Water Conservation Case Study

Restroom Faucet Retrofit Potential

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CALIFORNIA STATE UNIVERSITY
EAST BAY

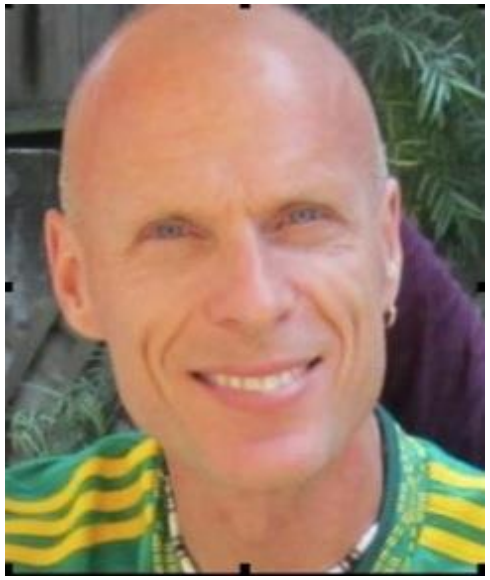
Restroom Faucet Retrofit Potential

Presentation Agenda

- Presenter Bio, Cal State East Bay Profile
- GEOG 4350 Water Resources and Management
- Faucet Survey Methodology
- Survey Results
- Survey Recommendations
- Suggestions for Future

Presenter Bio

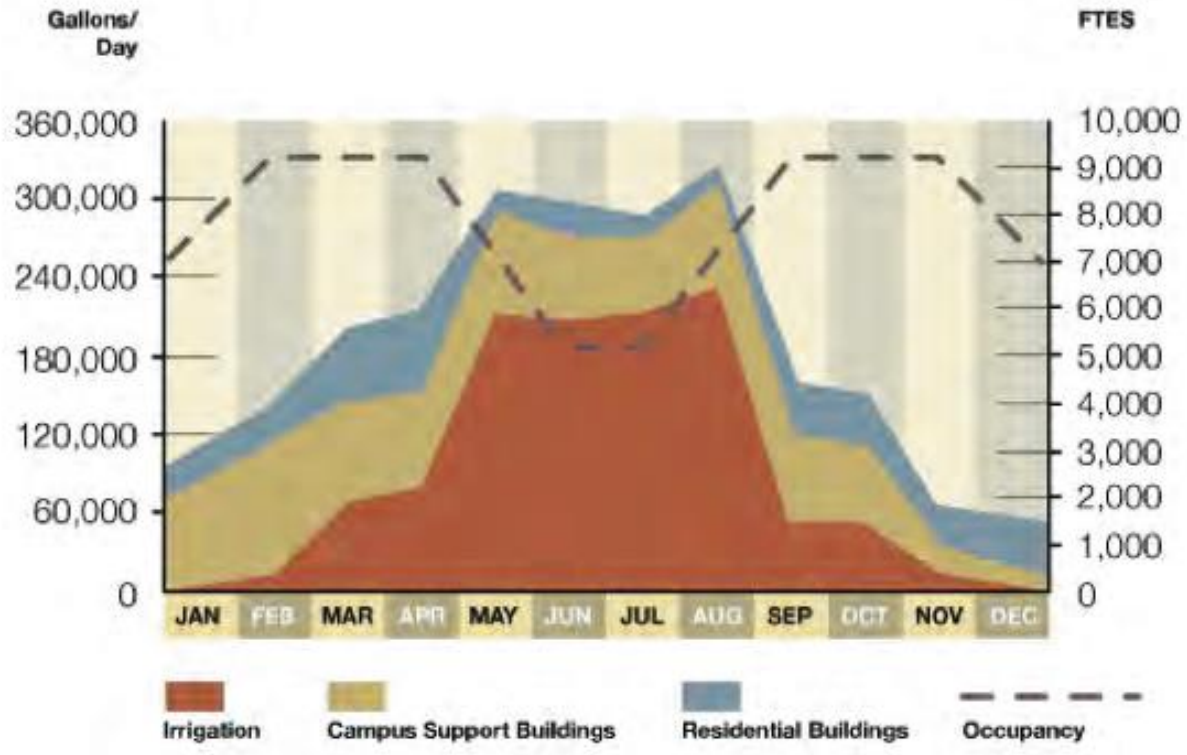
- Geographer/Hydrologist
- 1991-1992 - **Water Conservation Specialist**, East Bay Municipal Utility District, Oakland
- 1992-1993 - **Integrated Water Resources Planning Consultant**, Barakat & Chamberlin (Clients – EBMUD, ACWD, SDCWA, CUWA, Portland MWP, etc.)



- 1993-Present - Professor & Consultant – Water, Development, Sustainability

Cal State East Bay Profile

- Three campus locations – Hayward, Concord, Oakland
- Almost 1,300 FTE employees
- Almost 14,000 FTE students



Hayward campus water use (Master Plan p61)

GEOG 4350

- Recognizes water sector as career prospect for grads
- Covers broad range of material related to water management and use
- History, hydrology, infrastructure, quality, laws, efficiency, etc.

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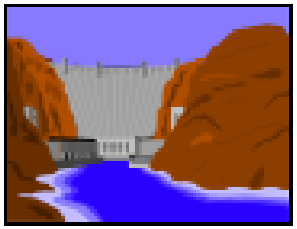
Geography 4350-01: Water Resources and Mgmt



Classes: MW @ 2:00pm-3:50pm
Location: Robinson Hall RO119
Office hours: MW @ 11:45am-1:45pm or by appointment

Catalog Description: The historical, geographical, legal and economic bases for the distribution and allocation of water, stressing California and the arid west; the environmental impact of water use; past and current issues and controversies in water distribution and redistribution.

Course Objectives: Water is one of the most important of our natural resources for the sustainability of our human and environmental systems. At the same time it is under tremendous pressure from changes to these systems. This course will give you an introduction to and an overview of the key concepts related to this situation so that you may better understand some of the issues and how they can be resolved. Using California and other examples, you will appreciate the complexity of, as well as the necessity for better water resources management through an introduction to basic hydrology, water regulations, water management and environmental concerns.

Learning Outcomes:

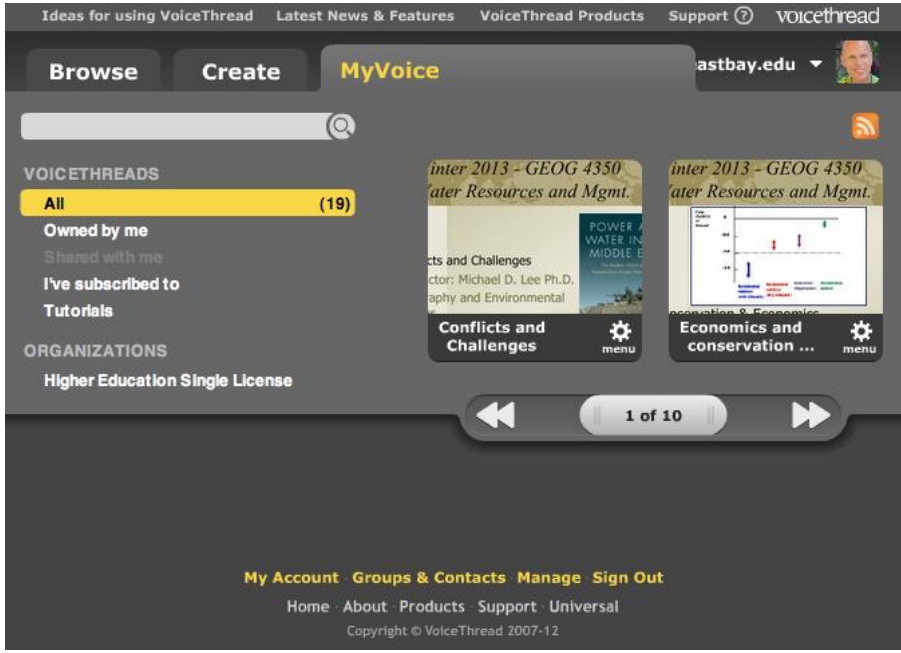
- You will develop a clearer picture of where our water supply comes from, how it gets to us, and how we use and dispose of it along with the historical precedents for these practices.
- You will understand the different qualities, values and uses of water - consumptive and non-consumptive; economic and environmental and the differences and inequities in water supply across regions.
- You will increase your awareness of the major regional and global issues with respect to water resources and their management, especially with respect to California.
- You will understand the various factors affecting water supply reliability and the management challenges to maintain and improve long-term quality and equity of service in different situations.
- You will be familiar with the basic aspects of water quality, water contamination and its importance
- You will be familiar with the different ways that domestic, industrial and agricultural water users can conserve water and will acquire direct hands-on experience of water conservation auditing and planning.
- You will develop a clearer idea of the field of water management and the career opportunities therein
- You will be given the opportunity to further develop your writing and critical thinking skills as they apply to the management of water resources.

Required Textbook: The foundation text for this course is:

Gleick, P.V. 2010. *Principles of Water Resources: History, Development, Management and Policy.* John Wiley & Sons, Inc. New York. 3rd edition. (please note I have placed a copy of this textbook in the library reserve)

GEOG 4350

- “Flipped” Class - all lectures at home via Voicethread
- All class time devoted to discussion and practical activities/group work
- Permitted real-world practicum: water conservation audit
- Linked to campus sustainability and PEIL initiative

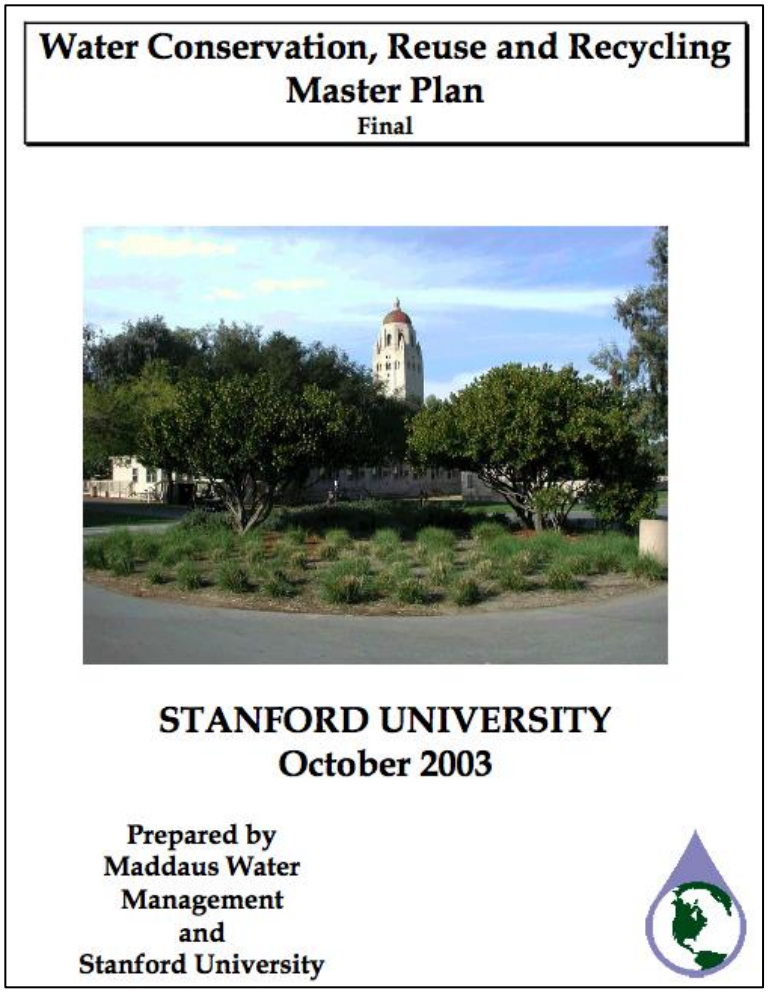


Conservation Project Selection

- Suitable for group implementation
- Likely to result in significant savings, short payback (best of low-hanging fruit)
- Minimal need for equipment, expenditures, technical assistance
- Executable in short time frame
- Relevant to student home/work life
- Clearly part of a “sustainability skill set”
- Approved by Facilities Management

Faucet Retrofit

- Reviewed two university conservation projects – Stanford Master Plan 2003 and UCSF study 2012, both by Maddaus WM
- Class elected to complete campus restroom faucet survey and analysis
- Accessible, simple, no expenses, potential to yield signif. savings



Hayward Campus Master Plan (2009)

Makes no specific mention of restroom faucet retrofit

Current Initiatives

The Hayward campus is currently implementing retrofits to fixtures in existing buildings, primarily upgrading to water-efficient toilets and urinals. Retrofits are being undertaken during the natural course of maintenance and as funds are available.

Developing the Project

- What kinds of sinks and faucets are we dealing with – **taxonomy**?
- How do we develop a comprehensive inventory for a 100% audit of our campus - **preparation**?
- How do we standardize the audit for consistency by 25 auditors - **training**?
- How do we capture and process the required information correctly and accurately - **execution**?
- How do we process the data and generate and interpret the results - **analysis**?
- Can we just study or can we also implement - **scope**?

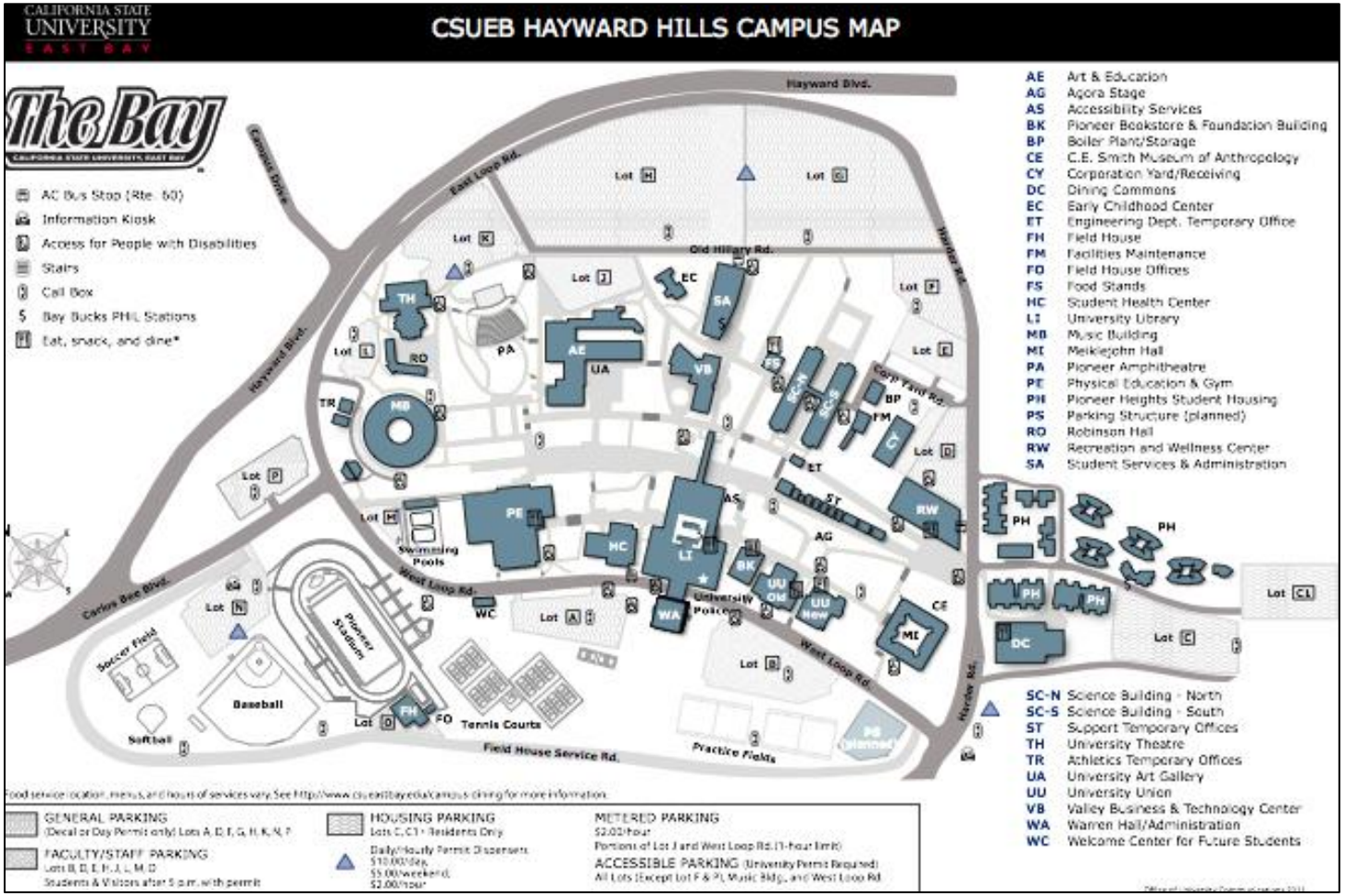
Hayward Campus Water Cost Data

- Volumetric tariff = $5.15 per 100 ft^3 (CCF) for 1-200 CCF, $6.10 for each CCF thereafter (always >200 CCF).
- Billed every 60-62 days (2 month cycle) based on City of Hayward meter reader data
- Billed at 2 main water meters at edge of campus.
- Wastewater (sewage) charges (volumetric tariff) = $4.26 per CCF of metered usage on buildings.
- Effective water savings from conservation = $6.10 + $4.26 = $10.36 per CCF
- **Per gallon water savings rate = $0.01385 per gallon (1.385 cents per gallon).**
- Does not include savings in hot water

Simple Payback if 2gpm ➔0.5gpm retrofit

	A	B	C	D	E
1	Unit Cost of retrofit	Gallons @ $0.01385/gal	Reduction from Existing gpm to retrofit 0.5gpm (in gpm)	No washes @ 15 secs/wash	No uses per day (assuming 44 wks, 220 days)
2	$2.50	180.51	1.50	481	2
3	$5.00	361.01	1.50	963	4
4	$7.50	541.52	1.50	1444	7
5	$10.00	722.02	1.50	1925	9
6	$12.50	902.53	1.50	2407	11
7	$15.00	1,083.03	1.50	2888	13
8	$17.50	1,263.54	1.50	3369	15
9	$20.00	1,444.04	1.50	3851	18
10	$22.50	1,624.55	1.50	4332	20
11	$25.00	1,805.05	1.50	4813	22
12	$27.50	1,985.56	1.50	5295	24
13	$30.00	2,166.06	1.50	5776	26

All Admin/Academic Buildings – not student housing, Health Ctr.



Faucet Inventory

- Conducted scavenger hunt (faucet taxonomy)
- Obtained floor plans
- Obtained restroom inventory
- Divided buildings between students (25)
- Inventoried hardware

Your Name	Raymond
Building ID (e.g. AE)	Library
Floor Number (e.g. 3)	2/ main floor
Restroom ID (e.g. 131)	2136

RESTROOM SKETCH (Be sure to draw the hand-basins and mark their identifier)

1 2 3 4

The fourth faucet on the right is the same as the two left.

Hand Basin ID (e.g. AE-161-1)	Hand Basin Type (e.g. 3)	Center/Left Faucet Aerator (E/I Thread) – note gpm if you can	Right Faucet Aerator (if 2 on hand basin) (E/I Thread) – note gpm if you can
Li-2136-1,2 & 4	5	E 1.0	N/A
Li-2136-3	8	E 0.5	N/A

Flow Rate Survey

- Developed standard methodology for each faucet type
- Used Maddaus UCSF measure (time (secs) to fill 0.25 gal)
- For auto faucets also used ml + time (secs)

FAUCET	TYPE	DESCRIPTION
	1	Goose neck two lever mixer tap faucet (manual)

METHODOLOGY

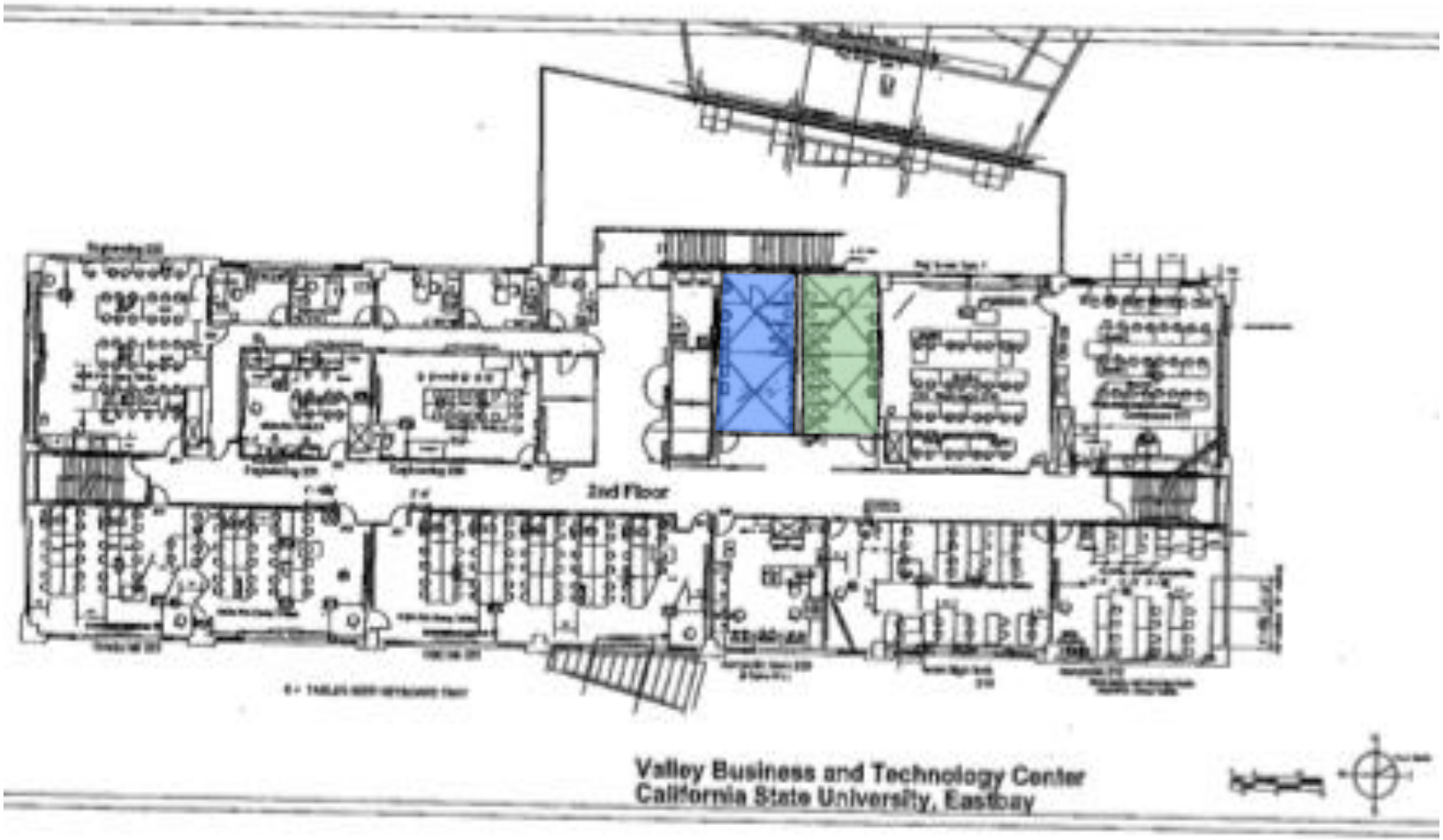
1. Identify sink from restroom data sheet – is it 1, 2, 3, etc.
2. Turn both handles 1/8 turn toward spigot (i.e. 45 degrees from closed – half way to maximum turn of 90 degrees) to start water flow.
3. Place 0.25 gallon container under water flow from spigot and start stopwatch simultaneously.
4. Stop stopwatch when container is full to top line.
5. Record time on data sheet in seconds to the nearest 0.1 seconds.
6. Empty 0.25 gallon container.
7. Repeat steps 2-6 two more times.
8. Move to next sink.

Measuring flow rates

0.25 gal beaker + stop-watch

Floor Plan with Restrooms Marked

Each student given shaded copy/data sheet



Example Data Sheet

Average of approx. 20 faucets per student pair

Sheets | Charts | SmartArt Graphics | WordArt

	A	B	C	D	E	F	G	H	I	J
1	Building	Building ID	Rest Room Number ID	Men's	Women's	Unisex	Inventory Sink	Actual Sink		
2	Library	LI	3137	x			4	4		
3	Library	LI	1127	x			3	3		
4	Library	LI	2136	x			4	4		
5	Library	LI	SB (South Basement)	x			2	2		
6	Library	LI	2012	x			1	1		
7	Library	LI	3156	x			4	4		
8	Library	LI	2358	x			2	2		
9	Library	LI	3136		x		4	4		
10	Library	LI	1126		x		3	3		
11	Library	LI	2135		x		4	4		
12	Library	LI	1080		x		2	2		
13	Library	LI	SLM (South LM)		x		1	1		
14	Library	LI	2025		x		2	1		
15	Library	LI	3136		x		4	4		
16	Library	LI	2356		x		2	2		

39	Reviewer	Raymond								
40	Measurer	Raymond								
41	Building ID	LI								
42	Rest Room Number ID	2136								
43	Gender	Men's			Flow Test Data					
44	Faucet	Sink Type	Aerator Thread	Aerator GPM	Secs/ 0.25gal	Secs/ 0.25gal	Secs/ 0.25gal	Average	GPM	
45	LI-2136-1	5	E	1	12.10	11.8	11.1	11.7	1.3	
46	LI-2136-2	5	E	1	12.60	11.7	12.2	12.2	1.2	
47	LI-2136-3	8	E	0.5	Non-Func.	Non-Func.	Non-Func.	No Data	No Data	Not working
48	LI-2136-4	5	E	1	12.70	12.3	12.4	12.5	1.2	

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Example Spreadsheet

Data entered into building sheet rolls up to campus sheet

Opportunity to improve student Excel skills

	A	B	C	D	E	F	G	H	I	J	K	L	M
1												Seconds per wash	10
2						Flow Test Data						$/gallon	$0.0139
3	Faucet	Gender	Sink Type	Aerator Thread	Aerator gpm	Secs/ 0.25gal	Secs/ 0.25gal	Secs/ 0.25gal	Average	Measured gpm	% Reduction @ 0.5gpm	Water Savings (gal/Wash)	Water Savings ($/Wash)
119	LI-3136-1	Women's	4	E	1.0	16.20	16.50	17.20	16.63	0.90	44.6%	0.07	$0.0009
120	LI-3136-2		4	E	1.0	16.60	16.80	17.10	16.83	0.89	43.9%	0.07	$0.0009
121	LI-3136-3		4	E	1.0	16.90	17.80	17.70	17.47	0.86	41.8%	0.06	$0.0008
122	LI-3136-4		4	E	1.0	16.80	17.20	16.40	16.80	0.89	44.0%	0.07	$0.0009
123	LI-1126-1	Women's	3	E	2.2	7.00	6.60	7.10	6.90	2.17	77.0%	0.28	$0.0039
124	LI-1126-2		4	E	2.0	6.60	8.30	8.50	7.80	1.92	74.0%	0.24	$0.0033
125	LI-1126-3		3	E	2.2	7.90	8.60	7.60	8.03	1.87	73.2%	0.23	$0.0032
126	LI-2135-1	Women's	5	E	1.5	11.30	11.90	12.00	11.73	1.28	60.9%	0.13	$0.0018
127	LI-2135-2		8	E	0.5	Non-Func.	Non-Func.	Non-Func.	No Data	No Data	No Data	No Data	No Data
128	LI-2135-3		5	E	1.5	12.80	13.20	12.60	12.87	1.17	57.1%	0.11	$0.0015
129	LI-2135-4		5	E	1.5	11.90	12.00	11.50	11.80	1.27	60.7%	0.13	$0.0018
130	LI-1080-1	Women's	4	E	2.5	12.30	11.10	13.80	12.40	1.21	58.7%	0.12	$0.0016
131	LI-1080-2		4	E	2.5	9.90	8.10	8.70	8.90	1.69	70.3%	0.20	$0.0027
132	LI-SLM-1	Women's	4	E	1.0	22.90	22.40	22.90	22.73	0.66	24.2%	0.03	$0.0004
133	LI-2025-1	Women's	4	E	2.2	6.90	9.90	8.70	8.50	1.76	71.7%	0.21	$0.0029
134	LI-2025-2	Women's	4	E	2.2	7.70	7.90	7.40	7.67	1.96	74.4%	0.24	$0.0034
135	LI-3136-1	Women's	4	E	1.0	20.40	21.90	25.60	22.63	0.66	24.6%	0.03	$0.0004
136	LI-3136-2		4	E	1.0	23.50	23.90	22.10	23.17	0.65	22.8%	0.02	$0.0003
137	LI-3136-3		4	E	1.0	21.50	24.90	23.20	23.20	0.65	22.7%	0.02	$0.0003
138	LI-3136-4		4	E	1.0	21.00	22.90	19.50	21.13	0.71	29.6%	0.03	$0.0005
139	LI-2356-1	Women's	5	E	0.5	35.50	35.50	37.30	36.10	0.42	Less than 0.5gpm	Less than 0.5gpm	Less than 0.5gpm
140	LI-2356-2		5	E	0.5	26.70	32.80	25.20	28.23	0.53	5.9%	0.01	$0.0001

Summary Faucet Performance Data

- 340 public restroom sink faucets
- 10 faucets non-functioning, 1 restroom used as storage
- 80 already had measured flow rate < 0.5gpm
- 249 had measured flow rates > 0.5gpm
- 6 of these had missing aerators
- 62 of these could not determine the gpm of aerator
- 10 of these had aerators with 0.5 gpm rating
- Assuming flow rates could be reduced to 0.5 gpm
  - Average reduction would be 0.18 gals per 10 sec wash
  - Maximum reduction would be 1.39 gals per 10 sec wash
  - Average savings would be $0.0025 per 10 sec wash

Frequency of use estimation

Adapted methodology of Morales et al. 2011 (click here)

- Functional population is a building's population normalized to 24 hours per day.
- Use published frequency of use of toilets/urinals per 24 hours (7.65 per person), assume hand wash each time, and assume avg. no. of seconds per wash (10)

Table 3. Male and female frequency of fixture use coefficients per 24-hour period (Adapted from Mayer et al. 1999).

	Male	Female
Toilet (flushes/person/day)	1.91	7.65
Urinal (flushes/person/day)	5.74	0
Faucet (minutes/person/day)	1.28	1.28
Shower (minutes/person/day)	5.6	5.6

Functional Population (in progress)

- Personnel data Is not easily available
- Campus inventory of offices by type, with number of desks/stations maps to employee occupancy by building
- Class scheduling data provides student enrollment, class durations, by building/room
- Provides for reasonable estimates of functional population
- Can apply to 4 * 11 week quarters, ~220 days of instruction – will give conservative estimates of use
- Can determine FP per 24hr * avg. toilet visits per 24hr then divide by number of faucets in building for average use
- Could generate more sophisticated estimation by faucet if made more assumptions or had empirical data

Draft Results and Recommendations

PRELIMINARY RESULTS (In progress)

- Projected average savings = ** gal per yr per faucet
- Total campus savings = ** gal per yr
- Percent of faucets with < 1yr payback = ** %
- Total 1st year net savings from retrofit of faucets with <1 yr payback (assume $15 per faucet) =

RECOMMENDATIONS

- Campus is a living lab: seek win-win partnerships between student projects and campus physical plant
- Put savings into student sustainability project fund

Unfinished Business and What Next?

Unfinished Business

- Refine wash frequency assumptions component to better estimate hierarchy of paybacks, priority retrofit sequence
- Collect student self-reflection survey re: sustainability ILO
- Prepare and submit proposal for retrofit funding to CFO/Facilities colleagues based on findings
- Write paper for publication, conferences
- Perform follow up study of actual savings from retrofit

What To Do Next Year in GEOG 4350?

- Suggestions? Leak detection audit. Irrigation system efficiency audit. Go off campus?

Thank you for your attention

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Cal State East Bay Hayward campus looking to SF

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