Flint Futures: Alternative Futures for Brownfield Redevelopment in Flint, Michigan

Landscape Architecture/Resource Policy Group Master's Project
School of Natural Resources and Environment
University of Michigan, Ann Arbor

Jennifer Dowdell
Dave Laclergue
Emily Marshall
Rebekah VanWieren
Advisor: Joan Iverson Nassauer

Table of Contents

Acronym List

Acronym	Name
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
DDA	Downtown Development Authority
EPA	U.S. Environmental Protection Agency
GCLB	Genesee County Land Bank
GM	General Motors
LEED	Leadership in Energy and Environmental Design
LID	Low Impact Development
LUST	Leaky underground storage tank
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
MEDC	Michigan Economic Development Corporation
NREPA	Natural Resource and Environmental Protection Act
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
UAW	United Auto Workers
USACE	U.S. Army Corps of Engineers
UST	Underground storage tank
VOC	Volatile organic compounds

> Flint is ahead of the rest of the country. The problems that the rest of the country will soon experience exist there now. It is an ideal place to work on new solutions.
>
> -Dr. Frithjof Bergmann, Center for New Work
> "Brave New Work," Detroit Free Press, June 18, 1987
> (Cited in Dandaneau 1996)

Introduction

Throughout the United States, communities face challenges related to the loss of manufacturing jobs. Few places in the country, however, have experienced these problems as severely as southeast Michigan. In this region, which was the international center of automotive manufacturing for almost 70 years, decades of factory closures and the steady evaporation of automotive jobs in and around Flint and Detroit have resulted in devastated economies, dwindling populations, and a profound loss of individual and collective identities (Mellon 2002).

In this project, we address the challenges of deindustrialization by exploring redevelopment options for a 130-acre site in Flint, referred to by locals as Chevy in the Hole. The birthplace of General Motors (GM), it now stands as a massive vacant lot, likely a source of hazardous contaminants into the Flint River watershed and surrounding communities. Planning efforts are underway for the district surrounding Chevy in the Hole, but none have directly addressed the economic and environmental complexities of this large property adjacent to downtown.

The site's owners are reluctant to transfer property rights due to liability concerns and a lack of consensus among stakeholders regarding future uses. In order for Flint to reclaim Chevy in the Hole, these stakeholders need to develop a strong, realistic vision of the site's future. To this end, we have developed two separate scenarios that describe plausible redevelopment trajectories: the Flint Urban Riverfront scenario and the Flint River State Park scenario. These differ from one another in their assumptions about development pressures, contamination, remediation, ecological enhancements, and circulation (Figure I.1). Each scenario is planned in two phases of different lengths, but they both start in 2010 and are fully implemented by 2040 (Figure I.2).

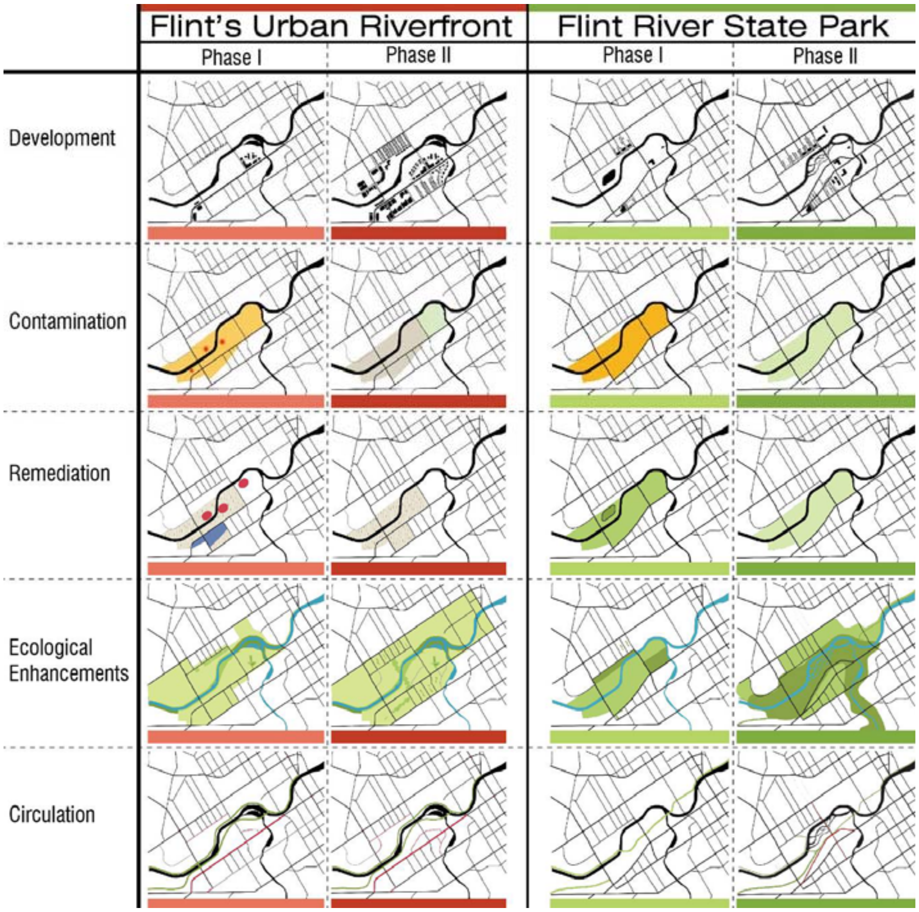


Figure I.1: Scenario assumptions differentiating the Urban Riverfront and State Park scenarios (explained in detail in Chapter 4.

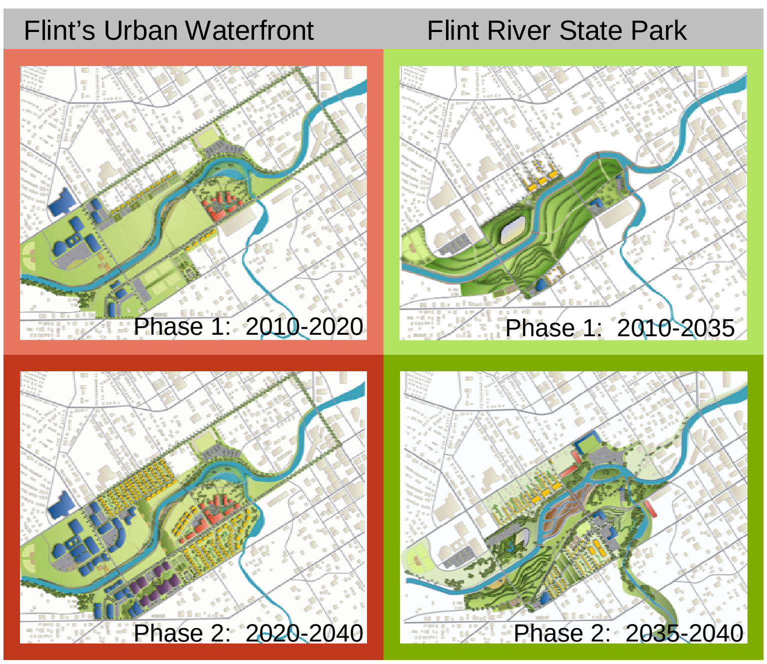


Figure I.2: Two phases for each scenario, with both trajectories ending in 2040. Chapter 5 describes these designs in detail.

While Flint was once seen as a shining example of the American Dream, the collapse of GM's domestic operations has created an ongoing state of crisis in the city. The manifestations of this crisis, shown to the world in director Michael Moore's contentious documentary work *Roger and Me*, include a loss of over half the city's population since the 1970s, large-scale abandonment of property, and a spike in violent crime that has caused Flint to repeatedly receive ratings as one of the most dangerous cities in the country (Morgan Quitno 2006).

Against this bleak backdrop, signs of rebirth are appearing throughout the community. Foundations, nonprofits, government agencies, and assertive neighborhood groups are coordinating programs to encourage redevelopment and improve quality of life. Bold "urban pioneers" are investing in Flint, renovating entire blocks one house at a time. Coalitions of optimists are seeking ways to revitalize the city, hoping that establishing a more diverse economic base will stabilize Flint and allow it to flourish again. Central to these efforts is the reclamation of derelict buildings and properties, ranging from empty lots to single family homes to entire downtown blocks.

Chevy in the Hole is one of the most symbolically charged abandoned properties in Flint. At the height of GM's production in the 1960s, around 8,000 people were employed at the site (Figure I.3) (White 2006). Layoffs at the plant began in the 1970s, peaked in the 80s, and continued until the last factory was shut down in 2004. Starting in 1995, the shuttered plants were demolished one by one, leaving an empty expanse of asphalt and weeds adjacent to downtown Flint (Figure I.4). Several residential neighborhoods, some of the taller downtown buildings, and Kettering University look directly down on the massive vacant lot.

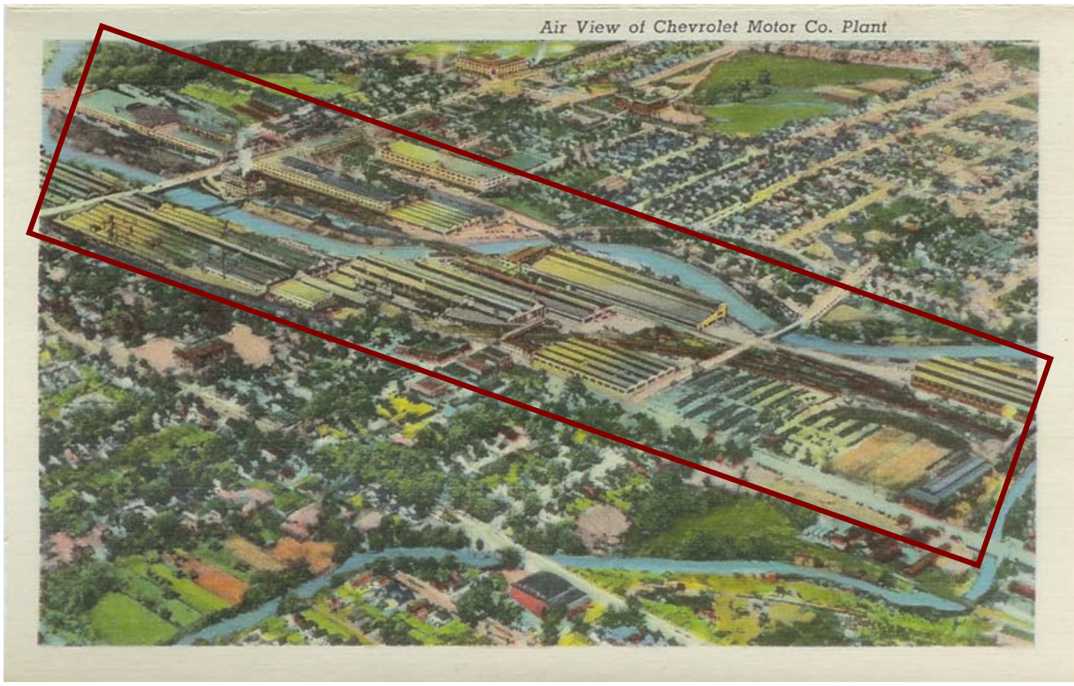
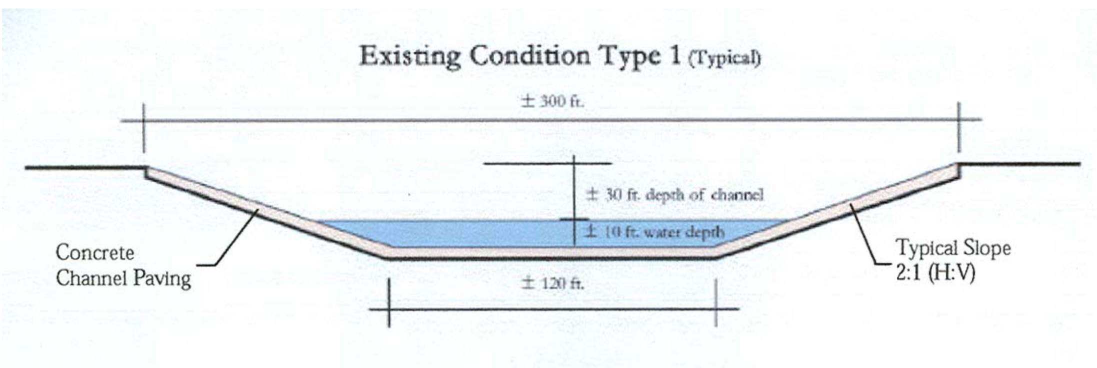


Figure I.3: Historic postcard showing Chevy in the Hole at the peak of GM's production in Flint. The approximate boundaries of the current vacant lot are outlined in red (www.tedjankowski.com).

Figure I.4: Chevy in the Hole, 2006, as seen from the C.S. Mott building in downtown Flint.

The site is a textbook example of a brownfield, "…an abandoned, inactive, or underutilized industrial or commercial site…" located in an urban area or its surrounding suburbs (Geltman 2000). The presence or perceived presence of contamination is a defining factor of brownfields that complicates their reuse and stigmatizes surrounding properties (Nassauer 2005b). Sites like Chevy in the Hole often fall into a trap of “brownfields paralysis,” an unintended consequence of federal and state brownfields policy (Geltman 2000). The enactment of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or the “Superfund Act”) was the first time the U.S. government directly addressed the responsibility of property owners to clean up contaminated land before getting rid of it; while the legislation has resulted in significant gains for public and environmental health, CERCLA also has inadvertently encouraged owners of former industrial properties to hold potentially contaminated land indefinitely in order to avoid cleanup costs.

In addition to the complications posed by residual contamination, the highly engineered channel along this reach of the Flint River poses serious problems. Armored in concrete in the 1950s to avoid flooding GM facilities, the channel’s habitat quality has been significantly degraded, and the river’s aesthetics severely impaired (Figure I.5). Although the factories are gone and the channel is no longer needed for flood control, it likely continues to serve a role as a barrier between contaminated groundwater and the river. In any case, it presents a challenge for most types of potential redevelopment.



Figures I.5: An Army Corps of Engineers section of the Flint River’s concrete channel structure (USACE 2004).

Chevy in the Hole is owned by the Delphi Corporation, Kettering University, and GM. Kettering’s portions of the site are limited by strict deed restrictions imposed by Delphi to decrease the company’s liability risks (Engle 2006). Under CERCLA, if Delphi and GM were to transfer the rights of their former manufacturing property, they would likely be held responsible for any contamination found persisting on the site, and could potentially be held responsible for contamination created by future uses. On the other hand, Flint’s decline after the departure of GM and Delphi has been disastrous for the companies' public relations, so any positive moves that they make on the city's behalf will be mutually beneficial.

Stakeholders in Flint also believe that the companies' reluctance to transfer the site stems from uncertainty about future uses (Beckley 2006; Greer 2007). Conflicting plans from neighboring businesses and neighborhood groups make it unclear whether future development could result in hazards to the public, additional contamination, or controversial development, all of which would cause problems for GM and Delphi in the future. An agreed-upon development trajectory that assures GM and Delphi that Chevy in the Hole will contribute to safe and positive change in Flint will help the community build momentum for redevelopment.

We have worked with the Genesee County Land Bank (GCLB) in this project to explore plausible, innovative concepts for redevelopment of Chevy in the Hole that fit into the context of Flint's larger revitalization efforts. Our work builds on a broader planning effort that Sasaki Associates led in 2005, adding detailed consideration of several key factors: specific site constraints such as residual contamination; the creation of ecological amenities; and Flint residents' priorities for the site. We have drawn on national and international precedents of brownfield redevelopment to create a picture of what is possible and advisable at Chevy in the Hole. It is our intention to propose ideas that will help stakeholders see the range of possibilities, and to generate momentum for new growth on and around the former manufacturing site. By considering a variety of options within realistic bounds, Flint residents will be better prepared to make decisions about the future of their city as new information becomes available.

We met with various groups of community members in Flint to discuss their hopes for their city and this specific site. In a community brainstorming session we hosted in fall 2006, residents' priorities fell into the following categories: new housing in a variety of price ranges; a stronger job base; increased safety, both in terms of crime prevention and contamination cleanup; and improvements in livability, especially with consideration of how to attract young people and keep them in Flint. These community priorities led us to identify four key questions which then guided our development of scenarios and phases:

- What economic drivers will spur redevelopment and stimulate new growth at Chevy in the Hole?
- Given the economic context and environmental risks of this site, what kinds of remediation are advisable?
- After remediation, what kinds of redevelopment and ecological restoration are feasible?
- How could redevelopment phases respond to both community needs and brownfield constraints?

Brownfields present extraordinarily complex challenges, with overlapping layers of political, economic, social, and environmental resistance to change. It is important and exciting to recognize that they also provide great opportunities for cities like Flint. The numerous abandoned properties around Flint add up to a significant amount of land right at the city's core, available for redevelopment in whatever way best suits the community's present and future ambitions. They give Flint a chance to decrease public health risks, improve its network of recreation amenities, and create healthy wildlife habitat along the Flint River. Finally, the wide range of brownfield redevelopment incentive programs that exist at multiple jurisdictional levels create possibilities for new jobs and new housing, which could help stimulate Flint's economy.

Redevelopment of Chevy in the Hole gives Flint an opportunity to redefine itself in the eyes its own citizens as well as those of the outside world. If it is successful in its attempts at revitalization, Flint will serve as a model for cities all across the country that need to adapt to an increasingly post-industrial economy.

Chapter 1: Flint History and Site Context

The social and ecological histories of Flint play a crucial role in understanding the city's context within the broader environment, its past prosperity, and its current problems. This understanding is vitally important as we re-envision what is plausible for Flint moving into the future. In this chapter, we consider Flint's social and industrial history, watershed and landscape ecology context, landuse patterns, and complementary planning efforts for downtown and the Flint River.

Early Settlements

Flint is located in the mid-eastern part of Michigan, halfway between Detroit and Saginaw Bay. The earliest known people living in present-day Flint were Native Americans, most recently the Chippewa band of the Saginaw tribe. Native Americans in the area used the Flint River as their main transportation route to Saginaw Bay as well as for water and food resources. Also, Native American trails to Saginaw crossed the Flint River between the Chevy in the Hole site and downtown, which was also the crossing where the first white settler, Jacob Smith, established a fur trading post. (Figure 1.1) Jacob Smith took part in the land treaty agreement that established Indian reservations along the Flint River in 1819 before European settlers took over the area (Peters 2004).

Before European settlement, John Blois describes Genesee County's landscape in 1839 as "rolling" and the soil as "mostly dry, sandy loam, free from stone" (Blois 1839). He also describes the vegetation being a combination of oak openings and dense, lofty forests. Blois' observations correspond with the vegetation types surveyed by the General Land Office in the circa-1800 vegetation map, which shows Genesee County comprising primarily oak-hickory forest, sugar maple-basswood forest, and white pine forest (Comer and Albert 1997) (Figure 1.2). This rich forest resource led to the prosperous early industries of white pine and hardwood logging and helped establish the City of Flint in 1855.

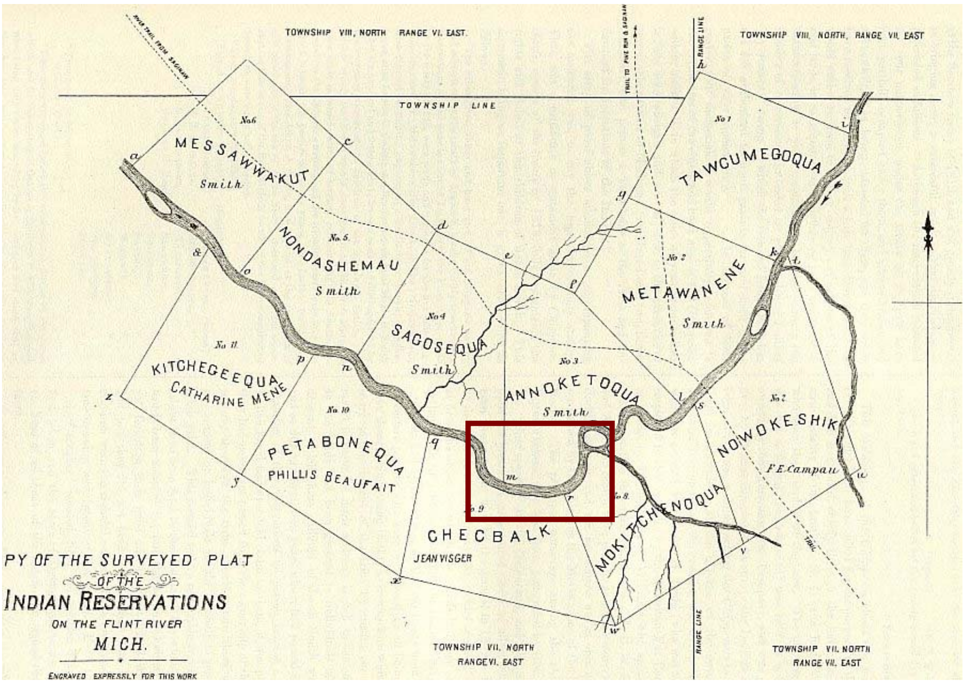


Figure 1.1: Native American reservation map (Mott Park Neighborhood Association Website). Approximate site boundaries of Chevy in the Hole are outlined in red.

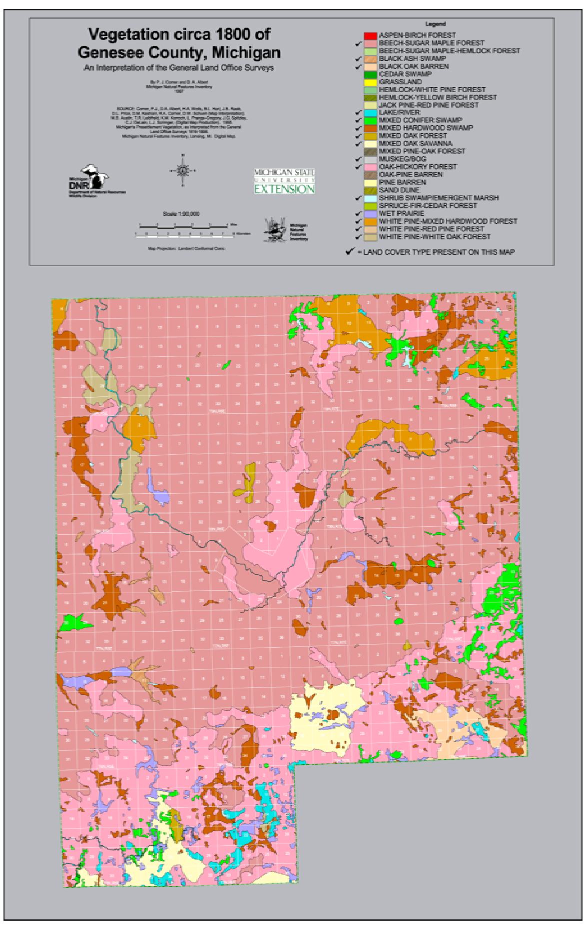


Figure 1.2: Historic vegetation, pre-European settlement (Michigan Natural Features Inventory).

The logging industry started in Flint in the mid-1850s and the largest lumber mill was established in 1856 by Henry H. Crapo. (Figure 1.3) Lumber production increased significantly after the Flint and Pere Marquette railroads opened between Flint and Saginaw in 1862, which allowed lumber to be sent to the eastern and western United States. From 1866 to 1871, Flint's logging industry boomed. At the height of the logging industry in Flint there were nine mills, employing 500 people, and milling 90 million feet of lumber each year. White pine stands were harvested throughout Genesee County upriver from Flint, but by 1879 the pine stands were nearly exhausted and only three mills remained (Figure 1.4). In the 1880s the logging industry shifted from harvesting pine to hardwoods, which supported the beginnings of the horse-drawn carriage industry (Wood 1916).

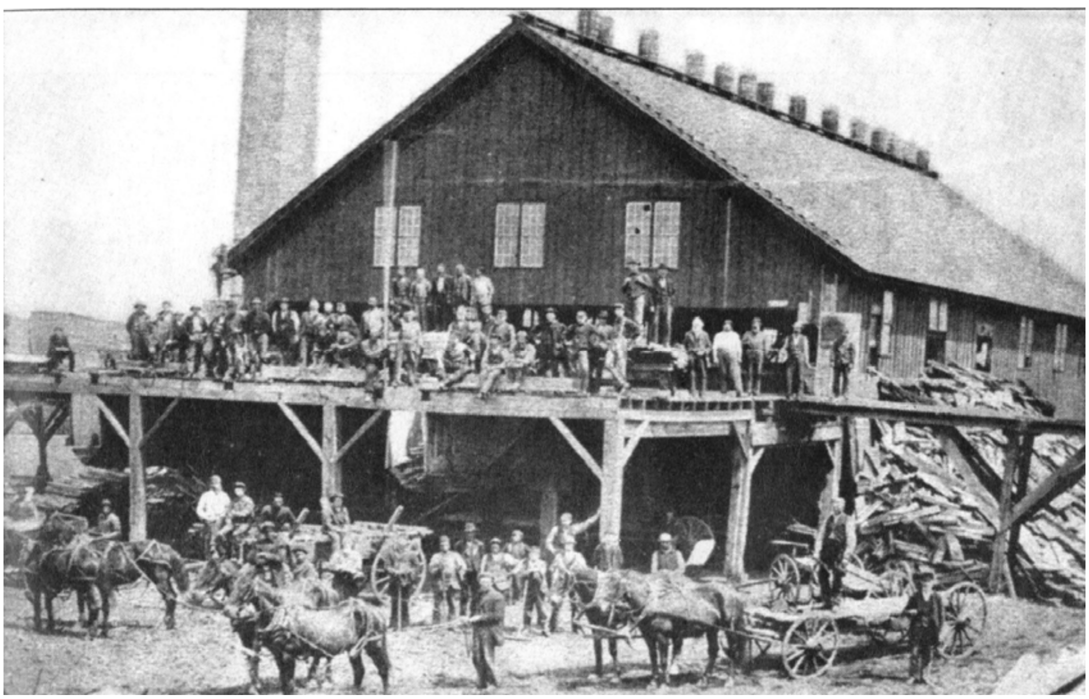


Figure 1.3: Crapo logging mill (Genesee County Historical Society).

Figure 1.4: Flint in 1867 (Clarke Historical Library, Central Michigan University).

Manufacturing

Flint first became known as “Vehicle City” for being the top producer of wagons (Flint Wagon Works), buggies, and other horse-drawn vehicles at the end of the 19th century (Figure 1.5). In 1886, William Crapo Durant, the grandson of the logging industrialist Henry H. Crapo, along with Josiah D. Dort started the Durant-Dort Carriage Company, which held the first patent on a road cart and was Flint’s largest carriage manufacturing company. The Carriage Company built many different types of horse-drawn vehicles and later produced light commercial trucks and automobiles, making them the “General Motors of the carriage industry” (Genesee County Historical Society 2004). Durant-Dort Carriage Company supported the creation of several manufacturing businesses and subsidiaries that made parts for the various carriages, including Flint Axle Works, Flint Varnish Works, Imperial Wheel Company, and Armstrong Spring Works (Wood 1916; Flint Public Library 2007). These companies were extremely influential in the establishment and expansion of the automobile industry at the turn of the 20th century, because many of these companies were able to shift production of carriage parts to motor parts and accessories.

Figure 1.5: Photo of Saginaw St with buggies and street cars (Genesee County Historical Society).

Flint was the natural choice for the growth of the automobile industry when it arrived in the 1900s. General Motors was first organized in 1908 and would slowly incorporate many of the automobile assembly, parts and body manufacturing companies in Flint and around the U.S. (GM 2007). Chevrolet Motor Company was founded in 1911 and bought by GM in 1918. By the 1930s General Motors had established four major industrial 'campuses' within Flint: Chevrolet Division on the west site (Chevy in the Hole), Buick Division in the north (Buick City), Fisher Body Division in the south, and AC Spark Plug on the east side (Genesee County Historical Society 2004) (Figure 1.6). During the first half of the 20th century, GM grew to be the largest and most profitable corporation in the U.S. (PBS 2006). At its peak in the 1950s, GM employed almost 90,000 workers in Flint, but by 1989 the number was down to 30,000. In 2006, there were only 10,400 GM employees in all of Genesee County's seven GM plants, with further layoffs occurring in 2007 at the GM Truck and Bus Plants south of downtown and other remaining operations in Flint (PBS 2007; Princhard 2006).

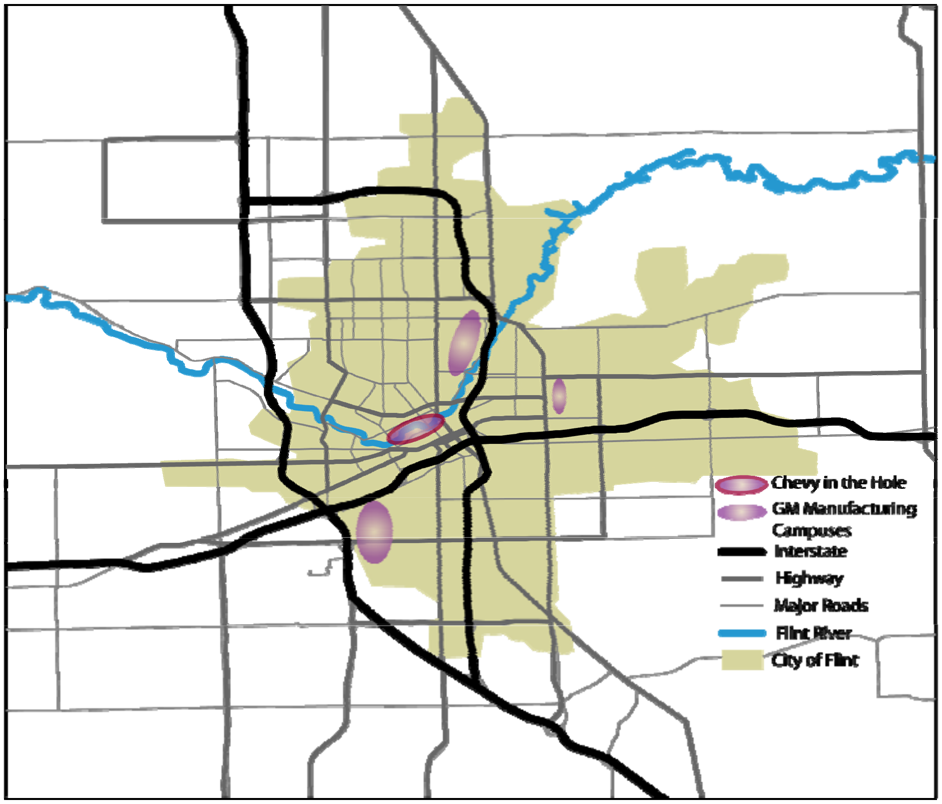
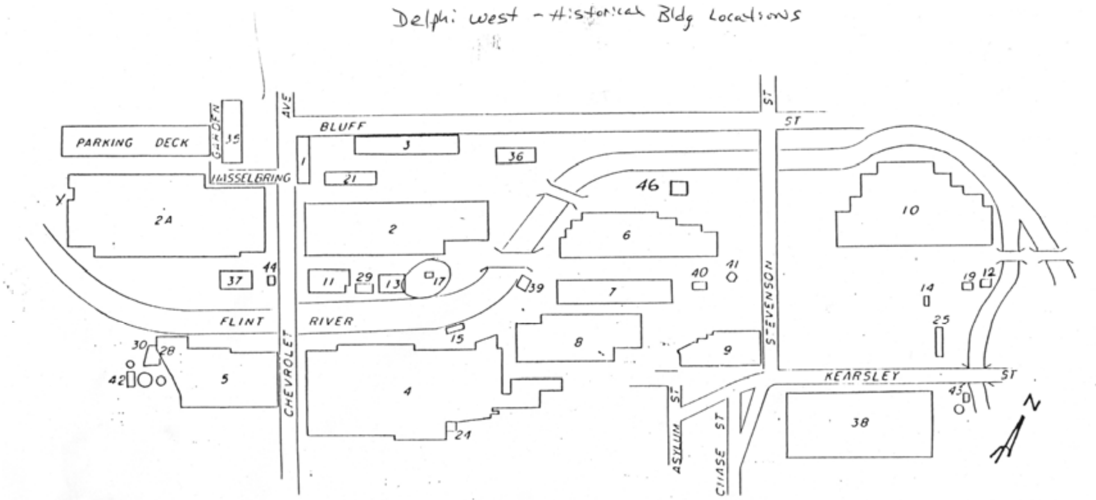


Figure 1.6: Flint's Distribution of Industrial Manufacturing.

Chevy in the Hole

The Chevy in the Hole site once housed 17 plant buildings, including engine assembly (Plant 2 and 2A), engine parts (Plant 5), other parts (Plant 4) and body production (Plant 2A) as well as an office building and hospital (Figure 1.7).



PLT	NAME	PLT	NAME	PLT	NAME
1	MAIN OFFICE	16		32	
2	MOTOR SHEET METAL PARTS	17	OIL HOUSE	33	
2A	SHEET METAL PARTS	18		34	
3	PARTS AND SERVICE	19	MAINT SUPPLIES	35	GARAGE AND SHEET METAL
4	MOTOR	20		36	PERSONNEL AND HOSPITAL
5	MOTOR	21	EXECUTIVE CAR GARAGE	37	PRIMARY SWITCH HOUSE
6	SHEET METAL	22		38	DIE BUILD
7	DYN. LAB. MAINT. GEN. STORES	23		39	PUMP HOUSE (RESERVOIR)
8	SHEET METAL	24	OIL SEPARATOR BLDG	40	STEEL STORAGE BLDG
9	MOTOR	25	WOODWORKING	41	GAS STATION
10	SHEET METAL	26		42	WATER TREATMENT PLANT
11	POWER HOUSE	27		43	PUMP HOUSE
12	MAINT SUPPLIES	28	BRIQUETTING BLDG.	44	OIL PUMP HOUSE
13	MAINT	29			
14	INCINERATOR BLDG	30	WASTE WATER	46	PAINT STORAGE
15	PAINT MIXING	31			

Figure 1.7: Plant layout (MDEQ Freedom of Information Act record, no documented source).

It was a major hub for GM automobile manufacturing; by 1963, one out of every 10 cars sold in the U.S. was a Chevrolet. General Motors had started establishing manufacturing plants worldwide by the 1920s, and this shift overseas was eventually a major factor in the closing of plants in Flint. Layoffs started in the 1970s, and around 1995, GM started to shut down and raze plants at Chevy in the Hole. The last building (Plant 4) was razed in 2004. There are two remaining buildings that were part of the Chevy in the Hole “campus.” Building 35, which originally housed new car delivery and also built the first Corvette prototype, was donated to Kettering University and was refurbished for their Mechanical Engineering and Chemistry Center. Plant 38, is still operated by GM/Delphi for Tool and Die and currently has around 250 employees. Today, Chevy in the Hole is the closest abandoned industrial “campus” to the main downtown business district, which provides a unique and significant opportunity to redevelop this area and the surrounding neighborhoods.

Chevy in the Hole was also a site of national importance in the birth of the labor movement. The United Auto Workers (UAW) union was first formed in 1935, backed by the National Labor Relations Act which had passed in Congress earlier that year. The law provided governmental support for “unemployment councils” to organize and bargain collectively with employers. The UAW leaders quickly gathered members and organized labor strikes throughout the country to fight for better wages, hours and work environments. As a strategic effort to strike against the world’s largest auto manufacturer, General Motors, UAW leaders started strikes in Flint, with a sit-down at the Fisher Body Plants #1 and #2 (Fisher Body Division) starting on December 30, 1936. The sit-down strike continued at the Fisher Body Plants and also moved to Chevrolet Plant #4, where the sit-down strike ended on February 11, 1937, therefore making Chevy in the Hole a lasting icon in the labor relations movement of the U.S. (United Auto Workers 2007; Baulch and Zacharias 2007). As a result of the Flint sit-down strikes, General Motors officially recognized the UAW in 1937.

Landuse Context

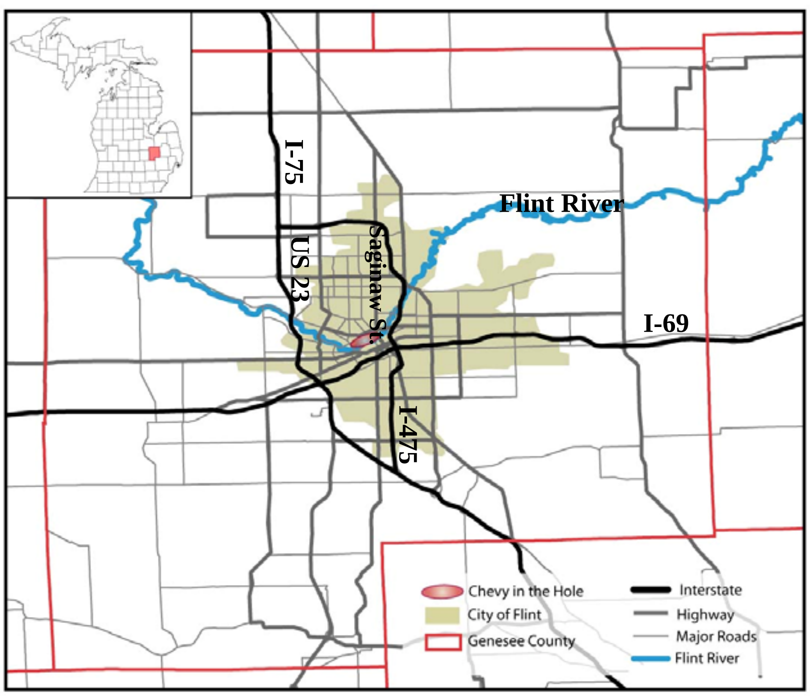


Figure 1.8: Flint’s Setting within Genesee County.

The downtown area of Flint can be accessed from major highways to the east, west and south, which has made the area a convenient hub for shipping and receiving products for the manufacturing industries (Figure 1.8). The carriage and automobile industries relied on the railroads for transporting goods, most of which are no longer in service through Flint. The railroad connected to Chevy in the Hole ran along the south site of the site, with several spurs throughout the site, all of which have been shut down. To make use of the abandoned railroad corridors, the Genesee County Planning Department has a non-motorized transportation program developing rails-to-trails projects in Flint, along with other non-motorized transportation programs. There are other efforts and stakeholders working on transportation and recreation issues. The non-profit organization, Friends of the Flint River Trail, is working to create a network of trails that link to the existing Flint River Trail, which currently ends at Riverside Park in downtown Flint and runs north to the northern edge of Flint. There is significant community support to continue the Flint River Trail through the Chevy in the Hole site; at a community meeting we hosted in November, participants identified a non-motorized trail through the site as the single highest priority for short-term improvements.

Today, around 36% of Flint residents do not own cars, so many people rely on Flint's Mass Transit Authority bus system or other non-motorized options (Bryant 2005). Traffic patterns have changed significantly with Flint's population decline. Many of the streets in the downtown area were made one-way in the 1970s and 80s in an attempt to improve livability for a dwindling population, however these one-ways failed and have caused severe disconnections between many areas. For example, Kearsley Street and Glenwood Avenue on the south side of Chevy in the Hole are both one-way, which greatly reduces the traffic moving along the Chevy site, creating a dead zone around the area. The City of Flint has is planning to convert some of the one-way streets to two-way.

There are numerous open spaces throughout the City of Flint and around the Chevy in the Hole site, including park spaces, golf courses, cemeteries, school grounds, and vacant land (Figure 1.9). The vacant lands offer a tremendous opportunity to create a broader, more connected network of recreation areas and habitat corridors through the city. The City of Flint park system includes 67 parks throughout the city totaling almost 2,000 acres of green space, including four golf courses and 25 neighborhood parks (City of Flint 2005). Glenwood Cemetery and Mott Park Golf Course, two of the large green spaces close to downtown, are just west of Chevy in the Hole. In addition, several of the schools nearby have play fields and extended green spaces as part of their grounds that add to the overall open space. Genesee County runs two large recreation areas northeast of the City of Flint and a smaller park space southwest of the City of Flint, but does not offer any county-run park space within the City of Flint.

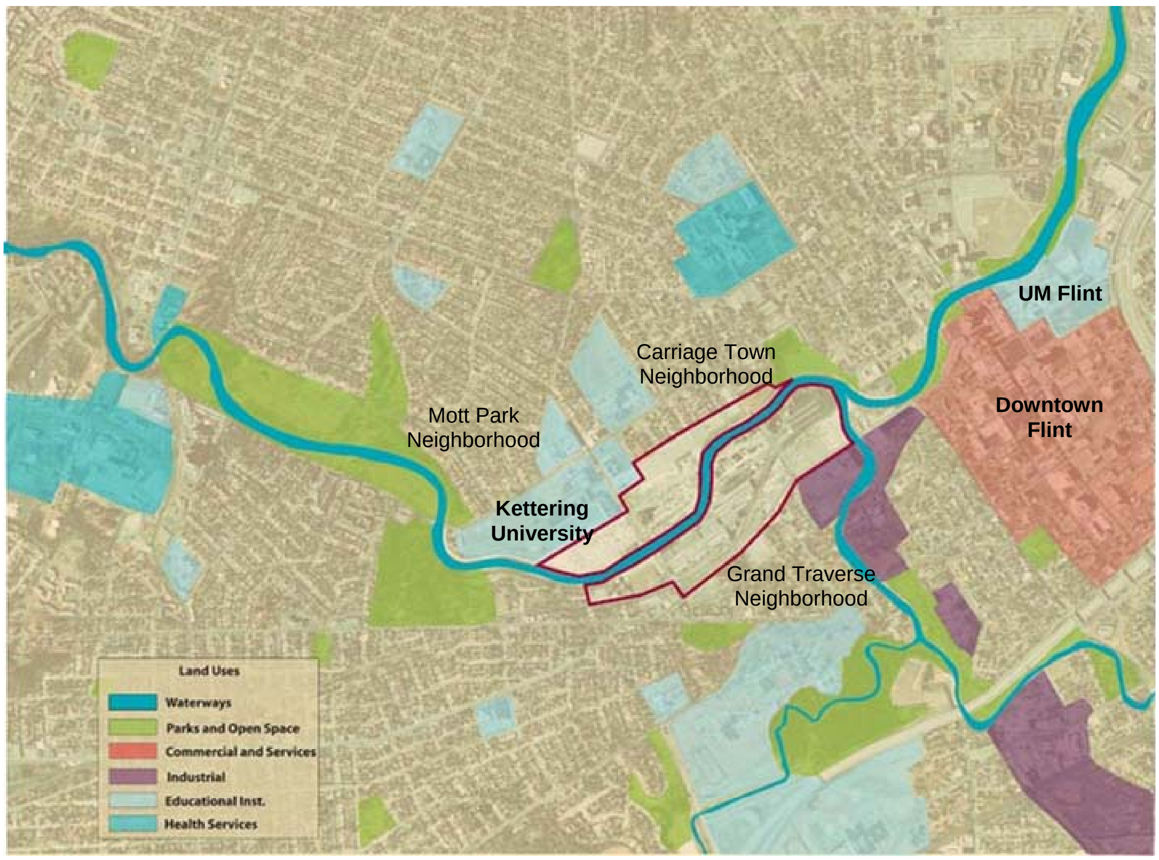


Figure 1.9: Chevy in the Hole site context.

Although there are several semi-natural areas around the Chevy in the Hole, many of these spaces do not provide quality habitat needed to support healthy, diverse plant and wildlife populations. In addition, the habitat patches are fragmented and habitat corridors need to be restored. Moving further out from Chevy in the Hole, the Happy Hollow Nature Area is a significant preserve along Swartz creek that could be connected to the site to create a habitat corridor that has greater ecological value than the current green spaces provide. There are currently some efforts to improve habitat corridors and restore tributaries of the Flint River to improve stream habitat and riparian ecosystems. For example, the Applewood Estate operated by the Ruth Mott Foundation is working on daylighting Gilkey Creek, previously in a culvert below a parking lot (Elliott 2007).

Flint boasts three higher-education institutions, including University of Michigan-Flint, Kettering University, and Mott Community College, which provide much of the activity in the downtown area (Figure 1.9). University of Michigan-Flint is along the Flint River on the east end of downtown and Kettering University is along the Flint River on the west end. The City of Flint and other stakeholders have been trying to strengthen the link between the two Universities, particularly by improving the Third Avenue corridor that runs north of Chevy in the Hole. University of Michigan-Flint is an undergraduate and graduate institution and is primarily a commuter campus, however the university has been trying to offer more on-campus housing options for students and plans to build new dorms in 2008. Kettering University, originally called General Motors Institute, was established in the early 1900s as a research and development school in the automotive field, and many GM workers attended the school while working in Flint (GM 2007). The school is no longer a part of GM, and over time has expanded its engineering programs beyond automotive engineering. Their programs in industrial and manufacturing engineering, mechanical engineering, and electrical and computer engineering all ranked in the top 10 by U.S. News, America’s Best Colleges 2007 report (Kettering 2006). They offer students a unique co-op program, where students are on a rotating schedule of taking classes for three months followed by an internship for three months with a partnering organization. Other schools directly around the Chevy in the Hole site include Durant Tuuri Mott Elementary School to the north, and the Michigan School for the Deaf to the south.

There are many other civic and cultural organizations and facilities that add to the character and community of the downtown area. Some notable places include the Children’s Museum, which is on Third Avenue just north of the Chevy site, the thriving Farmer’s Market east of Saginaw Street, and the Flint Cultural Center east of downtown, which includes a performing arts center, planetarium, youth theater, library, and a newly-renovated Institute of Arts (Figure 1.10).

Figure 1.10: The newly-renovated facilities of the Flint Institute of Arts (Connor Coyne 2006).

The main business district in Flint flanks Saginaw Street, only about six blocks from the eastern edge of the Chevy site. Over the last 3-5 years, there have been visible improvements along Saginaw Street, despite the notable prevalence of vacant buildings. In 2003, street arches were installed that recreate earlier features that adorned Saginaw at the turn of the 20th century. Some vacant buildings have been torn down and rebuilt, while others have been renovated. These projects include the Genesee County Land Bank building and the new Rowe Engineering buildings (Figure 1.11).

Figure 1.11: Saginaw Street running through downtown Flint. Signs of new investment include the recreated metal arches and several renovated buildings.

Saginaw Street was the center of the town until the late-1800s, when neighborhoods moved outward to connect to the growing automobile manufacturing campuses. In general, neighborhoods in Flint have suffered decline along with the decline of the auto industry, especially in the vicinity of the former manufacturing sites at Chevy in the Hole and Buick City. Flint reached its peak population at 200,000 in the 1970s, and was expected to grow to 250,000. In 2000, however, Flint's population was 124,943 and it is unclear when the population losses will level off or reverse. While Flint as a whole is diverse, with 53% African Americans and 41% whites, neighborhoods tend to be segregated by race and income, and at Chevy in the Hole the river serves as a separation line, with the north side residents generally being white and in a higher income bracket and the south site residents being lower income African Americans. With the decline of Flint, poverty has become much more prevalent, with the median income now at $28,000 and 26% of the population below the poverty level (U.S. Census Bureau 2000).

Most neighborhoods in the downtown area of Flint are fragmented and lack a critical mass, dotted by pockets of vacant lots and deteriorating houses. There have been housing market studies in Flint that show new, better-built and more diverse housing types are needed in the downtown Flint area (Peterson 2007). Much of the housing built in the early to mid 20th century was built very quickly and of lower quality to accommodate the influx of population, particularly from 1910-1920 when the population rose from around 13,000 to 92,000 (Peters 2004). For this reason, along with ongoing neglect, the majority of the available houses in the downtown area are in such poor condition that renovation costs would be higher than what the house could sell for or be worth after it was renovated in the current housing market. These neglected pockets surrounding Chevy in the Hole perpetuate neighborhood decline, but also provide a unique opportunity to redefine and re-envision the area at a much broader scale than would otherwise be available in more thriving city-centers.

The Genesee County Land Bank is working to clean up and reuse more than 4,000 abandoned, dilapidated, and brownfield properties throughout the county, including Flint, with the aim of revitalizing communities, improving the environment, and returning properties to the tax roll. The GCLB was created in 2002 through the county treasurer's office to manage widespread tax-foreclosed properties in a more coordinated, expedient way. Previously, abandoned properties would sit off the tax roll for up to seven years, leading to increased dereliction and urban decline. With the creation of the Land Bank, new policies turned tax-foreclosed properties over to the county treasurer after two and half years, so that the properties could be cleaned up and returned to the tax roll much sooner (GCLB 2004). The GCLB also serves as the Genesee County Brownfield Redevelopment Authority, which gives them the responsibility and authority to manage cleanup and redevelopment of brownfield properties. In addition to the efforts of GCLB to improve neighborhoods in the Flint area, several of the neighborhoods around Chevy in the Hole are part of state-defined Renaissance Zones, where any new businesses or residents are exempt from state and local taxes for a period of time.

Other remarkable beautification and enhancement projects are improving neighborhood communities. For example, the Ruth Mott Foundation established its grant programs in 2001 and is committed to contributing its grant dollars only within the greater Flint area, making substantial improvements to and investments within the community. The Foundation has grant programs for the arts, health promotion, and beautification, including grants for tree planting, watershed improvements, and community gardening (Ruth Mott Foundation 2003). Flint also has a strong community gardening network and recently the Flint Urban and Land Use Corporation and Prevention Research Center of Michigan cooperated to implement a program that worked to curb violence in the community through community gardens (Alaimo 2003). These programs are just a couple of inspiring, successful activities going on in Flint that offer signs of hope as Flint rebuilds itself.

Around Chevy in the Hole there are five distinct neighborhoods: Carriage Town Neighborhood, Grand Traverse Neighborhood, Third Avenue Neighborhood, Mott Park Neighborhood, and the neighborhoods south of the project site (see Figure 1.9 Chevy in the Hole site context).

The Carriage Town neighborhood is located on the west side of Saginaw Street and is designated as a Historical District of Flint, with historical buildings including Atwood Stadium and Durant-Dort Carriage Works. There are many old Victorian homes that were built when the carriage industry was booming, which have since been renovated and restored. There is an active neighborhood group, which has brought back investment to the neighborhood, including a new townhouse project along the Flint River.

Grand Traverse is also a historical neighborhood, extending into downtown. Grand Traverse has multiple land uses including downtown and neighborhood businesses, historically significant homes, vacant land, and many rentals. Of all the neighborhoods around Chevy in the Hole, Grand Traverse is the most diverse in both race and income. Only 23% of Grand Traverse residents are homeowners, a percentage significantly lower than Flint as a whole (Bryant et al. 2005). Grand Traverse also has one of the more active neighborhood groups.

Third Avenue neighborhood is located between Carriage Town and Mott Park neighborhoods on the north side of Chevy in the Hole. This area has more vacant lots, especially along streets that have direct access to the site, and is much more dilapidated than the Carriage Town and Mott Park areas. Though not as active as some, there is a neighborhood group.

Mott Park is the most stable and well-maintained neighborhood around the Chevy site. In the 1920s, there was such a housing shortage that General Motors started their own development firm, Modern Housing Corporation, and built one of the country's first subdivisions in Mott Park for Chevrolet workers (Peters 2004). Mott Park has the fewest vacant lots, its residents are primarily white, and the average income is higher than the surrounding neighborhoods. Also, Mott Park is a popular area for Kettering students to rent houses, so the area adjacent to Kettering does experience some turnover. Mott Park has a very active neighborhood association.

The neighborhoods south of the Chevy in the Hole site have historically been working-class and African American, and this is generally true still today. None of these neighborhoods have an active neighborhood association, and they tend to have more vacant lots than other neighborhoods around the Chevy site.

Flint River

The Flint River has always been an important asset to the Flint region, from logging operations to transportation to recreation. The Flint River watershed stretches through seven counties in east-central Michigan and drains more than 1,358 square miles into Lake Huron via the Saginaw River, with Flint sitting almost exactly in the center of the watershed (Figure 1.12).

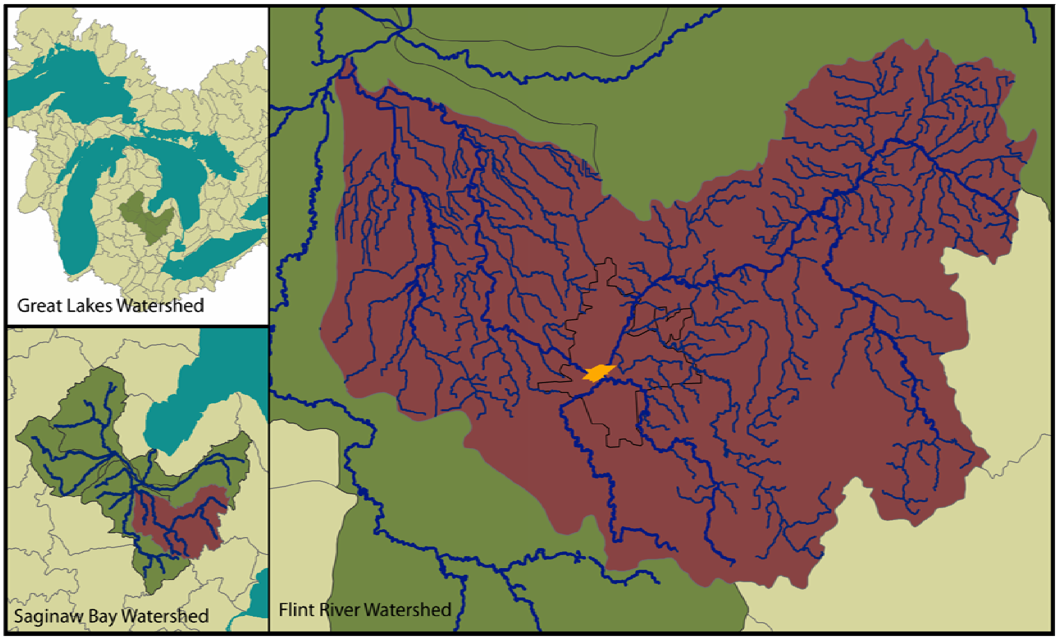


Figure 1.12: Flint River Watershed, draining into the Great Lakes through Saginaw Bay (Michigan Department of Natural Resources).

At the turn of the 20th century, the Flint River was a place where people would go boating, have picnics, and spend leisure time with family and friends (Figure 1.13). People also spent time along the river near Chevy in the Hole at Atwood Park, located on Moon Island, which used to exist where Swartz Creek converges with the Flint River (Figure 1.14). In 1929, Atwood Stadium and its parking lot were built on the island and the river was re-routed to flow on the south side of the stadium, filling in land so that the stadium was built into the area that used to be the riverbank. During the logging days, a millrace ran down the hill near the present-day Atwood Stadium. This information provides insight into the historical river flow patterns and flood plain as well as how a restored buffer may incorporate and connect to other historic open spaces.

Figure 1.13: A leisure outing on the Flint River prior to heavy industry and channelization (Genesee County Historical Society).

Figure 1.14: Moon Island and the original route of Kearsley Street (Bentley Historical Library, University of Michigan).

Before heavy industry, the river had a natural channel and dense vegetation along the riverbank, although much of the oak-hickory stands along the river's edge were lost to logging. The river channel varied in width as it ran through Flint and the riverbank ranged from steep slopes to flat floodplain areas. As the magnitude of industry in Flint increased, the Flint River was significantly degraded in the city and downstream, due to unregulated discharges from factories and municipalities along the river. This degradation was and continues to be exacerbated by unstable flows caused by an increase in development, impervious surfaces, and tiled agricultural land throughout the watershed. These changes direct water to the river immediately after rainfall begins, with little or no time moving through the ground. These flashy flows have accelerated riverbank erosion, degraded habitat, and increased sediment loading downstream. At Chevy in the Hole, plant buildings were built to extend directly to the river's edge, without concern for contaminants getting into the waterway. For example, coal was stored in an area directly adjacent to the river next to Plant 2, and the site's designated hazardous storage area was mere feet from the riverbank.

The river has a broad floodplain as it passes through Flint, and the city has developed in that floodplain for much of its history (Figure 1.15). In 1963, the USACE channelized the Flint River downtown with a concrete-trapezoidal channel in order to control flooding on Chevy in the Hole site (Leonardi and Gruhn 2001). Flint experienced significant flood events in the early to mid-1900s, often flooding Chevy in the Hole, and occasionally flooding all the way to Saginaw Street through downtown (Figure 1.16). The concrete channel is approximately one mile in length, spanning the project site through the downtown area. Chain-link fences line these concrete walls through the project site, preventing any public access or recreational opportunities in this portion of the river.

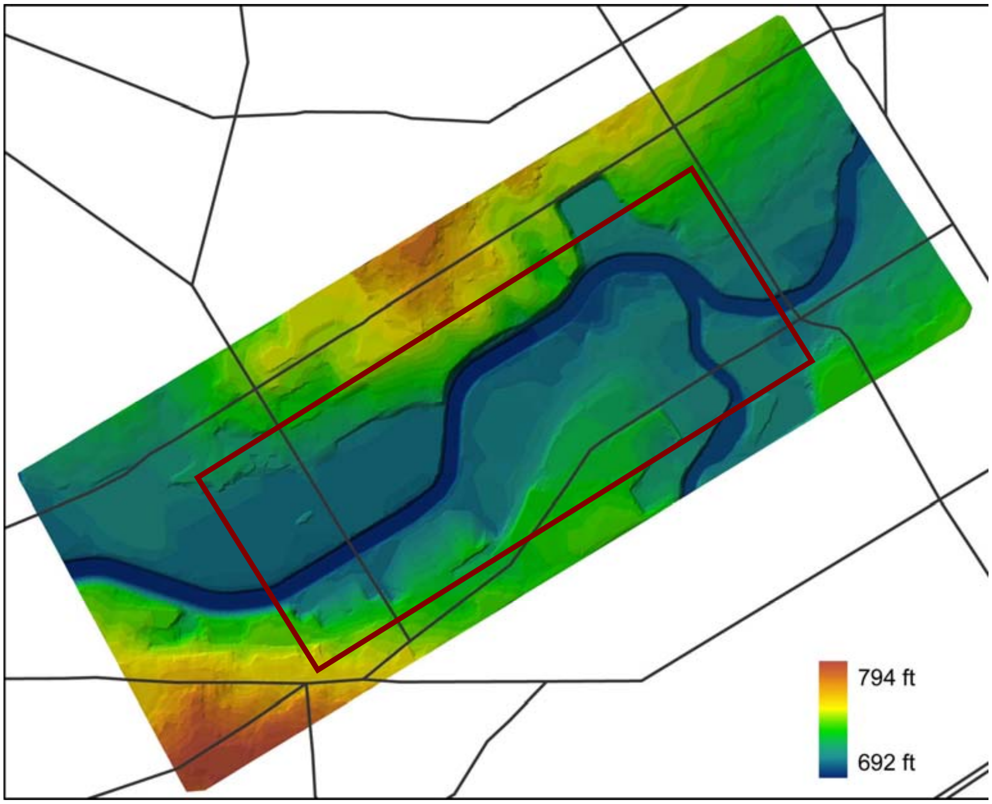


Figure 1.15: Topography surrounding Chevy in the Hole (outlined in red). The blue areas on both sides of the river show the approximate floodplain prior to channelization of the river (MDNR).

Figure 1.16: The 1916 Flood rose all the way to Saginaw Street (Genesee County Historical Society).

When the channel was constructed, a natural meander in the Flint River was straightened to move water through the channelized portion as quickly as possible (Finkbeiner, Pettis & Strout, Inc. 2002) (Figure 1.16). In addition to Moon Island, this natural meander would have helped to minimize increased speed and size of flows as Swartz Creek converges with the Flint River, naturally controlling erosion and sediment loads.

The engineered channel structure has eliminated the natural river channel, floodplain, and all riparian vegetation, causing degraded water quality and a major loss of habitat. It also straightened a meander in the Flint River that once decreased flow speed and erosion at the junction with Swartz Creek. Although the channel helps prevent flooding in the immediate area, which was important in preventing damage to the factory buildings, it increases the likelihood of downstream flood flows and deposition. In fact, Mott Golf Course, adjacent to the river just downstream from the channelized area, regularly floods and informally acts as flood storage. Furthermore, channelization minimized the river's potential as an economic, social, aesthetic, and ecological asset to the community. In addition to the concrete channel, the river portion in Flint contains five dams that have also altered stream flow (Leonardi and Gruhn 2001).

Today, the water quality and ecological value of the Flint River have been significantly degraded by a number of human-related stresses, such as channelization, non-point and point source pollution, development within the floodplain, and increased impervious surfaces. Aquatic life has suffered significantly from loss of habitat and impaired water quality, supporting little to no indigenous plant, fish, and other aquatic species in the portion of the river that flows through downtown Flint. Still, it should be noted that residents do fish on the river at a few areas in the downtown area, including where Swartz Creek and the Flint River converge, and that canoeing is a popular activity both upstream and downstream from downtown. Restoration of some of the site's historical hydrology and habitat value would result in dramatic benefits for the watershed as a whole. The feasibility of removing the concrete channel in part or entirely is greater now that GM's manufacturing operations no longer occupy the floodplain. Fortunately, the relatively short length of the concrete channel would result in a less complex engineering project than would a more extensive system.

Planning Projects Related to the Flint River & Chevy in the Hole

The first planning efforts in Flint were around the 1920s when the City of Flint hired John Nolen, a city planner from Cambridge, MA. He created several planning reports and documents, of which his Parks & Recreation Area plans are most notable. Nolen proposed a network of connected, continuous green spaces along the waterways in Flint (Figure 1.17) (Nolen 1920). Today, protected open space is generally concentrated along the city's rivers, but it does not achieve the level of connectivity proposed by Nolen.

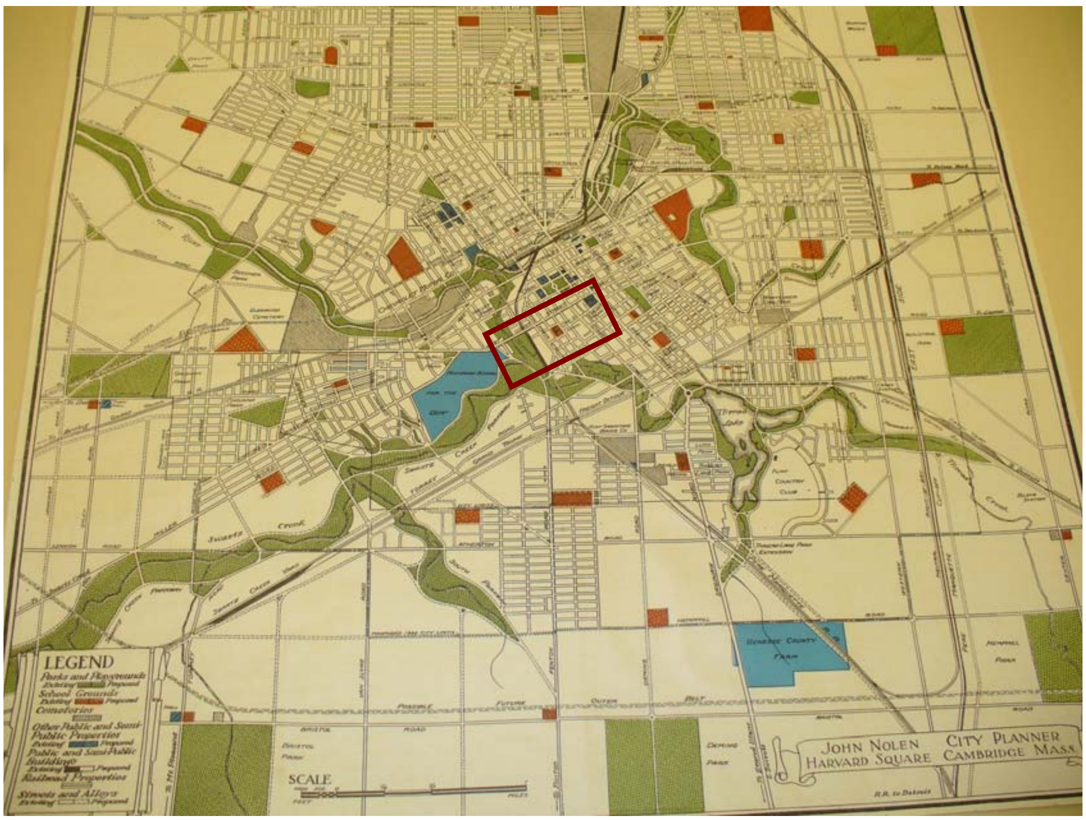


Figure 1.17: Nolen Plan of 1920, showing an extensive connected open space system along riparian areas. Chevy in the Hole is outlined in red (Bentley Historical Library, University of Michigan).

This approach was popular with planners of Nolen's time; one such example that is still widely recognized is Frederick Law Olmsted's Emerald Necklace plan for park space around Boston (Emerald Necklace Conservatory 2007). The City of Flint invested in city planning efforts until the city's population started to decline heavily. Until recently, the most recent city master plan dated back to the 1960s, when the population was predicted to grow to 250,000 (Beckley 2005).

Several planning studies in recent years have focused on how the Flint River might once again become an ecological, economic and community asset. In 2004, the US Army Corp of Engineers (USACE) finished a preliminary plan for modification of the original concrete channel on the Chevy site to improve the environment of the Flint River. The USACE report recommends two possible channel modifications for the river. The first alternative assumes that contamination is at safe levels, and recommends removing the channel walls where possible, leaving only the concrete bottom in place. The river would be widened to create oxbows and backwater marshes for habitat and floodplain storage, and allow for a series of trails for recreational activities. The second alternative assumes substantial soil contamination, and recommends removal of only limited areas of concrete walls. This approach would use terraced channel walls where possible, and a pedestrian path alongside of the channel. This more conservative alternative would not significantly change aquatic life or hydrology, but would prevent the potential spreading of contamination into the river and improve the aesthetic quality of the channel (USACE 2004). While feasibility studies were planned to start in 2005, followed by implementation starting in 2007, there have thus far been insufficient funds to execute any further studies or changes to the channel (USACE 2004).

The Flint River Corridor Alliance was formed in 2005 as a way to collaborate between multiple stakeholders interested in redevelopment and planning efforts for the Flint River. An underlying assumption was that developing community consensus about the area would help in negotiations with GM about the future of Chevy in the Hole. Shortly before the Flint River Corridor Alliance was formed, the Genesee County Land Bank hired Sasaki and Associates to develop a strategic plan for the regeneration of the Flint River District, including the Chevy in the Hole project site. The strategies for redevelopment and visions for the district build on the concept of reclaiming the Flint River to create an attractive and inviting open space feature at the center of the district and transforming Third Avenue into a new University Boulevard with a strong visual identity (Sasaki 2005). The strategy for the restoration of the Flint River is to reclaim vacant land along the river to create a green spine of connected open space that will then encourage adjacent redevelopment. Development of the plan involved extensive interviews and meetings with various stakeholders which developed a plan that has had strong community support (see Table 1.1).

Atwood Stadium Authority	Friends of the Flint River Trail
Carriage Town Historic Neighborhood Association	Genesee County Institute
Flint River Watershed Coalition	Genesee County Land Bank
Flint West Village Community Development Corporation	Hurley Hospital
Genesee, Lapeer, Shiawasee Counties Green Links	Kettering University
Grand Traverse District Neighborhood Association	McLaren Hospital
Mott Park Neighborhood Association	Third Avenue Community Association
Representative Dale Kildee and Mayor Don Williamson	University of Michigan – Flint

Table 1.1: Stakeholders involved in the Flint River District Strategy planning process (Sasaki, 2005).

The Flint River District Strategy builds on the USACE report and outlines two redevelopment schemes - the Wide Park and Narrow Park concept plans. Both concepts propose an open space system that would extend along the river from Mott Golf Course and Glenwood Cemetery to River Bank Park in downtown Flint as well as south along Swartz Creek to Second Avenue. The Wide Park concept plan proposes open space in the Chevy in the Hole area that extends further south than in the Narrow Park concept, allowing for more space to widen and restore the river corridor as suggested in the USACE's channel removal/river restoration alternative. Both concepts propose a pedestrian network that would link the park with surrounding neighborhoods, the downtown, and the existing Flint River Trail. The land overlooking the wide or narrow park on the Chevy in the Hole site would be used for a new research park and mixed-use development. New campus buildings for Kettering University are proposed for the north side of the river in both concepts. Lastly, pockets of open space would extend from the park into the surrounding neighborhoods (Sasaki 2005).

The Flint River District Strategy provides a long-term redevelopment framework that the Flint River Corridor Alliance is working to implement. Our research project builds on the redevelopment schemes and planning goals developed by Sasaki, but looks at more site-specific redevelopment alternatives for Chevy in the Hole, given its particular contamination constraints and ecological and economic opportunities. By realistically addressing some of the key details that will be involved in redevelopment of the brownfield site, we hope to add momentum to the realization of the larger Sasaki scheme.

Summary

A history of rapid urbanization and intensive manufacturing has permanently altered the landscape of Flint and the Flint River, especially at Chevy in the Hole. The site's location is of major social, economic, and ecological importance within southeast Michigan, with an ecological impact that extends throughout the Saginaw Bay watershed. The decline of this site has been inextricably linked with the decline of Flint, and neither can recover without the other.

Several specific aspects of this history will be addressed in our proposed design solutions. Most significant are the heavily re-engineered channel system, recent job losses, and the legacy of contamination left by a century of manufacturing.

Chapter 2: Contamination and Remediation

The industrial activities that once fueled Michigan's automotive industry have left a legacy of contamination at Chevy in the Hole. It is important to carefully consider the implications that contamination in the soil and groundwater will have on the site's future development. Both existing and perceived contamination are major barriers that must be overcome before development can occur. A comprehensive and innovative development plan should establish a holistic approach to remediation, acknowledging both short and long term risks and opportunities for the site and Flint. Brownfield redevelopment not only presents the opportunity to bring new investment to the city, but also to improve the health and safety of its residents and environment.

The Michigan Department of Environmental Quality (MDEQ) is the state agency that enforces the laws regulating brownfield cleanup and redevelopment. Contamination of soils and groundwater falls under the Natural Resources and Environmental Protection Act (NREPA). Cleanup standards are calculated based on chemical toxicity and potential exposure pathways. The State of Michigan establishes remediation requirements based on planned landuse, contamination found on site, and institutional and engineering controls for the intended land use. To maximize the development potential of a brownfield, the intended end-use of the brownfield should be the objective of the remediation plan, and cleanup strategies become one element in achieving the broader development goal (Cichon 2002).

The process of brownfield redevelopment uses a risk-based approach. The degree of risk is influenced by both toxicity and exposure (Long et al 2002). The state regulating agency determines the threat of a polluted property based on exposure pathways of the residual contaminants. Institutional controls are measures that control human exposure by restricting the types of activity and access to a property with residual contamination (EPA). Addressing contamination more directly, remediation strategies eliminate or reduce exposure pathways by removing contaminants or by creating a barrier between the contaminant and the surrounding ecosystem.

Currently, the exposure pathways between residual contamination and the surrounding ecosystem at Chevy in the Hole have been labeled incomplete by MDEQ, indicating that theoretically, people can't be exposed to whatever contaminants are present. After the buildings were razed, parts of the site were paved with asphalt caps and access was restricted only to authorized personnel. Highly restrictive institutional controls minimize interaction between humans and the site: the area is entirely fenced off, and on the parcels already transferred to Kettering, deed restrictions prohibit most kinds of redevelopment. These restrictions reflect the concerns of GM and Delphi about liability on the site. Some residual contamination is known to exist, but the precise nature and extent of this contamination remain unclear.

Two of the basic first steps in brownfield redevelopment, EPA Phase I and II assessments, have not yet occurred. In Phase I, consultants scour a site's records to determine what contamination issues are already known, what issues are likely to exist, and where the issues may occur. In Phase II, soil and water samples from across the site are analyzed to characterize any problems more specifically. Phase I and II are both triggered by the transfer of property and/or plans for new development, and although most parcels along the north edge of Chevy in the Hole have been partially transferred to Kettering, development plans have not yet progressed to a point requiring assessments.

In the absence of Phase I and II assessments, our assumptions about contamination on the site rely on analysis of conditions at similar sites and a close examination of public records relating to industrial activities at Chevy in the Hole.

Potential contamination at Chevy in the Hole

The automotive manufacturing processes at Chevy in the Hole included machine shops, metal fabrication, motor assembly and painting of automobile body parts. Machining and metal fabricating are likely to generate waste metals, lubricants, cleaners and other materials (EPA 2005). The typical contaminants used during the process of painting automobiles include toluene, acetone, perchlorethylene, xylene, gasoline and diesel fuel, carbon tetrachloride, various metals, and hydrochloric and phosphoric acids (EPA 2005). These contaminants present a threat to the environment when they are spilled, leaked or improperly disposed of. Many of the facilities also had underground storage tanks (USTs) containing gasoline, diesel fuel, and assorted industrial chemicals. Faulty installation or inadequate maintenance procedures can cause USTs to leak contaminants into the environment (EPA 2005). According to the EPA, the greatest hazard from leaking USTs is from petroleum fuels and fuel additives that can contaminate soil and groundwater (EPA 2005).

Considering the site's historical industrial operations, the contaminant groups assumed to be present at Chevy in the Hole are halogenated and nonhalogenated volatile organic compounds (VOCs), polycyclic aromatic hydrocarbon compounds (PAHs) from the storage and combustion of fossil fuels, and metals.

VOCs are organic compounds that can easily become vapors or gases. If residual VOCs remain on site, even under an impermeable cap or in groundwater, there is potential for these volatile chemicals to emit vapors that can drift through the subsurface into the air and overlying buildings through cracks in remediation caps, cracks in foundations, and small gaps around pipes and utility lines (EPA 2005). Health effects of exposure to VOCs can vary greatly based on the compound and its concentration. Exposure to VOCs has the potential to cause skin and respiratory irritation, anemia, reproductive damage, and cancer (U.S. national Library of Medicine 2006 and EPA VOCs).

PAHs are semi-volatile organic compounds formed during the incomplete combustion of coal, gas, garbage or other organic substances. PAH compounds adsorb readily onto particles such as soil or dust and are potentially present as pollutants in soil and groundwater. Additionally, some PAHs also readily evaporate into the air. PAHs are among the most potent known human carcinogens with the most toxic PAH compound being benzopyrene (National Library of Medicine 2006).

Metals are natural elements extracted from the earth and used for industrial purposes (Hu 2002; EPA 2005). The most common toxic metals found on industrial brownfields are arsenic, chromium, copper, lead, mercury, silver, and zinc (EPA 2005). Metals accumulate in tissues of living organisms and have the potential to be toxic even at relatively low levels of exposure (Hu 2002). Exposure to metals can occur through inhalation of dust or fumes, or they can be ingested involuntarily through soils or plant tissues. Metal toxicity most commonly affects the brain and kidneys but some metals, such as arsenic, are capable of causing cancers (Hu 2002).

Many of the effects of chemical contaminants on human health are not clearly known. Predicting or confirming that a disease is the result of exposure to a chemical contaminant is extremely complicated because of the many possible interrelations between the hundreds of chemical compounds and the unique genetic and environmental circumstances of individual humans (MSU www.envirotools.org). Prior to redevelopment of a site with known or unknown contamination, vapor barriers and or active and passive venting systems should be included. As development proceeds, an ongoing effort with maintenance and monitoring should be established to ensure that public and environmental risks are minimized.

Hazardous materials at Chevy in the Hole

Through a Freedom of Information Act inquiry, we conducted a review of technical reports submitted to MDEQ from all previous owners of the site. The reports were submitted in accordance to NREPA regulations for sampling of contamination or for the removal of USTs. We summarize three examples here to illustrate both probable and known contamination on the site. These specific examples are not intended as a thorough description of residual contamination, but rather to serve as a basis for the assumptions that we have made in our design work for this project.

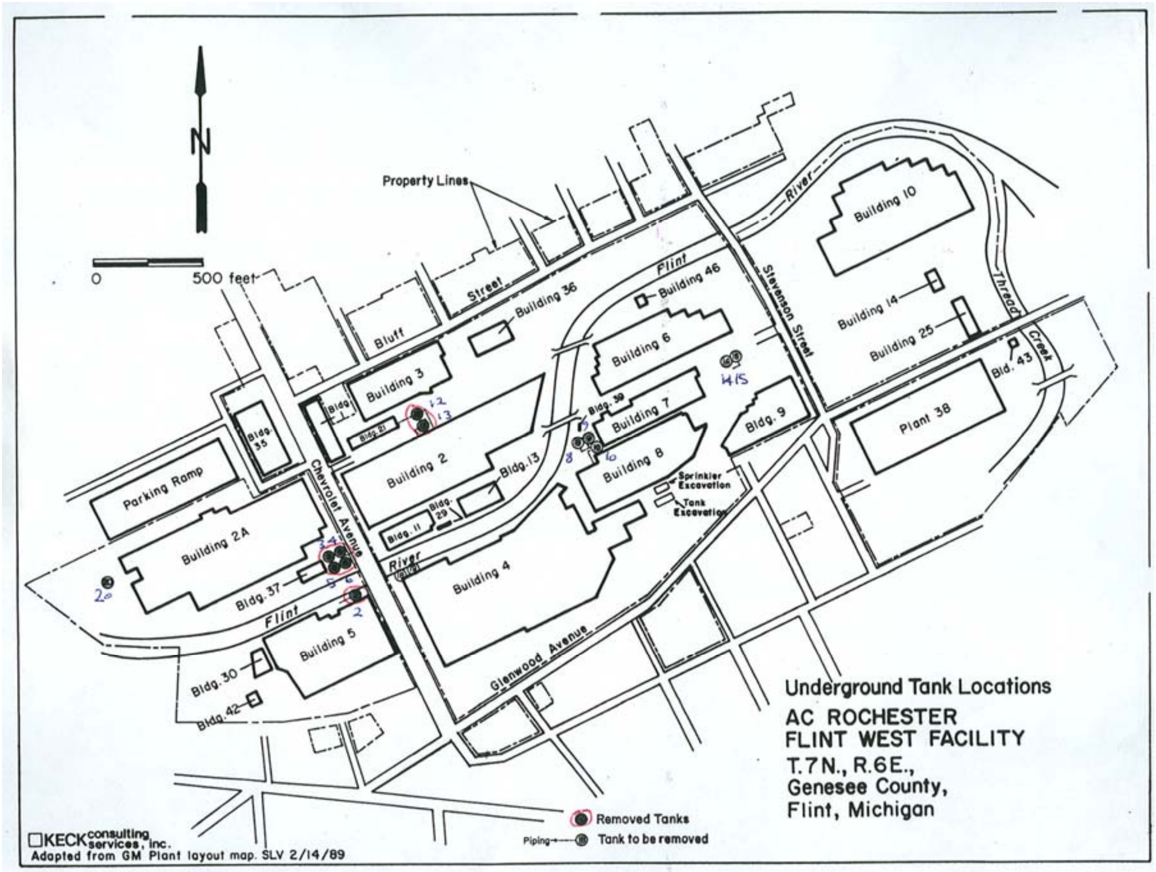


Figure 2.1: Locations of underground storage tanks (Keck Consulting, Inc. 1989).

Figure 2.1 shows historic locations of underground tanks on the Chevy site. When tanks removed, MDEQ reviews the environmental monitoring report to determine if successful remediation has occurred or if further action needs to be taken. If there is no residual contamination, the agency ‘closes’ the UST site. However, if the tank has been classified as a leaking underground storage tank (LUST) and contamination is present in the soil or groundwater after removal, site remains ‘open’ or active in MDEQ records. An open LUST site is defined as “a location where a release has occurred from an underground storage tank system and where corrective actions have not been completed to meet the appropriate land use criteria” (MDEQ web). Once corrective actions have been completed to meet appropriate landuse criteria, MDEQ will close the LUST site. An analysis of the MDEQ Storage Tank Information Database in 2007 indicates that Delphi has 22 closed USTs, 0 active USTs, and 9 storage tanks on the active LUST site database (MDEQ STID 2007).

Building 2A

Building 2A, located west of Chevrolet Avenue and north of the Flint River, once housed sheet metal parts and was noted to contain a power wash area, compressed gas cylinder storage, and oil dispensing areas (HAZMAP 1989). In 1996, Building 2A was demolished and USTs were removed. An assessment of soils and groundwater found concentrations of benzene, toluene, ethylbenze, and xylenes (BTEX) in the groundwater that did not meet acceptable risk-based screening levels (BBL 2000). In 1997 and 1998 quarterly monitoring was conducted to evaluate the movement of contaminated groundwater (BBL 2000). A technical action plan, submitted to MDEQ in 2000 found that the levels of the dissolved hydrocarbons or BTEX were still present at concentrations above acceptable levels (BBL 2000).

The contaminated plume of groundwater is of concern because the groundwater flows toward and eventually into the Flint River. BBL suggests that remediation by natural attenuation is cleaning the groundwater before it reaches the river (BBL 2000). As of October 2006, the Delphi-Flint West Facility LUST site at building 2A was still listed as an open LUST (MDEQ Storage Tank Information Database). According to the engineering firm that conducted this report, there are currently no open pathways for the groundwater plume to directly interact with its surrounding environment. However, this report does illustrate that there is contaminated groundwater at this location of the Chevy site.

AC Rochester Yard 17**:**

Yard 17 was the location of a hazardous material storage building. Six underground storage tanks were located in and around building 17. In 1985, the building was demolished and the USTs were removed (ESE 1992). During the excavation, it was determined that a 15,000 gallon tank had been leaking mineral seal, a petroleum hydrocarbon (ESE 1992). Groundwater samples around the UTS were extracted and analyzed in 1987. The results detected elevated levels of lubricant hydrocarbons and xylenes. In 1991, additional monitoring wells were installed and benzene was detected in the groundwater at concentrations above state standards. Additionally, elevated levels of polynuclear aromatic hydrocarbons (PAHs) have been detected in soil samples.

The Yard 17 site has been closed in accordance with state regulations (MDEQ UST database). The contaminated groundwater and soils are stabilized but have likely not been removed.

UST 16 &17:

In 1970 a petroleum release occurred from USTs 16 and 17, located between buildings 4 and 8. At that time, the groundwater was contaminated by the release and a two well recovery system was installed for remediation (ECT 1995). Further monitoring occurred in 1989 and 1992 which both found BTEX compounds present in the groundwater that exceeded the Type B criteria of the MDEQ (ECT 1995). In 1994, additional groundwater pumping was initiated and removed 69,445 gallons of contaminated groundwater. BTEX concentrations were still present in 1995 samples but were lower than the 1994 concentrations.

Environmental Consulting & Technology, the consulting firm who conducted the assessment, states "Contamination remains in the shallow groundwater zone, there is not a complete groundwater exposure pathway and the plume will not impact the nearby Flint River, due to the concrete sides and bottom" (ECT 1995). While this may be largely true, the pathway is certainly not incomplete, as cracks and weep holes exist in the channel which could allow movement of contaminants from the former UST sites to the Flint River.

Dispersed contamination

In addition to discrete areas of contamination documented in MDEQ records, it is probable that some contaminants are dispersed widely across the site. Numerous residents who live around the site and former GM employees have informed us that the demolition process left foundations and other parts of the buildings on site. This greatly increases the likelihood that asbestos, metals, and other contaminants in or attached to the structures themselves persist in the site's soil and groundwater.

Our analyses by no means illustrate a complete picture of the contamination likely to exist on this site, but they begin to give an idea of the types of problems that will need to be addressed before redevelopment can occur. While reclaiming the site can and will lead to enormous economic, societal, and visual improvements for the area, keeping public health and environmental quality at the forefront of redevelopment plans is imperative.

Analysis of Potential Contamination at Chevy in the Hole

Using the information above and other MDEQ records, we have developed maps showing the likely relative contamination loads of different zones around the site. Our assumptions in creating these maps were guided by knowledge of contaminants commonly associated with automobile production and assembly and by analyzing available information from UST closure reports and locations of hazardous material storage when plants were still operating.

Figure 2.2 is a map that shows extremely hazardous waste locations in 1989. The map depicts locations of above ground storage tanks, underground storage tanks, onsite extremely hazardous substance storage, polychlorinated biphenyl (PCB) transformers, hazardous material/waste storage areas and satellite accumulation areas.

Information from historical maps and reports led to the development of Figure 2.3, an interpretation of historical contamination. Plants 2A, 2, and 4 were the center of the industrial activities for much of the history of the site. The majority of the site's USTs were located in this area, as was the hazardous material storage facility. Residual contamination in this area is likely to be high. Areas of the site that were employee parking lots are most likely fairly clean. The likelihood of soil contamination is low because there were no industrial activities or storage directly on those portions of the site, and because the ground was protected by an asphalt cap. Further, both parking areas are likely to have clean groundwater, since they are upslope from the known contaminated groundwater plumes.

We categorized the site into three main zones: areas likely to have a low level of contamination, areas likely to have contaminated soils and/or groundwater, and areas likely to have high levels of contaminated soils and/or groundwater (Figure 2.4). The significance of these zonal categories relate to concepts that drive design development and remediation. Areas with the lowest levels of contamination are the safest and least expensive to redevelop to a residential standard. Second, a precautionary approach should be taken when unknown levels of contamination may be located across a large area. Without a comprehensive soil and groundwater sampling report, a precautionary approach is to assume that there is potentially contaminated soil and/or groundwater within the majority of the site. Third, “hot spots” of highly contaminated soils and/or groundwater are likely to complicate redevelopment efforts until they are remediated. We have identified potential areas where these hot spots may be found, however, these areas are only based on a limited amount of information.

A thorough site investigation and characterization study will determine the actual levels of contamination at the Chevy in the Hole site. In order for this site to seek its optimal future, a strong relationship should be established between the remediation strategy, potential residual contamination and future land use.

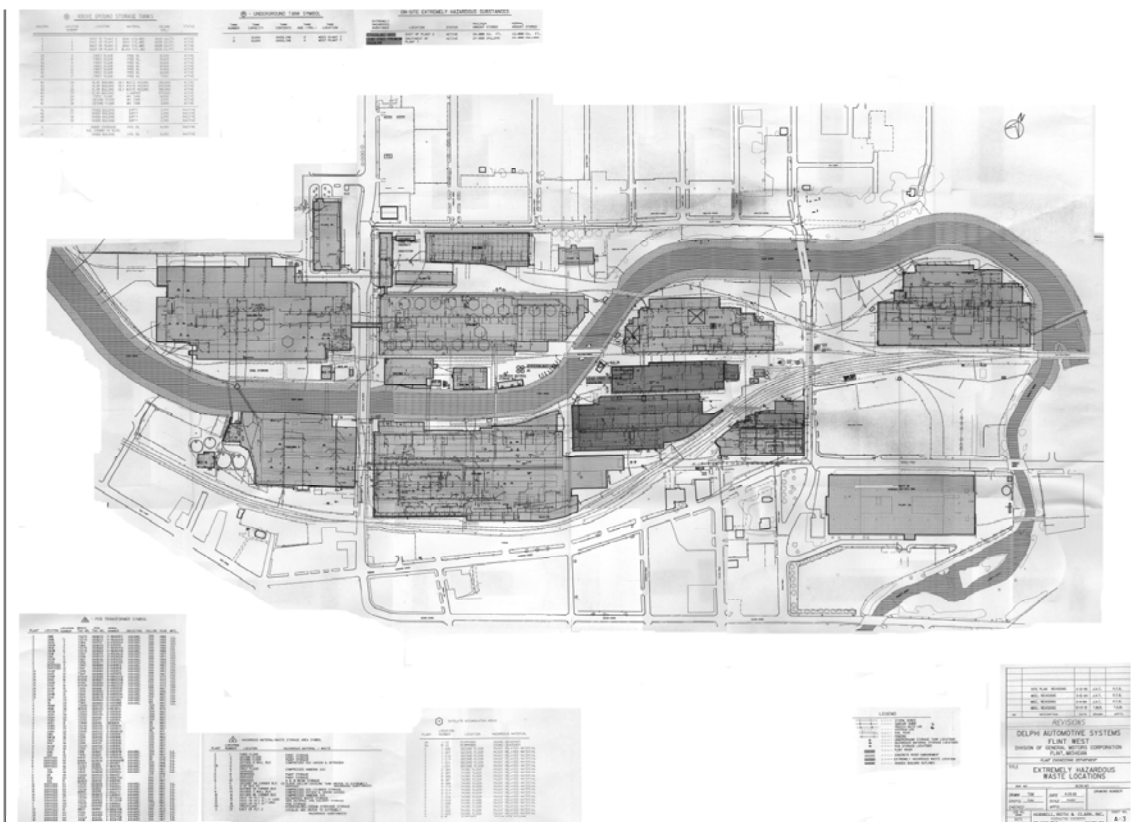


Figure 2.2: Extremely Hazardous Waste Location map of Delphi Automotive Systems Flint West (Hubbell, Roth & Clark, Inc. 1989).

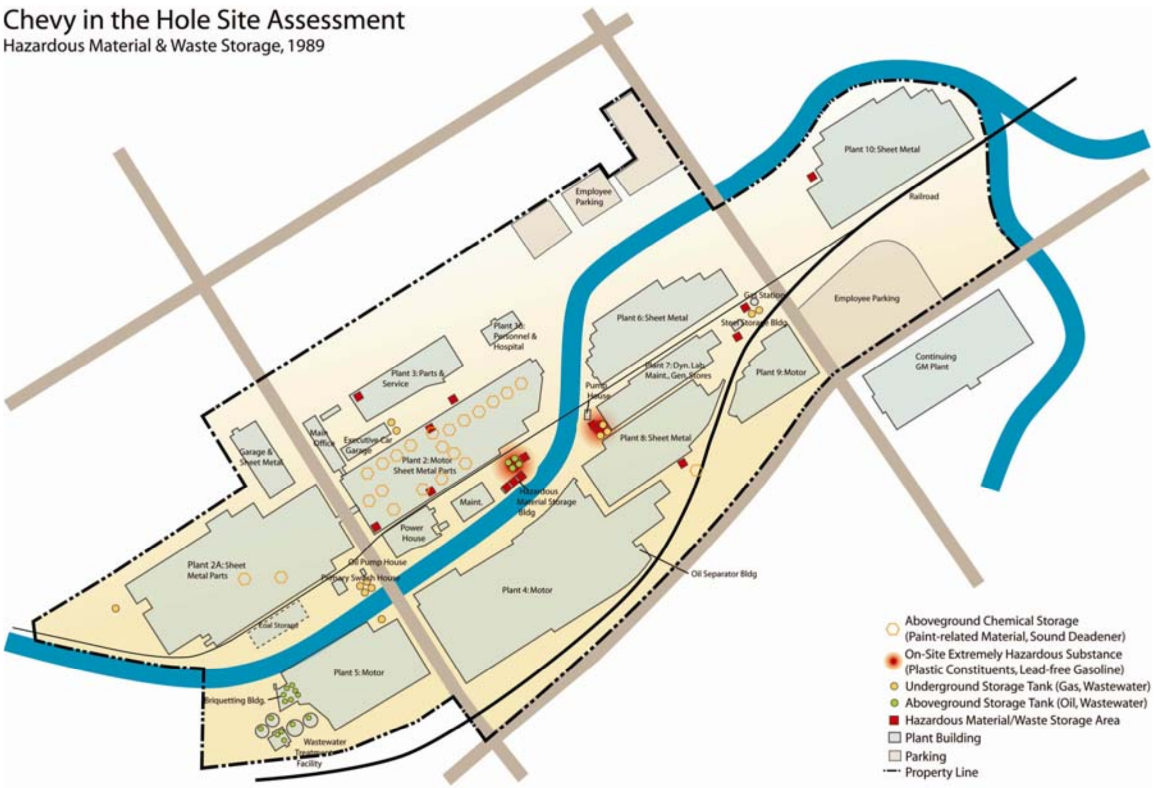


Figure 2.3: Chevy in the Hole contamination assessment, based on analyses of known contamination areas and past hazardous material storage areas.

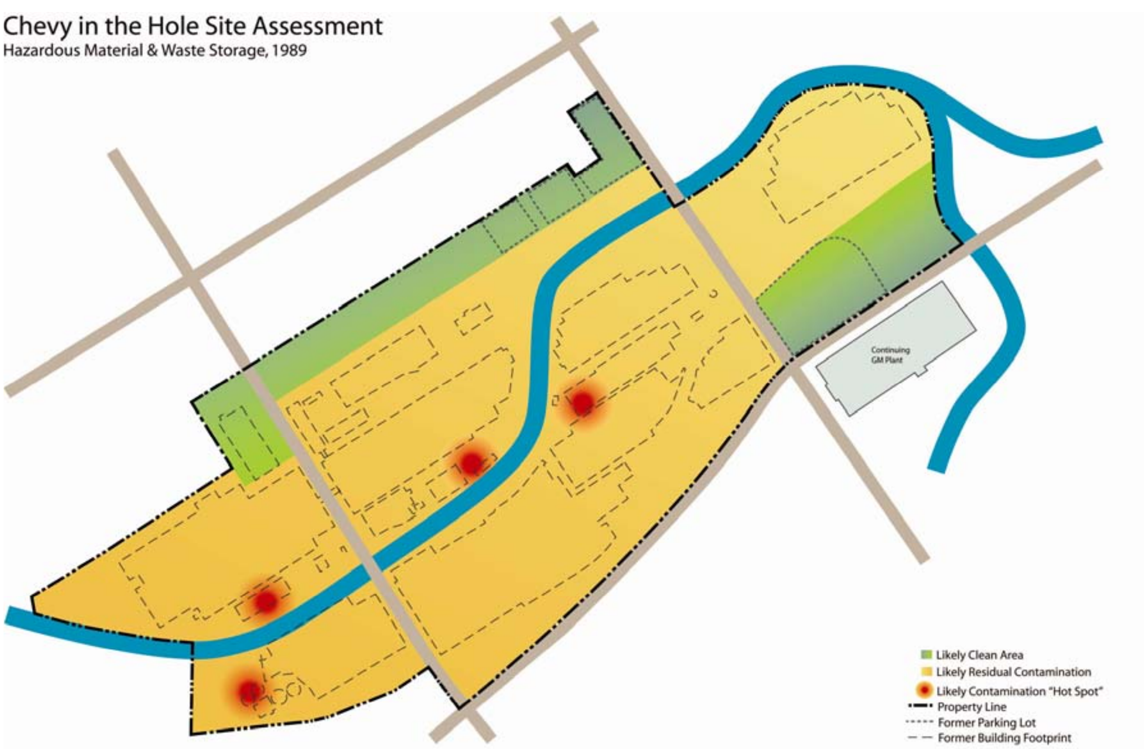


Figure 2.4: Chevy in the Hole contamination zones, based on assessment above. Green represents the zone likely to be clean, orange represents widespread residual contamination, and red designates likely "hot spots."

Remediation Strategies

Once a thorough risk assessment has been conducted for a site, a remedial action strategy must be developed. There are hundreds of remediation techniques being employed at brownfield sites around the world. However, selection of an appropriate corrective action is a site-specific decision that is based on a comprehensive evaluation of site characteristics and planned future uses. The costs and benefits of alternate remediation methods are ranked by comparing the flexibility, efficacy, speed, and cost of each method in response to the specific contaminants found on the specific brownfield site (Reddy et al 1999). One or more technologies may be appropriate for a given site.

Remediation methods are generally divided into two categories; in-situ remediation and ex-situ remediation. In-situ remediation methods stabilize, contain, encapsulate and or degrade contaminated soils and/or groundwater in-place. Ex-situ methods excavate soils and/or extract groundwater and remove them from the site. In-situ methods can be advantageous because they decrease the potential for contamination of surrounding communities and ecosystems by keeping contaminated media on site (Reddy et al 1999). Ex-situ methods offer easier control and monitoring during remedial activity and are often a faster, more predictable form of remediation (Reddy et al 1999).

The most common in-situ remediation technique is to encapsulate contaminated soil with an impermeable cap in order to prevent movement of any contamination. This can be a relatively fast, low-cost way to minimize exposure risks, because it prevents physical contact between humans and contaminated soil, and it greatly reduces the potential for percolating rainwater to move contamination away from the site. Caps are not without problems, however: sealing the contamination under a barrier does not prevent the escape of hazardous gasses, and it may defer the contamination problem to a future point. A cap's effectiveness decreases over time, and very often the abiotic conditions under the cap result in very little degradation of contaminants. In these cases, when cap is eventually compromised, the original contamination problem is virtually undiminished.

Ex-situ remediation typically involves the "cut and haul" approach. Like capping, cut and haul tends to be a predictable, rapid way to deal with contamination. One major shortcoming of cut and haul is that it can be quite expensive, since it involves moving massive volumes of earth. It is often controversial in neighborhoods, since it results in a cleaner site but can take months of intensive truck traffic and heavy equipment. This approach is also problematic in that it doesn't resolve a problem but moves it elsewhere. Finally, it is often discovered that contamination goes deeper than initially thought, so excavation may not clean the site as thoroughly as promised.

Moving beyond these traditional remediation approaches allows for stakeholders to capitalize on opportunities to reduce cleanup costs and create a healthier site, with benefits for the community and surrounding ecosystems. Many alternative remediation techniques exist or are being developed, but in our proposals for Flint we focus on remediation that accelerates natural biological processes.

Table 2.1: Remediation methods (Van Deuren et al 2002; Reddy et al 1999; EPA 2005).

Place of remediation	**Treatment Category**	**Treatment Method**
Soil and Sediment		
In situ	Biological treatment	Phytoremediation Bioremediation Bioventing Natural attenuation
	Physical/chemical treatment	Soil vapor extraction Soil washing Chemical oxidation Electrokinetics Fracturing Solidification/stabilization
	Thermal treatment	Soil heating Vitrification
	Containment	Landfill cap Landfill cap with enhancements
Ex situ	Excavation	Excavation and off-site treatment or disposal
Groundwater		
In situ	Biological treatment	Enhanced biodegradation Natural attenuation Phytoremediation
	Physical/chemical treatment	Air sparging Bioslurping Passive treatment walls Oxidation Directional wells Dual phase extraction Thermal treatment Hydrofracturing enhancements In-well air stripping
	Containment	Physical barriers Deep well injection
Ex situ	Pumping	Pump and treat or dispose offsite

Remediation with biological processes

Given long enough periods of time, many types of contamination are eliminated or made safer through a process of natural attenuation, whereby plants, microorganisms, and the interactions between soil, air, and water all work to break down hazardous substances into basic elements. While this can take centuries to occur, various remediation techniques stimulate and accelerate this degradation. These techniques provide tools for passive, in-situ remediation of a variety of contaminants. Natural processes such as phytoremediation and bioremediation can be used as an alternative to, or in conjunction with traditional remediation technologies in site cleanup. Bioremediation is the use of microorganisms to break down organic contaminants into more benign compounds, while phytoremediation employs plants to degrade, stabilize, or accumulate contaminants from soil as well as ground and surface waters (Carman 2001; Pivitz 2001).

There are a range of applications in which plants can be used in site remediation. They can degrade contaminants through rhizodegradation, a process in which plant roots stimulate the breakdown of organic contaminants such as VOCs and PAHs into less harmful constituents (Pivitz 2001). Plants can also directly take up contaminants, resulting in accumulation, biodegradation, or volatization of the hazardous substance (Carman 2001). Additionally, phreatophytes (trees that take up large volumes of water) can act as natural barriers or caps by reducing infiltration into contaminated soils through evapotranspiration processes, ultimately mitigating the contamination of groundwater (Carman 2001).

Phytodegradation, phytostabilization, and phytovolatilization are examples of remediation techniques that can create ecological improvements to a site. During these treatment methods, plants do not bioaccumulate contaminants in the plant material and thus do not expose wildlife to contamination. These phytoremediation methods may show possibility to create temporary or permanent habitat during remediation (IRTC 2006). The ecological benefits of these phytoremediation techniques in are only applicable to specific site conditions and certain types of contaminants. Organic compounds such as petroleum byproducts are good candidates for these processes (Prasad and Freitas 2003).

Phytoremediation of heavy metals is better understood than phytoremediation of organic contaminants (Prasad and Freitas 2003). Heavy metals are removed from contaminated soil and water through phytoextraction, and are then accumulated in plant tissue (Privetz 2001). The tissue is harvested and disposed of in a highly controlled manner. Phytoextraction is not a viable option for creating temporary habitat during remediation. In fact, this type of phytoremediation poses potential threats to wildlife, since organisms feeding on contaminated plant material may pass contaminants up the food chain. The design of phytoextraction areas should discourage their perception as wildlife habitat or naturalized areas (Nassauer et al 2001). Certain plants used for phytoextraction are referred to as "hyperaccumulators," meaning that they can store extraordinarily high concentrations of contaminants. Some plants species naturally work as hyperaccumulators, and others have been genetically modified to take on the role in phytoremediation applications (Pivetz 2001). In either case, these offer a faster route to cleanup, but they also pose a greater wildlife risk.

Since plant species used in remediation may be genetically modified to improve uptake of contaminants or to spread vigorously on contaminated sites, these species can act as invasive weeds and sources of genetic contamination to surrounding landscapes (Gressel and Al-Ahmad 2005). In urban settings these concerns may be less of an ecological risk because of the existing degradation of the surrounding environment, but this is an important factor to consider in planning a phytoremediation plan. Native species with bioremediation properties could be preferentially used in phytoremediation to reduce the spread of invasive species or non-native gene flows, and ongoing research from MSU and UM Dearborn researchers indicate that some Michigan native species have significant potential for phytoremediation uses (Rugh 2003).

Phytoremediation has further limitations that restrict its use for some environmental applications. As with many remediation techniques, the application and performance of phytoremedition varies widely with site conditions. Depth and concentration of contaminants, interactions between different contaminants, soil conditions, climate, existing vegetation, and water table level can all affect the success of phytoremediation (Pivetz 2001). Phytoremediation is only effective when contaminants are within 20 feet of the land surface (Carman 2001). If roots are unable to reach the contaminated soil or water table, then phytoremediation is not effective. Furthermore, phytoremediation takes time and is a long-term application (Carman 2001). As a very rough generalization, where conditions are right, phytoremediation can be expected to remediate 5-10% of contaminants on a site every year (Thomas 2007). If a site poses immediate threats to the surrounding ecosystem, then a technology with a shorter time frame would have more ecological benefits.

Although the limitations of phytoremediation may restrict its widespread use in remediation, it has the possibility, in some applications, to greatly improve the ecology of existing site conditions in urban settings. It is an especially attractive option in places like Flint, where low development pressures mean that a longer-term approach may be appropriate. To reduce ecological risks during phytoremediation, monitoring levels of contamination in soil and plant tissues is essential (Carman 2001).

Contamination and remediation are two of the greatest hurdles that Flint will have to clear before Chevy in the Hole can be reconnected with the community and reclaimed as a living, livable area. There is a tendency in some brownfield redevelopment projects to make superficial changes that suggest safety without really creating it—this is to be avoided at all costs in Flint. It is crucial for public health and environmental quality that contamination issues be considered carefully, and that the eventual solution is holistic and forward-looking.

Chapter 3: Restoration and Redevelopment Precedents

When proposing alternative futures for a brownfield site, it is helpful to first examine completed brownfield redevelopment projects. In addition to helping evaluate the advantages and disadvantages of various strategies, precedents illustrate the wide range of potential solutions for complex brownfield problems. This group of precedents emphasizes brownfield redevelopment projects in the Upper Midwest, although additional relevant projects exist elsewhere in the country and abroad.

The case studies presented here all feature some elements relevant to the proposed Urban Riverfront and State Park scenarios. The first category of precedents focuses on restoration of rivers in urban areas, both through ecological restoration and new commercial and municipal investment. The second category includes cases of brownfield redevelopment for recreation and economic growth; often the two are closely intertwined. Finally, we include a precedent from Chicago, where brownfield redevelopment places an emphasis on sustainable stormwater management.

Category	**Precedent**	**Location**
Urban River Restoration	Milwaukee River walk	Milwaukee, WI
	Tri-Centennial State Park	Detroit, MI
	Rouge River Restoration	Metropolitan Detroit, MI
	Daylighting Arcadia Creek	Kalamazoo, MI
	Duwamish River Estuary	Seattle, WA
Brownfield Redevelopment for Recreation and Economic Growth	American Seating Park,	Grand Rapids, MI
	Phalen Wetland and Phalen Corridor	St. Paul, MN
	Goose Island Eco-industrial area	Chicago, Il
	Fairlane Green Shopping Center	Allen Park, MI
	Emscher Park: Landschaftspark Duisburg-Nord	Duisburg, Germany
	Gasworks Park	Seattle, WA
Low Impact Development for Brownfields	Chicago Center for Green Technology,	Chicago, Il

Table 3.1: Case studies used as precedents in the alternative futures for the redevelopment of Chevy in the Hole.

Urban River Restoration –

Reintegrating Waterways into Social and Natural Communities

Milwaukee RiverWalk, Milwaukee, Wisconsin

Key elements: greenway, economic growth, waterfront redevelopment

After decades of neglect, the Milwaukee River has been rejuvenated through the Milwaukee RiverWalk project. Started in the 1990s, the RiverWalk is a phased plan to encourage pedestrian movement along the river corridor (Sweeney 2005). The pedestrian route has been created through cooperation between property owners along the river and city government. It connects existing historic and commercial areas to one another and to various park nodes, including Milwaukee's Pere Marquette Park.

In addition to creating a safe, pleasant walking experience between points in downtown, the RiverWalk also has stimulated investment along the corridor, with a new wave of restaurants, clubs, and shops opening on the river. Further, it has become a forum for public art, incorporating sculptures by local artists and artwork by Milwaukee schoolchildren. The star of the RiverWalk trail, however, is the Milwaukee River; the trail allows residents and tourists to become better acquainted with this waterway through increased opportunities for fishing and boat watching. As a result of this new access, the community is gaining a stronger interest in the health of the river, which will pay long-term ecological dividends.

One of the keys to the success of this project is its phased approach (A. Nelessen Associates 1999). Making changes along a long section of an established city may seem like an overwhelming task, but this project and others like it demonstrate that pieces of a greenway can build into something significant in relatively short periods of time. The first steps of this process have already occurred in Flint, with the establishment of the Flint River Trail and preservation of numerous riverside parks. The trail system needs to be made more continuous, and increased activity would help achieve greater public safety. Chevy in the Hole is a crucial node for driving these improvements.

Figure 3.1: Downtown Milwaukee workers walking on the River Walk trail during their lunch break (City of Milwaukee).

Tri-Centennial State Park and Harbor, Detroit, Michigan

Key elements: urban state park, shrinking city, brownfield redevelopment, ecological enhancement

In May, 2004, Tri-Centennial State Park became Michigan's first urban state park. Located along the Detroit River, the park demonstrates the ability of a partnership between state and local governments to provide urban residents access to natural resource based recreation opportunities. The park is currently 12 acres, but a master plan has been developed to expand the park 19 additional acres. The vision for the completed 31 acre state park has four distinct areas reflective of Michigan's natural history: a wetland area reflecting pre-settlement conditions; an upland hardwood and meadow environment; a harbor for recreational access to Michigan's water resources; and an interpretive center with educational programming. The goal of Tri-Centennial Park is to provide visitors a sample of what the other Michigan State parks have to offer.

The park is located in the East Riverfront District of Detroit and is a part of a larger city-wide redevelopment strategy. The City of Detroit retains ownership of Tri-Centennial Park and leases the land under a long-term agreement. The state funds the development of the park as well as future park improvements. Management of the park and harbor is carried out by the Michigan Department of Natural Resources (MDNR) staff.

The implementation strategy for the park has been divided into 5 phases. The first phase, completed in 2004, renovated St. Aubin Marina and Park, existing parkland owned by the City of Detroit. The renovations now provide Detroiters a 52-slip harbor and 12 acres of upland park area. Features of the park include walking paths, picnic areas and picnic shelters, shoreline fishing, a historic lighthouse replica, and public restrooms.

The adjacent properties surrounding the existing 12-acre Tri-Centennial Park allow for the expansion of the park. These properties were former industrial land uses and will have to be cleared and remediated by the City of Detroit before further development of the park can occur. An approximate total cost for all phases of park development was estimated at 42 million dollars in 2004 (MDNR). As of January 2007, construction of phases 2-5 has not begun.

Tri-Centennial Park is a successful example of how a state/city partnership can be an effective strategy for building and maintaining public space in a city with limited resources such as in Flint.

Figure 3.2: Tri-Centennial Park and Harbor is just east of the downtown district (http://www.michigandnr.com).

Figure 3.3: Artist rendering of the Uplands park design Phase II of Tri-Centennial Park (http://www.michigandnr.com).

Rouge River Restoration, Southeast Michigan

Key elements: revitalization organization, dechannelization, urban river restoration, ecological enhancement, watershed planning

The Rouge River is located in the Detroit Metropolitan Region and is Michigan's most densely populated watershed. Industrialization and rapid urban growth during the 20th century lead to the degradation of this river system. The largest industrial complex in the world, the Ford Rouge Complex, is built along the banks of the Rouge River (Rouge River National Wet Weather Demonstration Project 2004). In 1986, the Rouge was the most polluted and degraded river in the state.

The Rouge River Gateway Partnership was established in 1999 as a public-private partnership dedicated to restoring the lower Rouge River (Rouge River National Wet Weather Demonstration Project 2004). It is comprised of county government officials, corporations, local communities and academic and cultural intuitions. Its mission is to "To create a national model for redevelopment of historic, industrial communities and an urban river through public/private partnerships" (Rouge River National Wet Weather Demonstration Project 2004). This group has been an effective organization to help coordinate and implement revitalization and sustainable development along the lower reaches of the Rouge River. They have initiated a number of projects including an oxbow restoration to create new wildlife habitat, a greenway that connects regional attractions along the Rouge River, and a project with the Army Corps of Engineers to remove portions of the concrete channel and re-naturalize the riverbank (Rouge River National Wet Weather Demonstration Project 2004).

The Rouge Oxbow restoration project is located at the Henry Ford Museum and Greenfield Village along the lower branch of the Rouge River. The goals of this project were to restore fish and wildlife habitat through riparian wetlands, improve water quality, increase floodplain storage, create educational opportunities, and improve aesthetics. In the spring of 2002, Phase I of the oxbow restoration was completed. The project site consists of a 2,200 ft. channel surrounded by 3 acres of submergent and emergent wetlands (Rouge Oxbow Restoration Project 2003). Bioengineering techniques were utilized for bank stabilization and native plants were used in the habitat plantings. By early 2006, the ends of the oxbow were anticipated to be reconnected with the main river channel (Rouge River Gateway Master Plan 2005).

During the boom of the automotive industry, the Rouge River experienced impacts similar to those at the Flint River. The Flint River Alliance and the Flint River Watershed Coalition are two groups that could help to initiate implement restoration of the Flint River to improve revitalization in the region. Improvements in the river ecology and aquatic habitat could be made with the stretch of the Flint River that runs through the Chevy in the Hole property through the creation of an oxbow or an oxbow lake.

Figure 3.4: Rouge River's concrete channel closely resembles the existing condition of the Flint River (http://www.miseagrant.umich.edu/greenways/08LGa.html).

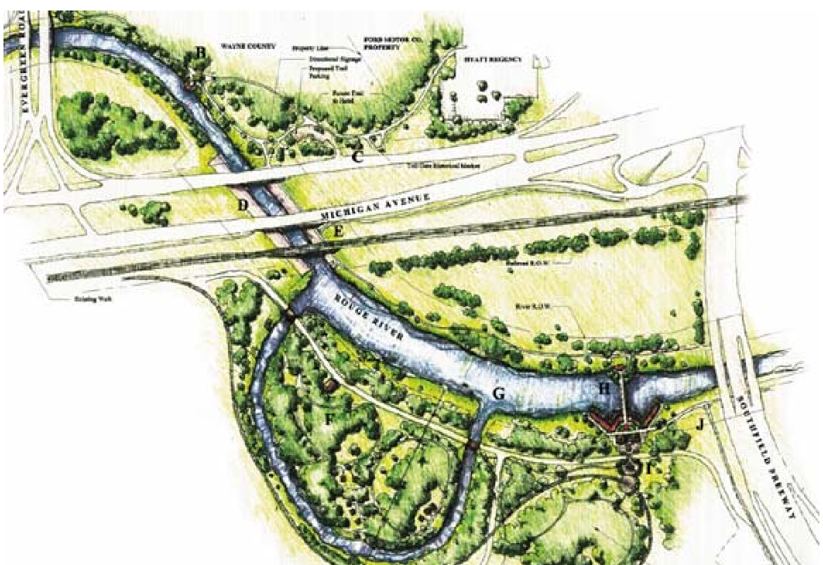


Figure 3.5: Artist rendering of the restored oxbow along the Rouge River (Hamilton Anderson http://www.miseagrant.umich.edu/greenways/08LGa.html).

Daylighting Arcadia Creek, Kalamazoo, Michigan

Key elements: Urban stream restoration, festival area that creates revenue and serves as flood control, city incentives for new construction

Arcadia Creek was buried in underground pipes more than a century ago as it ran through downtown Kalamazoo. As the city grew, the underground pipes were not able to handle the increase in stormwater runoff, resulting in flooding of downtown streets. As a result of flooding problems, economic decline, vacant buildings and increased crime, in 1986 the city began efforts to revitalize the northern portion of the central business district downtown. Daylighting Arcadia Creek was considered as part of the redevelopment plan as a strategy to bring businesses and life back to this part of downtown as well as reduce flooding by increasing the creek's capacity (Hoobyar 2002).

The city created a Downtown Development Authority (DDA) to coordinate and leverage funds for the redevelopment zone. The DDA finished engineering studies, design work, and funding in 1992, and from 1989 to 1995 construction of new buildings and daylighting the creek took place. The redevelopment zone was primarily industrial prior to redevelopment and most sites required removal or capping of contaminated soils. The city maintained ownership of the land that was redeveloped around the daylighting project to protect developers from potential environmental liabilities due to contaminated soils (Pinkham 2000).

The daylighting included exposing five blocks (1,550 feet) of Arcadia Creek that was previously buried in underground pipes. Three blocks were converted to a concrete-lined channel and two-blocks were converted to an open stream with a large adjacent grassy area with planted terraces for flood control and recreation (Pinkham 2000). This grassy area along with an adjacent parking lot serve as a downtown festival site, which hosts around fifteen events and generates more than $12 million each summer (NPS 2002). The planted terraces and adjacent festival space serve as a precedent for improving the riverfront at Chevy in the Hole in Flint's Urban Riverfront scenario.

The total project, including remediation, planning and construction, cost $18 million, and from that investment the city leveraged a revenue of $200 million from both renovating existing buildings and new constructions of buildings (Hoobyar 2002). One of the city's strategies to bring development back into the area was to offer low interest, 30-

year leases to businesses for new construction along Arcadia Creek before the project began. These leases can be renewed at $1.00/year after the initial lease expires. The city felt strongly that they needed to first build a strong economic base that would then support the daylighting project (NPS 2002).

Figure 3.6: Arcadia Creek daylighted in downtown Kalamazoo (www.city-data.com/city/Kalamazoo-Michigan)

Duwamish River Estuary, Seattle, WA

Key elements: brownfield remediation, waterfront development, habitat enhancement, grant funding

The Duwamish Waterway, south of downtown Seattle, contains one of the largest concentrations of Superfund sites on the West Coast. A century of shipping and manufacturing have led to its degraded condition, but recent restoration efforts have mobilized citizen participation and attracted grant funding.

Prior to development, the Duwamish River estuary served as the outflow of the Green River watershed into Puget Sound. The mouth of the river consisted of a large network of marshes, tidal forests, and tidal flats. For the past 100 years, the area has been reshaped by industry, and the impacts are substantial: the estuary lost most of its freshwater inflow through a series of hydrological engineering projects in the early 1900s; dredging and filling destroyed 98% of the estuary's wetlands; and industrial pollution built up extraordinarily high levels of metals, PCPs, PCBs, and PAHs (Simenstad et al 2005). The present-day waterway is a narrow, highly engineered channel occupying a tiny fraction of the land that was once a large, biologically productive system.

Regulatory incentives, particularly those focusing on water quality and species conservation, have driven numerous ecological rehabilitation projects in this area in the past 15 years. Funding for this work has come from the Port of Seattle and other local, state, and federal sources. The largest source of funds has been NOAA's Community-based Restoration Program (CRP) grants, which encourages citizen participation in restoration of aquatic resources (Ghitis 2006). Many of the projects have involved an initial cleanup phase where contractors remove contaminated sediment, followed by a restoration phase where crews of local volunteers plant native vegetation. Non-profit organizations and neighborhood groups have been instrumental in moving this work forward.

Remediation of these sites has encountered several hurdles. Contaminated sediments led to a political battle over where Duwamish sediments should be disposed, and later to a controversy over removal methods (sparked by an accidental release of

PCB-laden sediment into the river during a cleanup) (Paulson 2003; Ith 2004). In 2006, neighborhood groups from the surrounding area argued that EPA cleanup standards for a proposed project were not stringent enough to safeguard their health. They were also concerned that the site was only being treated to a level sufficient for future industrial use, which would preclude public access to the river. In June 2006, the Port of Seattle decided to require a higher standard of remediation than that recommended by the EPA (Modie 2006). The more thorough cleanup will cost several million dollars more than the initially proposed cleanup, but will also allow higher value land uses in the future (McClure 2006).

These ongoing efforts are informative for river restoration in Flint; they offer particular insight into the ability of citizens to push forward higher cleanup standards, as well as the challenges of remediation of industrial contaminants near water bodies. Projects implemented along the Duwamish to date have all focused on water quality and habitat enhancement, but long term plans include residential and recreational development.

Figure 3.7: An impaired inlet to the Duwamish Waterway, before and after ecological restoration (People for Puget Sound 2006).

Brownfield Redevelopment for Recreation and Economic Growth

American Seating Park, Grand Rapids, Michigan

<u>Key elements:</u> *Mixed-use redevelopment, Michigan state brownfield redevelopment financing used, tax benefits for residents, remembering the historic legacy through design and development decisions*

Grand Rapids has been noted as one of the fastest growing cities in Michigan and the second fastest in the Midwest. Since 1990 over a billion dollars has been invested in downtown redevelopment, along with $60 million in parks and infrastructure improvements. Along the river the new DeVos Place Convention Center is being joined by a new Marriott hotel. Many of the old manufacturing and production facilities along the river are being redeveloped to include housing, office space and retail.

One example of the brownfield redevelopment that is contributing to this unprecedented growth is the American Seating Park redevelopment project in downtown Grand Rapids. What used to be a 12-acre furniture manufacturing site has been completely transformed into a mixed use development which is serving to revive the city's west side. For over a hundred years American Seating Company produced and manufactured office, stadium, transportation, and event seating at this site. Once this site was closed down the lot was left vacant, save for the old manufacturing facilities. While manufacturing had been relocated to other factories around the Midwest this site was still very important to the company's history so in the late 1990's the company decided to use the financing opportunities offered by brownfield redevelopment incentives to redevelop the site as a mixed-use zone, and bring the headquarters of American Seating back to the industrial heart of the city. The company still considers the site its headquarters but has completely transformed it to accommodate 230,000 sq feet of residential space, and 100,000 sq feet of commercial space (American Seating 2007).

This $30.8 million redevelopment project included many financing incentives and sources available now in Michigan for brownfield redevelopment. The Michigan Economic Development Corporation (MEDC) offered a state brownfield redevelopment credit worth 10% of the eligible investment, up to $2.8 million. The MEDC and the city of Grand Rapids also endowed the site with a state Renaissance Zone designation. Any company located in the Renaissance Zone, including American Seating and various commercial and retail firms, would operate nearly free of all state and local taxes. In addition, residents living in the development's lofts and apartments would pay no state or local income tax, nor any personal property tax. The businesses and residents in the Renaissance Zone will enjoy these tax benefits through Year 2011. In 2004 this site was recognized by the University of New Orleans center for brownfield initiatives as a featured site of urban brownfield redevelopment success (MEDC 2007).

Because this example is located in Michigan it is a key precedent for understanding possible funding opportunities at the Chevy in the Hole site. Although funding might be less available as the Michigan economy struggles to steady itself, it is important to note the different elements of funding that were combined to make this project successful, and the way it was able to attract both residents and businesses. In order to right the economy there will have to be incentives and this serves as an example of possible incentive that might be used at Chevy in the Hole. The work being done in Grand Rapids also serves as an example of redevelopment focusing on an urban river, not unlike the Flint River, as an amenity rather than a “backyard” to development.

Figure 3.8: The redevelopment of the American Seating Factory highlights the industrial legacy while providing for public access (http://www.americanseatingpark.com/CommSpaceHome.asp).

Phalen Wetland and Phalen Corridor, St. Paul, Minnesota

<u>Key elements:</u> Ecological rehabilitation provides amenity for further redevelopment, mixed-use redevelopment, mixture of state and local funding

The Phalen Wetland restoration and redevelopment project is a unique combination of ecological restoration and economic revival in an urban center. The wetland, located south of Lake Phalen in eastern St. Paul was in the 1960's the last remaining undeveloped parcel of land in a growing industrial and blue-collar residential corridor that had been growing as a transport line for Minneapolis/St. Paul(City of St. Paul. 2007a and 2007b).

For the most part the wetland land had been spared development. However in the early 1960's it was filled and paved over in preparation for the development of Phalen Center shopping mall. This created a significant gap in the natural corridor and substantially cut off Phalen Village from the area's natural systems and natural amenities. It seemed to seal its fate as an industrial urban parcel.

The wetland began to reappear in the mid-1990's, after the shopping center was abandoned. Puddles would appear in areas of the parking lot for long periods of time. The concept of demolishing the shopping center and constructing a wetland within an amenity park was proposed, and became part of a larger regional redevelopment scheme that included revitalization of the whole corridor between the wetland and downtown St. Paul. The whole of the Phalen corridor had originally been built along the rails that traversed the area, connecting residents with many factories and heavy industry. The end of the industrial boom in the region left a legacy of over 100 acres of brownfields, and job losses totaling over 2500 (City of St. Paul. 2007a and 2007b, Olson-Kase 2007).

So the city decided to construct the wetland park, purchased the shopping center, tore out the pavement and old shopping structure, and used the park to leverage commercial and residential redevelopment around the periphery. Restoration of the wetland was seen as a way to use the naturalized landscape of an historic wetland as a neighborhood signature amenity, which could enhance property values and invite further development. Because the wetland is located along a major migratory flyway the restoration would also provide for habitat. It would also contribute to low impact development by allowing for improved stormwater management on the site, restoring some of the original hydrological function to the site. Since the late nineties the region around the Ames Wetland has seen the addition of a Wells Fargo Branch Bank- a $4 million dollar investment which included the forfeiture of 50 parking spaces in order to accommodate the plan to face the wetland, a Walgreen's drug store, several nice housing developments skirting the perimeter of the wetland, the Phalen Village Health Center, an elder care facility, and renovated low-income housing. The construction of the Minnesota Bureau of Criminal Apprehension, brought "the CSI of Minnesota" to Phalen Village, according to Curt Milburn, with the City of St. Paul (Dowdell 2005).

The Phalen Wetland serves as an important example of redevelopment for the Chevy in the Hole site in terms of its role as part of a larger urban corridor revitalization project. By using ecological restoration patterns and priorities as part of an amenity at the wetland site they have cultivated renewed pride in the area and interest in further re-investment.

Figure 3.9: Before and after photos of the wetland restoration at Phalen Shopping Center (Phalen Corridor Initiative 1996-1997, Jessie Duggan 2001 and http://www.phalencorridor.org).

Goose Island Eco-industrial area, Chicago, Illinois

Key elements: Industrial waterfront redevelopment, TIF spurs investment including new R&D facility, a university satellite campus, and new small business ventures

Once dubbed "Little Hell" and "Smokey Hollow" from years of industrial pollution, Goose Island is experiencing a slow but steady rebirth from heavy industrial to R&D and new industry. It historically served as an important industrial district for the city from the 1860’s to the 1970’s. Unfortunately during the 1980’s competitive pressures forced many businesses to move out of Chicago or cease operations, which led to many vacancies and widespread blight on the island. A 94-acre industrial and commercial area on the north side Goose Island is one of 112 premier TIF areas in Chicago. It is currently home to facilities for Federal Express, Republic Windows and Doors, Goose Island Brewery, Kendall College and Wrigley (Weaver Boos Consultants 2007).

Kendall College opened a new Riverworks Campus on the south end of Goose Island in 2004, and in 2005 Wrigley, famous for their chewing gum and confectionary production, built a 193,000 s-f office/lab building for research, design, and collaboration on a waterfront portion of the site. The Wrigley Global Innovation Center provides lab and office space for the company's team of scientists, designers, technicians, and marketers to continue creating high-quality confectionery products. Flexible office space and laboratories were designed with collaboration in mind and they also provide modular furniture and equipment to facilitate communication and sharing among the disciplines of Sensory, Scientific & Regulatory Affairs, Quality, Research & Development, Packaging Innovation, and Global Engineering (HOK 2007, Weaver Boos Consultants 2007).

In terms of funding, with the approval of the Community Development Commission, the mayor committed $15 million in tax increment financing (TIF) district funds and a Cook County Class 6(b) property tax incentive worth $1 million, along with investment money from Wrigley. A local non-profit organization called Local Employment Economic Development (LEED) trains people from the low-income, Cabrini-Green community to prepare them for jobs with Federal Express, located at Goose Island. LEED used tax increment funds for workforce development—one of the first applications of these funds for training rather than infrastructure. While the training package was not the main reason that Federal Express located at Goose Island, the company is now using the success of the program to justify additional public subsidies to train city residents for another major project near the Chicago-O'Hare airport (Metropolitan Planning Council 2007, Tradeline 2005, University of Wisconsin Milwaukee 2005).

This project shows the strength that one or two large site stewards can have on the Chevy in the Hole site, if there is smart planning for the expansion of a potential steward like Kettering University. Like the Wrigley and Federal Express, Kettering's actions on the site could offer employment and training opportunities to local residents, while revitalizing the area. Funding opportunities might open up if there were a focus on workforce development.

Figure 3.10: Goose Island Industrial Area (http://neighborhoods.chicago.il.us/a/River_North/Goose_Island/).

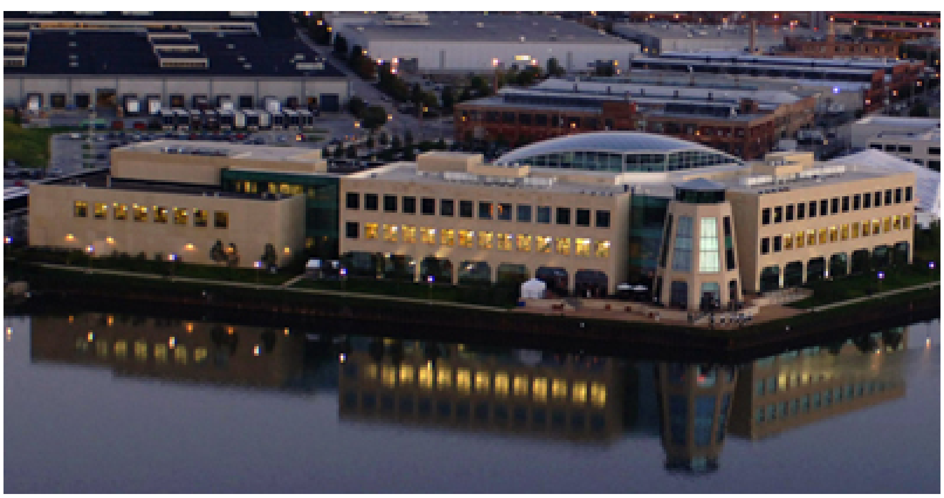


Figure 3.11: The new Wrigley research and development center on Goose Island (http://www.powerconstruction.net/experience/details.cfm?proj_id=148).

Fairlane Green Shopping Center, Allen Park, Michigan

Key elements: Redeveloped industrial site, open space preservation, LEED certification, TIF incentives for redevelopment

The site of Fairlane Green shopping center was originally a clay quarry and was then used as a landfill for Ford Motor Company's industrial waste starting in the 1950s (Ford 2005). When the landfill reached its capacity around 2004, Ford Land, Ford's real estate and development arm, decided to turn the 243-acre brownfield site into an environmentally-friendly shopping center, making it the largest landfill redevelopment project for retail use in Michigan.

The Fairlane Green project plan leaves almost two-thirds of the site as green space, of which a large portion is a 43-acre park with 3.5 miles of trails around the site. The other green landscaping features are stormwater retention ponds that collect water runoff from the site to reuse for irrigation, bioswales to manage stormwater runoff, and native plants and minimal use of turf to decrease maintenance and water use. There are other energy saving features incorporated into the construction of the buildings, including white reflective roofing, skylights, and high-efficiency heating and cooling systems. Together, these green features earned the development a LEED Gold rating for core and retail development (Ford 2005).

Fairlane Green includes three development phases of "big box" retail stores found in a typical large retail complex along with a few restaurants. Phase 1 was completed and opened in fall of 2005, including Target, Barnes & Noble, World Market, and Pier 1 Imports among others. Phases 2 and 3 will be completed by 2008 and includes places like Meijer, Home Depot and Best Buy. The stores and restaurants will offer over 2,000 jobs (King 2005) in addition to increasing the city's tax base. Similarly, big box retail may be an option for the Flint's Urban Riverfront scenario.

Before construction began, the landfill was capped and more than 300,000 cubic yards of clay were trucked to the site to add on top of the existing landfill cap to further buffer contaminated waste (APWA 2005). Ford also obtained $30 million in Tax Increment Financing from Michigan Department of Environmental Quality and the City of Allen Park to help offset the higher costs associated with building on a landfill, including added costs to reduce settlement, protect the landfill cap, reinforce slopes and construct the utilities (Ford 2005). In order to sell the property to third-party companies, Ford maintained ownership of the subsurface land of the original landfill and then sold the rights to develop only the surface of the site. This strategy could also be employed at Chevy in the Hole to minimize liability for and to attract developers.

Figure 3.12: Artist rendering of Fairlane Green (www.fordlanddevelopment.com).

Figure 3.13: Artist rendering of Fairlane Green (www.fordlanddevelopment.com).

Emscher Park: Landschaftspark Duisburg-Nord, Duisburg, Germany

Key elements: shrinking city, public park, historic elements, ecological enhancements, social restoration, stormwater management

The Emscher district in western Germany has been left with a legacy of a contamination from the coal, iron and steel industries it once supported. This region was formerly the principal concentration of coal mining and steel production and the largest industrial landscape in Europe. During the mid 1970's a crisis in the iron and steel industries caused a global restructuring of those industries. As a result, many production facilities were closed down in the Rhurgebiet. This restructuring led to the loss of thousands of jobs and an economic crisis in the region. The social implications of industry closure are similar to the conditions in Flint, MI.

In 1989, the International Building Exhibition (IBA) initiated a project to transform the identity of the region and improve the quality of life and cultural value of the landscape. Their goal was to restore the fundamental ecology of the area and bring in new investment strategy. They created a park system, Emscher Park, as the main driver for the regeneration of a heavily degraded and shrinking region. The Emscher Park covers an area of 1700 square miles and includes 17 cities and has helped to rebuild ecological and scenic qualities of the region (Figure 3.14) (Shaw 2002).

Landschaftspark is a keystone project of Emscher Park. The park is built at a former pig-iron factory in Duisburg, on the western side of Emscher Park. Landschaftspark reflects new ideas about landscape and nature by incorporating old industrial structures as the framework for the design. The design reflects three evocative elements that offer a number of exciting solutions to addressing the seminal challenges in redeveloping post-industrial spaces.

First, the design has utilized the history and culture of the site as an asset rather than a hindrance to future investment. The park has recycled old industrial structures into recreational attractions and educational opportunities. For example, the walls of former ore bunkers have been designed into rock climbing walls. A scuba diving school now operates out of an old gas tank. A beer garden and an outdoor cinema are found in courtyards between blast furnaces and smelting buildings. Other areas of the park create interesting spaces for more reflective use. Formal gardens have been designed in abandoned storage bunkers and a derelict smelter is used as an observation tower offering expansive views of the industrial landscape of the Rhurgebiet.

Second, the park intentionally incorporated the separation of clean and contaminated water systems as a design feature of the park. Figure 3.15 shows one example where an existing overhead pipe system now carries clean rainwater into a central water feature.

An additional innovation of the park is its use of forms to define the programming of space in terms of the level of contamination in various areas of the park. Some areas of highest contamination remain physically inaccessible, but create a stimulating visual experience. For example, large slag heaps with low-level hydrocarbons remain in place in the park, but limited access prevents physical interaction with the contamination.

Although the Chevy in the Hole site does not have any industrial relics remaining, elements from Landschaftspark serve as an inspiring precedent for the site in Flint. Remembering the history of the land use and the legacy of the industrial land use is important for future generations' understanding of the region. In addition, low impact development strategies can help to improve water quality on site while maintaining the separation from clean stormwater runoff from contaminated groundwater. Finally, the remediation strategy should be incorporated into a holistic site design plan where institutional controls can be used where contamination may remain on site.

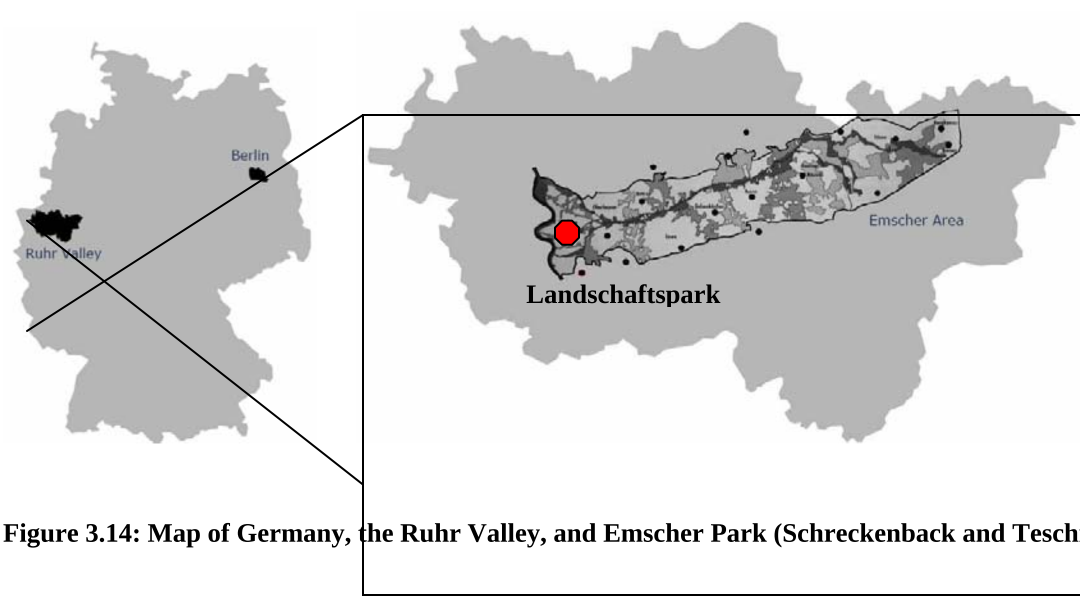


Figure 3.14: Map of Germany, the Ruhr Valley, and Emscher Park (Schreckenback and Teschner).

Figure 3.15: Reuse of overhead pipes caries clean rain water into this garden where it is detained and infiltrated into clean soils (Emily Marshall).

Figure 3.16: Landschaftspark Park is located within the industrial Rhurgebiet. Visitors are encouraged to climb up and explore the existing structures and see the park within its industrial landscape context (Emily Marshall).

Gasworks Park, Seattle, Washington

Key elements: public park, historic elements, waterfront redevelopment, onsite remediation, economic growth, greenway

Formerly the site of a coal gasification plant, Gasworks Park was built in 1975 on 19 acres of redeveloped brownfield at the northern end of Lake Union, just north of downtown Seattle (Brynolson 1977). It is remarkable for its use of retained industrial elements as pieces of post-industrial art. It was also a pioneering work as one of the first collaborations between a landscape architect (Richard Haag) and a remediation specialist (soil scientist Richard Brooks). Haag kept concrete rubble on site and buried it in huge conical mounds, adding a bold geometric design to the park and eliminating the cost required to remove heavy debris. He also worked with Brooks to introduce soil-cleansing enzymes to clean the site through bioremediation (Baird 2002).

Redevelopment of this site as a public park has been one step in the transformation of the neighboring Fremont and Wallingford neighborhoods into two of the most desirable areas to live in Seattle. Adjacent to the park are multiple restaurants, shops, and apartment complexes that have appeared since the park's creation. Property values in the neighborhoods have skyrocketed in the past two decades, partially because of their proximity to public green space.

Although cherished by Seattleites for its superb views of the city skyline, its annual Fourth of July fireworks show, and its extraordinary industrial "sculptures," Gasworks Park has experienced repeated closures due to resurfacing residual contamination. The park was remediated to acceptable safety levels and capped during the creation of the park, but PAHs and other fossil fuel byproducts persist in the soil. These contaminants have occasionally surfaced and caused alarm among residents and officials, initiating several park closures and costly cleanup processes. Some of the preserved industrial structures were brightly painted and used as play structures in the early years of the park, but are now off-limits due to concerns about exposing children to contaminants.

The park is a central node along the Burke-Gilman Greenway, a pedestrian/bike trail that runs 27 miles along the shipping canal, Lake Union, and Lake Washington. The greenway facilitates movement between neighborhoods, encourages recreation, and creates a safe, pleasant route for bicycle commuters from numerous residential areas into downtown. It is extraordinarily well used on weekends and weekdays.

Gasworks Park illustrates the potential popularity and economic importance of brownfields redeveloped into public parks, but also serves as a warning that remediation should be thorough and aggressive in areas that will be open to public activity. Gasworks Park is also one of the first examples of *in-situ* remediation of industrial contaminants, an approach that appears in both design scenarios.

Figure 3.17: Gasworks as a coal gasification plant in the 1920s (top) and as a public park in the 1970s (Smithsonian).

Low Impact Development for Brownfields

<u>Chicago Center for Green Technology, Chicago, Illinois</u>

Key elements: site remediation, building restoration, green building practices, LEED certification

The Chicago Center for Green Technology (CCGT) is owned and operated by the City of Chicago. The City decided to remodel an existing 1952 building as a model for and to demonstrate strategies in the highest standards of green technology. The city acquired the 17-acre Brownfield site and building in 1996 through a settlement with a construction materials recycling company, when 600,000 cubic yards of illegally dumped debris were found on the site, which was in violation with the company's dumping agreement with the city. The total project costs invested by the city was around $14.4 million - about $9 million for the clean-up costs and an additional $5.4 million on construction and renovation (USGBC 2003). Clean-up included clearing 600,000 tons of concrete from the site, some of which they were able to crush and resell ($1.5 million earned) to recoup some of the removal costs. Because the site was formerly used to recycle construction waste, they were also able to salvage materials to use in the renovation. For example, redwood from old pickle barrels was used in the canopy over the building's entrance (USGBC Poster 2003).

The project received LEED Platinum level rating in 2003 and the site and building feature many green technologies. Building features include a green roof covering one half of the roof, photovoltaic panels covering the other half of the roof, an elevator that runs on canola oil, 36% recycled or renewable building materials, 50% regional building materials (within 300 miles), and natural lighting. Around the building there are many green features that help manage stormwater runoff from the site, including cisterns to collect roof runoff to reuse for site irrigation (up to 12,000 gallons), parking lot bioswales to clean runoff, and a bioretention area to reduce run off flows and recharge groundwater. In addition, the site includes strategic tree plantings for energy conservation, native plantings, and a demonstration garden and solar greenhouse run by GreenCorps Chicago (community gardening and job skills program operated by the city) (CCGT Poster 2003).

As a way to continue with the site's environmental focus, the building tenants all have a sustainability-related mission; the current occupants are GreenCorps Chicago, City Department of Environment, and WRD Environmental. The CCGT holds weekly educational programs open to the public and has a Resource Center and library with resources on how green technology can be incorporated at visitors' homes or businesses. (CCGT 2006).

Figure 3.18: Stormwater wetland, installed in clean soil brought on site to replace slag heap (CCGT).

Figure 3.19: A greenroof reduces the building's energy consumption and reduces runoff from the building (CCGT).

Chapter 4: Normative Landscape Scenarios and Alternative Futures for the Chevy in the Hole.

We used a normative landscape scenarios and alternative futures methodology to create a series of future development possibilities for the Chevy in the Hole site, emphasizing ecology, economic prosperity and community investment, with careful consideration of the urban, social, and historical context. Using the information we gathered from both the research we have done on the history, the plausible site contamination, and the community's desires for the site we have worked on developing a set of alternative visions through an iterative design development process.

The Studio Design Process

Landscape architecture is informed both by "disciplined aesthetics of art" and the "rigorous applications of science and technology" (Cantor 1997). Common in landscape architecture and architecture alike, the studio approach to design is an integrated and applied way of problem solving, a "way of thinking during which the many elements, possibilities, and constraints of architectural knowledge are integrated" and where the "discovery, the application, and the integration of knowledge are creatively pursued" (Boyer and Mitgang 1996). Studio-based design allows designers to explore and generate many ideas, working through iterations of design solutions in a collaborative environment. The designers make representations through sketches, plans, elevation drawings, and reason through design problems in an applied process of creation. This process allows the designer to use the various forms of representation to "inquire, analyze, and text hypotheses about the designs that they represent" (Gross and Do 1997).

The basic studio approach utilizes a cyclical process of problem identification, research and inquiry; an iterative approach to naming the main issues of a problem, outlining limits of the problem, making an experimental design move, evaluating and criticizing the move, and then refining the problem, the limits, and the design moves, proposing and disposing of applied design ideas (Lyle 1985; Nelson 2003; Nassauer 2005a). The design problem is identified and located spatially, then analysis of the site is conducted through onsite observation and in-depth research, drawn design proposals are begun immediately, allowing the designers to get many ideas out on paper. As research continues and the program for the site is developed designs continue to evolve, in a combination of big moves and small refinements. Throughout this process critiques are held, among collaborators on the design team, with the client, and sometimes in informal sessions with the community. These critiques serve to provide cursory feedback and to strengthen the iterative process of proposal and disposal of ideas (Nelson 2003; Nassauer 2005a).

Alternative Normative Scenarios and Futures

In landscape planning, a ***scenario*** is a set of alternative assumptions, narratives of plausible landscape change (Steinitz et al. 2003). The landscape pattern, or consequence of those assumptions, is the ***future*** that results from a proposed scenario (Steinitz et al. 2003). Normative scenarios and their resultant futures are focused on portraying the future that should be, not necessarily what is predicted, but what could plausibly exist (Nassauer and Corry 2004). According to Nassauer and Corry the process of creating normative landscape scenarios allows imagination and speculation, pushing policy makers, developers, and community members to imagine new landscapes that have never existed before, "inspiring policy by providing images of landscapes that could meet societal goals" and developing new patterns with an "explicit functional intent" (Nassauer and Corry 2004). The alternative futures can then be used by policy makers or community members in order to understand and evaluate the consequences of future policy decisions and to anticipate time-frames for future development (Steinitz et al. 2003; Hulse, Eilers et al. 2001).

A key question in the development of *normative* scenarios is "how should the landscape change?" (Nassauer and Corry 2004). This is a question that must be considered through the lens of the stakeholders, from the user to the potential site steward. The goals should be selected imaginatively, allowing for new policies that may never have been conceived of in the past to be considered for the future, giving the public something to aspire to (Nassauer 2004). Nassauer and Corry go further in their description of normative scenarios to describe a clear distinction between normative scenarios that examine technical assumptions of landscape function versus those assumptions developed by a stakeholder group for a specific landscape, where the former rely on science to invent imaginative landscape patterns that are "hypothesized to have certain ecological, economic, or cultural effects" and the latter engage stakeholders and help them understand their own values of the landscape and their wishes for change (Nassauer and Corry 2004; Fry 2001). Furthermore, in planning, the development of alternative futures from normative scenarios is complimentary to "smart development" principles because the futures promote a long-term perspective of planning and design, and encourage interdisciplinary participation and engagement (Stewart, 2005).

The process of developing normative landscape scenarios and alternative futures draws upon many recent precedents. In 2001 a study of alternative futures in the Willamette River Valley (Oregon) evaluated landscape trends under three scenarios, one suggesting a trajectory of continuing trends, a second that examined a loosening of regulations with a market-oriented approach, and a final scenario that proposed a higher priority set on conservation practices and policies. The alternative futures served as the basis for dialogue among citizen groups as future planning decisions were made (Hulse, Eilers et al. 2001; Hulse, Gregory et al. 2002). The Global Millennium Ecosystem Assessment used alternative scenarios to assess potential impacts on human well-being in multinational systems[1], based on potential changes in ecosystem services including biodiversity, water quality and quantity, soil protection, landscape aesthetics, and recreation and tourism, with a focus on decision-making at the political or social scale (Carpenter, Pingali et al. 2005). A regional Corn Belt alternative futures study (Figure 4-1) generated plausible alternative futures for Iowa agricultural landscapes as part of an integrated assessment designed to improve the understanding of landscape ecology and the impacts of land use change (agricultural practices) on water quality, social and economic goals, and native flora and fauna health (Santelmann et al. 2004).

[1] In the MEA they were divided into "sub-global" multinational assessments in order to have diverse ecosystems and stakeholder groups represented.

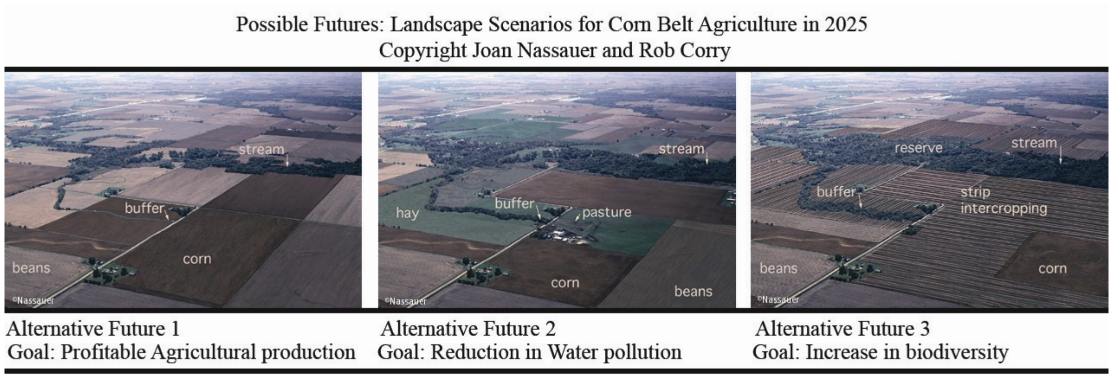


Figure 4.1: Three alternative futures for agricultural landscapes in the Corn Belt (Nassauer and Corry 2004).

Chevy in the Hole

The Chevy in the Hole study described here is a hybrid of the two types of normative scenarios described by Nassauer and Corry, because while it was important to engage the community from the start and understand the functional and social needs facing the citizens of Flint, it was also important to recognize the capacity to invent new patterns based on principles of brownfield redevelopment and landscape ecology. With the creation of the Sasaki visioning plan of 2005, it became clear that the community was ready to consider future development of the Chevy in the Hole site and this project goes a step further than the Sasaki plan in suggesting plausible options for development and new ideas for innovative land use and management.

The development of normative landscape scenarios for brownfields like Chevy in the Hole begins with consideration of the current landscape, goals for the future, the implications of past uses of the landscape and the constraints they may pose, and the potential driving forces of change. Then one considers the goals of the proposed landscape change, and what landscape patterns might contribute to those goals. For brownfields the level of impact of the site’s former uses is key to smart and safe development, planning for varying levels of onsite contamination and considering the degree of uncertainty associated with remediating such areas. Landscape scenarios and alternative futures are recognized as accommodating “complexities associated with brownfield redevelopment in a more creative and imaginative way” (Stewart, 2005). The scenarios then serve to generate futures, models of landscape change based on contextual and societal data that will be sued by stakeholders to leverage future development choices (Nassauer and Corry 2004; and Stewart 2005).

Developing Normative Landscape Scenarios for Flint

Using the current land-use and ecological data about Chevy in the Hole, introduced in Chapters 2 & 3 and the information we gathered after meeting with stakeholders we developed a set of shared assumptions about the site, which would guide our design and development process of alternative futures. We determined a series of "big questions" in order to better understand our goals, recognizing the landscape legacy as well as current community needs and the potential for habitat restoration along the River.

The two scenarios that resulted from our research differ from one another in many important aspects. The first scenario is **Flint's Urban Riverfront**, restoring the urban fabric in order to entice new development into Flint, in which future growth pressures in Flint drive new local investment and institutional expansion. The second scenario is the **Flint River State Park** scenario, supported by broader state and regional investment and state management, and focusing on a situation where the population stabilizes and modest economic growth begins.

The big questions posed for the site focused on the issues of economy and ecology:

1. What economic drivers will allow redevelopment and stimulate new growth at Chevy in the Hole?

2. Given the economic context and environmental risks of this site, what kinds of remediation are advisable?

3. After remediation, what kinds of redevelopment and ecological restoration are feasible?

4. How could redevelopment phases respond to both community needs and brownfield constraints?

Both scenarios shared some key assumptions: that there would be a positive response to development pressures with a cautious but reasoned approach to the treatment of potential residual site contamination and remediation; that ecological enhancement along the Flint River would be proposed where appropriate; and that new and innovative circulation proposals would be considered. More specific goals mentioned by various stakeholders and community members included but were not limited to: an increased job base in Flint, more options for recreation and entertainment, an inspiring new public face for Flint, a “green spine” that serves as an ecological and recreational area along the Flint River, increased habitat for wildlife, new housing opportunities, and the accommodation for future growth of Kettering University.

Among the assumptions that we made about what would make future development feasible in either scenario were:

- **that there is a market for new housing**
- **there will be no development in the 100-yr floodplain**
- **that contaminated groundwater exists**
- **that more testing is needed to determine real contamination risks and locations**
- **that metals and other volatile contaminants exist**
- **that remediation efforts would minimize public risk**
- **that contaminated groundwater will not flow directly into the river**
- **that the hardened concrete channel removal considered**
- **that LID strategies would be considered in appropriate areas**
- **that all one-way roads become two-way**
- **that design for non-motorized transportation be considered in all plans**

All of these elements act on one another and contribute to a certain trajectory for the future. Development pressures determine the preferable timeframe for contamination analysis and remediation. Remediation techniques then drive or determine the level of ecological enhancement that is wise. And circulation acts to better connect this part of the city with downtown and the surrounding communities. Circulation choices in our scenarios were made independently of the above constraints and assumptions, and reflect specific ideas about how to improve movement on and around the site. (Table 4.1)

Key elements of Brownfield redevelopment	Shared Assumptions	Flint's Urban Riverfront Assumptions	Flint River State Park Assumptions
Development Pressures	- Market exists for a variety of new housing - No development in 100-year floodplain	- Flint grows mixed use campus/institutional growth residential	- Flint stabilizes civic residential
Contamination	- Contaminated ground water exists - More testing is needed - Metals & VOC/PAHs	- Concentrated/localized	- Wide spread - Lower level
Remediation	- Ground water not allowed to flow directly to river - Minimize public risk	- Emphasizes cut/condense/cap - Expedient/open site sooner	- Emphasizes bioremediation - Longer timeframe
Ecological Enhancements	- Dechannelization considered - LID strategies	- Urban form - Managed by City	- Naturalistic form - Habitat improved and increased -Managed by MDNR
Circulation	- All one-way roads become two-way - Design for non-motorized transportation (greenways)	- Gateway from west - New road/Blvd. (like 3rd Ave)	- Parkway - Sasaki wide-park roads

Table 4.1: Driving assumptions for the Urban Waterfront and State Park scenarios.

In the first scenario, Flint's Urban Riverfront, Flint's economy sees steady growth, driving the need for new mixed use development on site, as well as an increased institutional and light industrial presence, particularly through partnerships with Kettering University. Jobs increase, as does the desire to live closer to the new work opportunities. The resultant population growth requires an increase in housing accommodations and desires more public recreation space. Contamination is assumed to be concentrated or localized in certain hot spots around the site. Remediation uses a combination of cutting and consolidating contaminated soils onsite along with impermeable capping, focusing on expedience, in order to accommodate more rapid redevelopment. Ecological enhancements are assumed to have a more urban form, intent on increasing livability of the area while serving as an urban ecological patch, providing open space for recreation and community connectivity as well as improved habitat for urban and aquatic wildlife. This scenario is intended to catalyze new development due to regional growth by utilizing the natural amenities of the river and open space and creates a new circulation route, which increases view to the river while opening the space to promote safe recreational use.

In the second scenario, Flint River State Park, contrasting assumptions inform another plausible vision of the site. Contamination levels are lower than in the first scenario but contaminants are spread throughout the site. Remediation emphasizes innovative bioremediation techniques over much of the site, using longer periods of time and natural processes to break down contaminants while creating a green visual amenity at the heart of Flint and suggesting rebirth along the river. The ecological character of the site takes on a more natural form and eventually hosts more native riparian habitat. In terms of development pressures, Flint's economy is stabilized but does not see immediate growth. Therefore the most pressing development pressures are for improved and increased residential opportunities, outdoor recreation and a strong site presence that may draw in visitors and better connect and stabilize the existing residential community. A strong state institutional presence is required on the site for management and administration (Michigan DNR). This scenario promotes circulation that supports connections to the surrounding residential neighborhoods and to the downtown, building off of the road networks proposed in the Sasaki *wide river* plan. Assumptions for both scenarios are summarized graphically in Figure 4.2.

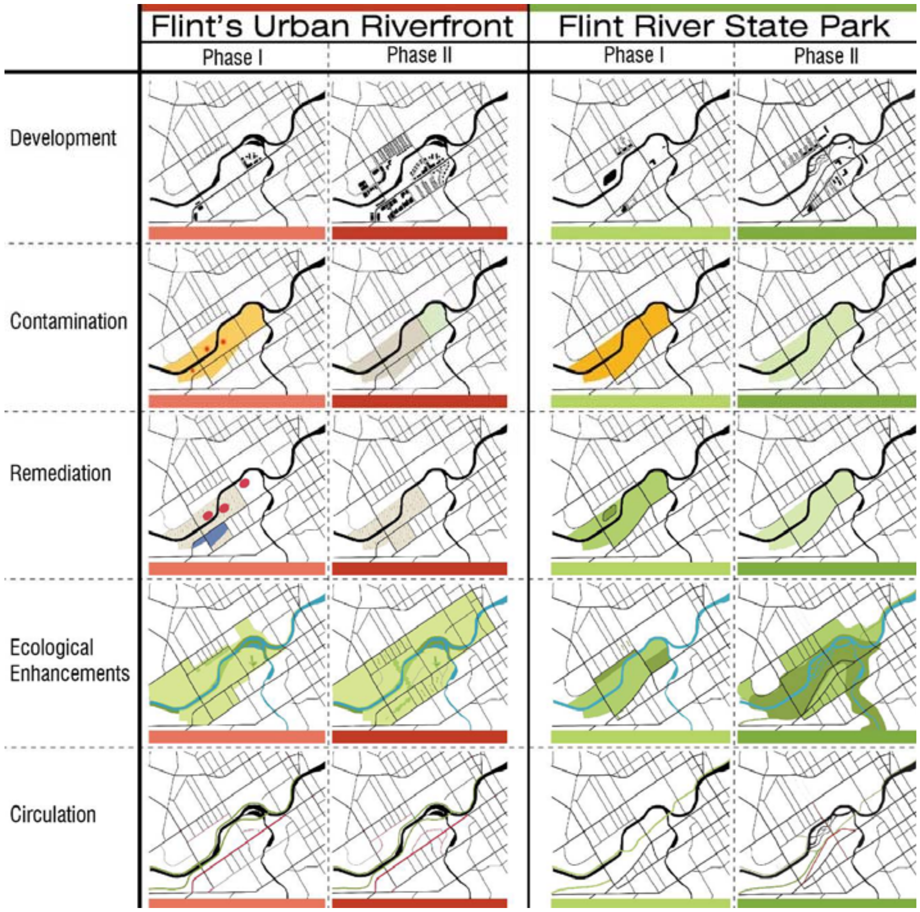


Figure 4.2: Graphic summary of the two scenarios and their differing assumptions.

Based on our research and our work with Flint residents, the assumptions made in developing the two scenarios are very plausible, covering many of the factors likely to influence future development. From the two scenarios described in this chapter four futures have been developed for these two scenarios of Chevy in the Hole and are described in greater detail in the following chapter.

Chapter 5:Alternative Futures for Chevy in the Hole

The formulation of the Urban Riverfront and State Park scenarios, each with its own set of assumptions, leads to the development of alternative futures. These futures represent plausible manifestations of landscape pattern, parcel organization, land uses, and landscape management for each scenario. We present these futures in phases: for each scenario, a Phase I future considers initial cleanup and development options, while the Phase II future looks further ahead, specifying the types of development and management that will occur as the site evolves. These phases are summarized in Figure 5.1.

In this chapter, we present explanations of how these futures could unfold, as well descriptions of their experiential characteristics. These are not definitive prescriptions for what *should* happen at Chevy in the Hole, but rather depictions of what is possible if certain priorities are followed

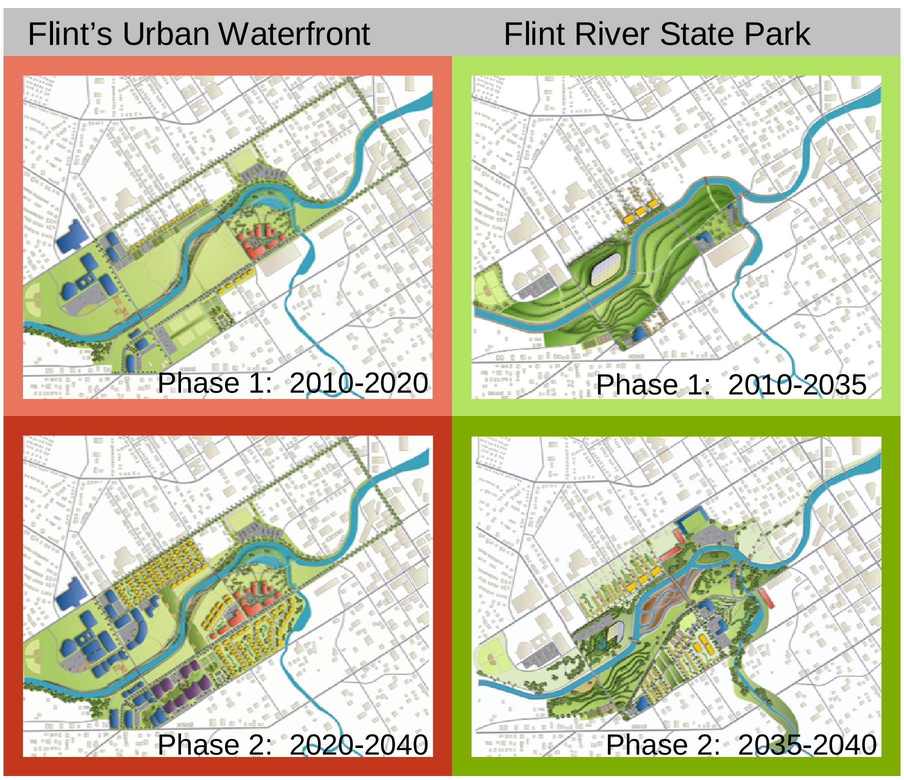


Figure 5.1: Future phases for the two proposed scenario. Each scenario features an early stage focusing on remediation and development groundwork, and a later stage showing a master plan for eventual development.

Scenario 1: Flint's Urban Waterfront

Overview

The "Flint's Urban Waterfront" scenario assumes that Flint's reinvestment strategy for the downtown area is successful and the city begins to see economic growth. This scenario utilizes a remediation strategy that opens the site to the public within the first few years, generating infrastructure and ecological improvements that set the stage for further development of the site. Phase I capitalizes on public investment from the city and the Army Corps of Engineers to put in place new roads and an improved river edge, with the goal of attracting future development and accommodating growth near the downtown within 10 years. In Phase II, Kettering University grows to become an institutional steward on the site, and the development of a new business and research park stimulates diversification of Flint's economy. With a revitalized downtown area, an active business corridor along Kearsley street, and vibrant natural amenities, residential property on the site and in adjacent neighborhoods becomes highly desirable, reinforcing the rejuvenation of Flint.

Flint's Urban Riverfront: Phase I

Flint's Urban Riverfront: Phase I

Phase I: Rapid remediation, river improvements and City Park

The design of this scenario's first phase is intended to catalyze growth in the City of Flint by opening up the Chevy in the Hole property and providing public access to the river and a new amenity park for the neighborhood. Within ten years, a green spine with an urban feel connects the downtown to surrounding neighborhoods. This goal is accomplished through four driving gestures on the landscape; a holistic remediation strategy, ecological enhancements of the river, creation of a recreational park space and investment through public and private development projects.

<u>Holistic Remediation</u>:

Figure 5.2: Location of remediation strategy in Phase I.

Scenario I assumes that there are hot spots of contaminated soils in discrete locations around the former industrial plants. Pockets of contamination immediately adjacent to the river are of greatest concern because of their potential to leak into the surrounding environment. One of the quickest forms of remediation is to excavate the contaminated soils from these areas. Often, highly contaminated soils are transported off a brownfield site by train or truck to a hazardous waste landfill. However, the cut and haul process can cause a dispersal of contamination during transport and can be cost prohibitive; shipping and landfill fees are often high.

The existing topography of the site allow for a remediation solution that addresses both of these previously stated concerns. Highly contaminated soils will be cut from areas near the river and consolidated upslope on the south side of the site. This same strategy of cut/consolidate/cap, was used at Gas Works park in Seattle, WA. The highly contaminated soils were dug from areas around the industrial structures and consolidated to form a sculpted mound as seen in Figure 5.3. During phase I of this future, the cut soils will be used to fill in the slope that currently exists between the former rail line and Glenview Avenue on the Southwest corner. Figure 5.4 depicts likely areas to be cut in red and the location of the consolidation of that fill in blue. The consolidated fill material will be covered with an impermeable cap. Furthermore, residual contamination will likely remain on the site between Chevrolet Avenue and Stevenson Street, so this central area will also be covered with an impermeable cap to prevent exposure to residual contamination which is depicted by the hatched lines in Figure 5.4.

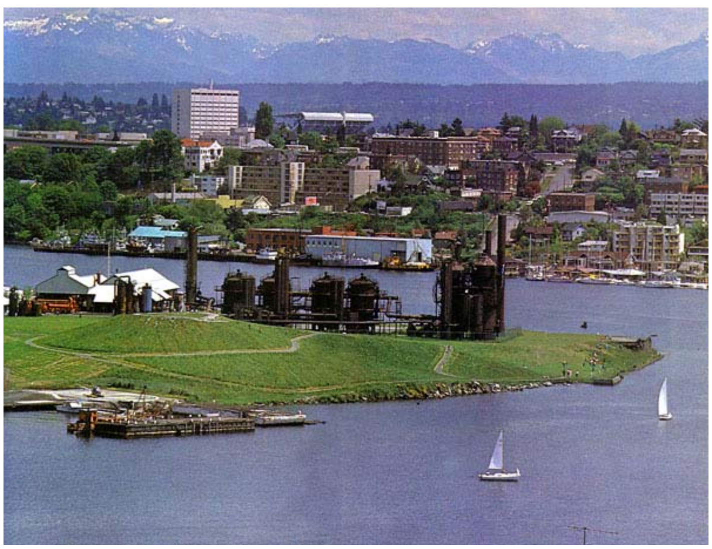


Figure 5.3: Phase I of Flint's Urban Riverfront future uses a similar remediation strategy as seen here in Gas Works Park in Seattle, WA. Contaminated soil dug from the industrial site was consolidated to form the sculpted mound feature (Smithsonian).

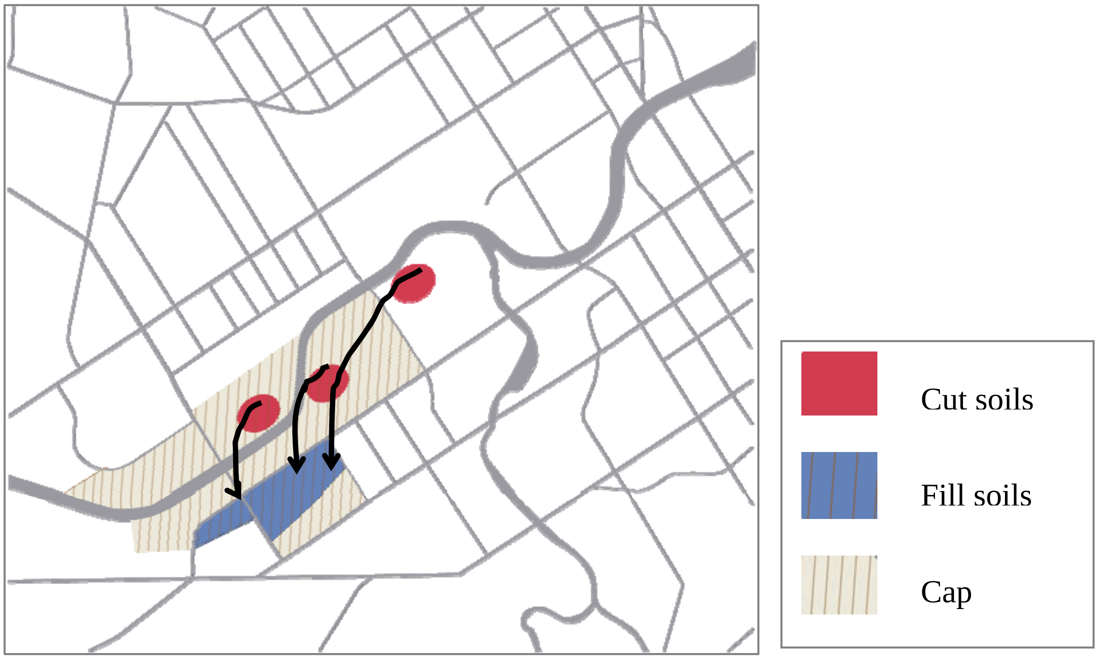


Figure 5.4: Hot spots of highly contaminated soils will be cut (areas in red) and condensed (area in blue). An impermeable cap will cover the hatched area of the site.

The cut and consolidation strategy can be considered a holistic approach because it creates new opportunities for future land uses on the Chevy in the Hole site. First, it allows for Kearsley to be restored to its original route and extend straight into the site. Second, it creates a new land parcel for use as light industrial land use. Third, the new road alignment clarifies the existing intersection at Court St. and establishes a gateway for Kettering, who has extended their campus across the river.

When plant 4 was constructed, Kearsley was re-routed down Glenwood Ave. A historical map shown in Figure 6.4 depicts the original path of Kearsley which intersected with Chevrolet Avenue. The creation of a new Kearsley Boulevard will create an east-west corridor that mirrors Third Avenue on the north side of the site. Creating this parallel provides a circular connection to downtown and develops alternative routes to establish equitable connections to downtown and the surrounding neighborhoods (see Figure 5.6). In addition, the boulevard brings the southern neighborhoods closer to the river helping to both build a strong relationship between the southern and northern neighborhoods and to improve access to the new park from the south.

Extending Kearsley straight into the Chevy in the Hole property and removing parts of Glenwood Avenue allows for the creation of new developable land, labeled in Figure 5.6. Institutional land use controls on this property will provide additional protection to the contaminated soils that were consolidated and capped to form this parcel. The boulevard itself is the first control proving a physical separation between the public open space and the consolidated contaminated fill. Second, the property will be zoned for a light industrial land use which will allow for future jobs to be brought to Flint during Phase II of this future while minimizing risks of exposure. An initial and temporary use of this space is soccer fields and parking.

Finally, the boulevard simplifies the existing intersection at the corner of Glenwood Ave., Court St. and M21. Access to downtown Flint and Kettering University can be accessed from the west on M21. However, some traffic is directed away from this route because of that confusing intersection. Extending Kearsley and making it a two way road improves access from the west off of M21 and creates a gateway entrance for Kettering.

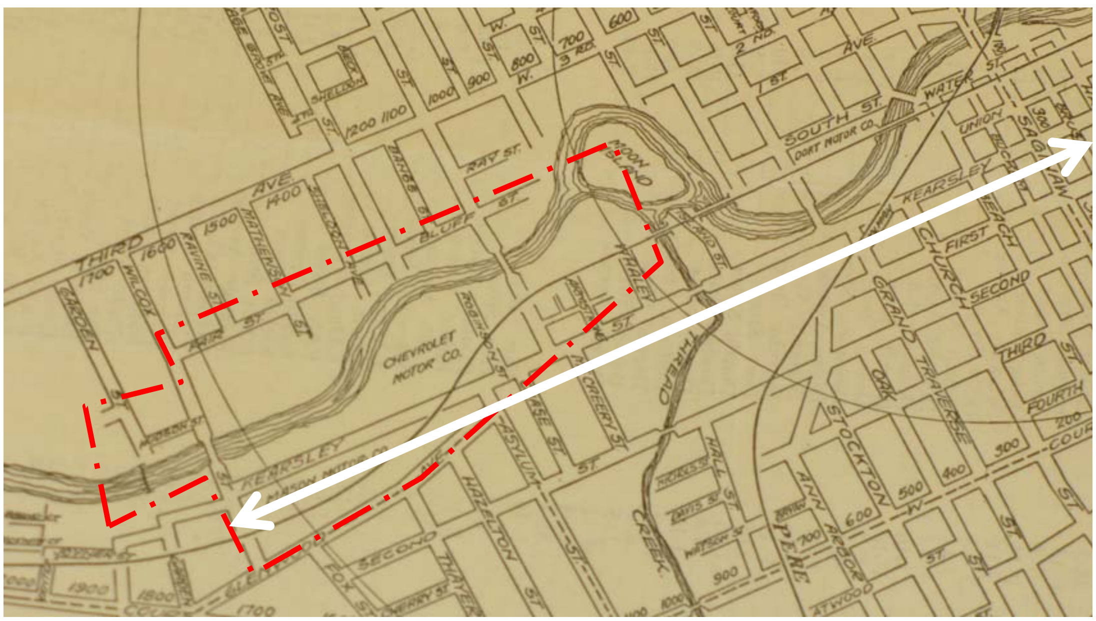


Figure 5.5: Historical Map of Flint showing the original path of Kearsley St. (Bentley Historical Library, University of Michigan).

Figure 5.6: The proposed Kearsley Boulevard provides a parallel to Third Avenue allowing for a circular connection to downtown.

River Rehabilitation:

Figure 5.7: Location of river rehabilitation.

The greatest driving force for remediation and redevelopment during Phase I of the "Flint's Urban Riverfront" future is to improve river ecology and aesthetic experiences of the Flint River. This will be accomplished by amending the river channel with stone and concrete terraces. A similar precedent can be seen in Figure 5.8, an urban river restoration project in Kalazamoo, MI. Federal funding could be brought in from the Army Corps of Engineers ecosystem restoration authorities. The role of the restoration authorities program is to "restore degraded ecosystem structure, function, and dynamic process to a less degraded, more natural condition," a task the Corps is tackling aggressively to make up for ecological damages caused by past projects (USACE 2004). In 2004 the USACE considered two alternatives for restoration of the Flint River in a preliminary restoration plan. Figure 5.9 shows a section of the USACE paved terrace design.

Figure 5.8: River terraces were created when Arcadia Creek was daylighted and restored in Kalamazoo, MI (www.city-data.com/city/Kalamazoo-Michigan).

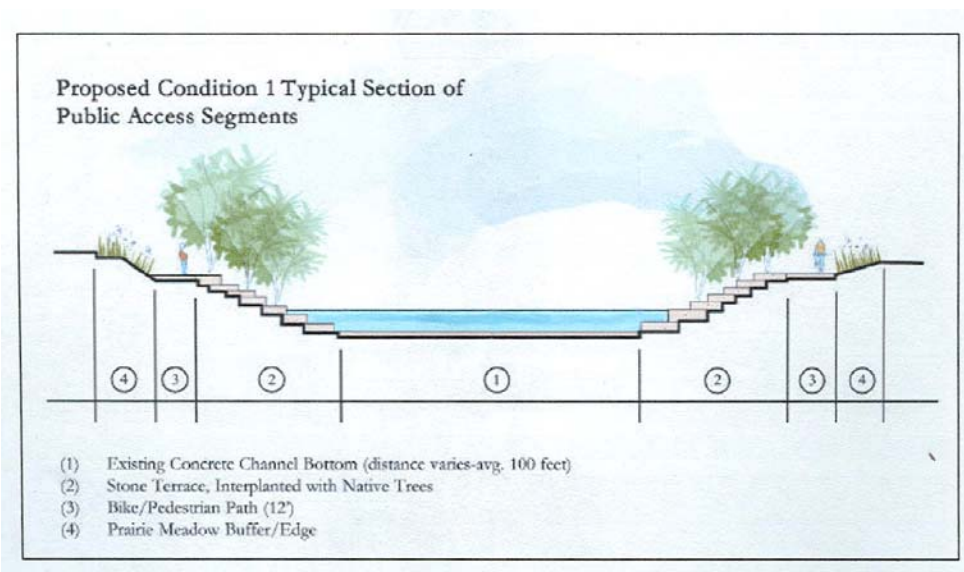


Figure 5.9: One of the terrace design alternatives proposed by the USACE is similar to the terrace design in Flint's Urban Riverfront future (USACE 2004).

Our design builds upon the ideas of the USACE where we also propose a terraced channel design. The terraces preserve flood control measures and a vertical barrier to prevent any residually contaminated soils and groundwater from directly entering the river while greatly improving both aesthetic appearance and water quality. The concrete nature of the channel is intentionally preserved to reflect the history of the industrial land use legacy. This design feature is an educational marker of past industrial activities.

Proposed vegetated terraces will detain and clean stormwater from upland areas before it enters the river. Stormwater infiltration is not possible over an area with a remediation cap. Therefore, clean surface runoff from the surrounding areas is graded to flow through pockets of native vegetation to slow the speed of the runoff before entering the river, Figure 5.10. For more information, please refer to Appendix 2 for low impact stormwater management techniques on a brownfield sites. Additionally, native floodplain trees planted within the terraces help to shade the river improving habitat conditions for fish and other wildlife.

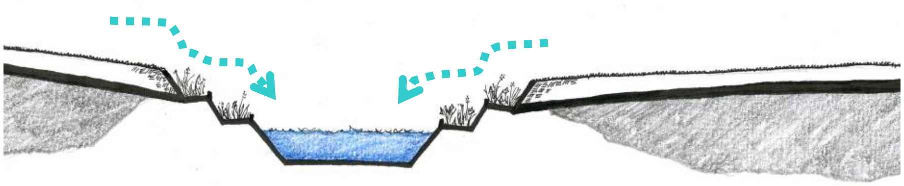


Figure 5.10: Vegetated terraces will detain and purify clean surface stormwater runoff from surrounding park land.

Points of access are designed into the terraces which allow park users to step down and access the river directly. The main riverside gathering space is a plaza located on the south side of the river and a smaller fishing nook is accessed from the north side of the park (see Figure 5.11).

On the east side of the property, the concrete channel will be removed to create a naturalized river edge (Figure 5.12). Under our plausible assumptions, this stretch of the concrete channel will be the easiest to remove because issues of residual contamination are not as severe as in the middle of the Chevy in the Hole property. Additionally, removing the channel could help to unite Atwood Stadium which is located along the northern bank, with a park across the river. A wetland marsh and oxbow lake are designed to create additional flood storage capacity and provide habitat to waterfowl and bird species. Figure 5.13 shows an example of a meandering riparian wetland habitat and oxbow lake found in Ontario. The oxbow lake will be the central feature of a new city park and the urban bird sanctuary and wetland with limited public access, designed to be viewed from across the lake and river from Atwood Stadium.

Figure 5.11: Two riverside access points are located on the north and south sides of the river.

Figure 5.12: Naturalized river channel and wetland along the eastern side of the site adjacent to Atwood Stadium.

Figure 5.13: The oxbow lake is inspired by natural riparian wetland habitat found in rivers around the Great Lakes Region. The river in this image is located in Ontario (www.on.ec.gc.ca).

Improving both the ecological function and the look of the Flint River will dramatically change the community's perception of the Chevy in the Hole site. Opening the riverfront and providing opportunities for the residents to come down and interact with the river will also help to foster a greater connection to their river. By leveraging public funding from the Army Corps for rehabilitation activities, private investment will be more willing to invest in the redevelopment of the site.

Public Park Amenities:

Figure 5.14: Location of public park amenities.

Among the most striking elements of this design are the expansive playing fields in the center of the site. The open fields allow for clear views down into the site from adjacent roads and neighborhoods. This design element acts as both a safety feature and provides residents with pleasant views across the Flint River. Large open play fields such as those in Parc de la Vilette (Figure 5.15) provide flexible public open space that can be used for a range of activities such as a canvas for local artists to display sculptures, a space for local or national festivals or independent recreation. Large open play fields are also a low maintenance design approach which would be a low cost public open space for the City of Flint to maintain. Finally, a new pedestrian bridge connects the northern and southern fields.

This bridge will allow for movement across the river, helping to unite the historically divided north and south neighborhoods.

Turf grass, with its shallow roots, is an appropriate planting choice to complement the impermeable cap that lies below the surface encapsulating residual contamination. Penetrating the cap with plant roots or careless development will decrease the effectiveness of the cap and create potential pathways for contamination. For this reason, trees have been selectively planted with the river terrace structures with root barriers to protect the surrounding remediation cap. The trees and placed to provide visual interest and give shade to the river and park users.

Figure 5.15: The play fields will have a similar aesthetic to the lawn areas in Parc de la Villette in Paris. Flint artists would be able to display sculptures providing visual interests such as the architectural follies do in this precedent (www.villette. com).

A section cut though the park shows how the spaces in the park relate to one another (see section in beginning of chapter). Notable areas of the park include greenways, community gardens, and an urban tree nursery. The park will serve as a node along a regional greenway system. Two greenway trails run along and within the river terraces. Both trails connect to the Flint River Trail on the eastern side of the site. The trail on the north side of the river overlooks the riverfront plaza. It is a local spur that connects to Mott Park Golf Course. The trail along the south is the regional extension of the Flint River trail and connects to the abandoned rail line to the west.

The linear area along Bluff Street provides a great opportunity for a large community garden space. This uphill location is where soil contamination is less likely to be a problem since this area was historically used as parking lots. Flint has a strong history of urban community gardening. The Flint Urban Gardening and Land Use Corporation, organized in

2000, enables neighborhood groups, schools, and individuals to build and preserve urban and community gardens in Flint and Genesee County (Alaimo and Hassler 2003). This group could serve as stewards for the new community gardens at Chevy in the Hole. A community tree nursery reflects the site's and the community's early connection to the logging industry, and will serve as a place to cultivate trees for use around the city, contributing to both new and pre-existing urban renewal projects. These uses serve as an ideal connection between past and present and further extends the green uses of the former manufacturing site.

Confluence Park (Figure 5.12) builds on the activities associated with Atwood Stadium and provides a synergistic park space. The upland park area will have an open but shady feel, offering picnic facilities, a playground and access to the lake and river (see Figure 5.16a). A canoe livery on Oxbow Lake will allow access to the river. Oxbow Lake will provide ecological, educational and recreational opportunities such as fishing and ice skating (see Figure 5.16c). The multiple programmed uses will make it an inviting and fun space for all members of the community.

a. b. c.

Figure 5.16: a. open tree covered look of Confluence Park (www.greatsaltplains.com). b. Oxbow Lake in the summer (http://www.realty-guild.com/images) c. Ice skating in the winter (http://www.wirednewyork.com/parks/bryant_park).

Investment from public and private development:

Figure 5.17: Locations of public and private development projects during Phase I.

As stated before, federal funding from the Army Corp of Engineers is a major driver to rehabilitate the riverfront and entice further investment in the site. Three types of development occur in Phase I; single and multi-family residential housing, an expansion of Kettering, and a mixed use development.

A mixed-use development will be located at the corner of Kearsley Boulevard and Stevenson Street. This is an ideal place for the first phase of development since the land was historically used for parking lots, leaving low levels of contamination that can most easily be remediated to a residential standard. The development along Kearsley Street will provide a more urban edge along the boulevard side and will be complemented by a grey-water recycling wetland in between the buildings. The location of the buildings around the constructed wetland will create a corridor that draws people into the wetland amenity area and then into the adjacent park. Shared parking is offered for retail users, park users and residents, located between the buildings and along Kearsley Boulevard.

a.  b. 

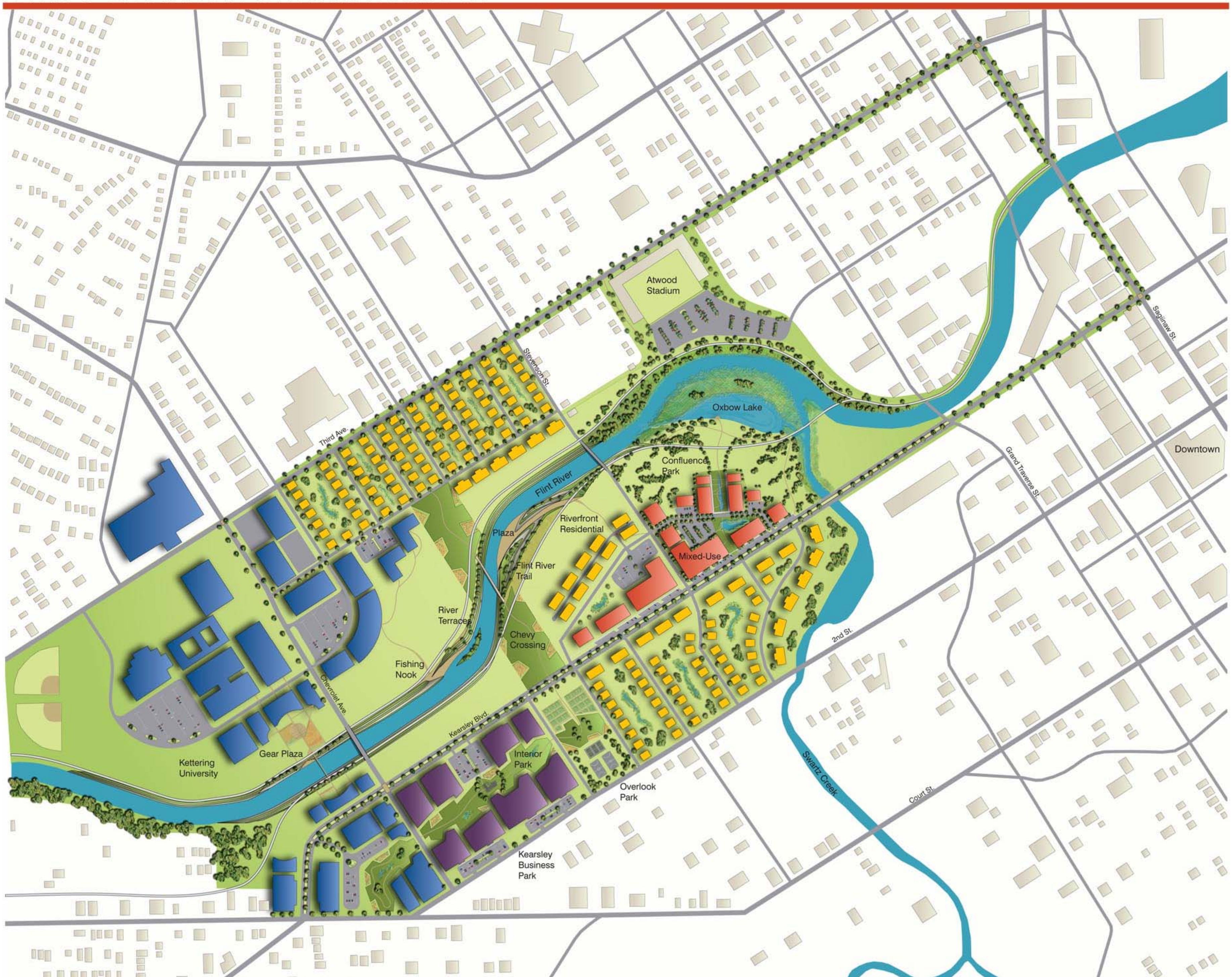
Figure 5.18: Precedent photos of stormwater feature in the mixed use courtyard. a. interactive stormwater feature (http://static.flickr.com/29/57117664_f2115d48c6.jpg?v=0) b. stormwater as a landscape feature in Portland, OR (www.murase.com).

The new development is anchored by a 35,000 square foot grocery store and offers 112,000 sq ft of retail space for neighborhood stores and restaurants. Development of recreational facilities will also complement the adjacent city park, providing such services as canoe rentals or a bait shop. 80,000 sq ft. of residential units are located on the top floors of most buildings, and the residents of these apartments and condos will have a strong sense of stewardship for the new park. This new development is planned not to pull investment away from downtown, but to complement the types of development occurring downtown and fill the needs of the neighboring community. Finally, the development provides for private investment on the site, expanding the city's tax base and helping to offset the cost of remediation through the utilization of tax increment financing (TIF-see Appendix 1) and tax credits.

Figure 5.19: Mixed use development with stormwater landscape water feature

Overall, the design of phase one of the Flint's Urban Waterfront scenario opens up the site to new development, creating a river and urban park amenity. Since residual contamination is left on the redeveloped site, the design establishes institutional controls on land uses where potential risks occur.

Flint's Urban Riverfront: Phase II




Single-
family
Bluff
Street
Townhouses
Terraces
Flint River
Plaza
Flint River Trail
Play Field
Riverfront Lofts
Mixed-Use
Kearsley Blvd
Apartments/
Multi-family

Phase II (35 years): ***Developing an Urban Corridor***

In Phase II, a developed urban corridor is established between the main business district along Saginaw Street and Kettering University, building on the circulation pattern, mixed-use amenities, and improved riverfront completed in Phase I. This phase assumes that remediation is complete and the area is clean or capped and residual contamination is continued to be monitored to ensure pubic and ecosystem health. The new development within the corridor will compliment the main downtown business district, offering different types of business spaces. There are three significant moves within the landscape that happen in Phase II. First, Kettering University expands its campus across the River, becoming an active site steward and developing a campus that is focused on the riverfront. Second, the establishment of Kearsley Business Park, along the new boulevard, diversifies Flint's economy. Third, new types of urban residential will accommodate Flint's assumed growth and meet market demands for a variety of new housing.

Kettering University

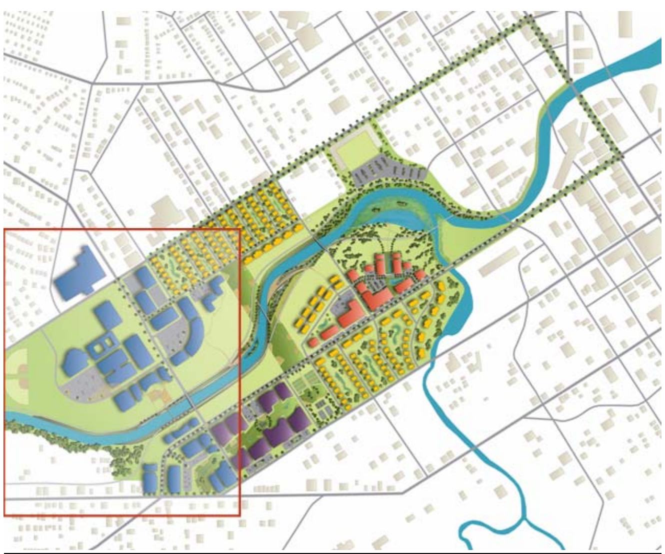
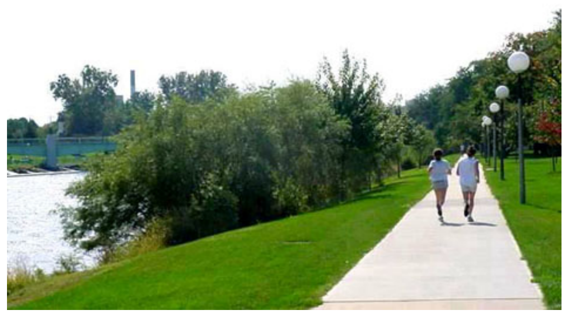


Figure 5.20: Location of Kettering University campus expansion.

The most significant development occurs at Kettering University, as Kettering expands across the river and across Chevrolet Avenue, adding around 480,000 square feet of building space (Figure 5.20). Kettering University makes a strategic decision to focus on creating a riverfront campus, where the Flint River becomes a unique place for campus life, offering spaces where students and staff can gather, study and relax, similar to other waterfront-focused campuses like University of Wisconsin-Madison and University of Iowa (Figures 5.21). In addition, this scenario assumes that Kettering builds on its nationally-ranked engineering programs to include research and curriculum oriented on alternative energy technologies and sources, in recognition of changing global energy markets.

The most recent Master Plan for Kettering shows the development of a research park across Chevrolet Avenue and the addition of a small river park along the north side of the river (Rowe Incorporated 1998). Flint's Urban Waterfront incorporates these elements, but further develops the plan by extending Kettering across the river in order to create a gateway entrance from the I-69 exit to the west and to make Kettering's presence on the site a central asset and steward of the site design. The campus move across the river, along with surrounding new development, also promotes new investment on the south of the site, which is in need of revitalization.

a.  **b.** 

Figures 5.21: Examples of universities that embrace their waterfront as an integral element of campus. a.)Memorial Union, University of Wisconsin-Madison, student union terraces along Lake Mendota (www.ssc.wisc.edu) ; b.) University of Iowa, campus trail along the Iowa River (www.uihealthcare.com).

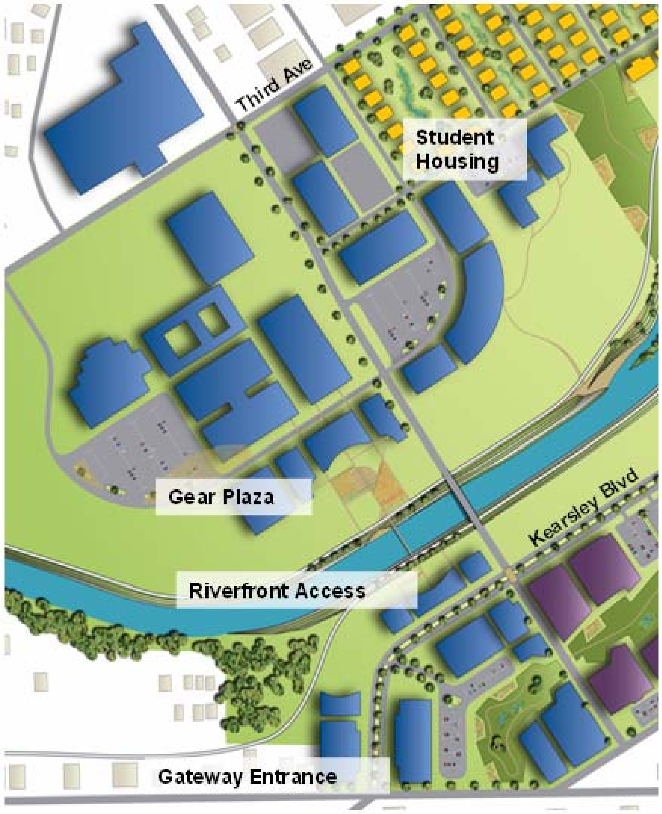


Figure 5.22: Kettering University campus extension

As shown in Figure 5.22, Kettering's new campus plan will include a plaza along the river that will be a central focus of campus life and will also include design elements that speak to the site's industrial legacy and Kettering University's history. The river terraces installed in Phase I will be designed to provide river access on campus, and new vegetation will be planted in raised beds or in buried planters to prevent damage to the cap. A new bridge will connect the campus across the river and access to the Flint River Trail will run through campus on the south side of the river.

The new campus buildings will house new research and academic endeavors, as well as the continuing education program, business and research incubator program, student housing, and a riverfront student union. A gateway entrance to Kettering will be designed where Kearlsey Boulevard begins, including raised planters and building design to calm traffic movement. As people drive on Kearsley through Kettering's campus they will experience long views across the Chevy in the Hole Site, with clear views of the campus, the Flint River, and park spaces.

Kearsley Business Park:

Figure 5.23: Location of Kearsley Business Park.

Along with the expansion of Kettering University, Kearsley Business Park (Figure 5.23) will be established, which will support a range of uses, including light industrial, research and development, commercial or office space close to downtown. The business park will contribute to Flint's assumed improved economic base by diversifying Flint's economy, and will offer larger building spaces totaling around 280,000 square feet near the downtown core, allowing businesses to take advantage of urban amenities. In addition, the business park will bring business to the south side of the river, which will improve the southern neighborhoods that need to be revitalized.

a.  **b.** 

Figures 5.24: Urban business park precedents. a.)University Research Park, University of Wisconsin-Madison (http://universityresearchpark.org) b.) Visteon Corporation,Dearborn, Michigan (www.jjr-us.com).

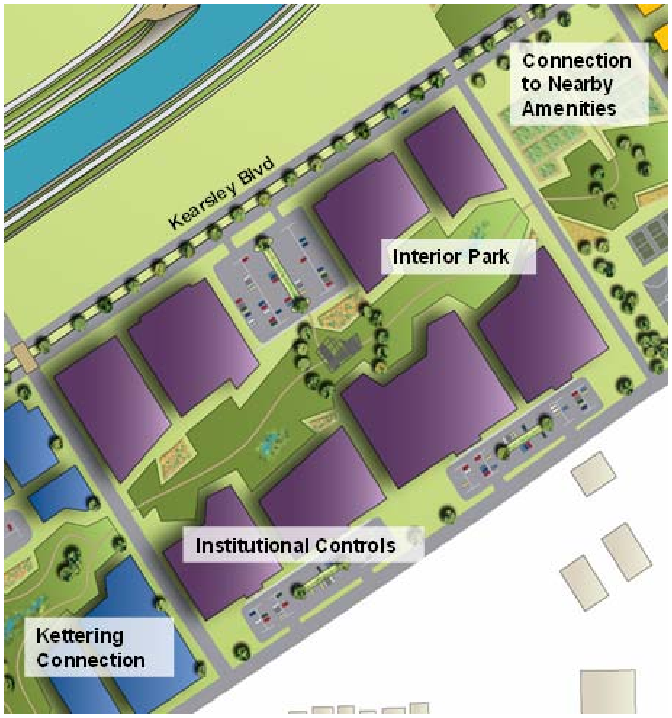


Figure 5.25: Kearsley Business Park

Kearsley Business Park will especially provide opportunities for research partnerships with Kettering University and University of Michigan-Flint. In order to gain interest in the business park, Kettering University will collaborate with their cooperative program partners to attract tenants to the business park, strengthening Kettering's role as site steward and offering more opportunities for students from Kettering, University of Michigan-Flint and Mott Community College to stay and work in Flint after graduation, creating a more sustainable workforce. Also, Kearsley Business Park is physically located next to the Kettering campus in order to provide direct connections to Kettering's facilities (Figure 5.25).

Kearsley Business Park will be conveniently located adjacent to new housing and will be well connected to the established network of park spaces and trails. In addition, because this location is the area where contaminated fill from the rest of the site is condensed, the business park provides further institutional controls on residual contamination through surface parking, building footprints, and other impervious surfaces, and by restricting land uses and circulation. In addition to being well connected to larger park spaces and mixed-use amenities, an interior park space will be designed in the middle of the buildings to provide spaces where workers can hold meetings, eat lunch, or take a break (Figure 5.25). The design for the park space was inspired by the interior park space at the Google Headquarters campus in Mountain View, California (Figure 5.26). This shared space will serve as a pedestrian corridor between the business park and Kettering to the west and the neighborhood park to the east, providing direct connect to business partners and to neighborhood park amenities including community gardens and active recreational spaces. The connected formal park spaces also incorporate a trail loop for employees and students to use.

Figure 5.26: Google Headquarters, Mountain View, California. The internal park space is a design precedent for the business park along Kearsley Boulevard (www.googleearthing.com).

Residential:

Figure 5.27: New residential units in and around Chevy in the Hole.

Increased regional growth, along with the site's improved riverfront, park spaces and mixed-use amenities, will offer opportunities for new types of housing that fit with the revitalized urban fabric extending from downtown to Kettering University. The emphasis on the river as a natural amenity for new housing will foster stronger residential connections across the river, as people use the trails along the river and cross the river to access new stores and new work opportunities, or go downtown. All new residential development will be designed to have a more urban character and density, including improved walkability, both between the river and adjacent neighborhoods as well as between downtown and the site. The neighborhood parks on the south and north side of the site provide a gateway for residents in adjacent neighborhoods to access the bigger park spaces along the river as well as views across the site.

Figure 5.28: New residential offers a typology of housing options

New single-family homes and around 230,000 square feet of multi-family buildings will meet the need for improved housing in the downtown area, providing a typology of housing types, including townhouses, condominiums, riverfront housing, affordable housing, senior housing, and live/work space, all of which support an urban lifestyle (Figure 5.29). The housing along the north and south sides of the river and Swartz creek are 2-3 story multi-family units and provide an opportunity to offer higher-end waterfront properties. Units along Kearsley Boulevard are also 2-3 story multi-family units to fit with the scale of the mixed-use and business park buildings, and can be used for apartments, senior housing, or affordable housing. Adjacent neighborhoods, especially the Third Avenue Neighborhood and the neighborhood directly south of the site, will experience improvements to or demolition of existing houses that cannot be remodeled along with in-fill of new single-family homes to re-establish the density of these historical, urban neighborhoods.

a.  **b.** 

Figure 5.29: a.) Midtown Lofts, Minneapolis, Minnesota. This development is built along a regional greenway and utilizes green building standards (www.landergroup.com). b.) Upper Landing housing development, St. Paul, Minnesota. This redevelopment project along the Mississippi River provides dense, urban housing options near downtown amenities. These are precedents for the types of new housing in Phase II. (www.fmr.org).

The park space created in Phase I that crosses the river at the new pedestrian bridge through the middle of the site will become a more formalized park space, called Chevy Crossing, in Phase II (Figure 5.28). The design for Chevy Crossing will be a continuation of the park areas created within the Business Park and Kettering, to both visually and physically connect these spaces. Large raised beds will be planted with native perennials to define the space moving toward the bridge across the river. The raised beds are used to minimize plant roots from penetrating the cap. Finally, rainwater gardens will be installed in the single-family residential neighborhoods to the north and south of the site, to help slow down, minimize and clean stormwater runoff in surrounding areas rather than on the site. An underdrain that is connected to existing storm sewer pipes will be used where water infiltration is a concern due to contamination.

In conclusion, Flint's Urban Riverfront scenario opens the site sooner through a holistic remediation strategy to allow for quicker and more development of the site, in response to Flint's assumed growth. With Phase II complete, Chevy in the Hole will be a revitalized urban corridor focused on the Flint River waterfront with its ecological and aesthetic improvements. The site will complement the downtown core by providing a variety of new housing, establishing business and research space that diversifies Flint's economic base, and building on Kettering University to become a long-term steward of the site.

Scenario 2: Flint River State Park

Overview

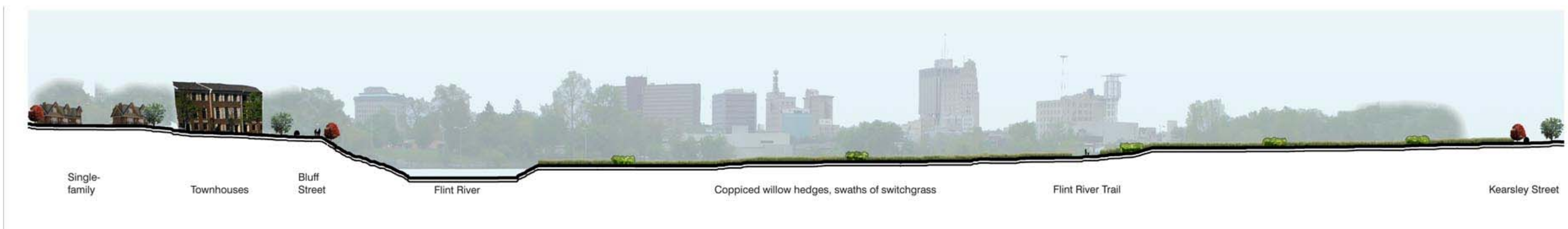
As described in Chapter 4, this scenario focuses on a future in which Flint is stabilizing but is not yet experiencing rapid growth; Phase I covers the period from 2010-2035, while Phase II occurs between 2035 and 2040. Population losses stop and gradual improvements in Flint's economic health and quality of life begin to become apparent. Chevy in the Hole is reclaimed by the community as a new park space at the heart of Flint, with striking views, new opportunities for recreation, and a significant restoration of ecological functions. These new amenities are funded in part by the site's adoption as a new urban state park, and Michigan's Department of Natural Resources (MDNR) uses the area to showcase phytoremediation of brownfields and river restoration.

In Phase I, an innovative approach to phytoremediation incorporates the production of biofuels crops, opening the door to productive use of abandoned industrial land and allowing a cost-effective cleanup of the site over time. A new greenway system allows limited public access through the site, and several new recreational nodes around the edges of the site encourage new activity and engagement in the area. In Phase II, the river channel is restored and a more natural hydrological regime is established, with a meandering braided channel. New public gardens and a natural history museum further encourage public interaction with nature and help draw visitors to the area.

In both phases of this scenario, a vibrant, distinctive urban park with improved ecological function is created where a contaminated, abandoned lot once stood. The scenario dramatically increases livability around Chevy in the Hole, and helps Flint gain recognition as a bold, forward-thinking city, capable of overcoming major obstacles.

Flint River State Park: Phase I

Flint River State Park: Phase I



Phase I: Phytoremediation, biofuels, and recreation

In the first 25 years of redevelopment at Chevy in the Hole, this scenario's biggest moves are large-scale phytoremediation of residual contaminants, the simultaneous production of crops for cellulosic ethanol, and controlled public access to increase activity and community engagement with the site. The pioneering combination of remediation and biofuel production offers a sustainable, economically viable solution for cleanup of the site.

Remediation

In comparison to the Gateway to Growth scenario, this scenario assumes lower contamination levels but more widespread contamination. This scenario recognizes that contamination is likely to be more concentrated in some areas, and the first step of this phase is to excavate "hot spots" and consolidate them in a large, enclosed remediation greenhouse. This structure allows more intensive remediation to occur and minimizes the public's risks of exposure to the site's most contaminated materials. This scenario assumes that cutting and consolidating the most contaminated soils cleans the site to a level acceptable for industrial redevelopment—subsequent phytoremediation acts as a "polishing" treatment for the rest of the site, intended to increase the level of safety over time.

The remediation greenhouse is attractive and aesthetically interesting, made from industrial materials. It serves as a clear, continuing reminder to visitors and neighbors that contamination is present and cleanup is occurring. It could follow the precedent of Pritzker Pavillion, the metal trellis attached to Frank Gehry's amphitheater in Chicago, a voluminous steel structure with an attractive form and an expansive interior (Figure 5.30).

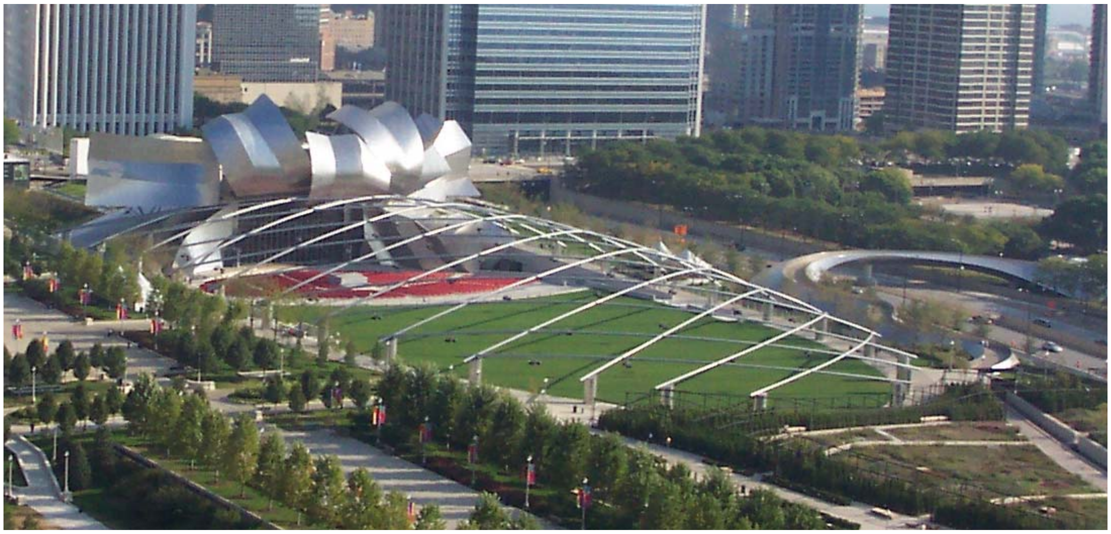


Figure 5.30: Frank Gehry's amphitheater in Millenium Park, Chicago. The metal trellis structure, Pritzker Pavillion, serves as a precedent for Chevy in the Hole's remediation greenhouse (www.greenroofs.org 2006).

After excavation is completed, MDNR will remove the asphalt cap over the rest of the site, and amend soils with organic matter from the city's leaf waste dump located at Aldrich Park, just upstream on Swartz Creek. This helps reopen Aldrich to the Grand Traverse neighborhood at the same time that it improves structure in the Chevy in the Hole soils, impoverished by a century of compaction, pollution, and capping. Organic matter is a critical ingredient in healthy soil, encouraging plant growth, helping to bind contaminants in place, and stimulating the soil microbe community necessary for remediation to occur.

Next, site managers will plant vegetation to clean up residual contamination and produce biofuel crops. The majority of the site will be covered with swaths of switchgrass (*Panicum virgatum*), given form and contrast by hedges of short rotation coppiced (SRC) willows (*Salix spp*.). These hedges follow and emphasize the existing landforms and topography on and around the Flint River floodplain in an undulating, agricultural pattern (Figure 5.31). After three years of establishment and initial maintenance, the perennial plants begin to be harvested for the production of ethanol. Switchgrass will be harvested annually in late winter, and willows will be harvested every two to three years, also in late winter.

Figure 5.31: This rice paddy has a very different plant palette than that proposed at Chevy in the Hole, but the pattern is similar in that it is characterized by relatively thin swaths following topographic contours (Yann Arthus Bertrand, 2007).

Switchgrass and coppiced willows are ideal crops for both phytoremediation of residual contaminants on this site. Both have deep roots that allow deeper remediation activity, and their capability to take up large amounts of water may serve as a barrier to lateral flow of contaminated groundwater. They require relatively little irrigation and fertilizer, and can thrive on marginal soils (DEFRA 2002; Brown et al 2000). Both plants have been found to accelerate the breakdown of complex industrial contaminants, and both have some ability to uptake metals (Chen et al 2003; Spriggs et al 2005; Kuzovkina et al 2004; Vervaeke et al 2003).

Biofuels

In addition to their cleanup capabilities, both plants are fast-growing and will produce large volumes of biomass usable in the production of ethanol. Iogen, the Canadian bioengineering company at the forefront of ethanol technology and the first commercial producer of cellulosic technology in the world, cites coppiced willow and switchgrass as two model plants for ethanol production (Erickson 2006). While ethanol from cellulose is not yet produced in large quantities, energy companies and governments are investing tens of millions of dollars in the industry and it appears poised to become a major part of the international fuel market in the next 5-10 years (Hesse 2007).

Researchers at MSU and elsewhere are already exploring the possibility of biofuel crop cultivation on brownfield sites (DePolo 2006).

While the site is not large enough to raise enough crops to produce a sizable profit, returning it to some level of productivity in concert with remediation could provide economic support for the cleanup. Also, as the problems of America's dependence on fossil fuels become widely acknowledged, government grant programs for biofuel production and research have been skyrocketing; attaching biofuels to Chevy in the Hole greatly expands the range of possible funding sources. Underlying these incentives is the basic principle that phytoremediation tends to be a lower cost approach to cleaning brownfield sites where it is practical, since using time and natural processes to break down contaminants is less costly than more intensive engineering practices.

Social benefits to the community include educational opportunities and a chance for Flint to act once again as a national leader, but the most immediate and tangible benefit will be improved views and quality of life around the site. By replacing visual blight with a green, semi-agricultural landscape, this design radically changes the context around the site from an atmosphere of dereliction to an atmosphere of curiosity and admiration. The plant materials change dramatically through the seasons, and the two species specified create a bold textural contrast to one another (Figures 5.32 and 5.33).

Figure 5.32. Harvesting switchgrass as a biomass energy crop in the Netherlands (http://www.switchgrass.nl/photo_gallery.htm).

Figure 5.33. Short rotation coppice willow fields for biomass energy production in the U.K. (www.relu-biomass.org.uk/Research.php).

There are four major categories of risk raised by this approach that must be considered. First is the increased risk of human exposure caused by removing the cap and allowing access to Chevy in the Hole. The risk is small in this scenario, given our assumption that the site will be cleaned to industrial standards through excavation and consolidation, and nobody will be living or working in the area with residual contamination. Ongoing, regular testing is needed to ensure that contamination does not surface in public access areas. Further, the design seeks to minimize the risk through the plant choice and clear visual cues to visitors. Both switchgrass and coppiced willow are sufficiently thick as to discourage trespassing—the plants themselves act as physical barriers to areas off the designated trail. To make the distinction between public and closed areas even clearer, a low fence will stand between the mown path buffers and the crop vegetation. Finally, park managers will coordinate with neighborhood groups to support park stewardship programs, keeping neighbors involved in the day-to-day safety practices.

The second risk is that of wildlife exposure to contaminants. Phytoremediation has the potential to create habitat in unsafe areas, which can cause hazards for animals and create a pathway for contaminants to leave a site (Rock 1997). The lack of plant diversity and the physical structure of these two particular plants lessen this risk. Grown in dense, virtual monocultures, switchgrass and willows are poor habitat for most wildlife. Also, although some uptake and accumulation of metals is likely, neither of these plant species is a hyperaccumulator, that is, a species that can incorporate unusually high levels of contaminant in its tissues. Since plant material will be harvested regularly, there will be no opportunity for contaminants to accumulate in aboveground plant parts.

Third, biomass harvested from a contaminated site has a higher probability of being contaminated itself, and it is undesirable to spread that contamination off-site through contaminated fuel or fuel byproducts. While this is a relatively new and untested field, several engineering solutions could likely filter contamination out of the material while it is being processed into ethanol (Semrau 2007). Even so, it is important to deal with byproducts in a way that acknowledges their potential contamination; byproducts should not be reused as additives for livestock feed or burned in biomass plants for example, but should be disposed of in regulated landfills.

Finally, plantings that will lead to dense vegetation for part of the year must be recognized for the potential threats they pose to public safety. If not maintained properly, a phytoremediation area along a trail system could invite criminal activity. This must be avoided through appropriate upkeep by MDNR, maximization of views onto the site from neighboring landuses, and regular patrolling by caretakers, as described above.

Recreation

In addition to the phytoremediation/biofuels concept outlined above, this design invites Flint residents and visitors to enjoy active recreation of various types around Chevy in the Hole. Along the south side of the site outdoor basketball courts and a new indoor recreational facility encourage activity and interaction between neighbors, while the new Michigan Museum of Industry and a canoe launch on Swartz Creek draw participation from residents and visitors alike. On the north side of the site, Kettering’s recreation fields open to the public to increase utilization, and are jointly managed with the park. The Round River Playground, a clean area perched above Chevy in the Hole, offers unique play opportunities and an excellent overlook of the phytoremediation area, drawing especially from the Third Avenue neighborhood and new residential development on GM’s former parking lots. The playground’s namesake water feature is based on a Paul Bunyan story used by Aldo Leopold as a metaphor for ecosystem cycles, and the playground itself draws on Flint's history for its spatial arrangement (Figure 5.34). Concentric circles of pine trees and hardwoods allude to early logging and woodworking, while play structures in the forms of wagon wheels and cogs refer to the Flint's manufacturing history.

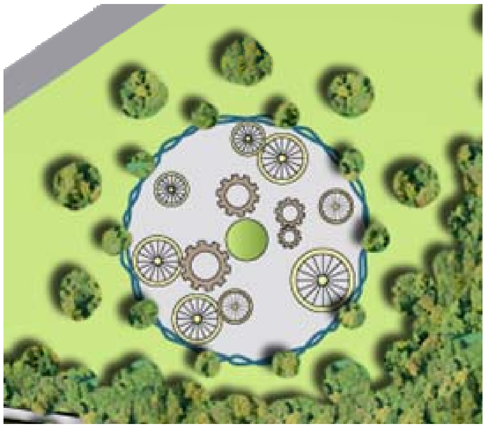


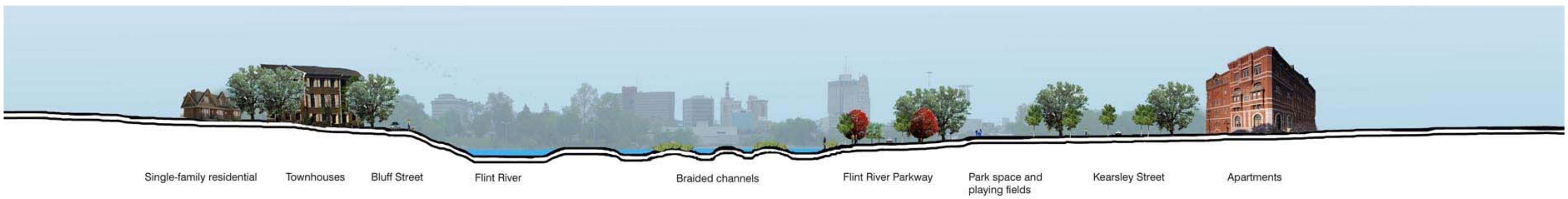
Figure 5.34: The Round River Playground alludes to ecological cycles and Flint's history.

Extending the Flint River Trail through the site to facilitate non-motorized transportation in Flint was repeatedly referenced by community members as an important first step for redevelopment. This expanded trail facilitates movement between neighborhoods and from neighborhoods to downtown, allowing increased options for pedestrians and bicyclists in Flint. Long views down the trail, together with the changing spacing of willow hedges will create visual interest. To enhance visibility for safety along the trail, a 10' buffer is mowed on either side.

Together, these Phase I interventions in the landscape at Chevy in the Hole begin the process of cleaning the site, improving quality of life, and providing new opportunities for recreation, engagement, and education. The bold design and integrated remediation strategy will draw attention from around the country and make Flint a leader among cities struggling with similar issues.

Flint River State Park: Phase II

Flint River State Park: Phase II



Phase II: State Park expansion- Ecological Restoration and Recreation Amenity

30 years after remediation processes began, the second phase of the Flint River State Park scenario steers the park in a new direction. With the incorporation of an innovative approach to remediation this park has become a unique example of the state's continued interest in ecological protection and management and innovative land use patterns, After the completion of the onsite phytoremediation, the site experiences dramatic changes to topography, circulation, and overall amenity, offering greater access and recreation throughout the site, as well as more substantial ecological enhancements along the whole of the Flint River. It makes sense to wait for these dramatic changes at Chevy in the Hole, in order to ensure that the remediation has made the site safe for recreation and restoration activities. The assumption is that the land has been cleaned to a point where residual contamination does not pose a large risk, but where continued testing is advised in order to ensure no unexpected dangers.

The second phase focuses on the concept of further development of the natural resources of the space through ecological restoration and the creation of amenity nodes, opening the state park in full to users, from both near and far. It continues to fulfill the mission of the Michigan Department of Natural Resources with its commitment to the "conservation, protection, management, use and enjoyment of the State's natural resources for current and future generations" (MDNR 2007). The three main gestures on the landscape that continue the process of opening up the site to users are: riparian restoration that naturalizes the whole of the river channel, the creation of public open space connections, and residential growth through further amenity.

Riparian Restoration

Figure 5.35: Riparian restoration along the Flint River

The switchgrass and coppiced willow elements of the widespread remediation efforts begun in Phase I remain in some areas on the western edge of the site, while most of this vegetation is removed, as well as the whole of the concrete channel, to make way for greater public access and the restoration of the Flint River floodplain. This dramatic landform change broadens the width of the river on the southern side, forming a braided channel with gravel hummocks, planted with lowland and emergent wetland species. (Figure 5.37) When the river experiences high flows, the water spreads throughout these braided channels, slowing down and dropping sediment. Over time the braided channels will evolve with the movement of the river, meandering and breaking as erosion and deposition occur in the naturalized channel. (NRCS 2001) (Figure 5.36)

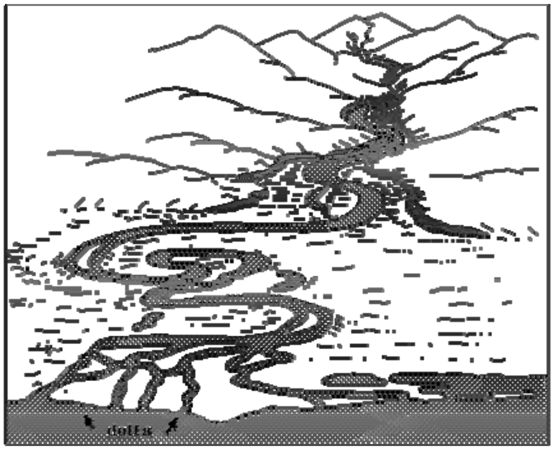


Figure 5.36: River valley with meandering and braided channel (http://www.geographyhigh.connectfree.co.uk/s3riversgeoghighlandforms.html)

The whole of the expanded floodplain area will be available to accommodate peak flows. Views of the braided river will be most dramatic from the new botanic garden conservatory on the northwestern bank of the river, and from the new bridge along Stevenson Street which spans the broadened floodplain.(Figure 5.37 and 5.38)

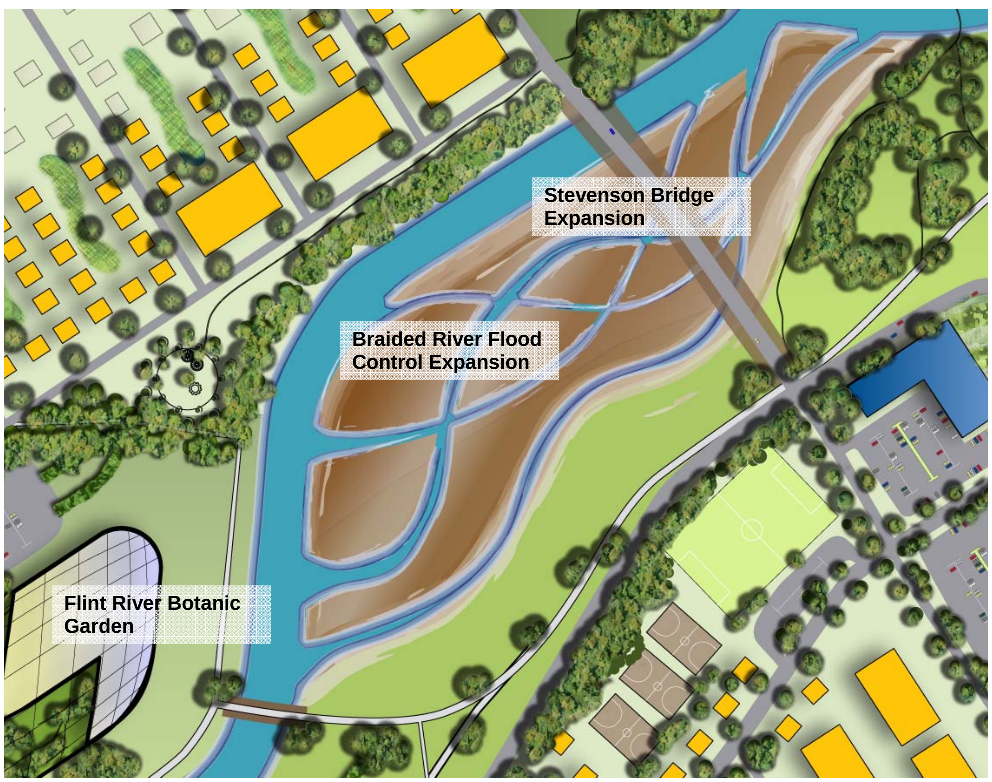


Figure 5.37: The braided channel floodplain can be seen from the park, parkway, the new botanic garden and the expanded Stevenson bridge, Jennifer Dowdell

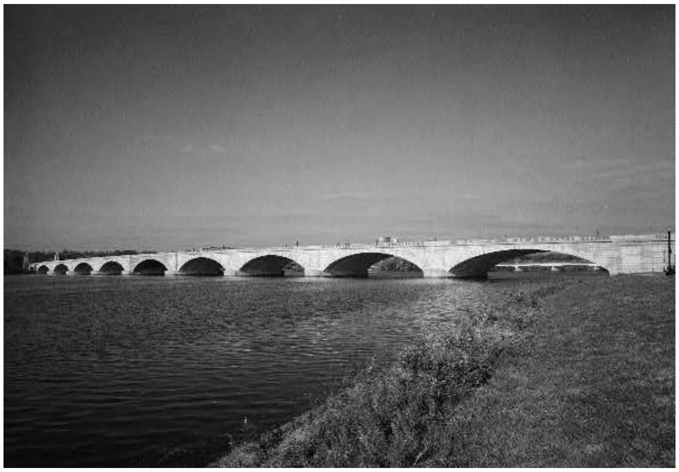


Figure 5.38: The new Stevenson Bridge will have a wide pedestrian friendly character, bridging the new development of the site with its old industrial past.: Predecent Image of Memorial Bridge over the Potomac River, Library of Congress, Historic American Buildings Survey (HABS) and the Historic American Engineering Record (HAER)

From the new Stevenson Bridge, if the visitor looks west toward downtown the recreated Moon Island will be in view. (Figure 5.39 a and b) An extension of the park area that was begun in the first phase, this natural feature acknowledges the historic landforms that provided for the creation of neighboring Atwood Stadium, by diverting some of the flows from Swartz Creek south through a channel that then links up with the river further to the west. The island forms a focal point for visitors to the stadium, as well as a place of respite for park users. Pedestrian bridges connect Atwood Stadium and the surrounding Third Avenue and Carriage Town communities to Moon Island, as well as the mainland of the state park on the southern side of the river. This offers much greater connections for recreation on both sides of the confluence of the river and Swartz Creek, making Atwood an integral part of the state park extensions into downtown.

Figure 5.39 a)The proposed re-creation of Moon Island as part of the new Flint River State Park (left), and b) the original Moon Island as noted in Nolen's plans for Flint at the turn of the last century, City of Flint, Genesee County, Michigan, 1920. Plan for City of Flint. John Nolen, city planner. Flint, Mich. : City Planning Board, 1920: from the Bentley Historic Library Collection, University of Michigan, Ann Arbor.(right)

On the eastern end of the site is the growing museum campus, including the Michigan Museum of Industry (established in Phase I) and a new natural history museum that abuts the Swartz Creek Nature Reserve.(Figure 5.40a) The nature reserve restores native riparian habitat along Swartz Creek and provides environmental education and research opportunities, and is managed jointly by MDNR and the US Fish and Wildlife Service. Besides providing workshops and classes for Flint residents, the Nature Reserve serves as an outdoor laboratory for the development and testing of a variety of innovative outdoor programs and research on habitat restoration (SNR online 2007). The nature reserve also provides an amenity for the neighboring Grand Traverse neighborhood on the eastern edge of Swartz Creek.

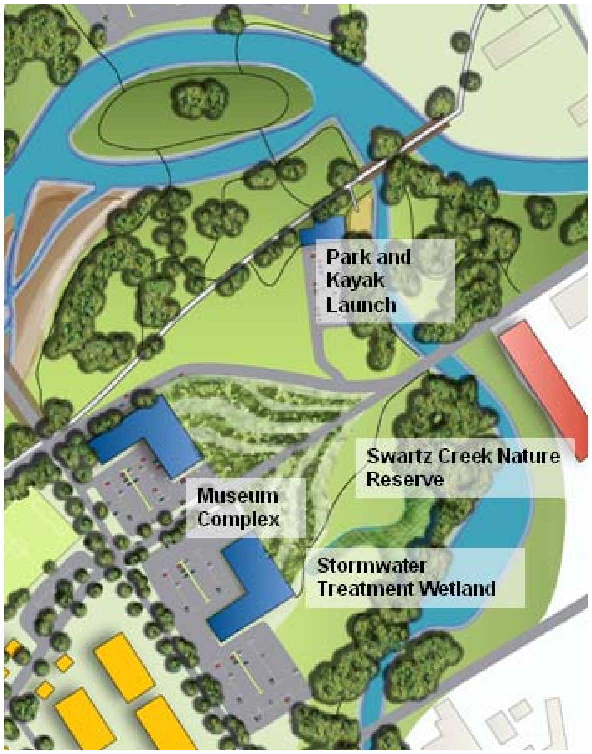


Figure 5.40 a)Design for the Swartz Nature Reserve and Museum complex, Jennifer Dowdell (left); b) Image of proposed swale and stormwater wetland system along Swartz Creek: *http://natl.ifas.ufl.edu/seepgall.html* *(right)*

At the interface between the natural history museum and the restored riparian edge of the creek, a new stormwater wetland and swale system that snakes down slope toward the creek infiltrates high stormwater flows before emptying into the creek. The low impact development landscape feature acts as an educational tool for various stormwater management practices being implemented across the area in Phase II. (Including new neighborhood stormwater swales in the residential areas both north and south of the river. Figure 5.40b)

Creation of Public Open Space Connections

Figure 5.41

The eastern end of Flint River State Park includes one of the entries to the new Flint River Parkway, a wide tree-lined spur of Kearsley Street that guides drivers coming from downtown into the heart of the park. The parkway creates a sense of wooded intimacy as one drives along the park's edge and takes in the views of the new bridge, the braided channel and the new Flint Botanic Garden and Conservatory on the southern boundary of Kettering University, across the river. (Figure 5.42)

.

Figure 5.42: The proposed character of the parkway drive, Precedent image of the Blue Ridge Parkway: http://www.wabweb.net/verkehr/bilder/usa/blueridge.htm

The Flint River Trail continues to move through the park connecting to the larger regional trails system, and building off of the abandoned rail lines that traverse the state park.(Figure 5.43) At time the trail runs alongside the new parkway while at other times it swings into the park offering greater access to different riverside recreation nodes, like Swartz Creek Nature Reserve, Moon Island, the Flint River Botanic Garden, and the playing fields dotting the park.

Figure 5.43: Biking on the proposed greenway that runs alongside the river and the parkway at different points in the Flint River State Park. Precedent photo: http://outdoortravels.com/biking_fl_overview_littleecontrail.html

As one continues westward along the parkway the remnants of the willow and switchgrass remediation appear in the form of swaths of wildflowers and prairie. Just east of Chevrolet Avenue on the southwestern edge of the park, at the site of the former factory #2, small stands of oak offer moments of repose as a memorial wall rises out of the ground, like the one pictured here by Andy Goldsworthy, to honor the individuals who participated in the historic UAW sit-down strike of 1936-37.(Figure 5.44 and 5.45) The memorial stands as a testament to the men and women who sacrificed their welfare for the good of the factory worker, a quiet space for reflection and observation affording long views across Chevy in the Hole. Remnants of the willow and switchgrass appear in this area as another reminder of the landscape legacy.

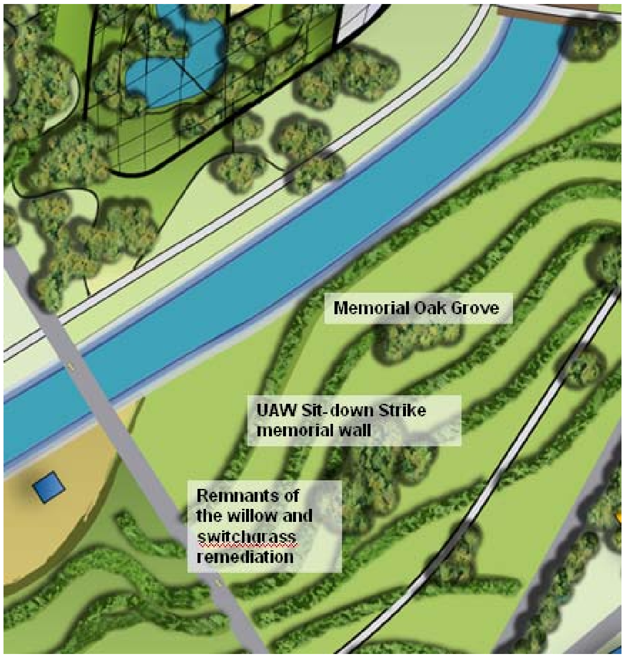


Figure 5.44: The UAW Sit-down strike memorial wall and oak grove at the southwestern edge of the state park.

Figure 5.45: Andy Goldsworthy precedent for the memorial wall, (© 2000 Andy Goldsworthy from *Wall* by Andy Goldsworthy, published by Harry N Abrams, 2005)

Residential Growth through Further Amenity

Figure 5.46

South of the state park single-family housing (approximately 97,600 s-f) fills in around the new recreation nodes established in the Museum complex, along the parkway, and the indoor recreation center located near Chevrolet Avenue. Three higher rise buildings with lofts and apartments overlooking both the Nature Reserve and the State Park are built at the western corner of Stevenson and Kearsley offering 97,200 s-f of new high-end to medium range residential. Within this steadily growing residential area a community garden area and new playing fields allow for further connectivity and recreation. In order to ensure no residual contamination effects and user safety the new community gardens are set in raised planters in an area that has open views into the park along the parkway to the north (Figure 5.47).

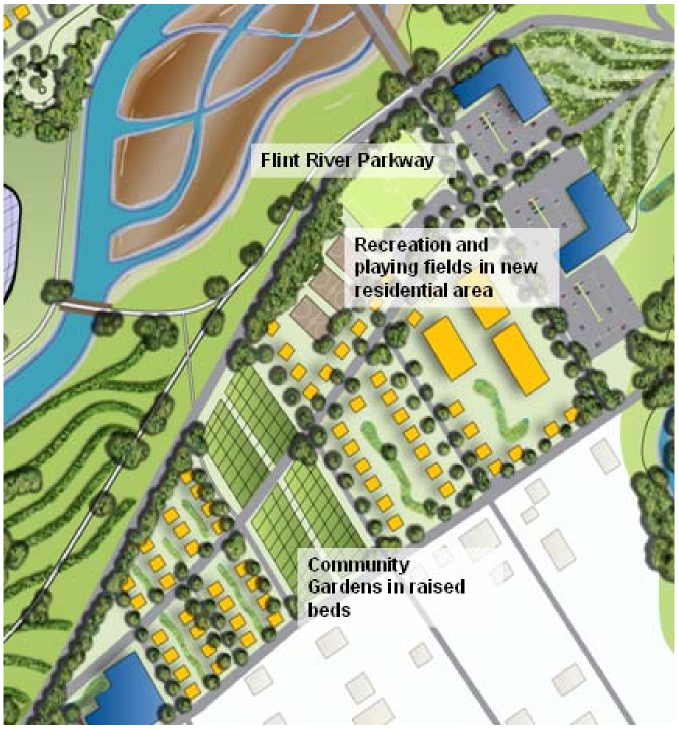


Figure 5.47: Along the parkway new residential housing starts to fill in. New community amenities include new playing fields and community gardens.

With the completion of the remediation in the greenhouse structure on the northern shore of the river the structure is modified to house the new Flint Botanic Garden, using the structure as a conservatory space for indoor exhibits. The conservatory overlooks the braided river channels and provides outdoor areas for eating and repose along the riverbank. (Figure 5.48 and Figure 5.49)

Figure 5.48: The Flint River Botanic Garden sits along the northern shore of the river, at the site of the Phase I remediation greenhouse.

Figure 5.49: Proposed character of the new botanic garden conservatory.

http://koti.phnet.fi/halsilk/pagenglish/museumofn_th.html

Just west of the Botanic Gardens is the Kettering University campus, overlooking the last amenity node of newly expanded Flint River State Park. Here at the crossing of the historic Chevrolet Avenue bridge, a beach and fishing pier have been created on the southern shore for residents to enjoy the natural flows of the river and the increased aquatic diversity (Figure 5.50). This serves as both an amenity for park users as well as a new recreation spot for Kettering students.

Figure 5.50: River's edge beach, Precedent image of Saginaw beach access, http://www.epa.gov/glnpo/aoc/sagrivr.html

As the western entry point to the park, Chevrolet Avenue retains much of the contour-enhancing vegetation forms of the remediation phase, creating directed views into and out of the site, and leading both to the beachfront access along the river to the west, and the braided channel to the east.

Through these two phases of the Flint River State Park scenario the site is renewed and revitalized as a strong ecological corridor and green spine for the city of Flint. It attracts visitors from the surrounding neighborhoods and from across the state and is a model for sustainable design and innovative brownfield redevelopment.

Appendix 1: Funding Brownfield Redevelopment

Former industrial sites present serious challenges, but they also provide new opportunities. Among the opportunities are the possibility of innovation in design, new development and increased economic activity in the affected neighborhood or region. A common misconception is that brownfield redevelopment is not economically feasible, when the truth is that there are a multitude of funding and partnership programs, addressing brownfield redevelopment directly and through other programs that consider wider issues of urban growth, small business promotion, and ecological restoration or rehabilitation. Even something as seemingly disconnected as transportation funding may offer some financial incentive for a brownfield redevelopment site, if infrastructure improvements are part of redevelopment plans.

Michigan is recognized as a national leader in its support of brownfield redevelopment, identified for "recognizing the need to provide legislation, guidance, education, and financial incentives" (CRDC 1998). The Brownfield Redevelopment and Financing Act, first enacted in the nineties in order to establish brownfield redevelopment financing authorities, to facilitate the implementation of brownfield redevelopment and revitalization plans, along with liability reform and cost reductions that have been implemented as law in subsequent years, positioned Michigan as one of the leading states in redevelopment and remediation of former industrial and other contaminated or polluted site. Success was seen almost immediately, with the MDEQ reporting that there had been 2,300 jobs created and $221 million in private investment in brownfield redevelopment initiatives in the first year of the program (Davis 2002). The Michigan Department of Environment now reports that in total, the program has awarded $121 million in grants, leveraging $2.4 billion in private investment, and spurring the creation of over 10,000 jobs (MDEQ 2007).

Under Michigan's law, municipalities establish brownfield redevelopment authorities in order to facilitate local brownfield redevelopment through a series of options: reimbursing or paying parties for activities including environmental cleanup and infrastructure improvements; leasing, purchasing or conveying property; accepting grants, loans from sources of interest; investing the authority's funds in eligible activities and/ or borrowing money; acquiring insurance; and establishing revolving funds for local remediation and redevelopment activities (Davis 2002).

The Northeast Midwest Institute's report on the financing of brownfields was used as the framework to summarize the financing options suggested below, starting with the broad federal funding incentives that are available and working down to the local (NEMW 2003). Other important sources were used to fill in information gaps or add other programs that have been used in contemporary redevelopment precedents. See source list in the associated table for more information on the programs mentioned below.

Federal Funding Opportunities

The U.S. Environmental Protection Agency, in Michigan's case EPA Region V, awards site assessment grants, site cleanup grants, as well as revolving loan funds to establish locally administered loans for brownfield remediation and cleanup and further loans toward mitigation to prevent water quality problems. Partnered with the EPA, the Economic Development Agency also offers grants through their **Public Works and Economic Development program** to cover costs of contamination cleanup, including Underground Storage Tanks, asbestos, PCBs, and lead paint, with a focus on communities experiencing long term economic deterioration and infrastructure enhancements for industry and commerce. This program could be of particular value for the Chevy in the Hole site, as one that focuses on remediation of contamination in a city that has faced long term economic hardships.

The U.S. Dept of Housing and Urban Development (HUD) awards grants to finance site preparation and infrastructural improvements in a way that allows a municipality or community to tap the resource on an interim basis; as well as financing site clearance, property acquisition, and rehabilitation, activities that are often too large for single year grant funding; and awarding funding for partnerships with non-profits for support of rehabilitation and redevelopment activities that directly affect affordable housing or assistance to low-income households. HUD's **Brownfields Economic and Development Initiative (BEDI)** is especially designed to assist cities like Flint with redevelopment of brownfields, where expansion and redevelopment might be burdened by environmental contamination.

The U.S. Army Corps of Engineers (USACE) awards grants for projects that can be tied to water quality under related authorities that cover civil works and water resources, assisting with site assessment, environment studies, redevelopment planning and comprehensive plans for conservation of water and land resources, and oversight for cleanup activities. In the case of Chevy in the Hole, because the channelized part of the Flint River, which flows through the site, was initially built by the USACE any work on the channel or any proposal to remove the channel might involve them. In that case the **Continuing Authority Programs** would offer some funding opportunities.

The U.S. Department of Transportation (DOT) programs may provide funding if a brownfield redevelopment plan is related to transportation enhancements and facilities, by expanding access via added transit measures, or by controlling exposure to pollutants through transportation structures or infrastructure. Since all of the futures suggested in this project suggest some circulation and road changes the DOT would be an appropriate funding source. The National Oceanic and Atmospheric Agency (NOAA), an agency of the U.S. Department of Commerce, like the DOT has partnering programs with local or national associations that may provide funding for a brownfield redevelopment project that includes small-scale locally driven habitat restoration projects which support natural resource stewardship in the community. NOAA's **Community Based Restoration Program** would be an ideal funding source for the proposed riparian restoration programs along the Flint River.

Also the **Federal Tax Code** allows taxpayers to deduct cleanup costs in the year they incur them and allow for tax credits when a brownfield project includes affordable housing. These could be considered once ownership and development proposals have been finalized, and would be of great incentive for further development of the site.

State and Local Funding

The Michigan Economic Development Corporation (MEDC) has a series of programs that can be applied to brownfields. The most fitting program might be the **Neighborhood Enterprise Zone**, under our suggested program of development, which provides a tax incentive for the development and rehabilitation of residential housing. The Michigan Department of Environmental Quality (MDEQ) has a series of programs that can be applied to brownfields, including the **Michigan Brownfield Grant and Loan Program,** which funds brownfield remediation and cleanup, and often targets projects that promote economic development of brownfield properties, and a **Michigan Coastal Management Program** which might offer some incentive for restoration of the Flint River, part of the Saginaw River Watershed emptying into Lake Huron.

The Michigan program that is of particular importance for Flint is the **Tax Increment Financing program,** which is a program that is being implemented at the state or local level in areas all over the country. **Tax Increment Financing (TIF)** uses the annual increment of tax generated between the property before improvement and the property after it has been rehabilitated/remediated/improved to finance a portion of the eligible cleanup costs. The authority to use TIF is delegated to municipal governments by state-enabling legislation. Some states supplement TIF revenues with sales tax, although that has been controversial in some places. Nearly half of the state TIF legislation requires documentation that "but for" the use of TIF the project would not be feasible. Traditionally the purpose of TIF was to eliminate blight. The taxes of the entire inventory (in GCLB case) of redeveloped tax-foreclosed properties are cross-collateralized to support the cleanup of tax-foreclosed property- tax captured from more valuable property goes to support improvement on all properties. (MDEQ: Michigan Tax Increment Financing)

Funding Information Sources

The U.S. Environmental Protection Agency, www.epa.gov/
EPA Region V
General EPA resource: Brownfields Federal Programs Guide
Programs:
Site Assessment Grants
Site Clean-up Grants
Brownfield Cleanup Revolving Loan Fund
Clean Water State Revolving Loan Fund
Public Works and Economic Development Program (EDA Partnership)
The Economic Adjustment Program and Planning Program (EDA)

U.S. Dept of Housing and Urban Development, www.hud.gov/
Community Development Block Grants, Entitlement Community Grants**,** Michigan Economic Development Corporation
HUD, Brownfield Economic Development Initiative (BEDI)
HUD Home Investment Partnerships
Low Income Housing Tax Credits

U.S. Army Corps of Engineers, www.usace.army.mil/,
General information available in: Northwest Midwest Institute Corps Report & US Army Corps of Engineers
Continuing Authorities Program
Support for Others Program
Planning Assistance to States Program (capped at $500,000 per state, manly funds studies)
General Investigations Studies and Projects (requires special authorization by congress)

U.S. Department of Transportation, www.fhwa.dot.gov/,
Federal Highways and the Environment
Federal Highways and Brownfields

National Oceanic and Atmospheric Agency (agency of the U.S. Department of Commerce), www.nmfs.noaa.gov/
NOAA Community Based Restoration Program (CRP)

Federal Tax Code programs
Brownfield Tax Expensing Incentive from the Council of Development Finance Agencies

State & Local : Citizens Research Council of Michigan - Brownfields Information

Michigan Brownfield Redevelopment Authority: Link

Michigan Economic Development Corporation (MEDC)
http://www.michigan.org/medc/ has a series of programs that can be applied to brownfields MEDC Brownfields,
Michigan Brownfield Authority Single Business Tax Credit
Industrial Property Tax Abatement
Michigan Brownfields Single Business Tax Credits, Michigan Land Use Institute - Tax Credits Information
Michigan Business Improvement Districts
Michigan Neighborhood Enterprise Zone
Obsolete Property Rehabilitation Act
Urban Land Assembly Program (ULA)

Michigan Department of Environmental Quality (MDEQ), www.deq.state.mi.us/, has a series of programs that can be applied to brownfields,

Michigan Brownfield Grant and Loan Program
Michigan Brownfield Assessment Grants
Michigan Coastal Management Program

Flint
Genesee County Brownfield Redevelopment Plan:
The Land Bank, www.thelandbank.org

Appendix 2: Stormwater Management on Brownfield Sites

In the past twenty years, a variety of new stormwater management strategies to minimize the negative ecological impacts of rain in developed landscapes have generated substantial benefits for water quality. While traditional engineering relying on underground piping is effective at handling local drainage, it results in many downstream problems: nonpoint-source pollution, flooding, excessive erosion and sedimentation, elevated water temperatures, and decreased baseflows (Hinman 2005). In contrast, Low Impact Development stormwater management (LID), an increasingly popular approach that encourages filtration, infiltration, and detention, is better able to mitigate many of the stormwater impacts of development. It has also rapidly gained political acceptance, because it can offer a less expensive alternative to costly underground infrastructure. Both LID and brownfield redevelopment suggest great potential to increase sustainability in urban areas, but without careful consideration, the intersection of these two fields may potentially increase environmental hazards.

LID uses soil and plants to clean and detain stormwater. This is an effective strategy on a wide range of sites, but it becomes more complicated when contaminants from industrial uses are present. On brownfield sites, encouraging interaction between relatively clean stormwater and contaminated soil of contaminated groundwater can cause leaching of contaminants to groundwater, erosion of contaminated sediments, and lateral movement of contamination onto neighboring properties. In planners' and designers' enthusiasm to utilize LID, it is crucial that they avoid situations that could spread contamination from brownfield sites.

With some modifications however, many LID applications can be used on brownfield sites to gain most of LID's benefits while significantly decreasing risks. In this appendix, we outline general guidelines for responsible LID on brownfields, and examine how these principles might apply to brownfield redevelopment in Flint.

Guideline #1: Differentiate between contaminants as a way to better minimize risks.

In all stages of brownfield cleanup and redevelopment, it is crucial to think about the specific characteristics of whatever contaminants might be found on site; stormwater management is no exception. Contaminants typically found on industrial brownfield sites include VOCs, PAHs, heavy metals, and other metalloids. Within and between these groups, there is considerable variation in terms of compounds' solubility, volatility, soil binding strength, and degradation rates. For example, VOCs tend to dissolve readily in water, while metals are often relatively immobile once in the soil. This means that you might prioritize concerns about infiltration in areas with benzene contamination differently than you would in areas with a stable form of lead. Simply, this guideline suggests that you categorize all the properties of on-site contaminants that might relate to stormwater and use that information to guide stormwater planning.

Guideline #2: Keep clean stormwater separate from contaminated soils and water to prevent leaching and/or spread of contaminants.

As discussed above, this is the central risk of LID on brownfield sites. Careful placement of parking lots and other impervious surfaces can reinforce cap function. Also, modification of standard LID practices such as bioswales and flow-through planters can allow filtration and detention of stormwater while preventing infiltration into contaminated soils (Figures A.1 and A.2).

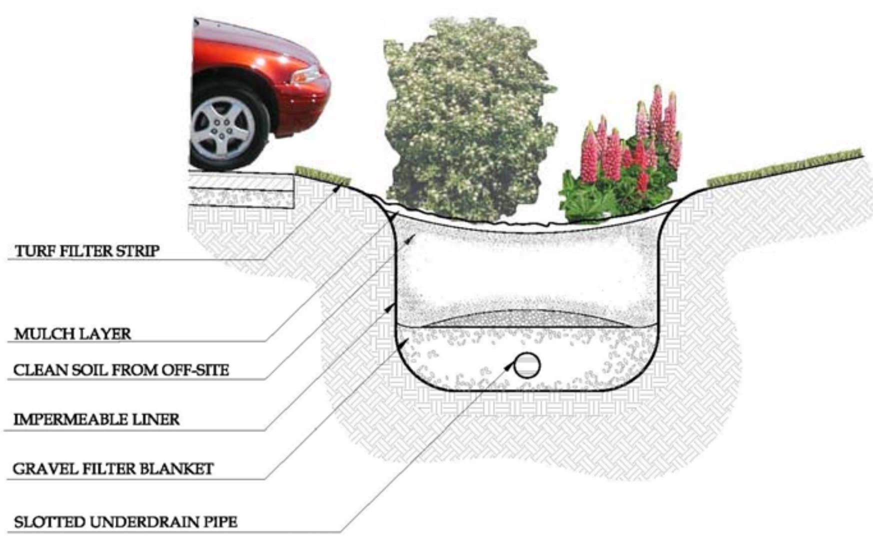


Figure A.1: Filtration swale. Much like a standard infiltration swale, a filtration swale uses plants, soil organic matter, and well-drained soil to remove pollutants from stormwater and slow its movement off site. The key differences are that an underdrain is installed and the filtration swale is lined with an impermeable liner.

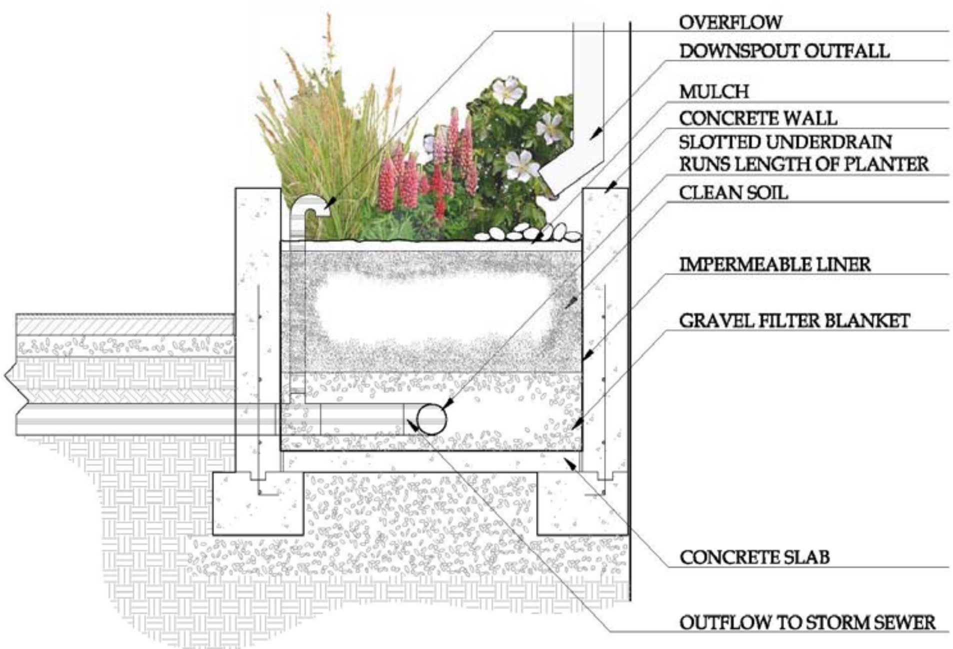


Figure A.2: Flow-through planter. Used to slow and filter roof runoff, flow-through planters such as this are increasingly used for stormwater management in dense urban areas (City of Portland 2004). Like the filtration swale, the planter features an underdrain, and does not allow movement into surrounding soils.

Finally, Guideline #2 suggests an approach that often seems counterintuitive for LID practitioners: if you are low in the watershed and detention time is less crucial for downstream hydrology, the most responsible way to handle stormwater on a contaminated site may be to use conventional engineering to get it to the receiving body of water with as little interaction with the site as possible.

Guideline 3: Prevent soil erosion.

While this is important in all construction projects and ongoing land management regimes, it becomes even more so when contaminants are bound to site soils. Erosion can be reduced or stopped via appropriate vegetative or structural practices. Careful placement of planting strips as well as strategic manipulation of water movement away from hot spot areas can reduce the risks of spreading contamination through sediments.

Guideline 4: All new development on and around the brownfield site should include measures to minimize runoff.

Runoff coming onto a brownfield from new development or from existing neighborhoods around the site can be reduced through numerous measures, including green roofs, vegetated walls, tree retention or installation, or rainwater cisterns. All of these steps decrease the complications involved with handling stormwater on the brownfield itself.

Guideline 5: Plan for the possibility of residual contamination after remediation.

Remediated brownfield sites are often deemed to be "clean," and stormwater planning is likely to proceed accordingly. Unfortunately, sites thought to be clean frequently have new contamination appear at later times, or are found to be unsafe under stricter future standards. Consequently, we recommend a precautionary approach to design that accommodates the potential for residual contamination.

LID at Chevy in the Hole

As described in detail in Chapter 2, there is good reason to expect significant contamination in the soils and groundwater of Chevy in the Hole, although the specific types and locations are not yet known. For this reason, we feel that our general guidelines for LID on brownfields are highly relevant to the site's redevelopment, whatever approach Flint decides to take. Here, we outline a series of specific recommendations, each of which appears in some form in our proposed futures.

First, new development minimizes runoff through green roofs, rainwater harvesting, and similar measures, and that neighborhoods on either side of the site are retrofitted with LID practices. All LID applications in upslope areas should feature underdrain systems to avoid increasing groundwater flow through the site. These steps will minimize the potential movement of contaminants by decreasing surface flow on the site and groundwater flow through contaminated soils and groundwater (Figure A.3). This approach is applied throughout both scenarios and all futures.

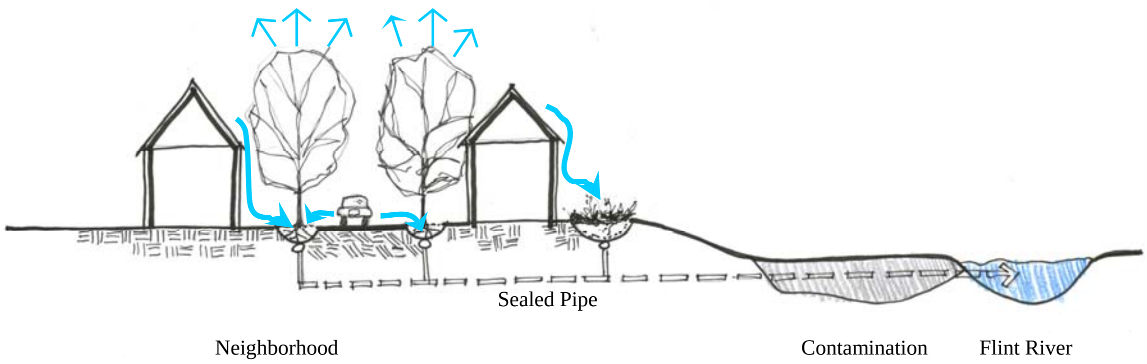


Figure A.3: Street trees, swales, and rainwater gardens collect, filter, and dissipate rainwater, minimizing flow surface and groundwater flow onto the site. An overflow pipe drains directly to the Flint River.

Second, contaminated groundwater from the site should be prevented from directly entering the Flint River. Keeping some form of impermeable channel may be advisable as long as contamination persists (Figure A.4). Although channels have weep holes that allow some movement of groundwater, they will reduce the inflow. By forcing groundwater to move farther downstream before entering the river, time for natural attenuation is increased. This recommendation is illustrated in both stages of Scenario I and the first stage of Scenario II.

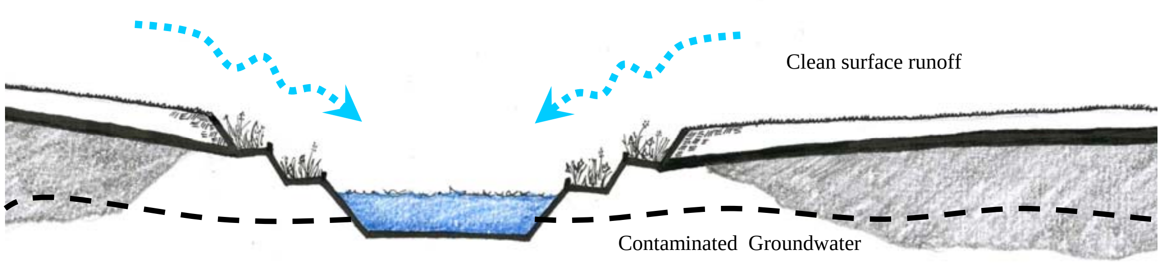


Figure A.4: A redesigned concrete channel, kept in place to prevent groundwater flow into the Flint River. Relatively clean runoff from cap surface is filtered through planting terraces before it is flows into the river.

Third, areas that require extensive capping should be designed to include some pockets of deeper cover fill (Figure A.5). These areas can be designed to allow short-term infiltration and detention, allowing a greater density of plants and roots, which will improve filtering and evapotransporation. An adequately engineered underdrain is essential to prevent standing water on the cap, which could shorten the cap's lifespan. This approach can be seen in both phases of Scenario I, in the large capped areas.

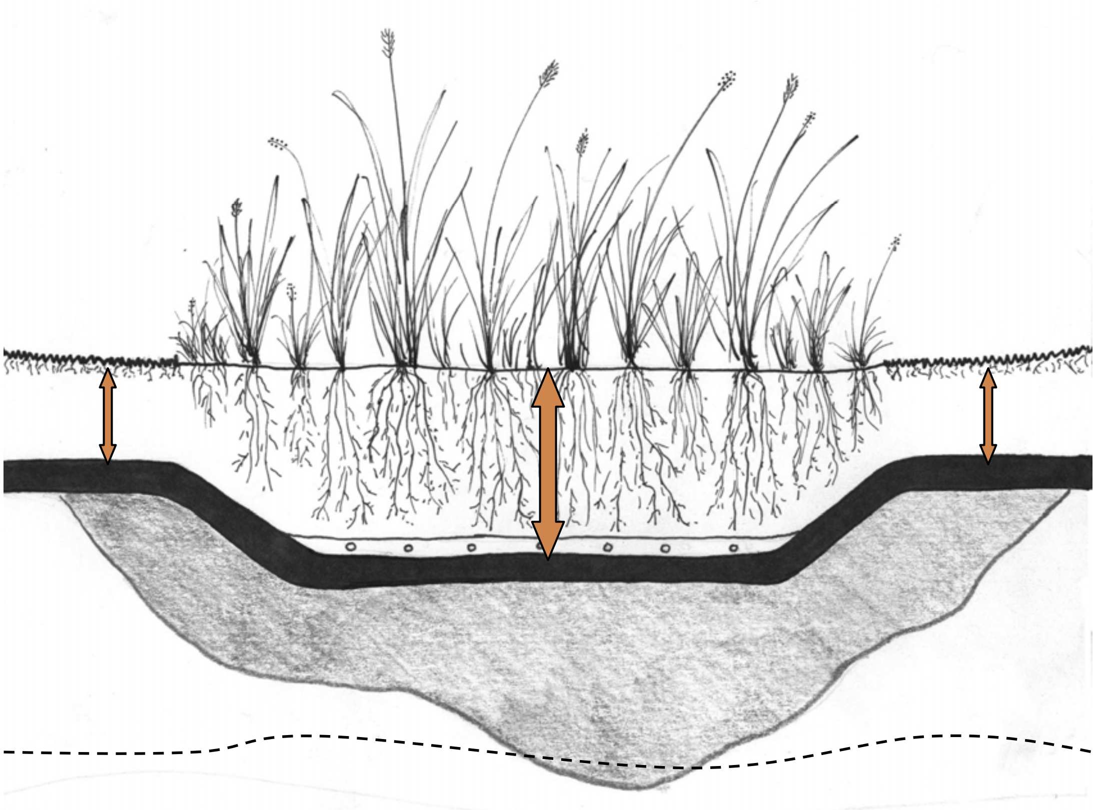


Figure A.5: An area of deeper, clean fill allows more flexibility for planting and stormwater management over a cap. Note the drainage layer between the fill and the cap.

Next, it is important to control surface runoff in phytoremediation areas. For successful remediation, phytoremediation plants need sufficient water to grow, but excess water that moves below the root zone and into groundwater should be discouraged. This strategy can be realized through careful grading and/or the strategic use of structural elements (Figure A.6). Similar to the first recommendation, the basic concept is that the amount of water moving through contaminated soils should be reduced as much as possible. This approach would be important in the realization of Scenario II, Phase I.

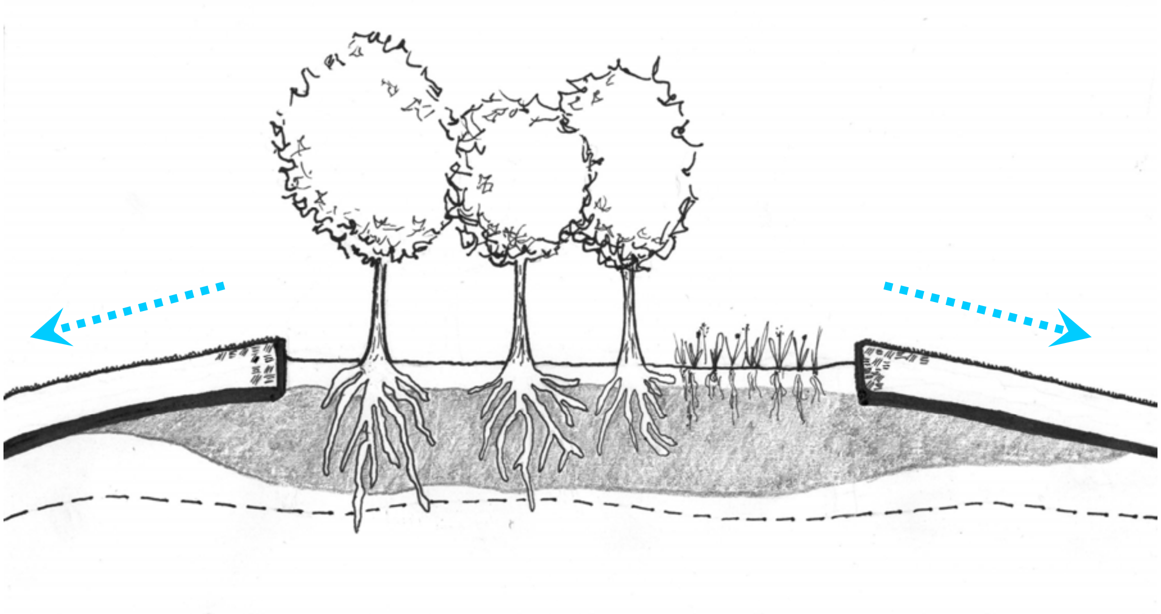


Figure A.6: Phytoremediation areas should be designed in such a way that they allow plants meet their water requirements while minimizing additional infiltration.

Finally, impervious surfaces such as roads, parking lots, and buildings should be strategically placed where they can reinforce cap function by preventing infiltration over hotspots. Roads and parking may be more flexible than buildings for this approach, since they can be placed over areas with potential off-gassing, while buildings should only be used over areas with very stable soil contamination. This approach is an important part of Scenario I's remediation plan.

Together, these guidelines and strategies offer several important ways to minimize the spread of contaminants from Chevy in the Hole and similar sites through the use of thoughtful stormwater management. At the same time, many of these recommendations allow for improved water quality through filtration and detention of stormwater. LID offers many useful tools for planners and designers, but as with any new technology, the context in which it is used must be carefully considered.

References

Alaimo, K. and D. Hassler, eds. 2003. From Seeds to Stories: The community garden storytelling project of Flint. Flint Urban Gardening and Land Use Corporation, Flint, Michigan.

A. Nelessen Associates. 1999. Milwaukee Downtown Plan. City of Milwaukee. <http://www.mkedcd.org/planning/plans/downtown/pdfs/DPPart1Introduction.pdf> accessed November 27, 2006.

American Public Works Association (APWA). 2005. "Ford Allen Park Clay Mine Landfill – Fairland Green Redevelopment". Reporter Online. June 2005. <http://www.apwa.net/Publications/Reporter/ReporterOnline/index.asp?DISPLAY=ISSUE&ISSUE_DATE=062005&ARTICLE_NUMBER=1060> accessed on November 22, 2006.

American Seating. <http://www.americanseating.com/newsArticle.aspx?ID=177> accessed April 2007.

Baird, T.C. 2002. Sacred Ground: Must sustainable landscapes mimic the form and spatial organization of nature? *In* M.E. Deming, editor. Selected conference papers, Annual Meeting of the Council of Educators in Landscape Architecture, September 25-28, 2002. Syracuse, New York.

Baulch, V.M. and P. Zacharias. 2007. The historic 1936-37 Flint auto plant strikes. The Detroit News Rearview Mirror online. <http://info.detnews.com/history/story/index.cfm?id=115&category=business> accessed April 16, 2007.

Beckley, R.M., Executive Vice President, Genesee Institute. Personal communication, September 6, 2006.

Beckley, R.M. 2005. Flint Michigan and the cowboy economy, deconstructing Flint. Portico **3**: 14-16.

Blasland, Bouck and Lee, Inc (BBL). 2000. Corrective action plan year 2, annual report. Former Building 2A Delphi-Flint West facility. Flint, Michigan.

Blois, J.T. 1839. Gazetteer of the State of Michigan. S.L. Rood & Co., Detroit, Michigan.

Boyer, E.L. and D.L. Mitgang. 1996. Building community: a new future for architectural education and practice. The Carnegie Foundation for the Advancement of Teaching, Princeton, New Jersey.

Bryant, C. J. Ippel, R. Murphy. J. Wu, A. Zettel, J. Zimmer, B. Zwagerman, A. Zwas, 2005. Creating a neighborhood of choice: a neighborhood plan for Grand Traverse.

University of Michigan, Urban and Regional Planning, Ann Arbor, Michigan.

Brynolson, Grace. 1977. Gasworks (ugh!) reborn as city park. Smithsonian, **8:**116-118.

Cantor, S.L. 1997. Innovative design solutions in landscape architecture. Van Nostrand Reinhold. New York, New York.

Carman, E. 2001. From laboratory to landscape: a case history and possible future directions for phyto-enhanced soil bioremediation. Pages 43-50 *in* N. Kirkwood, ed. Manufactured sites: rethinking the post-industrial landscape. Spoon Press, New York, New York.

Carpenter, S. R., P. L. Pingali, E. M. Bennett, and M. B. Zurek, editors. 2005. Ecosystems and human well-being. **Volume 2**. Scenarios. Island Press, Washington, D.C.

Chicago Center for Green Technology (CCGT). 2006. Department of Environment, City of Chicago. <http://egov.cityofchicago.org/city/webportal/portalEntityHomeAction.do?entityName=Chicago+Center+for+Green+Technology&entityNameEnumValue=161&Failed_Reason=Session+not+found&com.broadvision.session.new=Yes&Failed_Page=%2fwebportal%2fportalEntityHomeAction.do%3E accessed on November 22, 2006.

Chicago Center for Green Technology Poster. 2003. <http://egov.cityofchicago.org/webportal/COCWebPortal/COC_ATTACH/CCGTGreenbuildPoster.pdf> accessed on Novemer 22, 2006.

Cichon, E.J. 2002. Remediation strategies for brownfield development. *in* Brownfields: a Comprehensive guide to Redeveloping Contaminated Property. T.S. Davis, ed. American Bar Association, Chicago, Illinois. Pages 348-349.

City of Flint. 2005. City of Flint, Parks and Recreation, Parks Summary. <www.cityofflint.com/parks/parks_summary.asp> accessed March 23, 2007.

City of Portland, 2004. City of Portland stormwater management manual. <http://www.portlandonline.com/bes/index.cfm?c=35122> accessed October 15, 2005.

City of St. Paul 2007a. Phalen Corridor Initiative Online, <http://www.stpaul.gov/depts/ped/pci/wetland.htm> accessed April 16, 2007.

City of St. Paul 2007b, Phalen Village Small Area Plan, <http://www.stpaul.gov/depts/ped/pci/phalen_sap.html#background> accessed April 16, 2007.

Comer, P.J. and D.A. Albert. 1997. Vegetation circa 1800 of Genesee County, Michigan: an interpretation of the general land office surveys 1816-1856. Michigan Natural Features Inventory. Lansing, Michigan.

Consumer Renaissance Development Corporation (CRDC). 1998. National Comparative Analysis of Brownfield Redevelopment Programs. October 1998.

Dandaneau, S. P. 1996. A town abandoned: Flint, Michigan confronts deindustrialization. State University of New York Press, Albany, New York.

Davis, Todd S. 2002. Brownfields: A Comprehensive Guide to redevelopment Contaminated Property, 2nd edition. A publication of the Section of Environment, Energy, and Resources, American Bar Association. Chicago, Illinois.

Dowdell, J. A., H. Fraker and J.I. Nassauer. 2005. Replacing a Shopping Center with an Ecological Neighborhood. Places Journal- A forum for design in the public realm, University of California Berkeley, <http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1935&context=ced/places> accessed April 16, 2007.

Elliott, D. Estate Manager, Applewood Estate, Ruth Mott Foundation. Presentation for University of Michigan Landscape Ecology Studio. March 9, 2007.

The Emerald Necklace Conservatory, 2007. <http://www.emeraldnecklace.org/index.cgi> accessed April 14, 2007.

Engle, P. Director of Physical Plant, Kettering University. Personal communication, November 21, 2006.

Environmental Consulting & Technology, Inc. 1995. Closure report USTs 16 & 17. Delphi Energy and Engin Management Systems, Inc. ECT Project No: 91-123-0705.

Environmental Protection Agency (EPA). An introduction to indoor air quality: organic gases (volatile organic compounds –VOCs). <http://www.epa.gov/iaq/voc.html> accessed on March 24, 2007.

Environmental Protection Agency (EPA). 2005. Road map to understanding innovative technology options for brownfields investigation and cleanup, fourth edition. Office of Solid Waste and Emergency Response and Office of Superfund Remediation and Technology Innovation. EPA-524-B-001. Washington, DC.

Environmental Science and Engineering, Inc. 1992. Type B closure report Building 37 Underground Storage Tank Nos. 3,4,5,6 and A. AC Rochester Flint West Flint, MI. ESE No. 590-0872.

Federal Remediation Technologies Roundtable. U.S. Army Environmental Center report SFIM-AEC_ET_CR_97053. <http://www.frtr.gov/matrix2/top_page.html> accessed October 12, 2006.

Finkbeiner, Pettis & Strout, Inc. 2002. Portage River hydrologic study. <http://www.tmacog.org/Environment/portage%20hydro%20study%201.pdf> accessed March 30, 2006.

Flint Public Library. 2006. Flint timeline project. <www.flint.lib.mi.us/timeline/> accessed March 17, 2007.

Flint River Watershed Coalition. 2006. The Flint River watershed. <www.flintriver.org/watershed.htm> accessed March 28, 2006.

Ford Motor Company. 2005. Ford Announces New Green Retail Development in Allen Park". August 8, 2005. <http://media.ford.com/newsroom/feature_display.cfm?release=21279> accessed on November 21, 2006.

Ford Motor Company, Sustainability Report 2005-2006. <www.ford.com/en/company/about/sustainability/2005-2006/envRebiewBuildingsLEED.htm> accessed on 11/22/2006.

Fry, G.L.A. 2001. Multifunctional landscapes: towards transdisciplinary research. Landscape and Urban Planning **57**: 159- 168.

Geltman, E.G., 2000. Recycling land: understanding the legal landscape of brownfield development. University of Michigan Press, Ann Arbor, Michigan.

General Motors. 2007. Corporate history. <www.gm.com/company/corp_info/history/> accessed March 16, 2007.

Genesee County Historical Society. 2004. Postcard history series: Flint 1890-1960. Arcadia Publishing, Chicago, Illinois.

Genesee County Land Bank. 2004. About us/planning and development. <www.thelandbank.org> accessed March 17, 2007.

Ghitis, Eliza. 2006. People for Puget Sound habitat restoration coordinator, phone interview, November 8, 2006.

Tradeline 2005. Global Innovation Center. Wm Wrigley Jr. Company.in Tradeline Online Journal. <http://www.tradelineinc.com/content/07A239A0-2B3B-B525-8D37BBC2EFC37655/display/a20svf/0#story> accessed April 2007.

Greer, F. Principal, G.A.V. and Associates. Personal communication, March 9, 2006.

Gressel J. and H. Al-Ahmad. 2005. Assessing and managing biological risks of plants used for bioredemidation, including risks of transgene flow. Zeitschrift Fur Naturforschung **60c**:154-165.

Gross, M. and E.Y. Do. 1997. The design studio approach: learning design in architecture education. *In* Design Education Workshop , J. Kolodner & M. Guzdial (eds.). EduTech/NSF, College of Computing, Georgia Institute of Technology, September 8-9, 1997, Atlanta, GA., <http://depts.washington.edu/dmgftp/publications/pdfs/edutech97-eyd.pdf> accessed online March 15, 2007.

Gunnell, J., Editor. 1987. The standard catalog of American cars 1946-1975. Kraus Publications, Iola, Wisconsin.

Hinman, C. 2005. Low Impact Development: Technical Guidance Manual for Puget Sound. Puget Sound Action Team, Washington State University Pierce County Extension. <http://www.psat.wa.gov/Publications/LID_tech_manual05/lid_index.htm> accessed August 21, 2005.

Hoobyar, Paul. 2002. Daylighting and Restoring Streams in Rural Community City Centers: Case Studies. Rivers, Trails and Conservation Assistance Program, National Park Service. Seattle, Washington.

Hellmuth, Obata & Kassabaum (HOK). 2007. <http://www.hokchicago.com/news/current/a2c23781-82cb-4c06-acfd-b30ca4f926a7.htm> accessed April 2007.

Hu, H. 2002. Human health and heavy metals exposure. *In* Michael McCally, Ed. Life support: the environment and human health. MIT press, Boston, Massachusetts.

Hulse, D., J. Eilers, K. Freemark, C. Hummon, and D. White. 2001. "Planning alternative future landscapes in Oregon: evaluating effects on water quality and biodiversity." Landscape Journal **19(1/2):** 1-20.

Hulse, D. W., S. V. Gregory, and J. P. Baker. editors. 2002. Willamette River basin: trajectories of environmental and ecological change. Oregon State University Press, Corvallis, Oregon, USA.

Ith, Ian. 2004. Superfund dredging spreads Duwamish River pollution. Seattle Times, Thursday, June 10, 2004. Seattle, Washington.

Kettering University. 2006. News and information from Kettering. <www.kettering.edu/visitors/storydetail.jsp?storynum=474> accessed March 24, 2007.

King, R.J. July 28, 2005. Allen Park project adopts green approach. The Detroit News. < http://www.detnews.com/2005/business/0507/28/C01-261989.htm> accessed April 16, 2007.

Leonardi, J.M., and W.J. Gruhn. 2001. Flint River assessment. Michigan Department of Natural Resources, Fisheries Division, Special Report 27, Ann Arbor, Michigan.

Lewis, P.F. 1965. Impact of Negro migration on the electoral geography of Flint, Michigan, 1932-1962: a cartographic analysis. Annals of the Association of American Geographers **55(1):** 1-25.

Long, T.F, M.L. Gargas, R.P. Hubner, and R.G. Tardiff. 2002. The role of risk assessment in redeveloping brownfield sites. Pages 281-286 *in* Todd Davis, editor. Brownfields: a comprehensive guide to redeveloping contaminated property, second edition. American Barr Association, Chicago, Illinois.

Lyle, John. 1985. Design for human ecosystems :landscape, land use, and natural resources. New York : Van Nostrand Reinhold.

M & M Planning and Genesee Institute. 2006. Flint River Corridor Alliance mission and priority setting process, final report. Flint, Michigan.

McClure, Robert. 2006. 'Malarkey' cleanup pits port, activists – Extent of pollution removal from site is at issue. Seattle Post-Intelligencer, Thursday, May 25. Seattle, Washington.

Mellon, S. 2002. After the smoke clears: struggling to get by in Rustbelt America. University of Pittsburgh Press, Pittsburgh, PA.

Metropolitan Planning Council. 2007. Revitalizing Industry: A look to the 21st Century. <http://www.republicwindows.com/articles/020323.pdf> accessed April 2007.

Michigan Department of Environmental Quality (MDEQ). Storage tank information database. <http://www.deq.state.mi.us/sid-web/Default.aspx> accessed March 18, 2007.

Michigan Department of Environmental Quality (MDEQ) . 2007. Michigan Brownfield Redevelopment Grants and Loans, Fact Sheet. <http://www.deq.state.mi.us/documents/deq-ess-bgl-factsheet.pdf> accessed January 7, 2007.

Michigan Department of Natural Resources (MDNR). 2006. Dam removal. <www.michigan.gov/dnr/0,1607,7-153-10364_27415-80303--,00.html> accessed April 2, 2006.

Michigan Department of Natural Resources. (MDNR) 2007. Tri-Centinnial Park and Harbor Presentation. <http://www.michigandnr.com/Publications/PDFS/RecreationCamping/TSPH2.html> accessed on January 2007.

Michigan Economic Development Corporation (MEDC). 2007. American Seating Park in Grand Rapids: Rescue and Renewal. The Center for Brownfields Initiatives at the

University of New Orleans. <http://www.brownfields.com/Feature/Feature-10-2004-AmericanSeating.htm> accessed April 16, 2007.

Michigan State University (MSU). Hazardous substances research center and the Superfund basic research program. Michigan State University, East Lansing, Michigan. <www.envirotools.org> accessed March 24, 2007.

Modie, Neil. 2006. Port opts to exceed EPA's South Park cleanup plan – Recreational use could be in Duwamish tract's future. Seattle Post-Intelligencer, Wednesday, June 28, 2006. Seattle, Washington.

Morgan Quitno Awards. 2006. America's safest (and most dangerous) cities. <http://www.morganquitno.com/cit07pop.htm#25> accessed March 17, 2007.

Nassauer, J.I. 2005a. Propose and dispose lecture in Landscape Ecology Design Studio, Winter Term 2005. School of Natural Resources, University of Michigan, Ann Arbor, Michigan.

Nassauer, J.I. 2005b. Brownfield development graduate seminar lecture. Fall Term 2005. School of Natural Resources and Environment, University of Michigan, Ann Arbor, Michigan.

Nassauer, J.I., A. Chiesa, and R.C. Corry. 2001. Principles for ecological landscape design in brownfield business parks, draft report. <www.snre.umich.edo/~nassauer> accessed November 11, 2006.

Nassauer, J. I., and R.C. Corry. 2004. Using normative scenarios in landscape ecology. Landscape Ecology **19:** 343-356.

National Library of Medicine. 2006. Tox town, toxic chemicals and environmental health risks where you live and work. Bethesda, Maryland <http://toxtown.nlm.nih.gov> accessed March 20, 2007.

National Park Service (NPS). 2002. Rivers & Trails Program. Giving New Life to Streams in Rural City Centers brochure. Seattle, Washington.

National Resources Conservation Service (NRCS) 2001. <http://www.nrcs.usda.gov/technical/stream_restoration/PDFFILES/CHAPTER8.pdf> accessed April 2007.

Nelson, Wayne A. 2003. Pages 39-44 *in* Knowlton, Dave S. and David C. Sharp, editors. Problem-Based Learning in the Information Age. New Directions for Teaching and Learning, No. 95. San Francisco, CA: Jossey-Bass.

Nolen, John. 1920. City of Flint, Michigan, Genesee County: parks and parkways plan. *and* City of Flint, Michigan, Genesee County: general plan. Bentley Historical Library, University of Michigan, Ann Arbor, Michigan.

Northeast Midwest Institute (NEMW) 2003. Financing Strategies for Brownfield Cleanup and Redevelopment. June 2003. <http://www.nemw.org/BFfinancingredev.pdf> accessed Fall 2005.

Olson-Kase, Tonya. 2007. Phalen Wetland Park: The Kind of Wetland You Could Take Home to Your Mother. University of Minnesota. <http://horticulture.coafes.umn.edu/vd/h5015/96papers/olson-ks.htm> accessed April 2007.

Paulson, Tom. 2003. Tainted sludge won't go to Tacoma – Duwamish River sediment will be sent instead to Klickitat County. Seattle Post-Intelligencer, Thursday, September 11, 2003. Seattle, Washington.

Peters, S.M. 2004. History of Mott Park Community. <www.mottpark.org/history.html> accessed March 20, 2007.

Peterson, H. 2007. President, Grand Traverse District Neighborhood Association and Associate Planner, Genesee County Planning Authority. Presentation. Genesee County, Michigan. March 9, 2007.

Pinkham, Richard. 2000. Daylighting: New Life for Buried Streams. Rocky Mountain Institute, Old Snowmass, Colorado.

Pivetz, B.E. 2001. Phytoremediation of contaminated soil and ground water at hazardous waste sites: Ground Water Issue Agency EPA/540/S-01/500., U.S. Environmental Protection, Technology Innovation Office, Office of Solid Waste and Emergency Response, Washington, DC.

Prasad, M.N.V., and H.M.O. Freitas. 2003. Metal hyperaccumulation in plants: biodiversity prospecting for phytoremediation technology. Electronic Journal of Biotechnology **6:**3.

Prichard, J. 2006. With GM buyouts, Flint sees bleak times: city works hard to attract new businesses, but resurgence may be difficult. Associated Press. <www.msnbc.msn.com> accessed March 18, 2007.

Public Broadcasting Service (PBS). 2006. Auto workers prepared to fight for their future. NewsHour with Jim Lehrer Transcript. http://www.pbs.org/newshour/bb/business/jan-june06/delphi_1-26.html accessed April 16, 2007.

Reddy, K.R, J.A. Addams, and C. Richardson. 1999. Potential technologies for remediation of brownfields. Practive Periodical of Hazards, Toxic, and Radioactive Waste Management. **3(2):** 61-68.

Rock, S.A. 1997. Introduction to phytoremediation. In Harry Freeman, Ed. The Standard handbook of hazardous waste treatment and disposal, second edition. McGraw Hill. <http://www.epa.gov/nrmrl/lrpcd/rr/introphy.htm> accessed April 16, 2007.

Rouge River National Wet Weather Demonstration Project. 2004. <http://www.rougeriver.com> accessed on March 19, 2007.

Rouge River Gateway Master Plan. 2005. Wayne County, Michigan. November 2005.

Rouge Oxbow Restoration Project. 2003. Wayne County, Michigan. Henry Ford Museum and Greenfield Village.

Rowe Incorporated, 1998. Harley/Ellington Design, Kettering University Campus Master Plan Map. <http://www.roweincorp.com/focusweb/Kettering/KU_campus_master_plan_map.htm> accessed on April 1, 2007.

Rugh, C. 2003. Phytoremediation of polycyclic aromatic hydrocarbon contaminated soil using native Michigan plant species. PowerPoint slideshow. Michigan State University, Lansing, Michigan.

Ruth Mott Foundation. 2003. Programs webpage. <www.ruthmottfoundation.org> accessed March 23, 2007.

Santelmann, M.V., D. White, K. Freemark, J.I. Nassauer, J.M. Eilers, K.B. Vaché, B.J. Danielson, R.C. Corry, M.E. Clark, S. Polasky, R.M. Cruse, J. Sifneos, H. Rustigian, C. Coiner, J. Wu and D. Debinski. 2004. Assessing alternative futures for agriculture in Iowa, U.S.A. Landscape Ecology **19:**357-374.

Shaw, Robert. 2002. The International Building Exhibition (IBA) Emscher Park, Germany: A Model for sustainable restructuring? European Planning Studies, **10(1)** pages 77-96.

Shaw Nature Reseve (SNR online). 2007. <http://www.shawnature.org/about/SNRhistory.aspx> accessed April 2007.

Simenstad , C., C. Tanner, C. Crandell, J. White, J. Cordell. 2005. Challenges of habitat restoration in a heavily urbanized estuary: Evaluating the investment. Journal of Coastal Research, Special Issue **40**:6-23.

Steinitz, C., H. Arias, S. Bassett, M. Flaxman, T. Goode, T. Maddock III, D. Mouat, R. Peiser, A. Shearer. 2003. Alternative futures for changing landscapes: the Upper San Pedro River Basin in Arizona and Sonora. Washington, D.C., Island Press.

Suren, A.M., T. Riis, B. Biggs, S. McMurtrie and R. Barker. 2005. Assessing the effectiveness of enhancement activities in urban streams: habitat responses. River Research and Applications. **21**: 381-401.

Sweeney, N. 2005. A stroll along the RiverWalk. MKE Online. <http://www.mkeonline.com/story.asp?id=342124> accessed April 14, 2007.

Thomas, J.C. 2007. Associate Professor of Biology, University of Michigan Dearborn. Personal communication, February 2, 2007.

United Auto Workers. 2007. UAW history: seventy years of solidarity. <http://www.uaw.org/history/uaw70years.html> accessed March 18, 2007.

United States Army Corps of Engineers (USACE). 2004. Flint River project modification for improvement of the environment: preliminary restoration plan. Great Lakes and Ohio River Division, Detroit District. Detroit, Michigan.

United States Census Bureau. 2000. Census 2000, profile of general demographic characteristics for Flint, Michigan. <http://www.census.gov/census2000/states/mi.html> accessed April 16, 2007

U.S. Green Building Council (USGBC). 2003. Leadership in Energy and Environmental Design, LEED Certified Project Case Study. <http://leedcasestudies.usgbc.org/overview.cfm?ProjectID=97> accessed on November 22, 2006.

University of Wisconsin Milwaukee. 2005. Curbing Industrial Decline or Thwarting Redevelopment? <http://www.uwm.edu/Dept/CED/publications/pmdstudy1.pdf> accessed April 2007.

Van Deuren, J, T. Lloyd, S. Chetry, R. Liou, and J. Peck. 2002. Remediation technologies screening matrix and reference guide, fourth edition. Prepared for the U.S. Army Environmental Center, by Platinum International, Inc., Alexandria, Virginia.

Weaver Boos Consultants. 2007. Goose Island Brownfield. <http://www.weaverboos.com/wrigleybrownfield.html> accessed April 2007.

White, David. 2006. Scharchburg Archives, Kettering University. E-mail communication, March 26, 2007.

Wood, E.O. 1916. History of Genesee County, Michigan, her people, industries and institutions. Lumbering and allied industries, Chapter XIV Michigan Historical Commission. <www.usgennet.org/usa/mi/county/lapeer/gen/> accessed March 16, 2007.