DEPLETION OF INTERCONNECTED SURFACE WATER: A SUSTAINABLE MANAGEMENT INDICATOR

7/23/2020

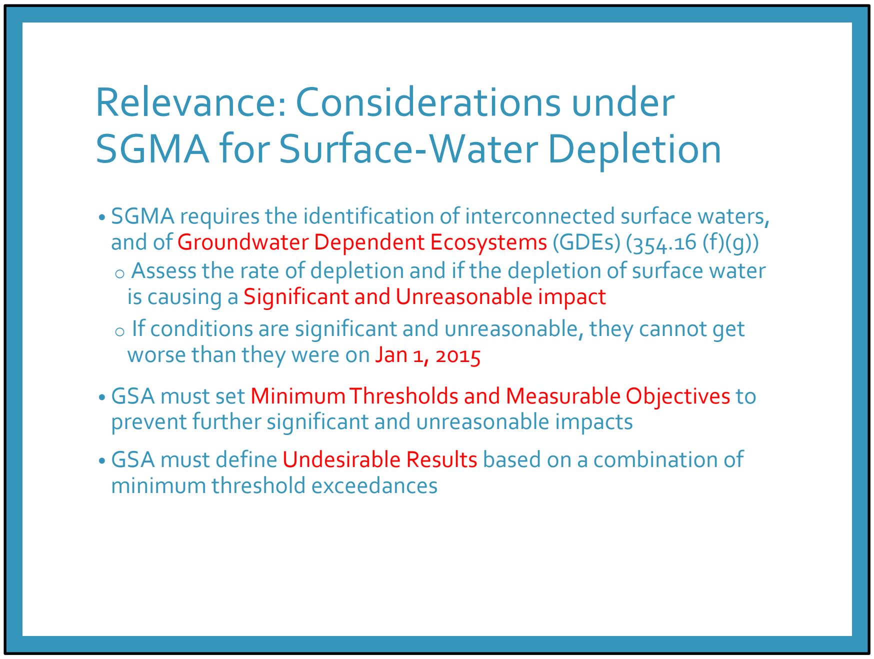
Balance Hydrologics

Analysis of streamflow depletion from groundwater pumping is required under SGMA to establish significant and unreasonable statements and minimum thresholds for sustainable management of the basin aquifers.

Outline

- Relevance of depletion of interconnected surface water
- Conceptual process
  - Identify potential GDEs
  - Identify interconnected surface waters and GDEs influenced by pumping
  - Identify priority species
  - Quantify streamflow depletion
  - Significant and unreasonable statement for depletion of interconnected surface water
  - Approach to minimum thresholds

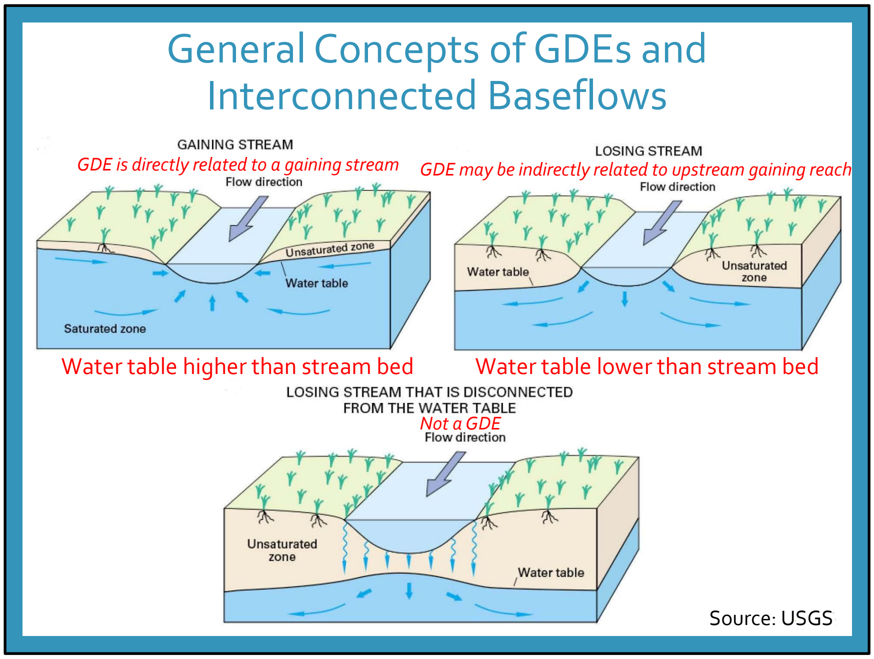
Groundwater Sustainability Agencies (GSAs) must develop and implement Groundwater Sustainability Plans (GSPs) for managing and using groundwater without causing undesirable results. At minimum, each GSP must consider the following six sustainability indicators: 1) significant groundwater-level declines, 2) groundwater-storage reductions, 3) seawater intrusion, 4) water-quality degradation, 5) land subsidence, and 6) surface-water depletion. Our job is to assist the GSA in developing "significant and unreasonable" statements and "minimum thresholds" for basin management. This presentation explains the process we're following to reach an understanding of what significant and unreasonable levels of streamflow are, so as to develop minimum thresholds for the depletion of interconnected surface water indicator.



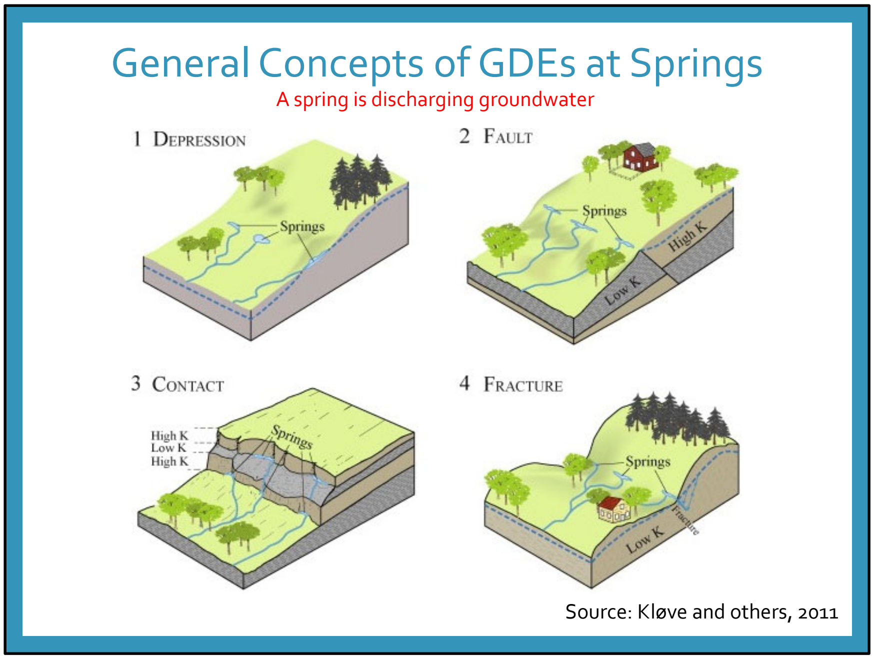
The depletion of interconnected surface waters is one the six sustainable management criteria that must be evaluated under SMGA to evaluate how groundwater management impacts groundwater dependent ecosystems and the species they support.

Groundwater Dependent Ecosystems found in the Santa Margarita Basin were classified into 4 categories:

1. Open water includes features such as lakes and ponds
2. Riverine and riparian includes in-stream habitat, riverine wetlands, on-channels ponds, and other wetland features that occur within the riverine corridor
3. Springs are points of discharging groundwater that can support adjacent wetlands
4. Other groundwater dependent wetlands includes quarry floor sites and seep/seep complexes



Under SMGA we are only concerned with areas where ecosystems are supported by groundwater. Specifically, SGMA defines “interconnected surface water” as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. Gaining streams are those where the water table is higher than the streambed and groundwater is supporting instream flow. Losing streams are those where the water table is lower than the streambed and instream flow may infiltrate to groundwater. Losing reaches may be areas of groundwater recharge. Areas where the streambed is disconnected from groundwater do not support groundwater dependent ecosystems and thus do not need to be considered under SGMA.

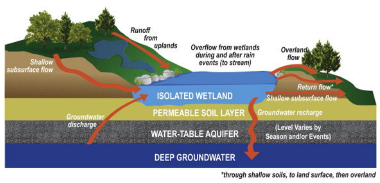


Springs are points where groundwater is discharged. Springs can occur as a result of a few processes:

1. In areas where there is a depression in the topography and the low-lying areas intersect groundwater
2. Where there is a fault and water easily moves along the fault and the fault contact
3. At the contact between two different geologic formation. For example, where the contact between the Santa Margarita (permeable) and the Monterey (less permeable) is exposed.
4. Along fractures within the bedrock

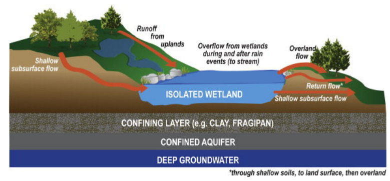
General Concepts of Open water and Other GDEs

GDE



Groundwater connected to feature

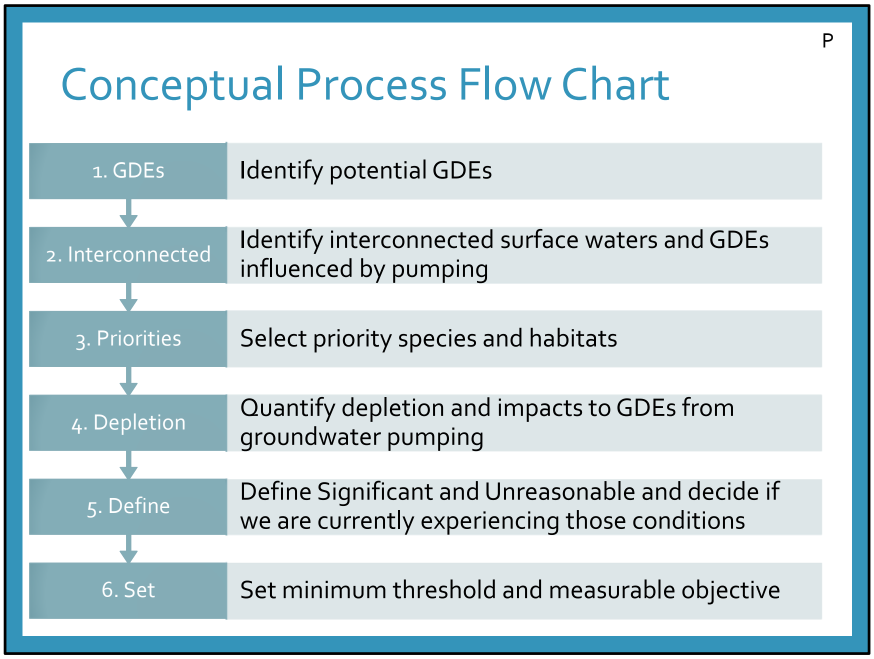
Not a GDE



Groundwater not connected to feature

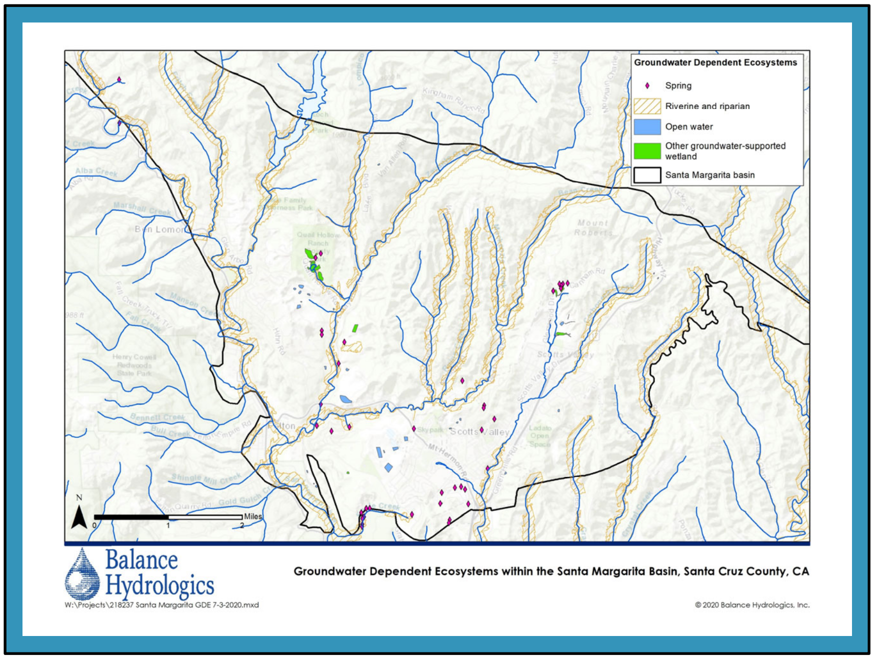
Source: Golden and others, 2014

Open water features, such as ponds and lakes, and other GDEs, such as quarry floors or wetlands, function similarly. When the feature is connected to groundwater, or within the rooting depth of plants, the feature is a GDE. In instances where there is a confining layer beneath the feature, the feature is perched and not connected to groundwater. This is not a GDE. In some quarries the ground has been compacted to create a confining layer, causing the water to be perched, and thus is not a GDE.



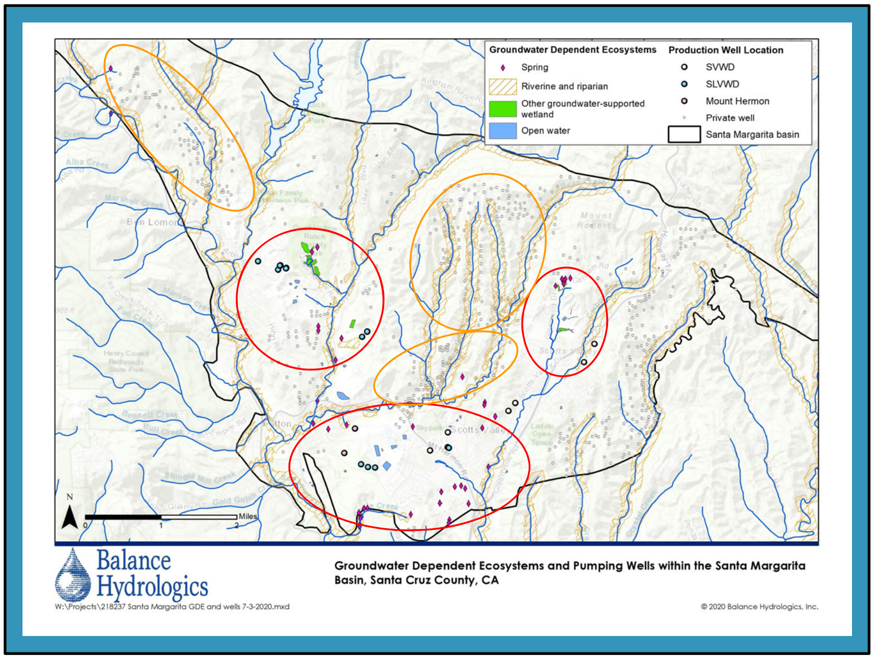
To address the depletion of interconnected surface flow management criteria we will use this process to get to the goal of establishing minimum thresholds and measurable objectives. This process is the same process that was used in the MidCounty GSP.

1. IDENTIFY POTENTIAL GDES

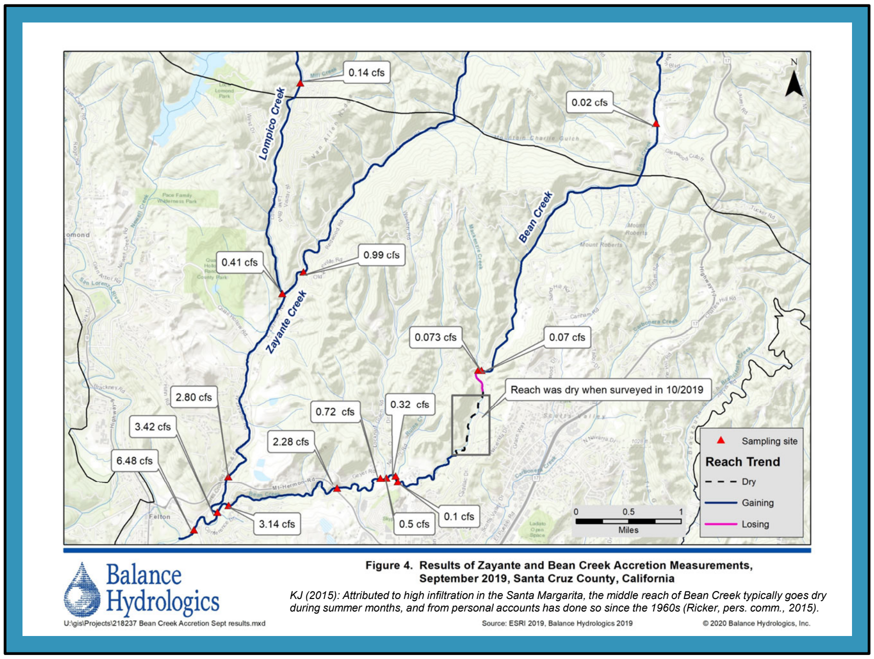


We identified the groundwater dependent ecosystems within the basin from a variety of sources including existing databases (National Wetlands Inventory, National Hydrography Dataset, CALVEG), previous studies (Kennedy Jenks 2015 report), and other known locations (project team). Under SGMA we are required to use the best available data to identify GDEs. We have already done more than that with additional GDE field verification and studies. Work is on-going to continue to identify and evaluate other GDEs within the basin. This includes using aerial imagery to identification potential GDEs, as well as field verification of GDEs.

2. IDENTIFY INTERCONNECTED SURFACE WATERS AND GDES INFLUENCED BY PUMPING



Through the GSP we specifically need to consider GDEs that are influenced by groundwater pumping. This map shows the location of pumping wells and their proximity to GDEs. Areas that are circled in red show the primary areas where GDEs may be impacted by municipal pumping. The areas circled in orange show the areas where GDEs may be impacted by private pumping. As previously mentioned, lower Bean Creek is one of the primary gaining streams in the basin. There are a number of pumping wells that could be impacting this area. The pumping wells located along upper Carbonera Creek are relatively far from the GDEs around the Glenwood Preserve and the Canham road springs. The impact of pumping on those GDEs needs to be further evaluated.



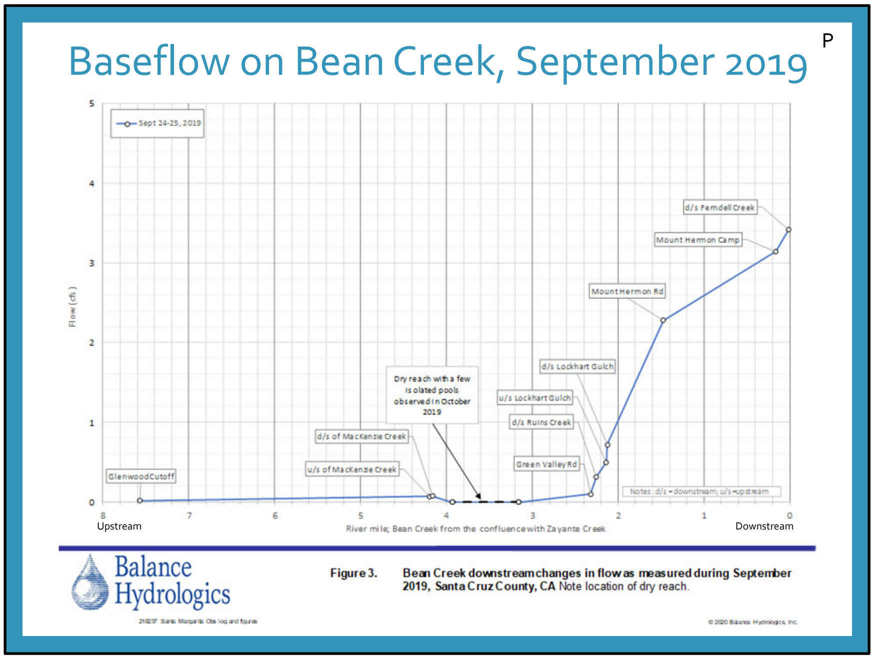
One method of analyzing the surface water groundwater interaction in streams is through an accretion study, which tells us where and how water enters and leaves a stream during low flow conditions. Accretion studies are conducted by measuring changes in flow and specific conductance ("salinity") at various points from downstream to upstream in a stream system on a single day. It also tells us where the aquifer is adding flow to the stream, and where the stream is replenishing the aquifer.

In support of the GSP we conducted accretion measurements along Zayante and Bean Creek during the dry season of 2019 – on May 30-31, July 10, and September 24-25. Water year 2019 was a wet year with annual rainfall 112 percent of mean.

This map shows the results of the accretion measurements from September 24-25. Stream segments in dark blue show areas where the flow was gaining (groundwater is supporting instream flow). Segments in pink show where the flow was losing (instream flow infiltrating to groundwater).

There is one reach within Bean Creek that has historically gone dry. We walked this reach in October, 2019 to document the extents of the dry reach. Depending on the year this dry reach may extend as far upstream as Redwood Glen (approximately one mile upstream of the dry reach surveyed in 2019).

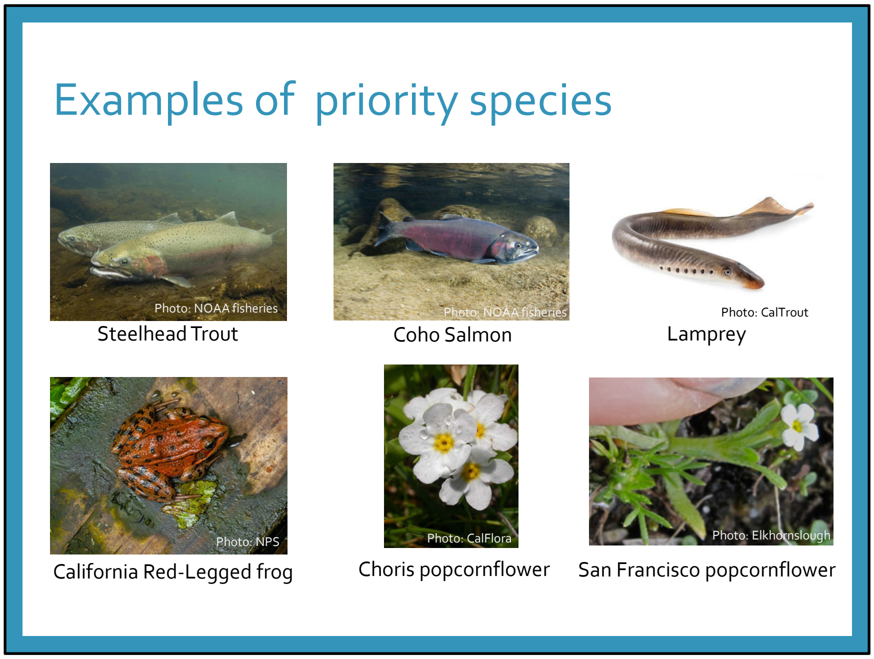
We also just completed accretion measurements on July 7-8, 2020. Water year 2020 was a dry year with annual rainfall of 16.39 inches (approximately 32% of the long-term average) at the SLVWD Boulder Creek rain gage.



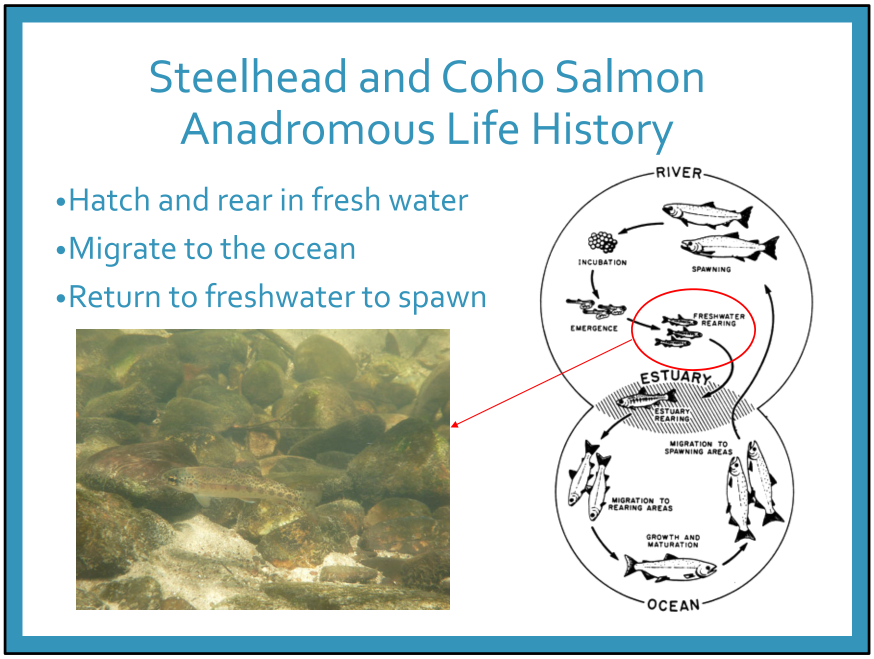
This profile shows baseflow measurements during September 2019 on Bean Creek from upstream (on left) to downstream (on right). If there was no interaction between groundwater and surface water, then the profile between tributaries would be flat. However, in general we see an increase in baseflow along Bean Creek, with the greatest increase in flow near the downstream end of the Creek. This reach has been noted as being one of the largest gaining reaches within the basin.

We also measured flow during May and July of 2019. This allows us to see the seasonal variability of flow. The trends in flow were largely the same during the other times, but with more flow earlier in the season.

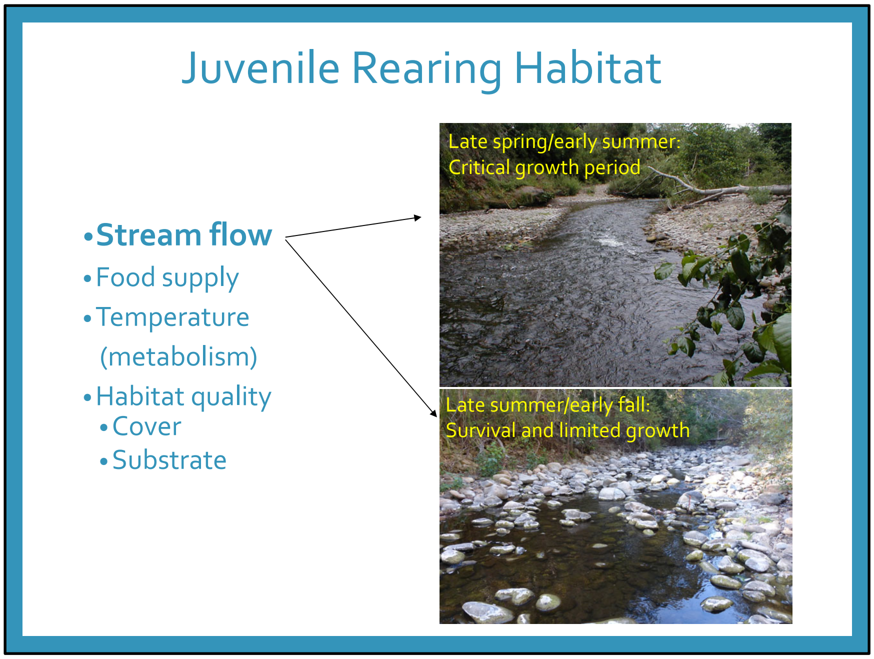
3. SELECT PRIORITY SPECIES AND HABITAT



Species of concern are included as beneficial users of interconnected surface flow. These are examples of priority species. The current list came from the California Natural Diversity Database (CNDDB) with additional updates from the County Biologist. This list will be updated by the Surface Water Technical Advisory Group.



Understanding salmon life history is important for assessing the critical times for maintaining instream flows and evaluating how groundwater (and pumping) could impact salmon habitat. We will briefly talk about steelhead as an example of a beneficial user of surface water. We will focus on the development of juveniles, which occurs from late spring into the fall. We are specifically concerned with this life stage because this is when groundwater influences to streamflow will have the greatest impact on the amount of flow.



Stream flow is one of the most important elements of juvenile salmon habitat. The late spring and early summer flows are critical for juvenile growth. During the driest time of the year (late summer and early fall) flows are critical for juvenile survival. These periods in time are also when groundwater has the greatest influence on instream flows. Further, the amount of flow is directly related to food availability and to the temperature of the stream. Streams are more productive when there are greater flows (greater food availability). Groundwater can aid in decreasing instream temperatures, which can be critical for juvenile survival.

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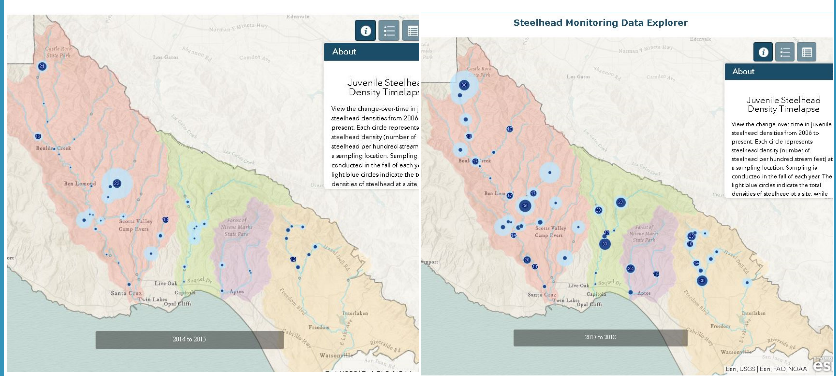
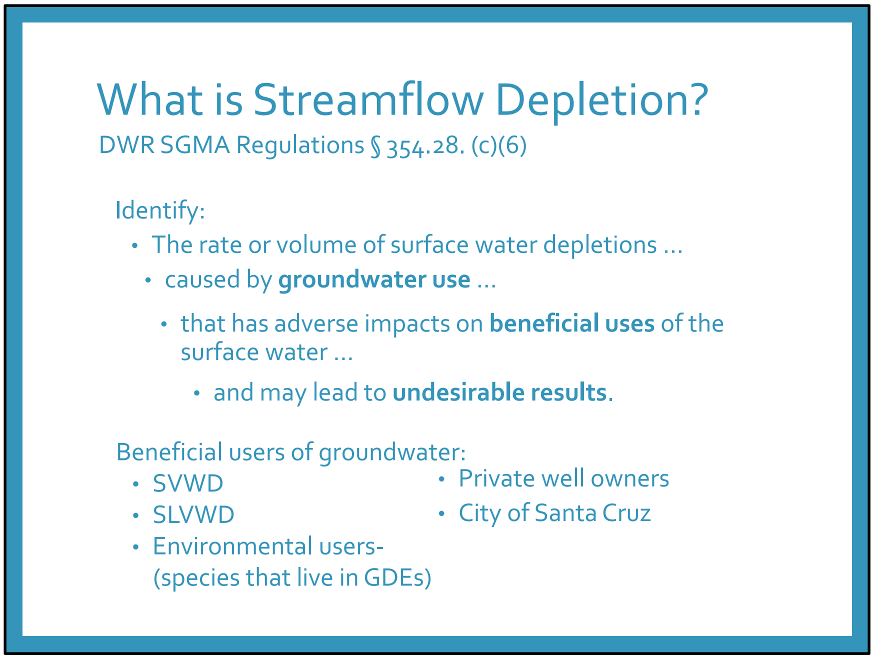
Comparison of juvenile steelhead densities in 2014 (drought year) to 2017 (wet year)



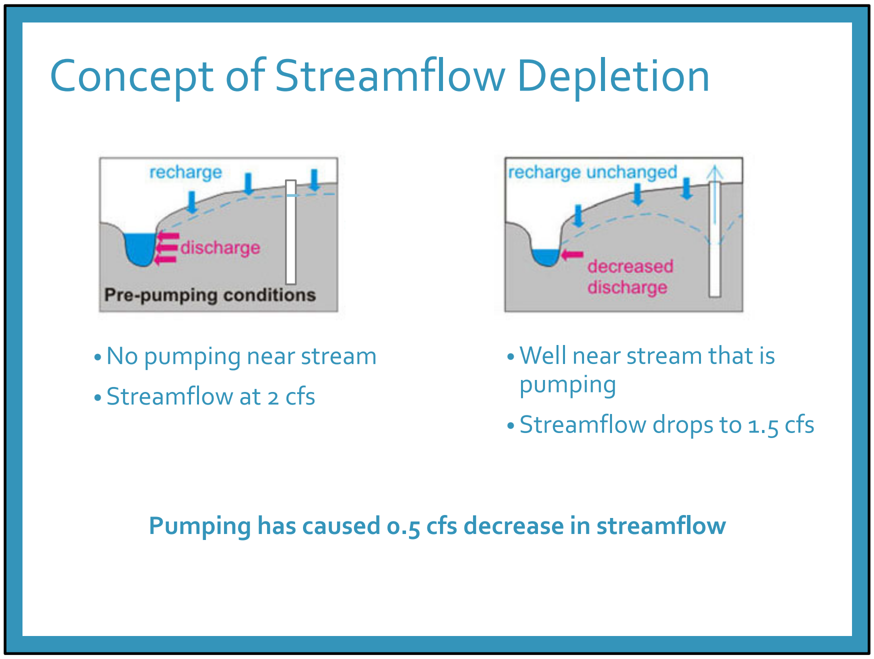
** More information and data available though county steelhead monitoring program: http://scceh.com/steelhead.aspx*

The County steelhead monitoring program measures the density of juvenile steelhead throughout the San Lorenzo, Soquel, Aptos, and Pajaro watersheds. The light blue circles represent the small young of the year and the dark blue circles represent larger fish. Here we can see the difference between steelhead densities between a drought year (2014) and a wet year (2017) during the fall of each year. The relationship between year type (wet or dry) and salmon survival is complicated and there are a number of factors, other than streamflow, that influence salmon survival. The higher densities during a wet year suggest that higher sustained baseflow during the summer is likely a contributing factor to juvenile survival.

4. QUANTIFY DEPLETION AND IMPACTS TO GDES FROM GROUNDWATER PUMPING



As part of the GSP, the amount of streamflow depletion from groundwater use needs to be quantified. To quantify this amount we need to calculate what the surface flow would be if there was no groundwater pumping. We are specifically concerned with the potential impact that groundwater pumping has on beneficial users of groundwater, such as water districts and private wells, that supply people with water and species that live in GDEs.



As a conceptual example, there is a stream flowing with 2 cfs when the well is not on (left). When the well is turned on the streamflow drops to 1.5 cfs (right). The streamflow has decreased by 0.5 cfs as a result of the pumping. In reality, this is very challenging (if not impossible) to measure. The impact of pumping can take many years to decades to result in a response in streamflow. Wells do not have to be near streams to cause depletion if there is overall lowering of groundwater levels.

Quantifying streamflow depletion caused by groundwater pumping is complicated because there are a number of other factors that influence streamflow, such as: rainfall/runoff, surface water diversions, surface water management, evapotranspiration, etc. Because of these factors, it is nearly impossible to accurately measure streamflow depletion. Using the model is the best approach for quantifying the depletion.

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Baseflow Response by Aquifer

Aquifer	Approximate contribution to groundwater discharge in basin	Historic trend in groundwater discharge to stream
Santa Margarita	68%	Relatively constant since 1980's
Monterey	15%	Relatively constant
Lompico	12%	Declining
Butano	4%	Declining

Based on previous modeling results from the 2015 Kennedy Jenks report, we can look at the contribution to groundwater discharge and the historic trend to groundwater discharge for each aquifer. The approximate contribution of groundwater discharge is the approximate amount each aquifer contributes to the total groundwater discharge within the basin. We will be able to interpret the updated model results within the next few months.

In general:

- Santa Margarita contributes by far the largest amount to groundwater discharge of all the aquifers. It has had relatively constant groundwater discharge to streams, since higher pumping began in the 1980's.
- Monterey has had relatively constant groundwater discharge to streams over the long-term record
- Lompico has had declining groundwater discharge to streams and declining dry-season baseflow.
- Butano has had declining groundwater discharge to stream

5. SIGNIFICANT AND UNREASONABLE DEPLETION OF INTERCONNECTED SURFACE WATER

Example Statements: Significant and Unreasonable Depletion of Interconnected Surface Water

- *Significant and unreasonable depletion of surface water due to groundwater extraction, in interconnected streams supporting priority species, would be undesirable if there is more depletion than experienced since the start of shallow groundwater level monitoring through 2015. – Mid-County GSP*

- *Significant and unreasonable depletions of interconnected surface water in the Eastern San Jaoquin Subbasin are depletions that result in reductions in flow or levels of major rivers and streams that are hydrologically connected to the basin such that the reduced surface water flow or levels have a significant adverse impact on beneficial uses and users of the surface water within the Subbasin over the planning and implementation horizon of this GSP. – Eastern San Joaquin and Merced GSPs*

- *Significant and unreasonable depletions of interconnected surface water are reductions in the viability of agriculture or riparian habitat within the Basin over the planning and implementation horizon of this GSP. – Cayuma Basin GSP*

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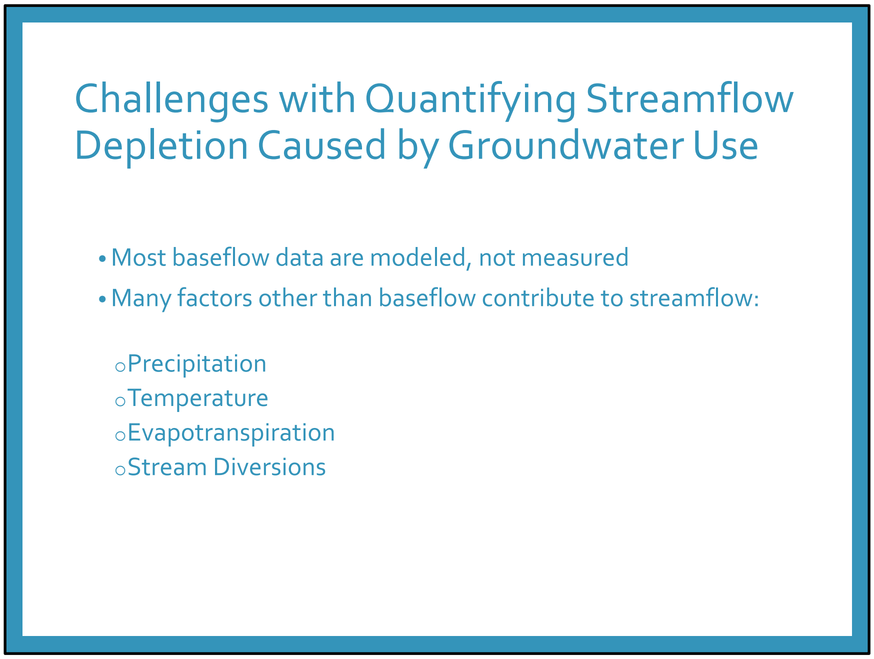
Significant and Unreasonable Depletion of Interconnected Surface Water: General Format

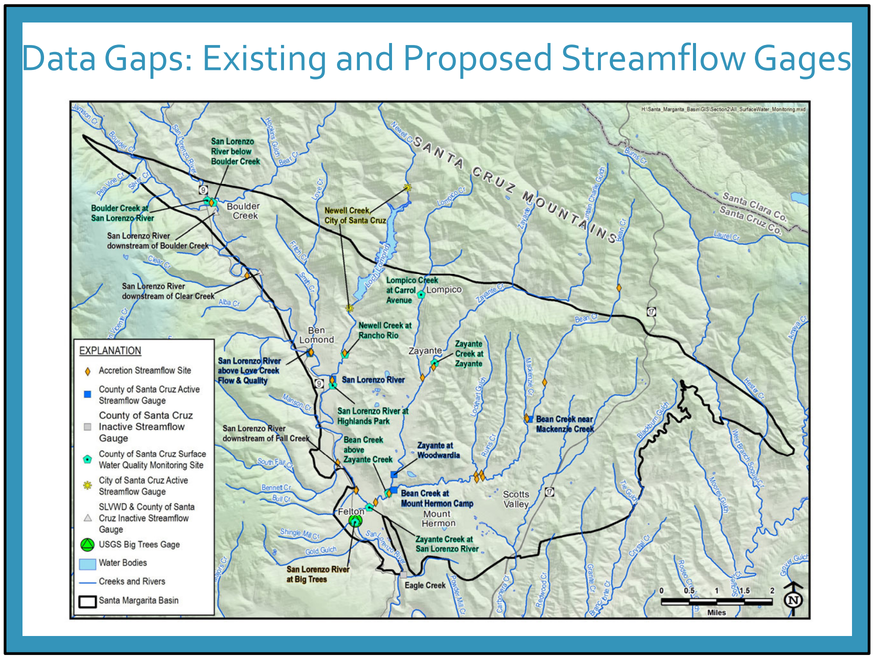
- Statement should be descriptive, not quantitative
- Who or what is impacted?
- What kind of impact?
- Over what time period?

The significant and unreasonable statement should be descriptive and include a few key elements: who is impacted, over what time period, and what kind of impact. Beneficial users or priority species are examples of who is impacted. The time period could be since 2015 or over the planning and implementation of the GSP, for example.

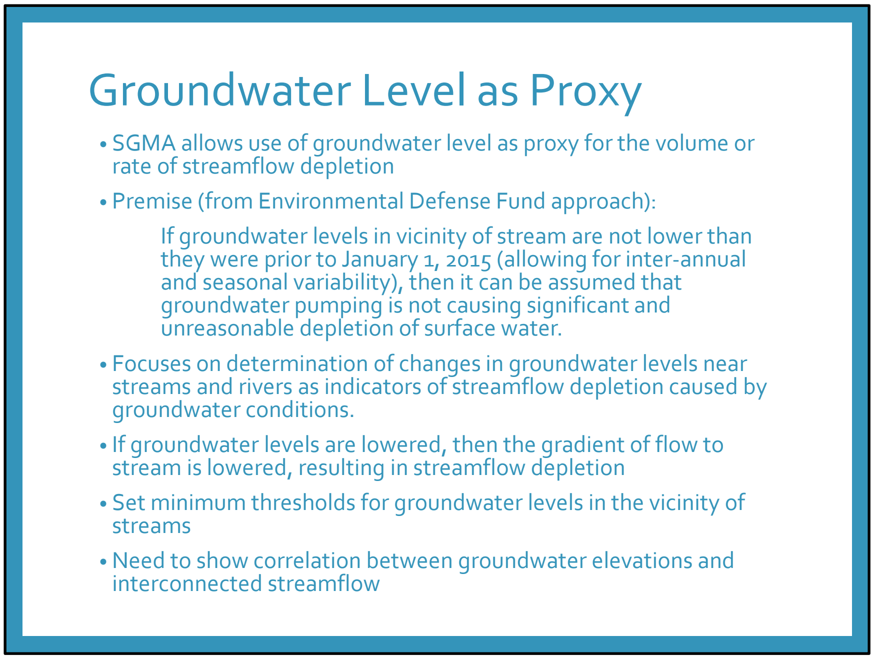
6. APPROACH FOR MINIMUM THRESHOLDS AND MEASURABLE OBJECTIVES



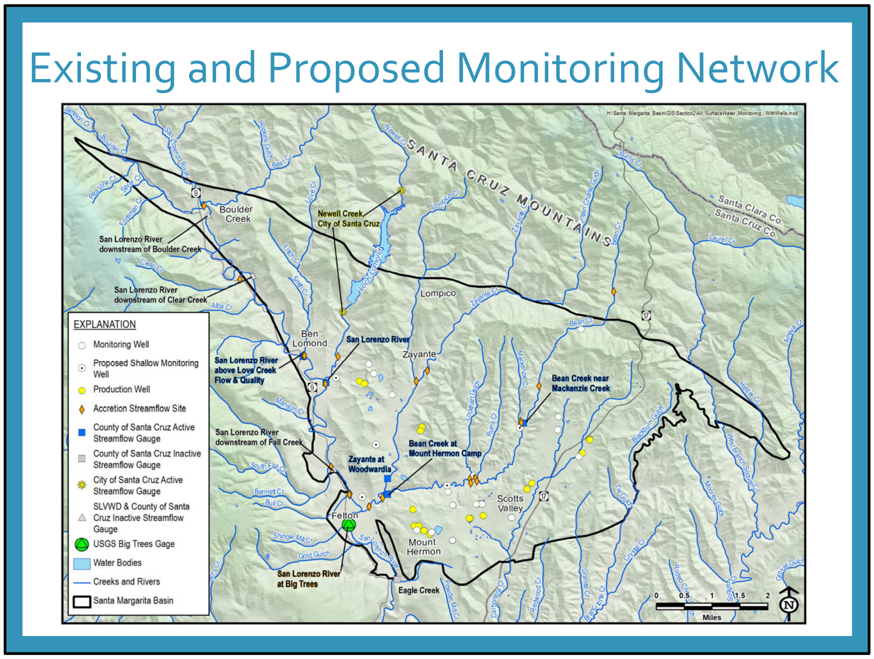
Because of the many factors that influence streamflow and the simplifying assumptions associated with the groundwater model, it can be very difficult to accurately measure and quantify streamflow depletion caused by groundwater use.



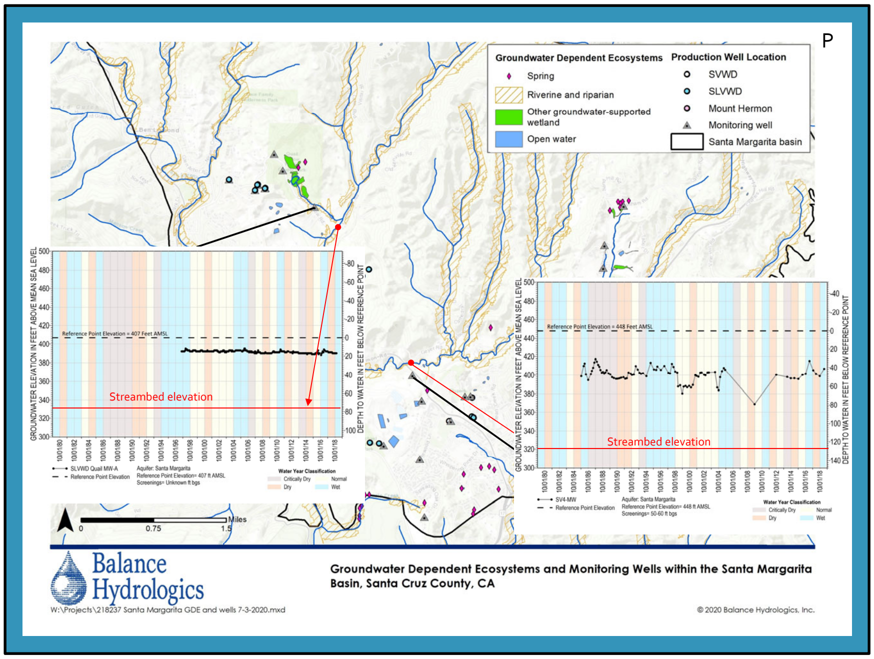
The County has previously monitored streamflow at 4 gaging locations. Water year 2020 updates to the gaging network included the addition of 2 new gages: San Lorenzo River above Love Creek, and Bean Creek near Mackenzie Creek. The Eagle Creek gage was suspended for the water year 2020 monitoring season. Accretion measurements are occurring at two different times, one in July 2020 and one in late September 2020. Data from these gages was used to calibrate the model and will continue to be used for monitoring. Due to the other factors that influence baseflow and the limited period of record for the gages, using instream flow alone is likely not a viable approach to quantifying streamflow depletion and developing minimum thresholds.



Given that the use of streamflow to establish the rate of depletion is challenging and that monitoring groundwater levels is more practical, SGMA allows the use of groundwater levels as a proxy for sustainable indicators. The Environmental Defense Fund has established a rationale and methodology for this approach (Addressing Regional Surface Water Depletions in California: A Proposed Approach for Compliance with the Sustainable Groundwater Management Act)

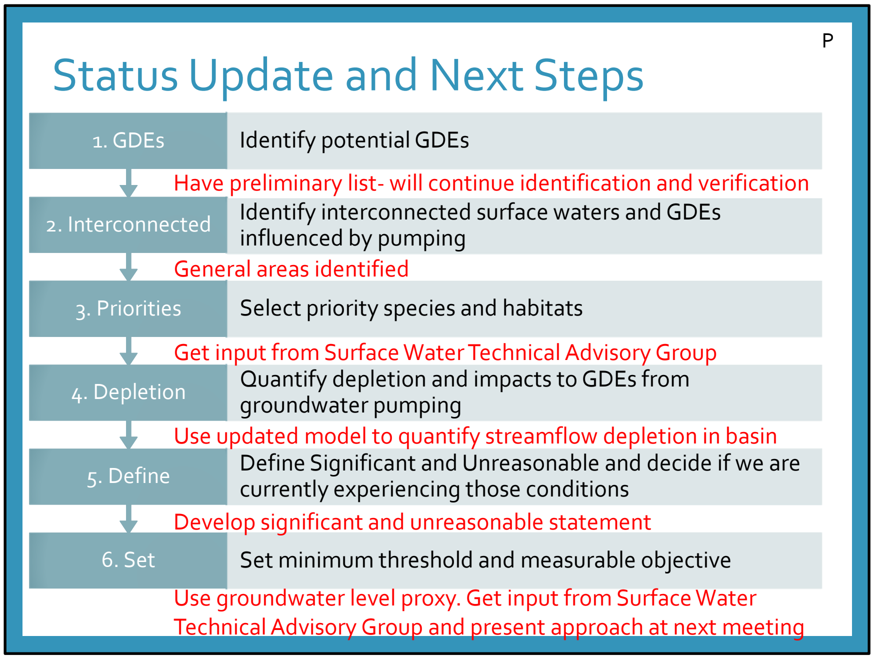


We can use the existing monitoring well data to evaluate groundwater levels near GDEs and to set minimum thresholds. The existing well monitoring is also limited throughout the basin, but provides a longer record than the streamflow gaging network. Here the proposed shallow monitoring well network is also shown, which will provide more coverage of groundwater levels.



To use groundwater elevation as a proxy we need to show that there is a correlation between groundwater level and interconnected streamflow. We can look at groundwater levels from existing monitoring wells and compare the groundwater elevation to the elevation of a nearby streambed or GDE. If the groundwater level is higher than the streambed, then groundwater is contributing to streamflow. Changes in groundwater elevation will directly relate to groundwater contribution to streams. We can then establish minimum thresholds of groundwater levels to prevent undesirable results to instream flow.

6. STATUS UPDATE AND NEXT STEPS



1. We have identified potential GDEs using existing databases and other known GDEs. GDEs will continue to be identified and verified.
2. We have generally identified areas where GDEs may be influenced by pumping from both water districts and private wells. These areas will be our primary focus for evaluating GDEs and for setting minimum thresholds and measurable objectives
3. We will work with the Surface water Technical Advisory Group to refine the priority species list
4. The updated model will be used to quantify streamflow depletions
5. The board will develop a significant and unreasonable statement for the depletion of interconnected surface water. Once the statement is developed, we can evaluate the basin settings and decide if we are currently experiencing those conditions.
6. We will use groundwater levels as a proxy to set minimum thresholds and measurable objectives. We will continue to evaluate the existing data and will get input from the Surface Water Technical Advisory Group. The approach to setting minimum thresholds and measurable objectives will be discussed during the next board meeting.