



Draft Memorandum

To: Santa Ana Stormwater Quality Standards Task Force

From: CDM

Date: August 31, 2010

Subject: Draft - Analysis of Diversion of Dry Weather Urban Runoff to POTWs for Bacteria Control in Orange County

This technical memorandum describes a theoretical engineering analysis performed to produce a cost estimate for diverting urban dry weather runoff from human/controllable sources to Publicly Owned Treatment Works (POTWs) to control bacteria levels during dry weather conditions within Orange County. Waterbodies currently listed as having recreational use designations (REC-1 or REC-2) are identified in the Santa Ana Regional Water Quality Control Plan (Basin Plan). To comply with the requirements of the Basin Plan and Municipal Separate Storm Sewer System (MS4) permits adopted by the Santa Ana Regional Water Quality Control Board, some or most of these waterbodies may require implementation of dry weather runoff controls to reduce bacteria levels in the waterbodies to support recreational uses and adequately assure compliance.

Engineering alternatives that could approach reasonable assurance of complying with Basin Plan bacteria objectives were considered, including distributed full / tertiary treatment of dry weather runoff in numerous locations (end of pipe / storm drain treatment) and diversion of dry weather flows to already existing collection systems and POTWs. Based upon work previously performed by the Task Force related to BMP options for controlling bacteria, dry weather diversion to POTWs was assumed to be the lowest cost option for adequately assuring compliance. Other approaches such as source control, local or regional infiltration, or bio-treatment BMPs may be feasible in some subwatersheds to reduce bacteria loads during dry weather conditions, however these options may be less reliable with respect to meeting water quality objectives for bacterial indicators. Additionally, dry weather diversion facilities should require a minimal footprint to implement relative to larger regional BMPs or more natural solutions.

Orange County Sanitary District (OCSD) and the Orange County Public Works (OCPW) established a formal workflow process through the Orange County Stormwater Technical Advisory Committee (TAC) to prioritize and approve diversion projects in Orange County. To date, the Stormwater TAC has approved 24 diversion projects. In addition to obtaining a

dry weather urban runoff permit, OCSD requires that the permittee enter into an agreement with OCSD requiring indemnification of all damages, spills, fines, etc. that are attributed to the discharge of urban runoff.

Though based upon standard engineering infrastructure assumptions and cost factors, the costs presented in this memorandum are theoretical. They were prepared as a means to provide a realistic, high-level (low detail) estimate of the costs that could be expected to be incurred to divert dry weather flows to POTWs on a regional basis.

The approach used to evaluate dry weather diversions to POTWs involved two primary steps:

- Identify MS4 outfall locations to surface waterbodies within the county.
- Based on the number of outfalls, estimate capital and operations and maintenance (O&M) costs associated with dry weather diversions to POTWs.

Identification of Diversion Locations

For this analysis, it was assumed that all storm drain outfalls from MS4 facilities to surface waterbodies will require a diversion. The resulting costs are representative of what could be required under a condition where exceedances of bacterial indicator water quality objectives regularly occur in all surface waterbodies under dry weather flow and runoff from MS4 facilities is present at all storm drain outfalls during dry weather.

Potential locations for dry weather runoff diversions were determined by comparing GIS layers of surface waterbodies and enclosed MS4 facilities throughout Orange County. This spatial analysis utilized a GIS database of flood control and MS4 facilities compiled by Orange County Public Works (OCPW), which included attribute information distinguishing surface drainage systems (e.g., channels) from enclosed systems (e.g., storm drains). The OCPW GIS database encompasses both county and city-owned facilities. This desktop GIS analysis was completed using both ArcGIS and Google Earth mapping tools.

A total of 273 outfall locations were identified using this spatial analysis. These outfalls, shown in Figure 1, represent potential locations where diversion of dry weather urban runoff could be implemented in Orange County. Because MS4 facility data was not available from all cities, this number is likely an underestimate.

Theoretical Cost Estimate

Cost estimates were developed for the three main components that would be necessary for implementation of dry weather diversion facilities in the county: 1) construction of a typical dry weather diversion facility, 2) construction cost to provide increased capacity at a POTW where dry weather flows would be diverted, and 3) annual cost of operation and maintenance (O&M) for operating the diversion facility and providing treatment.

The costs developed for by this analysis are theoretical, based on typical costs but not specific to any existing sanitary sewer agency in the county. If low flow diversions were implemented, it would be necessary to work with local sanitary sewer agencies to determine their willingness to accept dry weather runoff in their facility. Agreements would then need to be established with locally negotiated costs.

Component 1: Typical Dry Weather Diversion Facility

A typical dry weather diversion facility at an existing MS4 facility outfall location would consist of the following elements:

- **Diversion Structure (two additional manholes or junction boxes).** One manhole or junction box would be equipped with a gross solids removal device to protect pumping equipment and provide wet weather bypass. The second would be used as a wet well for pumping dry weather flows to the closest location in the sanitary sewer collection system with adequate capacity to accept the flow. Capital cost for construction of similar facilities in southern California is approximately \$1.7 million¹.
- **Forcemain.** In most cases within urban settings, existing sanitary and MS4 facilities are relatively close in proximity. For this analysis, it is assumed that 1,000-feet of small diameter (six-inch) forcemain pipeline would be required to connect the dry weather diversion pumping structure to the nearest sanitary sewer manhole. At a rate of \$100 per linear foot, the cost of the forcemain per diversion structure would be approximately \$100,000.

Table 1 summarizes total cost estimates of diversion facilities required in each city in Orange County, based on the following equation:

$$\left(\begin{array}{l} \text{Dry Weather Diversion} \\ \text{Facility Cost} \end{array} \right) = (\$1.7 \text{ million} + \$100,000) * (\text{Number of Diversions})$$

The total dry weather diversion structure cost is estimated at \$491.4 million. Individual project costs would need to be revisited prior to proceeding with design and construction to account for varying site characteristics and dry weather flow conditions.

Component 2: Capacity Improvements to Existing Sanitary Sewer Collection System and Treatment Facilities

Capital costs for potential conveyance and treatment upgrades that would be required for increased flow to the sanitary sewer collection system have been estimated using data from OCSD, which intercepts, treats, and discharges wastewater from all of the north Orange County area that lies within the Santa Ana River Watershed. OCSD has limited available system capacity, and already treats up to 4 MGD of diverted dry weather urban runoff from a

¹ Take-off estimate completed by CDM Constructors Inc. for similar facilities for City of Los Angeles Bureau of Sanitation

number of locations in cities with storm drains that discharge directly to the ocean along the Orange County coastline to protect beach water quality.

Several key assumptions were made to estimate the capital cost of conveyance and treatment, including:

- Flow at each diversion is 0.4-cubic foot per second (cfs). This estimate is based on an assumed urban dry weather runoff generation rate of 190 gallons per acre per day routed to 273 outfalls over the urbanized area (393 square miles).²
- Biochemical oxygen demand (BOD) of urban dry weather runoff is 11 mg/L.³
- Total Suspended Solids (TSS) of urban dry weather runoff is 19 mg/L (USEP monitoring).

Costs associated with potential additional POTW capacity for dry weather urban runoff are low for up to 10 MGD of allocated capacity compared to the potential cost of diverting more than 10 MGD (see Class I Permit User Rate at the OCSD website <http://www.ocsd.com/civica/filebank/blobdload.asp?BlobID=6441>).

OCSD has not planned for additional facilities necessary to capture more than the 10 MGD of allocated capacity. Any flows above 10 MGD will not be accepted into OCSD, thus alternative treatment systems are required in lieu of diversions. Per this analysis, at a rate of 190 gallons per acre per day for dry weather runoff generation, approximately 50 MGD of urban runoff may require diversion from MS4 outfalls in the Orange County portion of the Santa Ana River Watershed. This analysis assumes the necessary capacity above the allocated 10 MGD could be diverted to OCSD's system for rates comparable to new residential development. Table 1 shows the varying capacity costs and a weighted average capacity rate for 50 MGD of capacity.

² City of Los Angeles, Integrated Resources Plan, Department of Public Works Bureau of Sanitation and Department of Water and Power, 2006.

³ McPherson, Timothy N., Steven J. Burion, Michael K. Stenstrom, H.J. Turin, Michael J. Brown, and I.H. Suffet, 2005. Dry and Wet Weather Flow Nutrient Loads From a Los Angeles Watershed. *Journal of the American Water Resources Association*, 41(4): 959-969.

Table 1: Potential OCSD Capital Facilities Capacity Charges for Urban Runoff

Dry Weather Flow Capacity	Flow (\$/MGD)
0 - 4 MGD (\$/MGD)	\$0
4 – 10 MGD (\$/MGD)	\$1,900 ¹
11 - 50 MGD (\$/MGD)	\$12,000,000
Flow weighted Average (\$/MGD)	\$9,600,000

1) Includes charges associated with flow, BOD, and TSS for Permit Users

OCSD waives fees and charges for discharge flows less than 4 MGD. Once the flows exceed the 4 MGD, the discharger will be charged, not limited to, permit fees, sewer use charge, capital facilities charges, operations and maintenance cost, and supplemental capital facility capacity charge as reflected in the most current fee ordinance.

The weighted average OCSD sewer capacity rate shown in Table 1 was applied in the following equation to estimate the conveyance and treatment cost for each city, shown in Table 2. The total conveyance and treatment cost is estimated at \$458,500,000 for Orange County.

$$\left(\begin{array}{c} \text{Conveyance} \\ \text{and} \\ \text{Treatment} \\ \text{Cost} \end{array} \right) = \left(\frac{\text{Conveyance \& Treatment \$}}{\text{MGD}} \right) * \left(\begin{array}{c} \text{Dry Weather Flow} \\ \text{per Diversion} \end{array} \right) * (\text{Number of Diversions})$$

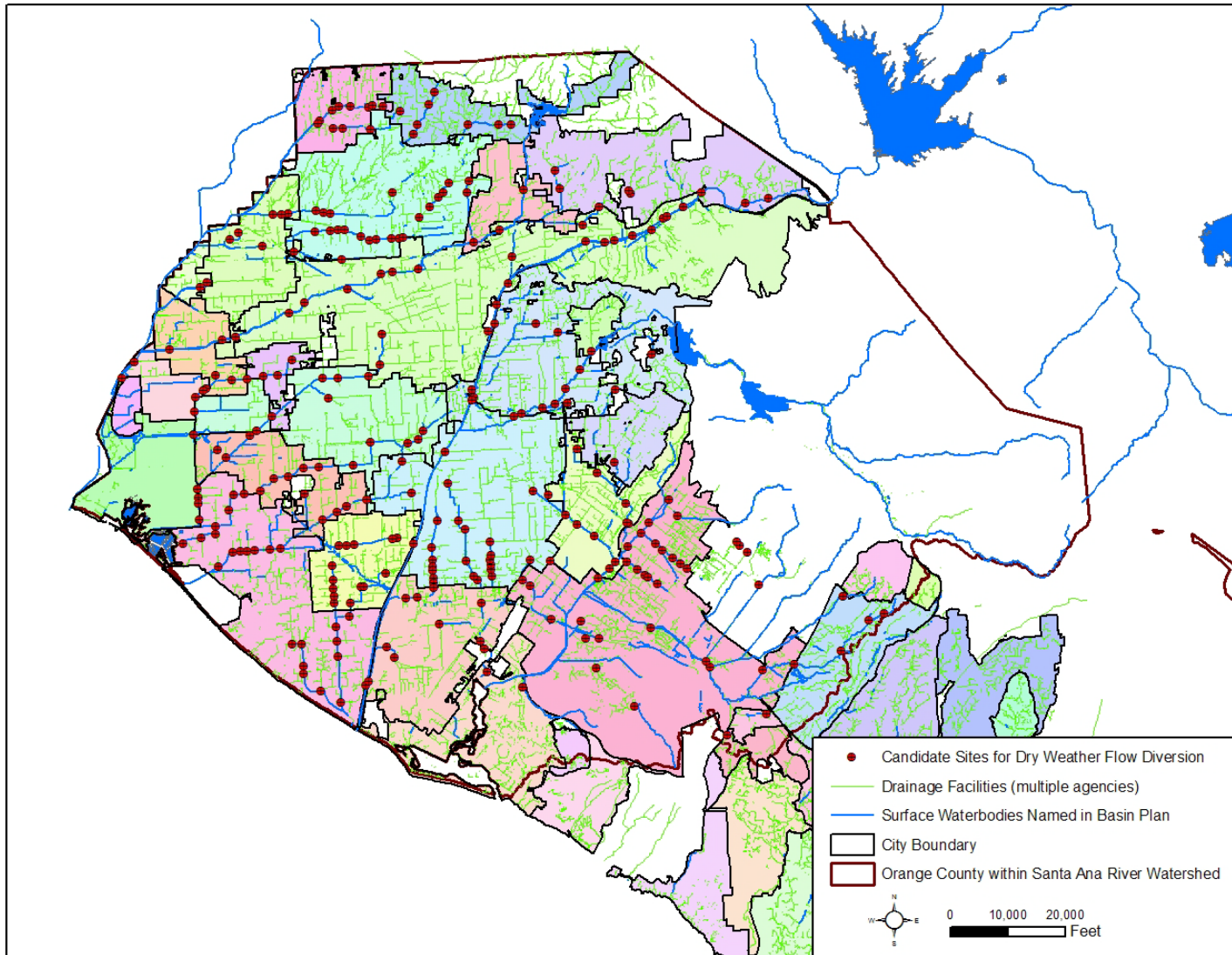


Figure 1
Map of Candidate Dry Weather Runoff Diversion Locations in Orange County
within the Santa Ana River Watershed

Table 2: Total Cost of Diversion Facilities in Orange County

Jurisdiction	Number of Outfalls	Drainage Area (mi ²)	Typical Dry Weather Facilities Cost	Conveyance & Treatment Capital Cost	Annual O&M (\$/yr)
Anaheim	22	50	\$39,600,000	\$36,900,000	\$3,440,000
Brea	8	10	\$14,400,000	\$13,400,000	\$850,000
Buena Park	6	11	\$10,800,000	\$10,100,000	\$780,000
Costa Mesa	8	16	\$14,400,000	\$13,400,000	\$1,110,000
Cypress	5	7	\$9,000,000	\$8,400,000	\$530,000
Fountain Valley	14	9	\$25,200,000	\$23,500,000	\$1,020,000
Fullerton	23	22	\$41,400,000	\$38,600,000	\$2,050,000
Garden Grove	12	18	\$21,600,000	\$20,200,000	\$1,390,000
Huntington Beach	24	27	\$43,200,000	\$40,300,000	\$2,350,000
Irvine	30	47	\$54,000,000	\$50,400,000	\$3,570,000
La Habra	11	7	\$19,800,000	\$18,500,000	\$820,000
La Palma	2	2	\$3,600,000	\$3,400,000	\$170,000
Laguna Hills	1	6	\$1,800,000	\$1,700,000	\$360,000
Laguna Woods	1	3	\$1,800,000	\$1,700,000	\$200,000
Lake Forest	5	13	\$9,000,000	\$8,400,000	\$850,000
Los Alamitos	6	4	\$10,800,000	\$10,100,000	\$450,000
Newport Beach	2	17	\$3,600,000	\$3,400,000	\$940,000
Orange	14	24	\$25,200,000	\$23,500,000	\$1,770,000
Placentia	3	7	\$5,400,000	\$5,000,000	\$450,000
Santa Ana	27	27	\$48,600,000	\$45,300,000	\$2,470,000
Seal Beach	4	12	\$7,200,000	\$6,700,000	\$760,000
Stanton	4	3	\$7,200,000	\$6,700,000	\$320,000
Tustin	10	11	\$18,000,000	\$16,800,000	\$960,000
Villa Park	1	2	\$1,800,000	\$1,700,000	\$150,000
Westminster	14	10	\$25,200,000	\$23,500,000	\$1,070,000
Yorba Linda	7	20	\$12,600,000	\$11,800,000	\$1,290,000
Unincorporated	9	8	\$16,200,000	\$15,100,000	\$770,000
Total	273	393	\$491,400,000	\$458,500,000	\$30,890,000

Component 3: Operations and Maintenance (O&M)

Annual O&M costs for the dry weather diversion facilities include costs to pump runoff and maintain the diversion structure as well as rates for treatment at the POTW. Costs associated with O&M of a single diversion facility, at an assumed rate of 2 percent of total capital cost, would be approximately \$40,000 per year. Annual O&M costs associated with treatment of runoff at OCSD plants are a function of OCSD’s rates for flow in million gallons (MG), BOD and TSS, which are shown in Table 3.

Table 3: OCSD Rates for Operations and Maintenance

Annual O&M Cost	Orange County Sanitation District ¹
Treatment Flow (\$/MG)	\$1,016.80
BOD (\$/1000 lbs.)	\$483.30
TSS (\$/1000 lbs.)	\$514.10

1) <http://www.ocsd.com/civica/filebank/blobload.asp?BlobID=6441>

Summary of Costs

Table 4 provides a summary of the total theoretical (high-level) costs for Orange County.

Table 4: Total Costs

Summary of Estimated Costs (millions of \$)	
Dry Weather Facilities	\$491.4
Conveyance & Treatment	\$458.5
Total	\$949.9
Annual O&M	\$30.89/yr

Limits of Analysis

The costs presented in this technical memorandum are high-level estimates based on broad assumptions about the required level of implementation for adequate assured compliance with bacterial indicator water quality objectives. There a number of factors or considerations that would influence the actual cost:

- Limited data from some cities within the area of analysis suggest that the number of outfalls requiring treatment could increase significantly in certain areas.
- Additionally, the cost and feasibility for local sewerage agencies to collect and treat urban dry weather runoff is not fully quantified. A number of factors, many of which are site-specific, could influence the cost and feasibility of implementing dry weather runoff diversions. These factors include, but certainly not limited to:

- Costs associated with capital improvement projects at POTWs necessary to accept additional flows;
 - Costs of financing and inflation over time;
 - Constraints on local sanitary sewer collection and treatment systems – potential increases necessary in the capacity of collection system pipelines, pump stations, etc;
 - Flow rate and presence of continuous flow - flow may be more peaky in nature, not the constant rate of 0.4 cfs assumed for this analysis. Typical dry weather runoff occurs mainly in the early morning hours due to irrigation;
 - Operation and maintenance considerations – manual operation or automatic, manual or remote switching from wet to dry and dry to wet, telemetry and remote observation or control, potential for system malfunctions causing sanitary system overflows;
 - Compliance sampling and reporting costs; and
 - Timing of flows - acceptance of flows only during off-peak hours, necessitating storage.
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- The number of MS4 outfall locations actually discharging during dry weather conditions could have a significant impact on the costs associated with diversion and treatment. This preliminary analysis has assumed that each outfall described above is discharging at the assumed flow rate. The number or percentage of outfalls expected to be discharging during dry weather conditions would need to be investigated and predicted to further refine the analysis costs. There may be a large percentage of outfalls within the county not contributing dry weather flows.
 - Not all areas of the County are sewered, making diversion to a POTW potentially more complicated and costly.

Other Considerations

Additional Treatment Alternatives - This analysis focused on a treatment method that provides high certainty for bringing MS4 facilities in compliance with water quality objectives for bacterial indicators. An alternative to diversion from MS4 facilities to the sanitary collection system is to construct on-site treatment or infiltration, in the form of an urban runoff plant (URP), infiltration BMPs, treat and release wetlands, etc. These types of facilities can provide integrated resource benefits and are potentially more land intensive than diversion to the sanitary sewer system. In the case of URPs, treatment and discharge provides a low bacteria source of water to receiving waterbodies, which can dilute uncontrolled sources of bacteria, or the URP can be designed for reuse for irrigation demands near the project site. Similarly,

infiltration BMPs or treat and release wetlands can provide “clean” runoff to impaired waterbodies or recharge underlying groundwater basins through infiltration.

Potential Environmental Impact of Dry Weather Flow Diversion - Aside from the potential physical infrastructure impacts, analysis of the options for controlling dry weather flow would need to consider the environmental impacts. Besides the direct environment impacts, such as energy consumption and greenhouse gas generation, indirect impacts of removing dry weather flows from waterbodies would need to be considered. Most drainages in the Santa Ana River watershed have aquatic communities at least in part dependent on dry weather flows.

Assured Compliance - This memorandum evaluates the cost of bringing MS4 facilities into compliance with bacterial indicator water quality objectives. However, there are other miscellaneous water sources and temporary discharges (e.g., permitted “de minimus” discharges, permitted intermittent discharges such as potable water system flushing, construction activities, illegal and unauthorized activities such as homeless encampments, and emergency activities such as fire fighting) that may influence water quality. Additionally, flood control channels are frequently used for transport of water through controlled dam releases or raw water pipeline turnouts and for transport of recycled water to downstream spreading basins. The impact of these activities on water quality is not well understood.

Modifications to Recreational Uses - Modifications to receiving water recreational uses to better reflect existing and potential recreational activity would result in changes to the applicable bacterial indicator water quality objectives. The outcome of these changes (which would be accomplished through the development of use attainability analyses) could be a significant reduction in the number of outfalls requiring diversion and treatment. This approach would greatly reduce the cost of compliance.