This presentation premiered at WaterSmart Innovations

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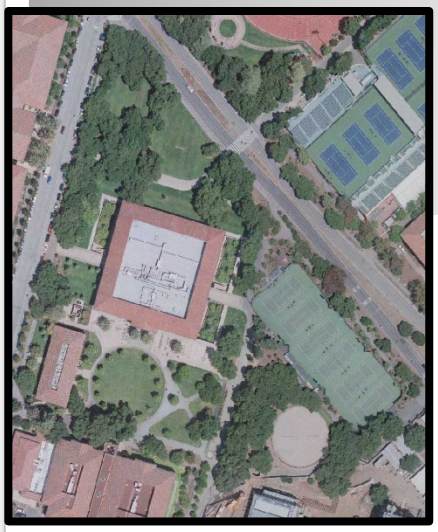
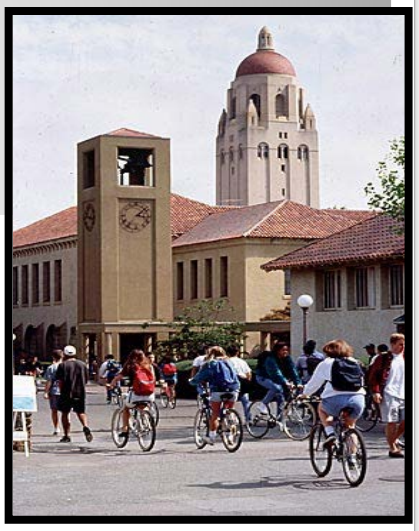
Real Time Metering and Internet Tracking for Efficient Landscape Irrigation



Stanford University



Water Smart Innovations Conference
October 3, 2012

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MADDAUS WATER MANAGEMENT

Acknowledgments

Team working on BMP and Metrics Study

Stanford University

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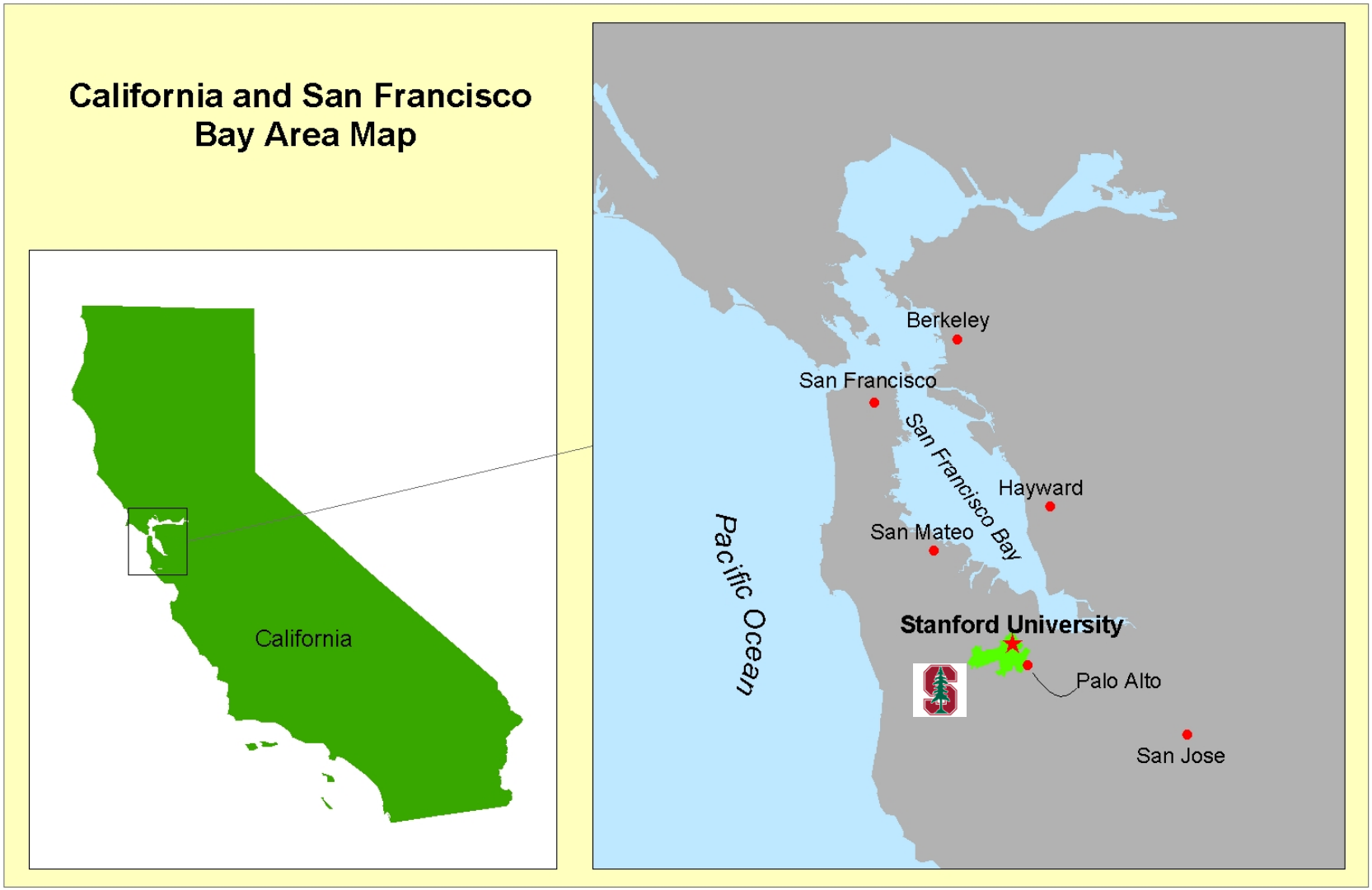
Aquacue Inc. (Barnacles)

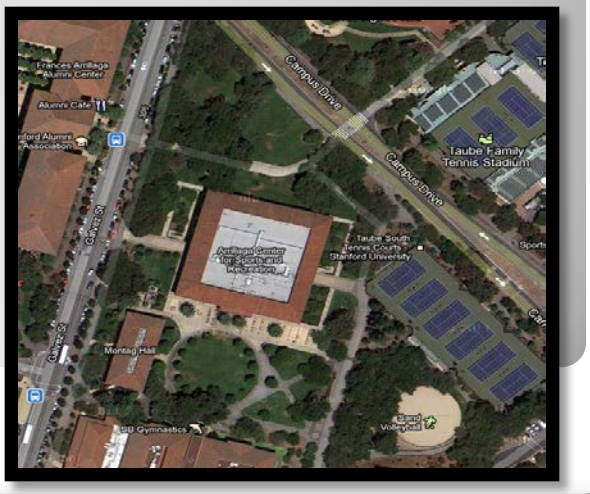
Shahram Javey, Nathan Hoover, Don Walker

Stanford University Campus, California



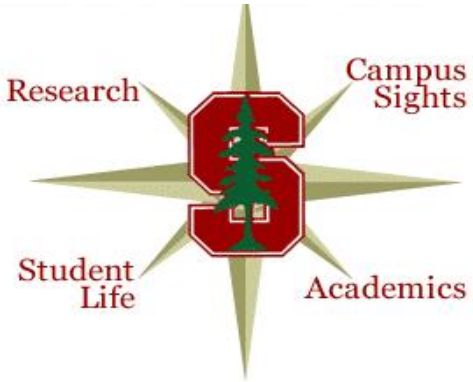
Overview

1. Stanford's Water System & Water Conservation Program
2. Landscape BMP, Metrics Study
   - Site Selection
   - Technology and Tools
3. Data Collection & Analysis
4. Summary & Results
5. Questions



Stanford's Potable & Non-potable Water Systems

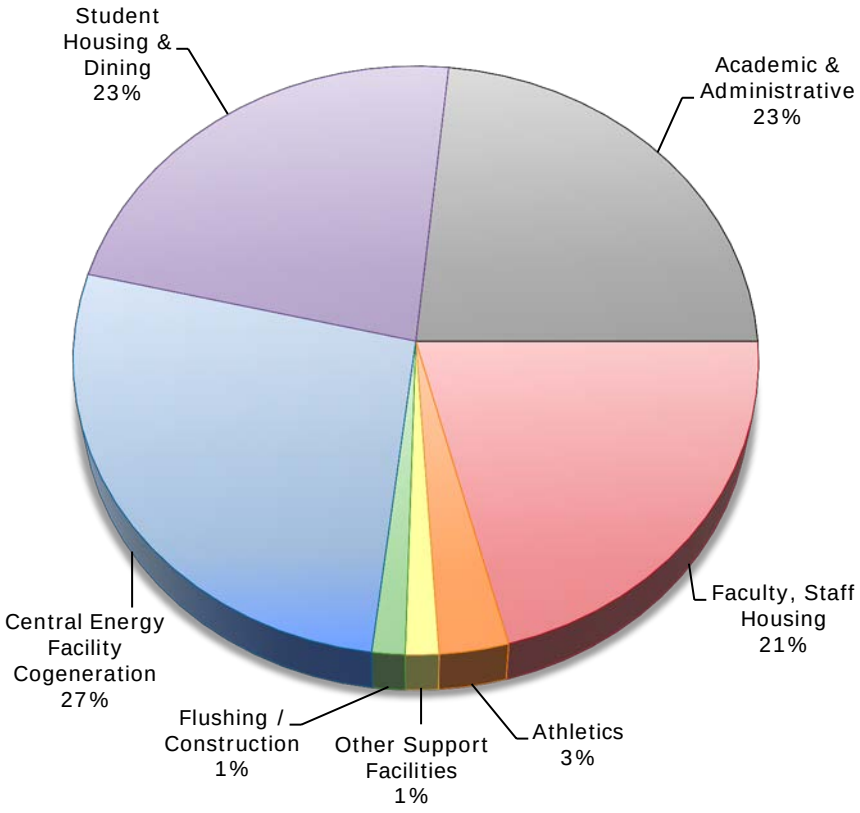
- ✓ <u>Potable Water:</u> San Francisco Public Utilities Commission (SFPUC), allocation is 3.033 MGD
- ✓ <u>Non Potable Water:</u> (used for most campus irrigation)
  - 1.2 M sqft green areas,
  - 1 M sqft of shrubs,
  - 580,000 sqft groundcover
- ✓Water systems serve daily average campus population of 30,000
- ✓Conservation planning provided in 2000 Water Master Plan: necessary to meet campus growth



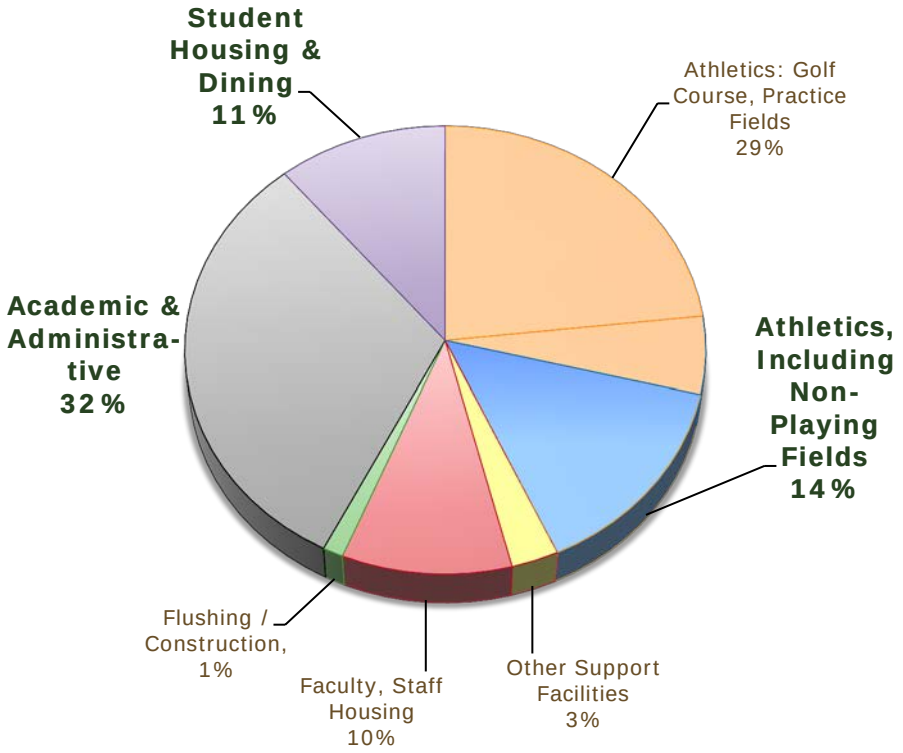
Potable and Non-Potable Water Consumption by Campus Groups

Potable Water Consumption

FY12: 2.16 MGD



Non-potable Water Consumption FY12: 1.18 MGD



Water Conservation Program at Stanford

- **Water Conservation & Recycling Master Plan 2001**

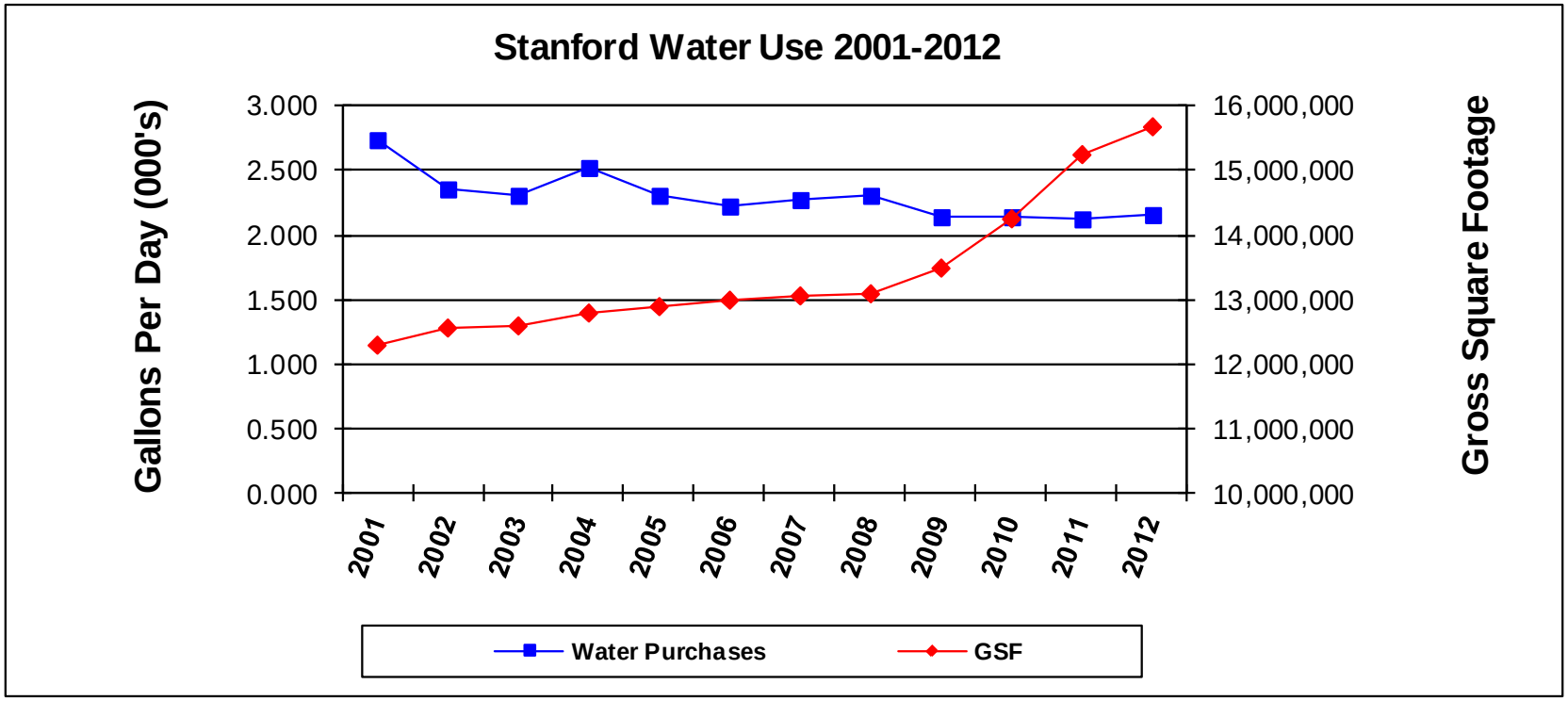
Goal	Water Savings 2001- 2010	Cost
Planned	0.58 MGD	$5.14M
Actual	0.59 MGD (22% reduction of potable use)	$2.3M + Rebates from SCVWD

- **20 Different Measures Since 2001-2012:**

Device	Number
Toilets, Showers, Faucets, Urinals	12,433
Clothes Washers	525
Spray Valves	74
Steam Sterilizers (For research equipment sterilization)	66
Various Projects: Vacuum Pump Replacement, Energy Facility Blowdown Reuse, Once Through Cooling Retrofits	Numerous
Landscape – Retrofits to Efficient landscape, ET Controllers, Faculty / Staff Home Landscape Audits, Demo Garden	Numerous

Conservation is Working!

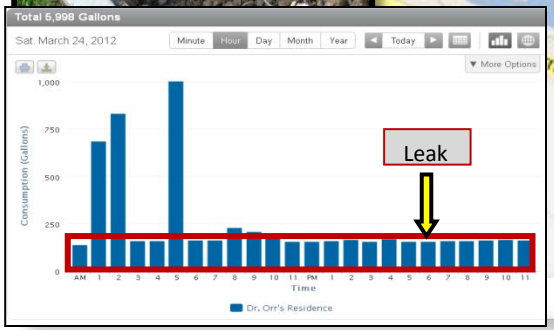
Water Use Decreasing as Campus Sqft Increasing



2001: 2.7 mgd

2012: 2.16 mgd

Stanford University Water Efficiency Projects 2000 to 2012



Landscape BMP, Metrics Study - Why do it?

Large Landscapes

- Several groups managing campus landscape
- Different management styles and levels of water efficiency
- Not all areas on ET
- Need new methods and tools to encourage efficiency for the long term

Goals

- **Provide facts about consumption**
- **Develop BMPs and Metrics**
- **Provide routine feedback about water use**
- **Identify tools for landscape managers**

Large Landscape Site Selection

Goal

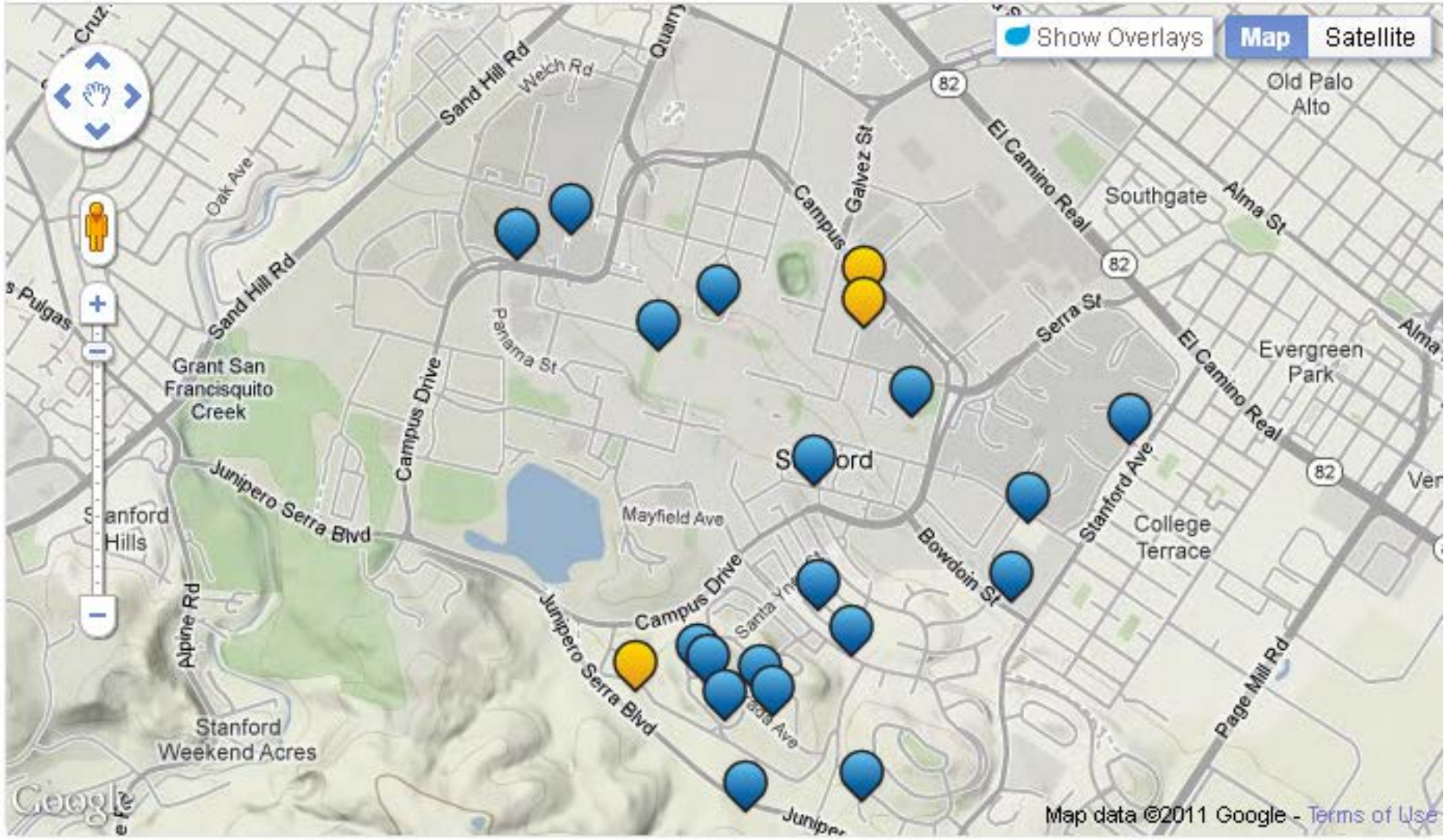
Select Sites with Similar Physical Characteristics –
Focus on Decorative Turf

Comparative Criteria

- Size
- Exposure (N, S, E,W facing, etc.), Slope
- Typical Use of Each Area
- Grass Type(s)
- Soil Type(s)

Landscape and Residential Study Areas

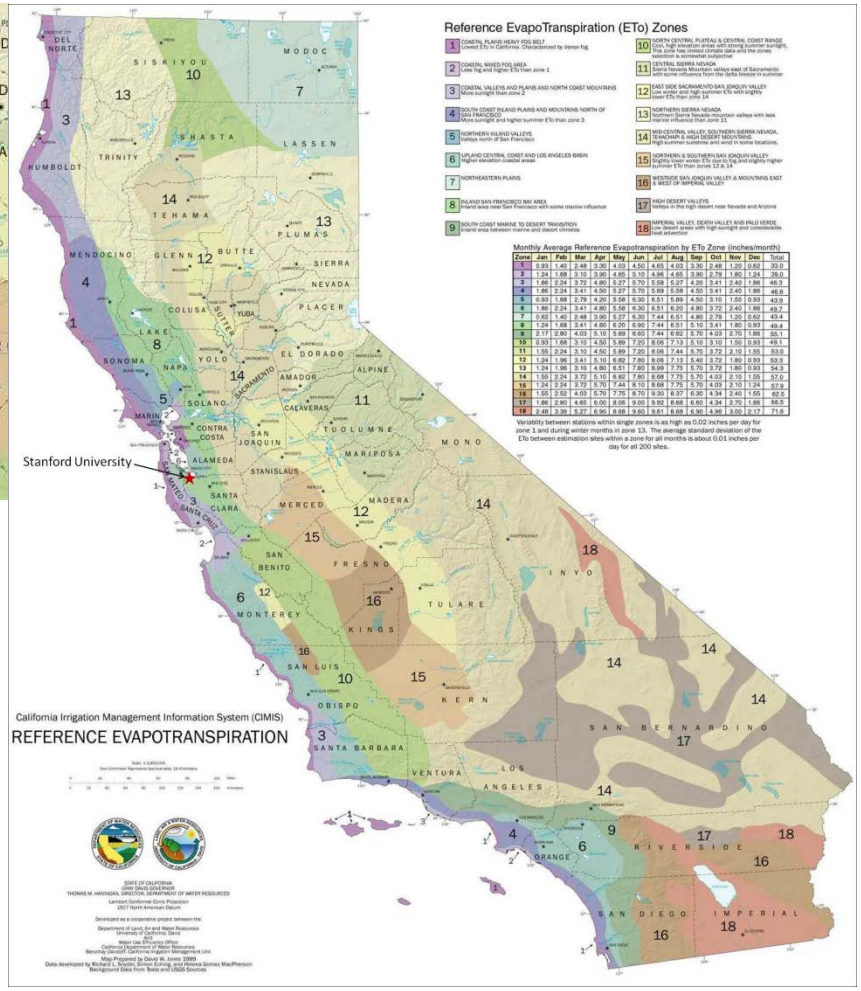
Blue = No meter issue Yellow = Leak / Issue



California Irrigation Management Information System (CIMIS)
REFERENCE EVAPOTRANSPIRATION

Stanford University

ET Zone 8 – Inland San Francisco Bay



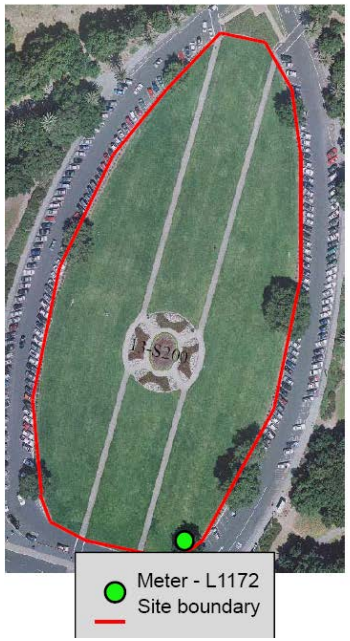
Typical Weather

Annual Precipitation.: 15.5 inches
Avg. July High Temp: 78°F
Avg. Jan Low Temp: 38.6°F

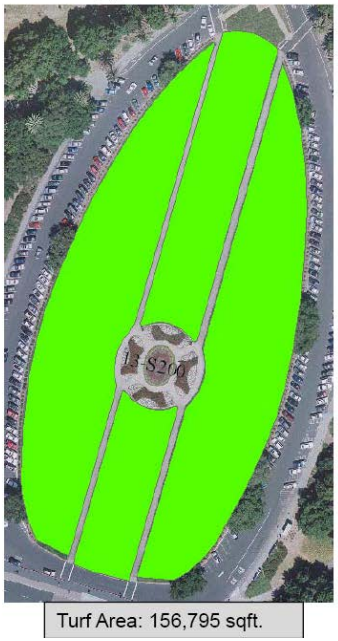
Site-Specific Management Information

- Landscape site size, acres of turf
- Managing group, and how long have they managed each area?
- How many staff manage each area?
- When and how often is each area fertilized?
- When and how often is each area mowed?
- Approximate age of turf in each area, type of irrigation system, age of infrastructure (e.g., piping)

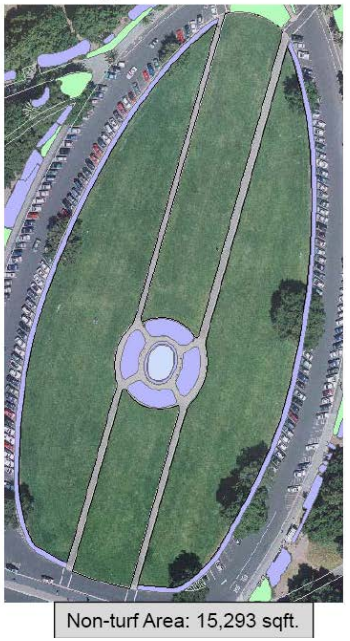
Landscape Site



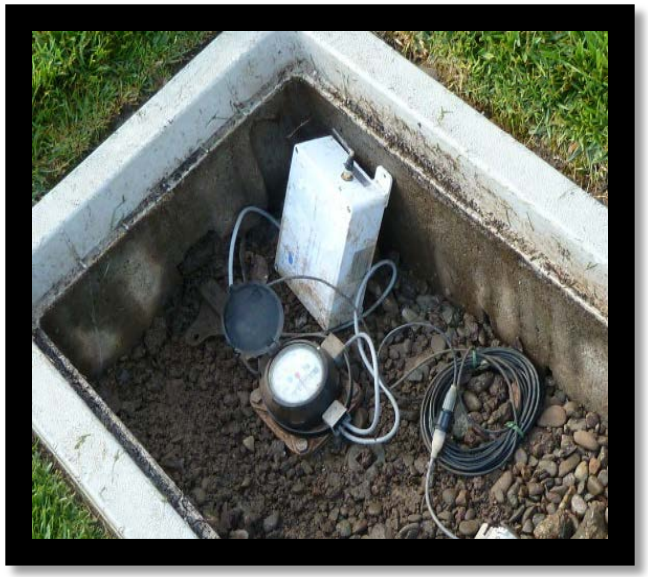
GIS Polygon Areas - Turf



GIS Polygon Areas – Non-turf



Real-time Monitoring & Reporting Technology



Stanford monitoring account

Data, Technology & Tools Used for developing BMPs & Metrics

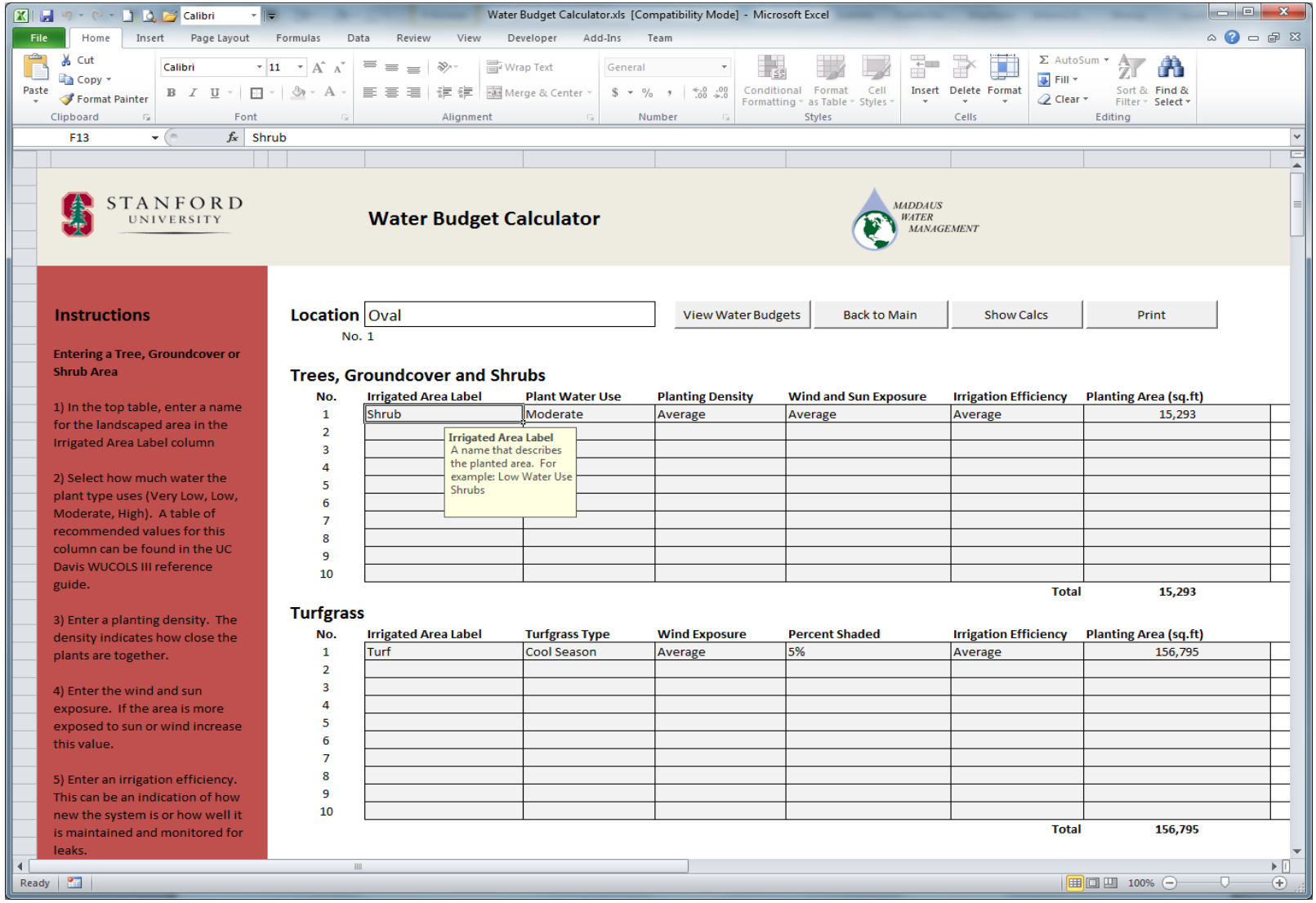
DATA

- Existing Utility Meter Database
- Campus Weather Data
- Site, Turf Size, Field Observations, Site Visits
- Photo Documentation

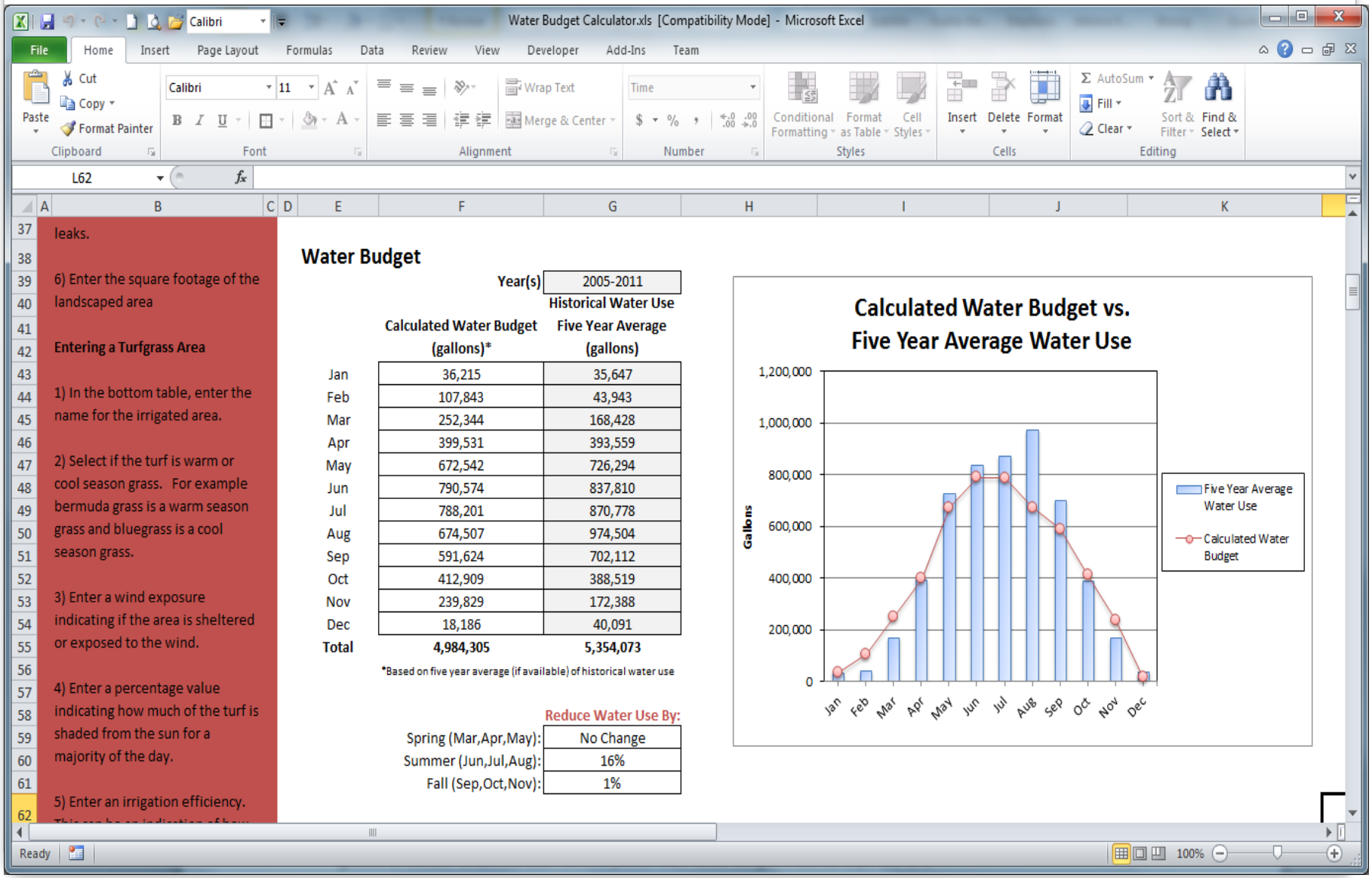
TECHNOLOGY & TOOLS

- New Real-Time Water Use Monitoring
- Water Use Budget Calculator Developed
- Historical Water Use Trends Analysis

Water Budget Calculator



Water Budget Calculator

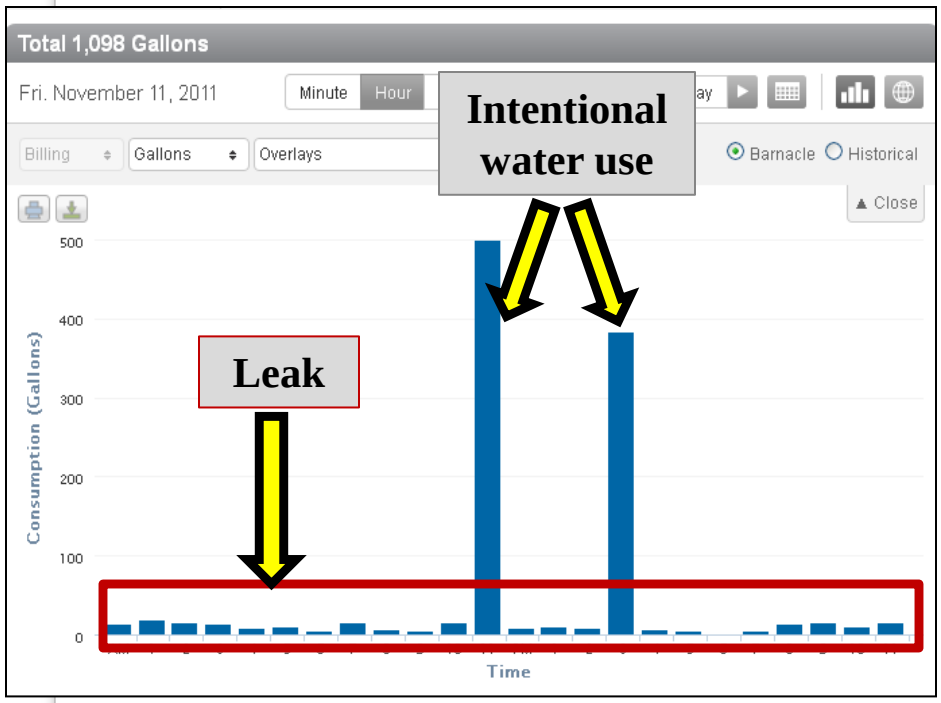


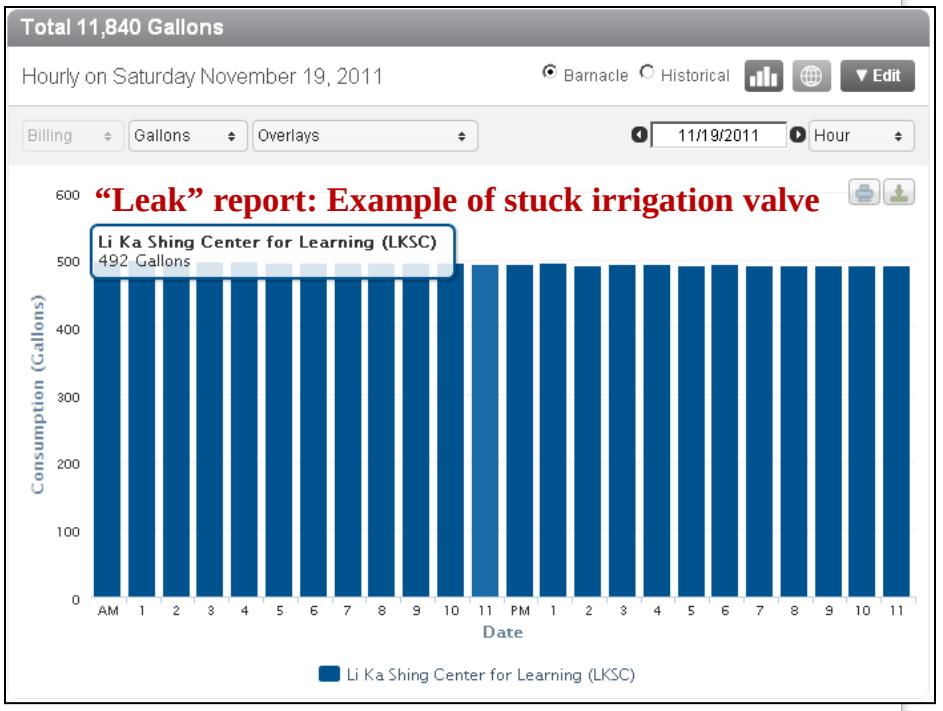
Weekly Water Report for Landscape Manager

Units: gal	Last 7 Days		Last 30 Days	
Barnacle Details	**Daily Average**	**Total**	**Daily Average**	**Total**
Manzanita Field-Serra & Campus Drive East, Manzanita Field, Stanford, CA Meter: L1660, Hersey MVR 2" Installed Apr 14, 2011	7,859	55,015	7,071	212,133
Stanford University Oval, Campus Dr E, Stanford, CA Meter: L1172, Badger Turbo 450 RTR 3" Installed Mar 29, 2011	18,267	127,866	18,587	557,608
Lomita Mall, Stanford, CA Meter: L1522, Hersey MHR 2" Installed Apr 14, 2011	6,294	44,057	5,797	173,910
Bing Nursery School, 850 Escondido Road, Stanford, CA Meter: D1947, Badger T-200 ADE 2" Installed Apr 06, 2011	8,688	60,817	8,221	246,631
Li Ka Shing Center for Learning (LKSC), 291 Campus Drive, Stanford, CA Meter: L1718, Badger T-450 3" Installed Apr 06, 2011	6,850	47,952	6,763	202,875
Stanford Campus Recreation Assn., 875 Bowdoin Lane, Stanford, CA Meter: D1233, Badger Turbo 200 RTR 2" Installed Apr 06, 2011	6,407	44,846	7,179	215,377
Arrillaga Recreation Center, 341 Galvez, Stanford, CA Meter: L1688, Badger T-200 2" Installed Apr 15, 2011 Continuous flow today: None Continuous flow this week: 31 gal/day average Continuous flow today: last week	31,526	220,679	31,371	941,115
EV Studios 5 & 6, Stanford, CA				

Leak Detection

- ✓ **Constant water use indicates a leak**



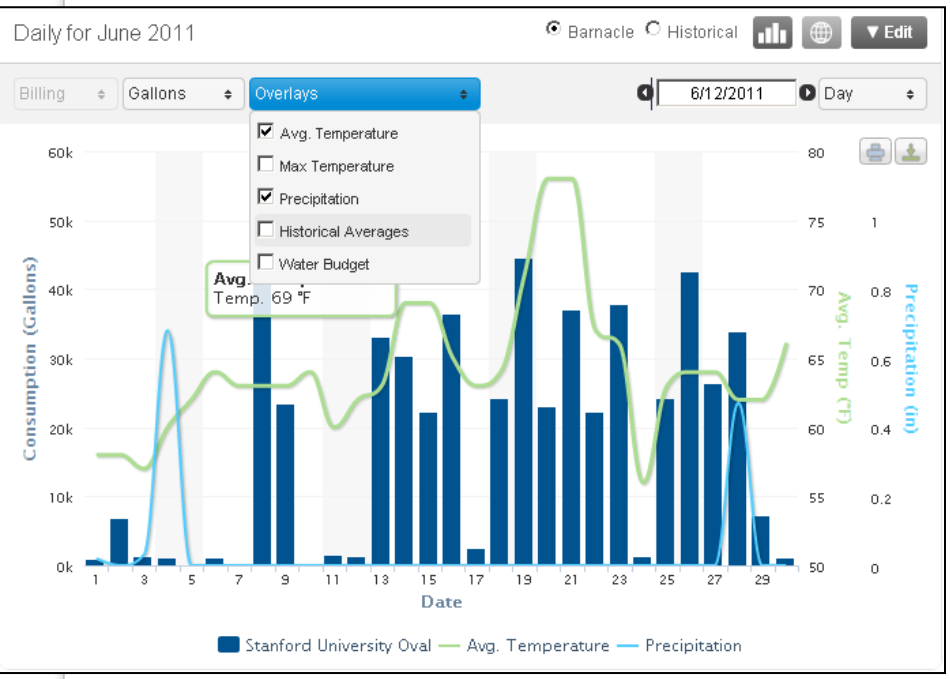


Large spikes are intentional water use; small consistent use is a leak

Daily water use,
ET Site June 2011,

Avg. temperature, precipitation

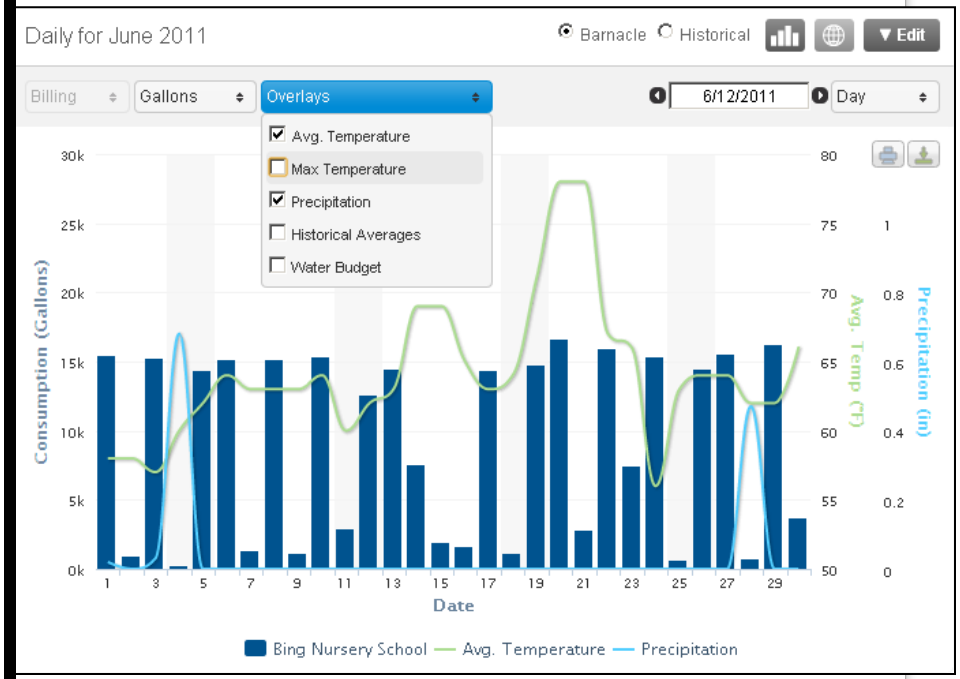
Note the irrigation reduced after rain



Daily water Use
NON-ET Site: June 2011,

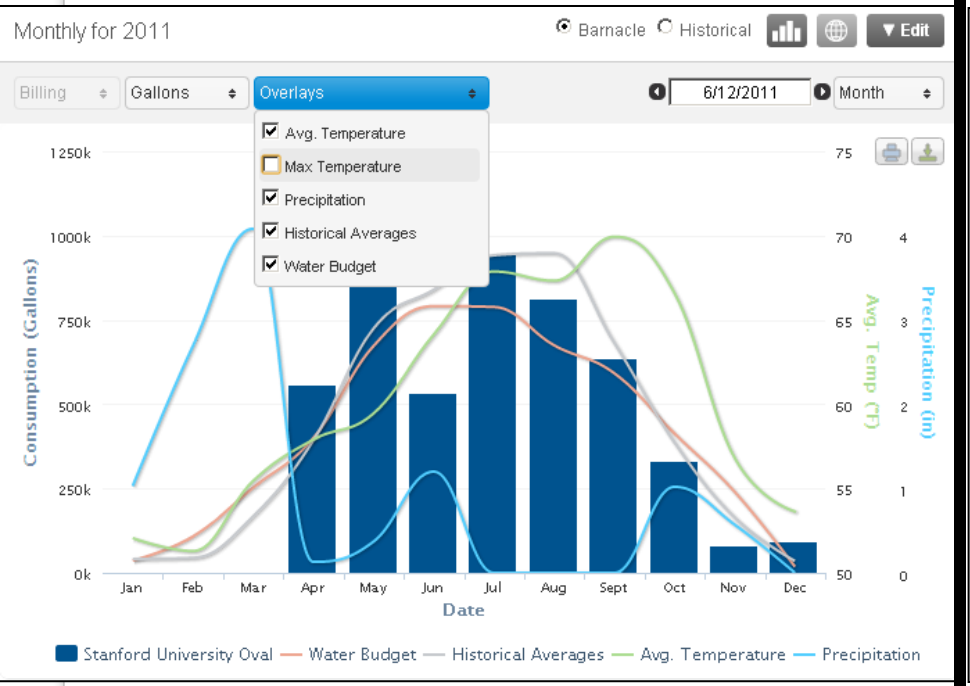
Avg. temperature, precipitation

Note irrigation NOT reduced after rain



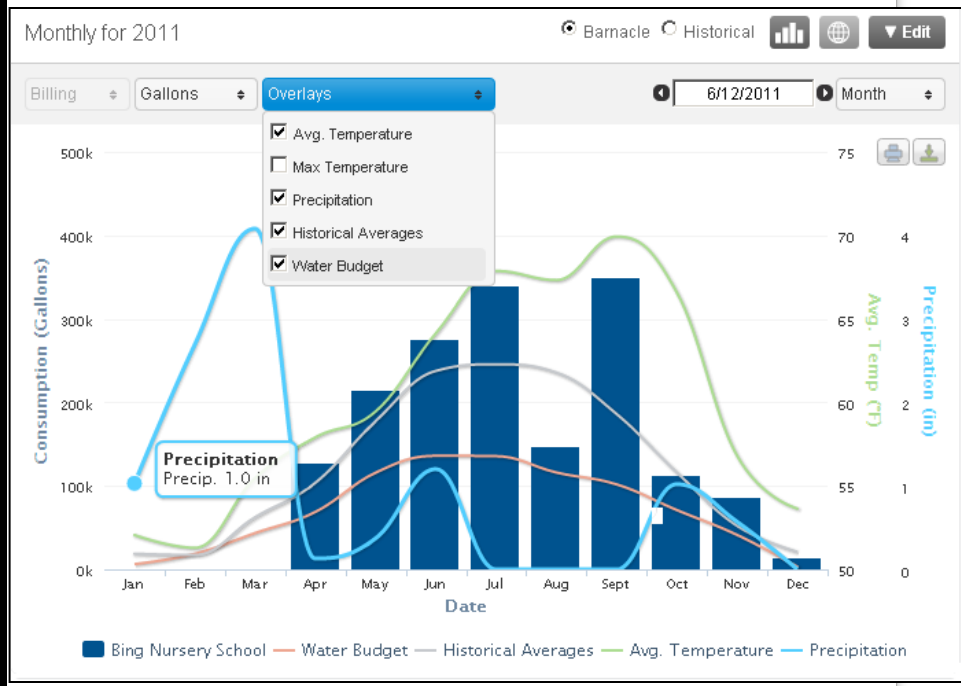
Monthly water use, ET Site:

Water budget, historical avg., temperature, precipitation



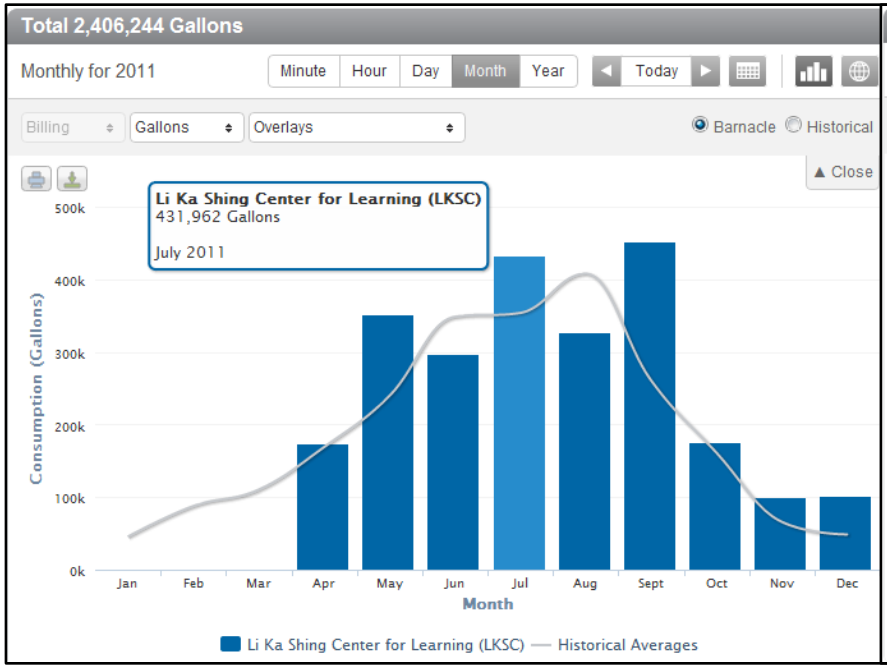
Monthly water use, NON-ET Site:

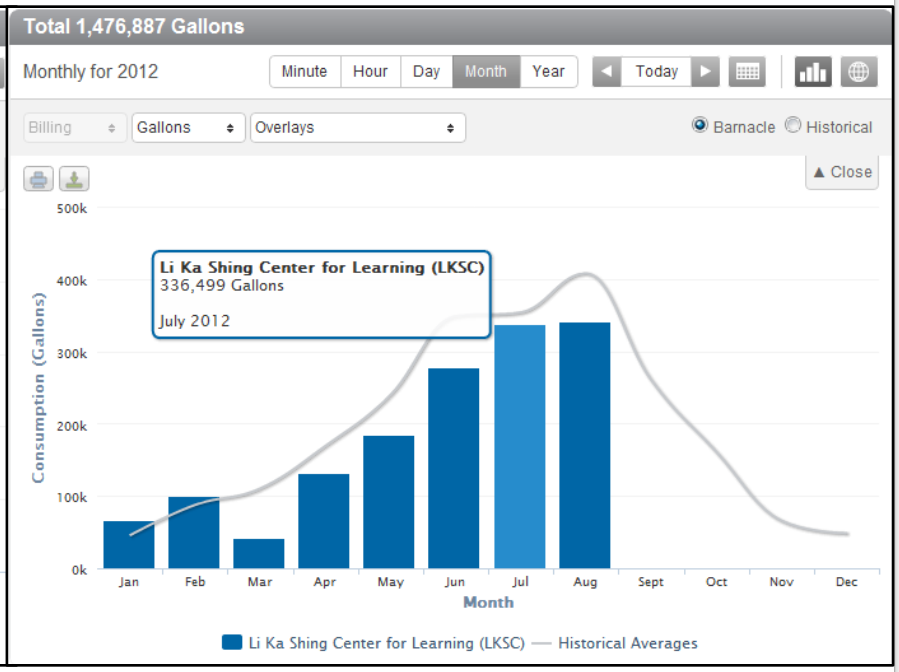
Water budget, historical avg., avg temperature, precipitation



Comparison: 2011 use to 2012 use

With Water Budget and Historical Use Overlays





Month	Water Use in 2011	Water Use in 2012	% Change for that month
May	351,157	184,548	47%
July	431,962	336,499	22%

New Weather-Based Irrigation Controller installed in May 2012.
Projected savings of 2.1 Mgal/yr for ~4 acres of irrigated landscape

Best Management Practices and Metrics Developed from this Study

BMPs

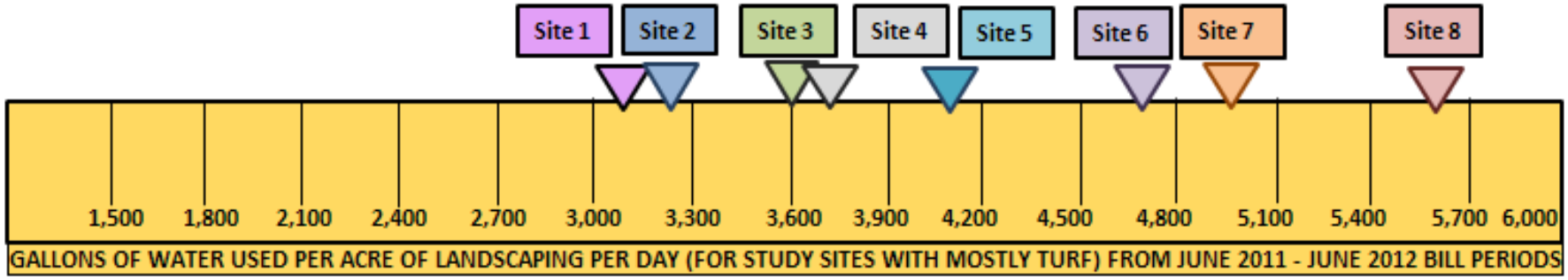
- Develop historic base/seasonal record
- Implement PM program
  Automate leak alerts
- Use weather-based controller
- Implement Site audits every 3-5 years
- Develop routine communication about water use, helping customers be more efficient

Metrics

- Update annual base/seasonal use data, send to customers
- Find “invisible” leaks within 48–72 hours
- Responsiveness to weather change within 24 hours
- Compare water use to audit recommendations
- All sites: compare water use/acre.
  Each site: compare monthly water use with monthly water use for previous year.

Consumption Ruler

Water use per acre – Sites ranked from lowest to highest



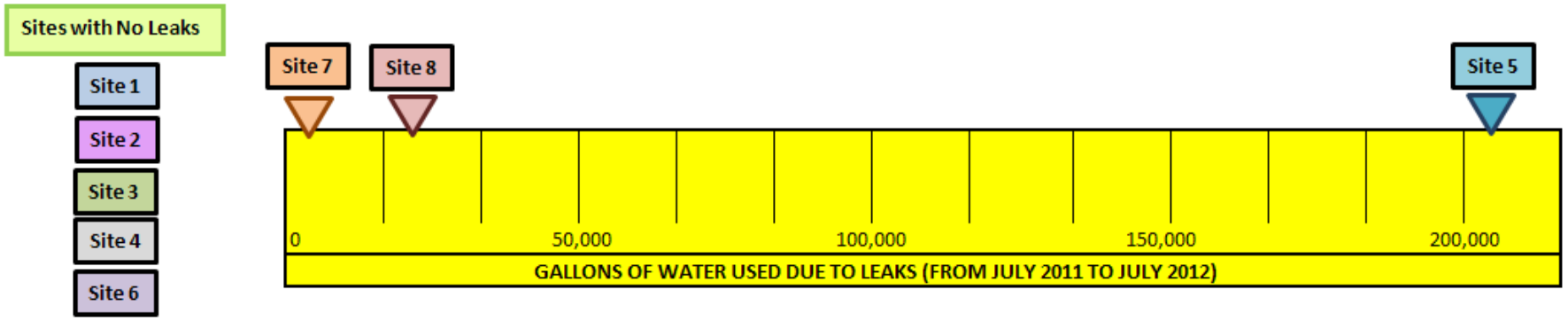
Gallons of water used per acre of landscaping
(for study sites with mostly turf)
From June 2011 - June 2012 bill periods

Site 5 installed a Weather Adjusting controller in May 2012.

Sites 8 and 3 have turned down the controllers by 25% starting June 2012.

Leak Ruler

Gallons of water used due to leaks (from July 2011 to July 2012)



Since Site 5 installed an ET controller in May 2012, they now get real-time alerts about leaks and are quick to respond.

Summary and Results

1. **Long-term success requires an integrated approach:**

   - ✓ **Landscape managers willing to take time to do things differently**
   - ✓ **New technology and tools to illustrate how the controller settings translate to water use.**

2. **Real-time monitoring technology & water budgets provide factual information for successful changes in irrigation management.**

   - ✓ **Hourly water use data is a good tool for identifying/verifying leaks.**
   - ✓ **Daily water use data illustrates ET controllers respond faster to weather events than manually operated controllers.**

Summary and Results, Cont.

3. However, ET controllers are not accepted by all customers.
4. Tools need to be fast and easy to use.
5. Continuity is important: weekly reports, other communication about site water use is helpful to keep priming managers to take action. Small steps and patience yields successful results.
6. Development of useful metrics, BMPs require persistence, iterative verification:
   - ✓ using real-time water use data
   - ✓ understanding site characteristics
   - ✓ communicating with site managers & customers
   - ✓ fine-tuning the irrigation to local conditions.



Questions?

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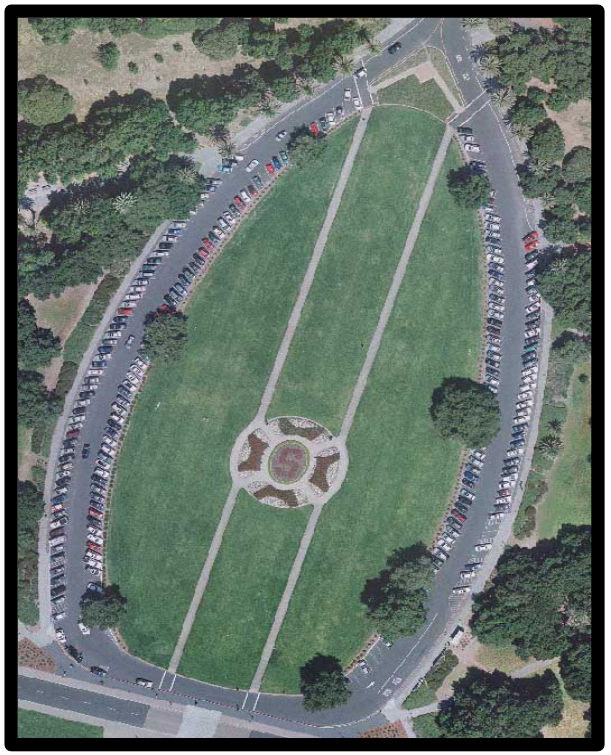

Stanford Water Conservation Website:
http://lbre.stanford.edu/sem/water_conservation