

The economy

## High tech dependent on plenty of clean water

### Even so, semiconductor firms are finding ways to conserve

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The greater Austin area has become well-known nationally as a high-technology center.

With that in mind, take this one-question quiz. Which of these factors make the area attractive to semiconductor companies and research consortia such as Sematech:

- A. The city has a well-educated labor force.
- B. It has a large, prestigious research university.
- C. It has relatively ample, clean water supplies.
- D. All of the above.

If you answered "D," give yourself an "A."

Perhaps less known than other factors, prodigious quantities of potable water are crucial to the manufacturing of semiconductor wafers — a surprisingly water-intensive business.

Large computer chip fabrication plants, or "fabs," often use 1 million to 2 million gallons of water a day to clean and rinse silicon wafers. As much as 2,000 gallons of ultrapure water can be used to clean a single eight-inch wafer. These wafers contain more than 100 fingernail-sized microchips that run everything from personal computers and cell phones to traffic lights and coffee makers.

When it comes to economic development, "If you don't have an adequate water supply, you are not going to get a semiconductor fab — period," said Angelos Angelou, former chief economist for the Greater Austin Chamber of Commerce. He now is principal of AngelouEconomics, an Austin-based technology-based economic development consulting firm.

Jubal Smith, manager of Austin's Economic Development Department, said: "There are a lot of communities that are eliminated from those site searches because of a lack of availability of water. Fortunately, in Austin, so far we have not run across a situation in which we cannot accommodate a prospect based on lack of water."



Photo courtesy of Sematech  
As much as 2,000 gallons of ultrapure water is used to produce a single silicon wafer.

### **Chip makers big water users**

Because the chip-making process requires massive volumes of water, Austin semiconductor companies are among the largest customers for Austin Water Utility, the city's water and wastewater department.

In the utility's fiscal year that ended last Sept. 30, Freescale Semiconductor ranked as Austin's largest industrial water user with more than 1 billion gallons. Other semiconductor industry stalwarts also were among the city's top water users: Advanced Micro Devices (652 million gallons), Samsung Electronics (499.6 million gallons) and Sematech (101.2 million gallons).

"Water is a universal solvent and is indispensable in semiconductor operations," said Dan McGowan, spokesman with Sematech, the consortium of U.S. semiconductor manufacturers based in Austin.

### **How water is used in making computer chips**

Many people are familiar with clean room environments where computer chips are made. Chip-making employees wear special lint-free, hooded body suits, called "bunny suits." (Remember the dancing technicians in Intel Corp.'s commercials?) By one measure, these clean rooms are 10,000 times cleaner than a hospital operating room; huge air filtration systems completely change the air about 10 times per minute.

All this cleanliness prevents impurities from landing on the chips and creating barriers within the tiny transistors and connectors. The tiniest speck could ruin a chip with features that measure less than a hundred-thousandth of an inch across. Reliability is crucial — production stoppages can cost more than \$1 million per day.

In this superclean world, it's not just the air that must be free of impurities — so must the water.

A large modern fab uses extensive water purification technology to upgrade the quality of municipal "feed" water to what is known as ultrapure water (or UPW). This water is used to clean and reclean the wafers during manufacturing.

Managing water in an economically and environmentally responsible manner is a huge task for semiconductor manufacturing facilities. Chip makers use multiple steps to remove particulates and control biological growth in what starts as ordinary drinking water. This includes using advanced filtering systems, reverse osmosis and ultraviolet processes.

Finally, after the water is used it is pretreated to neutralize its pH composition and remove certain contaminants before being returned to the city and eventually finding its way back to the Colorado River, said Todd McCay, Freescale's Austin manager for Environment, Health & Safety.

### **Conservation efforts**

Several years ago, the semiconductor industry developed aggressive environmental goals, including reducing fabs' water intake by 60 percent, according to a "technology road map" compiled by Sematech. (No immediate word on how closely the industry is to reaching the goal, McGowan said.)

Citing industry norms, McGowan said about 70 percent of the water used in a fab is either recycled or reclaimed for use in other areas. Of that amount, about 20 percent is used for other processes, such as cooling towers and heat exchangers. Another 10 percent is used for secondary processes such as lawns, bathrooms and sprinkler systems.

Sematech has sponsored many water conservation projects to find ways to reduce water usage in processes, equipment and tools, McGowan said. Many of these projects were done in cooperation with its members, including Austin chip makers Freescale and AMD. Last month, Samsung also joined the consortium. (See [news release](#).)

By optimizing operational processes, using reclaimed water in facility systems — such as air-conditioning in campus buildings — and using rainwater collection to partially supply landscape irrigation systems, Freescale has saved 375 million gallons of water since 2000, said McCay of Freescale. The company set up a utility conservation team made up of members from its Ed Bluestein and Oak Hill fab sites to implement water conservation projects and share information between the sites.

For these conservation efforts, the Texas Commission for Environmental Quality in 2004 awarded Freescale the [Texas Environmental Excellence Award](#) in the large business technical category. (Freescale is the only three-time winner since the awards program began in 1993.)

Other chip companies are also reducing water usage:

- **Samsung Austin Semiconductor** implemented extensive water conservation efforts when it opened its memory chip fab in 1997. The facility includes a series of pipes, tanks and a retention pond to reuse and recycle water, including reusing water rejected from its reverse osmosis filtering process and collecting stormwater for irrigation needs. All told, this has resulted in a 60 percent reduction in water consumption for its manufacturing operations, and an overall annual savings of nearly 450 million gallons over what it would have used if it didn't install the \$4.1 million system, said Ron Brooks, manager of environment, health and safety at the North Austin site. Later this year, Samsung plans to unveil an additional ultrapure water delivery system as part of a facility expansion to conserve even more water, Brooks said.
- **AMD** this year plans to complete a project that will treat reclaimed water to a level that makes it comparable with water supplied by the City of Austin. This will allow this water to be used for its ultrapure water feed, doubling its usage of reclaimed water and further reducing its wastewater flow, said AMD Senior Environmental Engineer Britt Taylor-Burton.

#### **Benefits for city's utility**

The semiconductor makers' water conservation efforts provide significant benefits for Austin's water and wastewater system, said Bill Hoffman, supervisor of industrial and commercial water conservation programs for Austin Water Utility. These include delaying the city's need to secure additional raw water supplies, lessening the need to build water and wastewater treatment plants, and saving on operating costs.

The bottom line: "It's keeping the cost down so we don't have to raise rates," Hoffman said.

He added that the semiconductor operations account for about 5 percent of the utility's water, but the benefits to the area economy are hard to measure. Freescale (5,600), AMD (3,000), Samsung (960) and Sematech (500) combine to employ more than 10,000 area employees.

Looking ahead, it is clear there is a limit to how far water conservation efforts can go at chip plants like those in Austin. These fabs make wafers that are 200 millimeters in diameter. New-generation chip plants — ones that use 300-millimeter wafers — have many advantages, including being able to incorporate new water conservation tools and processes from the ground up.

Even so, Freescale plans to continue explore ways to conserve water, said Chris Nauert, the company's site services manufacturing liaison. "I don't think we will ever stop optimizing processes, and finding more ways to use less water," he said.

*Charles Boisseau is LCRA's Web editor.*

**Related links:** Intel Corp.: [How microchips are made](#) CleanRooms magazine: [Reducing water usage in semiconductor manufacturing](#) Forbes: [Water and the Environment](#) Austin Water Utility: [Industrial Waste Control/Pretreatment](#) [Freescale](#) [AMD](#) [Sematech](#) [Samsung](#) [Austin Semiconductor](#)