State of the Art Techniques in Characterizing, Design and Operating Optimum Surface Spreading Groundwater Recharge Projects

Session 3: Surface Spreading Applications

Michael Milczarek

17TH BIENNIAL SYMPOSIUM ON MANAGED AQUIFER RECHARGE
RESILIENCE THROUGH RECHARGE AND RECOVERY

Surface Spreading Applications

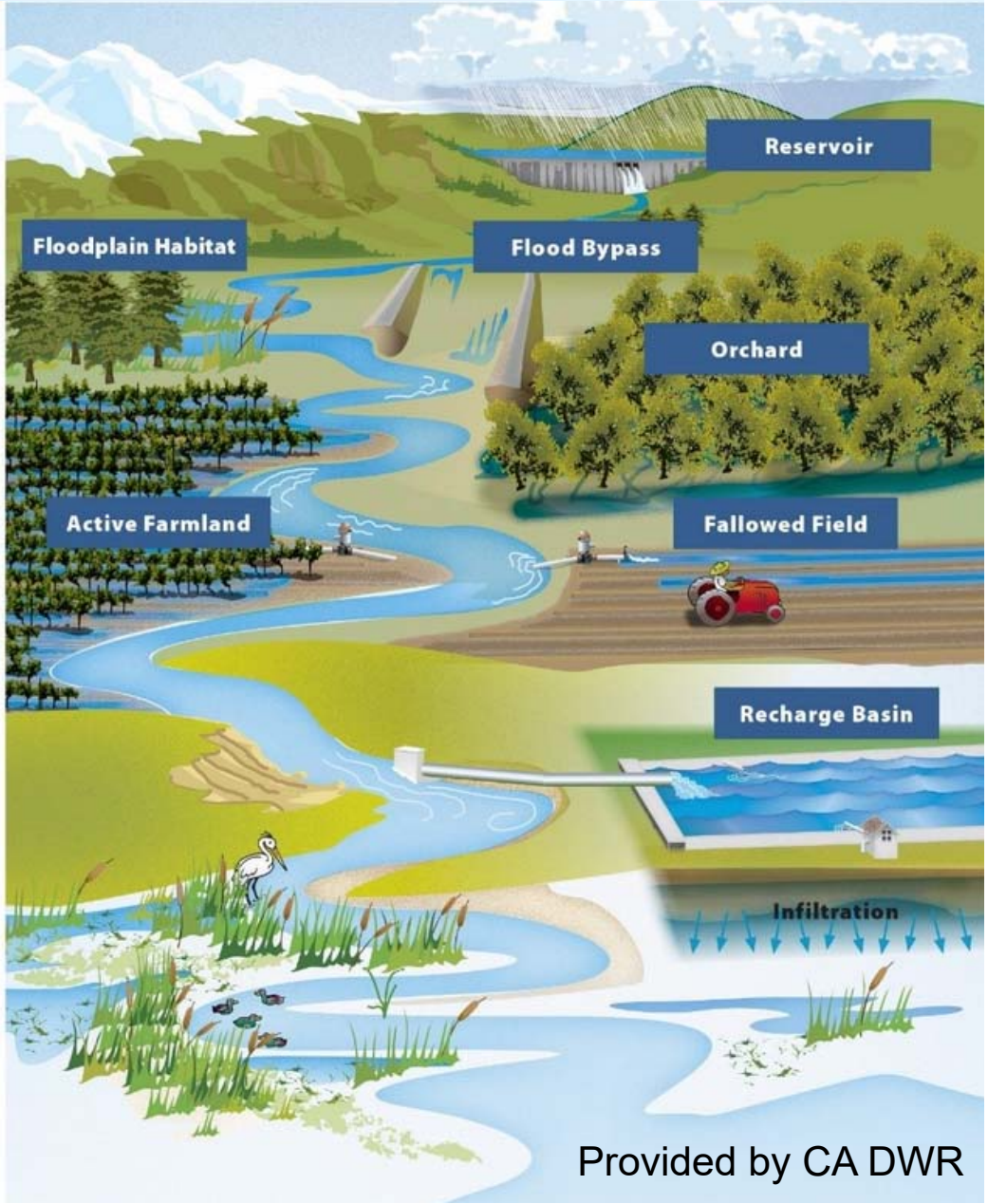
- MAR Basins
  - Dedicated surface water supply, effluent
- Riverbank/Bed Filtration
- Ag MAR, Flood MAR, On Farm Recharge (OFR)
  - Periodic flood/peak water
- Multi-benefit MAR
  - MAR to support riparian and wildlife habitat, Parks
- Stormwater Capture and Recharge
  - Detention, channel and basin recharge
- Recharge Enhancement Methods
  - Infiltration Galleries
  - Drywells and Vadose Zone Injection wells
  - Wick drains, Parjana EGRP

Riverbank/Bed Filtration

- Surface water treatment to remove sediment and lower organic carbon and macronutrients
  - Orange County Water District (Milczarek 2010)
  - Fifteen Mile MAR/ASR project (this conference)

Ag-MAR, Flood MAR, On-Farm Recharge

- Recharging flood flows into basins or farm lands
- In CA, 2 to 3 wet years every 10 years
- Extensive research into crop effects
  - Bachand et al., 2012, 2014, 2017, Dahlke et al, 2018
- Potential water quality effects
- Watch Plenary Session and other papers



Provided by CA DWR

Off-channel Basins
Groundwater Banks/Dedicated Fields

- Just in Kern County
  - AVEK WSSP
  - AVWB
  - Kern Water Bank
  - Pioneer Water Bank
  - Berrenda Mesa WD Water Bank
  - Kern Delta WD Water Bank
  - North Kern WSD Water Bank
  - Shafter Wasco ID Water Bank
  - Semitropic WSD Water Bank
  - Buena Vista WSD Water Bank
  - Rosedale Rio Bravo WSD Water Bank
- Growers Recharging
  - Sun World
  - Wonderful (Paramount)
  - Pacific Resources & Pacific Ag
  - JG Boswell
  - Marvin Meyers
  - Maricopa Orchards

Source: Renewable Resources Group

Multi-benefit MAR

- Walla Walla Watershed MAR
  - Approximately 7,000 afa used to support agriculture and maintain low flows in Walla Wall River
    - Scherberg et al., 2014, 2018
- Colusa County Multi-benefit MAR Project
  - MAR to support agriculture, DACs and migratory bird habitat
    - Barfield – this conference
- Parks (Effluent MAR)
  - City of Tucson Sweetwater Facility
  - City of Gilbert Riparian Preserve at Water Ranch
  - City of Sierra Vista Environmental Operations Park
  - Many others

Stormwater Capture and Recharge

- Numerous small-scale stormwater detention and recharge systems throughout AZ, CA, OR and WA
- Projects to quantify stormwater capture and recharge
  - Upper San Pedro River Basin
    - Lacher et al., 2014, Bunting – this conference
  - Stanislaus County Dry Creek Project
- Challenges:
  - How much runoff can be captured and when?
    - Most ephemeral/unallocated sources are ungauged
  - Sediment control and contamination?
  - Site hydrogeology?
  - Defining water rights/instream flow requirement/allocations

Recharge Enhancement Methods to Access Higher Permeability Sediments

Drywell Installation

- Over 50,000 drywells in Phoenix area alone
- Vadose zone injection needs very pure water and maintenance (Gastelum, et al, 2009)
- CA is developing new drywell guidance (water quality)

- Infiltration galleries have higher benefits than drywells
  - Restricted to 10-15 feet bgs


Infiltration Gallery

Underground Infiltration Galleries

Other Potential Recharge Enhancement Methods

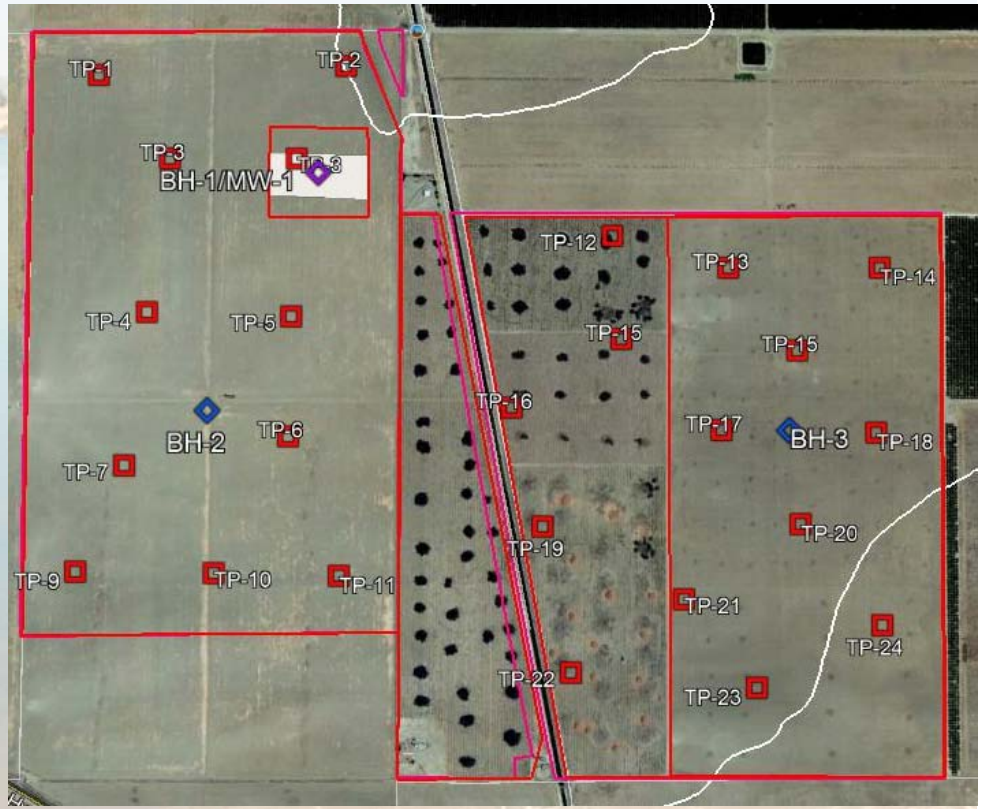
Provided by American Wick Drain

How Do We Make Projects Successful?

- Course is focused on basins – but same tools are needed for other applications
- Riverbed/bank filtration should be considered for surface water pre-treatment
- Ag/Flood/On Farm MAR has significant potential benefits but water quality needs to be addressed
- ALWAYS think of Multi-benefit MAR
- Stormwater capture and recharge has significant modeling and design challenges
- Site limitations may require use of recharge enhancement methods

Ag MAR Water Quality Case Study
Keck's Corner Water Bank

- Proposed 260 acre water bank
  - Five-acre pilot test (2019)
  - Water table approximately 80 to 90 ft bgs
- Monitoring:
  - Nested vadose zone and groundwater well (MW-1)
  - Inflow, weather station, stage
  - Drill core leaching tests
- Test ran for 3 months
  - Avg 1.0 ft/day infiltration
  - Wetting front arrival = 14 days
  - 1 PV = 38 days



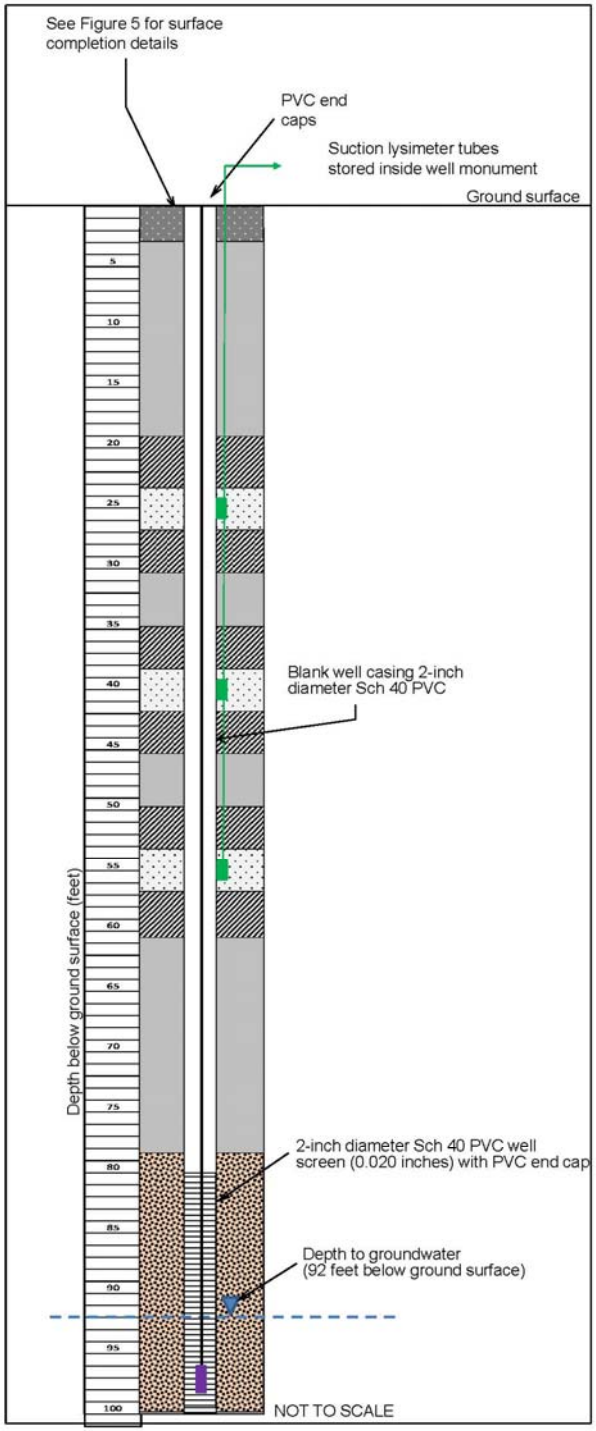


Figure 4.
Monitor Well Completion Diagram

INSTRUMENT KEY
(SUBJECT TO FIELD SELECTION OF TEST INTERVALS)

- Dual chamber suction lysimeter
- Solinist 3001 LTC Levelogger

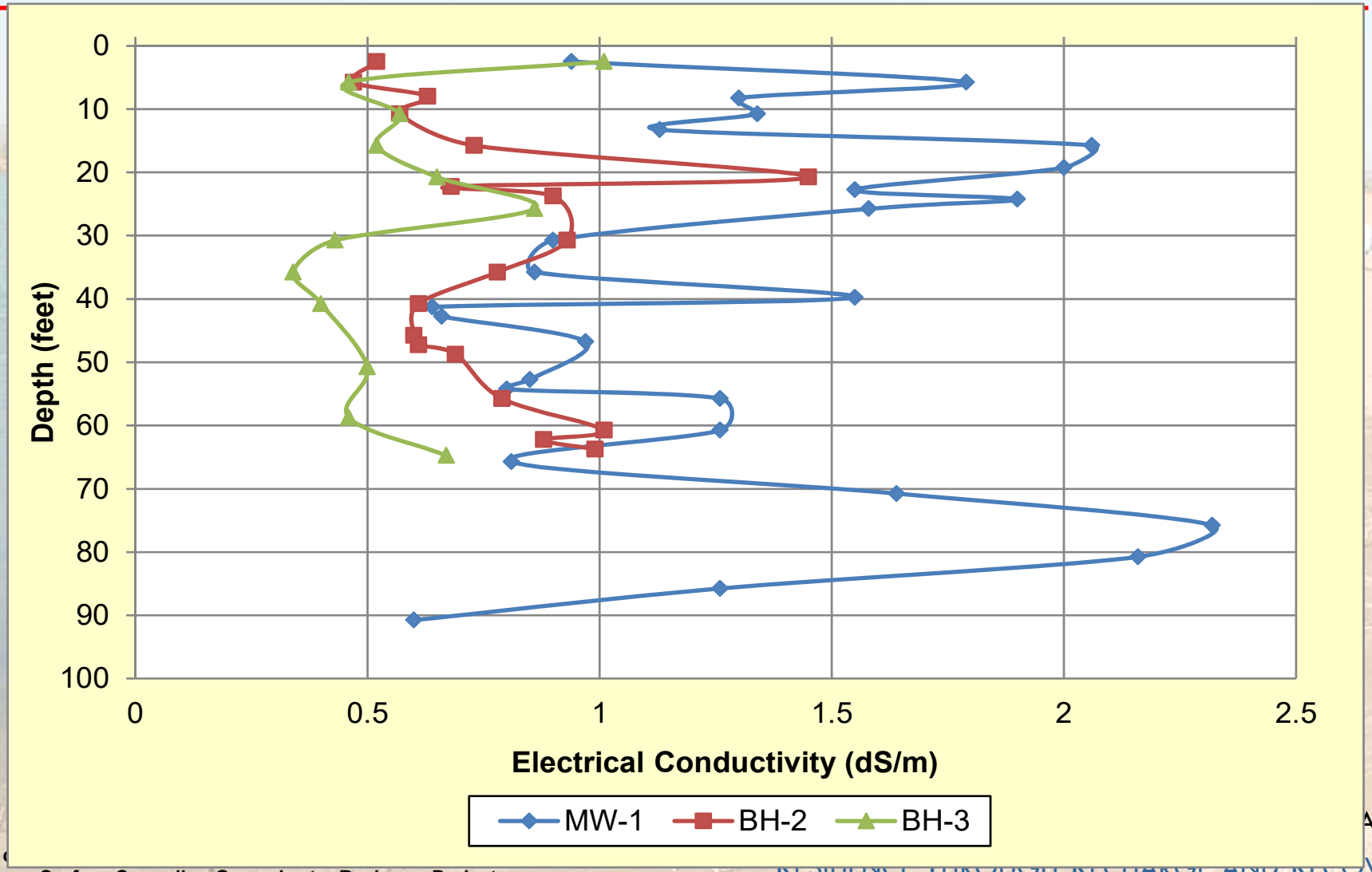
BACKFILL MATERIAL

- Concrete
- 8/12 mesh Sand
- 12-20 Sand/Silica flour mix
- Bentonite (3/8-inch chips)
- Bentonite (Granular)

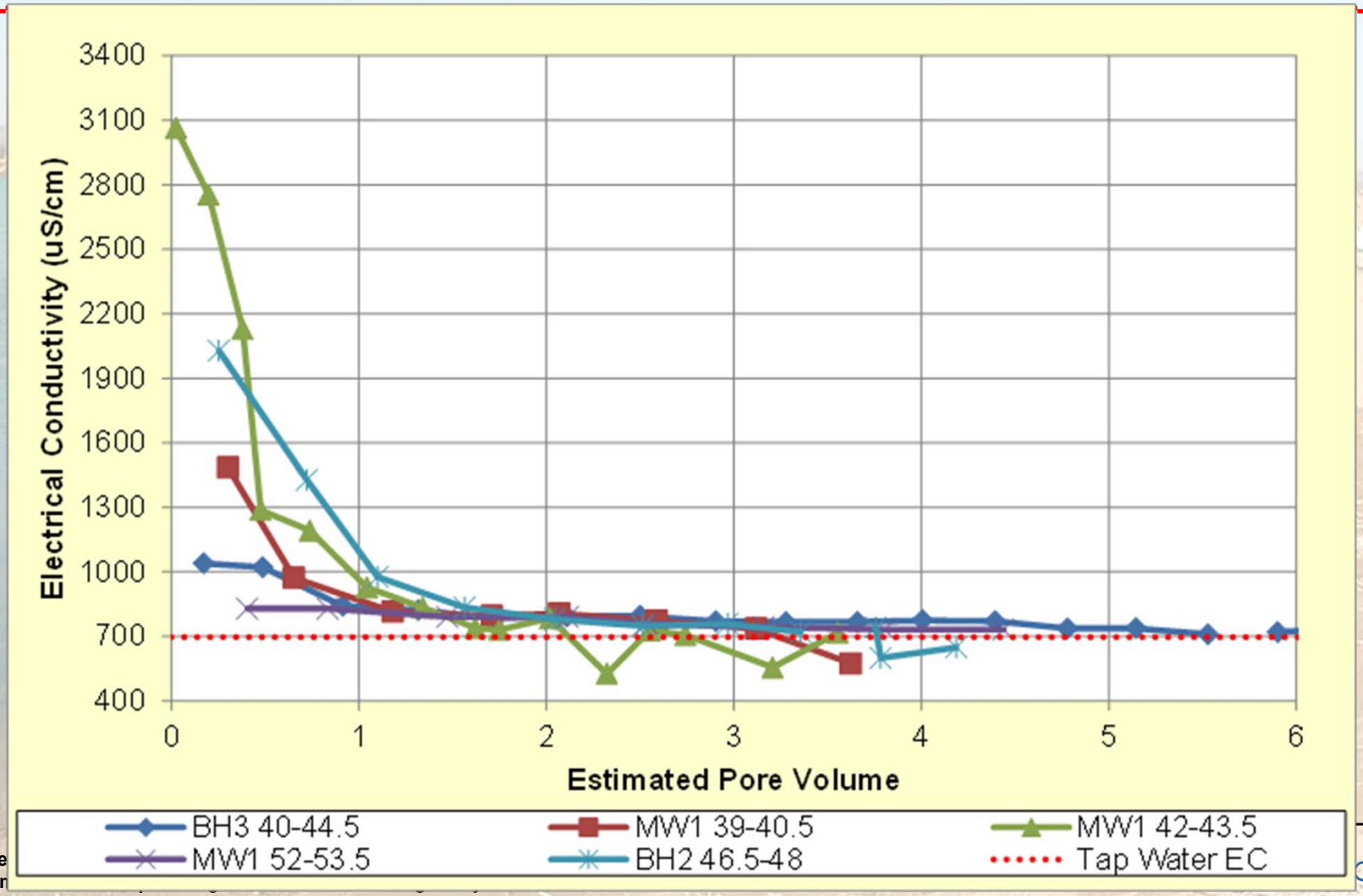
Prepared by:

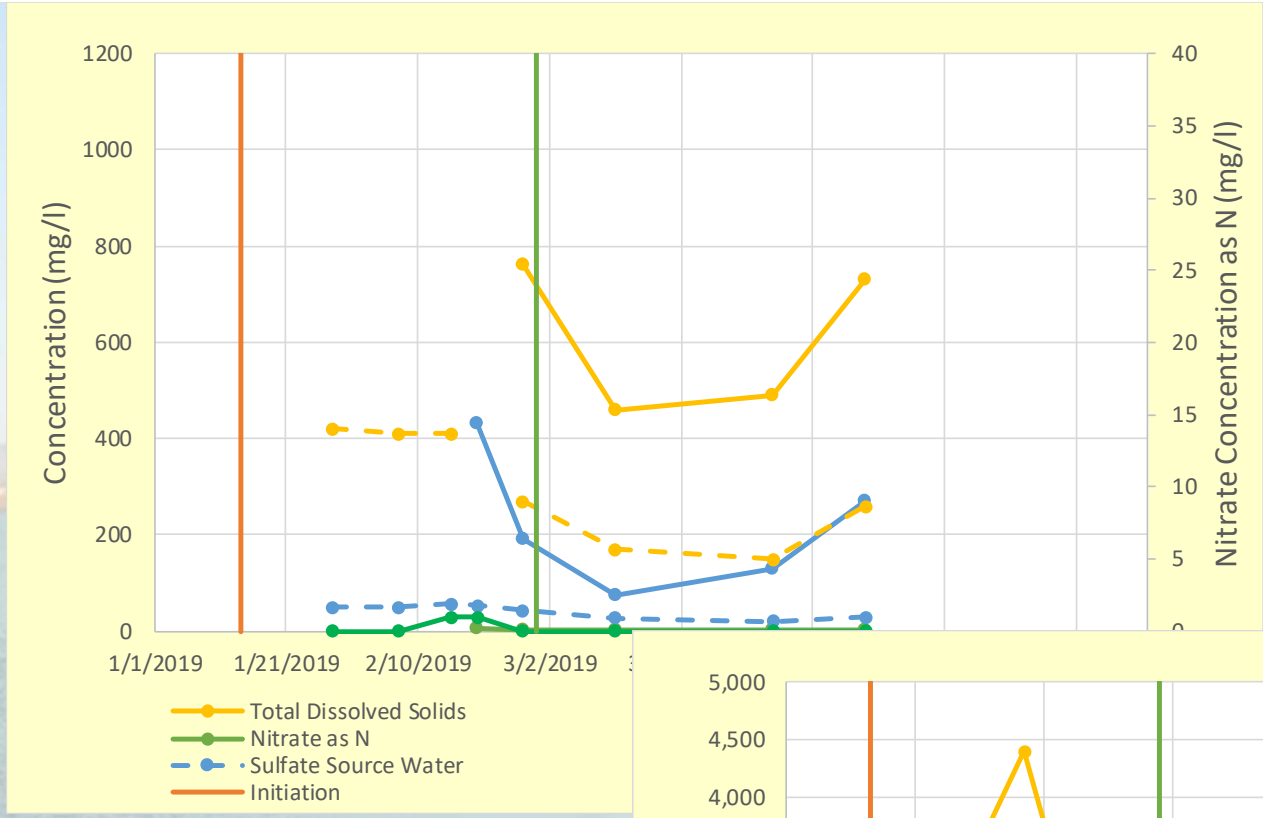
GSA GeoSystems Analysis, Inc.
Innovations in Hydrology

Drill Core 1:1 EC Extract

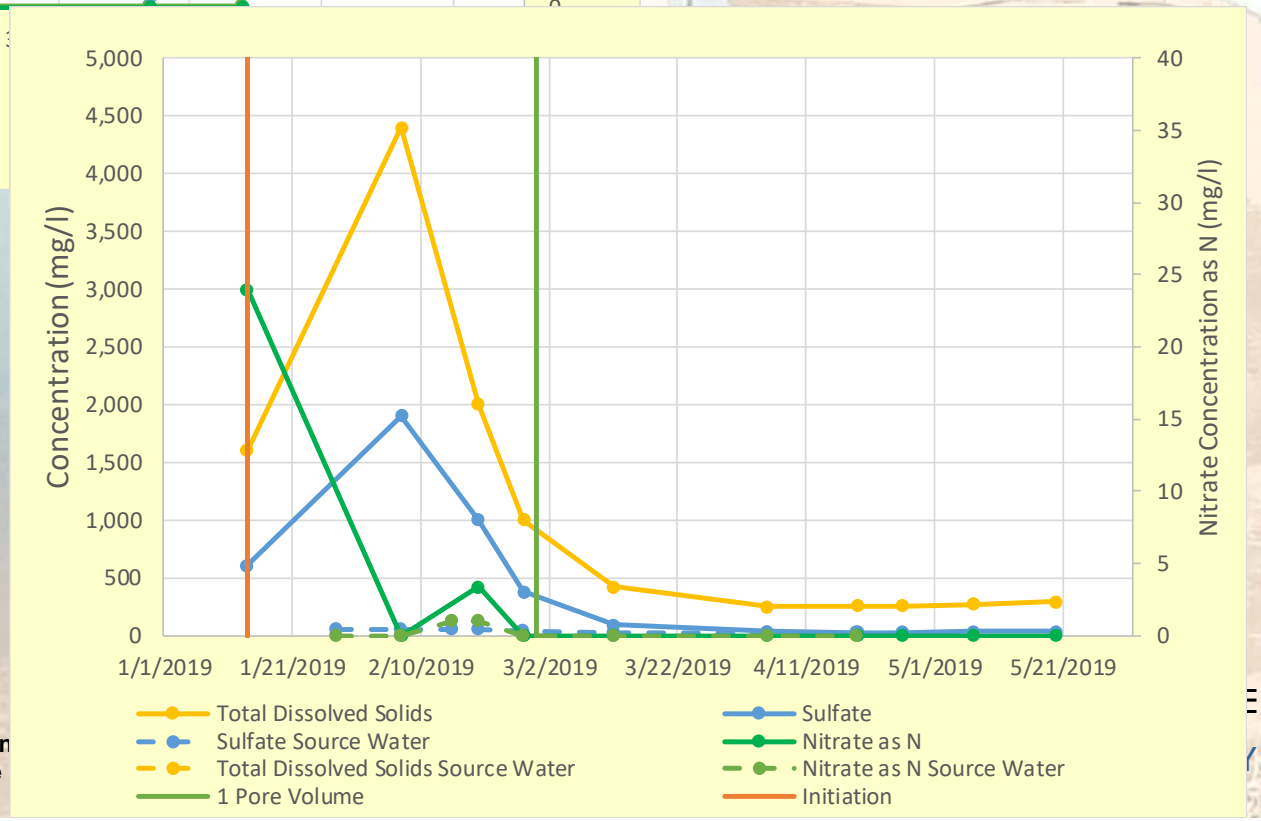


Drill Core Flushing Data



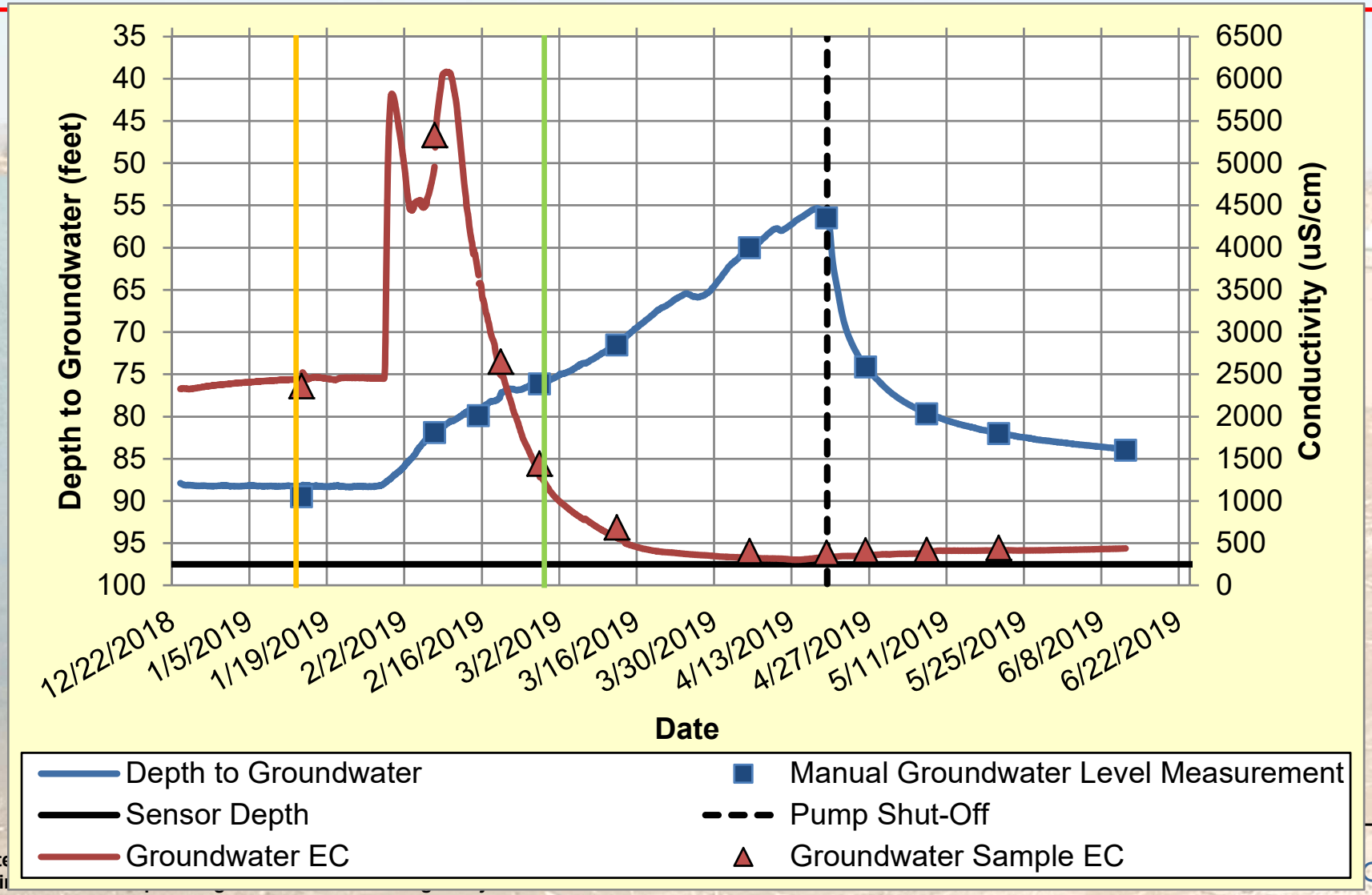


25 ft Lysimeter Water Quality Data



Groundwater Quality Data

Groundwater Data



Conclusions

- Potential water quality impacts depend on:
  - Length of historic agriculture and leaching fraction
  - By agricultural land use
  - By soil type
- Initial flush of water will most likely exceed SDWA parameters for TDS (secondary), possibly antecedent NO_3 and oxyanions
- Field studies indicate 1 to 3 pore volumes needed to flush majority of vadose zone
- Projected flushing is dependent on duration of recharge