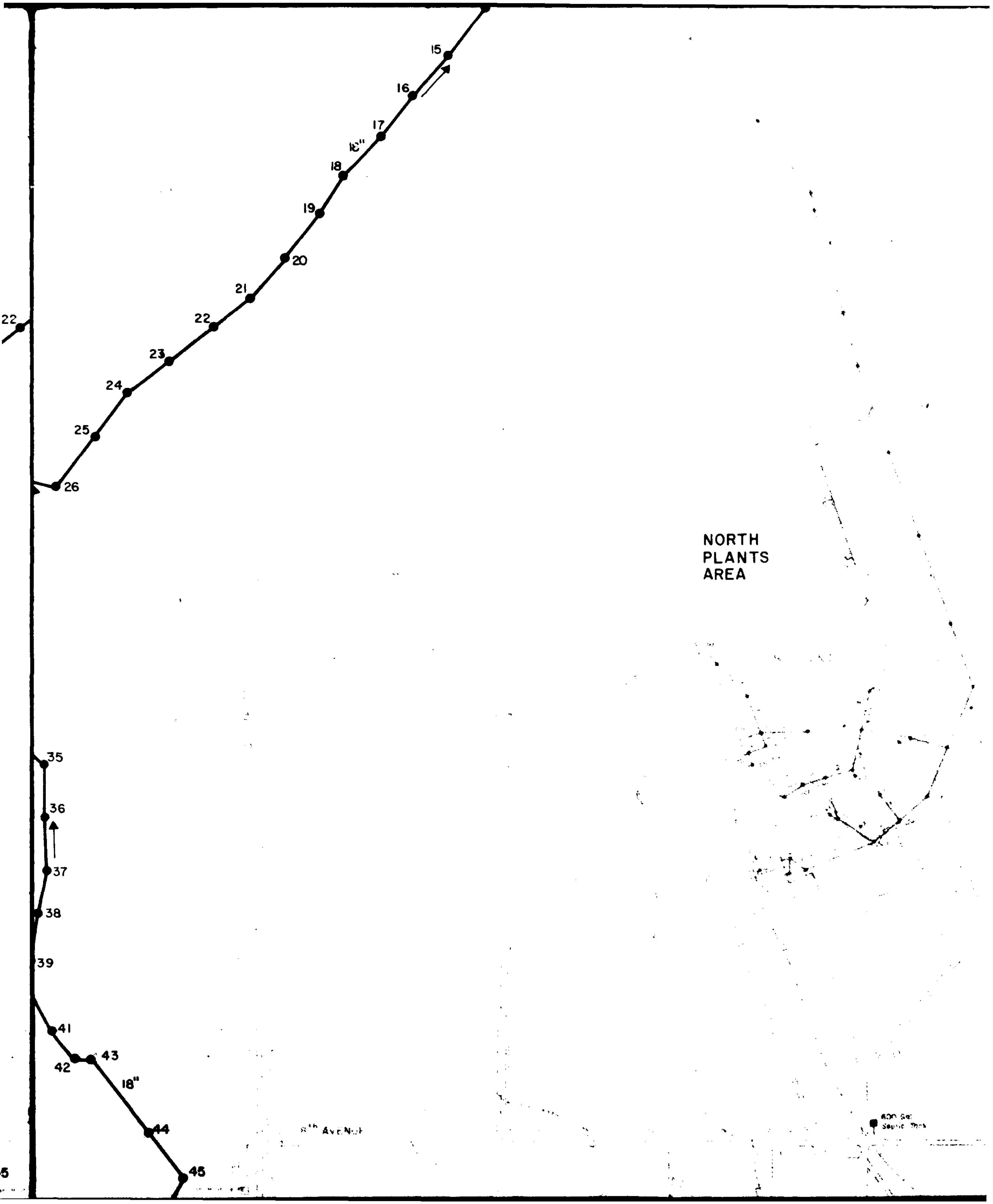
SEWAGE TREATMENT PLANT
18"
10
11
13
14
15
16
17
18"
18
19
20
21
22
23
4
22



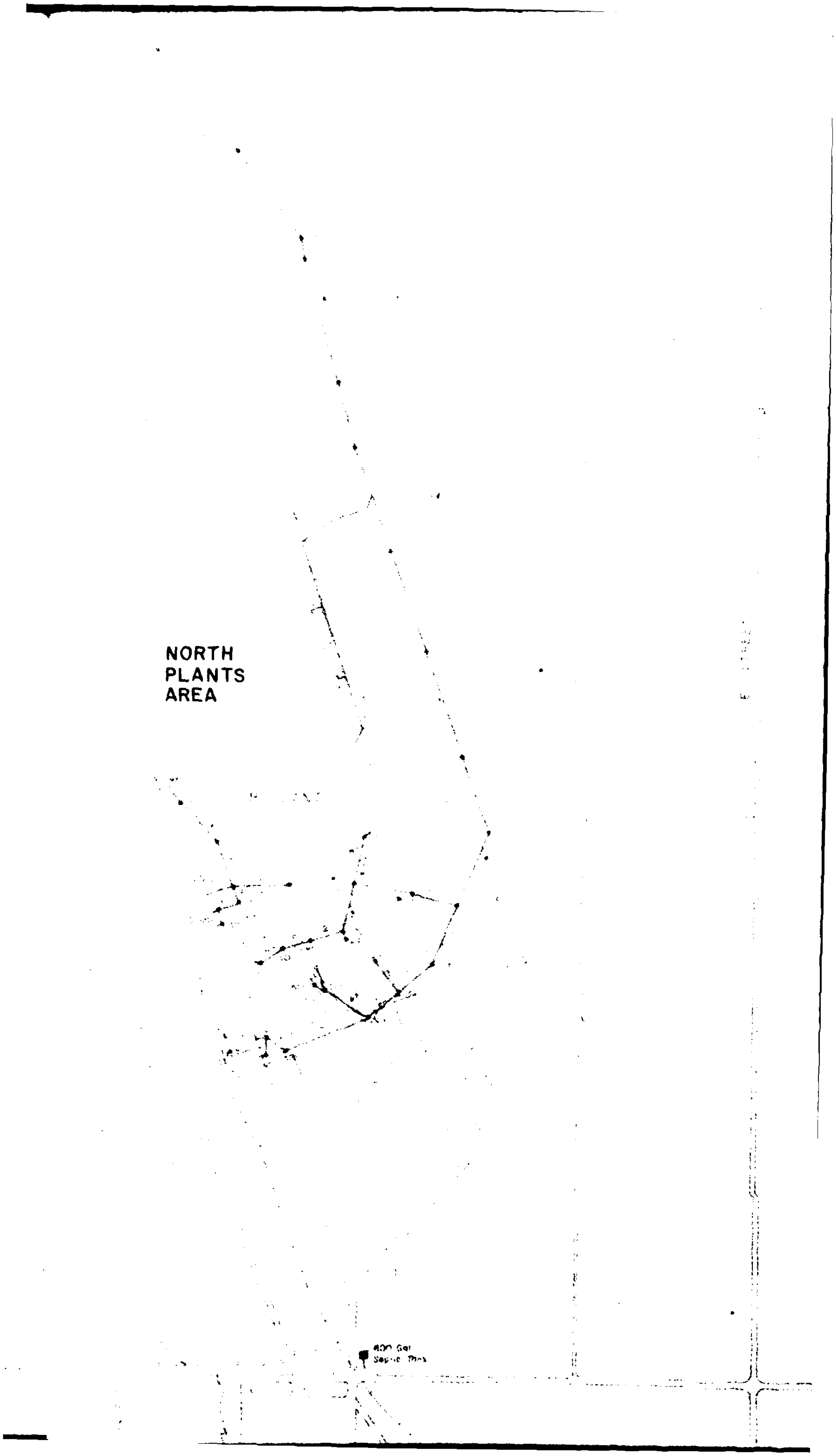
2000
SEWAGE
TREATMENT
PLANT
18"

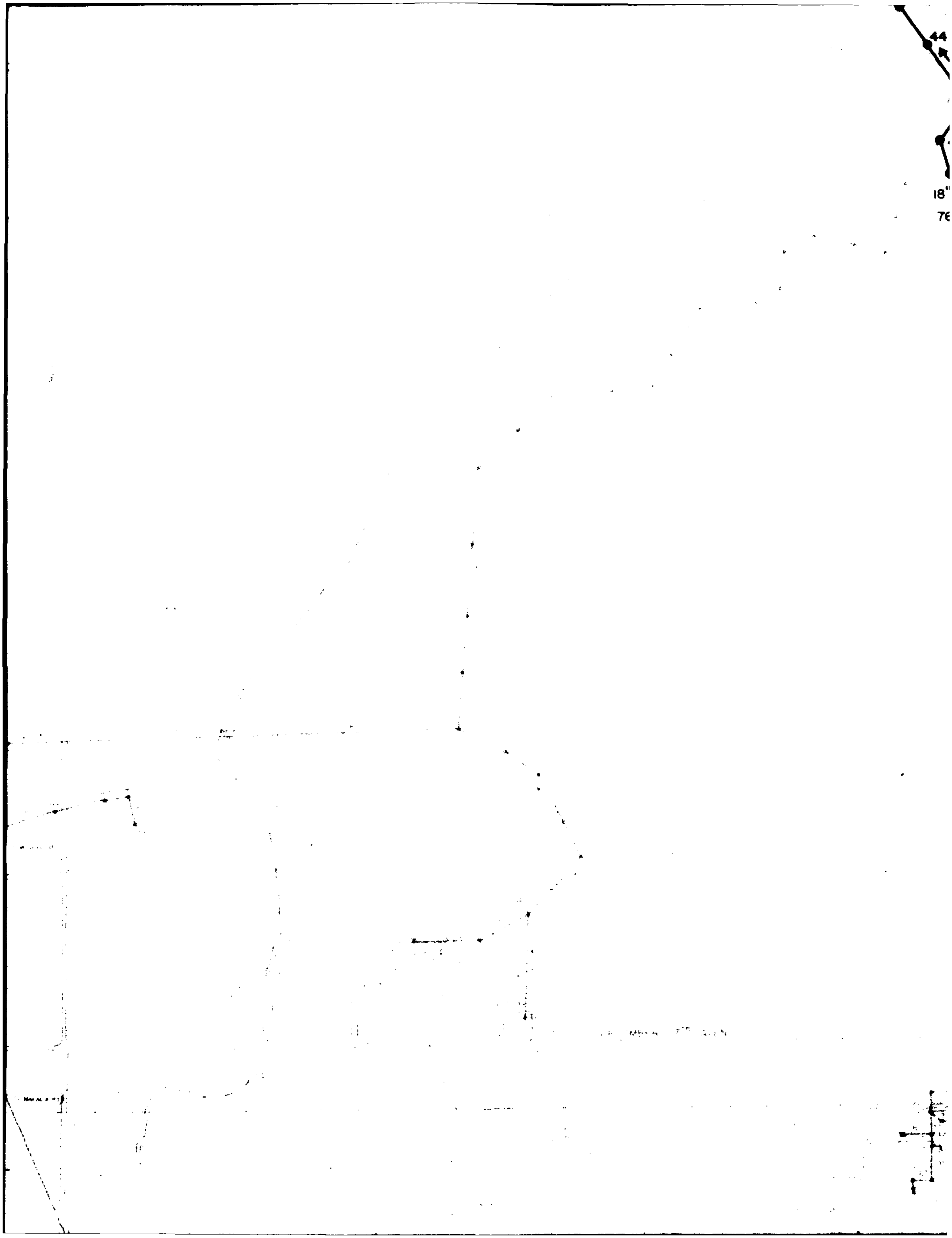


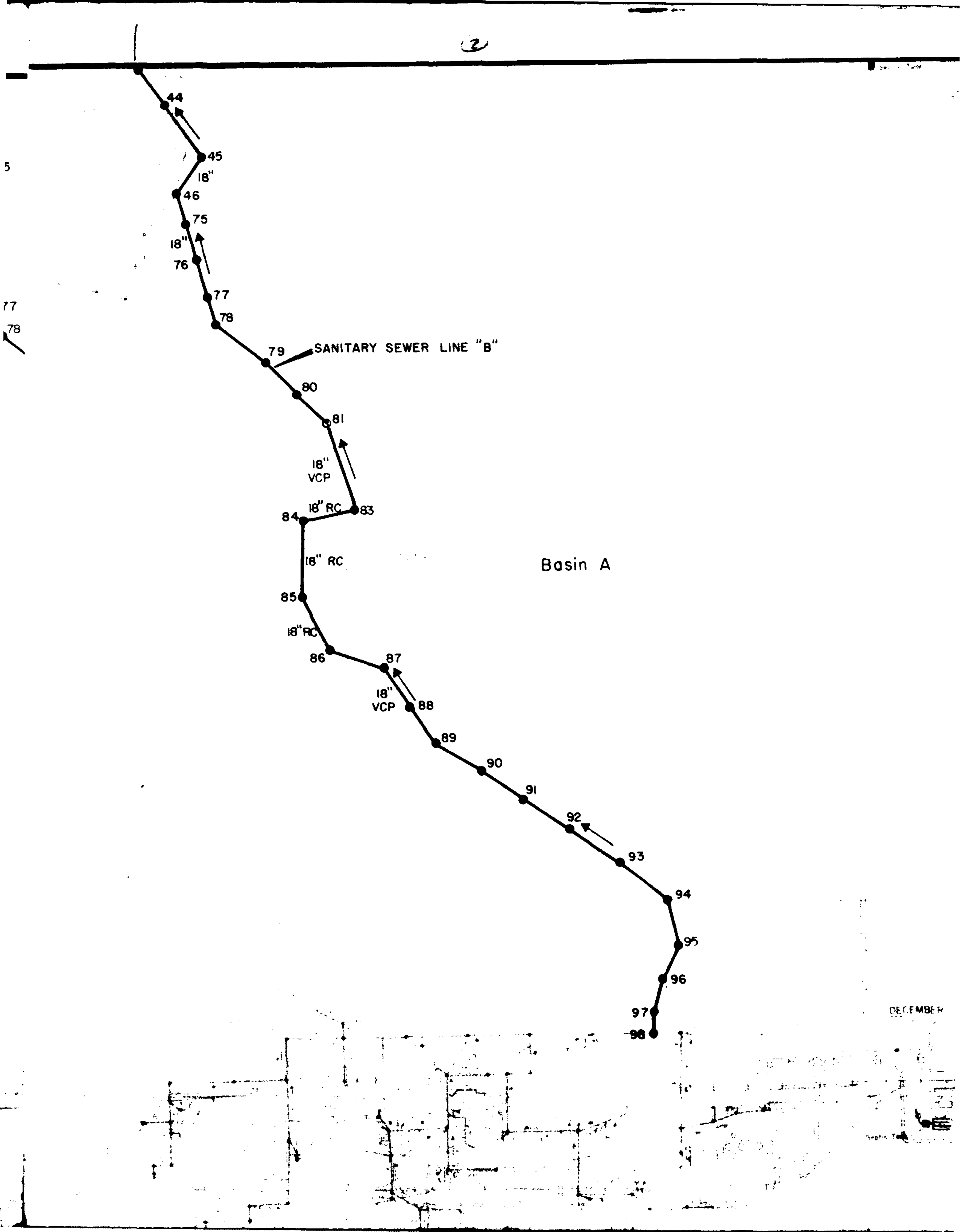
Basin "F"
Basin "C"
23
24
25
26
27
28
18"
29
30
31
31A
32
33
34
35
36
37
38
39
40
41
42
43
18"



15
16
17
12"
18
19
20
21
22
22
23
24
25
26
NORTH
PLANTS
AREA
35
36
37
38
39
41
42
43
18"
44
45

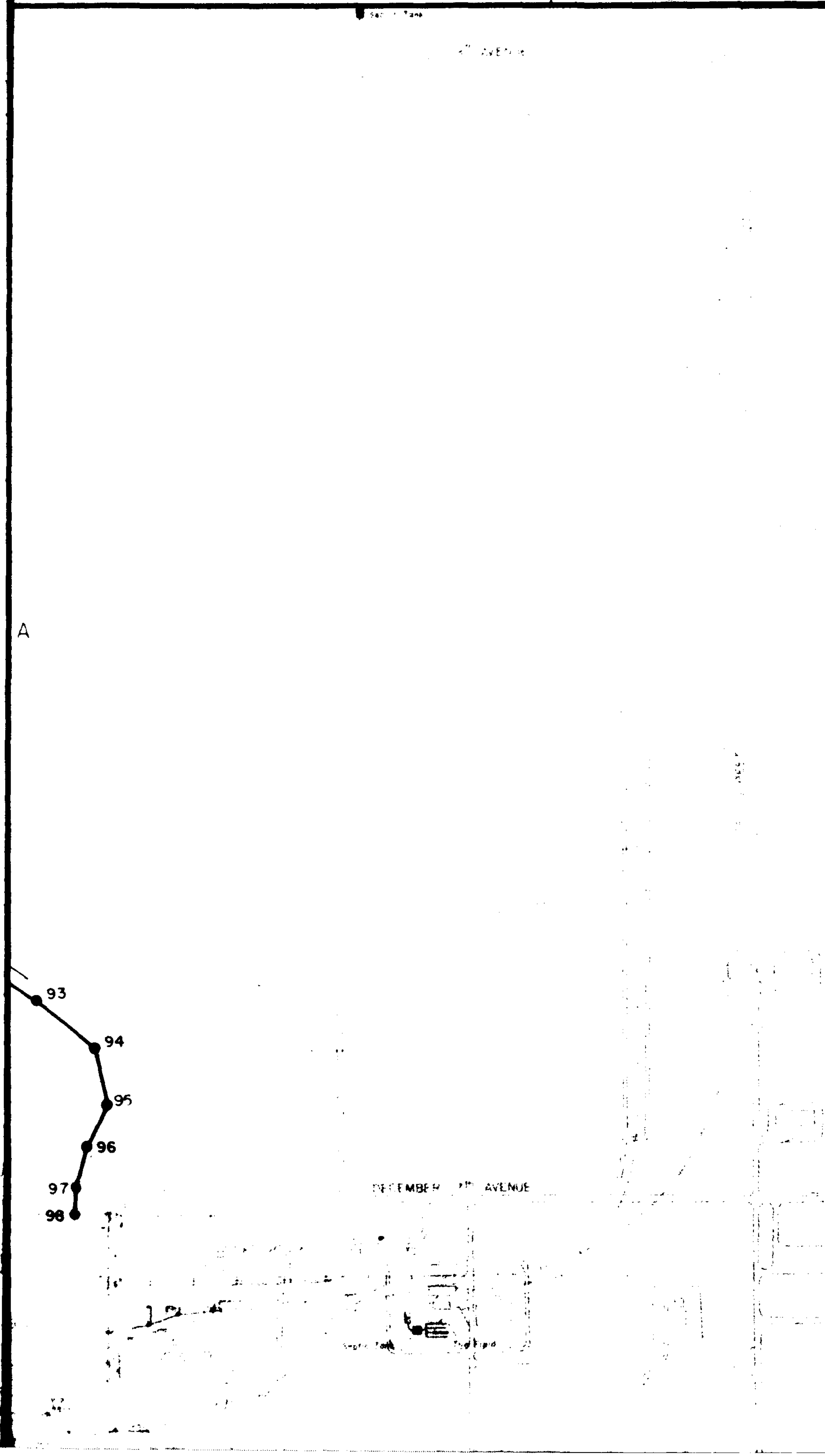

NORTH
PLANTS
AREA


44
18"



2
44
45
18"
46
75
18"
76
77
78
79
SANITARY SEWER LINE "B"
80
81
18"
VCP
18" RC
83
84
18" RC
Basin A
85
18"RC
86
87
18"
VCP
88
89
90
91
92
93
94
95
96
97
98
DECEMBER

3



EXPLANATION

BUILDING , EXISTING

BUILDING, REMOVED

ROAD, PAVED

ROAD, UNPAVED

RAILROAD

SECTION NUMBER

SANITARY SEWER SYSTEM

8" SEWER MAIN, WITH SIZE

91 MANHOLE, WITH NUMBER

ABANDONED SEWER MAIN

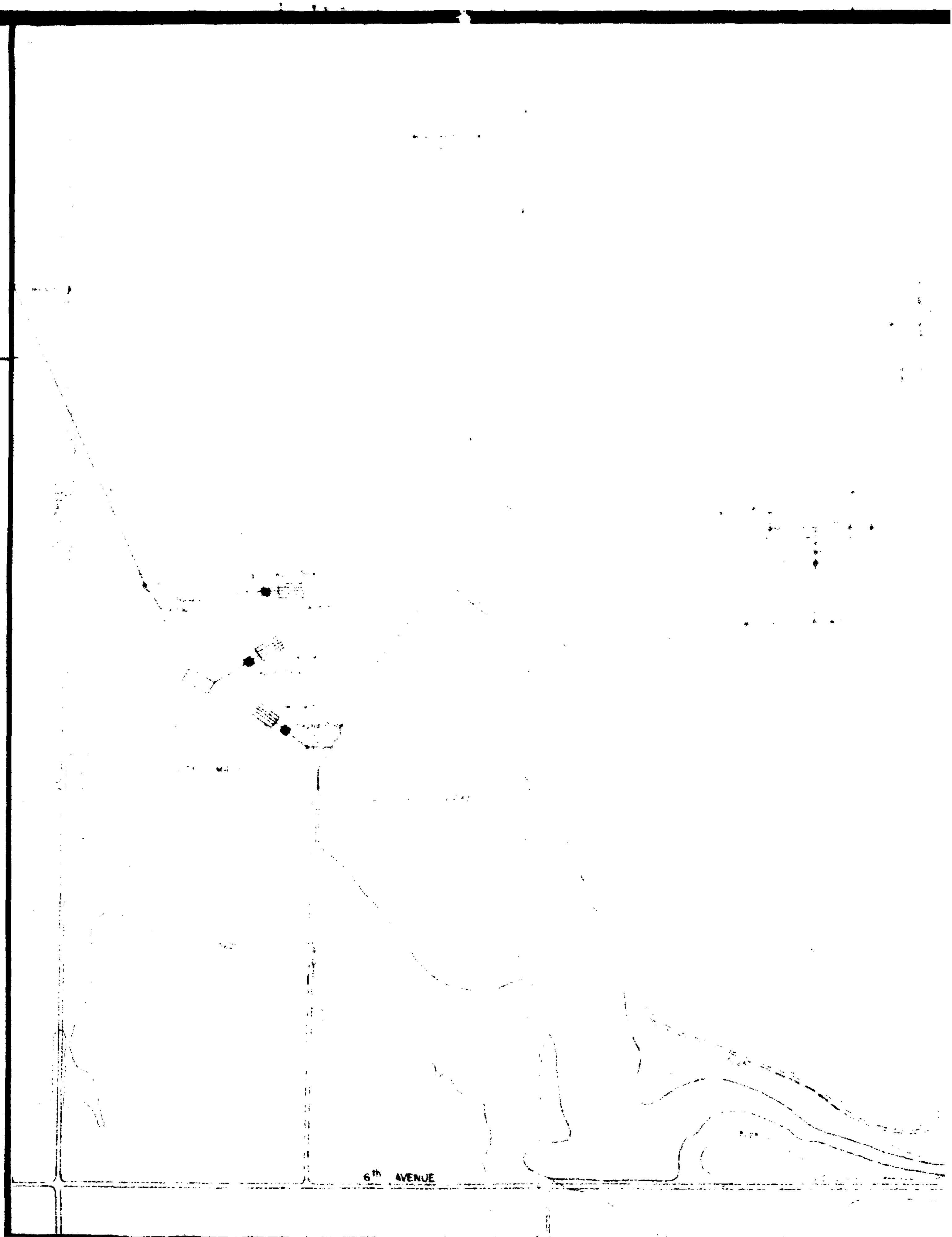
LIFT STATION, WITH BUILDING NUMBER

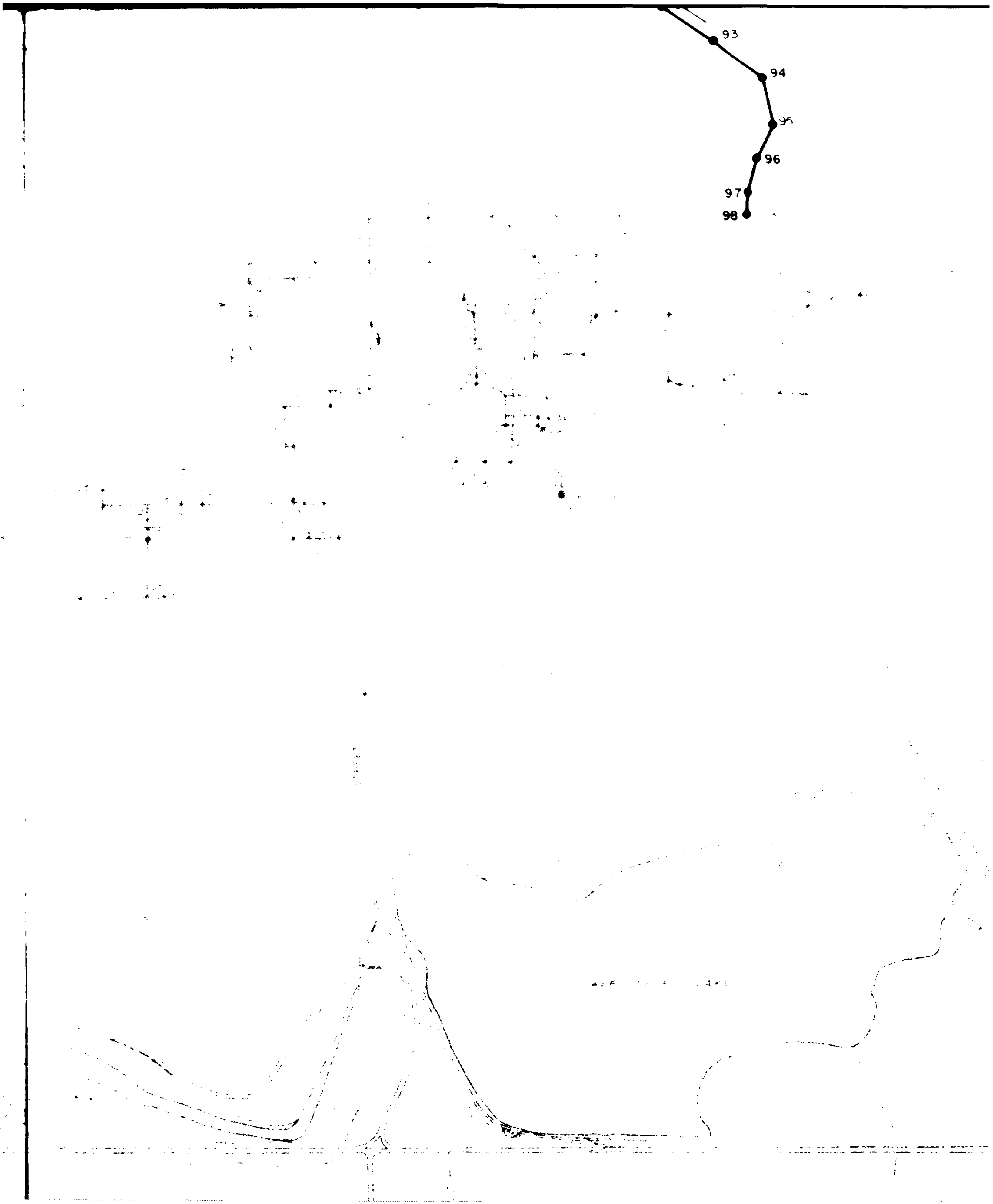
INLET

CLEANOUT

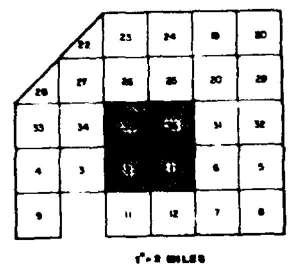
VCP- VITRIFIED CLAY PIPE

RC- REINFORCED CONCRETE


6th AVENUE


93
94
95
96
97
98

ROCKY MOUNTAIN ARSENAL LOCATION



N

0 300 600
FEET

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FIGURE 3.4-6B
Area 5
Interceptor Sewer Line
Sanitary Sewer System

1 6