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July 10, 2015

Dr. Terry Young, PhD, Chair
Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

Subject: Comments on Tentative Order R2-2015-XXXX, NPDES No. CAS612008

Dear Dr. Young and Regional Board Members,

Thank you for the opportunity to review and comment on this Tentative Order. My comments in this letter are focused on bioretention requirements in section C.3. Accompanying this letter is list of other specific recommended changes to Provisions C.3 and C.10 of the tentative order along with justification for those changes.

The following improvements must be made to Provision C.3 to bring it in line with other contemporary Phase I California permits.

- Distinguish between bioretention designs that retain the design storm and those with underdrains that treat and release a portion of the design storm (biofiltration)
- Restore a BMP selection hierarchy that prioritizes BMPs that retain the design storm (rainwater harvesting, infiltration and bioretention without underdrains) above those that treat and release a portion of the design storm (biofiltration).
- Establish clear treatment goals for biofiltration and provide a process for review and approval of alternative designs that meet those performance goals

These changes and supporting information are discussed in more detail below.

Post-construction Best Management Practice (BMP) selection hierarchy

Section C.3 is a critical component of this program as it establishes the framework for new development and redevelopment project design and approval. The current tentative order has been modified from the first draft to include the assumption that bioretention systems as described in section C.3 are as effective as infiltration and rainwater harvest systems. This assumption is then used to justify a decision to allow C.3 bioretention to be used without first exhausting stormwater infiltration and rainwater harvesting options. This would be fine if the C.3 bioretention systems were always designed to retain the entire design storm. However, they will more commonly be designed with an underdrain, through which treated water and residual pollutants will be discharged.

The failure to distinguish between true bio-*retention* designs with no underdrain, and bio-*filtration* designs that release water downstream makes this tentative order inconsistent with other contemporary Phase I NPDES permits in California. Other permits covering Los Angeles, Orange County and San Diego regions require that retention options be used where feasible and allow biofiltration or “bio-treatment” facilities only where retention of the design storm has been demonstrated to be infeasible. This permit must be changed to restore retention of the design storm to the top tier post construction stormwater management strategy. C.3 bioretention designs that include an underdrain must be distinguished from true bioretention systems and must be used only where retention systems are infeasible.

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This assumption about biofiltration equivalency found in the tentative order is linked back to a "White Paper" on Provision C.3 in MRP 2.0 provided by BASMAA which states:

"Bioretention is, on balance, equal in water-quality effectiveness to harvesting/use or infiltration."

This is a patently false assumption since C.3 bioretention systems most often do not retain the water quality event in its entirety. As the white paper notes in section 4.2, "few developable sites have sufficient soil permeability to support infiltration of the specified amount of runoff". It is further noted that an infiltration rate of 1.6 inches per hour is required for the standard biofiltration design to infiltrate the design storm. This is far greater than the actual infiltration rate at most locations governed by the MRP, so it logically follows that the vast majority of bioretention systems designed to current C.3 standards will routinely discharge treated water during storms. Where runoff is discharged from a treatment facility, pollutants will also be discharged unless that treatment facility is 100% effective for all pollutants. Put simply, any flow-through treatment system will be less effective than a retention system that has no discharge. This is the basis by which other permits have elevated retention BMPs above flow-through treatment BMPs.

Other Phase I NPDES permits and implementation manuals in California identify a threshold native soil infiltration rate between 0.3 and 0.5 inches per hour above which infiltration is considered feasible and must be used as long as there are no other site constraints. Infiltration BMPs infiltrate the entire design storm and do not need underdrains. This class of BMPs includes bioretention (without an underdrain) and other infiltration systems like infiltration trenches, infiltration basins and subsurface infiltration galleries.

Even at native soil infiltration rates lower than 1.6 inches per hour, infiltration systems are rarely bigger than 4 % of the contributing impervious drainage area since they can be designed with greater ponding depths. For example, an infiltration trench draining the water quality volume over 48 hours into soils with a permeability of 0.5"/hr could be designed with an effective ponding depth of 24 inches and would have a sizing factor of 3%. Where infiltration is feasible, infiltration BMP siting requirements have not proven overly burdensome in other areas of California. On the contrary, at higher infiltration rates and ponding depths, some systems can be significantly smaller than C.3 bioretention systems. For example, on very constrained sites, such as urban redevelopment or infill projects, subsurface infiltration BMPs can be placed under parking lots or roadways with no dedicated site footprint. Non-vegetated infiltration systems have no ongoing potable water demand and, depending on type of pretreatment used, may have a lower operation and maintenance burden.

Bioretention performance

The white paper notes that there has been a decade of experience with bioretention systems in the Bay Area. However the only pollutant removal effectiveness and runoff retention data presented in the report is for PCB and Methylmercury removal for four storms. Considering that the 5 inch-per-hour bioretention design is the very foundation of the post-construction stormwater mitigation program, it is astounding that in 10 years there has been no other water quality or runoff reduction data collected. It is also surprising that the tentative order would essentially double down on this untested design by elevating it to equal status with retention BMPs.

The stated goal of Provision C.3 "is for permittees to use their planning authority to reduce pollutant discharges and runoff flow into the storm drain system"[i]. How can we be sure that C.3 bioretention applied on virtually every priority project is actually reducing the discharge of pollutants of concern to the maximum extent practicable if no performance data is collected? Provision C.3 requirements result in significant costs to the development community and are the best tool for minimizing the impact of urban development. Therefore, it is imperative that we move beyond generous but untested assumptions about performance and design and toward careful, quantitative assessment of performance. We

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owe it to the environment, development community, and our own scientific integrity to restore the iterative process by measuring the impact of our regulatory directives.

Thankfully, bioretention and biofiltration system performance has been assessed in other places. There are two readily available performance summaries that shed light on the likely performance of the C.3 bioretention system. The first is the International Stormwater BMP Database (www.bmpdatabase.org) which includes results from 22 bioretention studies. In 2014, a summary report[ii] was published that detailed bioretention performance for a variety of conventional stormwater pollutants. A subset of that data is presented below in Table 1. Significant removals for TSS, E. coli, Total Copper, Total Zinc, and Total Nitrogen were observed based on median influent and effluent concentrations. A significant net export of phosphorus was observed. While the system design, sizing and media composition of systems represented in this summary vary compared to the C.3 standard, they do suggest that biofiltration systems are effective for sediment and sediment bound particles, less effective for dissolved or very fine pollutants and can actually be a source of nutrient pollution.

Bioretention BMP performance from the 2014 International Stormwater BMP Database Pollutant Category Summary Report for Solids, Bacteria, Nutrients and Metals							
Parameter		TSS (mg/L)	E. coli (#/100mL)	Total Copper (µg/L)	Total Zinc (µg/L)	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)
Count of Studies		22	4	7	6	27	13
EMC Count	Influent	461	61	125	126	515	245
	Effluent	393	61	107	112	435	194
25th percentile	Influent	18	44	3.03	10.7	0.062	0.75
	Effluent	4.9	6	2.81	2.72	0.08	0.59
Median	Influent	38.1	290	5.21	19.7	0.12	1.16
	Effluent	9.9	101	5.79	12.2	0.24	0.92
75th percentile	Influent	86	2400	9.7	53.5	0.246	1.87
	Effluent	20	2400	13.45	23	0.6	1.61

Table 1 - Bioretention BMP performance from the 2014 International Stormwater BMP Database Pollutant Category Summary Report for Solids, Bacteria, Nutrients and Metals

A second reference is an evaluation of biofiltration performance that was conducted by Roseen and Stone[iii] for the City of Seattle as part of an effort to understand how design criteria and media composition influence performance. As part of their research, they compiled site, design, and performance data for 80 field bioretention systems and 114 lab columns/mesocosms. Data from the International BMP Database were included in this pool as well as other research studies. Performance data were compiled as study summaries (e.g., study median influent, effluent, and removal efficiency).

Roseen and Stone then utilized design information to categorize systems into groups based on common combinations of factors. They then conducted a statistical evaluation of how performance was influenced by design factors such as presence/absence of mulch layers, use of compost in media, infiltration rate of media, ratio of tributary to biofiltration area, presence/absence of pretreatment, presence/absence of internal storage layers, etc. Roseen and Stone found that the presence of compost in mixes strongly influences the variability in performance and potential export of pollutants,

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including phosphorus, nitrogen, and copper. Systems without compost and/or with a high fraction of sand tended to provide the most consistent and best performance for these pollutants.

There have also been a few notable studies recently that are not included in either report that follow the C.3 bioretention design more closely. Recent bioretention studies, mainly in Washington State[iv,v,vi], have identified the potential severity of pollutant export of nitrogen, phosphorus, and copper from traditional biofiltration systems and have evaluated the potential sources of these issues. For example, a full scale field monitoring study in the City of Redmond (WA) observed export of nitrate on the scale of 100 mg/L higher than influent quality and dissolved copper on the scale of 10 to 20 µg/L higher than influent. Follow up research has shown that compost is consistently associated with export of copper, nitrogen and phosphorus, even when the highest quality compost products available are used in designs and at proportions as low as 10% of the media blend by volume. This research also found that some sand products can also contain elevated levels of phosphorus and copper. These studies are relevant because the standard biofiltration media specifications for Western Washington are similar to C.3 bioretention soil specifications, calling for 60 to 65 percent sand and 35 to 40 percent compost.

Taken together, these reports demonstrate that bioretention effluent performance is highly variable and that where the water quality volume is not fully retained, biofiltration soil composition is critical, not just to maintain plant vitality and hydraulic capacity, but also to ensure significant pollutant removal performance. It also suggests that widespread implementation of sand and compost based systems may actually cause or contribute to nutrient impairments downstream. Rather than ignoring these lessons, the MRP 2.0 should be written to stimulate research that further illuminates the link between system design and performance and results in more effective BMPs.

Engaging the private sector to reduce costs and stimulate innovation

The burden of BMP performance research and development does not have to be borne by the permittees. Ideally, the MRP 2.0 would establish a performance standard which must be met for flow–through treatment systems. If this clarity was provided, along with a verification process whereby performance relative to that standard could be assessed, the academic and private sectors would come alive to develop innovate solutions. This is the approach taken in some other states, notably Washington, where specific performance targets for TSS, oil, dissolved metals and phosphorus removal have been set and a program for the evaluation of emerging technologies has been established[vii]. Closer to home, a similar approach has been taken by the Sacramento Stormwater Quality Partnership[viii] where peer reviewed field verification of TSS removal performance is required for use of innovative stormwater treatment systems.

A simple change to the MRP would be to require that any flow-through treatment system, including any future media blends developed by the permittees or others, be demonstrated to meet the Basic (TSS), Phosphorus and Enhanced (dissolved Cu and Zn) performance standards set by the Washington State Department of Ecology. Those standards are attached to this letter. These standards are readily achievable by as is evidence by multiple approvals of public and private domain technologies by the Washington State Department of Ecology. Based on research of similar designs they are also likely unattainable by the current bioretention soil blend used in the region, and as such would represent an improvement in performance.

The San Diego region permittees recently completed their BMP Design Manual[ix] as a requirement of their Phase I municipal stormwater permit. That manual requires that infiltration and rainwater harvesting BMPs be used where feasible and that were these BMPs are infeasible, biofiltration systems with a design similar to the C.3 bioretention system be used with an underdrain. Alternatively, bio-treatment systems that meet Ecology performance standards can be used. In the meantime, the City of San Diego and others are collaborating to research and improve the performance of their bioretention soil mix. This is a fair and objective approach that should be replicated in this permit.

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As it stands now, Section C.3.c.i.2.c.ii allows the permittees to propose alternate bioretention soil blends to regional board for approval. Unfortunately, this puts all the media development and testing responsibility on the shoulders of the permittees which would divert precious resources away from other important stormwater program activities. This provision should be improved in three ways. First, a performance target should be set for alternative designs. Currently, plant survivability and hydraulic capacity are the only criteria. Adopting the Ecology standards would be a good approach that is consistent with other programs. Second, alternative system designs should be allowed as well as alternative 5”/hr soil blends. As long as pollutant removal and hydraulic capacity performance standards are met, there is no reason to constrain systems to 5 inches per hour. Third, any party should be allowed to bring alternative designs forward for Regional Board review, not just permittees.

Summary

The San Francisco Water Board has been a leader on stormwater issues in the past with some of the first hydromodification regulations and in pioneering the design of 5 inch per hour bioretention systems. However, much has been learned in the decade or more since these concepts took hold, and now section C.3 of this permit now lags behind other contemporary West coast permits in setting clear water quality and quantity goals and providing flexibility to meet them. To bring the permit up to speed with current research and understanding, and to stimulate academic and private sector investment in stormwater BMP research and development, I urge you to make the changes suggested in this letter as well as the accompanying comment log.

If you have any questions or would like more supporting information, please let me know.

Sincerely,

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Director - Stormwater Regulatory Management

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References:

[i] Fact Sheet Findings. Page A-27. Section C.3-2

[ii] Geosyntec Consultants and Wright Water Engineers (2009). Pollutant Category Summary Report - Solids, Bacteria, Nutrients and Metals. Available at: http://www.bmpdatabase.org/performance-summaries.html

[iii] Roseen, R.M. and Stone, R.M. (2013). Bioretention Water Quality Treatment Performance Assessment. Technical Memorandum. Prepared for Seattle Public Utilities.

[iv] Herrera (2015 in draft). Analysis of Bioretention Soil Media for Improved Nitrogen, Phosphorous and Copper Retention, Draft Final Report, Prepared for Kitsap County by Herrera Environmental Consultants, Seattle, WA, March 16, 2015 (draft).

[v] Herrera (2015). Interim Project Report: City of Redmond Six Bioretention Swales Monitoring. Prepared for City of Redmond, by Herrera Environmental Consultants, Inc., Seattle, Washington. February 20, 2015

[vi] Herrera (2014). Final Report: 185th Avenue NE Bioretention Stormwater Treatment System Performance Monitoring. Prepared for City of Redmond, by Herrera Environmental Consultants, Inc., Seattle, Washington. March 6, 2014.

[vii] Washington State Department of Ecology. "Evaluation of Emerging Stormwater Treatment Technologies". Available online at: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

[viii] Sacramento Stormwater Quality Partnership. Proprietary Stormwater Quality Treatment Devices, Available online at: http://www.beriverfriendly.net/newdevelopment/propstormwatertreatdevice/

[ix] Project Clean Water. Final Model BMP Design Manual for San Diego Region. Available online at: http://www.projectcleanwater.org/index.php?option=com_content&view=article&id=250

Suggested Changes
Draft NPDES NO. CAS 612008
Draft Municipal Regional Stormwater Permit

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Section	Proposed Change or Comment	Justification
C.3.c.i.2.c.iii	Add a baseline performance standard that alternative soil mixes must meet in order to be approved by the Executive Officer. Suggest referencing Basic, Enhanced and Phosphorus treatment goals set by the Washington State Department of Ecology. http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html	Currently there is no water quality or volume reduction performance standard associated with the 5"/hr biofiltration system described in this section. Permittees may be developing innovative media blends intended to minimize irrigation demand or for other non-water quality purposes, but there is no clear performance goal for conventional pollutants like TSS, heavy metals, nutrients and oil. Without clear goals and performance verification requirements for any new media blend, how can we be sure that a new media blend will improve water quality? The fundamental purpose of this stormwater permit is to reduce the discharge of pollutants of concern to the maximum extent practicable. To assume that pollution removal is happening on the basis of media hydraulic capacity and plant vitality is to ignore current research that shows that sand and compost bioretention media blends frequently are a source of nutrient enrichment and at times also export TSS and heavy metals.
C.3.c.i.2.c.iii	Add a provision allowing alternative system designs to be submitted to the Executive Officer for approval on the basis that they will provide an equal or greater load reduction for conventional pollutants of concern as compared to the 5"/hr design described in this section.	Regulations are most effective when they set clear performance standards and allow the private sector to innovate to develop more efficient means of meeting those standards. The biotreatment system described in this section shall be designed to "maximize stormwater runoff retention and pollutant removal". This is not a quantitative standard and does not provide a useful basis for innovation. However, the performance of conventional biotreatment systems can be estimated using bioretention results from the International Stormwater BMP Database and other high quality studies of similar designs. These pollutant removal and effluent concentration results can be used as a performance benchmark against which innovative systems can be judged. Innovative systems that can be demonstrated to provide similar or better pollutant load reduction should be considered for approval regardless of whether they are created by permittees or by private industry.

Section	Proposed Change or Comment	Justification
C.10.a.ii a	Change first sentence to read: "Permittees shall implement trash prevention and control actions, including full capture systems or other trash management actions, or combinations of actions, with trash discharge control equivalent to or better than fill trash capture systems, **to eliminate the discharge of trash from the MS4 system.**	This section seems to establish a low trash generation rate (<5 gallons/acre/year) as the compliance target. This is not the same as zero discharge of trash which is the only defensible water quality standard. Reducing trash generation rates will presumably lead to lower trash discharges, but the trash discharge prohibition should not be replaced with a loading standard.
C.10.a.iii	Change text to read: "A stormwater treatment facility implemented in accordance with provision C.3 **may be deemed to be a full capture system only where it is sized to treat the trash capture design flow rate (peak 1-year, 1-hour flow rate) and where there is a maintenance plan in place to remove trash accumulating in the facility such that it does not create an adverse visual or water quality impact.**	C.3 devices can be sized to treat the water quality flow rate resulting from a 0.2"/hr rainfall intensity per section C.3.d.i.2.a. The full capture system definition in section C.10.a.iii sets the trash capture design storm as the one-year, one-hour event which ranges from about 0.3 inches per hour to about 0.9 inches per hour in the area covered by this permit. So, typically sized C.3 facilities will be undersized by a factor of 2-4 for most locations. Peak one-year, one-hour precipitation intensities for sites in the MRP area can be easily retrieved from the NOAA Precipitation Frequency Data Server (http://hdsc.nws.noaa.gov/hdsc/pfds/). Sending the excess flow through the C.3 facilities may overload those facilities hydraulically and cause scouring of mulch and soil materials which can degrade pollutant removal performance. Screened outlets may become clogged by landscaping materials and debris which can cause flooding. Trash that is captured in the facilities, may also cause aesthetic blight and can be remobilized by wind and wildlife.

Section	Proposed Change or Comment	Justification
C.10.b.i.a	Replace the last sentence of this section with:**• For on-line systems that route flows exceeding the 1-year, 1-hour flow rate through the trash storage area, specify that maintenance should be triggered when 25% of the storage volume is consumed, and must be conducted prior to 50% storage capacity consumption to remain in compliance.** **• For "off-line" systems that route peak flows around the storage area, maintenance should be triggered by a 50% consumption of storage capacity and must be conducted prior to 100% storage volume consumption to remain in compliance.** **• Inspection observation of 25% screen area occlusion should trigger maintenance for all systems, and all systems should be maintained prior to 50% screen blockage to remain in compliance** **• Compliance with the permit should be based on documentation of the proper operational condition of controls. Areas draining to systems that are inadequately maintained should be considered out of compliance from the time of last documented acceptable condition.**	Off-line trash capture systems store trash where it cannot be resuspended and released when the screen clogs or during extreme flow events. As such, maintenance of these systems when half full is adequate. On-line trash capture systems send peak flows through the trash storage area and can resuspend and wash trash downstream when the screen clogs or during peak flows. To minimize this risk, more frequent maintenance is necessary. Since full capture systems must be maintained in order to be effective, areas draining to inadequately maintained full capture systems should be considered to be non-compliant with the trash removal provisions of the permit.
C.10.b.i.b	Add a requirement that before and after maintenance photos be collected and provided upon request of the Regional Board	Photos provide an easy and fast means of spot checking the condition of full capture systems for the Regional Board. Photo histories should also be valuable to the public works staff who are establishing proper inspection intervals. Los Angeles County includes before and after photos for all of their trash capture system maintenance events.
C.10.b.ii.b	Check reference in first sentence	No such section in the permit
C.10.b.ii.b	Add a receiving water monitoring based assessment of effectiveness of "other trash management actions", or add storm drain system inspection to the visual assessment actions.	Site trash loading rates are not the same as discharge rates. This permit should be regulating discharge rates, not site generation rates. If trash is blown by wind or transported by runoff or pushed by street sweeping equipment into the drain system, it will not be observable on site. Preferably add a requirement to assess trash discharge from the MS4, or at a minimum assessing trash accumulation in inlets and other MS4 infrastructure to help avoid scenarios where sites are observed to be clean because the trash has entered the MS4.

Section	Proposed Change or Comment	Justification
C.10.d, C.10.b.iv	Credits offered should be phased out over time.	A 20% total trash reduction credit is very generous. Source control efforts should reduce the operation and maintenance burden on full capture systems and require a greater ongoing burden to demonstrate effectiveness. This may be enough incentive to reduce trash loading. Cleanup from the shoreline and stream banks does not prevent discharges from the MS4 system. It simply cleans up trash that has already been discharged. It is also not likely to be a complete cleanup as discharged trash can be transported to the bay and/or come to rest in waterbodies in non-shoreline areas.
C.10.f.v.b	Change the penalty for not meeting compliance deadlines from triggering submittal of a report, to requiring installation of full capture systems in the watershed at an accelerated pace to bring the permittee into compliance. If this accelerated schedule is not met, enforcement actions should be initiated including issuance of a notice of violation for noncompliance.	The current penalty for non-compliance does not provide much incentive for a permittee to come into compliance.