CONTAMINANT SOURCE INVESTIGATION
JOHNSON CITY WELLFIELD

FINAL REPORT
VOLUME 1 OF 2

JOHNSON CITY WELLFIELD
JOHNSON CITY (C)

BROOME (C)

Prepared for:

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
50 Wolf Road, Albany, New York

Thomas C. Jorling, Commissioner

DIVISION OF HAZARDOUS WASTE REMEDIATION

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MAY 22, 1992

CONTAMINANT SOURCE INVESTIGATION

JOHNSON CITY WELLFIELD

JOHNSON CITY, BROOME COUNTY, NEW YORK

W.A. NO. D002340-12

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(Volume 1 of 2)

PREPARED BY

URS CONSULTANTS, INC.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1. INTRODUCTION

The Village of Johnson City, Broome County, New York municipal water supply has been found to contain unacceptable concentrations of organic chemicals at the Village's Camden Street Wellfield. The New York State Department of Environmental Conservation (NYSDEC) requested URS Consultants, Inc., to supply emergency services to attempt to identify the source of these contaminants and to provide temporary remediation measures. This report presents details of a Contaminant Source Investigation as well as findings and recommendations. A site location map is presented as Figure 1-1.

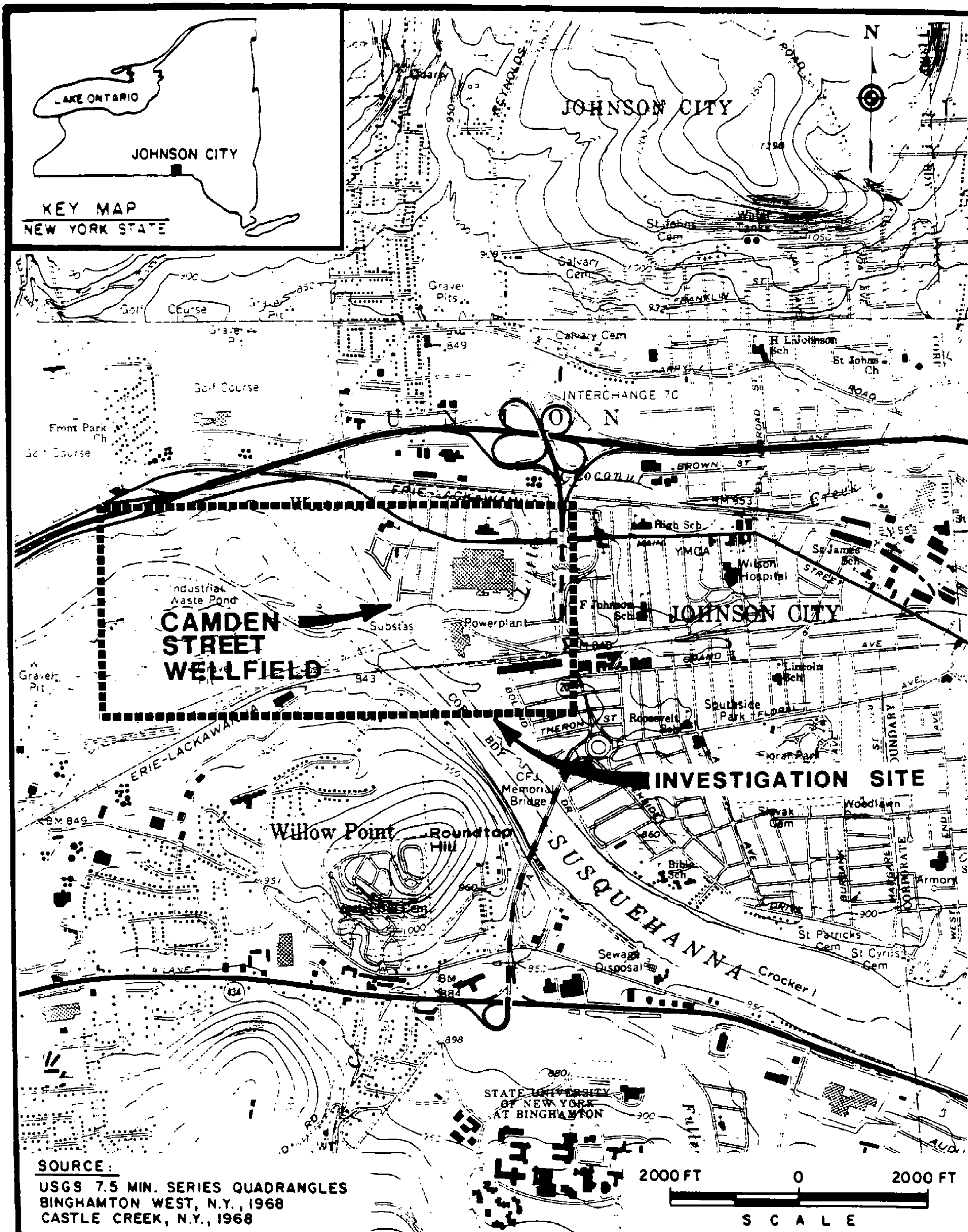
1.1 Background

In written correspondence dated August 13, 1991, from Mr. Michael J. O'Toole of the NYSDEC to Mr. John Gorton of URS, NYSDEC requested immediate engineering services in regard to the Johnson City Public Water Supply.

In addition to two municipal groundwater wells reported unusable due to mechanical problems, the Johnson City Public Water Board was forced to shut down a third well (on July 23, 1991) due to trichloroethane (TCA) contamination (12 ppb), rendering nearly half of its well system unusable. Further sampling on August 1, 1991, showed a second well at the Camden Street location to have TCA above the Principal Organic Contaminant (POC) Standard of 5 ppb. URS agreed to proceed with the development of emergency recommendations to provide interim water treatment and identify the source of contamination.

1.2 Project Team

URS, as prime contractor, was responsible for coordination of all subcontractor activities, for preparation of all final study reports, and



URS CONSULTANTS, INC

CAMDEN STREET WELLFIELD AND INVESTIGATION SITE LOCATION MAP

FIGURE 1-1

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for all contractual and technical communications with NYSDEC. URS conducted all project activities not specifically designated to other subcontractors.

As part of the Contaminant Source Investigation, URS retained American Auger & Ditching to provide drilling and monitoring well installation services at the site, and IEA for chemical analysis of groundwater samples. The subcontractors selected for this work were approved by NYSDEC and are under current URS subcontract for State Superfund work.

2. PURPOSE

The purpose of this project is to provide emergency engineering recommendations to minimize the impact of chemical contamination at Johnson City's Camden Street Wellfield, and to develop and implement a plan to identify the source of groundwater contamination there.

The project includes the following tasks:

- Task I - Development of Project Management Work Plan
- Task II - Site Evaluation
- Task III - Preliminary Engineering Evaluation
- Task IV - Health and Safety and QA/QC Plans
- Task V - Well Installation
- Task VI - Aquifer Testing
- Task VII - Sampling and Analysis
- Task VIII - Survey and Mapping
- Task IX - Site Assessment and Final Report
- Task X - Temporary Treatment System

The purpose of this report is to present the findings of the Contaminant Source Investigation, which included Tasks II, and IV through IX. Task III, Preliminary Engineering Evaluation was submitted on August 23, 1991. Task X Temporary Treatment System is in the final stage of completion and is being reported separately.

3. SCOPE OF WORK

3.1 Records Search

A records search was conducted to update and expand information regarding the Johnson City Camden Street Wellfield. URS personnel reviewed all available file information at the NYSDEC Kirkwood office, as well as Broome County Health Department and Johnson City Water Department files.

Information obtained during the records search was used to develop the work plan for the Contaminant Source Investigation, and has been incorporated into this report.

3.2 Drilling and Well Installation

Drilling and well installation activities were conducted between September 4 and October 3, 1991. A total of 4 shallow and 6 deep wells were completed at 6 locations in the vicinity of the Camden Street Wellfield. These drilling locations were selected in an effort to intercept potential contamination migrating from a suspected source to the Wellfield. Shallow monitoring wells, which range in depth from 30 to 60 feet, were constructed to screen the upper portion of the aquifer. Deep wells, which range from 57.5 to 96 feet deep, were constructed to screen the same zone screened by Johnson City Water Department Wells #2 (94 feet) and #3 (87 feet). All well locations were selected in cooperation with NYSDEC personnel and are illustrated on Figure 3-1.

Shallow well borings were advanced using a Mobile Drill Model B-57 drill rig and hollow-stem auger drilling techniques. Deep well borings were advanced using a Bucyrus-Erie Model 20W drill rig and cable tool drilling techniques. Soil samples for materials classification were recovered from shallow borings by split-spoon sampler and from deep

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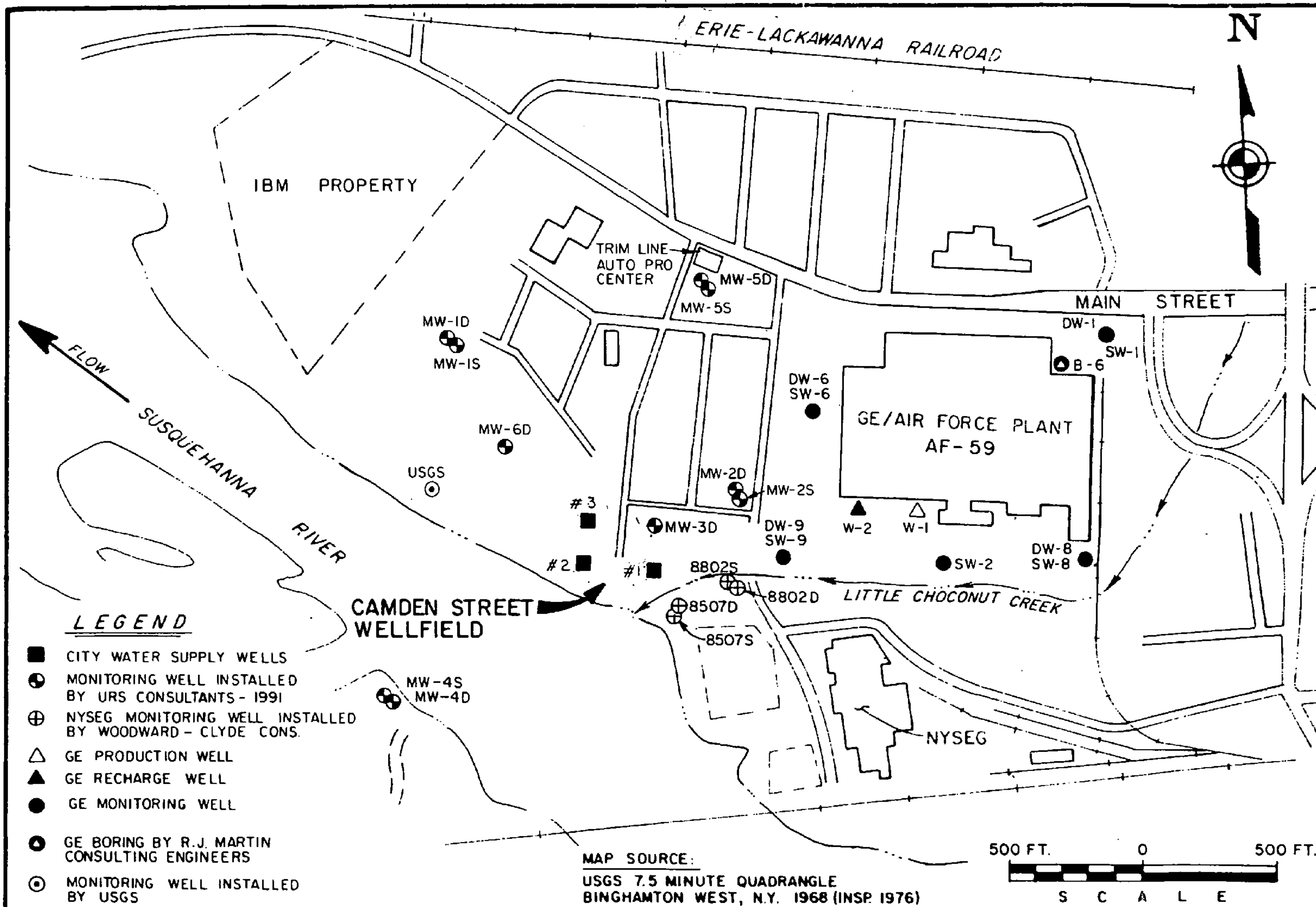


URS CONSULTANTS, INC.

JOHNSON CITY
CONTAMINANT SOURCE INVESTIGATION WELL LOCATIONS

FIGURE 3-1

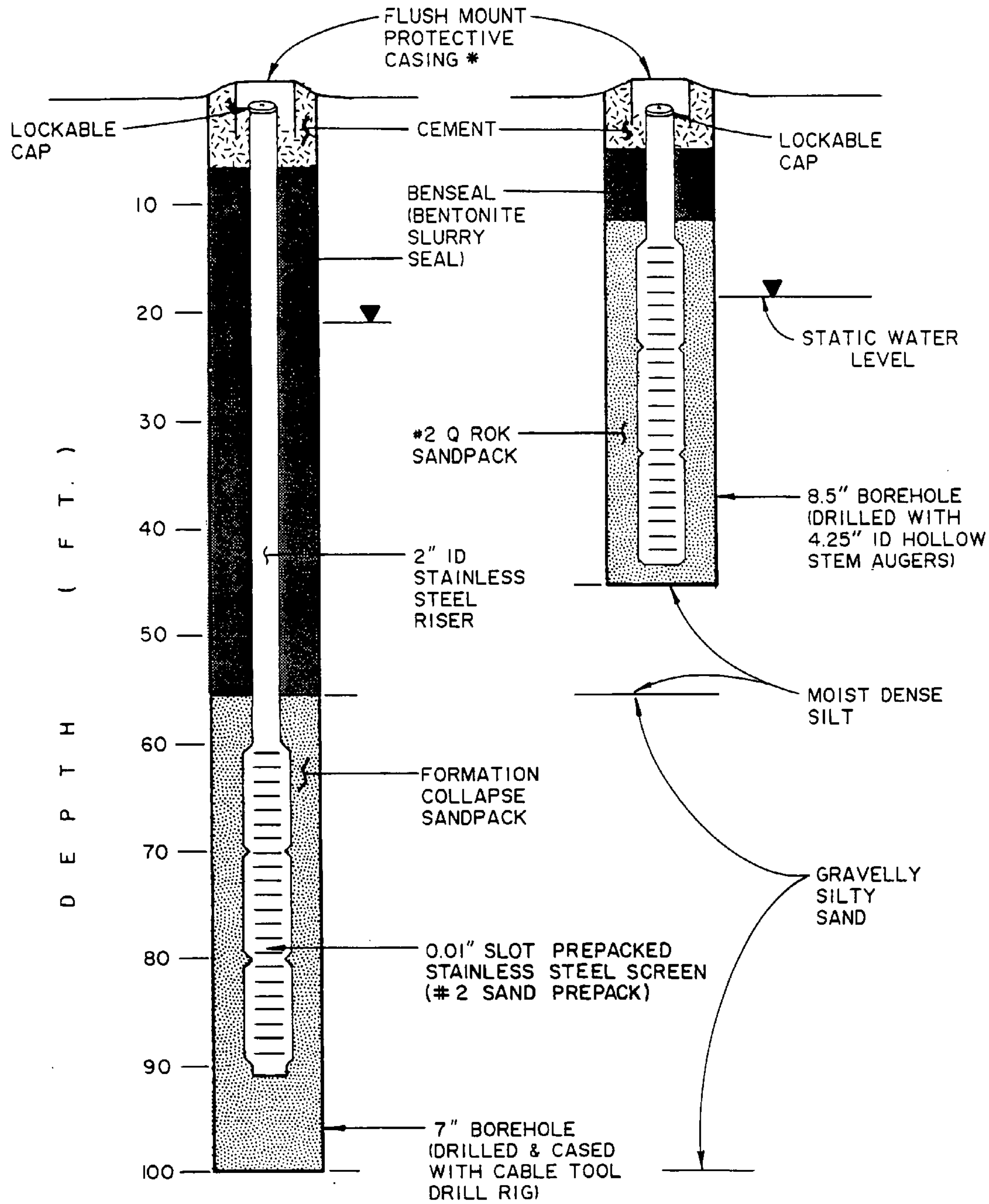
borings by split-spoon sampler and bailer. Boring logs are presented in Appendix A.

Monitoring well construction utilized 2-inch ID pre-packed 0.01-inch slot stainless-steel screen and 2-inch ID threaded flush-joint stainless-steel riser. With the exception of wells MW-2S, MW-2D, MW-4S, and MW-6D, each well was constructed with a 30-foot screen section. Wells MW-2S and MW-2D were constructed with a 25-foot screen section and wells MW-4S and MW-6D were constructed with a 20-foot screen section. Natural formation sand was allowed to collapse around the screen during construction; this was supplemented with #3 Q-Rok as needed. Annular space above the screen was backfilled with bentonite slurry. The uppermost four feet of annulus was backfilled with cement. On completion, each well was equipped with a protective casing and lockable cap. Wells MW-1, MW-2, MW-5, and MW-6 have flush-mount casings, and wells MW-3 and MW-4 have stick-up type casings. Typical well construction details are illustrated on Figure 3-2. Specific construction details for each well are presented on the drilling summary sheet for each well, found in Appendix A.

Following well construction, each well was developed to remove silt and sediment from well screens prior to sampling. Well development was accomplished using a Waterra Hydrolift pump with polyethylene tubing and foot valve dedicated to each well. Development was deemed complete when discharge water achieved a turbidity measurement of less than 50 NTU, and pH, conductivity, and temperature measurements stabilized. Well development logs for each well are presented in Appendix A.

3.3 Sampling and Analysis

Following development of the newly installed monitoring wells, each of these wells and Johnson City Water Department Well #2 was sampled. Prior to sampling, each well was purged of at least three volumes of water standing within the well column. Turbidity, temperature, conductivity,



* WELLS MW-3D, MW-4S AND MW-4D CONSTRUCTED WITH ABOVE GROUND STEEL PROTECTIVE CASING.

URS CONSULTANTS, INC.	JOHNSON CITY CONTAMINANT SOURCE INVESTIGATION **TYPICAL WELL CONSTRUCTION DETAILS**	**FIGURE 3-2**

A-4133

and pH measurements were recorded during purging and sampling of each well. Monitoring wells were evacuated using a Waterra Hydrolift pump with dedicated tubing and foot valve. City Well #2 was pumping to the system. Well purging logs are presented in Appendix B.

Well sampling was conducted by URS personnel between October 21 and October 24, 1991. Samples were collected into precleaned bottles provided by IEA Laboratory, of Monroe, Connecticut. Monitoring well samples were recovered using dedicated disposable teflon bailers and nylon line. City Well #2 was sampled directly from a tap in the well house. Following recovery, each sample was chilled and shipped that evening under chain-of-custody to the IEA Laboratory for analysis.

All monitoring well and City Well #2 samples were analyzed for Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry Method 524.2. In addition, each sample was also analyzed for dichlorodifluoromethane (freon), acetone, and methyl ethyl ketone (2-butanone), as well as Target Analyte List (TAL) metals, cyanide and Target Compound List (TCL) PCBs. The appropriate quality assurance/quality control (QA/QC) samples were submitted to the laboratory for analyses, including matrix blank and drill water along with groundwater samples. Results of sample analysis are presented in Section 4.3. Laboratory data are presented in Appendix B.

On December 10 and 11, 1991, a second round of sampling was performed. The second sampling and analysis was performed to confirm results of the first-round analysis. Each new monitoring well was evacuated and sampled, and groundwater analyzed as during the previous sampling (with the exception of PCB analyses, which were not performed). In addition to monitoring well sampling, one sample was obtained from a sump at the Trim Line Auto Pro Center, located at the corner of Main Street and Camden Street. The sump sample was analyzed for TCL volatiles only. Results of analysis are presented in Section 4.3, and laboratory data are presented in Appendix B.

3.4 Survey and Mapping

Following completion of monitoring well installation, all new wells were surveyed for location and elevation. Well elevations were determined relative to the National Geodetic Vertical Datum of 1929 using benchmark elevations established near the Camden Street Wellfield. Horizontal locations were established relative to a local and site-specific datum. In addition to the new monitoring wells, the following wells were also surveyed: Johnson City supply wells #2 and #3; General Electric/Air Force Plant 59 (AF-59) monitoring wells SW-1 through SW-3; G.E. discharge well W-2; New York State Electric and Gas (NYSEG) monitoring wells 8802 and 8507 (shallow and deep); and Village of Vestal monitoring wells 4-26, 4-27, and 4-29. These data were used to develop site and groundwater contour maps.

All surveying was performed under the supervision of a New York-licensed Land Surveyor. The site maps were prepared based on the USGS 7.5 minute topographic quadrangle map.

3.5 Aquifer Test

An aquifer test was performed at the Camden Street Wellfield between December 17 and 20, 1991. In preparation for the aquifer test, pumpage from Well #2 was shifted to Wells #6 and #7 on November 20, 1991. The wellfield was allowed to remain idle until December 17 in order to allow as much water level recovery as practicable prior to the test. Groundwater levels were measured intermittently from December 3 through December 17 at three well sites by NYSDEC personnel prior to the test to assess antecedent conditions. Measurements in all of the wells observed during the test were taken immediately prior to test start. Water level measurements were used to develop potentiometric surface contour maps, presented and discussed in Sections 4.2 and 4.4.

The aquifer test was conducted at a constant rate of approximately 2,960 gallons per minute (gpm) for a duration of 72 hours. Some minor fluctuations in discharge rate were created by the varied demand on the water system. Well #2 was pumped to the water supply distribution system at approximately 2,100 gpm and Well #3 was pumped to waste into the Susquehanna River at approximately 860 gpm. Discharge to the Susquehanna River was performed under consent of the NYSDEC Chemical Systems Section.

Throughout the aquifer test, water levels were measured by URS and NYSDEC personnel at regular intervals within the 10 new monitoring wells and the 9 monitoring wells at AF-59. Additionally, a NYSEG subcontractor monitored water levels within well pairs 8802 and 8507 at the Goudey substation. Discharge rates at Wells #2 and #3 and changes in Susquehanna River stage were also monitored by URS personnel. Following 72 hours of pumping, the water system was switched back to pre-test conditions by shifting Well #6 and #7 on line and shutting Wells #2 and #3 off in order to allow an eight-hour test recovery period, during which time water levels were also monitored. Results of the aquifer test are presented in Section 4.4. Aquifer test data are presented in Appendix D.

4. SITE CHARACTERIZATION

4.1 Site History

4.1.1 Johnson City Well Usage

The Johnson City Water Department supplies potable water to the Village of Johnson City as well as to part of the Town of Union and the IBM complexes north of the Village. The entire water system is supplied by groundwater drawn from the valley fill Clinton Street-Ballpark Aquifer, which has been designated as a sole source aquifer by USEPA under the Safe Drinking Water Act (50 Federal Register 2026, January 14, 1985). The Village has additional supply interconnections with the City of Binghamton to the east, and the Village of Vestal to the south, although sizes of interconnections restrict adequate volume for sole supply. Additionally, the Village of Vestal water supply, which is also drawn from valley fill deposits, has been found to contain unacceptable concentrations of organic contaminants.

The Village of Johnson City maintains seven deep wells within the supply system (Wells #1 through #7). Wells #1, #2, and #3 are located at the Village Water Department Office at the foot of Camden Street. Construction details indicate that these wells were installed in 1931. Wells #4 and #6 are located on Olive Street, Well #5 on Endwell Street and Well #7 on North Broad Street, all northeast of the Camden Street Wellfield. Wells #1 and #4 are presently inoperative due to mechanical problems.

The entire water system demand is approximately 4.5 million gallons per day (MGD). The Camden Street Wellfield capacity is approximately 4.0 MGD. The village typically supplies the system using Wells #2, 3, 6 and 7. Well #5 is capable of producing only about 1.0 MGD. Under normal summertime conditions Well #3 is operated as the main well, supplemented by Well #6. Well #2 is a backup which can be converted to operate by a natural-gas-fueled engine in the event of power outages. Without Well #3 operating, the Village is in an emergency situation unless Well #2 can be operated.

The only other known production well within the vicinity of the Camden Street Wellfield is operated by G.E. at AF-59. This well is also screened within the Clinton Street-Ballpark Aquifer and produces approximately 350 gallons of water per minute, which is used for non-contact cooling purposes and is discharged to Little Choconut Creek. Private homeowner supply wells are prohibited by village ordinance.

4.1.2 History of Wellfield Contamination

In compliance with Part 5 of the New York State Sanitary Code, the Village of Johnson City regularly samples the village water supply wells for Principal Organic Contaminants (POCs). Concentration standards for individual POCs are presently set at 5 ug/l (ppb) by the New York State Department of Health.

Results of analysis of water supply samples recovered June 29, 1991, showed that City Well #3 contained 9 ppb 1,1,1-trichloroethane (TCA). Subsequent confirmatory sampling on July 18 and 22 found TCA concentrations of 8 and 12 ppb, respectively. Sampling prior to June 29, 1991, and as recently as September 12, 1990, did not detect TCA within Well #3.

On July 22, 1991, in an effort to eliminate substandard groundwater, Well #3 was taken offline and replaced with Well #2. Previous sampling of Well #2, on March 29, 1991, found TCA at 3.7 ppb, although subsequent sampling (July 19 and 23) showed concentrations of TCA to be below the laboratory detection limit.

Analysis of an August 1, 1991, sample from Well #2 and a homeowner tap within the distribution system showed TCA and dichlorodifluoromethane (freon) in contravention of POC standards. Freon was found at 35 ppb at Well #2, and at 22 ppb at the homeowner tap. TCA was found at 7 ppb at both locations. Based on these results, NYSDEC anticipated loss of the Camden Street Wellfield as a source of drinking water and recommended enlistment of a standby contractor to evaluate site conditions and remediation alternatives.

In addition to the Camden Street Wellfield, the Village of Johnson City maintains and periodically monitors three supply wells northeast of the Wellfield. These wells (#5, #6, and #7) have also been found to exhibit trace levels of organic contaminants. Results of sampling on June 29, 1991, indicate the presence of tetrachloroethane at 0.7 ppb within Well #6. Results of sampling at Well #6 on July 23, 1991, indicate trichloroethene (TCE) and TCA at 2 ppb and 0.7 ppb, respectively. Wells #5 and #7 have also been found to contain 2 ppb TCA and trace levels of TCE and benzene.

Following identification of contamination at the Camden Street Wellfield, NYSDEC directed attention toward identifying the source or sources of the contaminants. Based on historical information, NYSDEC identified numerous inactive waste disposal sites and potential industrial sources. Potential sources included the Endicott Johnson and Tri Cities Shopping Center Dumps, southeast and northwest of the Wellfield, industrial waste ponds west of the Wellfield, AF-59 east of the Wellfield, and the NYSEG Goudey Station southeast of the Wellfield. Based on available information, including a site-specific hydrogeological study conducted by the Air Force, and its proximity to the Wellfield, AF-59 was identified as a suspect source. The Air Force was subsequently notified of the problem by NYSDEC and was requested to initiate emergency response action at the Johnson City Camden Street Wellfield. In response, the Air Force maintained that the NYSDEC assertion that Wellfield contamination was a result of Plant 59 activities could not be validated, since the Air Force had no Wellfield data to compare with Plant 59 well data. Furthermore, previous meetings and telephone conversations with NYSDEC on July 23 and 24, 1991, were thought by the Air Force to have resolved that the Plant 59 well and Wellfield wells contained different contaminants and differing concentrations of TCA. At this time also, the Air Force again verified that the plant uses TCA, but maintained that no major spills or unplanned releases had occurred. Additionally, the Air Force pointed out that TCA is widely used in private industry, and that potential sources are numerous in the vicinity of the Wellfield. The Air Force, in order to more accurately define the extent of aquifer contamination identified in Phase II Stage 1 study under its Installation Restoration Program (IRP), has initiated an additional study under the IRP. Field work for the IRP was scheduled to begin in mid-October 1991 and to be conducted under the direction of Argonne National Laboratory, of Argonne, Illinois. Air Force personnel have requested that NYSDEC forward information supporting the assertion that TCA disposal has been documented at AF-59.

On August 13, 1991, NYSDEC requested that URS provide engineering services to address emergency conditions at the Camden Street Wellfield. Water supply problems began developing when two of the seven wells in the system (Wells #1 and #4), became unusable due to mechanical problems. The situation has since worsened with the discovery of contamination in Wells #2 and #3. Wells #2 and #3 are high-capacity wells and when these wells are inoperative the Village is in emergency conditions, with loss of volume for distribution and fire protection. Additionally, Well #2 is the only well equipped with a natural-gas engine for standby operation of the well pump in the event of a power failure.

URS initiated this study by conducting a review of NYSDEC Kirkwood files related to the Johnson City Wellfield, AF-59, and regional hydrogeology. Information obtained from these files was used to develop an understanding of the Wellfield and AF-59 history, and to propose monitoring well locations for the contaminant source investigation. These monitoring well locations were selected by their geographical location between the Wellfield and the potential sources. No site-specific groundwater flow information was available to assess the impact of the potential sources or to guide the selection of monitoring well installation locations.

On August 14, 1991, the Air Force and G.E. held an informational meeting outlining the proposed scope of work for the additional investigation to be performed with the IRP. In attendance were representatives of the Air Force, G.E., Argonne, NYSDEC, Johnson City Water Department, NYSDOH, and URS. Air Force and G.E. personnel presented details and schedules for the IRP Supplemental Site Inspection at AF-59, which would include monitoring well installation, sampling, and groundwater modeling. Results of the supplemental site inspection are anticipated December 1992. During the meeting, Air Force personnel explained that the IRP investigation program would include monitoring wells constructed within the shallow and deep aquifers, and sampling both inside and outside of the plant building. Field work was scheduled to begin in mid-October. In discussion of plant operation, G.E. revealed that the plant utilizes TCA, which is stored on site in drums. Currently waste TCA is recycled or disposed of as hazardous waste, although during the years of early plant operation, waste TCA may have been poured onto the ground surface. ?

On August 15, 1991, URS personnel met with NYSDEC and Johnson City Water Department personnel to discuss Wellfield conditions and temporary water supply treatment system installation. Preferred locations for the installation of an air stripper were discussed, as well as changes in Wellfield plumbing. Additionally, URS proposed the contaminant source investigation, including well installation and sampling.

A preliminary review of historical data, proposed course of emergency action, cost estimate, and schedule were presented to NYSDEC by URS on August 21, 1991. Preliminary findings indicated that the lower portion of the aquifer beneath AF-59 had been contaminated with 1,1-dichloroethane, trans-1,2-dichloroethane, and TCE. The contaminant source has not been identified. Several potential sources of contamination have been identified in the vicinity of the Camden Street Wellfield and AF-59.

Based on all available information to date, URS outlined potential sources of contamination and initial interpretation of findings in an August 23 letter to NYSDEC.

4.1.3 Potential Contaminant Sources

Review of the NYSDEC registry of inactive hazardous waste disposal sites and files related to the Johnson City Wellfield has identified several potential sources of contaminants found at the Wellfield. Potential sources listed in the NYSDEC Registry of Inactive Hazardous Waste Disposal Sites include: U.S. Air Force Plant No. 59 (AF-59) located on Main Street in Johnson City, approximately 1,000 feet northeast of the Camden Street Wellfield; the Robintech Site, located on Commerce Road in the Village of Vestal; and Monarch Chemical, located on Prentiss Road in the Village of Vestal. AF-59 and Robintech have been assigned NYSDEC priority classification 2, representing a significant threat to the public health or environment and requiring action. Monarch Chemical has been assigned priority classification 3, indicating that the site does not present a significant threat to the public health or environment, and that action may be deferred. NYSDEC Inactive Hazardous Waste Disposal Site Reports for these sites are presented in Appendix C.

Contaminants confirmed in groundwater or soil at AF-59 include cadmium, chromium, arsenic, lead, 1,1-dichloroethane, trans-1,2-dichloroethene, TCE, and TCA. Groundwater and subsurface soil at the Robintech site have been found to contain TCA, polycyclic aromatic hydrocarbons (PAHs), various metals, cyanide, and arsenic.

In addition to those sites listed in the registry, NYSDEC Kirkwood files identify several additional potential sources near the Camden Street Wellfield. Suspect dump sites include the Tri-Cities Shopping Center Dump, located near the corner of Main Street and Endwell Street, approximately 1,500 feet northwest of the Wellfield, and the Endicott Johnson Dump, located off Boland Drive approximately 2,000 feet southeast of the Wellfield. Also, the Trim Line Auto Pro Center reportedly discharges to a dry well located at the corner of Main and Camden Streets. No information was obtained with regard to materials disposed of at these sites. Locations considered to be potential contaminant sources are presented on Figure 4-1.

Further potential sources of contamination identified in NYSDEC Kirkwood files include SPDES-permitted discharges at IBM, 1,500 feet to the northeast; a New York State Electric and Gas (NYSEG) substation, 1,500 feet southeast; and Champion Oil, 2,500 feet northeast of the Wellfield. No information was obtained regarding discharge, receptors, or chemistry.

In addition to those sites identified in the NYSDEC registry and files, an industrial waste pond is identified on the USGS topographic map of the Johnson City area. This pond is located across the Susquehanna River in the Village of Vestal, approximately 2,500 feet west of the Wellfield and in the vicinity of a gravel-mining operation. No information was available regarding operation of the waste pond or the nature of industrial waste retained in the pond.

Due to the location of the Camden Street Wellfield within the highly productive Clinton Street-Ballpark Aquifer, further potential sources of contamination may be considered further away from the Wellfield. Additionally, surface discharges to the Susquehanna River have the potential for entering the Wellfield, with recharge through the river bed

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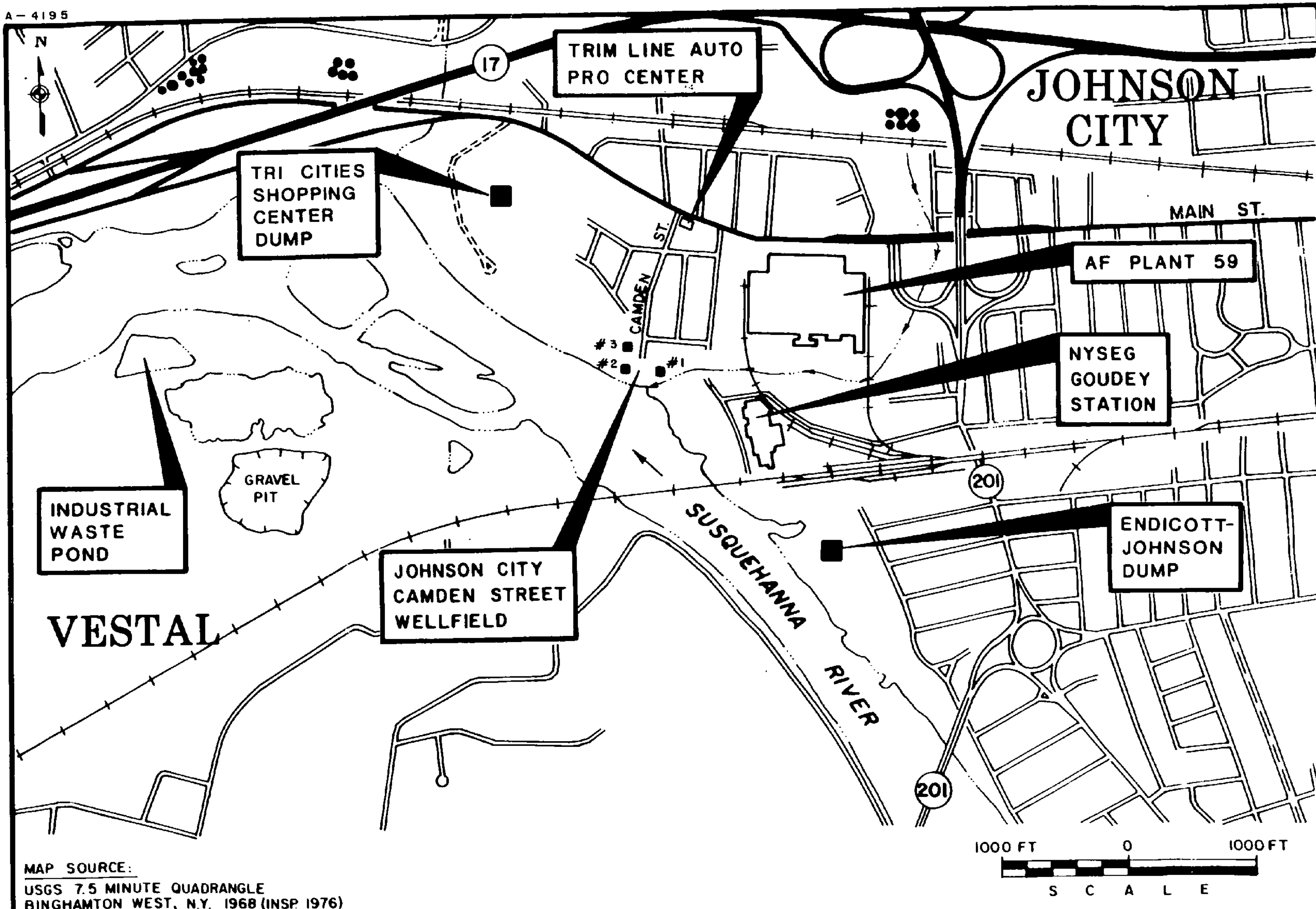


MAP SOURCE:
USGS 7.5 MINUTE QUADRANGLE
BINGHAMTON WEST, N.Y. 1968 (INSP 1976)

URS CONSULTANTS, INC.	JOHNSON CITY POTENTIAL CONTAMINANT SOURCES	FIGURE 4-1

to the aquifer.

4.1.4 Previous Investigations at Air Force Plant 59

The United States Air Force initiated an IRP investigation at AF-59 during March 1984. The four-phase IRP was developed under direction of the Department of Defense (DOD) in order to identify and evaluate suspected hazardous materials disposal or spill sites on DOD facilities, to control contaminant migration, and to control hazards to health and welfare.

Phase I of the IRP, the Records Search, was conducted by CH2M Hill between March and October 1984. The purpose of the Phase I investigation was to compile all information on hazardous materials use and disposal practices and to identify potential problems associated with those practices. The Phase I report also detailed the history of the AF-59 site, as summarized below.

The plant was operated between 1942 and 1945 by Remington Rand for the production of airplane propellers. The plant was idle from 1945 until 1949, when it was reopened by G.E. for the production of aerospace control and electrical systems. G.E. currently produces avionics devices at the facility for military and commercial aircraft.

Plant production activities have generated varying quantities of industrial waste such as cutting and lubricating oils, coolants, solvents, paint residue, and process chemicals. Waste solvents have included TCA, TCE, freon, acetone, and methyl- ethyl ketone. Process chemicals include acids, caustics, chromium solutions, and cyanide solutions. Paint residues include liquid paint contaminated with thinners and solvents, as well as varnishes and sludges. The total volume of wastes generated in 1984 was approximately 50,000 gallons.

Waste disposal practices, which have also varied over time, have included:

- Neutralization of concentrated plating baths, with removal and disposal by contractor;

- Recovery and regeneration of waste cutting oil resulting from parts machining, with discharge of water to Little Choconut Creek via storm sewers following separation of oil and water;

- Containment of chromium and other metal-plating waste rinsewater in settling tank prior to discharge to Little Choconut Creek;

- Containment of cyanide and paint waste in drums for offsite transport and disposal by contractor;

- Onsite incineration of combustible waste, and offsite disposal of ash by contractor;

- Underground tank storage of waste oil and degreasing solvents, with removal and disposal by contractor;

- Onsite recycling of waste solvents, with contractor transport and disposal of still bottoms and spent solvents; and

- Offsite disposal of solid waste.

Air Force Plant 59 receives all potable and most industrial water from the Johnson City municipal water system. Additional non-contact cooling water is drawn from an onsite production well which was installed in 1974. A discharge well was also installed with the production well. Its use, however, was terminated shortly after completion due to the "failure of the geologic strata". Discharge water was subsequently directed through two outfalls to Little Choconut Creek south of the plant building. These discharge outfalls were sampled in August 1982, July 1983, and February 1984. TCE was found in these investigations to range from 23 to 120 ppb; methylene chloride from 8 to 105 ppb; and TCA up to 2 ppb.

Phase II, Stage 1 investigation activities for confirmation and quantification of hazardous waste were performed between September 1986 and March 1988 by Fred C. Hart Associates, Inc. The Phase II investigation was designed to provide a characterization of the plant site as well as of areas of suspected contamination such as the stained ground at the waste oil storage tank noted during the Phase I investigation, and discolored soil underlying the plating building found during repair of an underground sprinkler main.

The Phase II investigation program included drilling and sampling of six shallow borings, and installation of three monitoring wells. Two soil samples were analyzed from each of four selected shallow borings. Additionally, groundwater samples were recovered and analyzed from the three shallow monitoring wells and the G.E. production well. Soil and groundwater samples were analyzed for total petroleum hydrocarbons (TPH), primary metals, volatile organics, and cyanide. Selected soil samples were also analyzed for EP Toxicity metals and total chromium. Results of soil sample analysis found total chromium concentrations above background within the area of the plating building. Results of groundwater analysis found lead, cadmium, TCE, and trans-1,2-dichloroethene in contravention of applicable standards in various wells. TCE was detected in contravention of standards in monitoring well SW-3 and the G.E. production well at 6 ppb and 11 ppb respectively. Trans-1,2-dichloroethene, found at 66 ppb, also contravened New York State standards within the G.E. production well. Lead was found in contravention of applicable standards within all groundwater samples, with the highest concentration detected within the apparent upgradient well SW-1 (300 ppb). Arsenic, barium, TCA, and 1,1-dichloroethane were also detected in groundwater.

Conclusions of the Phase II investigation suggest that sources of site contamination may include offsite sources, such as surface water recharging the aquifer or unknown locations on the Air Force plant property.

4.2 Hydrogeology

4.2.1 Regional Geology

Numerous studies have been conducted regarding the geology and hydrogeology of the Susquehanna River basin in the vicinity of Binghamton and Johnson City. This section presents a brief description of regional characteristics obtained from the numerous publications available from the U.S. Geological Survey and public and university libraries, and listed in the Reference section.

The Johnson City region lies within the floodplain of the Susquehanna River. The Susquehanna River valley was originally carved by stream erosion and subsequently widened and deepened by episodic advances of glacial ice sheets. The glaciers retreated by melting, producing rivers and lakes which filled the valley with deposits of silt, sand, and gravel. Additional ice contact deposits such as kames and kame terraces, and outwash deposits such as kame deltas, also fill the valley and form highly productive aquifers. Surficial soils within the region consist of recent floodplain and stream sediments and exhibit moderate to high infiltration potential.

4.2.2 Local Geology

Subsurface drilling near the Camden Street Wellfield has shown local geology to consist predominantly of glaciofluvial and glaciolacustrine valley-fill deposits. The basic stratigraphic sequence consists of shale bedrock overlain by lodgement till, which in turn is overlain by extensive deposits of kame and outwash sand and gravel. The site vicinity is mantled by recent floodplain alluvium consisting of predominantly silt and sand. Site stratigraphy, as identified during the contaminant source field investigation, and as presented for other area borings, is illustrated on geologic cross-sections A-A' and B-B,' presented as Figures 4-3 and 4-4. Cross-section locations are depicted on Figure 4-2.

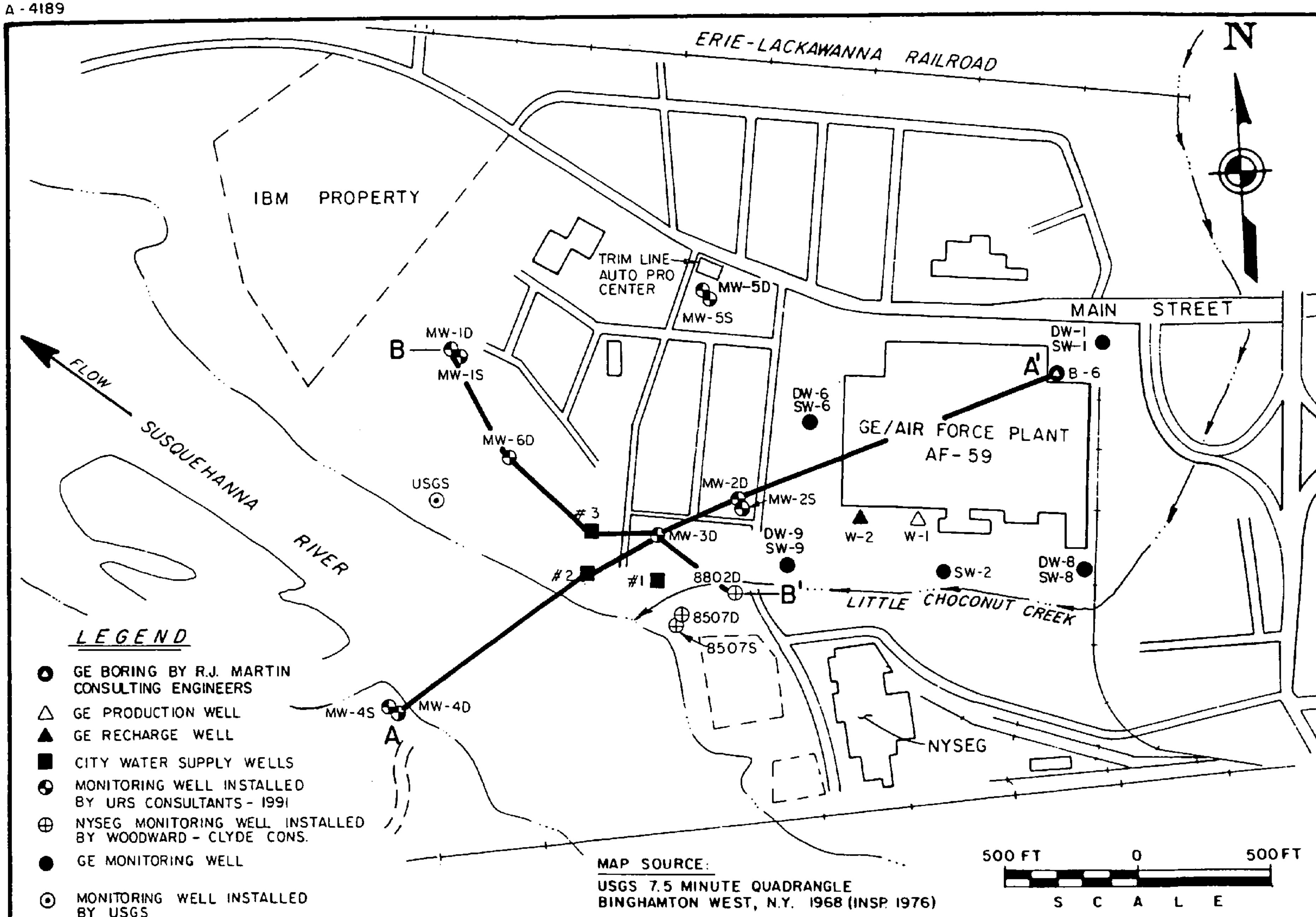
Many borings completed in the vicinity of the Camden Street Wellfield also encountered a unit of lacustrine clayey silt. This unit consists predominantly of silt with thin interbeds of fine sand. The clayey silt unit varies from stiff to hard in consistency and is slightly cohesive. It may represent a local semi-confining layer. However, this unit is found to vary in thickness and is apparently discontinuous within the study area.

4.2.3 Groundwater Hydrology

Glacial valley-fill deposits have formed many highly productive aquifers within the Greater Binghamton area, such as the Clinton Street-Ballpark aquifer underlying Johnson City, and the Camden Street Wellfield. The Clinton Street-Ballpark aquifer, which occupies three square miles, is associated with the Endicott-Johnson City aquifer, which occupies 21 square miles within the Susquehanna and Chenango River valleys. Due, however, to boundary conditions, the Clinton Street-Ballpark aquifer is considered as a separate aquifer.

The Clinton Street-Ballpark aquifer comprises highly permeable kame and outwash deposits, with occurrences of interbedded silt and clay lenses that locally restrict groundwater movement. The aquifer is bounded by impermeable bedrock to the north, till and bedrock to the south, the

A - 4189



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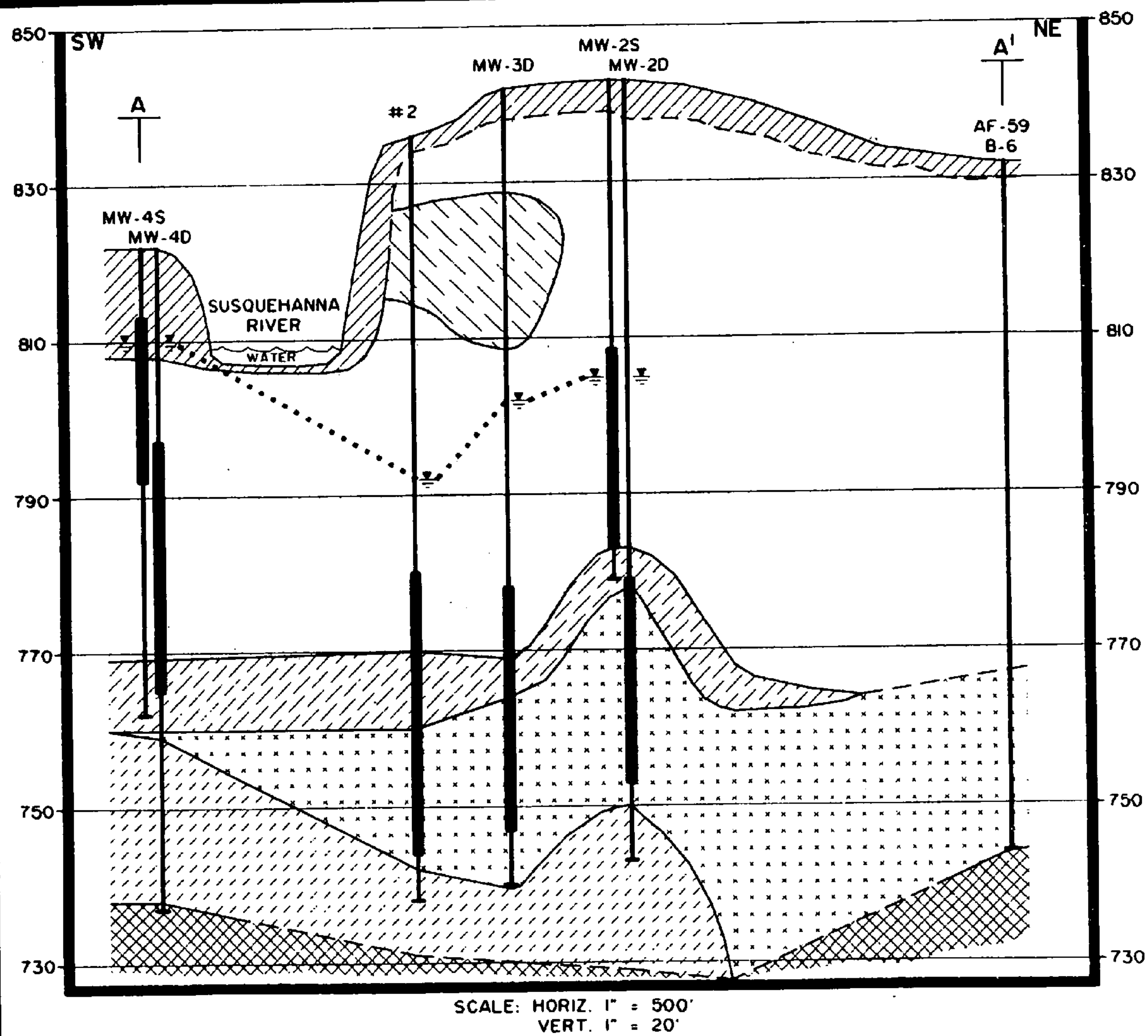
JOHNSON CITY
CROSS SECTION LOCATION MAP

FIGURE 4-2

AC-4192

1:1 5/19/92-2



NOTES:

1. GEOLOGIC UNIT DESIGNATIONS AFTER HOLECEK et. al., 1982.
2. ELEVATIONS BASED ON USGS BENCHMARK. (TOWN OF UNION ENGINEERING DEPT.)
3. GEOLOGIC CONDITIONS SHOWN ARE REPRESENTATIVE OF CONDITIONS ENCOUNTERED AT EACH BORING LOCATION TO THE DEPTH DRILLED. EXTRAPOLATIONS BETWEEN BORINGS HAVE BEEN INTERPRETED USING STANDARDLY ACCEPTED GEOLOGICAL PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY BETWEEN BORINGS FROM THOSE SHOWN.

LEGEND

MW-2D — BORING & MONITORING WELL No.

WATER SURFACE INDICATOR (10/22/91)

SCREENED INTERVAL OF MONITORING WELL

BOTTOM OF BORING

RECENT ALLUVIUM, CUT & FILL

OUTWASH SAND & GRAVEL

FINE-GRAINED ICE CONTACT DEPOSITS

LAKE SILT & CLAY

KAME SAND & GRAVEL

GLACIAL TILL

BEDROCK

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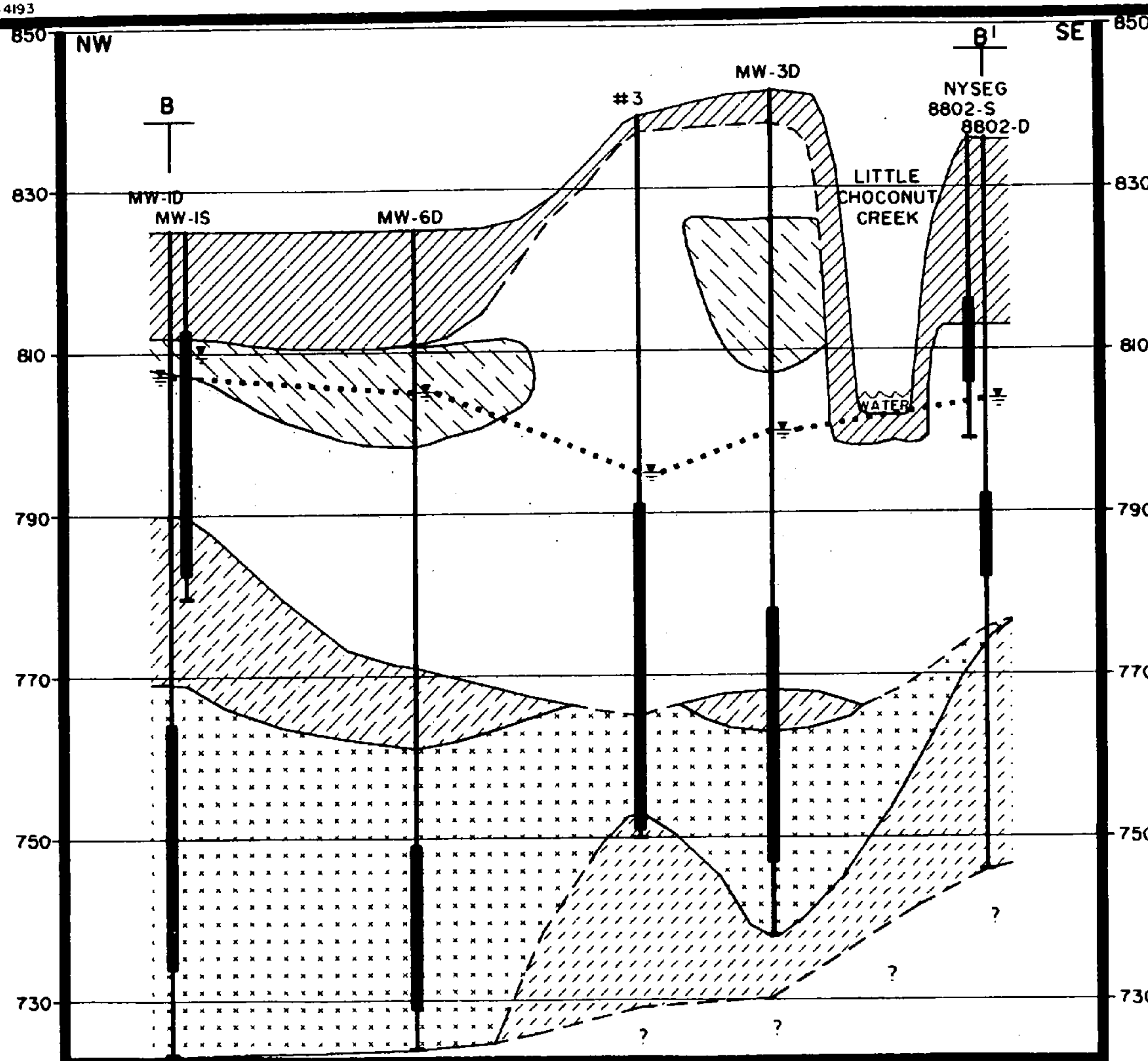
JOHNSON CITY
GEOLOGIC CROSS SECTION A-A'

FIGURE 4-3

AC-4193

1=1 5/19/92-2



SCALE: HORIZ. 1" = 300'
VERT. 1" = 20'

NOTES:

1. GEOLOGIC UNIT DESIGNATIONS AFTER HOLECEK et. al., 1982.
2. ELEVATIONS BASED ON USGS BENCHMARK. (TOWN OF UNION ENGINEERING DEPT.)
3. GEOLOGIC CONDITIONS SHOWN ARE REPRESENTATIVE OF CONDITIONS ENCOUNTERED AT EACH BORING LOCATION TO THE DEPTH DRILLED. EXTRAPOLATIONS BETWEEN BORINGS HAVE BEEN INTERPRETED USING STANDARDLY ACCEPTED GEOLOGICAL PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY BETWEEN BORINGS FROM THOSE SHOWN.

LEGEND

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RECENT ALLUVIUM, CUT & FILL

OUTWASH SAND & GRAVEL

FINE-GRAINED ICE CONTACT DEPOSITS

LAKE SILT & CLAY

KAME SAND & GRAVEL

GLACIAL TILL

BEDROCK

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JOHNSON CITY GEOLOGIC CROSS SECTION B-B'

FIGURE 4-4

Chenango River to the east, and the Susquehanna River to the southwest. The area overlying the aquifer is predominantly urban, with numerous nearby industrial and commercial enterprises.

The demand of Johnson City Water system on the aquifer is approximately 4.5 million gallons per day (MGD). Major sources of recharge to the aquifer are precipitation, streams, runoff from upland areas, and underflow from adjacent aquifers. Significant recharge is induced by high-volume pumping, which is the principal discharge from the aquifer. Additional significant discharge is realized through seepage, underflow out of the aquifer boundary, and evapotranspiration. Elevation of groundwater fluctuates with seasonal precipitation, evapotranspiration, river stage, and pumping. Transmissivity of the aquifer generally exceeds 10,000 sq ft/day and may reach 100,000 sq ft/day in specific areas. Maximum available storage for the aquifer is reported to be approximately 1,700 million gallons.

Based on the findings from monitoring wells installed for the Contaminant Source Investigation, the shallow outwash sand and gravel aquifer includes an interbedded layer of clayey silt in many locations. However, this layer is found to be discontinuous throughout the study area, leaving the shallow portions of the aquifer in direct geologic contact with the deep or kame sand and gravel aquifer.

The aquifer is typically pumped at high volume to the Johnson City public water supply system via Wells #2 and #3, creating a substantial drawdown and cone of depression around the Wellfield. Prior to the aquifer test discussed in Section 4.4, the Wellfield was shut down from November 20 to December 17, allowing the aquifer to recover in the vicinity of the Wellfield . Groundwater measurements throughout the monitoring system during the recovery period exhibit flow northward across the Wellfield, with continued recharge of the aquifer from the Susquehanna River. Potentiometric surface maps for the shallow and deep aquifer zones are presented as Figure 4-5 and 4-6. Figure 4-6 indicates a northeastward component of flow, most probably produced by production well pumping at AF-59.

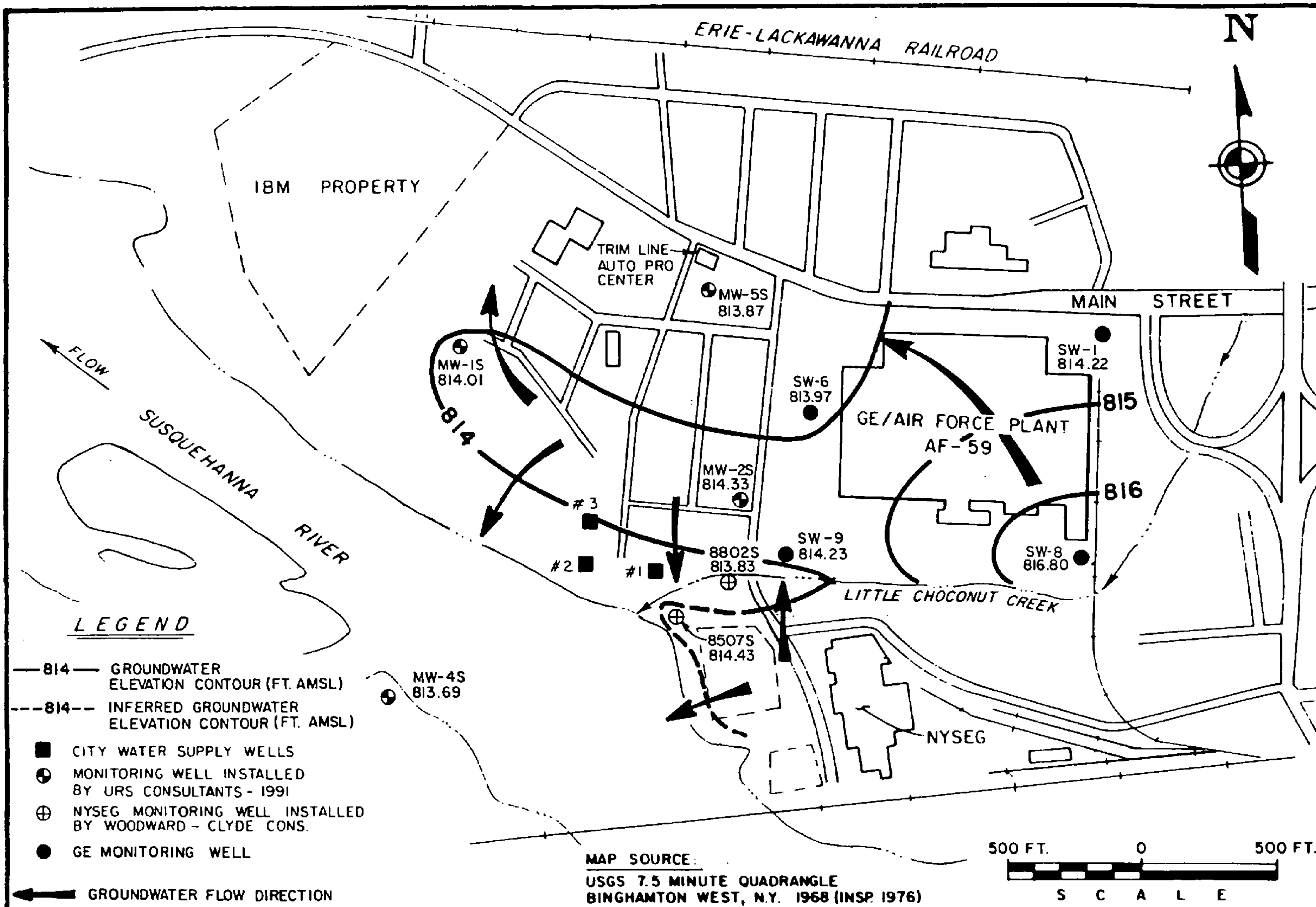
4.3 Contamination Assessment

For the purpose of defining the spatial extent of chemical contamination within the vicinity of the Camden Street Wellfield, monitoring wells were constructed within the shallow and deep aquifer zones. Shallow wells were constructed to screen the upper zone, and deep wells were constructed within the kame deposits at depths and intervals similar to those of the Wellfield wells. Where possible, construction of well pairs established well screens within the shallow and deep zones of the aquifer, with well screens above and below the lacustrine silt and clay unit. Relating distribution of contaminants within the shallow and deep aquifer zones to Wellfield contamination and performance was later found to be somewhat impractical since Well #2 is screened across the silt and clay unit and draws from both the shallow and deep zones. Furthermore, Well #3 encounters no silt and clay unit. Wellfield performance is discussed with the aquifer test in Section 4.4.

Groundwater samples were collected on two occasions for the contaminant source investigation. The first sampling event was conducted in October 1991, and included shallow and deep monitoring wells MW-1 through MW-6 and Johnson City Wells #2 and #3. Drill water used during the subsurface investigation was also sampled at this time (Drill-1 and Drill-2). Drill-1 was obtained from the drilling subcontractor's (American Auger and Ditching) private well in Constantia, New York, and Drill-2 was derived from the Johnson City Water Supply at the Camden Street Wellfield.

The second sampling was conducted in December 1991. This event again included samples from the shallow and deep monitoring wells MW-1

A-4198



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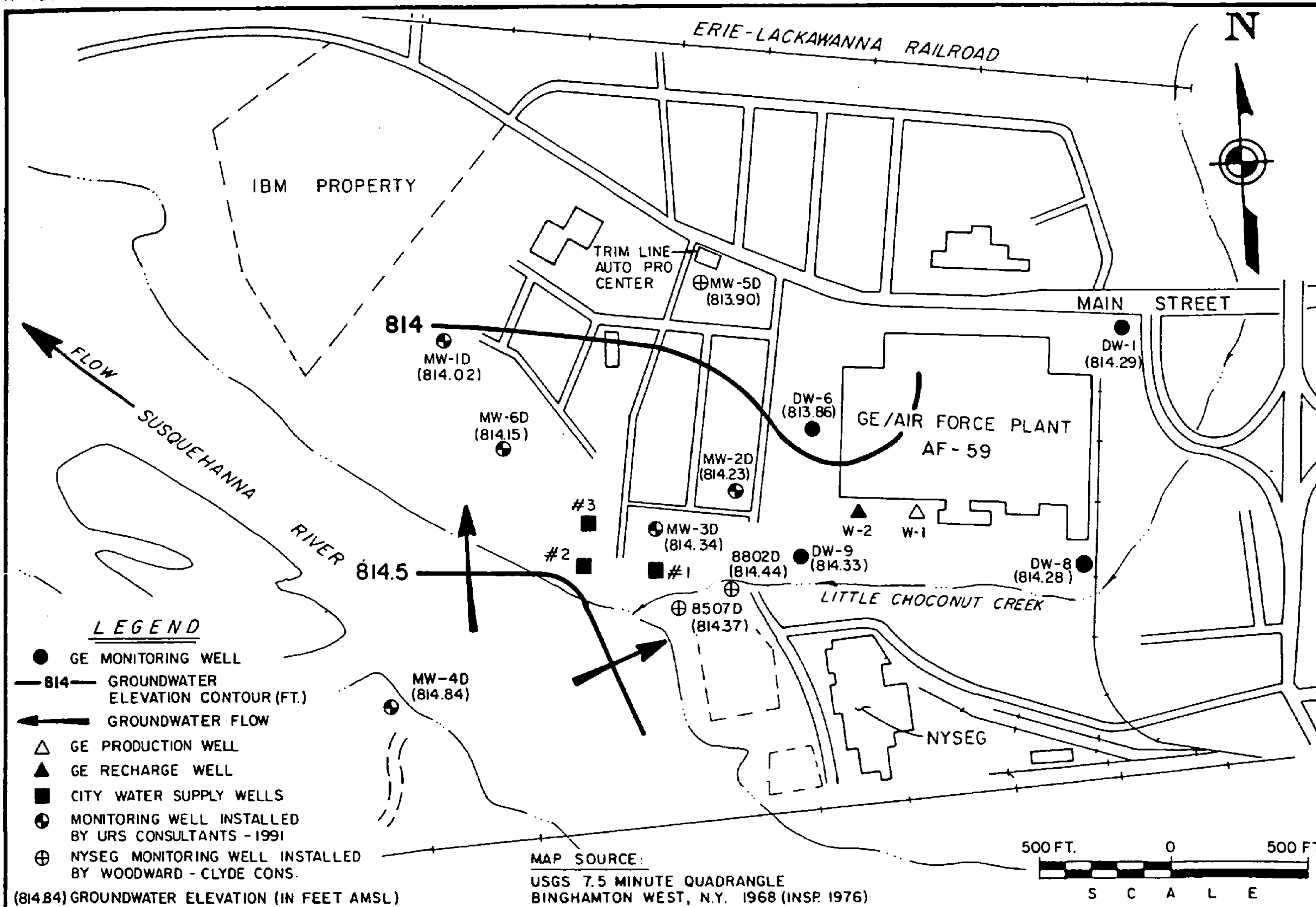
JOHNSON CITY - PRE PUMP TEST
STATIC GROUNDWATER ELEVATIONS - SHALLOW WELLS 12/17/91

FIGURE 4-5

A-4201



URS CONSULTANTS, INC.

JOHNSON CITY - PRE PUMP TEST
STATIC GROUNDWATER ELEVATIONS - DEEP WELLS 12-17-91

FIGURE 4-6

through MW-6. However, the Johnson City Camden Street Wellfield had been shut down in preparation for the aquifer test, and samples from the municipal wells were therefore unobtainable. Subsequent sampling of Johnson City Wells #2 and #3 was conducted during the aquifer test as reported in the following section. In addition to groundwater, one water sample from a sump at the Trim Line Auto Pro Shop (Trim Line), located at the corner of Main and Camden Streets, was also sampled.

4.3.1 Organics Contamination

In the interest of regulatory concerns, the contaminant assessment is focused toward identification of Principal Organic Contaminants (POCs) and metals detected at concentrations above current drinking water source groundwater (NYSDEC Class GA) standards or guidance values as specified in the NYSDEC Division of Water Technical and Operational Guidance Series (1.1.1) AMBIENT WATER QUALITY STANDARDS AND GUIDANCE VALUES (9/25/90), and 6NYCRR Part 703.5.

Results of sample analysis showed TCA above GA standards within shallow and deep monitoring wells only at location MW-5. Analysis of samples taken in October 1991 showed TCA within shallow well MW-5S at 11.0 ppb and within deep well MW-5D at 8.1 ppb. TCA concentrations were found in the December 1991 sampling to have increased at MW-5, with TCA levels reaching 13.0 ppb and 12.0 ppb within shallow and deep wells, respectively. These results appear to indicate a source for TCA contamination north of the Camden Street Wellfield. A summary of the organics analysis is presented in Table 4-1. Contaminant distribution is illustrated on Figures 4-7 through 4-10.

Sample results also indicate the presence of benzene above GA standards at several locations throughout the study area. Benzene was first found within deep well samples from locations MW-2 and MW-3 at 0.3 ppb each. Samples collected in December showed a wider occurrence of

TABLE 4-1

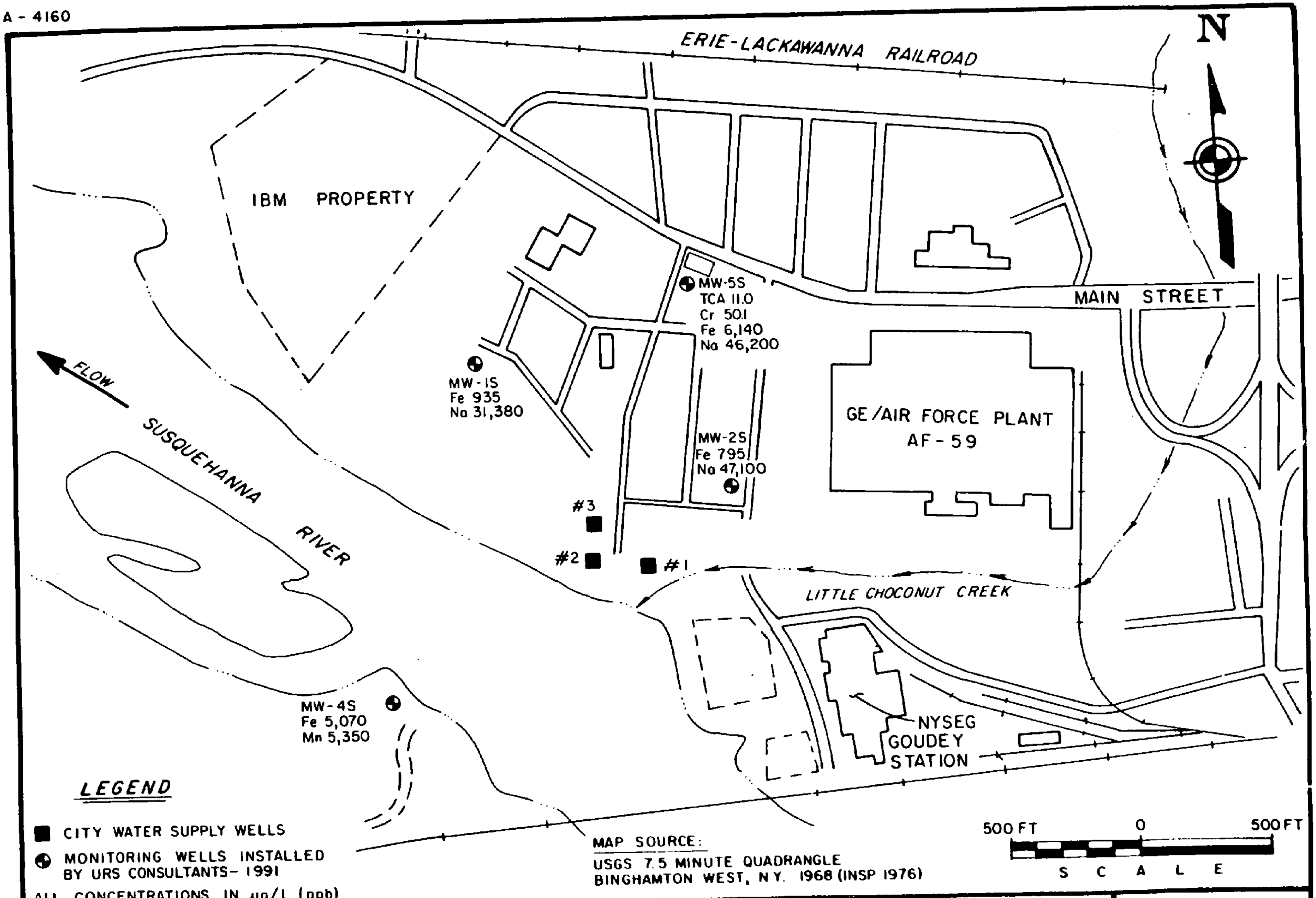
SUMMARY OF ORGANIC ANALYSIS
COMPOUNDS EXCEEDING CURRENT GA STANDARDS

	TCA		BENZENE	
WELL ID/GA STANDARDS	5.0 ppb		0.7 ppb	
	10/91	12/91	10/91	12/91
MW-2D	---	---	---	0.7 J
MW-3D	---	7.1	---	1.3
MW-5D	8.1	12.0	---	3.3
MW-5S	11.0	13.0	---	---

All results reported in ug/l (ppb).

J - Estimated Concentration

A - 4160



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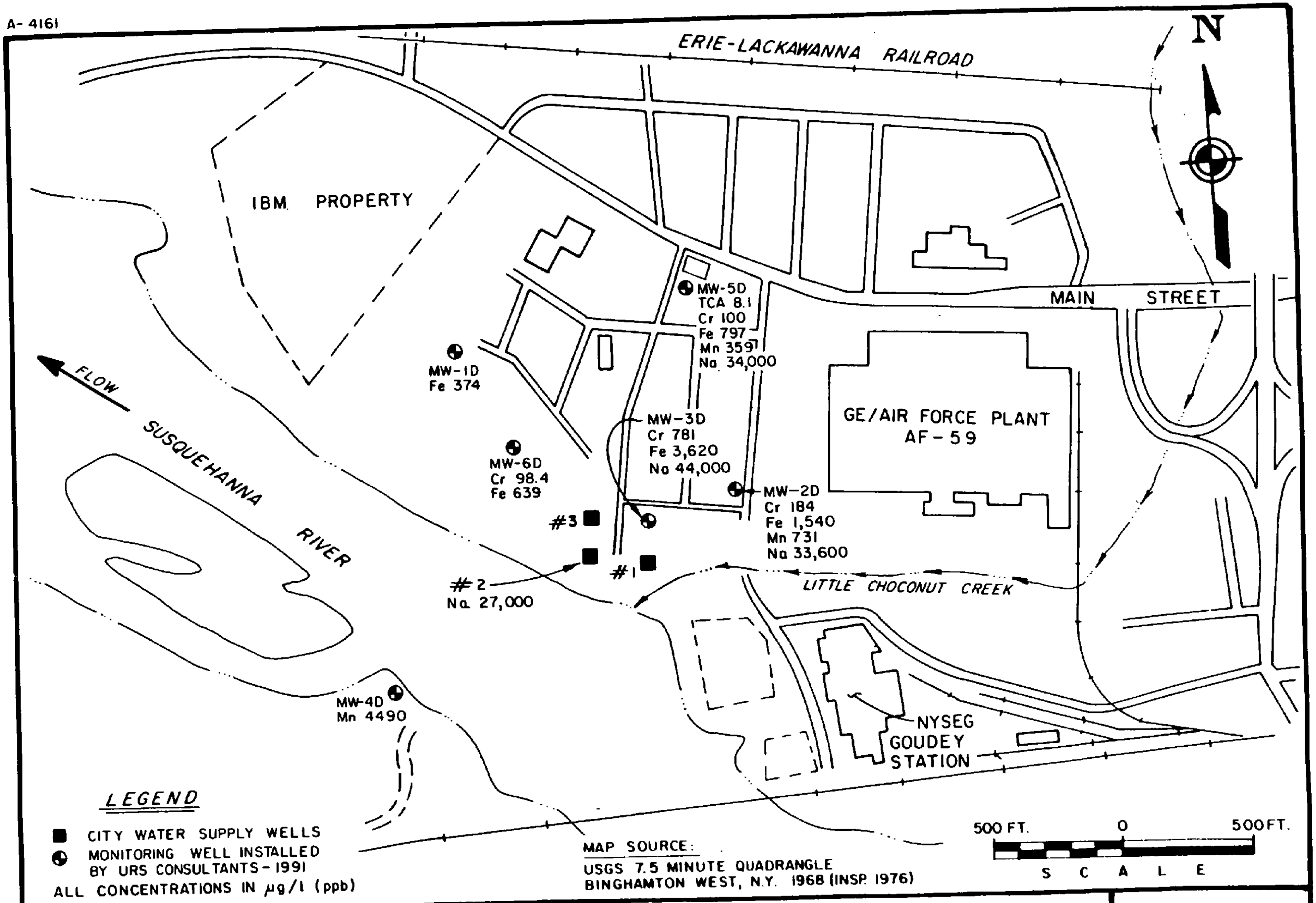
RESULTS OF GROUNDWATER SAMPLE ANALYSES 10/91
CONTAMINANTS EXCEEDING CURRENT GA STANDARDS - SHALLOW WELLS

FIGURE 4-7

A-4161



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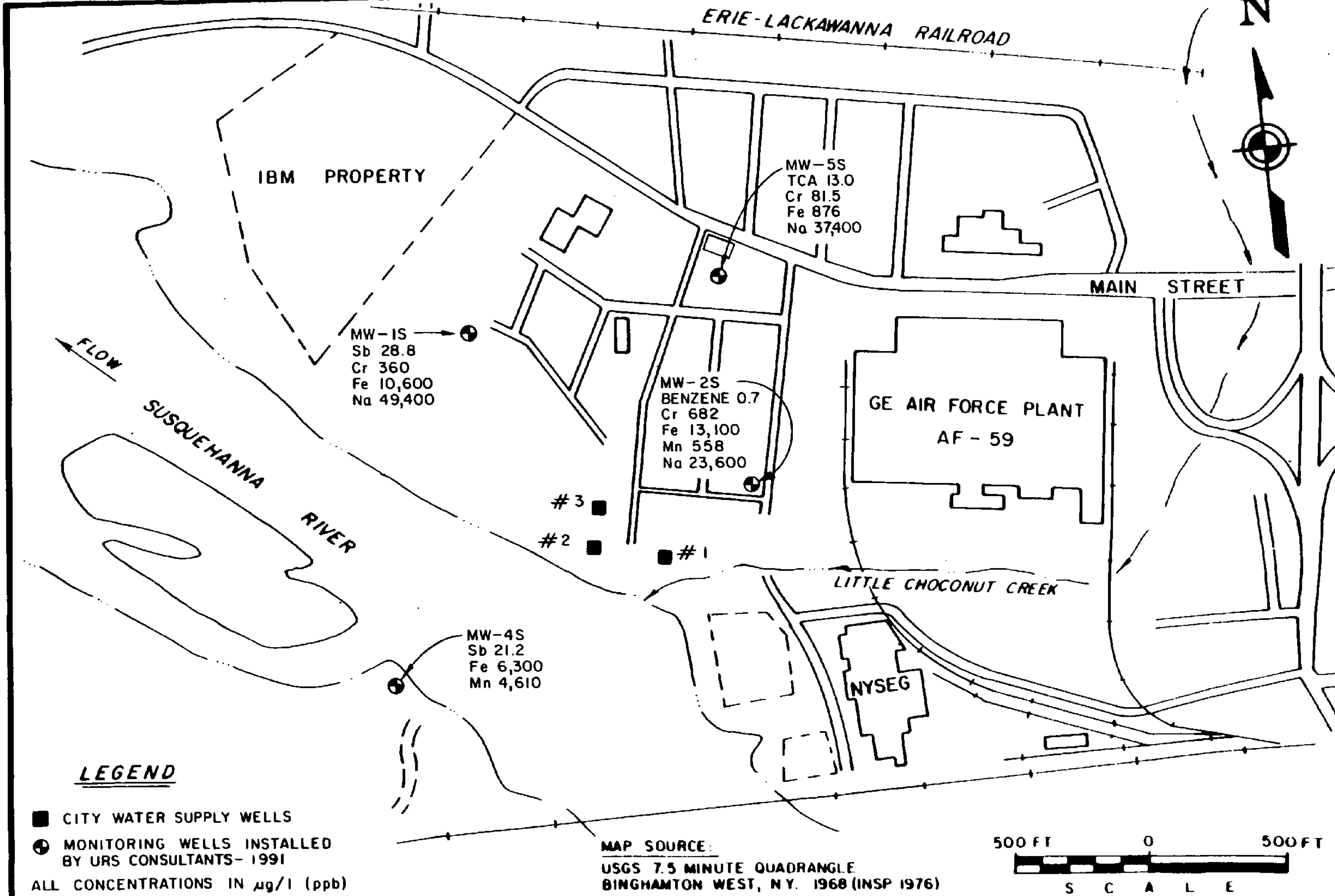
RESULTS OF GROUNDWATER SAMPLE ANALYSES 10/91
CONTAMINANTS EXCEEDING CURRENT GA STANDARDS - DEEP WELLS

FIGURE 4-8

A-4196

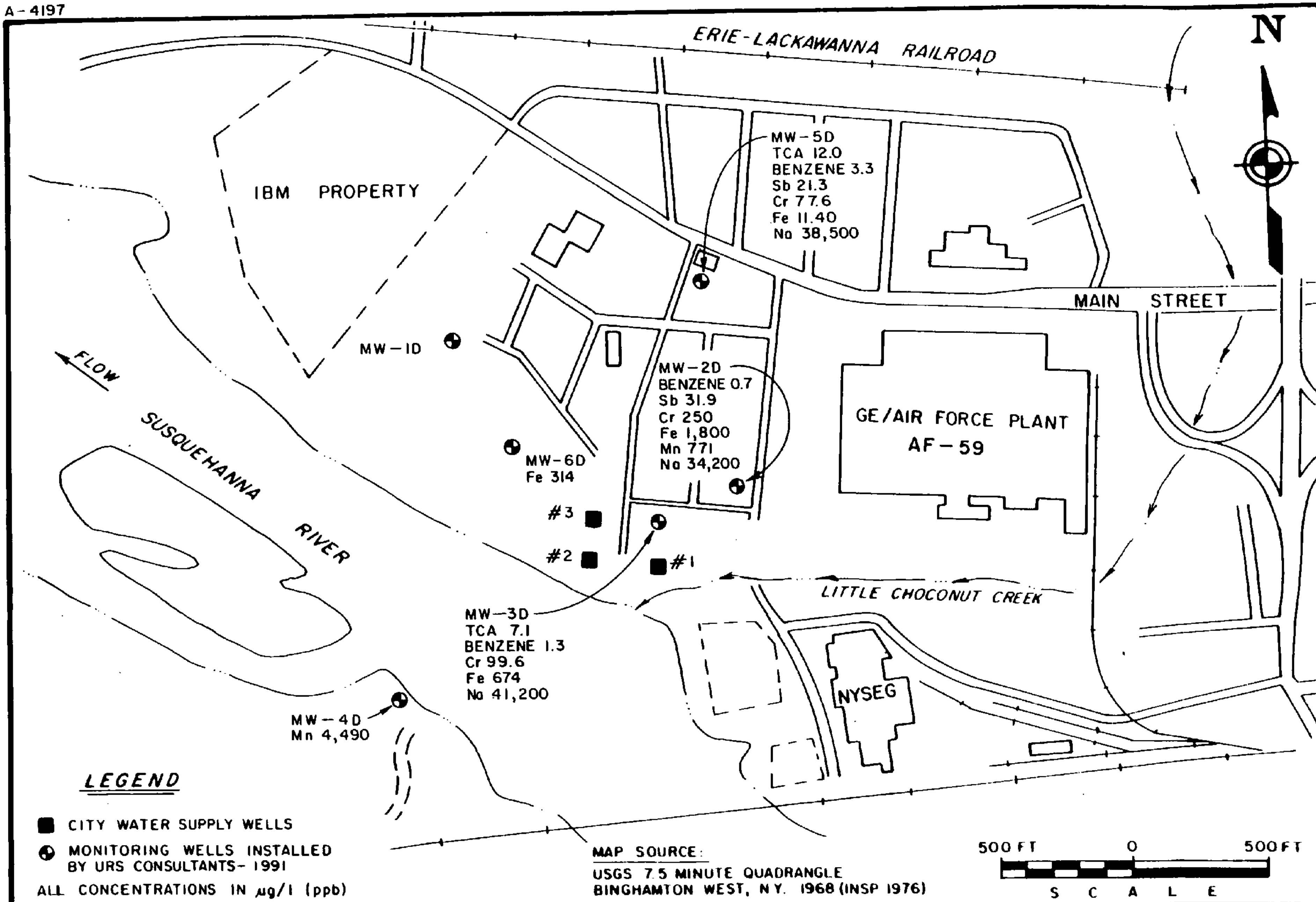


URS CONSULTANTS, INC

RESULTS OF GROUNDWATER SAMPLE ANALYSES 12/91
CONTAMINANTS EXCEEDING CURRENT GA STANDARDS - SHALLOW WELLS

FIGURE 4-9

A-4197



URS CONSULTANTS, INC.	**RESULTS OF GROUNDWATER SAMPLE ANALYSES 12/91** **CONTAMINANTS EXCEEDING CURRENT GA STANDARDS - DEEP WELLS**	**FIGURE 4-10**

benzene, including detection at shallow well MW-2S, and deep wells MW-2D, MW-3D, and MW-5D. Concentrations above the current GA standard of 0.7 ppb were identified at location MW-5D at 3.3 ppb, followed by MW-3D at 1.3 ppb. Concentrations at MW-1D and MW-2D were 0.1 ppb and 0.7 ppb, respectively. Although benzene was not detected within the October sample from MW-5D, the relatively high concentration found within the December sample suggests a source for benzene contamination north of the Wellfield. PCBs were not detected in any of the groundwater samples.

The water sample recovered from the sump at the Trim Line Auto Pro Center was analyzed for additional TCL analytes. Results of analysis are basically unusable for comparison with the groundwater samples due to a large increase in detection limits caused by dilution of the sample. [This was required due to the concentration of acetone within the sample.] This dilution precluded detection of TCA and benzene at low levels. The data do indicate, however, the presence of compounds in the sump containing high concentrations of acetone and 2-butanone, such as some solvents. The presence of toluene also indicates a solvent. Xylenes were also detected in the sample, possibly representing a gasoline residual. A summary of analytical results for the Trim Line sample is presented in Table 4-2.

During the aquifer test, Johnson City Well #3 was pumped to waste at approximately 860 gpm into the Susquehanna River. Analytical results indicate steadily increasing TCA concentrations at Well #3 as the test progressed. TCA was also detected in the sample from Well #2 at the end of the test. A summary of discharge analytical results is presented in Table 4-3.

4.3.2 Metals Contamination

One or more metals contravening the current GA standards were found at every location sampled for the Contaminant Source Investigation.

TABLE 4-2

SUMMARY OF ORGANIC ANALYSES 10/91

COMPOUNDS EXCEEDING CURRENT GA STANDARDS

Well ID	1,1,1-Trichloroethane	Benzene	Sec-Butylbenzene
MW-2D	--	0.3J	--
MW-3D	--	0.3J	--
MW-5S	8.1	--	--
MW-5D	11.0	--	--
Drill Water #1	--	--	11.0

All results reported in ug/l (ppb).

J - Estimated Concentration

TABLE 4-3

SUMMARY OF ORGANIC ANALYSIS 12/91
AQUIFER TEST DISCHARGE MONITORING
COMPOUNDS DETECTED

Compound	Well #3 24 Hours	Well #3 48 Hours	Well #3 72 Hours	Well #2 72 Hours
1,1-Dichloroethane	--	0.3 J	--	--
Cis-1,2-Dichloroethene	0.2 J	0.2 J	0.2 J	--
1,1,1-Trichloroethane	11.0	12.0	14.0	2.6
Trichloroethene	0.8 J	0.7 J	0.7 J	0.4 J

All results reported in ug/l (ppb).

Metals contravening the GA standards include: chromium, iron, manganese, sodium, antimony, and zinc. Summaries of analytical results for metals in the October and December samplings are presented in Table 4-4. Distribution of metals concentrations throughout the study area is also presented on Figures 4-7 through 4-10.

Results of metals analysis shows little in the way of trends in concentrations, with the exception of increases in chromium concentrations at shallow well locations MW-1, MW-2, and MW-5. Chromium concentrations decrease at MW-3 with the December sampling. Iron, sodium, and manganese concentrations fluctuate throughout the study area. Antimony found at locations MW-1, MW-2, MW-4, and MW-5 in the December samples was not detected above GA standards in the October samples.

4.4 Aquifer Test

4.4.1 Test Data Processing

Prior to commencement of the aquifer test, water levels were monitored by NYSDEC personnel in six of the new monitoring wells at three locations. These data, collected between December 3 and 17, 1991, indicate that water levels in the aquifer surrounding the Wellfield were rising, a possible result of regional aquifer recharge or continuing recovery of the aquifer from the pumping that ceased on November 20, 1991, or a combination thereof. Regression analysis of these data points determined an areal recharge rate of 5.7×10^{-5} ft/min during the aquifer test (Figure 4-11). The field water level measurements were therefore corrected (before the data were analyzed) by a factor of -5.7×10^{-5} ft/min, in order to account for the recharging condition of the aquifer.

Corrected drawdown data from the aquifer test were analyzed using the PC ISOAQX program to estimate aquifer parameters. This is a multi-model analysis package, with graphics capabilities, that services numerous

TABLE 4-4
SUMMARY OF METALS ANALYSES 10/91
METALS EXCEEDING CURRENT GA STANDARDS

Well ID	Cr	Fe	Mn	Na	Zn
MW-1S	--	935	--	31300	--
MW-1D	--	374	--	--	--
MW-2S	--	795	--	47100	--
MW-2D	184	1540	731	33600	--
MW-3D	781	3620	--	44000	--
MW-4S	--	5070	5350	--	--
MW-4D	--	--	4490	--	--
MW-5S	50.1	6140	--	46200	--
MW-5D	100	797	359	34000	--
MW-6D	98.4	639	--	--	--
Well #2	--	--	--	27000	--
Drill Water #2	--	1120	--	27500	618

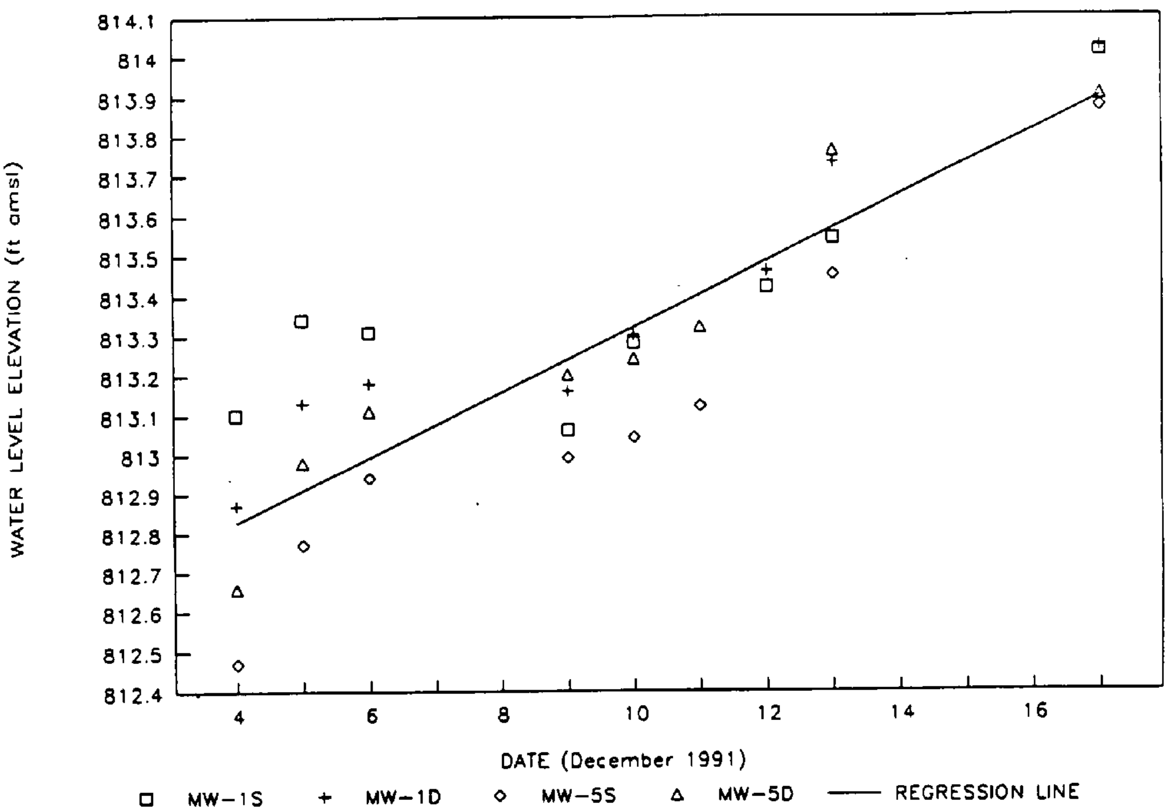
SUMMARY OF METALS ANALYSES 12/91
METALS EXCEEDING CURRENT GA STANDARDS

Well ID	Cr	Fe	Mn	Na	Sb
MW-1S	360	10600	--	49400 E	28.8 B
MW-2D	250	1800	771	34200 E	31.9 B
MW-2S	682	13100	558	23600 E	--
MW-3D	99.6	674	--	41200 E	--
MW-4D	--	--	4490	--	--
MW-4S	--	6300	4610	--	21.2 B
MW-5D	77.6	1140	--	38500 E	21.3 B
MW-5S	81.5	876	--	37400 E	--
MW-6D	--	314	--	--	--

All Results Reported in ug/l (ppb).

B - Value reported is less than the quantitation limit but greater than the instrument detection limit.

E - Estimated value due to interference.



A-4222

URS CONSULTANTS INC

JOHNSON CITY WELLFIELD

AQUIFER WATER LEVELS TREND PRIOR TO TEST START

FIGURE 4-11

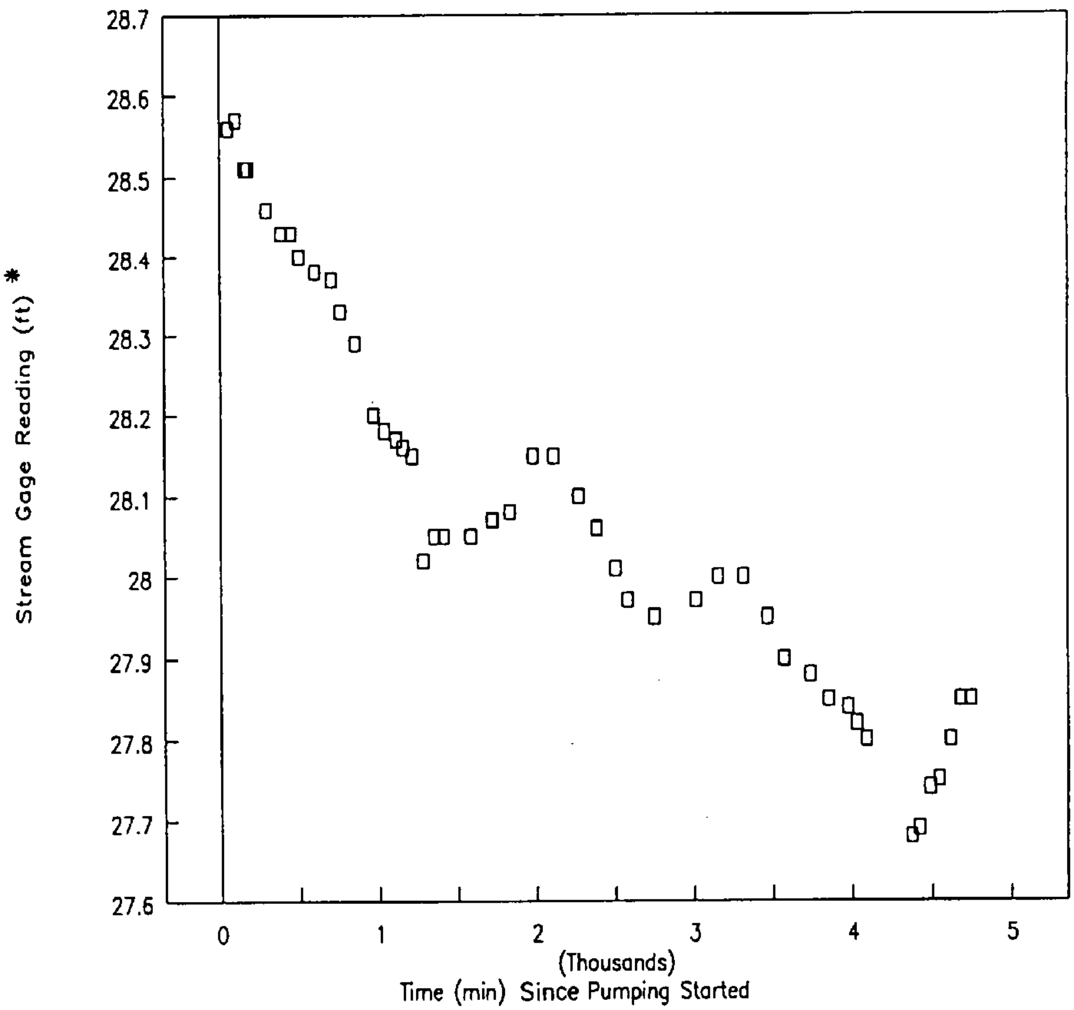
applications. The program utilizes mathematical minimization (in the least-square error sense) to fit time/drawdown data to user-specified hydrologic models (Theissian water table model, Boulton-Gambolati gravity-drainage full penetration model, etc.), and thus derive the aquifer parameters of hydraulic conductivity and specific yield or storativity. Most of these hydrologic models traditionally utilize type-curves fit to the observed data by graphical methods. The ISOAQX program, however, mathematically fits data to the type curves in a more uniform or objective manner. The curve-matching results are displayed to the user to ensure acceptability.

Semi-logarithmic plots of the uncorrected field time/drawdown data are presented in Appendix D. Additional complexity in the analysis of these data was introduced by the complex surficial geology at the site, falling river levels measured in Little Choconut Creek near its confluence with the Susquehanna River (Figure 4-12), and the intermittent use of the high-capacity well at AF-59. Well pumping at AF-59 caused relatively short wave-length, nearly contemporaneous water level fluctuations to be superimposed over the Wellfield-test-induced time-drawdown trend. Consequently, the deviant data points that reflected the use of the AF-59 well were eliminated from the analysis. The water levels in monitored well IW-9 did not conform to any time-drawdown trend and were therefore not analyzed.

4.4.2 Test Analysis

Time-Drawdown, Neuman Method

The aquifer test data were initially analyzed using both unconfined and confined aquifer hydrologic models for comparison. Examination of the time-drawdown curves and the mathematical type curves associated with each hydrologic model demonstrated a consistent tendency to match more of the curve when the gravity drainage water-table curves of Neuman were applied.



* Gauge reading from arbitrary scale with no datum

URS CONSULTANTS, INC.

STREAM GAUGE READINGS IN LITTLE CHOCONUT CREEK AT THE SUSQUEHANNA RIVER DURING THE AQUIFER TEST

FIGURE 4-12

A-4223

The interpretation of an unconfined aquifer condition is consistent with the time-drawdown curves generated during the aquifer test and with the geologic information developed (Figures 4-3 and 4-4). Although the lacustrine silt and clay unit described in Section 4.2.2 may inhibit vertical conductivity locally, its lack of continuity across the aquifer and compositional variations within the unit, and the fact that Johnson City wells #2 and #3 draw water from above and below it, apparently prevent it from presenting a hydrologic barrier.

The type curves of Neuman plot solutions for a range of dimensionless parameters are represented by the equation:

$$\text{drawdown} = \frac{Q}{4\pi T} \int_0^\infty 4y\, J_0(y\beta^{1/2})[u_0(y) + \sum_{n=1}^{\infty} u_n(y)]\, dy$$

As previously mentioned, the ISOAQX program uses a least-square error method to fit drawdown data to a type curve. The program automatically applies aquifer dewatering and partial penetration corrections to calculate the hydraulic conductivity, storativity and specific yield of the aquifer at the observation well. The multiplication of the aquifer thickness by the hydraulic conductivity determined for each well results in a corresponding aquifer transmissivity.

The hydraulic conductivities calculated by the ISOAQX program and the associated aquifer transmissivities are summarized in Table 4-5. Transmissivities ranged from 15,200 ft^2/day to 164,000 ft^2/day, with a geometric mean of 29,100 ft^2/day. The median time-drawdown transmissivity was 20,100 ft^2/day and results within ± 25 percent of the median value were obtained from 15 of the 22 wells analyzed. Significant deviations from the median (>±25 percent) at MW-4S and MW-4D are likely attributable to the wells' proximity to the Susquehanna River. SW-1, DW-1, SW-8, and DW-8 were located near the outermost margin of the cone of depression generated during the aquifer test, and the anomalously high values probably reflect the sensitivity of the aquifer model to the minimal amount of drawdown

TABLE 4-5
SUMMARY OF TIME-DRAWDOWN
AQUIFER TEST ANALYSES

WELL ID	AQUIFER THICKNESS (ft)	K (ft/day)	Kz (ft/day)	S	Sy	TRANSMISSIVITY (ft^2/day)
MW-1S	81	424.54	75.78		8.29E-02	34,388
MW-1D	81	250.58	4.22	1.18E-02	3.15E-02	20,297
MW-2S	68	288.53	5.31	3.25E-02	6.82E-02	19,620
MW-2D	68	277.33	11.2	3.41E-02	8.19E-02	18,858
MW-3	74	244.29	69.87	2.71E-02	9.10E-02	18,077
MW-4S	63	1002.98	10.9		2.56E-02	63,188
MW-4D	63	1017.24	29.22		1.18E-01	64,086
MW-5S	75	293.87	24.86		6.80E-02	22,040
MW-5D	75	263.72	13.66		7.03E-02	19,779
MW-6	81	213.75	52.11		5.61E-02	17,314
SW-1	76	1375.12	1939.74		1.09E-01	104,509
DW-1	76	991.73	16.83		9.93E-02	75,371
SW-6	76	199.72	5.04	3.31E-02	4.42E-02	15,179
DW-6	76	261.13	7.05	1.91E-02	5.93E-02	19,846
SW-8	76	2160.27	148.73		9.41E-02	164,181
DW-8	76	734.63	31.6		9.72E-02	55,832
SW-9	76	221.04	3.64	2.75E-02	6.40E-02	16,799
DW-9	76	243.27	2.71	2.39E-02	5.30E-02	18,489
8507S	55	340.33	9.01	3.78E-02	1.04E-01	18,718
8507D	55	392.77	10.11	3.57E-02	1.09E-01	21,602
8802S	75	295.52	9.75	9.80E-03	4.37E-02	22,164
8802D	75	242.99	4.76	1.33E-02	4.18E-02	18,224

measured at those more distant locations from the Wellfield.

Table 4-5 also summarizes storativity, specific yield, and vertical hydraulic conductivity values calculated by the ISOAQX analysis. Specific yield values ranged from three to 12 percent, with an arithmetic mean of seven percent. Storativity values ranged from one to four percent and vertical hydraulic conductivity values ranged from 2.7 ft/day to 1,940 ft/day, with a median value of 11 ft/day.

Distance-Drawdown, Cooper and Jacob Method

In addition to the Neuman Gravity-Drainage analysis, 72-hour corrected drawdown data from three arrays of wells were analyzed using the Cooper and Jacob distance-drawdown method. The arrays were chosen to reflect hydraulic gradients along different directions from the Wellfield and the river. Drawdowns of observation wells in the arrays are plotted arithmetically against the logarithmically plotted distance from the center of pumping. A straight line is determined either graphically or by regression analysis, and aquifer parameters of transmissivity and storativity are calculated from the formulas:

$$T = \frac{70\,Q}{\Delta}$$

$$S = \frac{Tt}{640\,r_o^2}$$

Where: T = Transmissivity (ft^2/day)

S = Storativity (dimensionless)

Q = Pumping Rate (gpm)

Δ = The drawdown per log cycle of distance (ft)

t = Time since pumping began (minutes)

r_o = Intercept of the straight line with the zero-drawdown axis

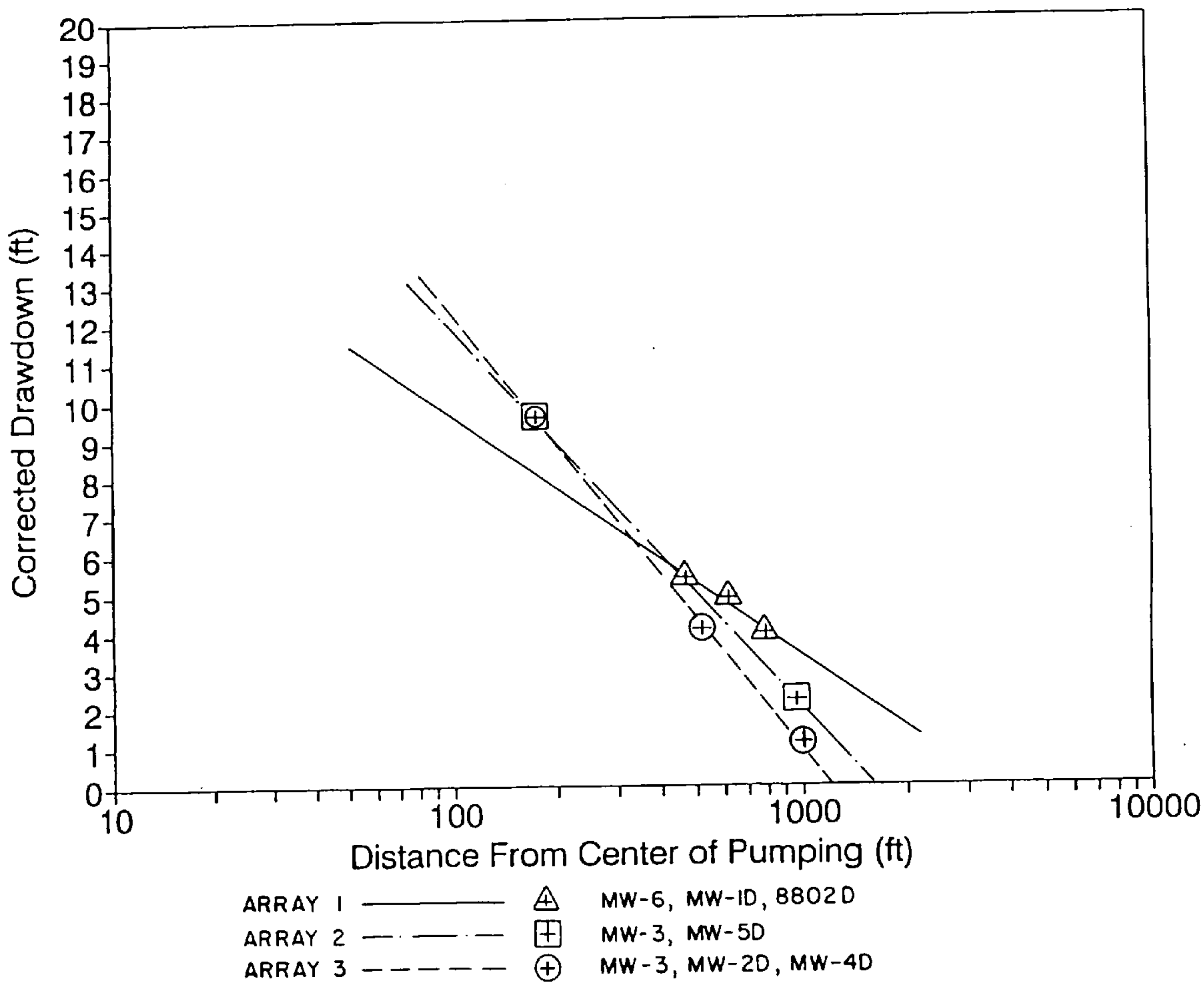
The distance-drawdown relation of the three arrays of wells is presented in Figure 4-13. The calculated transmissivities fall in a range between 20,300 ft^2/day (Array 3) and 33,400 ft^2/day (Array 1) with a median value of 23,300 ft^2/day. Calculated specific yields ranged from 1.7 to 9.5 percent. A summary of the distance-drawdown results is presented in Table 4-6. The similarity of the median time-drawdown and distance-drawdown transmissivities (20,100 ft^3/day vs. 23,300 ft^2/day) and the realistic magnitude of the specific yields (maximum 12 percent) indicate little hydrologic influence of the wellfield by the Susquehanna River. The relative uniformity of the time-drawdown analyses (68 percent of the transmissivities within ± 25 percent of the median) also conform with the data above to indicate little apparent short-term hydrologic impact or recharge from the river to the aquifer near the Wellfield.

The representative specific yields generated from both the time-drawdown and distance-drawdown analyses indicates that shortly after the onset of pumping, the aquifer begins to yield water directly from interstitial storage through its entire saturated thickness. This is indicative of a water table or unconfined aquifer. This hydrologic interpretation conforms with the geologic information generated during this investigation, that indicates the local absence of a fine-textured confining bed. The interpretation of a water table aquifer is also consistent with a comparison of the construction data of Johnson City Wells #2 and #3 and the geology of the aquifer immediately nearby, as there is little evidence of a confining stratum above each well screen.

During the course of the 72-hour aquifer test, all the well sites that were monitored showed water level declines related to Wellfield pumping. Figure 4-14 is an illustration of the distance-drawdown relationship which existed during the test using uncorrected field drawdown data. The magnitude of the measured drawdown and its general conformance with the radial flow type curve trace indicates that those portions of the aquifer at each respective well site are in direct

A- 4191A

DISTANCE-DRAWDOWN RELATIONS OF THREE ARRAYS OF OBSERVATION WELLS AFTER 72 HOURS OF PUMPING AT 2960 GPM



URS CONSULTANTS, INC.

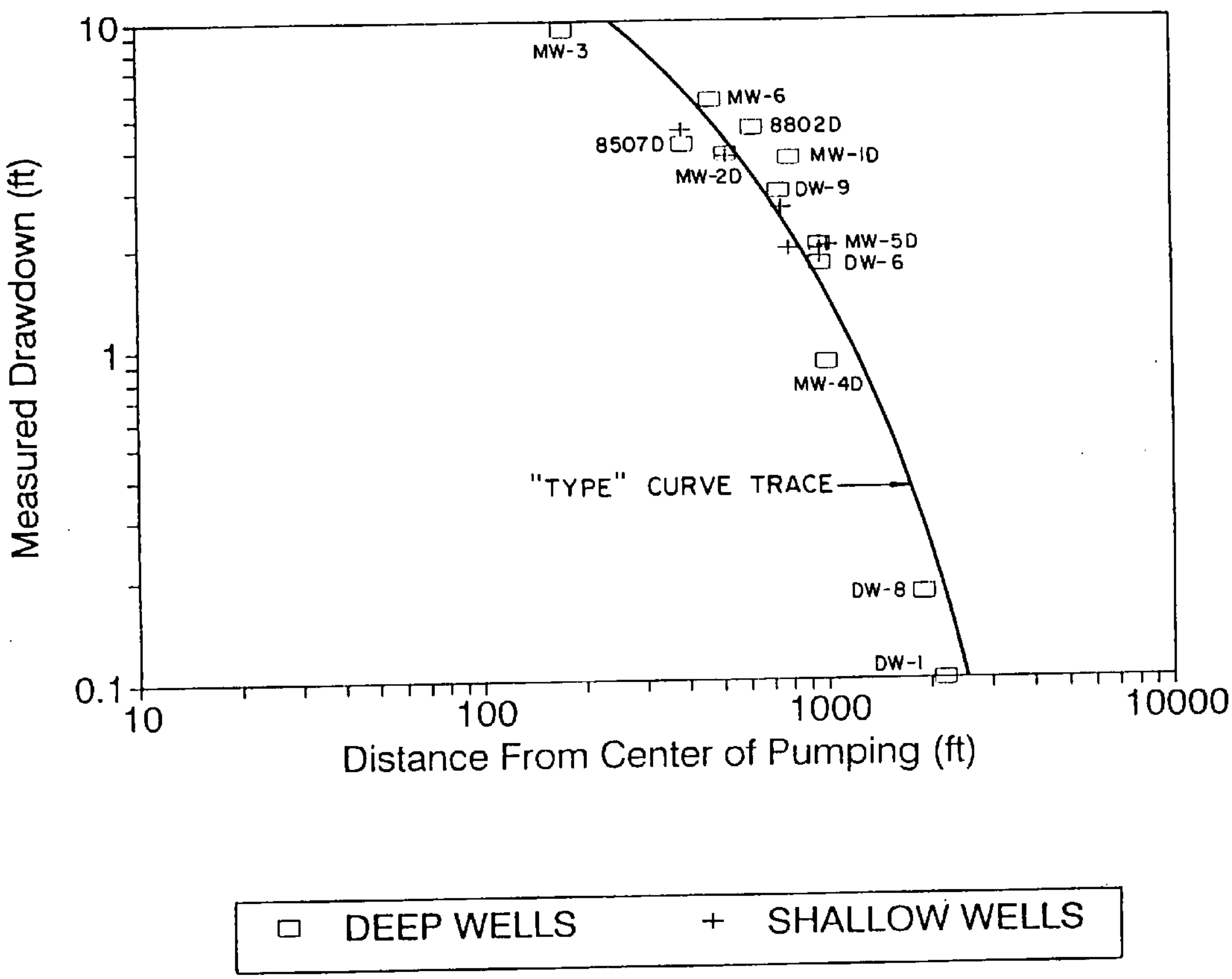
JOHNSON CITY WELLFIELD

FIGURE 4-13

TABLE 4-6

TRANSMISSIVITY AND STORATIVITY (SPECIFIC YIELD) VALUES
CALCULATED BY THE DISTANCE-DRAWDOWN METHOD

WELL ARRAY	COMPONENT WELLS	CALCULATED TRANSMISSIVITY (ft^2/day)	CALCULATED STORATIVITY
1	MW-6, MW-1D, 8802d	33,400	.017
2	MW-3, MW-5D	23,300	.051
3	MW-3, MW-2D, MW-4D	20,300	.095



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DRAWDOWN - DISTANCE RELATIONSHIP NEAR THE CAMDEN STREET WELLFIELD AFTER PUMPING 2960 GPM FOR 72 HOURS

FIGURE 4-14

A-4207A

hydrologic communication with the Johnson City Wellfield up to a distance of at least 2,040 feet (AF-59, SW-1/DW-1). Had more distant wells been observed during a longer-duration test, it is likely that the drawdown in the aquifer due to the Wellfield pumping would have extended a greater distance.

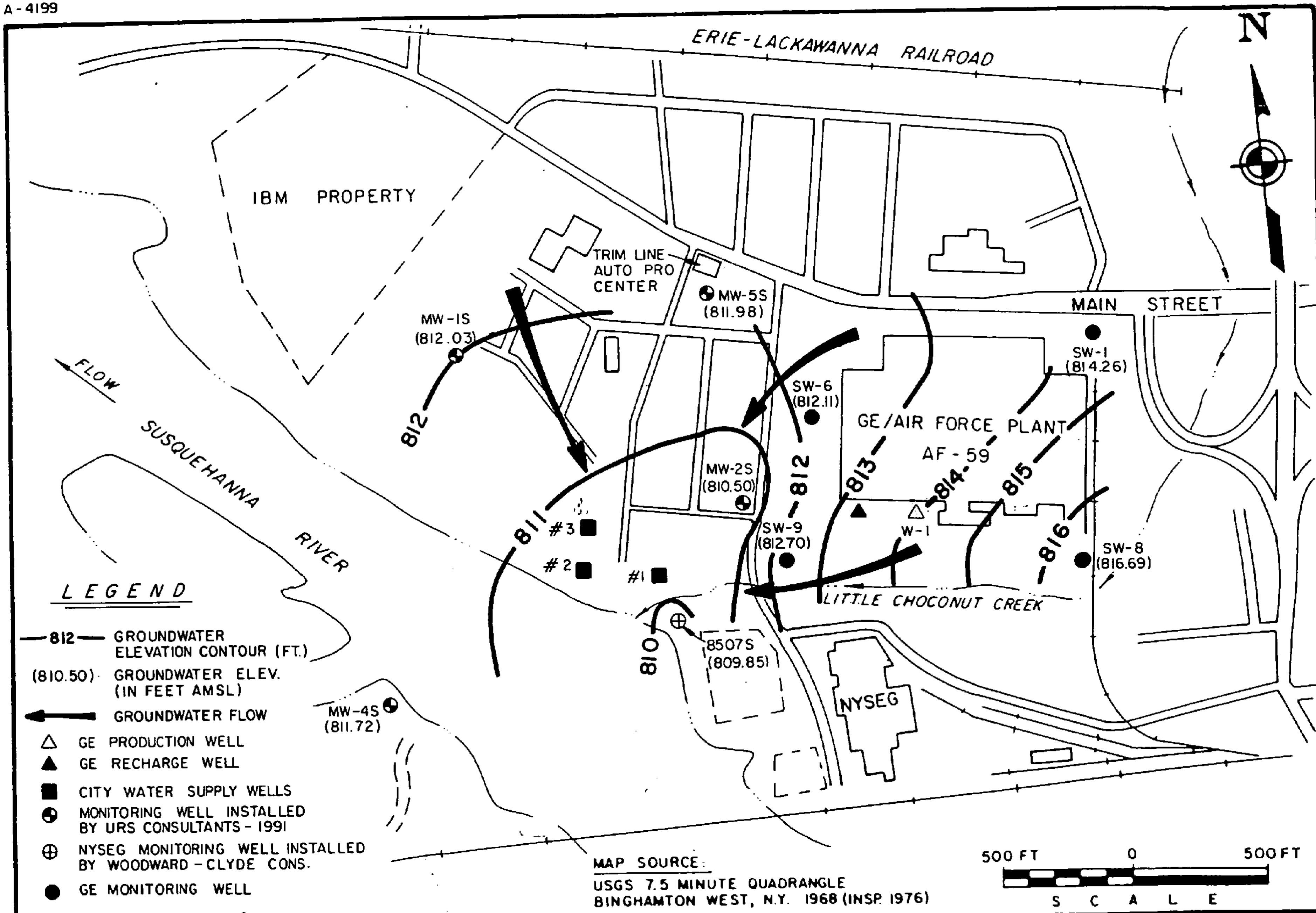
4.4.3 Operational Wellfield Performance

The hydrogeologic investigation included mapping shallow and deep aquifer potentiometric surfaces under various operational conditions. Data generated December 17, 1991, represent non-pumping conditions (see Figures 4-5 and 4-6). Potentiometric maps generated on December 20, 1991, after pumping 72 hours, represent developing operational conditions. Those of October 22, 1991, represent longer-term operational conditions. These maps, which are presented on Figures 4-15 and 16, and 4-17 and 18, clearly show the cone of depression generated by pumping at the wellfield. Groundwater measurements are presented in Tables 4-7 and 4-8.

A closer review of the groundwater measurements made at the recently installed nested well pairs under pumping and non-pumping Wellfield conditions provides some insight on intra-aquifer flow. The measurements shown in Table 4-9 indicate that under non-pumping conditions intra-aquifer flow has a slight upward component over much of the Wellfield. This is not uncommon in those portions of aquifers at potential groundwater discharge zones near surface water bodies. However, under pumping conditions such as existed on October 22, 1991, vertical potential components are reversed to indicate that over most of the Wellfield flow is downward, toward eventual discharge at the Wellfield.

A closer review of the deep well potentiometric surface shown on Figure 4-18 indicates the presence of a groundwater divide in the apparent vicinity of MW-2 when water level measurements were taken on October 22, 1991. The presence of this divide is not surprising as one would be

A-4199



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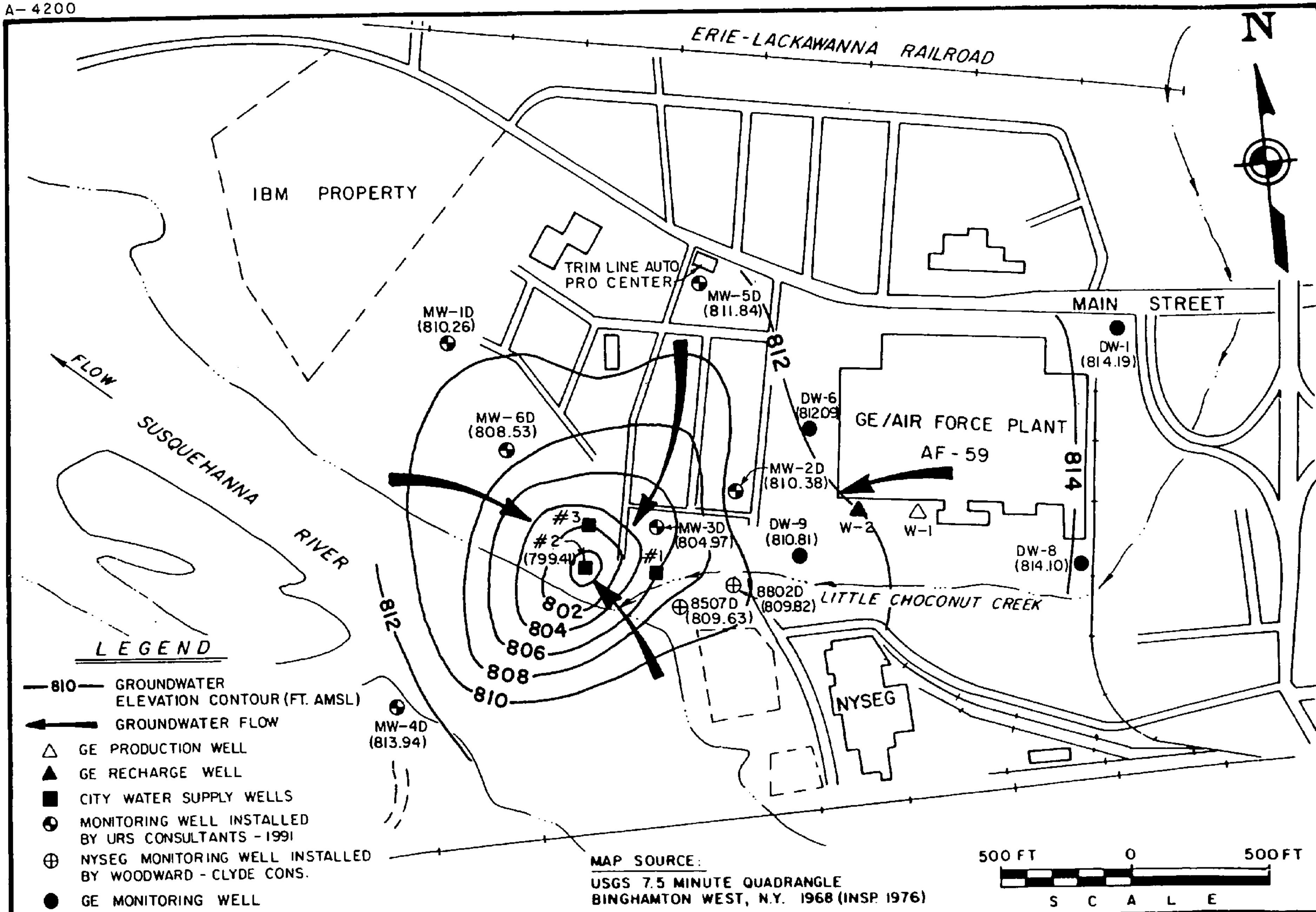
JOHNSON CITY - 72 HOURS INTO PUMP TEST
GROUNDWATER ELEVATIONS - SHALLOW WELLS 12-20-91

FIGURE 4-15

A-4200



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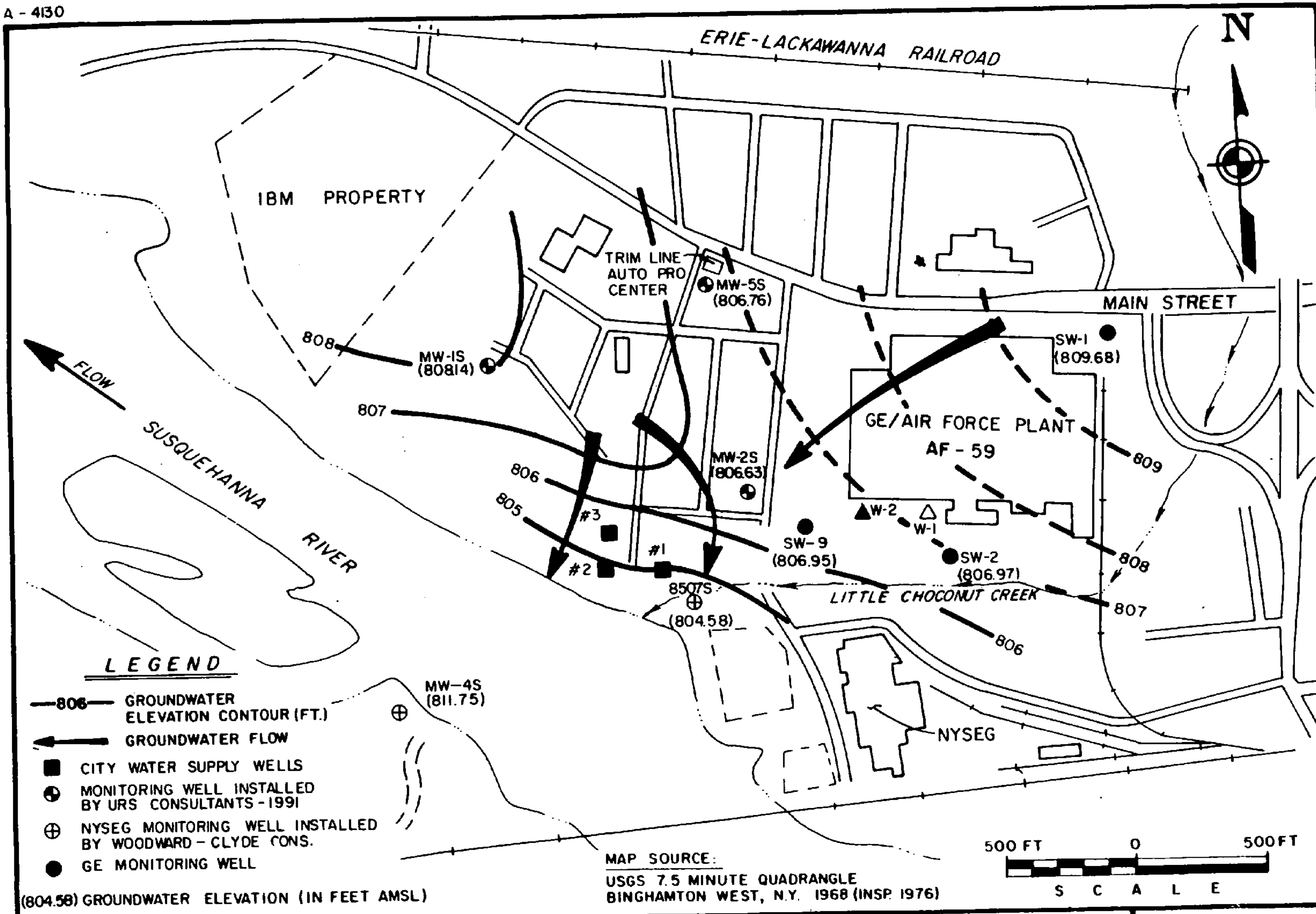
JOHNSON CITY-72 HOURS INTO PUMP TEST
GROUNDWATER ELEVATIONS- DEEP WELLS 12-20-91

FIGURE 4-16

A - 4130

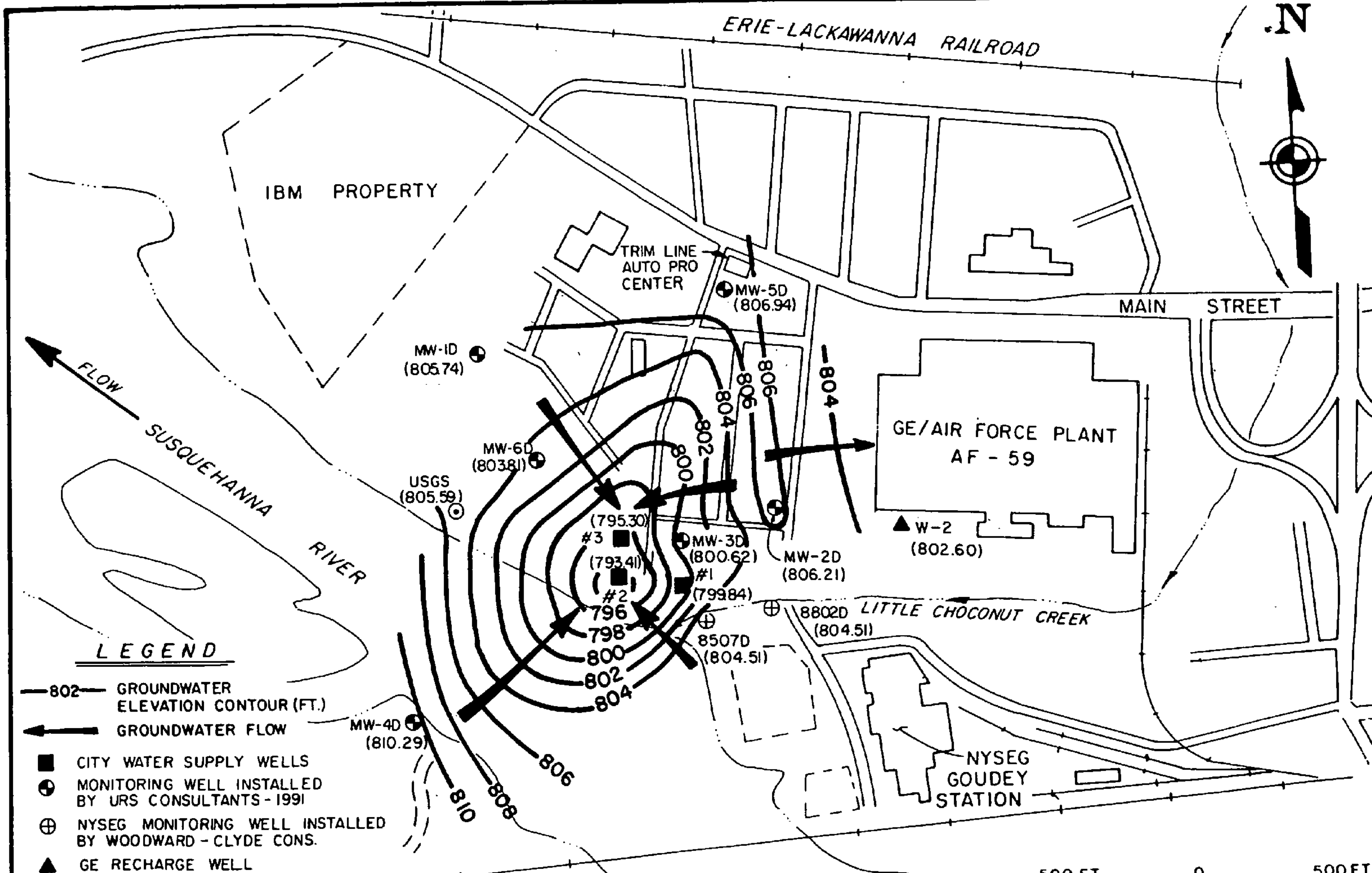


JOHNSON CITY

GROUNDWATER ELEVATIONS - SHALLOW WELLS 10-22-91

FIGURE 4-17

A-4132



LEGEND

- 802 — GROUNDWATER ELEVATION CONTOUR (FT.)
- GROUNDWATER FLOW
- CITY WATER SUPPLY WELLS
- MONITORING WELL INSTALLED BY URS CONSULTANTS - 1991
- NYSEG MONITORING WELL INSTALLED BY WOODWARD - CLYDE CONS.
- GE RECHARGE WELL
- MONITORING WELL INSTALLED BY USGS
- (803.81) GROUNDWATER ELEVATION (IN FEET AMSL)

MAP SOURCE:
USGS 7.5 MINUTE QUADRANGLE
BINGHAMTON WEST, N.Y. 1968 (INSP. 1976)

URS CONSULTANTS, INC

JOHNSON CITY
GROUNDWATER ELEVATIONS - DEEP WELLS 10-22-91

FIGURE 4-18

TABLE 4-7
GROUNDWATER MEASUREMENTS ON 12/17/91 AND 12/20/91 AT
START AND FINISH OF PUMP TEST

	START	ELEVATION	FINISH	ELEVATION	RISER ELEVATION
MW-1S	10.90	814.01	12.88	812.03	824.91
MW-1D	10.50	814.02	14.26	810.26	824.52
MW-2S	28.64	814.30	32.44	810.50	842.94
MW-2D	28.59	814.23	32.44	810.38	842.82
MW-3	29.83	814.34	39.20	804.97	844.17
MW-4S	10.62	813.69	12.59	811.72	824.31
MW-4D	10.01	814.84	10.91	813.94	824.85
MW-5S	21.25	813.87	23.14	811.98	835.12
MW-5D	21.34	813.90	23.40	811.84	835.24
MW-6	10.13	814.15	15.75	808.53	824.28
SW-1*	20.26	814.22	20.30	814.18	834.48
DW-1*	20.28	814.29	20.38	814.19	834.57
SW-6*	14.52	813.97	16.38	812.11	828.49
DW-6*	14.65	813.86	16.42	812.09	828.51
SW-8*	13.05	816.80	13.16	816.69	829.85
DW-8*	15.42	814.28	15.60	814.10	829.70
SW-9*	17.15	814.23	18.68	812.70	831.38
DW-9*	16.98	814.33	20.50	810.81	831.31
CITY WELL 2	--	--	38 AIR LINE	799.41	837.41
NYSEG 8802S	24.28	813.83	--	--	838.11
NYSEG 8802D	23.69	814.44	28.31	809.82	838.13
NYSEG 8507S	21.34	814.43	25.92	809.85	835.77
NYSEG 8507D	21.11	814.37	25.85	809.63	835.48

Elevations are above mean sea level

* - AF-59 well elevation surveyed by Purdy Engineering for Argonne National Laboratory.

TABLE 4-8
GROUNDWATER MEASUREMENTS 10/22/91

Well ID	Well Depth	Elevation Top of Riser	Groundwater Depth	Groundwater Elevation
MW-1S	45.0	824.91	16.77	808.14
MW-1D	102.0	824.52	18.78	805.74
MW-2S	60.0	842.94	36.31	806.63
MW-2D	101.0	842.82	36.61	806.21
MW-3D	100.0	844.17	43.55	800.62
MW-4S	59.0	824.31	12.56	811.75
MW-4D	85.0	824.85	14.56	810.29
MW-5S	65.0	835.12	28.36	806.76
MW-5D	100.5	835.24	28.30	806.94
MW-6D	101.5	824.28	20.47	803.81
Well #1	100.5	841.84	44 Air Line	797.84
Well #2	101.0	837.41	44 Air Line	793.41
Well #3	88.0	840.30	45 Air Line	795.30
G.E. SW-1**	36.0	834.48	24.80	809.68
G.E. SW-2	26.0	830.89	23.92	806.97
G.E. SW-9**	30.0	831.38	24.43	806.95
G.E. W-2	94.0	829.70	27.10	802.60
NYSEG 8802S	37.0	838.11	Dry	--
NYSEG 8802D	90.4	838.13	33.52	804.61
NYSEG 8507S	36.0	835.77	31.19	804.58
NYSEG 8507D	57.2	835.48	30.97	804.51
USGS PARK	--	823.68	18.09	805.59
Vestal 4-26	76.3	837.19	27.37	809.82
Vestal 4-27	80.2	836.93	27.56	809.37
Vestal 4-29	114.3	837.36	Dry	--

* Measured at rim of manhole
Elevations are above mean sea level

** - AF-59 well elevation surveyed by Purdy Engineering for Argonne National Laboratory

Table 4 – 9

JOHNSON CITY WELLFIELD

WATER LEVEL ELEVATION DIFFERENCE BETWEEN SHALLOW AND DEEP NESTED MONITORING WELLS UNDER PUMPING (10/22/91) AND NON–PUMPING(12/17/91) CONDITIONS

	DATE		APPROXIMATE DISTANCE FROM CENTER OF WELLFIELD PUMPING (FEET)
WELL PAIR	10/22/91	12/17/91	
URS MW-1 S&D	-2.40	0.01	590
URS MW-2 S&D	-0.42	-0.07	320
URS MW-4 S&D	-1.46	1.15	1265
URS MW-5 S&D	0.18	0.03	625

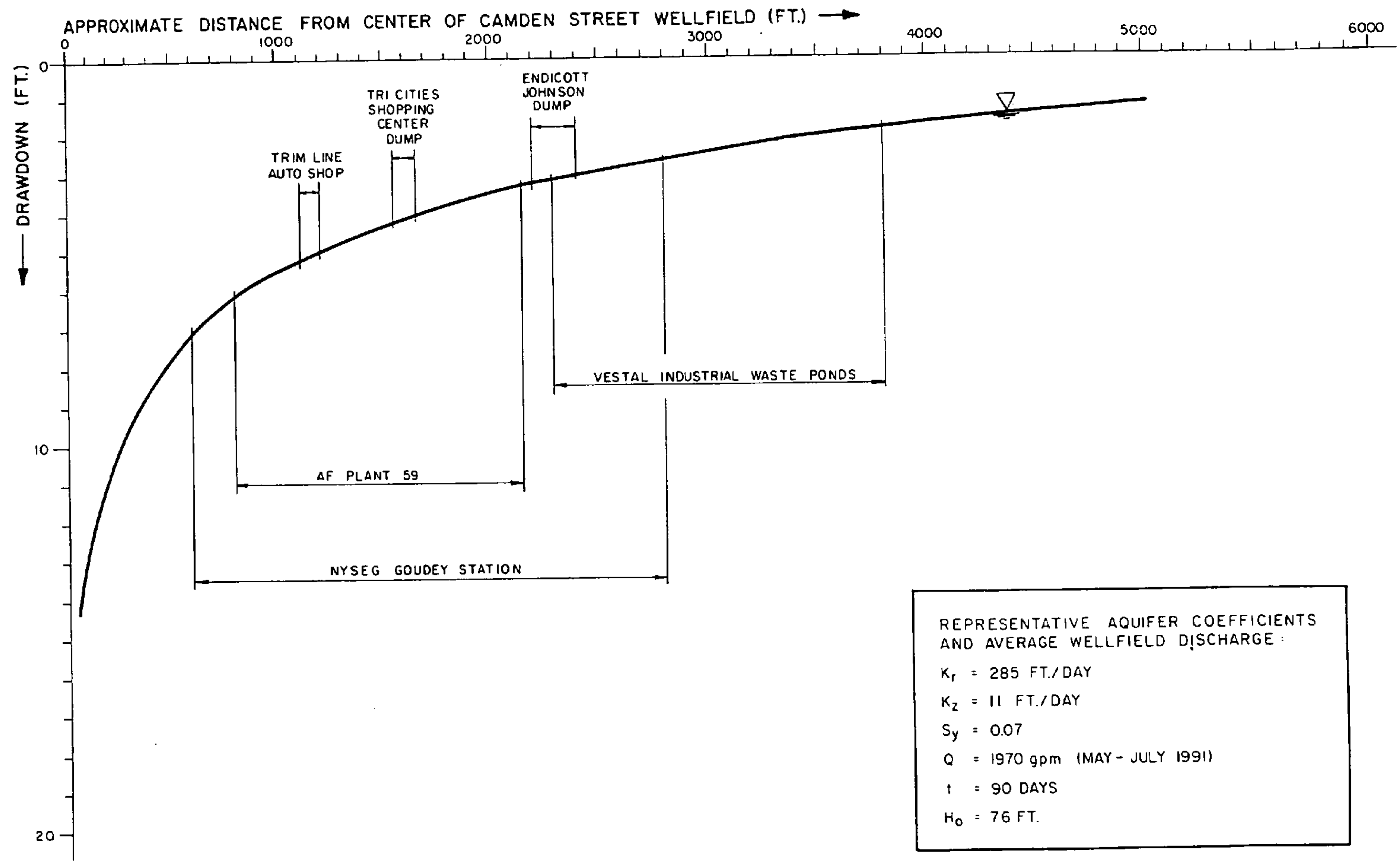
Note–Positive numbers indicate upward flow components and negative numbers indicate downward flow components.

expected to form somewhere between two relatively close, mutually-influencing high capacity wells. However, the nature of this divide is currently unknown as little additional data or information is available for better definition. Due to the complicating effects of the somewhat variable withdrawal at the Wellfield, reported intermittent use of the high capacity well at AF-59 for as-needed non-contact cooling, and aquifer recharge, the divide might be expected to be spatially and temporally transient. Under conditions of diminished recharge and high cooling water demand at AF-59, steeper gradients could exist on both sides of the divide as it migrates to an area west of MW-2. Whereas under conditions of greater recharge and limited use of the well at AF-59, the gradients on either side of the divide could diminish as the divide migrates to an area east of MW-2; closer to the AF-59 well. During prolonged periods of no pumping at AF-59 the divide might not exist at all.

In order to more fully assess Wellfield operating conditions, pumping rate data were averaged from Johnson City Wells #2 and #3 under typical operating conditions for a 90-day period ending July 31, 1991. The aquifer parameters determined by the aquifer testing and the average combined pumping rate at wells #2 and #3 (1,970 gpm) were then applied using the ISOAQX Neuman unconfined aquifer, gravity-drainage model, to develop a representative distance-drawdown relationship after 90 days of pumping (a typical aquifer stabilization point). This curve is presented in Figure 4-19 with potential sources of contamination plotted at their respective distances from the Wellfield.

The graph demonstrates that an average of approximately 5 feet of drawdown is developed under the Trim Line Auto Shop while an average of approximately 2.5 feet of drawdown is developed under the more distant Vestal industrial waste ponds.

It should be noted that the hydraulic gradients expressed by the slope of the curve probably do not represent actual gradients at specific



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JOHNSON CITY WELLFIELD

REPRESENTATIVE DRAWDOWN - DISTANCE RELATIONSHIP BENEATH POTENTIAL CONTAMINANT SOURCES UNDER TYPICAL CAMDEN STREET WELLFIELD OPERATING CONDITIONS

FIGURE 4-19

locations surrounding the Wellfield. Actual gradients which might be measured in the field would more realistically reflect important mitigating factors such as induced and natural recharge, topography, local changes in hydraulic conductivity, and, of course, pumping from nearby high capacity wells such as the one at AF-59. Nonetheless, the figure points out that, from a hydrologic perspective, the potential contaminant sources located closer to the Wellfield have a relatively greater potential for impacting water quality at the Wellfield.

5. CONCLUSIONS

5.1 Groundwater Flow System

The aquifer surrounding the Johnson City Wellfield exhibits several hydrogeologic characteristics which make it highly productive. The saturated glaciofluvial deposits that comprise most of the aquifer are thick, highly permeable, and, in the absence of an areally extensive confining unit, allow direct local recharge by precipitation. Although the Susquehanna River did not appear to recharge the aquifer in the vicinity of the Wellfield (as evidenced by the lack of aquifer test data suggesting a recharge boundary), it may provide recharge to the wellfield through the streambed under operational pumping durations and along other more remote points of its course.

Due to several other hydrogeologic and operational factors, the Wellfield is also vulnerable to chemical contamination. High-capacity, long-term Wellfield withdrawals are capable of inducing greater potential for downward migration by generating from two to six feet of drawdown beneath suspect sources. In the absence of a confining stratum above the screened zone of Wells #2 or #3, contaminants can move relatively unimpeded to the Wellfield at relatively high groundwater velocities, as dictated by high pumping-induced gradients.

The apparent presence of a groundwater divide between the Camden Street Wellfield and potential contaminant sources at AF-59 provides local flow restriction between the two sites. However, under certain circumstances as discussed earlier, a transient divide could allow either direct or circuitous groundwater flow from AF-59 toward discharge at the wellfield.

5.2 Source(s) of Contamination

Results of groundwater analysis show concentrations of TCA, benzene, and metals in contravention of groundwater standards within the direct hydrologic influence of the Johnson City Wellfield. Distribution of organic contaminants appears to indicate that the source of these contaminants is north of the Wellfield. The source of the TCA appears to be near or upgradient of MW-5. Accordingly, the Trim Line Auto Pro Center remains a suspect source, as above standard concentrations of organic compounds were found in a sump sample from that property. It is also possible that the source of TCA may originate from a location north of, and near, Trim Line Auto Pro Shop. The source of the benzene contamination also appears to be near or upgradient of MW-5. However, other contributing sources cannot be ruled out.

Metals contamination comprises varying concentrations of antimony, chromium, iron, manganese and sodium. Multiple sources of chromium are suggested near or upgradient of sites MW-1, MW-5, and MW-2. Sources of antimony appear to be northwest and southwest of the Wellfield, near or upgradient of well sites MW-1 and MW-4.

Based upon the data reviewed, no evidence of chemical contaminant contribution from the NYSEG Goudey Station, or the former Endicott Johnson Dump sites was found.

6. RECOMMENDATIONS

In order to better define or confirm the presence or absence of chemical contamination in the aquifer near the Camden Street Wellfield, the following recommendations are made for additional investigation.

1. The sump at the Trim Line Auto Pro Shop should be re-sampled and re-analyzed for TCL volatiles. High concentrations of acetone in the previous sample necessitated a dilution factor of 200, which consequently raised the detection limits of the contaminants of concern. Because of the highly transient nature of acetone (high volatility and water solubility), it is believed that high concentrations of the compound may not be present during a second sampling, thereby not requiring a significant dilution.

2. The construction of the sump sampled at the Trim Line Auto Pro Shop should be investigated to determine the potential for discharge to groundwater at that site, prior to the consideration of further investigations.

3. All available monitoring wells, including the U.S. Geological Survey, NYSEG, and AF-59 wells, should be utilized by collecting one complete round of water level elevations per month for a period of at least one year to better define long-term water level changes near the Wellfield.

4. The results of the additional IRP investigation being conducted at AF-59 by Argonne National Laboratory for the Air Force, currently scheduled for completion in late March 1992, should be reviewed.

5. Soil gas screening studies should be conducted in a radially outward fashion from the wellfield in an effort to better define existing contaminant plumes or identify others not currently intercepted by

the current array or monitoring wells.

6. A site-specific numerical groundwater flow model for the area of the aquifer influenced by Wellfield pumping should be developed. This high-nodal-density model could be based on an existing larger scale aquifer model of the entire Susquehanna River Valley in southwestern Broome County completed in 1986 by Allan D. Randall of the U.S. Geological Survey. The model would serve the critically important purpose of simulating more realistic groundwater gradients and flow paths. The model would also provide better definition of the hydrologic divide which sometimes exists between the well field and the high capacity well at AF-59 as well as lend further definition to the question of induced infiltration through the river bed near the Wellfield. The analytical results of the aquifer test can provide valuable input for the development of this model. Utilization of historic AF-59 and Johnson City pumpage records in the model could result in a very realistic simulation.

7. After the execution of the soil gas studies, the application of site-specific groundwater flow model, and the review of any additional data and information about potential contaminant source areas, additional monitoring wells can be installed and sampled to confirm the presence of contamination from each suspected site.

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