Appendix 5

Soils, Geology, and Aquifer Characterization

Contents

Soils, Geology, and Aquifer Characterization

Theme Subcommittee Members

The Flood-MAR Soils, Geology, and Aquifer Characterization Subcommittee consists of 2 co-chairs, 20 sub-committee members, and a theme coordinator. Subcommittee members are listed by name, title, and affiliation below.

Position	Name and Title	Affiliation	Email
State Co-Chair	Tim Godwin, Senior Engineering Geologist	California Department of Water Resources (DWR)	Timothy.Godwin@water.ca.gov
Non-State Co-Chair	Graham Fogg, Professor	University of California (UC), Davis	gefogg@ucdavis.edu
Sub-committee Member	Andrew Fisher, Professor	UC Santa Cruz	afisher@ucsc.edu
Sub-committee Member	Rosemary Knight, Professor Geophysics	Stanford University	rknight@stanford.edu
Sub-committee Member	Toby O'Geen, CE Specialist	UC Davis	atogeen@cudavis.edu
Sub-committee Member	Todd J. Greene, Associate Professor	California State University (CSU), Chico	tjgreene@csuchico.edu
Sub-committee Member	David Shimabukuro, Assistant Professor	CSU Sacramento	dhs@csus.edu
Sub-committee Member	Daniel Gamon, Engineering Geologist	DWR	Daniel.Gamon@water.ca.gov
Sub-committee Member	Chris Bonds, Senior Engineering Geologist	DWR	Chris.Bonds@water.ca.gov

Position	Name and Title	Affiliation	Email
Sub-Committee Member	Steven Springhorn, Senior Engineering Geologist	DWR	Steven.Springhorn@water.ca.gov
Sub-committee Member	Dan McManus, Hydrologist	DWR	Dan.McManus@water.ca.gov
Sub-Committee Member	Steve Phillips, Hydrologist	U.S. Geological Survey	sphillip@usgs.gov
Sub-committee Member	Tara Moran, Academic Research Staff	Stanford University	tamoran@stanford.edu
Sub-committee Member	Khalil Lezzak, Hydrogeologist	CSU Sacramento	khalil.lezzaik@owp.csus.edu
Sub-committee Member	Amanda Deinhart, Isotope Geochemist	Lawrence Livermore National Laboratory	deinhart1@llnl.gov
Sub-committee Member	Craig Ulrich, Senior Scientist Engineering Associate	Lawrence Berkeley National Laboratory	CUlrich@lbl.gov
Sub-committee Member	Ate Visser, Research Scientist	Lawrence Livermore National Laboratory	visser3@llnl.gov
Sub-Committee Member	Daniel Nylen, Associate Director	American Rivers	daniel-nylen@americanrivers.org
Sub-committee Member	Peter Roffers	California Geological Survey	Peter.Roffers@conservation.ca.gov
Sub-committee Member	Nate Roth	California Geological Survey	nathaniel.roth@conservation.ca.gov
Sub-committee Member	Daniel Mountjoy, Director of Resource Stewardship	Sustainable Conservation	dmountjoy@suscon.org

Position	Name and Title	Affiliation	Email
Sub-committee Member	Laura Foglia, Assistant Adjunct Professor	UC Davis	lfoglia@ucdavis.edu
Theme Coordinator	Francisco Flores-Lopez, Water Resources Engineer	DWR	Francisco.FloresLopez@water.ca.gov

Engagement Process

The subcommittee's objective was threefold to identify a priority list of up to 10 data, research, and tools needs with the top three to be reported to the Research Advisory Committee (RAC) as actions items; estimate costs to implement; and define a strategy to achieve the objectives.

The State and non-State co-chairs were proposed by the DWR Flood-MAR team. Both co-chairs were selected based on their leadership skills and well-known expertise and experience in the corresponding fields and organizations.

The co-chairs in collaboration with the DWR Flood-MAR team identified a list of potential members to integrate into the subcommittee. The identified candidates were academics, experts, practitioners, and researchers with experience and expertise on the Soils, Geology, and Aquifer Characterization theme. The final list of members who accepted to participate in the theme as subcommittee members is shown in the above table.

The subcommittee members had two in-person meetings with the co-chairs to identify the needs' themes, organize and process the identified information, and finalize the theme's contribution to the RAC. The co-chairs had, parallel to this process, different interactions to organize the subcommittee's contributions.

Available Research, Data, and Tools

During the its two in-person meetings, the subcommittee identified a set of needs for basic data, research (evaluation and analytical approaches), and tools/ analytical. Subcommittee members contributed to this set of needs based on their experience and expertise. The preliminary list is shown below as rough notes recorded during these meetings.

Rough Notes: First Flood-MAR RAC for Soils, Geology, and Aquifer Characterization

RAC Purpose

1. Priority list top 10 Data/Research/Tools needs
    a. Top 3 will be reported back further
2. Cost estimate to implement
3. Strategy to achieve the objectives

Problem Definition: What does the group believe to be the significant limitations to the current characterization of basins?

Graham's overview:

- Scope: Overdraft is in alluvial basins: soils and underlying sediments (mostly fine grained)
- Aquifers (sands and gravels) are typically only 20-40% of basin
- Research is showing that fastest recharge in course material but biggest changes in storage are in fine-grained sediments
- Goal is to soak water into the aquifer: even floodplains can recharge with long term soaking.
- Other states have done a lot better mapping of geologic aquifer
- Geophysics imaging alone will not suffice; must be done in concert with knowledge of geologic processes; need subsurface mapping based on all available data *and* geologic interpretation
- Recharge Roundtable White Paper provides broad needs for aquifer characterization

Technical Discussion

Basic Data Needs:

1. Refinement and improvement of geologic characterization:
   A. Existing Data include:
      I. Existing well completion report (DWR) and other well logs
         a. Most are of poor quality – inconsistent logging methods and vocabulary
         b. not digitized,
         c. limited depth distribution,
         d. inaccurate locations
      II. Possible solutions
         a. Quality driller logs
            i. Standards and agency oversight, training or incentivization, digital entry.
            ii. Categorize/rank logs in terms of quality according to defined standards
         b. Accessible geophysical logs
         c. Investigate other sources of data logs
            i. Levee
            ii. State water report
            iii. Underground injection control; state board, aquifer exemptions
            iv. Gas and oil data (geothermal), CGS
         d. Collect core/chip cuttings; storage and archiving;
         e. Incorporate environmental well logs
         f. Identify occurrence of paleosols / commonly cemented
         g. Require collection and submission of Electronic logs
         h. Notify scientific community when wells are drilled in case they want to collect more data in those boreholes?
         i. Geophysics
            i. Archiving for airborne and ground base
            ii. Standards for
         j. Land surface monitoring
            i. INSAR, GPS, Extensometers

- B. Identifying recharge areas
  - I. Natural current recharge areas
  - II. Enhanced areas/potential
  - III. Identify sedimentary structure to support recharge

2. Soils
   - A. Improving SAGBI
   - B. Recharge operation effects on soils
   - C. Soils management for recharge
3. Timing of available waters for recharge from flood flows
   - A. High flood flows - drinking from a fire hose
   - B. Limitations of recharge can be managed
4. Need for detailed geologic depositional environment characterization
   - A. Mapping and characterization of Paleosols - commonly cemented
   - B. Understanding lithology of source rock - WQ implications
     - I. Need to coordinate with water quality
   - C. Comparable vocabulary descriptions of geology in drill cuttings – improve logging
   - D. Point counts of cuttings to determine source areas
5. Soil characterization considerations
   - A. Soil health and susceptibility to regular Flood water application - compaction
   - B. WQ - flushing impacts, leaching of minerals
6. Drilling considerations
   - A. Drilling methods
     - I. Core collection
     - II. Core sample Archive in west sac
     - III. Levee evaluation studies (datasets nuwlee [?] and uwlee [?])
   - B. Geophysics
     - I. NMR logging
7. Aquifer testing and detailed water level analysis
   - A. Available info includes specific capacity testing
   - B. Long term aquifer tests identify connectivity - vertical and horizontal
   - C. Water levels with nested wells showing connections
     - I. Gradient analysis to id connections vertically
     - II. Repurpose CASGEM to look at this

Research - Evaluation and Analytical Approaches

8. Basin characterization – coordinated centralized effort
    A. Likely state agency DWR or CGS
    B. Develop atlas of subsurface to be used and improved over time
9. Drilling cuttings
    A. Develop repository for additional analysis and improved logging
10. Geophysics
    A. Wire line borehole logs – valuable for correlation and corroboration of cuttings/core logs
    B. Surface/ aerial geophysics – Absolutely require detail correlation with observations from borehole to be useful
11. Aquifer testing
    A. Observe stress conditions and recovery of aquifers to evaluate for aquifer connectivity (vertical and horizontal)
    B. Estimation of aquifer properties TKS
    C. Observe conditions of degrees of confinement

Tool / Analytical Needs

12. Need for a basin characterization agency to plan/map/characterize (CGS/DWR???)
13. NRCS is interested in providing assistance with soils characterization
14. Tools being developed at planning scale aren't appropriate for application (field scale)
15. How can we monitor and assess recharge - lateral and vertical impacts
16. Pull on the USGS and Universities for basin characterization studies
17. What should we tell GSAs?:
    A. Don't let data gaps stop water managers from continuing with recharge in places where they know recharge works
    B. Flood MAR (as well as SGMA) requires major effort in subsurface hydrogeologic mapping/characterization to maximize and optimize flood water capture
    C. Wherever you can get water into the ground, do it: don't worry about exactly where to do it to achieve specific purposes. Don't need tool.
    D. Make soils, geologic and aquifer data readily available to GSAs.

Research Needs and Gaps

The following is a distillation of notes from the first two meetings. These notes identified the theme's needs and gaps in research, data, and tools provided to the RAC as the soils, geology, and aquifer characterization contribution.

Distillation of notes from the first two meetings: First Flood-MAR RAC for Soils, Geology, and Aquifer Characterization

RAC Purpose

1. Priority list top 10 Data/Research/Tools needs
    a. Top 3 will be reported back further
2. Cost estimate to implement
4. Strategy to achieve the objectives

Problem Definition: What does the group believe to be the significant limitations to the current characterization of basins?

Graham's overview:

- Scope: Overdraft is in alluvial basins: soils and underlying sediments (mostly fine-grained)
- Aquifers (sands and gravels) are typically only 20-40% of basin
- Research is showing that fastest recharge in course material but biggest changes in storage are in fine-grained sediments
- Goal is to soak water into the aquifer: even floodplains can recharge with long term soaking.
- Other states have done a lot better mapping of geologic aquifer
- Geophysics imaging alone will not suffice; must be done in concert with knowledge of geologic processes; need subsurface mapping based on all available data *and* geologic interpretation
- GRA and UC Water's Recharge Roundtable White Paper provides broad needs for aquifer characterization Recharge Roundtable White Paper provides broad needs for aquifer characterization.

Needs

1. Data

1.1. Subsurface Geology

- 1.1.1. Quality driller logs
  - 1.1.1.1. Accurate locations
  - 1.1.1.2. Fully digitized
  - 1.1.1.3. Categorize/rank logs in terms of quality according to defined standards (policy needed)
- 1.1.2. Accessible and usable geophysical data
  - 1.1.2.1. Digital versions of geophysical borehole logs available in statewide database
  - 1.1.2.2. Archiving of surface (including airborne) geophysical survey data and interpretation (e.g., AEM, GPR, conventional resistivity, etc.)
  - 1.1.2.3. Land surface monitoring data (e.g., INSAR, GPS, extensometer data)
- 1.1.3. Collect core/chip cuttings; storage and archiving (policy needed)
- 1.1.4. Exploit, organize, curate alternative sources of subsurface data
  - 1.1.4.1. Recent (DWR’s Urban Levee and Non-Urban Levee Evaluation Projects, USBR’s San Joaquin Levee Evaluation Project) and historical levee investigations (descriptive, geophysical and core data)
  - 1.1.4.2. Bulletin 118 State report on the occurrence and nature of groundwater statewide
  - 1.1.4.3. Underground injection control; USEPA, State Board, aquifer exemptions
  - 1.1.4.4. Oil, gas and geothermal investigations (e.g., CGS, NATCARB, Geothermal Prospector)
  - 1.1.4.5. Incorporate environmental well logs
  - 1.1.4.6. As GSAs collect subsurface data, foster collaborations with state agencies to enhance data quality and cost of acquisition

1.2. Soils

- 1.2.1. Improving SAGBI
- 1.2.2. Water quality considerations

1.3. Subsurface Hydrology

1.4. Aquifer Properties

1.4.1. Gather and curate historical and new data on aquifer parameters (T, S, K, S_s) obtained from laboratory and field testing (e.g., pumping and slug tests)

1.4.2. Gather all specific capacity data already available in well completion reports and place in central database (transmissivity can be estimated from specific capacity)

1.5. 4D Groundwater Level Data

1.5.1. Improved areal, depth and temporal (4D) coverage of groundwater levels to better ascertain areas with 'space' for recharge and vertical connectivity/fluxes of/between aquifers

1.5.2. Improved temporal groundwater level data to better ascertain recharge (and pumping) aquifer responses and to produce better model calibrations

2. Analysis and Research: Hydrogeologic Synthesis of Data

2.1. Need detailed characterization of subsurface geology as related to the subsurface hydrology, including analysis of stratigraphic history, depositional environments, and structural geology.

2.1.1. Mapping and identification of incised-valley-fill deposits in Central Valley as special recharge resources or preserves (east side)

2.1.2. Mapping and identification of other, near-surface channels or other geologic features that represent good candidates for higher rates of recharge

2.1.3. Mapping and characterization of paleosols using sequence stratigraphic methods

2.1.4. Mapping and updated characterization of major aquitards such as the Corcoran Clay

2.1.5. Determining source of various alluvial sediments to ascertain sand/gravel body orientations and to provide better insights into groundwater quality trends

2.1.6. Develop atlas of subsurface to be used and improved over time

2.2. Need hydrogeologic synthesis of soils, geology, and hydrology data to identify best locations for recharge

2.3. Database management: determine how best to integrate and manage the data and analyses

2.4. Research on effects of recharge on soils

2.4.1. Redistribution of surface residues (manure, compost, biosolids)
2.4.2. Soil erosion: Can ideal flow rates be adopted?
2.4.3. Ideal water heights to limit hydro compaction
2.4.4. Soil management practices that can mitigate risks of MAR (e.g., ditching more slowly permeable soils to avoid risk to tree crops)

3. Policy

3.1. Establish a subsurface characterization team within an agency with the mission of collecting, curating and hydrogeologically interpreting (mapping) the subsurface aquifer and non-aquifer sediments/rocks. *This team must contain both geologic experts and hydrogeologic experts, including local and regional experts who are familiar with each basin and subbasin.*
3.2. Standards and agency oversight, training or incentivization, for improving quality of driller's logs
3.3. Consider regional repositories for storage and curation of drill cuttings and cores.
3.4. Require submission of geophysical logs when run in boreholes and wells
3.5. Update and expand CASGEM to achieve better 4D representation of groundwater levels
3.6. Potential for more engagement with NRCS for soils characterization
3.7. Engage the USGS and Universities for basin/source watershed characterization studies

Other context and comments:

- What should we tell GSAs?:
  - Don't let data gaps stop water managers from continuing with recharge projects in places where they know recharge works.
    - During events collect water level response data if possible, as any data collected helps tell a story and supports future investment decisions.
  - Flood-MAR (as well as SGMA) requires major effort in subsurface hydrogeologic mapping/characterization to maximize and optimize flood water capture.

    - Make soils, geologic, and aquifer data readily available to GSAs.

- A. Fisher comment on subsurface data: There should be a focused effort in each basin to co-register geophysical logs, digitized drillers logs, aquifer test intervals, and direct observations of cores/cuttings, so that basin-specific, empirical relations can be developed. Rules from one basin cannot be expected to work in other basins. Example – in the Seaside Basin, comparison of (limited) cores and logs showed that gamma logs were of little use for identifying estuarine clays below the main, unconfined aquifer (in fact, paleosols often had stronger gamma response), but induction logs worked well to differentiate between sand/clay. With additional induction logs run through casing, it was possible to leverage the limited core/cutting data, and also test accuracy of driller's logs (many were pretty good). This kind of "bootstrapping" of datasets should be possible in other basins – we will never get all the cores/cuttings/tests we desire, so need to make maximum use of limited direct observations.

- D. Gamon on Subsurface hydrology: I might suggest some sort of investigation on the west side to inventory similar sites. I have encountered surprisingly coarse packages that divert recharge into deeper aquifer zones. For example, near Westley (Ingram Creek area). Probably not as pervasive in scale nor as much precip as east side but still might be worth investigatingn areas to protect.
    - We see similar heterogeneity in coastal basins – there can be direct recharge "channels" in some areas immediately adjacent to seawater-intruded areas. The associated heterogeneity in water quality often causes confusion wrt the extent of intrusion and geometry of pathways. This illustrates that data value could be improved by co-registering geological/geophysical and geochemical data. In other words, there is a need for a common GIS-like platform for integrating many kinds of data.

- A. Fisher comment concerning "3.2 Standards and agency oversight, training or incentivization for improving quality of drillers logs": I think this is a fine idea, but reality is that we have many decades of existing data and should make sure to make good use of that. Also, it is very difficult to enforce "quality" in creating of driller's logs, no matter how much training is provided. And many drillers and others will balk at required red tape associated with training drillers – frankly, many drillers will argue that they know their geology better than outsiders.

That said, what about some kind of incentive program for helping people to learn how to generate better quality well logs (more detailed, more accurate)? For example, what if there were a statewide competition for access to characterization funds, maybe 20 or 30 new wells were selected for drilling in 10-15 basins, and then multiple tools were run in these wells to compare methods, cores/cuttings were collected, results were tied to seismic and other methods, and drillers were offered travel funds to visit and participate in the exercises. Make them part of the process of comparing the various data types and generate enough data to determine what is the right interpretation, what are the best logs, and post these as templates/examples of what we need.

Could even be small cash prizes – a drilling competition, kind of like the **AAPG Imperial Barrel Award Program?**

Maybe the NGWA, GRAC, and other organizations could be brought in as partners?

- A. Fisher concerning acquisition of new data for each basin: Develop a priority plan for acquisition of new data for each basin – where are the biggest gaps, what are the biggest needs? Base this on what data is available now, and where are the biggest concerns for supply and quality, where are models the least certain? Having priorities lined up in advance helps when funding becomes available for new wells, cores, logs, tests, and other opportunities to make improvements.

Prioritization Process

The theme subcommittee group consisted of 21 different academics, experts, researchers, and practitioners in different fields related to the Soils, Geology, and Aquifer Characterization theme. Through an open and thoughtful discussion among all subcommittee members, the subcommittee identified the top three needs. This exercise was prioritization process that was requested to execute. Those top three needs are listed below with a short description.

1. Subsurface geology data: greater accessibility to useable and better-quality data.

Adequate implementation and management of Flood-MAR requires better characterization of the subsurface geology and soils that define strategic recharge locations where one can achieve the high recharge rates needed to implement Flood-MAR. California has not put a high priority on availability of quality subsurface data, resulting in inadequate mapping of subsurface features that are relevant not only for Flood-MAR, but also for groundwater management in general. We need greater access to existing data and collection of higher quality data in the future. Key data types are drillers descriptive logs, borehole and surface (including airborne) geophysics, and core.

2. Subsurface hydrology data: greater accessibility to useable and better-quality data.

While the geology defines the framework for the aquifer as well as the non-aquifer sediments that typically compose a majority of California’s sedimentary (groundwater) basins, subsurface hydrology data on aquifer properties provide the means of defining the spatial distribution of properties needed to calculate (model) anticipated rates of recharge and the local and regional consequences of recharge. These data exist in the form of well testing and laboratory core analyses but in myriad reports and files such that most of the data is not available without time consuming searches. The subsurface hydrology data need to be compiled into a database that will provide adequate accessibility for Flood-MAR and SGMA. Furthermore, to define groundwater levels that determine the subsurface ‘space’ available for recharge and the system response to recharge and pumping, much better 4D groundwater level data are needed.

3. Hydrogeologic synthesis of data (mostly analysis, not "Research" or "Tool").

Hydrogeologic synthesis of data: The data must be analyzed to define the hydrogeologic architecture that ultimately determines the best locations for recharge and the local and regional benefits of that recharge. This synthesis must use the soils and subsurface geologic and hydrologic data to (a) define the geologic history and framework, (b) characterize the architecture of aquifers and aquitards as well as estimates of their properties (e.g., T, K, S, S_s), (c) combine the subsurface hydrogeologic data with soils data to identify the best locations for recharge. *The above will require new policy that establishes a subsurface characterization team within an agency with the mission of collecting, curating and hydrogeologically interpreting (mapping) the subsurface aquifer and non-aquifer sediments/rocks.*

Top Three Research, Data, and Tools Actions

As part of the recommendations provided to the co-chairs during the Research Advisory Committee (RAC) meetings; the RAC coordinators suggested to present consistent levels of information for all research themes to support a coherent message throughout the R&D Plan. Another recommendation was to define the top three actions items, corresponding description, connection to Flood-MAR, and the strategy for implementation that each theme wanted to move forward in the R&D Plan.

Based on these recommendations, the lead theme consulted and had to make some adjustments to the information provided by all subcommittee members. The final top three contributions and the format of how it was submitted to the RAC committee are shown below.

Priority 1

Action: Improve Subsurface geologic data and provide greater accessibility to useable and better-quality data.

Description and Connection to Flood-MAR: Subsurface geology data: Adequate implementation and management of Flood-MAR requires better characterization of the subsurface geology and soils that define strategic recharge locations where one can achieve the high recharge rates needed to implement Flood-MAR. California has not put a high priority on availability of quality subsurface data, resulting in inadequate mapping of subsurface features that are relevant not only for Flood-MAR, but also for groundwater management in general. We need greater access to existing data and collection of higher quality data in the future. Key data types are drillers descriptive logs, borehole and surface (including airborne) geophysics, and core.

Draft Strategy for Implementation:

1. Organize and consolidate the approximately 1 million existing well completion reports (well logs) and screen high quality logs for additional analysis.

2. Improve geolocation of high quality well logs and digitized lithologic and well construction information, including incorporation of any associated e-logs.

3. Organize and consolidate existing geophysical investigations, including downhole and surface geophysics.

4. Organize and consolidate existing drilling cores for use in detailed lithology review and confirmation of well log.

5. Conduct geophysical surveys (downhole and surface) to better inform connectivity of aquifer systems and lithologic observations.

Estimated Timeline:

Draft Costs Estimate (breakdown): $20 Million over 5 or more years.

Cost Estimate: $20 million

Priority 2

Action: Improve Subsurface hydrologic data and provide greater accessibility to useable and better-quality data.

Description and Connection to Flood-MAR: Subsurface hydrology data: While the geology defines the framework for the aquifer as well as the non-aquifer sediments that typically compose a majority of California's sedimentary (groundwater) basins, subsurface hydrology data on aquifer properties provide the means of defining the spatial distribution of properties needed to calculate (model) anticipated rates of recharge and the local and regional consequences of recharge. These data exist in the form of well testing and laboratory core analyses but in myriad reports and files such that most of the data is not available without time consuming searches. The subsurface hydrology data need to be gathered into a database that will provide adequate accessibility for Flood-MAR and SGMA. Furthermore, to define groundwater levels that determine the subsurface 'space' available for recharge and the system response to recharge and pumping, much better 4D groundwater level data are needed.

Draft Strategy for Implementation:

1. Consolidate and organize existing data pertaining to the aquifer and aquitard properties, including aquifer testing, laboratory core testing, infiltration testing, well performance testing.

2. Collect additional aquifer properties through aquifer testing to improve understanding spatial distribution of hydrogeologic properties based on improved subsurface geologic understanding (above).

3. Develop an accessible spatial database to allow for easy access and incorporation into various interpretative tools.

4. Utilize hydrologic information to characterize temporal variability to inform potential conditions for managed recharge at specific locations and ability for recharge water to reach targeted aquifer systems.

Draft Costs Estimate (breakdown): $10 Million over 10 years.

Cost Estimate: $10 million

Priority 3

Action: Synthesize hydrogeologic data.

Description and Connection to Flood-MAR: Hydrogeologic synthesis of data: The data must be analyzed to define the system hydrogeologic architecture that ultimately determines the best locations for recharge and the local and regional benefits of that recharge. This synthesis must use the soils and subsurface geologic and hydrologic data to (a) define the geologic history and framework, (b) characterize the architecture of aquifers and aquitards as well as estimates of their properties (e.g., T, K, S, Ss), (c) combine the subsurface hydrogeologic data with soils data to identify the best locations for recharge. The above will require new policy that establishes a subsurface characterization team within an agency with the mission of collecting, curating and hydogeologically interpreting (mapping) the subsurface aquifer and non-aquifer sediments/rocks.

Draft Strategy for Implementation:

1. Establish new policy that will support the establishment of a team within an agency to manage, organize, collect, curate, interpret, and report on consolidated subsurface hydrogeologic data to inform groundwater management and recharge efforts.

2. Develop a geologic history and framework to inform development of a quantitative hydrogeologic framework combined with mapped soils conditions to identify the best locations for recharge.

3. Provide a forum to engage with academic institutions to coordinate research needs and constructively build upon existing datasets to improve subsurface characterization

Estimated Timeline:

Draft Costs Estimate (breakdown): $20 million over 10 years.

Cost Estimate: $20 million