Presentation Topics

1. Introduction
2. Groundwater Model
3. Water Budget and Groundwater Model Update
4. Groundwater Model Update Results and Uncertainty
5. Steps to Improve Groundwater Model Accuracy
6. Next Steps
Groundwater Sustainability Plan Process

Step 1
Water Budget Update (Sustainable Yield)

Step 2
Baseline Pumping Allocation

Step 3
Sustainability Goals and Objectives

Step 4
Identify Projects and Management Actions

Step 5
Develop an Implementation Plan
Including Pumping Allocation Reductions to Achieve Sustainability
Groundwater Model: One-Water Hydrologic Flow Model

- **MODFLOW** – developed by the USGS, MODFLOW is considered an international standard for simulating and predicting groundwater conditions.

- **Farm Process (FMP)** – Estimates dynamically integrated supply and demand components of irrigated agriculture in the absence of reported agriculture irrigation production data.

- **One-Water Hydrologic Flow Model (MF-OWHM)** – a MODFLOW-based model designed for the analysis of a broad range of integrated groundwater and surface water issues.

Source: USGS 2017
Groundwater Model: USGS Numerical Model Development

- OWHM is MODFLOW-2005 w/ unsaturated flow
- Finite-difference grid, center-node
- Estimated most of Ag pumping via Farm Process.
- Assumed Specific yield (Sy) = 15% (ranged from 0.5% to 30%)

Estimated Recharge

- Used regional USGS Basin Characterization Model (BCM) to define precipitation and potential evapotranspiration (PET) in Borrego Valley and adjoining watersheds.
- Runoff from adjoining watersheds to Borrego Valley simulated as streamflow entering at 24 entry points.
Update from 2011-2016

- **Precipitation and Evapotranspiration** - Obtained precipitation (PPT) and potential evapotranspiration (PET) from Basin Characterization Model (BCM) data from USGS
- **Land Use** - Update Land Use based on aerial imagery and water credit sites
- **Pumping** - Updated recorded pumping
- **Stream Flow** - Estimated stream flow based on historical data

These updated data were incorporated into the groundwater model to account for the overall water budget of the Basin
Water Budget and Groundwater Model Update: Conceptual Model - What is a Water Budget?

Water Budget includes:

**Inputs:**
- Streamflow leakage
- Precipitation

**Outputs:**
- Pumping
- Evapotranspiration

Source: DWR 2016
Water Budget and Groundwater Model Update: Model Characteristics

Major Inflow and Outflow

Inflow
Stream Flow: Coyote Creek, Palm Canyon

Outflow
Pumping:
Agriculture, BWD, Golf Courses

These data are applied to a grid which represents the Basin.
Land use types were updated based on documented fallowed water credit sites and aerial imagery. Each characteristic of land use is applied to its respective grid cell.
Water Budget and Groundwater Model Update: Surface Water Entry Points

Basin Characterization Model (BCM) estimates runoff outside of the One-Water Hydrologic Flow Model (OWHM) domain. Streamflow ultimately plays the largest role in recharge to the basin.
Groundwater Model Update Results and Uncertainty: Average Annual Water Budget (1945 – 2010)

**Inflows**
- Stream Recharge: 71%
- Groundwater Underflow: 24%
- Other: 5%

Inflows: 5,700 AFY

**Outflows**
- Pumping: 74%
- Et/Other: 22%
- Groundwater Outflow: 4%

Outflows: 13,700 AFY
Total Annual Recharge and Total Annual Pumping
Groundwater Model Update Results and Uncertainty: Cumulative Change in Storage

![Graph showing cumulative change in storage over time. The graph indicates a decreasing trend from 1945 to 2014. The y-axis represents cumulative change in storage (acre-feet), ranging from 0 to -600,000. The x-axis represents water years from 1945 to 2014. Two lines are shown: Model Update in red and Original Model in blue.]}
Groundwater Model Update Results and Uncertainty: Conceptual Graphic - 500,000 Acre Feet

Source: Google Earth

500 Feet = ~167 yards
Groundwater Model Update Results and Uncertainty: Observed vs. Simulated Heads

North Management Area - MW-1/21A01
Groundwater Model Update Results and Uncertainty: Observed vs. Simulated Heads
Groundwater Model Update Results and Uncertainty: Observed vs. Simulated Heads

South Management Area
Well ID1-8
Groundwater Model Update Results and Uncertainty: Residuals

Residuals = Observed - Simulated Hydraulic Heads
Groundwater Model Update Results and Uncertainty: Residuals in Spring 2016

Residuals = Observed - Simulated Hydraulic Heads

Map indicates areas which may require model refinement.
Steps to Improve Groundwater Model Accuracy: Model Sensitivity

- Estimated Agricultural Pumping: 68%
- Specific Yield: 11%
- Stream Recharge: 7%
- Other Factors: 11%
- Underflow: 3%
Steps to Improve Groundwater Model Accuracy: Recommendations to Refine Model

- Dudek proposes incorporating new data to refine the numerical model and reduce uncertainty over next 5 years.

- Three main areas to refine:
  - **Pumping** — Model estimates agricultural pumping using Farm Process. Metered agricultural pumping will markedly reduce uncertainty in model simulations.
  - **Specific Yield** — Future aquifer tests will refine aquifer storage properties in the model.
  - **Recharge** — The addition of stream gauges in distinct areas within the Basin will refine recharge estimates and reduce uncertainty.
Conclusions and Next Steps

- The USGS model has been updated to year 2016.
- The model appears to show good representation of actual conditions in the Basin.
- Uncertainty has been identified and will be quantified by Dudek as part of the GSP process.
- GSP must identify criteria for sustainable indicators (i.e. groundwater levels in key wells which must not exceed defined levels, decline in groundwater storage, etc.).
- The model can be used to evaluate predictive simulations of alternative projects and management actions.