RETAIL GASOLINE OUTLETS: NEW DEVELOPMENT DESIGN STANDARDS FOR MITIGATION OF STORM WATER IMPACTS

Technical Report

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Introduction

On March 8, 2000, the California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) issued requirements for new development and significant redevelopment consolidated in a Standard Urban Storm Water Mitigation Plan (SUSMP). The SUSMP included requirements for retail gasoline outlets (RGOs), commonly referred to as "gas stations", among several other development categories. Several municipalities, the Building Industry of Southern California (BIA), and the Western States Petroleum Association (WSPA) appealed the action of the LA Regional Board to the State Water Resources Control Board (State Board) for review. The State Board issued its decision *In Re City of Bellflower et al.* (SUSMP Decision) in large part upholding the action of the LA Regional Board.

In its Order, the State Board set aside the numerical mitigation requirement for RGOs explaining that the decision did not preclude future inclusion of numerical mitigation standards for RGOs with proper justification.

On February 21, 2001, the California Regional Water Quality Control Board, San Diego Region (SD Regional Board) issued an MS4 permit for San Diego County and Cities which includes requirements for new development and significant redevelopment. The MS4 permit requires Permittees to develop a model SUSMP no later than February 21, 2002, that will establish new development controls for project categories including RGOs. The SD Regional Board did not propose a threshold for RGOs to apply numerical design standards, giving the MS4 permittees the first option to develop the threshold criterion for RGOs and the justification. On March 22, WSPA filed an appeal of the SD Regional Board action for review before the State Board contending that RGOs were being improperly subject to numerical design standards in the MS4 permit for San Diego County and cities.

Urbanization and Storm Water Quality

Urbanization alters the natural infiltration capability of the land and generates a host of pollutants that are entrained in storm water and urban runoff. These pollutants such as heavy metals and petroleum hydrocarbons result from the activities of dense human populations. The overall impact is an increase in storm water runoff volumes and pollutant loading in storm water discharged to receiving water-bodies.[1]

Urban development increases the amount of impervious surface in a watershed as farmland, forests, and meadowlands with natural infiltration characteristics are converted into buildings with rooftops, driveways, sidewalks, roads, and parking lots with virtually no ability to absorb storm water. Storm water and snow-melt runoff wash over these impervious areas, picking up pollutants along the way while gaining speed and volume because of their inability to disperse and filter into the ground. What results are storm water flows that are higher in volume, pollutants, and temperature than the flows in less impervious areas, which have more natural vegetation and soil to filter the runoff.[2] In addition to impervious areas increase, urban development brings with it proportionately high levels of car emissions, car maintenance waste, pet waste, litter, pesticides, and household hazardous wastes, which may be washed into receiving waters by storm water or dumped directly into storm drains designed to discharge to receiving waters.

Most organic compounds found in storm water are associated with various human-related activities, especially automobile use, or are associated with plastics.[3] Heavy metals found in storm water also mostly originate from automobile use activities, including gasoline combustion, brake lining, fluids, undercoatings, and tire wear.[4]

More recently, studies reveal a connection between urban development and contamination of local waterbodies. Studies found the highest levels of organic contaminants, known as polycyclic aromatic hydrocarbons (PAHs) (products of combustion including fossil

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[1] U.S. EPA (1992). *Environmental Impacts of Storm Water Discharges: A National Profile.* EPA 841-R-92-001. Office of Water. Washington, DC.

[2] U.S. EPA (1997). *Urbanization and Streams: Studies of Hydrological Impacts.* EPA 841-R-97-009. Office of Water. Washington, DC.

[3] Field, Richard, James P. Heaney and Robert Pitt. (2000). *Innovative Urban Wet-Weather Flow Management Systems*. Technomic Publishing Co., Inc. Lancaster.

[4] See, Durum, W.H. (1974), *Occurrence of some trace metals in surface waters and groundwaters.* In Proceeding of the Sixteenth Water Quality Conference. Am. Water Works Assoc., et al. Univ. of Illinois Bull. 71(108). Urbana, IL.; Koeppe, D.E. (1977). Comp. Vol. IV: *Soil-water-air-plant studies*. In: Environmental Contamination by Lead and Other Heavy Metals. G.L Rolfe and K.A. Peinbold, eds. Institute for Environmental Studies. Univ. of Illinois. Urbana-Champaign, IL. July.; Rubin, A.J., ed. (1976). *Aqueous-Environmental Chemistry of Metals*. Ann Arbor Science Publishers. Ann Arbor, MI; Shaheen, D.G. (1975). *Contributions of Urban Roadway Usage to Water Pollution*. 600/2-75-004. U.S. Environmental Protection Agency. Washington, DC.; Solomon, R.L. and D.F.S. Natusch. (1977). Vol. III: *Distribution and characterization of urban dists.* In: Environmental Contamination by Lead and Other heavy Metals. G.L. Rolfe and K.G. Reinbold, eds. Institute for Environmental Studies. Univ. Of Illinois. Urbana-Champaign, IL.; and Wilber, W.G. and J.V. Hunter. (1980). *The Influence of Urbanization on the Transport of Heavy Metals in New Jersey Streams.* Water Resources Research Institute. Rutgers University. New Brunswick, NJ.

fuels combustion), in the reservoirs of urbanized watersheds.[5] Studies also established a clear relationship between the adverse impact of urbanization and impairment of aquatic communities in receiving waterbodies.[6]

Federal Storm Water Regulations

Federal regulations require that MS4 permittees implement a program to control storm water pollution from new developments during and post-construction. Because there is no express national standard for the control of storm water pollutants from new developments, the permitting authority must defer to statements of policy and intent made by the U.S.EPA.

The U.S.EPA under Phase I regulations did not fully describe the expectations for MS4 Permittees in controlling post construction storm water discharges from new development and significant redevelopment except that "a comprehensive master plan" was required [55 *Fed Reg.* 48054]. For a better understanding of the regulatory expectation, we look to the Final Rule for Phase II storm water regulations. Therein, the U.S.EPA notes that "prior planning and designing for the minimization of pollutants in storm water is the most cost-effective approach to storm water quality management" [64 *Fed Reg*. 68759], and identifies four essential elements to control storm water from new development and redevelopment. These are, (i) to develop and implement strategies that include a combination of structural and non-structural BMPs; (ii) adopt an ordinance to address post construction runoff; (iii) ensure long term operation and maintenance of the BMPs; and (iv) ensure that controls are in place that will *minimize* water quality impacts. [Emphasis added] EPA goes on to say:

> "The requirements …..[are] consistent with the permit application requirements for large MS4s for post-construction controls for new development and redevelopment."

The permitting authority in order to comply with federal regulations must thus require the implementation of an MS4 program that will achieve all four enumerated objectives for new development and redevelopment. In order for the program to be enforceable, the program for new development and significant redevelopment must include objective criteria such as water quality design standards for treatment-control BMPs, for significant categories of development such as RGOs.

Further, the Federal Court of Appeals has unequivocally stated that Congress intended for "the Administrator or a State to design [substantive] controls" for storm water discharges from MS4s but did not mandate a particular approach [*NRDC v. USEPA*, 966 F.2d 1292 (9th Cir. 1992)]. The court held that it is appropriate to defer to U.S.EPA [and the State] where the agency supplied a "reasoned explanation".

Also, the USEPA is currently in the process of developing effluent guidelines for the construction and development industry, which will include controls for new development and significant redevelopment.[7]

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5 USGS (1998). *Research reveals link between development and contamination in urban watersheds.* USGS news release. USGS National Water-Quality Assessment Program.

6 USGS (2000). *Water Quality in the Long Island-New Jersey Coastal Drainages, New York and New Jersey, 1996-98*. USGS Circular 1201.

7 See, Fact Sheet: Effluent Guidelines for the Construction and Development Industry, USEPA, 1999, 3 pp.

Retail Gasoline Outlets

RGOs can range in size from about 3,000 square feet to more than 200,000 square feet. The median size of new RGOs in Los Angeles County is about 13,000 square feet.[8] There are about 2,133 RGOs in Los Angeles County servicing a population of 9.5 million, and nearly six million registered motor vehicles.[9] In San Diego County there are about 700 RGOs serving a population of 2.8 million, and nearly 2 million registered vehicles.

RGOs are points of confluence for motor vehicles for automotive related services such as repair, refueling, and ancillary services such as tire air inflation and radiator fillup. The vehicular traffic patterns at RGOs are similar to those on parking lots and on highways. Researchers have identified RGOs as toxic pollutant hotspots.[10]

Storm Water Quality

RGOs are a well identified source of urban storm water pollutants that impair receiving waters. WSPA has acknowledged that storm water discharges from even "normally operated and maintained" RGOs are no worse than discharges from commercial parking lots and diffuse urban runoff.[11] The reason that "normally operated and maintained" RGOs do not demonstrate any improvement in storm water discharge quality is because existing BMPs do not address pollutants generated by motor-vehicle traffic.[12] Heavy metals, significant concentrations of which occur in storm water discharges from RGOs, have been demonstrated to be the main cause of toxicity in Santa Monica Bay during wet weather.[13] Oil and grease in the storm water discharges from RGOs are also of concern.[14]

In a study conducted in Maryland, RGOs were identified to generate significantly higher concentrations of hydrocarbon and heavy metals than parking lots, convenience store lots, and

[8] Data Base Summary Report, New Gas Station Permits issued between Jan 1, 1999 and Dec 31, 2000, City of Los Angeles, Department of Building and Safety (2001)

[9] California Energy Commission, Fuels Office, 1999.

[10] Schueler, T. and D. Shepp (1992). *The Quality of Trapped Sediments and Poor Water within Oil Grit Separators in Suburban MD.* Metropolitan Washington Council of Governments.

[11] See, Results of a Retail Gasoline Outlet and Commercial Parking Lot Storm Water Runoff Study, Western States Petroleum Association and American Petroleum Institute (1994) at p 13. The study concludes that pollutant concentrations in storm water discharges from RGOs are similar to concentrations from commercial parking lots and diffuse urban runoff. See also June 7 State Board Hearing Transcript at p 231; comment by WSPA witness, that "concentrations of metals, hydrocarbons, and solids were no higher than…. roads and parking lots".

[12] See June 8 State Board Hearing Transcript at p 136, Regional Board staff testimony that current BMPs at RGOs do not address pollution associated with vehicular traffic.

[13] See "Study of the Impact of Storm Water Discharge on Santa Monica Bay – Executive Summary", Los Angeles County Department of Public Works (1999), which identifies Zn and Cu as principal pollutants that cause storm water toxicity.

[14] Rouge River National Wet Weather Demonstration Project, MI, - Evaluation of On-line Media Filters in the Rouge River Watershed, Report No. RPO-NPS-TPM59.00 (1999), 36 pp.

streets.[15] A study conducted in Sacramento County, California, identified heavy metals such as lead, copper, and zinc, as significant in storm water from RGOs.[16] Volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene, and xylene are rarely detected in storm water because of their volatility. In contrast, gasoline and other solvents, because of their physical and chemical characteristics, may present a significant risk for groundwater contamination, if underground and aboveground storage tanks leak.

The sources of storm water pollutants at RGO are from tail-pipe exhaust particles, fluid losses, drips, spills, and mechanical, brakepad and tire wear products, which build up on impervious surfaces at RGOs.[17] The pollutants of most concern in storm water are heavy metals such as Pb, Cu, and Zn and petroleum hydrocarbons such as PAHs.[18] The concentration and loads of these pollutants in storm water runoff from RGOs depends on the surface deposition and removal rates, and permanent storage. The permanent storage on surfaces is a function of surface area texture and condition and is literally trapped in the texture or cracks of the surface area. Pollutants are deposited any where vehicles travel, park, or are serviced, including RGOs.[19]

Review of New Development Design Standards

WSPA represents petroleum industry members in the States of Arizona, Hawaii, Nevada, Oregon, in addition to California. WSPA in its Petitions before the State Board has contended that new development standards that include numerical design standards for BMPs are impracticable and unnecessary at RGOs, and so we focussed the review on development standards that new RGOs are subject to in Western U.S. States. We are aware that new RGO developments in other States such as Maryland, Virginia, Florida, Alabama, Tennessee, Georgia, Oklahoma and Texas, are also subject to numerical mitigation requirements for storm water pollutants, but we did not review their programs for this technical report.

In Washington, RGOs in the western region that create impervious surfaces of 5,000 square feet or more are required to mitigate the 6 month 24 hour storm (about 1.2 inches of rainfall). In addition to the standard treatment menu based on a water quality design storm,

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15 *Hydrocarbon Hotspots in the Urban Landscape, Shueler T., and Shepp, D., (1995), pp. 259-264, National Conference on Urban Runoff Management: Enhancing Urban Watershed Management at the Local, County and State Levels, Chicago, IL,* Report No. EPA/625/R-95/003. A survey of oil and grit separators in suburban Maryland indicated that RGOs and convenience stores had much higher levels of hydrocarbons and metals both in the water column and the sediments.

16 *Action Plan Demonstration Project (APDP) - Demonstration of Gasoline Fueling Station Best Management Practices, County of Sacramento, (1994*), pp. 30 Submitted to US EPA Region IX, San Francisco Estuary Project.. This study funded by the USEPA and conducted by Sacramento County identified heavy metals such as lead, copper, and zinc in significant concentrations in storm water runoff from RGOs. Volatile Organic Compounds (VOCs) from fueling areas were rarely detected because of their volatility. Data on Polycyclic Aromatic Hydrocarbons (PAHs) was inconclusive because analytical detection limits used were higher than regulatory action levels.

17 Shaheen, D.G. (1975). *Contributions of Urban Roadway Usage to Water Pollution*. 600/2-75-004. U.S. Environmental Protection Agency. Washington, DC.

18 Field, Richard, James P. Heaney and Robert Pitt. (2000). *Innovative Urban Wet-Weather Flow Management Systems*. Technomic Publishing Co., Inc. Lancaster.

19 County of Sacramento, (1994). *Action Plan Demonstration Project (APDP) - Demonstration of Gasoline Fueling Station Best Management Practices.* Submitted to US EPA Region IX, San Francisco Estuary Project.

RGOs that are expected to generate ADT of 100 vehicles or more per 1,000 square feet of gross building area are required separately to treat to remove oil.[20] The City of Portland in Oregon under its MS4 program requires RGOs to mitigate storm water runoff from impervious areas equal to or greater than 500 square feet using any one of three different design approaches.[21] One of the choices is the 24-hour rainfall event standard (0.83 inch of rainfall). In addition, RGOs that are expected to generate 100 vehicles or more ADT per 1000 square feet of gross building area are subject to separate treatment controls for oil using a water quality design standard of a two year 24 hour storm.[22] In both Washington and Oregon, storm water treatment is required in addition to the source control BMPs identified by WSPA for implementation at its facilities in California.[23]

Treatment Control BMPs

The U.S. EPA funded a demonstration project to evaluate the effectiveness of on-line media filter media to treat pollutants from storm discharges at RGOs.[24] Four on-line media filter systems were tested and the study concluded that the treatment systems had sufficient ability to remove pollutants without risk of flooding, were easy to operate and maintain, and reasonable in capital cost.

We also reviewed storm water quality data results evaluating the pollutant removal effectiveness of a proprietary on-line filter media device located at a large RGO in Washington.[25] The device was installed underground and thus occupied no surface area. The treatment device was effective in removing between 50 and 90 percent of pollutants of concern in storm water discharges from RGOs. We note with interest that in perusing the treatment devices installation list of this proprietary manufacturer between 1997 and 2001 in the Western U.S., California had not a single installation at an RGO but Oregon and Washington had a combined total of 13 RGO sites where the treatment devices were installed. Considering that RGOs in the State of Washington and Oregon have ADT that is much less than in California, the aberration can only be explained by the lack of rigorous storm water regulatory controls in California to control the discharge of pollutants in storm water discharges from RGOs.[26]

Our review indicates that effective treatment devices for RGOs include on-line media filter systems with a combination of media placed in series to remove the pollutants of concern.

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[20] Such sites are considered "high use sites" because they typically generate high concentrations of oil from traffic turnover. See Stormwater Management Manual for Western Washington, Vol. V, Runoff Treatment BMPs, (2000), Washington Department of Ecology, p 145.

[21] Stormwater Management Manual, City of Portland, OR, (2000), p 1-11.

[22] Ibid. at page 9-47. Sites that meet the threshold are considered "higher risk categories".

[23] Cf. BMP Guide for Retail Gasoline Outlets, CA Storm Water Quality Task Force, and WSPA (1997); Storm Water Manual for Western Washington Vol. IV and V, Washington Dept. Ecology (2000).

[24] See, Rouge River National Wet Weather Demonstration Project, MI, - Evaluation of On-line Media Filters in the Rouge River Watershed, Report No. RPO-NPS-TPM59.00 (1999), 36 pp.

[25] See, Stormwater Sampling – StormFilter Performance Results: Burwell-Straley's Union 76 Station, Bremerton, WA (2000). 7 pp.

[26] Report, Database Summary List of Treatment Devices installed between 1997 and 2001, Provided by StormFilter, OR.

Sand filters are another option. There may be other treatment control BMPs that may be equally if not more effective.[27]

Economic Considerations

A review of costs of storm water treatment controls for RGOs indicates that the cost of storm water treatment is reasonable.[28] In addition, a demonstration project sponsored by the USEPA to evaluate the effectiveness and costs of on-line media filters placed the first year capital cost between $250 and $900 and an operations and maintenance cost of $240 annually.[29]

Justification

The State Board in its SUSMP Decision temporarily excluded RGOs from the numerical mitigation standard until Regional Boards provided proper justification and established appropriate thresholds. Issues to be considered included presumptions that RGOs were, (i) already heavily regulated; (ii) limited in their ability to construct infiltration BMPs; (iii) generally small in size; and (iv) storm water treatment may not be feasible or safe.

Over-regulation:[30] Under State law, the State Board and Regional Boards are the primary authorities for implementation of the federal Clean Water Act, and for matters related to water quality within the State.[31] There is no basis in federal or State statute that permits the State Board or Regional Boards to abdicate their water quality authority because discharges from facilities that impact water quality are already regulated for other purposes. Attainment and maintenance of receiving water objectives and the protection of beneficial uses are the paramount considerations.

Limitations of space or ability: Our review indicates that RGOs appear not to be limited by space or ability to treat storm water. The surface area of RGO developments is generally greater

[27] For a list of potential treatment options see, Storm Water Manual for Western Washington Vol. V, - Runoff Treatment BMPs, Washington Dept. Ecology (2000).

[28] See "Cost and Benefits of Storm Water BMPs", Preliminary Data Summary of Urban Storm Water Best Management Practices, USEPA, (1999) Report No. EPA-821-R-99-0012, pp. 6-1 – 6-44.

[29] Rouge River National Wet Weather Demonstration Project, MI, - Evaluation of On-line Media Filters in the Rouge River Watershed, Report No. RPO-NPS-TPM59.00 (1999), at p 15-18.

[30] The Regional Board's review of regulations that affect RGOs identified, (i) business license for business operation, (ii) Fire Department for tank/ piping integrity and gasoline storage; (iii) County Public Works for underground storage of hazardous chemicals; (iv) Air Quality Management District for VOC emissions; (v) Sanitation District for any sanitary sewer discharges; (vi) County Weights and Measures for sale of gasoline; (vi) Department of Toxics Substance Control for waste motor oil disposal; (vii) County Health for food and beverage sale; and (viii) Regional Board for regulation of leaking tanks to protect groundwater.

[31] Cal. Wat. Code § 13160 states that, "the State Board is designated as the state water pollution control authority for all purposes…. in federal act." Cal. Pub. Res. Code § 30412 states that, "other State agencies shall not modify, adopt conditions, or take any action in conflict with any determination by the State Board in matters relating to water quality".

than 5000 square feet. The fabricated storm water treatment systems we reviewed generally do not exceed 128 square feet in surface area when installed and do not impede traffic flow because they are situated sub-surface. While opportunities for infiltration practices may be limited, it is but one type of option for mitigation of pollutants in storm water. The SUSMP does not mandate infiltration BMPs. Other treatment options exist such as fabricated treatment control BMPs to remove storm water runoff pollutants using physical, biological, or chemical processes. Also treatment control BMPs can be installed sub-surface without interfering with surface use. RGOs situated in other Western U.S. States, which have lower impervious surface area and higher water quality treatment volume criteria thresholds already implement storm water treatment controls at new facilities.

Feasibility of storm water treatment: Our review of implementation of storm water treatment control requirements in other Western U.S. States indicates that storm water treatment at RGOs is both feasible and safe. In California, sub-surface fabricated treatment systems have been commonly used at RGOs to separate waste-oil before discharge to the sanitary sewer system. Safety or feasibility has not been an issue when sanitation districts required RGOs to install treatment systems in order to obtain connection permits to the sanitary sewer system. As previously mentioned storm water treatment controls are installed as a matter of practice by RGOs in other Western U.S. States. There is no reason to suppose that storm water treatment in California introduces new and different safety and feasibility considerations, as when compared to wastewater treatment systems which RGOs have readily installed in California and storm water treatment systems installed in other Western U.S. States.

Suggested criteria

Storm water pollution at RGOs is primarily a function of the number of motor vehicles that are refueled or serviced. Ancillary services such as auto repair may additionally contribute significant pollutant loads. A WSPA study concluded that the storm water runoff quality from well-maintained RGOs is comparable in pollutant concentrations to runoff from commercial parking lots.[32]

The State Board recommended that the Regional Boards undertake further consideration of a threshold relative to size of RGOs for application of the numerical design standard for storm water. Our analysis indicated the following criteria for thresholds may be appropriate.

Land area: 5,000 square feet or more of impervious area. RGOs in Portland, Oregon and Western Washington that meet this land area threshold are currently subject to storm water treatment requirements based on the water quality design storm.[33]

Projected Average Daily Traffic (ADT): 100 or more vehicles fueled per day. The projection for the number of vehicle trips a RGO can expect may be estimated using information published by the Institute of Transportation Engineers. The vehicular traffic at an RGO is a good determinant for the quantity of storm water pollutants generated at the site. RGOs in Oregon and Washington are subject to two tiers of threshold for treatment of storm water, the first based

[32] See 'Results of a Retail Gasoline Outlet and Commercial Parking Lot Storm Water Runoff Study (1994)', Western States Petroleum Association, and American Petroleum Institute, 49 p. Commercial parking lots 5,000 square feet or more are presently subject to the SUSMP numerical mitigation standard.

[33] WSPA represents companies that explore, produce, refine, transport and market petroleum in six western states including Oregon, Washington, and California. See www.wspa.org

on the impervious area threshold, and an additional tier storm water treatment requirement for sites that expect 100 vehicles or more ADT per 1,000 square feet of gross building area. [34]

Projected volume of gasoline sale: 25,000 gallons or more of gasoline sale per month. [35] The projected volume of gasoline sales is directly correlated with vehicular trips. 25,000 gallons of gasoline sale per month is equivalent to an average daily traffic of about 100 vehicles.[36]

Although other criteria such as the number of fueling dispensers ("nozzles"-4 or more) and the number of dispenser meters (12 or more assuming one meter per octane grade), were considered for thresholds, the relationship of such criteria to predict the potential for pollutant generation at RGOs is less direct.

It is recommended that numerical mitigation standards be made applicable, if the RGO development meets the following thresholds, (i) creates 5,000 square feet or more of impervious surface; and (ii) has a projected trip generation of 100 or more motor vehicles ADT.

Conclusion

RGOs have been well documented in the scientific literature as significant sources of storm water pollutants. These pollutants such as heavy metals and PAHs have been know to cause the impairment of beneficial uses in receiving waters. As a source of pollutants, storm water from RGOs is similar to runoff from driveways, roads, highways and parking lots.

In order to reduce the discharge of pollutants in storm water to the MS4, it is technically appropriate to require that new RGOs and significantly redeveloped RGOs be subject to the SUSMP numerical mitigation criteria. RGOs in other Western U.S. States already comply with higher numerical mitigation standards than those established by the LA Regional Board and the SD Regional Board. The treatment of storm water for RGOs is technically feasible, safe, and of reasonable cost.

[34] See, Storm Water Management Manual (August 2000), City of Portland, Oregon, (p 9-10) additional thresholds for fuel dispensing facilities. Also, Storm Water Management Manual for Western Washington, Vol. V, Runoff Treatment BMPs, Washington Department of Ecology, p 9-10, additional requirement thresholds for high-use sites.

[35] The average volume of gasoline sales at a RGO in California is approximately 100,000 gallons per month. Gasoline stations with outputs of 200,000 or more gallons a month are considered high output facilities by the industry.

[36] A typical "full" tank gas refueling is around 8 gallons delivered at a pump. Many RGOs use this benchmark for discount offerings or other type of incentives associated with refueling. 100 cars x 8 gallons per car x 30 days = 24,000 gallons of gasoline per month.

Table 1. Characterization of Pollutant Concentrations in the OGS Water Column: Effect of Land-Use Condition (Mean Values)[37]

Sampled Parameter	All-Day Parking (N = 8)	Convenience Commercial (N = 6)	Gas Stations (N = 7)	Streets (N = 6)	Townhouse/ Garden Apartments (N = 6)
OP (mg/L)	0.23	0.16	0.11	ND	0.11
TP (mg/L)	0.30	0.50	0.53	0.06	0.19
NH3-N (mg/L)	0.20	1.58	0.11	0.19	0.20
TKN (mg/L)	1.18	4.94	2.5	0.84	1.00
OX-N (mg/L)	0.65	0.01	0.21	0.92	0.17
TOC (mg/L)	20.60	26.80	**95.51**	9.91	15.75
Hydrocarbons (mg/L)	15.40	10.93	21.97	2.86	2.38
TSS (mg/L)	4.74	5.70	--	9.60	7.07
ECd (µg/L)	6.45	7.92[a]	**15.29**[a]	ND	ND
SCd (µg/L)	3.40[a]	ND	6.34[a]	ND	10.34[a]
ECr (µg/L)	5.37	13.85	**17.63**[a]	5.52[a]	ND
SCr (µg/L)	ND	ND	6.40[a]	ND	4.79[a]
ECu (µg/L)	11.61	22.11	**112.63**	9.50[a]	3.62
SCu (µg/L)	8.22[a]	ND	25.64	ND	2.40
EPb (µg/L)	13.42	28.87	**162.38**	8.23	ND
SPb (µg/L)	8.10[a]	ND	26.90[a]	ND	ND
EZn (µg/L)	190.00	201.00	**554.00**	92.00	NA
SZn (µg/L)	106.70	43.70	471.00	69.00	59.00

[a]Mean is for all observations in which the indicated parameter was actually detected.
ND = not detected; NA = not applicable.

OP = ortho phosphate phosphorus
TP = total phosphorus
NH3-N = ammonia nitrogen
TKN = total Kjeldahl nitrogen
OX-N = oxidized nitrogen
TOC = total organic carbon
Hydrocarbons = total hydrocarbons
TSS = total suspended solids
ECd = extractable cadmium
SCd = soluble cadmium
ECr = extractable chromium
SCr = soluble chromium
ECu = extractable copper
SCu = soluble copper
EPb = extractable lead
SPb = soluble lead
EZn = extractable zinc
SZn = soluble zinc

[37] *Hydrocarbon Hotspots in the Urban Landscape, Shueler T., and Shepp, D., (1995), pp. 259-264*, National Conference on Urban Runoff Management: Enhancing Urban Watershed Management at the Local, County and State Levels, Chicago, IL, Report No. EPA/625/R-95/003.

Table 2. Data Comparison – RGO Studies

Constituent (ug/l)	Study 1[38]	Study 2[39]	Study 3[40]	Effluent Criteria[41,42] (ug/l)	
Aluminum	**829**	ND	ND	750	--
Cadmium	0.7	ND	**15.29**	15.9	4.3
Chromium	4.2	ND	**17.63**	--	16[43]
Copper	**25.2**	**200**	**112.63**	63.6	13
Lead	33.4	ND	**162.38**	81.6	65
Nickel	4.7	ND	ND	1417	470
Zinc	**379**	**200 to 600#**	**554**	117	120
Oil & Grease (mg/l)	4.6	1 to **34**	**95.5**[44]	15	--
TSS (mg/l)	59	10 to ?	ND	100	--

= range; ND = No Data;

[38] *Demonstration of Gasoline Fueling Station Best Management Practices* - Uribe & Associates, Larry Walker Associates - Final Report - October 1994

[39] *Retail Gasoline Outlet Storm Water Runoff Study* - Western States Petroleum Association (WSPA), Draft Report, prepared by Hart-Crowser 1993

[40] *Hydrocarbon Hotspots in the Urban Landscape* - Schueler T. and Shepp D., Metropolitan Washington Council of Governments - Washington DC in Seminar Publication National Conference on Urban Runoff Management: Enhancing Urban Watershed Management at the Local, County, and State Levels - Chicago 1993 [EPA/625/R-95/003]

[41] *Parameter Benchmark Values* - Final Reissuance of National Pollutant Discharge Elimination System Storm Water Multi-Sector General Permit for Industrial Activities; Notice - Federal Register/ Vol. 65, No 210/ October 30, 2000. 64767

[42] *Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule* - 40 CFR Part 131 Federal Register/ Vol. 65, No 97/ May 18, 2000 pag. 31682 et. Seq.

[43] Chromium (VI)

[44] TOC

Environmentally Sensitive Areas – Technical Report

[to be transmitted later]

California Environmental Quality Act – Technical Report

[to be distributed later]