

LOCAL GOVERNMENT STORMWATER MANAGEMENT GRANT FINAL REPORT

For the Reporting Period: July 7, 2007 through June 30, 2009

Recipient: Mason County

Grant/Loan Number: G0800202

Project Title: Oakland Bay Local Government Stormwater Grant

Project Period: July 7, 2007 – June 30, 2009
(Start and end date [from grant agreement])

Ecology Contacts: Melanie Tyler, HQ, Lacey
(Project/Financial Manager)

Funding:	Total Budget:	<u>\$75,000</u>
	Total Grant/Loan Award:	<u>\$75,000</u>
	Grant/Loan Remaining in the Fund:	<u>\$ Still processing Invoices</u>

Stormwater / Water Quality Problem:

Oakland Bay connects to the larger Puget Sound via Hamersley Inlet and is a significant part of the shellfish industry in Washington State. High levels of bacterial contamination from ground and surface waters have been detected in areas along Oakland Bay. These levels pose health risks to animals and humans, and threaten the shellfish harvesting and recreation activities in this area.

Under this grant Mason County was looking to establish a program to improve and prevent future water downgrades with a new efficient and cost effective treatment to improve and protect the water quality in Oakland Bay.

Following Quality Assurance Project Plan (QAPP) approval, Mason County applied a new method of stormwater treatment with the use of mycofilters (burlap bags filled with woodchips that have been inoculated with mycelium, a fungus that feeds on fecal coliform in the water as it passes through). This cost effective treatment provides a natural way to reduce the level of fecal coliform bacteria, hydrocarbons and metals that are conveyed by stormwater drainages to the bay.

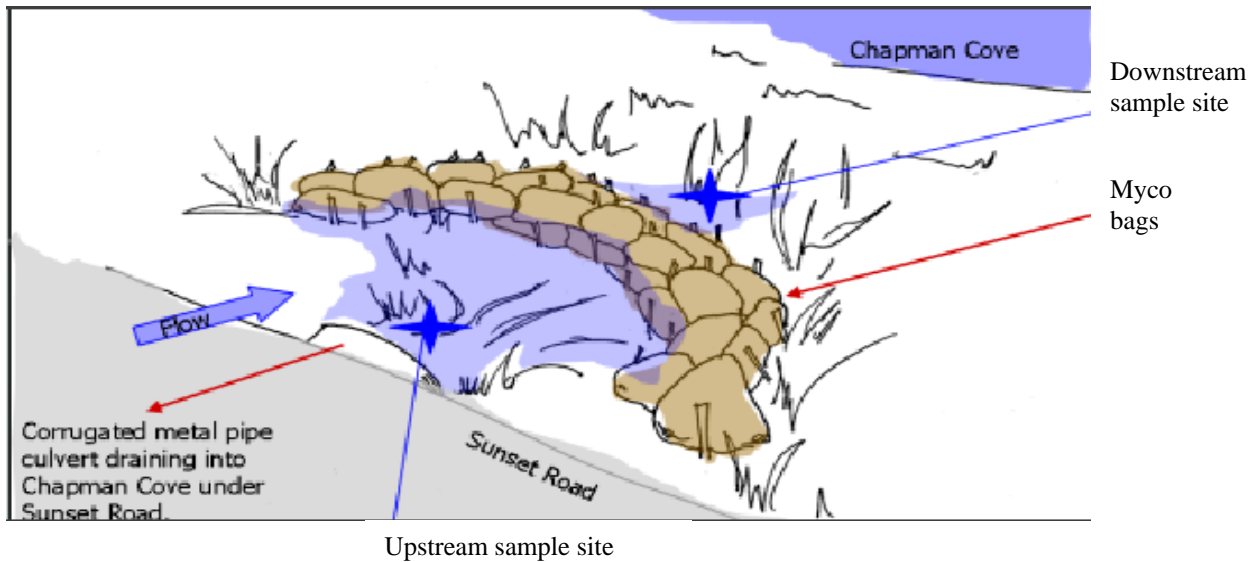
Community outreach has been a major factor in stormwater improvement and prevention. Workshops educating residents in the area about the problems with stormwater, shoreline stabilization, water quality protection, and the importance of preserving and planting native plants. Public workshops and hearings have been held to regulate stormwater management with plans adopted by ordinances.

With the help of other Stormwater grants from Ecology, the County's Stormwater Management Program has been moving forward with updates to the County's Stormwater Policies and Regulations and development of Stormwater Management Plans for Allyn, Belfair, and Hoodspport, Countywide Stormwater Management Plan all components acknowledging current regulations and also considering future implementation steps that provide a framework for continued Countywide Stormwater Management Program development and implementation.

Key Accomplishments:

With the use of mycofilters, Mason County is treating surface stormwater flows with cost-effective/time-effective treatment. Two mycoremediation sites were monitored during the sample period in order to test effectiveness of experimental mycoremediation technology. The mycofilters selected were at Ecler Road and Sunset Rd. The mycofilters test sites were selected based on a history of high fecal coliform counts in winter. The other factors that were considered in selecting sites were use of design elements may become typical in future installations and ability to measure flows at site.

Example mycofilter test site- Sunset Rd.



Mycoremediation sampling has been completed in accordance with the approved Ecology QAPP. At least 10 fecal coliform water samples were collected at each site.

Table 1 Fecal coliform results (MPN/100mL water)

Site	Geometric Mean	# samples	03/02/09	03/24/09	04/16/09	04/22/09	04/30/09	05/04/09	05/13/09	05/21/09	05/29/09	06/03/09	06/10/09
OBC-031 (Above Ecler)	9.33	10		80	8	2	2	2	7	30	8	26.50	22
OBC-032 (Below Ecler)	8.89	10		80	4	1.9	4	11	4	8	4	30	30
OBY-045 (Above Sunset)	3.36	11	2	8	8	4	2	1.9	11	4	1.9	1.9	2
OBY-046 (Below Sunset)	6.32	11	8	13	2	11	15.5	12.50	8	8	3	1.9	4

Water flow measurements were collected concurrently with FC sampling to assess FC loading at the time of sampling.

Table 2- Reduction in Fecal Coliform loading attributed to mycoinstallation (in FC/day)

	3/2/2009	3/24/2009	4/15/2009 or 4/16	4/22/2009	4/29/2009 or 4/30/09	5/4/2009	5/13/2009	5/21/2009	5/29/2009	6/3/2009	6/10/2009
Ecler	0	0	44928	950.4	-22464	-163296	101088	133056	20736	-12096	-27648
Sunset	-46656	-34560	25920	-18144	-11664	-18316.8	18144	-24192	-3801.6	0	-5184

Negative numbers indicate that results were higher after the mycoinstallation. Supporting data for flow calculations has been provided as a separate excel workbook

- Trend analysis- Probability results were calculated at <http://faculty.vassar.edu/lowry/wilcoxon.html>. A Wilcoxon signed rank test was used, which is a standard statistic for hypothesis testing before and after results for nonparametric data. Ecler results were W=3, n=9. W= 29 would be equivalent to a p=0.05 so there is no statistically significant difference between before and after mycoremediation. At the Sunset site W= -36, n=10 z= -1.81 and p=0.0351. That p value coupled with a negative W means that there is a statistically significantly increase in fecal coliform below mycoremediation.

Samples were collected under wet and dry conditions. Dry weather sample events were defined in the QAPP as 72 hours without precipitation and wet weather sample events as precipitation within 72 hours. The split between wet and dry weather was about even, with 6 wet sample events and 5 dry events. In the table below a wet weather sampling event is determined differently than in the QAPP. Over 0.5 inches of rain in the past five days was the criteria used for wet events. This is more similar to DOH shellfish methods of data analysis than to the QAPP.

Table 3 Fecal Coliform and Precipitation results

	Geo mean precip	Geo mean no precip	03/02/09	03/24/09	4/15/2009 or 4/16/09	4/22/2009	4/29/2009 or 4/30/09	5/4/2009	5/13/2009	5/21/2009	5/29/2009	6/3/2009	6/10/2009	event count- higher below after rain	event count- higher below no rain	percentage of sample events higher below
OBC-031 (Ecler above)	7.11	11.18		80	8	2	2	2	7	30	8	26.50	22			
OBC-032 (Ecler below)	10.89	7.76		80	4	1.9	4	11	4	8	4	30	30	2	2	40%
OBY-045 (sunset above)	3.45	3.29	2	8	8	4	2	1.9	11	4	1.9	1.9	2			
OBY-046 (sunset below)	8.34	5.02	8	13	2	11	15.5	12.5 0	8	8	3	1.9	4	4	4	80%

Days with precipitation are highlighted in grey. Sample results that show the FC higher after mycoremediation were highlighted in yellow. The distribution between wet and dry results looks roughly even, suggesting that precipitation did not reduce the effectiveness of mycoremediation. No additional statistical analysis can be done due to small sample size.

The results of this study pose questions about what factors influence fecal coliform reduction at mycoremediation sites. There may have been variability in environmental conditions such as temperature, light, precipitation and amount of nutrients that resulted increases or reductions of effectiveness. Samples were collected on ten different days over a three month period. Over the course of the study environmental conditions probably shifted from conditions typical of cool wet weather toward dry conditions.

Other factor that potentially affect the results of a mycoremediation study are-

- Variability in sampling environments upstream and downstream of the mycofiltration installation could affect the data. Samples collected above the mycofiltration weir installations were collected from a pool upstream the installation. Samples collected below the installations were collected from a shallow riffle downstream of the installation. Fecal coliform analysis is variable due to the fact that fecal coliform bacteria can be buoyant and can be concentrated in the surface layer of the water. Bacteria can also clump together and can adsorb to sediment. Sampling from a pool would reduce the possibility of sampling the surface layer of the water by collecting samples from below the surface of the water whereas the shallow riffle sample could have been contaminated by bacteria concentrated in the surface layer. In addition, a sample collected from a pool would be less likely to collect sediment and associated adsorbed bacteria than a sample collected from a shallow riffle.
- Other bacterial interference – Klebsiella bacteria
- Other mushrooms (turkey tail- trametes versicolor)
- Check dam designs allowing clumped bacteria to flow on surface and bypass treatment
- Biological viability of mycelium may be in question in some installations
- Impounded water above treatment may cause animals to move into the area below treatment. The CD observed this occurring during treatment bag installation at one site.

In future mycoremediation studies the variable mentioned above should be addressed in the study design. In order to accomplish this, a much larger data set will need to be collected. No provisions for control sites were included in the QAPP. In future studies control sites should be part of the study. Testing bags of plain wood chips would help determine what extent filtration is a factor in fecal coliform reduction at treatment sites. Testing for Klebsiella is needed.

Regular maintenance and replacement of the chips is definitely needed. Bags seem prone to disintegrate faster at some of the sites. Rain events cause blowouts. Checking sites at least quarterly in the rainy season seems advisable.

Project Outcomes Achieved:

- Cost-effective/time-effective treatment to surface stormwater flows with the use of Mycofilters
- Quality Assurance Project Plan (QAPP) approved February 18, 2009 for mycoremediation investigation for Annas Bay and Oakland Bay Grant Projects. Three mycoinstallations were selected for test sites in Oakland Bay, Lower Ecler Road #1, Upper Ecler Road # 2, and Sunset Road. Lower Ecler Road #1 was treated but not sampled for effectiveness. (See Project Pics & Info.)
- Purchased flow meter for site testing.

Other associated achievements to support Stormwater Management in Mason County:

- Volunteer Stormwater Advisory Committee (**Service term from October 9, 2007 to May 7, 2009**)
- Stormwater Management Plans for the Allyn and Belfair Urban Growth Areas (**Ordinance 180-07**)
- Hoodspout Rural Activity Center Stormwater Management Plan (**Ordinance 119-08**)
- Low Impact Development (LID) (**Ordinance 76-08**)
- Stormwater and Surface Water Utility (**Ordinance 80-08**)
- Update of County Stormwater Management (**Ordinance 81-08**) Revised to stimulate that development in UGAs, RACs, and Water Quality sensitive area must comply with requirements of the 2005 Ecology Manual and delegating authority to Public Works Director to establish Water Quality Sensitivity Areas (WQSA).
- Countywide Stormwater Management Plan (**Ordinance 33-09**)

Public Education and Outreach:

- **Mason Conservation District (MCD)** included a stormwater-management article in its winter 2009 Newsletter, Watershed Wise, **Tips for Managing Stormwater at Home**. (See Appendix I)
- A **Rain Garden and Stormwater Management Workshop** was held on **March 29, 2009** at the Mason County Public Works (MCPW) facility with 53 participants. Erica Guttman of the Native Plant Salvage Project presented and Karin Strelieff of MCD hosted the workshop. MCD and Washington State University Extension (WSU) collaborated on coordination of this workshop. The workshop was provided for residents of both the Annas Bay Shellfish Protection District and the Oakland Bay Watershed.
 1. MCD Staff designed posters, handouts and a press release. Posters were displayed at regional Oakland Bay and Annas Bay businesses as well as at libraries, garden centers and in the *Mason County Journal* and the *Olympian* newspapers with the help of WSU extension.
 2. A tour of the MCPW rain gardens and pervious paving installation was included at the end of the workshop.
(See Appendix II – Press release, posters, workshop evaluation questions/result, and sign-in sheet)
- A **Managing Stormwater in Your Backyard Workshop and Low Impact Development Tour of MCPW** were held on **June 2, 2009 at the MCPW facility** with 22 participants. Karin Strelieff, Resource Technician and Rich Geiger, P.E. of Mason Conservation District presented at the workshop. The workshop was provided for residents of both the Annas Bay Shellfish Protection District and the Oakland Bay Watershed.
 1. MCD Staff designed posters, handouts and a press release. Posters were displayed at regional Oakland Bay and Annas Bay businesses as well as at libraries, garden centers and in the *Mason County Journal*.
(See Appendix III – Press release, poster, workshop evaluation questions/result, and sign-in sheet)
- WSU Extension provided a one-day WSU Water Resources Realtor Education Program on **Low Impact Development** to 28 participants including: real estate professionals, including appraisers, planners, developers and the general public. Various speakers presented on stormwater issues, soils, LID principles and techniques, and LID Ordinances. Also included were field visits to view local LID demonstration sites to view recent instillations of Rain Gardens and pervious concrete. The class was held **at the Shelton Civic Center on October 27, 2008**. The registration fees were covered for three course attendees from Mason County Public Works and Planning Department, equaling \$300. LID Manuals were distributed to each participant of the course.
(See Appendix IV – Press release, poster, and workshop evaluation questions/result)
- WSU produced a **Shoreline Living Workshop** for 19 local residents **at the Pickering Community Club on April 26, 2009** in partnership with WSU Shore Stewards Program and Native Plant Salvage

Project. Erica Guttman presented on shoreline stabilization, water quality protection, and the importance of preserving and planting native plants. Each participant received a 75-page printed copy of *Excerpts of Living on the Shore: A Resident's Guide to Creating & Maintaining a Sound Landscape*. (See Appendix V – Press Release, poster, workshop questions/evaluation results.)

- Mason Conservation District produced **an information two-sided brochure on Stormwater Management Guidelines**. (See Appendix VI)
- **Low Impact Development, a four-page brochure** was created outlining the concerns and impacts of stormwater issues, benefits of LID practices along with descriptions of various LID techniques. This brochure was **distributed at the Shoreline Living Workshop as well as at WSU's On-Site Septic Maintenance Workshop** and will continue to be made available. (See Appendix VII)
- Informational Road Sign placed next to test sites. (See Appendix VIII)
- Local Newspaper article on the Stormwater treatment program taking place in the County. (See Appendix IX)
- Mason Conservation District provided and **distributed 67 rain garden manuals** at the Rain Garden Workshop, Stormwater Workshop, and to landowners receiving direct technical assistance for stormwater management from the Conservation District. (See Appendix X)
- Mason Conservation District produced **an information two-sided brochure addressing MC regulations and resources for LID & Stormwater** (See Appendix XI).
- Mason Conservation District held a **Rain Garden Workshop at Hood Canal Elementary School on April 9, 2009** for the natural resources class. The teacher is interested in working with the Conservation District on stormwater management and completing a demonstration project in the future at the school property.

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