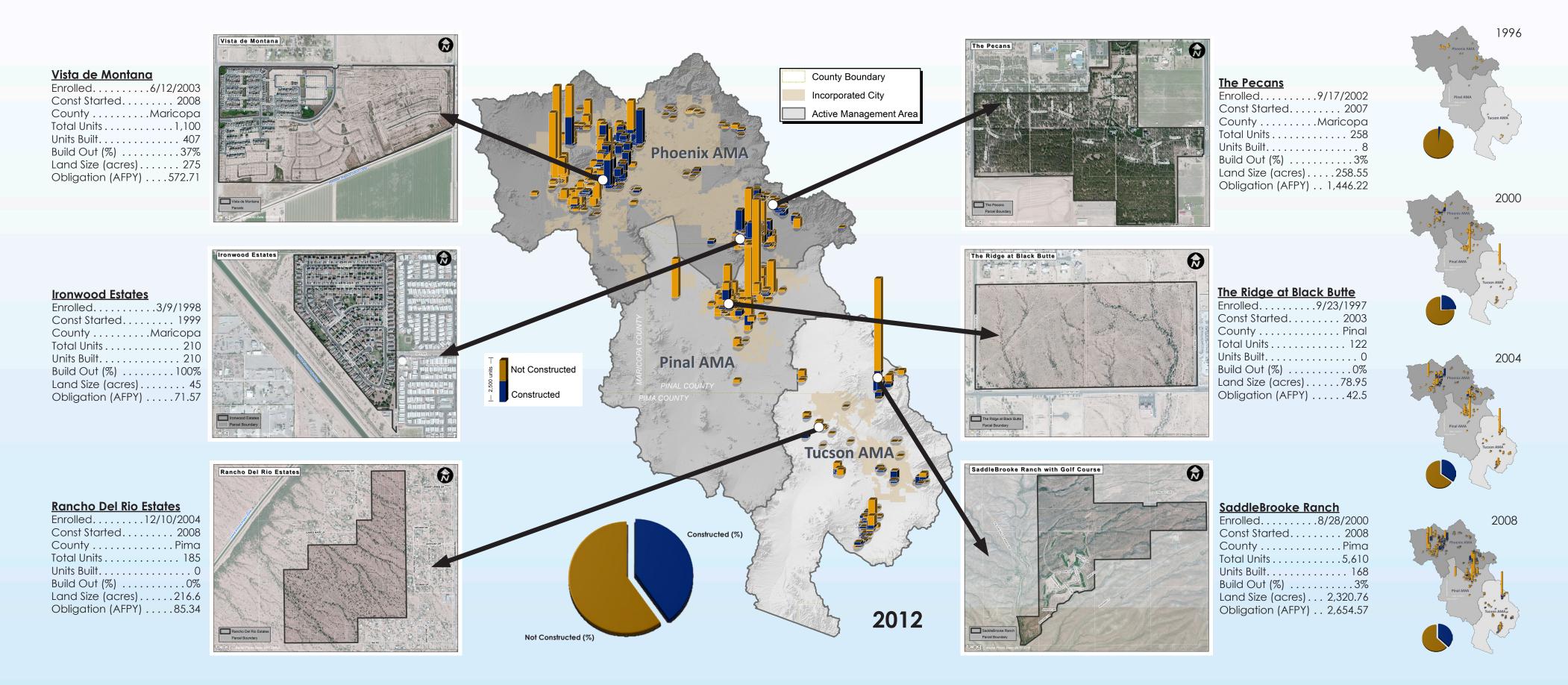
Central Arizona Growth and Water Use

BACKGROUND: Central Arizona, which includes some 5 million people in the Phoenix and Tucson metropolitan areas, has consistently been one of the fastest growing regions in the United States. Population growth and housing construction were particularly rapid in the early 2000s, until the near-complete collapse of activity during the Great Recession. In addition to impacts to Arizona's economy, the boom & bust of the housing sector has had significant water resource implications.

Proposed subdivisions in Central Arizona must demonstrate a 100-year assured water supply before sales can begin. Developers must ensure that most groundwater pumping will be offset by recharging renewable water supplies. One method for complying is to become a member of the Central Arizona Groundwater Replenishment District (CAGRD), which will perform the recharge on behalf of the parcels in the subdivision. There are now more than 1,100 enrolled subdivisions, representing more than 265,000 residential lots (time series maps, below right). As shown in the main map, many of those subdivisions are in the urban periphery, where more direct access to surface water supplies is limited. Estimating the future water demand of the CAGRD subdivisions is analytically challenging, in part because a large proportion of enrolled subdivisions have not yet begun construction. The construction status of CAGRD members ranges widely, from those fully built-out, to those that are likely to remain undeveloped for many years to come.



MODELING APPROACH

Projections of future water use are generated by coupling the subdivision-level estimates with regional projections of housing construction activity. In the past, those construction projections were tied closely to population projections, but the steep drop-off of the housing sector has altered that relationship. Most economic forecasters in Arizona expect housing activity in the next decade or so to be dominated by the overall recovery of the State's economy, rather than population growth per se. That adds an ever greater degree of complexity and uncertainty to projections of Central Arizona water use. To address some of that uncertainty, dynamic models and scenario planning approaches are being adopted.

2. Single Unit, Multiple Story parcel – Usually

separate parcels for each unit above

the ground floor. Each story houses a

a multiple story Condominium with

separate family or housing unit.

3 Multi-Unit Apartment Complex Example

HOUSING UNIT ANALYSIS

Modeling future growth and demand in central Arizona requires accurate existing residential housing unit numbers. CAP has analyzed different housing unit sources including county assessor parcel data, 2010 U.S. Census Bureau housing unit numbers and housing unit completion reports from local associations of governments. The following analysis compares three different types of housing units from Maricopa County Assessor's Office and the U.S. Census Bureau: Single Family Residential, Multi-Level Condominium, and Multi-Unit Apartment Complexes. Based on sampling and aerial imagery, the county assessor parcel data proved the most accurate.

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(Census Housing Unit Count

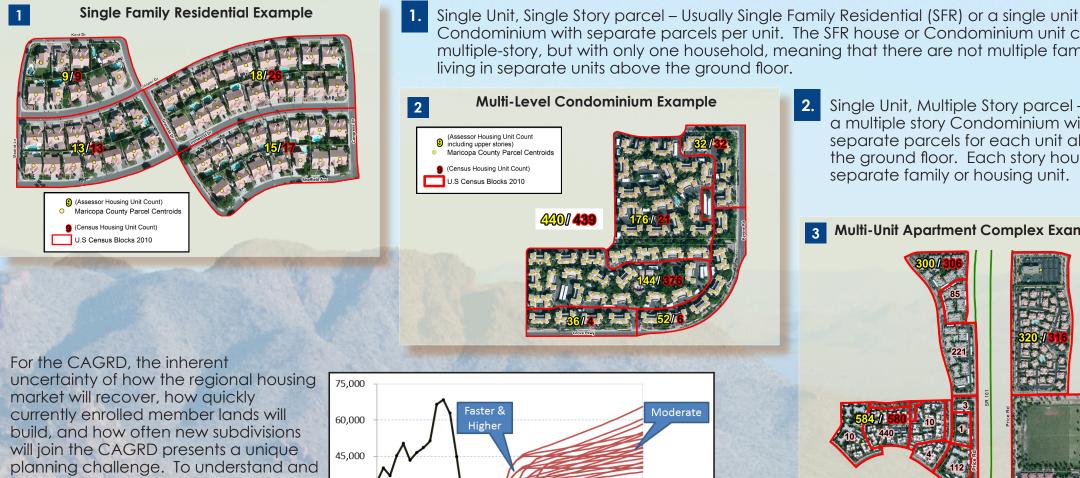
a County Parcel Centro

cluding upper

living in separate units above the ground floor.

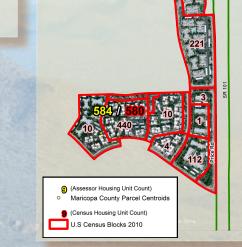
Multi-Level Condominium Example

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project potential future replenishment obligations (groundwater pumping that must be offset), we conducted an analysis of housing unit data, including parcel-level build out, and recovery scenarios. These scenarios can be converted to project water demand - specifically the replenishment obligations that the CAGRD could incur in the next ten years.





Multiple Unit parcel – A single parcel that contains multiple housing units. Usually this involves an apartment complex, duplex, triplex or mobile home park.

WATER USE ANALYSIS

Normalized Difference Vegetation Index (NDVI)

The CAGRD receives water use data by parcel from each of the water providers that supply member subdivisions. To help verify these numbers, CAGRD employees use current aerial photoaraphs to see if the lot has any buildings or if it has grass or a pool. With over 160,000 parcels, this process is very time consuming. Using an NDVI analysis approach, CAGRD can automatically

by individual parcel. These numbers, along with parcel property characteristics are then used to generate estimated water use based rough estimates are then compared to the water provider numbers and any large discrepancies are identified for further research.





An aerial photo is used to see vacant lots and

visually detect pools and grass.



With some re-sampling, we can simplify and categorize features into four basic types.

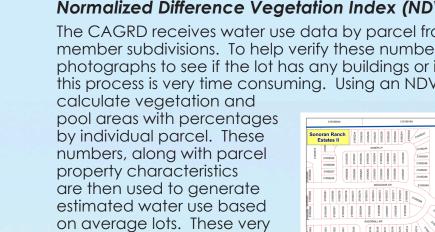


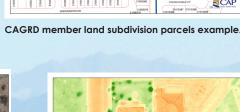


A Pima County 4-band aerial image showing an occupied parcel in 2011.

NDVI reclassification grid analysis to show percentages of each classification type.

A 2012 Pima County aerial image showing that same property is now probably vacant.



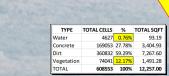














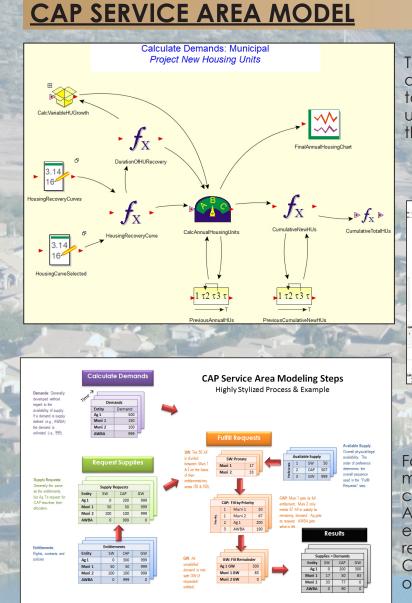








A 2011 Pima County 4-band aerial image focusing



The CAP Service Area Model of supply and demand, constructed in GoldSim (left), generates aggregate demand for water by entity based on regional-scale assumptions and factors unique to each entity. Demand factors include population and housing units, agricultural acreage and utilization, industrial sector trends, and social and regulatory trends. This snapshot shows some of the model elements and functions used to develop different housing unit growth scenarios.

Condominium with separate parcels per unit. The SFR house or Condominium unit can be

multiple-story, but with only one household, meaning that there are not multiple families

Modeling future water use in Central Arizona is a dataintensive proposition that must consider a large number of water users and a diverse portfolio of supplies. To help organize and manage the planning data, a relational database has been developed that contains historic monthly and annual records of water deliveries, rights, permits and characteristics for water companies, irrigation districts and American Indian tribes. The Resource Planning and Analysis database was developed in Microsoft Access and deployed in SQL Server.

For the service area supply and demand model to be "solved," the aggregate demand for each entity must be balanced with supplies in their portfolio. Temporary imbalances (i.e., demand > supply) can be calculated, but a complete model run involves full identification of the supplies used to meet demands. A diagram showing the simplified modeling steps is shown. The model first calculates demands for each entity, requests supplies for that entity based on its entitlements to the various supply types, fulfills those requests by supply priority and availability, and produces the final demand of supply by entity. For CAGRD member lands, any excess groundwater use can be considered the CAGRD's replenishment obligation.

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data (NDVI analysis) and other property characteristics such as number of bath fixtures are all used in further calculations to determine if the water use data provided has anomalies.