Case Study:
Reducing & Reusing Water in Manufacturing

Corporate Water Footprinting

Towards a Sustainable Water Strategy

Session 8: Sustainable Water Techniques: Reduce, Reuse and Recycle

December 3, 2008 / Hyatt Regency / San Francisco, CA

Tom Cooper
Corporate Water Programs Manager
Intel Corporation

intel

Agenda

- Overview of Intel
- EHS in Technology Development
- Water Recycling and Conservation
  - –CA Case Study
  - –AZ Case Study
- Selected Results
- Challenges & Opportunities

Intel Overview

Our "Fun" Facts:

- Founded on *July 18th,1968*
- Number of employees: >80K
- >$38 Billion in annual revenue
- 294 offices/facilities in 48 countries
- 43,000 technical degrees & "Intel U"
- Rated 7th most valuable brand by BusinessWeek and InterBrand

Intel's Manufacturing Sites

More than half of all Intel employees work in manufacturing

Leadership…

"It's no longer enough to just produce a profit. Instead, we need to continually improve our manufacturing process, thereby reducing our burden on the environment and becoming an asset to the communities in which we live and work".

Gordon Moore, Intel Chairman
Letter in EHS Report, January 1995

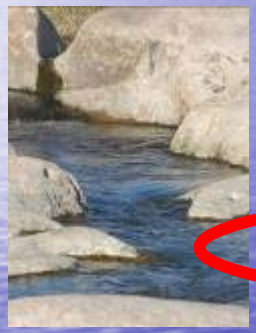
"Continuing our commitment to the highest performance in all we do—from product innovation to corporate responsibility—is good business.

Paul Otellini, President and CEO
CSR Report, May 07

Intel's EHS Guiding Principles:

- Prevent all injuries in the workplace
- Be an EHS leader in our communities and our industry
- *Reduce the environmental footprint of our products, processes and operations*

Environmental Goals

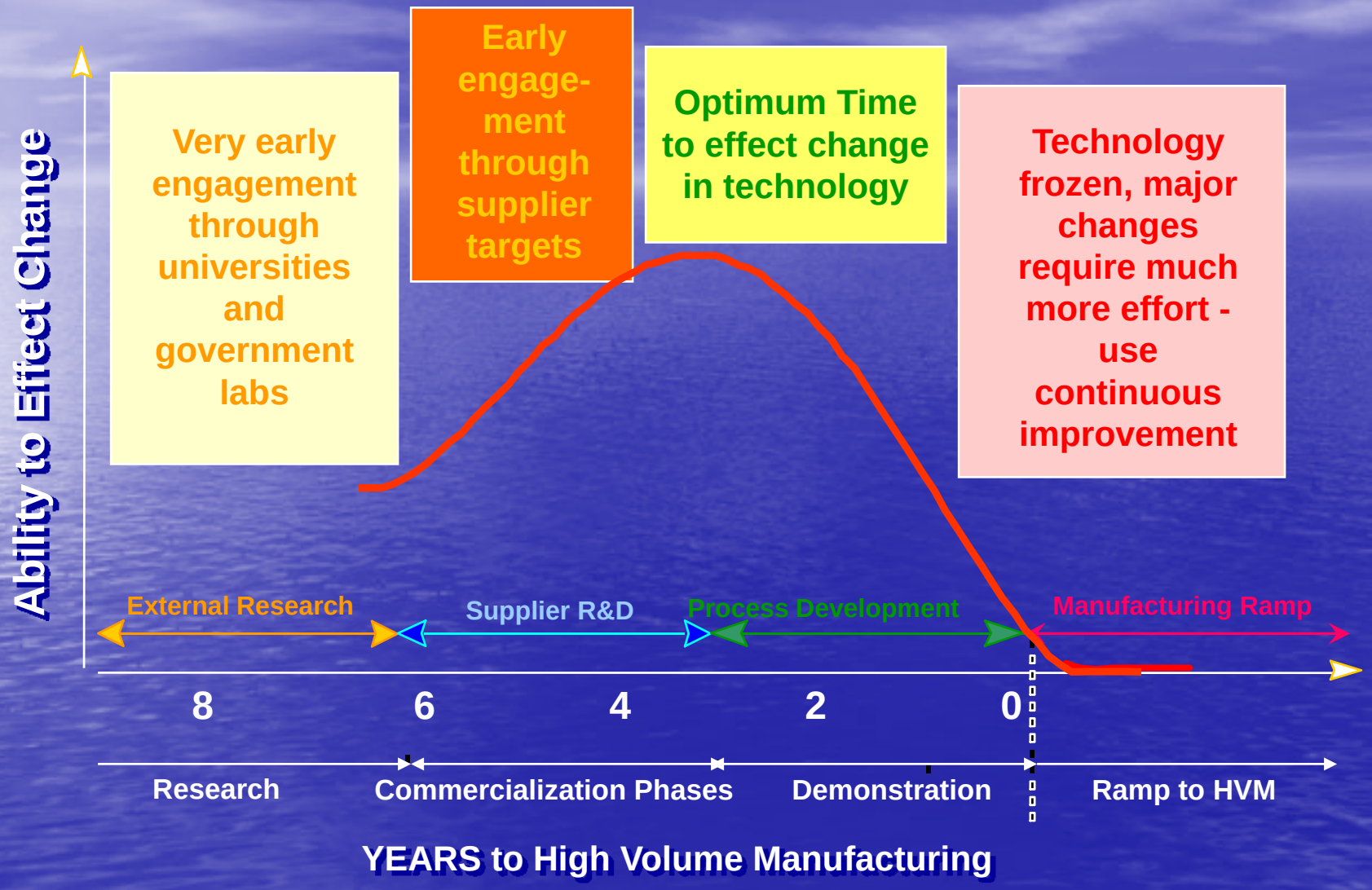


- Reduce absolute global-warming gas footprint by 20% by 2012 from 2007 levels.
- Reduce energy consumption per chip 5% per year from 2007 through 2012.
- Achieve engineering and design milestones to ensure that Intel products keep the energy-efficiency lead in the market for our next two product generations.
- Reduce water use per chip[1] by 2012 from 2007 levels.
- Reduce generation of chemical waste per chip by 10% by 2012 from 2007 levels.
- Recycle 80% of chemical and solid waste generated per year.

[1] Assuming a typical chip size of approximately 1cm^2. (Chips vary in size depending on the specific product.)

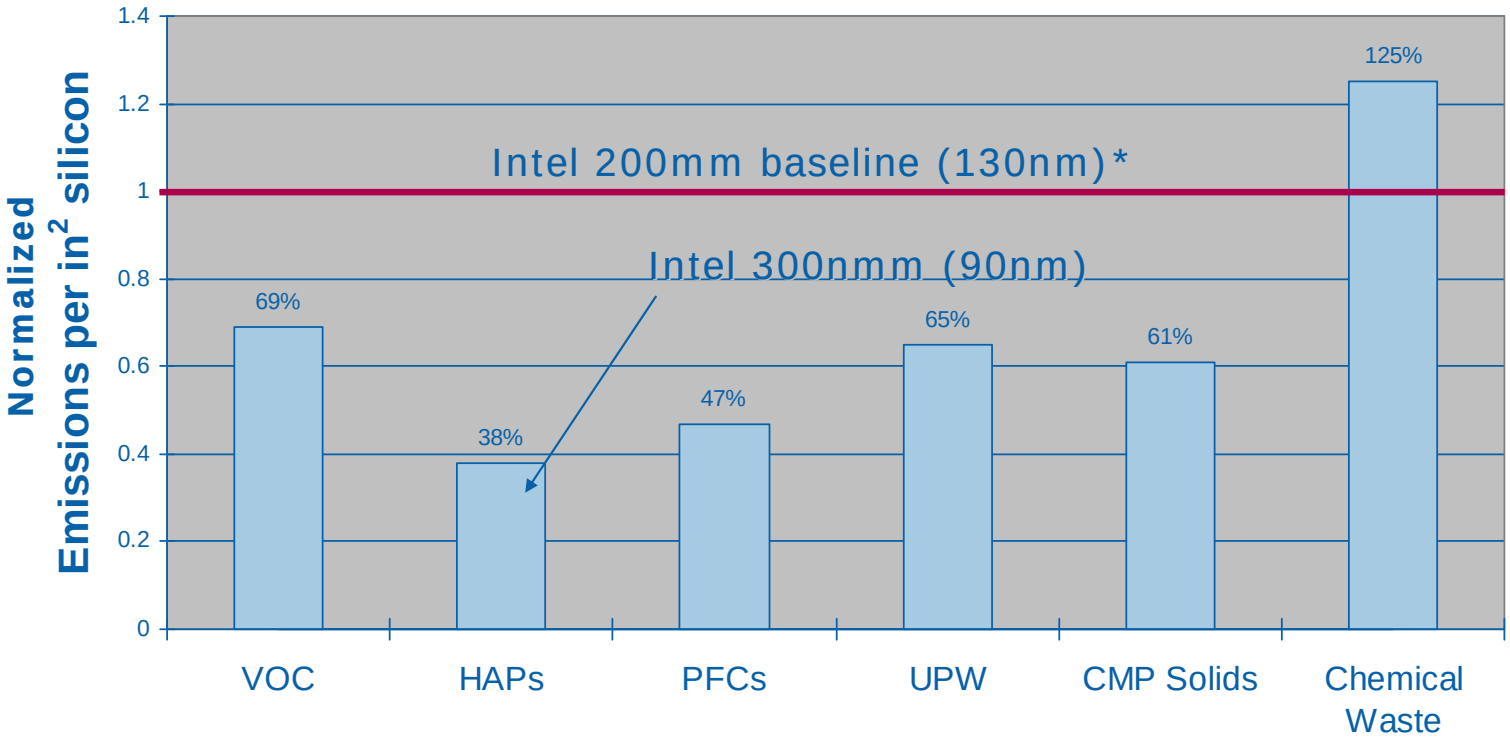
Environmental, Health & Safety in Technology Development (TD)

Intel EHS Technology Engagement Model



Reduce Demand - Emissions & Water
300 vs. 200mm Equipment Tool Set

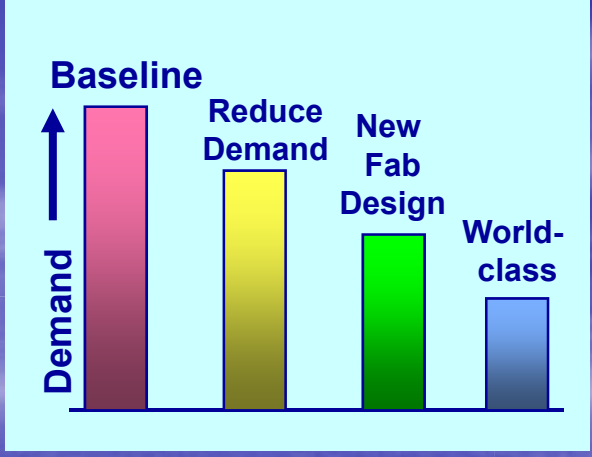
Normalized 200mm vs 300mm performance at peak of ramp



*Note: Intel 130nm baseline averages ~60% of Industry average

Water Recycling & Conservation

Intel's Overall Strategy



- ✓ Know your water…
- ✓ Reduce water demand at Tools
- ✓ Leverage worldwide team of water experts
- ✓ Drive water reuse/conservation in new Fab design
  - ✓ Baseline: Once through water use
  - ✓ Generation 1: Ultra pure Reclaimed Water (URW)
  - ✓ Generation 2: URW + Intense heat recovery (reduce cooling tower evaporation)
- ✓ Add conservation measures based on local conditions (e.g. water quality, infrastructure, climate)
  - – Developed standard "toolbox" for projects beyond BKM

1 - REDUCE

2 - RECLAIM

3 - RECYCLE

CA Case Study

“Local” Solutions

- Step 1: Wall-to-wall audit
- Step 2: Pareto Opportunities – biggest bang for $
- Step 3: Get Help!!! Examples include...
  - Commercial Water Softener Rebate Programs
  - Cooling Tower Rebate Programs
  - Commercial High Efficiency Toilet Program
  - Irrigation Technical Assistance Program (ITAP)
  - Water Efficient Technologies (WET) Program

Water Efficient Technologies (WET) Program

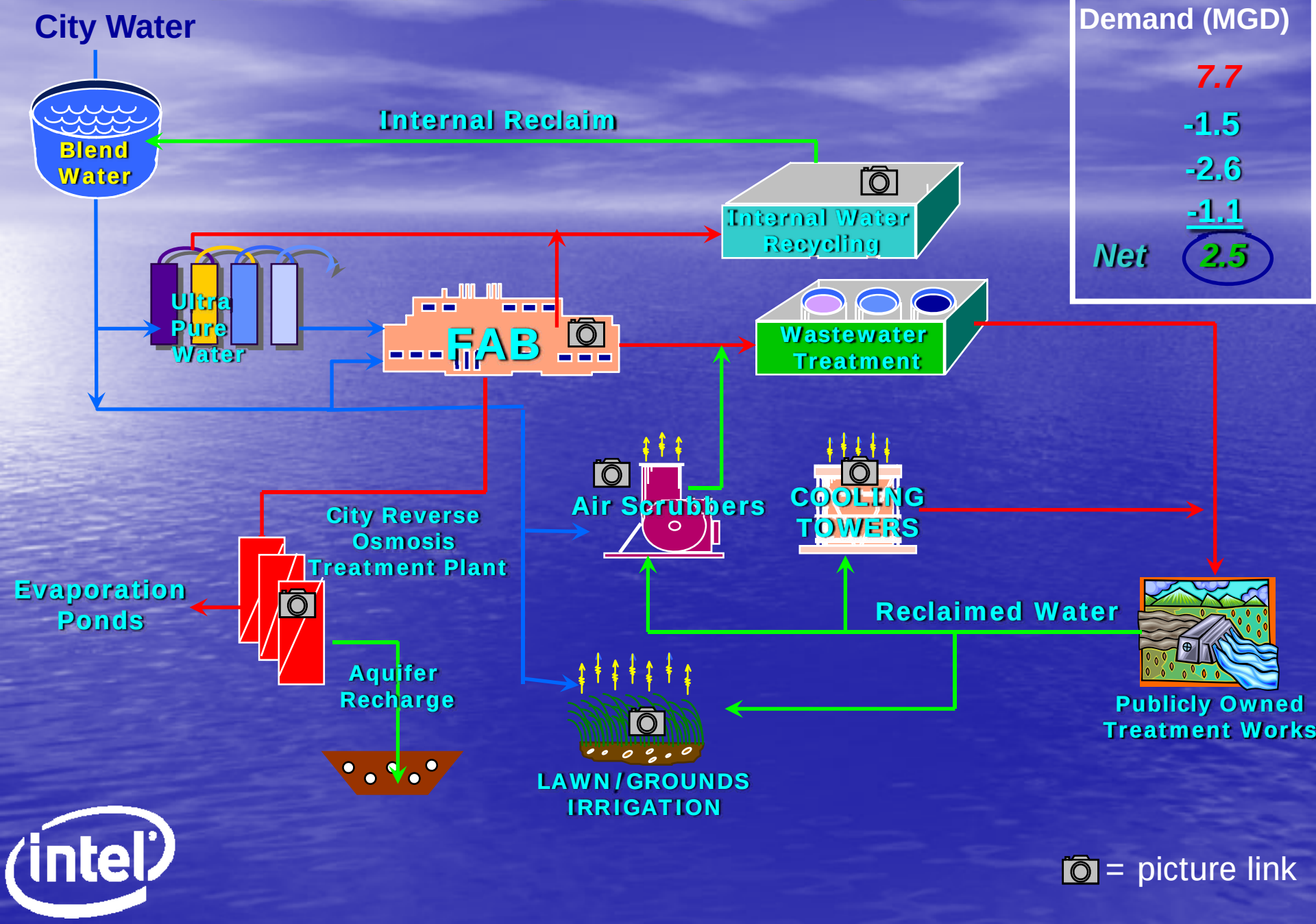
- '90s "Slow the Flow" Campaign in Santa Clara Valley
- Successful collaboration between Intel, SCVWD and SJ/SC/WPCP
- Santa Clara Campus "D2" Fab
  - Scrubbers
    - Caustic injection to replace water
  - Cooling towers
    - Installation of Electro Dialysis Reversal (EDR) to pre-treat RO Reject
- At least $175K in rebates –

  Easy Money! ☺

AZ Case Study

Chandler Reverse Osmosis Water Treatment Facility
Fab 32
Fab 22
Fab 12
Ocotillo Rd
Dobson Road
1,000 ft set-back from homes
Ocotillo, Arizona
Image © 2008 DigitalGlobe
Google
111°52'51.94" W
Eye alt 2.46 km

Case Study: Ocotillo Water Conservation



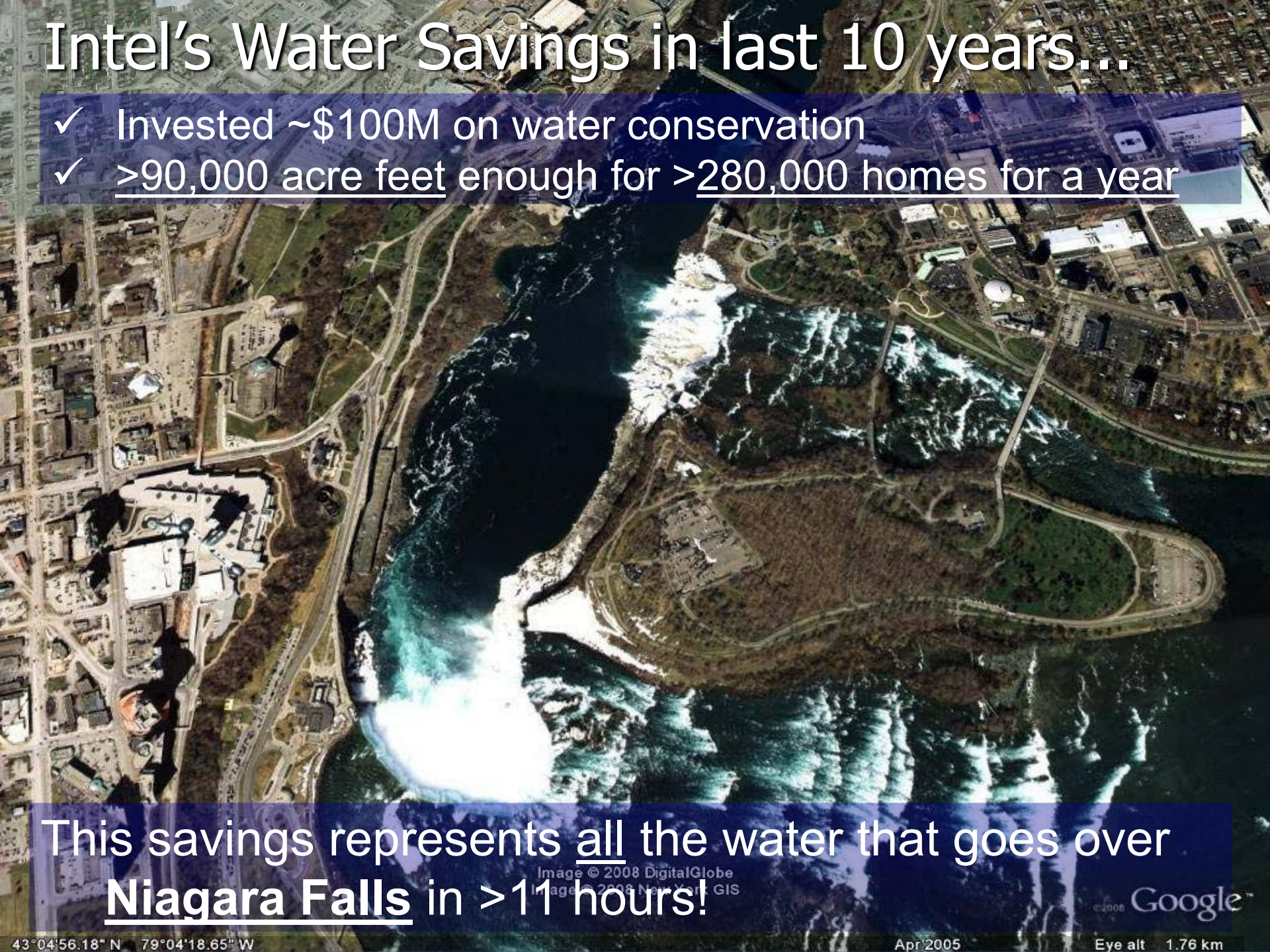
Selected Results

Selected Results:

- **Over <u>3.5 billion gallons</u> of drinking-quality water recharged into AZ aquifer**
- **Operations <u>conserve up to 75%</u> of daily water demand**
- **U.S. EPA's 2007 Water Efficiency <u>Leader Award</u>:**
  - EPA recognized Intel Ocotillo as one of six winners of the 2007 Water Efficiency Leader (WEL) awards.
  - Winners were chosen by a panel of national water experts and based on three criteria: Leadership, innovation and water saved

Intel's Water Savings in last 10 years…

- ✓ Invested ~$100M on water conservation
- ✓ >90,000 acre feet enough for >280,000 homes for a year



This savings represents all the water that goes over **Niagara Falls** in >11 hours!

Challenges & Opportunities

Challenges Ahead...

- Single Wafer Processing...
- Water Use Demands and ROIs...
- Moore’s Law and the Periodic Table...
- Infrastructure Limitations...
- Concentrating the problem...

Water-Related Opportunities…

- BE PROACTIVE (Covey's 7 Habits)
  - Get "out there", assess, prioritize, plan[4]
  - Follow through!
- Don't reinvent the wheel
  - NUMEROUS excellent water reduction planning documents and web sites available[4,5,6,7]
  - Leverage other people, companies, institutes
- Education and mentoring of others…
  - Share successes AND failures
  - Change paradigms (for example…)
    - Waterless urinals…
    - Thinking outside box (& even property boundaries)…
    - Holistic impacts – complete ROIs assessments

Supporting Data

References and Resources

1. USGS: http://wwwga.usgs.gov/edu/earthhowmuch.html
2. Source: Gleick, P. H., 1996: Water resources. In Encyclopedia of Climate and Weather, ed. by S. H. Schneider, Oxford University Press, New York, vol. 2, pp.817-823.
3. http://www.lenntech.com/water-trivia-facts.htm
4. Santa Clara Valley Water District - Water Conservation link (http://www.valleywater.org/conservation/index.shtm)
5. At the Crest of a wave: A Proactive Approach to Corporate Water Strategy (http://www.bsr.org/reports/BSR_Water-Trends.pdf)
6. Water Efficiency Guide for Business Managers and Facility Engineers (http://www.p2pays.org/ref/23/22629.pdf)
7. American Water Works Drip Calculator: http://www.awwa.org/awwa/waterwiser/dripcalc.cfm
8. Google – “Know your Water” and “Water IQ”

Comparative Water Use

Product	Gallons of Water to Produce
Glass of Milk	65
1 Steak	2,607
Ton of Alfalfa	13,500
1 Egg	120
Pair of Jeans	1,800
Sunday Newspaper (Average)	150
Wheat for 2 lb. loaf of Bread	1,000
Core 2 Duo	<10

***SOURCE*: Intel & EPA Office of Water**

Ireland – F24

Mtn View – F1

Chandler Reverse Osmosis Water Treatment Facility

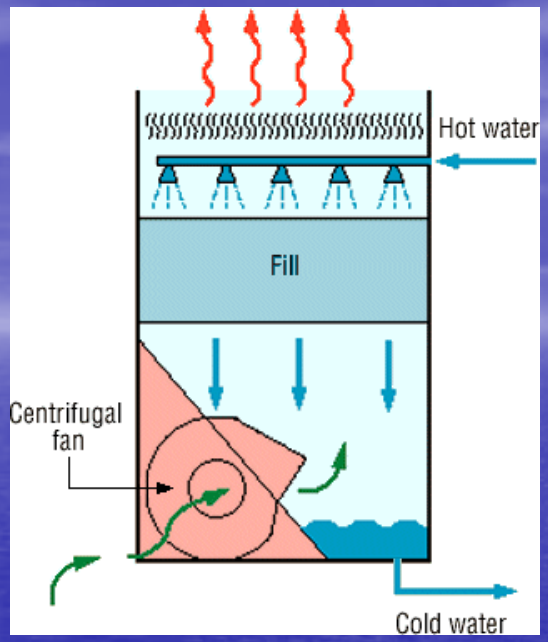
Brine Evaporator System

Air Scrubbers - Typical

Vertical

Horizontal

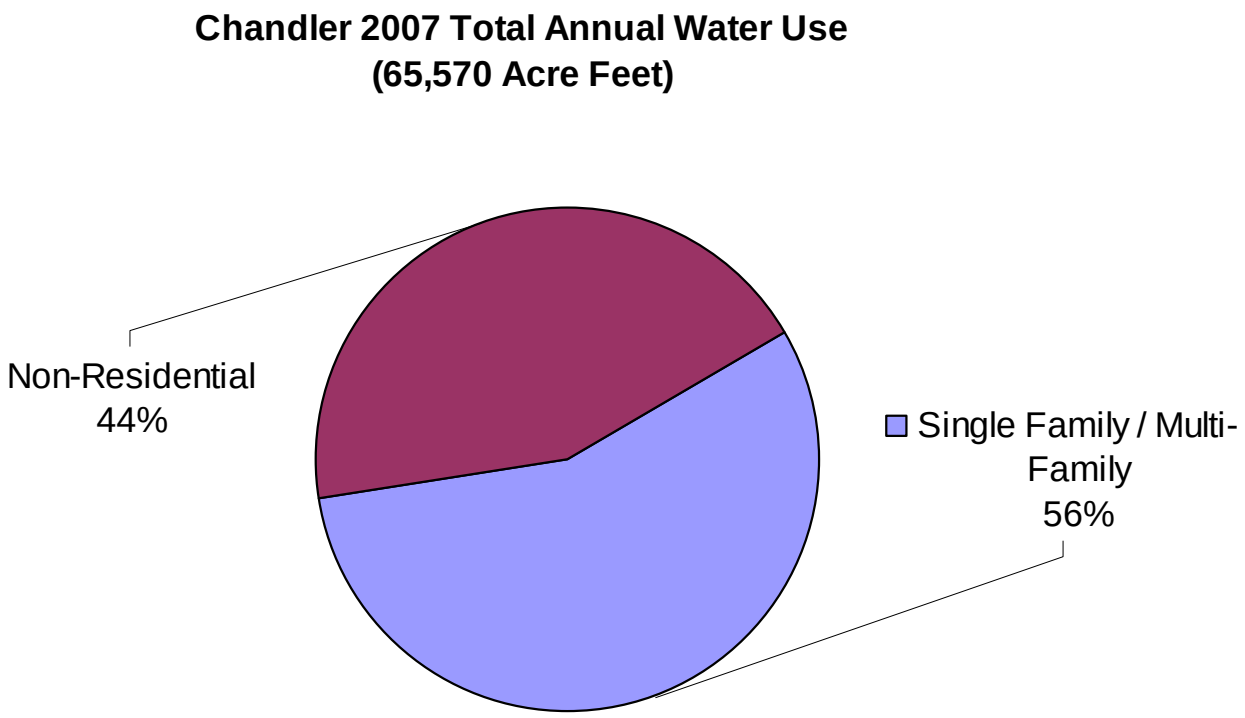
Cooling Towers - Typical



AZ Cooling Tower Utilizing Reclaimed Wastewater

Landscaping the Smart Way... Xeriscaping

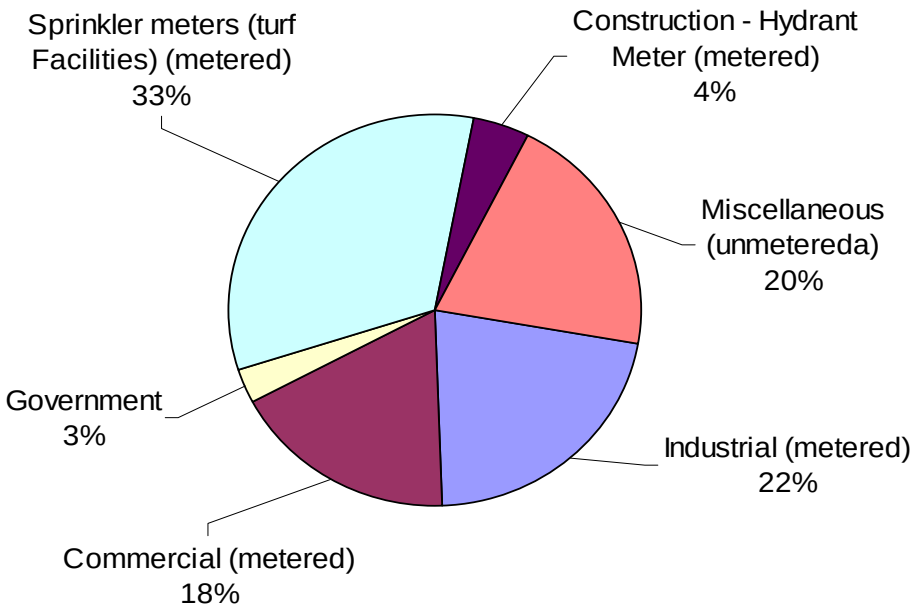
Chandler's Total Water Use



Intel = 4% of City's Total Non-Residential and Residential Use

Chandler's Total Water Use Non-Residential Sector

Chandler Annual Non-Residential Metered Water Use (2007)
(29,007 Acre Feet) by Major Sector



Intel = 10% of City's Non-Residential Use
Intel = 45% of City's Industrial Use