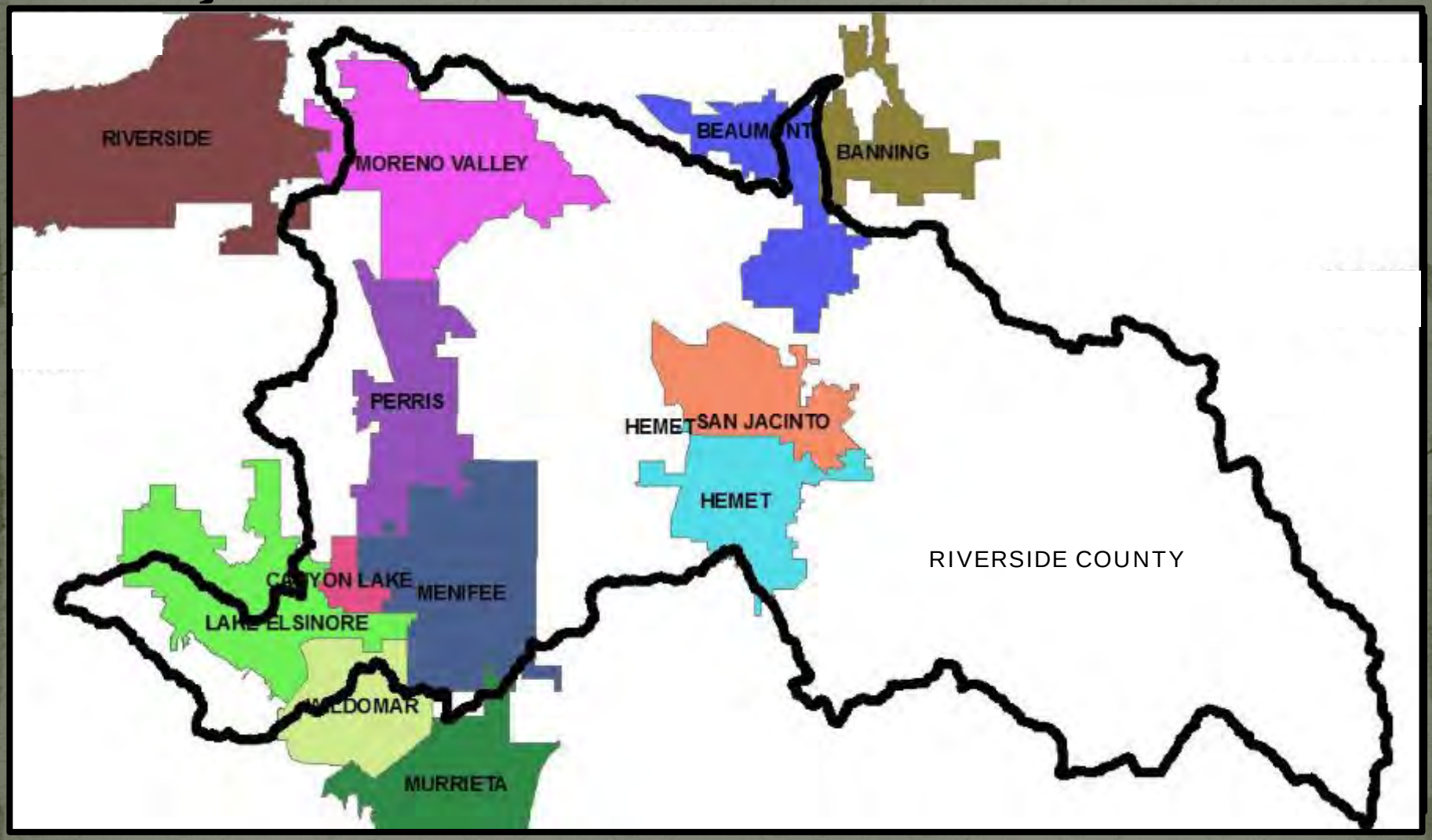
San Jacinto Watershed
2014 Comprehensive Land Use Mapping

September 8 and 9, 2015

Aerial Information Systems, Inc.


Project funding provided by:
San Jacinto River Watershed Council
Western Riverside County Agriculture Coalition
Riverside County Flood Control and Water Conservation District

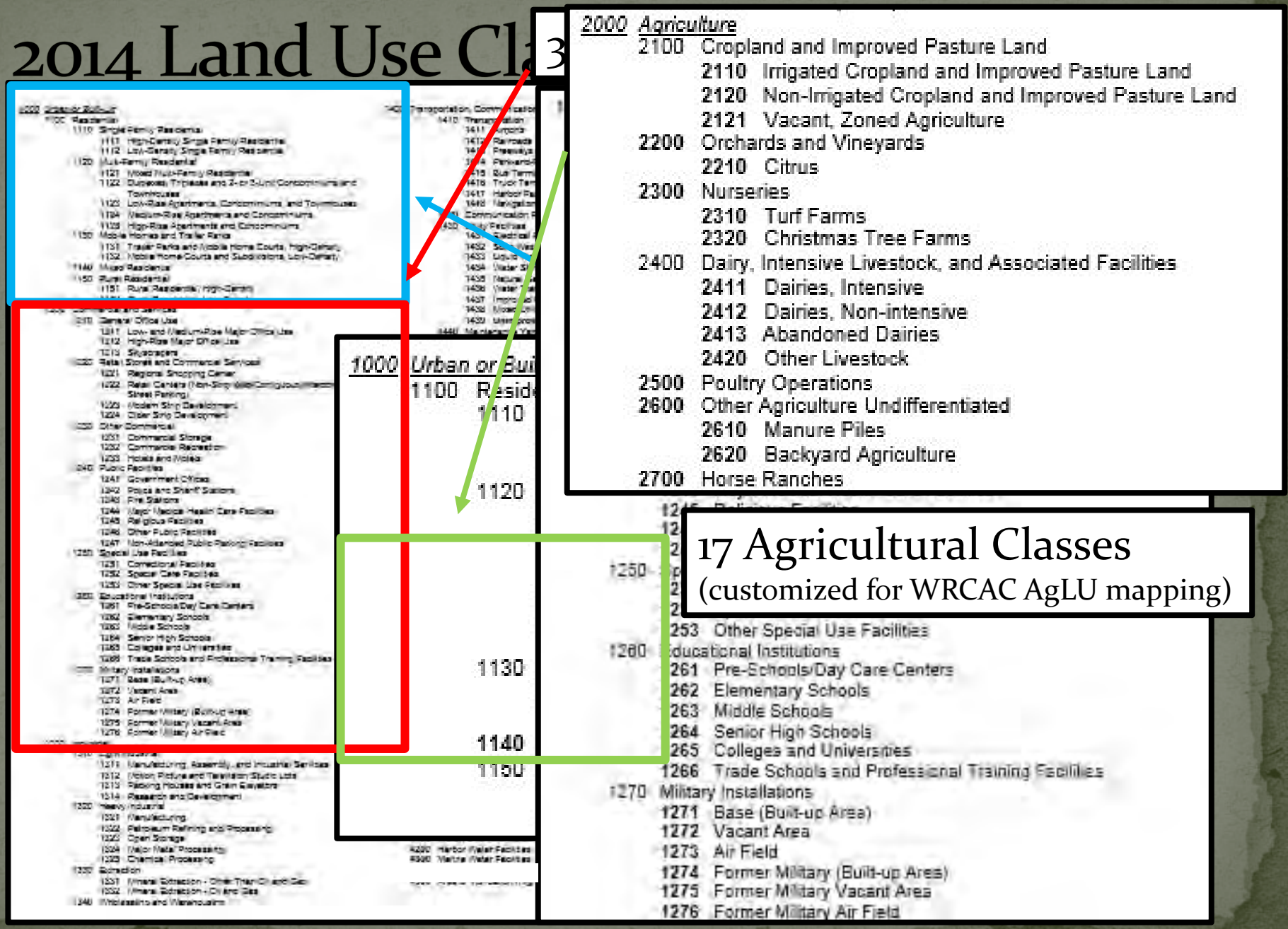
Study Area


RIVERSIDE
MORENO VALLEY
BEAUMONT
BANNING
PERRIS
HEMET
SAN JACINTO
HEMET
RIVERSIDE COUNTY
CANYON LAKE
MENIFEE
LAKE ELSINORE
MURRIETA

Project Materials

- 2014 NAIP digital natural color imagery
- Digital File of San Jacinto Watershed boundary
- On-line resources: Google Earth Imagery, Google, Bing, Websites

2014 Land Use Cl



2000 Agriculture
- 2100 Cropland and Improved Pasture Land
  - 2110 Irrigated Cropland and Improved Pasture Land
  - 2120 Non-Irrigated Cropland and Improved Pasture Land
  - 2121 Vacant, Zoned Agriculture
- 2200 Orchards and Vineyards
  - 2210 Citrus
- 2300 Nurseries
  - 2310 Turf Farms
  - 2320 Christmas Tree Farms
- 2400 Dairy, Intensive Livestock, and Associated Facilities
  - 2411 Dairies, Intensive
  - 2412 Dairies, Non-intensive
  - 2413 Abandoned Dairies
  - 2420 Other Livestock
- 2500 Poultry Operations
- 2600 Other Agriculture Undifferentiated
  - 2610 Manure Piles
  - 2620 Backyard Agriculture
- 2700 Horse Ranches

1000 Urban or Bui
- 1100 Reside
- 1110
- 1120
- 1130
- 1140
- 1150

1250
- 1253 Other Special Use Facilities

1260 Educational Institutions
- 1261 Pre-Schools/Day Care Centers
- 1262 Elementary Schools
- 1263 Middle Schools
- 1264 Senior High Schools
- 1265 Colleges and Universities
- 1266 Trade Schools and Professional Training Facilities

1270 Military Installations
- 1271 Base (Built-up Area)
- 1272 Vacant Area
- 1273 Air Field
- 1274 Former Military (Built-up Area)
- 1275 Former Military Vacant Area
- 1276 Former Military Air Field

17 Agricultural Classes
(customized for WRCAC AgLU mapping)

Photo Interpretation Overview

- Image Resolution
- Unique Characteristics of Feature
  - Color
  - Texture
  - Pattern
  - Tonal Qualities
- Feature Context

2014 NAIP

Project Base Imagery

- Difficult to work with in an ArcGIS production environment.
- Can be inconsistent image acquisition dates and resolution
- Image availability changes over time, does not provide a permanent record

Google Earth

Supplemental Imagery

- Open Source, data available free to public
- Permanent, provides an unchanging record over time
- Easily used in an ArcGIS production environment

Methodology

- Photo Interpretation
  - Map land use to 2014 conditions
  - 1 acre minimum mapping resolution
  - Down to 4th level Anderson/WRCAC Classification detail
- Computer Interactive Data Capture Techniques (heads-up digitizing)
  - On-screen photo interpretation
  - Input LU boundaries and attributes into GIS
  - Project specific tools and coding menus
- Field Work – Windshield Surveys
  - Field preparation
  - Windshield surveys
  - Field revisions
- Quality Control Review
- Crosswalk land use to TMDL land use classes
- Create Summary Tables
- Final Report

Photo Interpretation Process

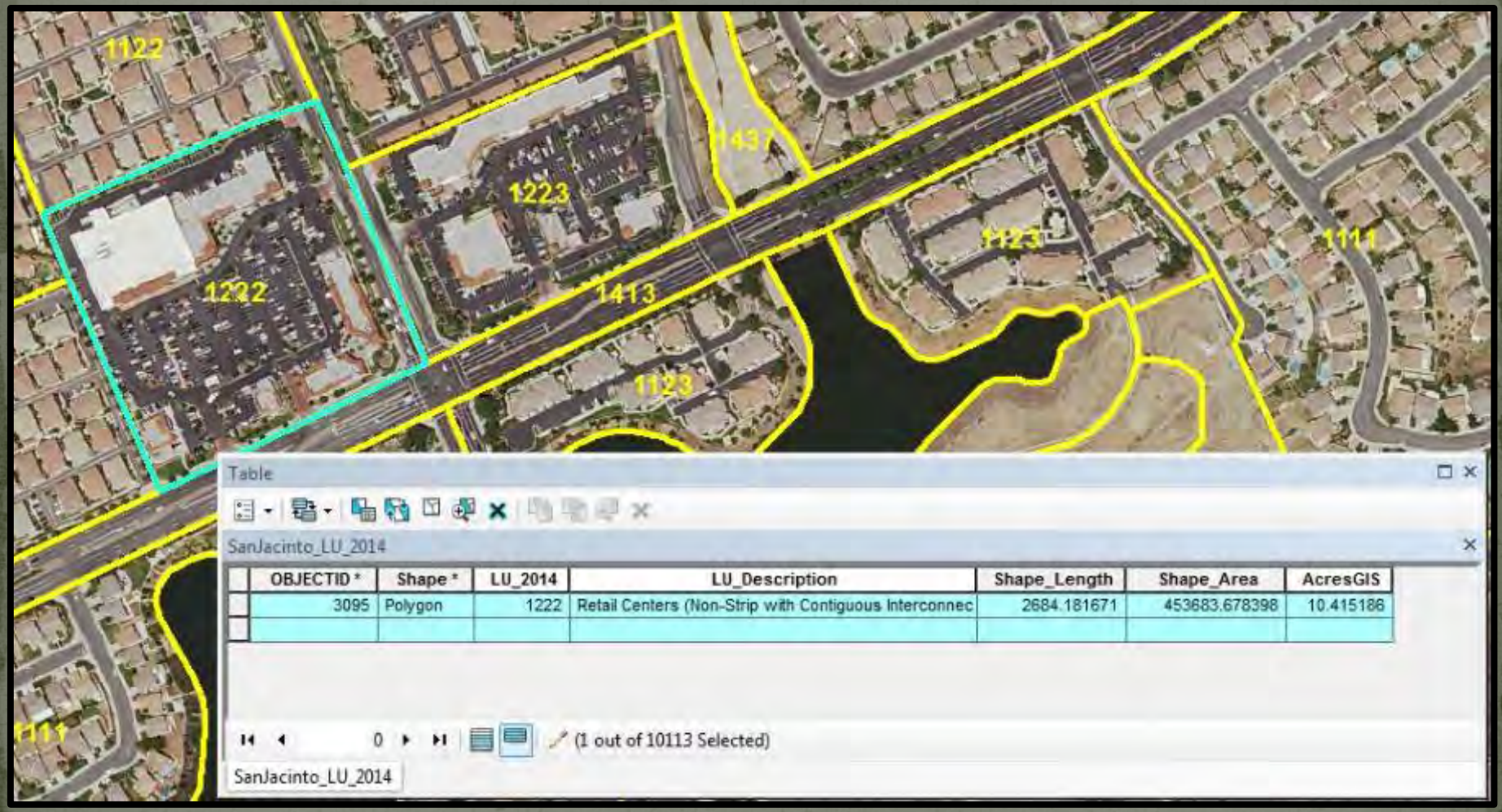
Boundaries delineated based on image interpretation and MMU

Detailed F bservations

Photo Documentation

- Resolv
- Valida
- Hardc
- Winds

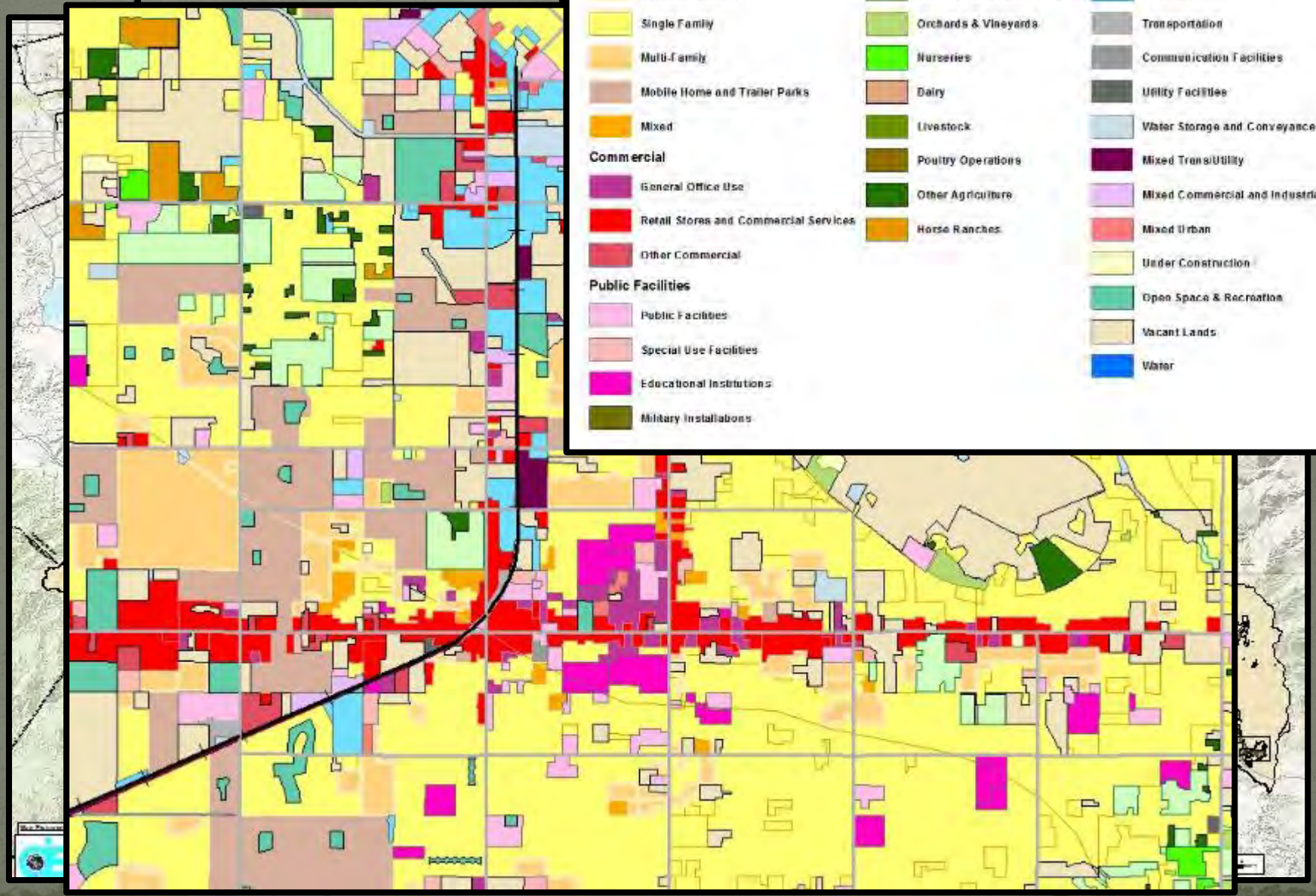
Land Use Geodatabase



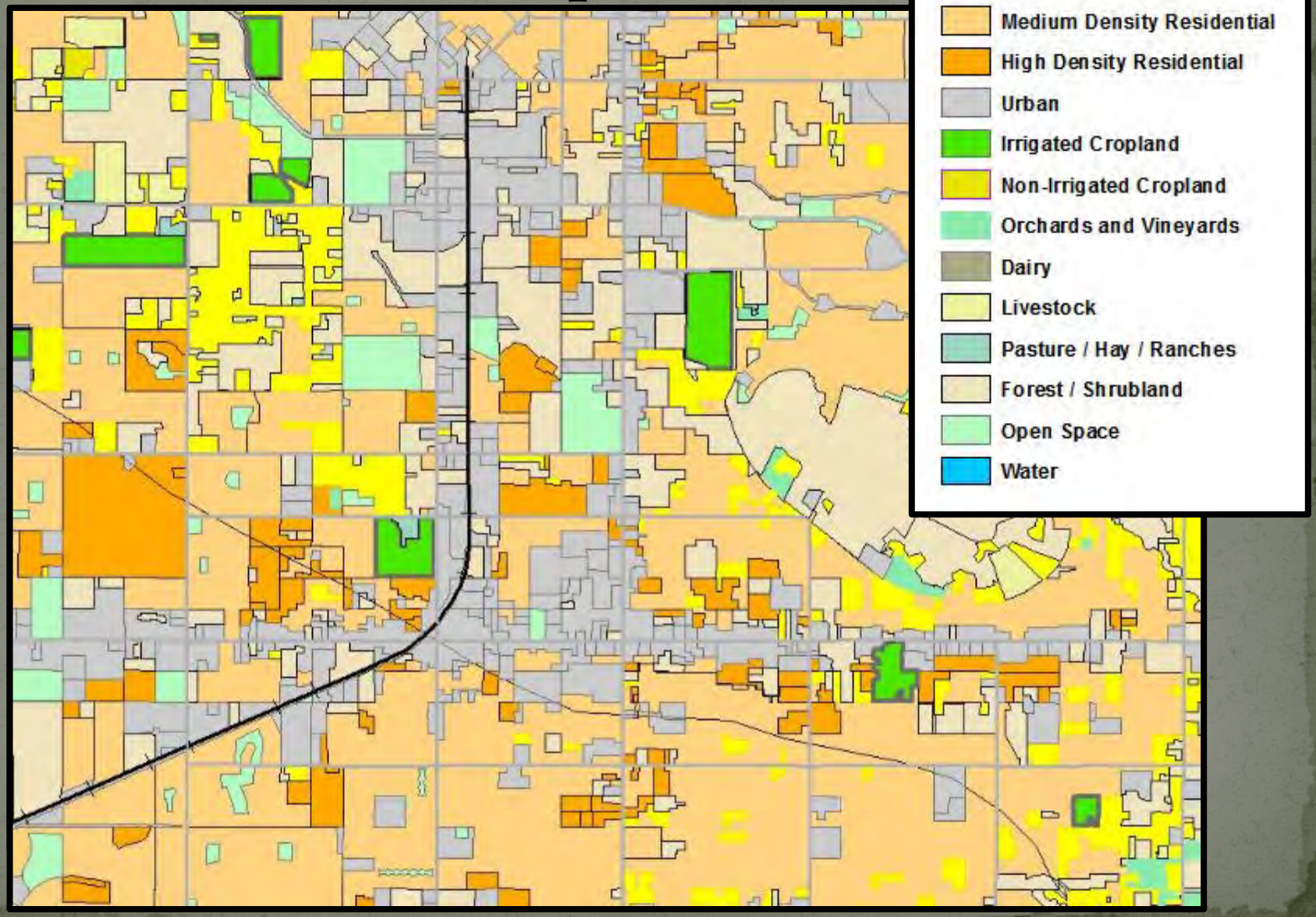
Land Use to TMDL Class Crosswalk Table

TMDL (13 classes)	2014 Land Use (95 classes)
11 Irrigated Cropland	2110, 2310
12 Non-Irrigated Cropland	2120
20 Livestock (non-dairy)	2420, 2500, 2610, 2620, 2700
21 Dairy	2411
30 Orchards and Vineyards	2200, 2210, 2300, 2320, 3200
40 Pasture/Hay/Ranches	2412, 2413, 2600
50 Forest Shrubland	1439, 1850, 1851, 1852, 2121, 3100
60 Low Density Residential	1112, 1132, 1152
70 Medium Density Residential	1111, 1131, 1151
80 High Density Residential	1121, 1122, 1123, 1124, 1140
100 Urban	1211, 1222, 1223, 1224, 1231, 1232, 1233, 1241, 1242, 1243, 1244, 1245, 1246, 1247, 1252, 1253, 1261, 1262, 1263, 1264, 1265, 1266, 1271, 1273, 1274, 1311, 1313, 1314, 1321, 1323, 1331, 1340, 1411, 1412, 1413, 1414, 1415, 1416, 1420, 1431, 1432, 1433, 1434, 1435, 1436, 1437, 1440, 1450, 1460, 1500, 1600, 1700
110 Open Space	1272, 1810, 1821, 1831, 1832, 1840, 1880, 3300
120 Water	4100

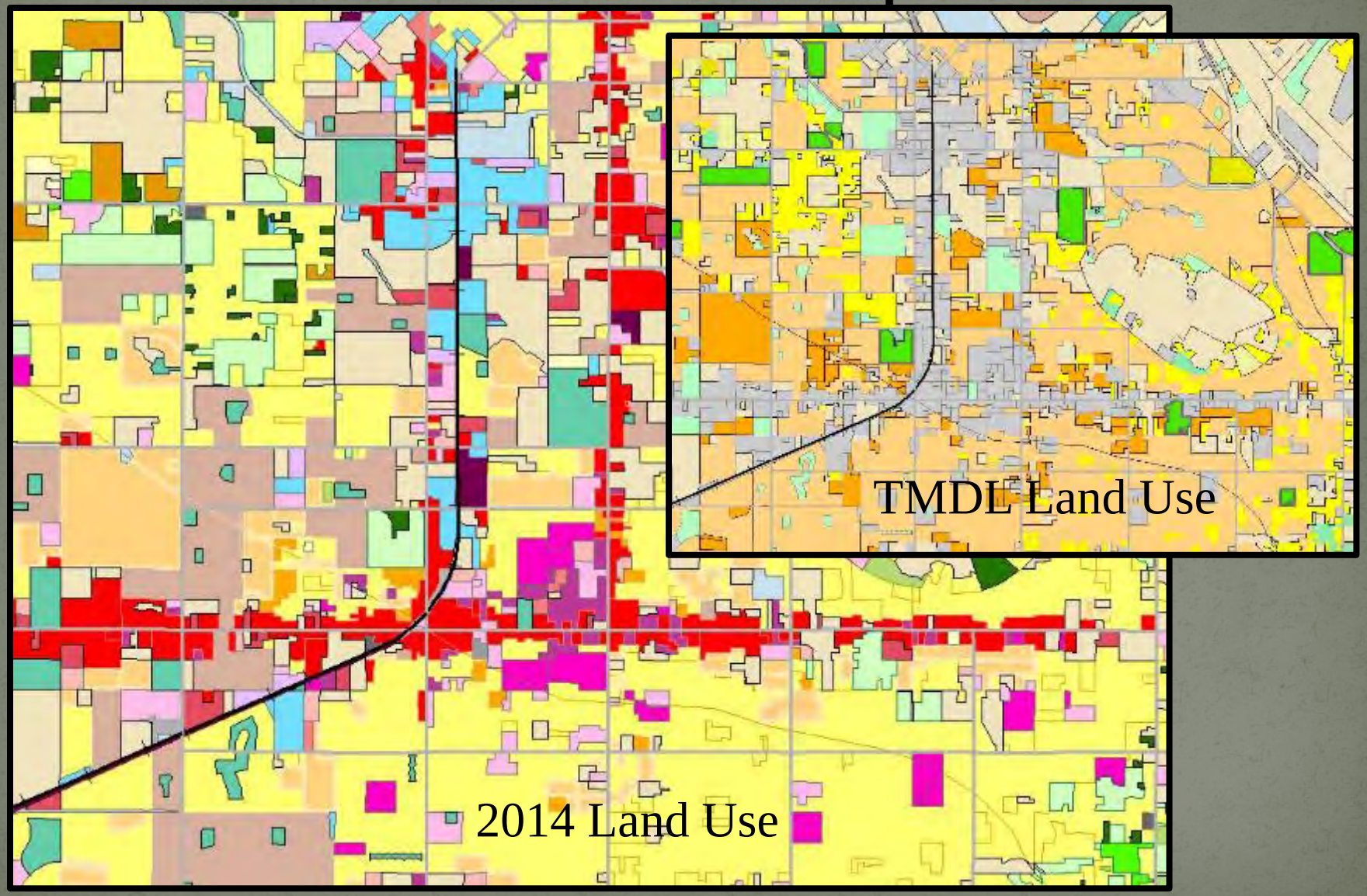
2014 Land Use Ma



TMDL Land Use Map



Land Use and TMDL Comparison



Land Use Table by City/County

Landuse Code	Landuse Description	BANNING	BEAUMONT	CANYON LAKE	HEMET	LAKE ELSINORE	MENIFEE	MORENO VALLEY	MURRIETA	PERRIS	RIVERSIDE	SAN JACINTO	WILDOMAR	RIVERSIDE COUNTY	Grand Total
1111	High-Density Single Family Residential	127.8	1,368.9	1,160.1	3,797.5	2,769.0	6,344.1	9,785.6	158.8	2,958.9	533.7	2,573.6	735.9	3,473.8	36,787.8
1112	Low-Density Single Family Residential		45.4	12.9	527.1	233.7	1,057.9	1,378.6	3.1	363.2		338.9	820.6	2,819.2	7,604.6
1121	Mixed Multi-Family Residential		3.9	1.7	3.4	1.6						26.3		1.4	38.3
1122	Duplexes, Triplexes, and 2- or 3-Unit Condominiums and		18.4		272.6	44.7	74.6	60.6		14.1		44.4		57.6	587.0
1123	Low-Rise Apartments, Condominiums, and Townhouses	14.5	38.4	20.2	306.5	125.6	192.0	373.9	20.7	109.6		66.2		60.8	1,349.2
1124	Medium-Rise Apartments and Condominiums				16.0	7.7	15.3	90.3		4.9					134.2
1131	Trailer Parks and Mobile Home Courts, High Density		35.9	28.6	1,158.6	62.9	175.1	130.7		54.6		235.9	19.7	639.4	2,541.8
1132	Mobile Home Courts and Subdivisions, Low Density				49.8	0.0	26.2			221.4		38.0	134.4	511.7	1,081.5
1140	Mixed Residential		4.1		48.0			27.7		30.2		13.5		25.1	148.7
1151	Rural Residential High Density					0.0	19.3	4.4		4.8			53.0	511.0	592.6
1152	Rural Residential Low Density		10.0	52.0	57.5	4.3	2,621.2	153.7	3.3	348.9		115.0	277.0	16,435.5	20,278.4
1211	Low- to Medium-Rise Major Office Use	4.1	15.5		115.0	12.9	30.1	80.3		43.6		23.1	1.0	13.4	338.9
1222	Retail Centers (Non-Strip with Contiguous Interconnected Off-Street Parking)	26.1	92.3		289.5	93.8	153.7	405.7	11.7	131.7		75.9		24.8	1,305.2
1223	Modern Strip Development	10.1	80.8	22.3	369.7	146.8	198.1	304.7	14.8	276.9		148.8	35.5	335.0	1,943.5
1224	Older Strip Development				26.0					12.2		9.2			47.3
1231	Commercial Storage		16.9	8.9	59.9	10.4	58.9	61.6	6.0	18.5		26.7	21.1	84.0	383.1
1232	Commercial Recreation				5.6	166.9		3.1		47.6		6.8	0.1	163.3	393.5
1233	Hotels and Motels	0.3	1.1	0.8	20.9	20.4	4.4	10.0		3.6		2.6		37.0	101.1
1241	Government Offices				51.1	2.9	15.0	48.1		38.5		21.0	11.9	55.8	244.2
1242	Police and Sheriff Stations		2.6		3.9			6.8		9.5		1.6			26.4
1243	Fire Stations		2.0	1.1	7.6	4.8	7.4	11.4		10.0		4.7		26.5	75.6
1244	Major Medical Health Care Facilities	7.2			8.8		10.2	70.8							96.9
1245	Religious Facilities		32.6	8.0	95.2	27.4	79.9	144.1		27.8	5.8	50.2	31.9	160.2	663.0
1246	Other Public Facilities		3.2		31.5	1.3	17.7	10.6		81.9		9.1	1.6	67.3	224.2
1247	Non-Attended Public Parking Facilities					0.0									0.0
1252	Special Care Facilities		5.4		32.5		5.8	4.4		19.5		4.8		51.8	124.3

Land Use Table by City/County

Landuse Code	Landuse Description	BANNING	BEAUMONT	CANYON LAKE	HEMET	LAKE ELSINORE	MENIFEE	MORENO VALLEY	MURRIETA	PERRIS	RIVERSIDE	SAN JACINTO	WILDOMAR	RIVERSIDE COUNTY	Grand Total
1253	Other Special Use Facilities		3.8		20.2	2.0	3.0	5.9		10.1		6.1	7.7	646.9	705.8
1261	Pre-Schools/Day Care Centers				0.0	1.0	3.3	16.3		11.4				5.0	37.0
1262	Elementary Schools		35.9		100.2	72.1	149.0	266.2	15.8	116.1	14.2	87.0	22.2	131.7	1,012.5
1263	Middle Schools		31.5		64.0	62.3	87.0	192.0		17.1	15.5	47.6		82.5	599.5
1264	Senior High Schools		11.3		146.5	72.4	145.9	277.7		88.1		70.5	54.0	154.3	1,020.6
1265	Colleges and Universities						48.5	51.3		3.3		89.3		45.4	237.8
1266	Trade Schools													2.1	2.1
1271	Base (Built-Up Area)													537.3	537.3
1272	Vacant Area							3.3		1.3				1,006.0	1,010.6
1273	Air Field							1.2						1,142.3	1,143.5
1274	Former Military Base (Built-Up Area)													5.3	5.3
1311	Manufacturing, Assembly and Industrial Services		20.1		161.5	17.0	111.4	71.7	3.1	375.9		133.7	7.3	170.8	1,072.5
1313	Packing Houses and Grain Elevators											3.7		14.6	18.3
1314	Research and Development													11.0	11.0
1321	Manufacturing						6.3								6.3
1323	Open Storage		0.3		39.5	4.9	165.1	47.0		389.1		48.6	14.8	130.1	839.4
1331	Mineral Extraction - Other Than Oil and Gas				11.0		18.3			0.1			30.2	218.9	278.5
1340	Wholesaling and Warehousing					12.9	10.2	842.2		613.5				371.1	1,850.0
1411	Airports				140.8	112.7				53.5				9.6	316.5
1412	Railroads	4.5	25.0		5.7					21.3				10.2	66.6
1413	Freeways and Major Roads	8.8	40.4	25.4	91.8	105.0	391.4	521.4	31.9	291.3		153.4	122.7	567.5	2,351.1
1414	Park and Ride Lots							2.4							2.4
1415	Bus Terminals and Yards		2.4		17.9		5.6	3.9		17.1			6.1	2.1	55.1
1416	Truck Terminals									6.3				34.1	40.4
1420	Communication Facilities				7.1					1.9				23.3	32.4
1431	Electrical Power Facilities	1.9	113.2		9.1	0.0	232.9	33.3		77.7		0.2	3.0	445.2	916.5
1432	Solid Waste Disposal Facilities					40.5		20.2		35.2				778.2	874.0

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1433	Liquid Waste Disposal Facilities					12.2		141.9		171.9				46.2	372.2
1434	Water Storage Facilities			11.9	104.2	156.2	16.8	26.9		58.1	0.9	34.7	5.5	508.7	923.9
1435	Natural Gas and Petroleum Facilities		0.9				1.6	20.0						1.9	24.3
1436	Water Transfer Facilities		4.2		46.7	2.0	130.5	11.2		11.4		395.7	12.6	343.6	958.1
1437	Improved Flood Waterways and Structures		71.1	0.3	406.1	71.4	520.5	465.9	25.9	626.5		399.5	4.2	1,511.6	4,103.0
1439	Unimproved Flood Ways (formerly 1438 in WRCAC)											219.4		204.5	423.9
1440	Maintenance Yards				34.3		35.4	28.9		21.0		17.6		19.1	156.4
1460	Mixed Transportation						74.9			202.2				292.6	569.7
1460	Mixed Transportation and Utility				70.3									21.6	92.0
1500	Mixed Commercial and Industrial				20.5	8.2	2.0	19.7		47.0		38.3		12.5	147.1
1600	Mixed Urban				8.0		15.6			9.2		16.7		14.6	64.2
1700	Under Construction		209.4		49.5	441.4	390.9	105.5		341.6		20.9	9.0	116.2	1,684.3
1810	Golf Courses	44.1	0.1	105.6	405.5	168.7	568.0	251.3				164.1		396.8	2,106.0
1821	Developed Local Parks and Recreation	1.3	44.6	29.1	251.3	125.2	241.8	216.2	8.4	145.5	15.0	158.4	14.3	86.8	1,339.9
1831	Developed Regional Parks and Recreation							0.0		39.8		36.9		576.9	653.6
1832	Undeveloped Regional Parks and Recreation						0.2	20.3		644.0		1.1		2,813.7	3,479.4
1840	Cemeteries		6.6		7.5		10.2			20.0		44.6		312.5	395.6
1850	Wildlife Preserves and Sanctuaries					327.0						55.2		702.9	1,085.1
1851	CDFG Wildlife Area - Davis Unit							1,325.8		0.0				8,753.9	10,079.7
1852	CDFG Wildlife Area - Portrero Unit		7,828.4											1,294.2	9,122.6
1860	Other Open Space and Recreation		36.1	19.1	118.0	114.1	75.4	63.9		54.1		43.7		814.2	1,338.6
2110	Irrigated Cropland and Improved Pasture Land				408.9		873.4	53.0		2,094.6		2,997.7		12,745.1	19,172.7
2120	Non-Irrigated Cropland and Improved Pasture Land		4.2		1,540.0		2,831.7	3,346.7	29.3	1,901.2		490.1	21.7	3,345.9	13,510.8
2121	Vacant Zoned Agriculture				1,183.4		810.7					0.0		11,042.1	13,036.2
2200	Orchards/Vineyards Undifferentiated		6.4		0.8		10.2	11.2		32.9		23.6	10.0	243.1	338.0
2210	Citrus				13.5	1.0	19.8	6.8				0.3	10.0	3,173.1	3,224.5
2300	Nurseries Undifferentiated				0.7		75.1	50.4		7.0		30.4	12.4	595.0	771.0

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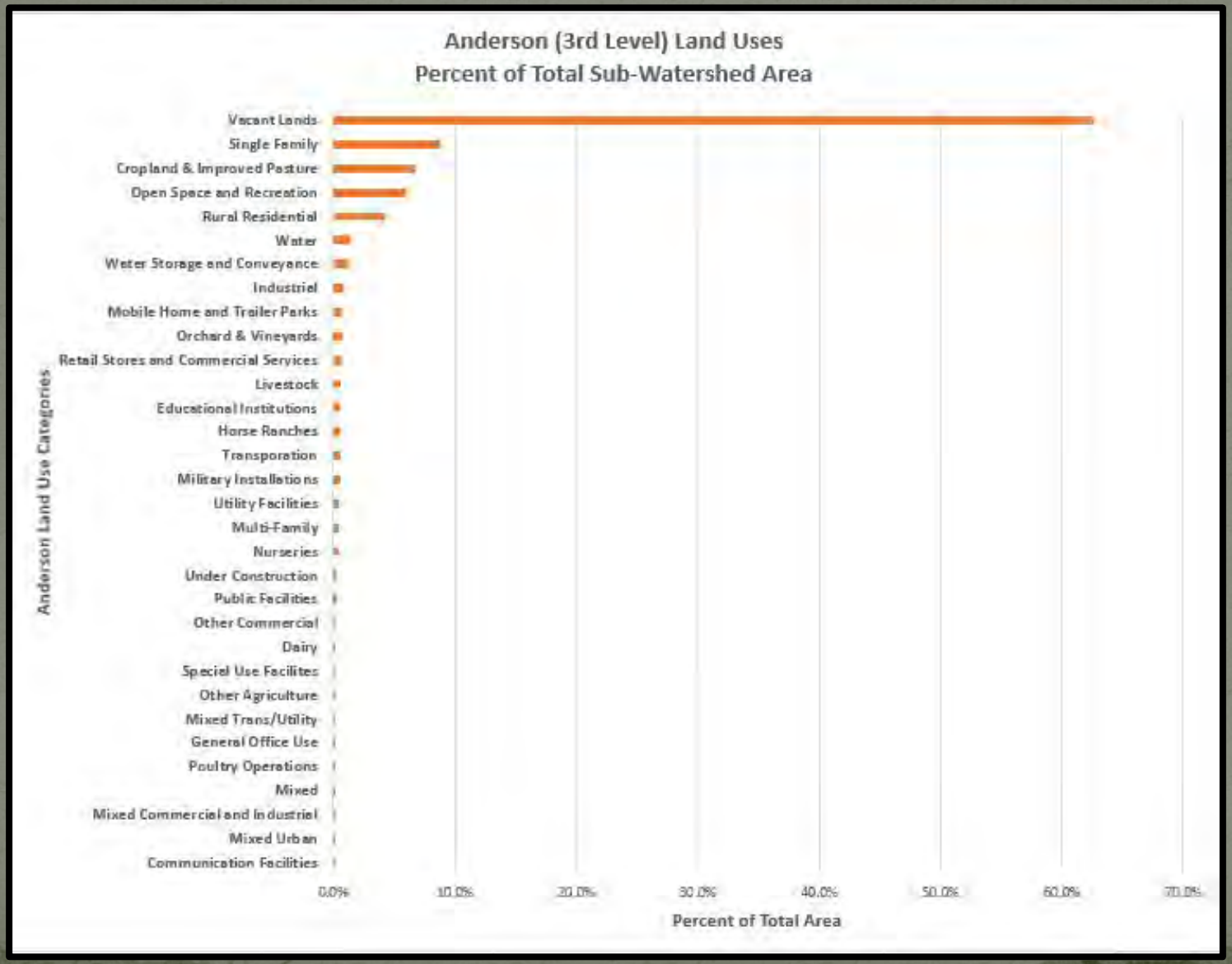
2310	Turf Farms											332.5		893.1	1,225.7
2320	Christmas Tree Farms						5.9							6.5	12.4
2411	Dairies - Intensive				19.0							392.8	4.0	423.8	840.4
2412	Dairies - Non-Intensive				44.2							607.2	2.5	387.4	1,041.3
2413	Abandoned Dairies						75.7					102.5		197.8	376.0
2420	Other Livestock						9.3					4.2		55.9	69.4
2500	Poultry Operations				8.5							67.0		196.4	272.0
2600	Other Agricultue Undifferentiated				42.5		20.2	3.2		6.6		23.5	3.3	378.0	476.3
2610	Manure Piles						3.8			9.3		40.7		154.0	213.9
2620	Backyard Livestock		0.3		44.2	1.6	303.3	82.0	0.1	13.1		42.6	16.4	1,203.8	1,707.3
2700	Horse Ranches			8.0	252.8		310.1	26.5	11.1			243.7		2,000.6	2,852.8
3100	Vacant Undifferentiated	86.5	1,979.1	950.6	3,763.5	6,502.2	7,560.1	8,312.3	89.6	6,621.4	3.6	4,715.2	2,534.0	246,999.8	290,095.1
3200	Abandoned Orchards and Vineyards							22.5						6.7	31.1
3300	Vacant With Limited Improvements			0.2	269.8	84.3	1,224.2	723.5		218.8		379.8	7.3	754.6	3,662.5
4100	Water, Undifferentiated	1.1		491.0	21.1	3,073.5	150.4	72.4		24.4		29.8	1.0	3,039.3	6,904.0
	Grand Total	336.2	12,253.8	2,956.2	17,309.3	16,306.7	29,059.5	30,932.2	433.5	20,284.5	568.8	16,667.0	5,960.1	338,993.2	490,267.0

Aggregated Land Use by City/County

Land Use Description	City Names													Grand Total
	BANNING	BEAUMONT	CANYON LAKE	HEMET	LAKE ELSINORE	MENIFEE	MORENO VALLEY	MURRIETA	PERRIS	RIVERSIDE	SAN JACINTO	WILDOMAR	RIVERSIDE COUNTY	
Rural Residential		10.0	52.0	57.5	4.4	2,840.5	158.2	3.3	353.7		115.0	330.0	16,846.5	20,671.0
Single Family	127.8	1,418.3	1,173.1	4,324.7	3,002.0	7,402.0	11,164.2	181.9	3,322.1	583.7	2,912.5	1,556.5	6,293.0	43,392.4
Multi-Family	14.5	60.7	21.9	598.5	179.6	282.6	524.6	20.7	128.7		158.9		119.8	2,106.0
Mobile Home and Trailer Parks		36.9	29.8	1,208.4	82.9	201.5	130.7		276.0		273.9	154.1	1,251.0	3,623.3
Mixed		4.1		46.0			27.7		30.2		13.5		25.1	146.7
General Office Use	4.1	15.5		115.0	12.9	30.1	80.3		43.6		23.1	1.0	13.4	338.9
Retail Stores and Commercial Services	36.1	173.1	22.3	685.2	240.7	351.9	710.4	26.6	420.7		233.9	35.5	369.8	3,296.0
Other Commercial	0.3	18.1	9.7	86.5	197.7	73.3	74.7	6.0	69.7		36.1	21.2	284.3	877.6
Public Facilities	7.2	40.4	9.1	198.1	36.4	130.2	293.9		167.6	5.6	66.5	45.3	309.8	1,330.4
Special Use Facilities		9.3		52.7	2.0	5.9	10.3		29.5		11.0	7.7	696.7	830.1
Educational Institutions		78.6		310.7	207.6	433.7	803.4	15.8	235.1	29.7	294.4	76.1	421.0	2,909.4
Military Installations							4.5		1.3				2,790.9	2,796.7
Cropland & Improved Pasture		4.2		1,948.9		3,706.1	3,399.7	29.3	3,986.8		3,487.8	21.7	16,091.1	32,683.5
Orchard & Vineyards		5.4		14.3	1.0	29.8	18.0		32.5		23.9	20.0	3,416.1	3,562.5
Nurseries				0.7		81.0	50.4		7.0		363.0	12.4	1,484.6	2,009.0
Dairy				19.8							382.8	4.0	423.8	840.4
Livestock		0.3		38.4	1.6	388.3	82.0	0.1	12.1		758.5	19.9	1,944.5	3,194.1
Poultry Operations				9.6							67.0		196.4	272.0
Other Agriculture				42.5		30.0	3.2		14.9		84.2	3.3	532.0	680.2
Horse Ranches			5.0	252.8		310.1	26.5	11.1			243.7		2,000.6	2,852.8
Industrial		20.5		212.0	34.8	311.3	961.0	3.1	1,378.5		186.0	52.2	916.5	4,075.9
Transporation	13.3	87.8	25.4	266.1	217.7	397.0	527.7	31.9	388.4		153.4	128.9	823.5	2,632.0
Communication Facilities				7.1					1.9				23.3	32.4
Utility Facilities	1.9	114.1		43.4	52.7	289.9	244.2		306.3		17.8	3.0	1,290.6	2,343.6
Water Storage and Conveyance		75.3	12.2	557.0	229.5	667.8	504.0	25.9	696.9	0.9	1,049.4	22.8	2,568.4	6,408.9
Mixed Trans/Utility				78.3		74.9			202.2				314.2	661.7
Mixed Commercial and Industrial				20.5	8.2	2.0	18.7		47.0		38.3		12.5	147.1
Mixed Urban				8.0		15.6			9.2		18.7		14.6	64.2
Under Construction		209.4		49.5	441.4	390.9	105.5		341.5		20.9	9.0	116.2	1,684.3
Open Space and Recreation	45.4	7,315.9	153.9	776.3	734.9	895.8	1,877.5	8.4	903.5	15.0	504.0	14.3	15,755.9	29,600.5
Vacant Lands	86.5	1,978.1	960.8	5,228.6	6,566.5	9,585.0	9,058.3	89.6	6,840.2	3.6	5,096.1	2,541.4	258,905.1	306,824.9
Water	1.1		491.0	21.1	3,073.5	159.4	72.4		24.4		29.8	1.0	3,039.3	6,904.0
Grand Total	**338.2**	**12,253.9**	**2,958.2**	**17,309.3**	**15,308.7**	**29,059.5**	**30,932.2**	**433.5**	**20,284.5**	**588.8**	**16,667.0**	**5,080.1**	**338,993.2**	**490,207.0**

Aggregated Land Use Distribution



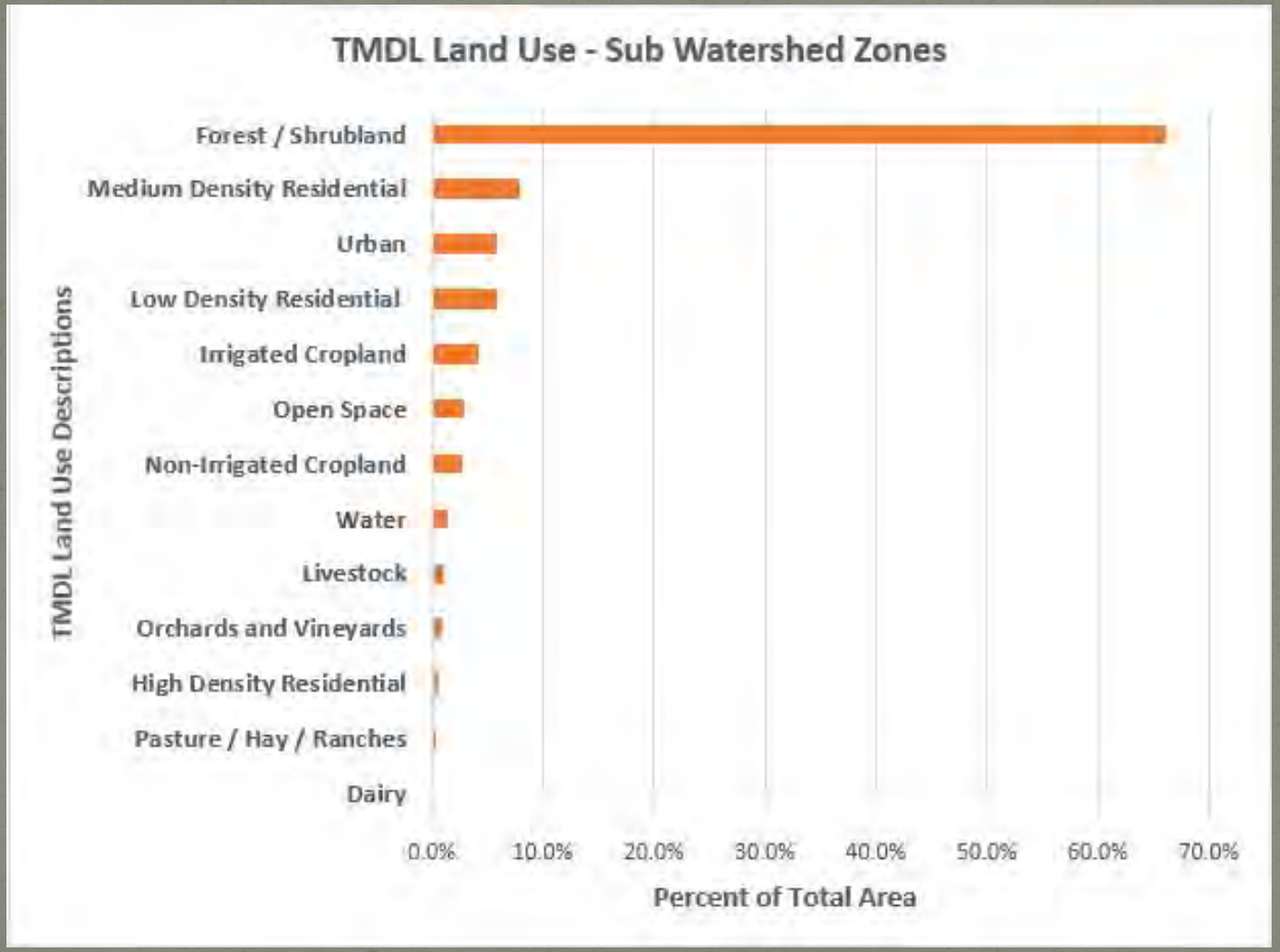
TMDL Land Use Table by City/County

TMDL Landuse Categories	BANNING	BEAUMONT	CANYON LAKE	HEMET	LAKE ELSINORE	MENIFEE	MORENO VALLEY	MURRIETA	PERRIS	RIVERSIDE	SAN JACINTO	WILDOMAR	RIVERSIDE COUNTY	Grand Total
Irrigated Cropland				408.9		873.4	53.0		2,094.6		3,330.2		13,638.2	20,398.4
Non-Irrigated Cropland		4.2		1,540.0		2,831.7	3,346.7	29.3	1,901.2		490.1	21.7	3,345.9	13,510.8
Dairy				19.8							392.8	4.0	423.8	840.4
Livestock		0.3	8.0	305.6	1.6	632.6	108.6	11.2	22.4		398.2	16.4	3,610.7	5,115.5
Orchards and Vineyards		6.4		15.0	1.0	110.9	90.9		39.8		54.3	32.4	4,026.3	4,376.9
Pasture / Hay / Ranches				86.7		95.9	3.2		5.6		733.2	5.8	963.2	1,893.6
Forest / Shrubland	86.5	9,804.5	950.6	4,937.0	6,829.2	8,360.8	9,638.1	89.6	6,621.4	3.6	4,989.8	2,534.0	268,997.4	323,842.6
Low Density Residential		59.4	65.0	634.5	238.0	3,905.3	1,532.4	6.4	933.5		491.9	1,231.9	19,866.4	28,964.5
Medium Density Residential	127.8	1,404.8	1,188.9	4,956.2	2,831.9	6,538.7	9,920.7	158.8	3,018.4	533.7	2,609.5	808.6	4,624.2	38,922.2
High Density Residential	14.5	64.8	21.9	646.5	179.6	282.6	552.5	20.7	158.9		170.5		144.9	2,257.3
Urban	62.9	822.0	78.7	2,672.2	1,681.8	3,157.4	4,335.3	109.2	4,341.0	36.4	1,948.0	402.5	9,547.2	29,194.7
Open Space	45.4	87.5	154.1	1,066.1	472.2	2,119.7	1,278.4	8.4	1,123.5	15.0	828.7	21.7	6,765.6	13,986.2
Water	1.1		491.0	21.1	3,073.5	150.4	72.4		24.4		29.8	1.0	3,039.3	6,904.0
Grand Total	338.2	12,253.9	2,958.2	17,309.3	15,308.7	29,059.5	30,932.2	433.5	20,284.5	588.8	16,667.0	5,080.1	338,993.2	490,207.0

TMDL Land Use Subwatersheds 1-9

TMDL Land Use Categories	Sub-Watershed Zone #									Grand Total
	1	2	3	4	5	6	7	8	9	
Irrigated Cropland		1,914.5	2,140.0	1,806.7	1,177.7	3,597.9	9,443.1	318.4		20,398.4
Non-Irrigated Cropland	21.7	2,196.4	2,891.9	2,537.8	2,557.7	603.4	2,699.1	2.9		13,510.8
Dairy	4.0		24.4				812.0			840.4
Livestock	83.1	782.9	460.5	1,147.8	318.9	423.3	1,259.9	76.5	562.7	5,115.5
Orchards and Vineyards	56.2	297.1	109.8	206.4	232.2	95.6	749.4	2,548.9	81.5	4,376.9
Pasture / Hay / Ranches	10.8	8.2	151.1	104.2	43.7	64.8	1,462.6	48.1		1,893.6
Forest / Shrubland	17,890.7	21,345.6	8,574.1	31,640.3	25,734.7	7,414.4	57,803.2	68,800.5	84,639.2	323,842.6
Low Density Residential	2,709.6	7,960.5	2,389.3	3,443.0	3,560.5	1,769.7	2,360.3	1,097.9	3,673.8	28,964.5
Medium Density Residential	4,116.1	4,110.2	5,212.4	4,636.3	12,847.8	374.3	6,075.8	1,503.3	46.0	38,922.2
High Density Residential	187.8	112.1	303.0	429.5	640.6	2.3	543.9	38.1		2,257.3
Urban	2,124.4	3,781.9	2,325.0	2,935.4	10,319.3	526.0	5,656.9	826.4	699.3	29,194.7
Open Space	547.9	1,417.2	2,644.8	1,349.1	4,246.5	33.2	2,509.7	715.6	522.1	13,986.2
Water	3,183.1	534.3	272.5	41.1	2,310.2		34.8	71.3	456.7	6,904.0
Grand Total	30,935.4	44,460.9	27,498.7	50,277.4	63,989.7	14,905.0	91,410.8	76,047.9	90,681.2	490,207.0

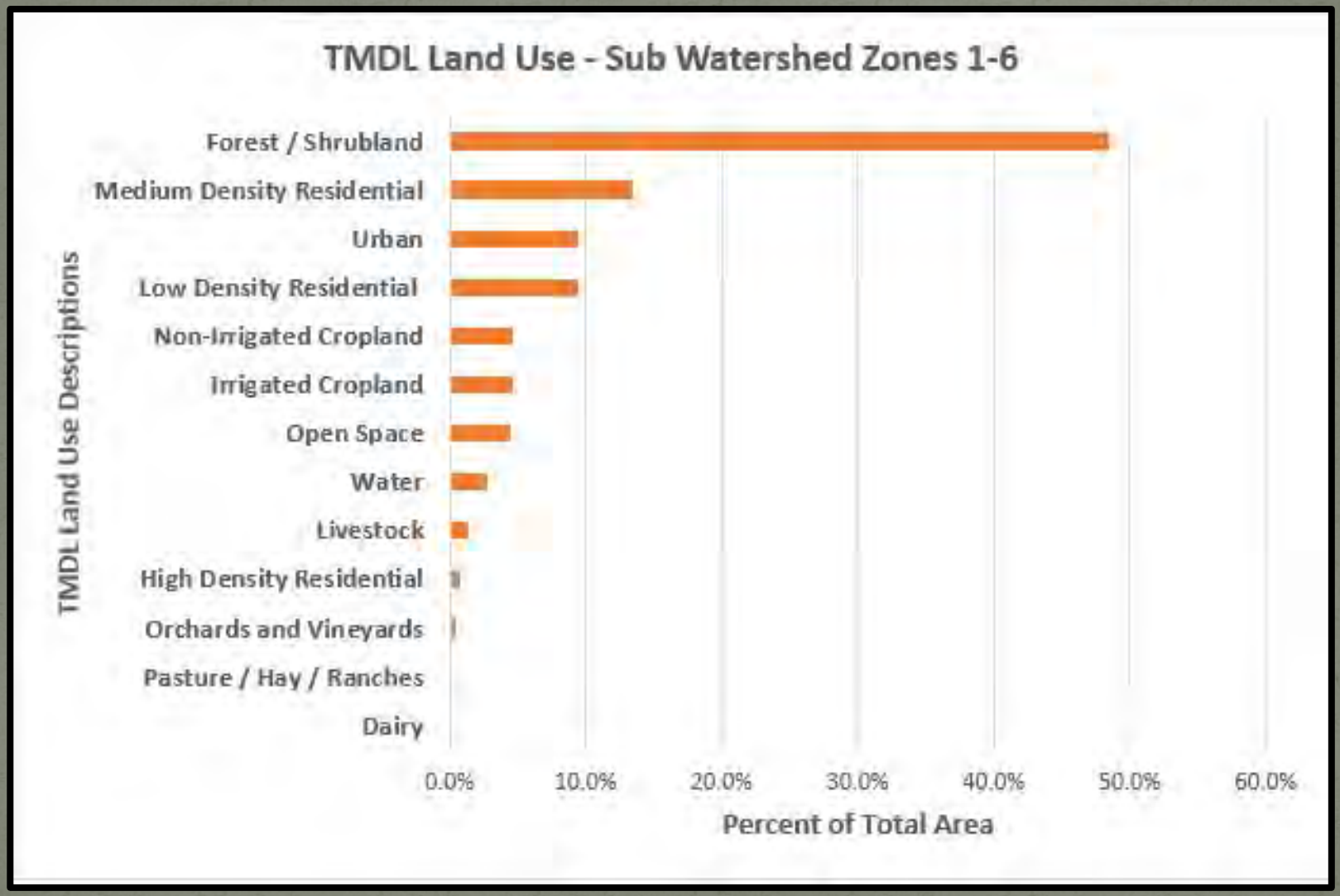
TMDL Land Use Subwatersheds 1-9 Distribution



TMDL Land Use Subwatersheds 1-6

TMDL Land Use Categories	Sub-Watershed Zone #						Grand Totals
	1	2	3	4	5	6	
Irrigated Cropland		1,914.5	2,140.0	1,806.7	1,177.7	3,597.9	10,636.8
Non-Irrigated Cropland	21.7	2,196.4	2,891.9	2,537.8	2,557.7	603.4	10,808.8
Dairy	4.0		24.4				28.4
Livestock	83.1	782.9	460.5	1,147.8	318.9	423.3	3,216.4
Orchards and Vineyards	56.2	297.1	109.8	206.4	232.2	95.6	997.2
Pasture / Hay / Ranches	10.8	8.2	151.1	104.2	43.7	64.8	382.9
Forest / Shrubland	17,890.7	21,345.6	8,574.1	31,640.3	25,734.7	7,414.4	112,599.7
Low Density Residential	2,709.6	7,960.5	2,389.3	3,443.0	3,560.5	1,769.7	21,832.5
Medium Density Residential	4,116.1	4,110.2	5,212.4	4,636.3	12,847.8	374.3	31,297.1
High Density Residential	187.8	112.1	303.0	429.5	640.6	2.3	1,675.3
Urban	2,124.4	3,781.9	2,325.0	2,935.4	10,319.3	526.0	22,012.0
Open Space	547.9	1,417.2	2,644.8	1,349.1	4,246.5	33.2	10,238.7
Water	3,183.1	534.3	272.5	41.1	2,310.2		6,341.2
Grand Total	30,935.4	44,460.9	27,498.7	50,277.4	63,989.7	14,905.0	232,067.1

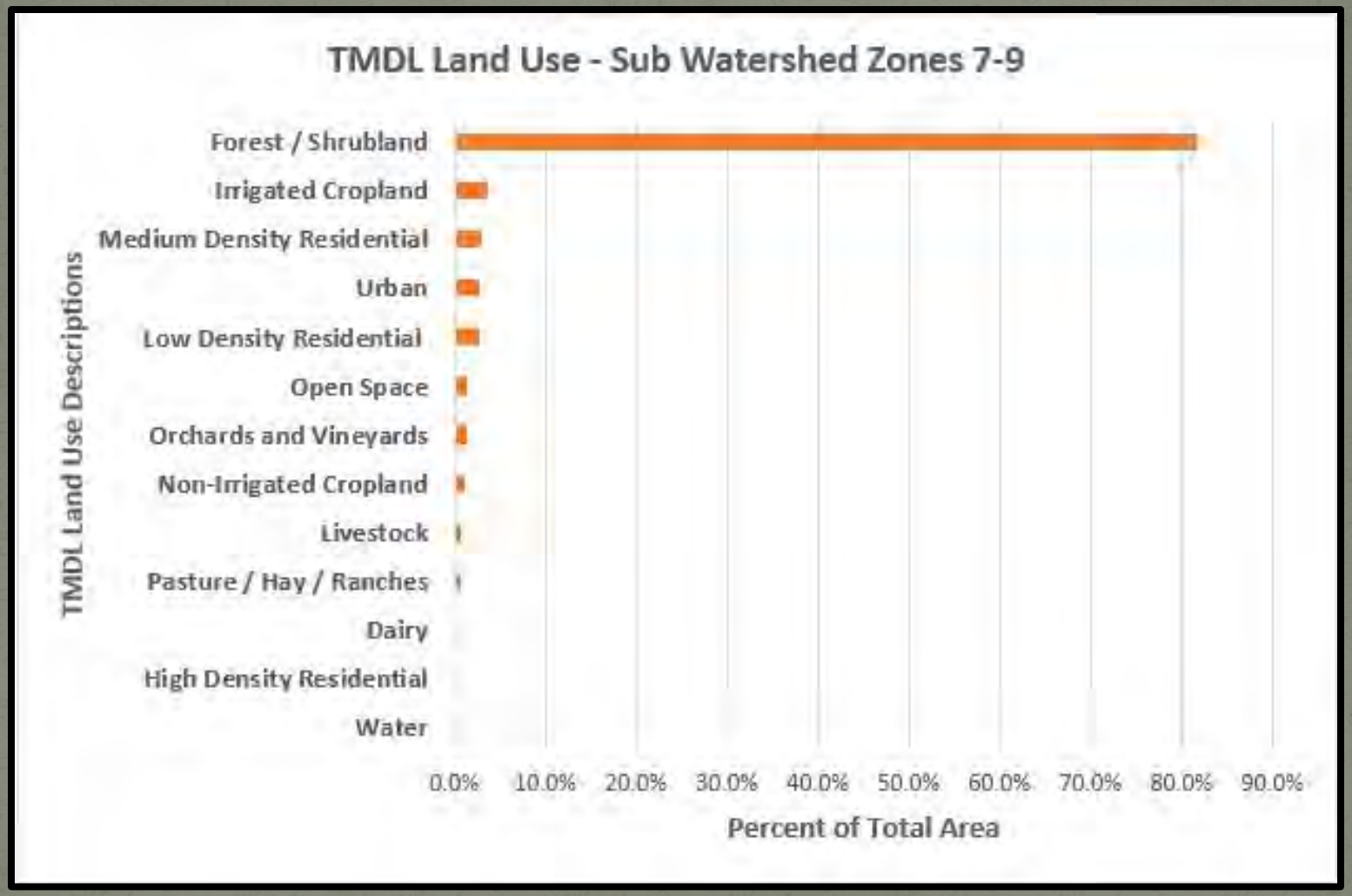
TMDL Land Use Subwatersheds 1-6 Distribution



TMDL Land Use Subwatersheds 7 - 9

TMDL Land Use Categories	Sub-Watershed Zone #			Grand Total
	7	8	9	
Irrigated Cropland	9,443.1	318.4		9,761.6
Non-Irrigated Cropland	2,699.1	2.9		2,702.0
Dairy	812.0			812.0
Livestock	1,259.9	76.5	562.7	1,899.1
Orchards and Vineyards	749.4	2,548.9	81.5	3,379.7
Pasture / Hay / Ranches	1,462.6	48.1		1,510.7
Forest / Shrubland	57,803.2	68,800.5	84,639.2	211,242.9
Low Density Residential	2,360.3	1,097.9	3,673.8	7,132.0
Medium Density Residential	6,075.8	1,503.3	46.0	7,625.0
High Density Residential	543.9	38.1		582.0
Urban	5,656.9	826.4	699.3	7,182.6
Open Space	2,509.7	715.6	522.1	3,747.4
Water	34.8	71.3	456.7	562.8
Grand Total	91,410.8	76,047.9	90,681.2	258,139.9

TMDL Land Use Subwatersheds 7–9 Distribution



Land Use Data Delivery

- San Jacinto River Watershed Council will distribute the data to the Regional Water Quality Control Board and any other non-MS4 requests

- Riverside County Flood Control and Water Conservation District will distribute the data to all MS4s

QUESTIONS?

Alum Effectiveness in Canyon Lake

Timothy F. Moore, Risk Sciences

Scope of Alum Project

- 5 applications over 24 months
- 311,000+ gallons of liquid alum applied
- 1,680,000 pounds of alum (dry weight)

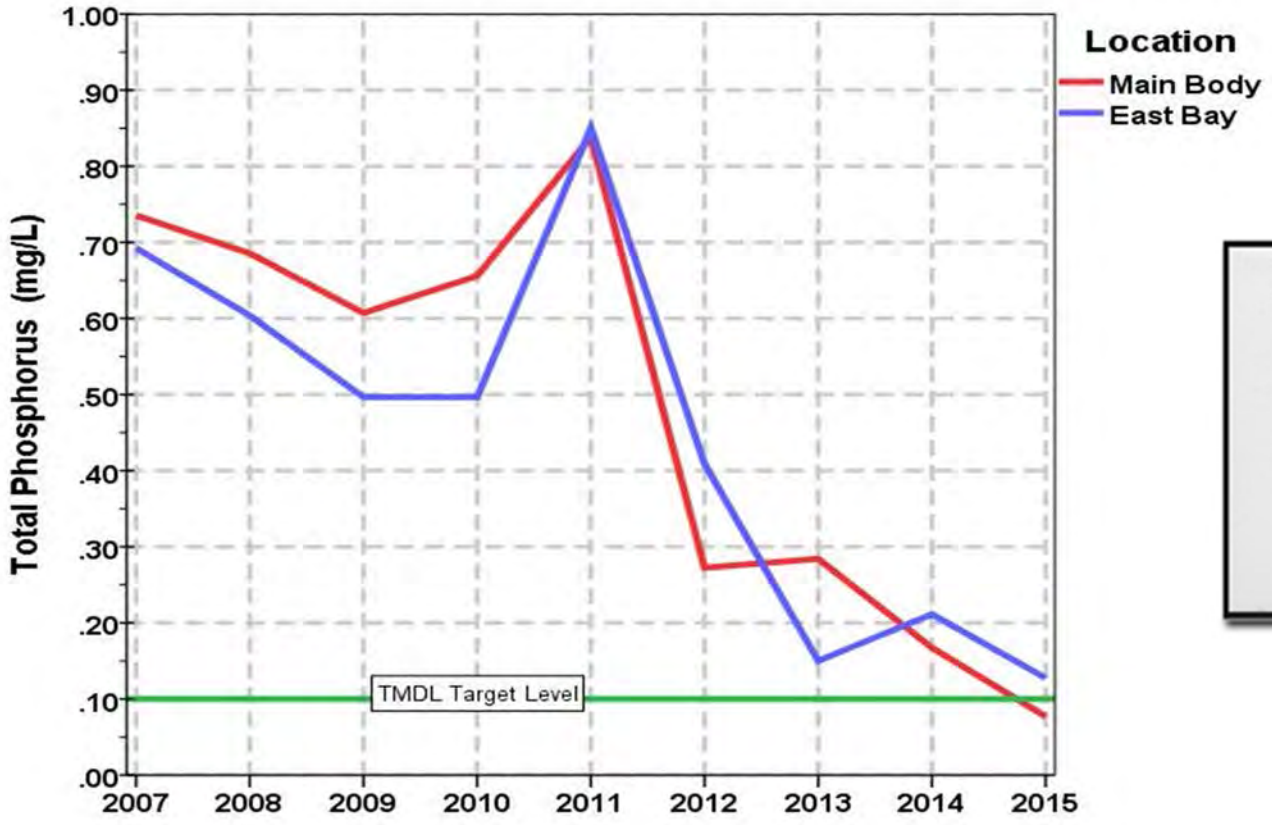
  32% in East Bay and 68% in Main Body

  Total alum dose was 2x higher in East Bay

Phosphorus Control

- Each ton of alum sequesters at least 9 pounds of phosphorous
- 840 tons of applied alum neutralized more than 7,600 pounds of phosphorus
- Equivalent to 3 years of the average urban runoff load

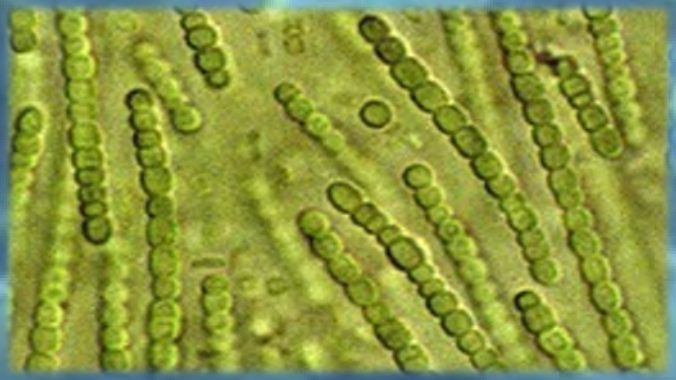
Phosphorus Concentrations



Phosphorus
15
P
30.974

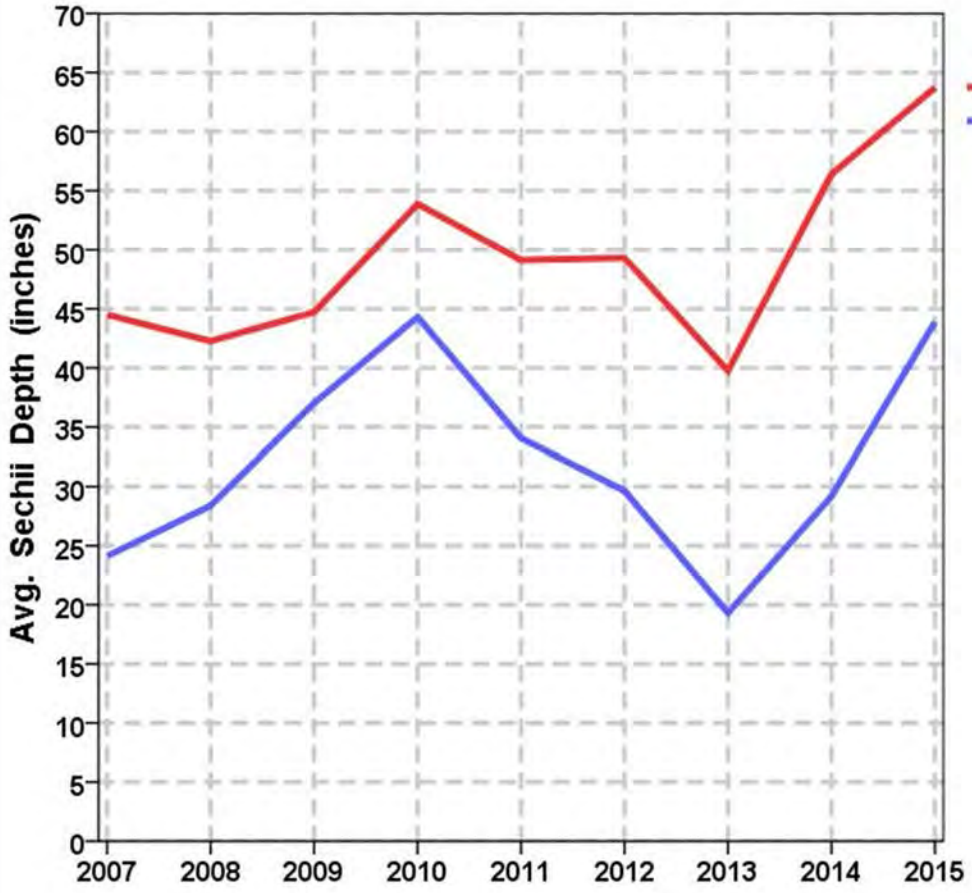
Algae Concentrations

Chlorophyll-A	Main Body	East Bay
2011-12	48 mg/L	81 mg/L
2014-15*	35 mg/L	51 mg/L
Algae Reduction	13 mg/L	30 mg/L
Pct. Improvement	27%	37%

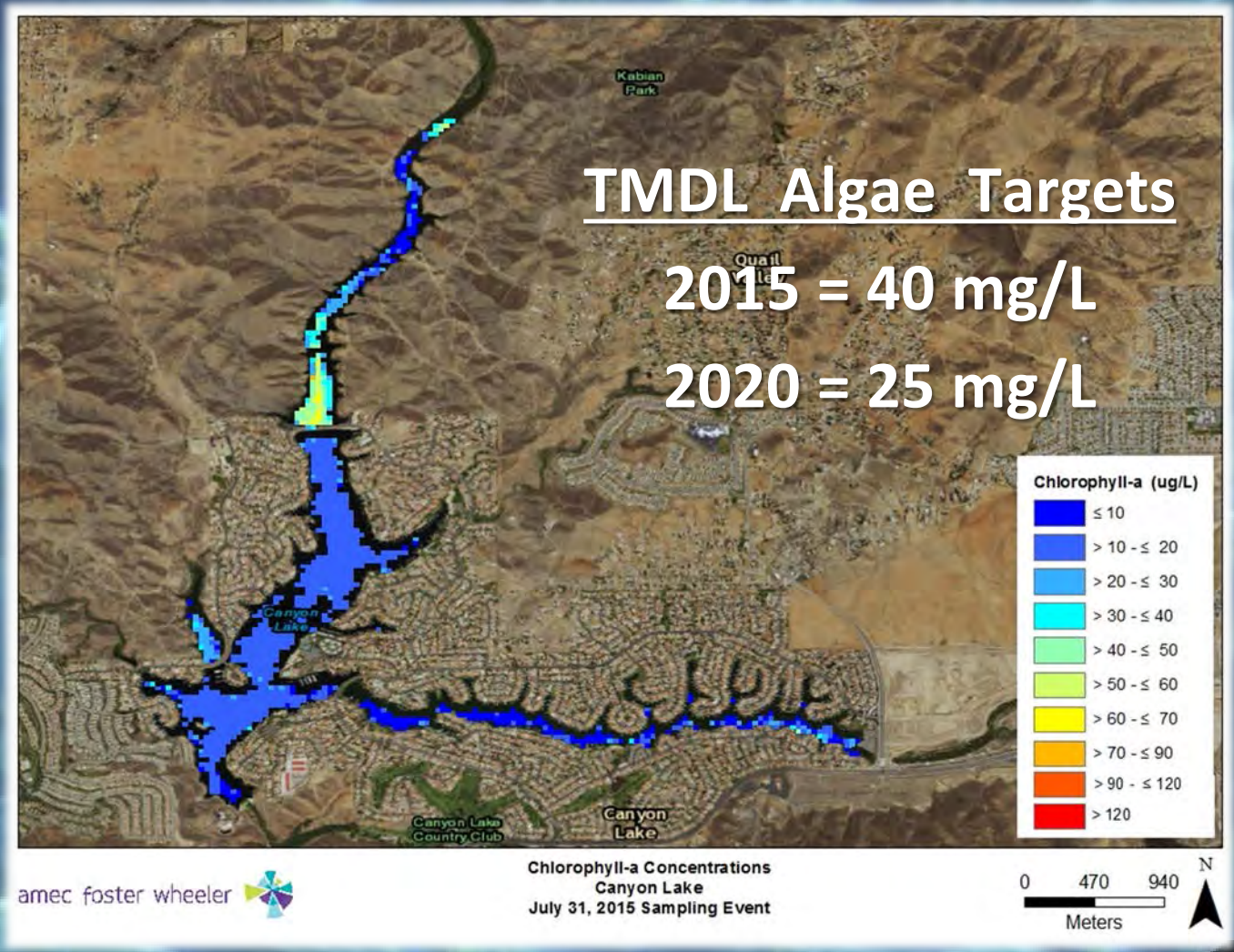


**Does not yet include data collected in the Summer of 2015*

Water Clarity Levels



Satellite Assessment on July 31, 2015



THE FRIDAY FLYER

Edition
April 18, 2014

Canyon Lake
80° F
Sunny

Alum treatments proving effective in lake clarity

MORE STORIES

- Lots of egg-citement at Holiday Harbor tomorrow
- Time is running out to register boats
- Consultants will explore possibility of UUT
- Anglers of all ages reel in the big ones
- CLCC crosses stand tall above the community

MOST POPULAR

- All are invited to Tony Klarich's '50 for 50' event
- Shop, eat and imbibe at Mermaid Festival tomorrow
- Help homeless dogs and cats
- Looking back at August of past years in Canyon Lake
- Letter: Support POA Board

SECTIONS

Schools and Sports
POA News
City Connection
Chamber Notes
Movie Reviews by Reel People
Teen Talk

Long-Term Water Quality Simulations for Lake Elsinore: Effects of Supplementation with Recycled Water

Michael Anderson

UC Riverside

Introduction and Review of Modeling Results

1. Long-term (99-yr) Analysis of Conditions in Lake Elsinore

- Lake surface elevation and salinity for the 99-yr period 1916-2014 simulated using DYRESM (Tech Memo 1.0)
  - Model accurately predicted measured lake surface elevations and available TDS concentrations
  - Significant loss of water to unsaturated soil and groundwater occurred in natural basin following large runoff events
  - Losses to unsaturated soils and groundwater were not apparent for the reconfigured (post-LEMP) basin
  - Over past 99 years, model predicted that the lake was dry for 6.8 years, with salinity exceeding sea water near lake dessication
  - Salt accumulated in Lake Elsinore at a predicted rate of 30-39 mg/L/yr at a surface elevation of 1240 ft for much of past century
  - Addition of recycled water has accelerated the predicted rate of salt accumulation at 1240 ft elevation to 136 mg/L/yr since addition of recycled water began in late 2002

2. Influence of Recycled Water on Lake Level and Salinity

- Effect of recycled water supplementation on lake surface elevation and salinity: LEMP basin 1916-2014 (Tech Memo 1.1)
  - Recycled water supplementation significantly increased lake surface elevation and lake area compared with natural inflows during periods of limited precipitation and runoff
  - Recycled water supplementation maintained predicted lake elevations >1234.5 ft and lake areas >2370 acres
  - Natural inflows resulted in complete desiccation of lake for almost 3 yrs during extreme drought in the late 1950s- early 1960s
  - Recycled water supplementation prevented extreme TDS levels from developing in the lake (TDS concentrations <6000 mg/L)
  - Recycled water inputs also increased average TDS concentrations by about 900 mg/L, from 1,163 mg/L to 2,055 mg/L over 99-yr (1916-2014) simulation period

- Simulations (and historical accounts) highlight the highly dynamic conditions in Lake Elsinore over past 99 yrs
  - Extreme ranges in lake level (widespread flooding to complete dessication)
  - Extreme variations in salinity (TDS values 200 to >30,000 mg/L)
- LEMP has been very successful at reducing extreme ranges in lake level and salinity, although lake nonetheless predicted to dry up during drought in 1950's-1960's drought
- Recycled water additions shown to help maintain lake level and avoid extreme TDS levels when approaching dessication
- Questions remain however concerning the water quality impacts associated with long-term recycled water inputs

Objectives

- Evaluate impacts of recycled water inputs on key water quality measures (chlorophyll a, DO, total N and total P concentrations) relative to no recycled water supplementation

Approach

- Extend previously developed DYRESM (Dynamic Reservoir Simulation Model) that quantified water budget and provides 1-D hydrodynamic/thermodynamic/salinity predictions
- CAEDYM (Computational Aquatic Ecosystem Dynamics Model) was linked to DYRESM model to predict water quality and ecological properties of lake
- Period from 1916-2014 simulated using LEMP basin and meteorological and runoff data for this interval as described in Tech Memo 1.1

- Water quality model was calibrated against available 2000-2014 data
- Influent concentration data were taken from a range of sources

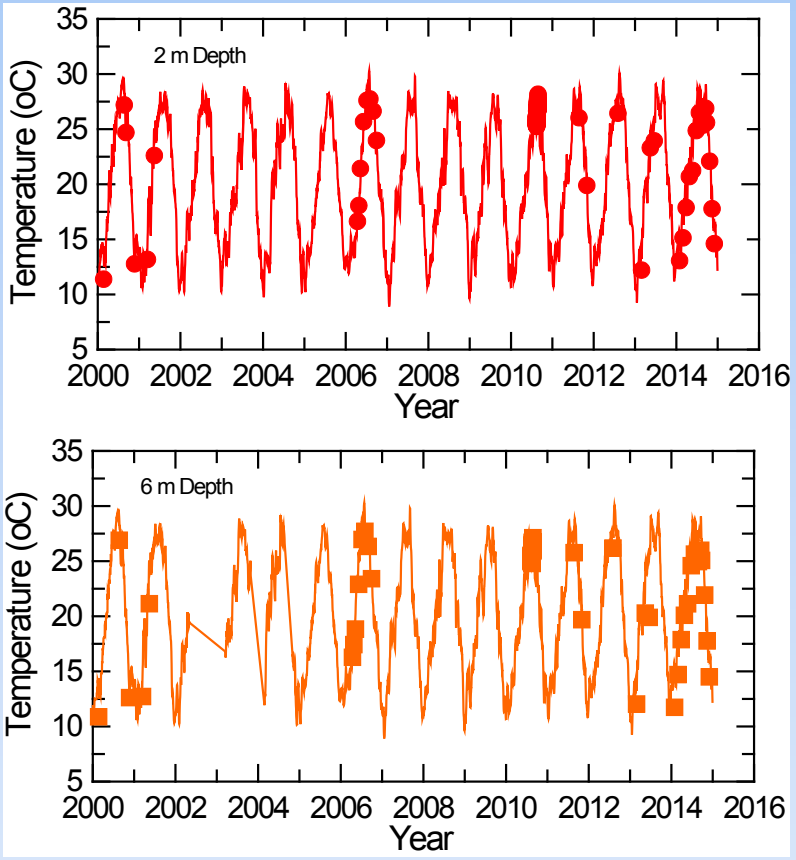
Source	TDS (mg/L)	PO4-P (mg/L)	Total P (mg/L)	NH4-N (mg/L)	NO3-N (mg/L)	Total N (mg/L)
San Jacinto R	310	0.28	0.50	0.22	0.57	1.62
Local Runoff	150	0.20	0.48	0.22	0.80	1.82
Recycled H_2O	720	0.32	0.47	0.24	8.00	9.6

- Default values were used for nearly all model parameters; a few parameters were adjusted to reflect observed conditions in lake

Model Calibration

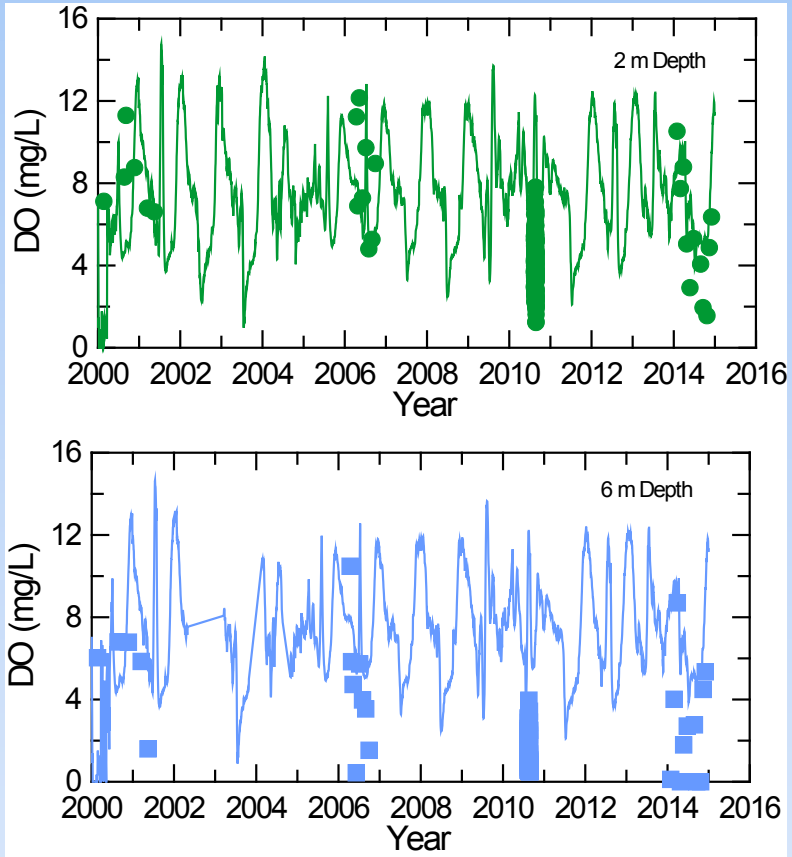
Temperature

- Model reasonably reproduced representative measured temperature values at 2 m and 6 m depth
- Strong seasonal trends evident, with summer temperatures 26-28°C and winter values typically near 11-12°C
- Strong stratification was not predicted within water column, consistent with generally well-mixed conditions in lake



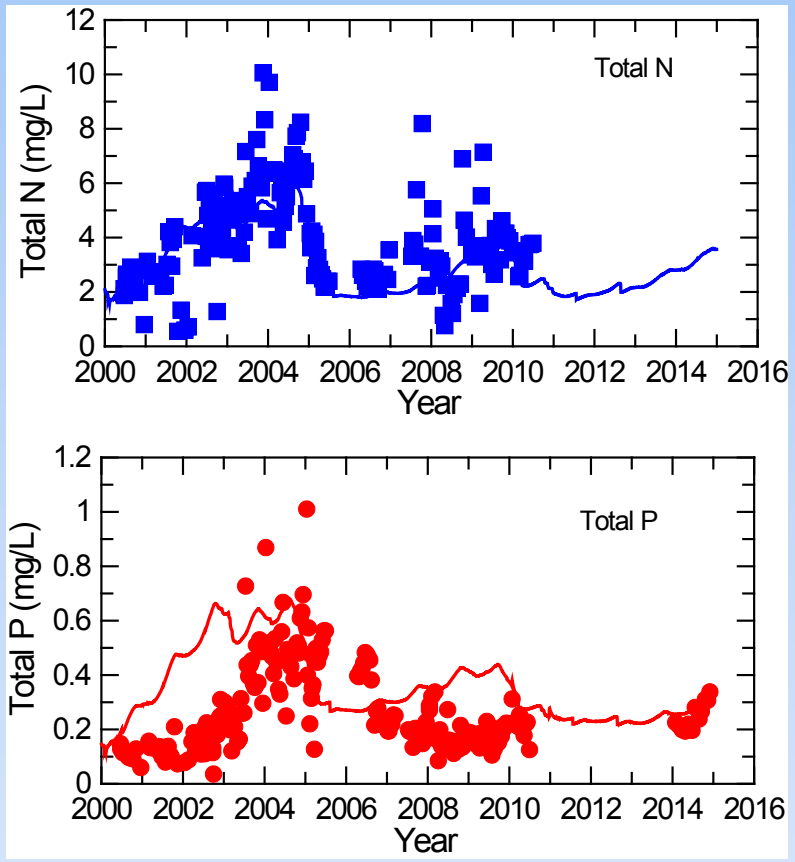
Dissolved Oxygen

- The model also predicted some seasonal trends in DO, with higher values during the winter cooler months when O_2 solubility is greater
- Evidence of both supersaturation and undersaturation was present
- Model did predict some low DO episodes (e.g., in 2000, 2003 and 2011), but over-predicted concentrations in 2006 and 2014
- Correctly timing such episodes can be challenging

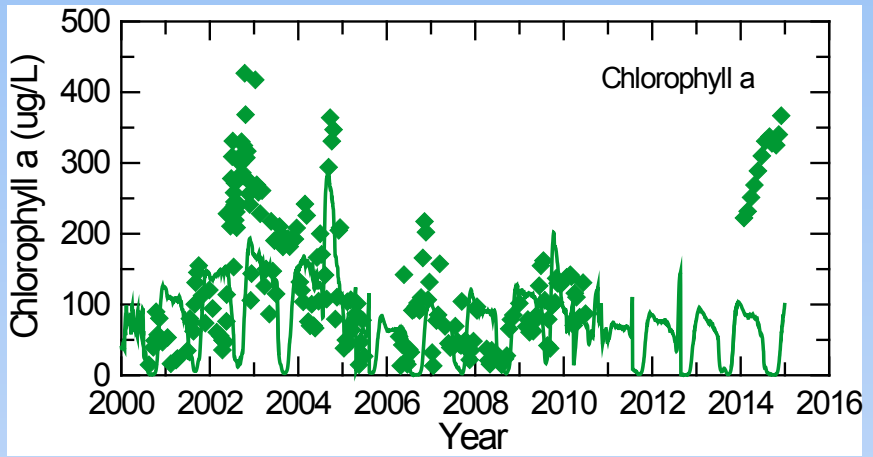


Nutrients

- The model correctly predicted observed trends in total N concentrations
  - Increased concentration from 2000-2004
  - Strong reduction in 2005
  - Subsequent increase in 2008-2010
- Model underpredicted total N concentrations however
- Total P trends less well-described, but did capture
  - increase from 2000-2004
  - reduction in 2005



- Chlorophyll a concentrations exhibited strong annual periodicity in both measured and predicted values
- Model strongly underpredicted very high values in late 2002 but did better in 2004



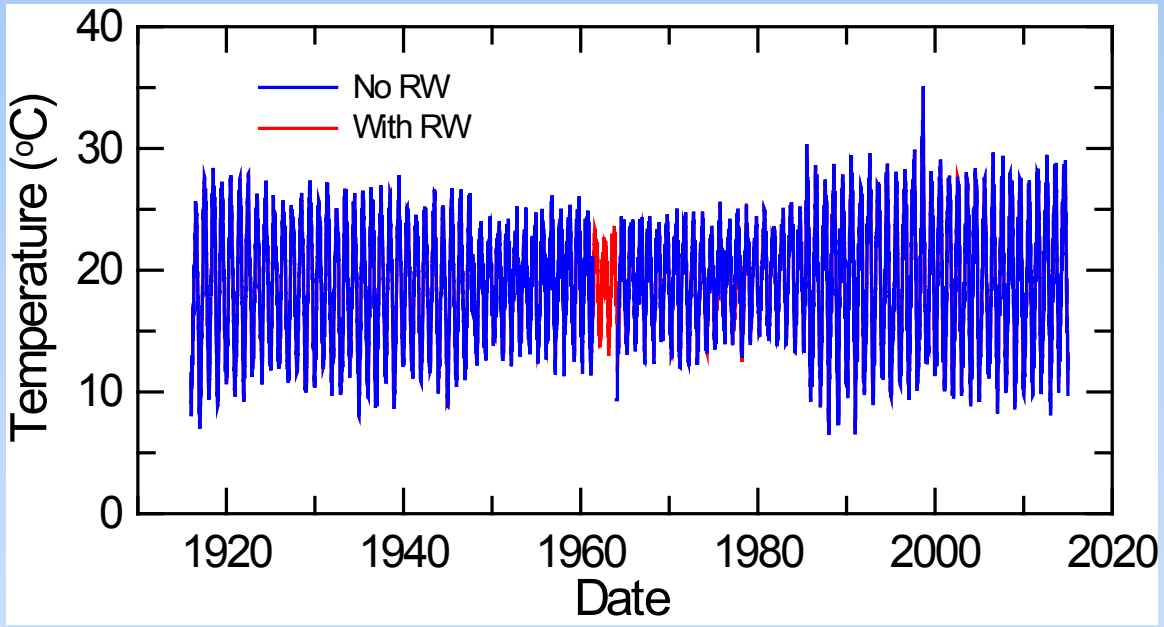
- It proved to be very difficult to capture the unique characteristics of *Oscillatoria*, which dominates the lake in extreme algal events
- A simple comparison was conducted using the 2000-2010 period (when regular monitoring data available)

Mean predicted and observed values: 2000-2010			
	Observed	Predicted	% Error
Total N	3.98	3.26	-18.1
Total P	0.265	0.395	49.1
Chlorophyll a	130.2	85.9	-34.0

- Overall, model calibration for this dynamic period of time was variable at best – adequate for temperature and total N, less successful for total P and chlorophyll a
- *Relative* features of model predictions, comparing with/without recycled water inputs, are valuable, although very large uncertainties in absolute concentrations exist

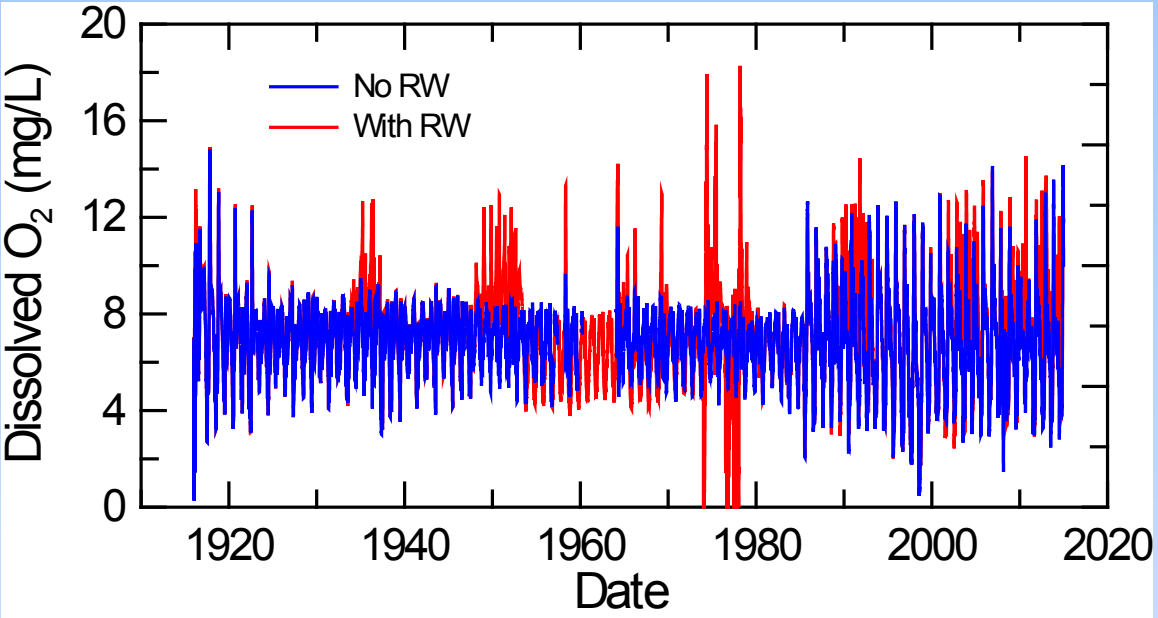
Results

Daily Average Water Column Temperature



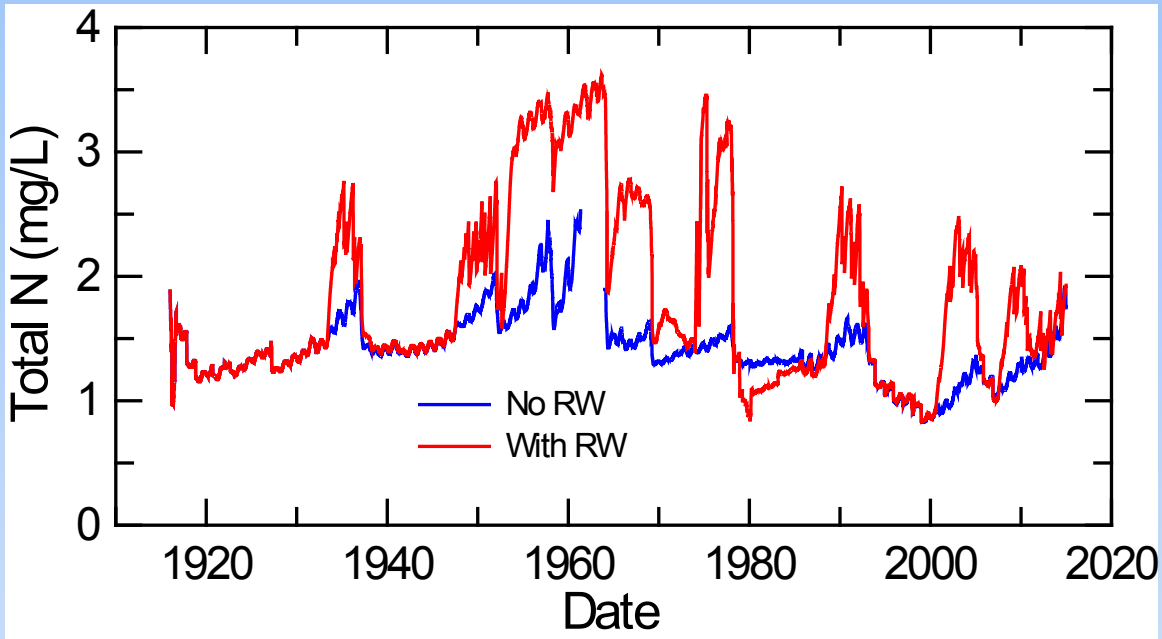
- Model predicted strong seasonal variation in average water column temperature
- Greater interannual temperature ranges in 1916-1945 and 1995-2014
- Recycled water inputs were not predicted to alter the heat budget or temperature of the lake

Daily Average Water Column DO



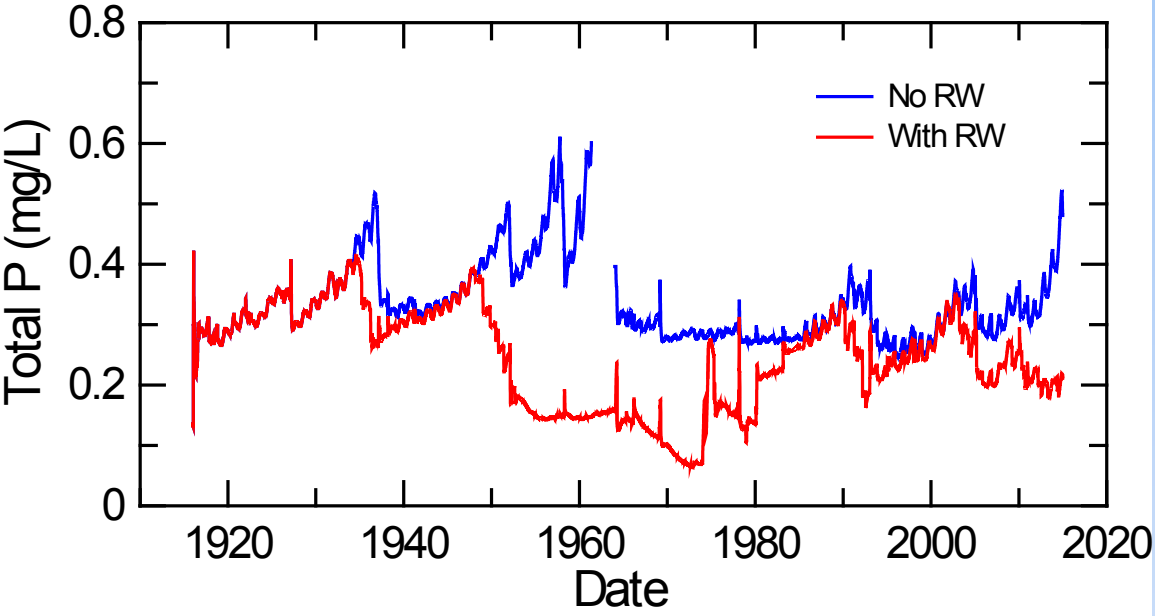
- Predicted daily average water column DO levels varied modestly from 1920-1985 without RW
- Greater oscillations predicted more recently
- Periodic inputs of RW yielded greater variance, often with DO supersaturation
- Acute anoxia that would have triggered near complete fish kills was predicted in 1974, 1976 and 1977

Daily Average Water Column Total N



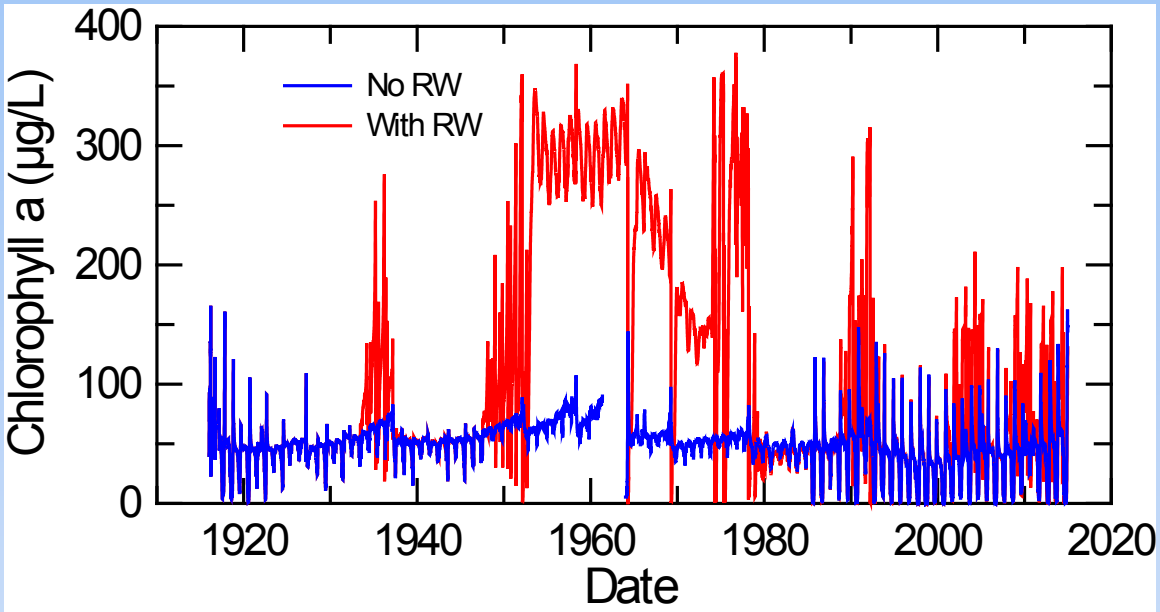
- Total N concentrations without RW inputs varied in response to watershed inputs and evapoconcentration
- Inputs of RW predicted to markedly increase total N concentration in the lake, beyond that due to evapoconcentration

Daily Average Water Column Total P



- Recycled water supplementation was predicted to actually *decrease* P concentrations relative to no RW inputs, due to:
  - Dilution during periods of strong evapoconcentration
  - Evidence for incorporation into food web and subsequent settling
  - System predicted to return to values of 0.2-0.25 mg/L

Daily Average Water Column Chlorophyll a



- Recycled water inputs were also clearly evident in predicted chlorophyll a values and followed TN
- Initial inputs in late 1930's triggered a marked increase in predicted chlorophyll a
- Inputs during drought in 1950's-1960's and beyond had persistent chronic negative impact

Mean Predicted Values: 1916-2014					
	Temp	DO	Total N	Total P	Chl a
No RW	18.95	6.76	1.41	0.33	49.5
With RW	18.96	7.08	1.81	0.24	104.9
Rel Change	0.10%	4.7%	28.4%	-27.3%	111.9%

- Addition of recycled water had no effect on mean temperature
- Recycled water inputs also had little effect on mean DO concentration although did increase variability in DO
- Supplementation with recycled water *increased* mean total N content by 28.4% and *decreased*, with this model parameterization, mean total P concentration by 27.3%
- Mean chlorophyll a concentration was most strongly and non-linearly altered in response to changes in available nutrients, more than doubling with recycled water inputs

Predicted Nutrient Inputs and Exports (1916-2014)						
	Total N (tonnes)			Total P (tonnes)		
	In	Out	Retain	In	Out	Retain
No RW	3351	575	2776	953	135	818
With RW	6023	826	5196	1084	164	920

- The majority of nutrients delivered in inflows are retained within the basin
  - Without recycled water inputs, 2776 tones of total N (83%) and 818 tonnes of total P (86%) retained within lake
  - With supplementation, 5196 tonnes of total N (865) and 920 tonnes of total P (85%) retained within lake
- Retention of nutrients is greater than that for salt (59% and 65% of salt delivered with inflows were retained within lake with no recycled water and with recycled water, respectively)

Conclusions

- Simulations provide some useful insights into response of lake to long-term recycled water inputs
- Supplementation with recycled water was predicted to:
  - Not affect temperature and heat budget of lake
  - Increase range of average water column DO concentrations, with both increased supersaturation and greater episodes of anoxia
  - Increase average total N concentration
  - Decrease average total P concentration
  - Markedly increase chlorophyll a concentrations
- Extreme hydrologic, chemical and ecological conditions of Lake Elsinore represent tremendous challenge to calibrating and confidently predicting water quality over long time-frames

TMDL Compliance Monitoring Program

September 9, 2015

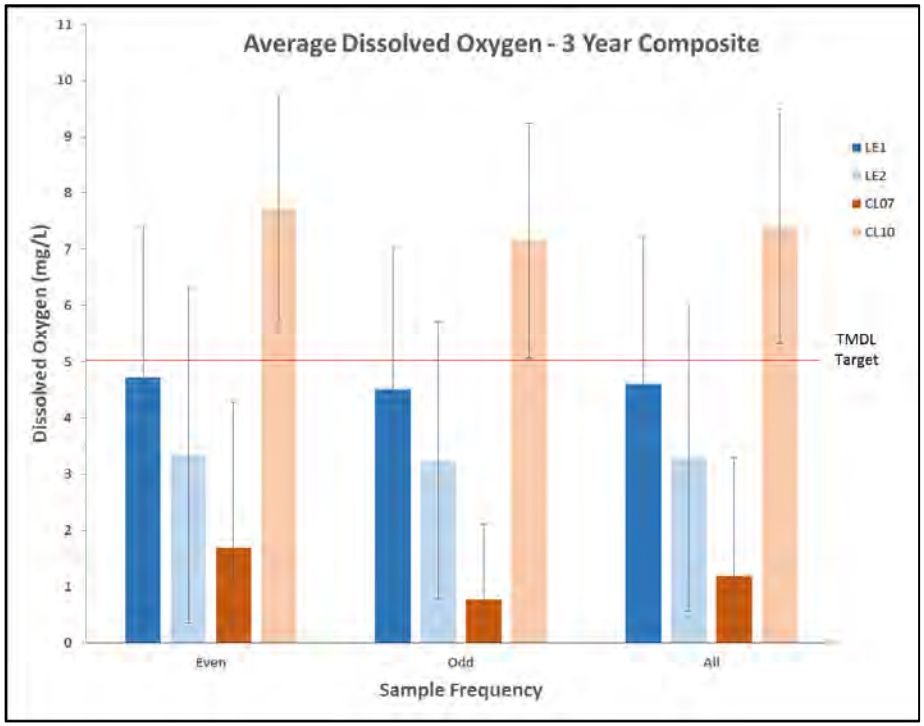
Agenda

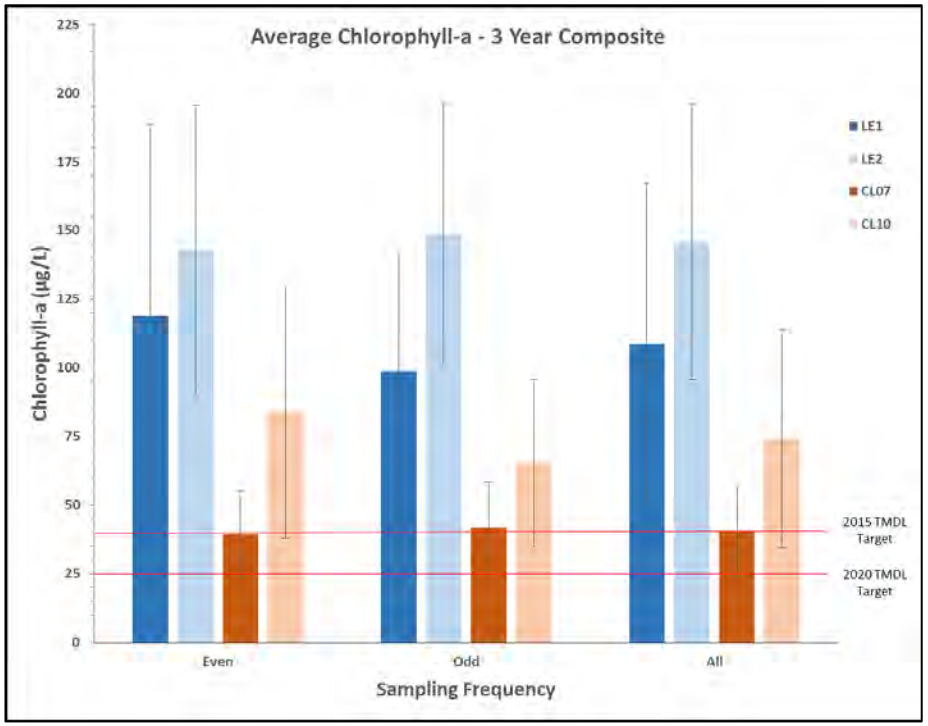
1. Frequency of In-Lake Monitoring Analysis
2. QA Validation of Satellite Data Provider

Sampling Frequency Analysis - Methods

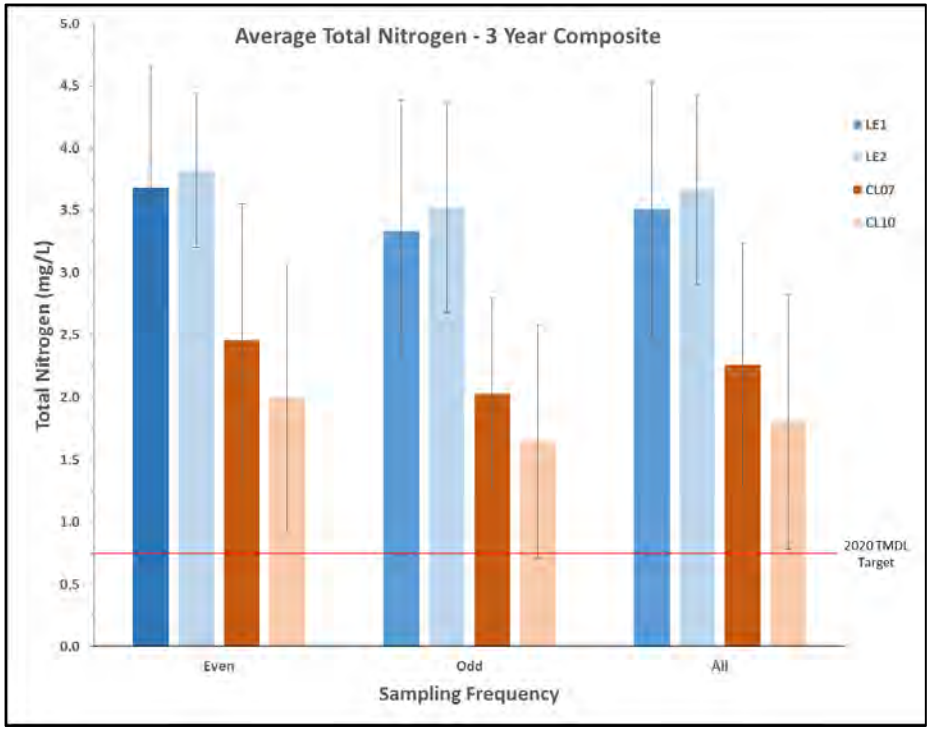
- Most recent complete 3-year data from Canyon Lake and Lake Elsinore
  - 2008 - 2011
  - CL07, CL10, LE1, LE2
- Focus on TMDL targets
  - Dissolved Oxygen
  - Chlorophyll-a
  - Total Nitrogen
  - Total Phosphorus
- Averaged values over different sampling frequencies
  - Even numbered months
  - Odd numbered months
  - All months
- T-tests to compare mean concentrations

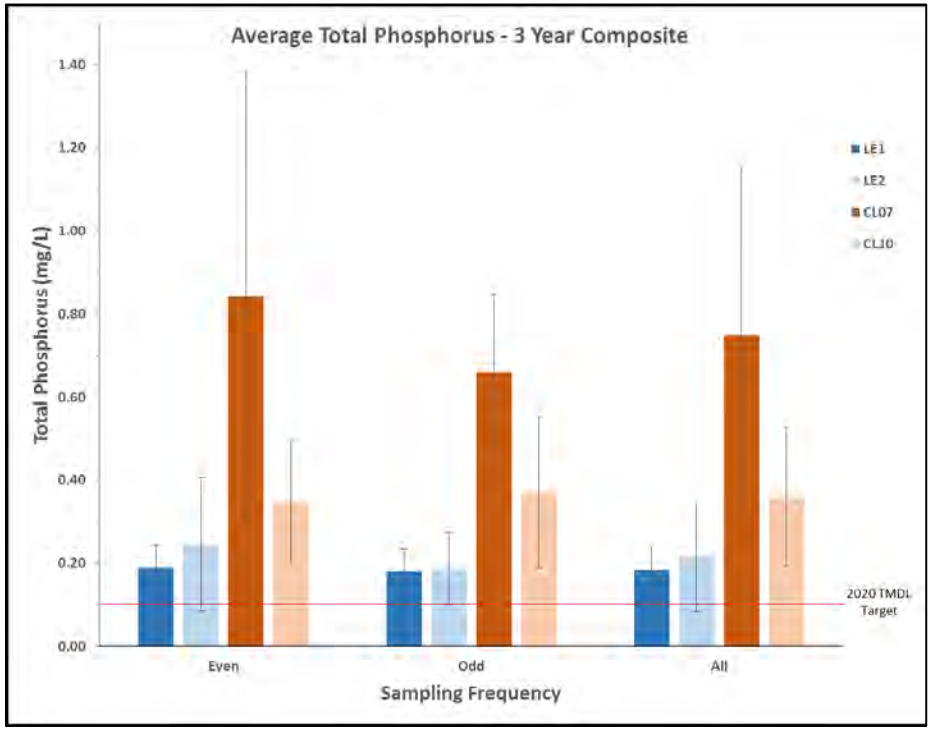
Dissolved Oxygen & Chlorophyll Monthly vs. Bi-monthly Sampling





Total Nitrogen & Phosphorus Monthly vs. Bi-monthly Sampling





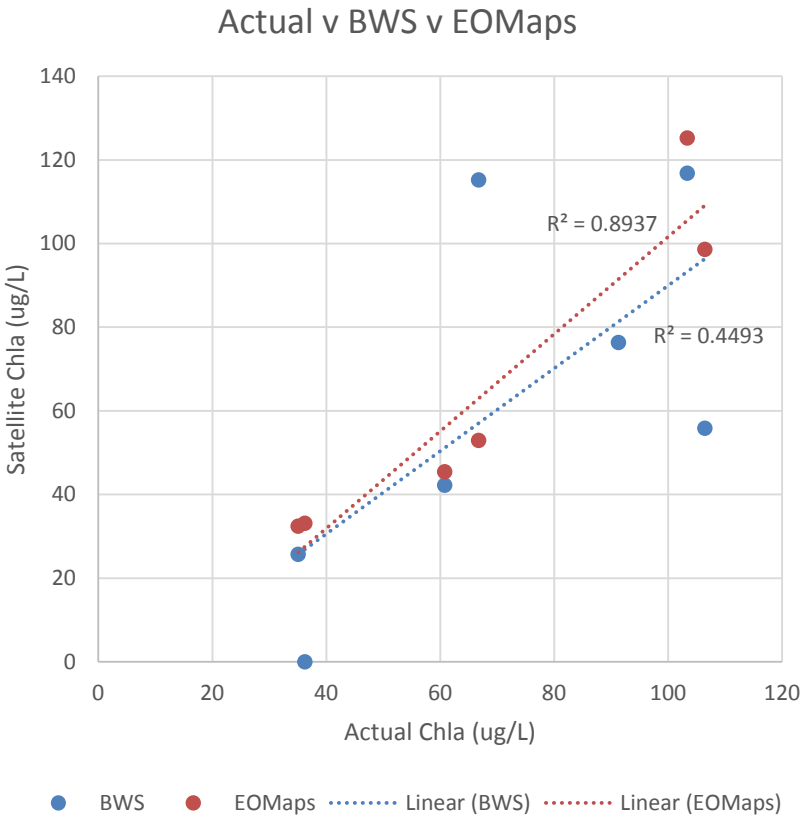
Monthly vs. Bi-monthly Sampling

- Statistical Analysis
  - July 1 to June 30 water year
  - Analysed within each individual year and 3 years combined
- Returned only 2 significant results
  - CL07 – Total Phosphorus during 2010-2011
    - Even v. Odd months
  - LE1 – Chlorophyll-a during 2010-2011
    - Even v. Odd months
- No difference between monthly vs. bi-monthly sampling

Satellite Chlorophyll Validation

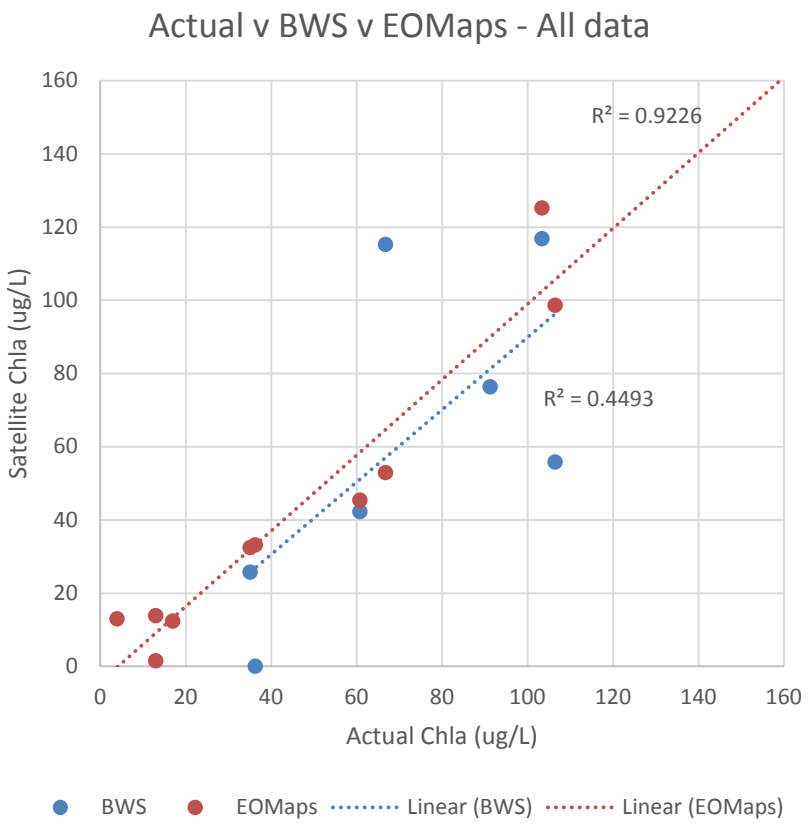
Validation of EOMaps Satellite Chlorophyll

- Methods
  - Calibration & Validation data sets
- Correlation coefficients
  - BWS = 0.670
  - EOMaps = 0.945
- EOMaps R^2 values higher

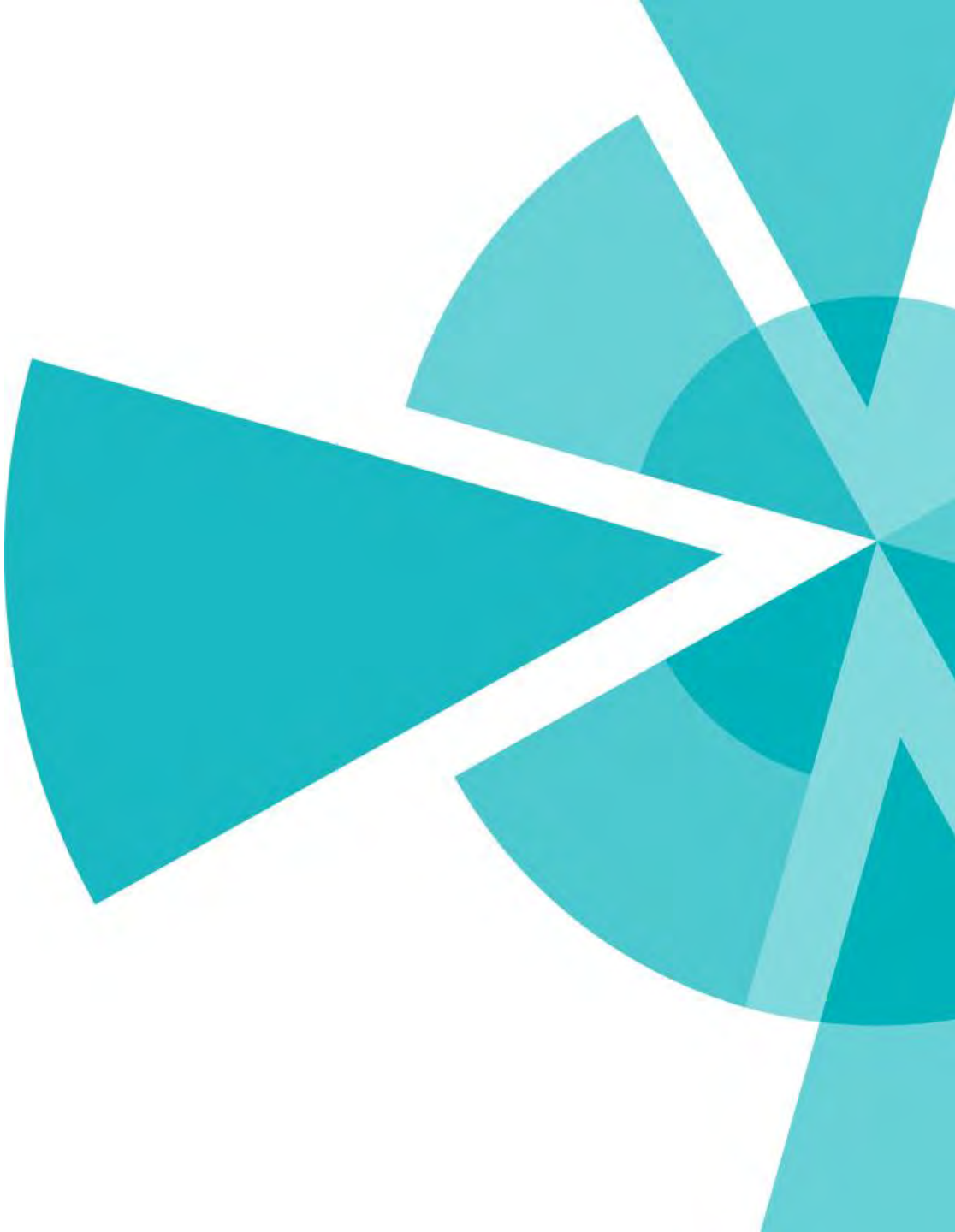


Validation of EOMaps Satellite Chlorophyll

- Methods
  - Calibration & Validation data sets
- Correlation coefficients
  - BWS = 0.670
  - EOMaps = 0.945
- EOMaps R^2 values higher
- Incorporate latest samples
  - Correlation = 0.961
  - R^2 = 0.923
  - One outlier data point



Questions?



MYSTIC LAKE BATHYMETRY

SEPTEMBER 9, 2015

MICHAEL VENABLE

JUNIOR ENGINEER
RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

OVERVIEW

- How Mystic Lake bathymetry changed from 2004 to 2014.
  - Current VS. Historic Lake Boundaries
  - Change in Mystic Lake storage volume
  - Will the San Jacinto River (SJR) bypass Mystic Lake?
  - Conclusions

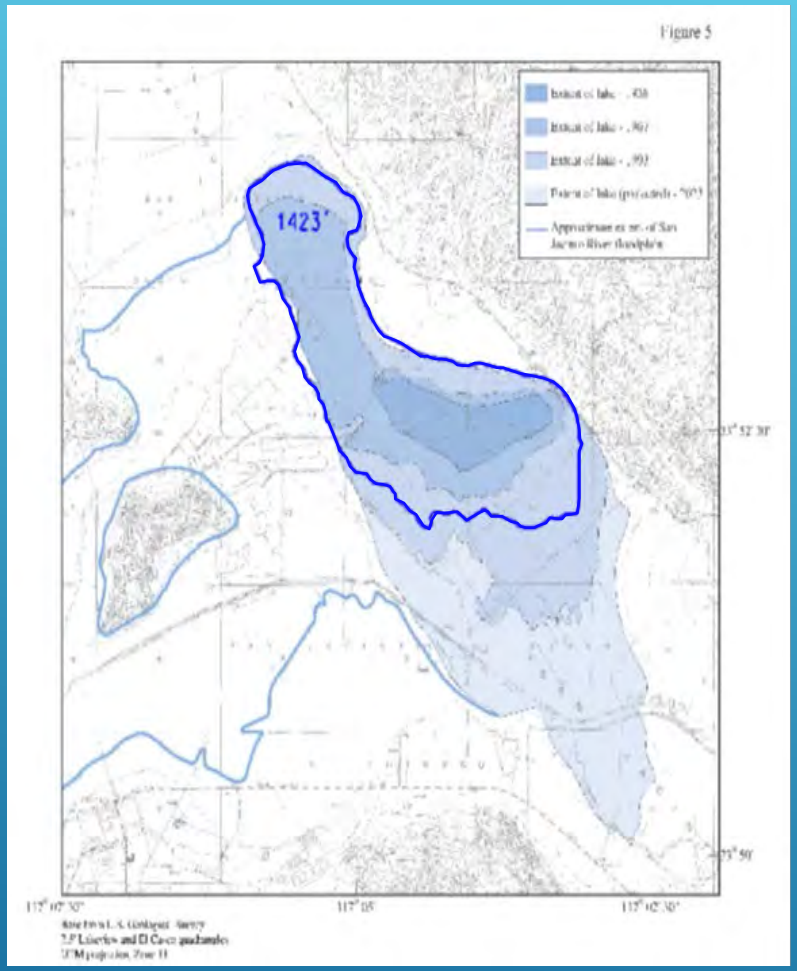
OVERVIEW


Mystic Lake Outlet
Gilman Springs Rd
Gilman Hot Springs
Bridge St.
Levee Breach
Bridge St
San Jacinto River Levee

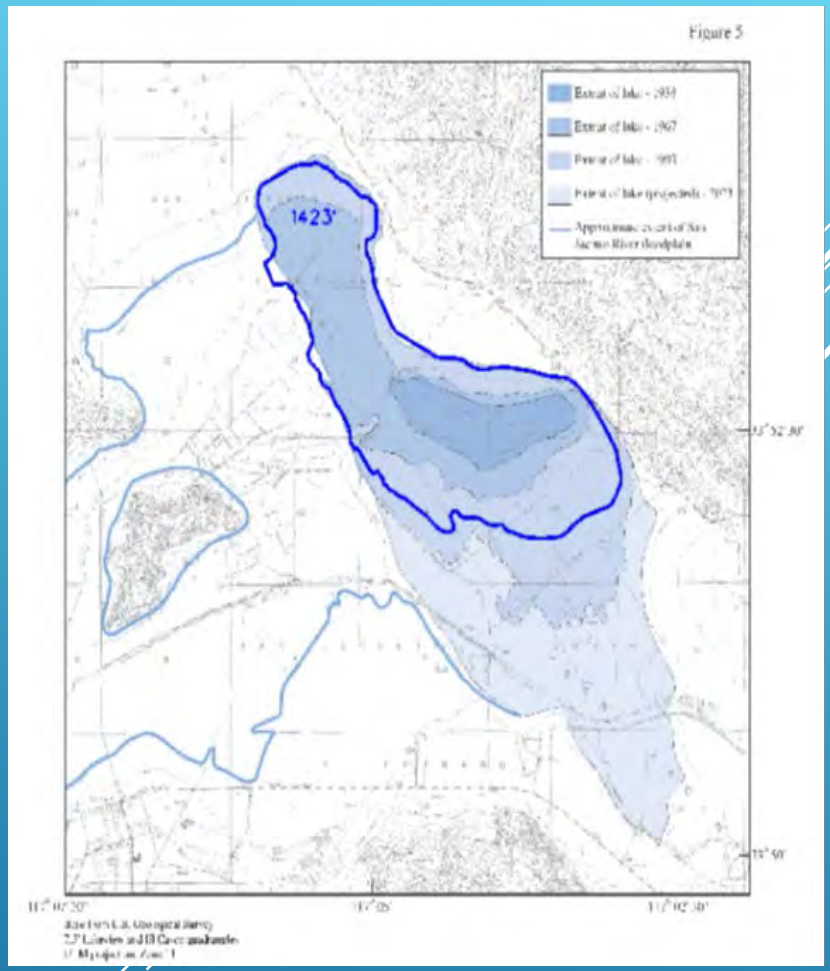
CURRENT VS. HISTORIC LAKE BOUNDARIES

- To establish a horizontal boundary for Mystic Lake, RCFC used a contour line at an elevation of 1423'.
- Mystic Lake horizontal limit at full storage capacity is contained within the 1423' contour line. If water surface exceeds 1423' the water will outlet in the westerly direction through an earthen channel.
- RCFC data shows no significant difference between the 2014 and 2004 horizontal limits at the 1423' contour.

CURRENT VS. HISTORIC LAKE BOUNDARIES



2004 1423' Contour Line



2014 1423' Contour Line

Provided by Dr. D. M. Morton with assistance from the USGS Denver electronic mapping facility. The map itself is available for download from the USGS Open File System.

CURRENT VS. HISTORIC LAKE BOUNDARIES

- No visible existing culvert at outlet of Mystic Lake
- Water surface elevation must reach road elevation to exit.
- Road elevation = 1423’

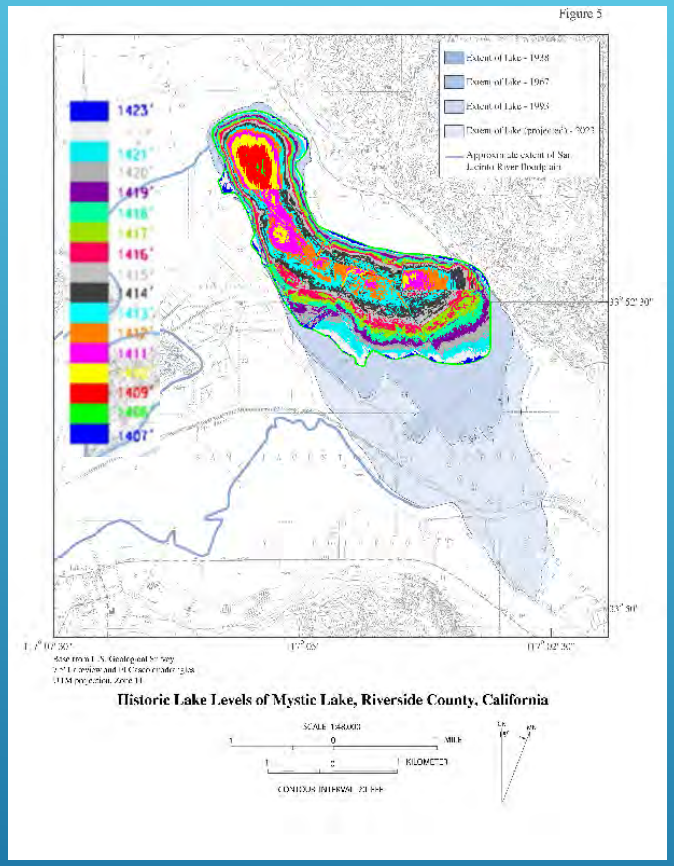
Photo #1

Photo #2

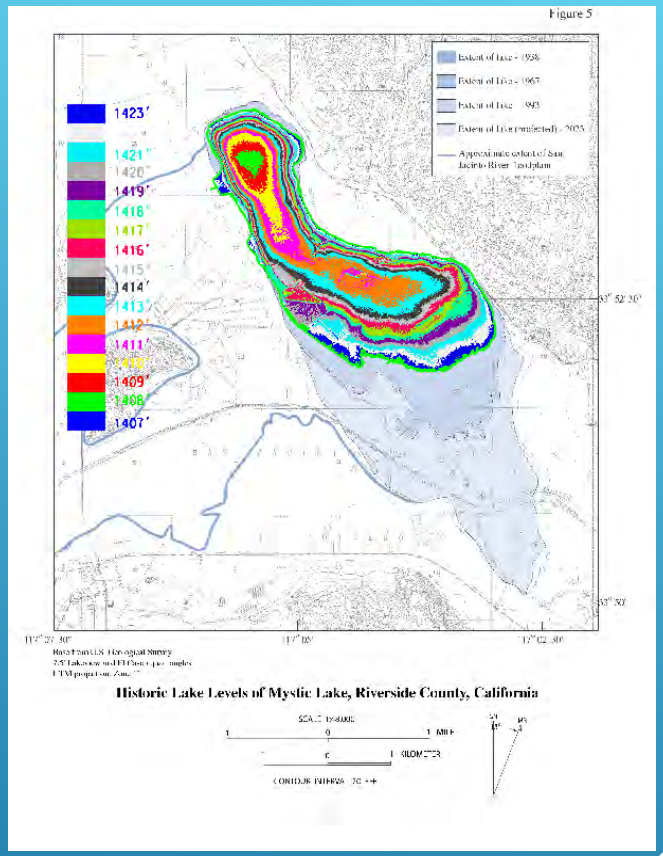
CHANGE IN MYSTIC LAKE STORAGE VOLUME

- Two studies of Mystic Lake's bathymetry were performed by RCFC&WCD. The boundaries and depth of the lake were determined by the use of Digital Terrain Models (DTM) supporting 4FT contour maps.
- Data points for the two studies were collected using aerial photogrammetry and LIDAR flights.
  - **2004 Data: Flown: Nov 3, 2004 Source: Aerial Photogrammetry**
  - **2014 Data: Flown: Sep 30, 2014 Source: LIDAR**
- Volumes for each study (2004 & 2014) were calculated using both; InRoad's Storm and Sanitary Software, and the "Average End" method. Results were cross referenced to confirm accuracy.

CHANGE IN MYSTIC LAKE STORAGE VOLUME



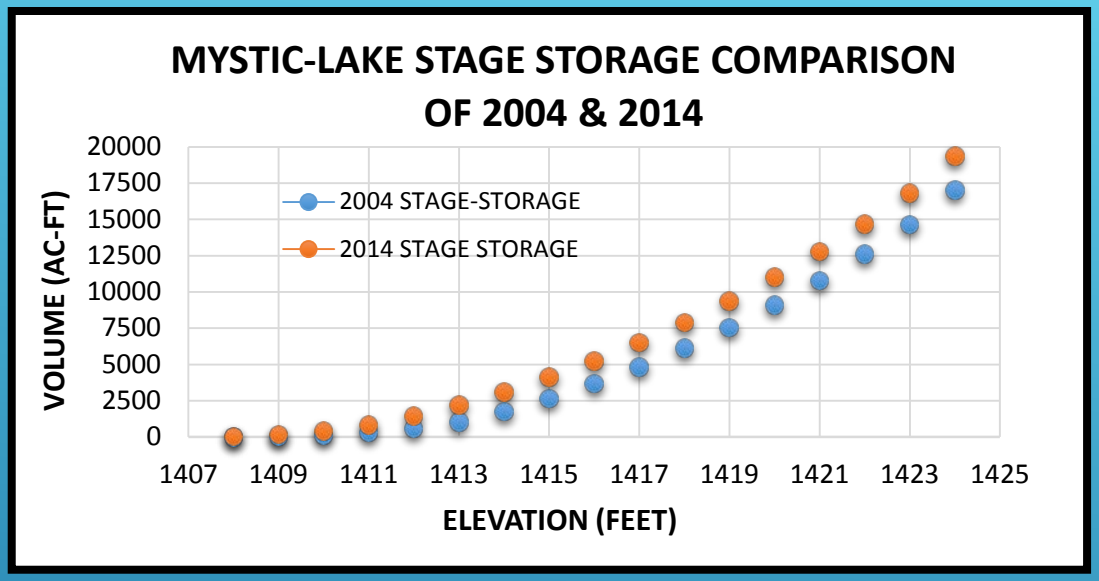
2004 Depths



2014 Depths

- 1423’ Horizontal Boundary remained similar for 10 years
- Green area (ELEV 1408’) appears in 2014 LIDAR data

CHANGE IN MYSTIC LAKE STORAGE VOLUME



The total increase in storage volume between 2004 & 2014 **is 2,054 acre-feet**. This brings the total storage volume up to 14,668 acre-feet, and suggests that the lake's volume is increasing by roughly 200 acre-feet per year.

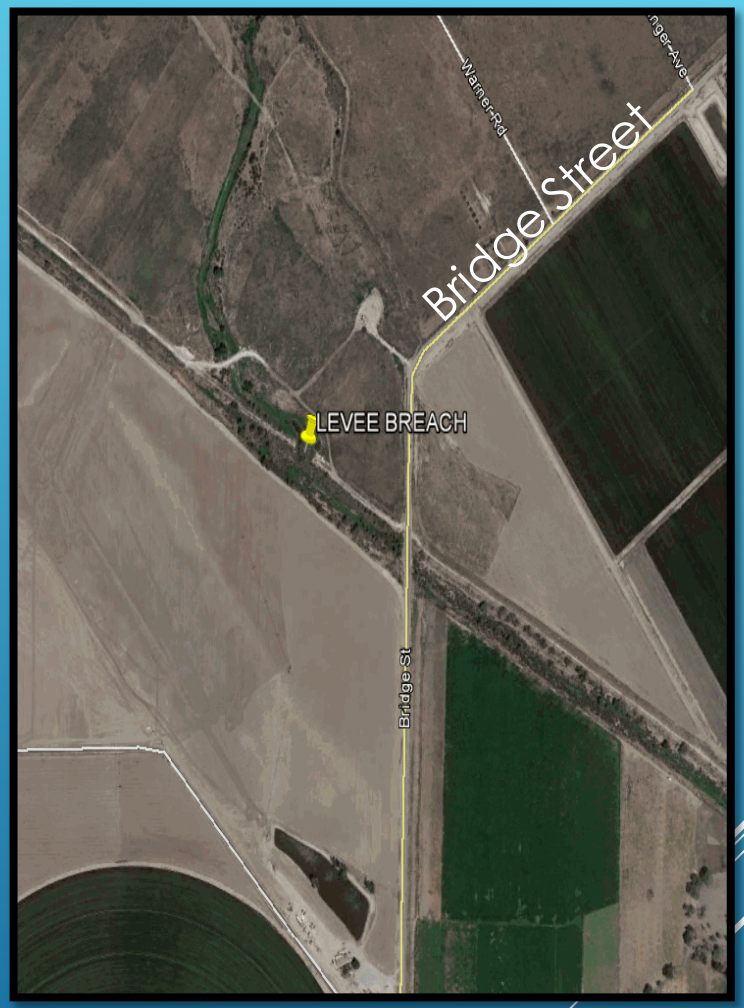
Note: Majority of the increase in volume occurred in the deepest areas of the lake between 1409' and 1415'.

CHANGE IN VOLUME			
ELEV (FT)	DIFF/FT (AC-FT)	CU VOI (AC-FT)	% Increase volume
1409			
	140	140	74%
1410			
	131	271	58%
1411			
	225	495	56%
1412			
	351	846	57%
1413			
	321	1167	41%
1414			
	186	1352	20%
1415			
	121	1473	12%
1416			
	112	1585	10%
1417			
	97	1682	8%
1418			
	70	1751	5%
1419			
	71	1822	5%
1420			
	72	1894	4%
1421			
	77	1970	4%
1422			
	84	2054	4%
1423			

WILL SAN JACINTO RIVER BYPASS MYSTIC LAKE?

Breached Levee Location

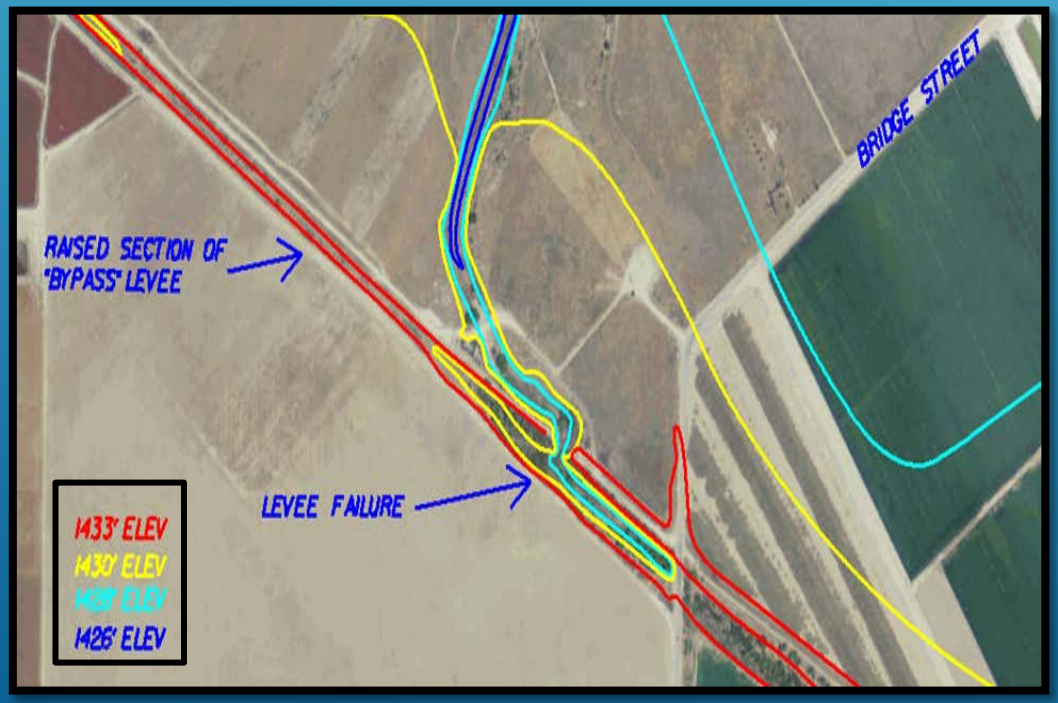
Breached Levee Looking West
(opening over 100ft wide)

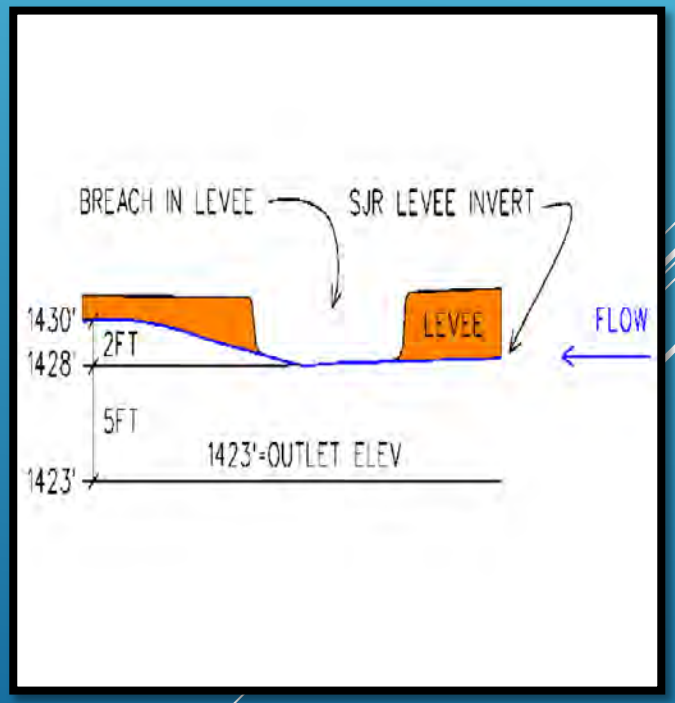


WILL SAN JACINTO RIVER BYPASS MYSTIC LAKE?

ISSUES WITH THE SAN JACINTO RIVER LEVEE

- From the latest topography (2008) the flow line of the levee floor rises 2ft (uphill) from the breach in the levee.
- In this location it appears the water ponds up and flows through the breach in the levee and into Mystic Lake.





WILL SAN JACINTO RIVER BYPASS MYSTIC LAKE?

CONCLUSION:

- Majority of storm runoff will flow into Mystic Lake through breach in SJR levee.
- Mystic Lake must be filled to a minimum surface elevation of 1430’ before the SJR will continue to flow in the levee. In this scenario the Mystic Lake outlet would already be flowing.
- It appears that Mystic Lake is being affected by subsidence. It should be noted that the majority of the subsidence is occurring within the current lake boundary (1423’ contour line) and is not necessarily expanding horizontally by a significant rate.
- Mystic Lakes volume increased roughly 200 acre-feet per year from the year 2004 to 2014.

QUESTIONS?