Section 6
Assessment and Screening of Management Alternatives

The practice of watershed management and protection is about making choices regarding which tools and measures to apply, and in what combination. Alternative structural and non-structural management and control measures that potentially could be considered for the Nine Mile Run (NMR) watershed were identified and described in Sections 4 and 5. In this section of the watershed management plan, the alternatives are evaluated and screened to determine an optimal mix of recommended management measures to apply to existing watershed problems and meet the watershed goals and objectives.

Evaluation criteria were established to facilitate the screening process and select which management alternatives are applicable and best suited to the NMR watershed. The following screening and selection criteria were formulated and used for the NMR watershed management plan.

- Applicability of the alternative – is it technically feasible and reliable within the specific conditions within the Nine Mile Run watershed
- Cost to implement the alternative – is the alternative cost-effective
- Effectiveness of the alternative to improve water and habitat quality and meet watershed goals and objectives
- Ability of the alternative to be implemented in the NMR watershed

This section of the plan will document how these screening criteria were applied to the alternative structural and non-structural control measures that were discussed in the previous sections. A table is provided at the end of each section summarizing the results of screening the various alternatives. Section 7 will provide the recommended watershed management plan elements based upon the screening of management alternatives documented in this section.

6.1 Screening of Alternative Land Use Controls

A basic goal of the watershed management plan is to apply land use planning techniques to redirect development, preserve sensitive areas, and maintain or reduce the impervious cover within the NMR watershed. When screening alternative land use controls, one must consider that the watershed is already extensively urbanized and that most of the available land area for development already has been built-out.

6.1.1 Direct and Indirect Regulatory Approaches for New Development

A wide variety of techniques can be used to directly and/or indirectly manage land use and impervious cover in watersheds. Watershed planners and local officials face hard choices when deciding which land use planning techniques are the most appropriate to modify current zoning. Individual development projects can be designed to reduce the amount of impervious cover they create. Some key questions to consider in the alternative screening process include:

- Considering the limited opportunity for new development, will better site design really make a difference in reducing the growth of new impervious cover in the watershed?
- What economic and other incentives can be used to encourage developers, homeowners, and business owners to utilize better site designs?
- What are the most important development and rules that need to be changed to promote better site design, and can a local consensus be achieved to actually change them?
- Are existing ordinances and controls being adequately implemented and enforced, and if not, what needs to be changed?

Alternatives

- Allow zoning to control land use practices so as to prevent incompatibility of neighboring uses and restrict uses that are harmful to health and the well-being of the community

Zoning is the dividing of a municipality into districts and the establishment of regulations governing the use, placement, spacing, and size of land and buildings. Zoning ordinances can be developed which place limitations on development and encourage the most appropriate land uses.

- Utilize better site designs toward new development in the NMR watershed with the goals of reducing impervious cover and the conservation of natural areas

Clustering, impervious surface reduction, setbacks, and protection areas are just some of the possible provisions toward utilizing better site designs in new development projects

- Evaluate the effectiveness of current state and local requirements for erosion and sediment control (E&SC) associated with new development

An effective E&SC program is an important tool to reduce the potentially severe impacts generated by the construction process. Effective E&SC practices are needed to protect sensitive aquatic communities, reduce sediment loads, and maintain the boundaries of conservation areas and boundaries.

- Evaluate the effectiveness of current state and local clearing and grading ordinances

Effective clearing and grading ordinances can reduce the potentially severe impacts to a stream and its watershed resulting from new development. Effective clearing and grading ordinances protect environmentally sensitive areas by controlling the clearing of vegetative cover and subsequent grading of a new development site.

- Examine techniques to indirectly manage land use and impervious cover from new development projects within the NMR watershed

There are indirect regulatory approaches toward controlling and reducing runoff from new development projects such as controlling the use of steep slopes, impervious surfaces, wetland and floodplain disturbance, and tree and vegetation removal. These indirect regulatory approaches can be used to control the potentially detrimental impacts new development can have on a watershed.

For more complete descriptions of these alternative direct and indirect municipal control measures, please refer to Sections 4.1.1 and 4.1.2 of this watershed management plan.

Applicability to the NMR Watershed

Implementing direct and indirect regulatory approaches toward new development in the NMR watershed has limited applicability to the NMR watershed. The NMR watershed is already extensively urbanized and most of the available land area for development already has been built-out. Therefore, changing municipal zoning and subdivision ordinances would have a limited potential impact on the NMR watershed.

There are a few opportunities for implementing land use techniques toward new development within the watershed. For example, the Urban Redevelopment Authority is currently in the process of constructing several hundred single- and multiple-family housing units on the former Duquesne slag pile as part of a development plan called “Summerset”. Another new development possibility is the construction of the Mon-Fayette Expressway that is expected to cross the mouth of the NMR stream. In addition, a limited number of open lots exist in many of the existing residential neighborhoods within the watershed, particularly in Wilkinsburg. There is a possibility for new residential development on the individual vacant lots that are located within existing urbanized areas.

However, as was discussed above, most of the developable land areas with in the NMR watershed have already been built out, and there are minimal opportunities for new development. Because of this, the effectiveness of only select direct and indirect regulatory approaches toward new development will be discussed and evaluated below.

Effectiveness

The effectiveness of direct and indirect regulatory approaches toward new development is largely dependant on controlling the amount and location of new impervious cover within the watershed. Better site design approaches are typically applied to new development with the goal of reducing impervious cover and directing proposed development to the least sensitive areas within a watershed. This would have very limited effectiveness within the NMR watershed because open land is mostly limited to individual lots within existing urban neighborhoods.

The effects of better site design in new development projects are largely positive. For example, one approach toward better site design is through "open space" or cluster development, which minimizes lot sizes within a compact developed portion of property while leaving the remaining portion predominantly open. Cluster development creates open space that provides many market and non-market benefits. For example, some communities have found that cluster development can reserve up to 15% of the site for active or passive recreation. When carefully designed, the recreation space can promote better pedestrian movement, a stronger sense of community space, and a park-like setting. In addition, it has been found that cluster development can reduce site impervious cover from 10 to 50% (depending on the original lot size and layout). This can thereby reduce the cost for both storm water conveyance and treatment. A third benefit is that, since most of the open space is managed as natural area, the future value of the property is often increased.

Many of the design concepts for clustered development were already applied to the Summerset Plan, of which Phase 1 is currently under construction on the east end of the abandoned Duquesne slag disposal site. New residential areas were clustered together to maximize neighborhood green space and prevent development on unstable steep slopes.

An example of the potential savings can be seen in the Remlik Hall Farm example produced by Land Ethics, Inc. for the Chesapeake Bay Foundation. Cost estimates were derived from two development scenarios. Table 6.1.1 shows the costs, land cover, and pollution associated with the two planning approaches.

Table 6.1.1: Comparison of Two Site Plans

	Scenario A **Conventional Plan**	**Scenario B** **Cluster Plan**
Development Costs		
Engineering Costs	$79,600	$39,800
Road Construction Costs	$1,012,500 (20,250 linear ft.)	$487,500 (9,750 linear ft.)
Sewage and Water (permit fees and design)	$25,200	$13,200
Contingencies	$111,730	$54,050
GRAND TOTAL	$1,229,030	$594,550
Land Cover & Storm Water Pollutant Estimate (Total Site Area = 490.15 acres)		
Total Developed Land	287.41 acres (58.6%)	69.41 acres (14.2%)
Roads & Driveways	19.72 acres	11.75 acres
Turf	261.09 acres	54.04 acres
Buildings	6.60 acres	3.92 acres
Total Undeveloped Land	202.74 acres (41.4%)	420.64 acres (85.8%)
Forests	117.55 acres	133.01 acres
Wetlands	11.46 acres	11.46 acres
Total Impervious Cover	5.4%	3.7%
Total Nitrogen (lbs. per year)	2,534	1,482
Total Phosphorus (lbs. per year)	329	192

Effective E&SC controls can provide direct and indirect benefits to both developers and adjacent property owners. On a typical site, the cost to install and maintain erosion and sediment can average $800 to $1,500 per cleared acre per year, depending

on the duration of construction and the site conditions (SMBIA, 1990; Patterson et al., 1993). By keeping soil on the site, a contractor needs to spend less time and labor re-grading a site to meet final plan elevations, and less effort stabilizing eroded slopes. The municipalities within the NMR watershed already have erosion and sediment control ordinances in place. The effectiveness of these existing ordinances in protecting the watershed will depend on the degree that they are enforced when any new construction were to occur.

Implementing indirect regulatory approaches toward new development have shown numerous benefits as well. For example, communities have repeatedly found that conserving trees and forests on residential and commercial sites can enhance property values by an average of 6 to 15% and increase the rates at which units are sold (Morales, 1980; Weyerhauser, 1989). Conserving trees also saves money on energy bills and treatment of runoff. Studies by the American Forest Association have shown that homes and businesses that retain trees save 20 to 25% in energy bills for heating and cooling, when compared to homes where trees were cleared. A modeling study by Henson and Rowntree (1998) reported that storm water runoff decreased by 17% due to forest cover in a Utah development during a typical one-inch rainstorm.

Cost

Implementing land use controls toward new development within a watershed is not without costs. Effective planning requires a careful local investment in technical studies, monitoring, coordination, and outreach. As Brown (1996) notes, a community can expend several hundred thousand dollars on a watershed study to obtain the scientific data needed to justify land use decisions. Furthermore, the long-term cost to fully implement them can be significant for local governments. Watershed planners and local officials face financial decisions when determining which land use planning techniques are the most appropriate to modify current zoning. For the NMR watershed, the costs associated with the technical watershed studies were provided by state grants. The cost to modify existing land development ordinances would be minimal. The significant municipal cost would be to enforce the revised ordinances and ensure that any new development within the watershed would comply.

Ability to be implemented

For the most part, the possibility for new development in the NMR watershed is minimal. As a result, managing new growth in a watershed context and reducing the impacts it has on receiving streams will not be a high watershed priority. However, these basic management tools need to be considered for any future development that does take place within the watershed. These watershed protection goals can be a guide to where and how new development occurs. The key toward revitalizing the NMR watershed, however, will be dependant on restorative redevelopment efforts.

6.1.2 Regulatory Approaches for Restorative Redevelopment

Most of the developable land within the NMR watershed is already urbanized. Many of the older properties have deteriorated and will need to be restored. Over time, buildings will be renovated, driveways and parking areas will be reconstructed, and patios and sidewalks will be replaced. Individual redevelopment projects can be designed to remove existing impervious surfaces and replace them with new semi-pervious materials and gradually reduce the amount of impervious cover in the watershed. Some key questions to consider in the alternative screening process include:

- What watershed neighborhoods and areas have the greatest potential for removing existing impervious surfaces as part of the restorative redevelopment process?
- What economic and other incentives can be used to encourage home and business owners to utilize more permeable building materials, especially when replacing deteriorated concrete or asphalt pavement on existing sites?
- Is there sufficient opportunity for redevelopment within the watershed to make a measurable impact on total impervious cover?

Alternatives

- During future restorative redevelopment projects within the NMR watershed, encourage home and business owners to replace deteriorated concrete and pavement with semi-pervious pavement materials, such as brick or concrete pavers, and to redirect storm water runoff to soil and vegetation.

In the NMR watershed, where a large portion of the land has already been urbanized, the concept of redevelopment or site restoration becomes vitally important. Deteriorated driveways and parking areas will be replaced, buildings will be renovated and reconstructed, deteriorated sidewalks and patios will be replaced, and sewage and drainage utilities will be maintained and replaced. These changes will provide opportunities to restore the communities and ecosystems of the urban watershed to health and vitality.

For more a complete description of the concept of restorative redevelopment and its potential uses in the NMR watershed as an alternative land use control measure, please refer to Section 4.1.3 of this watershed management plan.

Applicability to the NMR Watershed

Restorative redevelopment efforts within the NMR watershed are not only applicable, but may be the key ingredient toward revitalizing this older, urban watershed. Many of the older properties and older systems of sewage, drainage, and pavements in NMR have deteriorated and may need to be restored, revitalized, or reconstructed.

The regenerative capacity of soils and ecosystems is strong in the NMR watershed. Natural processes are waiting to help mitigate the pollutant loads associated with urban runoff. Taking advantage of them enacts a new concept of storm water infrastructure to include the capacities of soil and vegetation to absorb water and filter pollutants. This is a superior approach to infrastructure management because it puts nature to work, and reduces the work humans must do.

Effectiveness

The short-term effectiveness of restorative redevelopment for the entire watershed would be low. However, the long-term effectiveness could be very high if a majority of property owners would apply these principals when existing facilities wear out and need to be replaced. The benefits of restorative redevelopment efforts will not be seen in one year, or perhaps even five years. The redevelopment of individual sites will contribute incrementally to the restoration of watershed process and the overall benefits will be seen on a long-term scale. For example, retrofitting a single house by separating roof drainage from sanitary sewers will contribute only a small amount to the reduction of sewer overflows – but the impact is both immediate and maintainable over generations. The solution to a watershed-wide problem would require the contribution of many similar projects throughout the watershed.

For example, the average residential rooftop in the NMR watershed is approximately 1,300 square feet, and it will be assumed that 50% of these rooftops are currently connected to the sewer system. If these residential rooftops yield runoff from an average 40 inches of precipitation per year, a single rooftop catchment area will harvest approximately 32,500 gallons of rainwater per year – assuming minimal evaporation and other losses. There are approximately 9,200 residential housing units within the NMR watershed with an estimated 4,600 units with their downspouts connected to the sewer system. Table 6.1.2 below illustrates the annual reduction in storm water entering the sewer system based on percentages of roof leaders that would be disconnected.

Table 6.1.2: Estimates of Storm Water Removed through Disconnections

	Percentage of Homes Disconnected				
	10	20	50	75	100
Number of Disconnections	460	920	2,300	3,450	4,600
Quantity of Storm Water Removed (million gallons per year)	15	30	75	112	150

Disconnection of every residential home within the NMR watershed may not be realistic. However, within the City of Pittsburgh where homes are served by combined sewers and roof leader connections to sewers are legal, 15 to 25 percent removal could be an achievable goal over the next decade or so. In communities served by sanitary sewers, where roof leader connections to sewers are illegal, it would be expected that 80 to 95 percent of the existing illicit connections would be identified and removed within the next decade. The corresponding reduction of storm water entering the sewer system will reduce the frequency, duration, and volume of combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs). For a residential homeowner, valuable rainwater from roofs would be redirected to lawns and landscaping, plants would flourish, and the need to water would decrease.

Promoting the use of porous pavements at commercial, school, and church parking lots, as well residential driveways and patios, will aid in the infiltration of groundwater and reduction in storm water runoff. Also, increasing the urban forest by planting trees and shrubs can reduce storm water runoff, moderate urban climate, improve air quality, and reduce noise. Obviously, planting one tree or re-paving a single residential driveway with the intent of promoting infiltration will not showcase these benefits, but creating dense vegetative covers and reducing impervious cover throughout the watershed would be highly effective over a number of years.

The completed report, *Assessment of Point and Runoff Sources of Water Quality Constituents in the NMR Watershed*, provided in the Appendix, showed that most of the Biochemical Oxygen demand (BOD), Total Suspended Solids (TSS), Nutrients such as phosphorus and nitrogen, metals, and other pollutants found in the NMR watershed are carried into streams by storm water runoff from urbanized areas (Appendix Figures 4.1 through 4.9). Applying the principals of restorative redevelopment can significantly reduce urban runoff and the pollutants they carry.

Many of the subsequent sections will examine in more detail some of the measures that are available for restoring urban watersheds within individual sites and neighborhoods.

Cost

The costs associated with restorative redevelopment efforts will vary based upon the techniques, measures, and building materials that are implemented. However, the concepts of restorative redevelopment are based upon the premise that the existing facilities (driveway, sidewalk, patio, etc) are already deteriorated and need to be replaced anyway by the property owner. Therefore, the true cost is the incremental cost between traditional replacement with the original impervious materials (asphalt and concrete) and replacement with semi-pervious materials such as brick pavers laid in a sand-bed. There can sometimes be a cost savings for implementing restorative redevelopment principles. For example if an existing deteriorated 10-foot wide

concrete driveway were to be replaced with pavers, the replacement cost could increase by 15 to 20%. However, if at the same time the driveway width were to be reduced to 8 feet and the old driveway borders replaced with landscaping to intercept runoff, the driveway area would decrease by 20% which would offset the higher material costs for the pavers.

A recent example of the potential costs savings can be seen in a shopping center in Frederick, Maryland that was renovated and redesigned. Here, the existing parking demand was reduced by about 15% to reflect the actual parking demand more accurately. Grid pavers were used rather than normal paving materials. The redesigned parking lot, by virtue of its lower impervious cover and improved storm water practices, produced about 20% less runoff than the original lot. The cost to develop the redesigned parking lot was actually marginally lower than for the conventional parking lot – about 5% (CWP, 1998).

The costs associated with restorative redevelopment can be lower than other management approaches. For example, planting new trees and landscaping islands to intercept rainwater and reduce storm water runoff will certainly be less expensive than constructing regional detention facilities. Disconnecting roof leaders from sewers in just 10 percent of homes in the watershed could yield an annual cost saving of approximately $30,000 in sewage treatment costs alone (based upon estimated treatment costs of $2 per 1,000 gallons). This restorative redevelopment management option to reduce SSOs is less costly than structural modifications to the municipal sewer system. Many restoration projects, with the intent of watershed revitalization in mind, will yield similar costs as if the watershed was not a priority.

Ability to be Implemented

The principals of restorative redevelopment can be voluntarily implemented if home and business owners are adequately educated regarding the potential benefits to their property, their community, and the watershed as a whole. The more that watershed residents are educated about natural storm runoff processes and on-site connections to the watershed the more likely people would be to replace deteriorated on-site facilities with watershed-friendly alternatives. Storm water systems should be visible and a tangible part of the urban framework of the watershed. Public education could be even taken one step further and implemented into a school's educational curriculum. A greenhouse, utilizing water collected from the school's roof, could be a teaching tool for explaining the water cycle and the role of the school and neighborhood in the watershed. This educational process could encourage parents to implement similar management measures at their own homes. Regulatory land use approaches, when teamed up with public education, can be used to encourage home and business owners to apply the principals of restorative redevelopment whenever existing facilities wear out and need to be replaced or revitalized.

Financial incentives could also improve the rate at which the principals of restorative redevelopment are implemented. A number of commercial and industrial structures and parking lots sit abandoned or unused across the watershed (i.e. East Hills Shopping Center). Any proposed development within the watershed can be directed to these areas first. This can be done through incentives subsided by the state or local government including loans, tax breaks, and liability control. The re-use of abandoned parking areas, for example, may then be restored to native vegetation.

Everything that is done in a retrofit or redevelopment project should produce multiple, mutually reinforcing benefits. When a component is multi-functional, it attracts advocates promoting each of its several functions, and attracts a broad community and political support. The principals of restorative redevelopment should be implemented as a management approach within the NMR watershed.

6.1.3 Land Acquisition for preservation of Open Space and Buffer Zones

The riparian corridor, where land and water meet, deserves special protection in the form of buffers. A buffer can be placed along the stream to physically protect it from future disturbance or encroachment. Though the NMR watershed is highly urbanized, the existing riparian corridor along Fern Hollow and the lower 2 miles of Nine Mile Run is located within existing parklands and a cemetery. Some key questions to consider when screening alternative land acquisition measures include:

- Are existing riparian buffers sufficient to sustain the integrity of the aquatic and terrestrial ecosystems?
- Is restoration or better stewardship possible along an existing aquatic corridor?
- How much pollutant removal can realistically be expected from the buffer network?
- Who will own and maintain the buffer and how will maintenance be paid for?

<u>Alternatives</u>

- Purchase land to maintain existing open areas and buffer zones

Local governments can purchase land within the riparian zone to maintain existing open areas and buffer zones to protect valuable resources from the effects of development.

- Restore existing buffers to sustain the integrity of the aquatic and terrestrial ecosystems

Existing riparian buffers can be restored and enhanced to maintain the integrity of the aquatic and terrestrial ecosystems. Restoring existing buffers can add to the quality of the stream and the community in many diverse ways.

- Implement a strong educational plan to encourage greater buffer awareness and stewardship among watershed residents toward riparian buffer zones.

Future integrity of existing buffer systems require a strong educational program. The two primary goals of the program are to make the riparian buffer more "visible" to the community, and to encourage greater buffer awareness and stewardship among residents.

For more complete descriptions of buffer zones and their potential usefulness in the NMR watershed as an alternative land use control measure, please refer to Section 4.1.4 of this watershed management plan.

Applicability to the NMR watershed

Within the NMR watershed, no private land needs to be acquired to maintain existing open spaces and stream buffers along the existing riparian corridor. For the lower portions of the NMR watershed where urbanization is limited, the lands constituting the original stream alignment are owned by the City of Pittsburgh and a public cemetery. These include Frick Park, the valley floor and lower slopes along the Duquesne slag disposal area (below the new Summerset community), and Homewood Cemetery. In addition, the floodway corridor surrounding NMR is considered to be the property of the Commonwealth. As a result, no additional land acquisition is necessary for stream buffers as an urban watershed protection strategy.

However, stream bank vegetation along the NMR riparian corridor has been degraded. Revegetation of these areas would be beneficial, particularly in areas where the natural vegetation has been replaced with mowed grass or the slag slopes that currently have little or no vegetation. Substantial restoration benefits could be attained by revegetating these mowed and cleared bottomlands with native species.

Previously completed water quality studies along Nine Mile Run and Fern Hollow have shown that animal wastes from unleashed dog running and improper disposal contributes to the high bacteria concentrations that were observed. Discouraging these harmful practices within existing riparian buffer zones will improve water quality in streams.

Effectiveness

While the benefits of urban stream buffers are impressive, there capability to remove pollutants should not be overstated. In urban watersheds, rainfall is rapidly converted to concentrated flow. Storm water flows quickly concentrate within a short

distance in urban areas and often "short-circuit" a buffer. Consequently, as much as 90% of the surface runoff generated in an urban watershed concentrates before it reaches the buffer, and ultimately crosses it in an open channel or storm drain pipe. So from a storm water treatment system standpoint, a buffer system will only be able to treat runoff from less than 10% of the contributing watershed to the stream. Therefore, some kind of structural storm water practice may need to be installed to treat the quantity and quality of storm water runoff from the remaining 90% of the watershed.

However, a well-maintained and naturalistic stream buffer along the banks of a stream is effective in limiting the entrance of sediment, pollutants, and nutrients to the stream itself. When forested, a stream buffer is effective in promoting bank stability and serves as a major control of water temperature (Leopold, 1997). Previously completed water quality studies have shown that summertime urban runoff from heated pavement surfaces can sometimes cause stream water temperatures to exceed optimal values for healthy aquatic life. A forested buffer zone along the stream could help mitigate these urban impacts. A public education program could greatly improve the potential effectiveness of a restored buffer area by improving the public perception of the riparian greenway. Education could encourage public support for proposed changes to Frick Park (i.e. replacing existing lawn areas with natural vegetation) and help discourage potentially adverse activities (i.e. improper disposal of pet wastes).

Cost

Since no private land needs to be acquired to maintain existing open spaces and stream buffers, the primary costs will lie with revegetating the existing buffer areas and maintaining them once they are restored. Costs will include the purchasing and planting of native plant and tree species, maintaining the buffer areas, and efforts toward educating residents on the purpose, limits, and allowable uses of these areas.

Ability to be implemented

The creation, enhancement, and restoration of stream and wetland buffers have become an increasingly popular watershed protection technique due to simplicity, low cost, ease of implementation, and capability to protect resource areas. Within the NMR watershed, the buffer zone area along the stream corridor already is sufficient, and land acquisition to preserve these open spaces and buffer zones could not become an implementation obstacle.

The primary focus of this management measure will lie with restoring existing buffer areas with improved vegetative cover and preventing the revitalized buffer zones from being degraded in the future. Efforts to reforest existing buffer zones can be successful, even in urban areas like the NMR watershed. Foresting buffer areas is relatively simplistic and can provide valuable aquatic and riparian habitat areas for a

diverse range of species, reduce water temperatures in the stream, and can make the area more aesthetically pleasing to watershed residents.

Management of the forested buffer areas after they have been established should be relatively easy to implement as well. The objective should be to render them visible to residents and ensure they are protected from harmful human activities. Parks maintenance crews can add to their routine maintenance schedule periodic "buffer walks" to inspect the condition of the buffer network. Invasive and undesirable plant species that may gain a foothold in the buffer zone would need to be removed periodically to encourage native plants to flourish and promote greater species diversity.

Educating residents on the purpose, limits, and allowable uses of these areas becomes equally important. With regards to buffer awareness and stewardship among watershed residents, the underlying theme of buffer education is that most encroachment problems reflect ignorance rather than contempt for the buffer system. Awareness and educational measures can increase the recognition of the buffer within the community. Not all residents, however, may respond to this effort, and some form of enforcement may be necessary.

6.1.4 Runoff Control for Commercial and Industrial Sites

Pollutants most frequently associated with storm water include sediment, nutrients, bacteria, oxygen demanding substances, oil and grease, and other toxic chemicals. Industrial and commercial activities, even small businesses and relatively small facilities, have the potential to be significant pollutant contributors of these pollutants. Storm water pollution prevention and runoff control at these facilities includes selecting and carrying out cost-effective actions, or "Best Management Practices" (BMPs) that prevent the pollution of storm water discharges.

Alternatives

- Implement a "Best Management Practices" (BMP) approach toward pollution prevention for industrial/commercial facilities located within the NMR watershed.

The intent of this pollution prevention approach is to achieve a level of on-site pollution control at the point of origin so that storm water will not need to be treated in an off-site regional hydraulic detention facility or pollutant removal device. Owner and employee training is the vital component in implementing the BMP "operational practices" approach toward storm water pollution prevention. Trained inspectors can visit a participating facility, recommend management practices based on his/her observations, and educate employees on the problems and solutions. Common pollution prevention methods that should be stressed include non-storm water discharges to drains, vehicle and equipment fueling, storage of liquids, grounds maintenance, and waste handling, among others.

For more a complete description of BMPs and their potential uses in the NMR watershed as an alternative control measures for commercial and industrial sites, please refer to Section 4.1.5 of this watershed management plan.

Applicability to the NMR Watershed

Only a small portion of the total NMR watershed area is designated for industrial/commercial land use. However, in some cases, discharges from these industrial or commercial facilities located within the NMR watershed have the potential to be significant contributors to storm water pollution. Routine or accidental releases from these few industrial/commercial facilities can discharge pollutants in quantities far beyond the proportion of industrial/commercial land use area. As a result, implementing Best Management Practices within the NMR commercial/industrial establishments is both applicable and recommended.

Effectiveness

Pollutant loads from various commercial and industrial activities are highly variable, often episodic, and in practical terms, can defy quantification. The effectiveness of implementing the Best Management Practices approach will vary with each facility, even for the same type of industry.

It is known that certain BMP operational practices are 100 percent effective if implemented properly. However, it is difficult to determine within a reasonable degree of certainty what will be the reduction in loading, given in most cases that the original loading from the activity cannot be determined. If a facility has only one activity, then analyzing the effectiveness may be more straightforward. For a site with many activities, any prediction of loading reduction carries with it great uncertainty.

Cost

Costs associated with implementing the BMP approach toward controlling runoff from industrial and commercial sites primary involves the training and education of employees and customers. The cost of training employees can vary, depending on factors such as staff time, training components, and the extent of the training. Once an effective program is established, the cost for continuing educational materials and training will decrease significantly.

As for costs to industrial/commercial facilities for implementation, many of the "operational practices" carry minimal cost with them. For example, moving an outdoor operation indoors, discontinuing dumping pollutants into a storm drain, labeling containers or exposed piping, using drip pans, covering items stored outdoors, sweeping pavement sediments, and performing other good housekeeping practices have minimal costs associated with them.

However, if low cost "operational practices" are insufficient to meet numeric effluent pollutant limits, some structural modifications to facilities to enhance pollution prevention (design features of loading dock areas, vehicle fueling and maintenance areas, etc.) or on-site treatment control facilities (like oil / water separators) may be needed.

Ability to be implemented

The Best Management Practices approach to pollution prevention should be relatively easy to implement as it can be integrated into existing training programs that already may be required by other regulations. For smaller businesses not regulated by federal, state, or local regulations, developing a program is recommended. This can be especially attractive to smaller facilities and businesses that may not generate pollutants in large enough quantities to make on-site treatment or government regulation mandatory, but can be occasional sources of significant amounts of pollutants.

Further, small businesses may not have the wherewithal to implement extensive structural controls or to develop in-house expertise on specialized environmental issues and the described "operational practices" provide an attractive option. The approach is highly practical from a business standpoint because it focus on industrial / commercial operations and low-cost pollution control practices rather than expensive constructed solutions like new industrial structures or new storm water detention or treatment facilities.

In order to encourage best management practices among the participating industrial / commercial facilities, promotional tools like listings in newspaper ads, prize drawings, and discount coupon giveaways can be made available to help generate business for these participating facilities. Participating business owners can be given watershed stewardship stickers to display on-site. Watershed residents can encourage business by patronizing and supporting participating businesses who display the stickers.

6.1.5 Better Site Design

Individual development and redevelopment projects can be designed to reduce the amount of impervious cover they create, and increase the natural areas they conserve. Many innovative site planning techniques have been shown to sharply reduce the impact of development. Designers, however, are often not allowed to use these techniques in many communities because of outdated local zoning and / or subdivision codes. The better site design watershed protection tool is a nonstructural management measure that seeks to foster better site designs that can afford greater protection to the NMR watershed.

For more a complete description of better design concepts and their potential use in the NMR watershed as an alternative control measure to reduce urban runoff, please refer to Section 4.1.6 of this watershed management plan.

Alternatives

- Open Space or Cluster Residential Subdivisions

Cluster development designs minimize lot sizes within a compact developed portion of a property while leaving the remaining portion open, thus reducing the amount of impervious cover created by residential subdivision by 10 to 50%. The same development concept can be applied to new homes and businesses on individual lots.

- Green Parking Lots

Green parking refers to an approach that downsizes parking areas while still providing convenient access for the motorist. The common theme in green parking lots is minimization of impervious area at every stage of parking lot planning and design. The concept of green parking lots can also be applied to existing parking lots when they are refurbished.

- Roof Runoff Management

Re-directing rooftop runoff over pervious vegetated surfaces before it reaches paved surfaces can significantly decrease the annual volume runoff from a site. This can reduce the annual pollutant load and runoff volume being delivered to receiving waters and can have a substantial benefit in reducing downstream impacts.

Applicability to the NMR Watershed

There are few opportunities for implementing better site designs for new development. The only significant are of developable open space is the Summerset community, for which Phases 1 and 2 are currently under construction. Many of these design principals have already been integrated into the design of the subdivision to maximize green space and maintain vegetated buffer zones around the perimeter of the plan. There are many opportunities to implement better site designs on individual vacant lots within existing urban neighborhoods, such as those in Wilkinsburg Borough. Property owners building on these individual lots can be encouraged to design their homes, driveways, walkways and patios in ways that minimize the quantity of new impervious area constructed on the site.

Effectiveness

The use of better site design in new development projects can be highly effective in reducing the quantity of storm water runoff from the site and reducing the associated

pollutants that are transported in urban runoff. Some communities have found that innovative site design concepts can reduce site impervious cover from 10 to 50% depending on the lot size and layout. This can thereby reduce the cost for both storm water conveyance and treatment.

Cost

The costs associated with implementing better site designs tend to be minimal. Reducing driveway widths and patio areas can offset the higher material costs for semi-pervious paving materials. Directing roof and driveway runoff to vegetated areas instead of the street curb usually is a no-cost or low-cost measure that can save money over time due to the reduced need for watering.

Ability to be implemented

The principals of better site design can be voluntarily implemented if home and business owners are adequately educated regarding the potential benefits to their property, their community, and the watershed as a whole. The more that watershed residents are educated about natural storm runoff processes and on-site connections to the watershed the more likely people would be to modify their site plans to reduce the amount of impervious surface and redirect runoff from roofs and driveways onto vegetated surfaces. The principals of better site deign, when teamed up with a rigorous public education program, can be used to encourage home and business owners to develop their existing vacant properties in a way that reduces urban runoff and its associated pollutant loads to the watershed.

Table 6.1.3: Screening Summary of Alternative Land Use Controls

Control Measure	Applicabilty to the NMR Watershed	Effectiveness at Meeting Watershed Goals	Cost to Implement	Ability to be Implemented	Recommendation
Encourage reduction of impervious area and redirection of stormwater to vegetated areas during future restorative redevelopment projects within the NMR watershed	High	High	Medium	Medium	Recommended to Implement
Restore and enhance existing buffer areas within the NMR and Fern Hollow riparian zones to sustain the integrity of aquatic and terrestrial habitat	High	Medium	Low	High	Recommended to Implement
Implement the Best Management Practices (BMP) approach toward pollution prevention for industrial/commercial facilities located within the NMR watershed	High	Medium	Low	Medium	Recommended to Implement
Utilize better site designs toward new development in the NMR watershed with the goals of reducing impervious cover and directing runoff to vegetated areas	Low	Medium	Low	Medium	Consider Implementing
Evaluate the effectiveness of current state and local requirements for erosion and sediment control (E&SC) associated with new development and construction activities	Medium	Medium	Low	Medium	Consider Implementing
Allow zoning to control land use practices so as to prevent incompatability of neighboring uses and restrict uses that could be harmful to health and the well-being of the community	Low	Low	Medium	Low	Not Recommended to Implement
Evaluate the effectiveness of current state and local clearing and grading ordinances	Low	Low	Low	Medium	Not Recommended to Implement
Examine techniques to indirectly manage land use and impervious cover from new development projects within the NMR watershed	Low	Low	Medium	Low	Not Recommended to Implement

6.2 Screening of Public Education Programs

The goal of watershed stewardship is to increase public understanding and awareness about watersheds, promote better stewardship of private and public properties, and develop funding to sustain watershed management efforts. Promoting watershed advocacy is important because it can lay the foundation for public support and greater watershed stewardship.

An important element in crafting a watershed education program and screening alternative measures is to select the right combination of outreach techniques. Several communities have recently undertaken before and after surveys to measure how well the public responds to their watershed protection programs. From this research, two outreach techniques showed promise in actually changing behavior: media campaigns and intensive training. Media campaigns typically use a mix of radio, television, direct mail, and signs to broadcast a general watershed message to a large audience. Intensive training uses workshops, consultation, and guidebooks to send a much more complex message about watershed behavior to a smaller and more interested audience. Intensive training requires a time commitment from residents of a few hours or more.

Based on studies conducted, both media campaigns and intensive training showed 10 to 20% improvement in selected watershed behaviors among their respected target populations (CWP, 1999a). Both outreach techniques are probably needed in the watershed, as each complements the other. For example, media campaigns cost just a few cents per watershed resident reached; while intensive training can cost a few dollars for each resident that is actually influenced. Media campaigns are generally better at increasing watershed awareness and sending messages about negative watershed behaviors. Intensive training, on the other hand, tends to be superior at changing individual practices.

6.2.1 Littering and Illegal Dumping

Littering has been observed to be a pervasive problem in the NMR watershed. Refuse may be blown out of overflowing garbage cans or tossed by residents onto streets and yards and can eventually make its way into watershed streams. Vacant lots and abandoned commercial sites in urban areas can become a local dump site. Used motor oil, paint thinner, and other household toxic substances are dumped down storm drains. Education is a key to changing behavior and attitudes with regards to littering and dumping. Some key questions to consider in the alternative screening process include:

- Where are the existing dumping sites located, who owns the properties, and what can be done to encourage property owners and neighbors to clean up the site?

- What are the most cost effective ways to reach watershed residents and business owners?

- Who are the existing watershed advocates and how can the support base of volunteers be increased?

Alternatives

- Implement an educational program to familiarize residents and businesses with how littering and improperly disposed materials can affect storm water.

By locating and correcting littering and illegal dumping practices through educational measures, the many risks of public safety and water quality associated with these actions can be prevented. Littering and illegal dumping control programs focus on community involvement and focus on increasing public awareness of the problem and its implications. Alternative means to deliver the message of watershed education include public service announcements and local news features on television, newspaper ads and articles, community newsletters, brochures, internet websites, and training workshops.

- Coordinate special cleanup events where community volunteer groups conduct dumping site cleanups.

Cleanup projects require coordinated planning efforts and community involvement through volunteers to remove litter and illegally dumped materials. Residents who live nearby a dumping site or have special interests in the area are the key players. Once a site is cleaned, efforts are needed to discourage future littering and illegal dumping. Strong deterrents to littering and dumping are natural beauty and community pride. If an area is naturally beautiful and well cared for and if residents are proud of their communities, watershed properties are less likely to be trashed by uncaring people. Signs, lighting, barriers, and beautification efforts are all deterrents to discourage these acts.

For more complete descriptions of these alternative management measures and how they can be used to improve the quality of the NMR watershed, please refer to Sections 4.2.1 and 4.2.2 of this watershed management plan.

Applicability to the NMR Watershed

The need for littering and illegal dumping prevention programs in the NMR watershed to address the risks to public safety and water quality associated with these acts is both applicable and recommended. Littering and illegal dumping can occur everywhere and is particularly prevalent in the NMR watershed. Refuse from overflowing trash bins or inexcusably tossed by consumers onto streets and into yards can be seen throughout the watershed. Illegally dumped products ranging from

buried motorcycles to hypodermic needles have been observed all along the NMR stream.

Effective anti-littering and illegal dumping control programs make efforts to cleanup dumping sites and eliminate the future illegal discarding of wastes. There are existing volunteer groups within the watershed that could provide the labor resources needed to implement cleanup programs. Existing outreach programs like the ALCOSAN storm drain program label drains with a bright blue fish and the message "drains to stream." These labels can be used to highlight the connection between storm drains and streams and discourage illegal dumping of pollutants down them.

Effectiveness

While the effectiveness of illegal dumping and litter control measures at reducing pollutant loads to local waters are hard to quantify, there are a number of benefits these effective programs can have on public safety and water quality.

Litter can eventually make its way into receiving streams thus making it a risk to water quality and public safety. Illegal dumping of household and commercial waste can have a variety of impacts on water quality. Hazardous chemicals generated from household, commercial, and industrial sources can contaminate ground and surface water supplies, affect drinking water and public health as well as aquatic habitat. Reduced drainage of runoff due to blockage of streams, culverts, and drainage basins can result in flooding and channel modification. Property values can decrease as a result of littering and illegal dumping and the local tax base can be affected. Controlling illegal dumping and street litter can be an effective way to improve aesthetic and water quality in the NMR watershed.

Cost

The cost of illegal dumping and litter control programs can vary due to economic and social factors. Possible sources of labor for dumping site cleanups can include community and youth groups or corporations. Equipment for cleanup may be available through either public works or transportation agencies or through donations from private companies

Production costs for educational materials such as flyers and brochures can range from $0.10 to $0.50 per brochure. Estimated costs for folding, sorting, and distributing these materials to each individual household and business within the NMR watershed can range anywhere from $7,400 to $15,000.

The ALCOSAN Public Relations and Outreach Office provides the "blue fish" stencils used to label storm drains and directions for their use. The remaining material cost is for paint, and the cost is minimal. Existing volunteer groups in the watershed could provide the labor resources.

Ability to be implemented

A number of groups already have ongoing efforts to educate the public on litter and illegal dumping reduction. On such group, PA CleanWays, concentrate their efforts on changing the behavior of those who are littering on lands and waterways. Numerous cleanup efforts have been conducted as well. An event was sponsored by the Ohio Valley Water Sanitation to remove litter and debris along the NMR stream. However, within a month after the cleanup efforts, the stream side vegetation again was wrapped with plastic bags and other trash. This indicates that the key to local litter and illegal dumping control is through public education – to discourage residents and businesses from littering and illegally disposing of materials.

Illegal dumping and littering is often spurred by cost and convenience considerations, and a number of factors will encourage these practices. The fees for dumping at a proper waste disposal facility are often more than the fine associated with the illegal dumping offense, thereby discouraging residents to comply with the law. The absence of routine or affordable pickup service for trash and recyclables in some communities also encourages these acts.

Community education and involvement, in addition to targeted enforcement, is the key to regulate waste management and eliminate littering and illegal dumping. Integration of illegal dumping prevention into community policy programs can be an effective way to increase enforcement opportunities without the additional cost of hiring new staff. Producing simple messages relating the costs of littering and illegal dumping on local taxes can aid in eliminating the problem. Having a hotline where citizens can report illegal activities and educating the public on the connection between the storm drain and water quality can decrease the disposal of wastes into storm drains.

6.2.2 Landscaping and Lawn Care

Not many watershed residents understand that lawn fertilizer can cause water quality problems. According to surveys, less than one-fourth of watershed residents rated it as a water quality concern and only 10 to 20% of lawn owners conduct soil tests to determine whether fertilizer is even needed. Informing residents, employees of lawn and garden centers, and lawn care professionals on methods to reduce fertilizer and pesticide application and to limit water use can help alleviate potential impacts of a major contributor of non-point source pollution in residential communities.

Alternatives

- Implement an educational program to instruct those involved in the lawn care industry on the water quality impacts associated with lawn care products.

Lawn care companies can exercise considerable authority over which practices are applied to lawns they attend, as long as they still produce a sharp looking lawn. Lawn care industry educational programs should address alternate methods to reduce fertilizer and pesticide application, limit water use, and avoid land disturbance. Local governments that want to influence lawn care industries need an active program that supports those companies that employ techniques that limit fertilizer and pesticide application by providing promotional opportunities.

- Provide training for employees of lawn and garden centers regarding lawn care and pollution control.

The key goals for implementing a program like this are to substitute watershed friendly products for those that are not, and to offer training for the store attendants to pass on to consumers at the point of sale on how to use, and perhaps more importantly, how not to abuse or overuse such products. Study after study indicates that product labels and store attendants are the primary and almost exclusive source of lawn care information for the average consumer who takes care of their own lawn.

- Implement a pollution prevention program to educate residents within the NMR watershed regarding lawn care and pollution control.

Materials such as flyers and brochures can be distributed to educate the residents within the NMR watershed on the water quality impacts associated with lawn care and landscaping. These outreach materials should inform residents who perform their own lawn maintenance that nutrient runoff from lawns can contribute pollutants that contaminate storm water runoff into watershed streams and are toxic to both humans and aquatic organisms. Educational materials should encourage management practices such as ways to reduce fertilizer and pesticide application, substitution of watershed friendly products for those that are not, etc.

For more complete descriptions of these alternative management measures, please refer to Section 4.2.3 of this watershed management plan.

Applicability to the NMR Watershed

Implementing a pollution prevention program to address lawn care practices that can control pollutants and reduce storm water impacts in the NMR watershed is highly applicable to the NMR watershed. However, it is important to note that many of the residential lawns within the NMR watershed are located on small, urban lots. Therefore, it is safe to assume that most homeowners perform their own yard maintenance. As a result, the estimated potential reductions in fertilizer application shown in the table below may be high as the percentage of residents who fertilize regularly may be overestimated. Those who have lawn care services have the greatest tendency to over-fertilize their lawns and there are probably fewer-than-average watershed residents who use these services.

Nevertheless, lawn care is practiced within the NMR watershed and controlling fertilizer application to these lawns is vital. Chemicals associated with fertilizers (nitrogen, phosphorus, potassium) can find their ways to streams and reducing the application of these chemicals can reduce the water quality problems associated with them. Education programs targeted toward employees of lawn and garden centers and residents who perform their own lawn care would be most applicable to the NMR watershed.

The water quality screening analysis that is provided in the Appendix showed that most of the nitrogen and phosphorus pollutant loads found in the NMR watershed are carried into streams by storm water runoff from urbanized areas (see appendix Figures 4.4 and 4.5). Much of these nutrients come from lawns.

Effectiveness

The effectiveness of pollution prevention programs designed to educate residents on lawn care and landscaping practices have not been well documented to date. However, from the results of a number of market surveys, both media campaigns (TV, direct mail, signs) and training can each produce up to 10 to 20% improvement in watershed behaviors among their respected targeted populations.

Surveys suggest that roughly 70% of all lawns are regularly fertilized regardless of whether additional nutrients are needed or not and about two-thirds of all homeowners perform their own lawn care, with lawn care companies servicing the rest. Applying these same percentages within the NMR watershed, approximately 1,200 acres of residential lawn is regularly fertilized with approximately 4,300 residents performing their own lawn care and 2,150 persons using lawn care services. There is very little actual data on fertilizer application rates but reports suggest homeowner application can range anywhere from 44 to 261 lbs / acre / year and commercial lawn care services apply 194 to 258 lbs / acre / year.

According to the Northern Virginia Soil and Water Conservation District, a good rule of thumb is to use half of the manufacturer's application – generally less than 44 lbs / acre in a single application. Other current extension and garden literature recommendations range from 87 to 174 lbs / acre / year. Table 6.2.1 below provides rough estimates on potential fertilizer reductions within the NMR watershed. The table assumes that the average homeowner applies 153 lbs / acre / year of fertilizer and lawn care services apply an average of 226 lbs / acre / year of fertilizer on the lawns they care for. The table estimates the reduction in annual fertilizer application to residential lawns based upon realistic percentages of targeted outreach populations who change their behaviors and reduce their fertilizer applications to the recommended 44 lbs / acre / application twice per year (88 lbs / acre / year).

Table 6.2.1: Potential Reductions in Fertilizer Reduction through Public Outreach

			Reduction in Fertilizer Applied (lbs)		
Targeted Outreach	# Lawns Fertilized	Lawn Area (acres)	10% Change Behavior	15% Change Behavior	20% Change Behavior
Residents	4,300	800	5,200	7,800	10,400
Lawn Care Service	2,150	400	5,520	8,280	11,040
Both	6,450	1,200	10,720	16,080	21,440

Cost

The cost of creating and maintaining a program that addresses lawn care and landscaping practices and water quality varies depending on the intensity of the effort and the outreach techniques that are selected. Production costs for materials such as flyers and brochures are often inexpensive ($0.10 to $0.50 per brochure), and soil testing, and soil kits and testing to determine if fertilization is even needed may be done through a local university to reduce expense. Estimated costs for folding, sorting, and distributing these materials to each individual household and business within the NMR watershed can range anywhere from $7,400 to $15,000.

An example of a program that educates residents on better lawn care practices is The Water-Wise Gardener Program of Prince William County, Virginia. The program operates on an average annual budget of approximately $30,000 and requires the yearly time of 1.5 staff persons. Expense is deferred by the use of Master Gardener volunteers who act as consultants for volunteer lawns where lawn care practices have been implemented.

Ability to be implemented

Residents are typically not aware of the water quality consequences of lawn care – overall less than one fourth of surveyed residents rated it as a water quality concern (Syferd, 1995 and Assing, 1994). As a result, providing residents with educational materials can inform residents on the impacts of fertilizer runoff. These materials should attempt to convince residents that a nice green lawn can be achieved without using large amounts of chemicals and fertilizers.

However, the main focus of a lawn care outreach program should be on hardware and garden stores since store attendants are the primary source of lawn care information for residents who take care of their lawns. Store attendants on can pass on to consumers how to properly use lawn care products may yield the largest improvement in watershed behavioral changes toward lawn care.

6.2.3 Automobile Maintenance

Dumping automotive fluids down storm drains can be a major water quality problem, since only a few quarts of oil or a few gallons of antifreeze can have a major impact on streams and wetlands during low flow conditions. Automotive maintenance facilities are considered to be storm water "hotspots" where significant loads of hydrocarbons, trace metals, and other pollutants can be produced that can affect the quality of storm water runoff. Common activities at maintenance shops that generate this waste include the cleaning of parts, changing of vehicle fluids, and replacement and repair of equipment. These activities are also performed by residents at home in their driveway in the course of normal vehicle care.

Alternatives

- Implement an outreach and training program for businesses involved in automobile maintenance.

Automotive maintenance pollution prevention programs include targeted outreach and training to automobile maintenance businesses regarding practices that control pollutants and reduce storm water impacts. Trained inspectors can visit a participating facility and recommend management practices based on his/her observations. Common pollution prevention methods at maintenance shops that should be stressed include waste reduction, the use of safer alternatives, spill clean up, good housekeeping, and parts cleaning. In order to encourage behavioral changes among participating maintenance facilities, promotional tools like listings in newspaper ads, decals for shop windows, prize drawings, and discount coupon giveaways can be made available to help generate business for these participating facilities.

- Provide automobile maintenance educational materials to the residents within the NMR watershed.

Materials such as flyers and brochures can be distributed to educate the general public on the water quality impacts of automobile maintenance. These outreach materials should inform residents who perform their own vehicle maintenance that automobile maintenance has the potential to result in significant loads of hydrocarbons, trace metals, and other pollutants. Educational materials should encourage management practices such as the proper cleaning of parts, changing of vehicle fluids, replacement and repair of equipment, proper waste disposal, etc.

For more complete descriptions of these alternative management measures and how they can be used to improve water quality in the NMR watershed, please refer to Section 4.2.4 of this watershed management plan.

Applicability to the NMR Watershed

Implementing a pollution prevention program to address automobile maintenance practices that control pollutants and reduce storm water impacts in the NMR watershed is applicable. As with any other urban watershed, there are a significant number of automobile maintenance facilities and backyard mechanics that perform their own vehicle maintenance. With the advent of the $20 oil change special, the number of back yard mechanics who change the oil and antifreeze in their cars has been dropping steadily. However, estimates indicate that approximately 30% of car owners still change their own oil and antifreeze (CWP, 1999B). Fluid spills and improper disposal of materials result in pollutants, heavy metals, and toxic materials entering ground and surface water supplies, creating public health and environmental risks. Many automobile maintenance facilities and backyard mechanics are unaware of these water quality impacts resulting from automobile maintenance.

Cost

The cost of a vehicle maintenance pollution prevention program to train businesses involved in automobile maintenance depends on the intensity of the effort, what outreach techniques are selected, and the number of vehicle maintenance facilities within the watershed area. A program that had great success in controlling contaminated flows from vehicle maintenance facilities is the Clean Bay Business Program in Palo Alto, California. The initial per facility cost for the program was approximately $300, with a cost of $150 for subsequent years. The initial per facility cost includes inspector visits and follow-up work, outreach materials, mailing list, and database management.

Production costs for materials such as flyers and brochures are relatively inexpensive as well and can range from $0.10 to $0.50 per brochure. Estimated costs for folding, sorting, and distributing brochures to the each individual household within the NMR watershed range from $7,400 to $15,000.

Effectiveness

The effectiveness of automobile maintenance pollution prevention programs at removing pollutants is difficult to quantify. However, there are programs that have demonstrated the effect pollution prevention practices can have in reducing impacts from automotive fluids. The previously mentioned Clean Bay Business program in Palo Alto, California had great success in controlling contaminated flows from vehicle maintenance facilities. The effectiveness of the program at creating behavioral changes was evident in the increase in the number of businesses using all of the recommended practices. In 1992 when the program began, only four percent of the businesses used all of the recommended practices. By 1998, ninety-four percent of businesses had instituted the practices suggested (NRDC, 1999). The effectiveness of

the program at altering behaviors detrimental to storm water was impressive. After participation in the program, the changes facilities made had the following impacts:

- 78 direct discharges to storm drains were eliminated by ceasing or modifying the practices used for activities such as parking lot cleaning, vehicle washing, and wet sanding
- Violations of storm drain protection requirements fell by 90% from 1992 through 1995
- The number of shops conducting outdoor removal of vehicle fluids without secondary containment fell from 43 to 4

Ability to be implemented

Numerous programs in other watersheds have had success in removing pollutants from vehicle maintenance activities by changing behavioral patterns at vehicle maintenance facilities. The minimal per facility costs associated with addressing the handful of vehicle maintenance facilities within the NMR watershed pales in comparison to the potential water quality benefits associated these automotive maintenance pollution prevention measures.

On the other hand, distributing materials to educate NMR watershed residents on the water quality impacts of automobile maintenance may not be as beneficial. The number of backyard mechanics who perform their own vehicle maintenance has dropped steadily in recent decades. With the advent of the $20 oil change special, only about 30 percent of car owners change their own oil or antifreeze anymore. Not only would educational materials apply to only about 30% of the NMR residents, but studies have indicated that over 80% of backyard mechanics claim to dispose or recycle these fluids properly (Assing, 1994).

6.2.4 Car Washing

Outdoor car washing has potential to result in high loads of nutrients, metals, and hydrocarbons during dry weather conditions, as the detergent-rich water used to wash automobiles flows down the street and into storm drains. Car washing is a common routine for residents and a popular way for organizations such as scout troops, schools, and sports teams to raise funds. This pollution management measure involves educating the general public on the water quality impacts of the outdoor washing of automobiles and how to avoid allowing polluted runoff to enter the storm drain system.

Alternatives

- Implement a car wash outreach program devoted to car wash education

Outreach programs provide materials to charity car wash organizers to prevent car wash water from entering storm drains. These car wash kits are provided free of charge to charity organizers along with training videos on planning an environmentally friendly car wash. Two types of equipment can be made available for charity organizations to borrow: a catch basin insert with a sump pump or vacuum / boom device known as a Bubble Buster (Kitsap County, 1999).

- Provide car washing educational materials to the residents within the NMR watershed

Materials such as flyers and brochures can be distributed to educate the general public on the water quality impacts of the outdoor washing of automobiles. These outreach materials should inform car washers that car washing has the potential to result in high loads of nutrients, metals, and hydrocarbons to storm drains and streams in dry weather conditions. These materials encourage management practices such as using commercial car washes, washing cars on gravel, grass or other permeable surfaces, rinsing pavement to adjacent grassy areas, using biodegradable soaps, etc.

For more complete descriptions of these alternative management measures, please refer to Section 4.2.5 of this watershed management plan.

Applicability to the NMR Watershed

Implementing a pollution prevention program to reduce the impact of car wash runoff in the NMR watershed is clearly applicable. In urban areas like NMR, there are higher concentrations of automobiles that translate to a larger potential impact on water quality from car washing. According to surveys, roughly 55 to 70% of households wash their own cars and approximately 60% could be classified as "chronic car-washers," i.e. they wash their own car at least two times a month (Smith, 1996 and Hardwick, 1997). Similar statistics with regards to car washing can be expected within the NMR watershed.

Effectiveness

Little is known about the water quality of car wash water except that it has the potential to result in high loads of nutrients, metals, and hydrocarbons. The effectiveness of car washing management practices at reducing pollutant source loads has yet to be accurately measured. It is difficult to determine the exact impact of a particular pollution prevention measure at reducing pollutant loading.

Cost

Car wash outreach programs are relatively inexpensive to staff and require only a limited outlay for materials (training videos, etc.). In Kitsap County, Washington, the Sound Car Wash Program requires roughly ten to fifteen hours a week of staff time over a twenty-five week period from April to September. The purchase of wash water containment equipment for charity car washes is often a one-time expense and can be used for a number of years. For the catch basin insert, the approximate cost is $65. For the Bubble Buster, the cost ranges from $2,000 to $2,500.

Production costs for materials such as flyers and brochures are relatively inexpensive as well and can range from $0.10 to $0.50 per brochure. Estimated costs for folding, sorting, and distributing brochures to the each individual household within the NMR watershed could range from $7,400 to $15,000.

Ability to be implemented

Residents are typically not aware of the water quality consequences of car washing, and do not understand the chemical content of soaps and detergents. As a result, providing residents with educational materials on the impacts of car wash runoff and providing "water friendly" car wash kits to charity organizers can minimize the risk of contamination from wash water discharges at a relatively low cost. However, car washing is a difficult watershed behavior to change, since it is hard to define a better alternative without asking people to pay to use a commercial car wash that treats its wash water. Some potential alternative messages that might work are to wash cars less frequently, wash them on grassy areas, and to buy phosphorus-free detergents and non-toxic cleaners.

6.2.5 Animal Waste Collection

The presence of pet waste in storm water runoff has a number of implications for urban stream water quality with perhaps the greatest impact from fecal bacteria. According to recent research, non-human waste represents a significant source of bacterial contamination in urban watersheds. Animal waste collection as a pollution control source involves using a combination of educational outreach and enforcement to encourage residents to clean up after their pets. A popular use of the lower portion of Frick Park is dog walking. Residents need to be educated on the implications of their pet's waste on the stream water quality.

Alternatives

- Implement an animal waste collection program to educate residents on how and why dog waste can be a water quality problem

An animal waste collection program should use awareness, education, and signs to alert residents as to the proper disposal techniques for pet droppings. The goal of the program should be to educate dog owners on how the presence of pet waste in storm water runoff has a number of implications on urban stream water quality and perhaps the greatest impact from fecal bacteria.

For a more complete description of this alternative management measure, please refer to Section 4.2.6 of this watershed management plan.

Applicability to the NMR Watershed

Implementing a pollution prevention program to reduce the impact of animal waste in storm water runoff within the NMR watershed is clearly applicable to the NMR watershed. Communities within the NMR watershed have already begun taking measures toward educating residents on the importance of pet waste removal with signs in public parks and along residential streets. Continuing public education efforts is important due to the number of implications pet waste in storm water runoff can have on urban stream water quality.

Effectiveness

Genetic studies by Alderiso et al. (1996) and Trial et al. (1993) both concluded that 95 percent of fecal coliform found in urban storm water is of non-human origin. Bacterial source tracking studies conducted in Seattle, Washington also found that nearly 20% of the bacteria isolates were matched with dogs. This indicates that animal waste represents a significant source of bacterial contamination in urban watersheds.

In a survey of Chesapeake Bay residents, it was found that about 40% of residential households own a dog. Applying that same percentage to the NMR watershed would indicate approximately 3,700 dogs within the watershed. In the Four Mile Run watershed in Northern Virginia, a dog population of 11,400 was estimated to contribute 5,000 pounds of solid waste every day (0.44 lbs / dog / day). Applying this same estimate to the NMR watershed would indicate that approximately 480,000 to 710,000 pounds of dog waste is generated within the watershed each year.

Residents seem to be of two minds when it comes to dog waste. A strong majority agree that dog waste can be a water quality problem (Hardwick, 1997; Swann, 1999). However, the reluctance of many residents to handle dog waste is the biggest limitation. According to the Chesapeake Bay survey, 40 percent of dog owners admitted to not picking up after their dog and 44 percent of the dog owners who do not pick up indicated they would still refuse to pick up even if confronted by neighbors, threatened with fines, or provided with more convenient options for disposing of dog waste. Assuming the same reluctance toward dog waste pickup within the NMR watershed, approximately 1,480 dog owners do not pickup after their

dogs and 650 will never change their behavior toward dog waste pickup. This would indicate a targeted outreach population of approximately 830 dog owners.

Market surveys have indicated that media campaigns (TV, direct mail, signs) and training can produce up to 10 to 20% improvement in watershed behaviors among their respected targeted populations. Table 6.2.2 below estimates potential reductions in animal waste based upon realistic percentages of the estimated outreach population that would change their behavior toward pet waste cleanup.

Table 6.2.2: Potential Reductions in Animal Waste through Public Outreach

	10% change behavior	15% change behavior	20% change behavior
Number of Dog Owners Now Willing to Pickup	83	125	166
Reduction in Annual Dog Waste (lbs)	13,330	20,075	26,660

Cost

The cost of animal waste collection programs will vary depending on the intensity of the effort and the paths chosen to control pet waste. The most popular way is through ordinances (discussed in Section 6.3), but managers must consider public education as a reinforcement alternative. Public education program costs are determined by the type of materials produced and the method of distribution selected. Sending informative brochures to individual households within the NMR watershed could range from $7,400 to $15,000. Signs in parks may have a higher initial cost than printed materials, but can last for many years. Signs may also be more effective, since the act as on-site reminders in dog walking areas.

Ability to be implemented

The reluctance of many residents to handle dog waste is the biggest limitation to implementing a pet waste management program. Nevertheless, distributing informative brochures to residents within the NMR watershed is a recommended approach to educating dog owners on proper pet waste management techniques. These brochures should describe the environmental and hygiene/health concerns associated with pet waste as well as communicating the message that proper pet waste cleanup is the law and is courteous to neighbors. Identifying residents within the watershed who own dogs (if possible) can significantly reduce the cost of producing and distributing these informative materials. In addition, placing signs in dog walking areas where they currently do not exist can further spread the message of proper pet waste management. Although the educational measures discussed in

this section are viable alternatives, ordinances (discussed in Section 6.3) to regulate pet waste cleanup are likely to provide greater results – especially in public areas.

6.2.6 Vegetation Controls and Tree Planting

Public education of mechanical vegetation control includes properly collecting and disposing of clippings, cutting techniques, leaving existing vegetation, and planting new trees and vegetation. Clippings and cuttings are the primary waste produced by mowing and trimming and are almost exclusively leaf and woody materials. Once vegetative waste is generated, the main concern is to avoid transport of clippings and cuttings to the storm water system and receiving water bodies since the waste can degrade water quality.

Alternatives

- Implement a vegetation control program to educate the residents of the NMR watershed that clippings carried into the storm water system and receiving streams can degrade water quality

A vegetation control program should educate residents on the importance of properly collecting and disposing of clippings, cutting techniques, leaving existing vegetation, and introducing new vegetation. Residents should be encouraged to set their mowing heights as high as possible, leave their clippings on the lawn to provide nutrients and moisture, preserve existing vegetation, and introduce as much new vegetation as possible. Distributing informative brochures to the residents of the NMR watershed is the most common approach to educating the public on vegetation controls.

- Implement a public education program that encourages residents to convert managed turf and landscape areas to native vegetation that requires less water and maintenance.

Watershed residents could be educated and encouraged to convert managed turf areas to native vegetation. The notion that manicured lawns are more attractive than natural landscapes can be altered with education and examples. Existing lawn areas can be converted to landscape areas planted with carefully selected plant materials including trees wildflowers, ground covers and warm-season decorative grasses which require little maintenance and are draught tolerant. Many ground covers can thrive where grass does not. Trees and shrubs transpire rainfall through their leaves, consume carbon dioxide, release oxygen, and help moderate urban temperatures. Community awareness through programs, seminars, and field trips can be arranged to emphasize the advantages of natural landscaping in public areas and private property.

For a more complete description of these alternative public education elements, please refer to Section 4.2.7 of this watershed management plan.

Applicability to the NMR watershed

Implementing a pollution prevention program to address vegetation control practices that can control pollutants and reduce storm water impacts in the NMR watershed is applicable. Many of the residential lawns within the NMR watershed are located on small, urban lots, but the cumulative impact is significant - there is an estimated 1,700 acres of residential lawn area within the watershed. As a result, there are numerous opportunities to alter vegetation control behaviors and reduce the storm water impacts that poor vegetation controls can have on the watershed. There are also opportunities to encourage home owners to convert existing lawn areas to native vegetation that requires less water and maintenance.

Effectiveness

The pollutant removal abilities of a vegetation control programs are difficult to quantify and have yet to be measured accurately. However, it is clear that lawn care is a common watershed behavior and educating residents on proper vegetation controls can have numerous benefits.

Traditional lawn care practices call for raking and removing clippings, which were thought to promote thatch and disease. In fact, leaving clippings on the lawn is beneficial as they provide nutrients and moisture. Researchers at the University of Connecticut Agricultural Station used radioactive nitrogen to track the fate of applied nutrients when clippings are recycled. They found that within a week, most of the nitrogen from the clippings was incorporated into new grass growth. After three years, nearly 80% of the applied nitrogen had been returned to the lawn (Schultz, 1989).

One-acre of lawn area generates almost six tons of grass clippings a year, or nearly a thousand bags worth (Jenkins, 1994). Although grass clippings decompose rapidly on the lawn, they often persist for a long time in landfills. In 1981, the city of Plano, Texas, instituted a program that encouraged residents to leave clippings on home lawns to provide nutrients and moisture. Knoop and Whitney (1989) reported the results: the city saved $60,000 in disposal costs in the first year, even though the number of households served increased 12% over the same period. Residents participating in the program saved $22,000 in plastic bag purchases.

Traditional lawn care practices also look to the close-cropped putting green as the ideal lawn turf. Unfortunately, close mowing can weaken the grass and expose the grass crowns to sunburn. Keeping grass taller will actually shade out weeds, reducing them by more than 50% (Alliance for the Chesapeake Bay, 1994).

Trees, shrubs, and other vegetation are a watershed priority as they transpire rainfall through their leaves, consume carbon dioxide, release oxygen, and moderate urban temperatures. As a result, existing vegetation should be left in place and new

vegetation should be introduced. Most residential lawns have areas that are not suited for grass growth. These include frost pockets, exposed areas, dense shades, steep slopes, and wet, boggy areas. Converting these areas to less intensive plantings is an effective strategy for reducing lawn inputs. Existing flowerbeds or groupings of trees and shrubs can simple be expanded, or groundcovers can be used to replace grass. Other options include mimicking native plant communities such as forests, meadows, and wetlands and converting lawn areas into mulched beds.

Cost

The cost of creating and maintaining an education program that addresses vegetation control varies depending on the intensity of the effort and the outreach technique selected. Measures to improve vegetation controls, for the most part, should be simple and inexpensive. Production costs for materials such as flyers and brochures are relatively inexpensive as well and can range from $0.10 to $0.50 per brochure. Estimated costs for distributing brochures to the each individual household within the NMR watershed could range from $1,860 to $9,300. Information regarding this subject could also be incorporated into other local government education programs such as household hazardous waste education programs and pesticide education efforts – thus reducing the cost.

Ability to be implemented

The reluctance of many residents to change their conventional vegetation control techniques is the biggest limitation to implementing a vegetation control program. Nevertheless, distributing informative brochures to residents within the NMR watershed is a recommended approach to educating residents on properly collecting and disposing of clippings, encouraged cutting techniques, and lawn conversion. These brochures should emphasize that clippings carried into the storm water system and receiving streams can degrade water quality.

Alternative landscaping and the introduction of new vegetation can be a workable goal by encouraging volunteer community groups to plant native vegetation in public areas such as parklands.

Table 6.2.3: Screening Summary of Public Education Programs

Control Measure	Applicabilty to the NMR Watershed	Effectiveness at Meeting Watershed Goals	Cost to Implement	Ability to be Implemented	Recommendation
Implement an education program to familiarize residents and businesses with how littering, dumping, and improperly disposed materials can affect stormwater	High	Medium	Low	High	Recommended to Implement
Coordinate special cleanup events where community volunteer groups conduct dumping site cleanups	High	High	Low	Medium	Recommended to Implement
Implement a pollution prevention program to educate residents within the NMR watershed regarding lawn care and pollution control	High	Medium	Low	High	Recommended to Implement
Implement an outreach and training program for businesses involved in automobile maintenance	High	Medium	Low	Medium	Recommended to Implement
Implement a car wash outreach program devoted to providing materials to charity car wash organizers	Medium	Medium	Low	High	Recommended to Implement
Implement an animal waste collection program to educate residents on how and why dog waste can be a water quality problem	High	Medium	Low	High	Recommended to Implement

Table 6.2.3: Screening Summary of Public Education Programs

Control Measure	Applicabilty to the NMR Watershed	Effectiveness at Meeting Watershed Goals	Cost to Implement	Ability to be Implemented	Recommendation
Provide training for lawn and garden care center employees regarding lawn care and pollution control	High	Medium	Low	High	Consider Implementing
Implement and educational program to instruct those involved in the lawn care industry on the water quality impacts associated with lawn care products	Medium	Medium	Low	Medium	Consider Implementing
Provide automobile maintenance educational materials to watershed residents who perform their own vehicle maintenance	Medium	Medium	Low	High	Consider Implementing
Provide car washing educational materials to the residents within the NMR watershed	Medium	Medium	Low	High	Consider Implementing
Implement a vegetation control program to educate residents that clippings carried into the stormwater system and receiving streams can degrade water quality	Medium	Medium	Low	Medium	Consider Implementing
Implement a public education program that encourages residents to convert managed turf and lanscape areas to native vegetation	Medium	Medium	Low	Medium	Consider Implementing

6.3 Screening of Non-Structural Municipal Measures

The municipalities within the NMR watershed have many tools at their disposal to address environmental issues that contribute to urban impacts that contribute to watershed degradation. The NMR watershed will continue to be subjected to the wide variety of problems related to urban runoff if action is not taken on the municipal level. Municipal management programs impact watershed quality by the way existing municipal infrastructure is maintained and the way municipal ordinances are enforced. Leaking sewers and illegal connections, combined sewer overflows, storm water runoff, deicing salts, roadway runoff, household hazardous wastes, among others, all contribute pollutants loads to the NMR watershed, and all can be managed to some degree by the municipalities within the watershed.

6.3.1 Combined Sewer Overflow Reduction

Combined sewer overflows (CSOs) occur because the quantity of storm water runoff entering the combined sewer system exceeds the capacity of the regulator structures and the connections to the regional treatment plant. If an overflowing combined sewer system is thought of as a bucket that is spilling over, two options are available: 1) buy a larger bucket or, 2) reduce the amount and slow the flow of water entering the bucket. Investing in increased sewer conveyance and treatment capacity without carefully examining alternative ways to reduce the quantity of storm water that enters the combined sewer system can be costly. This section will examine and evaluate alternative non-structural management alternatives that can be implemented within the NMR watershed to reduce CSO discharges and their effects on receiving water quality.

Alternatives

- Implement proactive inspection, operation, and maintenance programs for the combined sewer regulator structures located within the NMR watershed

The Pittsburgh Water and Sewer authority (PWSA) has the responsibility to inspect, operate, and maintain of the combined sewer systems (CSS) and regulator structures within the City of Pittsburgh (COP). A proactive O&M program can significantly reduce the magnitude, frequency, and duration of CSOs by enabling the existing facilities to perform as effectively as possible. Operation and maintenance procedures should include routine inspections after every storm; regulator cleaning; and corrective and preventative maintenance and repair to the CSO regulator structures.

- Disconnect selected roof leaders from the combined sewer system and direct pavement runoff to flat vegetated areas

Wherever possible, rooftop drainage should be disconnected from the combined sewers and re-routed to flat lawn areas, dry wells, water gardens, and cisterns. Pavement runoff should be directed to flat vegetated yard areas. The reconnection

with natural processes reduces the volume of surface runoff and filters out pollutants. In some cases, roof leaders can be disconnected from the combined sewer rather easily. However, care must be taken to insure adjacent property is not flooded and some disconnections may require structural modifications.

- Perform simple modifications within the diversion chambers to increase the capture of combined sewer flow and decrease CSO discharges to the watershed

Simple modifications to the control devices within the CSO diversion chambers, such as adding another course or two of brick to existing diversion dams, can be made without complicated engineering designs. These simple measures can enable the regulator structures to capture a greater percentage of the combined sewer flow during wet weather.

For more complete descriptions of these non-structural control measures and how they reduce the frequency and duration of CSO discharges in the NMR watershed, please refer the Section 4.3.1 of this watershed management plan.

Applicability to the NMR watershed

Completed hydraulic and hydrologic studies have shown approximately 13 million gallons of commingled wastewater and storm water is discharged in an average year into the Nine Mile Run stream from PWSA diversion structures and another 117 million gallons is discharged into the Monongahela River from the ALCOSAN diversion structure. It is therefore applicable to implement non-structural CSO reduction controls within the NMR watershed to reduce CSO discharges and their effects on receiving water quality. The Pittsburgh Water and Sewer Authority (PWSA) has entered into a Consent Order Agreement (COA) with the Pennsylvania Department of Environmental Protection (PA-DEP) requiring that investigations and studies be undertaken in the combined collection system within and discharging to the NMR watershed. Part of the intent of the COA is to reduce CSO discharges.

Based upon continuous simulation rainfall-runoff modeling, the existing wet weather capture of the NMR system is reasonably good compared when with similar older combined sewer systems, but further reduction in CSO discharges is needed to reduce the concentrations of fecal coliform and other substances associated with sanitary sewage and storm water from entering the NMR stream. Implementing cost effective, non-structural measures can reduce CSOs and improve water quality within the NMR watershed.

Effectiveness

Proactive inspection, operation, and maintenance of combined sewer system diversion structure can be highly effective in minimizing the quantity of CSO discharges and their associated pollutant loads to the NMR watershed. Ultimately,

the effectiveness of an O&M program depends on the resources allocated and the extent to which CSOs are caused by conditions that can be mitigated by O&M practices. To quantify the pollution reduction resulting from a proactive O&M program, the existing frequency, duration, and volume of CSOs prior to conducting O&M practices would be documented, conditions that can be mitigated by O&M practices would be isolated , and the frequency, duration, and volume of CSOs after performing the O&M practices for a year would be measured.

The degree to which these non-structural pollution prevention measures can reduce contamination of receiving water bodies through CSOs is difficult to quantify. However, reducing the volume of pavement and roof runoff that enters the combined sewer system by directing it to flat vegetated areas can be effective at reducing CSO discharges and pollutants. The effectiveness of this management measure is further increased because the storm water runoff is filtered by vegetation and soil and directed to the groundwater table. Every gallon of storm water disconnected from the CSS is one less gallon mixed with sewage and one more gallon to feed vegetation and streams in dry weather. For example, assuming minimal evaporation and other losses, disconnecting 1,000 square foot of roof or pavement areas from the CSS can prevent approximately 22,500 gallons of rainwater from entering the CSS per year.

Implementing simple structural modifications to existing CSO regulator structures can be highly effective at reducing the frequency and duration of CSO discharges. By raising the height of the control dams within the structures, the capacity and effectiveness of the existing CSS is maximized. The start of CSO discharging during a storm can be delayed, and smaller storms may be completely captured instead of being discharged to streams.

Cost

The incremental cost associated with a proactive inspection, operation and maintenance program tend to be low because personnel and equipment are already dedicated to sewer maintenance and it is often a matter of using these existing resources more efficiently. The O&M program budget should provide sufficient funds, personnel, and equipment for routine O&M and a reasonable contingency amount for emergencies. Individuals responsible for day-to-day O&M should have the opportunity to participate in the budget preparation process so that the officials responsible for the final budget preparation and approval are aware of the O&M needs.

Costs associated with disconnecting drainage from combined sewers can vary greatly from site to site, but the cost for many sites can be low. In some cases, drainage can be disconnected from the combined sewer rather easily. In some instances, disconnecting rooftop drainage and routing it to flat lawn areas can be performed by residential homeowners at virtually no cost. The City of Portland's downspout

disconnection program averaged $53 per downspout to disconnect with costs for rain barrels ranging from $140-$170. On-site storage tanks can range from $560 to $875 depending on the height and diameter of the tank (Ferguson, Pinkham, and Bruce, 1999). Costs associated with making simple non-structural modification to existing CSO diversion structures tends to be low. Material costs are often limited to a dozen sewer bricks and mortar. A three-person sewer crew can usually complete the modifications in a single day. The total cost typically ranges from $500 to $1000 per structure.

Ability to be implemented

Both the PWSA and ALCOSAN sewer authorities have dedicated labor and equipment resources for maintaining the CSO regulator structures in the NMR watershed. It is therefore reasonable to expect that these existing resources could implement an improved and more proactive program to inspect the structures after every significant storm, perform preventive and corrective maintenance on a scheduled basis, and optimize the efficiency of the structures.

Diverting rooftop runoff from residential rooftops and directing it to vegetated soil or to infiltration basins is a viable option to reduce storm water inflows to sewers and reasonable can be implemented within the NMR watershed. The objectives of a downspout disconnection program should be to divert rainwater away from the CSS, thereby reducing the frequency of CSOs. Similarly, runoff from paved areas also can be redirected to flat vegetated areas.

An effective downspout disconnection program should be made available to all residents watershed-wide. One approach would be to target residents through direct mail campaigns. The mailing should describe the environmental benefits of disconnecting downspouts from the sewer system and how residents can participate in the program and be part of the solution. Residents interested in participating in the program can be requested to return a postage paid mail back response card. Program staff could follow-up to arrange a site visit with the property owner to determine if the property is feasible for disconnection and, if so, to design a disconnection plan.

6.3.2 Street Sweeping

Street sweeping is practiced in most urban areas, including the NMR watershed. Within the NMR watershed, each municipality performs their own street sweeping to remove sediment buildup, debris, and litter from roads and parking lot surfaces. Historically, performance monitoring studies indicated that street sweeping was not very effective in reducing pollutant loads. However, recent improvements in street sweeper technology have enhanced the ability of present day machines to pick up the fine grained sediments that carry a substantial portion of the storm water pollutant load. Integrating new street sweeping technology and techniques into existing

municipal street sweeping programs can impact the amount of sediment, debris, and litter that can be removed from streets and parking areas.

Alternatives

- Use the most technically improved sweeper technologies that are now available to improve performance in removing particulate matter from roadways

Many of today's sweepers can now significantly reduce the amount of street dirt entering streams and rivers. Innovations in sweeper technology have improved the performance of these machines at removing finer sediment particles, especially for machines that use vacuum assisted dry sweeping to remove particulate matter. By using the most sophisticated sweepers in areas with the highest pollutant loads, greater reductions in sediment and accompanied pollutants can be realized.

- Improve upon the frequency and location of street sweeping within each community's current street sweeping programs

Each community's existing street sweeping programs could be examined as to how often and what roads are being swept. Each program's budget and level of desired pollutant removal should be evaluated. Studies suggest that sweeping frequency should be conducted once every week or two and higher sediment removal can be obtained on residential streets as opposed to more heavily traveled roads.

For a more complete description of street sweeping as an alternative management measure, please refer to Section 4.3.5 of the watershed management plan.

Applicability to the NMR Watershed

Improving sweeper technologies and street sweeping techniques has limited applicability within the NMR watershed. As is the case in most urban areas, street sweeping is practiced within the NMR watershed and is designed to remove sediment, debris, and other pollutants from road and parking lot surfaces. It is unrealistic to expect that sewershed municipalities would make the large capital investment that would be required to purchase the new street sweeping equipment..

Effectiveness

Studies show that conventional mechanical broom and vacuum-assisted wet sweepers reduce non-point pollution by 5 to 30%; and nutrient content by 0 to 15%, but that newer dry vacuum sweepers can reduce non-point source pollution from 35 to 80%; and nutrients by 15 to 40% for those areas that can be swept (Runoff Report, 1998). While actual reductions in storm water pollutants have not yet been established, information on the reductions in finer sediment particles that carry a significant portion of the storm water pollutant runoff is available. Recent estimates are that the

new vacuum assisted dry sweepers might achieve a 50 to 88% overall reduction in the annual sediment loading for a residential street, depending on sweeping frequency (Bannerman, 1999).

A benefit of high-efficiency street sweeping is that by capturing pollutants before they are made soluble by rainwater, the need for storm water treatment practices may be reduced – which can be very costly when compared to collecting pollutants before they become soluble. Street sweepers that can show a significant level of sediment removal efficiency may prove to be more cost-effective, especially in more urbanized areas with higher areas of paving.

Computer modeling in the Pacific Northwest suggest that from the standpoint of pollutant removal, the optimum sweeping frequency appears to be once every week or two (Claytor, 1999). More frequent sweeping operations yielded only a small increment in additional removal.

Cost

The largest expenditures for street sweeping programs are in staffing and equipment. The capital cost for a conventional sweeper is between $60,000 and $120,000. Newer technologies are even higher than that, with prices approaching $180,000. The average useful life of a conventional sweeper is about four years, and programs must budget for equipment replacement. If investing in newer technologies, training for operators need to be included in operation and maintenance budgets.

Cost data for two cities in Michigan provide some guidance on the overall cost of a street sweeping program. Table 6.3.1 below contains a review of the labor, equipment, and materials cost for street sweeping for the year 1995 (Ferguson et al., 1997). The average cost for street sweeping was $68 per curb mile per year.

Table 6.3.1: Cost Data for Various Street Sweeping Programs

City	Labor	Equipment	Materials and Services	Total
Livonia	$23,840	$85,630	$5,210	$114,680
Plymouth Township	$18,050	$14,550	$280	$32,880

The cost associated with improving the frequency of existing street sweeping activities include additional labor costs for the driver, additional disposal costs for the solids that are collected, and additional maintenance costs to keep the equipment maintained.

Ability to be implemented

The high cost of current sweeper technologies is a large limitation to using this management practice within the NMR watershed. With costs approaching $200,000 for some of the newer sweeper technologies, limited municipal budgets make purchasing this equipment difficult. Additional possible limitations include the need for training for sweeper operators, the inability of current sweeper technology to remove oil and grease, and the lack of solid evidence regarding the level of pollutant removal that can be expected. The presence of parked cars along the sides of streets within the watershed presents an additional limitation to reducing non-point pollution.

Within the NMR watershed, each municipality performs their own street sweeping. Greater efficiency and reduced cost could be achieved by pooling each of the municipality's resources together. With each municipality working together, greater efficiency could be achieved in removing pollutant loads and sediment from the streets and costs for acquiring new sweeper technologies could be reduced.

However, it would be reasonable to implement improved sweeping schedules with existing street cleaning equipment. Comprehensive street sweeping during the spring snowmelt season should be encouraged to reduce pollutant loads from residual road salt and to reduce sand export to receiving waters. Seventy percent of cold climate storm water experts recommend street sweeping during the spring snowmelt as a pollution prevention measure (Caraco and Claytor, 1997). Also, the frequent sweeping of parking lots at commercial/industrial sites is encouraged in order to remove small quantities of dry chemicals and solids that can be exposed to rainfall or storm water runoff.

6.3.3 Catch Basin and Storm Inlet Maintenance

Catch basins and storm inlets can act as accumulation points for many of the most critical non-point source pollutants within a watershed. A fast flash of runoff from a storm event detaches, mobilizes, and transports these substances directly to surface waters. The performance of these devices at removing sediment and other pollutants is dependant on routine maintenance to retain the storage available in the sump to capture sediment. In combined sewer systems, the ability of catch basins to capture street litter and floatable materials is dependant on maintaining the sewer hoods.

Alternatives

- Improve upon the existing maintenance of catch basins and storm inlets within the NMR watershed communities

Municipal maintenance of catch basins and storm inlets should include trash removal if a screen or other debris capturing device is used, and removal of the sediment using

a vactor truck. At a minimum, catch basins should be cleaned once or twice per year (Aronson et al., 1983). The performance of storm drains at removing sediment and other pollutants depends on this routine maintenance so that the storage available to capture the sediment is retained. Maintenance should include keeping a log of the amount of sediment collected and the data of removal.

For a more complete description of alternative management strategies for catch basins and storm inlets within the NMR watershed, please refer to Section 4.3.2 of this plan.

Applicability to the NMR Watershed

Improving maintenance for drainage structures is directly applicable to the NMR watershed. There are dozens of catch basins within the City of Pittsburgh portion of the watershed, and hundreds of storm inlets within the watershed areas that are served by separate storm drain systems. Clogged storm drains are not only ineffective at collecting storm water runoff, but may even act as a source of sediments and pollutants to streams. Many of the storm drains within the NMR watershed are clogged thus limiting the storage available to catch sediment.

Effectiveness

What is known about the effectiveness of more frequent cleaning of storm drains is limited to a few studies. These studies found that trapped sediments found in storm drains were highly enriched with trace metals and petroleum hydrocarbons. Residential storm drains were found to have the lowest sediment metal concentrations, but exhibited the highest concentrations of petroleum hydrocarbons. Commercial sites (mall and vehicle maintenance operations) were comparable to industrial sites, with the exception of zinc, which was higher in commercial areas.

The same studies found that the maximum annual sediment volume could be removed by monthly cleanouts (three to five cubic feet), while quarterly, semi-annual, and annual cleanouts removed about the same amount of material (1.5 to 2.5 cubic feet). For industrial inlets, monthly cleanouts removed nearly six times more sediment than annual cleanouts. A qualitative analysis of the data indicated no seasonal differences between volume of material removed.

Cost

The true pollutant removal cost associated with storm drains is the long-term maintenance cost. An aggressive storm drain cleaning program requires a significant O&M budget. A careful study of cleaning effectiveness should be undertaken before increased cleaning is conducted.

A vactor truck, the most common method of catch basin cleaning, costs between $125,000 and $150,000. This initial cost may be high for individual communities;

however, it may be possible to share a vactor truck with other communities in the watershed. Typical vactor trucks can store between 10 and 15 cubic yards of material, which is enough storage for between three and five catch basins. Assuming semi-annual cleaning, and that the vactor truck could be filled and material disposed of twice in one day, one truck would be sufficient to clean between 750 and 1,000 catch basins during a typical year. Another maintenance cost is the staff time needed to operate the truck. Disposal costs of the sediment captured could be a significant cost factor as well.

Ability to be implemented

All four municipalities within the watershed have existing crews and equipment dedicated to cleaning storm inlets and catch basins. Therefore, it is reasonable to assume that improvements to storm drain maintenance could be implemented within the NMR watershed.

The major limitations to improving storm drain maintenance are the staff time and equipment costs associated with increased cleaning and the possible difficulty in finding environmentally acceptable disposal methods for removed sediment and debris. The key to successfully implementing a successful storm drain maintenance program is to quantify the additional solids removed from storm drains and compare the removal benefits of more frequent cleanouts with the corresponding increase in municipal costs and staffing. Based upon the amount of observed clogged storm drains within the NMR watershed, it is recommended that additional cleaning frequency be implemented to achieve maximum pollutant removal.

6.3.4 Sewer Inspection and Cleaning Program

Sewer lines deteriorate over time as solids build up in the system and pipes deteriorate or become corroded. Regular cleaning removes resistance to flow and thus optimizes the hydraulic performance of the system. Frequent inspections provide up-to-date information on the condition of a sewer system as a whole. Routine inspections allow for identification of deteriorated manholes and pipes, structural problems, and defects; as well as field verification as to what is in the system.

Alternatives

- Implement a regularly scheduled sewer cleaning program to remove accumulation of sediment and debris blockages in the NMR sewer system

Hydraulic conditions can deteriorate over time as solids build up in the system and pipes become corroded. Dirty sewers are less efficient and lose their carrying capacity. Routine sewer cleaning removes obstructions to flow, such as accumulated sand, slime, grit, grease, roots, and mineral deposits from sewers.

- Implement a routine sewer line and manhole inspection program within the NMR watershed

In addition to routine cleaning, sewers need routine manhole and internal visual inspections. Routine inspections provide access for making observations, testing, cleaning, rehabilitating, and maintenance operations. Regular inspections generate repair work orders, which in turn have a positive impact on system performance.

For a more complete description of these alternative sewer inspection and cleaning measure, please refer to Section 4.3.3 of this watershed management report.

Applicability to the NMR Watershed

Implementing a routine sewer cleaning program within the NMR watershed is highly applicable to the watershed. Television inspections of the NMR sewer lines were conducted to video record the conditions of the sewer pipes. The findings of these video inspections revealed segments of pipe with root intrusions, mineral deposits, and heavy debris. Scheduled cleaning of these problematic pipe segments can improve the performance of the existing sewers to adequately convey wastewater flows.

Implementing a routine manhole and sewer inspection program, utilizing either visual or televising inspection techniques, is applicable as well. A proactive inspection program can be an important tool to help focus maintenance and rehabilitation efforts in the NMR watershed where they are needed most. Frequent inspections allow for assessment of current manhole and pipeline conditions and are an important tool in determining cleaning, rehabilitation, and maintenance efforts.

Effectiveness

A proactively implemented sewer inspection and cleaning program can be highly effective in keeping all portions of the sewage collection system clean and unobstructed. Sewer inspection and cleaning are effective in optimizing the conveyance capacity of the existing network of sewer pipes. Quantifying the effectiveness of a routine sewer cleaning program involves accessing the hydraulic capacities of the sewer lines before and after they are cleaned. The degree of effectiveness will vary substantially with individual system characteristics.

Quantifying the amount of debris and sediment removed from a sewer line and comparing it to the frequency and cost of removing the debris can determine the optimal frequency in which a line should be cleaned. Closed-circuit video inspection (CCTV) can be an important tool in determining the most effective sewer line cleaning frequencies by pinpointing root intrusions and documenting the rate of sediment accumulation.

Cost

A number of factors must be considered when determining the cost of a routine sewer cleaning program. The frequency in which the sewer lines are cleaned is one cost consideration. Problem sewers with minimal slopes require more frequent cleaning than sewers with adequate slopes and low coefficients of friction. Another cost factor that needs to be considered are the length and diameters of the pipe segments to be cleaned. Costs to clean longer pipe segments with larger diameters will be higher. A third factor that needs to be taken into consideration is the sewer line cleaning method used. Jetting, flushing, and rodding are all different line cleaning techniques that have different price tags attached to them. Another factor that needs to be considered is the amount of sediment and debris in the sewer line and the cost to remove the trapped debris with a vactor truck.

Typically, cleaning a relatively clean 8" trunk sewer costs only one to two dollars per linear foot of pipe. However, a grit-filled interceptor line that has been neglected for years may cost between $30 and $40 per linear foot to clean or even higher – depending on the size of the interceptor and the amount of debris. These sewer cleaning estimates take into consideration the equipment and labor needed to conduct the cleaning, the cost to remove the solids from the sewer system, and costs for proper disposal. Again, the costs will vary depending on the factors described in the previous paragraph.

Televising can be an expensive inspection technique costing about $2 per linear foot, plus the cost of cleaning that can add at least another $1 per foot. While televising rigs can be purchased for about $100K, most municipalities find that it is more cost effective to hire a local sewer service company when this work is needed, or to pool resources with adjacent communities.

Manhole defects are readily apparent upon visual inspection. Sewer lines can be visually inspected through the manhole, by either lamping the lines and looking up them while in the manhole, or by using a remote halogen light and mirror while standing above the manhole. Costs associated with visual manhole and sewer line inspections are almost exclusively dependant upon labor and will vary depending on the size and skill of the inspection crews, and how proactive the inspection efforts are.

Ability to be implemented

Existing crews and equipment have already been provided for inspecting and cleaning sewers. It is therefore reasonable to expect that regularly scheduled sewer cleaning could and should be implemented in the NMR watershed. Historically, scheduled operations and maintenance of the sewers within the NMR watershed has been infrequent. Manholes have become inaccessible from overburden growth, and interior cleaning has not been routinely performed. As a result, obvious opportunities exist to improve upon the existing sewer cleaning programs within the watershed.

Municipalities should identify problem sewers with minimal slopes and clean them has often as necessary to prevent stoppages. In addition, critically important collector sewers should be identified and cleaned as often as possible to prevent the possibility of blockages. An evaluation of how often the sewers should be cleaned is important as sewer cleaning needs are not the same for every pipe.

The Pittsburgh Water and Sewer Authority (PWSA) and each of the three other watershed municipalities entered into a Consent Agreement and Order with the Pennsylvania Department of Environmental Protection (PA-DEP) requiring that certain investigations and studies be undertaken for sewer systems located within the NMR sewershed. The legal action taken by PA-DEP should significantly increase the certainty that regularly scheduled inspection and cleaning of watershed sewer systems are implemented. However, on-going televising and sewer inspection are also necessary to provide up-to-date information on the condition of the sewer system as it deteriorates over time.

The keys to a successful O&M program are dependent upon the organizations and people responsible for the O&M programs, the resources allocated to the O&M activities, procedures and schedules for routine maintenance, procurement procedures for responding to emergency situations, and policies and procedures for training O&M personnel. It is important to note that the need for an effective O&M program is not limited to PWSA who is responsible for the NMR combined sewers.

6.3.5 Pet Waste Ordinances

Waste from pets can be a significant a non-point pollution source. Pet waste provides three primary pollutants: nutrients, organic matter, and pathogens. Bacteria levels in storm water have been found to be higher in residential areas than industrial or commercial zones. The same can be said about the nutrients nitrogen and phosphorus. A possible cause for this may be the high occurrence of pets within residential areas. In addition, pets are frequently walked on trails and parklands that are in floodplain recreation areas, thus increasing the risk of pet waste reaching stream water. As discussed in Sections 4.2.6 and 6.2.5 of this plan, public education an important tool in addressing this issue. However, to reduce pet waste problems, ordinances may need to be passed and enforced, requiring that pet owners pick up after their animals and properly dispose of the material.

Alternatives

- Pass pet waste ordinances to require pet waste cleanup within the NMR watershed

Controlling pet waste typically involves the use of “pooper-scooper” ordinances to regulate pet waste cleanup. These ordinances require the removal and proper disposal of pet waste from public areas and other people’s property before the dog

owner leaves the immediate area. A fine is often associated with failure to perform this act as a way to encourage compliance.

Section 4.3.6 of this watershed management plan provides a more complete and detailed description of how past waste ordinances would be used to improve water quality in the NMR watershed.

Applicability to the NMR Watershed

Passing pet waste ordinances to reduce the impact of animal waste in storm water runoff within the NMR watershed is clearly applicable to the NMR watershed. Communities within the NMR watershed have already begun taking measures toward educating residents on the importance of pet waste removal with signs in public parks and along residential streets. However, enforcement of proper pet waste management through ordinances may be a more effective measure to minimize the adverse impacts from pet waste on stream water quality.

Effectiveness

The effectiveness of pet waste ordinances on improving water quality in streams is difficult to quantify. Based on several surveys, it was estimated in Section 6.2.5 that there are approximately 3,700 dogs within the NMR watershed and that each dog generates approximately 0.44 lbs of waste per day. A dog owner, however, is not always a dog walker. It has been estimated that just about one half of dog owners actually walk their dogs. In reality, only dog owners who actually walk their dogs on residential streets and parklands can be targeted to enforce clean up after their dogs. According to the Chesapeake Bay survey, 40 percent of dog owners admitted to not picking up after their dog and 44 percent of the dog owners who do not pick up indicated they would still refuse to pick up even if confronted by neighbors, threatened with fines, or provided with more convenient options for disposing of dog waste. Assuming the same reluctance toward dog waste pickup within the NMR watershed, approximately 740 dog owners who walk their dogs do not pickup after them and 326 will never change their behavior toward dog waste pickup. This would indicate a targeted outreach population of approximately 407 dog owners for enforcement through ordinances.

Table 6.3.2 provides estimated potential reductions in animal waste based upon realistic percentages of the estimated outreach population that would change their behavior toward pet waste cleanup through enforcement of ordinances.

Table 6.3.2: Estimated Animal Waste Reductions through Pet Waste Ordinances

	10%Change Behavior	15%Change Behavior	20% Change Behavior
Number of Dog Owners Now Willing to Change and Pick up Wastes	41	61	81
Reduction in Annual Dog Waste (lbs)	6,585	9,797	13,009

Cost

The cost of animal waste collection enforcement will vary depending on the intensity of the effort and the paths chosen to control pet waste. Passing an ordinance to regulate pet waste cleanup carries with it virtually no cost. It is enforcement that adds cost. Municipal managers must consider the cost of enforcement, including equipment and staff requirements. To effectively enforce proper pet waste cleanup, proper disposal of pet waste from public areas and other people's property would need to be patrolled. A designated municipal employee would need to routinely patrol dog walking areas, enforcing proper pet waste management and perhaps issuing fines to individuals who fail to comply. An estimated cost associated with patrolling dog walking areas could be costly when considering the employees salary and benefits, vehicle costs, and administrative costs to process fines. Collected fines partially would offset the cost.

Ability to be implemented

The majority of dog owners agree that dog waste can be a water quality problem (Hardwick, 1997; Swann, 1999). However, the reluctance of many residents to handle dog waste is the biggest limitation. Nevertheless, passing ordinances to regulate pet waste cleanup is likely to provide improved results in public areas.

To have a full-time municipal employee patrol dog walking areas may not be the most effective approach toward enforcing proper pet waste management considering the cost associated with the enforcement (>$40,000 per year when considering labor and equipment). In addition, only an estimated 11% of the dog population would be targeted for enforcement.

Many of the municipalities within the NMR watershed have already posted signs along residential streets and parklands encouraging proper pet waste cleanup. A recommended approach may be continue posting signs in areas that are not already marked and include on these signs the threat of a fine if dog owners do not comply. Signs in public parks enforcing that dogs remain on a leash and the provision of receptacles for pet waste may also encourage cleanup.

6.3.6 Household Hazardous Waste Collection

Improperly disposed household hazardous waste (HHW) can and does affect both surface water and groundwater quality. Leaking of, spillage from, and improperly disposed hazardous materials can enter sewers and degrade water quality of receiving streams. As such, HHW collection can be expected to reduce the presence of toxic materials and heavy metals in storm water runoff.

Alternatives

- Implement a municipal HHW collection program to collect and properly dispose of HHW products

HHW programs can ensure that HHW is recycled or, otherwise managed in an environmentally preferable way. These programs provide sites for residents to drop of their HHW. The materials can then be reused, recycled, and, when necessary, disposed of at a permitted hazardous waste facility.

For a more complete description of alternate HHW control programs and how they could be applied to the NMR watershed, please refer to Section 4.3.7 of this watershed management plan.

Applicability to the NMR Watershed

HHW are those wastes produced in households that are hazardous in nature. Each person in Pennsylvania, and in the NMR watershed, is estimated to produce an average of four pounds of HHW each year. Such wastes, if carelessly managed can, and frequently do, create environmental and public health hazards. Therefore, implementing municipal HHW collection programs is clearly applicable to the NMR watershed.

Effectiveness

While it is generally recognized that the potential exists for hazardous household materials to come in contact with storm water runoff, it is unclear at present how significant this source of contamination is. As such, it is difficult to quantify the benefits to water quality from a HHW collection program. However, HHW collection is a preventative, rather than a curative measure, and may reduce the need for more elaborate treatment controls.

Various studies have been undertaken to categorize the quantity and quality of HHW in the municipal solid waste stream. These studies indicate that 0.5% to 2.0% of the total municipal solid waste stream is HHW, the number typically used is 1% of the total municipal solid waste stream. Although the percentage of these materials is small, the large volume of solid waste generated daily indicates that a substantial amount of HHW is generated. The benefits to storm water quality from HHW

collection is unknown at present, but best engineering judgement indicates a potential of up to 15 percent.

Numerous examples of effective HHW programs exist throughout the United States. For example, one of the oldest (1998) and most convenient permanent collection centers is located in San Francisco, CA. In a single year, more than 8,800 residents brought over 123,000 containers containing more than 56,000 gallons of hazardous waste to the facility. Over 60% of the waste was recycled, about 25% burned as fuel, 10% incinerated, 2% neutralized, and less than 2% sent to a landfill.

Cost

HHW collection programs can be expensive. The major costs associated with these programs will be for contracted services involving the classification, packing, transportation, and management of the collected hazardous waste materials. Generally costs average 30 to 80 cents per pound of hazardous waste but may run as high as $1.00 per pound. In addition, staffing requirements will include at least one specifically trained hazardous waste professional, a full-time administrator, and trained personnel for sorting and packaging.

In-kind services, donations of material, equipment and labor from businesses, and government and community groups can all reduce program costs. In addition, discount rates on supplies and disposal fees can be provided by waste haulers and disposal companies to community collection programs. Recycling waste oil by giving it to a service station or selling it directly to a commercial recycler can reduce disposal costs and potentially generate some revenue.

Ability to be implemented

HHW programs are similar to recycling programs in that there are a number of alternatives available for material collection. In fact, HHW programs typically employ a variety of collection methods. Permanent or periodic collection centers are the most common but mobile collection centers and even curbside collection are used. Naturally, there are advantages and disadvantages with implementing each program.

Within the NMR watershed, the key considerations are determining the right HHW program for each municipality and sources of program financing to implement the programs. As a result, a pilot program should be used to determine what program (permanent, mobile, curbside, etc.) is right for the watershed municipalities. This will also allow for determination of what wastes will be accepted, what wastes will be excluded, and the quantities of waste that will be accepted. A pilot program will also allow for determination of the optimal time(s) of the year HHW programs should be held. For example, scheduling programs in spring or late summer/fall can take into account “spring cleaning” by homeowners and end of summer cleaning.

Program funding is another important consideration when implementing a HHW collection program due to the high costs associated with them. Sources of program financing should be explored through the following mechanisms:

- Grants – Act 190 of 1996 provides grants to reimburse up to 50 percent of the costs of developing and operating household and small business HHW collection programs

- Service charges – either using existing service charges such as utility bills if a reserve fund has been accumulated or by an increase in utility bills such as refuse collection or sewer bills

- User fees – most HHW collection programs are free of charge to participants; however a fee schedule can be developed for excess quantities per household or for households outside of the service area

6.3.7 Pest Control - Control Pesticides and Herbicides Used on Public Land

The presence of pesticides and herbicides in storm water runoff has a direct impact on the health of aquatic organisms and can present a potential threat to humans through contamination of surface water and drinking water supplies. The pesticides of greatest concern are insecticides, such as diazinon and chloropyrifos, (CWP, 1999 and Schueler, 1995) that can be harmful to aquatic life even at very low levels. The major sources of pesticides in urban streams are applications of products designed to kill insects and weeds in the lawn and garden.

For a more complete description of pest control management measures, please refer to Section 4.3.8 of this watershed management plan.

Alternatives

- Implement the use of integrated pest management (IPM) as a way to introduce alternatives to chemical pesticides and herbicides used on public lands

IPM reflects a holistic approach to pest control with the goal not to eliminate pests but to manage them to an acceptable level while avoiding disruptions to the environment. An effective IPM program incorporates practices in combination with non-chemical and chemical pest controls to minimize the use of pesticides and promote natural control of pest species.

Applicability to the NMR Watershed

Implementing IPM practices as a municipal management measure would only be applicable to public lands such as parks, municipal buildings, and schools. There would be no applicability to private residences and businesses. The parks and public

areas in NMR tend to be located near surrounding streams causing the potential for pest control pollutants to enter the stream to be great. The IPM practices can be enforced for municipal parklands and schools to limit pollutants washed off the ground during storm events.

Effectiveness

The Grounds Maintenance Program for the City of Eugene, Oregon provides a good example of successful use of IPM as a management measure. This program was started in the early 1980's and includes all the city public parks and recreation areas. The city uses a variety of IPM methods, including water blasting to remove aphids, insecticidal soaps and limited use of pesticides. The city has also adopted higher tolerance levels for certain weed and pest species that reduces the need to apply pesticides and herbicides. Since the programs inception, pesticide usage by the City of Eugene has dropped by more than 75% (Lehner *et al*., 1999). No exact cost savings have been calculated from the use of the IPM program, but the city turf and grounds supervisor is convinced that it saves money and has little citizen opposition.

Cost

The cost of educating parkland grounds supervisors on proper pesticide use varies greatly depending on the intensity of the effort. Like lawn care and landscaping programs, some cities have begun partnerships that include training of retail employees and parkland supervisors on IPM techniques. In addition, promotional materials and displays on safer pesticide alternatives are set up. The cost of staff time for training and production of materials must be included in any cost estimate.

Since there are currently a number of good fact sheets on IPM and pesticide use available through cooperative extension programs, the NMR watershed management plan should consider using these existing resources instead of trying to create new ones. Another way to save cost would be to utilize master gardener volunteers to help with training, for residents, parkland supervisors, and store employees.

Ability to be implemented

Any municipal ordinance regulating the use of products designed to kill insects and weeds in the lawn and garden cannot be enforced on private property. However, control over the use of these products can be regulated in public areas under municipal maintenance (e.g. parks and schools). It is reasonable to assume that IPM technologies can be implemented for public properties.

6.3.8 Bridge and Roadway Maintenance

There are a number of pathways for pollutant deposition on roadways and bridges that can influence the water quality of storm water runoff. Substantial amounts of sediments and pollutants are generated during daily roadway and bridge use and scheduled repair operations, and these pollutants can impact local water quality by contributing heavy metals, hydrocarbons, sediment and debris to storm water runoff.

The use of road salt is a public safety as well as a water quality issue. Aside from contaminating surface and groundwater, high levels of sodium chloride from road salt can kill roadside vegetation, impair aquatic ecosystems, and corrode infrastructure such as bridges, roads, and storm water management devices.

Alternatives

- Incorporate pollution protection techniques to reduce or eliminate pollutant loads from existing road surfaces within the NMR watershed as part of routine operations and maintenance

A number of pollution prevention techniques are available to reduce the level of pollutants generated from road surfaces. Routine performance of general maintenance activities such as sweeping, vegetation maintenance, and cleaning of runoff control structures can help alleviate the impacts of pollutant loads. Modifications in roadway resurfacing practices can also help reduce pollutant loads to storm water runoff and protect the quality of receiving waters.

- Train municipal employees in proper deicing application techniques, the timing of deicer application, and the type of deicer to apply

Municipal employees can be trained on the proper storage, the handling, and application practices of de-icing materials. In addition, municipal officials and employees can explore the use of alternative de-icing materials to road salt such as calcium magnesium acetate (CMA) and urea.

For detailed information on alternate management practices and deicing materials, please refer to Section 4.3.9 of this watershed management plan.

Applicability to the NMR Watershed

Municipal public works departments within the NMR watershed routinely participate in general road and bridge maintenance activities. Street sweeping, vegetation controls, and roadway resurfacing among others are commonly practiced. As a result, numerous opportunities exist to reduce pollutants generated from road surfaces during these practices making this alternative applicable for implementation within the watershed.

During certain days of the year, the waters of the NMR stream contain significant concentrations of sodium chloride, which can be attributed to de-icing salts. As a result, changes in proper deicing application techniques, the timing of deicer application, and the types of deicers to apply is highly applicable to the NMR watershed. Proper application of road salt or other deicers is essential for reducing storm water pollution.

Effectiveness

There is limited data available on the actual effectiveness of road and bridge maintenance practices at removing pollutants from storm water runoff. Table 4.3.8 in Section 4 examined the effectiveness and cost of some of the operation and maintenance practices recommended for storm water pollution control. It can be assumed that the recommended roadway management practices will have a positive impact on storm water quality by working to reduce pollutant loads and the quantity of runoff. Protecting and restoring roadside vegetation, removal of debris and sediment from roads and bridges, and directing runoff to vegetated areas are all effective ways to manage storm water runoff.

It is also difficult to determine the effectiveness resulting in changes in the application of road salt or other deicers. Improvements in reducing pollutants loads can be seen by reducing the use of de-icing compounds, better equipment calibration, and more careful application. However, quantifying the effectiveness of these practices is difficult.

The use of alternative de-icing materials may reduce the environmental and corrosive effects of deicers but may have less de-icing ability and cost more. The cost, de-icing ability, and environmental effects associated with the various alternative de-icing materials each need to be considered to determine the overall effectiveness of each of the de-icing agents available.

Cost

The maintenance of local roads and bridges is already a consideration of most community public works or transportation departments. Therefore, the cost of pollutant reducing management practices will involve the training and equipment required to implement these new practices. Costs associated with select maintenance management practices were shown in Table 4.3.8.

One area where costs can vary greatly is in the type of deicer selected for application. Table 4.3.7 in Section 4 included a comparison in the costs of various alternative de-icing materials and the cost for application. The material cost per ton can range anywhere from $5 per ton for sand to $650-$675 per ton for Calcium Magnesium Acetate (CMA).

Ability to be implemented

Roadway and bridge maintenance may be one of the easier pollution control measures to implement. Limitations to instituting pollution prevention practices for road and bridge maintenance involve the cost for additional equipment and training. Since the maintenance of roadways and bridges is already required in communities, staffing is usually already in place and alteration of current practices should not require additional staffing or administrative labor.

Encouraging reduction in the use of de-icing compounds may be more challenging to implement within the NMR watershed. Many of the roadways within the watershed are hilly and any significant reduction in the application of deicing materials may potentially compromise public safety. In addition, the use of alternative de-icing materials may not be an effective option to implement within the NMR watershed. Road salt has traditionally been the most attractive de-icing agent because of its high de-icing ability, utility at low temperatures, and low cost. Although many alternative de-icing materials exist, road salt should probably remain the de-icing material of choice because of the recent improved design and material modifications of road salt, the familiarity that municipal employees have with applying road salt, and the higher de-icing ability that road salt has over many of the alternatives

However, realistic opportunities do exist to educate municipal employees on better equipment calibration and more careful application of the deicing materials. Training municipal employees on proper de-icing application, the timing of deicer application, and the routine calibration of spreaders present viable, cost-effective options to alleviate impacts to water quality and aquatic habitat.

6.3.9 Vegetation Controls

Clippings and cuttings are the primary waste produced by mowing and trimming. Clippings and cuttings carried into the storm water system and receiving streams can degrade water quality in a variety ways. A related problem exists with the illegal dumping of clippings and cuttings in or near drainage facilities. Once vegetative waste is generated, the main concern is to avoid transport of clippings and cuttings to receiving water bodies.

Alternatives

- Incorporate mechanical vegetation controls to actively manage and control vegetation within the NMR watershed as part of routine operations and maintenance for public works crews

Municipal operators can be trained to use good judgment in determining whether clippings and cuttings should be collected or left in place. Also, operators can be

trained to perform mowing at optimal times. Also, the use of mulching mowers can be recommended for certain areas.

Applicability to the NMR Watershed

Implementing vegetation controls for public works (park maintenance) crews is applicable to the NMR watershed. The cutting of municipal parklands and roadside vegetation is a common practice among the municipalities within the watershed. As a result, numerous opportunities exist to implement proper vegetation controls in these areas.

Effectiveness

The effectiveness of vegetation controls as a practice at removing pollutants is difficult to quantify. The effectiveness is dependant upon the amount of vegetative waste generated and, more importantly, the amount of vegetative waste that does not enter receiving water bodies as a result of proper vegetation controls. Discouraging the dumping of clippings and cuttings down a nearby ravine or on the slope of a creek will reduce the amount of organic matter that can potentially enter a storm water collection system. In addition, using bagging equipment or manually picking up material can reduce the presence of clippings and cuttings in and around catch basins. Clippings and cuttings are almost exclusively leaf and woody material but litter may be intermingled with clippings. Any reduction of clippings and cuttings carried into the storm water system or receiving streams can reduce the degradation of water quality.

Cost

Vegetation control measures are relatively simple and inexpensive. A small cost will be associated with the training of municipal employees on proper vegetation control. Another potential cost may include the upgrading of certain mowing equipment for bagging. Another third potential cost is for additional laborers involved in hand cutting, raking, and picking up clippings where mechanical cutting and collecting is not practical. The magnitude of each of these costs is dependant upon the current vegetation controls used by municipal employees, the mowing equipment that is currently available, and the level of effort desired to upgrade existing vegetation controls.

Ability to be implemented

Vegetation controls may be one of the easiest pollution control measures to implement. Limitations to instituting pollution prevention practices for vegetation controls really only involve the cost for additional training, and possibly equipment upgrades. Since municipal parkland and roadside vegetation is routinely cared for anyway, staffing is usually already in place and alteration of current practices should

not require additional staffing or administrative labor. Implementing proper vegetation controls could even be taken one step further and encouraged at schools and cemeteries by educating the grounds crews at these facilities.

Table 6.3.3: Screening Summary of Non-Structural Municipal Measures

Control Measure	Applicabilty to the NMR Watershed	Effectiveness at Meeting Watershed Goals	Cost to Implement	Ability to be Implemented	Recommendation
Implement proactive inspection, operation, and maintenance programs for the CSO regulator structures located within the NMR watershed	High	High	Low	High	Recommended to Implement
Improve the existing maintenance of catch basins and storm inlets within the NMR watershed communities	High	High	Medium	Medium	Recommended to Implement
Implement a regularly scheduled sewer cleaning program to remove accumulated sediment and debris from NMR sewers	High	High	Medium	High	Recommended to Implement
Implement a proactive sewer line and manhole inspection program within the NMR watershed	High	Medium	Medium	High	Recommended to Implement
Implement a household hazardous waste (HHW) collection program to collect and properly dispose of HHW products	High	High	Medium	Medium	Recommended to Implement
Implement the use of integrated pest management (IPM) as a way to introduce alternatives to chemical pesticides and herbicides on public lands	High	Medium	Low	High	Recommended to Implement
Train municipal employees in improved deicing application techniques, the timing of deicer application, an the type of deicer to apply	High	High	Medium	High	Recommended to Implement

Table 6.3.3: Screening Summary of Non-Structural Municipal Measures

Control Measure	Applicabilty to the NMR Watershed	Effectiveness at Meeting Watershed Goals	Cost to Implement	Ability to be Implemented	Recommendation
Disconnect selected roof leaders and pavemenrt from the combined sewer system and direct runoff to flat vegetated areas	Medium	Medium	Medium	Medium	Consider Implementing
Pass and enforce pet waste ordinances to regulate pet waste cleanup within the NMR watershed	High	Medium	Low	Medium	Consider Implementing
Improve upon the frequency and location of street sweeping within each communitiy's current street sweeping programs	High	Medium	Medium	High	Consider Implementing
Incorporate pollution protection techniques to reduce pollutant loads from existing road surfaces as part of routine operations and maintenance procedures	Mdeium	Low	Low	Medium	Consider Implementing
Incorporate mechanical vegetation controls to actively manage and control vegetation as part of routine operations and maintenance for public works crews	Medium	Low	Medium	Medium	Consider Implementing
Purchase the most sophisticated sweeper technologies available to improve performance in removing particulate matter from roadways	Low	Medium	High	Low	Not Recommended to Implement

6.4 Screening of Alternative Structural Controls

Alternative structural control measures, often referred to as treatment controls, are physical structures designed or modified to remove pollutants from storm water runoff, reduce downstream erosion, provide flood control, and promote groundwater recharge. In contrast with non-structural control measures, structural measures typically involve complex engineering design and construction to implement.

Structural control measures evaluated in this section include:

- Source Control Measures
- Remedial Measures for Existing Municipal Infrastructures
- New Regional Facilities
- Stream Erosion and Velocity Controls

6.4.1 Source Control Measures

Source control measures are intended to eliminate urban pollutant sources before they find their way into storm water runoff. These techniques attempt to reduce the exposure of materials to storm water, thus limiting the amount of pollutants picked up by the water. Many of these practices are non-structural alternatives such as maintenance procedures and educational programs and were evaluated earlier in this section. However, the design or redesign of structures to reduce the amounts of pollutants entering storm water and accumulating on impervious areas may be necessary. These structural alternatives often involve reducing the amount of impervious surface on a site, thus reducing the peak flow and volume of storm water runoff.

Alternatives

- Implement an aggressive program to locate and remove illicit sewage and industrial discharges to municipal storm drain systems

Non-storm water discharges to the storm water collection system may include process wastewaters, cooling waters, wash waters, and sanitary wastewater among others. These discharges to municipal storm drain systems are not only illegal but can result in significant pollutant concentrations that impair receiving water quality.

- Reduce the quantity of pavement within public parking areas, within residential properties, and within street rights-of-way

Whenever an existing parking area is scheduled to be repaved, business owners should look for opportunities to reduce the number of parking spaces, eliminate

unnecessary pavement in non-traffic areas, and convert these areas to vegetated landscape islands. Homeowners should look for opportunities to narrow driveway widths and eliminate unnecessary paved areas.

- Encourage the use of alternative porous pavement methods in lieu of traditional asphalt and concrete within public parking areas and within residential lots

Permeable pavements can be used to reduce the imperviousness created by patios, walkways, driveways, sidewalks, and parking areas. These alternative paving systems can reduce surface runoff, increase infiltration, and improve groundwater recharge characteristics.

- Encourage the construction of rooftop gardens over existing public and private buildings

Constructing rooftop gardens over private and public buildings can be an effective structural management measure to reduce urban runoff and its associated pollutants to the watershed.

- Encourage the construction of tanks or cisterns for existing residential, commercial, and public buildings to capture and store runoff and irrigate vegetated areas.

An effective way to mitigate the impacts of urban runoff is to manage rooftop runoff on site instead of moving it through a conveyance system. Capturing rooftop runoff in tanks of cisterns for irrigation can be an effective alternative for reducing storm water runoff volumes.

For a more complete description of each of these structural management measures and how they can be used to reduce runoff and pollutant loads to NMR streams, please refer to Section 5.1 of this watershed management plan.

Applicability to the NMR Watershed

Field investigations and laboratory analyses have confirmed that there are illicit connections to municipal storm drains in the NMR watershed. By law, it is required that these illicit connections be identified and removed from the storm drainage system. As a result, implementing a program to locate and remove these illicit connections is clearly applicable to the NMR watershed.

There are numerous existing pavement areas that are deteriorated and will need top be replaced in the near future. With each of these pavement restoration projects, opportunities exist to eliminate unnecessary pavement areas and replace them with vegetated landscape areas.

Encouraging the use of alternative porous pavement methods in lieu of traditional asphalt and concrete for new development projects within the NMR watershed is not readily applicable since a large portion of the watershed has already been developed. However, the existing paved surfaces within the watershed (patios, driveways, parking areas, etc.) already have or will deteriorate and will need to be replaced. Therefore, opportunities exist to encourage the use of porous pavements during future resurfacing projects conducted within the watershed.

Theoretically, constructing rooftop gardens over existing public and private buildings in the NMR watershed appears to be an effective alternative to mitigate the impacts of urban runoff by managing rooftop runoff on-site instead of moving it through a conveyance system. However, there are a number of constraints that limit the implementation of this alternative. Many of the existing homes within the watershed have steeply sloped rooftops and are not eligible for the construction of a rooftop garden. In addition, the majority of the existing homes and buildings in the watershed are older and may not have the structural capacity for the additional structural loading of a rooftop garden. Therefore, this alternative is not applicable to the NMR watershed.

Rainwater harvesting – capturing and storing rainwater for later use – is an alternative control measure that is applicable to the NMR watershed. The harvested rainwater can be used for irrigation purposes or many other applications. The limiting factor toward implementing structural management measures, such as tanks and cisterns, may be the cost. Non-structural alternatives, such as installing rain barrels to existing downspouts, may be a more realistic alternative and applicable for the NMR watershed.

Effectiveness

An aggressively enforced illicit discharge program could be effective at removing illegal pollutant discharges from municipal storm drain systems. Aggressive inspection is the key component of this program. The more illicit connections that are identified and removed, the greater the reduction in illegal pollutant discharges to storm water. Every reduction in non-storm water discharges to a storm water conveyance system has a beneficial impact on water quality.

Eliminating unnecessary pavement areas and replacing them with vegetated landscape islands can be effective at reducing the quantity of urban runoff generated within the NMR watershed. Directing pavement runoff to flat vegetated areas where rain water can percolate into the soil and pollutants can be filtered, can further increase the effectiveness of this structural management measure.

Porous pavement itself functions less as a treatment and more as a conveyance practice to the other necessary component of the design, the underlying aggregate chamber, which functions as an infiltration device. As with other infiltration devices,

treatment is provided by adsorption, filtration, and microbial decomposition in the sub-soil surrounding the aggregate chamber, as well as by particulate filtration within the chamber. Operating systems have been shown to have high removal rates for sediment, nutrients, organic matter, and trace metals (Schueler *et al*., 1992).

The effectiveness of rooftop gardens has been seen throughout the world. Dust and air-borne particles have shown to be reduced since plants act as natural filters. Oxygen levels in the air have shown to increase. In addition, rooftops gardens have revealed decreased loads on storm drains and combined sewer systems since the roof is retaining storm water runoff. However, this management alternative would be ineffective within the NMR watershed because most of the existing roofs are structurally incompatible with rooftop gardening.

Rainfall harvesting technology has proven to be very effective throughout the United States and would be effective within the NMR watershed as well. Tanks and cisterns are an effective means of capturing and storing the runoff from roofs and driveways during storm events. Tanks and cisterns are capable of providing a sufficient water supply for most domestic landscaping irrigation applications. In addition, the use of rainwater has proven to be effective in lessening the demand on the public water supply system.

Cost

Cost considerations associated with illicit connection detection and removal involves program initialization costs for procuring necessary equipment and training, the labor effort needed to locate illicit connections, and the cost for disconnection. Illegal connection location can be very labor and equipment intensive. Comprehensive inspection and removal programs can cost many thousands of dollars. Exploration of equipment sharing among the NMR watershed municipalities is one alternative to reduce program costs. Including public participation in identifying illicit connections should be considered as a cost reduction alternative as well. By asking citizens and other agencies, such as the fire and water departments, to be on the lookout for dry weather storm water discharges and illicit connections, inspections can be increased at little additional cost. Citizens can be educated through utility bill stuffers, pamphlets, news articles, and public presentations.

Costs associated with removing unnecessary pavement are generally low. Pavement restoration and / or reconstruction is priced by the area of deteriorated pavement. The additional cost of removing unnecessary pavement areas and converting them to landscaping islands is often offset by the reduced pavement area.

Costs associated with alternative porous pavements, can be highly variable from site to site. Because of this variability, cost estimates for these devices have been widely different as shown in Table 6.4.1 below.

These estimates can be used in the NMR watershed to provide cost estimates for the re-paving of surfaces using porous pavements. For example, assuming a typical alleyway driveway is 9 feet by 5 feet, the cost to replace the deteriorated driveway with a porous pavement system would range from $50 to $85. Similarly, assuming a typical front yard driveway is 9 feet by 30 feet, the cost would range from $300 to $500. Some alternative paving materials can be more costly than conventional paving materials but most are quite comparable.

Table 6.4.1: Cost Estimates for Porous Pavements

Cost Estimate	Source
$50,000 per acre of porous pavement	SWRPC, 1991
$80,000 per acre of porous pavement	Schueler, 1987

It is important to note that the most cost effective approach toward porous pavements is not for the immediate replacement of all paved surfaces within the watershed with permeable pavements. This would not be feasible or cost effective. The idea is to encourage the use of porous pavements when existing pavements have deteriorated and need to be replaced. In many cases, costs will be reduced if the paved surface area also can be reduced. Opportunities to reduce the amount of impervious cover should always be evaluated for any re-paving project to reduce costs.

There is a wide range of costs associated with constructing rooftop gardens and these vary from site to site. There are a number of issues that need to be considered when estimating the cost for the design and construction of rooftop gardens. The size of the rooftop, the existing structural carrying capacity of the rooftop, and the quantity and type of vegetation to be included in the garden as well as many other issues need to be addressed. Cost would be prohibitive in the NMR watershed because most of the roofs are structurally incompatible with roof top gardening.

Storage tanks for irrigation are constructed of a variety of materials, including steel drums, large polyethylene plastic tanks, and underground concrete cisterns. The cost of this management measure varies considerably depending on location, type of materials used, and degree of implementation. Construction costs for underground cisterns can vary significantly, based on the size, the amount of excavation required, and the type of soil. The cost of an 8,000-gallon cistern is typically around $900 to $1,000, depending on the material used.

Ability to be implemented

Illicit connections need to be removed promptly because of the risk of untreated sewage draining to a natural water way. It is required by law to identify and remove these connections from the municipal storm drainage system. Identification of illicit connections typically can be performed by either smoke testing or video inspections. Equipment sharing among the NMR watershed municipalities and public participation are two ways that implementation of these programs can be made easier.

Existing paved surfaces within the NMR watershed already have or will deteriorate and will need to be replaced. Roads, sidewalks, driveways, parking areas, and patios all provide opportunities to implement porous pavements during future resurfacing projects. The key element in successfully implementing this alternative management measure is encouraging watershed communities and residents to consider the use of these alternative paving systems when rehabilitating existing paved surfaces. As previously mentioned, this alternative is suggested when existing pavements have deteriorated and need to be replaced. Residents and communities need to be aware of the paving alternatives that are available and the benefits that result from reducing impervious cover.

As previously mentioned, many of the existing homes within the watershed have steeply sloped rooftops and are not eligible for the construction of a rooftop garden. In addition, the majority of the existing homes and buildings in the watershed are older and may not have the structural capacity for the additional structural loading of a rooftop garden. These constraints make the construction of rooftop gardens a difficult alternative to implement.

The construction of a rooftop rainwater catchment system can be relatively simple. Watershed residents can be trained to build one, minimizing its cost. The technology is flexible. This allows lower income households to start with a single small tank or barrel and add more when they can afford to. The key toward implementing this alternative involves educating residents on how and why capturing and storing rainwater is an important storm water management tool.

6.4.2 Remedial Measures for Existing Municipal Infrastructure

Every existing municipal sewage collection and conveyance system is unique, yet all face similar problems. Ageing and deteriorating infrastructure is a typical problem most municipalities must deal with. In many urban watersheds including NMR, there is a linkage between sewage and storm water infrastructure and the social and economic conditions of the watershed communities. Sewer and storm water infrastructure needs to be renewed and the immediate imperative for infrastructure management is to eliminate existing health and water quality hazards resulting from combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs).

Alternatives

- Rehabilitate aging municipal sewage collection systems to significantly reduce extraneous infiltration and inflow and reduce the frequency and duration of existing sanitary sewer overflow discharges

SSO discharges can inflict a variety of human health and environmental risks. Major causes of SSOs extraneous inflow and infiltration that result in include peak flows that exceed system capacity, blockages and obstructions, and structural failure. A number of SSOs can be reduced through improved sewer system management, operation, and maintenance (as was discussed Section 6.3.4). However, structural alternatives, such as sewer rehabilitation and replacement, may be needed to more significantly reduce the frequency and duration of SSO discharges.

- Modify and rehabilitate existing combined sewer systems to reduce the frequency, duration, and volume of CSO discharges into the watershed

CSOs contain pollutants that are present in domestic and industrial wastewaters, as well as those in urban storm water runoff that enter the combined sewer system. In many cases, these discharges have an adverse effect on receiving water quality. Structural control systems and unit processes may need to be considered to reduce the magnitude, frequency, and durations of these CSO discharges.

- Modify existing storm inlets and catch basins without sewer hoods so that street litter and floatable debris is trapped and prevented from discharging into watershed streams

Floatables that enter watershed streams can have a negative impact on water quality and lead to the degradation of the stream. Existing storm inlets and catch basins within the watershed can be modified to trap these floatables and prevent them from discharging into receiving streams.

For more complete and thorough descriptions of these structural measures and how they could be used in the NMR watershed, please refer to Section 5.2 of this plan.

Applicability to the NMR Watershed

For a number of years, the NMR sewer system has experienced problems. The Allegheny County Health Department (ACHD) and the Pennsylvania Department of Environmental Protection (PA-DEP) have documented significant fecal coliform bacteria levels at several locations. As a result, the Pittsburgh Water and Sewer Authority (PWSA) and adjacent municipalities in the watershed were issued Consent Order Agreements by PA-DEP. Integrating structural SSO and CSO reduction controls within the NMR watershed to reduce their effects on receiving water quality is clearly applicable. Examination of alternative structural SSO and CSO control

measures may be necessary where non-structural measures cannot adequately reduce these overflows and improve water quality within the NMR watershed.

There are hundreds of catch basins and storm inlets within the NMR watershed. Most existing storm inlets and any catch basins without sewer hoods allow street litter and other floatable debris to pass through and be conveyed to streams. Implementing structural modifications to do a better job of trapping floatables and prevent their discharge into streams is clearly applicable to the NMR watershed.

Effectiveness

There are several important categories of benefits associated with SSO control. These include water quality related benefits; improved sewer maintenance, repair, and rehabilitation; reduction in damage resulting from basement back-ups; and human health benefits from reductions in pathogen concentrations. However, quantification of these benefits is difficult. Reducing and ultimately eliminating SSO discharges to receiving waters is highly effective in reducing pollutant loads in the watershed and effective in improving water quality along watershed streams.

Due to the highly variable nature of CSO flows, the relationships between pollutant removals and CSO control measures can be difficult to establish. Contributing to this limitation is the cost and difficulty of implementing effective monitoring programs to develop operating data on existing CSO facilities. In addition, because of the substantial variability in applied flows and pollutant loads, monitoring programs to characterize performance need to extend over a long period of time to reliably determine performance level. Structural control measures to reduce CSO discharges should be effective in improving water quality along Nine Mile Run.

Floatables and debris that make their way to watershed streams can have an adverse impact on stream water and aesthetic quality. The principal advantage of storm inlet and catch basin modifications as described is that they prevent these larger visible materials from entering receiving streams. The principal disadvantages with these devices is that they place a greater demand on existing municipal personnel and budget resources for regular and timely maintenance to clean these devices and dispose of the retained materials. However, these structural modifications can be considered effective.

Costs

The cost for structural CSO controls may be high in some areas and low in others. The severity and frequency of CSO occurrences and their effect of stream water quality determine the types of controls that are needed and their associated costs. A number of structural control alternatives are available to reduce CSO occurrences and impacts. For example, the upsizing of sewer pipes and the sealing of pipe joints and cracks offer opportunities to increase the storage capacity of the CSS. The costs

associated with these measures vary considerably based upon materials, design, and site-specific factors. More elaborate structural CSO storage and treatment facilities are available as well and carry with them higher costs. Cost data associated with these structural alternatives have been developed (U.S, 1992) and cost equations for selected CSO control technologies are shown in Table 6.4.2 below.

Table 6.4.2: Cost Equations for CSO Control Technologies

CSO Control Technology	Cost Equation	Applicable Design Range
Storage Basins	$3.637V^{0.826}$	0.15 to 30 MG
Deep Tunnels	$4.982V^{0.795}$	1.8 to 2,000 MG
Swirl Concentrators	$0.176Q^{0.611}$	3 to 300 MG
Screens	$0.072Q^{0.843}$	0.8 to 200 MG
Sedimentation	$0.211Q^{0.668}$	1 to 500 MG
Disinfection	$0.121Q^{0.464}$	1 to 200 MG

Sewer and manhole rehabilitation are the primary structural alternatives applied toward reducing SSOs. Sewer rehabilitation techniques can be expensive, but the cost must be weighed against the value of the collection system asset and the added costs of this asset if it is allowed to further deteriorate. The costs of rehabilitation and other measures to correct SSOs can vary widely by community size, sewer system type, and site-specific factors. For example, the list below shows all the variables that need to be considered in assessing the cost of pipeline excavation and replacement. Factors that influence cost are:

- Old pipe removal and disposal
- Manhole removal and replacement
- Trench shoring
- New pipe material installation
- Service reconnections to the sewer
- Street inlet reconnections to storm drains
- Upstream flow diversion during construction
- Traffic control
- Pavement restoration
- Influence with other utilities

Associated cost savings, realized from rehabilitation, are typically a result of less disruption caused by construction activities. Various trenchless technologies provide a relatively new approach toward pipeline installation and repair that involves little or no excavation that can result in reduced construction costs. In addition, communities that already have ongoing maintenance and rehabilitation programs in place will have lower costs for rehabilitation, renovation, upgrade, and repair than those who do not.

A program should be implemented to identify existing storm inlets and catch basins that do not have sewer hoods. These devices should then be modified so that street litter and floatable debris is trapped and prevented from discharging into watershed streams. Costs associated with implementing such a program primarily consist of materials and labor. The magnitude of these costs will be dependant upon the number and type of storm drain modifications that are made. In addition, additional costs will be accrued with regular maintenance to remove the trapped debris and floatables from these devices.

Ability to be Implemented

Due to the consent order issued to PWSA by PA-DEP, and the similar orders issued to the other three contributing municipalities, extensive sewer rehabilitation efforts will be implemented within the NMR watershed. The existing sewers will undergo rehabilitation, renovation, and repair. As a result, the discharge of raw wastewater into receiving streams will be corrected. Structural modifications to existing catch basins and storm inlets can be implemented gradually over time. A schedule should be prepared so that the modifications can be implemented within a 10 to 15 year time frame.

Establishing a coordinating body can be an effective way to carry out the infrastructure improvement programs and projects. The approach should be that the sewer lines and storm water pipes should not begin and end at the affected municipalities. An authority, utility, district, or other body should be organized along the watershed lines. This management entity can then effectively plan and manage the sewer overflow problem, improve the health of the ecosystem, and encourage integration of infrastructure solutions with community revitalization.

6.4.3 New Regional Facilities

A number of systems are available whereby storm water runoff is collected, temporarily stored, and percolated through the soil and released slowly over time. These systems include wet or dry ponds, detention basins, dry wells, infiltration basins, and constructed wetlands. Often, these facilities are fragmented in that individual basins are sited within individual development plans, but regional basins can be constructed to provide storm water management for an entire sub-watershed

area. In the NMR watershed, these structural alternatives can be considered on a regional level and are dependant upon the desired level of particulate and dissolved pollutant removal, groundwater recharge, and storm water runoff flow control.

Alternatives

- Construct dry wells and infiltration basins on individual properties to capture storm water runoff and allow it to infiltrate into the ground

Dry wells and infiltration basins are used to capture and store storm water runoff from rooftops or areas with low sediment loading. The use of these systems for storm water control is usually applicable where soil is sufficiently permeable to allow for a reasonable rate of infiltration.

- Construct new wetland areas to filter urban pollutants and act as "watershed sponges" to store storm water and augment dry weather stream flow

Storm water wetlands are designed to maximize pollutant removal through wetland uptake, retention, and settling. Constructed wetlands are ideal for large, regional tributary areas and provide multiple benefits of passive recreation and wildlife.

- Construct extended dry detention ponds and wet ponds, either on an on-site or regional basis, to temporarily store storm water runoff and discharge it slowly over time

Extended detention ponds are dry between storm events. During a storm, the basin fills and a bottom outlet releases the storm water slowly to provide time for sediments to settle. Wet ponds are similar to extended dry detention ponds except that they have a permanent water pool to treat incoming storm water.

For more detailed descriptions of these alternative regional control facilities, please refer to Section 5.3 of this watershed management plan.

Applicability to the NMR Watershed

The alternatives listed above are typically designed to fit aesthetically into the open space landscaping of new developments. They are usually placed within individual development projects or lots. The majority of the NMR watershed consists of existing urbanized, residential and commercial areas. As a result, realistic opportunities to implement many of these alternatives are limited. The applicability of constructing dry wells and infiltration basins on existing individual properties is very low.

Completed hydrologic/hydraulic modeling analyses have demonstrated that the potential storage volume that could be constructed along Nine Mile Run above Commercial Avenue is not sufficient to significantly reduce storm peak flows.

Therefore, the construction of regional detention facilities within the watershed appears to be inapplicable.

There are other constraints in implementing on-site alternatives, such as infiltration basins and dry wells, due to the characteristics of the NMR watershed. These devices are most effective where soil is sufficiently permeable to allow for a reasonable rate of infiltration. The clay soils of the watershed may prevent adequate infiltration. As a result, these on-site alternatives may be applicable to implement into existing development but are not highly recommended.

There are limitations to implementing extended dry detention ponds and wet ponds on a regional level. These regional facilities take up considerable land area because the side slopes of many of them are flat to allow for maintenance and to ensure public safety. In these cases where land availability is minimal, as is the case in most of the NMR watershed, these regional facilities are not readily applicable.

Constructed wetlands are applicable to the watershed and are a recommended feature with the Army Corps of Engineers (ACOE) Habitat Restoration Project. Constructed wetlands can provide storage and vegetative filtering for the treatment of storm water and to reduce flow velocities. The deeply incised valley of NMR presents limitations on the area of wetland that can be created and a combination of alternatives may be necessary that involve a pond / wetland system or extended wetland system. These systems require less space than other wetland systems and generally achieve a higher pollutant removal rate than other constructed storm water systems.

Effectiveness

There has been a great deal of storm water monitoring data collected across the country by a number of organizations. Most of these data have focused on characterization of pollutants in runoff, and not on the effectiveness of various control measures. However, several nation-wide monitoring programs have been conducted to characterize pollutants in urban storm water runoff and to evaluate the performance of the storm water control measure. Structural control measures can be measured in terms of reductions in pollutants discharged from the system and by the degree of attenuation of storm water flow rates and volumes discharged to the environment. Various physical, chemical, and biological evaluation methods exist for determining the pollutant removal efficiency of these facilities.

Structural facility performance can vary considerably based on differences in design criteria and performance standards for which the facility is designed. Comparing pollutant removal efficiency for similar facility types with very different performance goals may result in widely disparate efficiency estimations. In addition to performance goals, variations in watershed parameters (size of the drainage area, level of watershed imperviousness, land use, etc.) can cause significant differences in performance among the alternatives. Also, differences in design parameters such as

ratio of the facility volume to the contributing drainage area, the retention time in the facility, the physical dimensions and the construction of the facility further complicate direct comparisons between monitoring data.

Despite these shortcomings, some general ranges of expected efficiencies have been compiled from literature. Documents that summarize structural control measure efficiency information include the CWP's National Pollutant Removal Performance Database (Brown and Schueler, 1997), the Terrene Institute's report *The Use of Wetlands for Controlling Storm water Pollution* (Strecker et al, 1992), as well as a variety of other articles and documents contained in professional and scientific literature. Table 6.4.3 below summarizes the actual performance data contained in literature on pollutant removal efficiencies for the structural alternatives described in this section.

Table 6.4.3: Pollutant Removal Efficiencies of Structural Alternatives

Type	Typical Pollutant Removal (percent)				
	Suspended Solids	**Nitrogen**	**Phosphorus**	**Pathogens**	**Metals**
Dry Detention Ponds	30 - 65	15 – 45	15 - 45	< 30	15 – 45
Wet Ponds	50 - 80	30 - 65	30 - 65	< 30	50 – 80
Dry Wells	50 - 80	50 - 80	15 - 45	65 - 100	50 – 80
Infiltration Basins	50 - 80	50 - 80	50 - 80	65 - 100	50 – 80
Constructed Wetlands	50 – 80	< 30	15 - 45	< 30	50 - 80

Source: Adapted from US EPA, 1993

Costs

Storm water runoff can contribute loadings of nutrients, metals, oil and grease, and litter that result in impairment of local water bodies. The extent in which these impairments are reduced or eliminated by a structural control measure depends on a number of factors, including the number, intensity, and duration of wet weather events; facility construction and maintenance activities; and the site-specific water quality and physical conditions. Because these factors will vary substantially from site to site, developing dollar estimates for individual facilities becomes difficult. Some structural control measures can represent a significant cost to communities, but these costs should be weighed against the various benefits they provide.

Table 6.4.4 gives some typical base capital costs for various structural alternatives. The base capital costs refer primarily to the cost of constructing the facility. This may

include the erosion and sediment control during construction but the costs of design, geotechnical testing, legal fees, land costs, and other unexpected or additional costs are not included in these estimates. It should be noted that the cost of constructing any of these facilities is variable and depends largely on site conditions and drainage area.

Table 6.4.4: Base Capital Costs of Various Structural Facilities

Type	Typical Cost ($/ft^3)	Notes	Source
Dry Detention Ponds / Wet Ponds	0.50 – 1.00	Cost range reflects economies of scale in designing this facility. The highest unit cost represents approx. 15,000 ft^3 of storage while the lowest is approx. 150,000 ft^3. Typically, dry detention ponds are the least expensive design options among retention and detention practices.	Adapted from Brown and Schueler (1997)
Dry Wells	4.00	Represents typical costs for a 100-foot long trench.	Adapted from SWRPC (1991)
Infiltration Basins	1.30	Represents typical costs for a 0.25-acre infiltration basin	Adapted from SWRPC (1991)
Wetlands	0.60 – 1.25	Although little data are available to assess the cost of wetlands, it is assumed that they are approx. 25% more expensive (because of plant selection and sediment forebay requirements) than retention basins.	Adapted from Brown and Schueler (1997)

For extended dry detention ponds, wet ponds, and constructed wetlands, the total volume is generally a strong predictor of cost. There are some economies of scale associated with constructing these systems, as evidenced by the slope of the volume equations derived and shown in Table 6.4.5. This is largely because the costs of the inlet and outlet design - the mobilization of heavy equipment are relatively similar regardless of basin size.

Costs for infiltration practices are highly variable from site to site, depending on soils and other geotechnical information. Perhaps because of this variability, cost estimates for infiltration devices have been widely different as can be seen in Table 6.4.6.

Table 6.4.5: Cost Equations for Various Detention/Retention Facilities

Type	Cost Equation or Estimate	Costs Included		Source
		Construction	E&S Control	
Retention Basins and Wetlands	$7.75V^{0.75}$	√	√	Wiegand et al, 1986
	$18.5V^{0.70}$	√		Brown and Schueler, 1997
Detention Ponds	$7.47V^{0.78}$	√	√	Brown and Schueler, 1997
Wet Ponds	1.06V: 0.25 acre wet pond (23,300 cubic feet)	√		SWRPC, 1991
	0.43V: 1.0 acre wet pond (148,000 cubic feet)			
	0.33V: 3.0 acre wet pond (547,000 cubic feet)			
	0.31V: 5.0 acre wet pond (952,000 cubic feet)			

Note: V refers to the total basin volume in cubic feet

Table 6.4.6: Cost Equations for Various Infiltration Devices

Type	Cost Equation or Estimate	Costs Included		Source
		Construction	E&S Control	
Infiltration Trenches and Dry Wells	$33.7V^{0.63}$	√		Wiegand et al, 1986
	2V to 4V: average of 2.5V	√		Brown and Schueler, 1997
	\$4,400: 3-foot deep, 4-foot wide, 100-foot long trench	√		SWRPC, 1991
	\$10,400: 6-foot deep, 10-foot wide, 100-foot long trench			
	3.9V+\$2,900: 3-foot deep, 100-foot long trench	√		Modified from SWRPC, 1991
Infiltration Basins	$13.2V^{0.69}$	√	√	Schueler, 1987; Modified from Wiegand et al, 1986
	1.3V: 0.25-acre infiltration basin (15,000 cubic feet)	√	√	SWRPC, 1991
	0.8V: 1.0-acre infiltration basin (76,300 cubic feet			

Note: V for infiltration trenches refers to the treatment volume (cubic feet) within the trench, assuming a porosity of 32%. V for infiltration basins refers to the total basin volume (cubic feet).

Ability to be implemented

As was previously mentioned, there are limitations to implementing extended dry detention ponds and wet ponds on a regional level due to land availability. Also, there are constraints in implementing on-site alternatives, such as infiltration basins and dry wells soils of the watershed may preventing adequate infiltration.

However, there are several scenarios for the NMR watershed where wetland creation or expansion could be used to manage storm water and provide pollutant removal.

These constructed wetlands can include design elements such as a forebay, complex microtopography, and pondscaping with multiple species of trees, shrubs, and plants for even more effective pollutant removal.

Because of their shallow depths, storm water wetlands can consume two to three times the site area compared to other storm water quality options. The land requirements of these wetlands can be sharply reduced by deepening parts of the wetland, thus reducing detention times. Limited due to space constraints; however pollutant removal can be obtained by modifying existing degraded wetlands with the watershed for storm water control. Key factors influencing the longevity of constructed wetlands that should be examined include: the selection of an experienced wetland contractor for design, the ability to regulate water depths, replacement plantings, and the control of undesirable plants.

6.4.4 Stream Erosion and Velocity Controls

Stream erosion and deposition are controlled by a stream's velocity and the discharge through the stream during storms. Velocity is controlled by the stream gradient, channel shape, and channel roughness. Storm flow is controlled by the size and slope of the contributing watershed and the degree of urbanization. Streams are very effective in sculpting the land by cutting their own valleys, deepening and widening them over long periods of time. Urbanization in the watershed accelerates this process. Implementing structural stream restoration measures provide alternative control measures to control bank erosion, stabilize slopes, control stream gradients, and provide aquatic habitat.

Alternatives

- Stabilize existing stream channels, channel banks, and over-banks using natural "green engineering" techniques to restore existing eroded areas and prevent future erosion and scour

Stream bank erosion is dictated by the stability of the banks and the energy of the flowing water. Stream banks can be protected or restored either by increasing resistance of the bank to erosion or by decreasing the energy of the water at the point of contact with the bank. Armoring the bank with stone, flattening channel slopes, re-vegetation, or a combination can stabilize the bank.

- Reconfigure existing stream channels and reconnect them to their adjacent floodplains, using sound fluvial geomorphologic principals, to restore natural channel proportions and natural frequency of over-bank flooding

Stream channels in urbanized watersheds can become incised, keeping storm flow in the channel instead of spreading out over adjacent flood plains. Rehabilitation and

reconfiguring the shape and alignment of the stream can reconnect the stream channel to its over-banks and restore natural storm conditions within the flood plain.

Fluvial geomorphology is the science that assesses the shape and form of a watercourse and the contributing physical processes. This includes the conveyance of water as well as the supply and movement of sediment. Typical applications of fluvial geomorphology include inventory and assessments primarily for watershed planning, erosion assessment, and analyses for crossing structures, channel realignments and storm water management. In addition, this science applies natural channel design for restoring or rehabilitating channel reaches and provides integration with aquatic biology to enhance habitat and provide a more comprehensive understanding of channel dynamics.

For more detailed descriptions of these storm stabilization and restoration measures, and the alternative techniques that can be used to implement them, please refer to Section 5.4 of this watershed management plan.

Applicability to the NMR Watershed

The stream channel of NMR has been significantly impacted and degraded by urbanization for its entire length within the watershed. During dry weather periods, stream flow can almost disappear completely within the channel. However, when it rains, most of the rainwater quickly runs off impervious surfaces and into storm drains. Stream flows increase rapidly in response to these storm events. Sporadic wet weather flow events have been responsible for significant stream bank erosion and subsequent deposition of sediments within the open channel segments of the stream. The use of structural stream restoration measures provides an alternative control measure to remediate the negative impacts of watershed urbanization along watershed streams, and is clearly applicable to the NMR watershed.

Effectiveness

Stream stabilization measures can be highly effective in reducing erosion and scour and improving water quality. Reconfiguring and stabilizing existing stream channels can indirectly manage storm water by managing the effects of storm water draining into the stream. Pollutant reduction can be achieved through sediment avoidance by stabilizing stream-banks that are subjected to erosion during storm events. Vegetative barriers and buffers can also filter overland runoff. Additionally, methods that reduce velocity may remove sediment from the stream through deposition. Below is a list of addition positive impacts.

- Erosion control is effective in reducing downstream siltation, increasing downstream water quality

- Green engineering techniques used alone or in concert with mechanical stabilization methods are effective to enhance riparian habitat for wildlife (food and cover sources and temperature control for aquatic and terrestrial animals)

- Vegetated and restored stream-banks may also enhance purification of overland runoff and provide aesthetic appeal

Cost

The cost to implement stream stabilization measures depends on the size of the stream and the tributary watershed, the peak storm flow and velocity, and the accessibility to get materials and equipment to the stream. Stabilizing eroded channel areas along Nine Mile Run has been estimated to cost from $100 to $200 per lineal foot of stream channel.

Ability to be implemented

A detailed fluvial geomorphology study and assessment has already been conducted by Biohabitats, Inc. as part of the United States Army Corp of Engineers (ACOE) *Section 206 Environmental Restoration Report*. This work was funded through the Watershed Resources Development Act (WRDA) and was performed in conjunction and coordination with the efforts of a concurrent Section 319 Grant study.

The funding by Section 206 through the ACOE with the City of Pittsburgh as the local sponsor will enable the completion of many important steps in the restoration and management of the watershed. The project has local support and commitment, clearly stated goals and objectives, and will be able to produce measurable environmental results. Addressing channel morphology problems and re-introducing flood flows to floodplain areas will be a focus of the restoration project and will be very beneficial to the aquatic and riparian terrestrial habitat of the NMR stream. To support project goals, restoration alternatives will include the use of structural stream restoration measures to remediate the negative impacts that watershed urbanization has had along the NMR stream.

6.4.5 Leachate Discharge Controls

The Urban Redevelopment Authority (URA) is under a Consent Order and Agreement (CO&A) to develop and implement a plan and schedule for abatement of high pH seeps from the slag pile into the stream. These existing seeps significantly degrade water and aquatic habitat quality. An abatement plan for the NMR slag disposal site has prepared and submitted to PA-DEP that includes engineering designs, costs, and assurances of effectiveness. The success of the NMR Habitat Restoration Program and the availability of the Section 208 Grant funds is predicated on the success of these leachate mitigation measures. It is presumed that the CO&A will ensure that the required mitigation measures will be implemented.

Table 6.4.7: Screening Summary of Alternative Structural Control Measures

Control Measure	Applicabilty to the NMR Watershed	Effectiveness at Meeting Watershed Goals	Cost to Implement	Ability to be Implemented	Recommendation
Implement an aggressive program to locate and remove illicit sewage and inductrial discharges to municipal storm drains	High	High	Medium	Medium	Recommended to Implement
Reduce the quantity of pavement whenever existing parking areas, driveways, or streets are scheduled to be resurfaced	High	Medium	Low	High	Recommended to Implement
Rehabilitate aging municipal sewage collection systems to significantly reduce extraneous infiltration and inflow and reduce the frequency and duration of SSO discharges	High	High	Medium	High	Recommended to Implement
Modify existing storm inlets and catch basins without sewer hoods so that street litter and floatable debris is trapped and prevented from discharging into the watershed streams	High	High	Medium	Medium	Recommended to Implement
Construct new wetland areas to filter pollutants and act as "watershed sponges" to store stormwater and augment dry weather stream flow	High	Medium	High	High	Recommended to Implement
Stabilize existing stream channels, channel banks, and overbanks using "green engineering" techniques to restore eroded areas and prevent future erosion and scour	High	High	High	High	Recommended to Implement
Reconfigure existing stream channels and reconnect them to their adjacent floodplains using sound fluvial geomorphological principals	High	High	High	High	Recommended to Implement

Table 6.4.7: Screening Summary of Alternative Structural Control Measures

Control Measure	Applicabilty to the NMR Watershed	Effectiveness at Meeting Watershed Goals	Cost to Implement	Ability to be Implemented	Recommendation
Encourage the use of porous pavement methods in lieu of traditional asphalt and concrete within public parking areas and residential lots	Medium	Medium	Medium	Medium	Consider Implementing
Encourage construction of tanks or cisterns for existing residential, commercial, and public buildings to capture and store runoff and irrigate vegetated areas	Medium	Medium	Medium	Medium	Consider Implementing
Modify and rehabilitate existing combined sewer systems to reduce the frequency, duration, and volume of CSO discharges into the watershed	Medium	Medium	Medium	Medium	Consider Implementing
Construct dry wells and infiltration basins on individual properties to capture stormwater runoff and allow it to infiltrate into the ground	Medium	Medium	Medium	Low	Consider Implementing
Construct extended dry detention ponds and wet ponds, either on-site or on a regional basis, to temporarily store stormwater runoff and release it slowly over time	Low	Low	High	Low	Not Recommended to Implement
Encourage the construction of rooftop gardens over existing public and private buildings	Low	Medium	High	Low	Not Recommended to Implement

6.5 Institutional Mechanisms

Successful watershed planning in Nine Mile Run will require a combination of existing and new institutional organizations to focus the resources of a diverse group of stakeholders to implement the plan. A long-term management structure is not only critical to prepare and implement the plan, but to revisit and update the plan as goals are achieved or circumstances within the watershed change over time.

Alternatives

Several different options are available to structure a watershed management organization. There are three broad models to choose from to organize the stakeholders for a management plan:

- Government-Directed Model
- Citizen-Directed Model
- Hybrid Model

The primary difference between the three management options concerns the organization ultimately responsible for directing the watershed plan. In the government-directed model, local or governmental agencies assume responsibility for making decisions about how the watershed is managed. Conversely, the citizen-directed model is driven by citizen activists or grass roots organizations. A hybrid organization combines the best of both models and is recommended for the NMR watershed. The basic elements of these models are presented below in Table 6.5.1.

The hybrid management model generally includes members from the local professional community, government agencies, citizens, and non-profit organizations. The organization itself does not have regulatory authority, but makes recommendations to local government agencies like municipal government, the Allegheny County Health Department (ACHD), and the Pennsylvania Department of Environmental Protection (PA-DEP) to insure that management strategies are implemented. The goal of the hybrid model is to incorporate and involve as many stakeholders as possible in the process of implementing the watershed management plan, either in an advisory or technical role. A technical committee is often set up to provide expertise on scientific or engineering issues, while a citizen advisory committee affords the public the opportunity to voice their opinions in the management process. A central principal behind the hybrid model structure is that greater watershed improvements can be achieved when there is proactive involvement of many watershed parties.

Table 6.5.1: Typical Components of Watershed Management Structures

	Government-Directed Model	Citizen-Directed Model	Hybrid Model
Formation	Created by Legislative Authority	Created at "grass-roots" level from citizens or other interested parties	Created with some governmental authority, with some support from citizens
Membership	Organization membership is appointed by governmental authority	Stakeholder participation is voluntary	Some members are required to participate, but many are volunteers
Authority	Structure has regulatory authority over land use and other permits	Advisory capacity with no regulatory authority over land use or permits	Some members have regulatory authority, and others act in a volunteer or advisory capacity
Funding	Funding is through taxes or levied fees	Funding is either by grant, donations, or by local government contributions	Funding comes from a combination of grants and local government agreement
Implementation	Government agencies at the local and state levels implement the plan.	Local governments implement the plan	Local governments implement the plan, with some assistance from state agencies.

New and existing institutional entities will all play important roles in implementing the recommended management and restoration measures within the NMR watershed. The following entities either have or will have significant roles in implementing the NMR watershed management plan.

Nine Mile Run Watershed Management Association: A watershed association is being established to oversee and implement the NMR Watershed Management Plan. The association would be comprised of citizen volunteers with diverse backgrounds, interests, and areas of expertise. Association members would represent the interests of the NMR watershed, home and business owners in the watershed, other stakeholders in the watershed, and the completed Habitat Restoration Program. The management association would have no regulatory authority, but would make recommendations to local municipalities, the ACHD, and PA-DEP to implement recommended management strategies, restoration measures, and structural rehabilitation. The NMR Watershed Management Association would employ a part-time administrator to assist in the daily operation of the association, and the implementation of the watershed management plan. Funding for the Association would be provided through a series of grants from entities such as the Pennsylvania Environmental Council, the PA Growing Greener Initiative, the Heinz Foundation, and/or the Three Rivers Wet Weather Demonstration Program (3RWWDP).

Municipal Government: There are four municipalities, each with jurisdiction over their respective portions of the NMR watershed. They are the City of Pittsburgh,

Edgewood Borough, Swissvale Borough, and Wilkinsburg Borough. These four municipalities would need to transcend existing municipal boarders and work together as a unified watershed entity. The municipalities would have the authority to revise and enforce ordinances that would shape new development and restorative redevelopment, control the disposal of pet wastes and household hazardous wastes, and over see the rehabilitation of aging sewer, storm drain and pavement systems. Funding for municipal government activities would come from a combination of property and wage taxes, bond issues, PennVest loans, and possible demonstration grants.

Environmental Regulatory Agencies: The Allegheny County Health Department (ACHD), PA Department of Protection (PA-DEP), and the PA Department of Conservation and Natural Resources (PA-DCNR)are existing regulatory agencies that have authority and jurisdiction over environmental quality within the NMR watershed. The ACHD has conducted field investigations and laboratory analyses and determined that bacterial concentrations along the NMR stream channel greatly exceed established water quality standards. The PA-DEP has issued Consent Order Agreements (COAs) to the Pittsburgh Water and Sewer Authority (PWSA) and the Boroughs of Edgewood, Swissvale, and Wilkinsburg. These orders require comprehensive inspections of aging sewer systems, removal if illicit sewage connections to municipal storm drain systems, assessment of sewer system conveyance capacities, the elimination of SSOs, and meeting the standards of the National CSO Control Policy.

Sewer Authorities: The Pittsburgh Water and Sewer Authority (PWSA) has the responsibility to operate and maintain the combined and separate sewer systems located within the City of Pittsburgh portions of the NMR watershed. The separate sanitary sewer and municipal storm drain systems within the rest of the watershed are owned and operated by the respective Boroughs of Edgewood, Swissvale, and Wilkinsburg. Municipal governments usually are not as well suited as an authority to operate and maintain sewer and storm systems. Municipalities do not public water supplies, electric utilities, or cable television, and they should not have primary responsibility for sewer systems. Operation and maintenance responsibility should be relinquished either to a new NMR watershed authority or a larger regional authority. Wastewater and storm water infrastructure would be managed professionally and funded through user fees.

NMR Habitat Restoration Project: The Nine Mile Run Habitat Restoration Project (NMR-HRP) should be the vehicle to implement recommended restoration measures along the existing NMR and Fern Hollow riparian corridors. Under the project, the natural morphology of the stream and the connection to the flood plain will be restored, the stream channel and over-banks will be stabilized to control erosion and bed-loads, new wetland areas will be created, vegetation will be enhanced and managed, and aquatic and terrestrial habitat will be restored. Federal funding is

being provided through a WRDA Section 206 grant administered by the Army Corps of Engineers (ACOE). The City of Pittsburgh is the local sponsor for the program. Local match funding, required under the WRDA grant, is being provided by the combination of a PA-Growing greener initiative grant, PA Section 319 Grant, PA DCNR grant, 3RWWDP grant, and in-kind services from ALCOSAN.

Applicability to the NMR Watershed

To successfully implement the NMR watershed management plan, a combination of new and existing institutional organizations will be needed to focus resources, engage stakeholders, and evaluate costs and benefits of the recommended management measures as they are enacted. The various institutional entities are clearly applicable to the NMR watershed.

Effectiveness

The combination of institutional entities that are or will be active in the watershed should be highly effective in implementing the goals and objectives for the NMR watershed. The institutions should be effective in implementing management and restoration measures that ultimately will improve water quality, reduce pollutant loads, improve aesthetic quality, and improve and expand aquatic and terrestrial habitat.

Costs and Funding

Funding to support the various institutional entities that will be active in the NMR watershed will come from a number of sources as described below.

- **The NMR Watershed Association:** The members of the association would be a collection of citizen volunteers. Administrative and program support would be funded through a combination of grants from entities such as the Pennsylvania Environmental Council, the PA Growing Greener Initiative, the Heinz Foundation, and/or the Three Rivers Wet Weather Demonstration Program (3RWWDP).

- **Municipal Government:** The cost for activities conducted by municipalities would be provided by a combination of property and wage taxes, bond issues, PennVest loans, and possible demonstration grants.

- **Regulatory Agencies:** Activities conducted by environmental regulatory agencies would be provided by state and county budgets that are funded through state and county taxes.

- **Sewer Authorities:** Activities implemented by existing and/or future sewer authorities would be funded through user fees paid by customers.

- **NMR Habitat Restoration Program:** Restoration measures implemented under the NMR-HRP are being be funded by a Federal WRDA Section 206 grant with local match requirements being met by combination of a PA-Growing greener initiative grant, PA Section 319 Grant, PA DCNR grant, 3RWWDP grant, and in-kind services from ALCOSAN.

Ability to be implemented

Most of the institutional entities that would implement the NMR watershed restoration plan already exist and are already actively involved in the watershed. The NMR Watershed Association is currently in the process of being formed and will have primary oversight responsibility to implement the NMR Watershed Management Plan.

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