APPENDIX 4-D

Average Annual Pollutant Load Reduction Estimates

Approach

The stormwater-related impacts associated with urban development are well documented and include a decline in downstream receiving water quality (Arnold and Gibbons, 1996; Holman-Dodds et al., 2003; USEPA, 2013). Higher peak flows and increased total stormwater runoff volumes result from the expansion of urban impervious cover that limits the infiltration of rainfall and enhances the entrainment and transport of sediment, nutrients, bacteria, metals, pesticides, and other chemicals derived from urban land uses (Grove et al. 2001, Tang et al. 2005, USEPA 2013).

To quantify the water-quality benefits of stormwater projects, average annual reductions of stormwater volume and pollutant loads were estimated for those projects that had sufficient concept design information to allow these calculations. Pollutant types quantified included Total Suspended Solids (TSS), Total Copper (Cu), Total Zinc (Zn), Nitrate (NO_3) and Fecal Coliform (FC). These pollutant types were selected due to their common presence in urban runoff; known risks to aquatic biota and/or human health; and/or are identified in regulatory Total Maximum Daily Load designations within San Luis Obispo County that likely include municipal sources (i.e., NO_3 and FC).

Because site-specific monitoring data are not available for precise quantification of loadings, urban stormwater literature and databases were reviewed to define characteristic pollutant concentrations for urban land uses. Data were selected based their credibility (e.g., robust sampling methods, stated assumptions, clarity of reporting); relevance to San Luis Obispo County (e.g., data indicates national trends, geographic proximity); and suitability for planning-level pollutant reduction estimates. The data sources used included:

1. Butcher, Jonathan, 2003. Buildup, washoff, and event mean concentrations. Journal of the American Water Resources Association, 39(6): 1521-1528. DOI: 10.1111/j.1752-1688.2003.tb04436.x
2. Los Angeles County Department of Public Works and Los Angeles Flood Control District, Stormwater Quality Summary Data 1994-2000 http://dpw.lacounty.gov/wmd/NPDES/wq_data.cfm
3. Northwest Hydraulic Consultants Inc. (nhc), Geosyntec Consultants, Inc., and 2NDNATURE, LLC. 2010. Pollutant Load Reduction Model. Available at https://www.enviroaccounting.com/TahoeTMDL/Program/Display/ForUrbanJurisdictions. Accessed in May to September 2015.
4. Pitt, R., A. Maestre and R. Morquecho. 2004. The National Stormwater Quality Database (NSQD, version 1.1). Paper presented at the World Water and Environmental Resources Congress, Salt Lake City, UT. http://rpitt.eng.ua.edu/Research/ms4/Paper/Mainms4paper.html; see also the National Stormwater Quality Database at http://www.bmpdatabase.org/nsqd.html.

5. Stein, Eric D., Tiefenthaler, Liesl L., and Schiff, Kenneth C. Southern California Coastal Water Research Project. Sources, Patterns and Mechanisms of Storm Water Pollutant Loading from Watersheds and Land Uses of the Greater Los Angeles Area, California USA. Technical Report 510. March 2007.
6. U.S. EPA. United States Environmental Protection Agency. 1983. Results of the nationwide urban runoff program. PB84-185552. Washington, D.C.

Stormwater pollutant concentrations were usually reported by urban land uses as median values, and studies generally used similar land use types with slight differences in some cases (i.e., commercial, residential, industrial). For example, the data for total copper and total zinc from the Los Angeles County 1994-2000 data set included additional categories for residential and industrial land uses; those values were considered appropriate for inclusion as part of the calculation for representative concentrations. Some pollutants were not measured in all of the studies considered, such as nitrate (only available from Los Angeles County 1994-2000 and the National Stormwater Quality Database).

Determining a representative urban runoff concentration for Fecal Coliform was particularly challenging, given that there are fewer data available and they show high variation across studies within the same land use; different bacteriological indicators are often measured (e.g., Fecal Coliform, Escherichia coli, Total Coliform); and there is often inconsistency of reporting units (e.g., CFU, MPN). Another factor limiting relevant data availability is that Fecal Coliform is the current TMDL preference parameter for the Central Coast Water Board but is not the standard bacterial parameter used for TMDLs in California. Instead, E. coli is more typically used as it is thought to be a better indicator of risks to human health.

A representative TSS value was used that is consistent with the swTELR model, which employs characteristic runoff concentrations (CRCs) defined as the expected average annual pollutant concentration generated from a land use in a particular condition across a range of event types (nhc et al., 2010). While similar to event mean concentration (EMC) values commonly applied in stormwater modeling (e.g., Butcher, 2003), CRCs are intended to be an annual volume-weighted average of EMC values. We calculated the median TSS values for each land use, which helps reduce the effects of extreme values when characterizing central tendency compared to mean values. TSS values for urban land-use types used in swTELR are based on 23 literature studies, along with analysis of the National Stormwater BMP Database that includes thousands of individual measurements from hundreds of individual studies (NSQD, 2015; http://www.bmpdatabase.org/nsqd.html).

The various values of pollutant loadings are listed in Table 4D-1; the final values selected as representative for use in subsequent calculations are listed in Table 4D-2.

Table 4D-1. Median runoff TSS values from analysis of the NSQD and literature review for road and parcel land uses used in swTELR: High Traffic Roads (HTR), Moderate Traffic Roads (MTR), Low Traffic Roads (LTR), Industrial (IND), Commercial (COM), Multi-family residential (MFR), Single Family Residential (SFR), Other (OTH) (2NDNATURE, 2018).

Road Land Use TSS (mg/L)			Parcel Land Use TSS (mg/L)				
HTR	MTR	LTR	IND	COM	MFR	SFR	OTH
156	115	110	104	70	82	88	15

Table 4D-2. Data used for determination of representative urban runoff concentrations.

	Total Copper (ug/L)				Total Zinc (ug/L)				Nitrate (mg/L)		Fecal Coliform (CFU/100 ml)
	LA 1994-2000	LA 2001-2005	NSQD	NURP	LA 1994-2000	LA 2001-2005	NSQD	NURP	LA 1994-2000	NSQD	NURP
Land Use											
Commercial	22	17	17	29	192	156	150	226	2	0.62	
HD single R	11				66				2.1		
Multi R	12				89						
Mixed R	13				125					0.94	
Residential		18	12	33		103	73	135			
Transportation	39				218				1.8	1.55	
Light Industrial	21				366				2.4	0.48	
Industrial		33	22	27		550	210	154			
Mixed											21,000

For planning purposes, a single representative value for each pollutant parameter was established by calculating the median value among the land use types, within each data source, and then the average among the various data sources for those constituents with multiple entries (Table Z). Fecal Coliform was the exception to this methodology, given the data uncertainty described; the NURP "mixed" land use value was used (i.e., 21,000 CFU/100 ml).

Table 4D-3. Representative urban runoff concentrations used to estimate average annual pollutant reduction.

Constituent	Total Suspended Solids (mg/L)	Total Copper (ug/L)	Total Zinc (ug/L)	Nitrate (mg/L)	Fecal Coliform (CFU/100 ml)
Representative Urban Stormwater Runoff Concentration	96	20	155	1.4	21,000

Results

In total, 12 of the identified projects were judged to have sufficient design details to calculate average annual pollutant load reductions. Their results are tabulated at the end of this Appendix (Table 4D-4).

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Table 4D-4. Average annual pollutant load reduction, using the factors listed in Table 4D-3.

Project	Project Scale	SCM Type	Capture Area (sq.ft.)	Volume (T)reated and/or (I)nfiltrated	Estimated Average Annual Volume Treated and/or Infiltrated (ac-ft)	Estimated Average Annual Volume Treated and/or Infiltrated (cu.ft.)	Estimated Average Annual Pollutant Reduction				
							TSS (kg)	Total Copper (g)	Total Zinc (g)	Nitrate (kg)	Fecal Coliform (CFU)
1. Embarcadero Boat Wash Project (large)	neighborhood	biofiltration	130,000	T	3	150,000	400	90	700	6	9.00E+11
2. Embarcadero Boat Wash Project (large)	parcel	biofiltration	20,000	T	0	20,000	50	10	100	1	1.00E+11
3. Cloisters Project	regional	infiltration basin	14,300,000	T & I	30	1,500,000	4,000	800	6,000	60	9.00E+12
4. Embarcadero Surf Project	neighborhood	biofiltration	140,000	T & I	1	60,000	150	30	200	2	3.00E+11
5. Morro Bay State Park Marina Parking Lot LID	parcel	LID	60,000	T & I	2	80,000	100	90	300	3	5.00E+11
6. Upper Spring Street LID	neighborhood	green street bioretention	4,300,000	T & I	20	800,000	2,000	500	4,000	30	5.00E+12
7. 2nd Street Baywood Green Street Project	neighborhood	green street biofiltration	50,000	T & I	2	70,000	200	40	300	3	4.00E+11
8. Atascadero Sunken Gardens Stormwater Capture	neighborhood	infiltration gallery	630,000	T & I	10	630,000	2,000	400	3,000	30	4.00E+12
9. Mitchell Park Bioretention	neighborhood	bioretention	350,000	T & I	5	200,000	600	100	900	10	1.26E+12
10. Melody Basin Retrofit	regional	basin retrofit	5,000,000	T&I	20	800,000	2,000	400	3,000	30	4.63E+12