1 The Metabolism of the Industrial City

The Case of Pittsburgh

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THE CONCEPT of *metabolism* has been adopted from biology and refers to physiological processes within living things that provide the energy and nutrients required by an organism as the conditions of life itself. These processes can be described in terms of the transformation of inputs (sunlight, chemical energy, nutrients, water, and air) into biomass and waste products. While essentially a concept originating in science, I have found it useful as a means to comprehend the environmental history of cities. Just as living things require the inputs of light, energy, nutrients, water, and air, so do cities. That is, cities cannot exist without those inputs—urbanites require clean air, water, food, fuel, and construction materials to subsist while urban industries need materials for production purposes. These materials may initially come from the area of the urban site itself but increasingly over time they are derived from the urban hinterland or even further. That is, as the city grows, it extends its *ecological footprint* further and further into its hinterland.

The ecologist Eugene Odum has written that "the city is a parasite on the natural and domesticated environments," since it does not grow food and dirties its air and water. One can also note that it reshapes and consumes the land. Odum observes that a parasite "does not live for very long if it kills or damages its host." Therefore, for a parasite to survive, it must develop systems of exchanges that benefit both its host and itself.[1] While some may object to characterizing the city as a "parasite" on the environment, thus raising the ancient specter of the evil city and the natural countryside, from a purely descriptive perspective, the concept is a valid one. Cities do consume their environments and cannot survive unless they reach a point of equilibrium with their sites and their hinterlands in regard to the consumption of air, water, and land resources.[2] Today we call such a goal "seeking a *sustainable city*."

Cities and their metropolitan areas have had major effects on the natural environment since their appearance, but these impacts have accelerated over the past two centuries with the development of industrialism and rapid urbanization. In the United States urban development has advanced, and today a large majority of the population lives in sizable metropolitan areas. These metropolitan areas are growing not only in population but also in terms of aerial extent. In these habitats, city builders have reshaped and often destroyed natural landscapes and eliminated animal, bird, marine, and insect species, while urban demands for resources have profoundly affected hinterlands.

The relationship between the city and the natural environment has actually been interactive, with cities having massive effects on the natural environment, while the natural environment, in turn, has profoundly shaped urban configurations. Nature has not only caused many of the annoyances of daily urban life, such as bad weather and pests, but it has also produced natural disasters and catastrophes such as floods, fires, volcanic activity, and earthquakes. Often, however, the actions of urbanites—such as building on flood plains and steep slopes, under the shadow of volcanoes, or in earthquake-prone zones—have exacerbated the dangers they are exposed to from natural hazards.[3]

This essay will focus on the metabolism of one major industrial city—Pittsburgh—in the years from about 1880 to 2000. In doing so, it will explore issues relating to the resources of water, air, and land, and the ways in which they were used, misused, and remediated. That is, the essay will consider the ways in which the city has moved from a lack of concern with environmental goods toward a more sustainable level.

Pittsburgh is sited in southwestern Pennsylvania, west of the Allegheny Mountains. The physical geography of the region consists of an uplifted plateau about 1,200 feet high that has been dissected by an extensive river and stream network flowing from the Allegheny Mountains. The cutting action of rivers and streams carved a complex topography of hills and steep valleys with a general relief of five hundred feet but also sharp variations. Human action as well as natural forces have shaped and reshaped the landscape. Development has taken place especially along the floodplains and terraces in the major valleys as well as in interior valleys and hollows. The region's greatest mineral resource is bituminous coal, but it also has natural gas and petroleum deposits that were historically important. The city's population reached a high of approximately 676,000 in 1950, but today (2004) it is down to about half that total. The six-county metropolitan area is at a plateau of about 2.25 million, where it has remained for several decades. Territorially, through annexation, the city grew to fifty-five square miles during the nineteenth and twentieth centuries but has remained stagnant since about 1930. Conversely, the urbanized area of the mature metropolitan region has continued to expand along its periphery. During this period, the city and the region's environment—its water, air, and land resources—has undergone dramatic changes.

Water Supply and Wastewater Disposal

Cities require fresh water in order to exist. These supplies fill a number of functions, such as domestic needs, commercial and industrial purposes, street flushing, and fire fighting. One of the most serious environmental problems Pittsburgh has faced throughout its history is pollution of its neighboring rivers.[4] As a riverine city, Pittsburgh has been both blessed by abundant supplies and cursed by the extensive pollution of these supplies. This pollution, from both domestic and industrial sources, has severely impacted the quality of the water drawn from the rivers, as well as from wells, for both drinking water and industrial uses. In addition, pollution has sharply curtailed the availability of the rivers for recreational purposes.

Like other urbanites at the beginning of the nineteenth century, Pittsburghers drew their water from local sources such as wells, rivers, and ponds, and from rainwater gathered in cisterns. Both private and public water suppliers provided water to the city almost from its very beginnings. In 1802, for instance, the city councils passed an ordinance allowing the borough to construct four public wells and for the purchase of private wells "in useful and necessary parts of the Borough."[5] Private vendors peddled water in the streets, and the 1815 city directory listed five water carters. As the city grew, its water needs increased rapidly, requiring more ample sources.

The debate over improved water supply focused initially on the issue of public vs. private provision. In 1818 the councils refused to approve an attempt by private interests to obtain a municipal water franchise, and in 1821 sixty-one prominent citizens successfully petitioned the councils to provide new wells and to make all existing pumps public. In 1822, citizens again petitioned the councils, requesting that the municipality build a waterworks to supply Allegheny River water to the city. The petitions maintained that municipal ownership was required to guarantee improved fire protection and to secure lower fire insurance rates, to service domestic and manufacturing needs, and to meet public health requirements.[6] The insistence on public rather than private provision highlights the widespread belief that water was too important to city life to be left to the private profit-making sector.

In 1826 the Pittsburgh Select and Common Councils responded to citizens' demands and approved the construction of a waterworks that would, according to the councils' presidents, provide protection against fire and "beneficial effects to every manufactory and . . . family in the city." The city completed the waterworks in 1828. The system utilized a steam pump to draw water from the Allegheny River and raise it to a million-gallon reservoir for gravity distribution throughout the city. Responding to new demands caused by a major fire and the annexation of contiguous towns, the councils expanded the system in 1844 and in 1848. By the end of 1850, the city had laid twenty-one miles of water pipe, with the system serving 6,630 dwellings, stores, and shops. System expansion continued, especially after the major annexations of territory in 1868 and 1871. In 1879 the city opened a new waterworks that pumped water from the Allegheny River and stored it in two reservoirs for gravity distribution throughout the city. From 1895 to 1915, the city expanded the water supply network from 268 to 743 miles.[7]

The funding of the waterworks was the single largest expenditure made by the city during its first fifty years. Pittsburgh was not unusual in the extent to which waterworks costs constituted a substantial part of the total municipal budget. The building of New York's Croton Aqueduct in 1842, for instance, increased that city's debt from $500,000 to over $9 million and caused many citizens to predict financial disaster.[8] Pittsburgh's willingness to make such a large expenditure for a public good can be explained by the joining of a variety of interest groups—merchants and industrialists, homeowners, fire insurance companies, and those concerned with the public health—to demand the construction of an adequate waterworks. Waterworks were ordinarily the most expensive capital project undertaken by nineteenth-century American cities, indicating their importance to urban metabolism.

Access to water services, however, was unevenly distributed throughout the city, an important issue of what today we call environmental justice. Working-class districts had poorer water supplies than did affluent neighborhoods, often relying on local springs or wells, subject to pollution. Piped water was frequently accessed through a spigot in the back yard (frequently located near the privy vaults) rather than through indoor plumbing. The infamous Painter's Row, tenements owned by U.S. Steel on the South Side, had one spigot in the yard serving ninety-one families.[9]

An administrative ruling exacerbated the situation regarding water access. In 1872 the City Water Commission ruled that the size of the pipe laid on a particular street would be determined by the amount of potential revenue. This ruling resulted in either insufficient supply or no supply to poor neighborhoods. Such a policy, however, was not unusual for American cities. Robin L. Einhorn has called it the "segmented system"—a system that provided benefits to those who paid for them but which also "made the American urban landscape a physical expression of political inequality."[10] Typhoid death rates were high throughout the city, but were highest in working-class immigrant and African American areas.[11]

A supply of potable water was only one part of the city's metabolic system—wastewater from households and industries as well as storm water had to be disposed of. Household wastes and wastewater were usually placed in cesspools and privy vaults, and these were a frequent source of problems.[12] Many portions of Pittsburgh's heavily industrialized South Side, for instance, utilized springs for water that were located close to neighborhood privy vaults. Private scavengers under contract to the city were responsible for maintaining sanitary conditions by cleaning privy vaults and removing garbage. In the process of performing this task, however, they frequently fouled the streets and polluted the rivers. As the city grew, domestic waste disposal problems increased; in the late nineteenth century the Pittsburgh Board of Health identified privy vault nuisances as the major health issue facing the city.[13]

The provision of running water to homes and householder adoption of water-using appliances such as sinks, showers, and water closets exacerbated the nuisance problem. On the one hand increased water supply in the home was a benefit, but on the other hand it often had a devastating effect on public health. Pittsburghers made use of the availability of a supply of running water to adopt a number of water-using appliances such as sinks, showers, and water closets. In many cases, in order to dispose of the wastewater, householders connected these appliances to the existing wastewater disposal sinks—cesspools and privy vaults. In 1881, for instance, householders had connected 4,000 of the city's 6,500 water closets to privies and cesspools; only about 1,500 were connected to street sewers.[14]

Increasingly, it became obvious that only the construction of a sewerage system would alleviate wastewater disposal problems. A variety of public and private sewers existed. Until the 1840s, all municipal sewers were above ground and made of wood or brick. These sewers were intended to provide street drainage and to eliminate pools of water that could breed miasmas, but the conduits often became receptacles for decaying wastes. In June 1832, concern over epidemic disease, especially cholera, led the council to establish the Sanitary Board to "direct all such measures as they think necessary for averting the introduction of the frightful epidemics." The board had the power to "cause the streets, lanes, alleys, buildings, lots and shores of the rivers to be explored, cleansed and purified in an efficient manner." It proceeded to organize the city into sanitary districts and to exercise its sanitary duties. The councils also, in these crisis years, enacted ordinances to improve waste collection and to extend the water system.[15] But the city's response to the public health threat remained limited, and conditions soon reverted to their normal unsanitary state. Fear of epidemic disease alone could not persuade the councils to make the large expenditures necessary to build a sewerage system. In addition to costs, confusion over disease etiology as well as uncertainty about the technical and design requirements for an efficient system had a discouraging effect.

By midcentury, however, demands for improved services, particularly from the city's commercial interests, persuaded the municipality to construct underground sewers in the business district. By 1866 this district possessed a "fairly adequate" system of main sewers. Other sections of the city were provided with services in a more uneven and haphazard fashion. By 1875 the city had constructed about twenty-five miles of sewers, mostly for storm water drainage. These sewers, however, suffered from design faults and were often either undersized or oversized and subject to constant clogging. The city had no topographical maps until the 1870s, and sewers did not conform to topography; neither did they follow an overall engineering plan. Rather, the municipality built sewers as a result of council members' attempts to meet their constituent demands. In addition, householders often constructed their own sewers, many of which went unrecorded. In 1881 a noted New York civil engineer, J. J. R. Croes, hired to consult on improving the system, commented to a meeting of the Western Pennsylvania Engineers' Society, "You have no sewers; you don't know where they are going, or where they are to be found." Without sewers, the great majority of households in the city continued to depend on cesspools and privy vaults for disposal of domestic waste.

Debate raged about possible designs of the sewer system. Should it be a separate, small pipe system that carried only domestic and industrial wastes, the technology advocated by the famous sanitarian Col. George E. Waring, Jr.? Or, should it be a larger, combined system that could accommodate both waste water and storm water, a design favored by many noted sanitary engineers?[16] The city's public health and engineering professionals divided over this question. Physicians argued that the separate system was preferable because it would protect health by removing wastes from the household before they had begun to generate disease-causing sewer gas. Storm water was a secondary matter and could be handled by surface conduits.

Sanitary engineers took a different position, maintaining that sanitary wastes and storm water were equally important and that a large pipe system able to accommodate both was more economical. The superior virtues of the combined system in terms of both health and storm water removal convinced city officials, and by the late 1880s Pittsburgh had begun to build such a system.[17] Between 1889 and 1912, civil engineers from the new Bureau of Engineering of the Public Works Department constructed over 412 miles of sewers, almost all of the combined type. The construction of the planned centralized sewerage system signified a movement away from the "piecemeal, decentralized approach to city-building characteristic of the 19th century."[18] In constructing a large centralized combined sewer network, Pittsburgh was following the lead of other large American cities such as Boston, Chicago, and New York.[19]

Many citizens resisted connecting to the new sewer lines and attempted to keep their old privies and cesspools. The Board of Health used the sanitary code to compel connection. In a series of acts in the late nineteenth and early twentieth centuries, the councils barred the construction of cesspools where sewer service was available, outlawed water closets from draining into a privy vault, and prohibited the connection of privy wells to a public sewer. Resistance to connecting to the system continued, particularly in working-class areas, because of householder resistance to paying sewer assessments.[20]

Building the sewer system reduced nuisances but increased contamination of the city's water supply. By 1900 most of the Pittsburgh population received its water from either the Allegheny or the Monongahela River, and over the years the watersheds of these streams had become increasingly populated. By 1900, for instance, more than 350,000 inhabitants in seventy-five upriver municipalities discharged their untreated sewage into the Allegheny River, the river that provided water supplies for most of Pittsburgh's population. Some of Pittsburgh's own sewers discharged into the river at sites located above water supply pumping stations. The resulting pollution gave Pittsburgh the highest typhoid fever death rate of the nation's large cities from 1882 to 1907—well over 100 deaths per 100,000 population. In contrast, in 1905 the average for northern cities was 35 per 100,000 persons.[21]

Typhoid fever death rates were highest in working-class immigrant and African American living areas. The Health Department advised that drinking water be boiled but new immigrants often ignored such advice since they viewed the water as uncontaminated. "You cannot make the foreigner believe that Pittsburgh water is unwholesome," observed one physician, noting that roughly half of all foreign-born men sickened with typhoid within two years of arriving in the city.[22] Pittsburgh had one of the highest rates of bottled water consumption in the nation, but these supplies were out of reach for most working-class people. Thus, as a 1909 Pittsburgh Survey article observed, "those who could not afford to buy bottled water continued to drink filth." According to the municipal Health Department, Pittsburgh appeared "as two cities, one old and congested with a high mortality, and the other new and spacious with a very low death rate."[23]

Beginning in the 1890s, agitation increased among women's groups, engineers, and physicians about the need to protect the water supply from infectious disease. The new science of bacterial water analysis had convinced many of these citizens that mortality and morbidity from infectious waterborne disease could be prevented. In the 1890s, engineers and civic groups cooperated to investigate the quality of the water supply using the new methods of bacterial science. These studies conclusively demonstrated the relationship between typhoid and water quality, and in 1896 the councils approved an ordinance authorizing the mayor to create a Pittsburgh Filtration Commission to further study the matter and make public policy recommendations.[24]

The commission's investigations reconfirmed the link between water and disease, and its 1899 report recommended construction of a slow-sand filtration plant as the most economical means of dealing with the threat to the public health. In 1899, voters approved a bond issue for plant construction, but factional political battles over control of construction contracts and issues of technological choice necessitated a second vote in 1904 and delayed final completion of the filtration plant until the end of 1907. Once in operation, the filtration system had dramatic effects, and by 1912 Pittsburgh's death rate from typhoid fever had fallen to the average for the largest American cities.[25]

Water filtration provided one safety net in regard to polluted water, but many sanitarians and public health physicians believed that it was also necessary to treat the city's sewage for maximum protection. Professional, business, and medical groups protested against sewage disposal by dilution only. They demanded that municipalities treat their sewage and agitated for state laws against stream pollution.[26] In the years after the turn of the century, states such as Connecticut, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, and Vermont, responding to a series of unusually severe typhoid epidemics, gave state boards of health increased power to control sewage disposal in streams.[27]

The Pennsylvania act "to preserve the purity of the waters of the State for the protection of the public health," passed by the state legislature in response to the severe Butler typhoid epidemic of 1903, typified these laws. It forbade the discharge of any untreated sewage into state waterways by new municipal systems. While it permitted cities already discharging to continue the practice, it required them to secure a permit from the state commissioner of health if they wished to extend their systems.[28] Engineering opinion largely disagreed with these prohibitions. As the *Engineering Record* noted in 1909, "it is often more equitable to all concerned for an upper riparian city to discharge its sewage into a stream and a lower riparian city to filter the water of the same stream for a domestic supply, than for the former city to be forced to put in sewage treatment works."[29]

Although Pittsburgh was filtering its own water after 1907, the city continued to dump its untreated sewage into its neighboring rivers, endangering the water supply of downstream communities. In the beginning of 1910, the city requested the State Department of Health to grant it a permit allowing it to extend its sewerage system. The department, headed by a physician, Samuel G. Dixon, first responded by requesting a "comprehensive sewerage plan for the collection and disposal of all of the sewage of the municipality." In addition, the department argued that in order to attain efficiency of treatment, the city should consider changing its sewerage from the combined to the separate system. F. Herbert Snow, the department's chief engineer, maintained that the plan was needed to protect the public health of communities who drew their water supplies from rivers downstream from Pittsburgh. "The baneful effect of Pittsburgh's sewage on the health of the brightest citizens at her door," wrote Snow, "admonishes city and state authorities alike of the futility of defying nature's sanitary laws."[30]

The city of Pittsburgh responded to Dixon's order by hiring the engineering firm of Allen Hazen and George C. Whipple to act as consultants for the required study. Hazen and Whipple were among the nation's most distinguished sanitary engineers and were already known for their espousal of water filtration as an alternative to sewage treatment to protect drinking water quality. Hazen had actually served as chief consultant on the construction of Pittsburgh's sand filtration plants. The engineers based their study primarily upon an evaluation of the costs of building a treatment system and of converting Pittsburgh sewers to the separate system.

In their report, issued on January 30, 1912, Hazen and Whipple argued that Pittsburgh's construction of a sewage treatment plant would not free the downstream towns from threats to their water supplies nor from the need to filter them, since other communities would continue to discharge raw sewage into the rivers. The method of disposal by dilution, they maintained, sufficed to prevent nuisances, particularly if storage reservoirs were constructed upstream from Pittsburgh to augment flow during periods of low stream volume. Hazen and Whipple argued that there was no case "where a great city has purified its sewage to protect public water supplies from the stream below."[31]

Hazen and Whipple's most powerful argument concerned the lack of economic feasibility of converting Pittsburgh's sewerage system to separate sewers and building a sewage treatment plant. There was no precedent, they claimed, for a city replacing the combined system by the separate system "for the purpose of protecting water supplies of other cities taken from the water course below." They calculated that financing such a project would have caused the city to exceed its municipal indebtedness level and thus violate state law. Moreover, because the sewage treatment plant was intended for the protection of the downstream communities, it would not give Pittsburgh any direct benefits. Furthermore, downstream cities would still have to filter their water to protect against waterborne pathogens. No "radical change in the method of sewerage or of sewage disposal as now practiced by the city of Pittsburgh is necessary or desirable," they concluded.[32]

While the engineering press received the Hazen-Whipple report with enthusiasm, Pennsylvania Health Commissioner Dixon found it an insufficient response to his original instructions requesting Pittsburgh to develop a comprehensive sewerage plan based on long-range planning. He maintained that he had envisioned a report that would take a regional rather than a local approach to Western Pennsylvania water pollution problems. He argued that water pollution had to be viewed from a health rather than a nuisance perspective and that the immediate costs of sewage treatment would be outweighed by the long-range health benefits. The time had come, Dixon stated, "to start a campaign in order that the streams shall not become stinking sewers and culture beds for pathogenic organisms."[33]

Given the political context, however, and the financial limitations upon the city, Dixon had no realistic means by which to enforce his order. In 1913 he capitulated and issued Pittsburgh a temporary discharge permit. The city continued to receive such permits until 1939, and it was not until 1959 that Pittsburgh and seventy-one other Allegheny County municipalities ceased discharging raw sewage into the abutting rivers and began treating their wastes.[34] Thus, nearly a half century was to pass before Dixon's vision of sewage-free rivers would even begin to be realized.

This particular case has implications larger than those that relate only to Pittsburgh. The dispute pitted public health physicians against sanitary engineers and illustrated their different conceptions of the choice dictated by the urban environment. Sanitary engineers believed that they had a superior conception of the "relative needs and values" of cities in regard to public health because of their understanding of municipal financial limitations—thus sewage treatment was a luxury, less critical than other urban public health needs. Many public health officials believed, on the other hand, that sewage disposal was not a proper use of streams, especially if drinking water quality was involved.[35] From the perspective of urban metabolism and urban sustainability, the short-term nature of the engineering option is clear, however driven by fiscal necessities.

Smoke and Air Pollution

A vital part of the urban metabolism is clean air, but effective metabolism also requires a constant source of energy, which often conflicts with the goal of maintaining clean air. The primary air quality concern of cities before World War II was smoke pollution, which consisted primarily of particles generated by the burning of fossil fuels, especially bituminous coal. These particles blocked the sunlight, irritated the lungs, discolored clothing and other materials including building facades, and threatened the public health.

Heavy smoke pollution was a problem for many cities, but especially for those like Pittsburgh and St. Louis that were located close to large deposits of bituminous coal. Smoke pollution in Pittsburgh resulted from a conjunction of the factors of topography, urbanization, industrialization, and the availability at low cost of large sources of high-volatile bituminous coal. The coal was used for domestic and commercial heating purposes, for processing raw materials and manufacturing goods, and for providing fuel for transportation systems.[36] Early in the nineteenth century Pittsburgh gained the reputation as the "smoky city."

The increase of smoke pollution as Pittsburgh grew and industrialized compelled public authorities to make some gestures at control. In 1868 the city councils passed a statute banning the use of bituminous coal or wood by railroads within the city limits, and in 1869 they forbade the construction of beehive coke ovens. Neither statute, however, was strictly enforced. During the 1880s, the discovery and exploitation of local supplies of natural gas provided the city with approximately six years of clean air. Exhaustion of the local gas supply, however, caused a return to soft coal as a fuel and to heavy smoke palls, stimulating various elite and professional groups to press for smoke control.[37] The Women's Health Protective Association joined with the Western Pennsylvania Engineers' Society to push for smoke control statutes. The city councils responded by passing a series of ordinances in the 1890s and in the beginning of the twentieth century that regulated dense smoke from industrial, commercial, and transportation sources, but not from domestic sources. In 1911, the city council created the Bureau of Smoke Regulation for enforcement purposes. Rather than legal sanctions, the bureau's director believed that education, training firemen to operate furnaces and boilers more efficiently as well as retrofitting with various smoke-consuming devices, would persuade polluters to stop producing smoke. Fuel efficiency, it was argued, provided an incentive, since smoke was a sign of incorrect firing and fuel waste.[38]

Although it had some limited success, the smoke control movement failed to control the smoke nuisance to any appreciable degree during the first third of the century. During the 1920s and 1930s, therefore, smoke and fuel researchers and regulators redefined the problem. They agreed that industries and railroads had made advances in eliminating dense smoke through technological and fuel improvements, by care in firing methods, and through cooperation with smoke bureaus. The smoke problem persisted, smoke investigators held, because of a failure to control domestic furnaces. Experts argued that smoke from household furnaces was especially objectionable because "the amount of black smoke produced by a pound of coal is greatest when fired in a domestic furnace and that domestic smoke is dirtier and far more harmful than industrial smoke."[39]

Domestic furnaces had not been regulated for several reasons, the most important being the political and administrative problems involved in controlling the heating habits of a multitude of householders. In 1940, there were 175,163 dwellings in Pittsburgh, of which 141,788 burned coal and 30,507 consumed natural gas; 53,388 of those burning coal had no central heating plant and used stoves to heat their homes. Smoke regulators lacked an effective administrative mechanism to control domestic smoke without hundreds of smoke inspectors. Politically, the issue was difficult because control threatened to impose higher costs for capital equipment and fuel on householders. And, because of a historical equation between smoke and prosperity in Pittsburgh and other industrial cities, it was difficult to develop a public consensus for stringent controls.[40] In short, the problem was one of devising a strategy to change individual behavior in regard to fuel use in the name of the collective social goal of clean air.

The climate of opinion in Pittsburgh in the late 1930s, however, discouraged discussion of smoke control. A city dependent on heavy industry, Pittsburgh was badly scarred by the Depression; clear skies suggested closed factories and unemployed workers. In addition, many local businesses were related to the coal mining industry, which also suffered severely from the Depression. As a sign of its belief that smoke equaled prosperity and its relief at the return of full employment, in 1939 the Pittsburgh City Council actually eliminated the Bureau of Smoke Regulation. "You'll never get elected again," said one politician to a member of the city council who supported antismoke legislation. "Don't you know, the poor people, they don't want smoke control. It's going to cost them more money." "We like to see smoke," added another politician; "it means prosperity."[41] Many working-class people held opinions such as these—although they found smoke a nuisance and an annoyance, they were concerned that smoke control would cost them jobs. Pittsburgh, therefore, appeared an unlikely environment for the passage of substantive legislation controlling smoke emissions from either industries or homes.

At the end of the decade, however, the Pittsburgh smoke control forces received a dramatic assist from the city of St. Louis, also an industrial center dependent on bituminous coal. During the period 1937–1940, under the leadership of Smoke Commissioner Raymond R. Tucker, St. Louis took major steps to reduce its smoke pollution. Tucker realized that the key to solving the city's smoke problem was to persuade inhabitants to use either a smokeless fuel or improved combustion equipment.[42] In April 1940, the St. Louis Board of Aldermen approved an ordinance requiring the use of smokeless fuel or smokeless mechanical equipment by fuel consumers, including homeowners. The essential control mechanism was city licensing of fuel dealers in order to control the quality of fuel at the source. The result of the first test of the ordinance in the 1940–1941 heating season was a series of smokeless days that city officials claimed was the result of the smoke ordinance.[43]

In February 1941, the *Pittsburgh Press* began a concerted series of articles and editorials pointing to St. Louis's success and asserting that Pittsburgh could also achieve clean air.[44] Most effective in mobilizing opinion were two pictures published on the *Press's* front page showing a smoke-darkened St. Louis street before smoke regulation and the same street sunlit after the control ordinances had become operative. Egged on by the paper, readers, especially irate housewives, began bombarding Pittsburgh Mayor Cornelius D. Scully with hundreds of letters a day demanding action. Delegations of civic officials and politicians visited St. Louis on a "civic pilgrimage" to examine the administrative machinery of smoke control and to assess its potential political costs. Most returned convinced of its technical feasibility.

Three individuals who might be called "entrepreneurs" for the collective social good—Abraham Wolk, a lawyer and city council member who supposedly became involved in the campaign because of the effect of the smoke on his asthmatic son's health; Edward T. Leech, editor of the city's most influential newspaper, the *Pittsburgh Press*; and Dr. I. Hope Alexander, director of the Pittsburgh Department of Public Health—provided leadership for smoke control efforts.[45]

The antismoke campaigners stressed the achievement of St. Louis in achieving clean air and emphasized that the benefits of smoke control would outweigh the costs both for the community and its citizens. In February 1941, the mayor appointed the Commission for the Elimination of Smoke, which represented a broad spectrum of the community. In his charge to the commission, Mayor Cornelius D. Scully declared that "Pittsburgh must, in the interest of its economy, its reputation and the health of its citizens, curb the smoke and smog which has made this season, and many others before it, the winter of our discontent." The commission included representatives of business, labor, government, the media, the health professions, and voluntary associations with a civic and a welfare orientation; the inclusion of three women reflected the campaign leadership's perception of the importance of women in achieving smoke control. A technical advisory group stood ready to present recommendations concerning control of specific sources such as railroads and metallurgical companies and to gather information on questions such as the availability of smokeless fuel and smokeless equipment.[46]

While the commission was holding its hearings, the Civic Club and the League of Women Voters conducted a countywide campaign of public arousal and education through a network of voluntary associations. While voluntary organizations of all types were represented in the network, women's groups were most numerous, reflecting the deep involvement of women in the smoke elimination campaign. As homemakers, women of all classes knew how much extra cleaning smoke necessitated, with the burden falling most severely on working-class women who lived close to the mills. Middleand upper-class women in the Civic Club and the League of Women Voters coordinated luncheons and lectures and provided speakers to interested groups.[47]

Eventually, the Smoke Elimination Commission held twelve closed meetings and four public meetings. The purpose of the public meetings was to give interested groups a chance to be heard but even more to "get across to the public something which . . . still needs more hammering—the need for smoke control. . . . It gives the papers and the Commission a show. It gives the people a chance to be part of [the] . . . meetings."[48] While the public meetings served the function of public arousal and information transmission about smoke's negative effects, the closed meetings provided information on the more policy-relevant questions: smokeless fuel and technology supply; costs; effects of the policy on the coal industry, coal miners, and the poor; and administrative procedures and timetables for enforcement. The discussion within the commission clearly reflected the conviction of its members that, with the right policy, the socially desirable end of smoke elimination could be achieved without excessive costs to individuals or to industry. As Chairman Wolk noted early in the commission's proceedings, "We want to make this city smokeless without hurting anybody."[49]

Controlling smoke, however, would not be costless. Among the groups that would be most affected were coal miners and low-income workers. The representative of the Mine Workers on the commission, however, appeared to accept the argument that smoke control would not substantially impact mine employment because the need for smokeless coal would actually result in the mining of larger amounts of bituminous.[50] As for working-class consumers, the commission took the position that smoke control would bring more benefits than costs to the working class because it suffered the most from the effects of smoke pollution.[51]

In spite of disagreements within the commission, all members, including coal industry and labor representatives, signed the final report. The report listed the names of two hundred voluntary organizations, including fifty-six women's clubs, twenty-four business organizations, and many labor and civic groups as supporters of smoke control. The report held that smoke elimination would "bring about a new era of growth, prosperity and well-being" for the city and would impose "little or no additional burden on the low-income groups of the city."[52]

The commission report recommended a strategy based upon control of smoke at the source. Over a staged two-year period, all fuel users would have to either burn smokeless fuels or utilize smokeless mechanical equipment. By controlling the quality of the fuel inputs into the city's metabolic engine, air quality would improve.[53] The commission also recommended the creation of a Bureau of Smoke Prevention to be housed in the Department of Health and headed by a "qualified engineer" with the power to impose fines and to seal equipment in case of law violations. Only public opinion, concluded the report, would determine if the city would become smoke free.[54]

After a delay caused first by the war and then by a shortage of smokeless fuels, the smoke control ordinance was implemented in October 1947. The most critical question in terms of implementation continued to be enforcement against domestic consumers. The Bureau of Smoke Control solved the enforcement problem, as had St. Louis, by focusing on the coal distribution yards (approximately thirty) and the coal truckers. It forbade yards to sell high-volatile coal for use in hand-fired equipment and forbade truckers to deliver it. Truckers hauling coal for consumption in the city had to be licensed and to have license numbers painted on the side of the truck for easy identification. Those caught hauling illegal high-volatile (or bootleg) coal were subject to fines, as were dealers who made illegal sales.[55]

Successful implementation, however, would not have taken place without the support of the newly elected mayor, David Lawrence, and the efforts of two newly created and allied organizations—the United Smoke Council (USC), consisting of eighty allied organizations from Pittsburgh and Allegheny County, and the Allegheny Conference on Community Development (ACCD), formed in 1943. The council's function was to continue public educational efforts about the need for smoke control.[56] The mission of the Allegheny Conference on Community Development was the development of "an over all community improvement program" for Pittsburgh, in which smoke control played a vital part. The ACCD was especially critical because of its concentration of corporate power and its help in providing the planning essential for policy implementation.[57]

In spite of many difficulties with fuel supply, the heating season of 1947–1948 showed a considerable improvement in air quality compared to previous years. An unusually mild winter aided in reducing the smoke palls. "PITTSBURGH IS CLEANER" reported the *Press* on February 21—the worst smogs were gone, homes were cleaner, and white shirts did not have black rings around the collars.[58] Because of the visible improvement in Pittsburgh air quality, public opinion shifted from limited to strong approval of the law.[59] During the next few years, heavy smoke nearly disappeared from the Pittsburgh atmosphere. In 1955, for instance, the Bureau of Smoke Prevention reported only ten hours of "heavy" smoke and 113 hours of "moderate" smoke compared with 298 hours of "heavy" smoke and 1,005 hours of "moderate" smoke in 1946.[60]

The improvements in Pittsburgh air quality that occurred after the implementation of the smoke control ordinance, however, were not necessarily the result of the type fuel and equipment substitutions projected by the 1941 policy makers. In 1941, and also to an extent in 1946–1947, those involved in formulating and implementing the ordinance assumed that coal would continue to be the city's dominant domestic heating fuel for some years. The price of natural gas and oil was higher than that of coal through World War II and supplies were erratic.[61] Clean air would thus result from the use of smokeless coal produced from local bituminous or the use of equipment permitting smokeless combustion of bituminous.

While the use of low-volatile and processed coal (Disco) and smokeless coal-burning equipment did play a role in reducing smoke in 1947–1948, they steadily declined in significance. Increasingly, low-priced natural gas, furnished by pipelines from the Southwest and stored in underground storage pools, became the dominant fuel used for Pittsburgh domestic heating.[62] The rates of change for the city are striking. In 1940, 81 percent of Pittsburgh households burned coal and 17.4 percent natural gas (from Appalachian fields); by 1950, the figures were 31.6 percent for coal and 66 percent for natural gas. This reversal represented a change in fuel type and combustion equipment by almost half the city households, most of which took place after 1945.[63] In addition, railroad conversion from steam to diesel-electric locomotives between 1950 and 1960 also greatly reduced railroad contributions to the city's smoke burden.

Because of the shift to natural gas in Pittsburgh, the reduction in smoke pollution would undoubtedly have eventually occurred without the smoke control law. The price of natural gas made it very competitive with coal from an economic perspective and heating with gas was much more convenient. But, while not as critical as some Pittsburgh boosters would have one believe, the Pittsburgh smoke control ordinance undoubtedly accelerated the rate of change to clean fuel. Comparisons in rates of fuel change made between Pittsburgh and other cities make this clear. The clear air initiative was also important as a motivating factor in the famous Pittsburgh Renaissance, convincing Pittsburghers that positive change was possible.[64]

The movement for smoke control in Pittsburgh also produced a similar drive in Allegheny County. Here, industry and the railroads played a much more prominent role in standard setting and timetables for implementation than in the city. The 1949 county law omitted some of the region's key industries, such as steel and coal, from having to meet any specific performance standards for air pollution. The County Bureau of Smoke Control had only a handful of inspectors and was not capable of monitoring and enforcing air-pollution restrictions.[65]

The resulting system of business-government cooperation in the county brought very uneven progress. While fuel substitution and improvements in technology reduced county air pollution, progress was negligible in several key areas. To a large extent, emissions of fumes, gases, and odors, especially from by-product coke ovens and open hearth furnaces, were not regulated, and high levels of industrial pollutants plagued steelmaking areas. It could be argued that the actual success in controlling visible smoke actually masked the importance of regulating the other elements present in air pollution. By the 1960s it was obvious to clean air advocates that achieving clean air in the Pittsburgh region required control of all activities that affected the metabolism of the city and the region rather than a selected few.[66]

Uses of the Land

While water and air are commonly thought of as inputs into the metabolism of the city, the land also needs to be considered as an input. The building of a city creates a new landscape fitted into and imposed upon a preexisting landscape. As geographer Ian Douglas notes, while the foundations of the built environment have to be designed in congruence with the rock structures and soils beneath them, city development can drastically change conditions.[67]

Over the course of the nineteenth and twentieth centuries, industry usurped the Pittsburgh area river banks, building on the flat land along the flood plain. Integrated steel plants constituted the largest installations, sited especially on the flat land as the river meanders between river and rail lines. Some observers of the Pittsburgh scene, such as Robert Woods, writing in *Survey Magazine* in 1909, admired the development of the site—the "involved panorama of the rivers, the . . . long ascents and steep bluffs, the visible signs everywhere of movement, of immense forces at work,—the pillar of smoke by day, and at night the pillars of fire against the background of hillsides strewn with jets of light."[68] Others, such as R. L. Duffus, writing in the *Atlantic Monthly* in 1930, bemoaned the landscape alterations:[69]

> From whatever direction one approaches the once lovely conjunction of the Allegheny and the Monongahela the devastation of progress is apparent. Quiet valleys have been inundated with slag, defaced with

> refuse, marred by hideous buildings. Streams have been polluted with sewage and the waste from the mills. Life for the majority of the population has been rendered unspeakably pinched and dingy. This is what might be called the technological blight of heavy industry.

The devastation witnessed by Duffus was dramatically illustrated by the fate of the beautiful valley of Nine Mile Run (NMR), located at the city's eastern boundary. Nine Mile Run is one of Pittsburgh's major urban streams, named for its distance from the Pittsburgh Point. Its watershed drains the city's East End, winding its way southward down steep slopes to the Monongahela River. Throughout the late nineteenth and early twentieth centuries it had some minor development, serving as the site for a salt works, a few farms and houses, a golf course, and a natural gas field. Most significantly, it represented Pittsburgh's last remaining access point to the Monongahela River, since industry and railroads had already occupied the rest of the waterfront.[70]

Because of its beauty and its location close to densely populated mill areas, the valley attracted the attention of reformers concerned with Pittsburgh's environmental quality and social stability during the first quarter of the twentieth century. These Progressive Period reformers were largely the same elite individuals who had driven the campaign for water filtration and smoke control. Along with other urban reformers, they embraced the philosophy of Frederick Law Olmsted that a healthy environment would directly improve the well being of urban residents and reduce urban pathologies.[71] Their campaign was a part of a larger effort to exert control over the region's degraded environmental resources.

In 1909, George Guthrie, a Democratic reform mayor, appointed a Civic Commission composed of the city's leading business and professional leaders to deal with the deteriorating urban landscape. The commission interpreted its mandate broadly, embracing many aspects of urban and environmental reform. It employed landscape designer Frederick Law Olmsted Jr., son of the great designer of Central Park, as one of the commission's three major consultants. Olmsted prepared a plan for the city entitled *Pittsburgh Main Thoroughfares and the Down Town District 1910*, published in 1911. He recommended a new system of downtown roads as well as making suggestions for riverfront improvement, steep slope development, and transportation improvements. He also explicitly noted the value of Nine Mile Run:[72]

> Perhaps the most striking opportunity noted for a large park is the valley of Nine Mile Run. Its long meadows of varying width would make

> ideal playfields; the stream, when it is freed from sewage, will be an attractive and interesting element in the landscape; the wooded slopes on either side give ample opportunity for enjoyment of the forest, for shaded walks and cool resting places; and above all it is not far from a large working population . . . and yet it is so excluded by its high wooded banks that the close proximity of urban development can hardly be imagined. If taken for park purposes, the entire valley from the top of one bank to the top of the other should be included, for upon the preservation of these wooded banks depends much of the real value of the park.

Unfortunately, a new mayor, Chris Magee, ignored many of Olmsted's recommendations for land use changes. While the city issued bonds throughout the 1910s for playgrounds and to maintain the city's four parks, it did not attempt to acquire Nine Mile Run, reflecting a preference for active recreation rather than open space.[73]

The next attempt to preserve Nine Mile Run for public use occurred in the early 1920s as a result of the activities of the Citizens' Committee on Civic Plan. The Citizens' Committee was originated in 1918 from the decision of a group of Pittsburgh elites to create a city plan and to develop "city planning in all its aspects in the Pittsburgh district." The committee established six task forces to examine a range of urban problems, including recreation. In 1923, the Recreation subcommittee issued its Report on Parks. The subcommittee noted that there was only one place in the whole Monongahela River valley—Nine Mile Run—that could serve as the location for a waterfront park since in all other locations railroad tracks or industry blocked access to the river. The subcommittee recommended that Nine Mile Run become an active waterside attraction, with a botanical garden, athletic field, camp and picnic grounds, tennis courts, a theater, and a lake with a small beach. Because the site was close to working-class residential locations, it would provide open space to groups otherwise distant from such amenities. By providing healthy recreation, the park could supply physical and moral stability in the community.[74]

The Citizens' Committee also recommended that the city adopt a zoning ordinance to control land use, a recommendation that various civic groups had made several times in the past. In 1923, the city council approved legislation providing for zoning including separate zoning for heavy and light industrial and commercial areas and for low-density and high-density residential areas. It also limited building heights in certain zones. The river banks were largely zoned as heavy industrial, with light industrial in back of the heavy industrial. The zoning board, however, designated the 238 acres of Nine Mile Run valley as residential, providing exceptional access to the river.[75]

But the zoning ordinance provided only limited authority to the community to control development, and it did not prevent spoliation of the valley. In September of 1922, the Duquesne Slag Products Company had purchased ninety-four acres in Nine Mile Run Valley for the purpose of disposing of the wastes of Pittsburgh-area steel mills, especially those of the Jones and Laughlin Steel Company, located in the city several miles down the Monongahela River. This purchase grandfathered the industry in the valley, since it took place before the city council approved the zoning ordinance.[76] For the mills, the location of NMR valley close to their operations was ideal, since it kept transportation costs low and provided them and Duquesne Slag with a competitive advantage.

Over the years from 1922 to 1962, Duquesne Slag acquired further land within the valley, gradually filling it with slag, often leaving sharp slopes as steep as 80 percent. The slag generated by the iron- and steel-making process and dumped by the company consisted of silica and alumina from the original ore. For every ton of iron more than a half ton of blast furnace slag was produced, while steel making produced a quarter ton of slag for every ton of steel. By the time of the cessation of dumping in 1972, over seventeen million cubic yards of slag were deposited in the valley, forming a mountain of slag that was up to 120 feet high. Although the land was zoned residential, because Duquesne Slag had purchased property in the valley prior to the passage of the zoning ordinance, their industrial use of the land was categorized as a "nonconforming use" and they were allowed to proceed. Protests over the years by neighboring residents did little to control the nuisances created by the slag deposition.[77]

When slag dumping ceased in 1972, city officials and developers began thinking of possibilities for site development. As one of the city's last undeveloped sites it had great potential, especially because of its location between Frick Park and the Monongahela River. The City Planning Department completed a site development plan in 1982. Following this, over the next decade, several private interests prepared development proposals suggesting a mix of residential, retail, light industrial, office, research and development, and parks development. The complexities of site development, however, were large, and funding and developers were hard to find. Issues relating to traffic and neighborhood opposition were especially significant, and none of these plans became a reality.[78]

In 1995, however, the Pittsburgh Urban Redevelopment Authority (URA), at the initiative of Mayor Tom Murphy, purchased the land in Nine Mile Run for $3.8 million for possible residential neighborhood development. Murphy believed that attracting a residential population back into the city from the suburbs was critical for urban revitalization. New homes in Nine Mile Run would be located next to the stable middle-class residential neighborhoods of Squirrel Hill and Point Breeze, providing a powerful magnet. Environmental assessments and planning soon began, and in 1996 Copper Robertson & Partners, a New York design consulting firm, released a master plan. This plan proposed creation of a new community with 950 to 1,150 "new urbanism" housing units (since reduced to 713 units) including a mix of stand-alone homes, town house–type units, and apartment dwellings. The development was also projected to include 114,000 square feet of retail space, an elementary school, and fifty-four acres of open space. The plan was to be developed in four stages. Not only would the city's housing stock be substantially incremented by development, but it also involved converting a brownfield into a new residential neighborhood.[79]

Community involvement in the city's design and management of the site increased after the original proposal. Public meetings on both the housing design and the extension of adjoining Frick Park were held. An important public-private partnership formed involving local groups, the developer, the city, and a team of experts from Carnegie Mellon University. A dramatic change in the original plan, driven by the ecological perspectives of an interdisciplinary group from Carnegie Mellon University's Studio for Creative Inquiry, provided for daylighting rather than culverting the NMR stream and creation of a green corridor reaching to the river. Other changes were made to meet neighborhood concerns expressed at public meetings about construction and traffic nuisances and possible environmental hazards.[80]

The successful development of Nine Mile Run through a partnership involving the city, Carnegie Mellon University, developers, and the neighborhoods reflects a sharp change in attitudes toward the urban environment and land restoration. Prior to the 1990s, the history of Nine Mile Run had reflected a failure on the part of both civic and elite leadership to take steps to protect land and water resources. In addition, the history reflects the reluctance of the city to take steps to protect both natural areas and residential neighborhoods against industrial interests. Thus, as Andrew McElwaine notes, it favored industrial interests over ecological and preservation values.[81] Values, however, do change, and today a new administration and a city population that increasingly thinks in terms of urban ecology have moved to restore the site and to bring it to a state of environmental sustainability. Whether such ecological development will continue on other Pittsburgh brownfield sites has yet to be seen.

This essay has developed the concept of metabolism in relationship to the environmental history of the city of Pittsburgh. In so doing, it has examined the domains of water, air, and land in regard to their use, misuse, and restoration. The use and misuse of environmental resources was largely predicated upon a value system that emphasized production and material progress rather than environmental protection. Restoration of environmental quality in domains such as the air and the land has also been spurred mostly by economic development concerns, although, ironically, significant recent improvements have occurred because of the collapse of the steel industry. Concern over environmental values has been playing a larger role in driving change, but progress has been halting, and many aspects of the environment wait to be redeemed. Thus, although the city's metabolism has begun to move toward a point of balance, further environmental leadership and policy is required to help it reach sustainability.