INVESTIGATION AND ASSESSMENT OF THE LOCKPORT COAL TAR SITE

TASK 1 REPORT
PRELIMINARY SITE EVALUATION

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Prepared for

New York State Electric and Gas Corporation
4500 Vestal Parkway East
Binghamton, New York 13902

Submitted by

Woodward-Clyde Consultants
201 Willowbrook Boulevard
Wayne, New Jersey 07470

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1. SUMMARY

A preliminary site evaluation has been completed for the Lockport coal tar site, which included a literature review, site reconnaissance, and geophysical surveys. Results of the investigations indicated that local geologic and hydrogeologic conditions are typical of the region. In the site vicinity, the bedrock surface is believed to generally slope from the site toward the canal, and northeast- and northwest- striking joint sets appear to be the major structural features. These bedrock characteristics are likely to control the flow of both ground water and infiltration water. Additional Task 2 studies are recommended for determining if a contamination problem exists in the site vicinity.

2. INTRODUCTION

This report presents the results of Woodward-Clyde Consultants' Task 1 study of the Lockport coal tar site owned by New York State Electric and Gas Corporation (NYSEG). The purpose of the study was to complete a preliminary site evaluation including: 1) characterization of geologic and hydrogeologic conditions with sufficient detail to identify possible ground water/waste transport mechanisms and geometry, and 2) delineation of any existing ground water contamination with sufficient detail to optimize the design of any required additional investigations.

The study was performed as the initial phase of the Lockport coal tar site investigation and assessment, as described in Woodward-Clyde Consultants' revised proposal dated 7 October 1982. Work was initiated on 5 October 1982, and field work was performed between 14 and 29 October 1982.

3. INVESTIGATIONS

3.1 Literature Review

Records and literature pertaining to both regional and local geology and hydrogeology were compiled, reviewed, and summarized. Additional information made available by NYSEG regarding site history and operations was also reviewed. Locations of utility lines in the site vicinity were established as closely as possible before geophysical surveys were begun.

3.2 Site Reconnaissance

A geologic mapping program was conducted to provide information regarding the nature of bedrock underlying the site vicinity as well as to gain an understanding of the orientation, density, and aperture of bedrock joint systems. Local bedrock stratigraphy and lithology were examined and described at exposures along the canal walls and at other selected locations within and outside the site vicinity. Joints and other structural features were mapped in detail on both sides of the canal wall, and 155 orientation measurements were taken. Mapping locations in the site vicinity are shown in Figure 1.

Structural trends of joint sets and their interrelations were studied using stereographic projection techniques. The orientation of each measured joint was plotted by projecting the pole of its plane downward onto a Schmidt equal area net (Ragan, 1973). Plotted poles were then counted and contoured as a point density plot, with contours defining percentages of total number of points per one per cent area of the net (Figure 2).

Additional observations regarding local geomorphology, drainage patterns, ground water flow, and significant cultural features were also recorded during the course of site reconnaissance.

3.3 Geophysical Surveys

3.3.1 Terrain Conductivity

A terrain conductivity survey was performed to help to determine the possible presence and location of any plumes of contaminated ground water. The survey was also intended to provide insight into bedrock joint patterns across the site vicinity and as a tool for calibrating results of subsequent geophysical surveys by other methods.

The instrument used was a Geonics EM-31 conductivity meter, which consists of a 12-foot long, horizontally held boom with self-contained transmitter and receiver. Measurements were taken across the site and along other traverses in the site vicinity, as shown in Figure 1. Stations were generally at 10-foot spacings, and the instrument was oriented so that most effects were from a "look" depth of approximately 20 feet.

Measurements were plotted and contoured as shown in Figure 3 and interpreted in terms of the capacity of subsurface materials to conduct induced electrical currents. Apparent background conductivity was between 50 and 150 mmhos/m. Values greater than 400 mmhos/m were considered results of cultural interference and were not contoured. Conducitivity survey results are discussed in greater detail in Sections 4.3 and 4.4.

3.3.2 Seismic Refraction

A seismic refraction survey was performed to help define the depth and configuration of the bedrock surface. The instrument used was a Nimbus 12-channel signal enhancement seismograph. Seismic compression waves were generated by sledge hammer impact on an aluminum plate, and wave arrivals were detected by twelve geophones placed along the selected traverse line at 10- and 20-foot intervals. Approximately 2300 feet of seismic refraction traverses were performed in the site vicinity, at locations shown in Figure 1.

In most cases, two different velocity layers were indicated: an upper layer presumed to be soil and an underlying layer of bedrock. Depth to the inferred soil/rock interface was calculated to range from approximately 2 to 23 feet at surveyed locations. The inferred elevation of the bedrock surface was plotted and contoured as shown in Figure 4. Seismic refraction survey results are discussed in greater detail in Section 4.3 and 4.4

3.3.3 Subsurface Radar

A subsurface radar survey was performed to provide information on the configuration of the bedrock surface and the location of buried utility lines. The survey was performed by Detection Sciences Group under the supervision of Woodward-Clyde Consultants. Radar pulses were transmitted into the ground by a towed, cart-mounted radar system. A continuous subsurface profile was generated by recording reflections of the generated pulses off subsurface interfaces.

Radar profiling was performed along approximately 4000 feet of traverses at locations shown in Figure 1. Preliminary results were verbally transmitted to Woodward-Clyde Consultants from Detection Sciences Group. These data were considered in assembling the inferred bedrock elevation map shown in Figure 4. Radar survey results are included in the discussion of local geology in Section 4.3.2.

4. RESULTS OF INVESTIGATION

4.1 Facility Description

The Lockport coal tar site is currently an electrical substation owned by New York State Electric and Gas Corporation (NYSEG). The site is located in the village of Lockport, New York and is bounded on the west by South Transit Street, on the north by LaGrange Street, on the east by Saxton Street, and on the south by private residences. The surrounding area is commercial and residential and is served by municipal water and sewer systems.

The site was formerly a gas manufacturing facility with coal tar being produced as a byproduct of the gasification process. The site has been inactive for more than 50 years, and virtually all surface features of the gasification facility have been removed. A coal yard owned by a private coal supplier was at one time located one block north of the site, southeast of the Erie Canal. This land is now occupied by an Exxon gas station.

Seeps of an oily liquid have been noted on the walls of the Erie Canal in the vicinity of the site (Figure 1) by representatives of NYSEG, the Niagara County Health Department, and the New York Department of Transportation. These seeps were observed at discrete locations along bedrock bedding planes below the normal water line, when the canal had been dewatered for the winter months.

Studies performed by NYSEG have indicated that the site has the possibility of discharging pollutants in contravention of water quality regulations established by the New York State Department of Environmental Conservation. The U.S. Environmental Protection Agency has been notified by NYSEG that hazardous waste activities may at one time have occurred at the Lockport coal tar site.

4.2 Physiography

4.2.1 Regional Physiography

Lockport is located within the Eastern Lake section of the Central Lowlands province (Fenneman, 1938; Thornbury, 1965). The province is underlain by flat-lying Paleozoic-aged rocks, and probably existed as a relative lowland transected by resistant bedrock escarpments prior to Pleistocene glaciation. Glacial activity has produced the current land forms, which consist of very low relief, gently rolling plains (ground moraine and lacustrine deposits) interrupted by segments of end moraine. In some parts of the province, pre-glacial resistant bedrock escarpments still form moderately strong relief features (Figure 5). The Niagara escarpment is of particular regional significance, as it extends westward from Rochester, New York, across the province of Ontario and

Michigan's northern peninsula, before being buried by glacial drift in Wisconsin. The escarpment forms Niagara Falls at the Canadian border, where it has a height of over 300 feet. Elevations in the province range from 300 to 1600 feet above sea level, increasing to the south and west. Regional drainage is divided between the Mississippi-Ohio drainage system to the south and west, and the St. Lawrence drainage system to the east and north.

4.2.2 Local Physiography

The City of Lockport is bisected by the New York State Barge Canal and straddles the Niagara escarpment, a north-facing feature supported by the resistant rocks of the Lockport Group. The escarpment trends east-west as it crosses Lockport and parallels the Onondaga escarpment to the south. The plain that currently occupies the expanse between the two escarpments is variously referred to as the Lake Tonawanda or Huron Plain, while the plain that lies between the Niagara escarpment and Lake Ontario is known as the Ontario plain (Figure 5).

The Niagara escarpment is locally cut by a number of north-draining steep-sided valleys or gorges, cut by glacial meltwaters during the most recent stage of deglaciation. The gorges include the Niagara Gorge at the falls and The Gulf, a ravine about 1 mile northwest of Lockport. Another gorge, located within Lockport, has been excavated and is utilized as the Erie Canal. The gorges trend to the northeast and probably are joint controlled features.

Relief along the Niagara escarpment near Lockport reaches 200 feet and averages approximately 100 feet. Elevations increase to 900 feet on the Huron Plain south of Lockport and decrease to 280 feet towards Lake Ontario. Drainage around the City of Lockport is dominated by the Niagara escarpment, with streams in its vicinity draining to the north. To the south on the Huron plain, drainage flows to the west into the Niagara river and ultimately into Lake Ontario (Johnston, 1964; LaSala, 1968).

The NYSEG Lockport coal tar site is located on a hillside that approximates the brow of the Niagara escarpment. The site's maximum elevation is at its southeast corner where it reaches 620 feet, and the site's minimum elevation is 599 feet at its northwest corner. Topography in the site vicinity has been locally altered by excavation and fill placement.

4.3 Geology

4.3.1 Regional Geology

Western New York State is underlain by relatively flat-lying, undeformed sedimentary rocks that range from Ordovician through Pennsylvanian in age (Rickard and Fisher, 1970; Kindle and Taylor, 1913; Telford, 1978; Buehler, 1963). The rocks dip very gently (approximately one-half degree) to the south and outcrop in east-west trending bands. Due to the regional southerly dip of the rocks, and the increase in elevation as the Allegheny Plateau is approached, progressively younger rocks are encountered at the surface in a traverse from north to south (Figure 5). The oldest group of rocks exposed in the region outcrop north of the site, along Lake Ontario, and in the Gulf, and are represented by the upper Ordovician Queenston Shale (600 feet thick). A detailed stratigraphic column providing descriptions of the rock units in the vicinity of the site is provided in Table 1.

Lower Silurian rocks are represented by the Medina Group (about 100 feet thick) which contains sandstones and shales. The Clinton Group (about 150 feet thick) unconformably overlies the Medina group, and consists of shales and dolomites which grade into the Upper Silurian Lockport Group (about 170 feet thick). The balance of the Silurian is represented by the Akron Dolomite and the Salina Group (about 600 feet thick).

Results of drilling in the area indicate that all Silurian-age rock units are, or were at one time, capable of yeilding moderate amounts of natural gas, given favorable textural and structural conditions. The historically most productive rocks have been the sandstones of the Medina Group, although some production has been from rocks of the Salina, Lockport, and Clinton Groups (Kindle and Taylor, 1913). Maximum initial gas pressures from gas producing wells are reported to have been approximately 200 pounds per square inch.

Lower Devonian rocks are not represented due to a hiatus in deposition. However, the Middle and Upper Devonian represent nearly 3,000 feet of shales, carbonate rocks, and sandstones.

The rocks in western New York State are essentially undeformed, cut in some places by small faults, and with minor folding to produce local anticlines and synclines. These structures are of purely local significance, and their origin is poorly understood. Many of the minor structures described in the literature are not tectonically induced, but instead are related to stress release mechanisms associated with erosion, excavation and glacial rebound. The Clarendon-Linden Fault is a north-trending structure located approximately 30 miles east of the site.

The major structural features in the rocks are a group of vertical joint sets and a nearly horizontal bedding plane joint set. The dominant, regional, vertical joint sets trend approximately N45E and N80W. The joints tend to be tight but in some instances have been widened by solutioning.

The land forms of Western New York State have been modified by glacial activity and consist of gently rolling plains transected by sinuous ridges. The ridges are of two varieties: bedrock ridges forming fairly continuous escarpments and segmented hills formed by glacial moraines. In addition, numerous drumlinoidal hills dot the Huron plain south of Lockport.

Unconsolidated glacial deposits with an average thickness of 15 feet (50 feet maximum) cover bedrock throughout the area. The Ontario and Huron Plains are covered with ground moraine and elongated ridges of terminal moraine. The Ontario Plain contains a group of parallel recessional moraines that were deposited as the glacier was melting.

Lake and beach deposits are found in both the Ontario and Huron Plains. These lacustrine deposits are related to glacial lakes that occupied the plains during the most recent period of deglaciation. The runoff from these lakes cut the gorges described in Section 4.2.

4.3.2 Local Geology

The area is underlain by the Silurian, Clinton and Lockport Groups of the Niagara Series. A geologic section is given in Figure 6, and a map of bedrock geology is given in Figure 7. The Lockport group consists of interlayered dolomite and limestone with subordinate argillaceous and shaly units. At various locations, dolomites of the Lockport Group typically give off strong odors of petroleum on fresh fracture and may contain numerous films and partings of black carbonaceous material (Kindle and Taylor, 1913). The four members of the Lockport Group from youngest to oldest are:

- Oak Orchard Member - Fine grained, thin- to thick-bedded gray dolomite (approx. 70 feet thick)

- Framosa Member - Very fine grained, thin- to medium-bedded gray brown dolomite, with bituminous and carbonaceous shale partings (14 feet thick)

- Goat Island Member - Fine to medium grained, generally massive, gray dolomite with a considerable fraction of argillaceous material (26 feet thick). The Goat Island Member may be the bedrock unit directly underlying the site.

- Gasport Member - Results of mapping indicate that the Gasport Member is the youngest rock unit exposed along the canal at the hydrocarbon seep and within a few hundred feet of the seep. It attains an average thickness in this vicinity of 10 feet. Observations of the Gasport indicate that in the site vicinity it is a coarse grained, crystalline dolomite containing abundant fragments of fossilized crinoid stems and corals. The rock weathers to a light to medium gray color, but on fresh surfaces was observed to be gray to white, with pink crinoid fragments. The rock was found to be very massive, with only faint discontinuous bedding suggested by grading of some crinoid fragments.

The Upper and Lower Silurian Clinton Group lies below the Lockport Group and consists of the following members (youngest to oldest):

- DeCew Member - A sharp contact was observed to separate the Gasport from the underlying DeCew Member of the Clinton Group. In the site vicinity, the DeCew is a very fine grained, dark gray, crystalline dolomite that weathers to a medium gray color. It is easily distinguished from the Gasport Member because it is non-fossiliferous and displays clear bedding. In addition, numerous thin shale layers and partings were observed, with bedding thickness varying from less than 1 cm to 10 cm. The DeCew dolomite was found to release a strong hydrocarbon odor when fractured with a rock hammer. The average measured thickness of the DeCew Member in the site vicinity is approximately 5 feet.

- Rochester Shale Member - The contact of the DeCew Member with the underlying Rochester Shale is gradational in the Lockport area, marked by increasing thicknesses of shale and a proportionate decrease in the thickness of carbonate layers. Northeast of the site, the Rochester Shale was observed to be a medium gray, well-laminated rock containing minor discontinuous bands of dolomite. The canal lower contact of the Rochester was not observed in the site area; however a minimum thickness of 20 feet was measured. The hydrocarbon seep, which is described as occurring at the contact between the Rochester and DeCew Members, was not visible, because it was below the water line at the time of mapping.

Rocks in the site vicinity show no evidence of strong deformation. However, a small anticlinal buckle was observed in the Decew Member along both the northern and southern banks of the canal. The fold is symmetrical and has a northeast trending axis with limbs that dip no more than 5 degrees. The amplitude of the fold is less than 10 feet, and its length is no more than 20 feet across strike. The degree of deformation decreases with depth, so that beds 10 feet below the crest of the fold are horizontal.

The dominant rock structures mapped in the site vicinity were groups of joint sets that were observed in all three exposed members. The polar point density plot (Figure 2) was used to statistically determine the number of joint sets and their orientation. The data indicate that seven joint sets are present, five with nearly vertical dips, one essentially horizontal, and one with an intermediate dip to the southeast.

Two joint sets measured at the site, trending N40E and N84E, respectively, are regionally significant, with the N40E trend readily apparent from topographic features (e.g. The Gulf drainage on the Niagara escarpment). These joint sets also appear to be reflected in the conductivity contour plot (Figure 3) by east- to northeast-trending contours along Buffalo Street, LaGrange Street, State Road, and Saxton Street north of LaGrange Street. The mapped northwest-striking joint sets may also be indicated by northwest-trending contours near the canal, on the site, and on Saxton Street south of LaGrange Street.

Joint spacing, smoothness, persistence and aperture were found to vary with lithology. In general, the sub-horizontal bedding plane joints (pole concentration N1E, 6^{o}NW) were more open than the vertical joints. Bedding plane joints were more pronounced and closely spaced in the shales than in the dolomites. Vertical joints were typically tight, and spacing ranged from 2 to 10 feet. Vertical joints were most persistent in the massive dolomites.

Results of seismic refraction and subsurface radar surveys in the site vicinity indicate that the bedrock surface is roughly planar, with minor undulations. As shown in the contour map presented in Figure 4 and the geologic section in Figure 6, the bedrock surface appears to be generally inclined to the northwest, toward the canal, and approximately parallels topography. The bedrock high near the intersection of Genesee and Saxton Streets (Figure 4) coincides with a conductivity low observed at that location (Figure 3). Inferred depth to rock ranges from 23 feet along Saxton Street south of LaGrange Street to 2 feet at State Road across from the Erie Canal dock. The subsurface radar survey indicated boulders near the bedrock surface at various locations.

Lockport is transected by discontinuous segments of terminal moraines. The moraines were deposited in glacial lakes by the minor readvancement of ice lobes during deglaciation. The hill that rises southward from the canal, past the site, is probably composed of morainal deposits of gravelly, clayey silt. Surfical geology in the site area is shown in Figure 8.The major surficial deposits in the site area consist of till and glacial lake deposits. The average thickness of ground moraine in the area is approximately 15 feet, reaching a maximum of 50 feet in some places.

The dominant soil type at the site is the Schoharie silty clay loam, a brownish-gray soil derived from stratified silty and clayey glacial lake deposits (Pearson et al., 1947), in places overlying glacial till. The Schoharie soils are characteristically imperfectly drained due to their clayey nature. Other soils in the area include residual soils developed on bedrock and those soils developed on coarse grained, poorly sorted glacial deposits (Figure 8).

4.4 Ground Water Conditions

4.4.1 Regional Hydrogeology

The Niagara escarpment acts as a divide with respect to reginal ground water flow, similar to its influence on surface water flow. On the Ontario Plain, ground water generally flows north, towards Lake Ontario. The regional ground water gradient on the Huron Plain is south and west, more or less paralleling the dip of the rock strata.

The Lockport Group is the most important bedrock aquifer in the Erie-Niagara drainage basin. Although rocks of this group are cyrstalline carbonates with little primary permeability, ground water does occur in vertical and horizontal joints and dissolved gypsum cavities (Johnston, 1964). Vertical fractures are important as pathways of water movement in the upper few feet of bedrock.

In the upper part of the rock, a significant water bearing zone exists in the fractured rock near the soil/rock contact. This fractured zone is independent of the dip of the strata and closely follows the bedrock surface. Either artesian or water table conditions may occur locally. Where overlying glacial material consists of thick accumulations of sands and gravels, (e.g., the Tonawanda Creek Valley), unconfined conditions may exist in the overburden. Clay and silt deposits directly overlying rocks of the Lockport Group may in places act as confining beds, producing artesian conditions in the upper part of the rock.

In the lower part of the Lockport, artesian conditions predominate. Seven distinct water bearing horizons are present in horizontal fracture zones within the Lockport Group (LaSala, 1968). There is little vertical communication between these zones, and each acts as a distinct artesian aquifer (Johnston, 1964).

The upper zone of fractured rock is hydraulically connected to the overlying glacial deposits. Recharge to this system occurs by infiltration of precipitation downward through overburden. Artesian aquifers are recharged where fractures intersect the unconfined aquifer or the ground surface.

Wells in the Lockport Group yield, on average, 31 gallons per minute (gpm) with yields of 50 to 100 gpm considered exceptional (LaSala, 1968). Yields from unconsolidated sediment aquifers such as the Tonawanda Creek Valley may reach 1,000 to 1,400 gpm.

Water produced from the Lockport Group is generally very hard, and commonly has more than 2,000 ppm dissolved solids (1,400 ppm average). Calcium and magnesium are common constituents. High concentrations of hydrogen sulfide are found in about one-third of wells completed in the Lockport Group (Johnston, 1964), and a small sulphur-water spring issues from the lower layer of the Lockport near McNalls about 5.5 miles east of the site. Water from the lower two producing zones of the Lockport is generally saline and similar in composition to oil field brines (Johnston, 1964). A 100-foot deep well at Pendleton Center, 5.5 miles southwest of the site, encountered dark-colored water strongly flavored with iron salts (Kindle and Taylor, 1913). Water produced from unconsolidated sediments is typically hard, but is not as mineralized as water produced from bedrock.

4.4.2 Local Hydrogeology

Although regional ground water flow is to the north and south, away from the Niagara Escarpment, the construction of the Erie Canal has created a local perturbation of this flow regime. Small water seeps indicating local flow toward the canal were observed along the north and south canal walls at the soil/rock contact and at a limited number of fractures in the bedrock. No other information is available regarding the ground water gradient in the site vicinity. The ground water table appears to be within rock, although regional information indicates that multiple water levels may be present at depth.

Ground water transport in the site vicinity is believed to involve the infiltration of precipitation through the overburden to the bedrock surface. As infiltration water reaches the bedrock surface, it flows laterally along the surface until open near-vertical fractures are intercepted. If present, these vertical fractures would allow downward migration to lower horizons in the bedrock.

As shown in Figures 4 and 6, the bedrock surface in the site vicinity approximately parallels topography, but an irregular dip occurs north of the site at LaGrange Street. The exact magnitude of this irregularity is not known, but it may be sufficient to cause collection or local diversion of flow of infiltration water. The degree of fracturing in the upper few feet of bedrock in this area is not known.

It does not appear likely that significant quantities of ground water migrate downward via near-vertical fractures in rock. Vertical joints were observed to be generally tight, and except for two regionally significant sets (N40E and N84E at the site), were not of great length. Evidence of enlargement of joints by solutioning was not observed in the mapped area, although such occurrences have been reported for the Lockport Group (Johnston, 1964). In general, joints observed in outcrops were dry.

Additional lateral and vertical transport of infiltration water in the site vicinity may be occurring along the unlined sewer tunnel constructed in rock along Transit Street or along underground utility lines, especially if these are underlain by granular fill material.

No quantitative information is available regarding the quality of ground water in the site vicinity. The terrain conductivity survey performed in the site vicinity did not show any distinct plumes, but indicated a number of isolated anomalously low areas. Two of the low areas, at the northwest corner of the site, and along the canal (Figure 3), coincide with reported locations of coal tar contamination or oily seeps. The low anomaly at the southeast corner of Saxton and Genesee Streets probably reflects a bedrock high. Other anomalously low readings, including the prominent one at the intersection of State and Transit Streets, and south of the site on Saxton Street, are of uncertain origin but may indicate either localized stratigraphic variations or ground water contamination.

Insufficient information is available concerning the chemical nature of the observed hydrocarbon contamination along the canal wall and the local ground water to determine whether naturally occurring hydrocarbons are sources for contamination.

5. CONCLUSIONS

The site vicinity is underlain by glacial till and lacustrine deposits which generally increase in thickness toward the southeast. Bedrock is flat-lying dolomite and shale of Silurian age. The bedrock surface generally slopes to the northwest, toward the canal, but an irregular dip occurs north of the site at LaGrange Street.

Vertical joints in rock observed at the canal wall were essentially closed, and significant quantities of water are not likely to migrate downward below the reported upper zone of fractured rock. Infiltration water would be expected to percolate downward and then to move either along the bedrock surface or within the upper zone of fractured rock. This movement is likely to be to the northwest, from the site toward the canal, with some ponding at the LaGrange Street bedrock-surface depression.

Results of the terrain conductivity survey conducted in the site vicinity indicated negative anomalies in the vicinity of the observed hydrocarbon occurrences at the canal wall and at the northwest corner of the site. The configuration of these and other negative anomalies in the site vicinity suggest that concentrations of hydrocarbons in the subsurface may be controlled by a northwest-trending bedrock joint set. Alternatively, extensive, linear negative anomalies may be due to a localized high bedrock surface, which would also tend to follow a well-established joint set. The isolated negative anomalies within the site boundaries do not preclude the site as a possible contamination source area. However, the likelihood of contamination moving from the site to the point in question is remote.

Hydrocarbons occur naturally in the Lockport Group and in other Silurian-age rocks in the site area. These occurrences have generally been in the form of natural gas or as petroleum odors. No oil or tar-like substances have been reported, although their presence is not precluded. No conclusions can be drawn concerning the relation between naturally occurring hydrocarbons and the substance observed at the canal seep until quantitative water quality data are available.

To evaluate site conditions adequately to determine if a contamination problem exists in the site vicinity and to determine whether the observed seeps at the canal are related to previous activities at the site, the following additional information is required:

- Definition of contamination source and lateral and vertical extent of contamination of site soils.
- Definition of elevations of bedrock surface and stratigraphic contacts at key locations.
- Definition of permeability of soil/rock interface, upper zone of rock, and lower zone of rock.
- Definition of ground water gradient.
- Definition of chemistry of soil/rock/water system.

6. RECOMMENDATIONS

6.1 General

We recommend that investigations at the Lockport coal tar site be continued and that the proposed Task 2 program be initiated. This program would include installation of four monitor wells, two intermittent wells, and three borings. Permeability testing and sampling and chemical analysis of soil, rock, and water would also be performed. Details of the recommended Task 2 program are discussed in the following sections.

6.2 Monitor Wells

Installation of four monitor wells is recommended, at locations shown in Figure 9. All monitor wells would be used to monitor both water levels and water quality. Monitor well MW-1 would be installed near the reported oily seeps from the canal wall.

If possible, this well should be installed before the canal is drained for the winter months, so that the effect of the canal level on the ground water table elevation may be observed. Monitor well MW-2 would be installed northwest of the site to define subsurface conditions at the identified conductivity anomaly, and any possible link with the nearby gas station. Monitor well MW-3 would be installed near the northwest corner of the site, in the vicinity of the coal tars observed in near-surface site soils. This well would allow evaluation and monitoring of the vertical distribution of contaminants. Monitor well MW-4 would be installed southeast of the site, at a possible upgradient location, to monitor the quality of ground water flowing into the area.

All four monitor wells would be installed to a depth that would allow sampling of the upper 10 feet of ground water. Expected well depths are 50 feet for MW-1, 55 feet for MW-2, and 60 feet or more for both MW-3 and MW-4. Installation techniques and materials would be as described in Woodward-Clyde Consultants' revised proposal dated 7 October 1982.

6.3 Intermittent Wells

Two shallow wells are recommended for monitoring conditions near the soil/rock interface. These wells are likely to contain water only intermittently, after periods of precipitation and infiltration. Well IW-1 would be installed near the canal, approximately 5 feet from monitor well MW-1. This well would allow monitoring of the level and quality of infiltration water near the canal. Well IW-2 would be installed north of the site at the identified depression in the bedrock surface. This well would be used to monitor any intermittent collection of infiltration water at this location.

Both intermittent wells would be installed to sample infiltration water in the lower portion of the overburden and the upper portion of the bedrock. The anticipated well depth is approximately 15 feet for IW-1 and 20 feet for IW-2. Installation techniques and materials would be as described in Woodward-Clyde Consultants' revised proposal.

6.4 Borings

Three borings are recommended, at locations shown in Figure 9. Boring B-1 would be drilled southwest of the site to better define the configuration of the bedrock surface, of the rock unit contacts, and of the ground water table. Boring B-2 would be installed north of the site to provide information concerning soil and rock conditions at a point between the site and the observed seep. Boring B-3 would be drilled at the eastern end of the site, at the former tank location, to evaluate any possible effects on soil and rock at depth.

All three borings would extend below the ground water table, to at least 60 feet for B-1 and approximately 55 feet for B-2 and B-3. Soil and rock samples would be collected as described in Woodward-Clyde Consultants' revised proposal.

6.5 Permeability Testing

In-situ borehole permeability tests are recommended for all wells and borings as drilling progresses. Open-end casing tests would be performed to evaluate the vertical permeability, and short open sections of boreholes (5 feet or less) would also be tested to provide a value of the horizontal permeability in both the saturated and unsaturated zones. The permeability tests would be performed by first filling the casing with clean fresh water to a level at or slightly above the ground surface and a constant head test performed after the flow rate has stabilized. Subsequent to the performance of the constant head permeability test the flow of water would be terminated and the water level drop in the casing would be recorded vs time. This is referred to as a falling head permeability test. Results from both the constant head and falling head permeability tests would be reported for comparison purposes. Permeability testing in the bedrock would be performed using similar constant head and falling head techniques. Vertical permeability in the bedrock would not be determinable because casings would not typically be advanced beyond the top of bedrock.

6.6 Ground Water Sampling and Analysis

Subsequent to the completion of installation of the casing or screen, each monitor well would be fully developed by extended pumping. Immediately prior to the collection of any ground water sample, each well would be evacuated a minimum of three to five volumes or to dryness. The ground water sample would then be collected utilizing a teflon bailer. The water collected would be transferred to appropriate sample bottles containing preservatives as provided by the testing laboratory. Sample bottles would be individually labeled and sealed and placed in a cooler containing ice packs, and chain of custody documentation would be initiated. Samples would be transported to General Testing Corporation in Buffalo, NY on the day they are collected.

A priority pollutant analysis is recommended for a sample of coal tar collected from the site during the drilling of MW-3. After the results of the priority pollutant analysis have been presented, ground water analyses would be performed. This analyses would screen for hydrocarbons that could be used to fingerprint coal tar from other hydrocarbons including fuel oil, gasoline, or natural hydrocarbons, that may be present. The hydrocarbon screen would be performed by a gas chromatograph utilizing a FID detector for the range C_5 to C_{22}. Specific polynuclear aromatic and phenols present in coal tar would also be identified. Analyses of a site coal tar sample would be used to compare with ground water samples. Based on the results of the assessment, it may be recommended that a sampling program be continued on a quarterly basis for one year.

6.7 Laboratory Analysis of Soil and Rock

It is recommended that the proposed option of laboratory testing of soil and rock be accepted. These studies would consist of 10 to 15 chemical analyses, primarily of soil samples but also of selected rock samples. Such analyses would allow better definition of the chemistry of the soil/rock/water system and of the chemical link between soil contamination and any possible ground water contamination. In addition, physical property tests (grain size analysis) are recommended for 4 to 5 soil samples.

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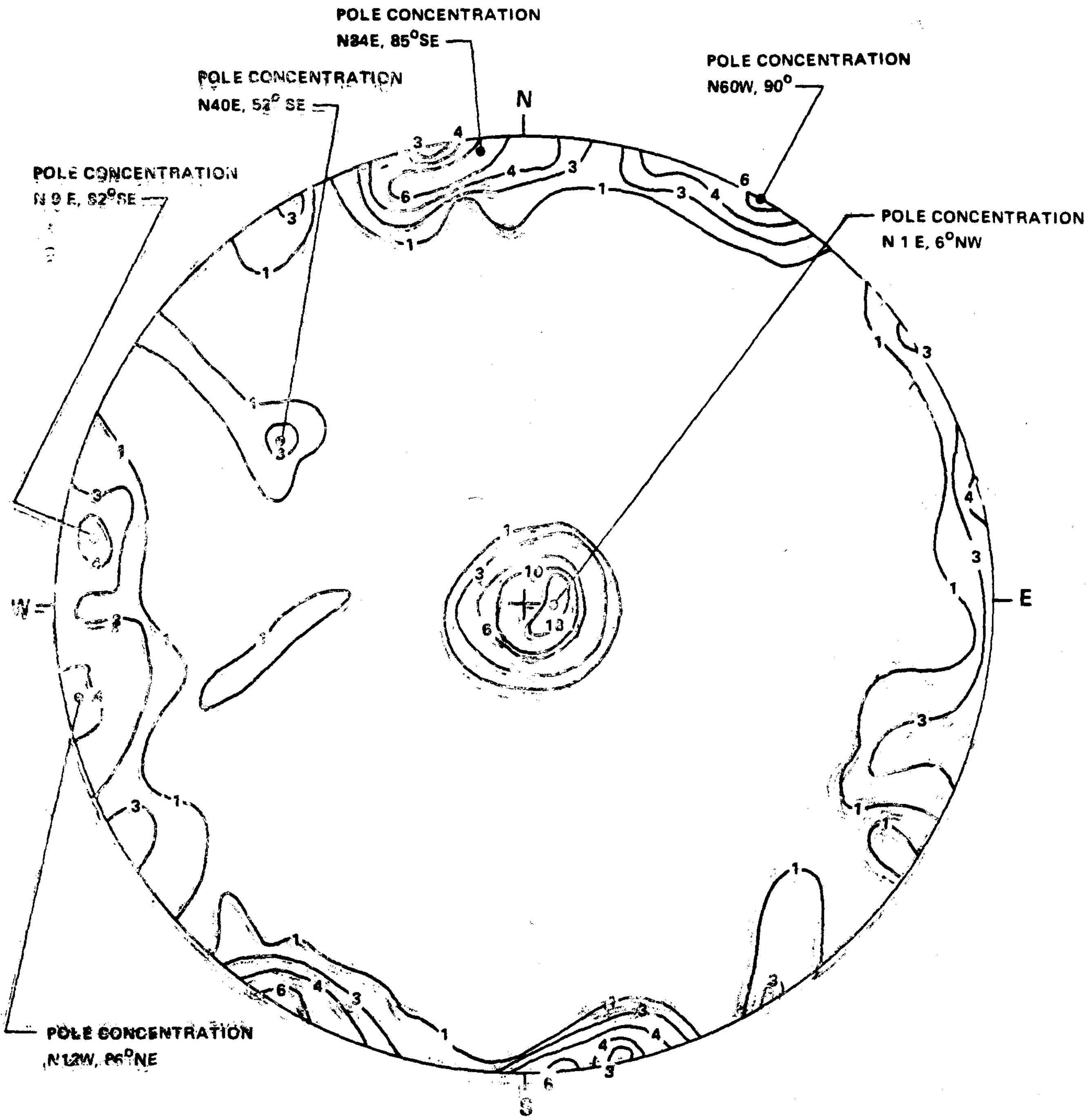
TABLE 1

Bedrock Stratigraphy in Site Area

SYSTEM	SERIES	GROUP	FORMATION	MEMBER	THICKNESS	DESCRIPTION
Silurian	Niagaran	Lockport	Lockport	Goat Island	8'+	Limestone: Medium to dark gray, thin to medium-bedded, medium hard, coarsely crystalline, fresh to slightly weathered. Abundant fossils. Occasional thin dolomite interbeds. Frequent irregular wavy bedding planes.
				Gasport	5'	Dolomite: Medium brown to medium gray, medium-bedded to massive, hard, fine to very fine crystalline, fresh to slightly weathered.
		Clinton		Decew	4-5'	Dolomite: Medium brown to dark gray, thin-bedded, medium hard, very fine crystalline, slightly to moderately weathered. Occasional shell lenses, faint lamination and pitted surfaces. Gradational contact with Rochester formation.
			Rochester		~70'	Shale: Dolomitic, dark gray, thin-bedded fissile, medium hard, microcrystalline, severely weathered. Occasional thin dolomite and limestone interbeds. Seldom more than 5' exposed before completely weathered to clay. Clay minerals: illite, chlorite, kaolinite, occasional montmorillonite.
			Irondequoit	Unnamed	12'	Limestone: Medium brown to medium gray with pinkish tint, thin to medium-bedded, hard, coarsely crystalline, fresh to slightly weathered, fossiliferous. Pink crystals: Rhodochrosite?
Silurian	Niagaran	Clinton	Irondequoit	Rockaway	9.0'+	Limestone: Dark gray, hard, fine to coarsely crystalline, occasional shale partings. Fresh to severely weathered at shale partings.
			Reynales		1.0'	Lime Dolomite: Medium to dark gray, thin to medium-bedded, medium hard to hard, very fine to coarsely crystalline, slightly to severely weathered, contorted beds and occasional clay filled solution cavities.
			Neahga		1.0'-1.5'	Shale: Dark gray, thin-bedded, very soft, fresh.
		Medina	Thorold		2.0'	Mudstone: Light green, medium soft, calcareous, fresh.
			Grimsby	Zone B	15.0'	Sandstone: Red to green, medium-bedded to massive, medium hard, fine grained, fresh to severely weathered. Occasional shale partings and siltstone and claystone interbeds.
				Zone A	~60'	Sandstone, Siltstone with interbedded Shale: Dark red brown to light green to white sandstone and siltstone with red and green shale interbeds. Sandstone/Siltstone: Thin to medium-bedded, very fine to medium grained, medium hard to very hard, fresh, occasional green mottling, fossiliferous. Shale: Thin bedded to fissile, medium soft, moderately to severely weathered.

NOTES: 1. Adapted from Bechtel, 1982.
2. Unit thickness may vary.


PARK AVE
AVE
WEST
ST
HAWLEY ST
W GENESEE ST
(OUTCROPS BENEATH BRIDGE)
(OUTCROPS BENEATH BRIDGE)
TOW PATH
CANAL
BUFFALO ST
ADDITIONAL GEOLOGIC MAPPING ALONG CANAL
ADDITIONAL GEOLOGIC MAPPING ALONG CANAL
ADDITIONAL GEOLOGIC MAPPING ALONG CANAL
WALNUT ST
COTTAGE ST
GENESEE ST
LA GRANGE ST
APPROXIMATE LOCATION OF SEEP
A
A'
N
START
END
SP-1
SP-2/3
SP-4
SP-5
SP-6/7
SP-8
SP-9
SP-10/11
SP-12
SP-14/15
SP-16
SP-17
SP-18/19
SP-20
SP-21
SP-22/23
SP-24
SP-25
SP-26
SP-27
SP-28/29
SP-30
SP-31
SP-32/33
SP-34
SP-35
SP-36/37
SP-38
SP-39
SP-40/41
SP-42
COAL TAR OBSERVED IN NEAR SURFACE SOILS
LIMITS OF SITE
DRIVE
ERIE
S TRANSIT ST
STATE RD
DOCK
SAXTON ST
HARVEY ST
LEGEND
SEISMIC REFRACTION SPREAD
RADAR TRAVERSE LOCATION AND DIRECTION
SP-27 SEISMIC SHOT POINT
GEOLOGIC MAPPING LOCATION
A A' LOCATION OF GEOLOGIC SECTION A-A'
NOTES:
1. BASE MAP COMPILED FROM NYSEG GAS CONDUIT PLAN AND 1929 NEW YORK STATE SEWER IMPROVEMENT PLAN
2. GEOLOGIC SECTION A-A' SHOWN ON FIGURE 6
0 50 100 150 FT
SCALE
SITE VICINITY LOCATION PLAN
NYSEG LOCKPORT COAL TAR SITE
WOODWARD—CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY
DR. BY: BTD
SCALE: AS SHOWN
PROJ. NO.: 82C4495-1
CK'D. BY: HBG
DATE: 5 NOVEMBER 1982
FIG. NO.: 1



N = 155
CONTOURS: 1, 3, 4, 6, 10, 18% / 1% AREA
LOWER HEMISPHERE PROJECTION
LOCATIONS OF MAPPED OUTCROPS SHOWN ON FIGURE

POINT DENSITY PLOT FOR POLES OF MAPPED JOINTS IN SITE-VICINITY		
WOODWARD—CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS WAYNE, NEW JERSEY		
DR. BY: BTD	SCALE: NONE	PROJ. NO.: 82C4495–1
CK'D. BY: MRD	DATE: 10 NOV 1982	FIG. NO.: 2


PARK AVE
AVE
WEST AVE
ST
W GENESEE ST
HAWLEY ST
DRIVE
ERIE
DOCK
STATE RD
TOW PATH
CANAL
BUFFALO ST
WALNUT ST
GENESEE ST
COTTAGE ST
LA GRANGE ST
HARVEY ST
CLINTON ST
NO DATA
LIMITS OF SITE
LEGEND
CONTOURS AT 50, 100, 150, 200, & 400 mmhos /m
< 50 mmhos / m
50 – 150 mmhos / m
> 150 mmhos / m
LIMITS OF INVESTIGATION
CLOSED AREA OF DECREASING CONDUCTIVITY VALUES
NOTES:
1. BASE MAP COMPILED FROM NYSEG GAS CONDUIT PLAN AND 1939 NEW YORK STATE SEWER IMPROVEMENT PLAN
2. LOOK DEPTH IS 20 FEET
3. VALUES GREATER THAN 400 mmhos / m WERE CONSIDERED RESULTS OF CULTURAL INTERFERENCE AND WERE NOT CONTOURED
4. CONTOURS DASHED WHERE INFERRED
0 50 100 150 FT
SCALE
CONDUCTIVITY CONTOUR PLOT
NYSEG LOCKPORT COAL TAR SITE
WOODWARD—CLYDE CONSULTANTS
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FIG. NO.: 3

LEGEND

INFERRED ELEVATION OF BEDROCK SURFACE IN FEET ABOVE SEA LEVEL

LOCATION OF SECTION A–A'

NOTES:

1. SEE FIGURE 5 FOR GEOLOGIC SECTION A–A'
2. GROUND SURFACE TOPOGRAPHY FROM SHOECRAFT, DRURY AND McNAMEE, SHEET 8, 1939
3. DEPTH TO ROCK INFERRED FROM GEOPHYSICAL DATA AND BORINGS BY SHOECRAFT, DRURY AND McNAMEE, SHEET 5, 1939
4. BASE MAP COMPILED FROM NYSEG GAS CONDUIT PLAN AND 1939 NEW YORK STATE SEWER IMPROVEMENT PLAN

INFERRED ELEVATION OF BEDROCK SURFACE
NYSEG LOCKPORT COAL TAR SITE

WOODWARD—CLYDE CONSULTANTS
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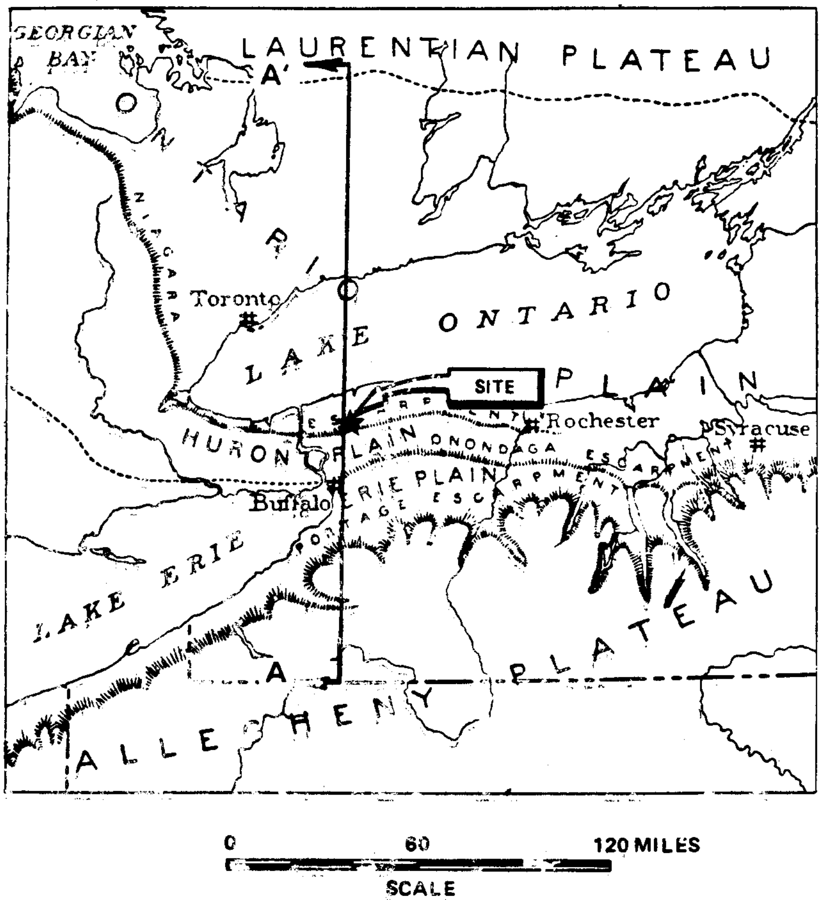
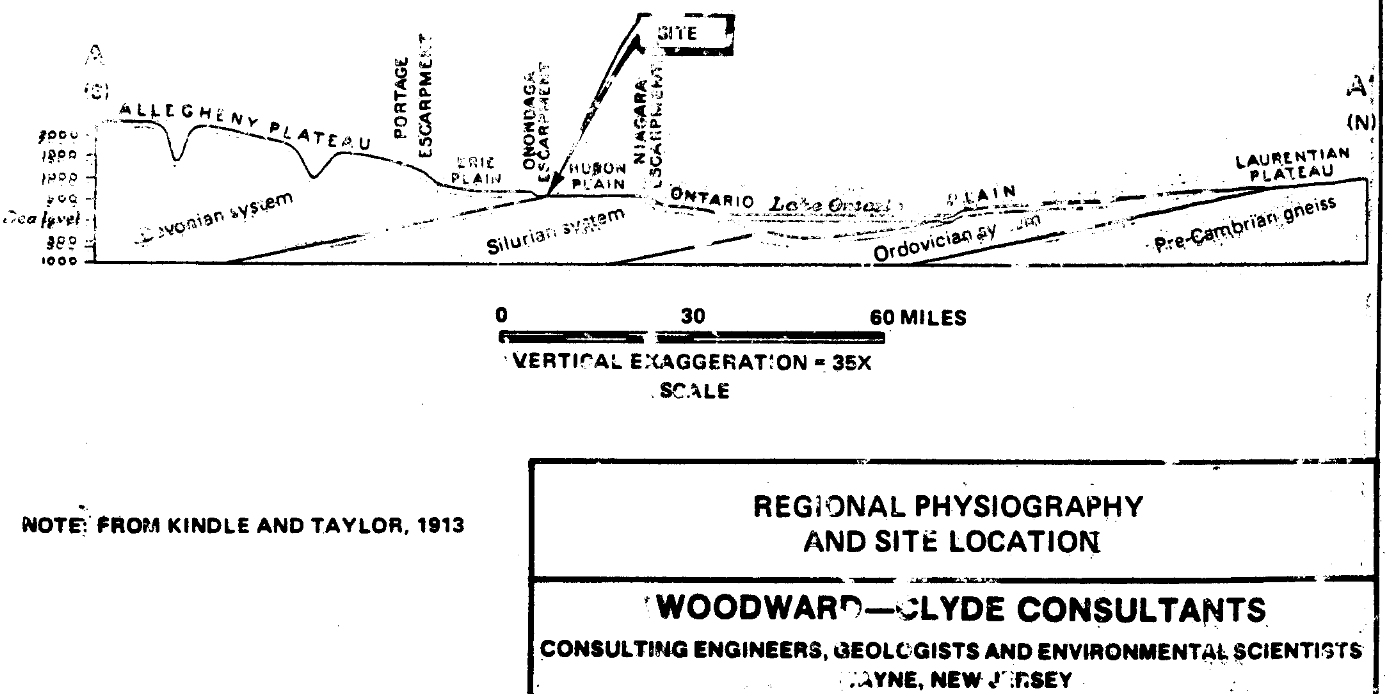
WAYNE, NEW JERSEY

DR. BY:	BTD	SCALE:	AS SHOWN	PROJ. NO.:	82C4495–1
CK'D. BY:	MRD	DATE:	11 NOVEMEBR 1982	FIG. NO.:	4





NOTE: FROM KINDLE AND TAYLOR, 1913

REGIONAL PHYSIOGRAPHY AND SITE LOCATION

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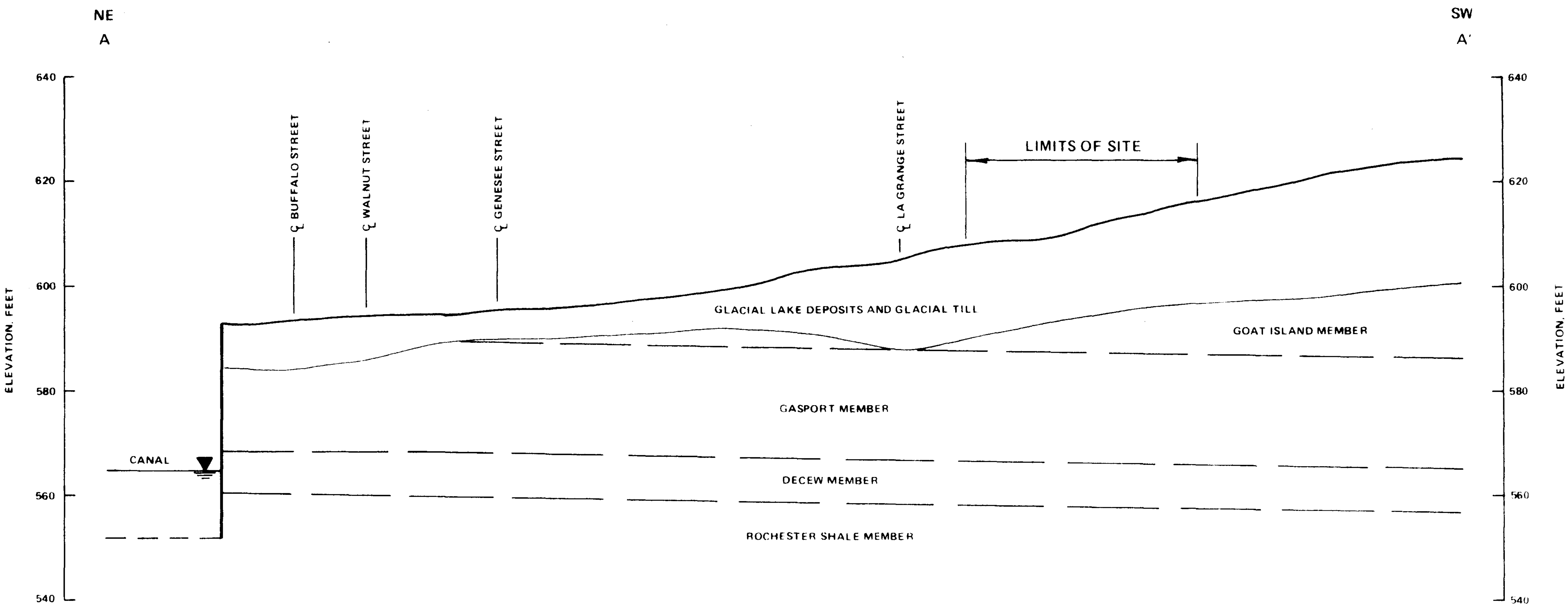
WAYNE, NEW JERSEY

DR. BY:	BTD	SCALE:	AS SHOWN	PROJ. NO.:	82C4495-1
CHK. BY:	MRD	DATE:	10 NOV 1982	FIG. NO.:	5



NOTES

1. SEE FIGURES 1 AND 4 FOR SECTION LOCATION
2. PROFILE IS INTENDED AS AN AID IN VISUALIZING SITE CONDITIONS. CONTACTS HAVE BEEN INFERRED FROM GEOPHYSICAL DATA, BORINGS BY SHOECRAFT, DRURY AND McNAMEE, (SHEET 5, JULY 1939), TELFORD, 1978, AND RICKARD AND FISHER, 1970
3. TOPOGRAPHY IS FROM SHOECRAFT, DRURY AND McNAMEE, SHEET 8, 1939
4. SOIL AND ROCK TYPES DESCRIBED IN SECTION 4.3 OF TEXT

0 50 100 FT

VERTICAL EXAGGERATION = 2.5X

SCALE

NE – SW GEOLOGIC SECTION
NYSEG LOCKPORT COAL TAR SITE

WOODWARD—CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
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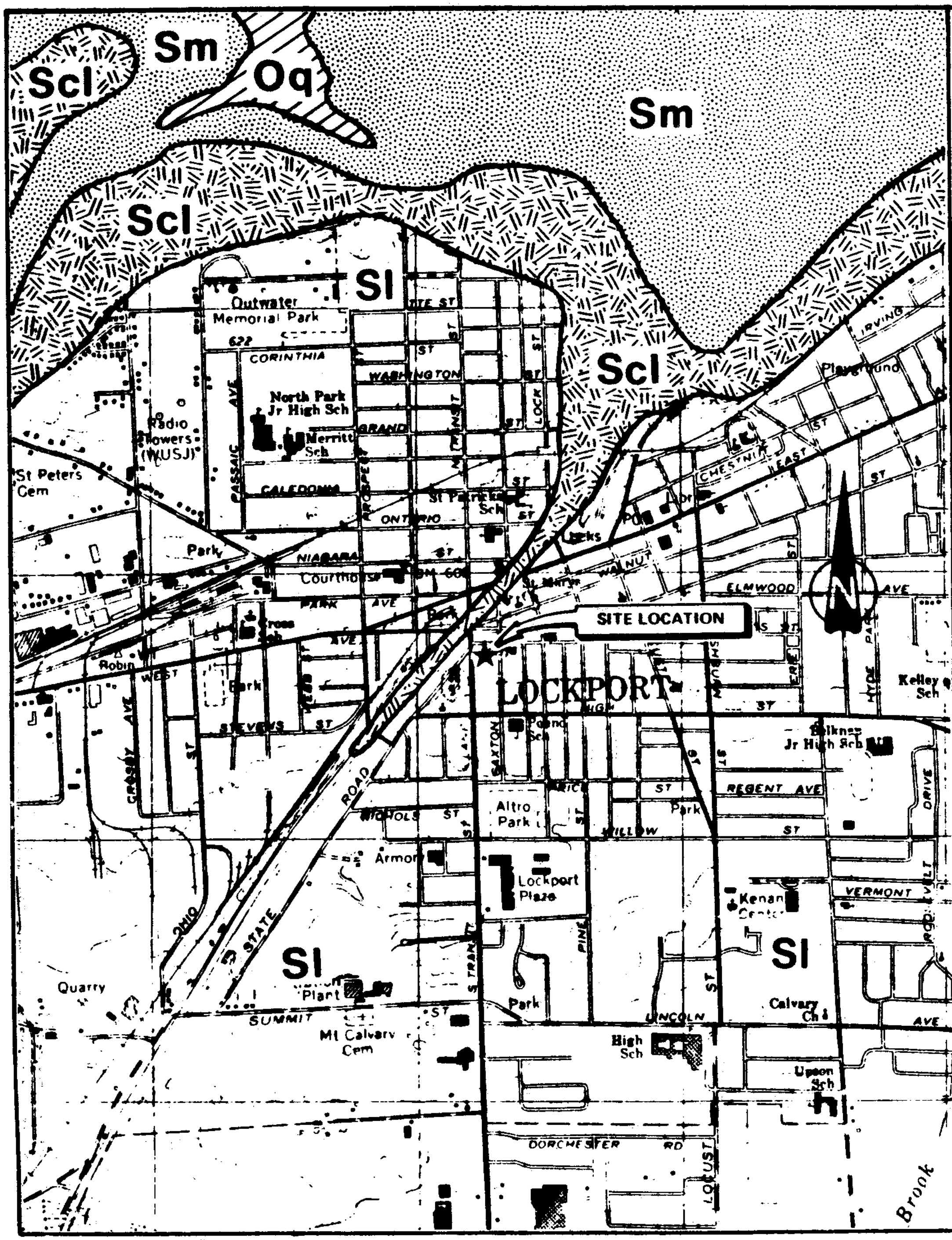
DR. BY:	BTD	SCALE:	AS SHOWN	PROJ. NO.:	82C4495 1
CK'D. BY:	MRD	DATE	11 NOV 1982	FIG. NO.	6



LEGEND

Sl	UPPER SILURIAN LOCKPORT GROUP (Dolomite and Limestone)
Scl	UPPER AND LOWER SILURIAN CLINTON GROUP (Dolomite, Limestone, Shale and Sandstone)
Sm	LOWER SILURIAN MEDINA GROUP (Sandstone and Shale)
Oq	UPPER ORDOVICIAN QUEENSTON FORMATION (Shale)

NOTES:

1. BASE MAP: U.S.G.S. 7.5 MINUTE TOPOGRAPHIC MAP, LOCKPORT QUADRANGLE, NEW YORK (1980)
2. GEOLOGY FROM KINDLE AND TAYLOR, 1913 AND RICKARD AND FISHER, 1970

0 1000 2000 3000 FT

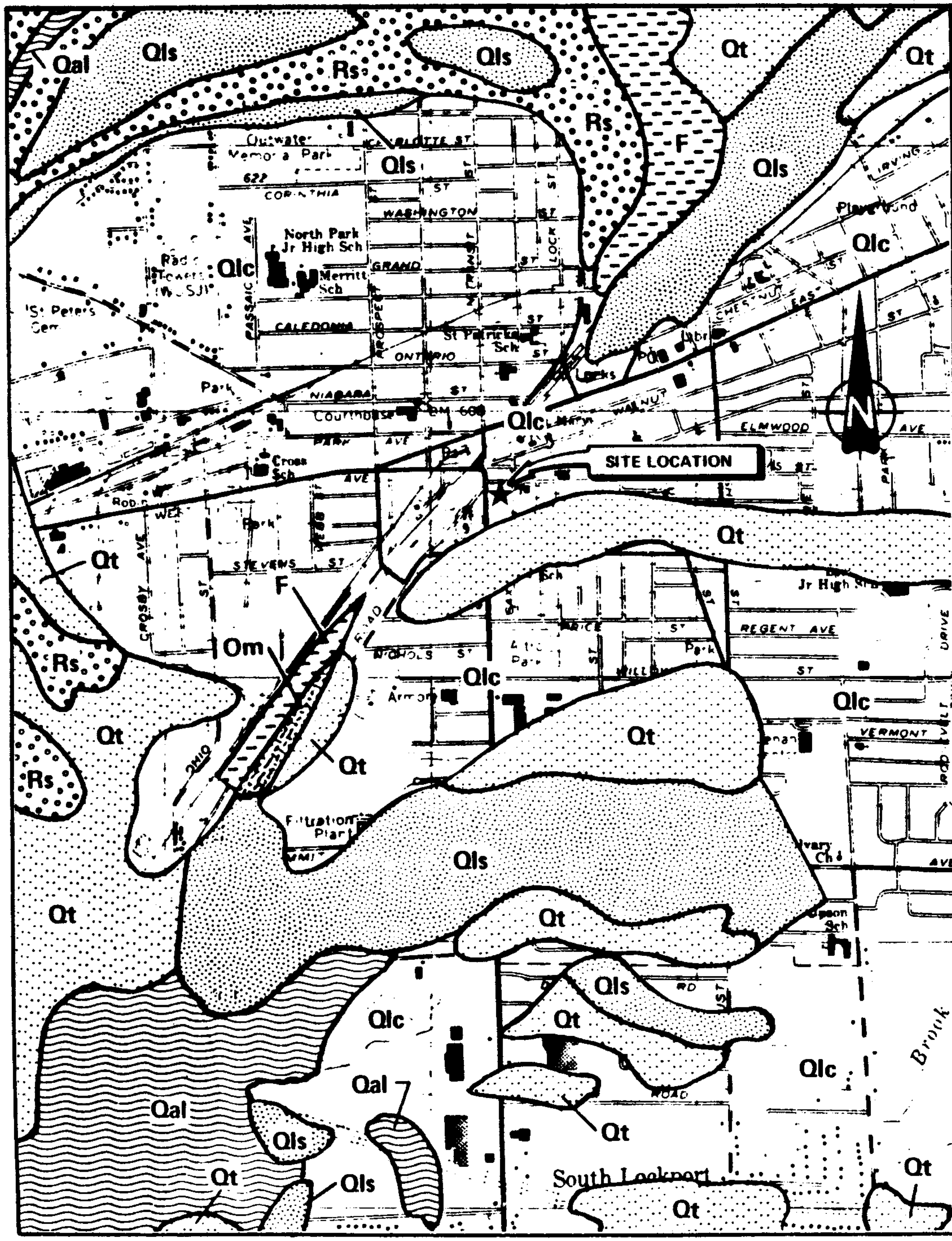
SCALE

BEDROCK GEOLOGY OF SITE AREA

WOODWARD—CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

DR. BY: BTD	SCALE: AS SHOWN	PROJ. NO.:	82C4495-1
CK'D. BY: MRD	DATE: 9 NOVEMBER 1982	FIG. NO.:	7



LEGEND

Qal	STREAM DEPOSITS
Qt	GLACIAL TILL
Qlc	SILTY, CLAYEY GLACIAL LAKE DEPOSITS (May overlie glacial till)
Qls	SANDY, GRAVELLY GLACIAL LAKE DEPOSITS
Rs	RESIDUAL SOILS DEVELOPED ON ROCK
Om	ORGANIC MUCK
F	FILL

NOTES:

1. BASE MAP: U.S.G.S. 7.5 MINUTE TOPOGRAPHIC MAP, LOCKPORT QUADRANGLE, NEW YORK (1980)
2. GEOLOGY FROM PEARSON, et al, 1947, AND KINDLE AND TAYLOR, 1913

0 1000 2000 3000 FT

SCALE

SURFICIAL GEOLOGY OF SITE AREA

WOODWARD—CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

DR. BY: BTD	SCALE: AS SHOWN	PROJ. NO.: 82C4495–1	
CK'D. BY: MRD	DATE: 9 NOVEMBER 1982	FIG. NO.: 8	


PARK
AVE
AVE
WEST
ST
W GENESEE ST
ST
TOW PATH
CANAL
BUFFALO
ST
IW-1
MW-1
WALNUT
ST
ST
COTTAGE
GENESEE
ST
B-2
ST
LA GRANGE
ST
MW-2
S TRANSIT
HAWLEY
DRIVE
ERIE
IW-2
M-3
B-3
LIMITS OF SITE
B-1
SAXTON
M-4
ST
HARVEY
STATE RD
DOCK
LEGEND
MW-1 PROPOSED MONITOR WELL LOCATION AND NUMBER
IW-1 PROPOSED INTERMITTENT WELL LOCATION AND NUMBER
B-1 PROPOSED BORING LOCATION AND NUMBER
NOTE:
BASE MAP COMPILED FROM NYSEG GAS CONDUIT PLAN AND 1939 NEW YORK STATE SEWER IMPROVEMENT PLAN
0 50 100 150 FT
SCALE
PROPOSED BORING AND MONITORING WELL LOCATION PLAN
NYSEG LOCKPORT COAL TAR SITE
WOODWARD—CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY
DR. BY: BTD
SCALE: AS SHOWN
PROJ. NO.: 82C4495-1
CK'D. BY: MRD
DATE: 16 NOV 1982
FIG. NO.: 9