



MEMORANDUM

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TO: BMP O & M Verification Work Group

FROM: Paul Randall and John Fusco, Program Staff

DATE: September 24, 2003 [FINAL]

SUBJECT: Utility of Existing Stormwater BMP Cost Estimates

The purpose of this memorandum is to compile and evaluate existing cost information for the operation and maintenance (O & M) of selected stormwater Best Management Practices (BMPs) owned and/or operated by public and/or private owners. The information provided within this memorandum can assist Co-permittees in making recommendations to the development community regarding the selection of practical and effective treatment control BMPs. In addition, municipal and agency staff can provide this information to their City Council or Board of Directors in support of future requests for additional resources needed for a BMP O & M Verification Program.

Background

During the April 23, 2003 BMP O & M Verification Work Group meeting, Program staff was requested to investigate existing information on the costs associated with BMP inspection and maintenance. This information would be useful in identifying resource needs; estimating the number of inspections possible within individual Co-permittee budgets; and educating Co-permittees on actual inspection and maintenance costs. During the May 15, 2003 BMP O & M Verification Work Group meeting, Program staff provided the Work Group with a summary table (compiled from three different sources) that included estimated BMP construction and maintenance costs. In addition, Program staff distributed several resource documents and summarized the caveats of using existing cost information. The Work Group agreed the existing BMP cost estimates may be useful at the planning level (i.e., comparison of relative costs between different treatment control BMPs) but mentioned that it was of limited use for predicting actual BMP O & M costs. The Work Group agreed that a memorandum (with summary tables) providing an explanation of how cost information can be used (and by whom) would be useful.

Existing Information Resources

Table 1 provides construction and O & M cost estimates for selected stormwater BMPs. This information, compiled from the following four information resources, are attached to this memorandum as electronic links:

- [Preliminary Data Summary of Urban Stormwater Best Management Practices](#) (prepared by the United States Environmental Protection Agency, August 1999);
- [California Department of Transportation BMP Retrofit Pilot Program](#) (prepared by the Stormwater Program, California State University-Sacramento Office of Water Programs, January 2001);
- [Stormwater Best Management Practice Handbook: New Development and Redevelopment](#) (prepared by the California Stormwater Quality Association, April 2003); and
- [A Survey of Installation and Maintenance Costs of Stormwater Treatment Facilities](#) (prepared by Gary Minton for the Bay Area Stormwater Management Agencies Association, June 2003).

Construction costs were identified since several BMP O & M costs were presented as a percentage of the total construction cost. Estimated budgets for BMP inspection programs (Minton, 2003) are shown in Table 2.

Discussion

Table 1

The information presented within Table 1 indicates a significant variation in construction and maintenance costs between selected treatment control BMPs. Several factors influence BMP construction and maintenance costs:

- Type of BMP
- Size of BMP
 - Rainfall quantity
 - Drainage area
 - Site characteristics (e.g., impervious area; soil stability)
- Location of BMP (i.e., above or below ground)

The type of BMP implemented has a significant impact to the annual costs needed for inspection and maintenance. The Environmental Protection Agency has determined that sand filters, bioretention and infiltration trenches have a significantly larger average maintenance costs compared to the other treatment control BMPs (EPA, 1999). On the other hand, the California Department of Transportation (CalTrans) Pilot Study indicates that wet ponds, filter strips and swales have the highest average maintenance costs for selected treatment control BMPs. High maintenance costs were associated with vegetation removal. It is unclear why filter strips and swales had relatively high maintenance costs in the CalTrans study but relatively low maintenance costs as reported in the EPA study. The BMP maintenance costs provided in the California Stormwater Quality Association BMP Handbook for New Development and Redevelopment (CA BMP Handbook) were difficult to compare due to differences in cost units. The CA BMP Handbook reported that porous pavement, wet ponds and constructed wetlands appear to have the highest maintenance costs.

A review of Table 1 indicates that some distinction can be made for general maintenance costs between selected BMPs. However, actual costs are very difficult to determine since BMP design and construction are greatly affected by a wide range of potential site characteristics and specific local conditions. As a result, local conditions will influence the size of the constructed treatment control BMP and materials used in the design. Localized factors that affect BMP size, design and maintenance include quantity of rainfall, drainage area, site characteristics (including land cover or imperviousness) and soil conditions.

Stormwater BMP construction and maintenance costs will likely be higher in areas which have no or limited treatment control BMPs in place compared to areas where treatment control BMPs are well established. Many of the existing BMP costs were obtained in areas where BMPs were installed for over ten years. It is possible that the number of contractors and local expertise in construction and maintenance of treatment control BMPs will keep associated costs lower over time.

Other factors affecting maintenance costs include BMP access and residual disposal. A treatment control BMP constructed below-surface is more expensive to maintain than a surface measure. However, the higher maintenance costs for below-surface BMPs may be offset by reduced land costs associated with BMP construction. Sediment accumulation in treatment control BMPs is another factor which may affect maintenance costs. When residuals are disposed of at off-site landfills, disposers are required to follow the waste acceptance criteria established by each landfill. In most cases, landfills will accept sediments generated from residential stormwater conveyance structures without analytical results. However, disposers may be required to characterize (by analytical testing) sediments prior to disposal. Program staff suggests that Co-permittees contact local solid waste disposal facilities to learn their policies regarding the disposal of residuals from urban stormwater conveyance structures. To assist with this process, Program staff developed a memorandum entitled *Information Regarding the Disposal of BMP*

Residuals at County Landfills. The memorandum includes the waste acceptance criteria of several County landfills.

Table 2

The information presented within Table 2 indicates different resource allocations for inspection and maintenance activities conducted within the State of Washington. Municipalities that inspect privately owned facilities have a wide range of costs for BMP inspections. Clark County, Washington reported < 1 FTE for inspection of approximately 275 facilities. On the other hand, the City of Federal Way, Washington reported 2 FTE and \$150,000 for inspection of approximately 650 facilities. Comparing inspection costs is confounded by differences in inspection frequencies.

Additional resources that provide BMP construction, inspection and maintenance costs include the following:

- [Cost Analysis: Washington Department of Ecology Year 2001 Minimum Requirements for Stormwater Management in Western Washington](#) (prepared by Herrera Environmental Consultants, Inc, August 2001);
- [Best Management Practices Guide for Stormwater BMP: Maintenance of Structural BMPs](#) (prepared by the Greater Vancouver Sewerage and Drainage District); and
- [Unit Costs for Stormwater Treatment Practice Maintenance - Draft](#) (prepared by the Center for Watershed Protection).

These resources are attached to this memorandum as electronic links.

Conclusions and Recommendations

Program staff has the following conclusions and recommendations:

- Existing BMP O & M cost data may be used to identify order-of-magnitude, planning level costs for a range of treatment control BMPs. Municipal staff can use cost estimates to inform the development community.
- Out of the four resources listed in Table 1, the California BMP Handbook for New Development and Redevelopment provides the best BMP O & M cost estimates. The BMP Handbook provides updated cost data (for construction and maintenance activities) relevant to conditions within California.
- Due to the inherent variation of maintenance costs associated with variable local conditions and regional characteristics, existing information is not useful in identifying actual O & M costs. Cost estimates are best determined by comparing treatment control practices or systems which have similar design and size; and which occur in areas with similar local conditions.
- Existing municipal BMP inspection budgets provided from municipalities within the State of Washington give a rough estimate of the resources needed by Co-permittees to inspect privately owned stormwater facilities. However, actual inspection costs for Co-permittees will largely depend on available resources to inspect a subset of prioritized treatment measures, with appropriate follow-up and correction, on an annual basis.
- Co-permittees should develop a mechanism to track O & M costs for publicly owned stormwater BMPs. In addition, Co-permittees should determine the inspection costs and effort required to verify proper maintenance of privately and publicly owned BMPs. Determining inspection and maintenance costs over time will assist Co-permittees in adjusting BMP selection and design criteria and improving inspection program efficiency.

References

California Stormwater Quality Association. Stormwater Best Management Practice Handbook: New Development and Redevelopment. [Online] Available: <http://www.cabmphandbooks.com/Development.asp>, April 14, 2003.

Center for Watershed Protection. *Unit Costs for Stormwater Treatment Practice Maintenance-Draft*. [Online] Available: http://www.stormwatercenter.net/Manual_Builder/Maintenance_Manual/6%20-%20Cost%20Data%20in%20Tabular%20Format-NA/cost_frequency.pdf, May 13, 2003.

Gary R. Minton. *A Survey of Installation and Maintenance Costs of Stormwater Treatment Facilities*, June 2003.

Greater Vancouver Sewerage and Drainage District. Liquid Waste Management Plan- Stormwater Management- Chapter 5: Maintenance of Structural BMPs. [Online] Available: http://www.gvrd.bc.ca/services/sewers/drain/Reports/best_mgmt_guide/Volume%201%20BMP/vol1_5.0operational.pdf, May 13, 2003.

Herrera Environmental Consultants, Inc. Cost Analysis: Washington Department of Ecology Year 2001 Minimum Requirements for Stormwater Management 2001. [Online] Available: http://www.ecy.wa.gov/programs/wq/stormwater/cost_rpt.pdf, May 13, 2003.

Stormwater Program, California State University-Sacramento: Office of Water Programs. California Department of Transportation BMP Retrofit Pilot Program. [Online] Available: <http://stormwater.water-programs.com/Papers/California%20Department%20of%20Transportation%20BMP%20Retrofit%20Pilot%20Program.pdf>, May 29, 2003.

United States Environmental Protection Agency, Office of Water. EPA-821-R-99-012: Preliminary Data Summary of Urban Storm Water Best Management Practices-Chapter 6: Costs and Benefits of Storm Water BMPs. [Online] Available: http://www.epa.gov/waterscience/stormwater/usw_d.pdf, May 13, 2003.

Table 1. Average construction and O & M costs for selected stormwater BMPs provided by four existing information resources.

Stormwater BMP	BMP Handbook ¹		EPA Study ²		BASMAA Guidance ³		CalTrans Study ⁴	
	Construct (units vary)	Annual Maintenance (units vary)	Construct (\$/cubic ft)	Annual Maintenance (% const cost)	Construct (\$/acre)	Annual Maintenance (total \$)	Construct (total \$)	Annual Maintenance (Hours)
Infiltration basin	\$2-18 cu ft	5-10% const costs	1.3	5-10			241,000-273,000	193
Infiltration trench	\$5-50 cu ft	5-20% const costs	4	5-20			196,000-218,000	70
Vegetated filter strip	\$0.3-0.7 sq ft	\$350/acre	0.0-1.3	\$320/acre			100,000	202
Vegetated swale	\$0.25-0.5 sq ft	\$0.58-0.75 per linear ft	0.5	5-7	240-669	\$790	59,000-156,000	211
Bioretention	\$3-40 sq ft	N/a	5.3	5-7				
Porous pavement	\$10,105 acre	\$3,960/year						
Wet pond	\$45k - 450k (1 acre-foot)	3-5% const costs			11,065-13,600	\$500-2,600	694,000	570
Constructed wetland	\$57k (1 acre-foot)	3-5% const costs	0.6-1.25	2				
Extended detention basin	\$41.6k (1 acre-foot)	3-5% const costs	0.5-1.0	<1	4500	\$2,000	166,000-855,000	136
Media filter (Sand filter)	\$18.5k (1 acre site)	\$1706/year	3.0-6.0	11-13	15,900	N/a	231,000-479,000	93
Underground detention tank					18,375-183,900	N/a		
Drain inlet filter	\$2-3k	N/a			6,410-17,072	N/a	32,000-44,000	118
Oil/Water Separator							178,000	139

¹ California Stormwater Quality Association. Stormwater Best Management Practice Handbook: New Development and Redevelopment, April 2003 .

² United States Environmental Protection Agency, Office of Water. EPA-821-R-99-012: Preliminary Data Summary of Urban Storm Water Best Management Practices-Chapter 6: Costs and Benefits of Storm Water BMPs, August 1999.

³ Gary R. Minton. *A Survey of Installation and Maintenance Costs of Stormwater Treatment Facilities*, June 2003.

⁴ Stormwater Program, California State University-Sacramento: Office of Water Programs. *California Department of Transportation BMP Retrofit Pilot Program*, January 2001.

Table 2. Inspection and maintenance budgets for seven municipalities in the State of Washington (Minton, June 2003)

City	Number of Facilities	Facilities Inspected/Year	Inspection Budget	Maintenance Budget
Bellevue, WA	302 public facilities	100%	\$15,000	\$39,000
	1,500 private facilities	50%	2.2 FTE	Privately Maintained
Clark County, WA	~275	100%	< 1 FTE	Privately Maintained
King County, WA	1,215 SFR 165 regional	Varies with history of the facility	\$350,000	\$1.27 Million
	850 commercial	100%	\$175,000	Privately Maintained
Olympia, WA	~300	50%	0.5 FTE, ~\$30,000	Maintain 25 public facilities, budget \$44,000
Redmond, WA	~1,300	50%	1.5 FTE + \$5,000 direct costs. Does not include vehicle usage cost	
Snohomish County, WA	~300	33%	\$500,000	
Federal Way, WA	~650	100%	2 FTE, \$150,000	Privately Maintained