NAVFAC Naval Facilities Engineering Command
ENGINEERING AND EXPEDITIONARY WARFARE CENTER

TechData Sheet

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Hybrid LID/BMP for Industrial Site Stormwater

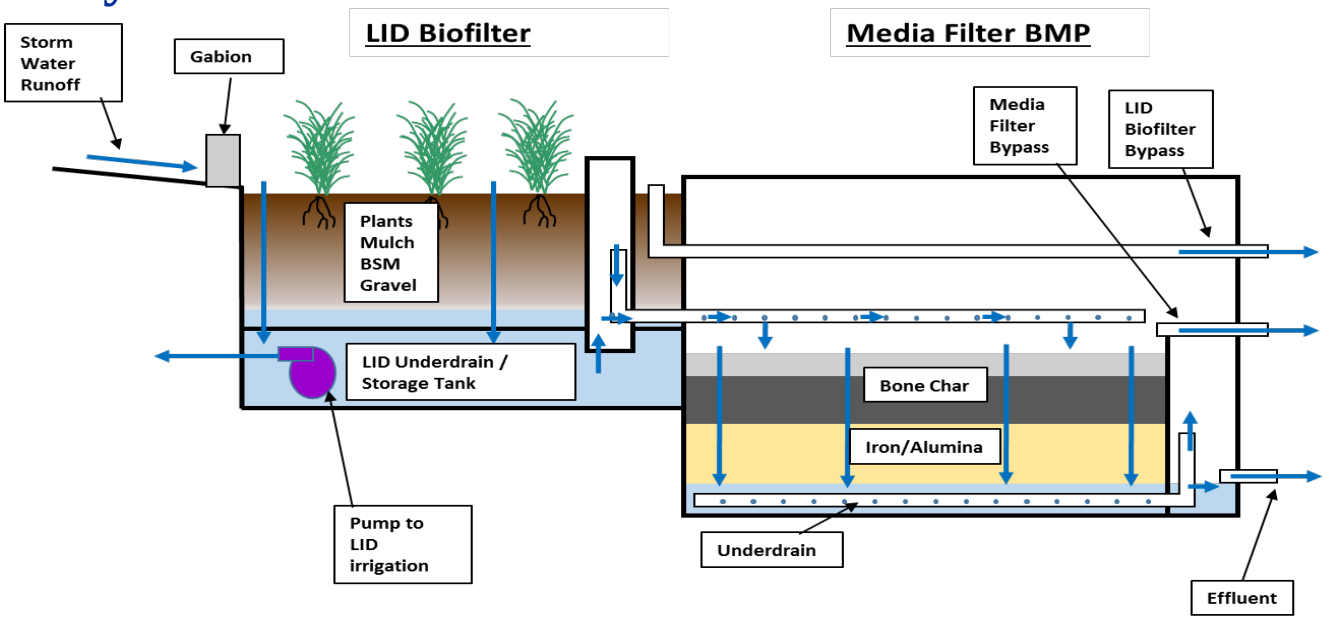

Figure 1: Hybrid LID/BMP Cross-Section View

OVERVIEW

NAVFAC Engineering and Expeditionary Warfare Center (EXWC) engineers developed a hybrid Low Impact Development (LID) / Best Management Practice (BMP) multi-media filter to remove heavy metals from industrial site stormwater. Navy industrial sites are under increasing pressure from regulating bodies to reduce stormwater pollution. Industrial activities, roofing and fencing contribute to elevated levels of zinc and copper in local receiving waters. These heavy metals are toxic to marine life at low levels and bio-accumulate, traveling up the food chain from marine organisms to fish to humans in greater and greater concentrations. EXWC evaluated over 25 heavy metal adsorbing media and pre-filtration technologies, selected the most effective ones, and demonstrated and validated a hybrid system with exceptional metal removal efficiencies.

PROCESS DESCRIPTION

A geotextile fabric wrapped gabion wall, a rock filled wire cage barrier, pre-filters stormwater before it enters the LID Biofilter, which consists of plants, mulch, biotic soil media (BSM) and gravel. The LID Biofilter removes small particulates that can blind the surface of the media. The LID Underdrain/Storage Tank retains stormwater for irrigating the system's plants throughout the year. The Media Filter BMP, housed in a precast concrete vault, adsorbs dissolved metals from the stormwater as it passes through. At a flow rate of 100 gallons per minute, stormwater contacts the media for 8 minutes. To accommodate industrial sites with greater flow rates, the modular design incorporates an additional Media Filter BMP for each additional 100 gallons of per minute. Stormwater exiting the Media Filter BMP gravity flows to the nearest stormwater conveyance or outfall. During heavy downpours, flow exceeding the system capacity bypasses the system.

PERFORMANCE & LIFESPAN

The system removes copper, zinc and total suspended solids with efficiencies greater than 95%, 97% and 88% respectively, as indicated by sampling results in Tables 1 & 2 below.

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For up to 10 years, EXWC projects the Hybrid LID/BMP to capture metal pollutants before requiring media replacement. Minimal routine maintenance, consisting of annual hardwood mulch replacement, general cleanup and plant care, is required to ensure effectiveness and extend system lifespan.

In climates with significant periods of freezing temperatures, the LID component may be impacted by seasonal vegetation die-off and buildup of ice within the structure. Spring thaw and related runoff may result in considerable flows where the LID component will not have sufficient storage capacity and residence time to contribute to pollutant reductions. In arid climates with low frequency, high volume runoff events, bypassing may occur. In addition, replenishment of soil moisture by artificial base flow may be required to maintain vegetation health and functionality during extended periods between rainfall events. Locations in tropical, subtropical and warmer temperate climates that do not experience severe drought are most favorable for the technology.

EXWC patented the Media Filter BMP and licensed it to California Filtration Specialists, the developers of the LID Biofilter. They can easily size a system for your application depending on the size and climate of your industrial site.

COSTS & BENEFITS

Projected capital expenditure to install this hybrid technology ranges from $150-$200K/impervious acre. Cost for maintenance contract support ranges from $3K to $5K per year, per acre. Rapid installation and maintenance is made possible by only using commercially available components and materials.

The Hybrid LID/BMP provides Department of Defense (DoD) facilities with a low cost, decentralized method of meeting their stormwater discharge requirements and maintaining their watershed's health. The system has achieved exceptional removal rates over 90% for copper and zinc as shown in the provided tables.

RECOMMENDATIONS

To acquire more information, contact the Technology Integrator or Principal Investigator listed below.

The development and validation of the Hybrid LID/BMP was made possible by the DoD's Environmental Security Technology Certification Program (ESTCP). Please feel free to visit the ESTCP web site at https://www.serdp-estcp.org. The site is a comprehensive resource of technologies and processes that have been or are being developed, addressing environmental needs identified by DoD personnel to promote DoD operations.

POINTS OF CONTACT

For more specific information about this project, contact:

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Table 1. System Copper Reduction Data from 2018-2019 Water Quality Sampling

Hybrid LID/BMP Copper Reduction, Event Mean Concentration (EMC)						
Rain Event Date	Total Copper EMC		Dissolved Copper EMC		Total Copper Efficiency Ratio (%)	Dissolved Copper Efficiency Ratio (%)
	Influent	Effluent	Influent	Effluent		
11/29/2018	308	5.79	98.5	1.82	98.1%	98.2%
12/5/2018	112	5.71	49.3	1.87	94.9%	96.2%
1/5/2019	39.3	3.20	31.8	0.95	91.9%	97.0%
1/12/2019	84.9	5.97	78.8	6.14	93.0%	92.2%
1/14/2019	66.5	4.23	64.5	3.90	93.6%	94.0%
1/31/2019	118	6.32	75.5	2.07	94.6%	97.3%
2/13/2019	82.3	5.02	53.8	2.31	93.9%	95.7%
2/20/2019	176	1.49	88.3	0.80	99.2%	99.1%
3/2/2019	218	5.29	35.8	2.87	97.6%	92.0%
3/11/2019	67.8	4.05	50.4	1.83	94.0%	96.4%
3/20-21/19	217	6.01	63.7	2.90	97.2%	95.4%
4/29/2019	379	5.64	298	3.08	98.5%	99.0%
5/10/2019	134	4.61	102	2.37	96.6%	97.7%
5/19/2019	137	9.32	116	5.59	93.2%	95.2%
Average Efficiency Ratio	152.8	5.2	86.2	2.8	95.4%	96.1%

Table 2. System Zinc Reduction Data from 2018-2019 Water Quality Sampling

Hybrid LID/BMP Zinc Reduction, Event Mean Concentration (EMC)						
Rain Event Date	Total Zinc EMC		Dissolved Zinc EMC		Total Zinc Efficiency Ratio (%)	Dissolved Zinc Efficiency Ratio (%)
	Influent	Effluent	Influent	Effluent		
11/29/2018	769	8.5	433	4.8	98.9%	98.9%
12/5/2018	320	10.0	223	6.1	96.9%	97.3%
1/5/2019	156	4.5	140	2.5	97.1%	98.2%
1/12/2019	246	5.3	242	9.2	97.8%	96.2%
1/14/2019	204	13.2	203	14.7	93.5%	92.8%
1/31/2019	473	7.1	404	4.2	98.5%	99.0%
2/13/2019	241	6.2	207	5.0	97.4%	97.6%
2/20/2019	702	2.5	625	1.9	99.6%	99.7%
3/2/2019	424	3.2	94.5	4.4	99.2%	95.3%
3/11/2019	240	4.3	204	2.1	98.2%	99.0%
3/20-21/19	379	4.2	291	2.2	98.9%	99.2%
4/29/2019	599	7.5	539	5.9	98.7%	98.9%
5/10/2019	217	6.1	181	4.7	97.2%	97.4%
5/19/2019	265	9.2	239	7.2	96.5%	97.0%
Average Efficiency Ratio	373.9	6.6	287.5	5.4	97.8%	97.6%

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Table 3. System Total Suspended Solids Reduction Data from 2018-2019 Water Quality Sampling

Hybrid LID/BMP Total Suspended Solids, Event Mean Concentration (EMC)			
Rain Event Date	**Influent EMC (mg/L)**	**Effluent EMC (mg/L)**	**Efficiency Ratio (%)**
11/29/2018	280	6.4	97.7%
12/5/2018	82.6	5.2	93.7%
1/5/2019	7.4	2.4	67.6%
1/12/2019	25	2.5	90.0%
1/14/2019	26.5	2.2	91.7%
1/31/2019	30.7	4.2	86.3%
2/13/2019	15.3	3.5	77.1%
2/20/2019	58	1.2	97.9%
3/2/2019	16.8	1[U]	94.0%
3/11/2019	4	1.2	70.0%
3/20-21/19	99.6	2.7	97.3%
4/29/2019	33.6	2.2	93.5%
5/10/2019	16.5	1[U]	93.9%
5/19/2019	9	1.2	86.7%
Average Efficiency Ratio	50.4	2.9	88.4%

[U] The analyte was analyzed for, but was not detected at or above the MRL. Substituted MRL value of 1.0 for calculation.

Table 4. System Total Phosphorus Reduction Data from 2018-2019 Water Quality Sampling

Hybrid LID/BMP Total Phosphorus, Event Mean Concentration (EMC)			
Rain Event Date	**Influent EMC**	**Effluent EMC**	**Efficiency Ratio (%)**
11/29/2018	0.356	0.021	94.1%
12/5/2018	0.145	0.019	86.9%
1/5/2019	0.043	0.011	74.4%
1/12/2019	0.125	0.064	48.8%
1/14/2019	0.084	0.032	61.9%
1/31/2019	0.072	0.015	79.2%
2/13/2019	0.044	0.025	43.2%
2/20/2019	0.102	.010[U]	90.2%
3/2/2019	0.095	.008[U]	91.6%
Average Efficiency Ratio	0.118	0.027	74.5%

[U] Less than Minimum Reporting Limit, estimated value.

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