Appendix I Lick Run Technical Report (MSD 2009)

Report

Lick Run Technical Report

Metropolitan Sewer District of Greater Cincinnati, OH

August 2009

SECTION 1
INTRODUCTION

1.01 PROJECT BACKGROUND

As one of the top five combined sewer overflow (CSO) dischargers in the country, the Metropolitan Sewer District of Greater Cincinnati (MSD) is under a Consent Decree to minimize overflows from their combined sewer system (CSS). The United States Environmental Protection Agency (USEPA) has mandated that MSD develop solutions to control the 14-billion gallons of CSOs that annually discharge from MSD's CSS. The solution to this problem is a two-phased, multiyear initiative comprised of hundreds of improvement projects throughout MSD's service area, identified as Project Groundwork. As a means to maximize the social, economic, and environmental benefits for our communities through Project Groundwork, MSD has developed a philosophy to CSO control called Communities of the Future. While the primary goal of Communities of the Future is to reduce the CSO volume discharging from MSD's CSS, it also focuses on garnering support for economic development and urban renewal. The innovative approach to identifying CSO solutions that maximizes the benefits to the community is a four-step process known as the Sustainable Watershed Evaluation Process (SWEP).

As one of MSD's largest CSO's, CSO 005, known as Lick Run, discharges approximately 1.7-billion gallons of overflow annually based on a typical rainfall analysis utilizing the collection system model. This single CSO accounts for about 10 percent of Cincinnati's total overflow volume. The 2,700-acre Lick Run watershed, located in the Mill Creek Valley on the west side of Cincinnati, is primarily comprised of the South Fairmount neighborhood, an area that has struggled economically for decades and faces tremendous challenges for economic development and urban renewal. Currently the Lick Run Watershed drains into a 19.5-foot-diameter pipe and is used to convey the sewage and stormwater runoff from the watershed. During dry weather, the sewage is transported to the Mill Creek treatment plant by the Auxillory Mill Interceptor 1.

The approach that MSD uses in identifying CSO solutions that maximize the benefits to the community is a four-step process known as the SWEP. The multifaceted solution for CSO 005, which is presented throughout this technical report, represents a concept level strategy for CSO control aimed at achieving maximum overflow volume reduction with a blend of grey and green infrastructure. Further refinement of the technical components of this strategy is necessary to confirm the feasibility and constructability of the watershed strategy.

1.02 DEFINITIONS

AECOM AECOM Technology Corporation (formerly ERA)
CAGR compound annual growth rate
cf cubic feet
CSO combined sewer overflow
CSS combined sewer system
DOTE Department of Transportation Engineering
ESRI Environmental Systems Research Institute
GIS geographical information system
Human Nature Human Nature, Inc.
LID Low Impact Development
LTCP long-term control plan
MSD Metropolitan Sewer District of Greater Cincinnati

NRCS	National Resource Conservation Service
ODOT	Ohio Department of Transportation
RDII	rainfall derived inflow and infiltration
RPC	Regional Planning Commission
Strand	Strand Associates, Inc.®
SWEP	Sustainable Watershed Evaluation Process
SWM	System Wide Model
USEPA	United States Environmental Protection Agency
WWTP	wastewater treatment plant
XCG	XCG Consultants, Inc.

SECTION 2
WATERSHED INVENTORY AND ANALYSIS

2.01 INTRODUCTION

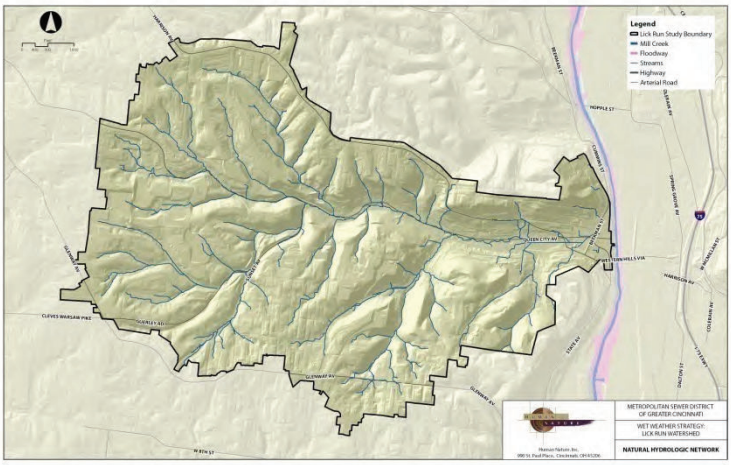
The initial phase of the SWEP involves compilation of relevant and available information necessary to gain an understanding of existing conditions and allow for a comprehensive evaluation of alternative solutions to CSO control. This includes an evaluation of natural systems, built systems, historical assets, and demographics.

2.02 NATURAL SYSTEMS

The Lick Run Watershed covers approximately 2,720 acres. The geographical information system (GIS) inventory of natural systems investigated the watershed's hydrologic network, topography, soil characteristics, geology, and tree canopy cover. Larger versions of these maps can be found in Appendix A.

A. Hydrology

The predevelopment hydrologic network (see Figure 2.02-1) shows an extensive system of creeks and streams within the watershed. At one point, the hydrologic network included almost 31 miles of streams within the Lick Run watershed. This network naturally conveyed stormwater runoff to Lick Run and, eventually, to the Mill Creek. Today underground sewer systems have replaced this stream network. The sewer system ultimately drains to a 19.5-foot-diameter pipe on the east side of the watershed, which is directly connected to CSO 005–Lick Run Regulator.

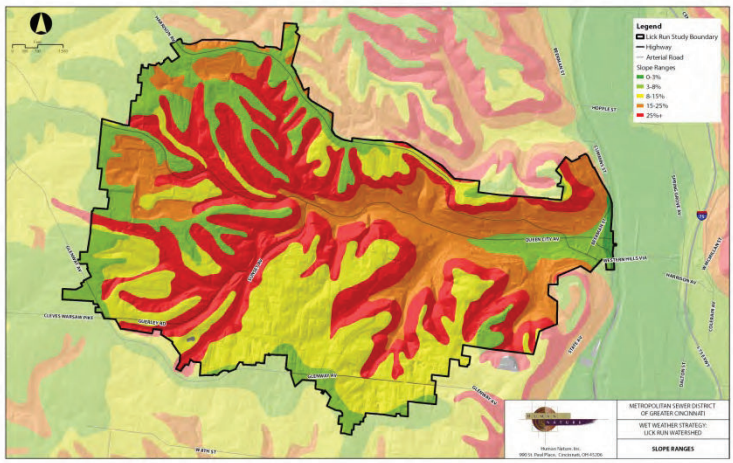


Source: Human Nature, Inc.

Figure 2.02-1 Predevelopment Hydrologic Network in the Lick Run Watershed

B. Topography

The topography of the landscape influences hydrologic patterns, vegetation and habitat, and can even constrain land uses. As shown in Figure 2.02-2, the project area was characterized in regard to slopes, allowing for a quick assessment of areas where stormwater can collect (flat areas), versus areas where stormwater will rapidly runoff (steep areas). Slopes were classified into five ranges: 0 to 3 percent, 3 to 8 percent, 8 to 15 percent, 15 to 25 percent, and over 25 percent. Wet weather strategies vary depending on the type and extent of slopes throughout the project area.



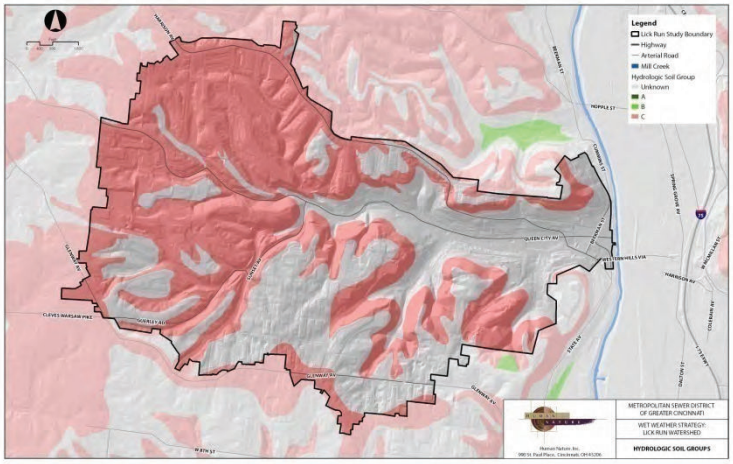
Source: Human Nature, Inc.

Figure 2.02-2 Slope Ranges in the Lick Run Watershed

Steep hillsides, defined as areas with slopes of 15 percent or greater, can exacerbate the volume of stormwater runoff entering sewer infrastructure. There are 1,345 acres that are classified as steep slopes, representing almost 50 percent of the total project area. Throughout the watershed, there are no natural waterways that flow naturally into the Mill Creek. All surface flow drains into a sewer network.

C. Hydrologic Soil Groups

As shown in Figure 2.02-3, the Lick Run watershed contains hydrologic soil groups C and D. Water transmission through group C and D soils is highly restricted. Therefore, the low infiltration rates associated with such soil conditions limit the opportunities for significant infiltration of stormwater runoff.



Source: Human Nature, Inc.

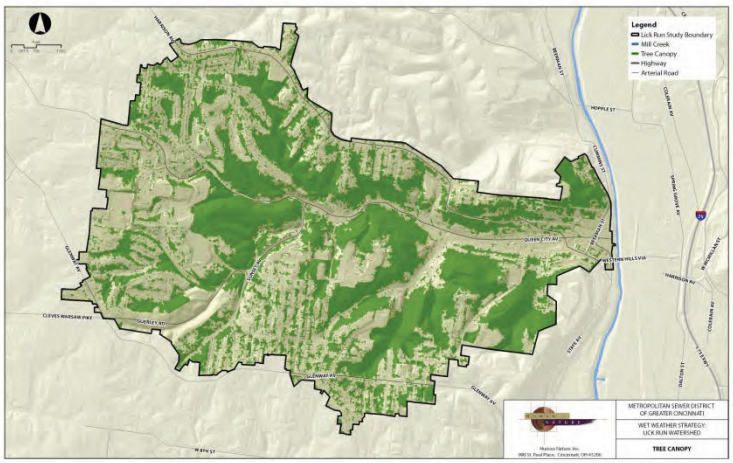
Figure 2.02-3 Hydrologic Soil Groups in the Lick Run Watershed

D. Surficial Geology

The nature of subsurface rock (geology) helps to determine not just the nature and chemistry of the soil above, but also the rate at which it forms. This in turn strongly affects the vegetation that will grow naturally and the type of agriculture or horticulture that can be sustained. Geologic formations of alluvium, sand, and gravel provide the greatest opportunities for natural infiltration, as they can allow for greatest subsurface transmission and conveyance of water; however, as shown in Figure 2.02-4, geology in the Lick Run watershed is primarily limestone and clay-loam till, with small deposits of alluvium near the Mill Creek basin.

E. Tree Canopy Cover

Tree canopy cover is an important component of natural systems. In addition to improving air quality, native trees cover can intercept, absorb, and filter stormwater. As shown in Figure 2.02-5, there are 1,261 acres of canopy cover in the project area, representing slightly more than 46 percent of the project area.

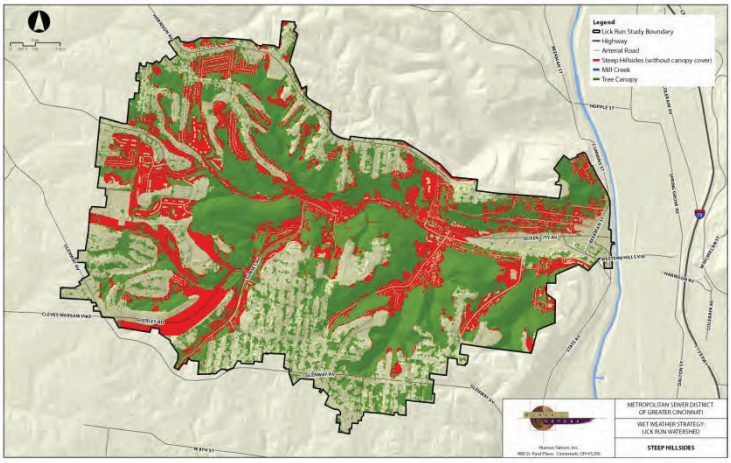


Source: Human Nature, Inc.

Figure 2.02-4 Tree Canopy in the Lick Run Watershed

F. Steep Hillsides and Tree Canopy

As previously mentioned, there are 1,345 acres of steep hillsides (areas with slopes of 15 percent or greater) in the watershed, 34 percent of which does not have tree canopy cover. These "canopy-deficient" hillsides are shown in Figure 2.02-6. Barren slopes can contribute to sedimentation of waterways, erosion problems, landslides and an increased rate of stormwater runoff.



Source: Human Nature, Inc.

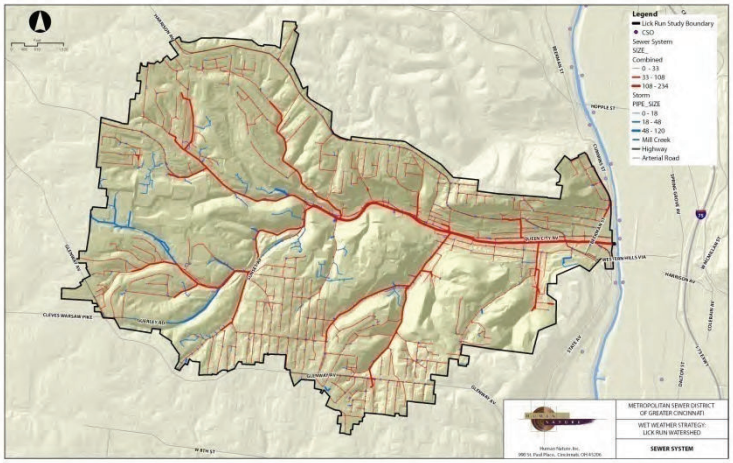
Figure 2.02-5 Canopy-Deficient Hillsides in the Lick Run Watershed

2.03 BUILT SYSTEMS

The GIS inventory of built systems investigated the watershed's sanitary and stormwater infrastructure, land use, impervious surfaces, neighborhood boundaries, and road right-of-way. Descriptions of and maps for these built systems are listed below. Larger versions of these maps can be found in Appendix B.

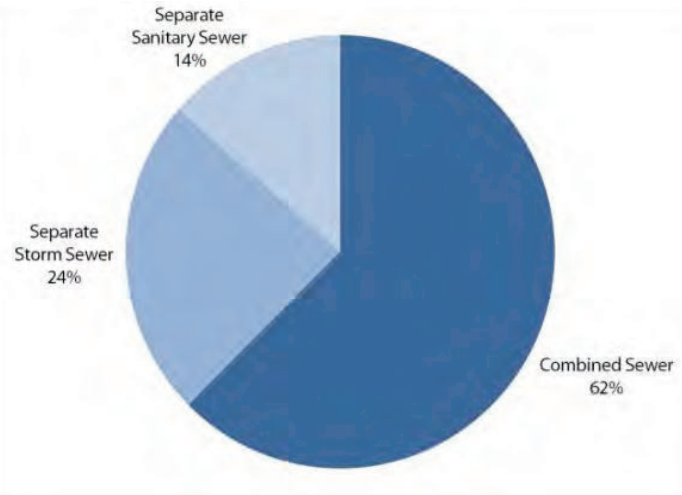
A. Sanitary and Storm Infrastructure

There are 88 miles of combined sewer, separate sanitary sewer, and separate stormwater sewers in the watershed. As shown in Figure 2.03-1, combined sewer infrastructure follows the predevelopment hydrologic network. Figure 2.03-2 shows the distribution of the underground sewer network by type (combined, separate sanitary, or separate storm sewer). As noted previously, the sewer network captures all the natural runoff from the watershed.



Source: Human Nature, Inc.

Figure 2.03-1 Sanitary and Stormwater Infrastructure in the Lick Run Watershed

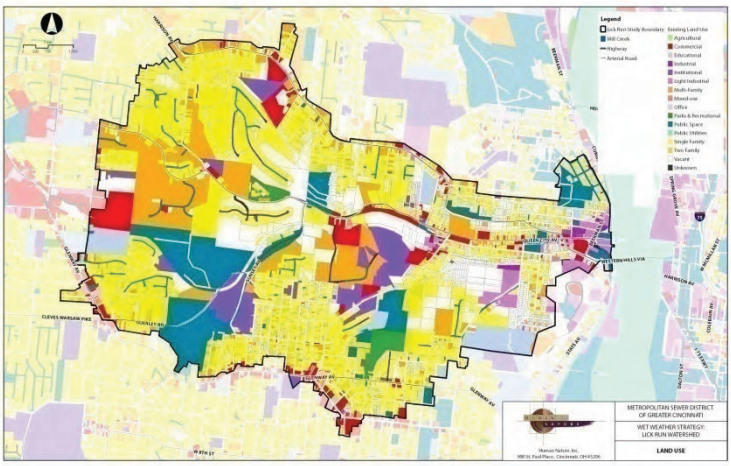


Source: Human Nature, Inc.

Figure 2.03-2 Distribution of Underground Infrastructure by Type

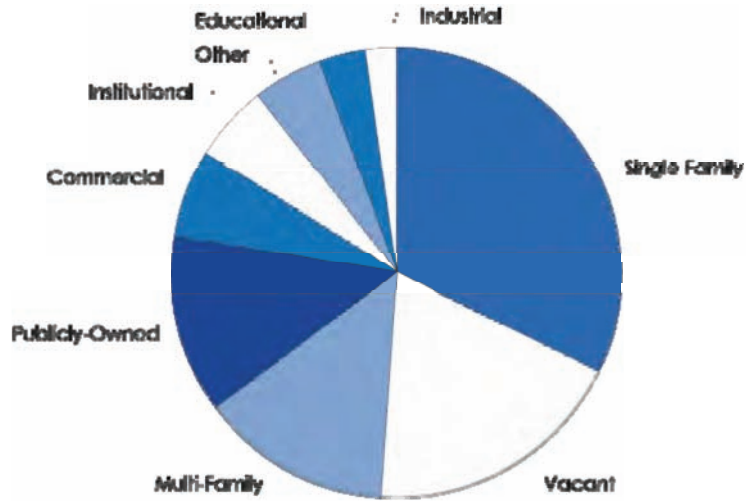
B. Land Use

Land use is the documentation of human uses of the landscape. Land use within the Lick Run Watershed is primarily residential (both single-family and multifamily). Vacant and commercial properties also comprise a significant portion of the watershed. Vacant is defined as empty parcels that do not have large-scale structures on the premises, as categorized by the Hamilton County Auditors database. Figure 2.03-3 shows distribution of land use within the watershed. Figure 2.03-4 summarizes the distribution of land use by area.



Source: Human Nature, Inc.

Figure 2.03-3 Existing Land Use in the Lick Run Watershed

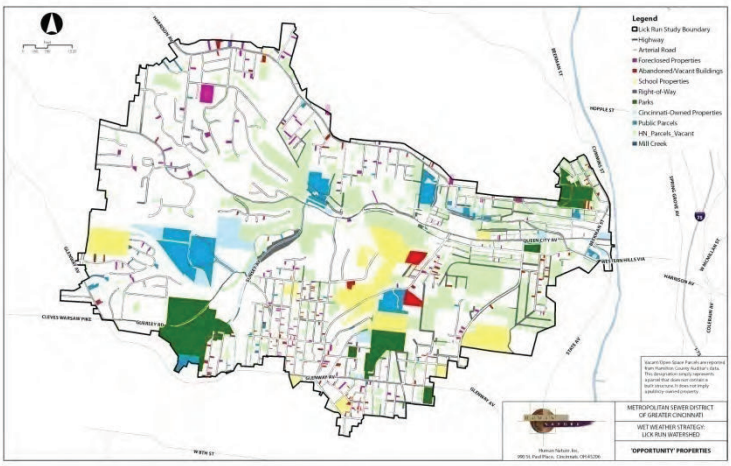


Source: Human Nature, Inc.

Figure 2.03-4 Distribution of Existing Land Use by Area

C. Opportunity Properties

Data for land uses were sorted based on type (institutional or vacant properties) and owner (public versus private). This provided a list of "opportunity properties," or land uses that may present opportunities for infrastructure partnerships and collaboration. Opportunity properties include schools, parks, open spaces, institutional properties, road right-of-way, and vacant and abandoned properties. As potential areas for public-private partnerships, these land uses can integrate multiple stakeholders, thereby increasing public involvement and improving public perception of infrastructure projects. For example, forging partnerships with institutional and educational properties can create highly-visible projects within the community, and foster long-lasting, interagency relationships. Figure 2.03-5 shows distribution of opportunity properties within the watershed.



Source: Human Nature, Inc.

Figure 2.03-5 Opportunity Properties in the Lick Run Watershed

D. Impervious Surfaces

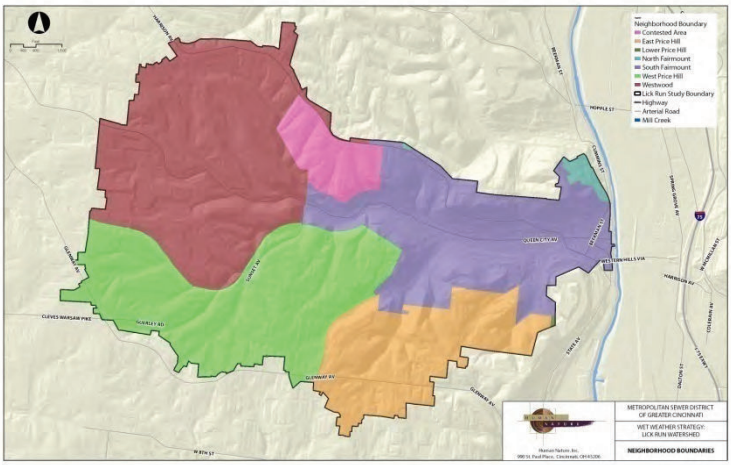
Impervious surfaces include buildings, pavement, roadways and highways, and bridges. These areas can greatly increase the rate of stormwater runoff by reducing or even preventing the natural infiltration of stormwater into soils. As shown in Figure 2.03-6, impervious surfaces cover 827 acres, or 30 percent of the total project area. The greatest concentration of impervious surfaces is along the Westwood/Queen City corridor in South Fairmount.

Source: Human Nature, Inc.

Figure 2.03-6 Impervious Surfaces in the Lick Run Watershed

E. Neighborhood Boundaries

The Lick Run Watershed covers approximately 2,720 acres and overlaps six of Cincinnati's western neighborhoods, including South Fairmount, Westwood, West Price Hill, East Price Hill, and a section of North Fairmount. As shown in Figure 2.03-7, there is also a contested boundary between Westwood and South Fairmount.

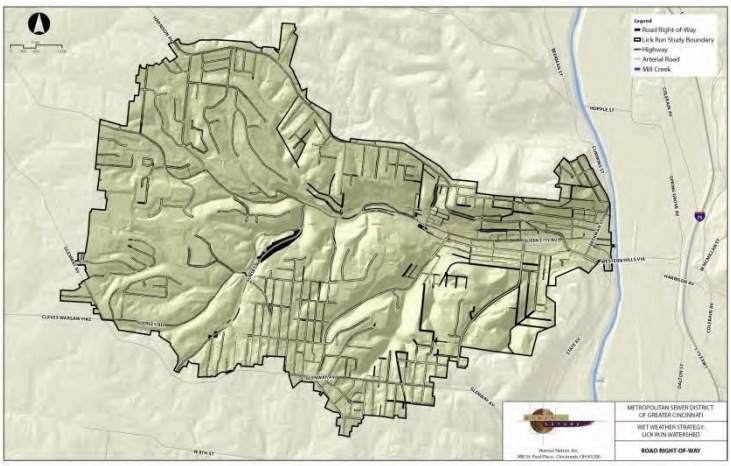


Source: Human Nature, Inc.

Figure 2.03-7 Cincinnati Neighborhoods in the Lick Run Watershed

F. Road Right-of-Way

Right-of-way includes publicly-owned land adjacent to interstates and roadways. Right-of-way can often be integrated with green infrastructure controls to capture stormwater runoff from impervious surfaces (roadways, sidewalks, rooftops). There are 214 acres of road right-of-way in the project area, the distribution of which is shown in Figure 2.03-8.

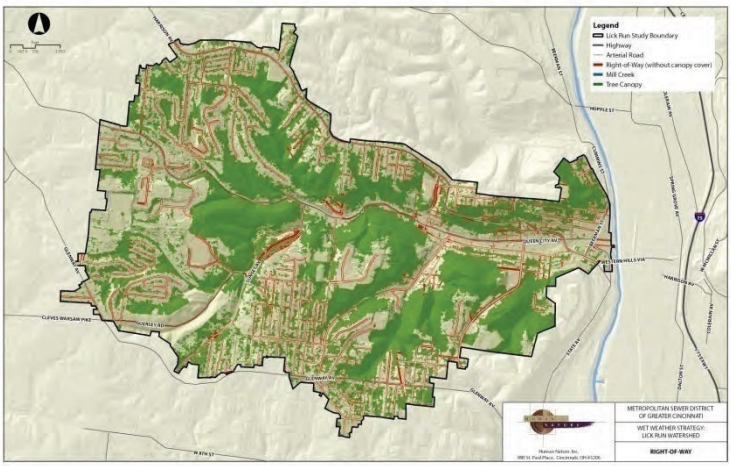


Source: Human Nature, Inc.

Figure 2.03-8 Road Right-of-Way in the Lick Run Watershed

G. Road Right of Way and Tree Canopy Cover

Road right-of-way can provide readily-available, publicly-owned land that can be reforested for stormwater benefits. There are 214 acres of road right-of-way in the project area. Of this amount, 176 acres (or 82 percent) does not have tree canopy cover. Figure 2.03-9 below shows the distribution of canopy-deficient right-of-way in the Lick Run watershed.



Source: Human Nature, Inc.

Figure 2.03-9 Canopy-Deficient Road Right-of-Way in the Lick Run Watershed

2.04 HISTORICAL COMMUNITY ASSETS, DEMOGRAPHICS, AND URBAN AUDIT

A. Historical Anchor Buildings

South Fairmount was a primary focus during the inventory and analysis of the Lick Run watershed. This neighborhood benefited from a strategic location in Cincinnati, adjacent to the city's primary traffic corridor, and serving as a gateway into Cincinnati's west side neighborhoods. This strategic location created a diverse economic base (including agriculture, lumber yards, flour mills, breweries, and machinery), which in turn created a unique stock of architectural styles. Figure 2.04-1 highlights some of these styles, which are referred to as historical anchor buildings. This is by no means a complete inventory of historically significant buildings in the watershed, but rather helps to characterize potential for redevelopment of a more vibrant community for the future.

Source: Human Nature, Inc.

Figure 2.04-1 Historical Anchor Buildings in the South Fairmount Neighborhood

B. Demographics of Focus Area

AECOM Technology Corporation (AECOM, formerly ERA) was engaged by MSD to provide a Lick Run watershed demographics study. Work efforts included a current demographic perspective for the South Fairmount neighborhood, covering population, income, household structure, housing vacancy, educational attainment, and employment concentrations. This includes information for 2000, as well as forecasts for 2008 and 2013.

This section describes the local area demographics of the South Fairmount neighborhood, the city of Cincinnati, and the state of Ohio. The data source is the United States Census from 2000 and estimates for 2008 and forecasts for 2013, generated by Environmental Systems Research Institute (ESRI). The reader should note that the demographics for noted years were extracted from a geographic information system base using boundary files from the Hamilton County GIS system. For this reason, noted estimates may vary from past reports based on slight variations in boundaries. In the tables below, the term compound annual growth rate (CAGR) 00/08 indicates the estimated CAGR between 2000 and 2008. The CAGR measures growth based upon growth over a period of years. (For example, a metric growing at 1 percent, compounded annually, over 5 years grows at an average of 1 percent the first year; then the new, higher figure grows at 1 percent the second year, and so on.)

1. Population

South Fairmount represents approximately 1 percent of the city's population and is estimated to have declined from a population of 3,251 to 2,842 between 2000 and 2008, based on past trends. The City of Cincinnati, meanwhile, is estimated to have decreased slightly by about 1 percent per year; however, more recent estimates by the Census Bureau, released July 1, 2009, indicate that the population may have actually increased by about 2,000 residents. While neither study area is experiencing sharp population changes, it does appear that South Fairmount has been struggling to retain residents more than the city as a whole (see Table 2.04-1).

	2000	2008	2013	CAGR 00/08
South Fairmont	3,215	2,842	2,669	-1.7%
Cincinnati	331,692	305,988	294,545	-1.0%
Ohio	11,366,392	11,645,739	11,817,922	0.3%

Source: AECOM

Table 2.04-1 Total Population

2. Households

The average household size in South Fairmount is higher than in the city as a whole. It is common for urban areas to have much lower household sizes than their corresponding states or regions. City housing units—houses and apartments—tend to be smaller than the average housing unit in other areas (see Table 2.04-3).

	2000	2008	2013
South Fairmont	2.49	2.44	2.42
Cincinnati	2.16	2.11	2.09
Ohio	2.49	2.45	2.43

Source: AECOM

Table 2.04-2 Average Household Size

However, within Cincinnati, South Fairmount has a higher average household size of about 2.44, compared with a city average of just 2.11. In the specific case of South Fairmount the number of four-or-more person households is 24 percent, compared with 16 percent for Cincinnati. In addition, the percentage of single family dwellings is higher in South Fairmount (42 percent) than for the city as a whole (38 percent) as shown in Table 2.04-4.

	2000	2008	2013
South Fairmont	54.2%	51.5%	50.0%
Cincinnati	49.4%	47.0%	45.5%
Ohio	67.3%	66.0%	65.1%

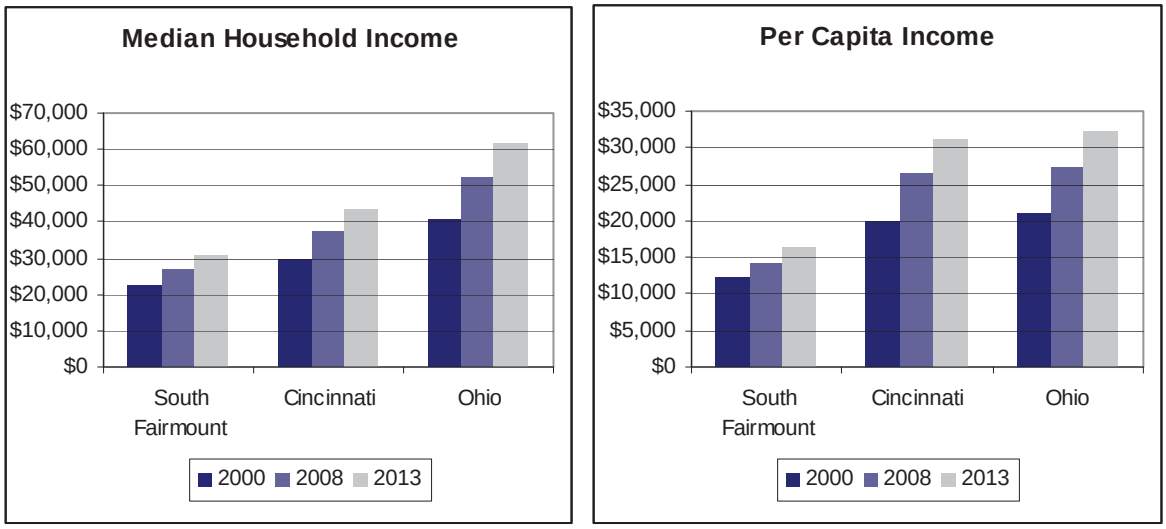
Source: AECOM

Table 2.04-3 Percent of Households that are Families

The percentage of households that are families is higher in South Fairmount than in the city as a whole, potentially reflecting fewer one- and two-person nonfamily households than in the city. It is also noteworthy that while South Fairmount and the state have almost identical average household sizes, 66 percent of the state's households are families, while just 52 percent of South Fairmount's households are families.

3. Income

As shown in Figures 2.04-5 and 2.04-6, South Fairmount is struggling by two common measures; median household income and per-capita income. The median household is estimated to have earned $27,197 in South Fairmount in 2008, compared with $37,209 in the city and $52,367 in the state.



Source: AECOM

Figure 2.04-2 Median Household Income and Per Capita Income

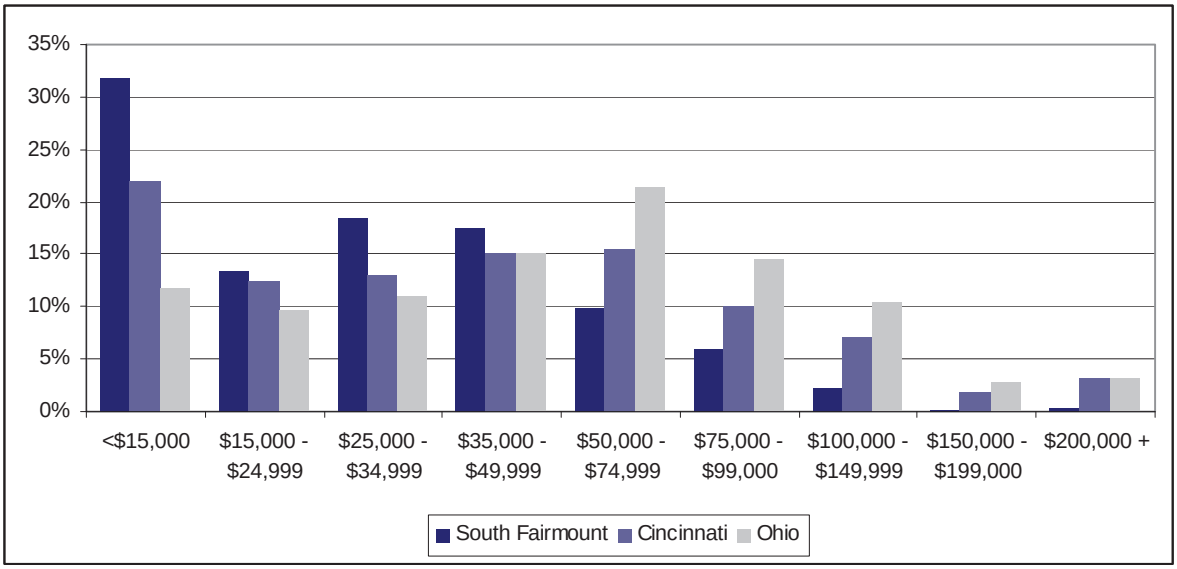
The disparity is even greater when considering per-capita income: the per-capita income in South Fairmount is just over half what it is in Cincinnati as a whole. Moreover, among the three study areas in this analysis, South Fairmount's household and per-capita incomes are growing the slowest.

	2000	2008	2013	CAGR 00/08
South Fairmont	$22,393	$27,197	$30,949	2.5%
Cincinnati	$29,684	$37,209	$43,753	2.9%
Ohio	$40,971	$52,367	$61,982	3.1%

Source: AECOM

Table 2.04-4 Median Household Income

In addition to the averages, it is possible to bracket households by income level. Figure 2.04-7 shows that almost 32 percent of South Fairmount households take home less than $15,000 per year, as of 2008. Just 2.8 percent earn $100,000 or above, compared with 12.1 percent and 16.3 percent in the city and state, respectively.



Source: AECOM

Figure 2.04-3 Population by Household Income

4. Age

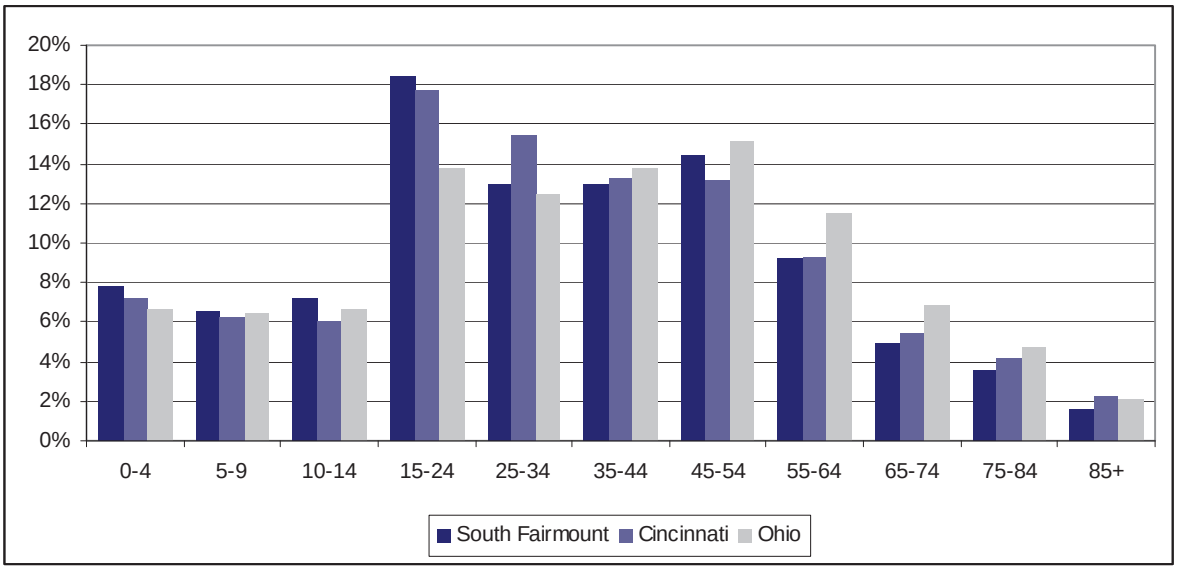
At 32.2, the average age in South Fairmount is slightly lower than for the city and well below the average age for the state (see Figure 2.04-8).

	2000	2008	2013
South Fairmont	31.1	32.2	32.6
Cincinnati	32.3	33.3	33.5
Ohio	36.2	38.1	39.1

Source: AECOM

Table 2.04-5 Average Age

As compared with the city and state, South Fairmount has a greater percentage of residents in each age bracket under age 24 and the lowest percentage in each age bracket over age 55 (see Figure 2.04-9).

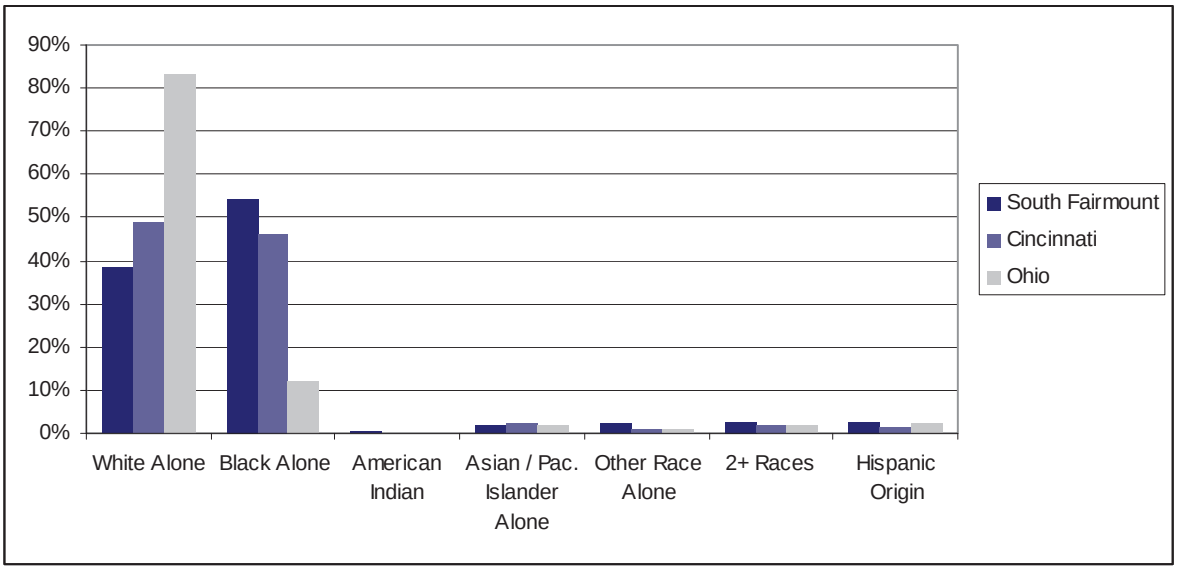


Source: AECOM

Figure 2.04-4 Population by Age

5. Race and Ethnicity

Figure 2.04-10 shows the race and ethnicity breakdowns for the three study areas.



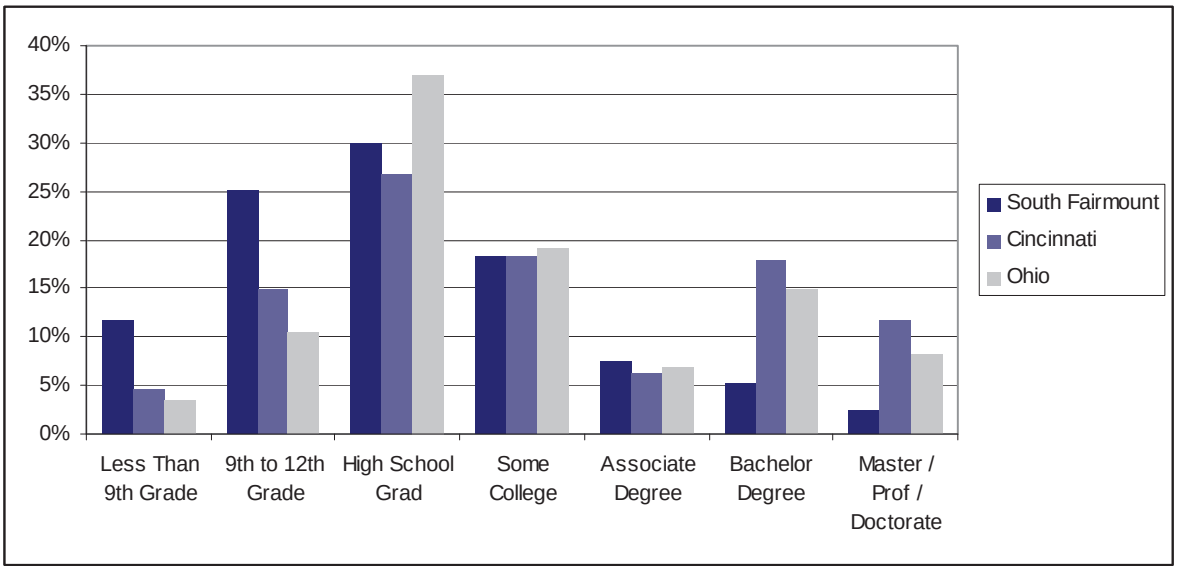
Source: AECOM

Figure 2.04-5 Population by Race and Ethnicity

The proportions of black and white are approximately reversed from the city average, though neither the city nor the neighborhood is dominated by one race. Although the proportion of residents of Hispanic Origin is almost twice as high in South Fairmount as for the city, that proportion is still very low (2.6 percent), considering the United States average is estimated to be around 12 percent. Cincinnati is fairly evenly split between those responding White Alone and Black Alone: they are 49 and 46 percent, respectively, compared with 38 and 54 percent in South Fairmount.

6. Educational Attainment

As shown in Figure 2.04-11, there are significant educational achievement gaps between South Fairmount and the city and state. Thirty-seven percent of South Fairmount adults over the age of 25 have not completed high school, compared with 19 percent for the city and 14 percent for the state. Just 5 percent of South Fairmount has a bachelor's degree; almost 18 percent of Cincinnati residents.

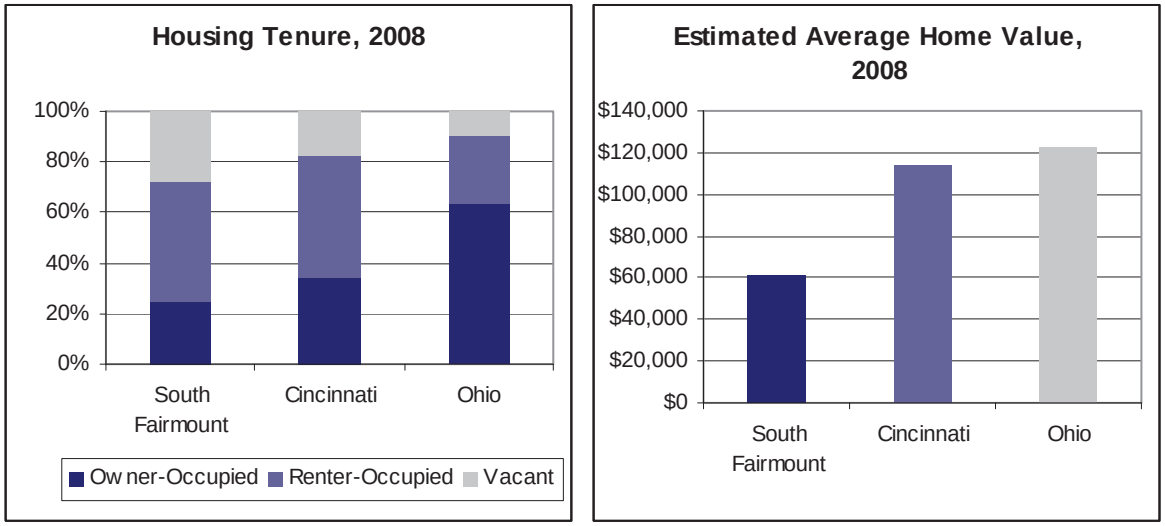


Source: AECOM

Figure 2.04-6 Population Over Age 25 by Highest Educational Attainment

7. Housing

According to information extracted from ESRI, housing in South Fairmount has more vacancies; more renters; and lower home values for owner-occupied units than for the city as a whole (see Figure 2.04-12).

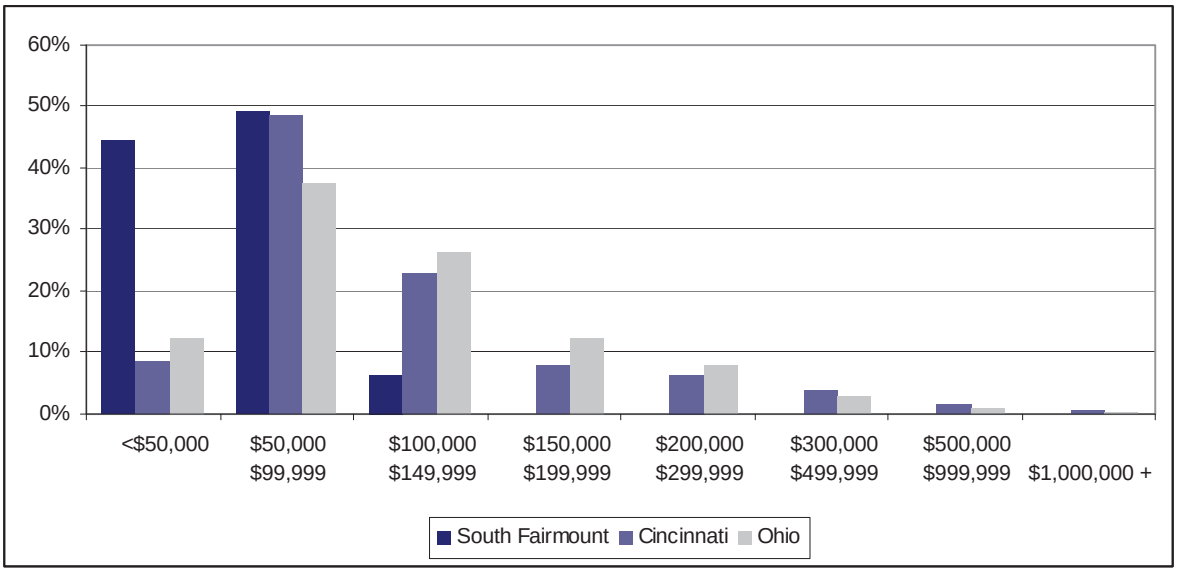


Source: AECOM

Figure 2.04-7 Housing Tenure and Estimated Home Value, 2008

Census estimates show that approximately 27 percent of housing units are likely to have been vacant in 2008. However, several extenuating circumstances could make that number higher in reality. Nationally, many low-income neighborhoods with previously low home values evolved into areas of concentration for high loan-to-value (sometimes 100 percent) subprime mortgages, which have high rates of default and foreclosure in other markets. The events of 2007 and 2008 would not be included in the estimates above, so aggressive mortgages sold in low-income neighborhoods may have exacerbated a significant trend toward vacant housing.

The biggest discrepancy is the value of owner-occupied housing units. In South Fairmount, a majority of owner-occupied homes are estimated to be worth less than $150,000; 94 percent are estimated below $100,000. At the bottom of the spectrum, 44 percent are estimated be worth less than $50,000. This compares with 8.5 and 12.3 percent in Cincinnati and Ohio respectively (see Figure 2.04-13).



Source: AECOM

Figure 2.04-8 Estimated Value of Owner-Occupied Housing Units, 2008

It should be noted here that the data source for Figure 2.04-13 is from the United States Census survey data taken in 2000 and adjusted using national and regional trends. Because it is survey based, it captures the owner-occupant's expectation of what his or her house is worth. ERA also evaluated home value breakdowns within the smaller target area, supplied by the Hamilton County Auditor. This analysis confirmed the overall breakdown of values, with a majority of property currently valued below $10,000 (land and improvements), and a total market value of about $11 million.

C. Urban Audit

Based on the demographic data gathered, MSD engaged the Hamilton County Regional Planning Commission (RPC) to conduct an urban audit of the Lick Run Watershed focusing on the blocks of buildings in South Fairmount abutting Queen City Avenue and Westwood Avenue (see Figure 2.04-9). Hamilton County Regional Planning is also evaluating the use of form base zoning, planned unit development, and other zoning options for areas of South Fairmount. The urban audit, which is expected to be complete in mid September, includes a building by building inventory and records the following data for each building:

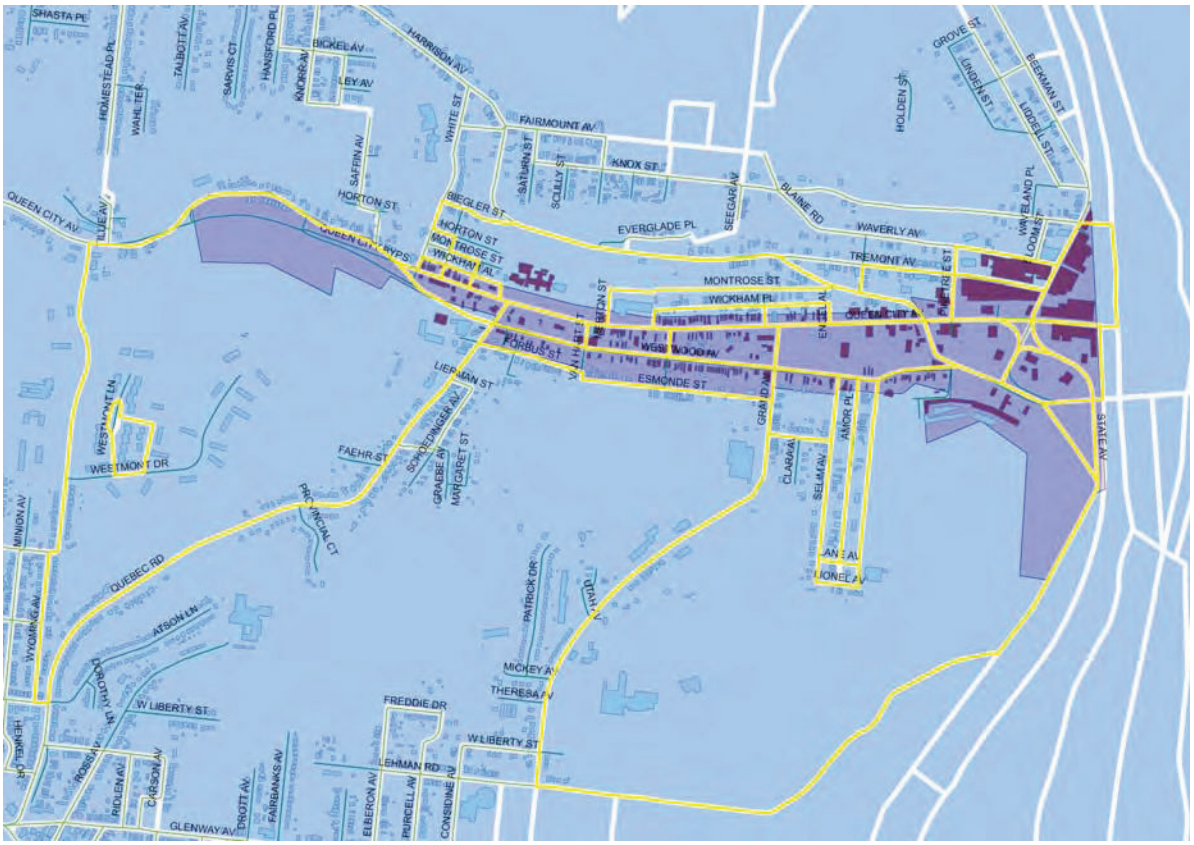
1. Property Location (Block number, street address, Auditor's book, page, parcel data).
2. Property size.
3. Owner's name and mailing address.
4. Description of property use (as classified by County Auditor).
5. Property value (land and improvements).
6. Land Use.

7. Building age and condition:
    a. Foundation.
    b. Walls.
    c. Roof.
8. Overall Building Rating.
9. Special Comments, for example: for sale, business, accessory buildings, and junk vehicles.
10. Foreclosure status.
11. Blighting Influences:
    a. Age.
    b. Obsolescence.
    c. Deterioration.
    d. Dilapidation.
    e. Abandonment/Excessive Vacancies.
    f. Periodic Flooding.
    g. Faulty Lot Layout/Overcrowding/Inadequate Loading/Parking.
    h. Deleterious/Incompatible Land Use/Site Conditions.
    i. Inadequate Facilities/ROW.
    j. Diversity of Ownership.
    k. Illegal Use/Code Violation.
    l. Unsuitable Soils Conditions.
    m. Unused Railyards or Service Stations-Landfill/Junkyard.
    n. Other Factors Inhibiting Sound Private Investment.
12. Historic designation (if any)

The RPC staff developed a ARC GIS 9.2 Urban Audit tool, creating a data layer that includes entry lines for all the data described above. RPC developed a Building/Housing Survey Form for use in the field for identifying property data (see Appendix C). Within the database contains photographs taken of the properties and special comments.

RPC staff completed the majority of the audit for CSO 005 Lick Run in late August 2009. Data evaluation is underway and will be available soon. RPC will query data for status of buildings (Sound, Requires Minor Repair, Requires Major Repair, In Critical Condition)for Building Use, Building Rating, and also for Blighting Influences.

After compilation of this data is complete, a report by block as well as for the total study area will be prepared. This report will identify the major land holders, total assessed value, overall vacancy rate, and a detailed description of property conditions as well as any other essential facts about the study area or specific parcels of interest.



Source: Hamilton County Regional Planning Commission

Figure 2.04-9 Estimated Value of Owner-Occupied Housing Units, 2008

SECTION 3
OPPORTUNITIES AND CONSTRAINTS

3.01 INTRODUCTION

Currently MSD's customer base within Lick Run watershed includes approximately 5,500 sewer users. As part of the evaluation of the 1.7 billion gallon overflow, MSD was challenged to determine the most cost-effective solution for the watershed as well as develop the best solution that will enhance future and existing customer base. The MSD management team engaged the Wet Weather Strategy Team to develop control scenarios that would reduce average annual overflow volumes by 800 million gallons.

Utilizing the outcomes from the data compilation and inventory analysis phase, the Lick Run Wet Weather Strategy Team (Strand Associates, Inc.® (Strand), Human Nature Inc. (Human Nature), and XCG Consultants, Inc. (XCG) and MSD) developed a range of wet weather strategies and redevelopment alternatives. This began with a refinement of XCG's existing hydrologic and hydraulic model of the CSS and concluded with a cost-benefit assessment of multiple wet weather strategies, including sewer separation, stream daylighting, downspout disconnection, reforestation, and real-time control.

3.02 HYDROLOGIC AND HYDRAULIC MODELING

XCG quantified the potential benefits from proposed watershed projects through hydraulic modeling. Specifically, XCG modeled the reduction in stormwater runoff and the corresponding reduction in CSO volume for various control alternatives being considered for the Lick Run watershed.

A. Original Model

For the Long-Term Control Plan (LTCP) and the Capacity Assurance Program Plan, the combined and sanitary collection system tributary to the Mill Creek Wastewater Treatment Plant (WWTP) was modeled. This model is known as the System Wide Model (SWM). The SWM included manholes, pipes, outfalls, and pumps. The flows in the system were developed using surface runoff to combined sewers, rainfall derived inflow and infiltration (RDII) in sanitary sewers, and dry weather flow throughout the system.

In August 2007, a model of Lick Run was developed for the Low Impact Development (LID) Assessment investigation. For this effort, the first step was to isolate the Lick Run watershed from the SWM to reduce the time required to perform multiple model runs. As part of this isolation, the catchment delineation and model parameters (i.e., slope, percent impervious) were adjusted to improve calibration and ease modeling of LID.

B. Catchment Realignment

Working with other team members, XCG updated the August 2007 Lick Run mode. The runoff parameters (area, percent impervious area, width, and slope) were revised to reflect the realigned catchments. The infiltration parameters of the catchments were kept the same as the original model.

One change to the August 2007 model was the restriction of the flow to the Auxillary Mill Creek Interceptor 1 to the WWTP to 10 cubic feet per second (cfs) as modeled in the LTCP.

Using flow data collected for the 2007 study, the realigned model results were compared with three observed storms to validate calibration. The results are shown in the Appendix D and are summarized in Table 3.02-1.

Storm	Observed Peak Flow (cfs)	Model Peak Flow (cfs)	Difference	Total Volume Observed (MG)	Total Volume Model (MG)	Difference
Oct 16-17, 2006	515	694	35%	105	106	1%
Oct 26-27, 2006	450	521	16%	117	106	-10%
Dec 31, 2006	419	440	5%	46	47	3%

Source: XCG Consultants, Inc.

Table 3.02-1 Validation of Model Calibration

3.03 MULTIFACETED WET WEATHER SOLUTIONS

After completing the watershed inventory analysis of the Lick Run watershed, the Lick Run Wet Weather Strategy Team explored and identified an array of wet weather strategies for the Lick Run watershed. The approach included strategic storm sewer separation, daylighting the historical Lick Run stream along Queen City Avenue and Westwood Avenue, downspout disconnection. Other strategies considered include: reforestation, detention, and real-time control. In addition, the team identified priority areas as well as redevelopment opportunities throughout the watershed. The priority areas were defined as those where the largest amount of stormwater could be removed for the least amount of cost through system separation.

A. Strategic Storm Sewer Separation

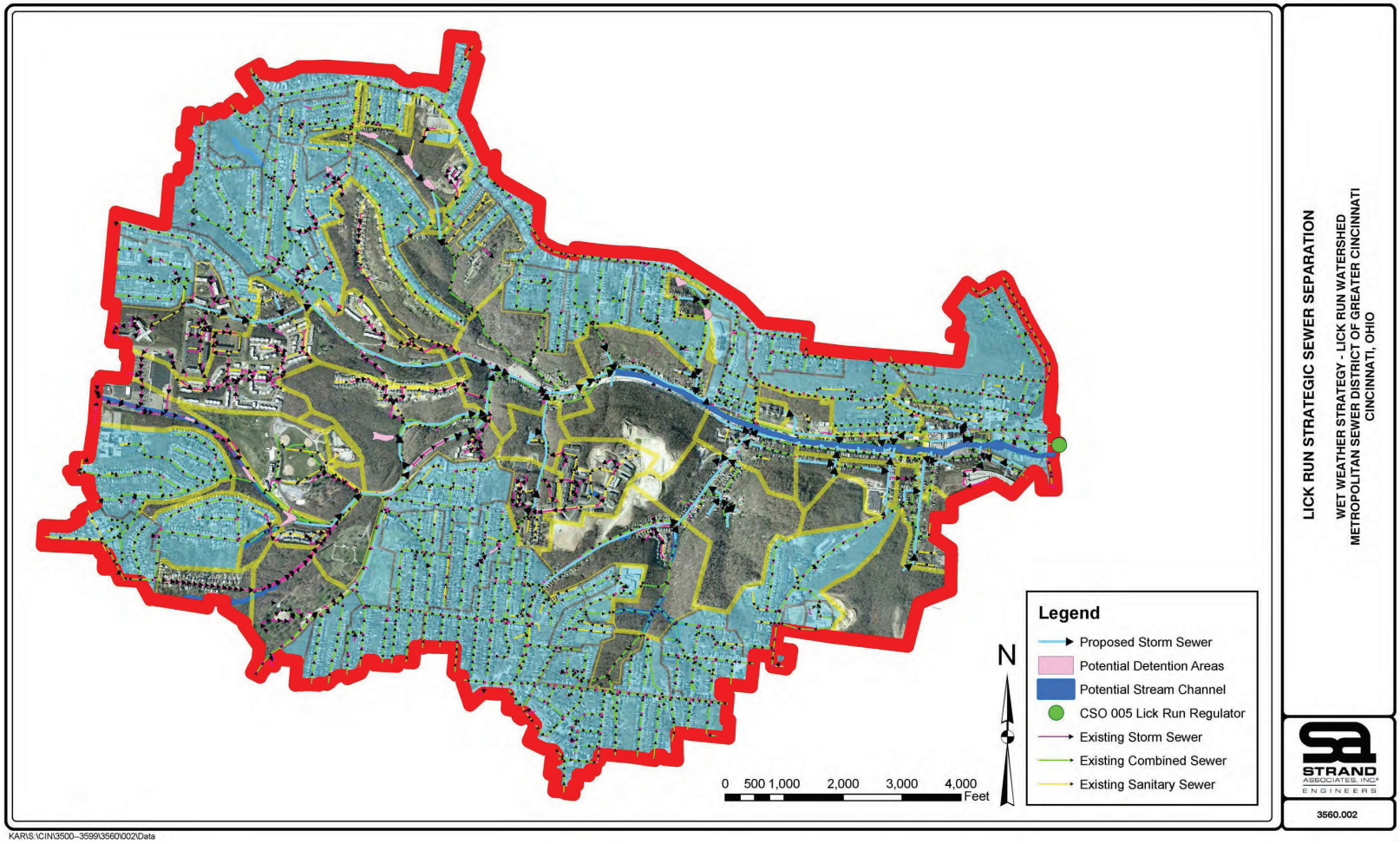
The first step in the sewer separation evaluation included identification of “priority” subcatchments where the proposed storm sewer could be cost-effectively installed. The plan is to construct a new storm sewer system and allow the existing combined sewer to serve the sanitary needs of the priority subcatchments. The priority subcatchments were strategically determined with the goal of capturing as much stormwater as possible while constructing the least amount of new storm sewer.

The strategic sewer separation approach targeted stream entry points, large undeveloped hillsides, and areas that were already separated but eventually discharged into the CSS. Essentially, highly-developed areas that would require extensive separation were avoided.

Based on GIS information, the strategic sewer separation in priority basins would require approximately 46,000 linear feet of new storm sewer, and approximately 1,040 new or retrofitted catch basins. Assuming that a manhole would be installed for every 400 linear feet of proposed storm sewer, an estimated 115 manholes would be necessary. This new storm sewer would ultimately discharge into the proposed, daylighted stream channel on the east end of the basin. Figure 3.03-1 illustrates the priority basins and proposed storm sewer.

FIGURE 3.03-1

LICK RUN STRATEGIC SEWER SEPARATION



1. Stormwater Benefits

In order to determine the reduction in CSO, Strand worked with XCG to incorporate the separation strategy into the CSO 005 model. Each basin was given a percent effective number that was applied to the model. Percent effective numbers were based on existing GIS information including impervious area, land use, topography, and soils. A high percent effective number was used in undeveloped areas, while lower percent effective numbers were used in developed areas where downspouts may be connected or buildings may be internally drained. Table 3.03-1 shows the percent effective assigned to each of the priority basins.

Catchment	Percent Effective		Catchment	Percent Effective
LMC001C0044x	90%		LMC01AC0047	85%
LMC001C0094	75%		LMC01AC0048	85%
LMC001C0167	90%		LMC01AC0050	75%
LMC001C0177	70%		LMC01AC0050U	95%
LMC001C0177C	70%		LMC01AC0053	85%
LMC001C0191	90%		LMC01AC0101Cx	95%
LMC001C0192	85%		LMC01AC0171x	90%
LMC001C0192PO	95%		LMC01AC0195	95%
LMC001C0194	80%		LMC01AC0205	85%
LMC001C0225	60%		LMC01AC0207	90%
LMC001C0225U	95%		LMC01AC0208x	95%
LMC001C0236	75%		LMC01AC0209x	85%
LMC001C0236U	95%		LMC01AC0213xc	75%
LMC001C0266	75%		LMC01AC0213xd	80%
LMC005C0290PBx	90%		LMC01AC0213xe	90%
LMC005C0290x	85%		LMC01AC0241	95%
LMC01AC0017x	95%		LMC01AC0251x	90%
LMC01AC0025	80%		LMC01AC0252	90%
LMC01AC0025PO	90%		LMC01AC0265	85%
LMC01AC0031x	95%		LMC01AC0290x	85%

Source: Strand Associates, Inc.® and XCG Consultants, Inc.

Table 3.03-1 Priority Basins Percent Effective

2. Cost Analysis

Since the project is in the conceptual stage and detailed engineering evaluations have not been performed, multiple assumptions were made to determine preliminary opinions of probable costs. It was assumed that the proposed storm sewer will be the same size as the adjacent

combined sewer (Alternative A). For comparison purposes the cost analysis also involved an alternative that sized the storm sewer one standard pipe size smaller than the existing, adjacent combined sewer (Alternative B).

For planning purposes the team used the following set of cost assumptions:

a. For storm sewer installed in grass, a unit cost of $7 per inch-diameter foot was used, and for storm sewer installed under pavement, a unit cost of $11 per inch-diameter foot was used. Therefore, the planning level construction cost of a 12-inch-diameter sewer was $132 per linear foot under pavement.

b. The planning level construction cost for proposed catch basins was $2,000 per catch basin.

c. The planning level construction cost for manholes varied depending on the size of storm sewer. The following costs were used for manholes:

(1) $2,500 per manhole for 12- to 18-inch-diameter pipes
(2) $4,000 per manhole for 21- to 54-inch-diameter pipes
(3) $10,000 per manhole for 60- to 168-inch-diameter pipes

Per the PMC/MSD costing manual titled ***Metropolitan Sewer District of Greater Cincinnati Capacity Assurance Program Plan–Project Cost Estimate Reference Document,*** total capital costs were derived by multiplying estimated construction costs by a factor of 1.67 to account for such things as program management, administration, field engineering and inspection, construction contingency, and funding. The opinion of probable cost for Alternative A was $41 million and the opinion of probable costs for Alternative B was $36.5 million. These scenarios are represented in Figure 3.03-2. See Figure 3.03-3 for a map of storm sewer sizes throughout the watershed.

FIGURE 3.03-2

STRATEGIC SEWER SEPARATION COST ANALYSIS

STRATEGIC SEWER SEPARATION COST ANALYSIS

Alternative A: Pipe Size is Equal to Adjacent Combined Pipe

New Storm Sewer & Manholes - Grass

Storm Sewer Pipe				Manholes		
Diameter (in)	Length (ft)	Unit Cost	Cost	Manholes	Unit Cost	Cost
12	5,959	$ 84	$ 501,000	15	$2,500	$37,244
15	181	$ 105	$ 19,000	0	$2,500	$1,131
18	507	$ 126	$ 64,000	1	$2,500	$3,169
21	0	$ 147	$ -	0	$4,000	$0
24	408	$ 168	$ 69,000	1	$4,000	$4,080
27	427	$ 189	$ 81,000	1	$4,000	$4,270
42	206	$ 294	$ 61,000	1	$4,000	$2,060
48	1,586	$ 336	$ 533,000	4	$4,000	$15,860
54	0	$ 378	$ -	0	$4,000	$0
60	1,645	$ 420	$ 691,000	4	$10,000	$41,125
78	0	$ 546	$ -	0	$10,000	$0
84	190	$ 588	$ 112,000	0	$10,000	$4,750
156	151	$ 1,092	$ 165,000	0	$10,000	$3,775
168	466	$ 1,176	$ 548,000	1	$10,000	$11,650
Sub Totals:	11,726	-	$ 2,840,000	29	-	$129,114

New Storm Sewer & Manholes - Pavement

Storm Sewer Pipe				Manholes		
Diameter (in)	Length (ft)	Unit Cost	Cost	Manholes	Unit Cost	Cost
12	11,694	$ 132	$ 1,544,000	29	$2,500	$73,088
15	1,003	$ 165	$ 165,000	3	$2,500	$6,269
18	2,312	$ 198	$ 458,000	6	$2,500	$14,450
21	239	$ 231	$ 55,000	1	$4,000	$2,390
24	669	$ 264	$ 177,000	2	$4,000	$6,690
27	1,738	$ 297	$ 516,000	4	$4,000	$17,380
42	189	$ 462	$ 87,000	0	$4,000	$1,890
48	306	$ 528	$ 162,000	1	$4,000	$3,060
54	2,570	$ 594	$ 1,527,000	6	$4,000	$25,700
60	4,041	$ 660	$ 2,667,000	10	$10,000	$101,025
78	2,097	$ 858	$ 1,799,000	5	$10,000	$52,425
84	5,672	$ 924	$ 5,241,000	14	$10,000	$141,800
156	940	$ 1,716	$ 1,613,000	2	$10,000	$23,500
168	784	$ 1,848	$ 1,449,000	2	$10,000	$19,600
Sub Totals:	34,254	-	$ 17,460,000	86	-	$489,266

Additional Pipe to Connect Inlets to System			
12	12,950	$ 132	$ 1,709,000

Storm Inlets

Storm Inlets	Unit Cost	Cost
1036	$ 2,000	$ 2,072,000

Assumptions

Cost/in-diameter-feet (pavement)	$ 11
Cost/in-diameter-feet (grass)	$ 7
Cost for inlet replacement	$ 2,000
Manhole spacing (ft)	400
Pipe to Connect Inlets to System:	
Sewer installed in center of roadway	
Average road width (ft):	25
Additional pipe needed per inlet (ft):	12.5
Percent contingency	66%

Strategic Separation Costs

Sub Total:	$ 24,570,266
Contingency:	$ 16,301,591
Total Separation Cost:	$ 41,000,971

Alternative B: Pipe Is One Size Smaller than the Adjacent Combined Pipe

New Storm Sewer & Manholes - Grass

Storm Sewer Pipe				Manholes		
Diameter (in)	Length (ft)	Unit Cost	Cost	Manholes	Unit Cost	Cost
12	5,959	$ 84	$ 501,000	15	$2,500	$37,244
15	688	$ 105	$ 72,000	2	$2,500	$4,300
18	0	$ 126	$ -	0	$2,500	$0
21	408	$ 147	$ 60,000	1	$4,000	$4,080
24	427	$ 168	$ 72,000	1	$4,000	$4,270
27	206	$ 189	$ 39,000	1	$4,000	$2,060
42	1,586	$ 294	$ 466,000	4	$4,000	$15,860
48	0	$ 336	$ -	0	$4,000	$0
54	1,645	$ 378	$ 622,000	4	$4,000	$16,450
60	0	$ 420	$ -	0	$10,000	$0
78	190	$ 546	$ 104,000	0	$10,000	$4,750
84	151	$ 588	$ 89,000	0	$10,000	$3,775
156	466	$ 1,092	$ 509,000	1	$10,000	$11,650
168	0	$ 1,176	$ -	0	$10,000	$0
Sub Totals:	11,726	-	$ 2,530,000	29	-	$104,439

New Storm Sewer & Manholes - Pavement

Storm Sewer Pipe				Manholes		
Diameter (in)	Length (ft)	Unit Cost	Cost	Manholes	Unit Cost	Cost
12	11,694	$ 132	$ 1,544,000	29	$2,500	$73,088
15	3,315	$ 165	$ 547,000	8	$2,500	$20,719
18	239	$ 198	$ 47,000	1	$2,500	$1,494
21	669	$ 231	$ 155,000	2	$4,000	$6,690
24	1,738	$ 264	$ 459,000	4	$4,000	$17,380
27	189	$ 297	$ 56,000	0	$4,000	$1,890
42	306	$ 462	$ 141,000	1	$4,000	$3,060
48	2,570	$ 528	$ 1,357,000	6	$4,000	$25,700
54	4,041	$ 594	$ 2,400,000	10	$4,000	$40,410
60	2,097	$ 660	$ 1,384,000	5	$10,000	$52,425
78	5,672	$ 858	$ 4,867,000	14	$10,000	$141,800
84	940	$ 924	$ 869,000	2	$10,000	$23,500
156	784	$ 1,716	$ 1,345,000	2	$10,000	$19,600
168	0	$ 1,848	$ -	0	$10,000	$0
Sub Totals:	34,254	-	$ 15,170,000	86	-	$427,755

Additional Pipe to Connect Inlets to System			
12	12,950	$ 132	$ 1,709,000

Storm Inlets

Storm Inlets	Unit Cost	Cost
1036	$ 2,000	$ 2,072,000

Assumptions

Cost/in-diameter-feet (pavement)	$ 11
Cost/in-diameter-feet (grass)	$ 7
Cost for inlet replacement	$ 2,000
Manhole spacing (ft)	400
Pipe to Connect Inlets to System:	
Sewer installed in center of roadway	
Average road width (ft):	25
Additional pipe needed per inlet (ft):	12.5
Percent contingency	66%

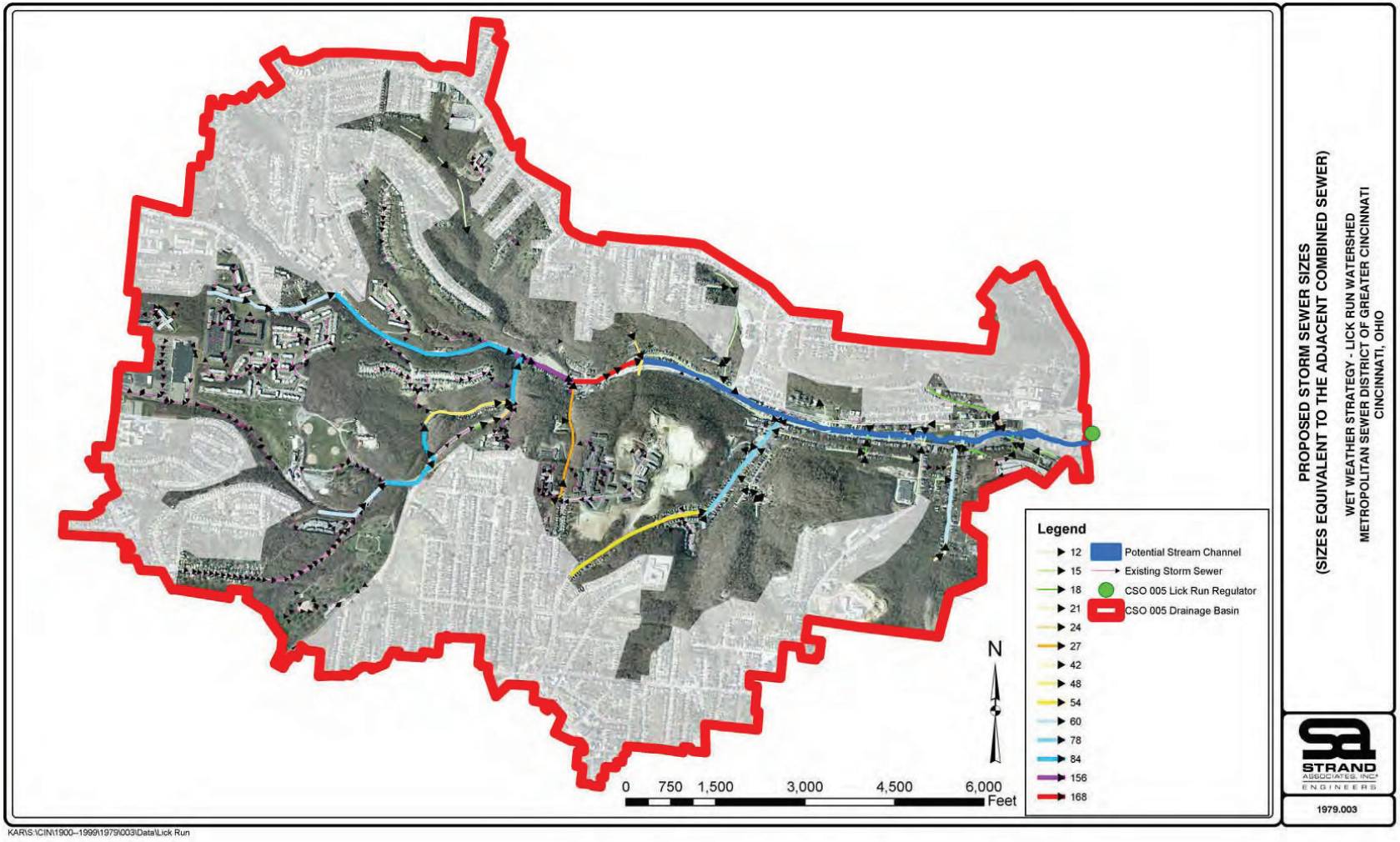
Strategic Separation Costs

Sub Total:	$ 21,913,194
Contingency:	$ 14,528,708
Total Separation Cost:	$ 36,541,902

DRAFT
Strand Associates, Inc
July 2, 2009

FIGURE 3.03-3

STORM SEWER SIZES THROUGHOUT WATERSHED



B. Stream Daylighting

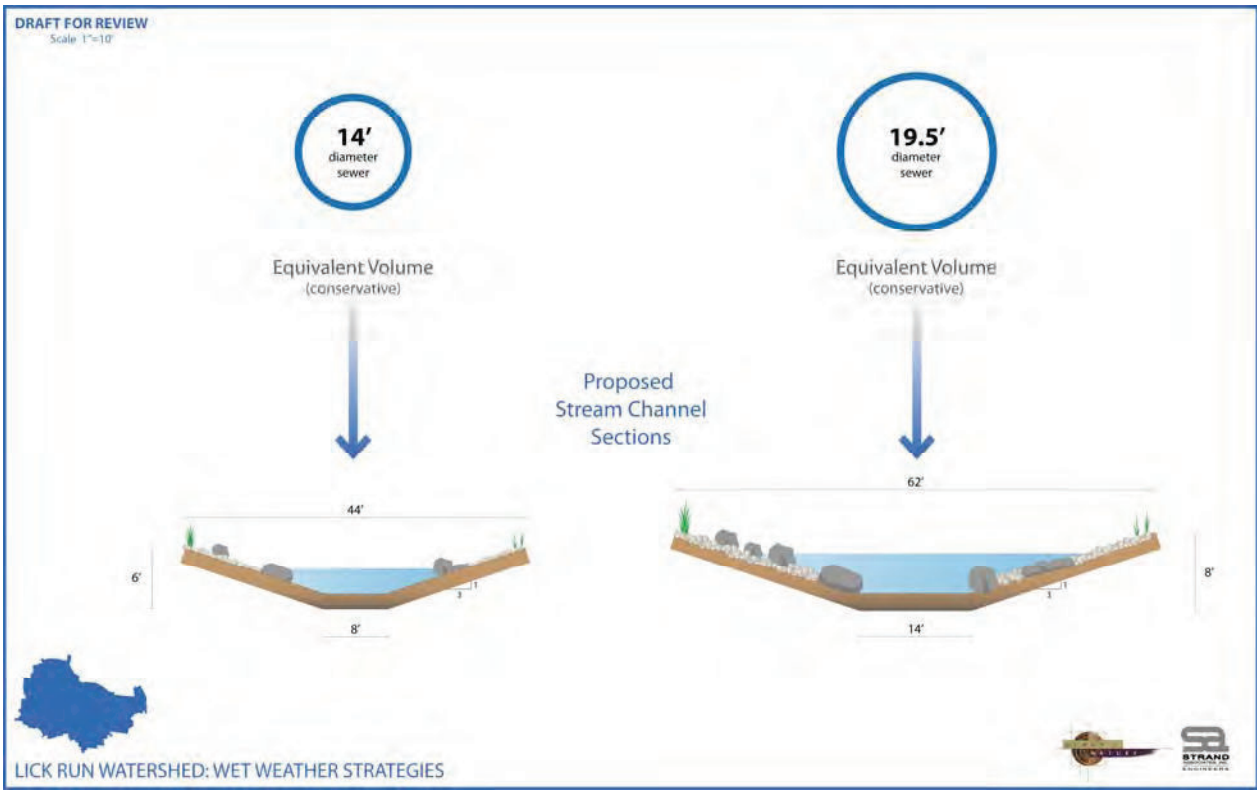
The proposed storm sewers will discharge into a proposed restored stream channel along Queen City Avenue and Westwood Avenue. This stream channel iis proposed to extend from the intersection of the Old Queen City Avenue with the New Queen City Avenue to Mill Creek on the east end of the basin, and will be approximately 8,000 feet long.

1. Stormwater Water Quality Benefits

Water quality and quantity benefits are achieved by removing stormwater from the combined sewer and returning it to a new, redeveloped urban stream channel. When stormwater is removed from the combined system, it frees up capacity in the system for sanitary flow. The additional capacity in the combined sewer can accommodate the sanitary flow and fewer overflows will discharge into the Mill Creek. Water that flows through the urban stream channel will improve the quality of the Mill Creek and the diversity of fish and other aquatic life that live in the streams.
The stream will convey stormwater runoff that has been removed from the CSS and will directly discharge into Mill Creek. The channel will be sized to provide the community with an equivalent or greater level of flood protection than exists today.

2. Preliminary Stream Channel Cross Sections

A preliminary analysis of the existing level of service that the Lick Run sewer currently provides indicates that adequate space exists between Queen City and Westwood to daylight the Lick Run stream and provide flood protection. The cross sections represented in Figure 3.03-4 show that a trapezoidal channel with a bottom width of 8-feet, depth of 6-feet, and 3 to 1 side slopes will convey an equivalent volume to the 14-foot diameter sewer located upstream of the 19.5' diameter sewer that currently outfalls into Mill Creek during storm events. Similarly, a trapezoidal channel with a bottom width of 14-feet, depth of 8-feet, and 3 to 1 side slopes will convey an equivalent volume to the 19.5-foot diameter sewer. The space between Queen City and Westwood Avenue amounts to approximately 150 feet on the west end of the proposed stream channel near Quebec Avenue and approximately 350 feet on the east end where the proposed stream discharges into Mill Creek. A more detailed condition assessment of the 19.5 foot sewer and identification of utilities must be completed to confirm the technical feasibility of the proposed daylighted channel and provide an adequate level of service for flood protection.



Source: Strand Associates, Inc.® and Human Nature

Figure 3.03-4 Preliminary Stream Channel Cross Sections

3. Cost Analysis

Based upon experience with similar projects, a preliminary opinion of probable costs was developed for the construction of the stream channel. Preliminary costs were developed for two scenarios: a basic channel and an enhanced channel. The enhanced channel includes greater amenities and an upgraded level of “fit and finish”.

The following elements were included in the basic channel cost:

a. Basic channel construction (6-foot deep; 93-foot wide on the east end and 45-foot wide on the west end of the channel).

b. Nine cast-in-place clear span bridges.

c. Water main relocations for crossing the new channel.

d. Sanitary sewer relocation for crossing the new channel.

The following elements were included in the enhanced channel costs:

a. Enhance Restoration: bike paths, restored sidewalks, aeration feature, concrete overlook at bridges with canopies, enhanced lighting, blue light emergency telephones, interpretive signs, benches, trash receptacles, enhanced landscaping, active recreation area, amphitheater with landscaped sitting area, sheltered gathering spaces, security lighting and cameras, and drinking fountains.

b. Roadway improvements: Westwood reconstruction with streetscaping; Queen City reconstruction with streetscaping; and three roundabouts.

c. Enhanced Conspan architectural multicell bridges.

d. Level control facility.

e. Pond area with landscaping.

f. Low-flow channel with concrete bottom and cut stone lined sides.

g. Water main and water service replacements (Westwood and Queen City).

h. Sewer main and sewer service replacements (Westwood and Queen City).

The preliminary opinion of probable cost for the base construction of the channel was $13.5 million and the enhanced construction cost would add another $44.5 million. Therefore, for planning and budgeting purposes the $58 million value has been utilized in developing total project cost values.

C. Reforestation

A watershed's tree canopy provides valuable benefits in regard to natural stormwater management, air quality improvement, habitat, and quality of life. Reforestation can be an effective tool at reducing the quantity of stormwater runoff and improving the quality of runoff. A CITYgreen™ evaluation was performed for the Lick Run watershed. CITYgreen™, a GIS-based tool that analyzes the ecological and economic benefits of tree canopy cover, was developed by American Forests, Inc., a pioneer in the science and practice of urban forestry. In addition to computing air pollution removal and carbon storage, this tool calculates storm water runoff using the Natural Resource Conservation Service (NRCS) model (TR-55 method). With this model, it was necessary to delineate and classify land cover types throughout the watershed. Figure 3.03-5 shows the type and distribution of land cover classes.

Source: Human Nature, Inc

Figure 3.03-5 Land Cover Map

Based on the CITYgreen™ analysis, the existing canopy cover provides approximately 56.8 million gallons of storage volume in the Lick Run watershed during a 2-year, 24-hour storm event of 2.86 inches. This storm event was obtained from Table 8, Page 184 of the ***Rainfall Frequency Atlas of the Midwest***[1]. This value for storage volume (56.8-million gallons) represents the volume of additional stormwater to be managed if the trees were removed from the landscape.

Human Nature also investigated tree canopy benefits in terms of annual rainfall using the 1970 typical year precipitation dataset. Table 3.03-2 summarizes the annual benefits from existing canopy cover based on the seven rain event categories. In a typical year, the existing tree canopy provides an annual benefit of approximately 1.21-billion gallons.

[1] Huff, Floyd A., and James R. Angel. 1992. *Rainfall Frequency Atlas of the Midwest*. Midwestern Climate Center (MCC) and Illinois State Water Survey. MCC Research Report 92-03. Champaign, Illinois.

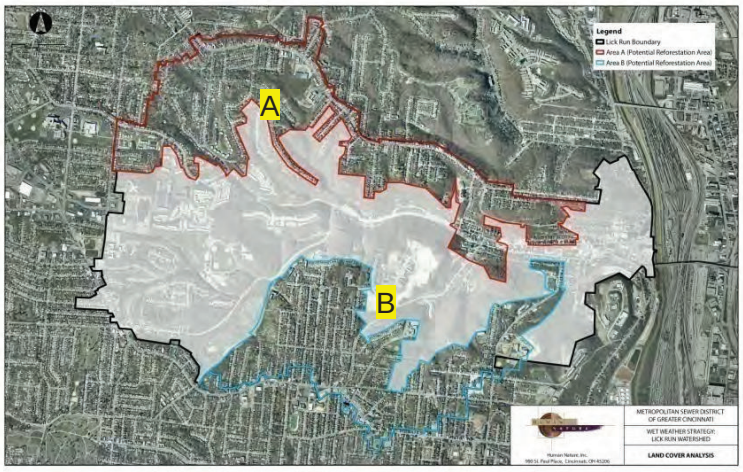
Rain Event (in)	Annual Benefit (MG)
0.25	8
0.50	239
0.75	283
1.00	364
1.50	132
2.00	55
2.50	125
TOTAL:	1,207

Source: Human Nature, Inc

Table 3.03-2 Summary of Annual Benefits from Existing Canopy Cover

1. Reforestation Scenario

The Lick Run watershed covers approximately 2,720 acres. With such a large area, it would be unrealistic to recommend reforestation for all canopy-deficient areas; additionally, with the installation of separate storm sewers in the center of the watershed, a strategic focus was placed on areas where the combined system would remain. therefore the watershed was divided into two separate, potential reforestation areas: Area A and Area B. Area A covers approximately 675 acres in the northern portion of the watershed, and Area B covers 450 acres in the southern portion. These areas were chosen because they were classified as combined sewer/nonpriority catchments, and because reforestation could supplement or replace more costly wet weather strategies. Figure 3.03-6 shows the boundaries for the two potential reforestation areas.



Source: Human Nature, Inc

Figure 3.03-6 Potential Reforestation Areas

Integrating the results from the CITYgreen™ analysis in areas A and B, Human Nature quantified the potential annual benefit from reforestation. Reforesting a total of 135 acres would capture 64.1-million gallons of stormwater runoff annually. The annual benefit from proposed reforestation in the Lick Run watershed is summarized in Table 3.03-3. Note that this value does not represent a direct correlation with reduction in annual CSO volume.

Rain Event (in)	Annual Benefit (MG)
0.50	6
0.75	13
1.00	21
1.50	9
2.00	4
2.50	10
TOTAL:	64

Source: Human Nature, Inc

Table 3.03-3 Summary of Annual Benefits from Proposed Reforestation

4. Retrofitted/Proposed Detention Basins

The team identified and evaluated existing detention basins and the opportunity to retrofit these basins to reduce CSOs. The team also evaluated potential areas in which new detention facilities could be installed. This evaluation led to the identification of fifteen low-lying areas which could serve as detention basins. Nine of these areas were located in the priority basins and the other six were located in combined sewer/nonpriority basins. At this point in the evaluation process, the team decided to include the nine detention basins located in priority basins as part of our multipronged solution. This coarse evaluation for detention basin opportunities will be further defined as more opportunities are identified during the feasibility study. Figure 3.03-7 shows the fifteen proposed detention areas throughout the watershed.

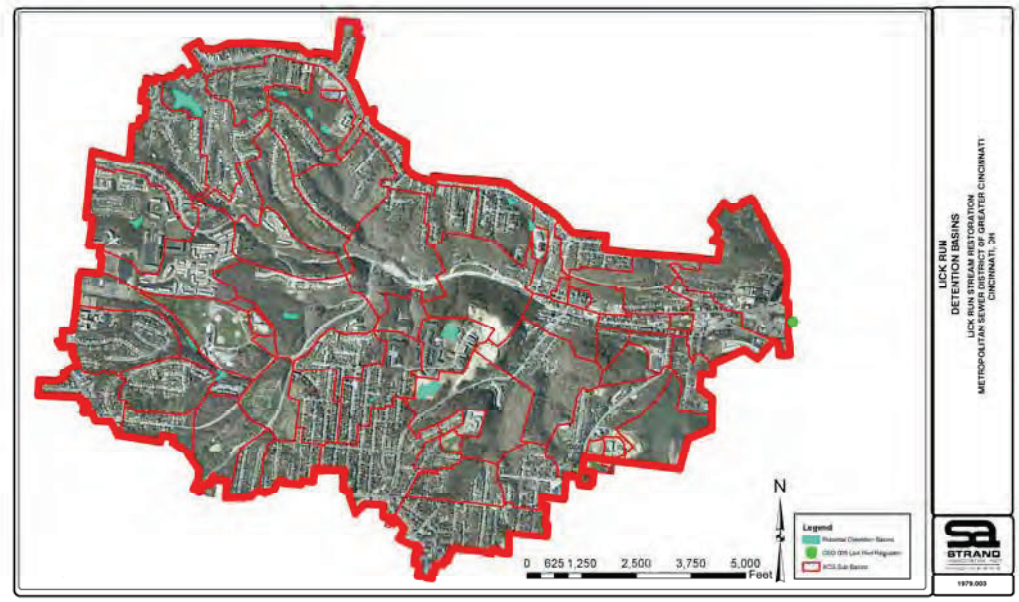


Figure 3.03-7 Potential Detention Opportunities

5. Downspout Disconnection

Utilizing GIS data, the total square footage of single and multifamily (2 or 3 family dwellings) rooftops was calculated for each combined sewer/nonpriority basin. The results of this effort indicated that, approximately 4,996,000 square feet or residential rooftop is connected to the combined system in the combined sewer/nonpriority area. Therefore, single and multifamily rooftops account for 96 percent of the impervious area within the Lick Run Basin combined sewer/nonpriority areas. By disconnecting roof downspouts, a significant portion of this impervious area can be removed from the combined system.

In estimating the potential stormwater reduction from disconnecting downspouts, each basin was assigned an effectiveness and participation rating. The “effectiveness” rating was based on criteria such as soil conditions, lot size, and density of the homes. This variable is intended to provide an estimate of the percentage of the stormwater removed through the disconnection that somehow flows back into the CSS through either direct or indirect means. Even if a downspout is disconnected from the CSS, some of the redirected runoff still may have the potential to reenter the CSS. The “participation” rating was based on local knowledge of the neighborhoods and willingness to participate in the disconnection program.

For the purpose of the Lick Run combined sewer/nonpriority basin downspout disconnection evaluation an effectiveness rating of 60 percent and a participation rating of 50 percent was applied to the residential rooftop area of each basin. For example, if a particular sewershed had 100,000 square feet of residential roof, 50 percent or 50,000 square feet would be disconnected from the combined system. However based on the 60 percent effectiveness rating only the runoff from 30,000 square feet would be removed from the CSS.

In order to determine the total number of downspouts within each basin the team evaluated the residential buildings throughout the watershed and estimated that approximately 200 square feet of impervious rooftop area drains to a typical downspout. Based on the total number of downspouts and participation rate, the program estimates assume that 12,000 downspouts will be disconnected.

Based on an evaluation of anticipated administrative and reimbursement costs, $250 per downspout was used to establish a program budget. In order to determine the estimated benefit of the disconnection program, typical year rainfall data was used to calculate the estimated runoff that could be removed from the CSS.

Using conservative estimates for each program variable, shown in Table 3.03-4, it has been estimated that once fully implemented the downspout disconnection program will remove approximately 38 million gallons of stormwater annually, from the Lick Run basins that remain combined sewer, and cost approximately $3 million.

Roof area that drains to a typical downspout:	200 sf
Cost to disconnect one downspout:	$250
Typical year rainfall:	41.17 in
Percent Effective:	60%
Percent Participation:	50%

Table 3.03-4 Downspout Disconnect Assumptions

See Tables 3.03-5 and 3.03-6 for a full listing of downspout disconnection evaluation results for each basin to remain as combined sewer.

Catchment	Residential Building Area (sf)	Total Downspouts Connected	Impervious Area Removed (sf)	Gallons Removed from System	Total Cost
LMC001C0014	526,899	2634	263,400	4,055,994	$329,250
LMC001C0043	95,226	476	47,600	732,974	$59,500
LMC001C0043PB	98	0	-	0	$0
LMC001C0043PO	0	0	-	0	$0
LMC001C0044a	65,496	327	32,800	505,074	$41,000
LMC001C0044b	69,016	345	34,600	532,792	$43,250
LMC001C0066	154,700	774	77,400	1,191,852	$96,750
LMC001C0072	367,532	1838	183,800	2,830,264	$229,750
LMC001C0093	121,541	608	60,800	936,235	$76,000
LMC001C0093PB	0	0	-	0	$0
LMC001C0093PO	0	0	-	0	$0
LMC001C0123	121,403	607	60,800	936,235	$76,000
LMC001C0136	62,445	312	31,200	480,437	$39,000
LMC001C0159	131,924	660	66,000	1,016,308	$82,500
LMC001C0195	113,804	569	57,000	877,721	$71,250
LMC005C0290	223,775	1119	111,800	1,721,565	$139,750
LMC005C0290PB	0	0	-	0	$0
LMC005CNortheast	131,769	659	65,800	1,013,228	$82,250
LMC01AC0010	130,247	651	65,200	1,003,989	$81,500
LMC01AC0017	235,620	1178	117,800	1,813,956	$147,250
LMC01AC0025POx	0	0	-	0	$0
LMC01AC0031	195,923	980	98,000	1,509,064	$122,500
LMC01AC0053R	111,790	559	55,800	859,242	$69,750

Table 3.03-5 Downspout Disconnect Evaluation

Catchment	Residential Building Area (sf)	Total Downspouts Connected	Impervious Area Removed (sf)	Gallons Removed from System	Total Cost
LMC01AC0065	169,324	847	84,600	1,302,722	$105,750
LMC01AC0073	194,096	970	97,000	1,493,665	$121,250
LMC01AC0101	173,568	868	86,800	1,336,599	$108,500
LMC01AC0101C	3,913	20	2,000	30,797	$2,500
LMC01AC0125	58,855	294	29,400	452,719	$36,750
LMC01AC0126	222,903	1115	111,400	1,715,405	$139,250
LMC01AC0126x	17,387	87	8,600	132,428	$10,750
LMC01AC0136	175,070	875	87,600	1,348,918	$109,500
LMC01AC0136x	40,448	202	20,200	311,052	$25,250
LMC01AC0171	105,478	527	52,800	813,047	$66,000
LMC01AC0178	50,245	251	25,200	388,045	$31,500
LMC01AC0208	135,191	676	67,600	1,040,946	$84,500
LMC01AC0209a	18,074	90	9,000	138,587	$11,250
LMC01AC0209b	42,847	214	21,400	329,530	$26,750
LMC01AC0209c	40,057	200	20,000	307,972	$25,000
LMC01AC0213	136,036	680	68,000	1,047,105	$85,000
LMC01AC0213xa	32,495	162	16,200	249,457	$20,250
LMC01AC0213xb	76,658	383	38,400	591,307	$48,000
LMC01AC0251	212,100	1061	106,000	1,632,253	$132,500
LMC01AC0269	138,109	691	69,000	1,062,504	$86,250
LMC01AC0290	94,123	471	47,000	723,735	$58,750
TOTALS:	4,996,185	24,981	2,498,000	38,465,726	3,122,500

Table 3.03-6 Downspout Disconnect Evaluation (continued)

3.04 MODEL RESULTS

Once the watershed alternatives were evaluated and refined, Strand prioritized the alternatives that provided the most benefit to CSO 005 and worked with XCG to incorporate these wet weather solutions into the Lick Run Model.

A. Stormwater System

XCG added a parallel pipe network to the model for the stormwater captured from the newly-separated catchments and directed those pipes toward the proposed daylighted stream. To reduce the processing time required to simulate the various control alternatives being considered, the storm network was modeled as an identically-sized parallel system to the CSS proposed. The elevations, lengths, and diameters of the stormwater pipes are the same as the combined system with the roughness adjusted to match the presumed concrete of the stormwater system.

In evaluating the stormwater reduction, to be addressed through separation, it was assumed that some stormwater would continue to enter the combined system. Through means such as incompleteness, leaks in the combined sewers, and hidden connections such as abandoned downspout connections.

To model this condition, catchments were assigned a percent effective based on estimated likelihood of problems. Priority catchments were split into two subcatchments so one subcatchment flowed to the stormwater system and a second flowed to the combined system. The areas of the split subcatchments were proportional to the percent effectiveness. The two subcatchments were identical except for the area and the width (area divided by flow-path length).

B. Downspout Disconnection

Disconnection of downspouts was examined to see the impact on the combined sewer outside the stormwater system. For modeling purposes, a decrease in impervious area for the affected catchments was made proportional to the percent effectiveness of downspout disconnection. A value of 30 percent effectiveness was assumed for downspout disconnection based on previous experience by the Lick Run Wet Weather Strategy team.

C. Detention Storage

Detention of stormwater was examined to see the impact on the combined sewer. Six detention areas were modeled in combined sewer/nonpriority areas. The volume of each detention area was found using the topography of the site. The outflow was assumed to be a small pipe (6 inch or 12 inch) flowing into the combined system.

D. Results

Based on the calibration storms modeled using the updated catchments, the existing conditions model was considered reasonably calibrated for the level of effort of this study. The existing conditions were modeled for the 2-year 24-hour, 10-year 24-hour, and the 1970 Typical Year rainfalls. The dry weather flow from the Lick Run basin entering the Auxillary Mill Creek Interceptor 1 was found to be 8.5 cfs or 5.5 million gallons per day. The wet weather volume was found by subtracting the dry weather flow volume from the total flow volume reaching the CSO regulator. The volumetric percent control of the event was the overflow volume divided by the wet weather volume.

In addition to the existing condition, five control alternatives were modeled and evaluated for the reduction in CSO volume from the Lick Run watershed. The results are summarized in Table 3.04-1.

1. Scenario One–Existing conditions.

2. Scenario Two–Separate stormwater system parallel to the existing combined sewer in priority areas.

3. Scenario Three–Separate stormwater system in priority areas with disconnected downspouts in combined sewer/nonpriority areas.

4. Scenario Four–Separate stormwater system in priority areas with detention basins routed to the existing combined sewer.

5. Scenario Five–Separate stormwater system in priority basins with detention basins routed to the proposed stormwater system.

6. Scenario Six–Separate stormwater system in priority basins with detention basins routed to the proposed stormwater system and disconnected downspouts in combined sewer/nonpriority areas.

Scenarios	Typical Year		2-Yr Storm		10-Yr Storm	
	Overflow (MG)	% Control	Overflow (MG)	% Control	Overflow (MG)	% Control
1. Existing	1,784	2.5%	160	0.6%	215	0.5%
2. Parallel Pipe	1,109	39.4%	108	33.0%	157	27.6%
3. Parallel Pipe and Downspout Disconnect	1,049	42.7%	104	35.4%	151	30.1%
4. Parallel Pipe with Detention Routed to Existing System	1,105	39.5%	108	32.8%	158	27.1%
5. Parallel Pipe with Storage Routed to Parallel Pipe	1,043	43.0%	105	35.0%	152	29.6%
6. Parallel Pipe with Storage Routed to Parallel Pipe and Downspout Disconnect	987	46.1%	98	39.1%	143	34.1%

Source: XCG Consultants, Inc.

Table 3.04-1 Model Results

With an existing annual overflow volume of 1,784 million gallons, the model indicates that if the projects identified in Scenario 6 is implemented, the annual overflow could be reduced by 797 million gallons. This does not include the additional benefits provided by real-time control and reforestation.

SECTION 4
COMMUNITIES OF THE FUTURE OPPORTUNITIES

4.01 COMMUNITIES OF THE FUTURE-CONCEPTUAL REDEVELOPMENT

One of the primary wet weather strategies during the conceptual exploration phase was strategically removing stormwater from the combined sewer network via a daylighted stream. Stream daylighting is one wet weather strategy that can not only effectively reduce CSOs, but also create a centerpiece for economic and community redevelopment. Stream daylighting refers to separating a once-existing stream from a combined sewer and constructing an exposed, flowing waterway. In this case, the wet weather strategy involved separating the historical Lick Run from the combined sewer, and allowing water (stormwater runoff and base flows) to flow naturally to Mill Creek.

This wet weather strategy focused on South Fairmount's primary transportation corridor, which consists of westbound Queen City Avenue and eastbound Westwood Avenue. The former is an arterial roadway into Cincinnati's western neighborhoods, and the latter is an arterial roadway connecting the west to Interstate 75, the Mill Creek valley, and downtown Cincinnati. Stormwater flowing through sewers in this corridor contribute to more than one billion gallons annually of CSOs into Mill Creek.

In response to the potential for daylighting a stream in this corridor, Human Nature explored three alternative redevelopment opportunities: an Urban Ravine/Canal alternative, a Green Spine/Central Park alternative, and a Green Street/Main Street alternative. These alternatives represent a spectrum of redevelopment scenarios, from one that closely mimics existing conditions (Alternative 1), to one that represents a complete transformation of the corridor (Alternative 3). Common to each is a centralized, daylighted stream and opportunities for a mix of redevelopment and community improvements.

A. Alternative 1: Urban Ravine/Canal

The Urban Ravine/Canal alternative, shown in Figure 4.01-1, involves slightly reconfiguring the existing Queen City Avenue/Westwood Avenue alignments. Queen City Avenue is better integrated with Harrison Avenue, another main thoroughfare into the city's western neighborhoods. This alternative encourages mixed-use redevelopment (including commercial, office, and residential uses) where purple blocks are shown. Stream-side building frontage would include terraces, outdoor seating, and/or patios overlooking the stream or canal. Larger-scale, mixed-use redevelopment (industrial, institutional, and/or commercial) is proposed at the eastern end of the corridor, and historical anchor buildings, shown as black blocks in plan, are preserved. Because of steep slopes south of Westwood Avenue, this alternative includes smaller-scale redevelopment in this area. In addition to a ravine-like daylighted stream, the central area contains opportunities for trails and pathways, active recreation, and other amenities. This eastern section of the corridor would be the primary interactive, civic, and celebratory space for the neighborhood, contain pathways and promenades, and celebrate the connection of the stream to Mill Creek.

Source: Human Nature, Inc.

Figure 4.01-1 Urban Ravine/Canal Alternative

B. Alternative 2: Green Spine/Central Park

Figure 4.01-2 shows the Green Spine/Central Park alternative, which would maintain current traffic configuration (the existing Queen City/Westwood alignments). This alternative also encourages mixed-use redevelopment (including commercial, office, and residential uses) where purple blocks are shown, and larger-scale mixed-use redevelopment (industrial, institutional, and/or commercial) at the eastern end of the corridor. Historical anchor buildings, shown as black blocks in plan, are preserved. Due to steep slopes south of Westwood Avenue, smaller-scale redevelopment is proposed in this section of the corridor. The keystone of this alternative is a central greenspace, which becomes the "Central Park" for South Fairmount. This area would contain opportunities for active and passive recreation. The primary interactive, civic, and celebratory space for the neighborhood is at the eastern end of the corridor, where the connection of the stream to Mill Creek is celebrated with several large-scale detention areas. In addition to providing additional water quality benefits, these areas would integrate opportunities for recreational uses (fishing, paddle boats), and contain civic spaces and/or plazas.

Source: Human Nature, Inc.

Figure 4.01-2 Green Spine/Central Park Alternative

C. Alternative 3: Green Street/Main Street

As shown in Figure 4.01-3, the Green Street/Main Street alternative combines Queen City and Westwood Avenues into one, multilane parkway with street trees and improved traffic flow. This would integrate well with recent improvements to Queen City Avenue. The former Queen City Avenue would be transformed into a "Main Street," with an improved pedestrian realm (traffic-calming elements, street trees, and street planters). This alternative encourages mixed-use redevelopment (including commercial, office, and residential uses) where purple blocks are shown. Buildings face the Main Street, and the stream-side buildings include terraces, outdoor seating, and/or patios. Historical anchor buildings, shown as black blocks in plan, are preserved. This alternative also promotes larger-scale mixed-use redevelopment (industrial, institutional, and/or commercial) at the eastern end of the corridor, and creates a central greenspace with a daylighted stream, trail/path opportunities, active recreation, and other amenities. The primary interactive, civic, and celebratory space for the neighborhood is at the eastern end of the corridor, where the connection of the stream to Mill Creek is celebrated with a large-scale pond/detention area.

Source: Human Nature, Inc.

Figure 4.01-3 Green Street/Main Street Alternative

D. Synthesis Plan

The synthesis plan represents the recommended alternative for the South Fairmount corridor. As shown in Figure 4.01-4, this plan adopts most of the components of Alternative 3: Green Street/Main Street, and contains the following components:

1. Combine Queen City and Westwood avenues into one, multilane parkway with street trees and improved traffic flow, which integrates well with recent improvements to Queen City Avenue.

2. Transform the former Queen City Avenue into a Main Street, with an improved pedestrian realm (traffic-calming elements, street trees, and street planters).

3. Preserve architecturally-significant buildings (shown as black blocks in plan).

4. Encourage mixed-use redevelopment (including commercial, office, and residential uses) where purple blocks are shown. Buildings face the Main Street, and the stream-side buildings include terraces, outdoor seating, and/or patios.

5. Promote larger-scale mixed-use redevelopment (industrial, institutional, and/or commercial) at the eastern end of the corridor.

6. Create a central greenspace with a daylighted stream, trail/path opportunities, active recreation, and other amenities.

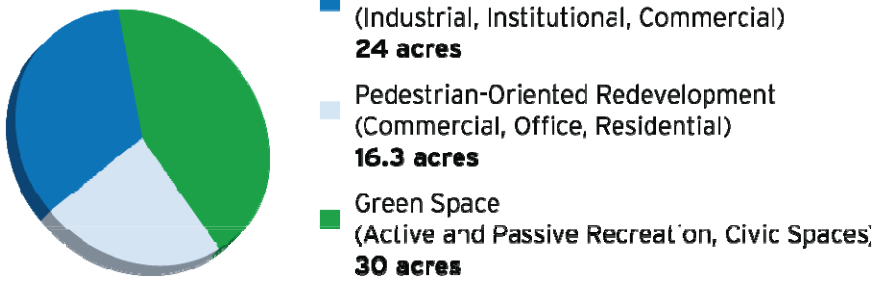
7. Celebrate the connection of the stream to Mill Creek with a large-scale pond/detention area, which would be the primary interactive, civic, and celebratory space for the neighborhood.

It should be noted that this plan is preliminary, as it was proposed prior to a detailed feasibility study.

Source: Human Nature, Inc.

Figure 4.01-4 Synthesis Plan

Figure 4.01-5 shows the distribution of redevelopment opportunities for the Preliminary Synthesis plan. The majority (30 acres) of the corridor is devoted to green space with active and passive recreation opportunities and civic spaces. There are 24 acres devoted to mixed-use redevelopment (industrial, institutional, and commercial uses), and slightly more than 16 acres proposed for pedestrian-oriented redevelopment (commercial, office, and residential uses).



Source: Human Nature, Inc.

Figure 4.01-5 Distribution of Redevelopment Opportunities for Synthesis Plan

4.02 TRAFFIC IMPROVEMENTS

Strand did a cursory review of the traffic counts provided by Ohio Department of Transportation (ODOT) and Cincinnati Department of Transportation Engineering (DOTE). This preliminary evaluation indicated that roundabouts could improve the flow of traffic for the Synthesis Plan. Figure 4.02-1 represents the current circulation of traffic in the project focus area.

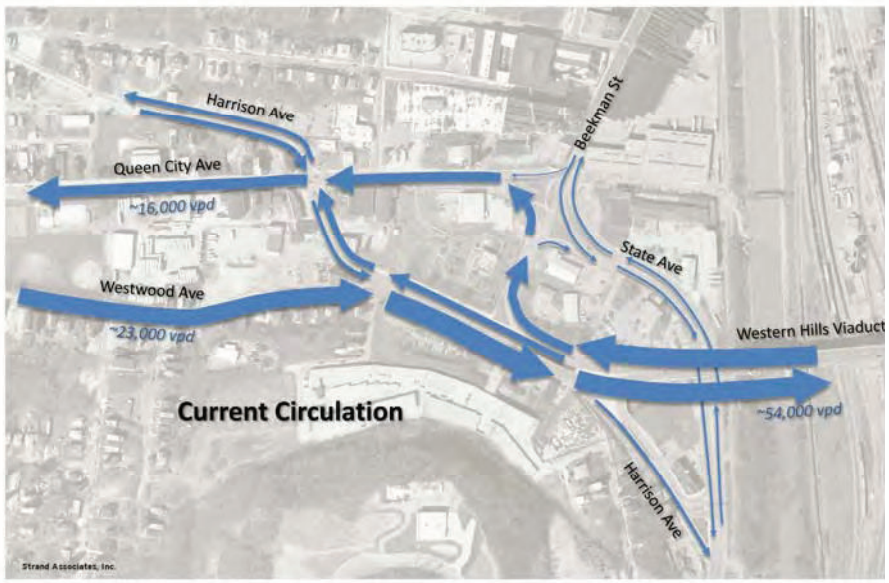


Figure 4.02-1 Existing Traffic Flow Patterns

Roundabouts provide significant benefits to the community including:

1. Improved safety.
2. Reduced traffic congestion.
3. Reduced pollution and fuel use.

Figure 4.02-2 shows a potential opportunity to improve traffic circulation with the installation of three roundabouts. Figure 4.02-3 shows an aerial view of the three proposed roundabouts.

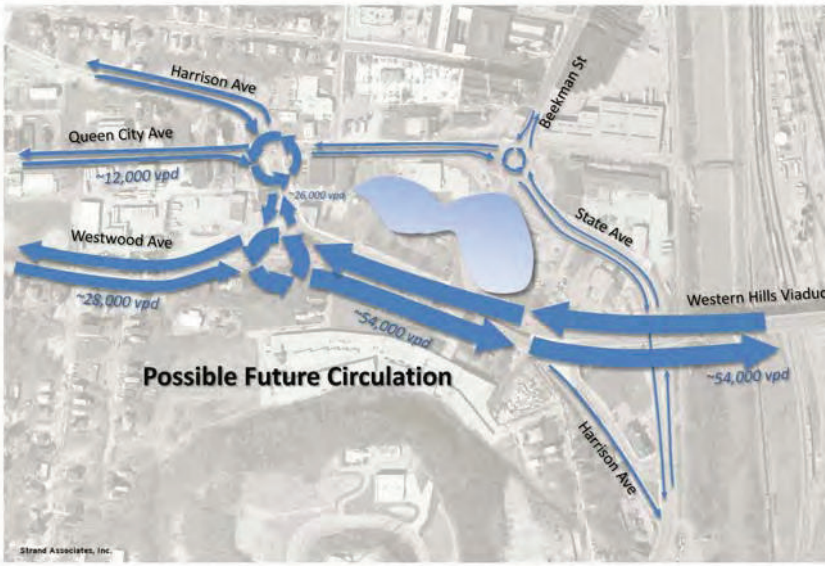


Figure 4.02-2 Possible Future Traffic Circulation

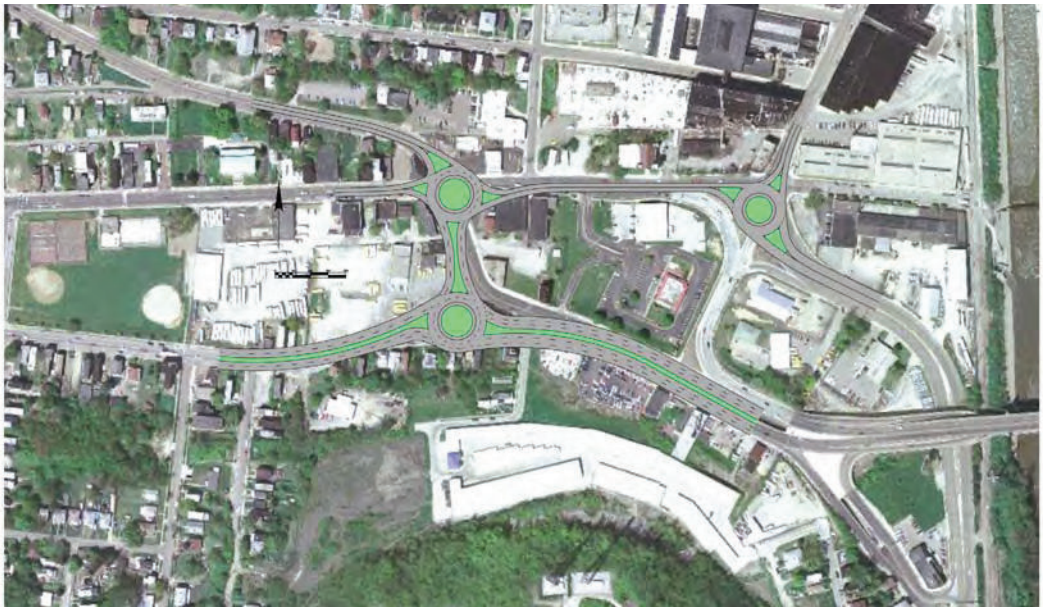
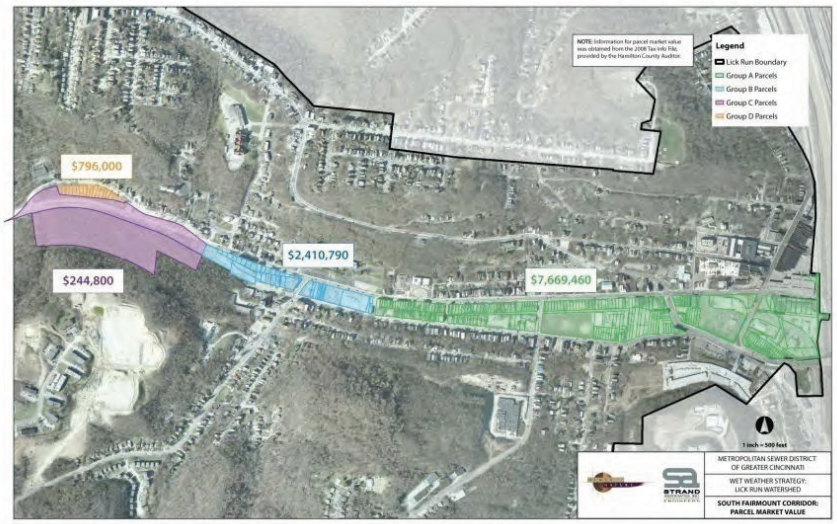


Figure 4.02-3 Possible Future Traffic Control: Roundabouts

4.03 PROPERTY MARKET VALUE

Daylighting Lick Run through such a large corridor requires significant coordination among existing property owners and local government agencies; therefore, Human Nature and Strand completed a coarse assessment of property in South Fairmount. Specifically, the consultant team identified property ownership, the number and area of parcels, and the current market value of the property, which is based on the Hamilton County Auditor's Tax Information Dataset. In response to different types of daylighting strategies, the corridor was divided into four groups (A, B, C, or D). Figure 4.03-1 shows the boundaries of the four different property groups in the South Fairmount corridor, and Table 4.03-1 summarizes the number of parcels, total area, and market value for each property group. As of June 2009, the total market value for properties in the corridor is approximately $11.1 million. The 65-acre corridor contains 349 parcels, 257 of which are privately owned and 92 of which are publicly-owned. In terms of area, however, publicly-owned parcels account for more than half of the total corridor.



Source: Human Nature, Inc., Strand Associates, Inc.®

Figure 4.03-1 Property Value Assessment

SECTION 5
COST-BENEFIT ANALYSIS

5.01 COST-BENEFIT ANALYSIS

In conjunction with MSD, the Lick Run Wet Weather Strategy Team evaluated a variety of alternatives for the overall project cost. Figure 5.01-1 indicates that the total project cost could range from $67.4 to $152.6-million dollars.

FIGURE 5.01-1

COST-BENEFIT ANALYSIS

STRAND

LICK RUN COSTING ALTERNATIVES - DRAFT

PROJECT ELEMENT	PROJECT ELEMENT COST (Million$)	ALTERNATIVES A	B	C	D
Strategic Sewer Separation					
Pipe Size of Separate System is Equivalent to Adjacent Combined System (66% contingency)	$41.0				X
Pipe Size of Separate System is Downsized from Combined System (66% contingency)	$36.5	X	X		
MSD Cost Estimating Group Unit Costs Strategic Sewer Separation (10% contingency)	$75.2			X	
Daylighting Stream Channel					
8,000 Feet of Open Stream Channel Enhanced Cost (66% contingency)	$96.0				X
8,000 Feet of Open Stream Channel Base Cost (66% contingency)	$22.1				
8,000 Feet of Open Stream Channel Enhanced Cost (40% contingency)	$80.9				
8,000 Feet of Open Stream Channel Base Cost (40% contingency)	$18.6				
8,000 Feet of Open Stream Channel Enhanced Cost (25% contingency)	$72.3		X		
8,000 Feet of Open Stream Channel Base Cost (25% contingency)	$16.6	X		X	
Property Acquisition					
Property Acquisition Areas A, B, C, & D (Hamilton County Auditor - Market Value)	$11.1			X	X
Property Acquisition - Without Public Properties (Hamilton County Auditor - Market Value)	$9.7	X	X		
Other					
Detention	$1.5	X	X	X	X
Downspout Disconnect Non Priority Basins	$3.0	X	X	X	X

ALTERNATIVE:	A	B	C	D
TOTAL PROJECT COST FOR EACH ALTERNATIVE:	$67.3	$123.0	$107.4	$152.6
COST PER GALLON OF OVERFLOW REDUCED:	$0.08	$0.15	$0.13	$0.19

Base Channel Project:

Basic channel construction
- 6' deep, 93' top width, 45' bottom width

Nine cast-in-place clear span bridges
Water main relocations for crossing the new channel
Sanitary sewer relocations for crossing the new channel

Enhanced Channel Project:

Enhanced restoration:
- Bike paths, restored sidewalks, aeration feature, concrete overlook at bridges with canopies, enhance lighting, blue light emergency telephones, interpretive signs, benches, trash receptacles, enhanced landscaping, active recreation area, amphitheater with landscaped sitting area, sheltered gathering spaces, security lighting and cameras, and drinking fountains

Roadway improvements:
- Westwood reconstruction with streetscaping
- Queen City reconstruction with streetscaping
- Three roundabouts

Enhanced Conspan architectural multi-cell bridges
Level control facility
Pond area with landscaping
Low flow channel with concrete bottom and cut stone lined sides
Water main and water service replacements (Westwood and Queen City)
Sewer main and sewer service replacements (Westwood and Queen City)

DRAFT
Strand Associates, Inc
July 15, 2009