Urban soils have long presented a challenge to the soil scientist. Many heavily urbanized sites have been repeatedly excavated, admixed, cut, filled, and graded over to the point where they look like dirt and debris mixed up in a blender and pressed with a giant trash compactor. When there's seemingly no rhyme or reason to a site, the soils can be difficult to map and their study may call for some unconventional approaches.

In Detroit, however, soil scientist and geologist Jeffrey L. Howard is finding that some of the city’s vacant lots and demolition do provide a surprising “natural laboratory” for studying certain processes involved in soil formation, particularly the weathering of rocky and mineral objects within the soil layers.

Howard has been analyzing soil pits in the heart of the Motor City since the early 1990s, when he first dug an experimental pit on the site of a demolished building a few blocks away from his office at Wayne State University. Despite the urban setting, he was surprised to notice the similarity between the chunks of mortar and iron nails weathering there and the rocky and mineral materials that undergo oxidation, leaching, erosion, and other weathering processes in naturally occurring soils.

But unlike with natural soils, which may develop over thousands of years, Howard can date the processes in his “natural laboratory” much more narrowly by digging at sites where a dated cornerstone or other historical record can tell him exactly how long those processes have been taking place.

“With an urban soil, we know what ‘time zero’ is,” Howard says. “We don’t know that as well in nature.” If he’s working on a vacant lot where the building was demolished in 1969, for example, “that’s when the soil started to form.”

Geologically, Detroit is an ancient lakebed atop 15 stories worth of glacial till, but as a city, its “time zero” begins in 1701, when Antoine de la Mothe Cadillac secured the area for France by building Fort Pontchartrain beside the strait joining Lakes Erie and Huron.

By 1950, it was a city of 1.85 million, a world leader from the Industrial Revolution through World War II at building everything from ships to railroad cars to automobiles to B-24 bombers. Today, thanks in part to a shriveled urban job market and a robust network of freeways leading out to the suburbs, the population has become outwardly mobile, with more than 5 million living in the greater metropolitan area while the city itself has shrunk to around 700,000.

Having vast tracts of vacant land is a problem for Detroit as a city, but it does provide many sites for studying urban soils.

This dramatic contraction has left thousands of surplus houses, abandoned factories, empty office buildings, and crumbling landmarks in its wake. Though the downtown boasts new casinos and sports arenas, an estimated 40 square miles of city land is now vacant—nearly 30% of the city’s total area—and every year more buildings are marked for demolition than the city budget can absorb. Pheasants, opossums, and wild turkeys are reportedly making their homes in what once were backyards, and the current mayor has set a goal of taking down 10,000 houses during his term.

Soils Display Surprising Order

Having vast tracts of vacant land is a problem for Detroit as a city, but it does give Howard many suitable research sites. He and his team have dug soil pits in anonymous corner lots off Woodward Avenue as well as at some of Detroit’s most cherished and iconic locations, including the Michigan Central train station and the Brewster–Douglass housing complex, once home to Motown legends Smokey Robinson, the Supremes, and the Temptations.
We saw that when we dug our horizons,” Howard’s derelict building weren’t chaotic, but that some pits displayed orderly sequences of distinct soil layers, just as he would expect to find in a non-urban environment.

“We saw that when we dug our first pit at the Brewster projects,” Howard says. “I thought, wow, this is kind of cool.” Then it happened again and again in one pit after another: “I thought, this can’t be right. I mean, it can’t be this consistent in downtown Detroit.”

Using the alphabetical system that soil scientists use to describe soil layers, or “horizons,” Howard’s derelict building sites often display an A horizon (the dark, uppermost layer colloquially called “topsoil”), and below that, in the subsoils, a C horizon developed in the layer of fill material that was brought in to help level the site and ready it for future construction. Under that layer, Howard then typically finds another A and C horizon of the buried native soil.

Finding those orderly layers meant that Howard could develop an “urban chronosequence” for each site. A chronosequence is a series of related soils whose properties differ primarily as a result of age. This proved interesting because while the sites were consistent in terms of having soil layers, variations in other factors—such as age, location, precipitation, contaminants, and the amount and composition of the fill materials—made the layers themselves very different from site to site.

**Train Station Soils Yield Interesting Results**

Michigan Central Station was the city’s main railroad terminal from 1913 on. Built as a Beaux Arts triumph of marble-walled waiting rooms with grand vaulted ceilings, it was for 75 years many peoples’ first experience of Detroit. Though today its interior is stripped of every salable material and its 18-story tower is a showcase of broken windows, it still inspires tremendous civic affection and ambitious plans for its restoration.

In the summer of 2011, Jeff Howard joined Wayne State archaeologist Tom Killion on a dig in Roosevelt Park, where acres of formal gardens once spread like a welcome mat in front of the train station. Hundreds of wooden houses from the 1860s and 1870s were demolished to make way first for the station and then a few years later, for the park, and Killion’s class dug numerous test pits in search of archaeological artifacts, foundation walls, and other landmarks.

At 27 cm, the topsoil is extraordinarily thick, extremely dark in color, and dense with worm casts. More surprising, the first layer of subsoil is colored a deep red but is not clay. The mystery lessens when the archaeologists uncover a buried sprinkler system date-stamped “1916.”

“‘It’s like a tropical soil in terms of probably the amount of water they were putting on it,” Howard says. “That’s why it’s got this humongous A horizon.”

The well-watered site was full of 19th-century wrought-iron nails, which oxidized and lent a rusty color to the subsoil. Many natural soils and subsoils have a reddish color due to the presence of iron oxides—think of the red clay of Georgia—but those iron oxides are not the result of rusting nails.

The team digs easily through the disintegrating cement and mortar that has also leached into the subsoil layers. Calcium carbonate is present in natural soils, too—particularly in dry areas, like the American West, where it tends to result from the weathering of substances like limestone or chalk, not from disintegrating cement, as at these urban sites.

As for the deep black color of the topsoil, Howard is investigating whether it could be tinted by soot from the coal that once powered the railroads and heated people’s homes and blackened the city’s stone facades.

That’s why Howard calls these urban soil sites a “natural laboratory.” “We have a chance to look at weathering processes, which are natural, with a chronosequence that we can really date,” he says.

Besides being able to run a clock on natural weathering processes, Howard says, “We’re also looking at weathering reactions involving things that you don’t normally see in soils and we don’t know anything about.”

A good example is some peculiar artifacts that come out of the train station site, one of which appears at first to be a lumpy rock about the size of a hand, but at the center of which they discover an iron nail—a wrought-iron nail that has undergone pedocementation. Iron leached out from it into the soil and then was oxidized, cementing the sandy soil around the nail.
Soil Horizons

Soil Artifacts May Have Beneficial Effect on Health

Howard’s research also suggests that some of that underground construction debris may actually be having a beneficial effect in certain polluted soils.

Detroit’s industrial heritage has left its soils—like those of many cities—contaminated with lead and other heavy metals, from coal burning, smelting, lead paint, and leaded gasoline.

Although lead paint and leaded gas have been discontinued and the numbers of children with lead poisoning has been dropping since the 1960s, urban lead contamination remains a public health hazard. A 2010 report on the Detroit public school system found that nearly 60% of 39,199 children tested had a history of lead poisoning (lead levels of 10 micrograms/deciliter of blood or more).

One ongoing source of lead exposure is contaminated particles from wind-blowing topsoil or demolition dust that can be tracked into homes from yards and sidewalks and be incorporated into household dust. Moreover, there is a flourishing urban farm and garden movement in Detroit, with many people eager to grow their own food. Drifting contaminated soils can settle on the leaves of vegetables and other plants.

This contamination—and research into possible soil remediation strategies—is of great concern to Howard. In a paper in *Environmental Pollution* in 2011 (with Dorota Olszewska), he noted that both calcium carbonate and iron oxide—by-products of the weathering of cement and iron nails, respectively—act as immobilizing agents for lead. They chemically combine with lead and prevent it from leaching into groundwater or being ingested in dust.

“Lead loves carbonate. Lead loves weathered iron,” Howard says. “Maybe we should be leaving these artifacts in the soil because maybe it would be beneficial from the standpoint of immobilizing the lead.”