CAP
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YOUR WATER. YOUR FUTURE.

CAP:SAM

Modeling Supply & Demand in the CAP Service Area

Service Area Model

- **CAP:SAM**
  - **Project Statement:** Develop a model, and supporting data, which projects future demands, and the water supplies used to satisfy those demands, for each major water-using entity in the CAP service area. The model must simulate a wide range of future conditions, including rates and patterns of growth, shortage impacts, effluent reuse, LTSC strategies, and complex supply portfolio management decisions.

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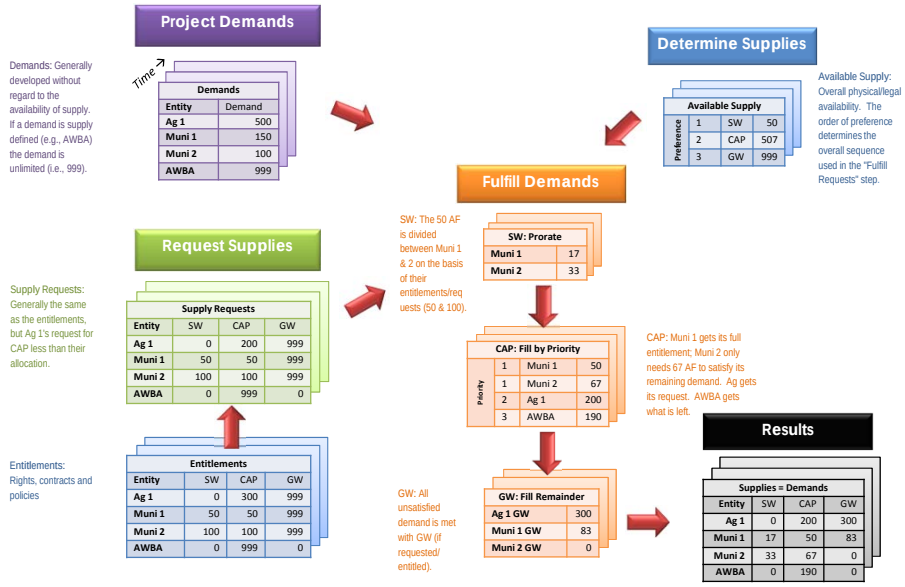
Model Steps

CAP:SAM performs a large number of interrelated supply and demand calculations, broadly organized into four conceptually simple steps

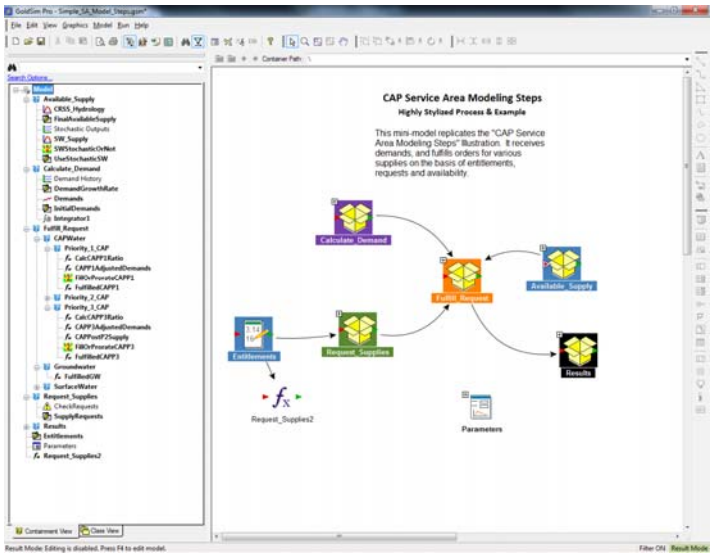
1. **Project Demands**
2. **Determine Available Supplies**
3. **Request Supplies**
4. **Fulfill Demands**

CAP Service Area Modeling Steps

Highly Stylized Process & Example

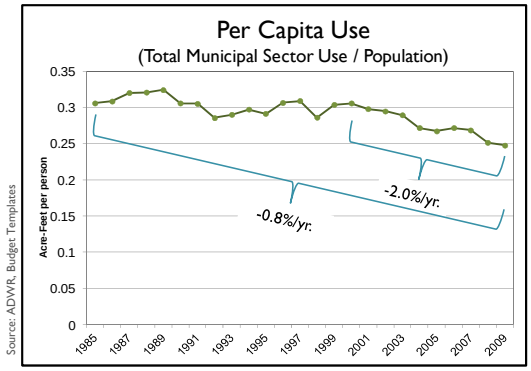


[Simple Model]



1. Project Demand

- The model differentiates between <u>new</u> and <u>existing</u> demand
- Existing demand is based on the last non-projection year, which can then be adjusted to reflect trends in use



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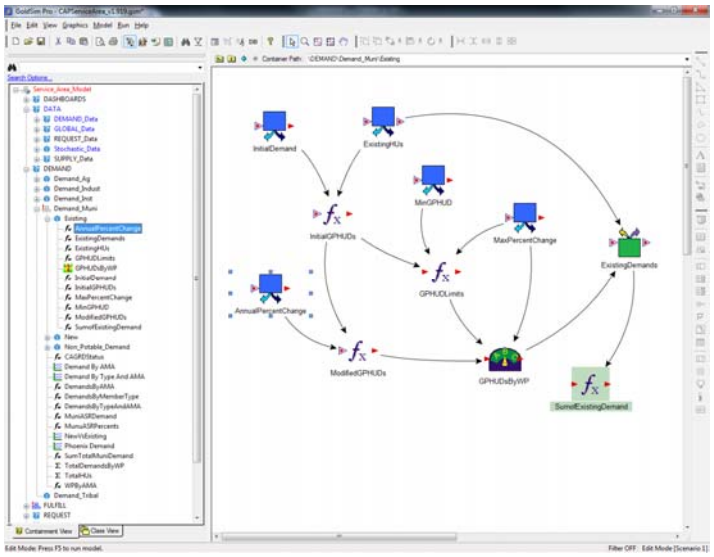
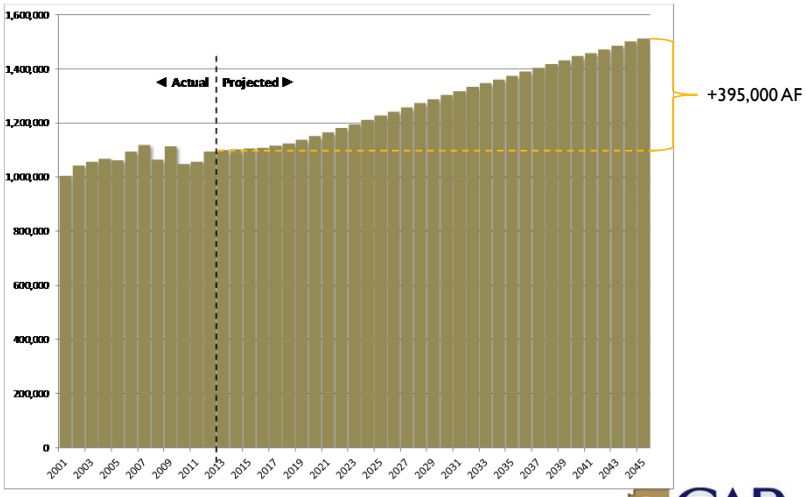
[Existing Demand]



Total Municipal Demand



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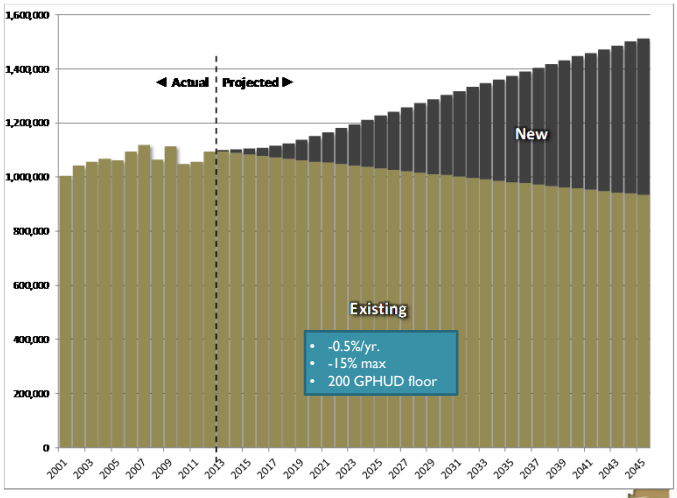
Total Municipal Demand



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1. Project Demand: New

- New demand is tied to housing unit projections for each water provider's anticipated service area
  - Calculation includes the demand from the housing unit itself, as well as a fraction of other service area uses (e.g., commercial uses, parks, etc.)
- The model considers both the **rate** and **location** of growth in four steps
  a) Develop Housing Unit Projection
  b) Spatially Distribute Housing Units Among Water Providers
  c) Convert Housing Units to Demand
  d) Calculate Member Land Demands

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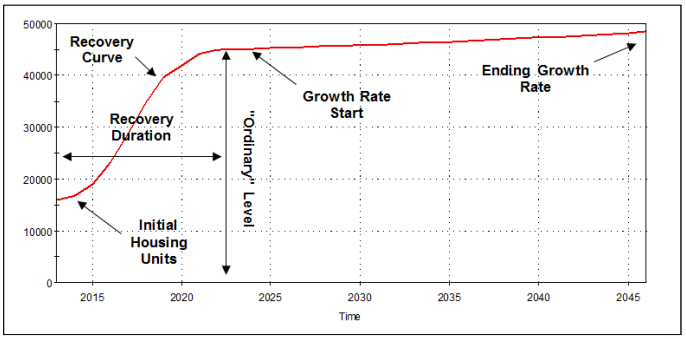
1. Project Demand: New

a) Develop Housing Unit Projection
- Annual growth can be adjusted to account for the effects of the housing bust, and longer-term trends



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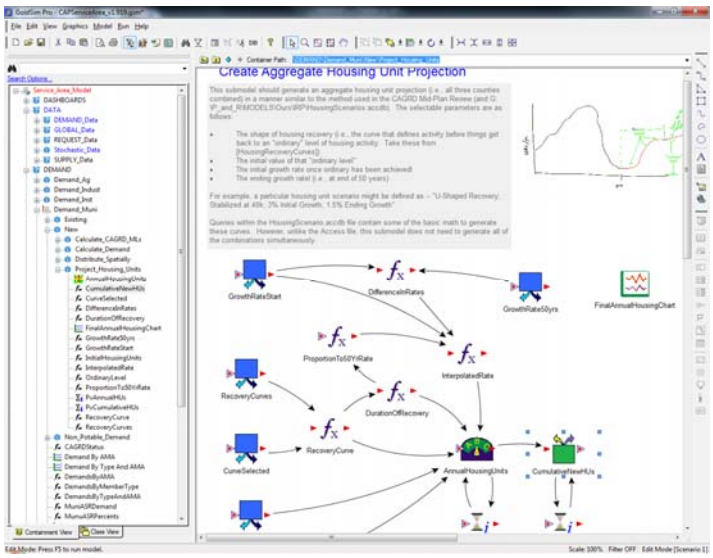
[Develop HU Projection]

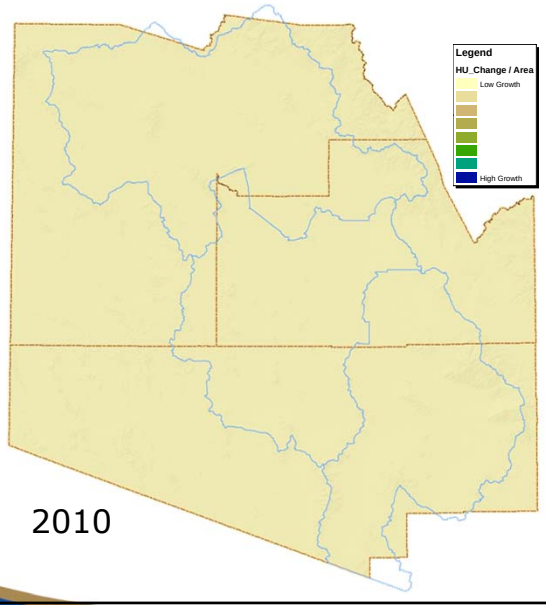


1. Project Demand: New

b) Spatially Distribute Housing Units Among Water Providers

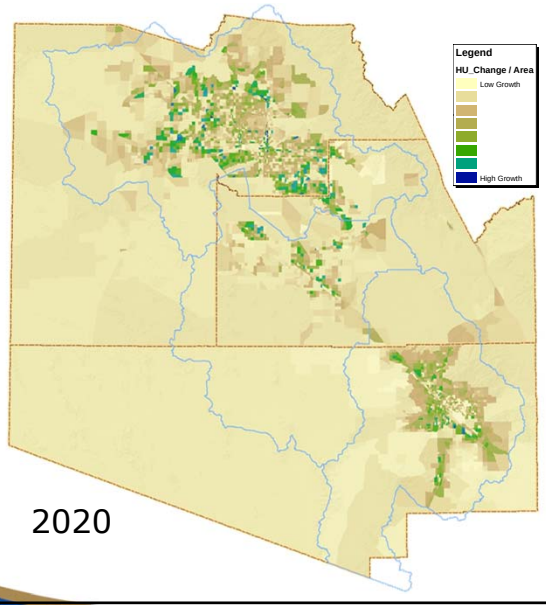
- The location of new housing units is critical for determining both demand and CAGRD obligation
  - Different water use characteristics for each provider
  - Different water supply portfolios
  - Different AWS Rules
  - Different relationship to CAGRD
- The model begins with a reference spatial projection
  - TAZ-level data from MAG, CAG & PAG are attributed to water providers using a GIS overlay

Projected Growth



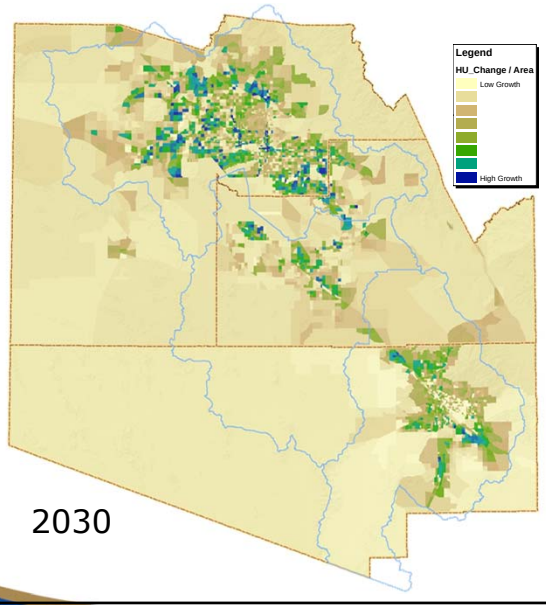
2010

Projected Growth



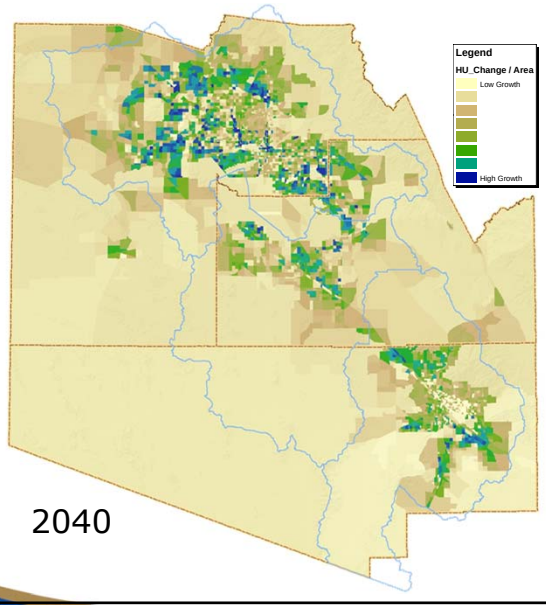
2020

Projected Growth



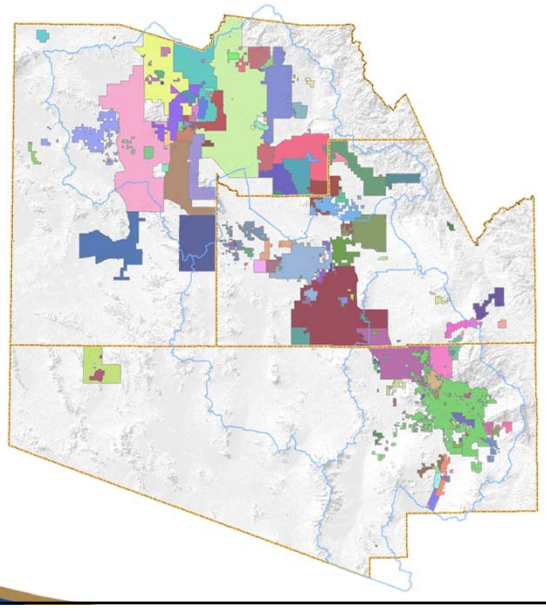
2030

Projected Growth

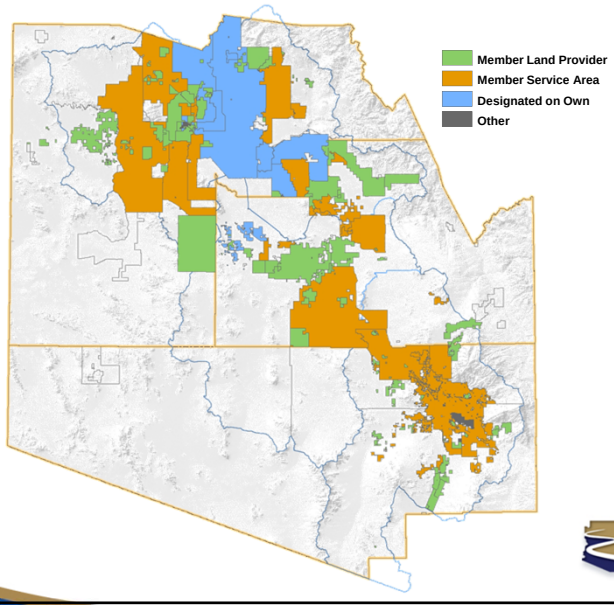


2040

Water Providers



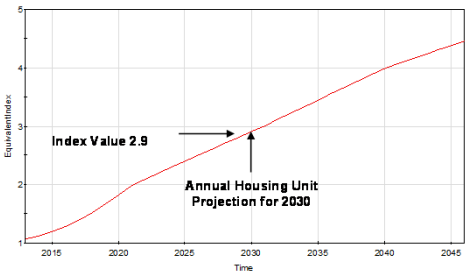
Water Providers



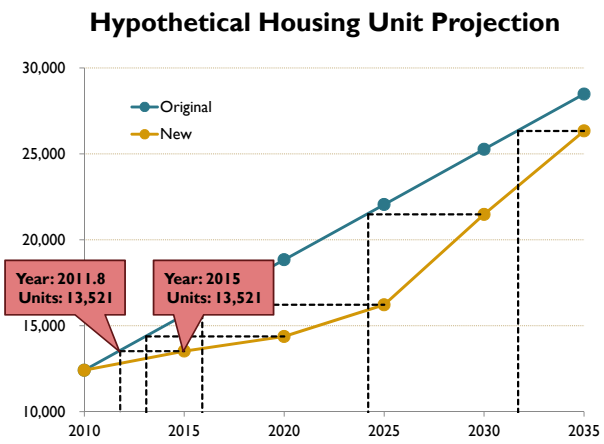
1. Project Demand: New

b) Spatially Distribute Housing Units Among Water Providers

- The model dynamically adjusts the reference housing unit projection to match the annual housing unit projection



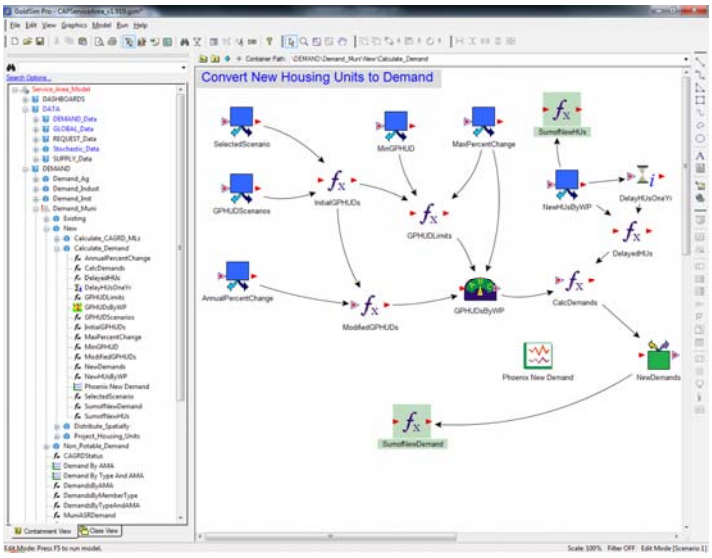
1. Project Demand: New



1. Project Demand: New

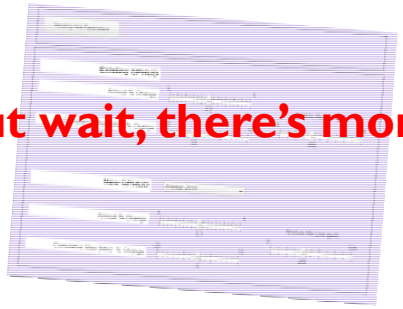
c) Convert Housing Units to Demand
- Housing units are multiplied by a provider-specific GPHUD
  - Different from Existing GPHUD
- User selects a set of GPHUDs (developed outside of model), and can adjust rate of change, max change and minimum floor
  - Different from Existing GPHUD adjustments

[convert to demand]



1. Project Demand: New

- The result is a unique demand forecast for each water provider, based on exiting demand, projected housing units, estimated demand per housing unit, and assumptions about the rate of change in demand per housing unit



But wait, there's more!

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1. Project Demand: New

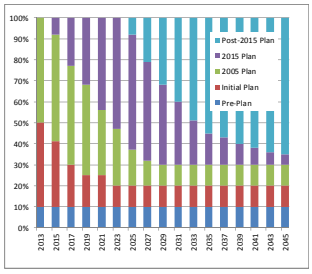
c) Calculate Member Land Demands

- Only applies to Undesignated providers (regardless of whether currently serving MLs)
  - Note: AWS/CAGRD status can change through time
- Projected housing units from previous step are further differentiated by five categories

Notation	Enrollment Category
E	Exempt (e.g., pre-95 subdivisions, infill lots, etc.)
P1	Plan 1 ("Initial Plan")
P2	Plan 2 ("2005 Plan")
P3	Plan 3 ("2015 Plan")
PP3	Post-Plan 3

1. Project Demand: New

- Allocation ratios are necessary to account for existing vs. new enrollment, as well as exempt lots and post-2024 activities
- The "seed" ratios in the Plan were developed based on a general assumption that the likelihood of a subdivision developing diminishes the longer it has been sitting idle



1. Project Demand: New

- The "Exempt" ratio is applied first
- For the remaining units, at each timestep, for each provider, the model attempts to allocate the housing units using the ratios
- Based on the providers' inventory of enrolled but unbuilt housing units, which is tracked, there are four possible outcomes

Notation	Allocation Scenario	Result
a	Sufficient inventory	Units are allocated based on the reference ratios
b	Insufficient Plan 1 inventory	Unallocated Plan 1 units are reallocated to Plan 2, Plan 3 and Post-Plan 3
c	Insufficient Plan 2 inventory	Unallocated Plan 2 units are reallocated to Plan 1, Plan 3 and Post-Plan 3
d	Insufficient Plan 1 & Plan 2 inventory	Unallocated Plan 1 & 2 units are reallocated to Plan 3 and Post-Plan 3

1. Project Demand: New

- The model determines which of the four allocation scenarios applies to each individual provider through a series of algebraic formulae

$$CO_a = 1.0$$

$$CO_b = \frac{T - U_{P1}}{T \times (R_{P2} + R_{P3} + R_{PP3})}$$

$$CO_c = \frac{T - U_{P2}}{T \times (R_{P1} + R_{P3} + R_{PP3})}$$

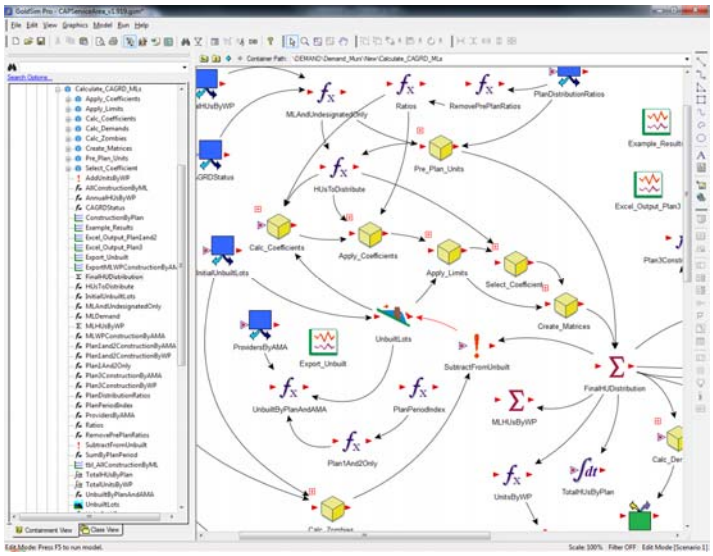
$$CO_d = \frac{T - (U_{P1} + U_{P2})}{T \times (R_{P3} + R_{PP3})}$$

where,
$CO_{a,b,c,d}$ = each the four possible coefficients
T = total housing units to be allocated
$U_{P1,P2}$ = unbuilt inventory from Plan 1, and Plan 2
$R_{P1,P2,P3,PP3}$ = reference distribution ratios for Plan 1, Plan 2, Plan 3, and Post-Plan 3

$$A_{P1} = \min(U_{P1}, (T \times R_{P1} \times CO_x))$$
$$A_{P2} = \min(U_{P2}, (T \times R_{P2} \times CO_x))$$
$$A_{P3} = (T \times R_{P3} \times CO_x)$$
$$A_{PP3} = (T \times R_{PP3} \times CO_x)$$

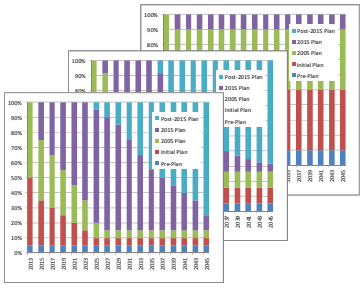
where,
$A_{P1,P2,P3,PP3}$ = allocated units for Plan 1, Plan 2, Plan 3, and Post-Plan 3
CO_x = one of the four possible coefficients (a, b, c or d)
T = total housing units to be allocated
$U_{P1,P2}$ = unbuilt inventory from Plan 1, and Plan 2
$R_{P1,P2,P3,PP3}$ = reference distribution ratios for Plan 1, Plan 2, Plan 3, and Post-Plan 3

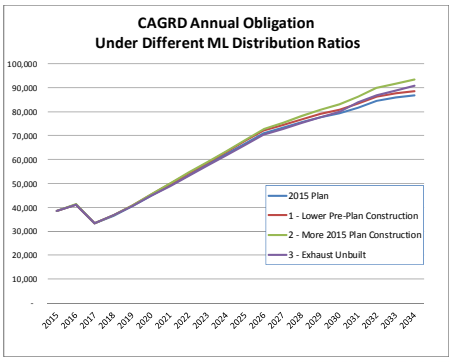
[Calculate CAGRD Demand]



1. Project Demand: New

- Though the ratios are necessary and important, their impact on obligation is modest





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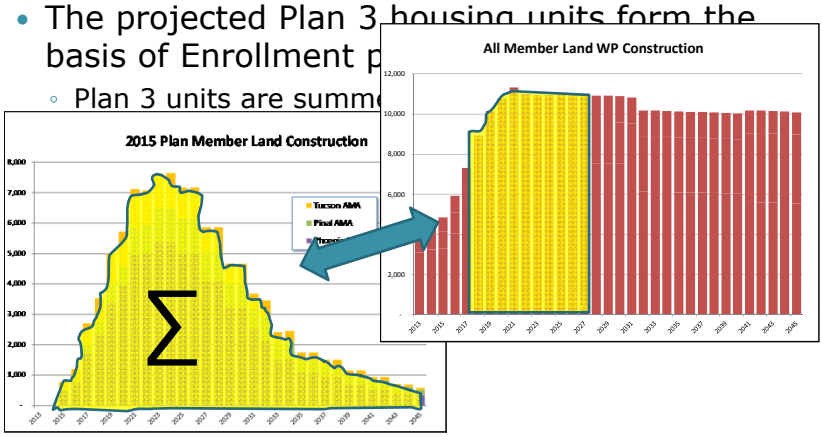
Enrollment

- The projected Plan 3 housing units form the basis of Enrollment p
  - Plan 3 units are summ



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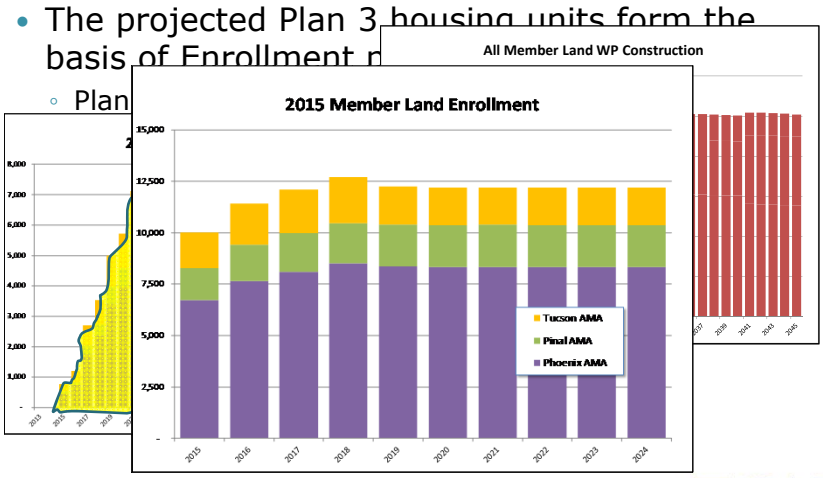
Enrollment

- The projected Plan 3 housing units form the basis of Enrollment p
  - Plan



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1. Project Demand: New

- The tracking of unbuilt ML housing units also accounts for "zombies"—Member Lands that have been inactivated due to an ML water provider getting a DAWS
  - The demands associated with Buckeye's projected zombies were added to the Plan's 100-year obligation projection

1. Project Demand: New

- The housing units allocated to Plan 1 & 2 are multiplied by a GPHUD that is based on ML-level demand projections, summed by Plan Period, divided by the number of unbuilt units
- Units allocated to Plan 3 and Post-Plan 3 are multiplied by a GPHUD based on the one used for the providers' overall New demand, further reduced by a factor to remove the non-subdivision demands
- Note that for an ML water provider, there may be as many as five different GPHUDs
  - Existing
  - New
  - Plan 1 MLs
  - Plan 2 MLs
  - Plan 3+ MLs

1. Project Demand: New

- The housing units allocated to Plan 1 & 2 are multiplied by a GPHUD that is based on ML-level demand projections, summed by Plan Period, divided by the number of unbuilt units
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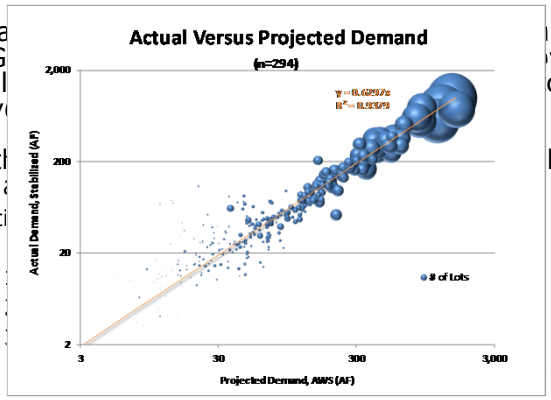

To be continued…