Santa Margarita Basin Water Budget

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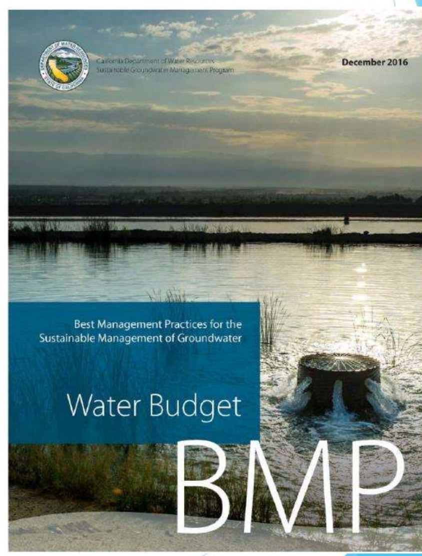
Suggested Reading for Water Budgets

- CA CCR §354.18
- Best Management Practices
  https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-4-Water-Budget_ay_19.pdf



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These are Best Management Practices that has DWR has provided to help guide water budget development

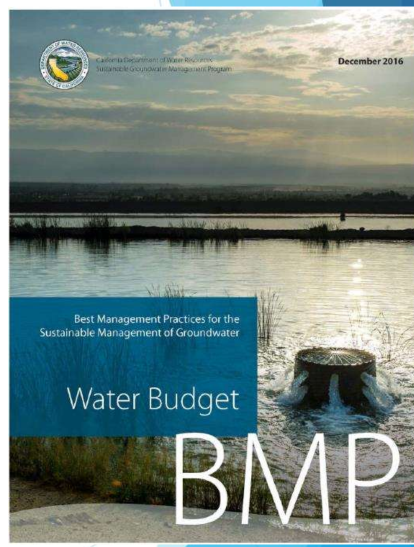
Objectives are to understand:

- What a water budget is and what its components are in the Santa Margarita Basin
- What the GSP requirements are for water budgets
- The overall Basin water budget and which areas have had the greatest water budget changes
- The water budget for the subarea with the greatest changes

SGMA Water Budgets

CA CCR §354.18 & BMP document

- Water budget must include:
  - Inventory of all inflows and outflows, not just net values
  - Summary of both groundwater budget and surface water budget
  - Water budgets shown as annual estimates, by water year (no seasonal variation)
  - Annual and cumulative changes in groundwater storage
  - Estimate of groundwater overdraft (if applicable)
  - Estimate of sustainable yield



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Key Items to Remember for GSP Water Budgets

- Only basin-wide is required, but we will also include subarea budgets
- Water Budget time frames
  1. Historical conditions (1985 – 2018)
  2. Current conditions (2010 – 2018)
  3. Projected conditions over the 50-year planning and implementation horizon (including climate change)
- A balanced water budget does **not** prove sustainability; it is only one component that helps identify aquifer interactions (Undesirable Results defines sustainability)

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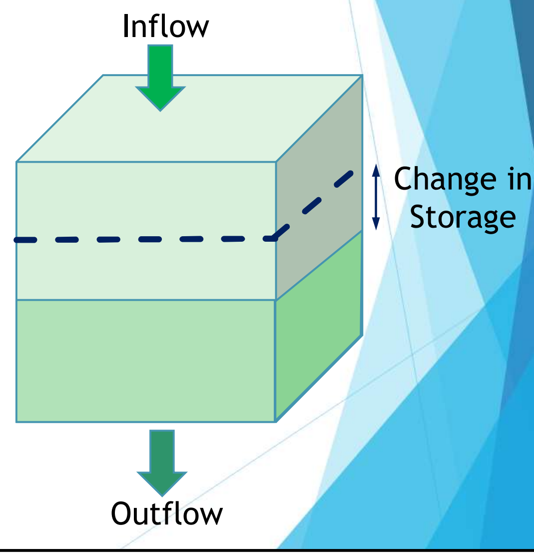
This presentation will only include water budget information for the historical and current periods. Once the future model simulation has been developed with PMAs, the projected water budget will be developed.

What is a Water Budget?
The Basic Water Budget of a Box

Pour water into the top of a box, and let water seep out the bottom

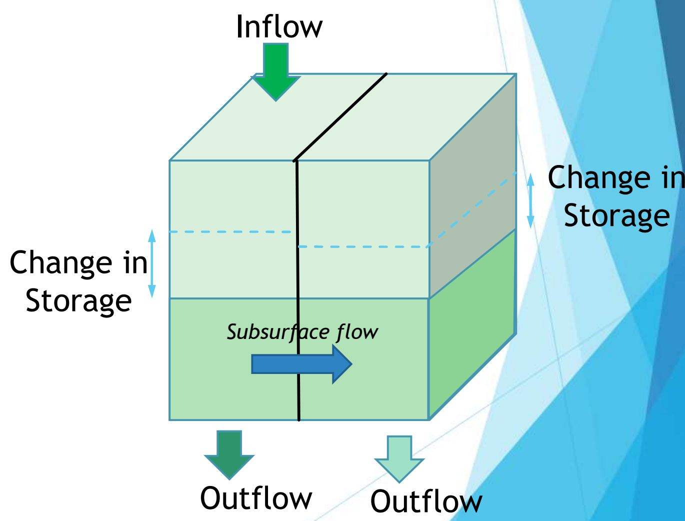
- Inflow – Outflow = Change of Storage
- Change of Storage ~ Change in Groundwater Level

But what if we know water is poured into only one half of the box?



Split the Box in Half: Two Water Budgets

- Each half gets its own water budget
- Groundwater flows from one half to the other half
  - Flow out of left cube equals flow into right cube
  - Groundwater budgets are linked through this flow



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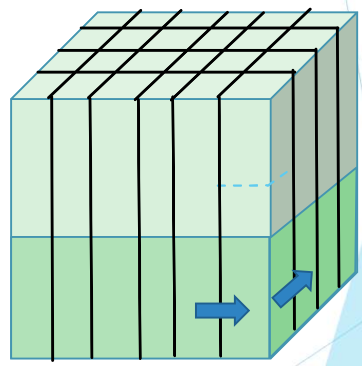
Continue to Split the Box – A Numerical Model!

- Many cubes, each with its own water budget
- All water budgets are connected by flow between cubes
  - Six sides
  - Six flows in or out of the cube



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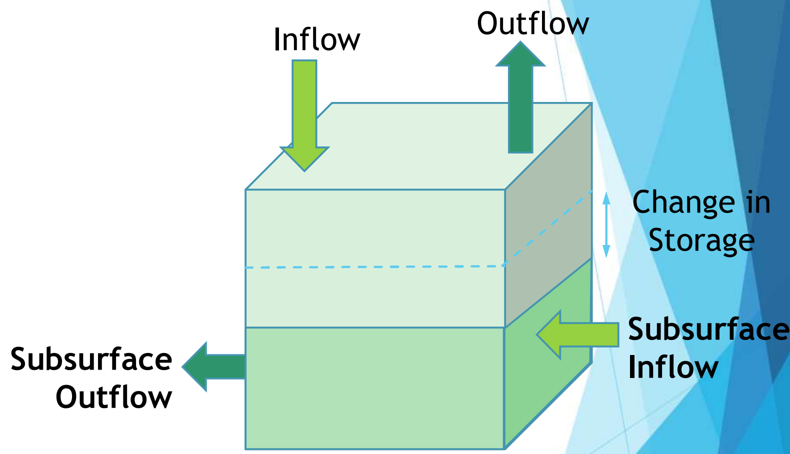
So Why Does it Seem So Complicated?

Inflow
- Percolation of precipitation
- Streambed recharge
- Return flow from irrigation
- Return flow from septic systems and water losses
- Foothills
- Subsurface inflow

Outflow
- Evapotranspiration
- Well pumping
- Discharge to Creeks
- Springs
- Subsurface outflow



Estimates of All of These in Every Model Cell - Then Aggregate at the Subarea Level

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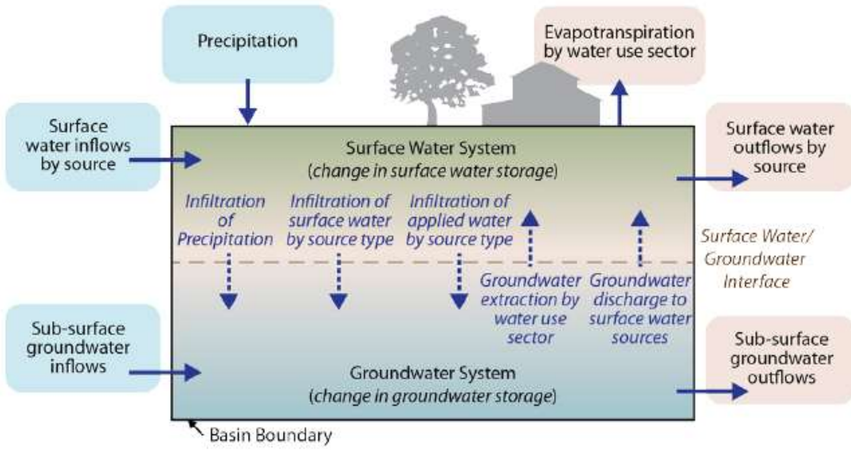
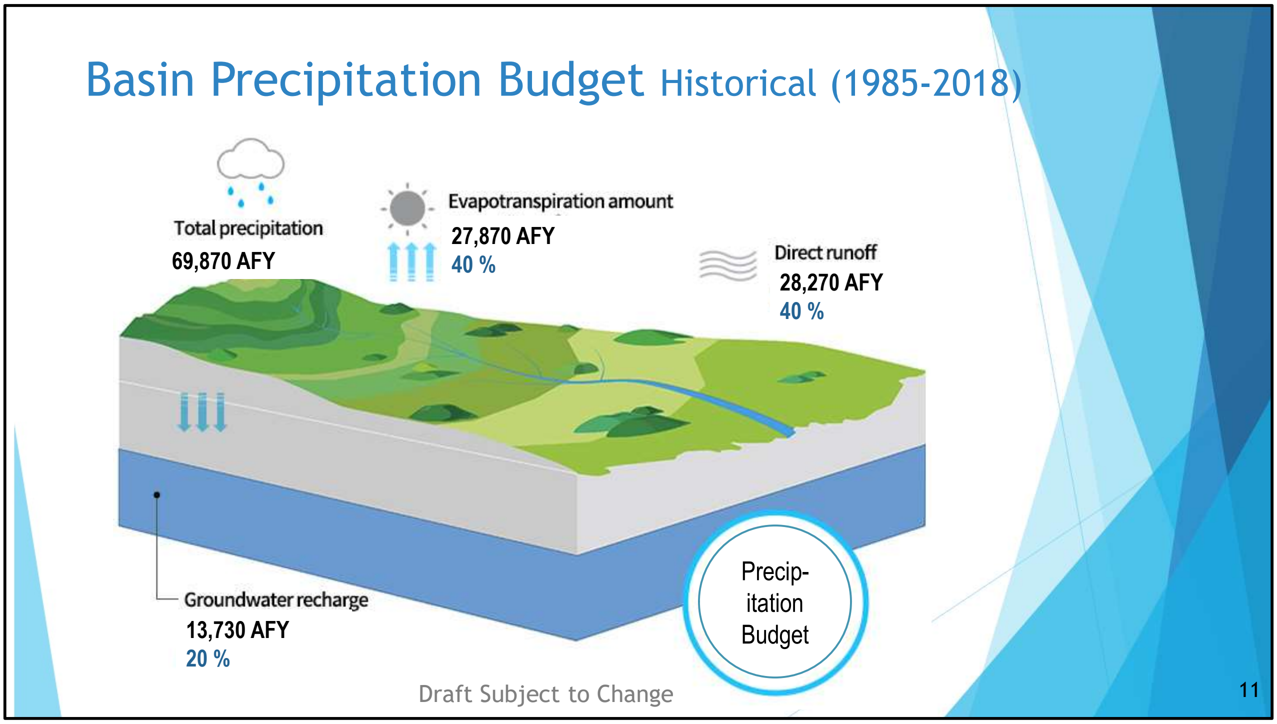
There are many items to track and many are inter-dependent, Many are difficult to estimate. The best tool to develop a water budget is a groundwater model.

Water Budget Components



From: Water Budget BMP, California Department of Water Resources, 2016



The precipitation budget accounts for all the rainfall that falls in the Basin. Evapotranspiration and runoff are roughly equal. 20% of groundwater recharge is high and is due to the permeable nature of the Santa Margarita Sandstone. Other basins typically have groundwater recharge of 5 – 10% of precipitation.

Summary of Surface Water Budget Components for Santa Margarita Basin

Surface Water Inflows

- Stream inflows from outside of basin
- Overland runoff (from precipitation)
- Groundwater discharge to streams

Surface Water Outflows

- Streambed recharge to groundwater
- Streamflow out of the basin
- ~~Direct stream diversions~~
- ~~Evaporation~~

Those components that have stikethroughs are not included because they are very small and also difficult to determine.

Summary of Groundwater Budget Components for Santa Margarita Basin

Groundwater Inflows

- Deep percolation (infiltration) of precipitation
- Deep percolation (infiltration) of applied irrigation water (or irrigation return flows)
- Streambed recharge to groundwater
- System loss return flows
- Septic system return flows
- Subsurface inflows from adjacent basins

Groundwater Outflows

- Riparian evapotranspiration
- Groundwater pumping (urban, domestic, quarry & agricultural)
- Groundwater discharge to streams and springs
- Subsurface outflows to adjacent basins

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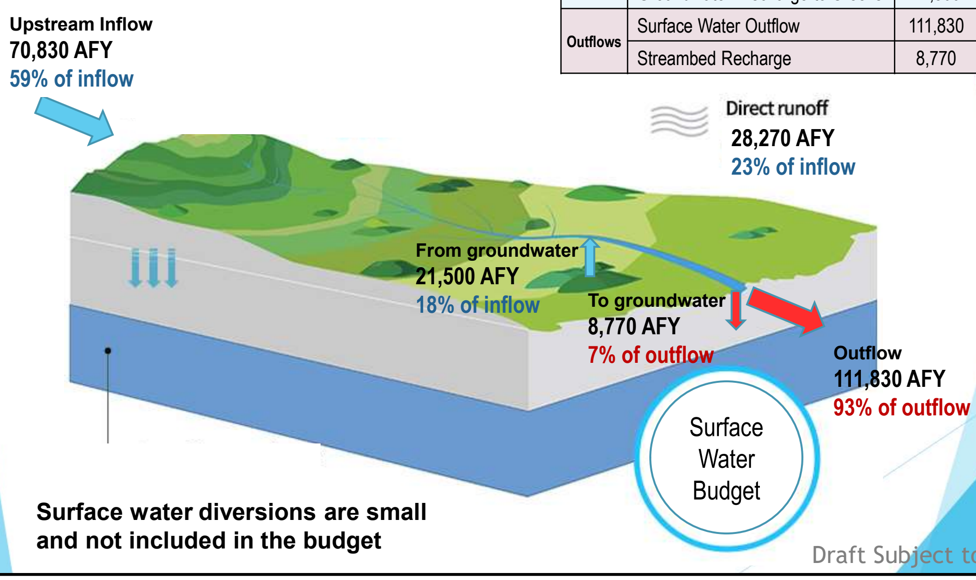
These are the groundwater inflow and outflow components that are included in the groundwater model and groundwater water budget

Surface Water Budget

Historical (1985-2018)

	Components	Historical 1985-2018		Current 2010-2018	
Inflows	Surface Water Inflow	70,830	59%	68,460	59%
	Runoff	28,270	23%	26,960	23%
	Groundwater Discharge to Creeks	21,500	18%	20,250	18%
Outflows	Surface Water Outflow	111,830	93%	106,960	92%
	Streambed Recharge	8,770	7%	8,840	8%



Surface water diversions are small and not included in the budget

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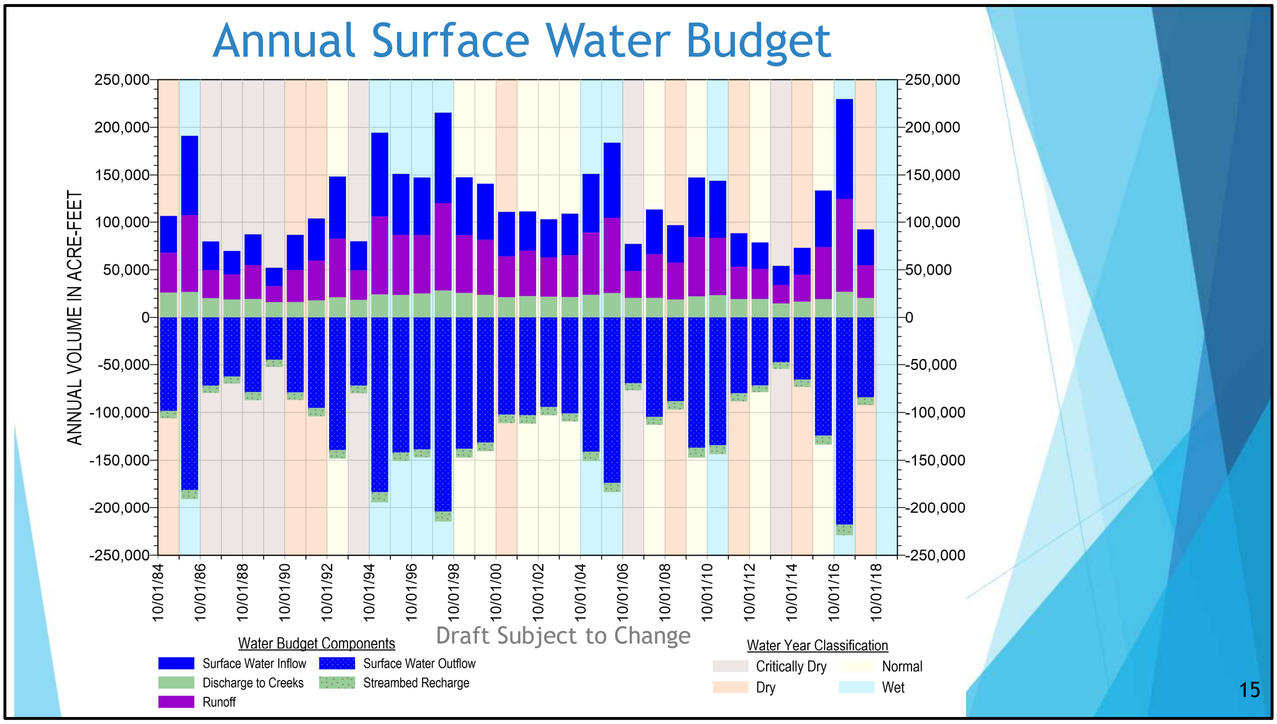
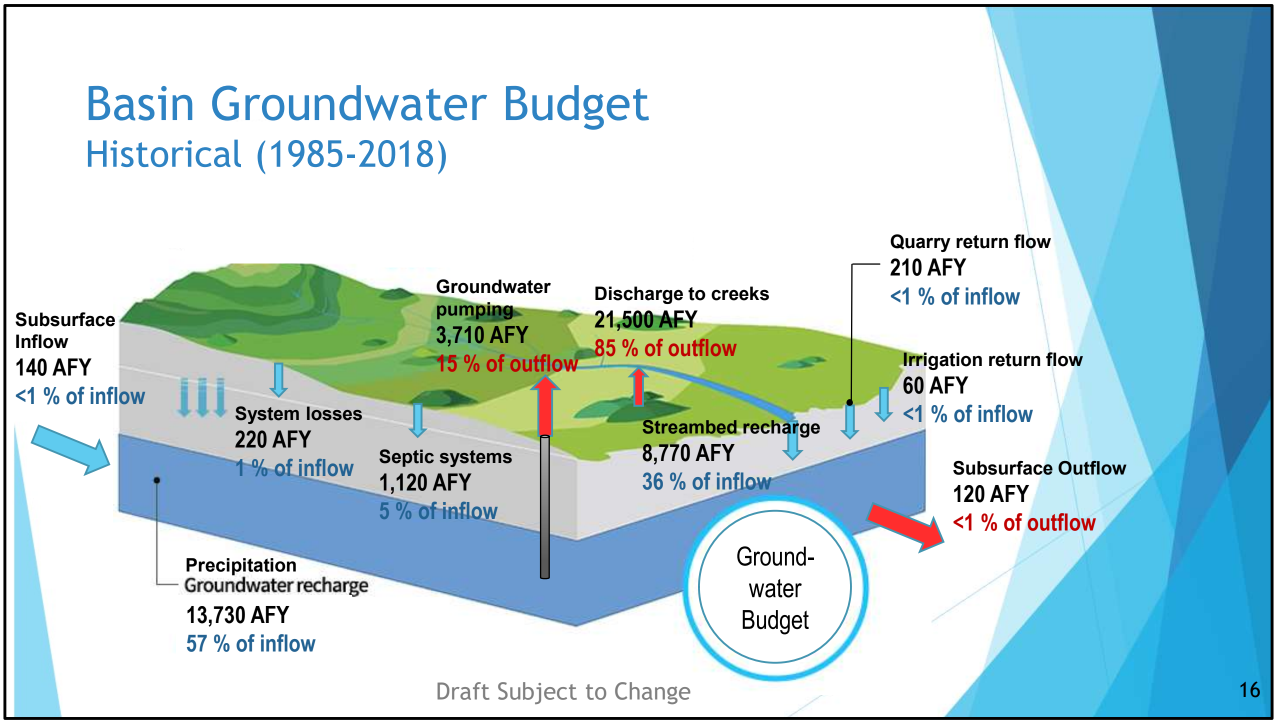
The average annual surface water budget from 1985-2018 is displayed on the graphic. Very similar distribution for current conditions from 2010 – 2018 but less surface water inflows overall



The water year type strongly influences the inflows and outflows. There is a net groundwater discharge to creeks (discharge to creeks less streambed recharge).



The average annual groundwater budget from 1985-2018 is displayed on the graphic with all the inflow and outflow components. The majority of groundwater outflows are to creeks and streams (85%) with only 15% due to groundwater pumping. All return flow components contribute ~7% in groundwater inflows. Most recharge to groundwater is from precipitation and streambed recharge.

Basin Groundwater Budget
Historical vs. Current in AFY

	Components	Historical 1985-2018		Current 2010-2018	
Inflows	Precipitation Recharge	13,710	57%	13,140	56%
	Subsurface Inflow	140	<1%	130	<1%
	System Losses	220	1%	200	1%
	Septic Return Flow	1,120	5%	940	4%
	Quarry Return Flow	210	1%	20	<1%
	Streambed Recharge	8,770	36%	8,840	38%
	Irrigation Return Flow	60	<1%	60	<1%
Outflows	Groundwater Pumping	3,710	15%	2,970	13%
	Subsurface Outflow	120	<1%	110	<1%
	Groundwater Discharge To Creeks	21,500	85%	20,250	87%
Storage	Cumulative Change in Storage	-36,840		70	

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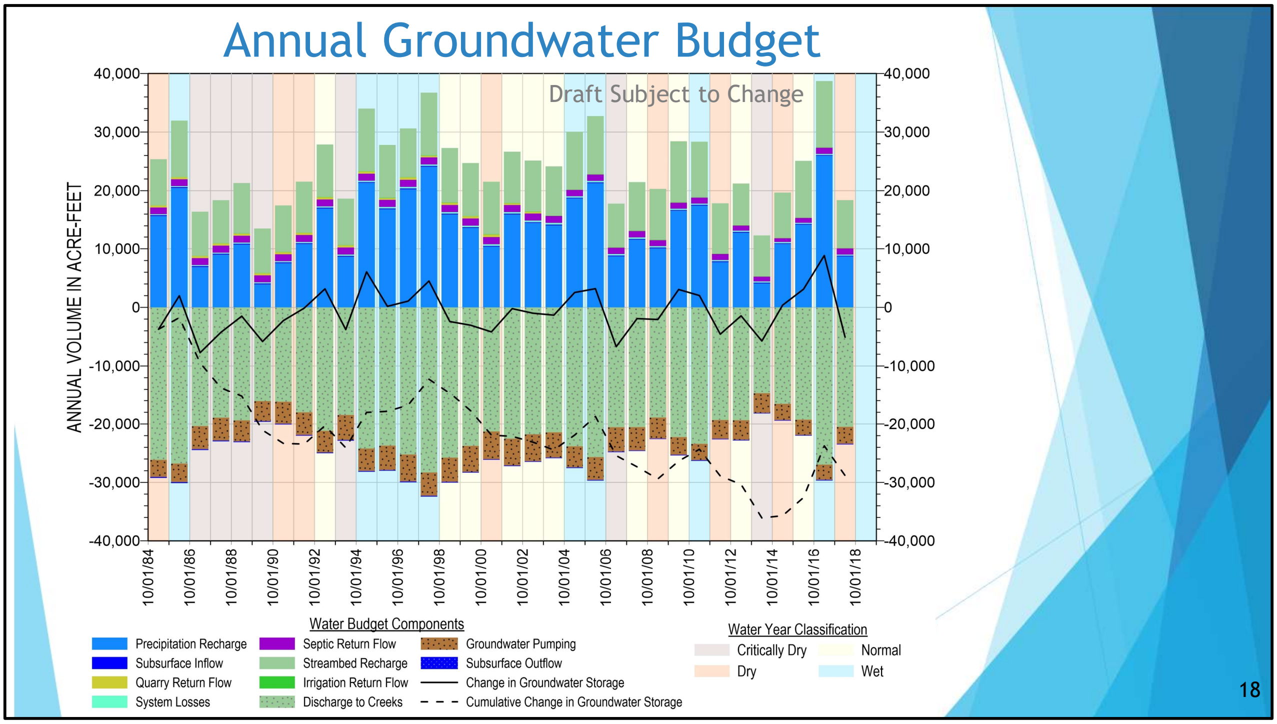
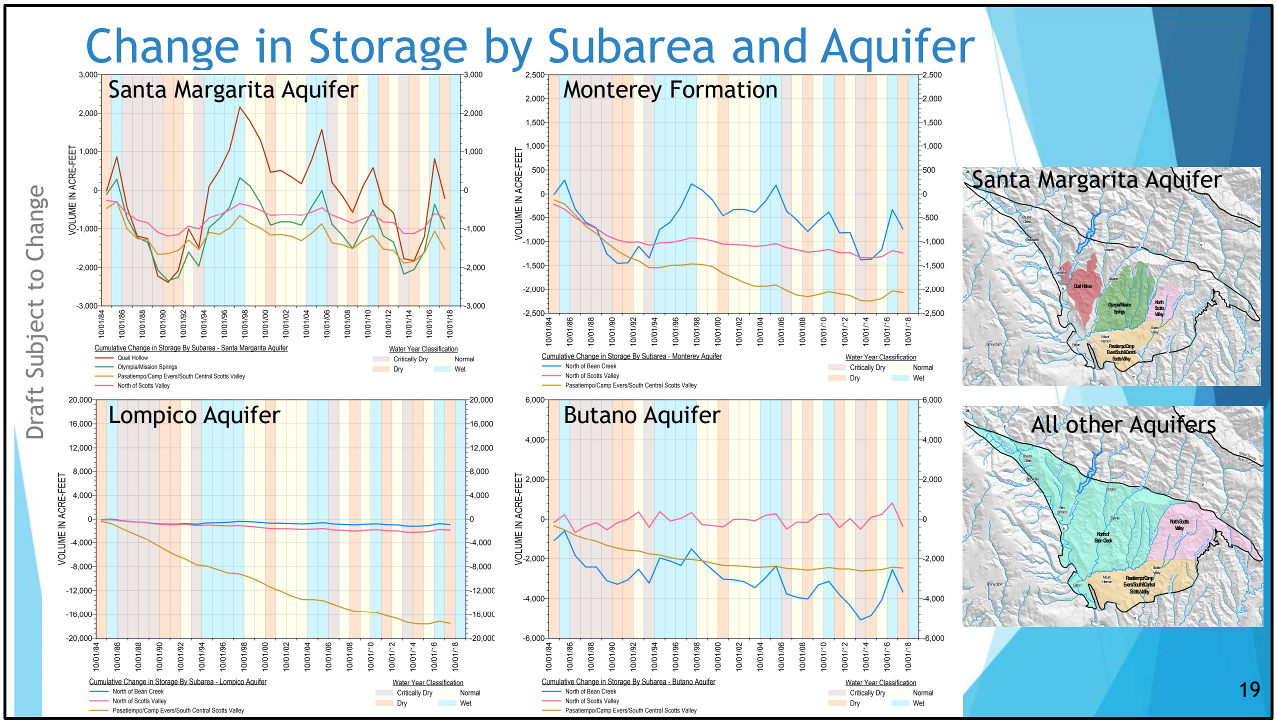
Average annual basin groundwater budget for historical and current periods in acre-feet per year. Since 2010, sources of groundwater inflow are overall lower and there has been less pumping and groundwater discharge to creeks. The distribution of components generally remains the same. The change of storage from 1985 – 2018 is significant but fortunately the long-term decline appears to have stopped and there has been a cumulative modest increase since 2010.



Inflows to groundwater are, like surface water, strongly influenced by the water year type. Many of the features described on the previous slide are also evident on this chart. The cumulative change in storage (dashed line) shows that although there have been some historical years with increased storage (solid line that is above the zero line on the y-axis), the overall long-term decline has been significant.



Each of these charts shows the cumulative change in groundwater in storage for each aquifer. Apart from the Quail Hollow subarea, there is an overall loss of groundwater in storage in the Santa Margarita aquifer. This includes the Olympia subarea where there appears to be a 20-year decline. The Monterey Formation, although not a productive aquifer, is included since it occurs between two principal aquifers and is impacted in changes in their groundwater in storage. The subareas south of Bean Creek have experienced an overall loss of groundwater in storage, while north of Bean Creek changes in storage correspond with precipitation recharge since it is exposed at the surface.

The Lompico aquifer has the greatest loss of storage over time in the Pasatiempo/Camp Evers/South & Central Scotts Valley subarea as expected because of declining groundwater levels in this area. The other subareas in comparison have had little change in storage over time.

The Butano aquifer has also had a loss of groundwater in storage. It is surprising that the subarea north of Bean Creek (blue line) has an overall loss since there are no wells pumping that deep. The fluctuations correspond to changes in storage in response to precipitation recharge since there are surface exposures of Butano aquifer along the Basin's northern boundary at the Zayante-Vergeles fault.

These charts show that the subarea with the greatest decline in groundwater in storage is the Pasatiempo/Camp Evers/South & Central Scotts Valley. The next set of slides will focus on the groundwater budget for just this subarea.

Pasatiempo/Camp Evers/South & Central Scotts Valley Subarea Groundwater Budget in AFY

	Components	Historical 1985-2018		Current 2010-2018	
Inflows	Precipitation Recharge	2,080	44%	1,980	47%
	Subsurface Inflow	70	1%	50	1%
	Return Flows (System Losses, Septic Systems, Quarry, Irrigation)	510	11%	290	7%
	Streambed Recharge	400	8%	390	9%
	Flow from Other Subareas	1,690	36%	1,520	36%
Outflows	Groundwater Pumping	2,100	39%	1,520	34%
	Subsurface Outflow	30	<1%	20	<1%
	Groundwater Discharge To Creeks	1,910	35%	1,700	38%
	Flow to Other Subareas	1,410	26%	1,200	27%
Storage	Cumulative Change in Storage	-23,580		-2,020	

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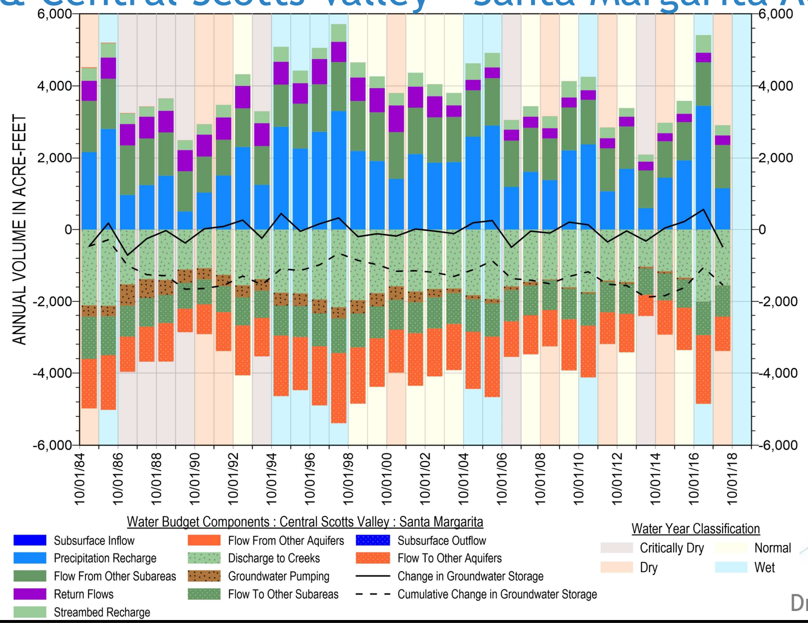
Average annual Pasatiempo/Camp Evers/South & Central Scotts Valley Subarea groundwater budget for historical and current periods in acre-feet per year. Flow from other subarea is from the North Scotts Valley subarea. Flows to other subarea is to North of Bean Creek subarea, and flow to other aquifers is primarily to the Monterey Formation. The current period has a much lower cumulative decrease in groundwater in storage than the historical period. 64% of the historical decline in storage occurred in this subarea.

Groundwater Budget for the Pasatiempo/Camp Evers/South & Central Scotts Valley - Santa Margarita Aquifer



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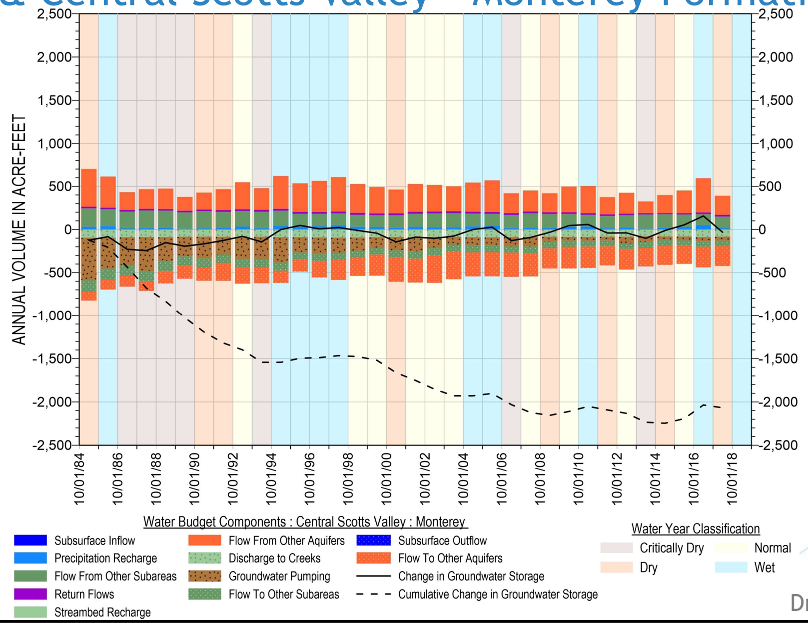
Of the 4 charts in this series showing the Pasatiempo/Camp Evers/South & Central Scotts Valley subarea groundwater budget by aquifer, the Santa Margarita chart has the greatest volumes of inflows and outflows because it is recharged more readily than the others. Note the different y-axis scales on the four charts. The decline in groundwater in storage mostly occurred in the 1980s with the cumulative change very similar in 2018 as it was at the lowest point in 1990, which indicates there has been no on-going loss of groundwater in storage.

Groundwater Budget for the Pasatiempo/Camp Evers/South & Central Scotts Valley - Monterey Formation



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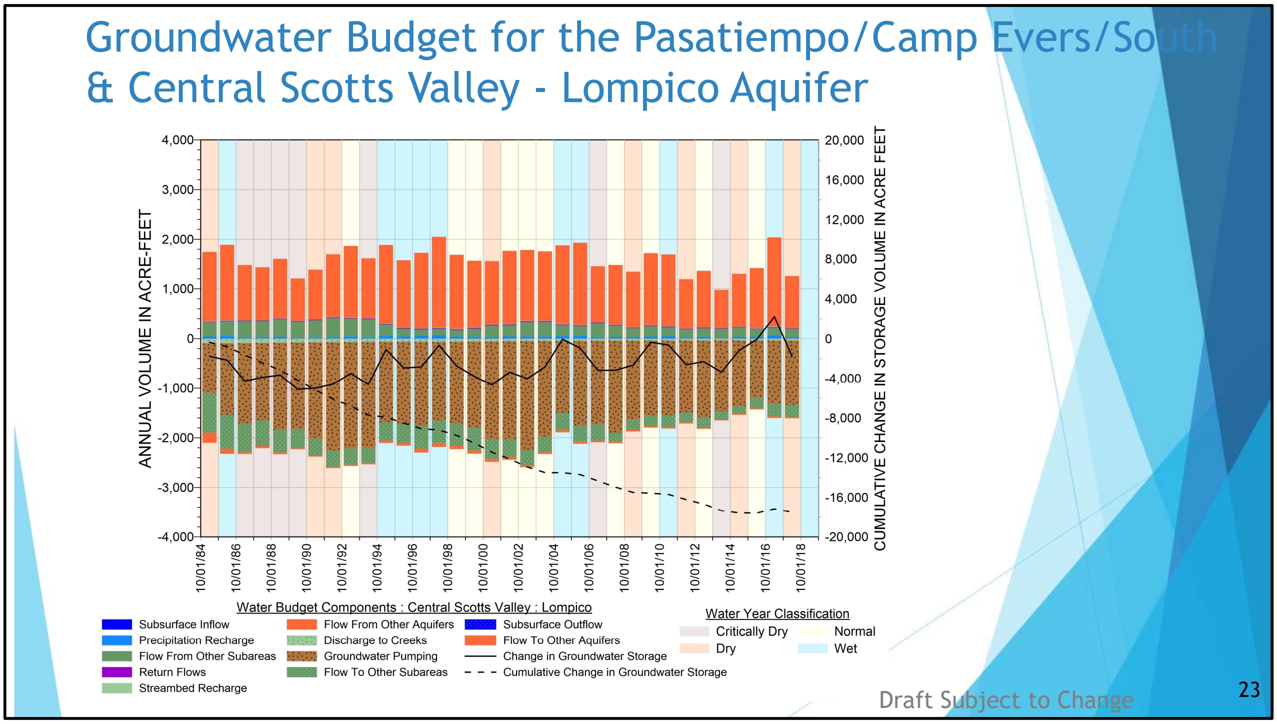
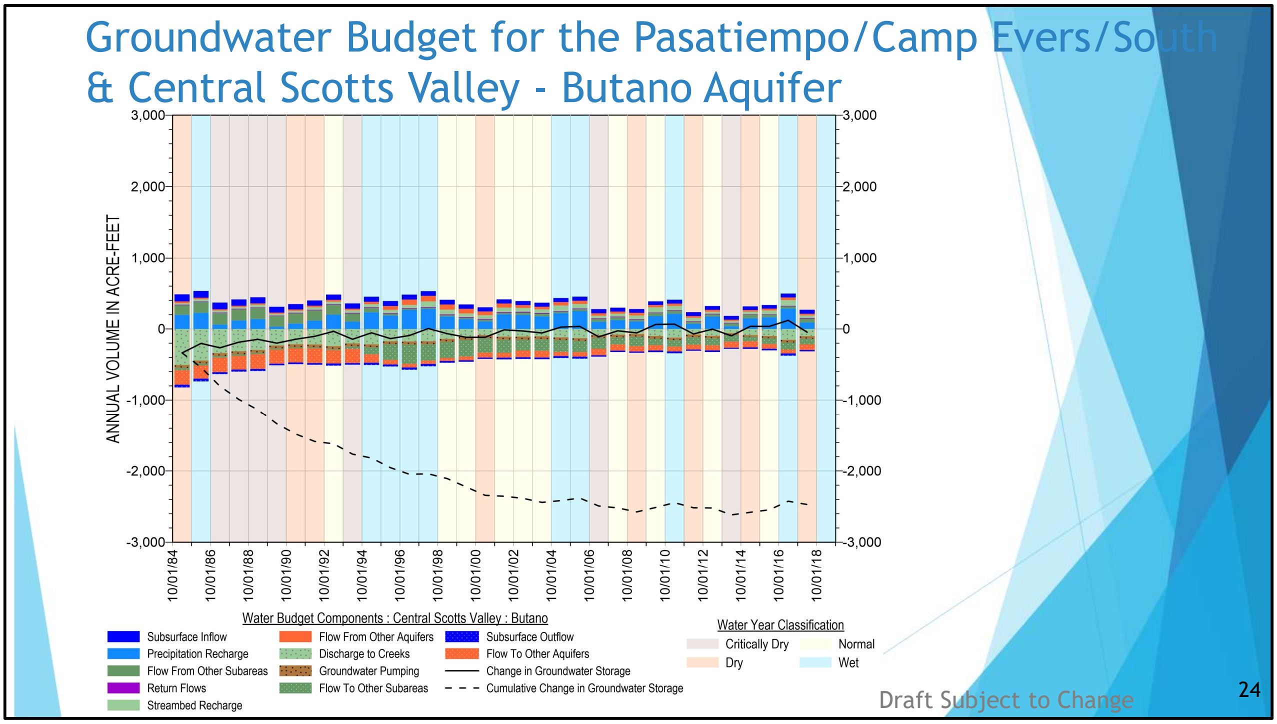
The Monterey Formation is not readily recharged in this subarea as evident by the small volumes. Most its recharge is from the overlying Santa Margarita aquifer. Its decline in groundwater in storage is similar to the Lompico aquifer.



This chart is slightly different to the previous chart in that the cumulative change in groundwater in storage is on a different scall to the bars and annual storage change. This is because the decline is so large that the bars are too small to discern. Groundwater pumping is the component that dominates this chart. It is clear that the amount of pumping has exceeded the inflows which has led to declining groundwater levels and groundwater in storage.



The chart for the Butano aquifer in the Pasatiempo/Camp Evers/South & Central Scotts Valley subarea shows that both flow to other aquifers and creeks has declines as groundwater in storage was depleted. There was also a change from other subareas contributing inflow to the Butano aquifer to there only being flow from the Butano aquifer to other subareas around the in 1995 that corresponds to the end of the 1986 – 1994 drought. The cumulative change in storage line appears to flatten out sooner (2005) than the Lompico aquifer (2015).

Water Budget Highlights

- The current water budget has less total inflows for surface water and groundwater than the historical water budget
- Surface water generated by rainfall falling in the Basin is almost equal to water flowing into the Basin from upstream
- Groundwater inflow to creeks and streams accounts for 18% of basin surface water inflows
- Groundwater flows to creeks and springs accounts for 85% of all groundwater outflows
- Return flows from septic systems, water and sewer system losses, quarry operations, landscape pond leakage, and outdoor irrigation accounts for ~7% of groundwater recharge
- Changes in groundwater in storage mirror changes in groundwater levels observed in wells

Thank you for your participation!