Agenda

1. Welcome/Introductions
2. Overview of Recycled Water Strategic Plan and Goals of Task 3.0
3. Hydrogeologic Findings
4. Review of Study Area Water Balance and Yield Estimate
5. Preliminary Groundwater Use Assessment Findings
6. Next Steps
7. Q & A
8. Adjourn

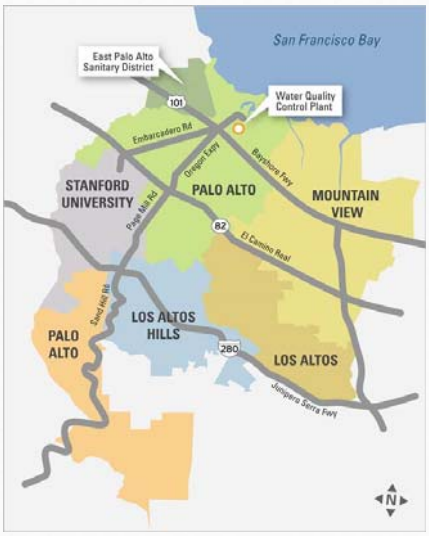
Welcome/Introductions

Palo Alto Regional Water Quality Control Plant

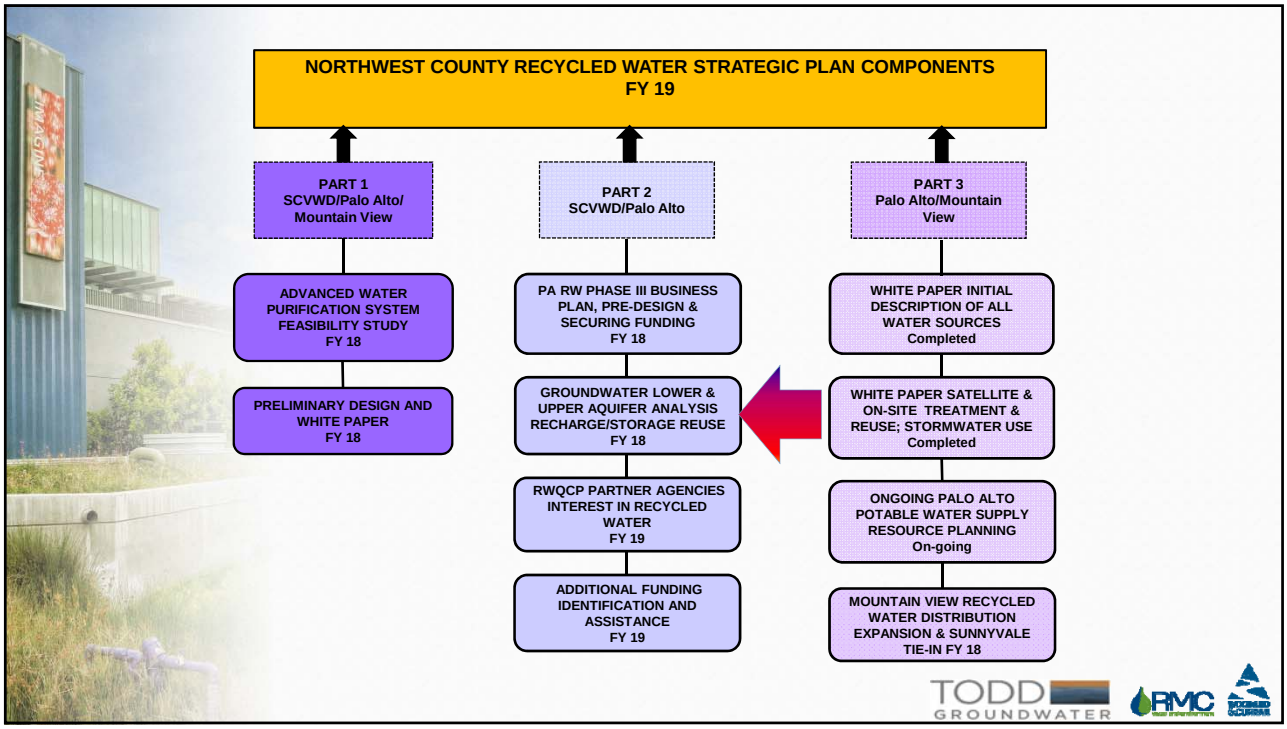
- Mountain View
- Palo Alto
- Los Altos
- Stanford
- East Palo Alto
- Los Altos Hills

Santa Clara Valley Water District

- Primary water resource agency for Santa Clara County
  - Water Supply
  - Flood Protection
  - Watershed Protection



TODD GROUNDWATER



TODD GROUNDWATER

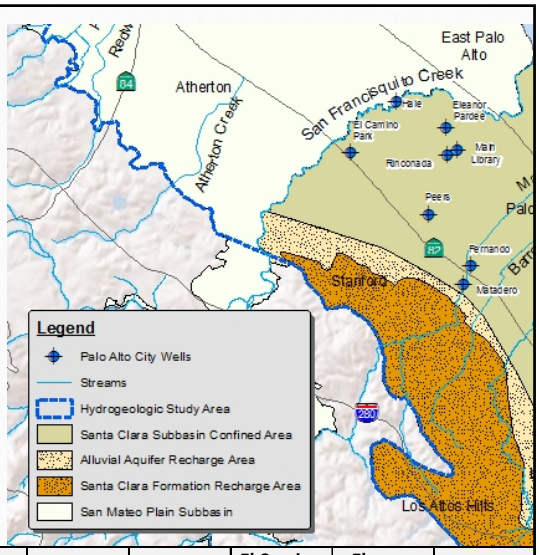
Goals of Groundwater Use Assessment and Indirect Potable Reuse Feasibility Study

- Develop refined understanding of the groundwater subbasin characteristics beneath Palo Alto and surrounding areas
- Evaluate the feasibility of Indirect Potable Reuse
  - Uses purified recycled water as a groundwater management strategy
  - Blended into an aquifer or reservoir that can eventually be used as drinking water – via groundwater recharge ponds or injection wells
- Establish a baseline and model potential impacts to groundwater under future use scenarios

TODD GROUNDWATER

Palo Alto Emergency Supply Wells

- 3 new wells - 2009 to 2013
- 5 old wells - 1950s
- All packed/screened in both shallow and deep aquifers
- Yields from 600 to 3,300 gpm



Well	Hale	Rinconada	Peers Park	Fernando	Matadero	El Camino Park	Eleanor Pardee	Library
Well Capacity (gpm)	1,450	3,300	1,700	700	700	1,850	1,000	600

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TODD GROUNDWATER

Palo Alto Projected 2020 Demand and Well Capacity

- 2020 Demand = 12,000 AFY (7,400 gpm)
- Total capacity of City wells = 11,300 gpm

- How much groundwater can City develop with and without IPR?
  - Initial estimate with water balance
  - More refined assessment with groundwater modeling

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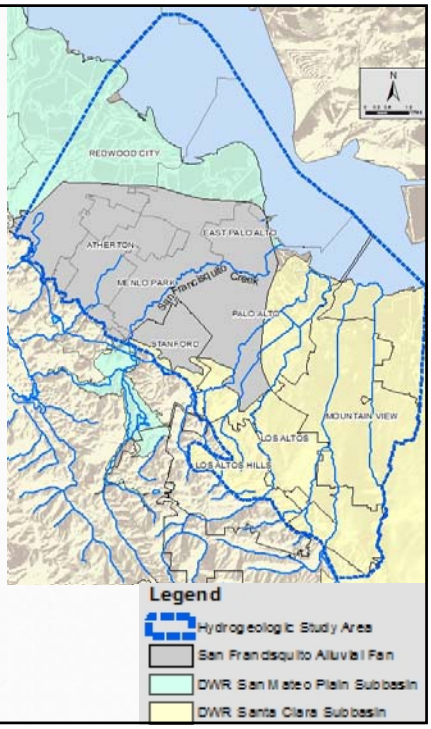
TODD GROUNDWATER

Hydrogeologic Study Area

- Part of the larger Santa Clara Valley Basin
  - NW to Redwood City
  - SE to Mountain View
  - North to San Francisco Bay
  - Encompasses San Francisquito Cone
  - Groundwater can flow across Study Area boundaries



Projected Groundwater Demand in AFY by Other Purveyors

- MV – small increase
- PA – zero ?
- Stanford – flat ?
- CWS – flat or decreasing
- EPA – 700 to 1,200 ?
- MP – zero ?
- RC - zero
- San Mateo County ?

Water Retailer	2020	2025	2030	2035	2040	Source
Mountain View					288	SCVWD WEAP model
	566	574	588	604	621	Mountain View, 2016, UWMP
Palo Alto [b]		0	0	0	0	Palo Alto, 2016 UWMP
Stanford University					828	SCVWD WEAP model
California Water Service (CWS)					3,624	SCVWD WEAP model
Los Altos Suburban District [a]	3,824	3,674	3,674	3,570	3,552	CWS Los Altos Suburban District, 2016, UWMP
East Palo Alto[c]	700 to 1,200??	700 to 1,200??	700 to 1,200??	700 to 1,200??	700 to 1,200??	EKI, 2016b, UWMP
Menlo Park[d]	0	0	0	0	0	EKI, 2016a, UWMP
California Water Service (CWS) Bear Gulch District	1,535	1,535	1,535	1,535	1,535	CWS Bear Gulch District, 2016, UWMP
Redwood City	0	0	0	0	0	EKI, 2016c, UWMP
San Mateo County[e]	0	0	0	0	0	San Mateo Plain Groundwater Assessment

a - SCVWD California Water Service Company service area includes some areas outside Los Alto Suburban District
b - Palo Alto is currently conducting studies to assess increased use of groundwater and managed aquifer recharge with recycled water
c - Mountain View recently agreed to transfer 1 mgd of Hetch Hetchy allocation to East Palo Alto
d - Short-term capacity of emergency supply wells is 3,000 gallons per minute
e - San Mateo County is conducting and assessment of groundwater resources
UWMP - Urban Water Management Plan
WEAP - District's regional water supply planning and operations model

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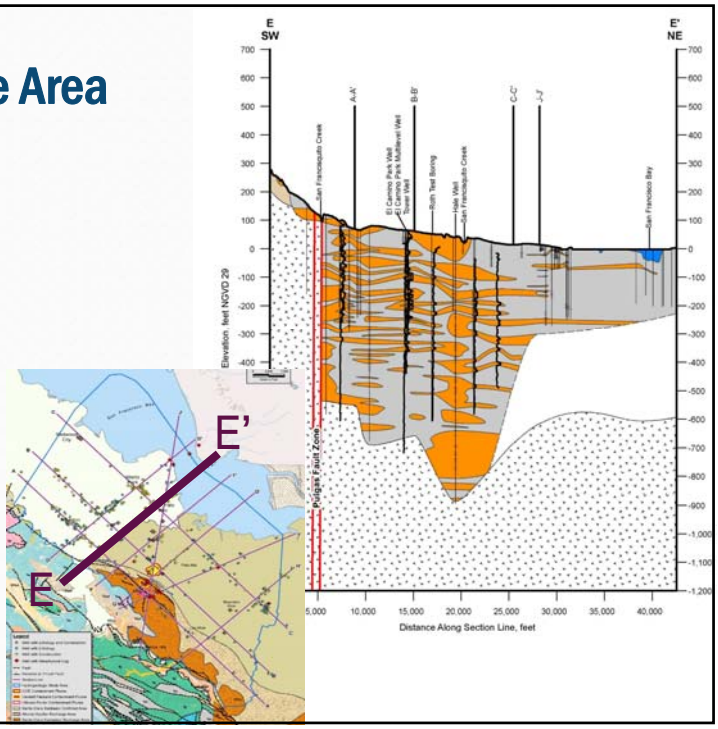
Confined and Recharge Area

- Shallow and deep aquifers separated by a laterally continuous confining layer near the Bay
- Unconfined aquifer near the foothills; unconfined shallow aquifer and confined deep aquifer closer to the Bay



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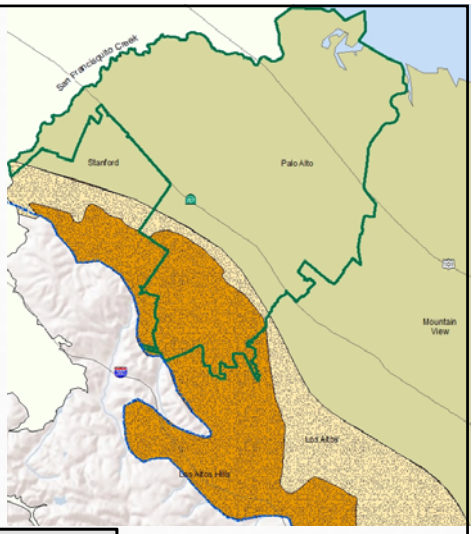
Confined and Recharge Area

- Most of Palo Alto in confined zone
- Unconfined includes alluvium and Santa Clara Formation
- Groundwater assessment confirmed previous designation



City of Palo Alto
Santa Clara Subbasin Confined Area
Alluvial Aquifer Recharge Area
Santa Clara Formation Recharge Area
San Mateo Plain Subbasin

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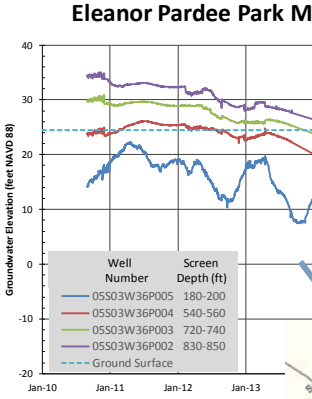
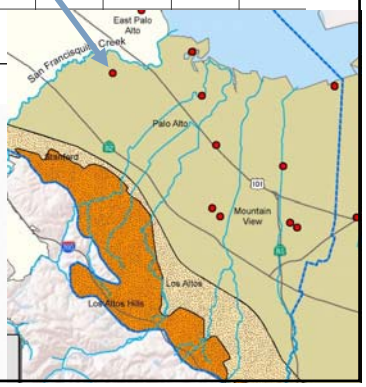
Shallow/Deep Vertical Gradients

- Water levels in confined deeper zones are higher than shallower zone (since at least 1970)
- Upward vertical gradient Flowing artesian conditions in some deep wells
- Artesian conditions limit subsurface IPR without additional pumping to reduce GW levels





Artesian Wells

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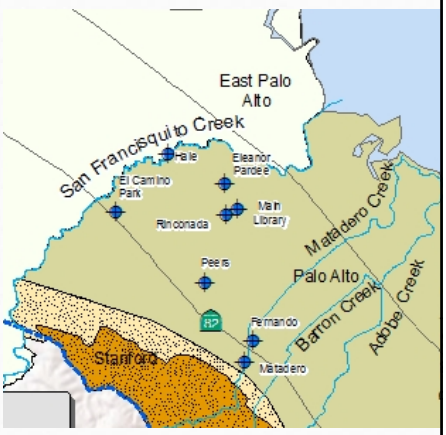
Shallow/Deep Vertical Gradients

- Significant pumping by City will provide space for IPR and reverse the vertical gradient to downward
- More hydraulic separation between Shallow/Deep near the Bay and less near the recharge area
- City wells pump from Shallow and Deep
- USGS has demonstrated significant interaquifer flow through supply wells mostly in upper 500 feet



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Groundwater Quality

- High TDS, chloride, iron and manganese
- Inland: shallow and deep aquifer have similar water quality
- Near Bay: shallow aquifer high in TDS and chloride

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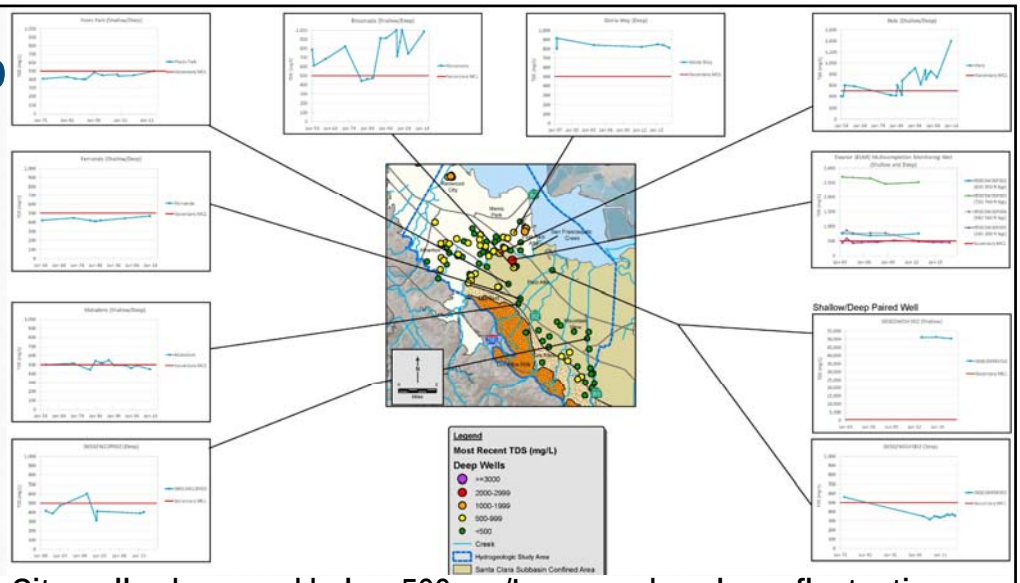
TDS Deep



- City wells above and below 500 mg/L; some show large fluctuation
- Hale showing recent increasing TDS and chloride trends
- Highest TDS and chloride in next to deepest ELNR well port

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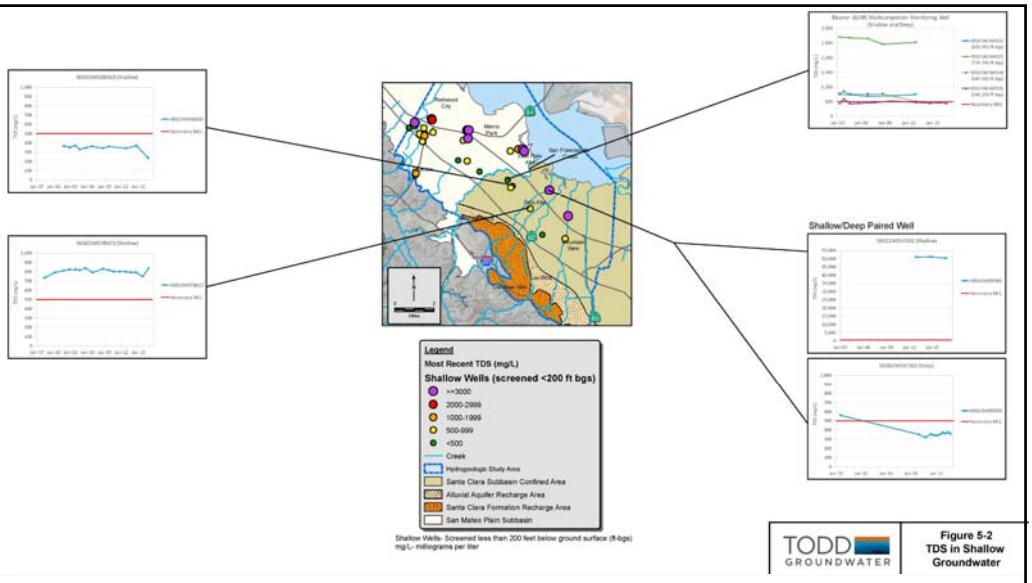
TDS Shallow



- High TDS and chloride near the Bay
- Shallow and deep have similar WQ inland

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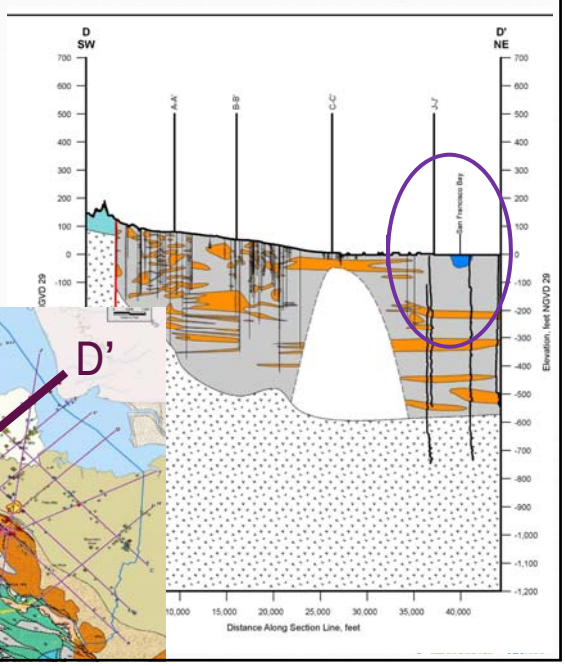
Saline Water

- Cross sections show little connection of permeable units shallow or deep aquifers with the Bay
- Hyper-saline water near the Bay due to evaporative concentration and percolation from salt marshes
- Some shallow and deep high chloride due to dissolution of marine sediments
- Not the result of typical seawater intrusion into permeable units



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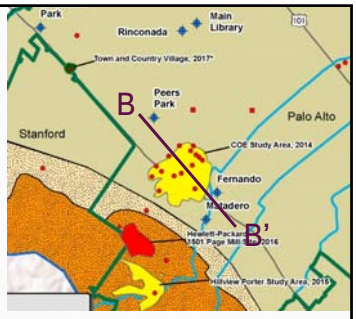
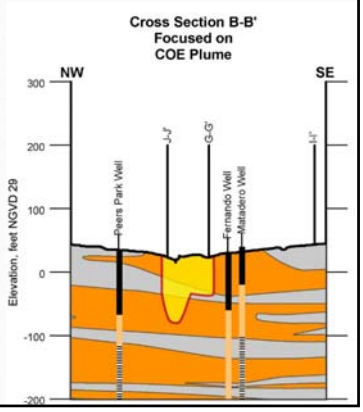
Environmental Contamination

- Fernando and Matadero wells near known plumes
- Wells have shallow surface seals
- Plume at low concentrations extends to gravel pack depth
- Wells at risk of contamination





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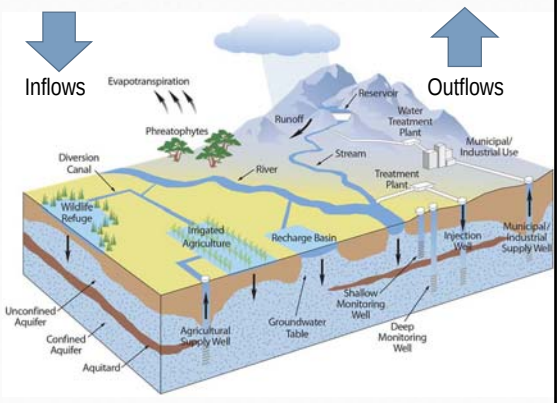
Water Balance

Inflow – Outflow = Change in Storage

Water balance is key to assessing increased pumping

- Estimate all inflows and outflows for the Hydrogeologic Study Area
- Considering different hydrogeologic conditions (wet, dry, normal)
- Utilize historical conditions to ground truth water balance



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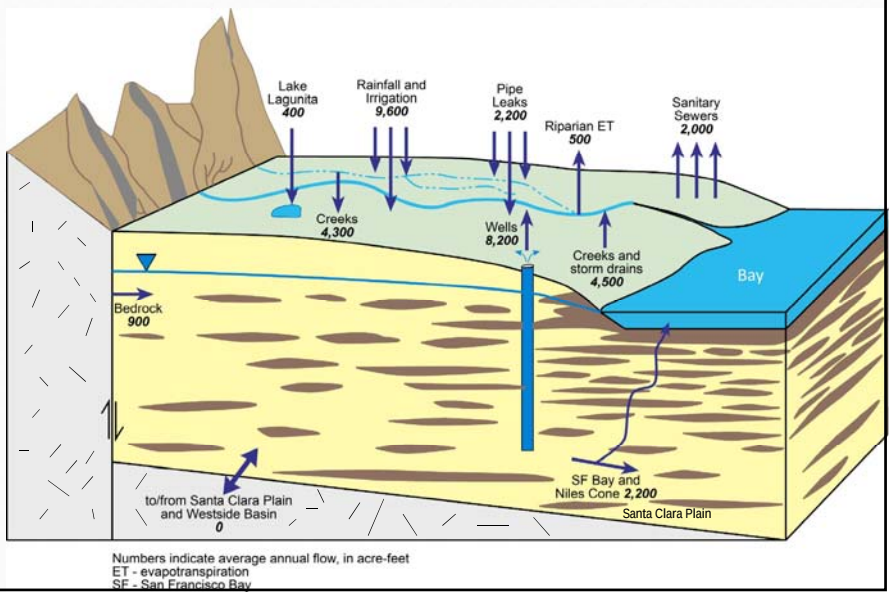
Contemporary Water Balance

- Time Period: 1985 - 2014



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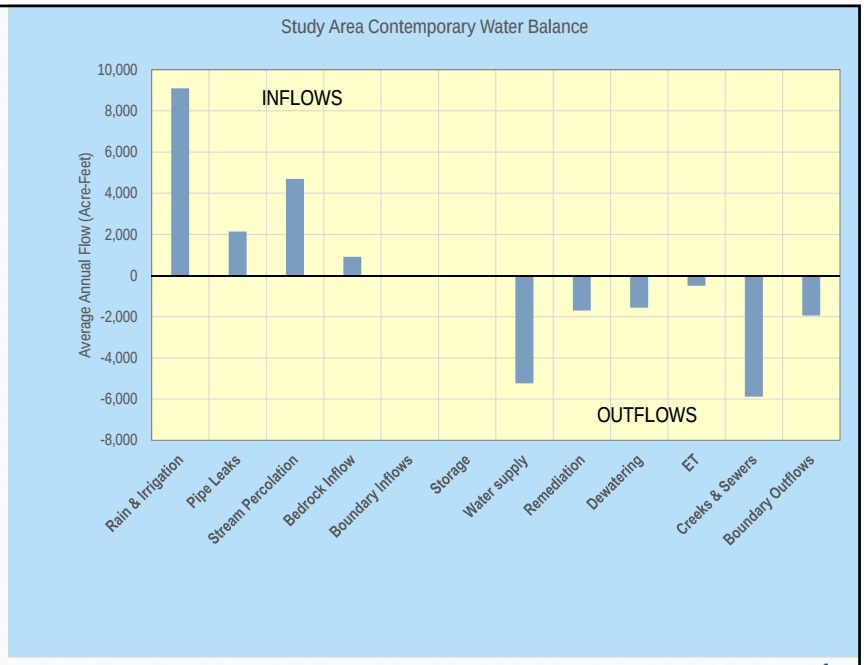
Contemporary Water Balance



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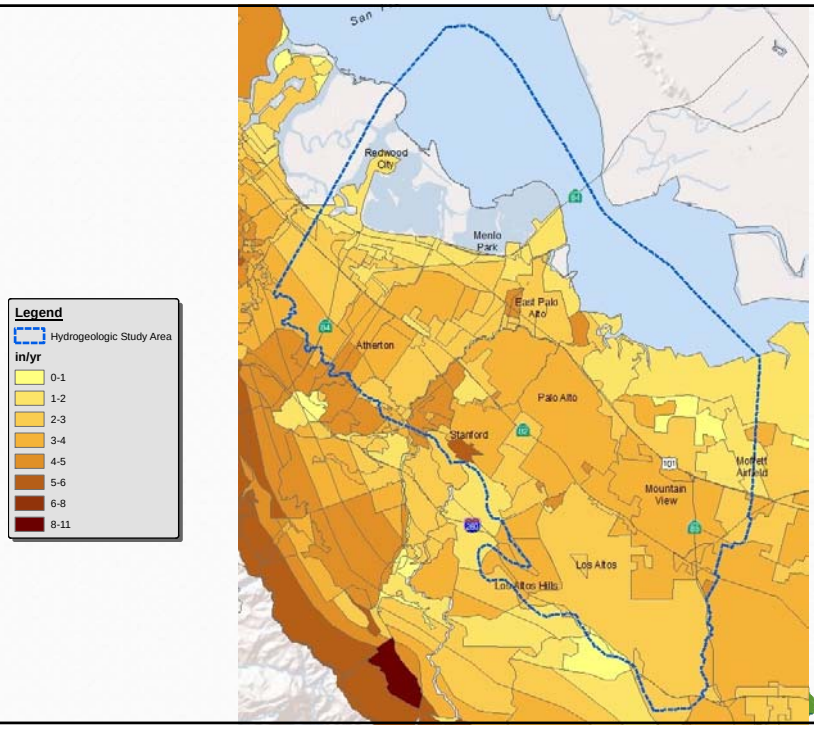
Dispersed Recharge



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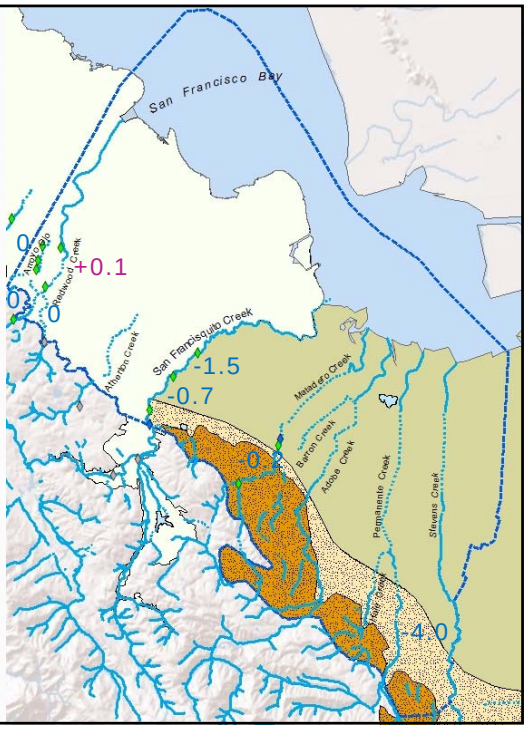
Stream Flow
Gains and Losses in cubic feet per second (cfs)

- Negative number indicates stream recharge to groundwater
- Positive number indicates groundwater discharge to creek



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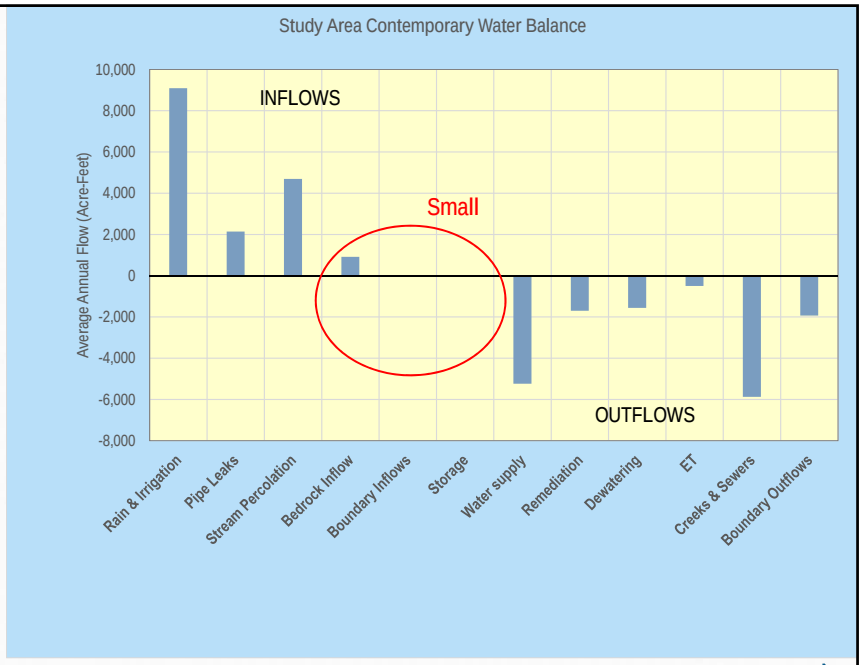
Contemporary Water Balance



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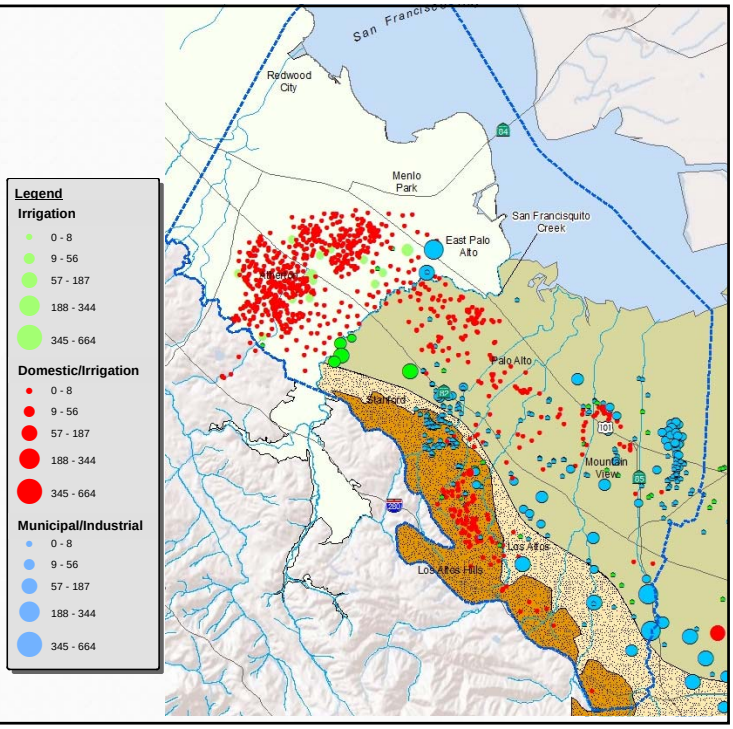
Municipal, Irrigation and Domestic Pumping in AFY



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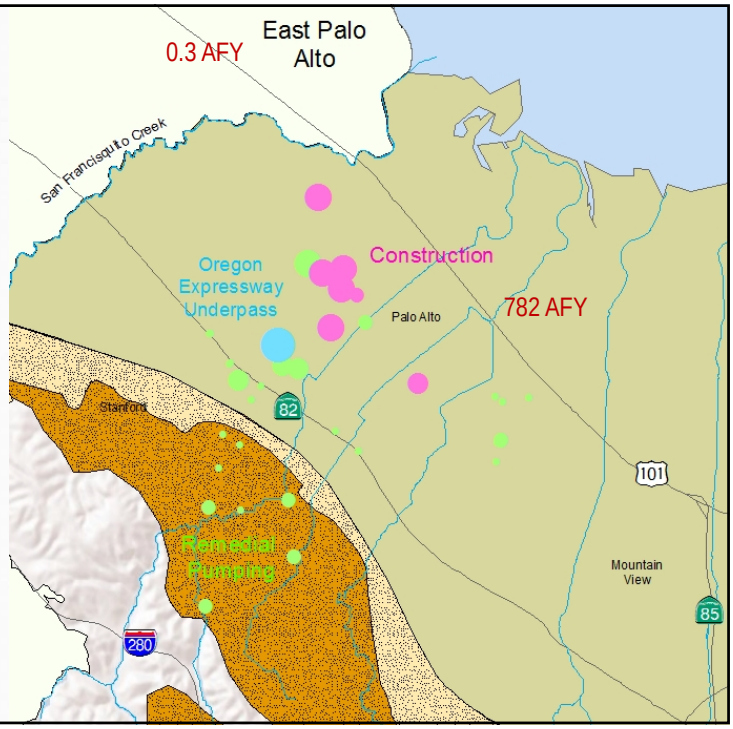
Dewatering Pumping in 2016



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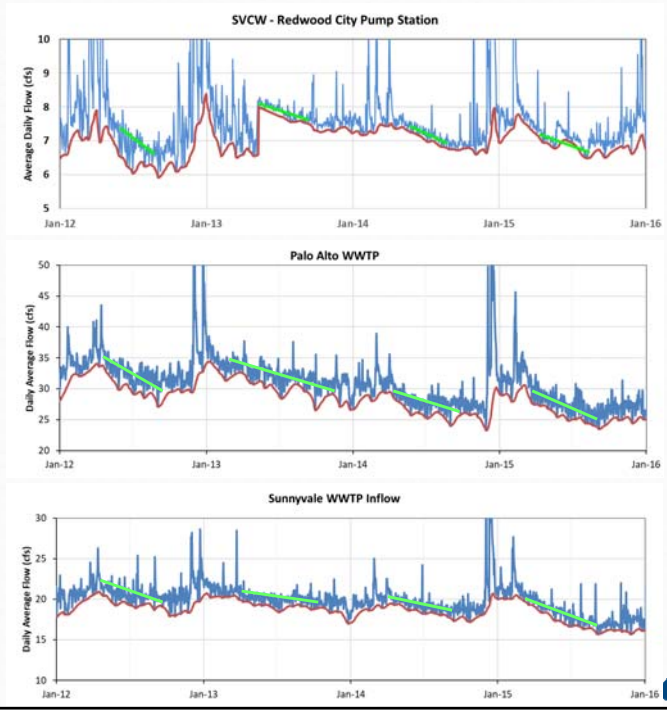
Groundwater Infiltration to Sewers



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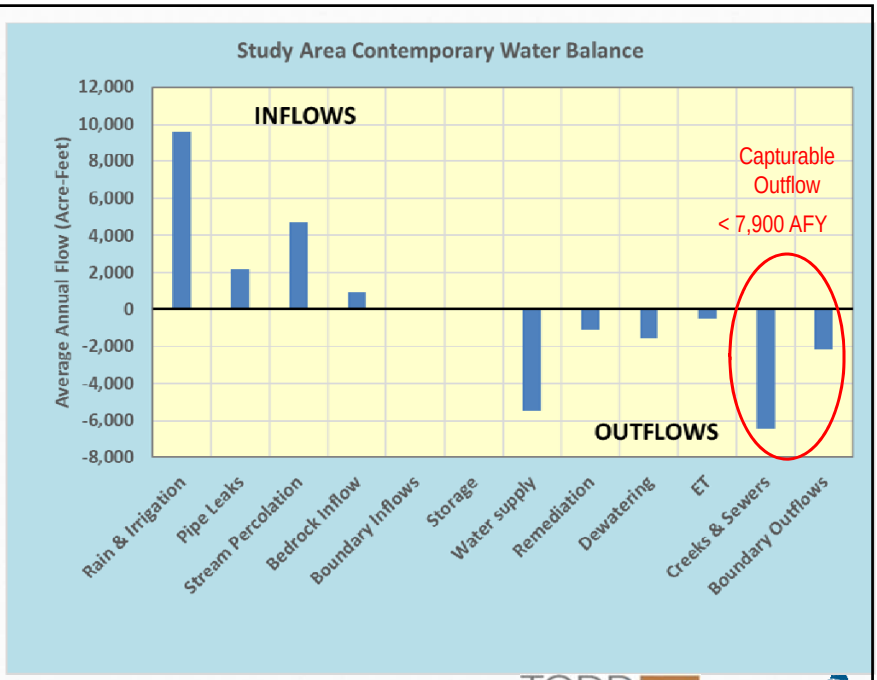
Contemporary Water Balance

- Capturable Outflow does not consider potential negative impacts



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Preliminary Yield Based on Capturable Outflow less Other Considerations

Current outflow	7,800 AFY
Minus outflow required for habitat and to prevent intrusion	-2,900
Subtotal	4,900
Reserve half for neighboring purveyors	÷ 2
Approximate yield available to Palo Alto	2,500 AFY

- Groundwater modeling proposed to refine preliminary yield and assess potential negative impacts

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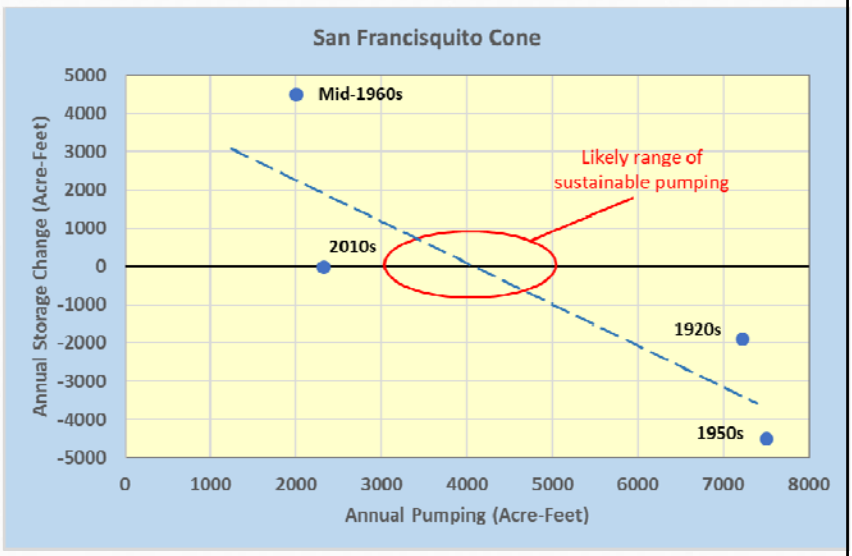
Yield Based on Practical Rate of Withdrawal

- The scatter reflects inaccuracies in estimating pumping and storage change and real differences in amounts of recharge among the historical periods.



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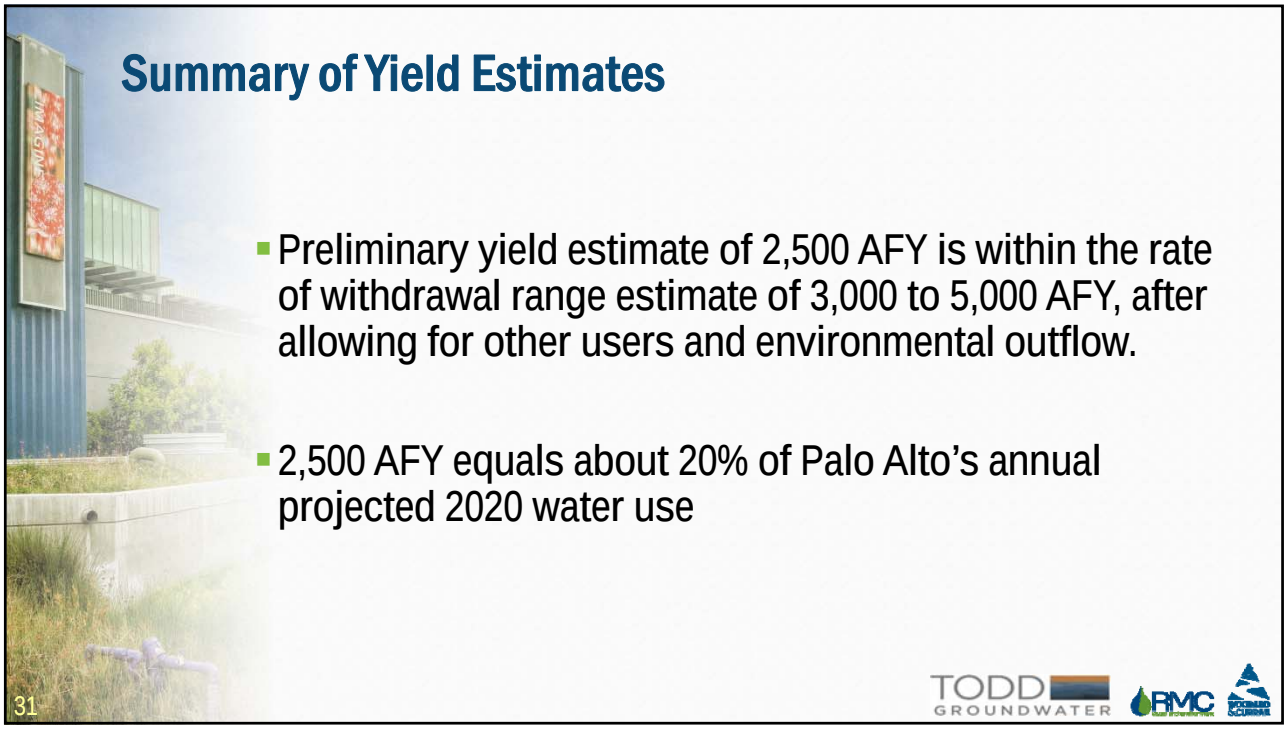
Summary of Yield Estimates
Preliminary yield estimate of 2,500 AFY is within the rate of withdrawal range estimate of 3,000 to 5,000 AFY, after allowing for other users and environmental outflow.
2,500 AFY equals about 20% of Palo Alto's annual projected 2020 water use
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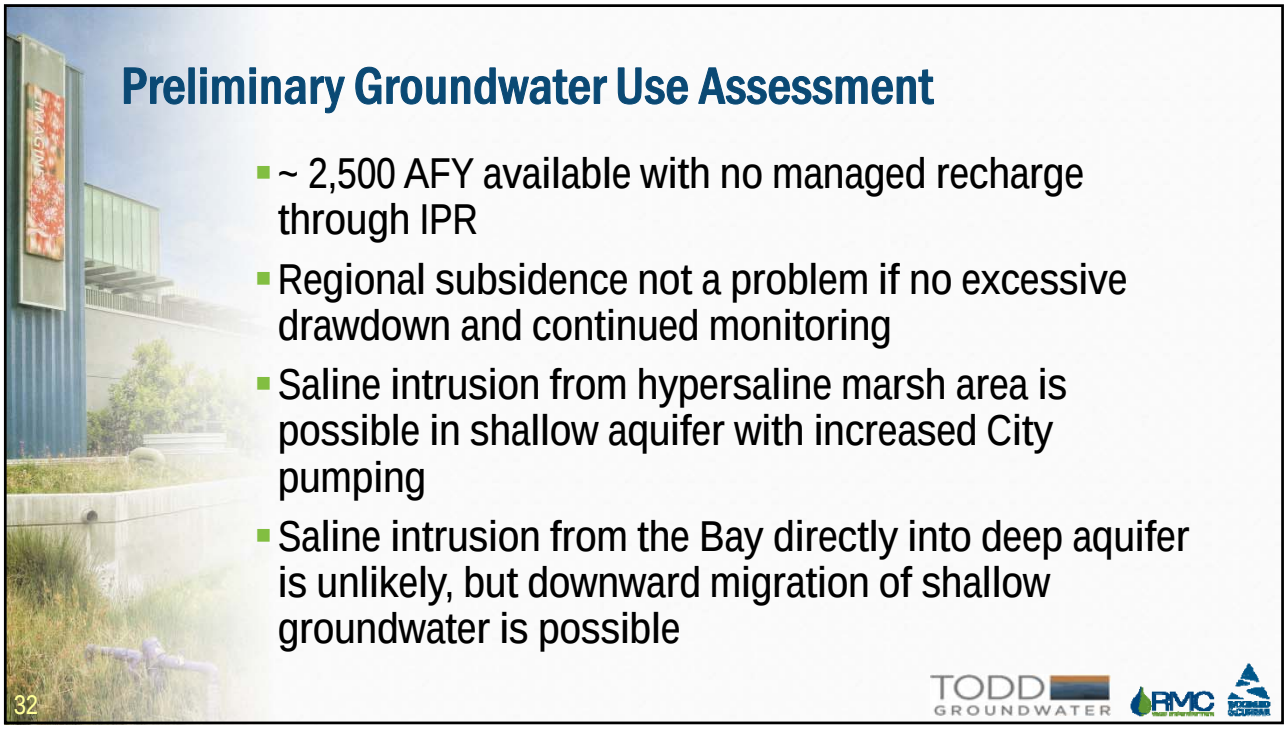
TODD GROUNDWATER
RMC


Preliminary Groundwater Use Assessment
~ 2,500 AFY available with no managed recharge through IPR
Regional subsidence not a problem if no excessive drawdown and continued monitoring
Saline intrusion from hypersaline marsh area is possible in shallow aquifer with increased City pumping
Saline intrusion from the Bay directly into deep aquifer is unlikely, but downward migration of shallow groundwater is possible
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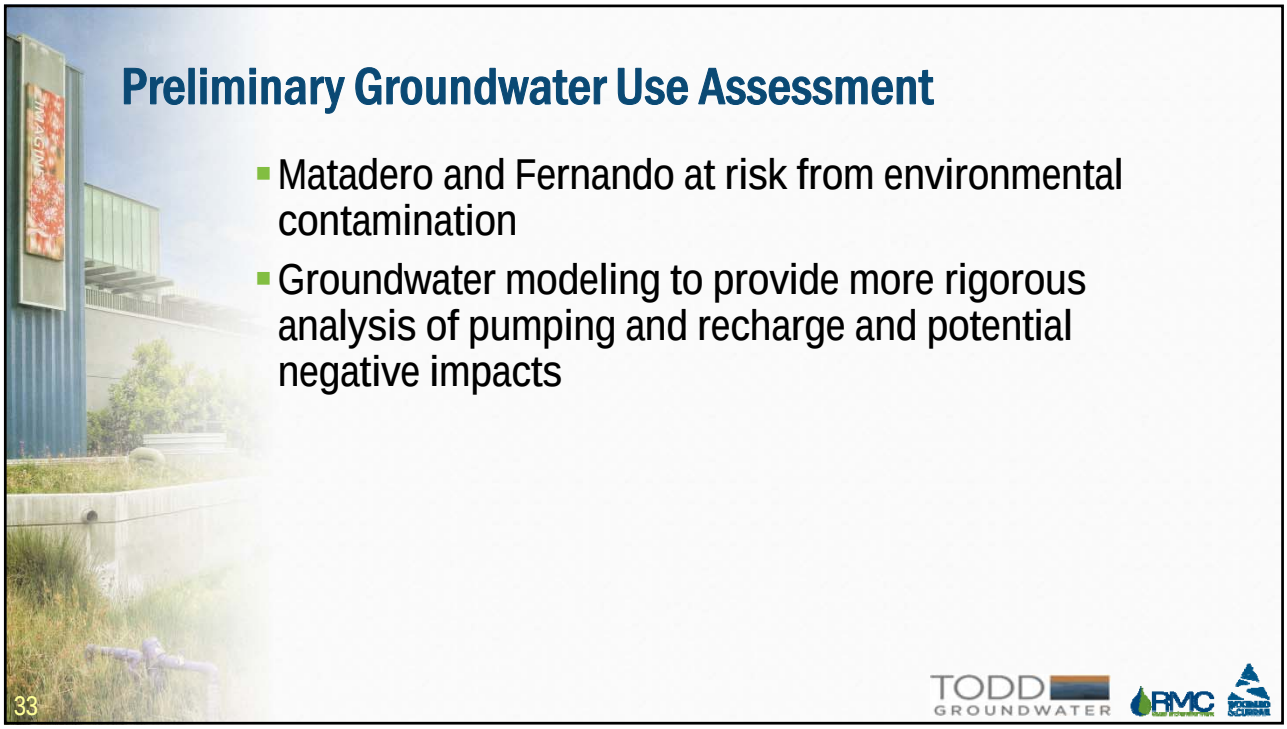
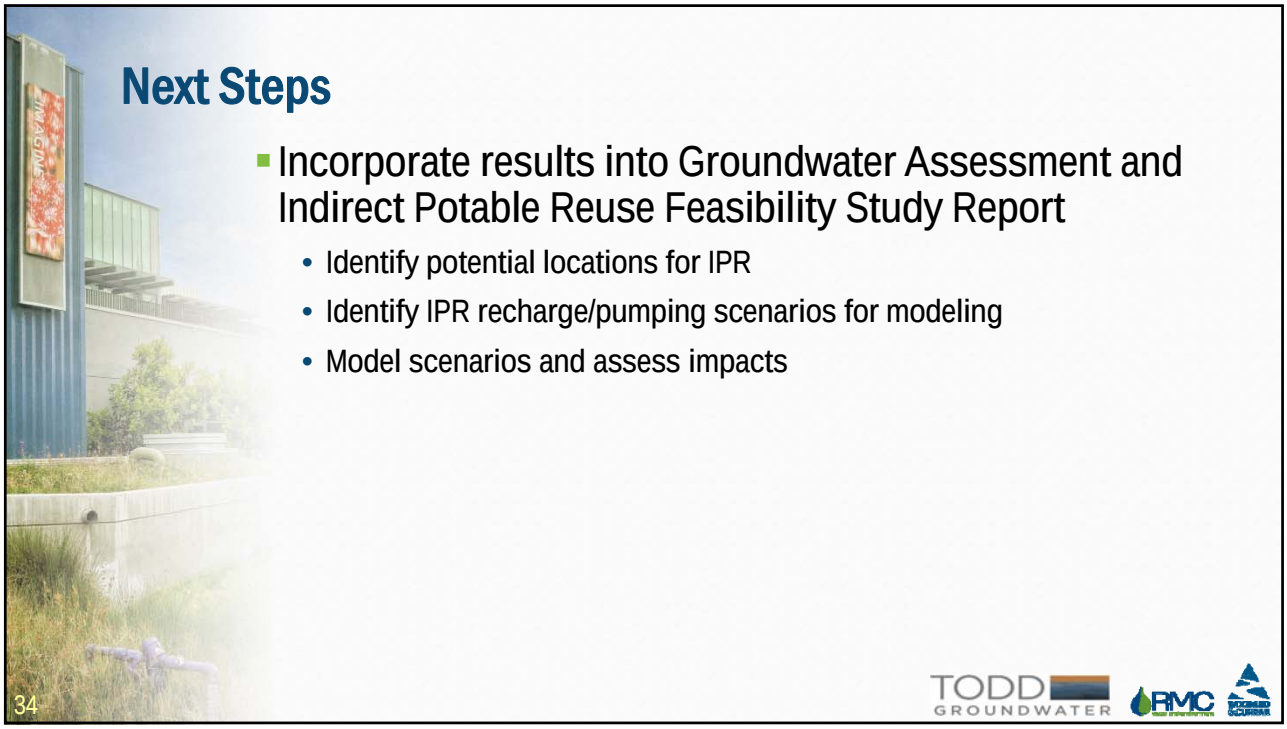
TODD GROUNDWATER
RMC


Preliminary Groundwater Use Assessment
Matadero and Fernando at risk from environmental contamination
Groundwater modeling to provide more rigorous analysis of pumping and recharge and potential negative impacts
33
TODD GROUNDWATER
RMC


Next Steps
Incorporate results into Groundwater Assessment and Indirect Potable Reuse Feasibility Study Report
Identify potential locations for IPR
Identify IPR recharge/pumping scenarios for modeling
Model scenarios and assess impacts
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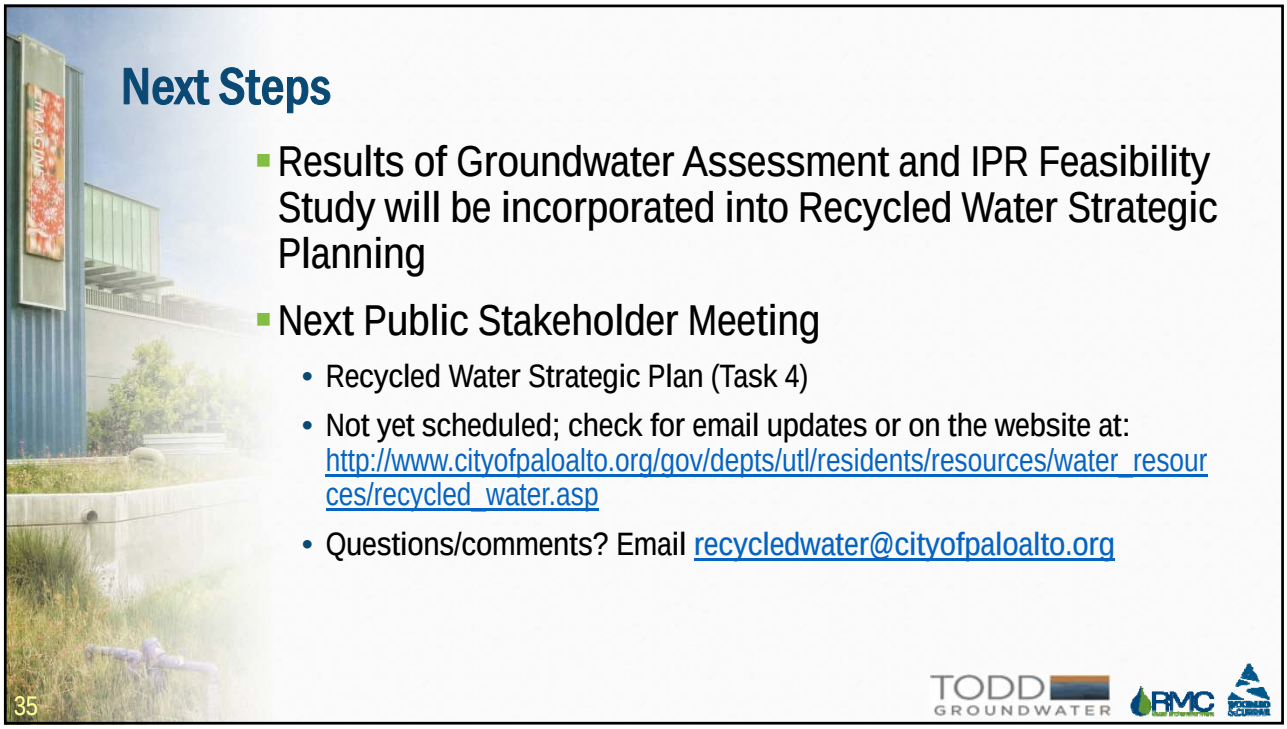
TODD GROUNDWATER
RMC


Next Steps
Results of Groundwater Assessment and IPR Feasibility Study will be incorporated into Recycled Water Strategic Planning
Next Public Stakeholder Meeting
Recycled Water Strategic Plan (Task 4)
Not yet scheduled; check for email updates or on the website at: http://www.cityofpaloalto.org/gov/depts/utl/residents/resources/water_resources/recycled_water.asp
Questions/comments? Email recycledwater@cityofpaloalto.org
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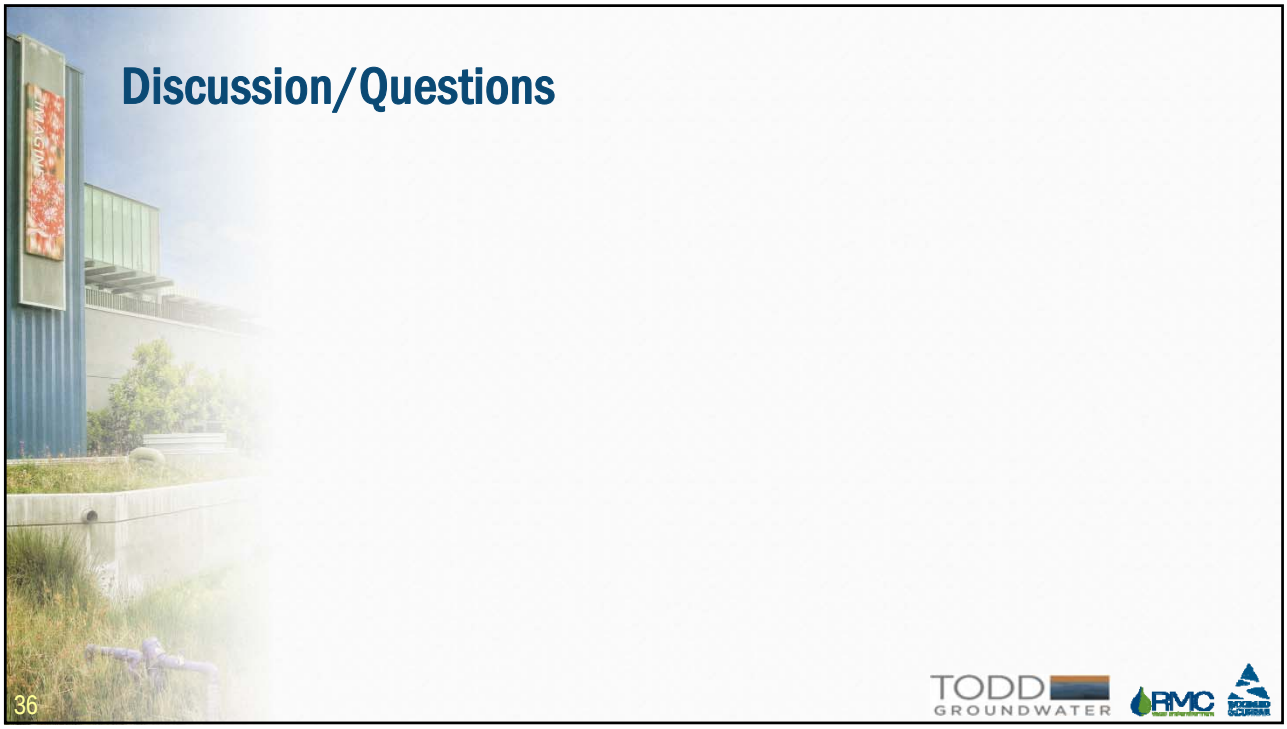
TODD GROUNDWATER
RMC


Discussion/Questions
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RMC