Strategy Analysis for Ballona Creek Watershed

Preferred Strategy - Focus on localized, non-structural and structural "subwatershed based" solutions, limited dry weather diversions, dry weather in-stream solutions and limited use of NOTF.
Alternative Strategy - Focus on dry weather diversions and "end-of-pipe" capture, divert, treat, disinfect, and discharge a targeted storm event solutions

Preferred Strategy

The components included in the Preferred Strategy are:

Component 1) Implement extensive source controls and institutional solutions to reduce dry weather flows (including "smart irrigation") and bacteria from dr and wet weather flows.
Component 2) Install cisterns at schools and government facilities to treat wet weather flows.
Component 3) Install neighborhood recharge facilities in open spaces to treat dry and wet weather flows.
Component 4) Install sand filters and Infiltration trenches to treat dry and wet weather flows.
Component 5) Retrofit NOTF to treat dry and wet weather runoff and treat up to 4 cfs of dry weather flow for reuse.
Component 6) Divert any remaining dry weather flows downstream of NOTF to wastewater collection system or develop local wetlands treatment system.

General Data:

Watershed area:	82,000	acres
Runoff coef =	0.47	(per Watershed Protection Div. Pollutant Load Model)
Dry weather runoff rate:	230	gpd/ac
Assume % of area north of NOTF:	50%	
1 acre-ft =	0.325851	MG
1 sq mi =	640	acres
1 mgd =	1.547	cfs

DRY WEATHER FLOW

(Based on max day dry weather flow rate from Technical Memorandum)

North of NOTF:	23	cfs =	15	mgd
Sepulveda & W. LA:	7	cfs =	5	mgd
Centinella:	5	cfs =	3	mgd
Total:	**35**	**cfs =**	**23**	**mgd**

WET WEATHER FLOW

Data for target storm event of 0.45-inches, based on EPA/Tetra Tech Model

Rainfall: 3,075 AF (82,000 acx.45 in/12)

Maximum Instantaneous Flows (from EPA/Tetra Tech model)

Subwatershed flows:				
Hollywood subwatershed	246.7	cfs =	159	mgd
Cienega	163.6	cfs =	106	mgd
Windsow Hills	77	cfs =	50	mgd
Flows within Ballona Creek:				
approx. at NOTF	439	cfs =	284	mgd
@Westwood Village subwatershed	447.5	cfs =	289	mgd
@West LA subwatershed	765	cfs =	494	mgd

Total flow from target storm event in Ballona Creek above estuary plus Windsow Hills = 544 mgd (Assumes flow occurs in one day or less)

LAND USE *(from the Ballona Creek Metals TMDL)*

Land use in Ballona Creek Watershed	
Land Use	**Area (acres)**
High Density Residential	45,600
Low Density Residential	2,950
Mixed Urban	100
Commercial	12,950
Industrial	4,200
Open Space	14,000
Other	2,200
Total	**82,000**
Source: Ballona Creek Metals TMDL Land use data	

COMPONENTS OF PREFERRED STRATEGY

Component 1) Source controls and institutional solutions to reduce bacteria from dry and wet weather flows and smart Irrigation.

a) Institutional Solutions

From the Metals TMDL, estimated costs for structural and non-structural compliance measures for the entire Los Angeles Region:

Area of Entire LA Region that costs were based on:	3,100	sq. mi
Ballona Creek Watershed area:	128	sq. mi
% area	4.13%	

Compliance Approach	Metals TMDL Estimated Costs	Adjusted Ballona Creek Watershed Estimated Costs
Source Control Measures Identified in the Metals TMDL		
Enforcement of litter ordinances.	$9 M/yr	$0.37 M/yr
Public education	$5 M/yr	$0.21 M/yr
Improved street cleaning	$8 M/yr	$0.31 M/yr
Increased storm drain cleaning	$27 M/yr	$1.11
Subtotal:	$49 M/yr	$2.00 M/yr
Additional bacteria source control measures		$1.00 M/yr
Total:		**$3.00 M/yr**

b) Smart Irrigation

"Smart Irrigation" installed watershed wide at residential and commercial facilities (assume 70% implementation)

	High Density Res.	Low Density Res.	Commercial	Total
Area (acres)	45,600	2,950	12,950	61,500
70% of area implementing S.I. (acres)	31,920	2,065	9065	43,050
Runoff coefficient (gpd/ac)	230	230	230	NA
Total runoff (mgd):	7.3	0.5	2.1	10
% Effectiveness of smart irrigation (%)[1]:	30%	71%	20%	NA
Total runoff reduction (mgd)[2]:	2.2	0.3	0.4	3.0

[1]the% effective is the effectiveness of the smart irrigation device at reducing the amount of runoff for a given land use and is based on IRP Smart Irrigation analysis, which was based on Irvine Ranch Water District pilot project data.

[2]Total Runoff Reduction is the total runoff multiplied by the % effectiveness of the devices.

Number of units required:

Assuming average lot size	1	acre (see tech memo discussion)
Total number of lots implementing S.I.	43,050	lots
Assuming one device per lot	43,050	units

Capital Costs

Unit cost:	$175	per unit (includes installation) - from LAIRI
Total capital cost for smart irrigation	$7.5	Million (number of units x cost/unit

O&M Cost:

Monthly signal fee	$4	per unit per month - from LARIF
Total O&M Cost (#units)*($/mo)*(12mo/yr):	$2	$M/yr

Summary:

Potential dry weather flow managed	3.0	mgd
Wet weather flow managed	N/A	
Capital costs ($M)	$7.5	Million
O&M costs ($M/yr)	$5	Million/yr

Component 2) Installing cisterns at schools and government facilities to treat wet weather flows.

a) This component accounts for installing cisterns at schools and government facilities as implementation is presumed to be easier than at private homes, commercial, etc. Cisterns at individual residences and commercial facilities will be encouraged and promoted as a part of the implementation plan but have not been included in the cost analysis.

b) For schools and government facilities, since the Metals TMDL does not provide this data directly, it was assumed that a similar percentage as was in the IRP would apply to Ballona Creek. Since 3% of the total area of the City of LA was for schools (per SCAG land use data analyzed during the LAIRP), for the 82,00 acres in the Ballona Creek Watershed the proportional amount would be 2,500 acres.

Ballona Creek Watershed Flow: Schools & Government Facilities

Land use	Area (acres)	Vol, MG/0.45" storm event)
Schools and Government Facilities	2,500	14.4

Vol = 2,500 ac x .45 in X .47 runoff coefficient)

c) To determine the number of cisterns needed, use IRP data adjust to Ballona Creek Watershed data:

IRP Cistern data for schools and government facilities:

Flow:	80	mgd (cisterns at schools/gov)
Area (schools & gov. facilities):	9,164	acres
Resulting # of units	10,000	units
Adjusting to Ballona Creek #'s:		
Ratio by flow (% difference):	18%	
Ratio by area (% difference):	27%	
Average % difference:	23%	
# cisterns for Ballona Creek Watershed:	2,261	

d) Capital cost based on # of cisterns, 10,000 gallon cisterns:

Size of cisterns:	10,000	gal (see Tech Memo)
Unit cost of cisterns:	$1.00	$/gal - from LAIRP
Total cost for cisterns	**$23**	**M**

e) O&M costs for cisterns are for pumping captured rain water for irrigation.

Volume pumped per year:	70,000	gal/yr/cistern (see Tech Memo)
Power:	3.00	hp
Flow rate:	10	gal/min
Energy cost:	0.1	$/kW-hr

Annual energy:

W=Power*Volume/Flow = (3hp)*(.745kW/hp)*(70,000gal/yr/cistern)/((10gal/min)*(60min/hr))=

W =	261	kW-hr/cistern/yr
2,261 cisterns results	589,659	kW-hr/yr
$0.10 /kW-hr results i	$0.06	$M/yr
Other Costs (assume)	$0.10	$M/yr

Summary:

Dry weather flow managed	NA	mgd
Wet weather flow managed	14	MG/ 0.45 inch storm event
Dry weather flow north of NOTF:	NA	mgd
Wet weather flow north of NOTF:	7	MG/ 0.45 inch storm event
Capital Costs ($M)	$23	$M
O&M Costs ($M/yr)	$0.2	$M/yr

Component 3) Installing neighborhood recharge facilities in open spaces to treat dry and wet weather flows.

a) Using land use table, for urban vacant, open space, parks:

Area (urban vacant, open space, parks):	14,000	acres
Approximate area that is in the hills:	6,500	acres (hills and mountains are not be suitable for neighborhood recharge)
Remaining area:	7,500	acres

b) Assuming 5% of the land not located in the hills could potentially be used for implementing neighborhood recharge, and assuming an infiltration rate of 0.5 ft/day:

Area:	375	acres	
Flow this area would be able to infiltrate:	61	mgd	(Area x 0.5 in/day)
Unit cost:	$0.65	M/ac	(From Sun Valley Project)
Total capital cost:	$244	M	

c) all dry weather flow could be managed in these units. Based on the 5% of land area, assume:

Amount of dry weather flow managed by smart irrigation (5% of total):
0.15 mgd (5% of 3 mgd)

Remaining dry weather flow from 5% of land area that would flow to neighborhood recharge:
0.98 mgd

d) O&M Cost

Basin maintenance cost:	3,000	$/ac/yr	(From Sun Valley Project)
	$1.1	**$M/yr**	(375 ac x $3,000/ac)

Summary:

Dry weather flow managed	1.0	mgd
Wet weather flow managed	61	MG/ 0.45 inch storm event
Dry weather flow north of NOTF:	0.5	mgd
Wet weather flow north of NOTF:	31	MG/ 0.45 inch storm event
Capital costs ($M)	$244	$M
O&M costs ($M/yr)	$1.1	$M/yr

Component 4) Sand Filters

These were used in the Metals TMDL and would treat for bacteria as well.
Assumed in Metals TMDL that sand filters would treat for 20% of the runoff from the 0.5-inch storm.
Adjusted to treat 20% the 0.45 inch storm = 109 MG/event

Flow Managed per Metals TMDL

The Metals TMDL assumed that 20% of flow from the urbanized portion of the watershed for a 0.5-inch storm would be managed.

Flow from 0.5-inch event:

Give that the flow from the 0.45 inch event is:	544	MG/event
Then the flow from the 0.5 inch event would be:	605	MG/event
20% of flow (MG):	121	MG/event = total estimated flow managed by sand filters in metals TMDL

For the Sand Filter, the Metals TMDL estimate costs as follows:
1) the Delaware sand filter which is installed underground and suitable for areas of approximately 1 acre,
Costs are based on 0.5 inches of runoff, total costs are based on a unit cost x total acreage of the urbanized portion of the watershed.
Assumed to use the Delaware filter because units would be designed for smaller areas.

	Delaware Sand Filter Construction Costs ($M)	Delaware Sand Filter Maintenance Costs ($M/yr)	WW Flow Managed for 20% of 0.45" Storm (MG/event)	Unit Capital Cost ($M/MG)	Unit O&M Cost ($M/MG)	Capital Cost for 20% of flow from 0.45"($M)	O&M Cost for 20% of flow from 0.45" event ($M/yr)
Based on USEPA Estimate	77	4	121	0.64	0.03	$69	$3.60
Based on FHWA Estimate	99	Not Reported	121	0.82	NA	$89	NA
Average of USEPA and FHWA Estimates	**88.00**	**4.00**	**120.93**	**0.73**	**0.03**	**$79**	**$3.60**
Source: Ballona Creek Metals TMDL - for columns 2,3,4. All other columns calculated based on this data and flow from 0.45-inch storm event.							

Assumed to use the average cost, such that the Capital costs are:	$79	Million	
and the O&M costs are:	$3.6	Million/yr	
Wet weather flow managed (20% of total):	109	MG/event	
Dry weather flow at this point based on area (for 20% of total area):	4.5	mgd	(20% of 23 mgd)
Less flow managed by smart irrigation (based on 20%):	0.59	mgd	
Dry Weather flow remaining to be managed by sand filters:	3.93	mgd	

Summary:

Dry weather flow managed	3.9	mgd
Wet weather flow managed	109	MG/ 0.45 inch storm event
Dry weather flow north of NOTF:	2.0	mgd
Wet weather flow north of NOTF:	54.4	MG/ 0.45 inch storm event
Capital costs ($M)	$79	$M
O&M costs ($M/yr)	$3.60	$M/yr

Component 5) Retrofit NOTF to treat dry and wet weather runoff and treat up to 4 cfs of dry weather flow for reuse.

a) This compnent includes diverting up to the nominal existing 150 cfs capacity, and using existing 1 MG of storage.
b) No additional storage will be built, and the plant will be retrofitted to treat this flow of runoff.
c) Using hydrograph used in cistern component, the following calculation was used to determine the flow to the 1 MG of storage:
Storage required = (x cfs-150cfs) * 3600 sec/hr * 2 hrs * 7.48 gal/cf / 1M Reverse calculation results in:
Solve for x, x = 19 cfs
which is the flow above the 150 cfs at NOTF that would be stored in the existing 1 MG storage.
d) Total flows managed at NOTF
Must subtract the flows that are managed north of NOTF through cisterns, neighborhood recharge, infiltration trenches and sand filters.

Dry weather flow already managed:	8	mgd	(From smart irrigation, neighborhood recharge, and sand filters)
Total dry weather flow at this point:	15	mgd	
Dry weather flow remaining to be treated at NOTF:	7	mgd	
Wet weather flow already managed:	184	MG/event	(From cisterns, neighborhood recharge and sand filters)
Total wet weather flow at this point:	284	MG/event	
Wet weather flow remaining to be treated at NOTF:	99	MG/event	
Capacity of NOTF: 150 cfs =	97	mgd	
For 1 MG storage, ~ 19 cfs add'l =	12	mgd	
Total flow that can be managed at NOTF =	109	mgd	

Therefore, the flow north of NOTF that remains could potentially be treated at NOTF without additional new storage (109 mg > 99 mg).

Based on updated IRP reclaimed water planning near Ballona Creek
4 cfs = 2.6 mgd
This amount will receive tertiary treatment, the difference will not and will be discharge into the creek.

e) Cost to retrofit plant:
Per the City of LA BOE Ballona Creek Treatment Facility Feasibility Study and Preliminary Design report:
Capital Cost to retrofit the NOTF is based on the alternative that included dry weather reuse and used the inflatable dam:
This study had costs for 1.3 mgd and 6.5 mgd of reuse (in 1996 dollars). Adjusted here for the 4 cfs (2.6 mgd) of reuse:

Capital Costs: In 1996 dollars:

	From BCTF Study (1996 $)		Interpolate (1996 $)	In 2005 dollars:
Reuse amount (mgd):	1.30	6.5	2.6	2.6
Total cost ($M):	$5.92	$8.11	$6.46	$9.04

Total capital cost is: $9.04 Million for the retrofit assuming 2.6 mgd of reuse.
(Note: Costs do not include the reuse distribution system capital costs)

O&M costs:

	1996 $ ($M/yr)		2005 $ ($M/yr)	
For reuse flow amount of (mgd):	*1.3*	*6.5*	*2.6*	*2.6*
Power	$0.15	$0.27	$0.18	$0.25
Labor	$0.21	$0.25	$0.22	$0.31
Chemicals	$0.08	$0.24	$0.12	$0.17
General Maintenance	$0.08	$0.09	$0.08	$0.12
Total	$0.52	$0.85	$0.60	$0.84

(Note: Costs do not include the reuse distribution system O&M costs)

Summary:

Dry weather flow managed	7.0	mgd
Wet weather flow managed	99	MG/ 0.45 inch storm event
Capital costs ($M)	$9.04	$M
O&M costs ($M/yr)	$0.84	$M/yr

Dry weather flow remaining below NOTF not managed: 7.8 mgd peak (average 3.9 mgd)
Wet weather flow remaining below NOTF not managed: 260 MG/ 0.45 inch storm event

Component 6) Divert dry weather flow from West LA and Windsow Hills.

Sepulveda north Centinela south

Component 6) Divert remaining flows downstream of NOTF to wastewater treatment plant (Hyperion).

Capital Costs:
The flow to be diverted is the flow south of NOTF that is not already managed by source control measures (both structural and non-structural), or rather the entire flow that remains.
From the IRP, the average costs for constructing the Santa Monica Bay diversions was - $1.2 M/mgd.
Adding 30% to account for non-construction costs: PM, design, CM, and startup:

Unit capital cost:	$1.56	M/mgd
Peak dry weather flow to divert:	7.8	mgd
Total capital cost:	$12.10	M

O&M Cost: (Source IRP)

Maintenance labor:	$12,000	/mgd/yr
Debris cleaning:	$2,800	/mgd/yr
Debris disposal:	$150	/mgd/yr
Sewer service charge:	$15,800	/mgd/yr
Utilities (e.g. pumping):	$3,000	/mgd/yr
Total Unit O&M Cost:	$33,750	/mgd/yr

Average dry weather flow to divert:	3.9	mgd
Total O&M cost:	$0.13	M/yr

Summary:

Avg. dry weather flow managed	3.9	mgd
Wet weather flow managed	N/A	
Capital costs ($M)	$12.1	Million
O&M costs ($M/yr)	$0.13	Million/yr

Summary Table

SUMMARY TABLE		
Option	**Capital Cost ($M)**	**O&M Cost ($M/yr)**
Non-Structural Source Controls[2]	$8	$5.1
Cisterns	$23	$0.2
Neighborhood Recharge	$244	$1.1
Sand Filters	$79	$3.6
NOTF Retrofit	$9	$0.8
Divert Dry Weather Flow to Wastewater	$12	$0.1
Totals:	**$374**	**$10.9**

[1]The % of total wet weather flow is based on the total wet weather flow from the 0.45-inch storm for Ballona Creek at West LA subwatershed point plus the flow from Windsow Hills (i.e. 765 cfs+77cfs=842cfs = 544 mgd).
[2]Non-structural source controls include programmatic/institutional solutions and smart irrigation implementation.