Appendix 3-A. Data Gap Appendix

Introduction

Multiple datasets were utilized during development of this GSP to characterize current and historical Basin conditions. Monitoring networks were designed to support the evaluation of Basin conditions throughout GSP implementation, particularly with respect to the six sustainability indicators. The representative monitoring points (RMPs) in these monitoring networks are sites at which quantitative values for minimum or maximum thresholds, measurable objectives, and interim milestones are defined. New RMPs will be considered for the 5-years update based on the suggested expanded monitoring network. Data gaps that were identified throughout the GSP development process can be categorized into:

I. Data gaps in information used to characterize current and historical basin conditions.
II. Data gaps in monitoring networks developed to evaluate future Basin conditions which will be used in reporting and tracking Basin sustainability.
III. Additional data or information valuable for measuring progress towards the Basin's sustainability goal. This information has been identified as information that may be useful but has not been confirmed as a data gap.

These data gaps were identified based on spatial coverage of data, the period for which data are available, frequency of data collection, and representativeness of Basin conditions. An overview of data gaps in the first category is provided in Chapter 2, as part of the characterization of past and current Basin conditions, and the data gaps in the second and third categories are in Chapter 3 as part of descriptions of the monitoring networks. This appendix details the identification of data gaps and uncertainties in each of the categories and the associated strategies for addressing them. The process of data gap identification, and development of strategies to fill data gaps is illustrated in Figure 1 below, sourced from the Monitoring Networks and Identification of Data Gaps Best Management Practice (BMP), provided by DWR (2016).

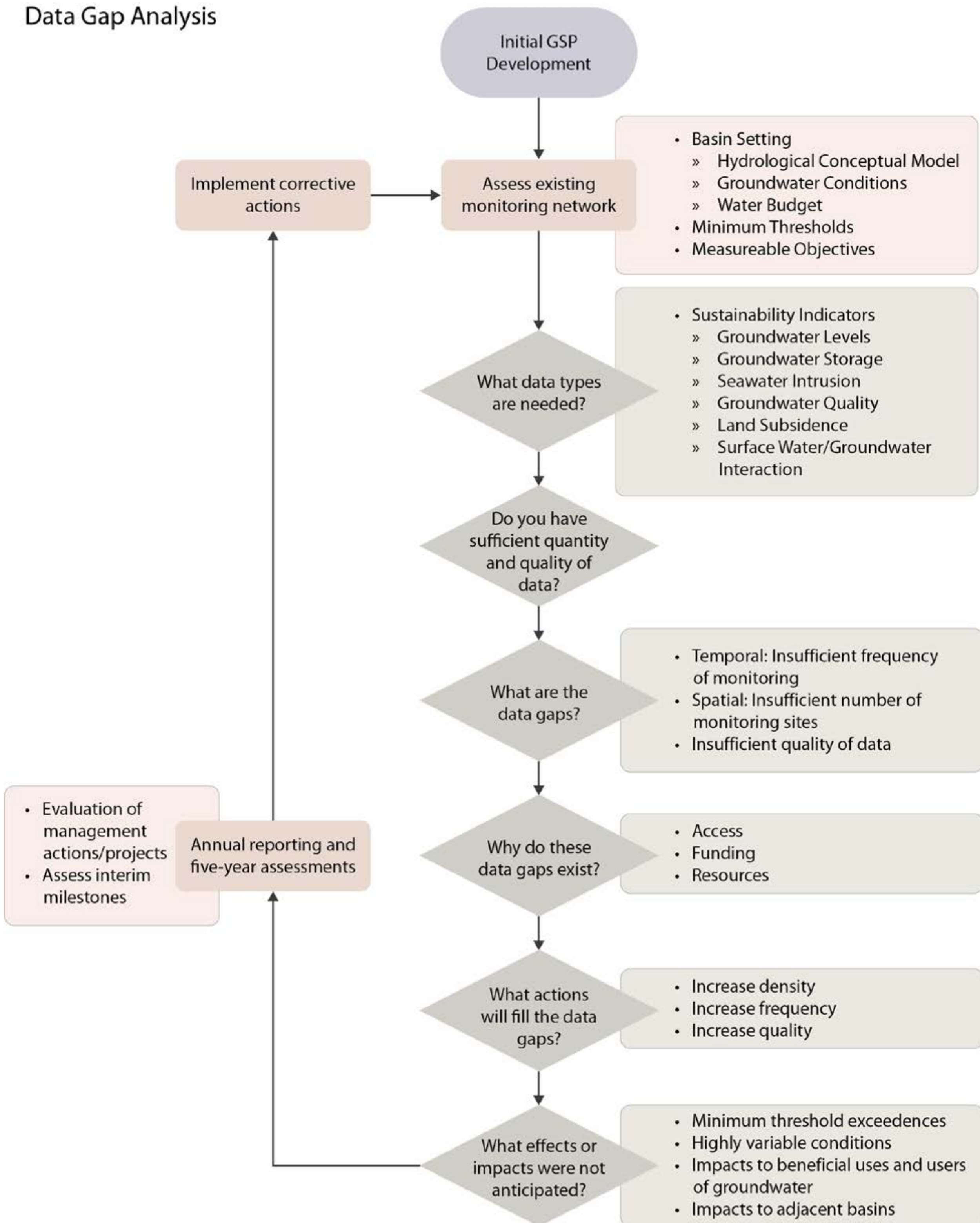

Figure 1: Data Gap Analysis Flowchart (DWR 2016).

I. Data Gaps in Existing Information Used for Basin Characterization

Definition of the hydrogeological conceptual model (HCM) is a key requirement for understanding the Basin setting and characterizing existing and historical Basin conditions. An accurate assessment of the physical setting and processes that control groundwater occurrence in the Basin is foundational to development of the sustainable management criteria and monitoring networks in Chapter 3 and identification of projects and management actions in Chapter 4.

Identification of data gaps and uncertainty within the HCM is a requirement per 23 CCR 354.14 (b)(5) and is important to choosing locations and types of additional monitoring that reduce these gaps and uncertainties.

Identification of Data Gaps

The HCM is detailed in Chapter 2 of this GSP. Data gaps and uncertainties were identified throughout development of the HCM and are briefly discussed in Chapter 2 under applicable subsections. A discussion of the components of the HCM for which key datasets were used, associated data gaps, and uncertainties is provided below.

Climate

Long-term records are available from National Oceanic and Atmospheric Administration (NOAA) weather stations in and around Butte Valley. A list of the applicable NOAA weather stations used in development of the climate component of the HCM can be found in Section 2.2.1.2. Data from these stations were used to evaluate historical and current precipitation and evaluate spatial and temporal (seasonal and long-term) trends in precipitation. Maximum and minimum air temperatures from 1942 to 2020 were obtained from the Mount Hebron Ranger weather station (USC00045941), and reference evapotranspiration (ET) from 2015 to 2020 is calculated at CIMIS Station 236, near Macdoel. Temperature and ET data was used to evaluate short and long-term trends in the Basin. Snow measurement data is not available in the Butte Valley watershed and is a data gap.

Current and historical climate data is readily available for the Butte Valley watershed (Watershed) and has insufficient spatial coverage, but adequate frequency of measurement and length of record to evaluate current and historical conditions and identify trends. Based on an initial assessment of the data, a rainfall gradient is suspected but not confirmed in the Watershed. The presence of a rainfall gradient is an uncertainty in this section of the HCM.

Geology

The primary sources of information used in development of the geology section of the HCM are the California Geologic Survey digitized geologic map (Charles W. Jennings, with modifications by Carlos Gutierrez, William Bryant and Wills 2010), and the foundational geologic report (Wood 1960).

Data gaps related to the total depth of alluvial deposits within the basin and the lateral extent of major buried features such as the Butte Valley Basalt were identified in development of this section of the HCM.

Soils

A 1985 soil survey of Butte Valley-Tule Lake Area (USDA 1994) was the primary source used for development of this component of the HCM. Additionally, soil properties as they relate to groundwater recharge were characterized through the Soil Agricultural Banking Index (SAGBI) ratings for the soil series in the Butte Valley area can be viewed on a web application (app), developed by the California Soil Resource Lab at the University of California at Davis and University of California Agriculture and Natural Resources (UC Davis Soil Resource Lab and University of California Agriculture and Natural Resources 2019).

No data gaps were identified in the development of this section.

Hydrology and Identification of Interconnected Surface Water Systems

The hydrology and natural flow regime in Butte Valley have previously been of limited study due to the limited number of surface water features. There are no stream gauges within the Butte Valley basin boundary. Historical surface water flows were recorded within the watershed along Butte Creek and Antelope Creek at USGS stations 11490500, 11489500, and 114900000, with no recent data. Reporting on Antelope Creek near Tenant from 1952 to 1979, on Antelope Creek nearer Macdoel from 1921 to 1922, and along Butte Creek during two periods, from 1921 to 1922 and from 1952 to 1960.

Data gaps were identified in historical and current information for this component of the HCM. Streamflow records contain significant data gaps any recent data since 1980. In addition, Ikes, Prather, Muskgrave, and Harris creeks also drain into Butte Valley but have no records. Data gaps were identified in the development of this section.

Identification of Groundwater Dependent Ecosystems

Data from the National Wetlands Inventory, The Nature Conservancy, and other sources (as detailed in Section 2.2.2.7) was used to identify groundwater dependent ecosystems (GDEs) in the Basin. While the results of the initial GDE inventory were evaluated by the Technical Advisory Committee, physical verification has not been completed. Uncertainty exists regarding habitat maps and presence of certain species in the Basin. Additionally, groundwater levels near the GDEs are poorly constrained and the groundwater level monitoring network must be expanded appropriately. There is therefore some uncertainty between riparian and non-riparian GDEs that were mapped and the existence and extent of these GDEs on the ground.

A GDE PMA addresses filling data gaps (see Chapter 4). Local habitat and potential GDEs must be groundtruthed using local knowledge, from ranchers to environmentalists. For example, local ranchers can review mapped GDE and habitat polygons on their property and mark the irrigation canals and natural stands of willow. The Butte Valley Wildlife Area (BVWA) manages its vegetation through irrigation (flooding) using both surface water and groundwater. Irrigation of natural vegetation and wetlands with groundwater does not establish these ecosystems as groundwater-dependent in the same way as natural, non-irrigated GDEs. The latter depend on specific water level depth, while the former depend on access of wells to groundwater. BVWA will work with the GSA to review mapped GDE and habitat polygons to provide feedback on which potential GDEs within their borders are irrigated versus natural habitat.

Current and Historical Groundwater Conditions

Groundwater Elevation Data

A total of 85 wells with groundwater elevation data are available in the Basin. Groundwater elevation data is sourced primarily from the California Statewide Groundwater Elevation Monitoring Program (CASGEM). Well data is available dating back to the 1950s and wells have reasonable spatial coverage of the Basin, measurement frequency and period of record. CASGEM wells are measured at a frequency of twice per year, however many wells have missed observations. These frequencies are reasonable to enable determination of seasonal, short-term, and long-term trends in most parts of the valley. A summary of the wells with groundwater elevation data, and additional available information is shown in Table 1. Some spatial and temporal data gaps are discussed in Chapter 3 and below.

Table 1: Wells with groundwater elevation data in the Butte Valley Basin. Recent is here used to refer to data from the past ten years.

Wells	**Groundwater Basin**
Wells with coordinates (including data from WCRs referenced to nearest PLSS section)	295
Wells with screen depth information	62
Wells with coordinates and recent1 water level data	74
Wells with pumping data	None

Estimate of Groundwater Storage

Partial groundwater storage data is available from the foundational geological report (Wood 1960) and overall specific yield and storativity were estimated using the Butte Valley Integrated Hydrologic Model (BVIHM). Data gaps include the depth and width of the High Cascades Volcanic unit (see Section 2.2.2.2).

Groundwater Extraction Data

No pumping monitoring program currently exists in the Basin and this data is not available for any of the wells with groundwater elevation data. This has been identified as a data gap.

Groundwater Quality

Groundwater quality data was obtained from several sources including the California Groundwater Ambient Monitoring and Assessment (GAMA) Program Database, the USEP Storage and Retrieval Data Warehouse (STORET), and GeoTracker GAMA. As detailed in Appendix 2-C, available water quality data were compared to regulatory standards and mapped. Constituents of concern were identified through visual analysis of recent data (within the past 30 years) of the generated maps and timeseries for each constituent (available in appendix 2-C). As seen on these maps, and noted in Section 2.2.2.3, there are multiple data gaps in the groundwater quality information used to develop the HCM. Spatially, groundwater quality data is frequently concentrated near Dorris and Mount Hebron and coverage in other areas of the Basin is missing for multiple constituents. Additionally, most of the groundwater quality data used in the assessment did not have a long record with consistent measurements, or measurements with a frequency that would be sufficient for determination of historical trends in groundwater quality. Further data gap discussion and the strategy for filling these data gaps is discussed under the groundwater quality monitoring network associated with Chapter 3, below.

Land Subsidence Conditions

Land subsidence data is entirely sourced from the TRE Altamira Interferometric Synthetic Aperture Radar (InSAR) dataset which provides estimates of vertical displacement from June 2015 to September 2019. No data gaps were noted in this section due to the lack of subsidence in the InSAR data and historical observations.

Water Budget

The water budget is dependent on monitoring data inputs. For data gaps in the water budget see previous sections on climate and hydrology (i.e., tributary) data gaps.

II. Data Gaps Monitoring Networks

Requirements

Multiple data gap requirements are relevant to the definition of monitoring networks for sustainability indicators. Per 23 CCR 354.38 (“Assessment and Improvement of Monitoring Network”):

(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency

(c) If the monitoring network contains data gaps, the plan shall include a description of the following:

   i. The location and reason for data gaps in the monitoring network
   ii. Local issues and circumstances that prevent monitoring

(d) Each Agency shall describe steps that will be taken to fill the data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

The following discussion summarizes the identified data gaps, description, and strategy to fill the identified data gaps.

Groundwater Level and Storage Monitoring Network

Data gaps in the groundwater level monitoring network are discussed in Section 3.3:

- Near surface water bodies (Meiss Lake and streams, particularly Butte Creek and Prather Creek)
- Potential groundwater dependent ecosystems
- Potential interconnected surface water
- Sam's Neck
- Butte Valley National Grassland
- Butte Valley Wildlife Area
- Wells within the Watershed in areas of interest, such as the Butte Creek diversion

The above spatial data gaps prevent completion of the groundwater dependent ecosystem (GDE) analysis, analysis of interconnected surface waters, and limits the analysis of Basin inflows and outflows for the Butte Valley Integrated Hydrogeologic Model (BVIHM). The GSA is seeking funding to install new monitoring wells.

Additionally, continuous groundwater level measurements would enable better monitoring of SMC compliance so PMAs can be initiated effectively in a timely manner. The GSA has begun the process of filling data gaps though voluntary continuous groundwater level metering (shown in Chapter 3 - Figure 1). Additional metering is needed.

Groundwater Quality Monitoring Network

Requirements

Requirements for the monitoring network for the degraded water quality sustainability indicator are outlined in 23 CCR 354.34 (c)(4):

Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.

Data Gaps

Data gaps in the groundwater quality monitoring network were identified due to inadequate spatial coverage, monitoring frequency, and/or lack of representativeness of Basin conditions and activities. The one site with existing and ongoing groundwater quality monitoring are public supply wells and is therefore concentrated near population, or seasonal population, centers near Dorris, leaving much of the Basin without representative monitoring data. The location of these data gaps is shown on the map of the existing groundwater quality monitoring locations (see Figure 2 in Chapter 3). The entire remaining basin has insufficient monitoring to interpret historical trends or are entirely outside the current monitoring network. These data gaps are due to the limited number of wells that conduct current and ongoing monitoring for the identified constituents of concern. The wells in the existing groundwater quality network also have a temporal data gap with a frequency of measurement annually or greater, corresponding to the public water supply system sampling frequency. A higher frequency of sampling, at minimum biannually, is necessary to enable determination of trends in groundwater quality on an intra-annual scale. No local issues or circumstances are expected to prevent monitoring. As discussed in Section 3.3.3, the groundwater quality monitoring network will be expanded with a minimum addition of five wells within the first five years of plan implementation to address this data gap. Candidate wells have been identified for inclusion in this expansion including wells in the monitoring network for groundwater levels.

Depletions of Interconnected Surface Water Monitoring Network

Requirements

The requirements for the depletion of interconnected surface water (ISW) monitoring network, as part of § 354.34. Monitoring Network, are detailed below:

(A) Flow conditions including surface water discharge, surface water head, and baseflow contribution.
(B) Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.
(C) Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.
(D) Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.
(E) Changes in gradient between river and groundwater system.

Data Gaps

Due to the lack of sufficient data on potential ISWs in the Basin, sustainability management criteria (SMC) cannot be set until data gaps are addressed. Critical data gaps include sufficient coverage of the groundwater level monitoring network near potential ISWs and stream gages. One new stream flow station is under development on Butte Creek near the Butte Creek diversion the understanding of surface water flow into Butte Valley. Under sufficient funding conditions additional stream flow gauging stations will significantly reduce uncertainty caused by this data gap. The GSA will address these data gaps and revisit potential ISW SMCs in the 5-year GSP update.

III. Additional Data or Information Valuable for Measuring Progress Towards the Basin Sustainability Goal

Additional data has been identified that may be valuable to evaluations of progress towards the Basin's sustainability goal. This is primarily additional monitoring information that may be useful to identify adverse impacts on biological uses of surface water, in addition to existing biological monitoring in the Basin.

These include evaluation of streamflow depletion impacts on juvenile salmonids and use of satellite imagery for monitoring riparian and non-riparian vegetation. The GSA may consult other entities or specialists, as feasible, to determine the value of this data.

IV. Data Gap Prioritization

The identified data gaps are prioritized for actions to be taken to resolve them. Data gaps are categorized into "high," "medium," and "low" prioritization statuses based on the value to understanding basin setting or in comparison to the defined SMCs to evaluate Basin sustainability. Filling data gaps can be achieved through increasing monitoring frequency, addition of monitoring sites to increase spatial distribution and density of the monitoring network or adding or developing new monitoring programs or tools. Summaries of the data gaps discussed in this appendix, associated prioritizations, and strategies to fill the data gap are shown in Table 2.

Table 2: Data gap prioritization

Priority	Data Gap Summary	Strategy to Fill Data Gap
High	Increase frequency of water quality sampling to develop a record of future seasonal and annual fluctuations in water quality	Develop and fund an annual sampling plan based on RMP groundwater elevation collection points
High	Expand the groundwater level network to cover current data gaps, particularly near surface waters (potential ISWs) and potential groundwater dependent ecosystems. The utmost priority is filling data gaps near Butte Creek and Butte Valley Wildlife Area (BVWA).	The GSA will seek local volunteers with historical groundwater level data and seek funding for installation of additional monitoring wells.
High	Expand groundwater sampling in RMP points to include continuous logging to improve the quality of observations during major pumping and recharge periods	Where possible, instrument RMP wells with continuous loggers and telemetry
Medium	Install surface water gauges on Butte, Ikes, Prather, Muskgrave, and Harris Creek to develop a record and surface water budget flowing into Butte valley	Establish stream gauges at strategic locations along creeks where existing infrastructure permits inexpensive observations, install data loggers and telemetry, and fund future work
Medium	Develop improved evapotranspiration estimates in Butte Valley to reduce uncertainty in the water budget	Install and maintain multi-season eddy covariance and energy balance towers on critical crops (alfalfa, hay, strawberry) and native vegetation in (sagebrush, willow).
Medium	Develop better estimates of snow water equivalent and weather station data from higher in the Butte watershed by building specialty stations	Develop weather stations in the western and south western watershed to collect snow water equivalent data and general atmospheric information

Table 2: Data gap prioritization *(continued)*

Priority	Data Gap Summary	Strategy to Fill Data Gap
Low	Improve the spatial coverage of irrigation management systems	Install an additional CIMIS station in Butte Valley

References

California Department of Water Resources (2016). BMP 2: Best Management Practices for the Sustainable Management of Groundwater Monitoring Networks and Identification of Data Gaps, December 2016. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-2-Monitoring-Networks-and-Identification-of-Data-Gaps_ay_19.pdf

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