This paper reports on materials available to create reused and recycled park furnishings for the Mill Creek Greenway Trail in Cincinnati, Ohio. Research was done during a summer 2005 internship with Mill Creek Restoration Project to identify materials that were available for use in the proposed Mill Creek Greenway Trail that would reflect a sustainability ethic. In other words, in what ways could furnishings for the greenway trial be created (multi-use trail, benches, signs, landscaping materials, etc) that would help protect the environmentally sensitive Mill Creek, while also reflecting and encouraging environmentalism in the Cincinnati region. Eight criteria were used when analyzing each material for possible use: proposed use for material, cost, durability, aesthetics, safety and health, sustainability and environmental impact, life cycle costs, and local, regional, state and national availability.
REDUCE, REUSE, RECYCLE & RETHINK: ASSESSING THE SUSTAINABLE AND CREATIVE DEVELOPMENT OF PARK FURNISHINGS FOR THE MILL CREEK GREENWAY TRAIL, CINCINNATI, OHIO

A Practicum Report

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Executive Summary

A greenway is a linear corridor of undeveloped space containing trees, shrubs and other vegetation that connects people and places together. The corridors of greenspace are often adjacent to rivers or streams, along existing or on top of old railways, or next to roadways and utility corridors (The Mill Creek Watershed Greenway Master Plan 1999, 1). Greenway corridors allow for the restoration or preservation of the natural systems that exist in an area. They also provide a means for alternative transportation and can connect natural areas, parks and historical and cultural features (Ohio Greenways 2005). Greenways are also environmentally beneficial because they help buffer adjacent waterways to help protect them from nonpoint source pollution, which can run off from nearby developed land during rain or melting events. They help preserve local wildlife and provide corridors through which birds and land animals can travel.

This report will assess what reusable and recyclable materials are available in the Cincinnati region that could be utilized to create park furnishings for the Mill Creek Greenway Trail. Mill Creek Restoration Project (MCRP), a local environmental organization that is dedicated to preserving and helping restore the natural functions within the Mill Creek watershed, is currently developing the greenway trail. Furnishings needed for the trail system include, but are not limited to, tables, benches, trash and recycling receptacles, bollards (car stops), signage, erosion control materials, overlooks, walkways and multi-use hike and bike trails. Mill Creek Restoration Project’s intention is to be as environmentally, economically and socially sustainable as possible when creating the greenway trail, and wants the materials chosen to create furnishings to reflect this ethic.

Locations of salvage yards owned by the City of Cincinnati and the Cincinnati Park Board (CPB), private salvage yard businesses, and places where salvaged, or unused, materials can be purchased were identified. The locations, contact people and an initial list of materials that were found to be usable were documented, and are listed in an appendix entitled, “Salvage Yards, Businesses and Material ‘Interchanges’ and
Exchanges in the Cincinnati Region,” at the end of this report (Appendix II). Materials found to be usable are also discussed, addressing their potential for reuse and the probable steps that need to be taken to utilize them. This is by no means a comprehensive list of salvage yards in the area, however. Contact information for all people, organizations and companies spoken to and mentioned in this report that would be good future contacts and may be interested in working with MCRP on the furnishings project, are located in Appendix I, which is entitled, “Reuse and Recycle Project Contacts.”

Research was also done to identify products presently on the market that are made from recycled materials. The most common, reliable recycled product on the market today that can be used for functional furnishings, as well as other uses, is recycled plastic lumber (RPL), and a large section of this report is devoted to its design and capabilities. Other sections address the recycling of materials to create asphalt and cement trail surface materials, which is also a large and promising market. The report assesses traditional hard-surface paving materials, and then addresses the potential for making pavements with recycled content. Because water quality improvement and management is one of the main focuses of MCRP’s work, researching porous, or pervious, pavement materials is also part of this report. However, the use of pervious materials may end up being a tradeoff since many companies continue to utilize virgin materials to create these watershed-friendly products. Other products made from recycled materials assessed in this report include recycled aluminum signage, ‘glassphalt’ and ‘rumber’ (rubber lumber).

**Background**

**A Polluted History**

In 1997, Mill Creek was named “the most endangered urban stream in North America.” (Mill Creek Restoration Project 2007) This unfortunate title came from over 200 years of environmental abuse due to urban growth and development in the Cincinnati region. Mill Creek has experienced multiple stressors since settlers began to lay claim to
the fertile lands along its banks in the late 1700s. Early impacts included deforestation to make space for farming in the Mill Creek floodplain, which led to higher floods (Hedeen 1994, 35). During the 1800s and 1900s slaughterhouses, breweries and distilleries flourished along Mill Creek. These industries disposed of their byproducts, mainly unused animal products and blood, spent hops, weak alkaline solutions, cooling waters and corn mash slop water, directly into the waterway. Other human activities and businesses along Mill Creek added further pollutants to the water including livestock manure, soap factory greases, dairy wastes, paper mill pulp, and domestic sewage. These wastes severely polluted Mill Creek: in 1913, 25 percent of its flow into the Ohio River consisted of sewage and effluent from industries (Hedeen 1994, 73-91, 105, 107).

In the late 1800s, the City of Cincinnati built a combined sewer overflow (CSO) system. This system unfortunately added to Mill Creek’s pollution. During heavy rain events stormwater overflowed into sewer pipes and discharged the combined water and raw sewage into Mill Creek (Hedeen 1994, 98-103; Ohio River Valley Water Sanitation Commission 2007). This system has yet to be replaced, though proposals have been made. In the 1980s, estimates for separating this combined sewer and stormwater system were over $1 billion (Hedeen 1994, 131).

Add to this archaic CSO system the fact that modern development moving north along Mill Creek and its tributaries has greatly increased non-porous surfaces, and Mill Creek’s troubles become even more convoluted. Heavy rain events now have an even larger impact on Mill Creek; a far greater amount of water rushes into the creek off of asphalt and concrete surfaces rather than being able to filter naturally through soils to aquifers below. More flooding means a greater economic impact upon residents and businesses in the Mill Creek floodplain. It also greatly increases the risk of erosion upon Mill Creek’s banks.

There also have been multiple channelization projects carried out by the Army Corps of Engineers to try and increase the speed that rainwater flows from Mill Creek to the Ohio River. The goal of each project was to decrease flooding in neighborhoods along the
stream, but it has only increased problems. Channelization rids a section of the stream of its natural qualities, replacing it with a cement half-pipe, which allows waters to flow very quickly through. However, when these faster moving waters reach the next natural section of the creek, flooding increases in this area as waters are slowed by natural conditions. This also greatly increases erosion along Mill Creek’s banks, impacting the natural environment greatly (Corathers 2005).

In 1992, the Ohio EPA conducted a comprehensive chemical and biological survey of the Mill Creek, sampling in various places along its main stem and tributaries. At most water sampling sites there were elevated levels of various contaminants including ammonia, pesticides, lead and other heavy metals, and organic compounds. On the main stem levels of bacteria and viruses from the presence of raw sewage due to combined sewer overflow exceeded federal standards. Sediment samples showed elevated lead, zinc, cadmium, chromium, and copper, and there were only pollutant-tolerant fish and other aquatic life (Mill Creek Restoration Project 2007). Mill Creek Restoration Project was formed soon after, and has been diligently working to clean up Mill Creek ever since.

**Birth of the Mill Creek Greenway Master Plan**

In June 1999, MCRP, with other local non-profit and governmental organizations, completed a comprehensive plan to establish a greenway system along both sides of the Mill Creek beginning at its headwaters in Butler County and continuing to its confluence with the Ohio River in Cincinnati. Major tributaries in the Mill Creek watershed would also be included in the greenway system. Creating an economically beneficial and environmentally sustainable corridor system is part of the overarching mission behind the Mill Creek Greenway Master Plan (Corathers 2005). This will help revitalize natural systems within the Mill Creek watershed, and will also help to economically revitalize struggling communities along the Mill Creek by encouraging economic re-growth within them (The Mill Creek Watershed Greenway Master Plan, 1-2, 7). Blighted conditions will be removed as the natural corridor is restored. In response, property values will increase and the stigma associated with living along Mill Creek will be removed.
The new focus of environmentalism in the 21st Century is to find common ground between environmental and economic sustainability, as is evident in Agenda 21, the United Nation’s plan for international sustainable development. Through sustainable development, communities work toward addressing holistically the preservation of ecological systems, while also taking into account the importance of economic stability (United Nations Conference on Environment and Development 1992). In fact, the United States Environmental Protection Agency (EPA) has created an Environmentally Preferable Purchasing program with the intent of helping government entities learn how to purchase cost-effective products that limit adverse impacts upon the environment (U.S. EPA 2005a). Mill Creek Restoration Project hopes to reflect this union of economics and the environment by utilizing local reusable and recycled items that can be made into park furnishings for the greenway trail. Reusing local resources for park furnishings, as well as finding local businesses and residents to create them, can become a new model for holistic sustainability to use in future community development projects in Greater Cincinnati.

**The Assessment Process**

All potential products made from recycled materials that may be used in the Mill Creek Greenway Trail will be analyzed based upon important sustainability criteria. These criteria were created by assessing MCRP’s needs and desired outcomes for the furnishings and trail materials, and by using EPA policy on recycled content and materials. Outdoor park furnishing design standards created by the Cincinnati Park Board (CPB) were also utilized when creating criteria since some of the greenway trial will pass through CPB land. These criteria will also apply to reusable items. However, due to time limitations for this project, and the depth with which each item could be analyzed based on the eight criteria, the most in-depth research will be done on recycled and recyclable materials and products. For example, trail materials, which will be the largest and most costly part of the greenway construction, is the largest analysis section, followed by
plastic lumber, a widely used and well-researched material. Reusable items will still be assessed based upon MCRP criteria, but will not receive as much in-depth analysis. Certain criteria will not apply to some items or materials and, therefore, will not be used in the assessment. For quick reference, criteria matrices (Appendix III) have been created for the reused and recycled materials and products assessed in this report. The criteria are as follows:

*Uses for Material or Item*

This section will describe what types of uses are best for the material or item being evaluated.

*Initial Cost*

The cost of the material or item is important to Mill Creek Restoration Project since it is a non-profit organization looking for the most cost-effective ways to implement the Mill Creek Greenway Trail.

*Durability*

Long-term durability, which is directly linked to cost-effectiveness, is also important. Mill Creek Restoration Project wants to utilize materials that will be long-lasting in urban, outdoor settings with little maintenance. Furthermore, materials should be as theft and vandal-proof as possible. Items requiring less maintenance will have higher preference, given that the greenway trail will not be overseen by one large entity since it will move through various properties privately owned by various people, businesses and governmental organizations. Staffing for maintenance will be very limited once the trail is built.

*Aesthetics and Other Considerations*

Aesthetics is always a difficult subject as ‘one person’s trash is another person’s
treasure.’ Mill Creek Restoration Project acknowledges this relativity. Finding the most
creative uses for reusable and recycled items will not necessarily be aesthetically pleasing
to all community members and property owners along the Mill Creek. Therefore, a
general aesthetic analysis will be done for some items, as is appropriate.

**Safety and Health Issues**

Besides the environmental safety of materials, MCRP is interested in how safe materials
are for human use. Liability is an issue since parts of the Mill Creek Greenway Trail will
be developed upon land owned by CPB, Metropolitan Sewer District, City of Cincinnati
Department of Transportation and Engineering, Mill Creek Conservancy District, the
State of Ohio, other public entities, and private owners. Liability can become extremely
complex when working with multiple parties. Therefore, items and materials will be
assessed for safety concerns as well. For some features of the greenway, like the multi-
use trail, special attention will be paid to the Americans with Disabilities Act (ADA)
requirements and CPB design standards.

**Sustainability and Environmental Impact**

Environmental analysis, along with sustainability concerns, will be addressed in this
section. As an environmentally-minded organization, the top priority within MCRP is to
create projects that will reflect an environmental ethic. Educating the public about the
Mill Creek while utilizing sustainable resources will be a reflection of MCRP’s overall
mission to develop sustainably within the Mill Creek watershed. It will be very important
to choose products and materials that have little, or no, adverse impacts upon the Mill
Creek and its surrounding natural and urban environment.

**Life Cycle Costs**

The Mill Creek Greenway Trail will most likely be paid for through fundraising and
grants. Therefore, MCRP wants to be able to make the best, most efficient use of this
money. For the sake of creating the most cost-efficient sustainable greenway system possible, life cycle costs will be assessed for the different materials researched, analyzing costs from inception to disposal, or most preferably from inception to the new reuse of the item through recycling. If full life cycle cost analyses cannot be found for the different materials being assessed, the author will do basic research on costs to fulfill this need.

**Local, Regional, State and National Availability**

Mill Creek Restoration Project would like to utilize local resources as much as possible to create a more sustainable trail system. After searches for local availability are exhausted, the most preferable will be regional, then state, and national lastly. Each material or item assessed will include local, regional, state and/or national contacts, when available. Any company named will have full contact information available in Appendix I for future reference.

It would also be economically beneficial to utilize local labor resources to create furnishings for the greenway trail. If local companies are not creating furnishings made from recycled materials or reused objects, and do not want to partake in the production of such items, it will be beneficial to the community to try to use other sources for local labor, allowing MCRP to pay locally and produce locally. For example, hiring workers from the Work Resource Center (WRC), a local non-profit organization dedicated to the training of individuals with disabilities and personal disadvantages, may be an effective way to still keep production of trail furnishings local.

**What is the Difference Between Reuse and Recycling?**

The most known slogan for environmental action today is, “Reduce, Reuse, Recycle,” which now includes “Rethink” in some documents and organizations, referring to rethinking our purchasing, use and disposal choices (Bring Recycling 2005). This slogan expresses distinctive ways to be environmentally sustainable. Reducing one’s use of
products and, therefore, limiting the production of new products to replace those you have purchased, as well as reducing the landfill waste from throwing these products away when you are done with them, is one way to create a more sustainable community.

The difference between reuse and recycling is a bit vague at first glance and requires clarification. Reuse refers to reusing items that already exist, possibly utilizing them in new, innovative ways. Recycling refers to re-processing existing items in order to reuse them in a more ‘raw’ material form to create new products (U.S. EPA 2005b). Both are good ways to encourage sustainability. However, through research for this project it appears reuse of items may be much more cost effective for MCRP. Buying newly recycled products like plastic lumber tables or signs and rubber asphalt pavement (made with recycled tires and traditional asphalt) will be more costly. However, there is evidence that these products last longer than conventional products and require less maintenance (King County, Washington 2005; Arizona Department of Transportation 2005), which will be further discussed in this report.

In 2005, 79 million tons of waste was diverted from landfills through recycling efforts. The United States currently recycles around 32 percent of its waste (U.S. Environmental Protection Agency 2007a). For those concerned with waste reduction, this may not seem like enough. However, add to this the fact that recycling has more than doubled in the last 15 years, and there is hope for an even brighter future in recycling.

**Environmentally Preferable Purchasing**

The importance of reducing and recycling has become commonplace within government entities like the EPA, as well as within organizations and corporations that support a sustainable future. The EPA has created an online database titled “Comprehensive Procurement Guidelines,” that links interested parties to vendors of products that are environmentally safe and made from recycled material (U.S. EPA 2005d). In 2006 the EPA expanded coverage to include outdoor recreation furnishings and materials including park benches, picnic tables, playground equipment, playground surfaces and
running tracks. There is a section dedicated to landscaping products, which may also be beneficial to MCRP. Each product has EPA recommendations on “recommended recovered materials content,” which will be helpful to MCRP when looking to purchase products made from as high a recycled content as possible.

**Local and Regional Municipal Solid Waste and Demolition Debris**

**Carrying Capacity**

Present regional environmental concerns often center around landfill carrying capacity, which is the amount of space left in a landfill that will support the population’s waste, and the years left until this capacity limit is reached. Carrying capacity also refers, in human terms, to “the number of individuals who can be supported with a good quality of life without degrading the physical, ecological, cultural and social environment” (Sustainable Community Roundtable 2005).

The carrying capacity for municipal solid waste (MSW) and construction & demolition debris (C&DD) is reaching its limit in the Cincinnati region. As of December 31, 2004, eight C&DD landfills have an average of 14.06 years left until they reach their full capacities, with the Loveland C&DD landfill having the least years left (3) and the Miamiview landfill in Whitewater Township having the most (29.5) (Hamilton County General Health District 2004, Table 1). The amount of space left at these eight sites is varied, as they differ in overall capacities. Unfortunately, according to Chuck Dejonckheere, Waste Management Director for the Hamilton County General Health District, C&DD landfills in Hamilton County are not required to keep yearly records on capacity, so these data are not available (Dejonckheere 2005).

There are, however, yearly data on MSW carrying capacities, which is where all non-hazardous household waste goes. As of December 31, 2004, Rumpke Sanitary Landfill had 10.7 years left until reaching full capacity. There were 45,767,788 cubic yards of air space left at the end of 2004, and 40,765,896 left at the year’s end 2006. (Hamilton County General Health District 2004b; Ohio Environmental Protection Agency 2007). As
of December 31, 2006 Bond Road Landfill, a second smaller MSW landfill, has 7,224,965 cubic yards left until it reaches capacity (Ohio Environmental Protection Agency 2007).

The City of Cincinnati currently has two landfills left. There is one in Winton Place, called Gray Road Fill, Inc, and one off of Wooster Pike, called the Hafner Construction & Demolition Debris Landfill. Both contain C&DD waste only. The Gray Road landfill, however, will close at the end of 2007 under an agreement reached by the City of Cincinnati and the Winton Place community. According to Rick Thornburg, health department supervisor of solid waste for the City of Cincinnati, all MSW for Cincinnati is being transported to the Rumpke landfill at this time. No long-term plan has been made public for what will be done about the need for landfill space in the future. A study was done in the past to find acceptable sites for a future landfill, but no community would agree to have one nearby, so the search was abandoned (Thornburg 2005).

Ultimately, in a perfectly sustainable world all items would be recycled to create not a “cradle to grave” closed process, but a “cradle to cradle” open system instead, where all materials could be recycled and reused to create new items. This would steer society away from natural resource depletion and further landfill production. However, though the recycling industry has been growing by leaps and bounds, there are plenty of untapped recycling markets that have yet to be explored. Ohio has plenty of room for growth in the areas of reuse and recycling, and often lags behind other more progressive states in their initiative to begin new projects and programs. This may be due to startup costs needed for new businesses, and lack of a market because of costs being prohibitive until state, regional and local markets demand recycled and reused products.
Reusable Materials

Figure 1. Tree grate table prototype designed by Miami University architecture students, summer 2004.

Creativity and Liability

As mentioned earlier, reusing materials can be a cost-effective way in which to create park furnishings for the Mill Creek Greenway Trail. There are a plethora of reusable materials available, possibly at no cost to MCRP, but the process by which these materials can be successfully reused for park furnishings has proven to be more difficult than expected.

During summer 2005 research, the author and MCRP revisited a project, crafted by Miami University architecture students in the summer 2004, which reuses obsolete sidewalk tree grates. The tree grate furnishings include two tables that fit around a tree to form one unit, and an s-shaped bench that curves around a tree (Figures 1 and 2).

A request for permission to install the furnishings at Salway Park, which is along Mill Creek in the Cincinnati Neighborhood, Winton Place, was sent to officials at CPB (who owns the Salway Park land) and Cincinnati Recreation Commission (CRC, who maintains the land). Unfortunately, the request was denied due to concerns with the furnishings not meeting design standards and possibly causing liability issues. Only one CRC official/staff person responded, sending an emailed list of concerns. They are listed below. These concerns will affect the entire park furnishings project regarding any future
items proposed to be created for MCRP. Issues with safety and liability will be important in the analysis of reused items and recycled items that do not necessarily meet industry standards to reduce liability. When reusing materials that are not traditionally used as site furnishings, MCRP will be sure to adhere to liability concerns in the design process, especially when working with other design groups. Tree grate furnishing liability concerns from CRC include:

- 1” rebar legs of the tree grate bench are not durable enough to withstand long-term use
- Cast iron grates and rebar welded to them “are not materials used for site furnishings”
- The grates will require a lot of upkeep because the finish is not baked on
- The table has “trip hazards on all access points”
- The wood planks located along the top of the backs is a hazard
- The edges look sharp
- There are various entrapment areas through the gaps in the tree grates
- Welding needs to be done by certified welders
- An agency should look at the tree grate furnishing prototypes and do testing on them
- Quality control needs to be practiced when constructing furnishings
As of January 2006, Cincinnati Park Board was working on refining and updating their guidelines for purchasing park furnishings. A rough copy of this work in progress was obtained from CPB, and will be used when assessing reusable and recycled materials and items in this report. Mill Creek Restoration Project wants to be sure to follow any guidelines that may be in place to ensure easy installation of reused and recycled furnishings. All of CPB and CRC’s concerns will be addressed to help ensure that future projects done by, and with the help of, MCRP can be installed within the greenway trail, which, as mentioned earlier, will at various points run through land owned or maintained by CRC and CPB. Human Nature, Inc., which is working with MCRP on a stormwater filtration installation called Laughing Brook at Salway Park, took into account concerns voiced by CRC and has redesigned a new, safer bench, a combination trash and recycling receptacle, both of which use old tree grates, as well as signage that can hopefully be made from recycled plastic or other sustainable materials (Appendix IV). The design includes no rebar, no wood planks, and attaches cast iron to cement pipes. The tree grates are shaved down to eliminate concern for injury. Hopefully, these new designs will be accepted by CRC, forging a positive relationship that will flourish as the Mill Creek Greenway Trail comes to fruition.

The CRC comments of most concern to MCRP are those regarding tree grates and rebar not being appropriate materials for site furnishings. Initially this is a very limiting statement, since MCRP’s goal is to find creative reuse of materials to reflect a sustainability ethic. However, if MCRP works closely with design companies, artists, industries, and others involved in design practices, most if not all concerns with the use of unusual items and materials can hopefully be solved. Multiple greenway trail systems and city or county park systems have been contacted throughout this research, spanning the entire United States. Unfortunately, no one contacted ever worked on a large-scale project utilizing reused objects to create furnishings for a public trail. Many park systems are ordering newly made park furnishings that are created from recycled plastic, but reusing objects is not a regular occurrence.

However, one small-scale recycled trail was discovered, called the Swift Creek Recycled
Greenway. Created by Greenways Incorporated, which is directed by the nationally recognized greenway designer, Chuck Flink, this .8-mile corridor trail contains recycled plastic, recycled aluminum, recycled asphalt, plastic waste from disposable diaper manufacturing facilities and reused incinerator ash, to name a few items used. The creation of this educational trail was done through the collaboration of multiple public and private businesses and cost almost $150,000, or around $30 per foot. The Swift Creek Recycled Greenway is located within the town of Cary, North Carolina, which has a strong history of dedication to the environment, beginning in 1976 with the creation of the Cary Greenways program (Greenways Incorporated 1992). It is this type of dedication and public/community collaboration that will be needed for the Mill Creek Greenway Trial to come to fruition as well.

Though comprehensive reused/recycled greenway projects were difficult to find during research, there are plenty of examples of individuals and artists who have created functional furnishings from reused outdoor items. However, finding ways to install them on property where a government entity or private property owner may be liable for these items appears to be fairly new territory.

**Reusable Items in the Cincinnati Region**

Items in this section were all found at salvage yards owned by the City of Cincinnati or Cincinnati Park Board and Building Value, a local business that salvages and resells reusable items from demolition and redevelopment sites. The three salvage, or reuse, yards include two owned by the City of Cincinnati: one next to the Mill Creek Road Bridge in South Cumminsville and one at the corner of William P. Dooley Boulevard and Ludlow (across from MCRP’s Freedom Tree Grove #1, along the Mill Creek). Various public service departments utilize these yards including Transportation & Engineering and the Asphalt Division. The third yard assessed for this research is the Sinton Road yard, owned by CPB. The City Engineer informed MCRP that they would not be able to utilize materials in the two yards owned by the City because, though some items have been there for many years, they may still be used in the future. However, MCRP has hope
that it can still work with City departments to allow collaborative reuse projects to take place in the future.

Dan Henson, Division of Neighborhood Operations: Asphalt, Department of Public Services, told MCRP that they are welcome to have reusable asphalt for use in the greenway trail, if they would like. This asphalt could be recycled into a new asphalt mix to be re-laid within the greenway trail. Therefore, there are discrepancies already in what can and cannot be done with reusable materials owned by the City of Cincinnati. Mill Creek Restoration Project hopes to work with the City of Cincinnati in the future on reusing items located in these salvage yards, putting unused items to creative use before they are removed and sent to landfills. The Cincinnati Park Board has agreed to let MCRP request to retrieve items from the Sinton Road salvage yard for use in the greenway trail, though permission must first be given to make sure items are not going to be reused by the Park Board staff. The following sections discuss reusable items found at these different sites in the summer of 2005. It includes assessments for prospective reuse, and an analysis of how these items fit within the eight criteria.

**Lumber**

*Uses for Material or Item*

Reusable lumber could be used for table and bench construction, trash and recycling receptacle construction and as bollards (car stops). It could also be used to create borders in garden areas or other ecologically sensitive areas where residents should not walk, as posts to install signs that educate and inform greenway visitors about the Mill Creek Greenway Trail and as materials for signage kiosks. Decking and railings could also be created for overlook areas along the Mill Creek Greenway. These are a few of many possible uses.
Initial Cost

Reusable lumber can be purchased at Building Value, which is located on Gilbert Avenue in Cincinnati. Lumber, with a minimum of 4 ft in length, is successfully sold and reused by customers (Building Value 2005). The cost of this lumber ranges $1.20 for a 2 x 4 x 8 to $4.40 for a 2 x 12 x 8 piece. Special pieces of wood that have decorative molding will cost more. There is no way to discern whether lumber has been pressure treated or not, since Building Value has no required process to check before resale, though treated wood often shows a red or green tint (Skees 2005). For comparison, buying sustainably harvested lumber from a local Home Depot (Western Hills) costs from $3.49 for a 2 x 4 x 8 to $5.97 for a 2 x 4 x 12.

Lumber from the CPB Sinton Road salvage yard would not cost MCRP anything. However, a request would need to be made for the lumber to make sure no other parties within the Park Board wish to use it. Old logs from city trees that needed to be cut by the Urban Forestry division of CPB could possibly be requested for use, and were being stored at the back of the Sinton Road salvage yard at the writing of this paper. In 2003, the Cincinnati neighborhood of Roselawn, in conjunction with CPB and CRC staff, created a contest to make designs for park benches using wood from city trees that had to be cut. It was a lesson in sustainability that was supported by multiple entities within the city. University of Cincinnati Department of Art, Architecture and Planning (DAAP) design students competed and created public benches using this wood. Benches chosen by a panel of judges, which included a university professor and a CPB urban forestry official, were installed on City of Cincinnati property that Roselawn maintains (Figure 3) and within Roselawn Park, maintained by CRC. This is a perfect example of the creativity and ingenuity that can be involved in sustainability work (Sunnenberg 2005).
Durability

Wood, though aesthetically pleasing to many people, is also considered to be the least durable when it comes to recreational use of the material. There are higher-end, more durable types of wood, including teak and ipe (‘ee-pay’) from South America, but these varieties may rarely be found for reuse since they can easily be resold for profit. Ipe wood, especially, is an environmentally friendly wood since it is naturally resistant to rot, mold, decay and insect infestations due to its dense cellular structure. It is also naturally fire-resistant and weather-resistant. This allows it to be used without the addition of chemical sealants. Though ipe costs more in the beginning, it averages out to be as cost-effective as cheaper options since it lasts longer than traditional decking (Everwood Decking Partners, Ltd 2002).

Given the tight budgets of most recreational programs in the United States today, managers are looking for long-lasting materials that may cost more in the beginning, but last much longer and require less maintenance (Anderson 2004, 4). Since MCRP is also looking for cost-effective, long-lasting alternatives, ipe wood may be a consideration, but finding reusable ipe lumber in large quantities will be difficult. Buying this product new
from companies will be the easiest option. However, though companies like Everwood Decking Partners, Ltd, claim to harvest ipe sustainably, this wood is found in the Amazon and is, therefore, being harvested from ecologically sensitive areas and not from tree farms. Ipe grows in clusters of trees instead of individually. Therefore, it is believed that harvesting ipe is better than harvesting individually growing trees like mahogany and teak. Ipe is harvested in clustered areas of a forest, which, it is argued, reduces the overall damage caused, as opposed to harvesting individually growing species from a larger area within a forest (Iannarelli 2002, The Atlantis Furniture Company 2005).

Aesthetics

Aesthetically, some people may prefer wood over other materials for furnishing due to its natural appearance. However, as can be seen at any park where wooden benches are installed and not maintained properly, wood does not always weather well, and can warp and crack easily in environments like Ohio, which is in a humid region where temperatures fluctuate from season to season (Delcourt and Delcourt 2000, 378). However, personal preference is just that – a decision based on one’s personal beliefs, likes and dislikes. Though wood will not outperform other materials structurally, especially as technological advances continue to bring forth better, longer lasting materials, there is still a very “strong appreciation of the value and beauty of wood” (USDA Foreign Agricultural Service 2005, 2).

Safety and Health Issues

Safety issues will relate directly back to concerns that CRC had for the tree grate furnishings. Wood furnishings, used for sitting, can have sharp edges that may cause injury. Sanding them will be an important part of the construction process to reduce the possibility of injury. There may also be a concern with splintering throughout use of the product, which sanding and sealing with an environmentally friendly wood finish or protectant can help reduce. Finishes or protectants can also help reduce the effects of ultraviolet rays, which can damage wood over time (Green Seal 2005a). Maintenance will
be very important with reused wood products to ensure their ability to last a long time without cracking or wearing down. Green Seal, a nonprofit organization that promotes the use of environmentally friendly products has available online a listing of paints and coatings that includes exterior sealants (Green Seal 2005b).

Sustainability and Environmental Impact

Time and again it has been scientifically proven that the remaining old-growth forests in the world are disappearing due to the increase in logging of these areas, leading to water pollution, habitat destruction and displacement of indigenous people, to name a few concerns (Forest Stewardship Council 2005). Reusing old lumber from previous projects, or using lumber scraps from finished projects, will be the best way to reduce harvesting of lumber from these forests. Some of our remaining old growth forests are ecosystems that have evolved and existed for over 70 million years, but are still at risk of being logged, for they contain very useful hardwood. Eighty percent have been deforested worldwide and ninety-five percent have been lost in the United States (Rainforest Action Network 2007).

The second best option, if reusable lumber is not available locally or regionally, will be to purchase lumber from companies that are accredited as harvesting sustainably in forests. The Forest Stewardship Council (FSC) requires third-party review of logging companies to make sure they indeed follow sustainable guidelines when harvesting forests. These guidelines help keep intact, as much as possible, the ecological elements within the forest being logged. The FSC lists all companies that sell accredited lumber. Companies include small operations and ones as large as Home Depot (Forest Stewardship Council 2005).

The most important environmental concern is the risk of exposure to chemicals used in treating the lumber, which can also leach into soils and water sources. Chemical treatments keep wood from rotting due to moisture, insect and microbial infestations. Some chemicals historically used to treat lumber have been linked to cancer risks in humans. Traditionally, Chromated Copper Arsenate (CCA), creosote or
pentachlorophenol have been used. As of December 31, 2003 no producer can use CCA to treat wood for residential use in the United States. This has been found to be an especially volatile compound, which can leach from lumber into soils and waterways, and also onto people’s hands when coming into contact with newly treated items (Wolnitzek 2005). Even when burned, the ashes from CCA-treated lumber are technically hazardous waste, and should be disposed of in hazardous waste facilities, though this is not consistently done (National Sustainable Agriculture Information Service 2005). The elimination of CCA-treated lumber from the U.S. market has affected an estimated 80 percent of the $4 billion annual lumber market. According to The Healthy Building Network, this was the “nation’s largest use of arsenic and the largest source of arsenic exposure to Americans” (Platt, Lent and Walsh 2005, iv).

Reusing CCA-treated lumber is possible through treatment with chemical processes like bioleaching and bioremediation. Much of the time these processes are done on chipped wood particles and not on pieces of lumber. According to the USDA Forest Service, since it is economically disadvantageous to remediate CCA-treated wood when companies can still cut them and send them to landfills, there is not a strong reuse market at this time (U.S. Department of Agriculture Forest Service 2005). Reused wood treated with CCA is often given away or sold without addressing the environmental risks involved in continued CCA exposure which, though amounts of CCA decrease over time, still poses an environmental threat. The amount of leaching that occurs for all three metals (chromium, copper, arsenic) increases with a decrease in the size of the wood item. Therefore, mulching reused lumber that has been treated with CCA will increase leaching into soils, groundwater and waterways nearby (Feldman 2005).

In 1993, the U.S. Department of Agriculture (USDA) Forest Service Laboratory developed and approved an above-ground wood preservative that could help wood last for up to 20 years. Though it was not tested for below-ground use, the USDA claims it is safe for use and will not leach toxins into the soil. The recipe, which can be created at home or by a business, is available through the National Sustainable Agriculture Information Service’s document, “Organic Alternatives to Treated Lumber” (National...
Sustainable Agriculture Information Service 2005) The main ingredients are linseed oil, paraffin wax and an approved thinner like citrus thinner or distilled pine tar. The Forest Stewardship Council also provides accreditation and information on companies that not only use sustainable harvesting techniques, but also do not treat with CCA (Forest Stewardship Council 2005).

Local, Regional, State and National Availability

Locally, as mentioned earlier, Building Value sells used lumber. Lumber is also located in salvage or storage yards like CPB’s Sinton Road salvage yard. Lumber may also be accessible at construction sites where MCRP can pick up materials before they are sent to C&DD landfills. There are multiple construction companies in the area that may be willing to let MCRP salvage materials, including Turner Construction Company, Messer Construction Company and H. Glasgow Construction Company. Megen Construction Company has been part of many well-known construction projects in Cincinnati including ones at the University of Cincinnati and The National Underground Railroad Freedom Center (Megen Construction Company 2005). This Minority Business Enterprise company may be an especially good contact for MCRP since it has worked on the Freedom Center, which is connected to MCRP through the Freedom Trees Program (Megen Construction Company 2005; Corathers 2005).

Building Value, the local non-profit reuse center, has a constant flow of good-quality, reusable lumber from deconstructed sites. However, this lumber may likely be treated with CCA. Local salvage companies may also be a good contact for multiple wood items and materials that can be used by MCRP, though there is still a risk of CCA-treated wood. (See “Salvage Yards” in Appendix I for listings of local businesses).
Cast Iron

Uses for Material or Item

Cast iron is the material from which tree grates are made. This is the main reason for why they are being assessed in this report, though reuse of cast iron might occur in other forms besides tree grate furnishings including benches, railings and tables. Building Value or other salvage businesses might deconstruct areas and find usable cast iron fencing. As of January 2006, the Sinton Road salvage yard, maintained by CPB, had old cast iron park benches and tree grates that could be reused, though a request would need to be made to acquire permission to reuse them.

Initial Cost

The largest expense for MCRP when reusing cast iron is having it refinished, which is especially important if rust is present. In order to refurbish cast iron, the item must first be stripped of the coatings originally applied. This can either be done through a chemical stripping process or through a sandblasting process. Both successfully take care of all coatings on cast iron (Schlake 2005). However, sand blasting would be a more environmentally friendly process, and is cost effective. This is the process recommended by Bernie Schlake, owner of Ridge Engineering in Northside (Schlake 2005). Sand blasting can be done at Powder Coating Specialty, located in Cincinnati. Powder Coating Specialty estimates the cost per half tree grate for sand blasting to strip them of any old coating, and then powder coating them with a desired color (size not exceeding 2.5’ X 5’) would be $86.

Durability

Cast iron is an extremely strong material that can be refinished over and over again for continued use (Buck Company, Inc.). This makes it a very attractive material for use in the Mill Creek Greenway Trail. The iron is very heavy, which makes it difficult to
remove and makes it more vandal-proof. The only durability issues will involve refinishing the iron over time. Many of the tree grates found in the Sinton Road salvage yard were already rusty. Those that had been coated with color had rust on them as well. Therefore, if cast iron items are used in the greenway trail, they will need maintenance, though not necessarily annually, to make sure rusting is eliminated and the material stays aesthetically appealing. One of CRC’s concerns with the tree grate prototypes was the need for a “baked on” coating. The prototypes were simply spray-painted by students. This concern can easily be addressed by professionally powder coating the tree grates, as discussed in the initial cost section.

Safety and Health Issues

As mentioned earlier, safety concerns were voiced by CRC staff when assessing the tree grate prototypes. The concern with the use of cast iron included not only rusting, but sharp edges that could injure users. In updated tree grate furnishing designs created by Human Nature, Inc., rough edges on the tree grates have been smoothed in order to address these concerns. The last safety issue includes the possibility of “entrapment” in the slats of the tree grates. This is, of course, not an easily solved issue, but given that there are often gaps between lumber used in wooden park benches, this may or may not be a valid legal concern. If this is a relevant safety concern, a sheet of material could be used on the bottom of each grate that would weld to cast iron. This would prevent people from being able to put their hands through the gaps.

Sustainability and Environmental Impact

The most environmentally friendly option when refinishing cast iron items is to sandblast the old finish. The other option is to dip the item into a chemical bath that will strip all coatings. The chemicals used are of concern to an environmentally conscious organization like MCRP, though local metal cleaning companies that do this work are required by law to follow environmental regulations. Mechanical Finishing, Inc, a local Cincinnati business, provides metal cleaning that is very environmentally responsible.
The wastewater created from the cleaning process is now reused by the company. In 1995 they qualified for Ohio’s Pollution Prevention Loan Program, which allowed them to install a $130,000 system that would treat the wastewater and allow them to reuse it in their cleaning process (Mechanical Finishing, Inc 2005). If MCRP wants to use metal cleaning instead of sandblasting it is recommended that Mechanical Finishing, Inc. be used, or a comparable local company that provides proof they are environmentally friendly.

Reusing iron materials will first keep them from ending up in landfills. There are successful businesses that will take scrap metals for profit, but clients have to be willing to transport their materials to scrap metal recycling companies. Though there were no concrete plans as of January 2006, the Cincinnati Park Board, Urban Forestry division may sell the old cast iron tree grates being stored in the Sinton Road salvage yard to scrap metal companies if MCRP does not use them. However, as old tree grates continue to be removed and replaced, there may be a stock available to MCRP in the future before being sold as scrap metal. A request would need to be made to CPB director, Willie F. Carden Jr., for the reuse of these grates before MCRP can utilize them (Hunt 2005).

To create cast iron one must first mine virgin ore to which iron, the most abundant metal in the world, is chemically bonded. The ores are most often hematite and magnetite, and iron has to be extracted from them at high temperatures to break chemical bonds. This process creates byproducts, including carbon monoxide and carbon dioxide (Wikipedia 2005a). Therefore, being able to reuse items for benches, for example, instead of purchasing cast iron park benches made from these virgin materials, will close the “cradle-to-grave” gap. This saves on the environmental cost of ore extraction and creation of cast iron (Wikipedia 2005b).

**Other Reusable Materials in the Cincinnati Region**

- **Granite Slabs** – Large, reusable slabs of granite can be found at the City of Cincinnati’s Mill Creek Road Bridge salvage site. Some of these slabs span over 4
feet in length. Granite is an expensive item. The City of Cincinnati may have a reuse planned for these items already, and may not want to donate them due to their worth. However, the slabs would make very nice, natural benches that could simply be placed on the ground in landscaped areas along the trail. They would be highly vandal proof, given that they could not be easily moved. The slabs could also be cut by a professional and be used for special signage. Schott Monument Company, located in Northside, is a very good resource if MCRP decides to proceed with a request to use the granite. The company could cut and engrave granite slabs of this size to desired specifications.

- **Reusable Asphalt** – As mentioned earlier, Dan Henson, Division of Neighborhood Operations: Asphalt, Department of Public Services, told MCRP that he would be willing to donate a truckload or more of reusable asphalt for the Mill Creek Greenway Trail project. If MCRP decides to work with a paving company that will reuse items in the community, this asphalt could be sent to an asphalt company, like Valley Asphalt in Cincinnati, which recycles asphalt to reuse it in paving projects. There may be difficulty, however, in requesting this asphalt. An administrator with the City of Cincinnati said items in this salvage area are not usable by MCRP, though Mr. Henson led one to believe otherwise.

- **Brick and Pavers** – There are bricks and pavers available at the Mill Creek Road Bridge site, as well as the CPB Sinton Road salvage area. If permission can be obtained, these pavers and bricks can be used for covering for special sitting areas along the trail. They can also be used in landscaping projects and for building small walls. Both pavers and bricks are important reuse items, so it may be difficult to retrieve them at no cost from the City of Cincinnati. A second option would be to contact Building Value, which could collect items as they are found at demolition and redevelopment sites.

- **Plastic Barrels** – Plastic barrels of multiple colors were discovered at the City of Cincinnati salvage site at the corner of William P. Dooley Blvd. and Ludlow Ave.
These barrels, which appear to only have an opening at the top, could be reused by MCRP to create trash and recycling receptacles. Children and other community members could paint the barrels and help install them. They would need to be secured to the ground to reduce vandalism.

- *Telephone Poles* – Imago, a nature preserve and environmentally focused community organization in Cincinnati, uses telephone poles as seating, though they are very low to the ground. Imago is planning on using other donated poles for bank stabilization and water bars in the future (Trokan 2005). The largest concern with reuse of telephone poles is the possibility that the wood may have been treated with CCA, as discussed earlier. Splintering may also occur, and therefore be deemed a hazard by CRC.

**Trail Materials: New and Recycled**

The largest and most expensive part of the Mill Creek Greenway Trail system construction will be creating a hard surface multi-use trail that will be accessible to neighborhoods along the waterway. Once in place, the trail will be a beacon drawing citizens to the Mill Creek from other parts of Cincinnati as well as from Hamilton County and beyond. There will be multiple environmental considerations when planning what materials to use to create the trail. Of utmost concern will be runoff from parts of the trail that might closely border the creek. There is also a sustainability issue with using virgin materials to create traditional asphalt or concrete paths. Therefore, an assessment will be done of alternatives to traditional asphalts that can be more sustainable as well as watershed-friendly. For comparative purposes, a review of traditional asphalt and concrete paving will also be done.

**Status Quo: Concrete and Recycled Concrete**

Concrete pavement is used throughout the United States for various projects, and has been in use since 1891 (American Concrete Pavement Association 2005a). Concrete
ingredients include aggregate (sand, gravel, crushed stone), which is 60-70 percent of the mix, plus paste, a highly heated mixture of cement (silica, iron, alumina and lime), water and ‘cementitious’ materials like fly ash, which is collected from industries and reused in the concrete mixture (American Concrete Pavement Association 2005b; American Concrete Pavement Association 2005c).

Recycled concrete is the “second most recycled material by weight” in the world, behind asphalt. It is reused in the same types of projects that it is taken out of by grinding it, removing metals, wood, and other undesirables, then reusing it in projects in its recycled aggregate form (Harrington 2005, 13). Recycled and virgin concrete will be assessed collectively in this report, since its recycled form and virgin form are so comparable. Given that concrete is easily recycled, and that local companies can be found that use recycled concrete, it could be easily implemented into the Mill Creek Greenway Trail if this material is found to be the most desirable overall. Recycled concrete will be more specifically addressed in the Sustainability and Environmental Impact section.

Uses for Material or Item

Concrete is versatile, being used for highways, sidewalks, curbs, parking lots, and other items used in highway and building construction (American Concrete Pavement Association 2005c). It is used for multi-use trails as well (Oregon Department of Transportation 1995).

Initial Cost

Concrete is the most expensive type of hard surface to use, initially. Costs can be as much as 15-20 percent higher than asphalt. However, due to it lasting sometimes twice as long as asphalt, according to concrete proponents, this cost can be well worth it in the long run. It lasts as long as 30-50 years without need for major repair (Rinker Materials 2005; Glacier Northwest 2005; American Concrete Pavement Association 2005d; Oregon Department of Transportation 2005).
Durability

Concrete projects can be designed for various lengths of time, lasting as long as 50 years, with an average lifespan of 30 years. Not as much brittleness, cracking or roughness occurs over time as with asphalt (Oregon Department of Transportation 2005; American Concrete Pavement Association 2005c). When dry, concrete creates a hard, rigid surface that actually hardens over time, gaining 10 percent more in strength once it has been in place for one month. Concrete projects have often outlasted their design lives, proving the longevity of this product (American Concrete Pavement Association 2005e). To replace concrete, whole sections must be removed, including surface and base layers, and replaced with all new sections (International Grooving and Grinding Association 2005), as opposed to asphalt, which can be patched with a hot mix often without removing any large sections of the original surface. The Oregon Department of Transportation suggests that for best long-term use, concrete should be used as opposed to asphalt on multi-use trails (Oregon Department of Transportation 2005). Concrete’s ability to withstand impact on a recreational trail is obvious when comparing the impact cars and trucks have on concrete highways, where it has proven to be a durable product.

Safety and Health Issues

Many documents show concrete to be smoother to ride upon, but seemingly the same number tout asphalt to be the smoother ride. One unbiased document created by a cycling transportation engineer (being neither part of the asphalt nor concrete industry) notes that the joints, or grooves, between concrete sections can be bumpy and sometimes dangerous (Forester, John 1995). This is an important consideration, especially for less stable modes of transportation like rollerblades or skateboards.

Some runners feel concrete has less flexibility than asphalt and is, therefore, less comfortable to run on (Swift Creek Greenway 2004; West 2003; Freemont 2005). This should be an important consideration since greenway trails are often used by runners as well as walkers, who also may be more comfortable on a more flexible material.
The ADA states that outdoor trail surfaces need to be “firm and stable” (American Trails 1999), with trails that are greater than .5 miles needing to be “very firm and very stable” (National Center on Accessibility 2001). Concrete trails would provide firm and stable travel for those with disabilities. Since requirements for hard surface trails built to accommodate bikes and skates tend to exceed ADA regulations, the construction of the multi-use trail, as long as it is at least 3 feet wide (the ADA required ‘clear tread width’) will be within ADA requirements (National Center on Accessibility 2001).

**Sustainability and Environmental Impact**

In many parts of the United States, finding sources of high quality virgin aggregate is becoming harder and harder as non-renewable sources are depleted. Due to increases in demand, however, the production of aggregate is estimated to increase from 1.8 billion tons currently to 2.3 billion tons by 2020 (Harrington 2005, 9). Given this projected increase, it will be even more important to find ways to reuse and recycle concrete in order to reduce the demand for virgin aggregate and to direct reusable concrete away from landfills.

Concrete is a nearly inert material that is recommended for use in building construction to reduce the toxicity content of the overall building. Therefore, being almost 100 percent inert makes concrete a desirable choice for a multi-use trail that is located in a sensitive, highly disturbed area like the Mill Creek watershed. Though less of a perk for multi-use trails, concrete has also been found to be more energy efficient on roadways, saving trucks up to 20 percent in fuel consumption as opposed to asphalt (Ridsdale 1994, 1).

The environmental burdens caused by concrete production and the products made from it include “limestone quarrying, burning and grinding of clinker [powdered cement], extraction, excavation and crushing of cement stone materials, manufacturing and transportation of raw materials and the final product” (Vares and Hakkinen 1998, 1). The manufacturing of concrete includes heating materials to high degrees of temperature, as high as 1450° Celsius (Glover 2004), requiring great amounts of energy and a loss of
other natural resources used that supply this energy, like coal or natural gas. Given that different process plants produce different concretes, depending on the types of aggregate and paste ingredients used, there can be many different amounts of air emissions, energy used, as well as solid waste produced.

The most detrimental air pollutants released during the construction of cement are carbon dioxide (CO$_2$), nitrous oxide (NO$_x$), and particulate matter. Carbon dioxide, the major source of global warming, is released during the decomposition of limestone in factories, and is released from power sources used to supply factories with electricity. A more minimal amount is released from ready mix trucks or trucks bringing virgin materials to the cement-mixing factory. Producing one ton of cement, the main ingredient in concrete, produces approximately 1 ton of CO$_2$. Currently cement manufacturing accounts for seven to eight percent of annual global CO$_2$ emissions (Ecosmart Concrete 2005).

Cement kilns used in the concrete-making process release nitrous oxide, a dangerous compound that creates ozone when mixed with volatile organic compounds coming from industry and tree resin. Kiln dust is a dangerous particulate released into the air during concrete-making, though most is collected and re-fed into the concrete-making process. The release of materials from the clinker stream, which can cause an “alkali aggregate reaction,” is detrimental to the natural environment (Bremner 2001, 3-4; Roy and Morrison 2000).

A loss of energy-producing natural resources from the use of fuel also happens during transportation of raw materials like limestone, gravel, crushed aggregate and iron ore. There is also energy use when transporting the final product to its destination, and then transporting used concrete to landfills or recycling centers (Vares and Hakkinen 1998, 6).

From documents and interviews, it is safe to say that utilizing recycled concrete will ultimately save in resources used, and has proven to save money as well. The Texas Department of Transportation, which has used recycled concrete for more than 10 years, has found it to have environmental, economic and engineering benefits. For example, using recycled concrete saves time and money not having to haul aggregate from
quarries. The Michigan Department of Transportation used recycled concrete on a project that saved $114,000 (U.S. Department of Transportation, Federal Highway Administration 2004).

Life Cycle Costs

When using recycled concrete, there will be no need for raw material extraction, except for when a percentage of the recycled product comes from virgin materials (Harrington 2005). There will be none, or little, transportation of raw materials for use, which is a large economic benefit (Turner-Fairbank Highway Research Center 2005). However, different costs incurred include transporting aggregate to concrete recycling facilities equipped to grind and reprocess the concrete into a usable aggregate. While there, the old concrete will need to be “cleaned of unwanted material such as bricks, wood, steel, ceramics, and glass.” After this, the concrete is crushed and electromagnets are used to remove residual metal. Then it can be screened and washed for reuse as recycled concrete aggregate (RCA) (Harrington 2005). Energy is used throughout this process, plus water for the final washing. However, recycling concrete does eliminate, or almost completely eliminates, the extraction of raw materials, depending on the percentage of recycled concrete that is used in the final product. This helps save precious natural resources.

Local, Regional, State and National Availability

The Sand & Gravel Division of Moraine Materials Company, located in Franklin, Ohio, is one of the largest ready mixed concrete producers in Southwest Ohio. This division has a concrete recycling operation within it. The Association of Ohio Recyclers will also be a good future contact for further information on where to find companies that can work with MCRP on special projects.

There are multiple concrete paving companies in Southwest Ohio. Most will not be willing to create alternative pavements (Keil 2005). However, Ohio Ready Mixed Concrete Association, which has created and installed pervious concrete, and Concrete
Promotion Council of Southwest Ohio are very good contacts for further information about all different types of concrete projects.

**Status Quo: Asphalt and Recycled Asphalt**

Asphalt is the most used paving material in the United States. Ninety-four percent of roads are covered with asphalt today (National Asphalt Pavement Association 2004). Asphalt cement, the sticky part of asphalt, is made from petroleum through a process that separates a tar-like substance from crude petroleum. This is mixed with aggregates like gravel, sand and crushed stone (Exxon Mobile Corporation 2005).

Like concrete, recycled asphalt has the same composition as virgin asphalt pavement, so both will be included in this section. Recycled asphalt will be focused upon specifically in the *Sustainability and Environmental Impact* section. Currently, recycled asphalt is the most recycled material in the world (Harrington 2005; Asphalt Pavement Association of Michigan 2005). It is also easily accessible in the Southwest Ohio region, which will be addressed in the *Local, Regional, State and National Availability* section.

**Uses for Material or Item**

Asphalt, like concrete, is used for a variety of projects including roadways, parking lots, roofing, greenway trails, driveways, playgrounds and tennis courts (American Federation of State, County and Municipal Employees 1989; Asphalt Education Partnership 2005a). The first asphalt to be used on roads is said to date back to the ancient city of Babylon in 625 C.E. (Asphalt Education Partnership 2005b).

**Initial Cost**

Using an asphalt pavement alliance study of Ohio pavement projects showing 2005 costs and an Ohio Department of Transportation (ODOT) five percent discount rate, asphalt pavement costs range from $6.83 - $8.26 per square yard (three inches of asphalt laid
over nine inches of Portland cement concrete). Comparable 2005 costs for concrete paving in Ohio, using an ODOT discount rate of five percent, range from $9.11 - $12.68 per square yard (Villacres 2005, 2, 10). These data show there is an obvious initial savings when using asphalt over concrete. The question remains, then, whether asphalt is as durable and environmentally friendly as concrete. Evidence has already been given in this report that users have a preference for asphalt over concrete due to increased comfort.

**Durability**

A well-designed asphalt pavement can last for decades. There are asphalt roads built over 35 years ago that have not had structural failures to this day, like the asphalt portions of Interstate 90 in Washington State, for example, which has similar weather to Ohio, but often more rain. Asphalt pavements are now deemed “perpetual pavement” because only surface layers need to be replaced, while the overall structures remain sound. Overlays of new asphalt can last 15-20 years (Asphalt Education Partnership 2005c). Lower impact on multi-use recreational trails will most likely allow for an extended life of this product, as it would for concrete. Asphalt is called a ‘flexible’ pavement because it does not distribute a load over a large surface area, but more locally absorbs the impact of weight. It can move under impact more easily than concrete, which is called a ‘rigid’ pavement (American Concrete Pavement Association 2005f). This flexibility may be why many runners prefer asphalt to concrete (Swift Creek Greenway 2004; West 2003, 2).

**Safety and Health Issues**

User preference is an important part of perceived and factual safety concerns. Many accounts of a preference of asphalt over concrete for runners and walkers have been documented (Forester 1995; Tom 2005; Swift Creek Greenway Phase II Meeting 2004; West 2003). The more flexible surface that asphalt provides for impact is better for the joints of walkers, and especially runners. It has also been documented that a majority of the ever-increasing trail users, including cyclists, roller-bladers, handicapped people, and
people pushing baby strollers, prefer a joint-free surface upon which to travel (Peterson 2005). Joints are referring to the gaps between slabs of concrete, which are part of the construction of the concrete surface.

As mentioned earlier, outdoor trail surfaces need to be “firm and stable” (American Trails 1999), with trails that are greater than .5 miles needing to be “very firm and very stable” (National Center on Accessibility 2001) to comply with ADA standards. Like concrete trails, a multi-use asphalt trail can meet ADA standards. In fact, the 80-mile Little Miami Scenic Trail, which runs from Milford, Ohio north to London, Ohio, is paved with asphalt and is very accessible to handicapped individuals (Ohio to Erie Trail 2005).

Sustainability and Environmental Impact

Seventy-three million tons of asphalt are removed from roads and recycled every year in the United States. This accounts for over 80 percent of the asphalt removed each year. The asphalt industry recycles asphalt as well as other materials in recycled asphalt mixes including rubber from recycled tires, slag from the steel industry, roofing and shingle rejects from factories, and sand that comes from metal-casting foundries (Asphalt Education Partnership 2005d; Asphalt Pavement Association of Michigan 2005).

Recycling asphalt helps reduce the use of virgin materials, saving non-renewable natural resources like petroleum. There is also a gas savings, since virgin materials do not need to be hauled from sites and used materials are not shipped to landfills (Asphalt Pavement Association of Michigan 2005). Furthermore, though asphalt production has increased by over 250 percent in the past 40 years, the asphalt industry is claiming to have decreased emissions from asphalt plants by 97 percent (Asphalt Education Partnership 2005e). This is, no doubt, due to air quality regulations mandated by the federal Clean Air Act. In 2002, the Environmental Protection Agency (EPA) removed hot mix asphalt plants from the list of industries that are “major sources of hazardous air pollutants” (Asphalt Education Partnership 2005e).
Any time asphalt is heated during the mixing or installation process, chemicals are released into the air that can be hazardous to human health. There is an inherent risk at the mixing and installation stages with the use of recycled asphalt, as well, since it is recycled in an asphalt mixing plant where high temperatures are again used to create recycled hot mix asphalt that has to be applied at high temperatures. Three toxic solvents, benzene, dioxane and toluene, are used in the ‘asphalt-cutting’ process, which brings the semi-solid or solid asphalt to a liquid state so that it can be installed with ease. All of these are known to be detrimental to human and animal health, causing cancer of the skin and various organs (American Federation of State, County and Municipal Employees. 1989).

Once installed, according to research, asphalt has a relatively inert character in the surrounding environment, not exposing soils or water to chemicals from the asphalt mix (National Asphalt Pavement Association 2004; Wess, Olsen and Haring Sweeny 2004). A recent study of the effects of runoff from asphalt pavements showed concentrations of dangerous hydrocarbons to be below detection limits. Researchers in the same study also believe that heavy metals found in elevated concentrations may have been from oil drippings, vehicle emissions, or other liquid releases from automobiles and trucks rather than from the asphalt. When studying tissue samples from fish and invertebrates in nearby waterways, toxins found in detectable amounts were attributed again to automobile and truck emissions and not to asphalt (Wess, Olsen and Haring Sweeny 2004, 1-2).

Using recycled asphalt will undoubtedly reduce environmental impact and, therefore, increase sustainability. However, emissions can still be released if the asphalt is reprocessed and remixed in a facility; though there is no need for extraction of virgin materials, as asphalt can be 100 percent recycled. There are various methods for recycling asphalt. A trail made of recycled asphalt will most likely come from a facility that recycles and reuses this material. The asphalt will most likely come into the facility in crumbled form from the site where it was removed. Aggregate, additives and emulsion materials, all of which may or may not be recycled, are added to create the new mix,
which uses energy and will unfortunately emit some toxins (California Integrated Waste Management Board 2003).

*Life Cycle Costs*

According to asphalt proponents, the reason the majority of roads in the United States are paved with asphalt are due to the “lower construction cost, reduced time of construction, ease of maintenance, and benefits related to improved smoothness, reduced pavement noise, and ability to resist deformation in colder climates and higher elevations” (Colorado Asphalt Pavement Association 2005). An asphalt pavement project can cost as much as three times less than a comparable concrete paving project (Asphalt Education Partnership 2005f). Using recycled asphalt, especially if MCRP can work with the City of Cincinnati and a local paving company to reuse asphalt from Cincinnati’s Asphalt Division (which was offered to MCRP at no cost), will hopefully help cut initial costs for the project.

It is suggested in order to maintain a safe trailway that maintenance be done on a yearly basis, and especially during the spring and summer months when trail use is most popular and vegetative debris most prevalent (Bucher, Willis & Ratliff Corporation 2005). Volunteers for MCRP could easily do this maintenance work. However, yearly asphalt trail maintenance should not only include keeping vegetative debris off of the trail surface to ensure safe traveling for users; it should also include patching parts of the trail that may collapse during rainy seasons, or parts that may crack over time due to Ohio’s freeze/thaw climate. Wayne National Forest in Southeastern Ohio had to delay opening 182 miles of non-motorized and motorized trail in the spring of 2005 due to heavy rains in January 2005 that caused massive flooding and trail damage (Wilberger 2005). Though parts of Mill Creek have been altered by the Army Corps of Engineers to eliminate flood risks, continued development north along the creek has amplified non-porous surfaces, like parking lots. This can increase flooding in the Mill Creek floodplain during heavy rain events (Corathers 2005). Therefore, future trail construction could be at risk, needing maintenance with every season that brings heavy rains and flooding, unless site planning
can move parts of the trail away from land that is at higher risk of collapse.

**Local, Regional, State and National Availability**

There are multiple asphalt pavement companies in Southwest Ohio. Valley Asphalt Corporation recycles asphalt for reuse in paving projects. Dave Patterson of Valley Asphalt Corporation will be a good future contact for future information about recycled asphalt. The Association of Ohio Recyclers will also be a good contact to identify other companies creating recycled paving.

**Rubber Asphalt**

Rubber asphalt is just like regular asphalt, except a portion of asphalt is replaced with crumb rubber. Most often, crumb rubber is made of recycled tires that are stripped of metals and ground to a consistency similar to coffee, and then added to the asphalt mix. At the right temperatures, the rubber melts with the asphalt and creates a workable surface that can be laid just like regular asphalt. It becomes hard like asphalt and is very durable, sometimes lasting longer than traditional asphalt mixes (Arizona Department of Transportation 2005b; Stutz et al 2003, 5). Rubber asphalt ingredients include crumb rubber, asphalt cement (regular asphalt), and a small amount of additives used for binding (I-25 Corridor Environmental Assessment Project 2005; Arizona Department of Transportation 2005a).

The Arizona Department of Transportation (ADOT) has used tire rubber in street paving for decades. Phoenix first used a ‘chip seal’ (tire rubber and aggregate mix) in the 1960s for a section of a street, and found early on that it was a durable, long-lasting option. Arizona has been using rubber asphalt on their highways since 1989 when the City of Phoenix used a one-inch overlay on a city street. This overlay proved to be beneficial in many ways including not reflecting cracks from the underlying street, being more durable than conventional asphalt and reducing traffic noise, while also providing a quieter ride that is pleasing to users (Arizona Department of Transportation 2005b).
Since 1988, ADOT estimates they have recycled 15 million-plus tires for use in hot mix rubber asphalt (Arizona Department of Transportation 2005c). This is a very positive move toward sustainability. However, rubber asphalt is not a well-known, trusted material everywhere. During research for this project, conversations were held with transportation engineers, asphalt proponents, and trail designers in various parts of the United States who were surprised to learn that rubber asphalt was used on a large basis by ADOT, as well as by Sacramento County, California (Kolling 2005). There are no companies using scrap tires for hard surface trails or roads in Ohio, as far as ODNR is aware, though recycled tires are currently reused in their crumb rubber form for playground cover and running tracks (Dummitt 2005).

Given that MCRP will be looking for funding for the entire Mill Creek Greenway system, it may be worthwhile to contact the Marketing Development Coordinator for Ohio Department of Natural Resources. The Recycling Market Development Grant, organized through ODNR, provides funding to cities, counties and solid waste management districts or authorities to implement recycling and litter prevention programs (Ohio Department of Natural Resources 2007). This grant may not only be useful for scrap tire recycling projects, but also for various recycling projects that MCRP can implement within the greenway trail system with the help of the City of Cincinnati, Metropolitan Sewer District of Greater Cincinnati, or the Hamilton County Solid Waste Management District.

*Uses for Material or Item*

Rubber asphalt, also known as “asphalt rubber,” “asphalt-rubber,” “rubberized asphalt” or “rubberized asphalt concrete,” is used for the same paving projects as regular and recycled asphalt, including roads, parking lots and multi-use trails. It is used most widely on roadways, but innovative projects have led to its use on multi-use trails, like the American River Parkway bike trail in Sacramento County, California, which will be discussed in the following sections (Rubber Pavements Association 2002).
Initial Cost

Rubber asphalt is more expensive to use than conventional or recycled asphalt because of the special mix created. Due to a lack of examples locally, costs for the American River Parkway bike trail in California will be used. In 2001, 17.6 miles of an old asphalt trail was resurfaced with rubber asphalt. An estimated 11,375 tons of rubber asphalt were used, which allowed 38,200 old tires to be recycled. The total cost of the project (labor, supplies, materials, etc), which included the 17.6 miles of old asphalt trail, 1.35 miles of trail converted from asphalt to a natural path and 1.55 miles of an old gravel area completely converted to rubber asphalt (not just resurfaced), was $1,446,680. Most was paid for by a Federal Transportation Enhancement Activities grant ($1,273,299), while the rest was paid for through a Sacramento Metropolitan Air Quality Management District grant ($234,606). This breaks down to a rough overall cost estimate of $82,197 per mile. Keep in mind that these are prices for California, which tends to be a more costly place in which to live and do business, and also keep in mind that these are costs from 2001 (American River Parkway Bike Trail Overlay Project 2001; Kolling 2005). This is also a project that, for the most part, is an overlay of an existing trail. Creating a new asphalt rubber trail, which requires soil assessments, digging, a layer of subsurface below the trail, and finally the rubber asphalt, will cost more per mile.

Durability

Concerns with freeze/thaw weather patterns in Ohio causing structural breakdown of any hard surface are common in the transportation industry. Rubber asphalt has proven to be extremely durable and long-lasting in warm weather as well as freeze/thaw climates, as is most evident in the highway projects produced by the ADOT, which are examples of the longest lasting rubber asphalt projects in the United States (Arizona Department of Transportation 2005a-d). According to Julie Nodes, rubber asphalt expert with ADOT, rubber asphalt is used in all different types of climates found in Arizona from low lying desert climates to mountainous areas like Flagstaff, AZ. Rubber asphalt has been used in Arizona up to 9,000 ft above sea level, has experienced snow and melt in the summer
months, and is still extremely durable. Ms. Nodes noted that in 2005, after decades of use, part of a road was found to have some water damage. This was the first incident reported in Arizona since the state began use of this product. Given that rubber asphalt would be used for a trail surface in Ohio where humidity is high, but where much less than one ton of weight would ever be applied to the trail for lengthy amounts of time, there should be no concerns with either freeze/thaw patterns or moisture affecting a hard surface rubber asphalt trail more than any other type of hard surface trail that is laid (Nodes 2005).

According to research on rubber asphalt road projects done throughout the United States, and according to Ms. Nodes, the most successful installations of rubber asphalt are done using the ‘wet’ method. Using a ‘dry’ process has repeatedly failed when used by various places in North America. The ‘wet’ method, according to ADOT, is used when mixing crumb rubber with asphalt cement so that it partially melts. This is a better method since it allows the materials to mix together better, creating a more durable surface. The ‘dry’ method still replaces aggregate with rubber, and it is partially melted. However, it is not melted to the same degree, and causes the particles to be seen more than with the wet method. Less melting leads to less successful installations. Studies showed California and Minnesota to have success with some dry method installations, but the Minnesota installations did not prove to be successful in offsetting the increased cost. The same studies showed projects in New York, Texas, Washington State and Ontario to fail using the dry method (Nodes 2005; Turner-Fairbank Highway Research Center 2005).

This research, plus the extensive use of ‘wet’ asphalt rubber by ADOT, indicates that if asphalt rubber trails were laid in Ohio, the ‘wet’ method would be the best, most durable method to use requiring the least maintenance. ‘Wet’ method rubber asphalt, termed “rubberized asphalt concrete,” was used by Sacramento County, California in the American River Parkway bike trail. The trail has been in place since 2001, and has not had any maintenance issues. Maintenance costs have been low, and the trail “flexes” more with use, which causes less cracking (Kolling 2005). Sacramento County is obviously a warmer climate than Ohio, but ADOT uses the wet method at higher
elevations, as well, with just as much success (Nodes 2005).

Research done into the durability of rubber asphalt indicates that in many areas it can outperform traditional asphalt. Due to rubber asphalt’s higher binder content, research has shown it to have better “resistance to surface initiated cracking.” Higher binder content and binder elasticity helps it resist fatigue and reflection cracking. It can also have a higher “resistance to low temperature cracking” (which is important in areas like Ohio where temperatures can greatly fluctuate from season-to-season), higher resistance to rutting and a higher lifetime durability overall (Stutz et al 2003, 6). It is important to remember, though, that the company chosen to create and install the rubber asphalt is important. With any project, picking a company with a good track record of consistency in their paving projects is going to be beneficial in the long run, even if it is a bit more costly.

Aesthetics

Rubber asphalt very successfully reduces automobile noise on the roadway and noise from alternative transportation modes on multi-use trails. The rubber content has been proven to reduce noise by many decibels. This has been noticed on the American River Parkway bike trail, creating a smoother and quieter ride for trail users (Stutz et al 2003, 7; I-25 Corridor Environmental Assessment Project 2005). Tim Landers of Liberty Tire Services in Columbus, Ohio (which sells recycled crumb rubber for reuse), has visited one of ADOT’s rubber asphalt plants and remarked about how impressed he was not only with the facility, but with driving on rubber asphalt roads. He noted a significant decrease in noise and a smoother ride as well (Landers 2005).

Safety and Health Issues

Like traditional asphalt, safety issues with asphalt rubber focus upon the health of those utilizing a multi-use trail. Runners and walkers especially, as well as others using the trail for rollerblading, biking, skateboarding, and other exercise may prefer rubber asphalt
even more than traditional asphalt due to the increased flexibility that the surface provides. Running tracks are often made with recycled crumb rubber, though using only crumb rubber will not hold up well on a multi-use trail. Having a combined asphalt-rubber surface will be very pleasing to those worried about injury due to impact during exercise. According to American River Parkway bike trail users, the rubber asphalt provides better grip for bike tires, especially in rainy weather. Rubber asphalt not only creates more traction, but it is also more porous. This allows some water to filtrate through the surface, which decreases the number of puddles on the trail, making it more pleasing for users (Kolling 2005; Stutz et al 2003, 7).

_Sustainability and Environmental Impact_

Many studies have been done to investigate the potential for leaching from scrap tires and crumb rubber, and many studies have been done with rubber asphalt in mind. The Wisconsin Department of Transportation performed leaching and toxicity tests on tire chip pieces in 1992 with promising results. Leaching and toxicity experiments are carried out by submerging pre-cut or chipped tire scraps in solutions and recording results based on changes in the solution which indicate leaching from the tire scraps. It was found that with increased leaching, there were declines in the concentrations of materials that leached from tires, except for barium, iron, manganese and zinc. However, overall results showed the leaching to be below that of designated hazardous wastes and, therefore, scrap tires were not hazardous and showed little or no risk to groundwater sources (Liu et al 1998, 6).

Experiments were done by the Minnesota Pollution Control Agency in 1990 to compare scrap tires to traditional asphalt. When scrap tires were subjected to high concentrations of toxins with very extreme pH conditions, it was found that traditional asphalt leached more metals than scrap tires. However, both were found to leach harmful amounts. These extreme conditions on roadways could only be related to “worst case scenarios” where chemical leaks from trucks would fall onto roadways and cause leaching, or come from nearby industries. The conclusions of the experiments recommend limited use of scrap
tires in roadway construction due to these risks, and that construction of roadways should especially limit infiltration of water through scrap tires.

Two discrepancies seem to arise in this research. First, it was found that in all cases, “asphalt samples leached similar or higher levels than scrap tires.” Therefore, recommending limited use of scrap tires in roadway projects, but not discussing the limitation of asphalt is of concern. Secondly, researchers reviewing these experiments stated that further assessments should be done to conclude if the extreme conditions that asphalt and scrap tires were subjected to were even “possible in a ‘real world’ environment.” (Liu et al 1998, 5). On the Mill Creek Greenway Trail there will be much less probability of a chemical spill than on a highway.

*Life Cycle Costs*

From the sustainability standpoint, utilizing recycled tires in rubber asphalt provides an effective way to reroute scraps from landfills. As mentioned earlier, a 17.6-mile project using rubber asphalt recycles 38,200 tires. Over 15 million tires have been recycled for use in rubber asphalt by ADOT (American River Parkway Bike Trail Overlay Project 2001; Kolling 2005; Arizona Department of Transportation 2005c).

Tire recycling not only helps reduce landfill waste. It saves on energy costs as well. Creating new rubber to use in rubber asphalt requires 55,000 BTU for one pound of rubber. In contrast, only 1,000 BTU are required to convert 1 pound of scrap tires into crumb rubber (Montanans Against Toxic Burning 2005). As when using recycled concrete and asphalt, recycling rubber instead of creating new rubber to create rubber asphalt will reduce costs associated with extraction (of petroleum and other virgin materials used to make new rubber), transportation and, as mentioned before, production.

*Local, Regional, State and National Availability*

No local, state or regionally located companies making rubber asphalt were found.
Liberty Tire Services of Ohio in Grove City, Ohio (near Columbus) is a well-known company that buys scrap tires, crumbs the scraps, and resells to companies making new tires and other new products from recycled rubber. However, none of Liberty’s clients, according to Tim Landers, general manager for Liberty Tire Services, are creating paving materials. He had no knowledge of paving companies creating rubber asphalt, though he believed a good future contact might be Valley Asphalt in Cincinnati, which is creating new asphalt from recycled asphalt (Appendix I). Valley Asphalt, however, is not creating porous or rubber asphalt at this time (Patterson 2005). Landers has visited one of ADOT’s rubber asphalt plants, knows that parts of Canada are using rubber asphalt as well, but stated that economically it is not a viable option here in Ohio yet (Landers 2005). Like with any new product, there needs to be regional demand created for rubber asphalt to become viable (Kolling 2005). For a listing of some local and state scrap tire services, see “Scrap Tire Services” in Appendix I.

Porous Asphalt and Concrete

Uses for Material or Item

Porous (or pervious) asphalt and concrete will both be addressed in this section, as they are similar in construction to traditional asphalt and concrete, but with smaller particles, or ‘fines,’ sifted out to produce a final material that is pervious to water. Both porous concrete and asphalt have been around for many decades, and have both become very popular for stormwater management. Porous asphalt pavement, developed in the 1970s, and porous concrete, created over 50 years ago, have both shown to be very effective in managing stormwater runoff, helping divert water into natural soils underneath pavement instead of into nearby streams, or stormwater overflow systems that eventually flow into streams or rivers (Adams 2003; Rinker Materials Corporation 2003).

As explained in the “Background” section of this report (p. 5), Mill Creek has been in decline for decades. Commercial, residential and industrial development within the Mill Creek Valley has caused a large amount of polluted stormwater runoff to flow into the
stream. Because the City of Cincinnati still has its original combined stormwater runoff and sewer system built in the 1800s, during heavy rains, water flows from paved areas along the Mill Creek into stormwater drains. These drains flow into sewer pipes, and when the pipes are overfed the excess water spills into the Mill Creek through ‘combined sewer overflow’ (CSO) caps that open into the waterway. This combination of water and raw sewage eventually makes its way to the Ohio River (Metropolitan Sewer District of Greater Cincinnati 2005; Mill Creek Restoration Project et al. 1999). Given that the creation of a hard surface trial along Mill Creek could potentially add to stormwater runoff, porous concrete or asphalt may be an effective way in which to divert waters back into groundwater sources where they can be filtered by soils, and then recharge aquifers below.

Initial Cost

It is difficult to find exact costs for recreation projects involving porous concrete or asphalt because there do not appear to be many large-scale porous concrete or asphalt trail projects in place. Besides the recycled asphalt trail in Sacramento County, California, no large-scale projects using alternative trail surfaces were found. No contacts made in the Midwest knew of any porous asphalt or concrete trail projects. When speaking with experts in the field from associations and asphalt and concrete businesses, it became clear that the cost of porous asphalt and concrete projects is comparable or higher than traditional concrete and asphalt.

If costs are higher, they are not excessively higher, according to professionals, though none were willing to send cost estimates for jobs and no one had comparison pricing for porous surfaces versus conventional non-porous surfaces (Patterson 2005; Keil 2005; Cahill et al 2004). The process by which fines (the smallest pieces) are eliminated from the concrete or asphalt mix can increase the cost. Installation costs can also be higher since a special layer of gravel is placed below the hard surface in order to ensure proper filtration of water into soils below (Keil 2005).

In 2003, Northern Kentucky Sanitation District created a parking lot made of porous
asphalt and porous concrete to be used as a stormwater management tool. The parking lot is located near a waterway and helps filter waters from the porous parking lots instead of washing residues from the lot directly into the waterway. According to Sean Blake, who is with the Sanitation District, the project has so far been extremely successful at filtering rainwater. Many companies were involved in the production of this stormwater installation, since there are no companies in the tri-state region dedicated only to porous pavements (Blake 2005; please see Local, Regional, State and National Availability for contact information for these different companies). It will take this type of collaboration for MCRP to implement porous pavement into the Mill Creek Greenway Trail. The porous asphalt and concrete project is now part of a larger park, called Public Service Park, filled with environmental best management practices (BMPS) that are used in sustainability projects and stormwater management (Sanitation District No. 1 of Northern Kentucky 2007).

**Durability**

Porous asphalt and concrete hold up “as well as, or better than,” traditional pavements (Cahill et al 2003), but there are some special considerations. First, porous asphalt may not hold up as well as porous concrete, due to asphalt’s higher ability to shrink and swell with moisture and temperature changes. This is an important consideration since Ohio is a seasonally rainy and humid climate and high propensity for freeze/thaw patterns throughout the winter months. Therefore, there may be a higher probability of structural breakdown over time with the use of porous asphalt, according to experts, though technological research is working to overcome these issues (Davidson 2005; Cahill et al 2003). There have been no structural problems with the Northern Kentucky Sanitation District’s porous pavements stormwater installation, but the project has been in place for less than three years (Blake 2005).

**Safety and Health Issues**

Porous pavements will still provide the stability needed for a multi-use trail to meet ADA
requirements. Both pavements will provide easy travel and a smooth ride like traditional pavements (Davidson 2005; Keil 2005). There will most likely be a higher desire for porous asphalt over concrete for runners who prefer traditional asphalt over traditional concrete. This may be an important consideration if MCRP wants to decide on one porous option over the other. From a safety standpoint, allowing water to filtrate through a hard surface will keep puddles from forming, making the multi-use trial not only more desirable to travel upon, but also safer for travelers. Those wanting to walk or bike to work will be much happier, as well, to not have clothing dirtied by puddles that may splash upon them.

Sustainability and Environmental Impact

There are typically layers of graded stone below the hard porous asphalt or concrete pavement, which act as recharge beds. If there is more than one layer, the first layer will be a smaller grade of gravel, which allows for initial filtering. The second layer, further below, will be larger gravel. This layer allows for runoff detention while waters filter through soils into the ground below. At least one layer is needed for proper storage of runoff water while it filtrates into soils (Patterson 2005; Cahill Associates 2003).

Environmentally, using porous concrete or asphalt is a perfect way in which to reroute waters from the Mill Creek, which is already at risk of flooding due to stormwater runoff. Water will not only be rerouted, but will also be cleaned through a natural filtration process before reaching groundwater sources below. However, porous pavements can not be placed upon any types of soils. The site proposed for installation must have the right soils for porous asphalt or concrete to work properly. It is important that they clay content in soils be minimal, or waters will not filtrate through soils fast enough, causing backup and the possibility of puddles upon the porous surface. It is very common to find soils with high clay contents in Southwest Ohio, so proper soil analysis will need to be done before planning for porous pavement (Patterson 2005).
Local, Regional, State and National Availability

The best contacts for future site planning for porous asphalt or concrete are state associations dedicated to concrete or asphalt. They can point MCRP in the direction of well-known local or regional companies that will provide a successful final product. As mentioned earlier, Ohio Ready Mixed Concrete Association, will provide specific information on who might be willing to work with MCRP on creating a porous concrete trail. Flexible Pavements of Ohio, an association dedicated to developing and improving asphalt paving in Ohio, will be a good contact for further information on porous asphalt paving in Ohio.

Many different entities were involved in the Northern Kentucky Sanitation District’s stormwater installation project. The following is a list of all companies involved in the project, though some do not do work out of state. They are not listed in Appendix I:

Porous Asphalt

1) Thelen Engineers designed the collection system under the porous asphalt: 513-746-9400

2) Tony Ogle (Eaton Asphalt) created the porous asphalt mix design. However, Eaton Asphalt does not do work in Ohio: 859-371-1274

3) Len Riegler Blacktop was in charge of installation: 606-371-8122

Porous Concrete

Thelen Engineers designed the collection system under the porous concrete: 513-746-9400

Kentucky Ready Mixed Concrete Association created the mix design: www.krmca.org/about/contact (author was not given contact name)

Lithco and Baker Concrete was in charge of installation: 513-539-4013
Glassphalt

Since the 1970s, glassphalt has been used in place of traditional asphalt mixes. It is very similar to traditional asphalt, and used for the same purposes, except that a percentage of virgin aggregate is replaced with ground glass particles (Clean Washington Center 1996). If a local or regional paving company was found that had the desire and equipment available to create glassphalt, MCRP could work with local recycling companies to collect recycled glass to use in the mix, helping support sustainability efforts. Though research has shown there are no local businesses creating glassphalt, there are recycled glass facilities that may be willing to work with MCRP if a paving company is found that will be willing to create this alternative hard surface trail.

In general, there is a risk of aggregate pulling away from the asphalt cement it is bonded to. The bond weakens under wet conditions, which Ohio is known for. This risk of “stripping” can be reduced if glass particles are very small (under 3/8 inches in size), and if an anti-stripping agent, like calcium hydroxide or hydrated lime, is used (Clean Washington Center 1996). Though no companies that specifically make glassphalt were found in Ohio, Matt Dummitt, Marketing Development Coordinator for Ohio Department of Natural Resources, would be a good contact for further information (found in Appendix I under “Dummitt”).

Soft Trail Products

Rubber Mulch

There are multiple companies who presently sell rubber mulch, made most often from scrap tires, which helps to increase recycling of tires for creative purposes. It can be cheaper than other playground coverings and can last longer since it is not easily degraded by environmental conditions. Rubber mulch has proven to be safe for use around children, and is often marketed for playground covering. Rubber mulch also helps to reduce injuries from falls, and there are no issues with it being used in freeze/thaw
climates, like Ohio (Ohio Department of Natural Resources 2005). Companies that sell rubber mulch in Ohio include Mulch-No-More, New Age Mulch and Groundscape Technologies. Contact information for these companies can be found under “Rubber Mulch Companies” in Appendix I.

Invasive Shrubbery Mulch

Using invasive shrubbery, like honeysuckle (*Lonicera mackii, Lonicera japonica*), as mulch may be an effective way to reuse a plant that is constantly being managed by local parks departments, and indeed grows in places along the Mill Creek where the greenway trail will be constructed. It is, however, dangerous to use invasive shrubs in mulch because any possibility that seeds or rhizomes can be spread from the plant to other areas will continue to exacerbate the management of these species (Litzsinger Road Ecology Center 2006). Recycled wood mulch can still be used, however, if it is known to come from tree or lumber sources (as long as the lumber is known to not have been treated with CCA). The logs from street trees stored at Sinton Road salvage yard may be a good source for mulch to use in conjunction with invasives.

Other New Products Made From Recyclables

Plastic Lumber and Other Recycled Plastic Products

Uses for Material or Item

Please note within this report when the terms, ‘plastic lumber’ and ‘recycled plastic lumber’ are used, they will both refer to recycled plastic lumber (RPL) unless otherwise noted.

Recycled plastic is an extremely versatile material that has been used for decades in the United States to create a variety of products, from farming and agriculture items to household clocks (American Plastics Council 2005a). Recycled plastic lumber (RPL) has been used extensively as well, and has seen much improvement in structure and
durability since early offerings entered the market in the 1980s (Platt, Lent and Walsh 2005). It is estimated that 2.7 billion pounds of post-consumer plastics were recovered and recycled in 2004. The market for recycled plastic is increasing at a rate of 4 percent every year, estimated to be at 3 billion pounds by 2009 (Sharp 2005). Recycled plastic lumber is made from multiple recycled plastics including milk jugs, bubble wrap, plastic wrap, detergent and water bottles. In fact, a local producer of plastic lumber, OnSpec Composites, uses locally recycled bottles for their plastic lumber composite, which is also made with recycled wood fibers (Mayer 2005).

Many city, state and national park departments, some of which will be discussed later, currently purchase RPL and recycled plastic park furnishings including benches, tables, fencing, informational signage, trash and recycling receptacles and playground equipment (Anderson 2004: Platt, Lent and Walsh 2005, 4). Locally, Northern Kentucky Sanitation District and Colerain Township has purchased plastic lumber signage from The Plastic Lumber Company, located in Akron, Ohio. Recycled plastic lumber is used residentially for decking material as an alternative to traditional wood decking lumber. Recycled plastic products and RPL is also popular with gardeners, being used to create flowerpots and lawn and garden edging (American Plastics Council 2005b). Hamilton County Department of Environmental Services (HCDOES) awarded multiple local municipalities, townships and counties grant money in 2003 and 2005 to purchase products made from recycled plastic, many of which were park furnishings like tables and benches, in order to encourage local communities to ‘buy recycled.’ Grant money came from the Ohio Department of Natural Resources Recycle Ohio! and Community Recycling and Litter Prevention grants (Christmann 2005).

The Healthy Building Network’s “Guide to Plastic Lumber” is an assessment of different plastic lumber products from various companies in the United States. The report is based upon a 3-criteria assessment of the different products: different materials used, recycled content and recyclability. There is a helpful list in the report of plastic lumber company products, which shows recycled content and whether the lumber is post-consumer or not. This is a very useful guide when choosing the most and least environmentally friendly
companies from which to buy plastic lumber products (Platt, Lent and Walsh 2005).

Initial Cost

Plastic lumber products, like park benches for example, are more expensive than traditional wood products. However, if purchased from a well-known company with a good track record, RPL products will last longer than wood products. Long-term maintenance costs are often reduced with plastic lumber products, making them a sound investment (California Integrated Waste Management Board 2005). Though recycled plastic products are more expensive than many wood products, costs for plastic lumber and higher quality woods, like red cedar and redwood, are quite comparable. Therefore, when assessing plastic lumber and its long-term durability in comparison to the long-term durability of higher quality woods, the initial cost of plastic lumber is quite reasonable. Research into multiple RPL companies found that local and Midwest regional costs for RPL can range from $1.37 per linear foot to $3.99 per linear foot. This variety in price can be due to regional differences as well as the ingredients and processes by which the plastic lumber is produced. For example, OnSpec Composites, the only local plastic lumber producer, uses recycled plastic bottles and recycled wood fibers from industry. The average cost is $1.37 per lineal foot. EPS Plastic Lumber, a company located in Illinois, produces 100 percent plastic lumber products, and has costs that range from $.79 cents to $3.99 per linear foot, depending on the width and depth of the wood, as well as additions of steel reinforcement or grooves for construction purposes (Mayer 2005; EPS Plastic Lumber 2001). See Appendix I for a listing of plastic lumber companies used in this report. They are listed under “Plastic Lumber Companies.”

Durability

Recycled plastic lumber is resistant to rot, moisture, corrosion and insect infestation. (Krishnaswamy and Francini 2000, 1). These are the largest problems with wood lumber, and RPL’s resistance to these affects is a large reason for why individuals, communities and companies have begun to use RPL more. According to Krishnaswamy and Francini,
RPL requires no maintenance, which makes it a very appealing product for people and organizations looking to cut maintenance costs (Krishnaswamy and Francini 2000, 1). However, there is evidence that some maintenance may be needed, depending on the plastic lumber product.

Some products like benches, though this is occurring less as plastic lumber technology improves, are prone to sagging over time with use, which is often enhanced in products that are exposed to hot sun in the summer (Betz 2005). Even with current technologies helping to improve RPL, products are still less stiff than wood and, therefore, will bend over time under certain amounts of weight. California’s Integrated Waste Management Board (CIWMB) has assessed different plastic lumber composites to address advantages and disadvantages, which tend to center around durability. 

**High Density Polyethylene (HDPE)** 

RPL will contain the same type of plastic that is used to make milk jugs, and will therefore often contain recycled milk jugs if the product is indeed made from recycled plastics. An example of a company that creates 100 percent recycled HDPE plastic lumber is EPS Plastic Lumber in Illinois. Though HDPE plastic lumber is well suited for use in decking and landscaping, disadvantages include a “much lower stiffness than wood” (CIWMB 2004). **Commingled RPL** is mostly created from polyethylene (PE), which are recovered thermoplastics (ones that can be re-melted and then reshaped). The cost is lower since thermoplastics do not need to be sorted to create RPL, like in HDPE plastic lumber, but stiffness is still much lower than wood (CIWMB 2004).

**Wood-filled RPL** contains plastic that is mixed with recovered wood or other fibers, or sawdust. It is usually a 50/50 mix of low-density polyethylene (LDPE) and sawdust or other recycled fibers. This combination allows the finished product to have better traction, and it is easier to paint. However, this also causes it to be more prone to moisture absorption due to its wood content, have a higher probability of degradation over time, and have more often unwanted flexibility than wood lumber (CIWMB 2004). OnSpec Composites, the Cincinnati-based plastic lumber company, has wood-filled RPL, but has a much higher content of recycled plastics than wood in the final product. The last type of plastic lumber is **Fiber-reinforced RPL**. This type has a mix of plastics and
glass fibers (fiberglass). The final product is stiffer than other types of RPL, but causes it to be less environmentally-friendly and may irritate skin due to the fiberglass content (CIWMB 2004). A durability concern with this stiffness, though, is that the product may not give enough, depending on the purpose for which it is intended.

There are concerns with ‘creep,’ or the permanent deformation of RPL and RPL products due to exposure to different weights, like walking or sitting, for example. A combination of time, temperature and load affect amounts of creep, and the composition of the RPL will effect this as well (whether it is 100 percent plastic, wood composite, fiberglass composite, etc). When comparing to wood, however, keep in mind that though wood has much less creep over time, it has a much higher propensity for water uptake, which can also cause structural breakdown (Krishnaswamy and Lampo 2001, 4). Companies are addressing issues with creep in their products by making steel-reinforced, or fiberglass reinforced, plastic lumber and plastic lumber products. Though these items may be more expensive, this reinforcement allows for even longer durability of the product and eliminates issues with creep (Anderson 2004). Companies like EPS Plastic Lumber sell steel-reinforced plastic lumber. American Plastic Lumber in California, which creates plastic lumber products with 100 percent recycled materials, uses recycled fiberglass to reinforce and strengthen their lumber products. American Plastic Lumber products have a 50-year guarantee due to the fiberglass-plastic composite (EPS Plastic Lumber 2001; American Plastic Lumber 2002).

Weathering will occur with RPL. One life cycle cost analysis (LCCA) done on RPL at Rutgers University in New Jersey, which has comparable weather patterns to Ohio, found that after 11 years of outdoor exposure, surface whitening occurred due to UV ray exposure. Very minimal surface degradation was found. It was theorized that the small amount of degradation may be due to UV ray exposure, but the overall UV ray threat was not detrimental to RPL use. A surprising finding in the study was the increase in structural strength of the RPL decking. Due to temperature fluctuations in New Jersey weather patterns, crystallinity increased and amorphous, or non-crystallized, parts of the RPL decreased. This led to an overall increase in the strength of the RPL, which, the
authors note, “offers promising results concerning RPL” (Lynch et al., 2001, 1-3).

Another consideration is the possibility of RPL burning easily, though this is obviously a consideration with traditional wood park furnishings as well. Plastic lumber is self-extinguishing, as opposed to traditional wood products. However, it can be very combustible if exposed to a large enough flame for an extended period of time (Burkhart 2005; Plastic Lumber Yard 2005).

Safety and Health Issues

Plastic lumber has been proven to be not only safer than wood in creating furnishings for human use, but it is also more vandal-proof than wood lumber products. It is less likely to chip, splinter or peel, which reduces risks to those using plastic lumber furnishings. It is also more vandal-proof because graffiti can be more easily removed with solvents. Wood often needs to be sanded to remove graffiti (Environmental Protection Agency 2004; King County, Washington 2005; Plastic Recycling of Iowa Falls 2000). Environmentally, sanding instead of using a solvent will be better, but being able to carry a solvent out to a site to use instead of a sander will be more maintenance-friendly. Numerous park systems and city parks within the Midwest have expressed their trust in plastic lumber’s safety by purchasing various plastic lumber products. Some of the parks include the Cincinnati Park Board, Colerain Township, Harmonie State Park in Indiana, and Anoka County, Minnesota (Burkhart 2005; Gamstetter 2005; U.S. Environmental Protection Agency 2004).

Sustainability and Environmental Impact

It is important that items purchased are able to be recycled when their useful lives are spent. Therefore, purchasing recyclable RPL is important. Local lumber and hardware companies will have plastic lumber in stock, but one must be careful when looking for these products. Through research for this report it was discovered that some companies making plastic lumber are using virgin plastic and other virgin materials to create a
composite product (Platt, Lent and Walsh 2005, 2-3, 6-9). Therefore, being certain of recycled content is important. The Healthy Building Network’s Guide to Plastic Lumber uses potential recyclability as one of three criteria for rating different RPL. Recycled plastic lumber companies that received a ‘most environmentally preferable’ rating use 50 percent or more post-consumer recycled plastic in their products and are more readily recyclable after the life of the product (Platt, Lent and Walsh 2005 1, 6).

The price of virgin plastic has been increasing since Hurricane Katrina went through the Gulf Coast region in late August 2005. This is directly due to the damage that energy infrastructure incurred from the storm. Resins used to create plastics that come from petroleum are increasing in price, which elevates the overall cost of plastic (Kaufman 2005). This is a very good economic reason for buying recycled. Recycled plastic, though some recycled kinds will use virgin resins, can be made without virgin materials. Buying RPL not only saves natural, non-renewable resources that are in less supply each year, but also helps save money that would be used for virgin material extraction and resin production.

Life Cycle Costs

The Rutgers University life cycle cost analysis done on RPL used criteria including human health and the environment, performance, and financial costs. The overall conclusion of the analysis, using an equation to account for different criteria, shows that over 40 years of service a wooden deck would cost $883 and an RPL deck would only cost $636. The cost advantage, according to the authors, would be even higher when assessing a whole deck area, since the study only assessed a small section of RPL decking. Though more expensive at first, RPL will pay off in the long-term due to its durability and ability to withstand weather fluctuations (Lynch et al., 2001, 1-3).

Local, Regional, State and National Availability

The Healthy Building Network’s Guide to Plastic Lumber is an extremely beneficial
guide to learn about different companies’ products that have been rated as most or least environmentally preferable. Company names are listed, and they are located all over the United States. However, even though the companies have products that were rated by the Healthy Building Network it does not mean all of their products will be as environmentally preferable as the specific items assessed in the guide. Therefore, when investigating companies for purchasing RPL products, it is important to ask if all products are made from recycled plastic, and how much of a product is recycled plastic (since some only contain a percentage).

**Rumber**

Rumber is a very promising, though less-known product, made of 100 percent recycled tires and plastics. It is used for decking, trailer beds, as landscaping timbers, dumpsters, pallets, bridge crossings, and on steps to increase traction, to name a few of many uses. According to Rumber Materials, Inc., it has been proven more durable than wood and other plastic composites (Rumber Materials, Inc 2005). In fact, Rumber is used in the military and has stood up to grenades without failure for more than a year. It has also been used by the military on training fields to deflect shrapnel (Castleblock 2005). Rumber Materials, Inc. (Texas) appears to have trademarked this product, as it is difficult to find alternative companies making Rumber at this time, or any research on the material. However, a simple web search will show various companies around the United States successfully sell it. Pricing requests for their different products can be done via the Rumber Materials, Inc. website.

**Recommendations**

The Mill Creek Greenway Trial will continue to be constructed piecemeal as funding is secured for different trailway projects in different areas of the Mill Creek. For MCRP, the ultimate expression of sustainability would be to utilize all locally recycled and reused materials for the greenway trail, from nuts and bolts to boards and blacktop. If MCRP had no limitations and access to a broad range of materials locally it would be feasible,
with enough support from businesses, organizations and community members, to make
the majority of trailway furnishings and trailways from mostly reused and recycled
materials. Given MCRP’s present limitations in funding, and the difficulty in working
with 37 different political jurisdictions through which Mill Creek runs from its
headwaters to the Ohio River, it is recommended that projects be catered based upon the
current needs of the jurisdiction and organizations that MCRP is working with for each
unique project.

For example, in Salway Park, where the tree grate furnishings were requested to be
installed, it may be best to find funding to purchase highly regulated, quality controlled
recycled plastic lumber furnishings that will meet the needs of Cincinnati Recreation
Commission and its concern for liability. In other parts of the Mill Creek it may be more
feasible to work with local community members on more maverick projects similar to the
Roselawn bench contest, which involved local university design students and a lot of
positive community support. The following recommendations are the author’s
suggestions for the best materials to use, in general, for the greenway trail based upon the
criteria discussed. The author presents these recommendations, however, with the
aforementioned considerations.

*Park Furnishings*

The best and also most expensive option for park furnishings and signage along the
greenway trail is to use recycled plastic lumber. Products made from RPL are reliable and
long lasting, and with newer designs they have proven to last even longer without
structural failure from temperature change and sun exposure. Though the initial cost is
higher, these products are assured to have high safety standards since the companies that
make them test them for quality assurance. If MCRP purchases from businesses that have
a commitment to sustainability, like Plastic Lumber Company, the majority of the
product content will be made from recycled materials. However, this option does not
allow for the use of local materials. OnSpec Composites, the only local plastic lumber
source at this time, would be able to sell recycled plastic lumber with locally recycled
plastic content to MCRP for park furnishing projects, but they do not create park furnishings in house.

The second option that would reflect a stronger sustainability ethic would be to use local salvage materials including reusable plastic barrels, lumber and cast iron items. These materials are readily available, and with a bit of planning depending on the project, park furnishings can be made that fit quality standards for the area in which the furnishings would be placed. For reusable lumber, testing may need to be done to assess CCA and other content that may be toxic to users, as well as to Mill Creek and the natural areas that surround it.

*Trail Materials*

Given that so much of the greenway trial will run close to the banks of the Mill Creek, it is highly recommended that porous trial surfaces be used in the majority if not the entire stretch of the trial system. In fact, the author recommends that environmental impact be held in higher consideration than utilizing a high-recycled content in the multi-use trial. Since many parts of Mill Creek are sensitive to flooding the most important concern is to not add to this load during rain events. Therefore, if a porous surface is to be used, it is more important that it indeed be porous rather than recycled.

The perfect option would be to create a porous asphalt trail, given that trail users tend to find it more comfortable to use than concrete, and to include recycled asphalt content in this porous asphalt mix. Since asphalt is the most recycled material in the world, and is readily available locally through companies like Valley Asphalt Corporation (though they do not create porous asphalt at this time), the author recommends MCRP work locally first to see if porous asphalt projects could be created as sustainably as possible. Flexible Pavements of Ohio will be able to help MCRP find local contacts for asphalt projects. Northern Kentucky Sanitation District #1 will also be a good contact for porous asphalt projects, though many of the companies that were involved in their experimental porous asphalt and concrete parking lot do not work out of Kentucky. Though a porous trail may
be more expensive to create it will ultimately pay off in the long run by not adding to negative environmental impacts upon the Mill Creek.

For more experimental areas along the Mill Creek Greenway Trail, which would be excellent public education opportunities, it would be beneficial to create sections dedicated to materials like glassphalt and rubber asphalt. There could be high-recycled glass and rubber content for these respective trail types, if local companies were found who could create and lay these mixes, but neither type would probably be porous unless special mixes were invented that the author is unaware of at this time. Therefore, it is recommended that these sections of the trail utilizing nonporous materials do not run so close to the Mill Creek that there would be an adverse impact during heavy rain events due to excess water runoff.

The best soft trail material to use would be invasive shrubbery. There will not be, any time soon, a dearth of invasive shrubbery along or near Mill Creek. Therefore, with a bit of volunteer help and a borrowed mulcher, MCRP can create very low-cost, sustainably made mulch to place upon soft trail areas of the Mill Creek Greenway Trail. The only concern is for when invasive shrubbery is removed and mulched. It should not contain any signs of seeds, as this will simply cause the plant to proliferate in areas where the trail is placed.

**Conclusion**

This report is a culmination of seven months of research to help Mill Creek Restoration Project reach its goal of one day preserving and reconstructing natural habitats that once existed along Mill Creek. The Mill Creek Greenway Trail has the potential to not only help spur conservation in the Mill Creek watershed. It will also provide inspiration for other projects in the Cincinnati region that will reflect an environmental ethic. Acting upon a dedication to the future of the region’s natural systems that support *all* life including plants, animals and humans, will be one of the best ways in which to support social and economic re-growth in the community.
Utilizing reused and recycled products throughout the greenway trail will encourage sustainability within the Mill Creek watershed. This will make available to MCRP, and other interested organizations, ample educational opportunities to teach children and adults about ways in which they can reuse and recycle materials in their own neighborhoods. The Mill Creek Greenway Trail will be a template that can be expanded as community members realize the larger positive effects of this project upon Greater Cincinnati. One day the Mill Creek will be seen again as a cherished waterway protected for its natural beauty and ecological importance, and protected because of what it brings to the citizens of Cincinnati socially and economically.
References


9, 2005.

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Interview by author, 22 August, Cincinnati. Telephone interview.


Burkhart, Jim, Crew leader, Colerain Township, Ohio. 2005. Interview by author, 23
September, Cincinnati. Telephone interview.

Right Choice for Porous Pavements,” in Better Roads: For the Government/


http://www.ciwmb.ca.gov/ConDemo/Roads/default.htm. Accessed September 6,
2005.


Christmann, Holly, Community Assistance Coordinator, Hamilton County Department
of Environmental Services. 2005. Interview by author, 23 June, Cincinnati. Email
interview.


Dejonckheere, Chuck, Waste Management Director, Hamilton County General Health District. 2005. Interview by author, August 24, Cincinnati. Telephone interview.

Dummitt, Matt, Marketing Development Coordinator, Ohio Department of Natural Resources. 2005. Interview by author, August 8, Cincinnati. Telephone interview.


Freemont, Mike, Mill Creek Restoration Project board member. 2005. Interview by author, October 7, Cincinnati. Email interview.


Kolling, Guy, Landscape Architect, Sacramento County Department of Regional Parks, Recreation and Open Space. 2005. Interview by author, 10 August, Cincinnati. Telephone interview.


Mill Creek Restoration Project et al. 1999. The Mill Creek Watershed Greenway Master Plan. Prepared by Fuller, Mossbarger, Scott and May; Greenways Incorporated; Biohabits, Inc.; Rhinoworks.


Patterson, Dave, Sales Representative, Valley Asphalt. 2005. Interview by author, 26 August. Telephone interview.


Appendix I

Reuse and Recycle Project Contacts

AIA (American Institute of Architects), Cincinnati – http://www.aiacincinnati.org

Pat Daugherty (for general inquiries)
aiacinti@fuse.net

General Contact Info:
Longworth Design Center
700 West Pete Rose Way
Cincinnati, OH 45203
513.421.4661

Akers EnviroSigns (plastic lumber signs)

Bob Blick, Owner
6360 Promler St NW
N. Canton, Ohio, 44720
330-499-1990
888-795-7659
bob@envirosigns.com

American Plastic Lumber

P.O. Box 514
Shingle Springs, CA 95682
530-677-7700
apld@directcon.net

Artworks

Colleen Stanton, summer program coordinator
811 Race St.
Cincinnati, Ohio 45202
(513) 333-0388
artworks.colleen@fuse.net

ASLA (American Society for Landscape Architects)

Kelly Coffman, chapter president
E-mail: Coffman@MetroParks.net
http://www.asla.org

Association of Ohio Recyclers
Diane Shew, Executive Director
PO Box 70
Mount Vernon, OH  43050
888.718.6639, ext. 7652
dshew@wastealternatives.net
www.aor-omex.org

Building Value

Jerry Janszen
Director
jjanszen@workrc.org

Patrick Skees
Retail Manager
475-6783
retail@buildingvalue-cincy.org

General
2901 Gilbert Ave.
Cincinnati, OH 45206
Ph: (513) 475-6783
F: (513) 475-6789
info@buildingvalue-cincy.org

Margaret Morone, Vice President and COO, WRC
(The Work Resource Center, Building Value’s parent organization)
Ph: 281-2316 Ext 203
mmorone@workrc.org

Cincinnati Park Board

Lisa Schafer, Parks Planning 475-9600
Lisa.Schafer@cincinnati-oh.gov

Dave Gamstetter – 861-8970
Dave.Gamstetter@cincinnati-oh.gov

Cincinnati Recreation Commission

Larry Kalker (Salway Park Contact)
378-4514
larry.kalker@cincinnati-oh.gov
City of Cincinnati

Jim Coppock, Senior engineer (bikeways, alternative transportation interest)
352-5305
Jim.Coppock@cincinnati-oh.gov

Joe Flading, City Engineering
352-5284
Joe.Flading@cincinnati-oh.gov

Dan Henson, Division of Neighborhood Operations: Asphalt
Office: 352-3391
Cell: 200-0335
(no email)

Don Rosemeyer, City Engineer
352-3720
Donald.Rosemeyer@cincinnati-oh.gov

Comprehensive Procurement Guidelines
U.S. EPA, “buy-recycled” program
http://www.epa.gov/cpg

Concrete Promotion Council of Southwest Ohio

John Davidson, executive director
(Member of Mill Creek Conservancy District)
7176 Lakota Ridge Dr
Hamilton, Ohio 45011
513-607-9921
concreteman@cinci.rr.com

Dummitt, Matt, Marketing Development Coordinator, Division of Recycling and Litter Prevention, ODNR
2045 Morse Rd. Building F-2
Columbus, OH 43229-6693
614-265-7003
matthew.dummit@dnr.state.oh.us

Envirosigns Ltd

Bob Blick
2700 Fulton Dr. NW
Canton, OH 44718  
Toll Free: 888-492-5377  
Phone: 330-236-4713  
bob@envirosigns.com  
www.envirosigns.com

**EPS Plastic Lumber**

885 Church Rd.  
Elgin, IL 60123-9309  
Phone: 847-289-8383  
info@epsplasticlumber.com  
www.epsplasticlumber.com

**Flexible Pavements of Ohio**

Fred F. Frecker – Executive Director  
37 W. Broad St., Suite 460  
Columbus, Ohio 43215  
fredfrecker@flexiblepavements.org

**Forest Park Environmental Awareness Program**

Wright Gwyn  
1201 West Kemper Rd  
Cincinnati, Ohio 45240  
513-595-5263  
environment@Forestpark.org  
http://www.forestpark.org/environmental

**Hamilton County Department of Environmental Services (HCDOES)**

Holly Christmann, Community Outreach  
holly.chrstmann@hamilton-co.org

Jeff Aluotto, Solid Waste  
946-7719  
Jeffrey.aluotto@hamilton-co.org

Christy Kellner, solid waste coordinator, Business Interchange contact  
946-7732  
Christy.Kellner@hamilton-co.org

**General**  
250 William Howard Taft Road  
1st Floor  
Cincinnati, OH 45219  
Phone: (513) 946-7777
Fax: (513) 946-7778
1-800-889-0474 (Ohio only)
http://www.hcdoes.org/

**Hamilton County Public Health**

Chuck DeJonckheere (“Dee-Yonker”), Director, Waste Management
946-7800
Chuck.dejonckheere@hamilton-co.org

**Hamilton County Park District**

Parks Engineering:

Tim Zelek
521-7275
tzelek@greatparks.org

Kevin Brill
521-7275
kbrill@greatparks.org

General
10245 Winton Rd
Cincinnati, OH 45231
521-7275
Information@GreatParks.org

**Hummel, Joe - Allied Construction Industries**

3 Kovach Drive
Cincinnati, OH 45215
Phone: (513) 221-8020
Fax: (513) 221-8023
jhummel@aci-construction.org

**Keep Cincinnati Beautiful**

Shirley Phillips, Program Manager/Recycling & Beautification
352-4385
shirley.phillips@cincinnati-oh.gov
http://www.keepcincinnatibeautiful.org
**Liberty Tire Service**

3041 Jackson Pike  
Grove City, OH 43123  
614) 871-8097

**Mechanical Finishing, Inc.** (Metal Stripping for Cast Iron or other Metals Used)

6350 Este Avenue  
Cincinnati, Ohio 45232  
Phone: 513-641-5419  
Toll-free: 1-888-WE-DEBUR  
Fax: 513-641-4193  

**Megen Construction Company** (Freedom Center builders)

11130 Ashburn Rd  
Cincinnati, Ohio 45240  
Phone: 513-742-9191  
Fax: 513-942-9393

**Moraine Materials Company** (Sand & Gravel Division has concrete recycling operation)

Max Cockerill, Contact  
Cell: 937-974-3338

**General**

1400 Commerce Center Dr.  
Franklin OH 45005-7203  
(937)743-0650  
[http://www.mormat.com](http://www.mormat.com)

**Northern Kentucky Sanitation District** (demo site using porous pavements)

Sean Blake, Contact  
859-578-7450

**Ohio Greenways**

Elaine Marsh, Director  
2179 Everett Road  
Peninsula, OH 44264  
Phone: 330-657-2055
Ohio Parks and Recreation Association

Michelle Park, Director
1069A West Main St.
Westerville, OH 43081
Phone: 614-895-2222
Toll Free: 1-800-238-1108
www.opraonline.org

Ohio Ready Mixed Concrete Association

Warren Baas, V.P. of Engineering & Promotions
2600 Corporate Exchange Dr., Suite 165
Columbus, Ohio 43231
Phone: 614-891-0210, ext. 17
warren@ohioconcrete.org

OnSpec Composites

Jay Mayer, owner
match@fuse.net
http://home.fuse.net/match/OnSpec.htm

Jason Mayer, son and employee – trained engineer (**easier to get a response from than Jay)
Listen2me22@hotmail.com

General
5500 Muddy Creek Rd
Cincinnati, Ohio 45238
922-1328

Plastic Lumber Companies

Ohio and Midwestern Plastic Lumber Companies (see alphabetical listings in this appendix for contact information)

Plastic Lumber Company (PLC) – Akron, Ohio. Provide 100 percent recycled content in their various products with 97 percent being post-consumer materials. Signage from PLC is made from 100 percent recycled materials as well. Please see www.plasticlumber.com for details.

Enviro Signs – North Canton, Ohio. Create routed and digitally designed signage. There are minimal amounts of recycled content (no more than 10 percent) on the ‘Enviro Poly’ sign, a routed sign option. There may not be any recycle content in the ‘Dura Reader’ sign, according to Enviro Sign representative. Please see
www.enviro_sign.com for sign options.

**EPS Plastic Lumber** – Elgin, Illinois. They sell 100 percent recycled plastic lumber and have plastic lumber products that may not have 100 percent recycled content. Please ask specifically about product if interested to discover the recycled content.

**Plastic Lumber Company**

115 West Bartges St.  
Akron, OH 44311-1034  
Toll Free: 800-886-8990  
Phone: 330-762-8989  
sales@plasticlumber.com  
www.plasticlumber.com

**Powder Coating Specialty**

“Ken” is the contact (declined to give his last name)  
7013 Mullen Rd  
Cincinnati, OH 45247  
(513) 353-2378

**Ridge Engineering, Metal Repair and Fabricating**

**Bernie Schlake**, owner  
1708 Blue Rock St  
Cincinnati, Ohio 45223  
513-681-5500  
Bernie@ridgemetalworks.com

**Rubber Mulch Companies**

**Mulch-No-More, LLC**  
(No street address provided, not found in phone book)  
Cincinnati, Ohio 45241  
Admin@nomoremulch.com

**New Age Mulch**  
(No street address provided, not found in phone book)  
Columbus, Ohio  
614-325-4637  
Email on website form at: [http://www.newagemulch.com/contact.html](http://www.newagemulch.com/contact.html)

**Groundscape Technologies**  
4595 Van Epps Road.
Salvage Yards and Salvage Material Businesses

State Avenue Salvage: Historic Building Materials
Earl (Charlie) Mattingly, Owner
958 State Ave
Cincinnati, Ohio 45204
513-921-1231

Good Wood Store, Inc
4404 Hamilton-Cleves Road
Shandon, OH 45063
513-738-4404

Lockland Salvage Co.
211 Longworth St
Cincinnati, OH 45215-4665
Phone: (513) 821-0514

Schott Monument Company

“Jack” is contact (declined last name)
4055 Spring Grove Ave.
Cincinnati, OH 45233
541-0515

Scrap Tires Services

Liberty Tire Services of Ohio
3041 Jackson Pike
Grove City, OH 43123
(614) 871-8097

Telintello, John – see U.S. Green Building Council

John Telintelo – USGBC representative
jjtelintelo@harleyellis.com

Valley Asphalt Corporation

Dave Patterson, contact
11641 Mosteller Rd # 1
Cincinnati, Ohio 45241
(513) 771-0820

Work Resource Center (Building Value’s parent company. Could provide labor to create furnishings)

Margaret A. Morone, Vice President and COO
2901 Gilbert Avenue
Cincinnati, Ohio 45206
513-281-2316, Ext. 203
www.workresourcecenter.org
Appendix II

Salvage Yards, Businesses and Material ‘Interchanges’ and Exchanges in the Cincinnati Region
*Items listed were documented summer 2005

City Salvage Yards

City Salvage Yard at William P. Dooley Blvd. and Ludlow Ave.

- Blue and yellow barrels
- Bricks
- Cement blacks

Mill Creek Salvage Yard (just north of Mill Creek Rd Bridge)

- Asphalt (per Dan Henson, public services Asphalt Division, this ground up asphalt, which came from parking lots/roads, can be free to us. Mr. Henson also stated that his drivers would be willing to drop off some truckloads for us)
  
  i. Contact: Dan Henson, Division of Neighborhood Operations, Asphalt, 352-3391

- Other possible materials to use
- Large Granite slabs
- Bricks – new and used
  o Red and larger granite ones
- Small street grates
- A few tree grates
- Piles of sand
- Curved cement arches/slabs (road curbs?)
- Straight cement edging/slabs
**Sinton Rd Salvage Yard, Cincinnati Park Board**

- Tree Grates: 3x6, 3x8, 4X4, 4X6, 6x6, 5x5
- Trash receptacle decorative holders (black iron)
- Trash receptacles made mostly of plastic lumber boards
- Victorian-style iron bench frames – 8 total
- Square 2x2 or 3x3 cement blocks, ~6” thick
- Square blocks from art installation – cubical, ~1.5x1.5x1.5
- Plastic lumber (appears to be used and unused)
- Pavers

**State Avenue Salvage** (Price Hill)

- Doors, sinks, cement blocks, tubs, windows, glass in windows
- Owner, Earl “Charlie” Mattingly, charges non-profits less, but doesn’t have anything to donate right now. Is willing to look out for materials if MCRP decides upon specific things needed.

**Other Sources for Unused, Reusable or Salvage Materials**

**Building Value**

- Will help MCRP locate future items for use, for sale, that can be gathered from future demolition sites by Building Value.
- They are willing to donate greenhouse display kits, which contain a large amount of treated lumber, to MCRP.

**Business Interchange** (HCDOES)

*The materials on the interchange are for buying, not for free or donation, according to Christy Kellner, HCDOES employee and coordinator for the interchange.*

- Drums
- Reusable Wood (sustainable? Not treated?)

- Other materials may or may not be usable depending upon what the investigation shows

**Freecycle** (yahoo group that organizes people locally to hook up if they need/have materials)

- MCRP will need to request membership to join this group. For the freecycle group within the Cincinnati city limits, go to:
  - [http://groups.yahoo.com/group/Cincinnati_Freecycle/](http://groups.yahoo.com/group/Cincinnati_Freecycle/)
## APPENDIX III

### Multi-Use Trail Material Options for the Mill Creek Greenway Trail – P.1

<table>
<thead>
<tr>
<th>Item</th>
<th>Use for Item</th>
<th>Initial Cost</th>
<th>Durability</th>
<th>Safety &amp; Health</th>
<th>Sustainability &amp; Environmental Impact</th>
<th>Availability (local, regional, state, national)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concrete &amp; Recycled Concrete</strong></td>
<td>Multi-use trail, sitting areas, walkways</td>
<td>High, but extremely durable</td>
<td>Can last 50+ years (repairs require moving entire section, not just patchwork like with asphalt)</td>
<td>Safe for use</td>
<td>Recycled concrete more environmentally-friendly</td>
<td>Moraine Materials Company, sand &amp; gravel division has traditional and recycled concrete, Ohio Ready Mixed Concrete Association</td>
</tr>
<tr>
<td><strong>Asphalt and Recycled Asphalt</strong></td>
<td>Multi-use trail, sitting areas, walkways</td>
<td>High, but extremely durable</td>
<td>Can last 35+ years (quite possibly as long as concrete, depending on climate and daily loads)</td>
<td>Safe for use</td>
<td>Recycled asphalt most likely more preferable than concrete for runners</td>
<td>Flexible Pavements of Ohio best source for companies, Valley Asphalt, uses recycled asphalt in projects</td>
</tr>
<tr>
<td><strong>Porous Asphalt and Concrete</strong></td>
<td>Multi-use trail, sitting areas, walkways</td>
<td>Can be higher than traditional pavements, but very durable</td>
<td>Relatively new materials, so no large-scale, long-term projects</td>
<td>Safe for use, like traditional pavements</td>
<td>Extremely watershed friendly; waters filter through pavement to groundwater below</td>
<td>Ohio Ready Mixed Concrete Association, Flexible Pavements of Ohio (asphalt)</td>
</tr>
</tbody>
</table>
## Multi-Use Trail Material Options for the Mill Creek Greenway Trail – P.2

<table>
<thead>
<tr>
<th>Item</th>
<th>Use for Item</th>
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<th>Safety &amp; Health</th>
<th>Sustainability &amp; Environmental Impact</th>
<th>Availability (local, regional, state, national)</th>
</tr>
</thead>
</table>
| **Rubber Asphalt** | Multi-use trail, sitting areas, walkways         | • High, but extremely durable  
• City of Sacramento completed ~18-mile multi-use recycled rubber asphalt trail at cost of nearly $1.5 million | • Extremely durable in hot and cold climates  
• Can last decades without major structural failures  
• May outperform traditional pavements due to higher binder content | • Safe for use  
• Most likely will be preferred more by runners than traditional asphalt – tracks are made of crumb rubber, so rubber/asphalt combo even more preferable than traditional asphalt over concrete | • Divert scrap tires, other rubber, from landfills  
• Toxins released during creation  
• No major leaching into waters once installed  
• Runoff from surface into streams would occur with rains, but some water is absorbed and filters through, as rubber asphalt is slightly porous due to crumb rubber content | • No state companies producing at this time  
• Some companies do buy and crumb scrap tires (Liberty Tire Services)  
• May be feasible to collaborate with scrap tire collector and paving company with means to create rubber asphalt |
| **Glassphalt**       | Multi-use trail, sitting areas, walkways         | • High, but extremely durable  
• Crumbled glass has been used since 1970s in traditional paving projects  
• Glass takes place of percentage of traditional aggregate  
• Risk of glass aggregate pulling away from asphalt cement, causing structural breakdown | • Safe for use  
• No health risks found | | • Using local glass recycling companies would encourage sustainability ethic in region  
• No major leaching into waters once installed  
• Runoff from surface into streams would occur with rains | • No companies in region or state are creating glassphalt, but collaboration between recyclers and local asphalt company (like Valley Asphalt) could occur if have proper equipment |
## Reusable and Recycled Items Assessed for Possible Use in the Mill Creek Greenway Trail – P.3

<table>
<thead>
<tr>
<th>Item</th>
<th>Use for Item</th>
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</table>
| **Reusable Lumber** | Benches, tables, trash/recycling receptacles, bollards, railings, landscaping timbers, signage posts | • Low when purchasing from Building Value  
• Freecycle, City & private salvage yards, construction sites may be even less costly or no cost | • Less durable than plastic lumber, cast iron, etc  
• Easily vandalized  
• Stronger popular types (ipe/teak) very costly and hard to find for reuse  
• Can warp and rot easily over time in wet environments | • Prone to splintering  
• Sharp edges can cause injury  
• Proper sanding of sharp edges important  
• Risk of re-using CCA-treated wood. Not banned until 2003. Can still leach into soils, water after many years. | • Helps curb virgin wood logging, especially risk of old-growth logging  
• If purchase new, should use companies Forest Stewardship Council accredits for sustainable logging  
• Using Freecycle, Building Value or salvage yards, will ensure local/regional sustainability  
• Environmentally-friendly sealants available (Greenseal.org) | • Available in multiple places: Building Value, salvage yards, construction sites, possibly Freecycle |
| **Reusable Cast Iron** | Tree grates, benches, railings, tables  
Can be costly to remove rust and repaint/reseal – around $90 locally per 2.5’ X 5’ tree grate | • Low, initially, if using Freecycle, City & private salvage yards  
• Can be costly to remove rust and repaint/reseal – around $90 locally per 2.5’ X 5’ tree grate | • Very durable, very long-lasting  
• Can refinish over and over, not effecting durability  
• Less likely to be permanently damaged by vandalism  
• Very heavy, so harder to steal | • Edges can be sharp and hazardous  
• To reduce hazard, special welding techniques need to be used when welding cast iron to cast iron  
• See pp.13-16 for CRC concerns with using MU tree grate furnishings | • Refinishing takes sandblasting (more environmentally-friendly) or chemical stripping (less friendly). Mechanical Finishing, Inc. is environmentally responsible local company. | • CPB, at writing of paper, had plethora of old tree grates, as well as benches, in Sinton Road salvage Yard |
### Reusable and Recycled Items Assessed for Possible Use in the Mill Creek Greenway Trail – P.4

<table>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Granite Slabs</strong></td>
<td>Benches, special engraved signage, landscaping</td>
<td>● None – if permission granted by City of Cincinnati for use</td>
<td>● Extremely durable</td>
<td>● If rough edges eliminated, low risk to injury</td>
<td>● Locally available</td>
<td>• Mill Creek Road Bridge salvage yard, other salvage sites</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>● Less likely to be permanently damaged by vandals</td>
<td></td>
<td>● Does not effect environment negatively</td>
<td>• Schott Monument (Northside) good contact for other availability beyond city salvage yards</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>● Very heavy, so harder to steal</td>
<td></td>
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</tr>
<tr>
<td><strong>Reusable Asphalt</strong></td>
<td>Multi-use trail, sitting areas, walkways</td>
<td>● None - if permission granted by City of Cincinnati for use</td>
<td>● Very durable and reusable</td>
<td>● As safe for use as newly-created asphalt</td>
<td>● Creating new mixture locally (Valley Asphalt) will still use some virgin materials, according to Valley Asphalt</td>
<td>• Mill Creek Road Bridge salvage yard has reusable asphalt from city projects</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>● Will create new product comparable in quality to asphalt made with virgin materials</td>
<td></td>
<td>● If reusable asphalt can be used to create porous asphalt mixture, could be very watershedi-friendly</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>● Can last 35+ years</td>
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</tr>
<tr>
<td><strong>Brick and Pavers</strong></td>
<td>Landscaping, walls, sitting areas, display areas, walkways</td>
<td>● None - if permission granted by City of Cincinnati for use</td>
<td>● Very durable and reusable</td>
<td>● As safe for use as newly-created bricks and pavers</td>
<td>● No negative impact</td>
<td>• Sinton and Mill Creek Road yards, other salvage, Building Value</td>
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## Reusable and Recycled Items Assessed for Possible Use in the Mill Creek Greenway Trail – P.5

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<tbody>
<tr>
<td><strong>Plastic Barrels</strong></td>
<td>Trash and recycling receptacles</td>
<td>• None - if permission granted by City of Cincinnati for use</td>
<td>• Plastic is quite durable, but less than concrete or heavy metal trash/recycling receptacles (which are more vandal-proof)</td>
<td>• No apparent safety or health issues</td>
<td>• Plastic, which does not degrade easily, is a great choice for reuse, diverting from landfills • No leaching into environment</td>
<td>• City of Cincinnati salvage site at William P. Dooley and Ludlow • Other salvage sites • Companies that receive materials in plastic barrels, then have no use for them</td>
</tr>
<tr>
<td><strong>Telephone Poles</strong></td>
<td>Landscaping timbers, seating, bank stabilization, water bars</td>
<td>• None, if donated</td>
<td>• Wood, so less durable • Less vandal-proof</td>
<td>• Splintering over time, rotting if not treated wood</td>
<td>• If treated and older poles, may have been treated with CCA</td>
<td>• City of Cincinnati or local electric companies</td>
</tr>
<tr>
<td><strong>Soft Trail Materials:</strong></td>
<td>Play areas, walkways, sitting areas, signage areas</td>
<td>• Fairly costly as new product bought from companies • If collaborate with tire scrappping company to recycle scrap tires, cost may be reduced</td>
<td>• Extremely durable as a rubber product</td>
<td>• Very safe for play areas, more comfortable to walk on than wood mulch • No risk of splintering</td>
<td>• If use locally recycled tires and company in area, encourages sustainability ethic • New rubber mulch products often made from recycled tires</td>
<td>• See Appendix I for list of companies creating new products • Scrap tire companies may be willing to collaborate with MCRP</td>
</tr>
<tr>
<td><strong>Rubber Mulch</strong></td>
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</tbody>
</table>
# Reusable and Recycled Items Assessed for Possible Use in the Mill Creek Greenway Trail – P.6

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</thead>
<tbody>
<tr>
<td><strong>Soft Trail Materials: Invasive Shrubbery Mulch</strong></td>
<td>Play areas, walkways, sitting areas, signage areas</td>
<td>• Minimal, if MCRP volunteers do work of extracting and mulching shrubs • Mulching machine will be needed</td>
<td>• Less durable than rubber mulch • Will need to be reapplied as mulch rots and deteriorates</td>
<td>• Very safe option, natural • Splintering from mulch pieces may be uncomfortable in play areas</td>
<td>• Very good example of sustainable use of natural materials • Risk of berries (seeds) being transported with mulch, which could cause new shrubs to grow in unwanted places • Need to mulch during plant’s off-season to reduce risk of spreading plant through seed</td>
<td>• Invasive honeysuckle is everywhere in the Cincinnati Region • Mulcher could be borrowed from City of Cincinnati department, or others</td>
</tr>
<tr>
<td><strong>Rumber™ (rubber lumber)</strong></td>
<td>Benches, tables, trash/recycling receptacles, bollards, railings, landscaping timbers, signage posts</td>
<td>• More costly than wood, but extremely durable</td>
<td>• Has stood up to over one year of shrapnel and grenade abuse on military testing sites • Rot and crack-resistant, as opposed to wood</td>
<td>• Said to be more comfortable than traditional lumber, which can be beneficial if used in seating • No adverse health or safety</td>
<td>• Very environmentally safe • Made of 100 percent recycled tires and plastics</td>
<td>• Appears to be created by only one company right now, but sold by various distributors • Company is Rumber Materials, Inc</td>
</tr>
<tr>
<td><strong>Plastic Lumber (PL)</strong></td>
<td>Benches, tables, trash/recycling receptacles, bollards, railings, landscaping timbers, signage posts</td>
<td>• More expensive than traditional wood products, but high-quality PL will last longer</td>
<td>• Extremely durable • Weathers better than wood • Sometimes strengthens over time with temp. fluctuations</td>
<td>• Very safe overall • No splintering • Resistant to vandalism (can remove graffiti more easily than on wood)</td>
<td>• There is non-recycled PL • Important to know how much recycled content products have (higher content doesn’t mean less quality) • Recycled PL very environmentally-friendly</td>
<td>• OnSpec Composites is local company making recycled PL (from local recycled bottles) • See Appendix I for company listings</td>
</tr>
</tbody>
</table>
GENERAL NOTES:
1. SALVAGED TREE GRATE MATERIAL AVAILABLE FROM CITY OF CINCINNATI BOARD OF PARK COMMISSIONERS.
2. CONTRACTOR TO PICK UP MATERIALS AT DESIGNATED LOCATION OF GRATES AND PROVIDE MODIFICATIONS, FABRICATION AND INSTALLATION AS NOTED.
3. GRIND SMOOTH ANY EXPOSED ROUGH EDGES.
4. SALVAGED STORMWATER GUTTER AVAILABLE FROM CITY CONTRACTORS, TO BE NOTED.

MILL CREEK GREENWAY
S.E.P. #1, #2, #4
CINCINNATI, OH

DRAFT SUBMITTAL NOT FOR CONSTRUCTION

75% CD SET

MILL CREEK GREENWAY
S.E.P. #1, #2, #4
CINCINNATI, OH