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INDUSTRIAL DEVELOPMENT, URBAN LAND-USE PRACTICES AND RESULTING GROUNDWATER CONTAMINATION, NEWARK, NEW JERSEY

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Founded in 1666, Newark, New Jersey became a major northeastern manufacturing and transportation center. Primary industries in Newark were malleable iron production, machine shops, leather works, varnish manufacture and smelting. Prior to European settlement a significant portion of the current city was salt marsh. With the growth of transportation corridors and the urban center, salt marsh became filled with man-made materials. Filling, initiated by the railroads, was expanded by Essex County in an effort to eliminate malarial mosquito habitat. Today, over 21 million tons of fill material occupy former salt marsh areas. Fill material consists of municipal solid waste, railroad cinders, dredge spoils and industrial wastes. Groundwater in shallow estuarine deposits, fill material, a glacial buried-valley aquifer and the Triassic Passaic Formation have all been degraded by urban development. The use of surface water for public distribution from 1870 to present fostered disregard for shallow groundwater resources. Industrial pumping and channel dredging contributed to deeper groundwater degradation from salt water intrusion and vertical movement of shallow contamination. Since 1947, brewery and industrial wells closed due to declining water quality. City, State and Federal files examined through April 1990 indicate 108 groundwater contamination cases are present within Newark city-limits. Many of these contamination cases correlate with former salt marsh areas and now have fresh groundwater within man-made fill.

INTRODUCTION

The City of Newark was founded in 1666 when New England Puritans led by Robert Treat landed on the shores of the Passaic River at the current city location (Cunningham, 1966). Incorporated in 1836, today Newark covers approximately 25 square miles and is bordered on the east by the Passaic River and Newark Bay; and by

Newark Bay Study Area
NBSA-00059

seven cities and towns along the north, west and southern boundaries (Figure 1).

Newark is located in northeastern New Jersey within the Triassic lowland physiographic province (Figure 1). The average rain fall for Newark is slightly greater than 42 inches per year (NOAA, 1988). The city is underlain by Pleistocene stratified drift resting on Triassic sandstones and shales of the Passaic Formation (Herpers and Barksdale, 1951). The eastern portion of Newark was originally covered by a tidal salt marsh (Figure 2). Groundwater under the City of Newark occurs within thin stratified drift deposits, a buried valley aquifer, and fractures in the Passaic Formation (Herpers and Barksdale, 1951; Figure 3). The greatest yields are produced by wells completed in the buried valley aquifer (Herpers and Barksdale, 1951).

The research for this study was started during 1987. Public file reviews initiated during 1987 were substantially completed during February 1990, although examination of public files is continuing. Research presented in this document includes municipal, State and Federal Freedom of Information reviews from the examination of 116 ECRA, 65 NJPDES, 48 CERCLA, 45 Enforcement and 21 Solid Waste files - all for sites within Newark city-limits. The New Jersey Environmental Cleanup Responsibility Act (ECRA) and New Jersey Pollutant Discharge Elimination System (NJPDES) are State regulatory programs.

INDUSTRIAL DEVELOPMENT

Newark was the site of many technological breakthroughs during the American industrial revolution. Cunningham (1966) provides an excellent summary of industrial development in Newark, while Karschner (1985) is a guidebook with detail on specific properties and thorough referenced-discussions of industry types. Unless other citation is provided, this section is derived from Cunningham (1966) and Karschner (1985).

By 1806 Newark was known for the manufacture of shoes (Holbrook, 1891). Industries such as tanning, slaughter houses and meat-packing surely accompanied the shoe manufacturers. Newark became well known for leather tanning establishments. Seth Boyden, a local inventor, developed production processes for both patent leather and malleable iron. Boyden did not obtain patents to either process but gave away the production secrets to stimulate jobs. Because of Boyden, numerous malleable iron foundries were present in Newark (Scarlett and Scarlett, 1889; Sanborn Map Co. 1882). Large iron forges included the Hay Foundry, Maher & Flockhart Foundry and the Sacks-Barlow Foundry. Balbach Smelting and Refining Company perfected the first commercial process to remove precious metals from non-ferrous ores in 1864 at their original plant site. Success with the process caused them to move during 1903 to a larger site on former salt meadow still within the city boundary.

PRE-1950 PAPER INFO ?

The first domestic production of plastics also took place in Newark. The Celluloid Company began by manufacturing plastic brushes, combs, collar fasteners and novelties. Celluloid Company occupied a large complex and historical maps show other plastics production companies in nearby locations (Sanborn Map Co. 1892-1951). Machine shops were plentiful within the city due to the diverse industrial base. Newark was well-known for the production of stationary steam-engines used to power factories. Tool manufacturers such as Stanley Works and Wiss Company also had factories in the city.

Jewelry production has been a consistent industrial activity in Newark. Krementz & Company started in Newark and invented the one-piece collar button; Tiffany and Company operated in the city. Many small jewelry establishments were also located within Newark (Sanborn Map Co., 1892-1951). Varnish, paint and varnish-remover manufacture were common industries in Newark. Both inorganic and organic pigment manufacture took place within the city at many locations. Coal gasification facilities were present in Newark and by-product processing included aniline dye, creosote and tar production. Newark was also known for its many breweries. Ballentine started here and an influx of German immigrants during the 19th century provided brewing expertise.

Many of the heavy industries were located on former salt meadows along the eastern side of the city, however land-use zoning was not practiced during the early industrial development of Newark (Newark Planning Commission, 1915). Factories and homes were interspersed with little thought and early efforts to impose planning failed.

WATER SUPPLY AND USAGE

For the first century Newark residents depended upon a natural spring and hand-dug wells (Newark Water Department, 1969). Since 1861 the City of Newark has been served by surface water supplies, although some residents persisted in using private wells. An 1885 survey showed seventy-five percent of all private wells in the city were polluted (Cunningham, 1966). Pollution of the Passaic River, first widely detected during 1873 by taste (Cunningham, 1966) was later confirmed by analytical testing (Leeds, 1881). Scientific observers during 1873 noted coal tar residues suspended in the river water and popular accounts reported fumes causing paint to peel from houses adjacent to the river (Brydon, 1974). In response, municipal officials developed a surface water reservoir system which, through expansion, has remained adequate to the present day.

Industrial consumers of water used both municipal and groundwater resources. Sanborn Maps (1892) disclose the presence of water wells at industrial sites. These early machine drilled wells have not been cataloged and do not appear in any published well inventory. A comprehensive investigation of published and unpublished sources indicates a minimum of 67 industrial wells

exist in Newark (Figure 4). The actual number of industrial wells could easily exceed 100. For instance, Herpers and Barksdale (1951) provide information from Celluloid well #27, but only four well logs for Celluloid could be located during a 1991 data retrieval. Twenty-two of the industrial wells shown on Figure 4 are located at confirmed hazardous-waste sites. During 1991 no industrial use of groundwater resources could be identified from public records and the only commercial groundwater use is for air conditioning purposes.

PUBLIC HEALTH

The City of Newark earned an unfortunate reputation due to high mortality rates (Galishoff, 1988). Public health problems included small pox, tuberculosis, typhoid, cholera and malaria. Some early observers linked industrial pollutants and over-crowding to incidence of tuberculosis (Galishoff, 1988). Degraded water quality was found to be responsible for diseases such as cholera and typhoid (Cunningham, 1966; Brydon, 1974). Unsanitary milk storage and processing contributed to the high mortality of infants (Galishoff, 1975). Malaria was prevalent in the city and initially "miasma" was blamed (Galishoff, 1988). During the early 20th century mosquitos were identified as carrying malaria and the salt marshes adjacent to Newark were linked to the spread of this disease.

SALT MEADOWS

The salt marsh (Figure 2) was initially used for growing salt hay by the Puritans and as early as 1667 the residents of Newark were ditching the meadows to increase agricultural production (Cunningham, 1966). Agricultural use continued into the early 20th Century as a hay market existed in Newark until at least 1912 (Essex County Mosquito Commission, 1912).

Railroad and Highway Construction

The railroads pioneered filling of the salt meadows during the early main-line and switching-yard construction. Railroads were located in the salt meadows with the first construction of the New Jersey Railroad in 1834 (Drummond, 1979). The Central Railroad's Elizabeth Branch line was in operation on the meadows by 1839 (Anderson, 1984). Drummond (1979) notes New York garbage was used as railroad fill during the 1860's. Another type of railroad fill-material which was abundant and widely-used was coal cinders (Anderson, 1984).

Recent repair to the Pulaski Skyway viaduct and expansion plans for the New Jersey Turnpike provides subsurface information under highway right-of-ways (Ebasco, 1987a, 1987b; Berger, 1989). Examination of boring logs reveals fill materials similar to those used by the railroad to be within public road easements. A newspaper insert examined early growth on the meadows (Newark Sunday Call, 1916). This article refers to Avenue R (now Doremus

Avenue) as "Chemical Row". Mention is made how Avenue R is not yet a dedicated easement, but local manufacturers have taken initiative and improved "a corduroy road built-up with slag and waste" in order to provide access to factories.

Essex County Mosquito Extermination Commission

During 1912 the Essex County Mosquito Extermination Commission began to eliminate malarial mosquito breeding-habitat. The Commission employed drainage ditches, tidal gates, oiling of catch basins and filling of the meadows. From 1912 through 1940, solid waste fill was used by the Commission to displace standing water and eliminate breeding pools. During the period of 1912 to 1920, local solid waste contractors were also asked to fill problem breeding-spots in residential neighborhoods throughout the city.

The filling activity was officially sanctioned and undertaken at the direction of the Commission. By review of the Annual Reports, it is clear that an objective was to fill swamp-land and promote industry (Essex County Mosquito Extermination Commission, 1913). By 1930 the Mosquito Commission had filled nearly all the salt meadows shown on Figure 2. The effect of tidal gates, ditching and filling caused a shift from salt-water dominated to fresh-water dominated marsh ecology. The indicator of this change is Phragmites australius, which forced the Mosquito Commission to build a specialized "Fox Tail Crusher" to travel through this hardy brackish-water grass (Essex County Mosquito Extermination Commission, 1927). Salt hay was displaced and the familiar phragmites grasses became dominant throughout the New Jersey meadowlands.

Hydraulic Fill

Dredging of Newark Bay provided an abundant source of fill material. Construction contractors of the Port Newark during 1915 used the material dredged from the ship channel to establish upland terminal facilities (Cunningham, 1988). The Comprehensive Plan for The City of Newark (1915) notes: "The Meadowland may be reclaimed by bulkheading and filling. The cheapest fill is that procured by dredging. Ashes and rubbish are used near the built-up sections of the city." The meadow-filling practices were also sanctioned by the State of New Jersey; in a 1930 report the Meadow Reclamation Commission recommended harbor dredging, channel development and hydraulic filling. Use of hydraulic fill has persisted up until at least 1980.

The source of the hydraulic fill, the Passaic River and Newark Bay have been known to be polluted for over 100 years. The aquatic life in Newark Bay is currently stressed by industrial pollution and has been investigated by many studies (Cristini, 1988; Belton and others 1988; DeVito and others, 1988; Bopp and other, 1988; Bopp, 1988; Tong and others, 1989; Belton and others, 1983; Belton and others, 1982; and Belton and others,

1985). The majority of these investigations focus on organic pesticides and pesticide by-products; authors conclude these compounds have had an impact on the aquatic life. A study by the State of New Jersey (Belton and others, 1985) precipitated a fishing ban for Newark Bay and a fishing advisory for the New York Bight.

Landfills

The City of Newark continued the Essex County Mosquito Commission landfilling practice by operating municipal landfills on the former salt meadows. Ordinance 13:4-4 permitted industrial waste disposal in city-licensed landfills (City of Newark, 1966). By 1986 the New Jersey Turnpike commission had mapped 7 former landfills adjacent to the right-of-way (Berger, 1986, 1987, 1990). The presence of hazardous and industrial waste co-mingled with municipal wastes have caused the Turnpike Commission to scale-down widening plans. Newark Housing and Redevelopment Authority reports (1965,1973) detail an industrial redevelopment plan to build factories upon waste-filled former salt meadows. This strategy had been devised as early as 1912 by the Mosquito Commission. Essex County Mosquito Extermination Commission documents (1941, 1948 and 1956) confirm some municipal landfills were placed upon areas previously covered with industrial wastes and hydraulic fill.

GROUNDWATER CONTAMINATION

The use of surface supply for drinking water fostered a disregard for groundwater resources. Herpers and Barksdale (1951) noted that industrial groundwater consumption was increasing and water quality was declining. Salt water intrusion into deep Passaic F Formation wells mapped by Herpers (1948; Figure 5) is thought to result from the combined effect of river-dredging and over-pumping (Herpers and Barksdale, 1951). Dredging reduced the silt and clay thickness of the river-bed and placed brackish water in close association with fresh groundwater. Because of declining water quality, Ballentine Brewery was forced to experiment with artificial recharge and began to close supply wells (Herpers and Barksdale, 1951; Nichols, 1968). More recent water supply wells drilled into the Passaic Formation show high chloride conditions persist (Figure 6).

Shallow groundwater resources have been studied under several State and Federal regulatory programs. File reviews show that by February 1990 there were 108 confirmed shallow groundwater contamination cases within Newark city-limits (Figure 7). Groundwater contamination cases form a heavy cluster in areas of former salt meadows and intensive filling activity. Boring logs from meadows locations indicate a variety of fill, including slag, paint sludge, municipal wastes and cinders in thicknesses of up to 40 feet. The majority of borings show 10 feet of fill overlying an identifiable organic-peat "meadow mat". Fresh, low-

quality groundwater is often found at shallow depth, 2 to 3 feet below surface, and in the fill material.

Two linear trends can be identified by examining the distribution of groundwater contamination cases (Figure 8). These are four gasoline stations along Bloomfield Avenue and a grouping of industries on both sides of Freylinghusen Avenue. A broad grouping of contamination cases in the Ironbound section of the city results from a cluster of varnish and paint manufacturers with a few chemical and dye formulators. Review of 116 ECRA cases indicates that, in Newark, an ECRA-subject manufacturer has a forty-eight percent chance of discovering groundwater contamination during the course of environmental investigations.

A marked anomaly in the distribution of groundwater contamination cases is the lack of publicly accessible information for property controlled by the Port Authority of New York and New Jersey at Newark Airport and Port Newark (Figure 8). Recent newspaper articles and file review information indicate this likely does not result from a lack of investigation. The former edge of salt meadows or "meadows line" has been shown by many cartographers (Walling, 1859; Scarlett and Scarlett, 1889; Lathrop and Ogden, 1012; USGS, 1899-1937; Parillo and Kasabach, 1963). By using the meadows line provided by Parillo and Kasabach (1963; Figure 2) and an average depth of 10 feet, calculations show approximately 21.5 million tons of fill material are present in former salt marsh areas.

CONCLUSIONS

Newark has a long industrial history which, although unique, is similar to many contemporary cities. Intensive industrial land-use and public health threats have resulted in over 21 million tons of fill deposited in a former salt marsh area. From 1912 to 1950, any available material including hazardous industrial-wastes were indiscriminately used to eliminate malarial mosquito habitat. Records also indicate waste-fill was used in some residential neighborhoods between 1912 and 1920.

No negative aspects of this filling were anticipated by the responsible local, State and Federal authorities. Documents prepared by County and State Commissions make it clear that using industrial waste in wetlands was viewed as acceptable and was even encouraged. An ordinance named "trade wastes" as being permitted for placement in city-licensed landfills. Officials saw a benefit from this "land reclamation" which was the creation of new areas suitable for industrial development.

The result of this filling and industrial land-use is over 108 known groundwater contamination cases with the potential for many more. Uncatalogued, forgotten water-wells at hazardous-waste sites have the insidious potential to vertically spread known shallow groundwater contamination. The urban location, tremendous volume of fill-material present and the strong

correlation of fill with groundwater contamination suggests a need for a balanced, regional management-strategy which monitors groundwater quality and minimizes disruption of contamination, but does not penalize lenders and maximizes landowner's ability to re-use these old industrial sites. For Newark and cities with similar conditions, proposed New Jersey regulatory cleanup standards should be deferred and appropriate alternate cleanup standards developed. The regional conditions found in cities like Newark make environmental cleanup technically impracticable from an engineering perspective.

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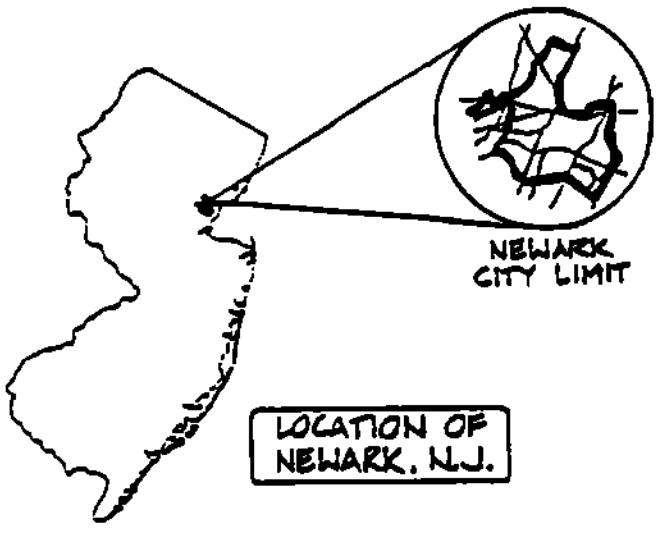

FIGURE 1 - LOCATION MAP

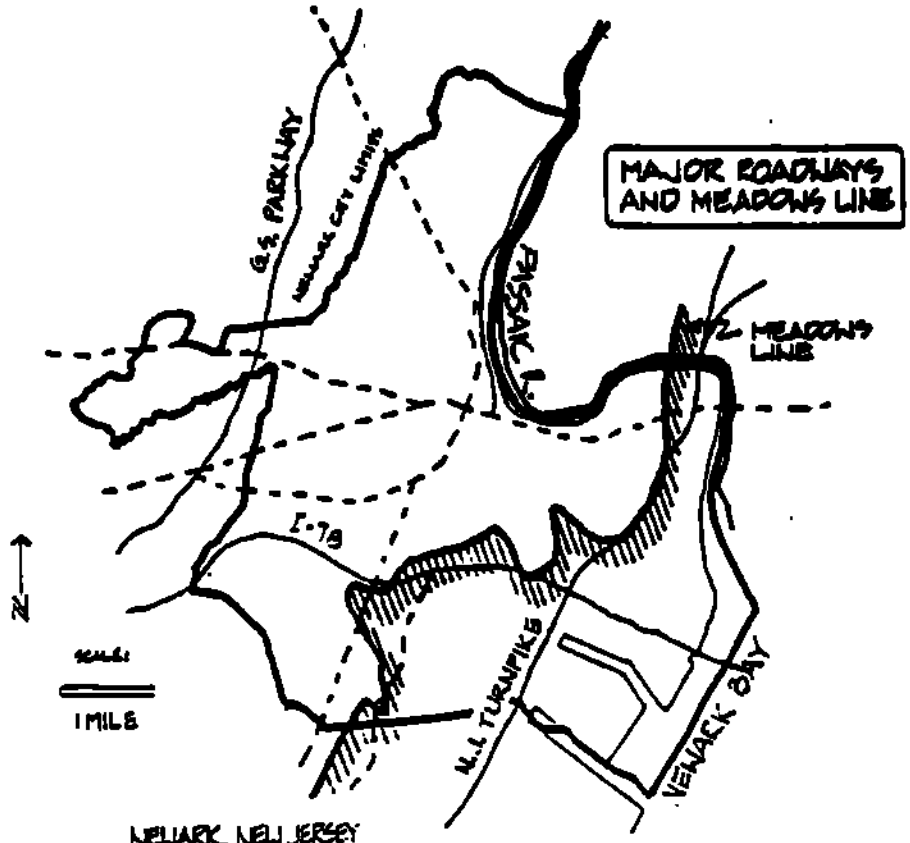

FIGURE 2 - MEADOWS AREA AND LOCAL FEATURES

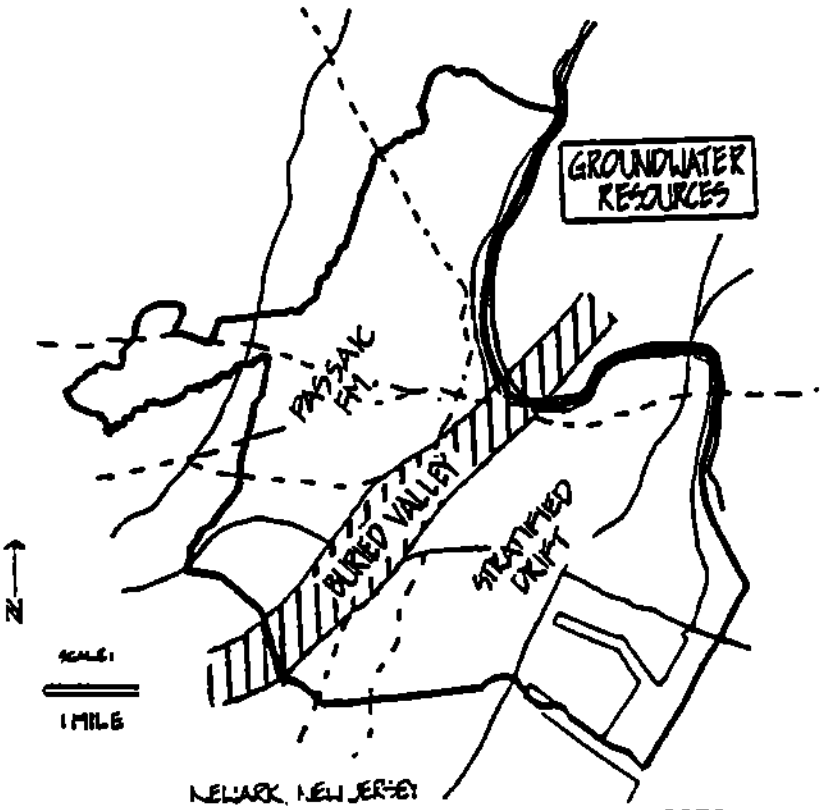

FIGURE 3 - GROUNDWATER RESOURCES

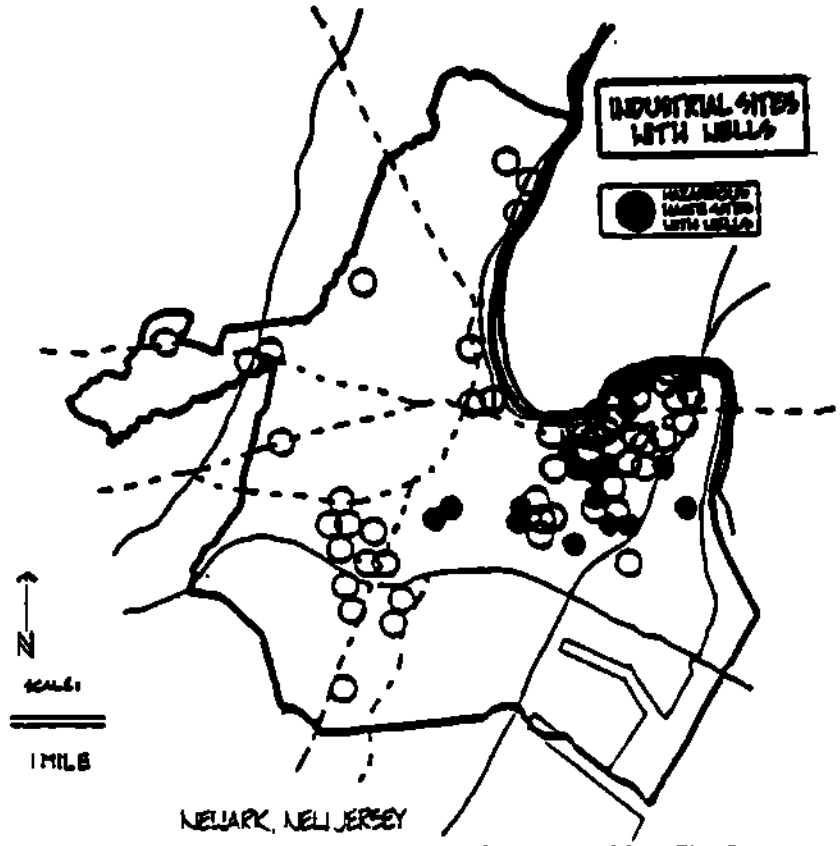

FIGURE 4 - INDUSTRIAL WATER WELLS

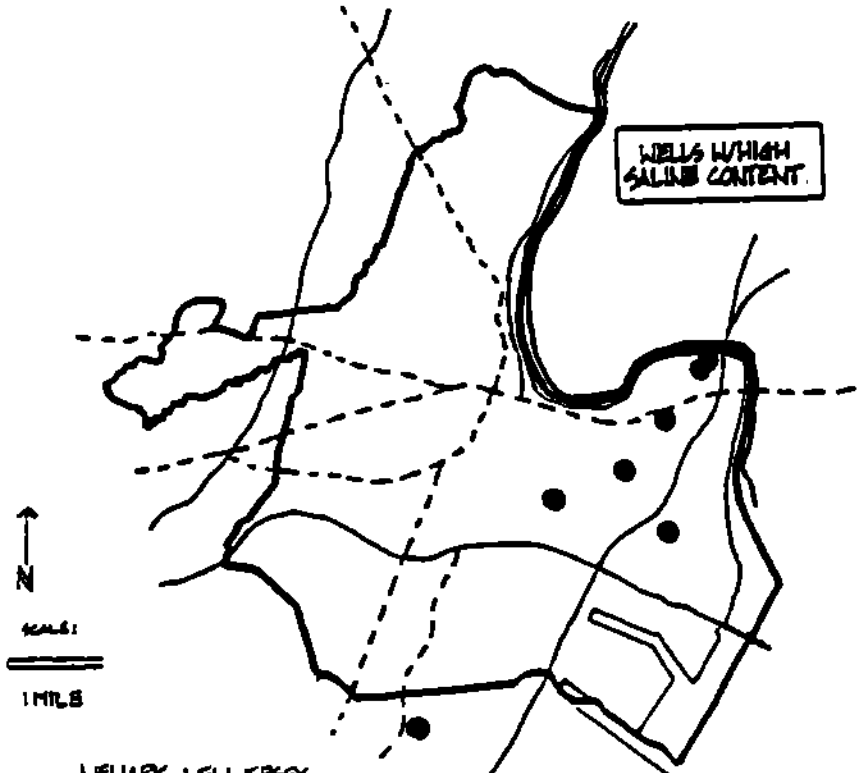

FIGURE 8 - HIGH CHLORIDE WELLS

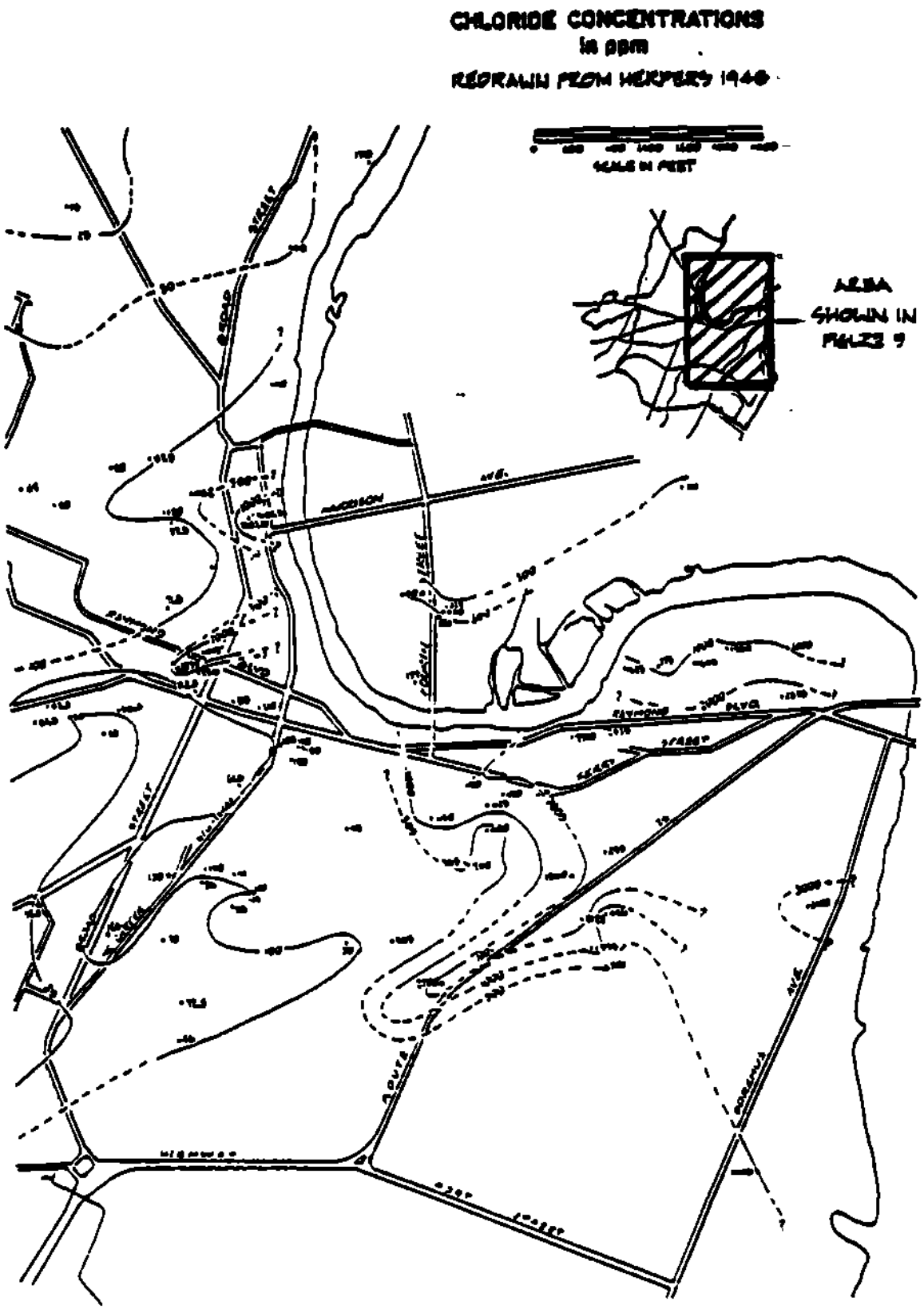

FIGURE 5 - SALT WATER INTRUSION

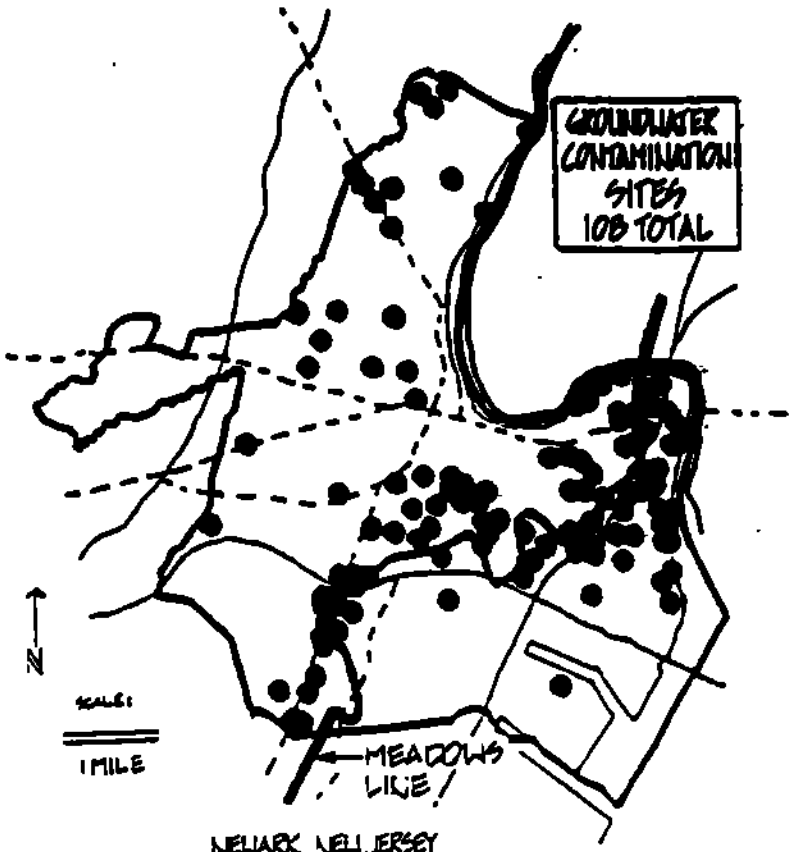

FIGURE 7 - GROUNDWATER CONTAMINATION
(showing meadows line)

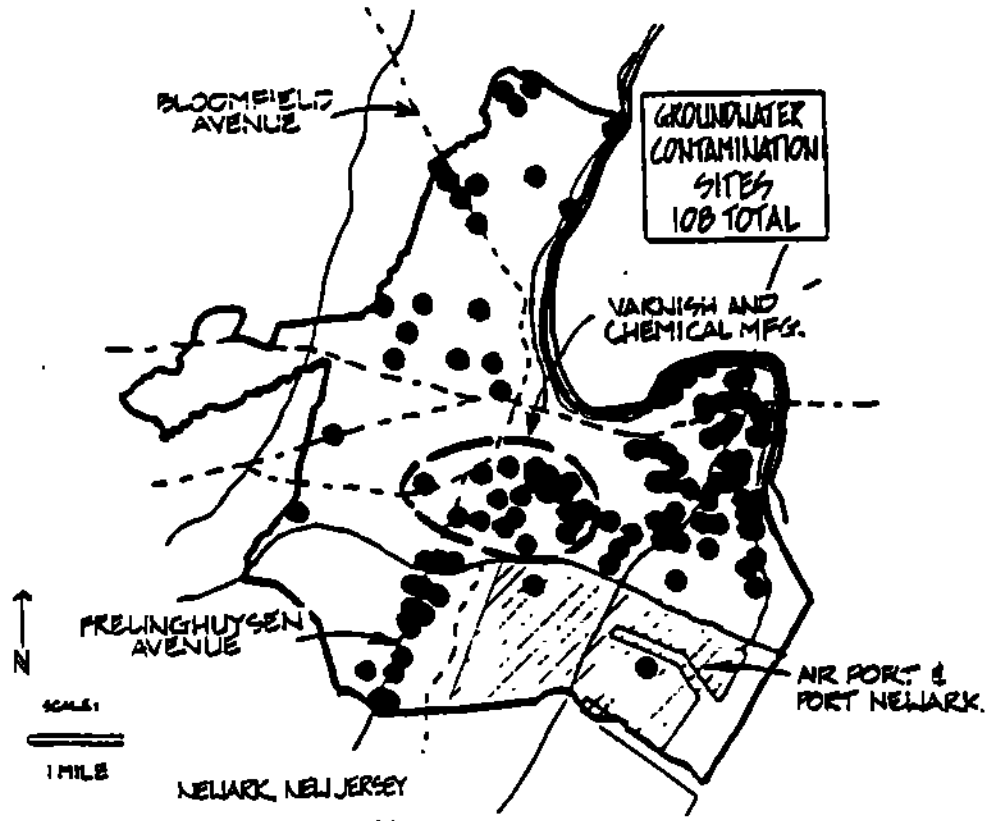

FIGURE 8 - GROUNDWATER CONTAMINATION
(showing trends)

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SOCIETY FOR INDUSTRIAL ARCHEOLOGY

NEWSLETTER

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Oldest U.S. carbarn, rare 1861 roof trusses, set for demo





Above (top) & right Interior of the 1861 Canal St. carbarn. Visible are the iron roof "principles" (trusses) and the building's heavy timber frame. Each truss slides onto a cast-iron shoe above a post.
Above (bottom) Modern exterior of Canal St. buildings: 1887 barn (L.) and 1861 barn (R). *E.D. Weber photos.*

The 1861 Canal Street carbarn in New Orleans, reportedly the oldest streetcar barn in the U.S., is threatened with demolition for a $30-million project of the Regional Transit Authority. The Canal barn is more significant than the one at Carrollton serving the city's 1835 St. Charles line [NR, ASME], the oldest surviving streetcar *line* in the world. While the line is ancient, nothing from 1835 survives and its barn dates only to 1893, when the line was electrified.

New Orleans was the second U.S. city, after New York in 1832, to have street railway service. Then known as the New Orleans & Carrollton RR, the St. Charles line and its few short branches served only part of the city, in addition to what was then the separate municipality of Carrollton. The first true citywide system was that built by the New Orleans City RR just before the Civil War. Constructed in 1860-61, its six lines formed a carefully planned network that penetrated all the built-up areas of the city, including that served by the NO&C.

Each of its five main lines had its own "depot"—carbarn complex—with car house, stable, and shops. The carhouses had similar, massive, timber-frame construction. The specifications were virtually identical for the roofs, referring to "wrought iron principles [sic: trusses], with the cast iron shoes, for the support of the roof," in addition to the "corrugated iron roof covering." The Canal St. "depot" contractor was John Page, an Englishman. The architect is unknown, but probably was S.L. James, chief engineer and superintendent, who was credited with most of the detailed work on the system. The Canal St. contract was signed Mar. 2, 1861.

All the Canal St. buildings survived the Civil War, but an 1887 fire destroyed several, including the stable and the enginehouse for steam dummies. The carbarn, perhaps protected by its metal roof, survived, together with that part of the "station" attached to its front. A noted local architect, Thomas Sully, was commissioned to design two replacement carsheds, one forming a long addition behind the 1861 building, and a second—even longer—next to the original. The 1887 structures had large wood trusses with metal roofs.

These buildings survived an 1893 fire and a disastrous 1915 hurricane, which leveled the streetcar buildings in the next block. During the 1890s the carbarns were adapted for electric cars. The early "station" section vanished after 1898,

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NEWSLETTER

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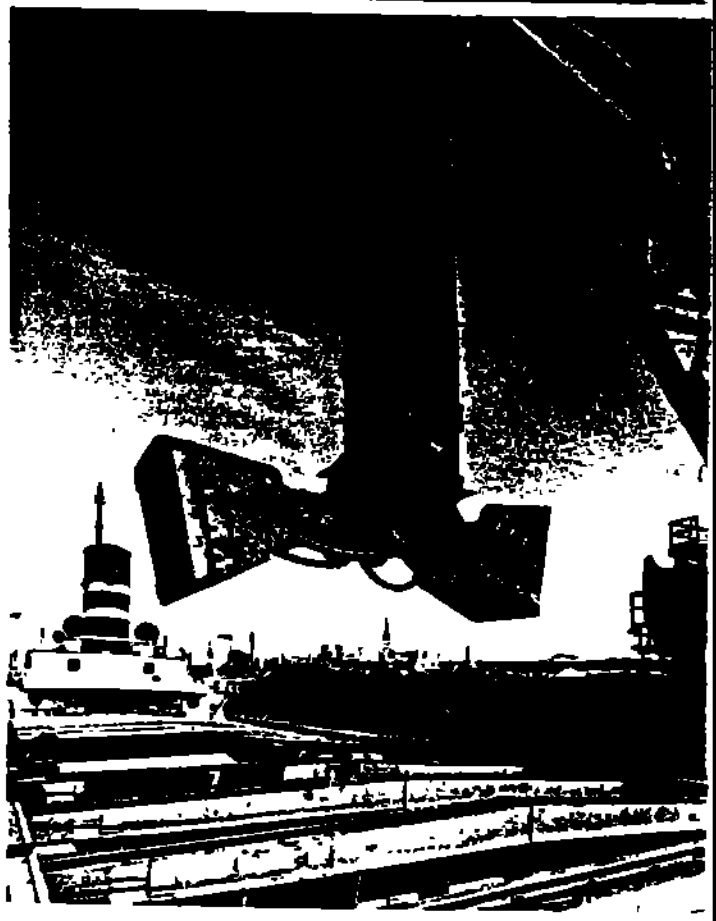
LANDMARK UNLOADERS FACE EXTINCTION

Can Cleveland's mighty Huletts be saved?



THE HULETT UNLOADERS.
Above General view of the Pennsylvania Railway Ore Dock (also known as the C&P Ore Dock) taken in June 1912, shortly after completion. Looking north toward Lake Erie. The Hulett unloaders can be seen at work between the powerhouse and the ore-stocking bridge. The bridge was destroyed in a 1978 storm. *HAER Collection, Library of Congress.*

Right: Hulett No. 4, C&P Dock, poised in full open position over the hold of the *George M. Carl*, in 1979. Cleveland's are believed to be the last Huletts operating. Note the operator in the cab window above the bucket. The dock was recorded by HAER in 1979. *Jet Lowe photo for HAER.*



If Conrail has its way, Cleveland's remarkable Hulett ore unloaders, among the last on the Great Lakes, could go the way of the dinosaurs—the very creatures to which they have so often been compared (see related story).

In June, Conrail announced that the 80-year-old unloaders will be stilled at the end of the shipping season because they are too costly to repair. They have also been rendered obsolete by modern self-unloading vessels, which carry their own boom-and-conveyor systems. (Since 1966, all new lake carriers have been self-unloaders. Of 66 U.S.-owned carriers on the Great Lakes, all but 5 are self-unloaders, according to the Cleveland-based Lake Carriers' Assn.)

Those who attended the 1986 SIA Annual Conference in Cleveland will remember visiting these unusual machines and watching them work. The Hulett unloaders have been a prominent feature of the city's industrial landscape since 1912, when the Pennsylvania Railway completed construction of the largest ore-unloading dock on the lakes.

Since the 1870s, the Cleveland & Pittsburgh Railroad had operated extensive ore docks at its western terminus on Cleveland's Whiskey Island, a strip of land sheared off from

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