LA SUSTAINABLE WATER PROJECT: LA RIVER, BALLONA CREEK, AND DOMINGUEZ CHANNEL WATERSHEDS

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SWRCB PRESENTATION NOV. 8, 2017

UCLA Grand Challenges
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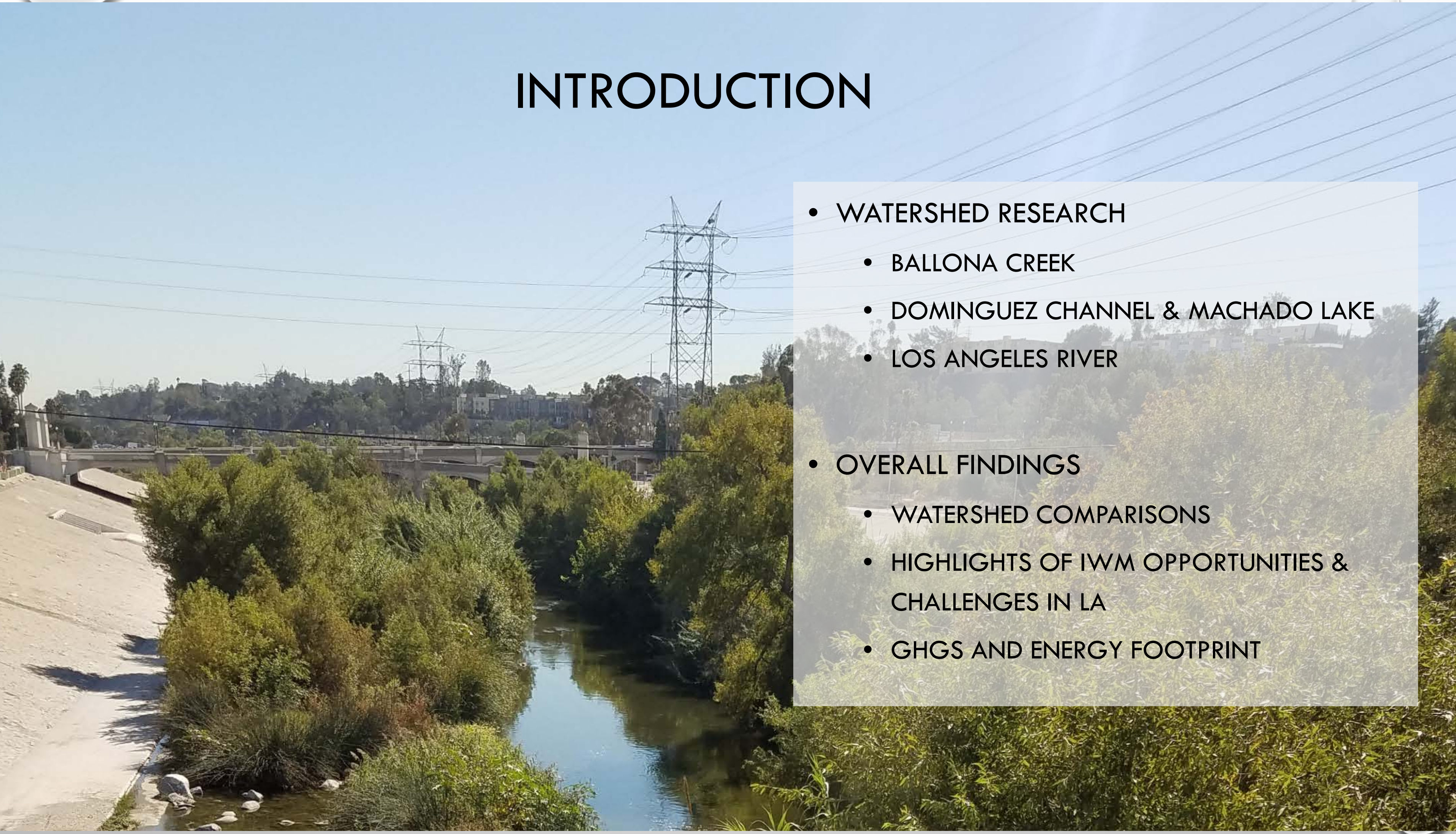
UCLA Institute of the Environment and Sustainability

environment LA SANITATION CITY OF LOS ANGELES

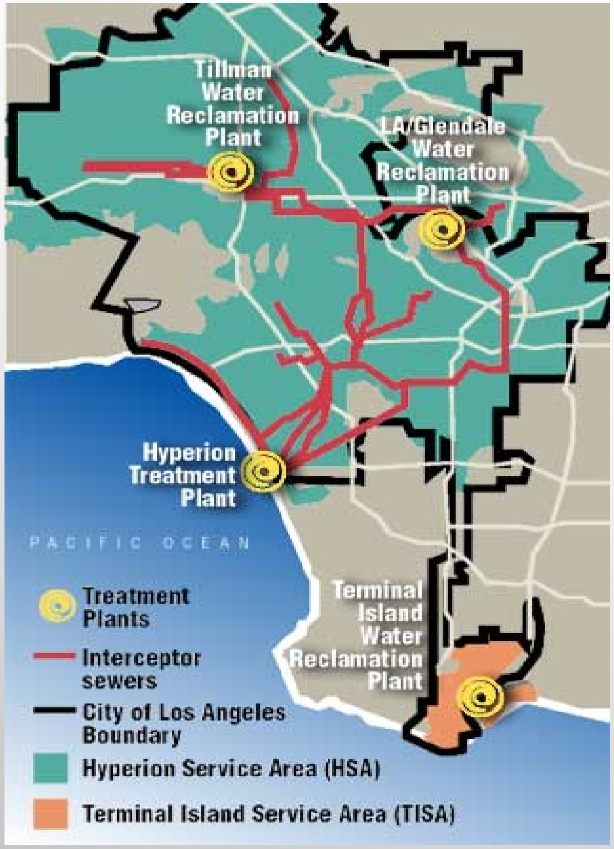
SCHOOL OF MINES 1874 COLORADO

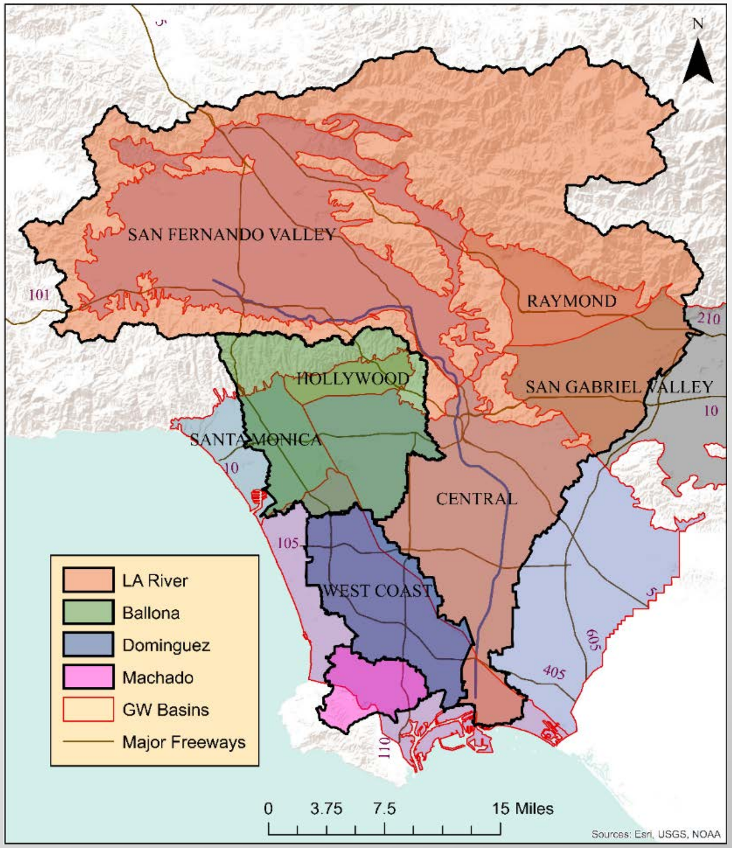
INTRODUCTION



- WATERSHED RESEARCH
  - BALLONA CREEK
  - DOMINGUEZ CHANNEL & MACHADO LAKE
  - LOS ANGELES RIVER
- OVERALL FINDINGS
  - WATERSHED COMPARISONS
  - HIGHLIGHTS OF IWM OPPORTUNITIES & CHALLENGES IN LA
  - GHGS AND ENERGY FOOTPRINT

INTRODUCTION - STUDY AREA OVERVIEW





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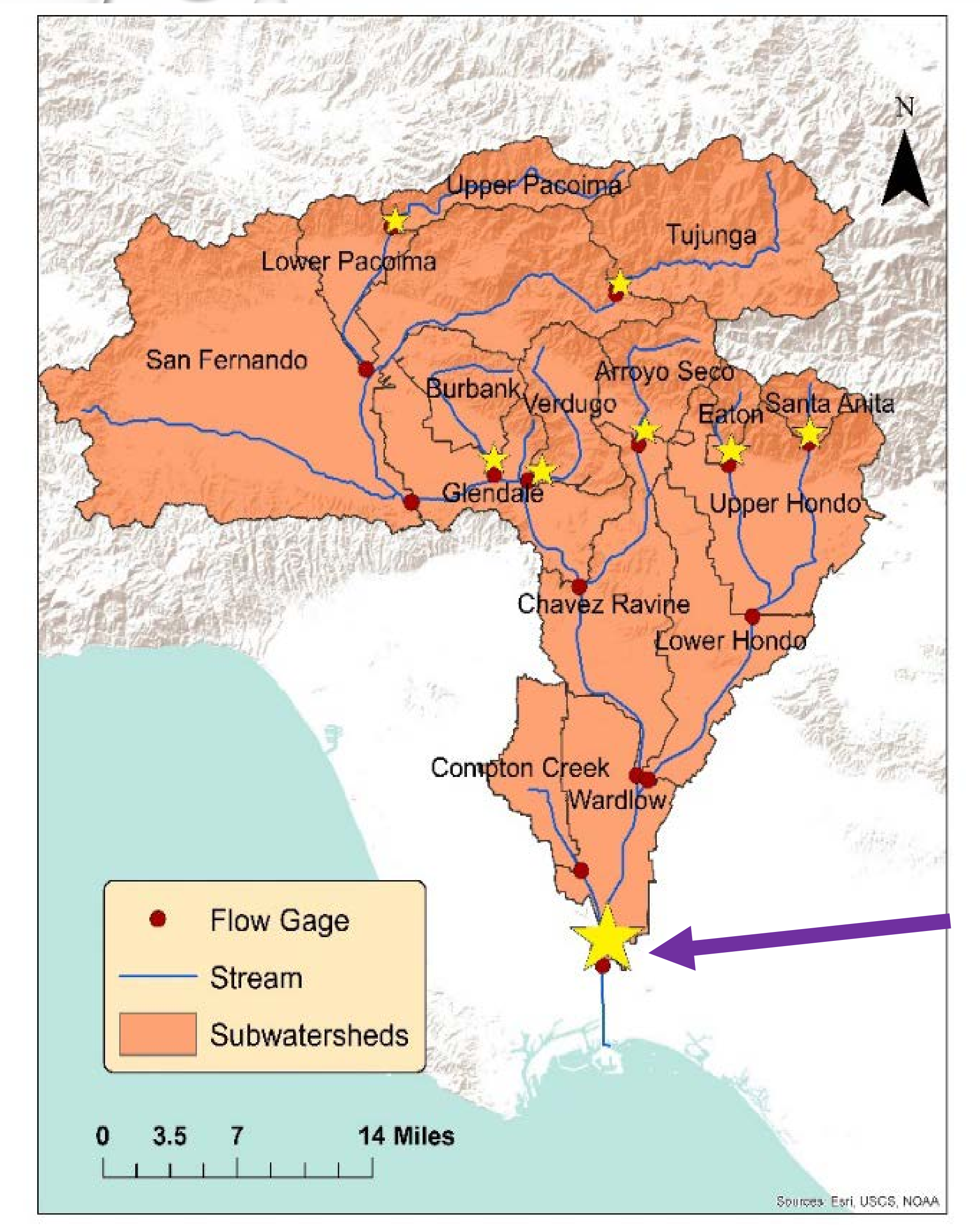


LA RIVER WATERSHED STUDY AREA

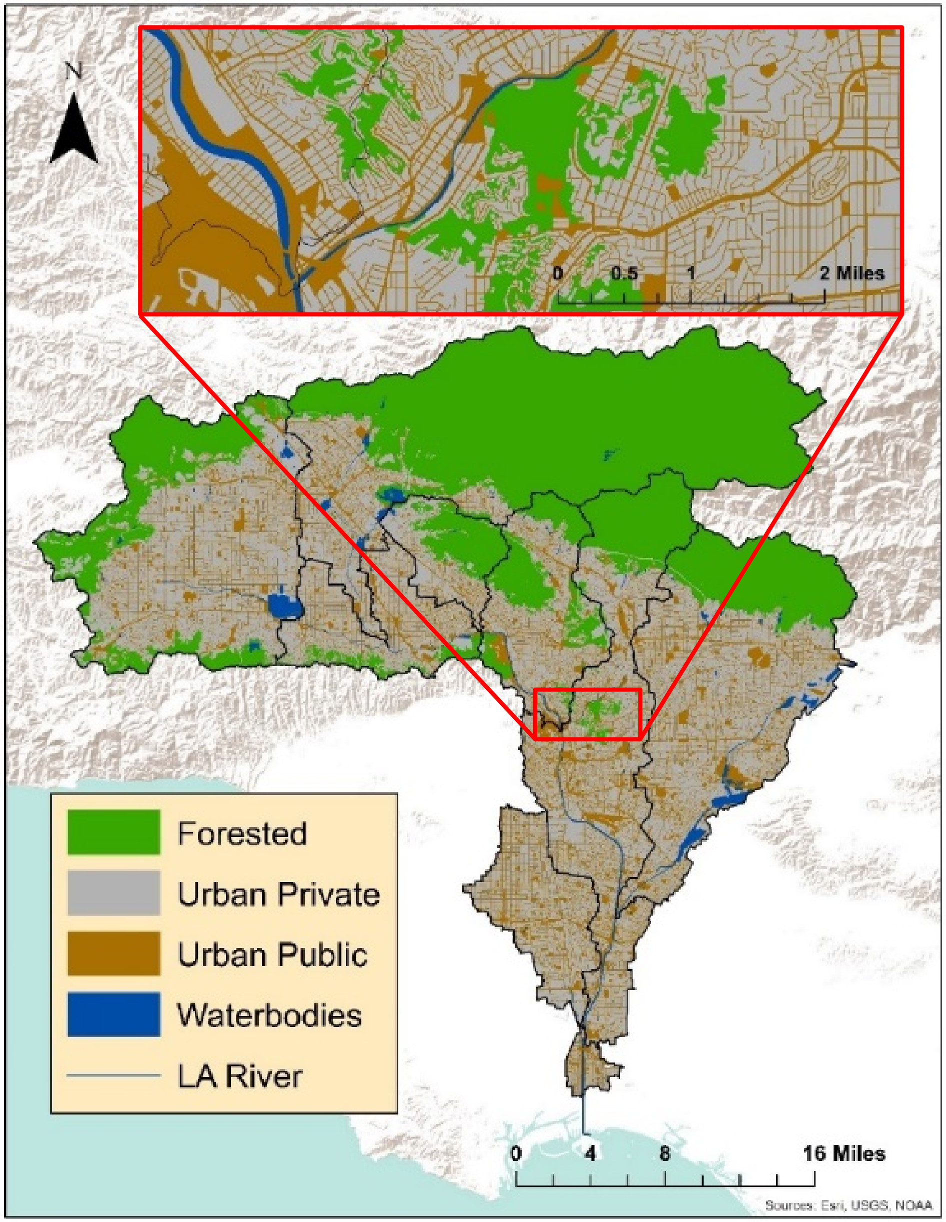
825 square mile watershed

Approximately 35% of watershed within LA City boundary

Measured flows at Wardlow Gage: 274,000 AFY (2004-2013)

Wardlow Gage

LA RIVER WATERSHED LAND USES



Highly developed, lots of undeveloped forested land at top of watershed

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LA RIVER WQ MODELING DECISION MATRIX

		Los Angeles River Scenarios BMPs	Baseline No BMPs	1a BR	1b PP + BR	2a VS + DP	2b PP + VS + DP	3a VS + IT	3b PP + VS + IT
		Volume Capture	0	10,396	10,396	10,396	10,396	10,396	10,396
		Storm Capture %	0	85th %	85th %	85th %	85th %	85th %	85th %
Ancillary Criteria		Cost (Billions)	-	6.60	6.80	3.80	5.20	3.80	5.20
Ancillary Criteria		BMP area (mi^2)	-	10.8	5.8	14.4	9.6	14.4	9.6
Ancillary Criteria		Infiltration (% of Precip)	-	20.8%	22.0%	16.4%	20.4%	22.6%	22.9%
Ancillary Criteria		Infiltration (Million AFY)	-	0.16	0.17	0.13	0.16	0.17	0.17
Ancillary Criteria		Peak Flow Reduction	-	47.0%	53.0%	29.0%	46.0%	55.0%	57.0%
Water Quality Criteria		Dry Weather Days/yr	333	358	360	350	358	361	361
Water Quality Criteria		DW Total Possible Exceedances/yr (Cu, Pb)	2997	3222	3240	3150	3222	3249	3249
Water Quality Criteria		DW Total Possible Exceedances/yr (Zn)	333	358	360	350	358	361	361
Water Quality Criteria	Dry Weather Exceedances/yr	Concentration Based TMDL (Cu)	13	47	49	35	39	43	44
Water Quality Criteria	Dry Weather Exceedances/yr	Concentration Based TMDL (Pb)	0	12	13	7	10	16	14
Water Quality Criteria	Dry Weather Exceedances/yr	Concentration Based TMDL (Zn)	3	8	8	3	7	9	9
Water Quality Criteria	Dry Weather Exceedances/yr	Load Based TMDL (Cu)	307	68	71	62	69	75	75
Water Quality Criteria	Dry Weather Exceedances/yr	Load Based TMDL (Pb)	127	51	53	47	52	57	57
Water Quality Criteria	Dry Weather Exceedances/yr	Load Based TMDL (Zn)	214	18	18	15	18	19	19
Water Quality Criteria		Wet Weather Days/yr	32	7	5	15	7	4	4
Water Quality Criteria		WW Total Possible Exceedances/yr (Cu, Pb, Zn	32	7	5	15	7	4	4
Water Quality Criteria	Wet Weather Exceedances/yr	Concentration Based TMDL (Cu)	5	1	2	1	1	0	2
Water Quality Criteria	Wet Weather Exceedances/yr	Concentration Based TMDL (Pb)	2	0	0	0	0	0	0
Water Quality Criteria	Wet Weather Exceedances/yr	Concentration Based TMDL (Zn)	14	5	5	2	5	2	4
Water Quality Criteria	Wet Weather Exceedances/yr	Load Based TMDL (Cu)	6	1	2	0	1	0	2
Water Quality Criteria	Wet Weather Exceedances/yr	Load Based TMDL (Pb)	2	0	0	0	0	0	0
Water Quality Criteria	Wet Weather Exceedances/yr	Load Based TMDL (Zn)	14	6	5	3	6	2	4
Water Quality Criteria		Cu Average Annual Load % Reduction	-	71.0%	60.8%	58.6%	55.6%	77.2%	61.2%
Water Quality Criteria		Pb Average Annual Load % Reduction	-	83.1%	62.9%	59.7%	53.9%	79.4%	59.7%
Water Quality Criteria		Zn Average Annual Load % Reduction	-	83.6%	63.1%	62.4%	59.4%	80.1%	59.9%

BR: Bioretention; PP: Porous Pavement; VS: Vegetated Swales; DP: Dry Ponds; IT: Infiltration Trenches; BMP Best Management Practice

BALLONA CREEK WQ MODELING MATRIX

	Ballona Creek Scenarios	Baseline	1	2	3	4	5
	BMPs	No BMPs	All	IT	DP	VS + BR + PP	VS + BR + PP
	Wet Weather Days/yr	106	106	11	26	25	87
	Volume Capture	0	1,102	2,510	2,510	2,270	255
Ancillary Criteria	Cost (Billions)	-	0.55	0.70	0.69	1.40	0.20
	BMP area (mi^2)	-	1.36	0.78	0.78	4.32	0.48
	Infiltration (% of Precip)	-	23.4%	60.9%	20.3%	43.7%	6.0%
	Infiltration (AFY)	-	23,000	60,000	20,000	43,000	5,904
	Peak Flow Reduction	-	43.0%	95.0%	10.0%	65.0%	11.0%
Water Quality Criteria	DW Exceedances/yr (Cu)	86	0	0	0	0	5
	DW Exceedances/yr (Pb)	0	0	0	0	0	0
	DW Exceedances/yr (Zn)	0	0	0	0	0	0
	WW Exceedances/yr (Cu)	106	10	10	6	11	84
	WW Exceedances/yr (Pb)	0	0	0	0	0	0
	WW Exceedances/yr (Zn)	19	1	8	0	2	18
	Cu Average Annual Load % Reduction	-	58.0%	75.0%	61.0%	74.0%	10.0%
	Pb Average Annual Load % Reduction	-	49.0%	69.0%	56.0%	69.0%	9.0%
	Zn Average Annual Load % Reduction	-	57.0%	72.0%	65.0%	75.0%	10.0%

DOMINGUEZ WQ MODELING MATRIX

	Dominguez Scenarios	Baseline	1	1b	2	2b	3	3b
	BMPs	No BMPs	BR	PP + BR	VS + DP	PP + VS + DP	VS + IT	PP + VS + IT
	Wet Weather Days/yr (2002-2011)	32	8	6	11	9	8	7
	Volume Capture	0	2353	2353	2353	2353	2353	2353
	Storm Capture %	0	85th %	85th %	85th %	85th %	85th %	85th %
Ancillary Criteria	Cost (Billions)	-	1.51	1.51	0.70	0.89	0.70	0.90
	BMP area (mi^2)	-	2.48	2.68	2.14	2.72	2.09	2.67
	Infiltration (% of Precip)	-	30.6%	22.8%	2.4%	14.9%	18.6%	22.1%
	Infiltration (AFY)	-	13,762	10,254	1,084	6,701	8,365	9,948
	Peak Flow Reduction	-	69.6%	55.7%	4.4%	34.0%	45.4%	55.3%
Water Quality Criteria	Concentration Based WW Exceedances/yr (Cu)	16	6	5	9	8	7	6
	Concentration Based WW Exceedances/yr (Pb)	0	0	0	0	0	0	0
	Concentration Based WW Exceedances/yr (Zn)	16	5	4	5	7	6	6
	Load Based WW Exceedances/yr (Cu)	18	7	5	11	9	8	7
	Load Based WW Exceedances/yr (Pb)	0	0	0	0	0	0	0
	Load Based WW Exceedances/yr (Zn)	17	6	5	5	7	7	6
	Cu % Load Based TMDL Compliance (WW)	4.20%	8.6%	7.5%	5.9%	4.9%	5.4%	6.2%
	Pb % Load Based TMDL Compliance (WW)	100%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	Zn % Load Based TMDL Compliance (WW)	8.40%	22.9%	11.3%	53.5%	20.7%	13.5%	12.3%
	Cu Average Annual Load % Reduction	-	80.4%	74.9%	74.7%	77.1%	80.0%	82.2%
	Pb Average Annual Load % Reduction	-	75.5%	73.5%	77.1%	78.3%	82.3%	83.1%
	Zn Average Annual Load % Reduction	-	84.5%	76.0%	80.3%	80.3%	82.2%	83.1%

MACHADO WQ MODELING MATRIX

	Scenario	Baseline	ML-1	ML-2	ML-3	ML-4	ML-5	ML-6
	BMPs		DP + IT	DP + IT + PP	WP	*	*	*
	N - Modeled Months	84	84	84	84	84	84	84
	Cost (Billions)	-	0.19	0.26	0.19	-	-	-
	BMP area (mi^2)	-	0.23	0.43	0.22	-	-	-
External SUSTAIN Criteria	**TN** External AAL % Reduction	-	55.3%	62.7%	89.3%	-	-	-
	TP External AAL % Reduction	-	76.6%	80.0%	90.0%	-	-	-
	TN WW External AAC (mg/L)	6.24	6.12	5.58	1.47	1	1	1
	TP WW External AAC (mg/L)	1.35	0.69	0.65	0.29	0.1	0.1	0.025
In-Lake SLAM Results	Months in Compliance (**TN**)	5	47	56	84	84	84	84
	Months in Compliance (**TP**)	0	2	2	29	46	67	84
	TN Compliance	6.0%	56.0%	66.7%	100.0%	100.0%	100.0%	100.0%
	TP Compliance	0.0%	2.4%	2.4%	34.5%	54.8%	79.8%	100.0%
	TN monthly average concentration mg/L	1.8	0.98	0.87	0.48	0.31	0.22	0.22
	TN Wet weather monthly average	1.5	0.89	0.78	0.34	0.16	0.12	0.12
	TN Dry weather monthly average	2.15	1.11	0.99	0.64	0.46	0.32	0.32
	TP monthly average concentration mg/L	0.77	0.31	0.29	0.17	0.11	0.05	0.02
	TP Wet weather monthly average	0.57	0.22	0.22	0.11	0.05	0.03	0.01
	TP Dry weather monthly average	0.99	0.4	0.38	0.25	0.16	0.08	0.01
	* Scenarios were not run in SUSTAIN, thus no set suite of BMPs. However daily flow was taken from scenario ML-1 in order to determine daily external load based on set external AAC.							

MODELING FOR EACH WATERSHED

- These modified SUSTAIN modeling analyses are a powerful tool to offer multiple streams of information on integrated water / one water management questions

  - water quality benefits (e.g., reducing number of water quality exceedances)
  - potential water supply benefits among scenarios
    - BMP scenarios for 85th percentile storm in LA River watershed offer potential to infiltrate 130-170K AFY)
    - BMP scenarios in DC watershed offer 1K to 13.7K AFY
  - peak flow reduction (29-57% in LA River BMP scenarios)
  - cost, area required for installation, etc.

- Modeling analyses focused on placing BMPs on public lands, private land will also be an important part of the solution

GROUNDWATER / RECYCLED WATER

- 330,000 AF OF SPACE IN CENTRAL BASIN
- 120,000 AF OF SPACE IN WEST COAST BASIN
- 600,000 AF BRACKISH GROUNDWATER PLUME IN WCB – OPPS TO PUMP AND TREAT & INCREASE STORAGE CAPACITY FOR NEW WATER
- CONTINUE WITH PLANS TO REMEDIATE AND RECHARGE UPPER LA RIVER AREA (ULARA) GROUNDWATER BASINS
- EXPLORE OPPORTUNITIES TO EXPAND RECHARGE AND EXTRACTION IN ULARA
    - E.G., STUDY TO MAXIMIZE USE IN ULARA WEST OF THE 405, POTENTIAL FOR STORAGE BEHIND SEPULVEDA DAM

WHAT MAKES UP THE LA RIVER FLOWS?

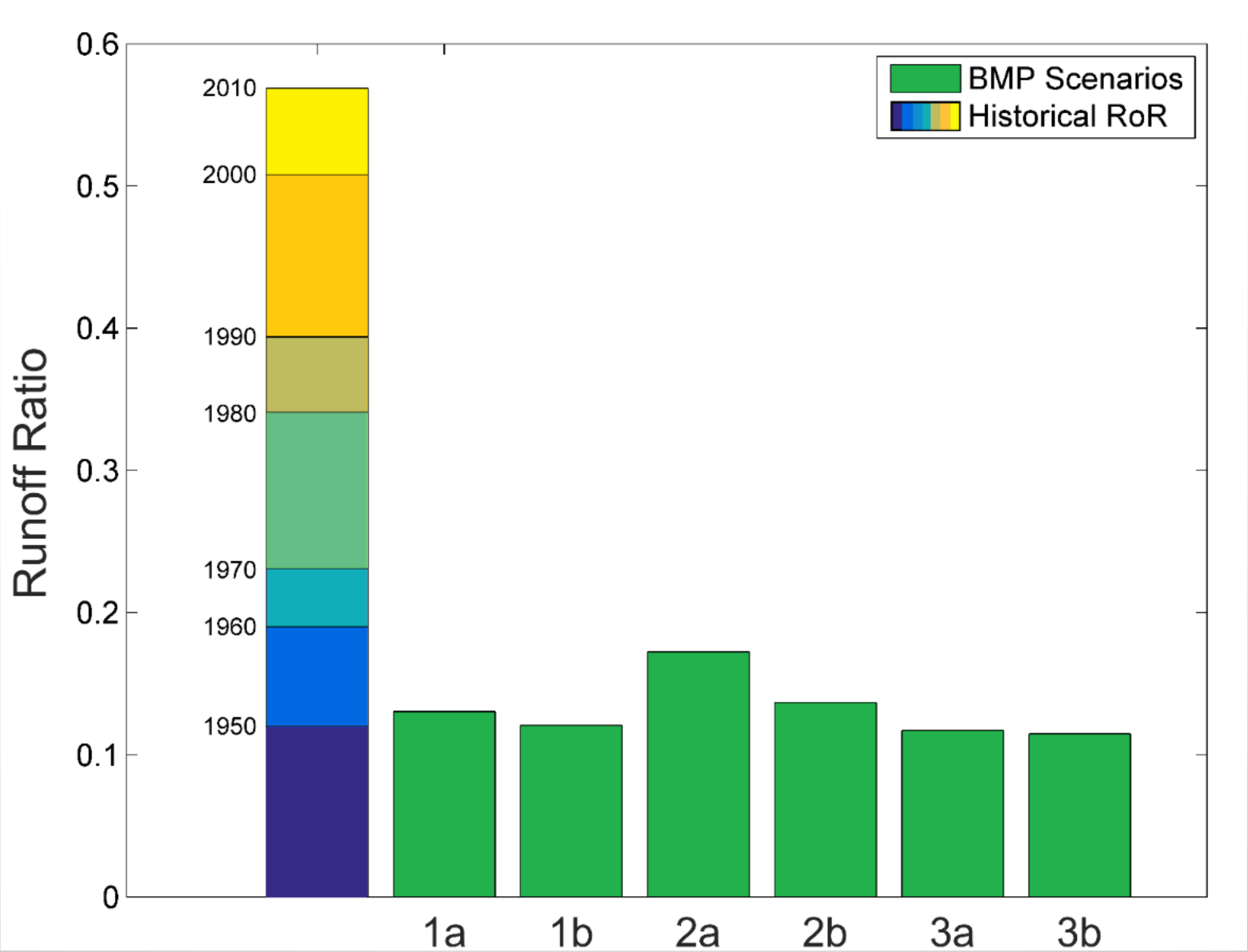
- CURRENT STATE:
  - WATER RECLAMATION PLANT EFFLUENT DISCHARGE
  - URBAN RUNOFF
  - RISING / UPWELLING GROUNDWATER
- BUT FLOWS ARE CHANGING –
  - MORE RUNOFF WILL BE CAPTURED AS ENHANCED WATERSHED MANAGEMENT PROGRAMS IMPLEMENTED AND LOW IMPACT DEVELOPMENT PRACTICES MORE BROADLY INSTALLED
  - INCREASED FOCUS ON LOCAL WATER SUPPLY MAY LEAD TO REUSE OF ADDITIONAL TREATED WASTEWATER (CURRENTLY DISCHARGED INTO LAR)
  - INCREASED USE OF ULARA GROUNDWATER BASINS MAY LEAD TO LESS OR NO RISING GROUNDWATER.

BMPS REDUCE LAR FLOWS

Season	Modeling Baseline Flow (2004-2013)			With BMPs		
	CFS	MGD	AFY	CFS	MGD	AFY
Fall	134	87	97,000	91	59	66,000
Winter	188	122	136,000	100	65	72,000
Spring	178	115	129,000	89	58	64,000
Summer	142	92	103,000	87	56	63,000

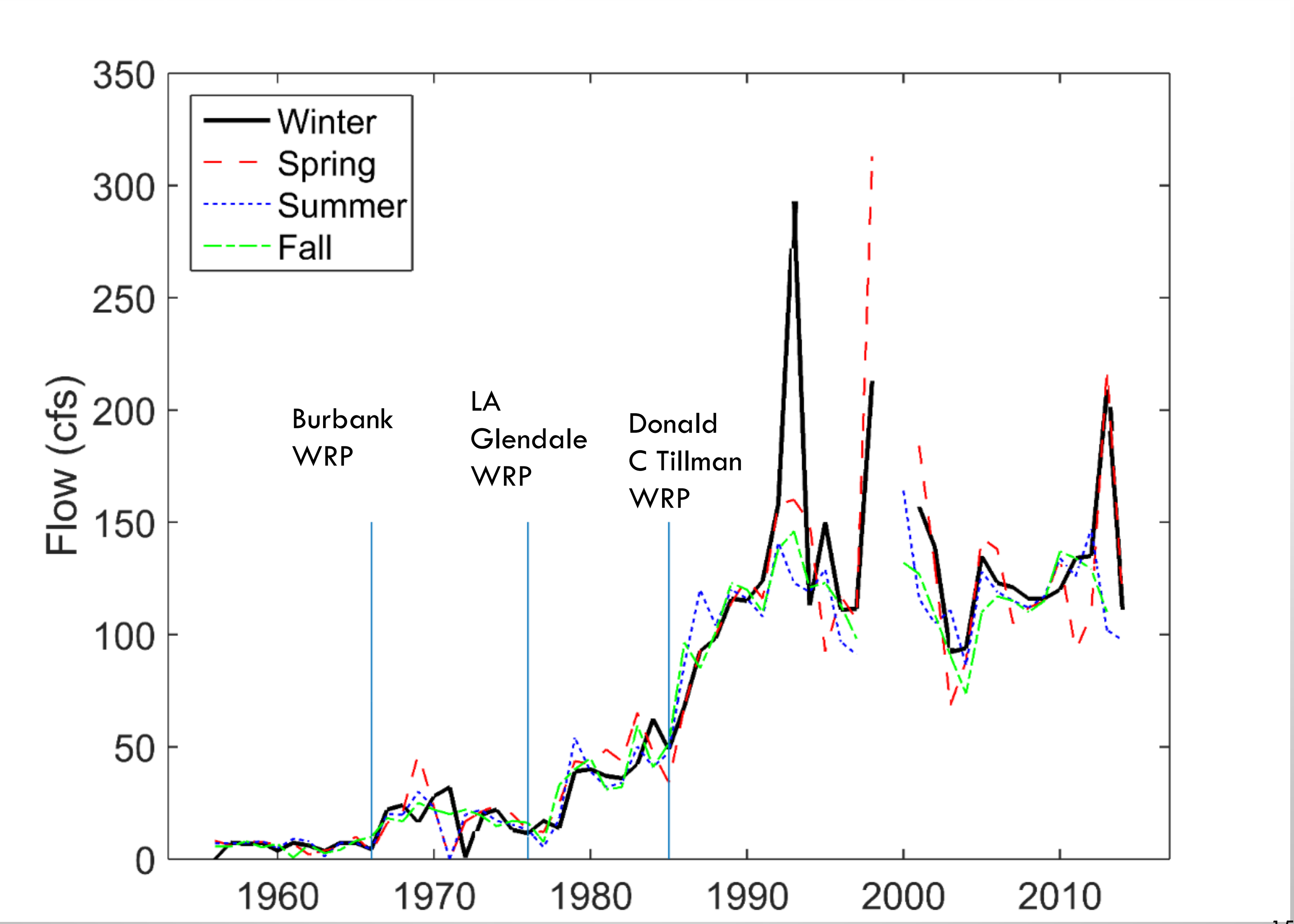
Modeled median seasonal flows for Wardlow Gage with and without BMPs.

RUNOFF RATIOS



- BMPs also influence the volumes of water that run off the watershed
- Historical (1940 – 2010 data) runoff ratios and runoff ratios after implementing BMPs (2004-2013 data)
- Runoff ratios post BMPs are similar to those in the 1950s and 1960s

HISTORIC SEASONAL ANNUAL MINIMUM FLOWS IN THE LAR



Historic seasonal annual minimum flows in the LAR, measured at the Wardlow gage; blue vertical lines represent Water Reclamation Plants coming online

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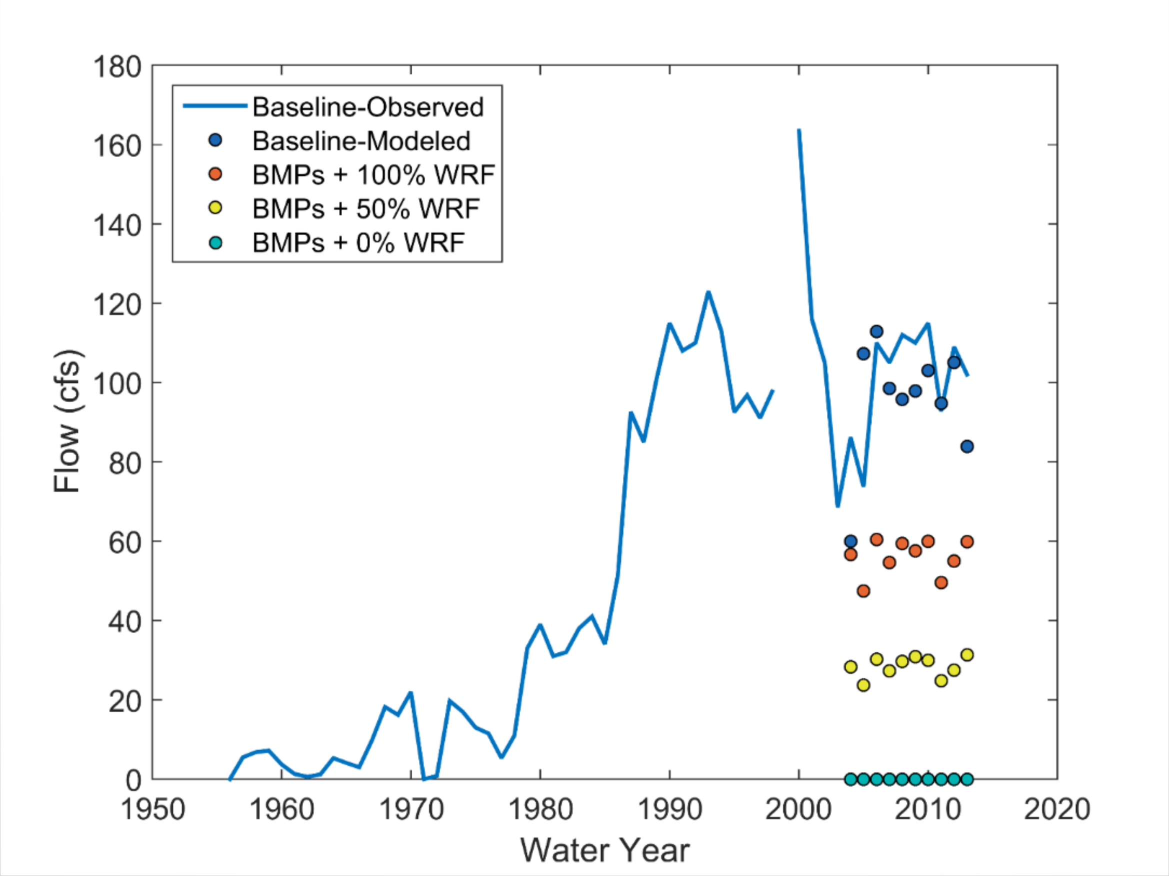
MODELED ANNUAL MINIMUM FLOWS CHANGE AT WARDLOW GAGE



Annual minimum flows at the Wardlow gage (blue line) compared with modeled flow before BMPs (blue points, 2004-2013 data), and post-BMP flows with varying amounts of WRP flow (0% - aqua, 50% - yellow, 100% - orange points)

In modeled scenarios with no water reclamation plant effluent flows discharged to LAR and implementation of BMPs to manage 85th percentile storm, annual minimum flows go to zero at Wardlow Gage

LOW FLOWS (7Q10)

Gage	Time Period	Years	7Q10 (cfs)
Wardlow	1956-1985	30	42.2
Wardlow	1986-2014	29	157
Arroyo Seco	1917-2014	98	1.7

7Q10 flow volumes (defined as the lowest average discharge over a period of one week with a recurrence interval of 10 years) shift in 1986 when DCTWRP comes online

No 7Q10 flow change was observed at Arroyo Seco, a less developed watershed (gage just below forested area), from 1917-2014 (~2 cfs over entire period).

CONCLUSIONS

- CHANGES TO THE CURRENT SOURCES OF FLOW TO THE LA RIVER CAN REDUCE FLOWS IN THE CHANNEL TO ZERO, IN PARTICULAR DURING MINIMUM FLOWS
- LOW FLOWS NEAR THE OUTLET OF THE LA RIVER WERE MUCH LOWER IN THE EARLY- TO MID- 20TH CENTURY THAN CURRENTLY.
- CURRENT FLOW VOLUMES IN LA RIVER MAY NOT BE NECESSARY IN ORDER TO SUSTAIN ALL BENEFICIAL USES AND SHOULD NOT BE ASSUMED NECESSARY IN PLANNING STUDIES FOR THE LA RIVER.
- STUDY NEEDS TO BE DONE TO QUANTIFY MINIMUM FLOW REQUIREMENT TO SUPPORT USES AND NEEDS (FLOOD CONTROL, WATER SUPPLY, ENHANCED HABITATS, RECREATION, ETC) AND DETERMINE IF THIS FLOW IS CLOSER TO 10-15 CFS THAN CURRENT ~90-100 CFS

LA RIVER FLOWS STUDY

- MULTIPLE NEEDS AND USES IN THE LA RIVER
  - HABITAT
  - RECREATION
  - WATER SUPPLY
  - FLOOD CONTROL

- STUDY TO ASSESS APPROPRIATE FLOWS TO SUPPORT ALL USES MUST BE CONDUCTED
  - BENCHMARKS
  - METRICS
  - MONITORING
  - CLEAR VISION OF WHAT FUTURE LAR SHOULD LOOK LIKE

LOW IMPACT DEVELOPMENT EFFECTS

Los Angeles River	% Redeveloped (2028)	Redeveloped Area (mi^2)	Volume Captured (AF)
Residential	12%	35.9	1,436
Commercial	10%	5.9	235
Industrial	22%	10.9	437
Educational	10%	1.8	70
	Pre - redevelopment	Post - redevelopment	% Reduction
Volume Captured (AF)	10,396	8,218	20.95%

City of LA-type LID ordinance implemented across the watershed. These numbers could be greatly expanded by expanding ordinance to include resale, and by establishing partnerships with NGOs to increase voluntary implementation.

Volume Captured (AF)	Pre - redevelopment	Post - redevelopment	% Reduction
Ballona Creek	3621	2902	19.85%
Dominguez Channel	2353	1837	21.91%
Los Angeles River	10396	7378	29.04%

Potential for LID ordinance across watersheds, 2035

INFILTRATION TRENCHES / DRY WELLS

	85th Percentile Storm (acre-feet)	Infiltration Surface Area Required (acres)	# of 10 ft by 20 ft Infiltration Trenches Required	# of 10 ft by 80 ft Infiltration Trenches Required
Ballona Creek	3,621	2,414	525,768	131,374
Dominguez Channel	2,353	1,570	341,945	85,486
Los Angeles River	10,396	6,931	1,509,496	377,374

Number of mid-sized IT required to capture 85th percentile storm volumes.

	85th Percentile Storm (AF)	Infiltration Surface Area Required (acres)	# of 6 ft Diameter & 10 ft Deep Dry Wells Required	Infiltration Surface Area Required (acres)	# of 6 ft Diameter & 20 ft Deep Dry Wells Required
Ballona Creek	3,621	1,035	2,290,077	517	797,137
Dominguez Channel	2,355	673	1,037,140	335	516,369
Los Angeles River	10,396	2,970	4,578,392	1,478	2,279,478

Number of mid-sized dry wells required to capture 85th percentile storm volumes

CITY OF LOS ANGELES WATER USE SCENARIOS

- ASSESSED THREE WATER PORTFOLIOS
  - 2013-2014 DROUGHT YEAR,
  - CITY-BASED, BUILDING ON UWMP AND PLAN GOALS
  - MAXIMIZE LOCAL WATER SCENARIO
- 98.25 GPCD, PROJECTED POPULATION OF 4.35 MILLION PEOPLE YIELDS DEMAND OF 479,000 AFY
- ELIMINATE IMPORTED WATER (126K AFY) AND INCREASE SW CAPTURE OR WATER RECYCLING BY 33K AFY AND DECREASE CONSUMPTION TO 75 GPCD (366K AFY)= SELF SUFFICIENCY!!

Supply Scenarios [AFY]	FY2013-2014	2035: city-based	2035: max local reuse
MWD	441,871	100,000	35,000
LA Aqueduct	61,024	139,400	91,000
Groundwater (net)*	79,403	114,100	114,100
Recycled Water (irr & industrial use)	10,054	45,400	161,400
Recycled Water (GWR)		43,100	
Stormwater	included in groundwater	37,000	58,000
Total	592,352	479,000	459,500

WATER PORTFOLIO GHG EMISSIONS

PP 2014	Energy Required (kWh/AF)	WS 2013 Average Volume (AF)	WS 2013 Total Emissions (MT of CO2e)	WS City 2035 Volume (AF)	WS City 2035 Total Emissions (MT of CO2e)	WS Max 2035 Volume (AF)	WS Max 2035 Total Emissions (MT of CO2e)
SWP East	4,520	66,281	99,764	15,000	22,577	5,250	7,902
SWP West	4,110	309,309	423,330	70,000	95,804	24,500	33,531
CRA	2,000	66,281	21,984	15,000	4,975	5,250	1,741
MWD	-	441,871	545,078	100,000	123,356	35,000	43,174
LAA	0	61,024	-	139,400	-	91,000	-
Ground-water (net)	580	79,403	25,393	114,100	36,490	114,100	36,490
Recycled Water	1,150	10,054	6,375	88,500	56,117	161,400	102,342
Stormwater	174	n/a	-	37,000	3,550	58,000	5,565
Total	-	592,352	576,846	479,000	219,513	459,500	187,571

Additional calculations with potential future power portfolio (e.g., 50% renewables), GHG emissions are greatly reduced compared to current power mix with no change in water supply mix.

Table 9.3: Comparison of monetized benefits and costs for 2035 max local scenario

	Net volume (AFY)	Annualized cost of supply (millions $2016)	PV cost of supply (millions $2016)	PV monetized benefit (millions $2016)*	Net PV (millions $2016)
Groundwater (net)	34,697	18.9	420.1	1,126.8	705.7
Recycled Water – NPR irrigation & industrial use	37,400	57.6	1,051.5	1,257.6	206.1
Recycled Water – GWR	113,946	144.6	1,861.9	3,383.3	1,521.4
Stormwater – Centralized	26,000	31.2	568.5	687.4 to 802.1	118.9 to 233.6
Stormwater – Distributed (including Direct)	32,000	243.2	4,434.0	9,248.5 to 11,898.9	4,814.4 to 7,464.9
Total	**244,043**	**495.5**	**8,336.0**	**15,702.6 to 18,467.7**	**7,366.4 to 10,131.6**

*Potentially important but non-monetized benefits include water quality benefits, improved reliability, improved flood control, job creation, reduced damages from drought, increased resiliency to climate change, the opportunity to reuse a water resource that would otherwise be lost, environmental benefits associated with reduced stress on the Bay-Delta resources due to lower demands for water extraction, and reduced human health risks associated with reduced energy-related emissions of air pollutants other than GHGs.

PUBLICATIONS

SUSTAINABLE LA WATER PROJECT REPORTS:

- LA RIVER WATERSHED, SEPTEMBER 2017
  HTTPS://GRANDCHALLENGES.UCLA.EDU/HAPPENINGS/2017/09/19/LOS-ANGELES-SUSTAINABLE-WATER-PROJECT-LOS-ANGELES-RIVER-WATERSHED/
- DOMINGUEZ CHANNEL AND MACHADO LAKE WATERSHEDS, AUG 2017.
  HTTPS://GRANDCHALLENGES.UCLA.EDU/HAPPENINGS/2017/08/03/NEW-UCLA-REPORT-LOOKS-AT-IMPROVING-WATER-QUALITY-AND-SUPPLY-IN-L-A-S-DOMINGUEZ-CHANNEL-AND-MACHADO-LAKE-WATERSHEDS/
- BALLONA CREEK WATERSHED, NOVEMBER 2015
  HTTPS://GRANDCHALLENGES.UCLA.EDU/HAPPENINGS/2015/11/13/100-LOCAL-WATER-FOR-LA-COUNTY/
- OVERALL CITY-WIDE REPORT, LATE 2017

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Questions?