Integrated Planning Opportunities Alternatives Analysis – Polycyclic Aromatic Hydrocarbon Reduction Measures

Springfield, Missouri

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Introduction

The City of Springfield (City), Greene County, and City Utilities of Springfield have developed an approach for integrated planning to best protect local environmental resources in an evolving regulatory landscape. The Integrated Plan (IP), titled "A Citizen Focused Approach," provides a holistic plan designed to prioritize investments based on the most effective solutions to address the most pressing problems that matter most to the community. Implementation of the IP includes a four-phased approach, which is designed to be iterative: 1) Assessment (What is the current status of the environment?), 2) Vision (Where do we want to be?), 3) Tactical (How will we get there?), and 4) Adaptive Management (What adjustments need to be made?).

Identifying and prioritizing the most effective solutions using the Sustainable Return on Investment (SROI) approach is a critical component of the tactical phase. The SROI process is an economic analysis method for analyzing triple bottom-line (i.e., economic, social and environmental) outcomes of investments and policies. This approach provides a comparison between the general cost of a solution to the benefits achieved so that a more informed investment decision can be made.

The SROI process was used here for estimating the sustainability value of polycyclic aromatic hydrocarbons (PAH) reduction measures, including social and environmental benefits and financial costs. The methodology entailed projecting the value of impacts over a 25-year planning horizon and applying a discount rate to bring future values into today's dollars. A description of this opportunity and details of the SROI analysis are provided below.

Opportunity Description

PAHs are compounds formed primarily as products of incomplete combustion (burning) of carbon containing substances such as, gasoline, coal, oil, wood, garbage, grilled meat, and tobacco (ATSDR 1995). Once released to the environment, PAHs are volatilized into the atmosphere, adhere to the surfaces of small solid particles, or solubilized into water. However, the solubility of most PAHs is low, so once in the water column most PAHs adsorb to solid particles and settle out as sediment. Breakdown in soil and water generally takes weeks to months and is caused primarily by the actions of microorganisms.

The Ozark Environmental and Water Resources Institute (OEWRI) conducted an investigation of coal-tar-based sealant coatings on parking lots and determined them to be a significant source of PAHs to Springfield urban streams. The study was a follow-up to the presentation given to the Springfield City Council on August 3, 2010 by Barbara Mahler and Peter Van Metre with the USGS discussing the national prevalence of PAH compounds in coal-tar-based sealant coatings and suggesting that coal-tar in surface coatings of parking lots may represent the primary contamination source of PAHs in streams and lakes. The OEWRI study identified 12 Springfield sites draining core urban areas that contained PAH concentrations exceeding five times the Probable Effect Concentration (PEC). PECs are generalized sediment concentration thresholds that are expected to cause harmful impacts to the aquatic community, although a number of site-specific factors (e.g., sediment organic content) potentially mitigate actual toxicity. In response to this and other studies, the Springfield community has initiated discussions to reduce the amount of coal-tar-based sealants that reach streams and lakes and is the subject of this SROI analysis.

Stormwater runoff from coal-tar sealed parking lots is a major source of PAHs.

Two PAH reduction measures were evaluated for this SROI include: 1) switching to non-coal-tar-based pavement sealants, and 2) switching to non-coal-tar-based sealants plus excavation of swales near parking lots. Excavation would serve to preemptively remove PAH-laden sediment before it enters a waterbody.

Environmental and Social Benefits

The primary benefit of PAH reduction measures is improved water quality. Water quality improvements were determined using a water quality index (WQI) approach. The WQI is a composite scoring system that evaluates the conditions of a waterbody on a scale of 0 to 10 based on different community priorities and indicators. The economic value of a change in water quality is determined by the number of people that benefit and an individual's "willingness-to-pay" for that change. A one point change to the WQI is worth about $40 for a direct user and about $14 for in indirect user.

Based on previous studies, switching to non-coal-tar-based sealants was assumed to result in a maximum 80% reduction in PAH concentration in area waterbodies after a 15 year period. This same reduction was assumed to occur in half this time or 7.5 years if accompanied with the excavation of PAH hot spots. The PAH reduction measures were estimated to improve the WQI of Springfield urban streams by 0.154 points for switching to non-coal-tar-based sealants and 0.185 points with excavation (**Figure 1**).

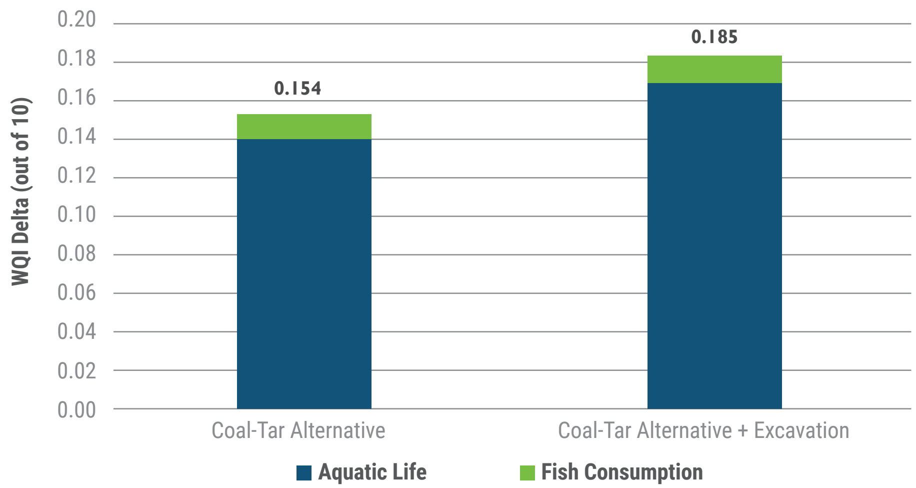

Figure 1. Change to the Water Quality Index from PAH Reduction Measures

Cost Considerations

PAH reduction cost impacts to the property owners of asphalt parking lots were estimated at a planning level. Asphalt emulsion sealant costs were determined be approximately 30% more expensive than coal-tar-based sealants (**Table 1**). In addition to the increased application costs, the industry anticipates the asphalt-based sealants will require more frequent reapplication. The recommended time between coal-tar applications is eight to ten years while the time between asphalt applications is four to six years (Pavement Coatings Technology Council 2015). It is assumed that coal-tar-based sealants would be reapplied every ten years and asphalt-based sealants every six years.

Table 1. Sealing Costs

Striping/Sealing	Cost ($/sq yd)	Cost ($/acre)
Coal-tar	$0.90	$4,360
Asphalt Emulsion	$1.17	$5,660

Additional costs would be incurred for the excavation of PAH hot spots adjacent to the parking lots. Sediments would need to be excavated annually until the parking lot is sealed with an asphalt-based sealant or the property owner elects to install other measures to collect the sediment high in PAH and prevent the material from washing into the area streams and lakes. The approximate cost for the excavation, disposal, and site restoration is estimated at $10.3 million for all sites within the City.

Additional cost savings arise from reduced administrative and legal costs associated with lower Total Maximum Daily Load (TMDL) impairment impacts. This category relates to internal costs related to TMDL regulatory impacts, specifically attributed to administrative time and/or legal costs.

SROI Results

Table 2 results provide the estimates of present value costs and benefits for opportunities that involve a switch to non-coal-tar-based sealants with or without excavation measures based on a 25-year planning horizon. From a cost perspective, a switch (only) to alternative sealants would not entail immediate capital outlays, but if the project opportunity involved excavation, the capital costs could reach a total of $10 million in present value terms. Switching to non-coal-tar-based sealants would increase maintenance costs for public and private property owners by about $18.9 million in present value terms over the 25-year planning horizon. In addition, the City may experience an increase in costs for handling additional public concerns, complaints, or comments, the cost of which is estimated at $4,000 per year, or about $70 thousand in present value terms.

The environmental impacts of switching to non-coal-tar-based sealants and excavation would lead to positive outcomes in water quality. If switching to non-coal-tar-based sealants alone, the value of water quality improvements amounts to about $12.4 million. With additional efforts to excavate contaminated sites the benefits rise to $14.9 million. Social benefits, such as the public health benefits associated with PAH reductions could also arise for the local community, but these are not specifically measured and monetized.

Table 2. Summary of Present Value Costs of Switching to a Non-Coal-Tar-Based Sealant ($2018, Millions)

Types of Benefits and Costs	Switch to Non-Coal-Tar-Based Sealants	Switch to Non-Coal-Tar-Based Sealants Plus Excavate Hot Spots
Environmental		
Water Quality Impacts	$12.4	$14.9
Social		
(No monetized benefit categories)	—	—
Costs		
Capital Expenditures	$0.0	($10.0)
Public and Stakeholder Relations Impacts	($0.1)	($0.1)
Sealant Cost Impacts to Public	($18.9)	($18.6)
TMDL Impairment Cost Impacts (Administrative/Legal Costs Only)	$1.1	$1.1
Totals		
Financial Lifecycle Cost	($17.9)	($27.6)
Total Social, Environmental Benefits	$12.4	$14.9
Total Value - All Costs and Benefits	($5.5)	($12.7)
Benefit-Cost Ratio	0.69	0.54

Overall, switching to non-coal-tar-based sealants alone would cost about $5.5 million more in lifecycle costs than it generates in benefits. While benefits improve with excavation, it is more than off-set by the increase in cost resulting in a net lifecycle cost of about $12.7 million. The benefit-cost ratio for switching to non-coal-tar-based sealants is 0.69 without excavation and 0.54 with excavation.

Figure 2 provides the best estimate of value created relative to cost by accounting for several uncertainties than can raise or lower the perspective on total value. The results indicate that while the expected value for switching to non-coal-tar-based sealants (only) is around 0.69, there is a large upside and downside range for this investment. The benefits per cost value of this investment could be less than 0.3 (with a 10 percent chance of this occurring). But, on the upside, it could generate as much as 70 cents more for every dollar spent above the breakeven point of the investment. The upside potential of adding excavation is approximately at the breakeven point.

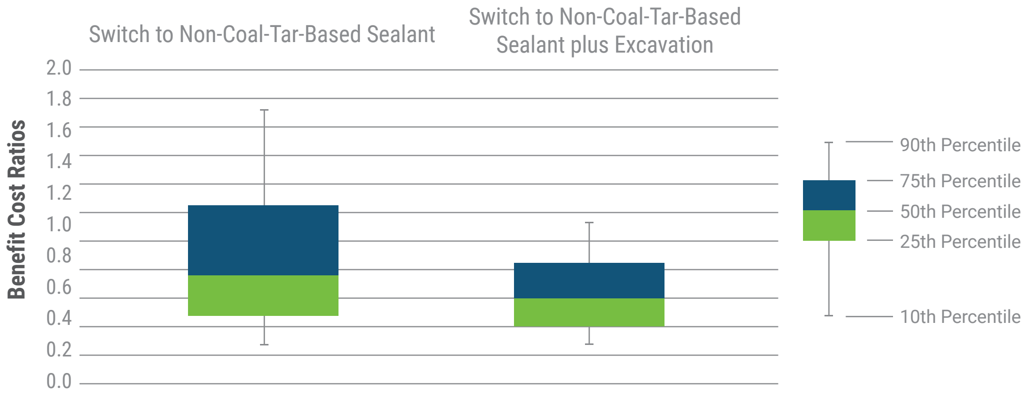

Figure 2. Range of Potential Benefit Cost Ratios for PAH Reduction

Summary

If the Springfield community were to switch to only non-coal-tar-based sealants, we could expect to see an increased cost to the community of approximately $18.9 million based primarily on the increased maintenance costs associated with pavement sealing. However, the estimated benefits to water quality would total approximately $12.4 million with an additional annual savings of about $60 in avoided TMDL compliance costs. While the estimated benefit-cost ratio is below 1 at 0.69, the SROI analysis suggests it could range anywhere from about 0.3 to 1.7. Additionally, these benefits do not include any of the potential human health related benefits that might be achieved with reduced coal-tar sealant use. If these benefits were quantified and included, we might assume a significantly higher benefit to the community. Based on this analysis, the benefits of switching to non-coal-tar-based sealants may outweigh the cost to the community. However, additional costs associated with excavation do not appear to be cost-effective.