Biofiltration: West Hylebos Log Yard

An innovative solution to a difficult stormwater problem

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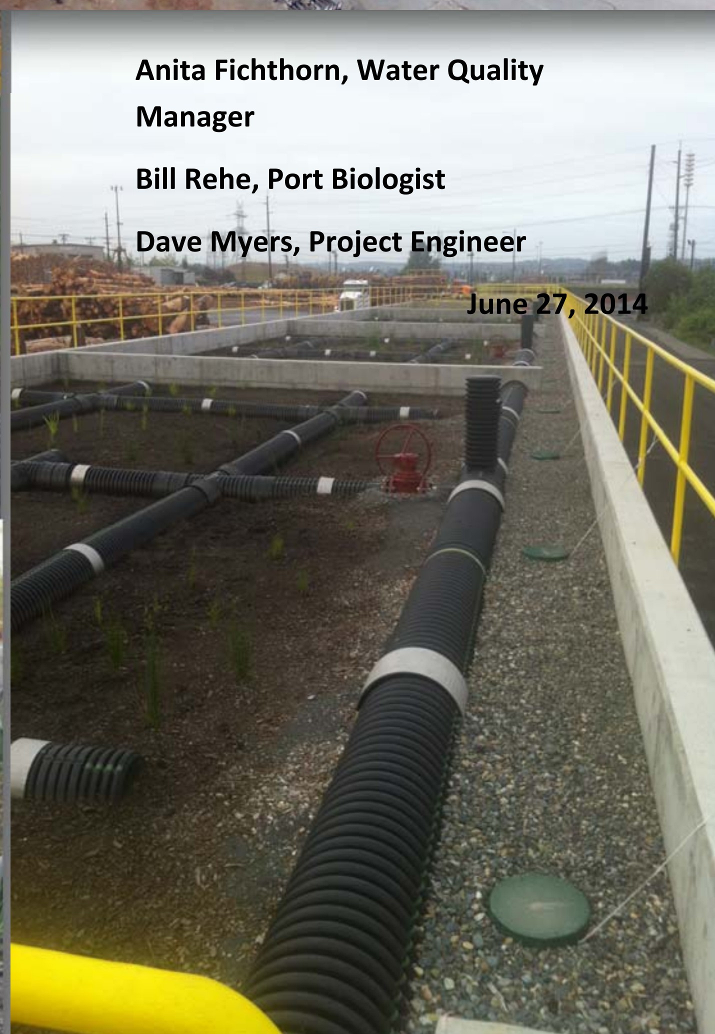

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Introduction

Tacoma was built on lumber. In the 1920s it was known as the lumber capital of America as it exported tens of millions of board feet of lumber around the world. While the Port of Tacoma's (Port) cargo mix is much more diversified these days, it still ships millions of board feet of lumber and logs around the world today. However, mostly due to debarking activities that ensure pests are not transported across oceans, stormwater runoff from the Port's log dock carried very high pollutant loads and was exceptionally difficult to control.

Figure 1 Port has a long history of log operations

In 2010, to comply with the most stringent stormwater regulation in the nation, the Port faced the choice of coming up with cost-effective treatment for the log dock, or shutting down the line of business that supports 40 direct jobs at the Port and hundreds of jobs in logging, trucking and associated services. The Port choose to design (actually invent) and build a $2.7 million treatment facility. After much study, it became clear that mimicking nature's own filtering processes provided the most cost-effective solution. To date, the treatment system reduces pollution loads by 92% and counting.

In 2013, log exports increased by 12.0 million board feet and $520,000 to reach 74.6 million board feet. The Port of Tacoma leases the 25 acre West Hylebos Log Yard (Log Yard) property located at 3401 Taylor Way in Tacoma, Washington to TPT US Limited for log debarking, sorting and export operations.

Goals and Objectives

Environmental stewardship and sustainability have become an increasing focus of the Port of Tacoma over the last decade. The Port has partnered with businesses, non-government agencies (NGOs) and government agencies to collaborate and solve regional environmental challenges. These challenges have included protecting the environment through energy choices, clean air and water strategies, and remediation of contaminated properties.

These environmental stewardship and sustainability efforts are reflected in the Ports Strategic Plan 2012-2022. Goal 5 of the Strategic Plan is to advance environmental stewardship. To meet the goal of advance environmental stewardship, the Port developed the strategy to form partnerships to find innovative solutions to our customers' environmental challenges. One of these challenges is identifying and developing maritime industrial stormwater treatment best management practices. The Port used this technique to identify and solve the industrial stormwater treatment challenge at the West Hylebos Log Yard.

The Port of Tacoma's primary objectives for the West Hylebos Log Yard Biofiltration stormwater treatment were to:

1. Develop a selection process to identify a treatment system that has the capacity to achieve ISGP Benchmarks, includes variability in treatment capacity, meets the land area requirements, use Low Impact Development (LID) Techniques and has an acceptable initial capital and life cycle operations and maintenance costs; and
2. Meets the permitting and conceptual construction schedules in order to implement stormwater treatment for the facility no later than December 31, 2013.

Background

The Log Yard was issued the Industrial Stormwater General Permit (ISGP) October 2009. After two quarterly monitoring events, it became very clear this facility would be required to implement some form of treatment in a very short time. The Port considered a range of runoff treatment approaches ranging from transferring flow to the local municipal wastewater treatment plant, engineered stormwater treatment wetlands, advanced treatment methods, including solids separation, oxidation, and media filtration, and a combination of transfer to City of Tacoma sewer and biofiltration. The aggregate results of the comprehensive evaluation indicated that a biofiltration treatment system (system) would most effectively achieve the project goals.

Objective and Methodology

This type of system is an innovative solution to stormwater treatment. It is traditionally use for flow-control in the urban environment. Since biofiltration is a relatively new stormwater treatment technology, its effectiveness for treating log yard runoff was largely untested and undocumented. For this reason, the Port performed a pilot study to evaluate the adequacy of biofiltration for treating runoff from the West Hylebos Log Yard (Figure 1). The primary goal of the pilot study was to evaluate effluent runoff quality after treatment through two different types of adsorptive filtration media, a non-proprietary biofiltration soil mix (BSM) and another proprietary high flow media (PHFM).

Based on the results of the initial pilot study, bench-scale column tests were conducted in a laboratory to evaluate the effectiveness of various media to treat stormwater runoff from the West Hylebos Log Yard. Additional pilot tests were performed onsite as a supplement to the bench-scale column tests. The main objective of this second round of pilot testing was to evaluate the hydraulic performance, the

Figure 2 Pilot testing of potential media mixes

system had to perform and the water needed to be able to move quickly through the system to keep the footprint within reason. The results of the bench-scale column tests and additional pilot tests guided selection of filtration media to be included in the four-stage biofiltration system (Figure 1).

Prior to preparing construction plans and specifications, the Port prepared a preliminary design based on the results of the pilot study, and worked closely with Ecology to gain their approval of the proposed treatment approach. An Engineering Report was prepared detailing the treatment processes associated with a <u>two-stage</u> treatment system. It was during the Ecology review process that the Port worked with Kennedy/Jenks Consultants to develop a <u>four-stage</u> system.

Figure 3 Pre-construction

Figure 4 Construction

Construction and Implementation – Not your traditional biofiltration system

Construction of the system was completed in December. The entire system is 600 feet long and 45 feet wide. Each of the internal treatment media are placed on top of a layer of pea gravel over a layer of drain rock. The pea gravel acts as a bridging stone to retain the treatment media so the drain rock can remain free of finer particulates and support free flowing conditions. Underdrain pipes are placed within the drain rock layer to collect filtered stormwater flows. The four filtration stages (stages) each have pollutant-specific targets:

- Pretreatment 1 (P1) – Pea Gravel
- Pretreatment 2 (P2) – Sand Amended with Biochar
- Biofiltration 1 (B1) – Sand Amended with Compost, planted with vegetation
- Biofiltration 2 (B2) – Sand Amended with Compost, planted with vegetation.

P1 provides initial treatment using physical filtration to target gross and settleable solids. The pea gravel media is sacrificial and intended to be replaced as needed. P2 applies physical filtration and chemical processes to remove fine solids, metals, and organic contaminants. This cell targets the high COD loading. B1 and B2 applies treatment using physical filtration, and biological processes (biological uptake in the plant materials) to remove remaining pollutants. During plant selection, the Port searched for specific plants that had the highest pollutant uptake ability.

For each of the four treatment stages, stormwater flows are distributed across the surface of the treatment media, filtered through the media, pea gravel, and drain rock layers, and is collected in underdrain pipes. In order to convey stormwater flows through the system, lift stations are installed at specific locations based on system elevations.

Figure 5 Post-construction: Stage 1 biofiltration distribution system in action.

To provide additional treatment when possible, stages B1 and B2 were designed to operate in series or parallel depending upon flow conditions. During low flow conditions (i.e., lesser storm intensity) stormwater flows are routed through the four stages in a series flow pattern (Figure 3A). During high flow conditions (i.e., greater storm intensity) flows automatically exit LS-2 and are valved to distribute flows evenly through both stages B1 and B2 (Figure 3B).

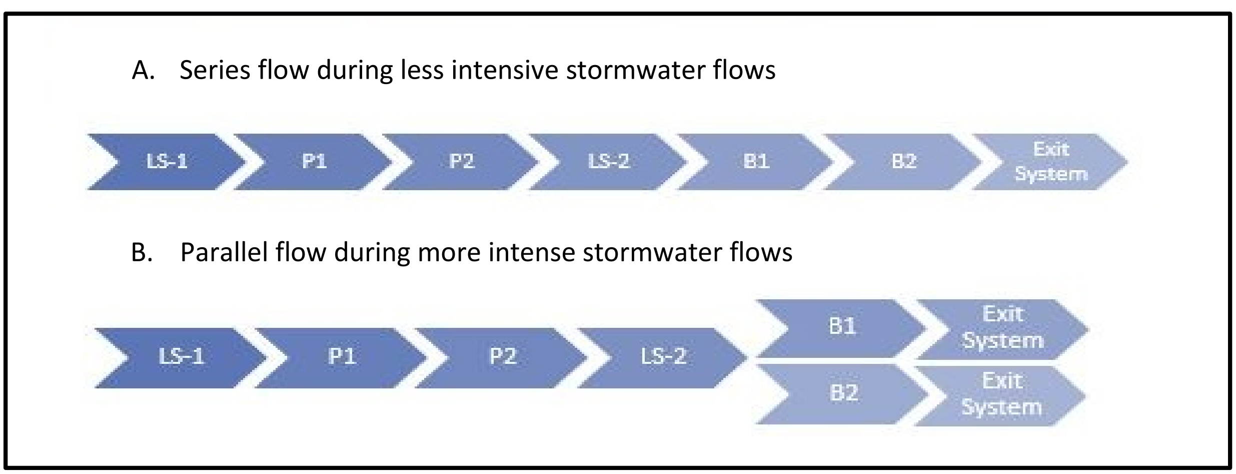


Figure 6 Treatment routing by flow intensity.

Biofiltration at the Log Yard Fulfills the Six Award Criteria

1. The level and nature of benefits to environmental quality, beautification or community involvement;

The Biofiltration system at the West Hylebos Log Yard has increased the environmental quality at the TPT log debarking, sorting, and exporting facility and Commencement Bay by substantially reducing pollutants in the stormwater. Monitored parameters have been reduced by:

- 92% for zinc,
- 81.3% for copper,
- 94% for turbidity, and
- 85% for total suspended solids.

In order to meet these impressive reductions in stormwater pollutants, the Port, led by Anita Fichthorn, worked tirelessly with community members including the Port tenant, Port management, Citizens for a Healthy Bay, local and state regulatory agencies.

2. The level of independent involvement and effort by the port;

The Port of Tacoma funded and led all aspects of the design, construction, and monitoring of the bioretention system. Project objectives and goals were met by engaging many team members from the Port's Planning, Environmental, and Engineering Departments. The Port Engineer and Water Quality Project Managers led the design and construction of the project including the management of consultants and contractors.

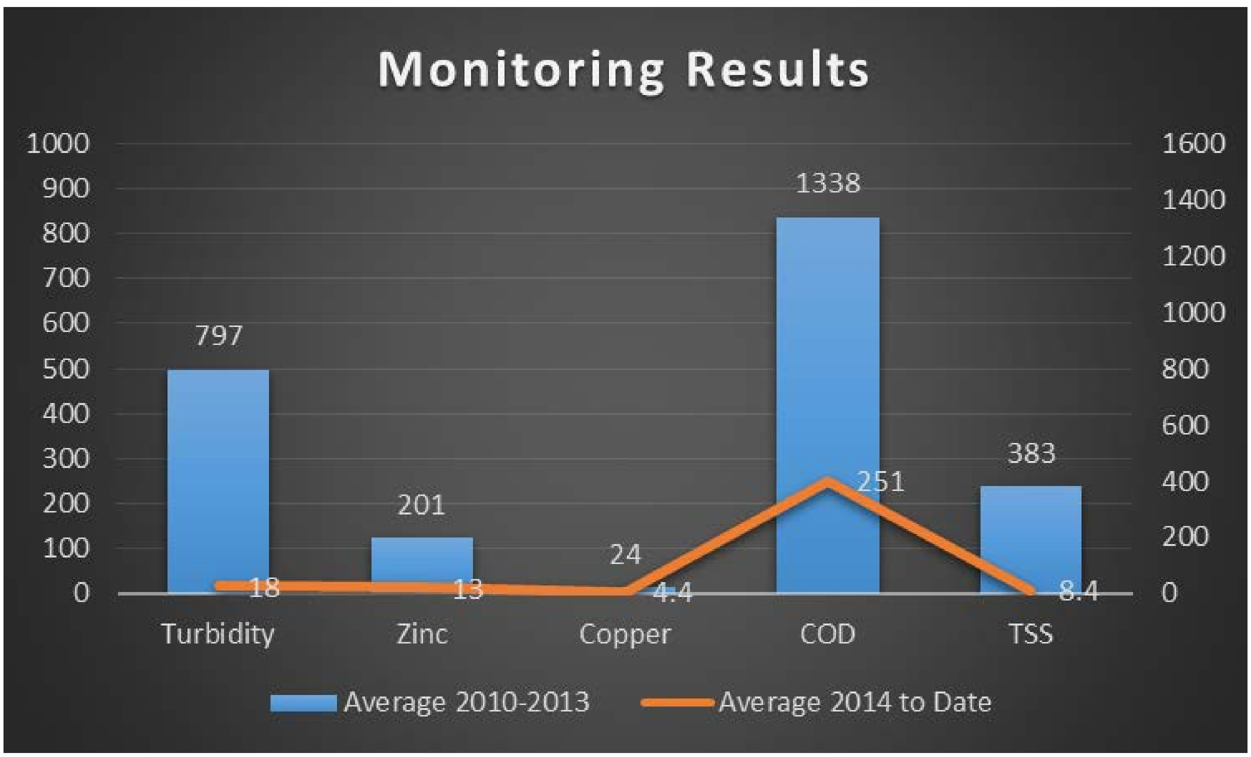
3. The creativity of the solution or program;

The goal of this project was to work with our tenant and regulatory agencies to find an innovative solution to the log yards stormwater issues. The Port analyzed six project alternative to determine the most cost effective stormwater treatment system for the log yard. Instead of rushing to the design and build stage, the Port initiated a pilot program to verify the effectiveness of the bioretention system. The results of the pilot study helped the Port refine the bioretention system and determine the size.

4. *Whether the project or program results are apparent (the project must be complete through some beneficial increment);*

The treatment system has been in operation since December 31, 2013. Since start-up, zinc, copper, turbidity, TSS and pH results have been below the permit benchmarks, however, Chemical Oxygen Demand (COD) has been the elusive parameter. The treatment has been rapid improving over the last 3 months, however, the plants in the Biofiltration system are still very young and small. We expect water quality to continue to improve over time, as the plantings mature and are able to provide a higher level of treatment.

Table 1 Monitoring results pre and post-treatment



The Industrial Stormwater General Permit has a benchmark of 120 mg/L for COD. The treatment system has not quite reached the 120 mg/L for COD yet, as the latest sample result was at 130 mg/L (Figure 7). The reduction percentage for COD from the 6/13/14 sampling event was 86.6%.

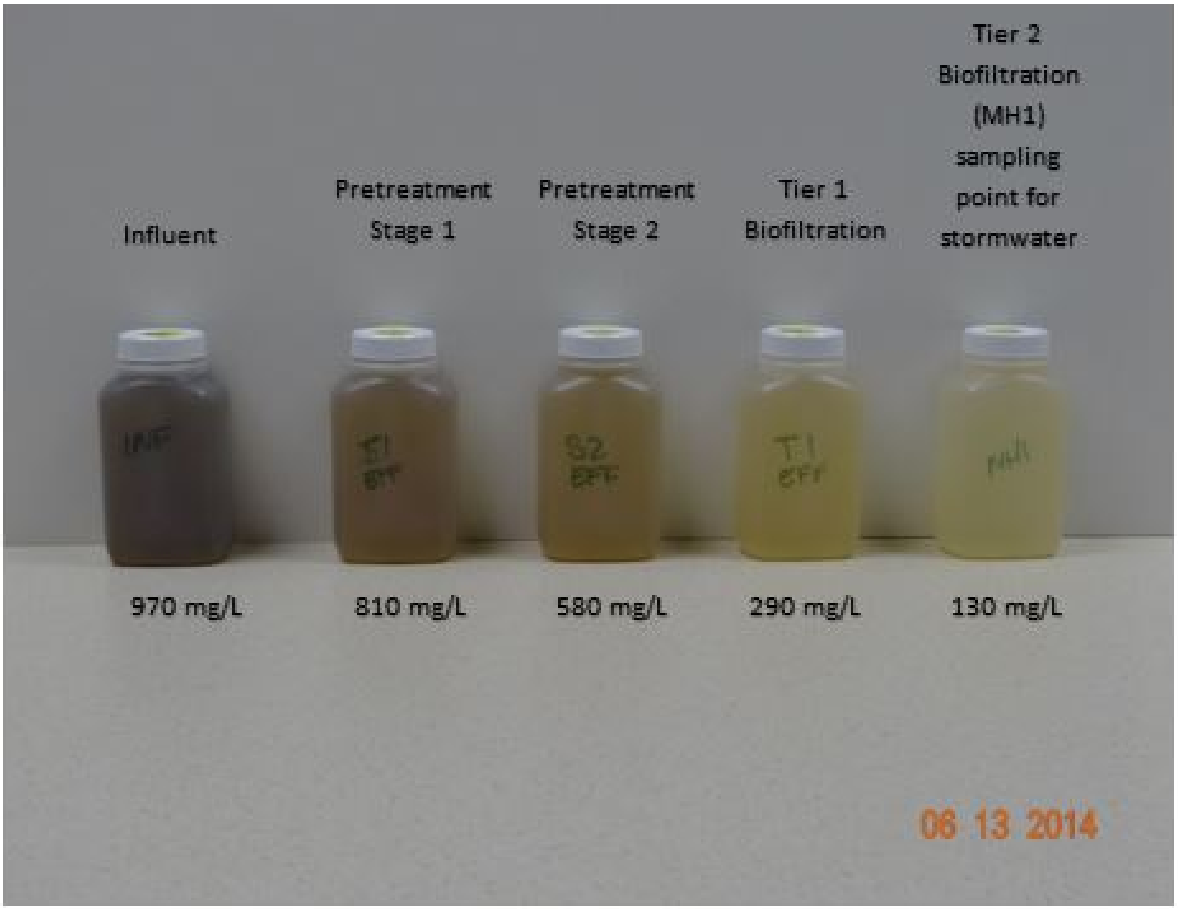


Figure 7 June 13, 2014 COD sample results at the effluent of each treatment stage.

5. *The cost effectiveness of the activity or program.*

The alternatives were analyzed for cost effectiveness based on performance, constructed cost, and operations and maintenance (life-cycle) costs. The Port's intent was to ensure the permit requirements were met for the log yard, while ensuring the preferred treatment system meets the same performance criteria for any type of land use or alternative cargo handling.

Table 2 Cost for alternatives analyzed

	Alternative	Constructed Cost	Life Cycle Costs-30 year	Revenue loss due to encumbered land	*Totals
1	Discharge to Sanitary Sewer	$4,106,000	$4,905,000	$1,067,000	$10,078,000
2	Stormwater Wetland	$3,541,000	$498,000	$4,835,000	$8,874,000
3	**Bioretention/Biofiltration**	**$1,084,000**	**$955,000**	**$2,304,000**	**$4,343,000**
4	Advanced Treatment System	$6,824,000	$3,856,000	$711,000	$11,391,000
5	Transfer to Sanitary Sewer/Bioretention	$6,205,000	$1,913,000	$1,906,000	$10,024,000
6	Off-site Bioretention	$2,396,000	$1,199,000	$2,261,000	$5,856,000
*Conceptual Estimates from revised Conceptual Project Plan, Kennedy/Jenks, September 7, 2011					

6. The transferability of the technology or idea to the port industry.

The technologies and ideas used in the creation of the West Hylebos Log Yard Bioretention Stormwater System are readily transferable to other port industry and municipalities. With the realization that stormwater requirements are going to become more restrictive over time, alternatives to sanitary sewers and advance treatment systems that rely on mechanical filtration and chemical treatment are needed. Designing a treatment system that meets the requirement of the particular port industry, is able to achieve ISGP benchmarks, has a variable treatment capacity and meets the size restrictions based on land available is needed. The pilot study approach and materials used in the construction of the stormwater treatment facility can easily be adapted to meet other port industry needs.

Conclusion

The Port has identified and implemented a highly successful stormwater treatment system for difficult-to-control stormwater runoff at the Log Yard. The Port had a number of physical parameters it needed to meet in addition to meeting stormwater benchmarks. Cost of building, maintaining and operating, along with size restrictions of the treatment system had to be carefully weighed. In the end all parties involved, led by the Port's Water Quality Project Manager, was successful in building consensus, substantially improving water quality and supporting the success of the business.

The Biofiltration stormwater treatment system at the Hylebos Log Yard met or exceed both the project objectives and the Port's Strategic Plan goals by:

- Developing a selection process to identify a treatment system that has the capacity to achieve ISGP Benchmarks, includes variability in treatment capacity, meets the land area requirements, uses Low Impact Development (LID) Techniques and has an acceptable initial capital and life cycle operations and maintenance costs;
- Meeting the permitting and conceptual construction schedules and was implemented no later than December, 31, 2013; and
- Forming partnerships to find innovative solutions to our customers' maritime industrial stormwater treatment challenges.