Groundwater and Soil Salinity Monitoring Network in Support of Long-term Irrigation and Salt Management of MSCP Restoration Areas

CRTR

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Relevant MSCP Background

- MSCP tasked with creation and maintenance of riparian habitat on LCR.
- Regulated river systems/disconnected floodplains prone to salinization.
- Irrigation and aquifer management to:
  - Maintain vegetation.
  - Provide moist soils.
  - Maintain acceptable salinity.

Project Objectives

- Identify problems and management options for salinity management and riparian restoration.
- Characterize three MSCP sites:
  1. Beal Lake Conservation Area
  2. Palo Verde Ecological Reserve—Phase 2 and 3
  3. Cibola NWR Unit 1 Conservation Area
- Develop and calibrate a salinity model.
- Model irrigation and drainage management scenarios.

A Unique Case: Riparian Restoration and Salinity Management

- Riparian habitat—shallow groundwater and/or high irrigation rates:
  - Shallow groundwater →
    - No salt “sink” available in soils.
    - Capillary rise, evapotranspiration.
  - Irrigation →
    - Salt addition.
    - Increased groundwater elevation.

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SOIL AND GROUNDWATER SALINITY MONITORING

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Soil Sampling and Testing Methods

- Randomized block: within vegetation, and/or distance from irrigation source.
- Soil sampled to 6 feet below ground surface.
- Composite two-foot sample intervals.

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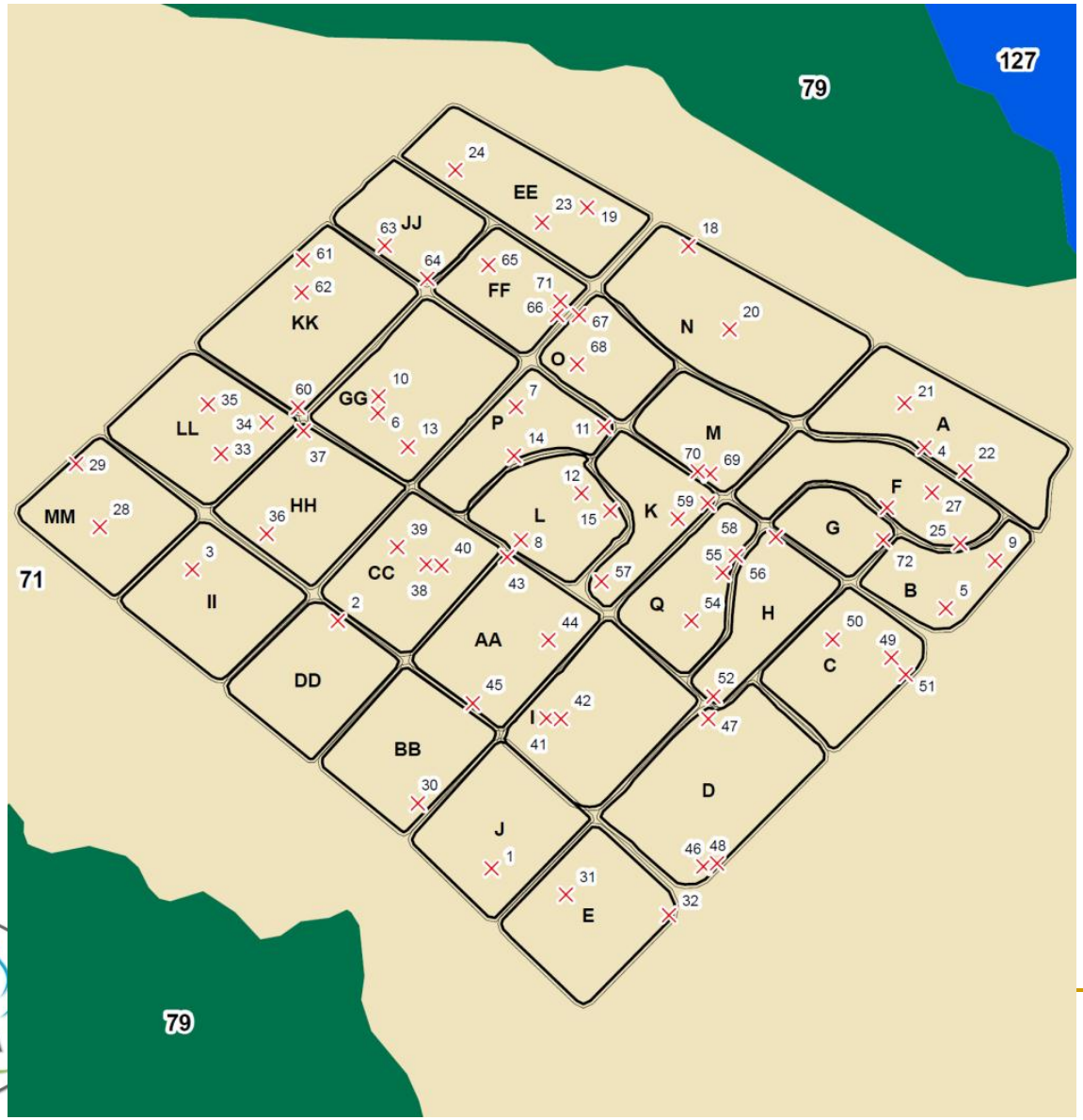
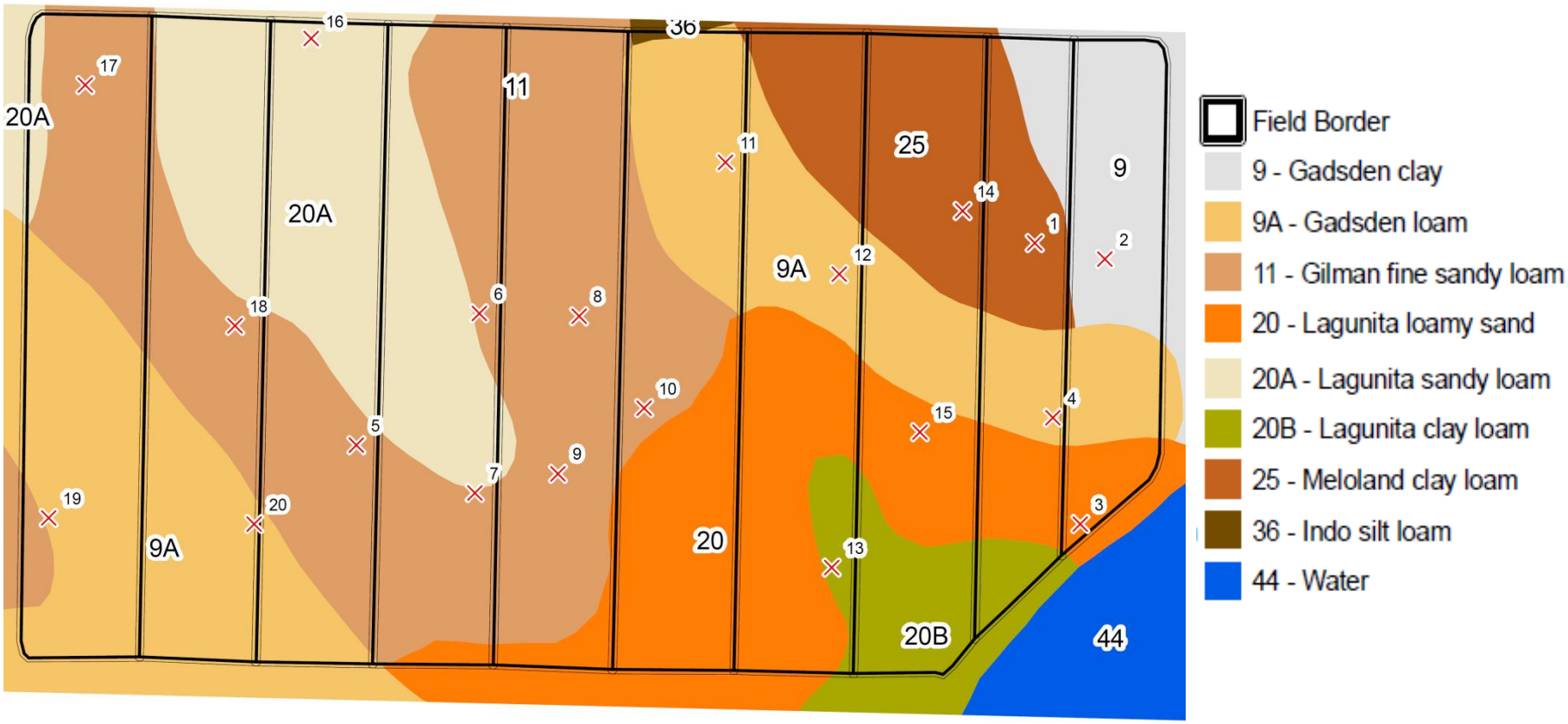
Beal Lake Conservation Area



Legend

- Field Border
- 71 - Lagunita Sand
- 127 - Water
- 79 - Marshes

PVER Phase 3



Total Area: 84 Acres
(~2000’ X 800’)

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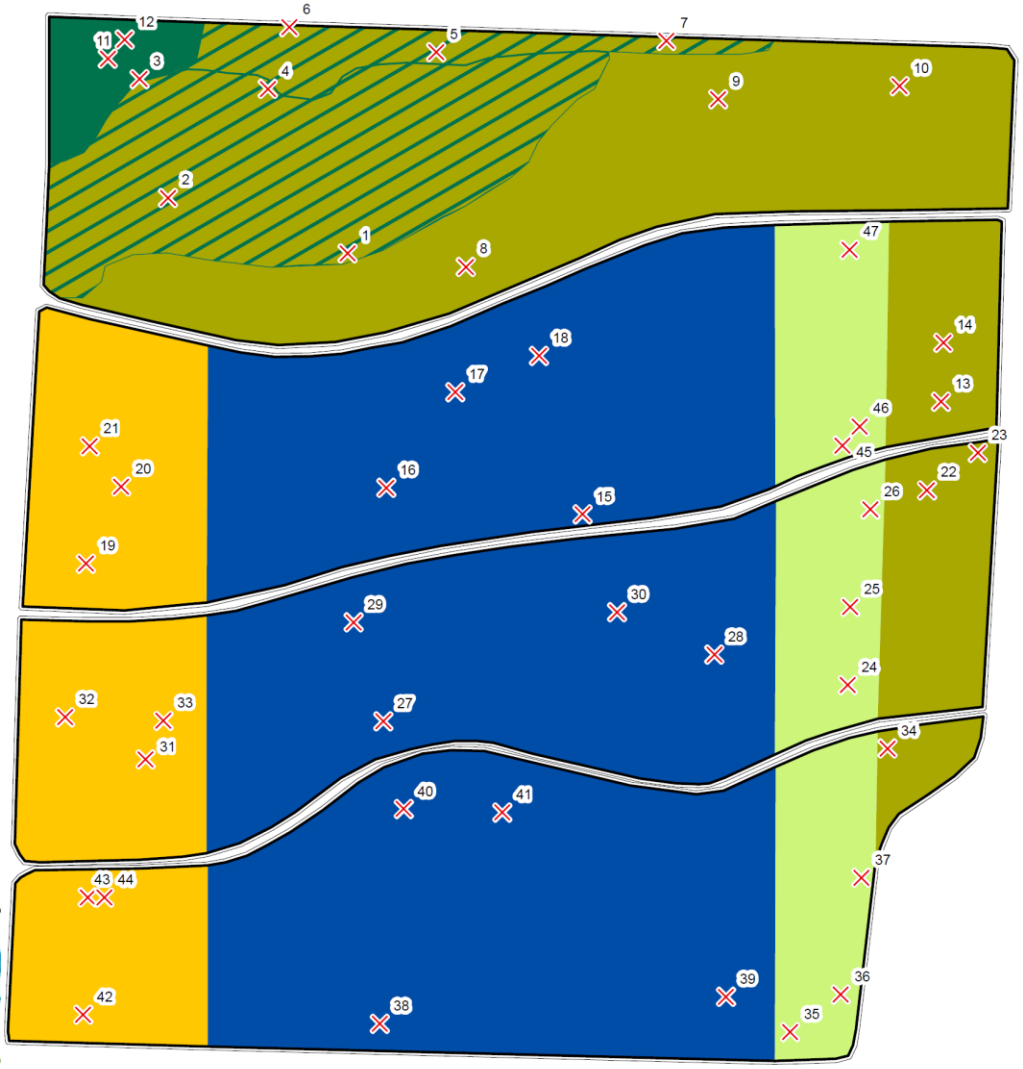
Soil Sampling Plan and Vegetation Variability: Crane's Roost at Cibola NWR

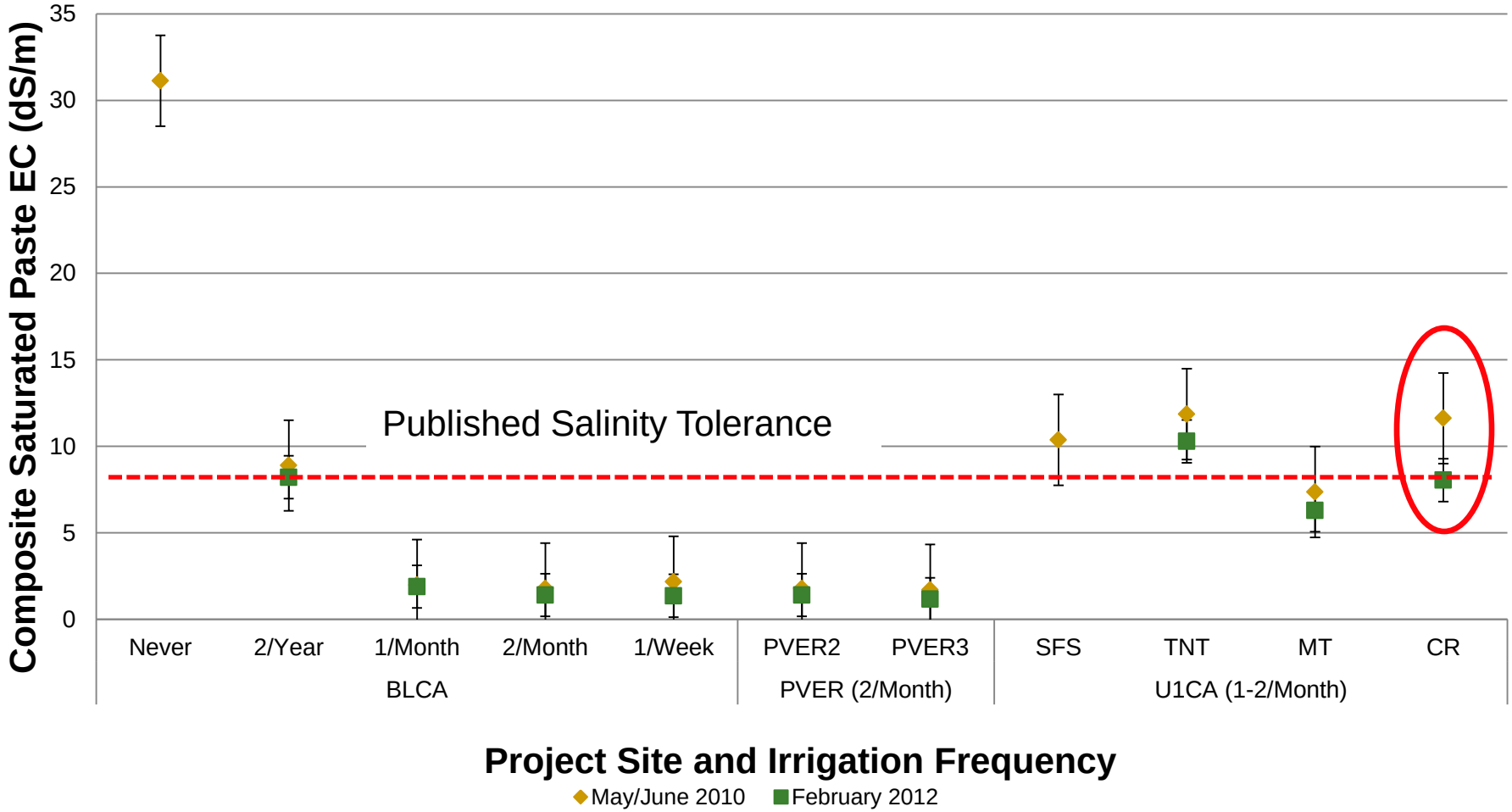


Legend

- Mesquite
- Mesquite w/ Riparian
- Cottonwood
- Coyote Willow
- Mixed Riparian
- Goodding's Willow
- Field Border

Total Area: 140 Acres
(~2000' X 2000')

Soil Salinity Results—Summary



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Soil Salinity Key Findings

- Soil Texture:
  - Lower EC with greater % sand, all sites.
    - Note—also lower soil moisture retention with higher % sand.
- Irrigation:
  - More Irrigation → Lower EC at BLCA and U1CA Crane Roost
  - No apparent irrigation effects at PVER.

Groundwater Monitoring

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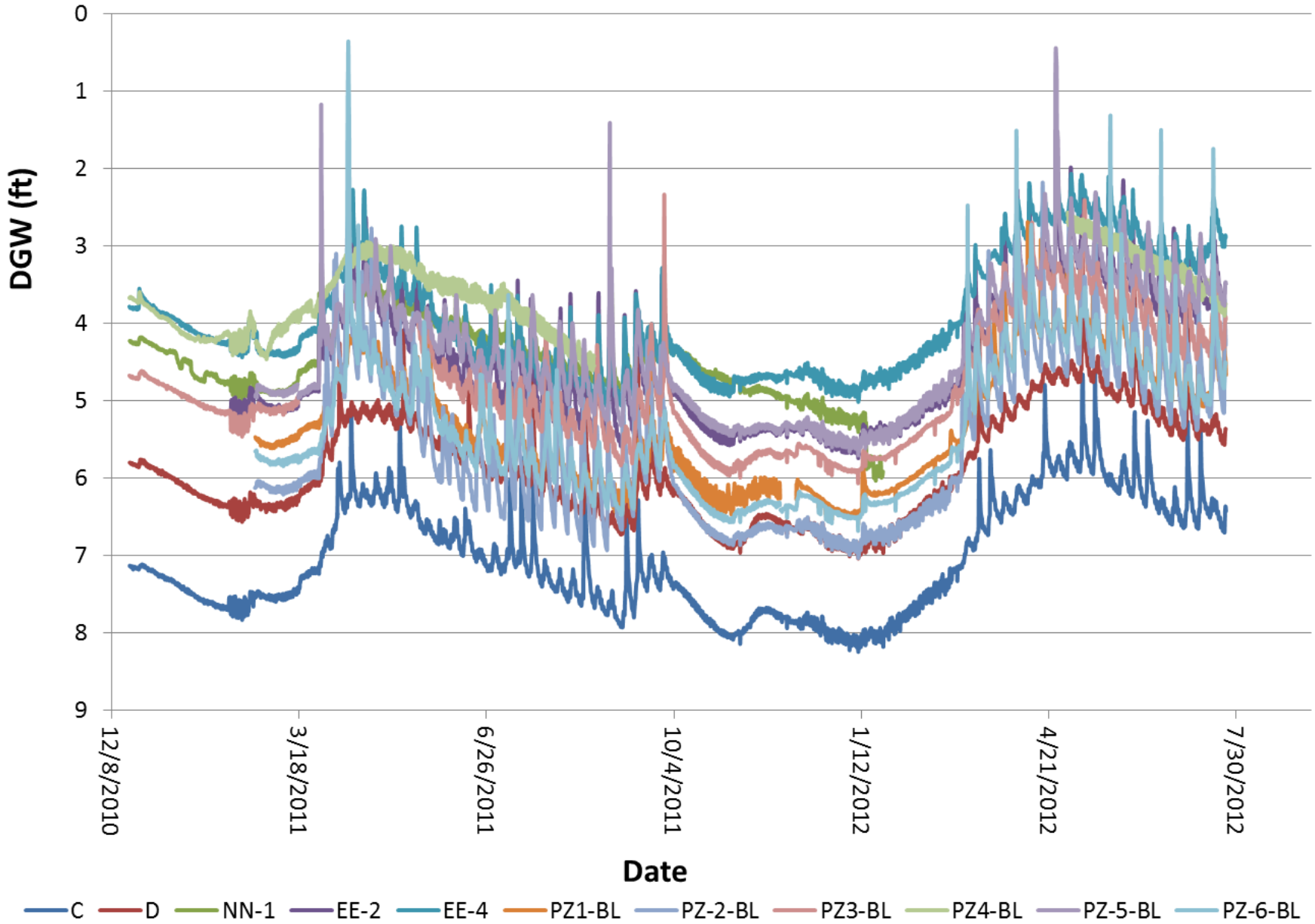
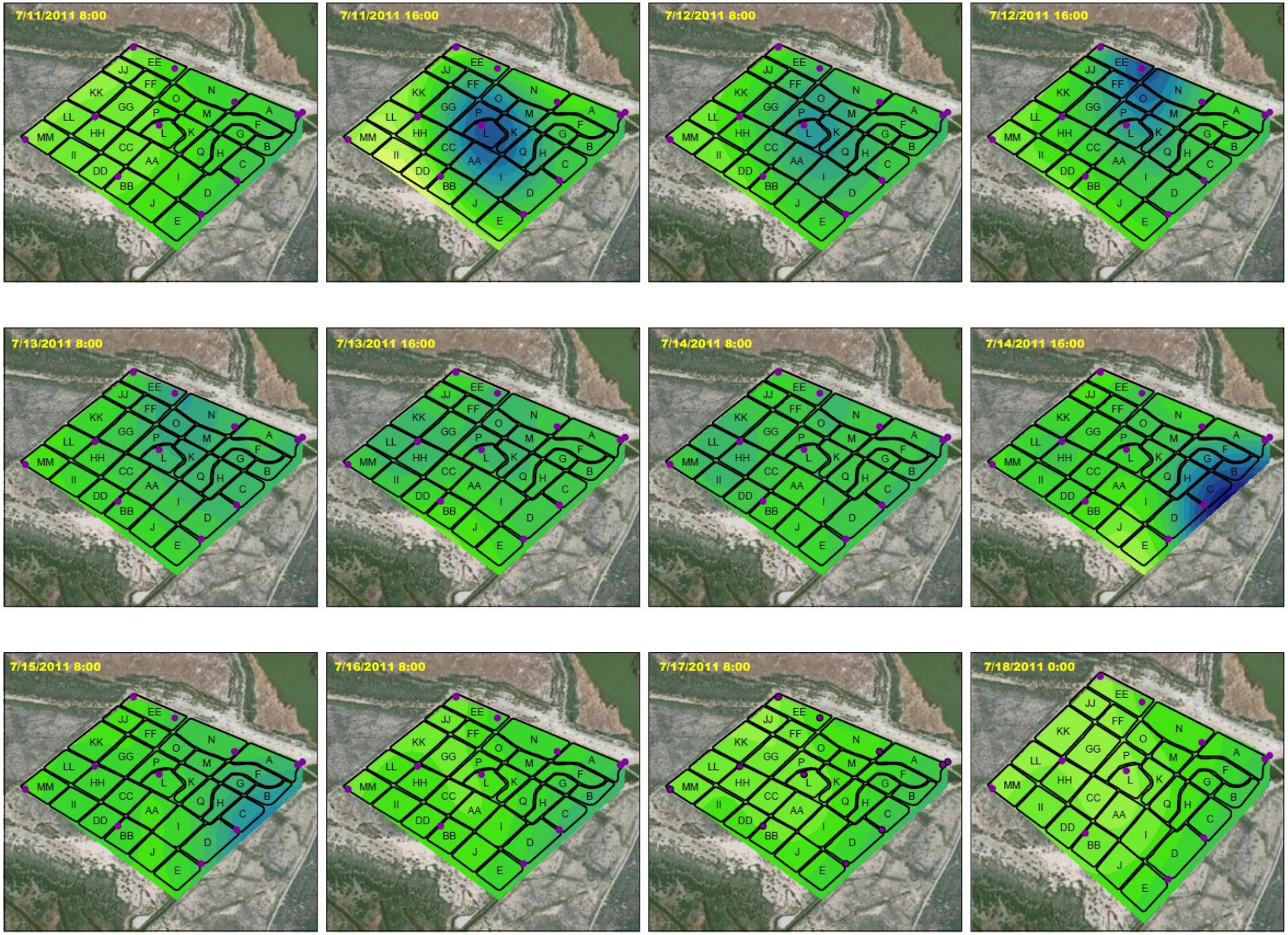
Groundwater Depth Data, Beal Lake Conservation Area



Beal Lake Conservation Area: Irrigation 3 (July 11, 2011- July 18, 2011)



Legend

Groundwater Elevation (feet above sea level)

- 454.3 - 454.4
- 454.41 - 454.6
- 454.61 - 454.8
- 454.81 - 455
- 455.01 - 455.2
- 455.21 - 455.4
- 455.41 - 455.6
- 455.61 - 455.8
- 455.81 - 456
- 456.01 - 456.2
- 456.21 - 456.4
- 456.41 - 456.6
- 456.61 - 456.8
- 456.81 - 457
- 457.01 - 457.2
- 457.21 - 457.4
- 457.41 - 457.6
- Well Locations
- Management Areas

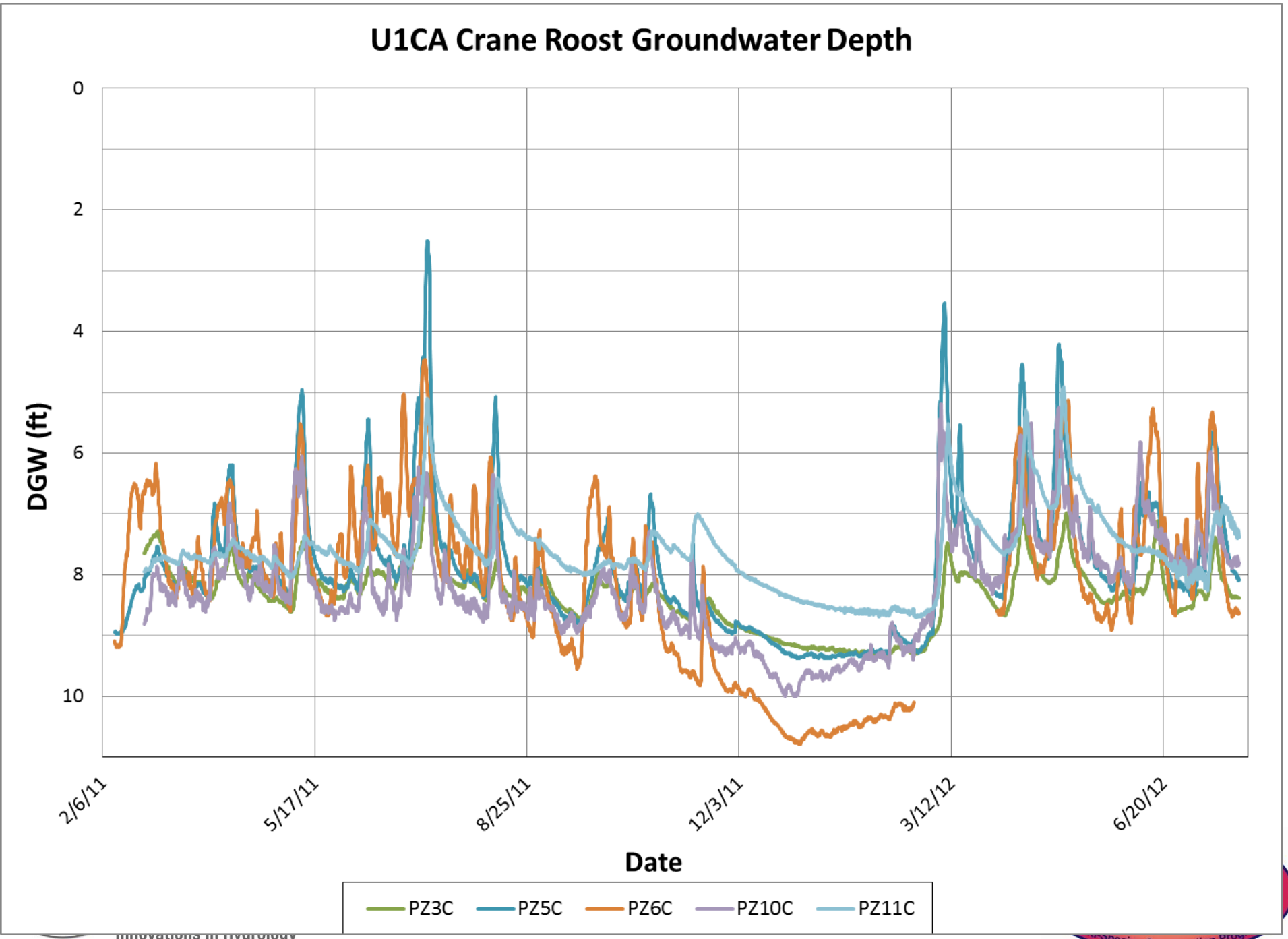
Map created by Jacob Scherberg and Chad McKenna
GeoSystems Analysis, Inc.
November 2012

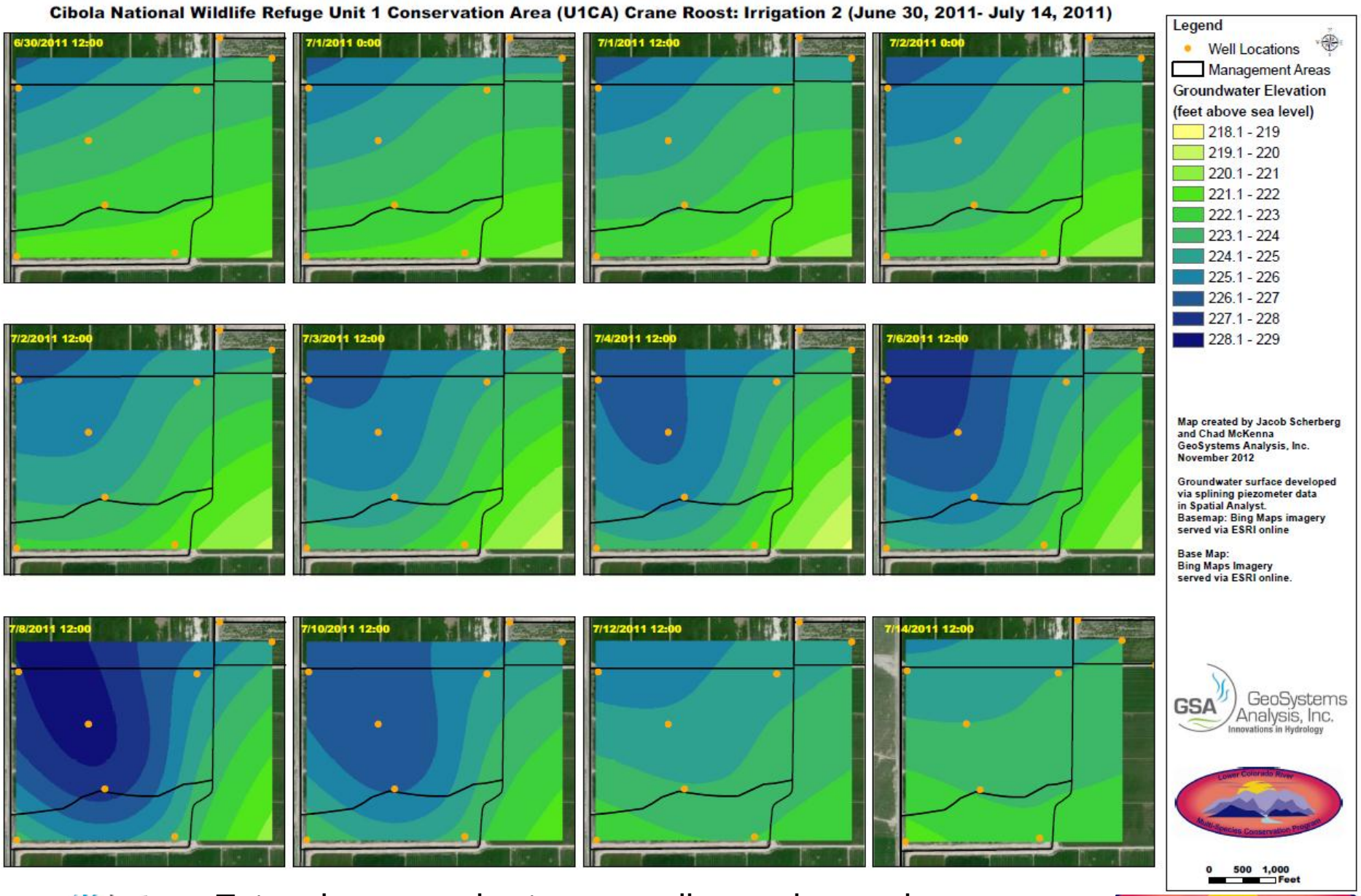
Groundwater surface developed via splining piezometer data in Spatial Analyst.

Base Map:
Bing Maps Imagery served via ESRI online.

0 500 1,000 Feet

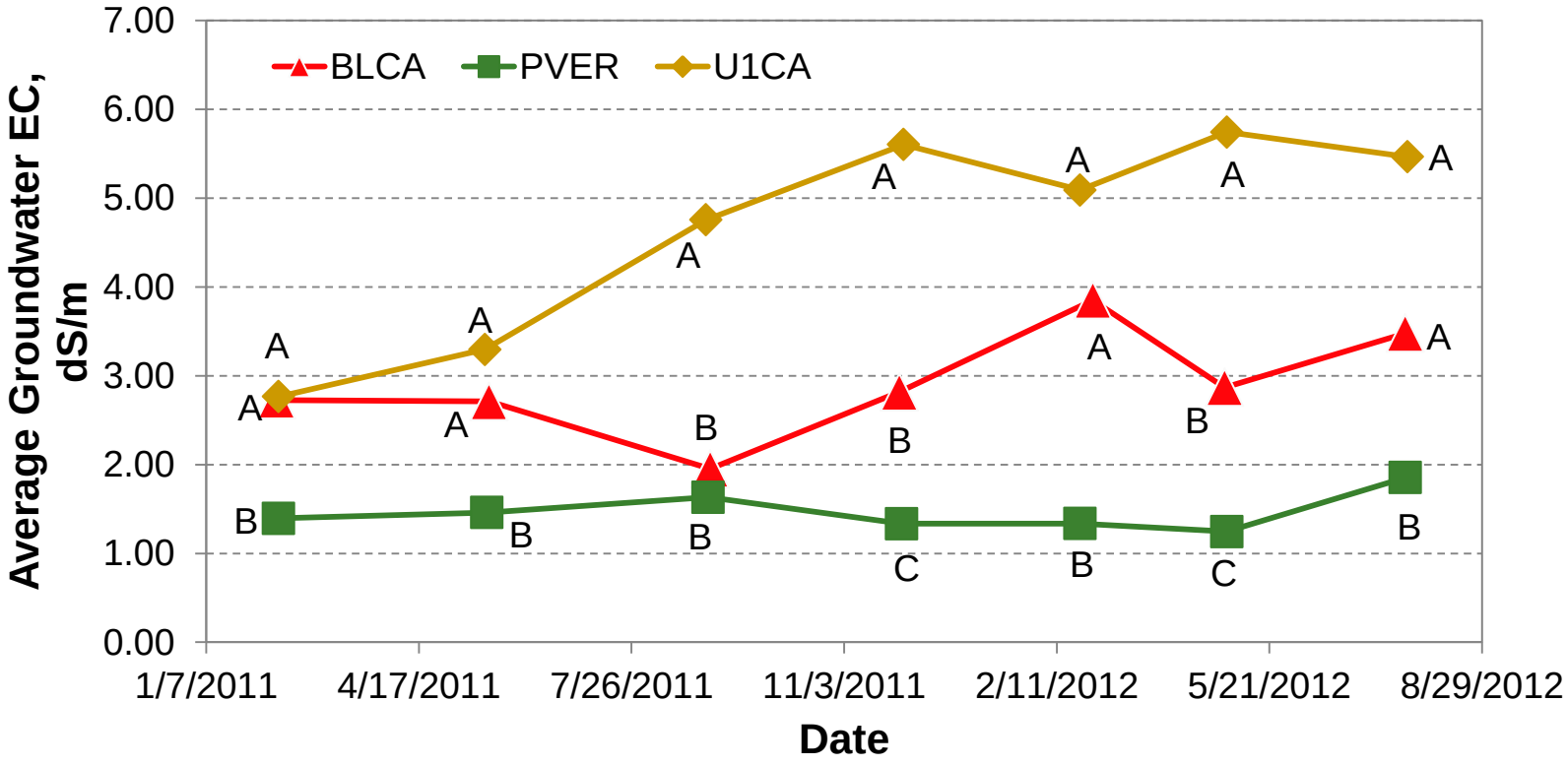
- Extremely rapid groundwater mounding and dispersal beneath irrigated and adjacent fields.


U1CA Crane Roost Groundwater Depth
DGW (ft)
0
2
4
6
8
10
2/6/11
5/17/11
8/25/11
12/3/11
3/12/12
6/20/12
Date
PZ3C
PZ5C
PZ6C
PZ10C
PZ11C



- Extensive groundwater mounding and very slow dispersal.

Groundwater EC



- Higher groundwater EC at Cibola, BLCA intermediate.
- Lowest EC at PVER—note: greatest depth to GW.
- Greater variation, and increasing trend at Cibola.

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SALINITY MODELING

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Beal, PVER, and U1CA Salinity Models

- SaltMod:
  - Interacting salinization processes.
  - Realistic management actions/options.

- Model Development:
  - Use available data to specify model parameters.
  - Calibrate to observed soil and groundwater salinity.
  - Analyze irrigation management and other mitigation strategies.
  - Detailed in MSCP report.

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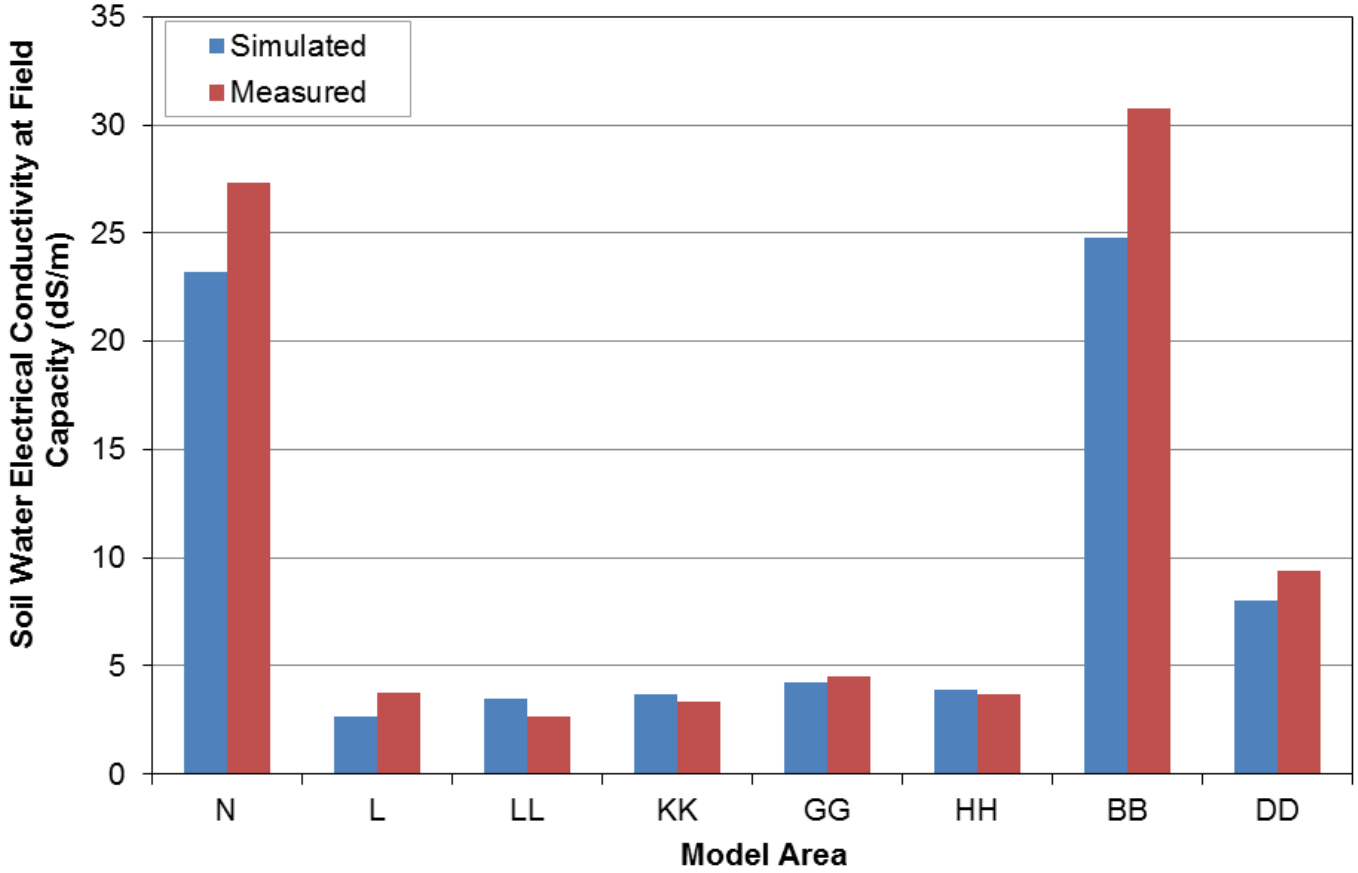
Model Development—Unsaturated Zone Calibration Parameters

- Storage Efficiency
  - Higher Value → More Moisture Retention
- Leaching Efficiency
  - Higher Value → Salts Easily Removed from Soil

Soil EC Calibration—BLCA



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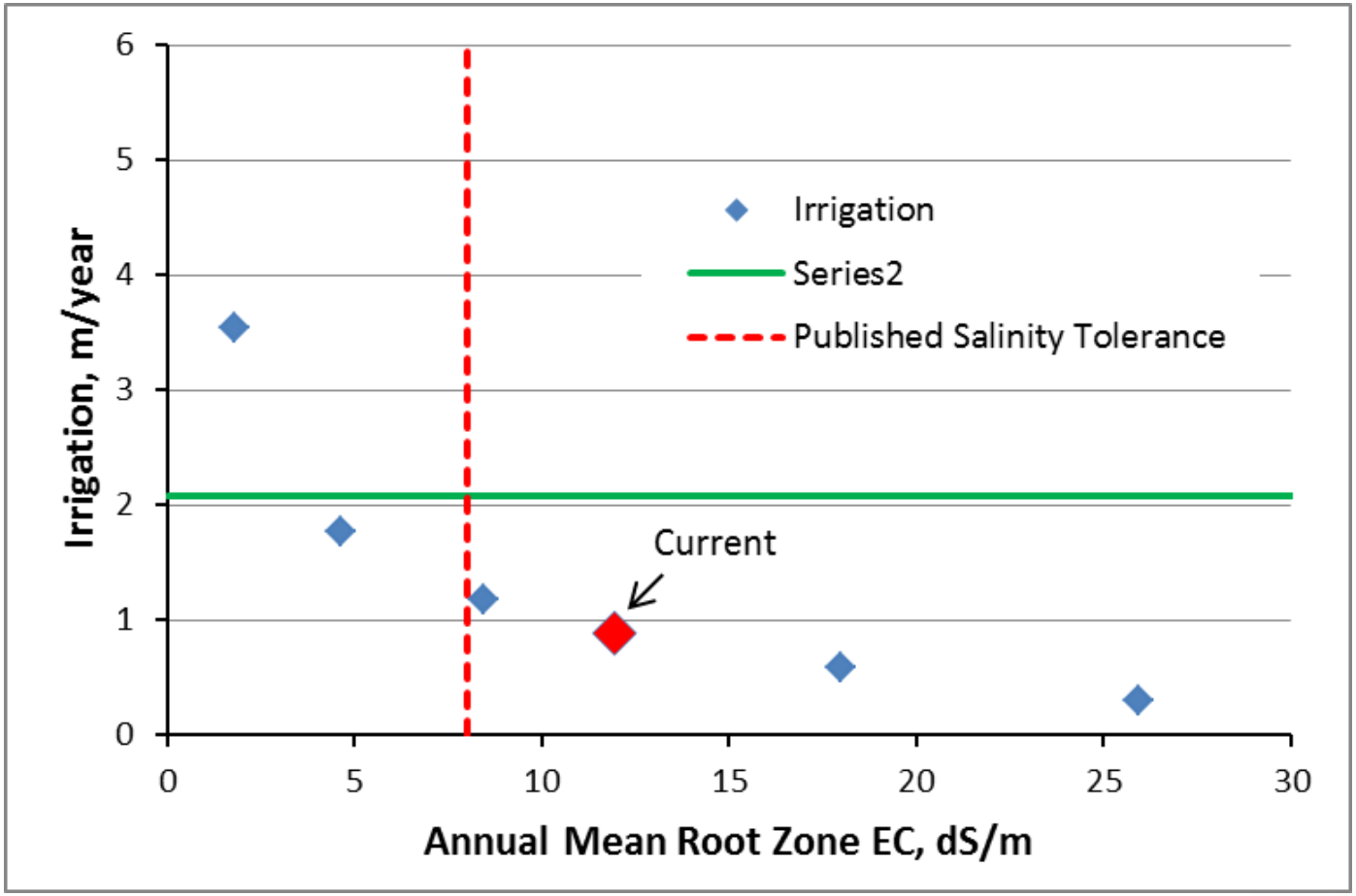
Model Application Example:
Beal Field N—Irrigated 3 times per year



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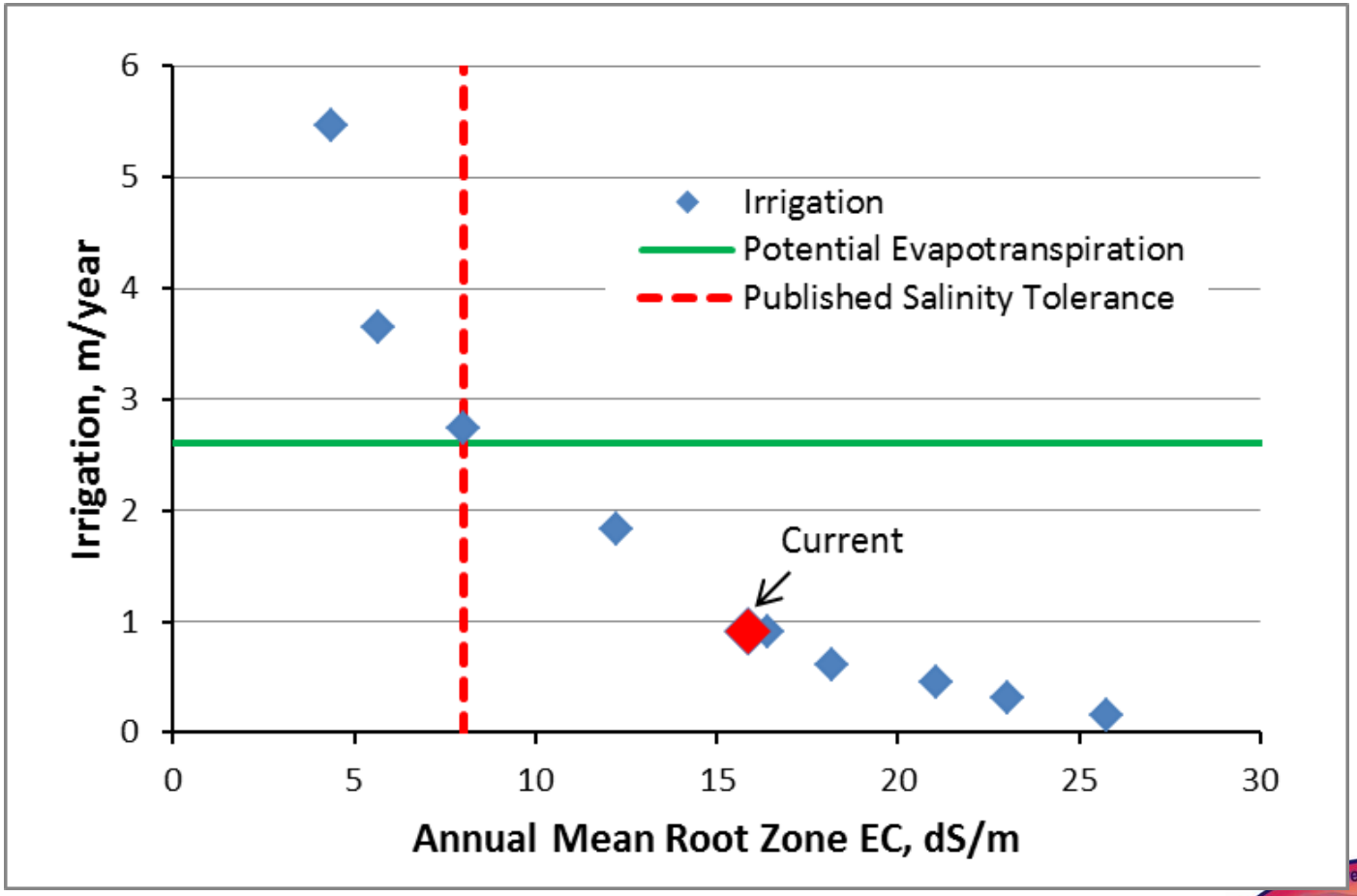
Model Application Example:
Cibola Crane Roost (Field 4)



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Conclusions

- Soil and groundwater salinity determined by:
  - Soil texture,
  - Depth to groundwater,
  - Groundwater flow rates, and
  - Irrigation and drainage management.

- SaltMod can be calibrated to current site conditions:
  - Good agreement with soil and groundwater salinity data.
  - Current limitations:
    - Require irrigation data.
    - Could not predict EC after a specified number of years—provides long-term “equilibrium” expectations.

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