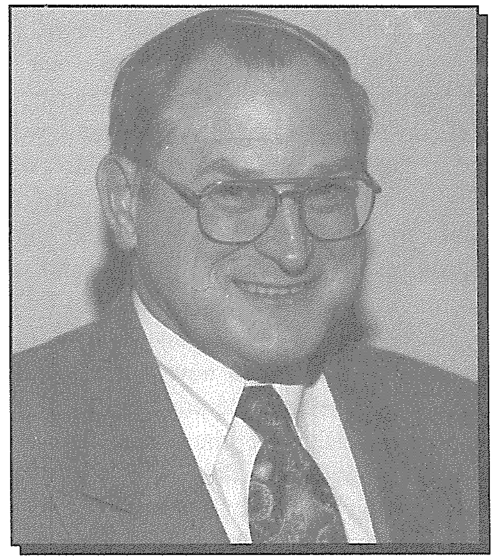
***Donald L. Hutchinson** graduated from the U.S. Air Force Academy with a B.S. in Engineering Science. After completing pilot training, he served in numerous line and staff positions in the U.S. and overseas. Don retired from the Air Force in 1982 as the Deputy Base Commander at Cannon AFB in Clovis and subsequently moved to Albuquerque. In September of that year, Don joined Intel which also had recently moved to Albuquerque. Over the past 12 years, he has served in numerous management positions and headed up the Intel team in its well-application efforts before the State Engineer. He currently is responsible for all central facilities operations. Don holds an M.S. degree in Personnel Management and an MBA. He is Chairman of the Board of New Mexico Industrial Energy Consumers, serves on the Mechanical Trades Advisory Board of T-VI, and was a pro bono member of the City of Albuquerque's electrical franchise negotiation team.*



INDUSTRIAL WATER MANAGEMENT: THE INTEL EXAMPLE

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Good afternoon. I hope everyone is refreshed after our break. I would like to keep this presentation very informal and I will try to make it as nontechnical, as understandable, and as free from acronyms as I can. Please feel free to participate and ask questions.

I was asked to talk about how industry manages its water resources. As you heard from many of the other presentations today, Intel recently made a well application to draw water from the middle Rio Grande underground water basin to use in our manufacturing effort. My presentation is based on that application and some of the things that have come of it. My focus is not on the technical aspects of the application, but more on the water needs of an industry, and how Intel feels an industry can contribute to conserving our natural resources.

First, I would like to talk about today's many challenges facing industry which include the following.

- competition in the market place
- manufacturing efficiency
- conservation of natural resources
- environmentally friendly manufacturing
- product quality

Most of us can identify with them whether we are in the industrial sector or not. Of the many challenges facing industry, I will concentrate on the conservation of natural resources. That is in itself a very broad topic. Timber, oil, water, natural gas, and extracted minerals are some of the many natural resources that industry uses. I will further narrow our focus today to water.

I'll begin with a brief history of water management here in New Mexico, specifically in the Middle Rio Grande underground water basin. Then I'll talk about the quantity and quality of water Intel needs to manufacture semiconductor devices, and what Intel currently is doing. Two diagrams will be presented to clarify what I am saying and to present pictorially the water requirements in the integrated circuit industry. I'll discuss how we plan to conserve approximately 39 percent of our current water requirements. Let me explain what I mean by conserving 39 percent of our water. Originally we made some estimates as to how much water we would need before we started our expansion. With our conservation efforts, primarily in water reuse, those estimates have come down by about 39 percent. That is what I mean by conservation. Others may have different definitions of conservation, but that basically is what I am talking about here.

First, a bit about the history of water administration within the state. Most everyone here is familiar with the doctrine that the State Engineer uses to administer water in this area. It is based on Technical Report 21 which was issued in 1961 and that was considered the definitive study for administration of water, and has been the definitive document that the State Engineer uses to administer water in our area. Basically that document says that there is an infinite connection between the river and the aquifer. That is, for every gallon of water you take out of the aquifer, you take a gallon of water out of the river to recharge the aquifer.

In the spring of 1993 there were three large permit applications filed with the State Engineer Office. Intel was the first of those applicants and it filed for 4,500 acre-feet of water. The second was the City of Albuquerque. If my memory serves me correctly, the City applied for 39,000 acre-feet of water. The third applicant was the Rio Rancho Utility Corporation, which is the utility that services Rio Rancho, and it filed for 12,000 acre-feet of water.

These three applications were followed very shortly by the August 1993 U.S. Geological Survey report that triggered some question as to whether the conclusions reached and assumptions made in the 1961 study were valid. Last summer, a lot of those assumptions were being called into question. I think they were being called into question more in the public's eye than in the technical community. One of the authors of the 1993 USGS report, Mike Kernodle, is giving a presentation on this very subject in another room. What he is basically saying is that the information we have is really information we have had for a long time. We are taking another look at it and refining it slightly. All in all, there is not a lot of information that we didn't already know, but the public has become aware of it from the stories that hit the front pages of our local newspapers. Although we currently do not have a water crisis, it is definitely time, especially given the speed at which governments work, to start planning for our future water needs.

In the spring of 1994, we started talking about conservation. I am sure everyone in this room knows of the conservation efforts of the City of Albuquerque and of Jean Witherspoon, their conservation officer. The City has been very proactive in leading the conservation effort. The mayor held a town hall meeting on this issue in September of 1994. Senator Domenici has had meetings focusing on water issues. He mentioned that this morning in his keynote address. There has been considerable attention focused on water issues in the last year-and-a-half.

In June of 1994 the State Engineer granted Intel a permit to divert 3,248 acre-feet of water. If you attended today's luncheon, you heard State Engineer Eluid Martinez refer to that application. In his talk, he boiled down four weeks of hearings into about 15 minutes. There were a lot of significant issues discussed during those hearings. The State Engineer discussed his thoughts during the Intel application deliberations; whether he was supposed to decide whether the water that was available—and everybody agreed the water was available—was to be used for semiconductor manufacturing or was it to be used for some other purpose. He sort of used the wisdom of Solomon and split the baby in half. He did not give us all that we had asked for; we had asked for 4,500 acre-feet. He gave us 3,248 acre-feet. If you wonder why that specific number, that amount comes out to 2.9 million gallons-per-day. As a part of that permit, he imposed some very strict monitoring conditions on us. We are required, before we can start to pump, to implement a very, very tedious monitoring program that will last for three years. We are locating three well nests within the village of Corrales with five separate wells. They are screened at 15 different locations so that we will have piezometer readings (pressure readings) from 15 different depths within the aquifer ranging from 200 feet to 1,500 feet. That data must be transmitted to the State Engineer monthly for the next three years, and at the end of that three-year period, he reserves the right to modify or alter the permit based on the data we collect.

As you may have gleaned from the State Engineer's remarks at lunch, he is reconsidering now, and he is getting a lot of pressure from various constituencies, whether or not he should make changes in how he administers the basin. The City of Albuquerque believes that, given the new data, the assumption of an infinite connection between the river and the aquifer is erroneous, and that Albuquerque has been contributing surplus water to the Rio Grande that is ultimately delivered to downstream users. There is much discussion as to whether or not he should revise the method by which he administers the water in the middle Rio Grande underground water basin.

Let me switch gears. I'd like to discuss the quality of water that Intel uses and what water quality is required in the semiconductor manufacturing industry. This should help you understand what the industry feels is the lifeblood of industry, and that is water. Just as we as individual citizens consider water to be our lifeblood, in the semiconductor industry, water also is our lifeblood. It is impossible to manufacture integrated circuits without water. We are as concerned about an adequate, ample and reliable source of water as is any citizen because without it we would be out of business. We do not consider ourselves to be exploitive. We consider ourselves to be good corporate neighbors and we try our very best to use water efficiently.

What happens with water, unlike other natural resources such as oil, is that it returns to the environment, albeit in perhaps a different form or in a different location, but it all returns, unlike oil, which is a very finite and limited resource. The water we are drinking today is the same water that has been drunk by the inhabitants of the world for millions and millions of years. It is not destroyed, it is just relocated, and that is part of the good thing about water. There are opportunities to save it, clean it and reuse it over and over again.

In the semiconductor industry we have to use very, very clean water. The water that comes out of the ground, as Norm Gaume mentioned today, is really great drinking water. There is hardly anything you have to do to it to make it drinkable. However, Intel has to put its water through some very high-tech processes to make that water clean enough to use in rinsing off our wafers. Technology is driving us down to line sizes (the size of the conductors that conduct the electricity) on the submicron level. A human hair is about 100 microns wide and our technologies are below one micron. So we go to great lengths to keep everything clean: our rooms, our water, our chemicals and everything else. That's why we need ultra-pure water. We remove the 330 parts-per-million of dissolved salts, and to lay people, that means hard water containing calcium, magnesium and the like. We remove those dissolved salts from the water, and we concentrate them into what we call reverse osmosis reject water, and we use that water in our landscaping. We'll discuss that more later.

We send water through two phases. The first, a reverse osmosis phase, which is very similar to a filtering phase in which the results are similar to what you get with a filter for suspended solids, removes dissolved solids. The deionization process is similar to what happens in our home water softeners, except our process is at a much higher level and grade. At home we use salt to regenerate the demineralization resins. Intel uses various chemicals that combine back into water when we use the deionization process. Finally, we run the water through an ultraviolet light which kills bacteria and then through .04-micron filters to remove dead bacteria carcasses.

I now want to talk about the quantity of water Intel uses. I think Norm Gaume gave a fairly good comparison of categories of water users in Albuquerque on one of his slides this morning. There are approximately 134 million gallons-per-day of water taken out of the basin. Intel's projected use without conservation is about 9 million gallons-per-day. We estimate that we will be using approximately 5 million gallons-per-day by 1998, 2.9 of that will be coming from our wells, the rest will be purchased from Rio Rancho Utility Corporation. That corporation currently is involved in a legal case with the City of Rio Rancho, which has filed a condemnation action in the courts to take over that utility and municipalize it.

I would like to show you the various water streams within our factory. Figure 1 is the current water flow diagram for Intel. The grey areas represent those areas where we reuse water or will have water conservation measures put into place. The diagram is a little dated now because we have moved more toward the diagram in Figure 2, our projected conservation plan. We now have about 50 percent of the recycling hardware installed—the piping, the chemical injection, and things like that—which is needed to maintain the chemical balance allowing the use of the water over and over again in our chillers and scrubbers.

We use approximately 10 percent of our water supply in our public areas—the restrooms, drinking fountains, kitchens, and so on. About half of our facilities have low-flow, water conserving fixtures in them. This water, after use, goes to the sewer system. Another 30 percent of our water supply is used for industrial purposes. Cooling towers are analogous to swamp coolers, except we use cooling towers to reject heat, rather than cool air, but it is exactly the same process that home swamp coolers use. We operate cooling towers by running water down through them. The towers cool the water and return the water back to us for producing cold water which we use to cool buildings and maintain the appropriate environment within our factories. Incidentally, our factories are called fabs or fabrication facilities.

Scrubbers are devices used to clean exhaust air. We do have chemical baths, acid baths, for instance, containing sulfuric acid. We have exhaust systems that capture all the fumes so as not to expose people to the fumes. These exhaust systems are ducted to big scrubbers, which operate like a curtain of water that the air has to pass through. When it passes through the water, fumes are absorbed by the water and the water becomes a bit acidic. When the water comes out, we treat it—control the pH—and then it goes to the sewer system. There are no harmful or toxic chemicals in it. There are no fluorides, no heavy metals, no radioactivity, none of that is discharged to the city. Our effluent is heavily controlled by the City of Albuquerque and we must comply with our permit conditions.

The cooling towers make "cool" and the boilers make "hot" and the humidifiers make "wet." The process vacuum is a vacuum that we use to handle the wafers, so you don't have to touch them. You just place a little vacuum wand on the wafer and you can move the wafer around.

Our most significant use of water is in our RODI (reverse osmosis/deionization) process. We use approximately 60 percent of our water there. We concentrate all the dissolved solids in about 50 percent of that water. Some of it we use for landscape irrigation and the remainder goes to the sewer. We have a deionization process which takes out all of the ions, and by the time it gets to the factory, the water is so pure that it does not conduct electricity.

We currently are installing conservation measures. Basically we will take water from the acid-waste neutralization area (AWN) where the pH is controlled before it is discharged, run it back up through the cooling towers where water is evaporated, the same way it is evaporated in your swamp cooler, into the scrubbers and eventually it flows back into the acid-waste neutralization area.

We are planning to convert all of our domestic-type fixtures to low-flow fixtures. We will continue to use reverse osmosis reject water for irrigation. We have plans to capture some other production water. This is what the Cooperative Research and Development Agreement (CRADA) that we have with Sandia National Laboratories is all about. Sandia is working on high-tech methods for removing the water in the factory before it gets contaminated. We use a lot of overflow processes and things like that because we would like to recover that water and put it back in at the front end of the process.

That is our water conservation scheme. This scheme will result in saving approximately 39 percent of our water. We feel we have a responsibility to use the water that we have asked for wisely. We feel we have a responsibility to use only the amount of water that we need. This initial project that I have talked about here, not the one covered by the CRADA, is a $5 million investment. The process to implement the results of the CRADA is a $20 million investment. But, the provisions for this process, which are not fully developed, are being built into our newest application facilities.

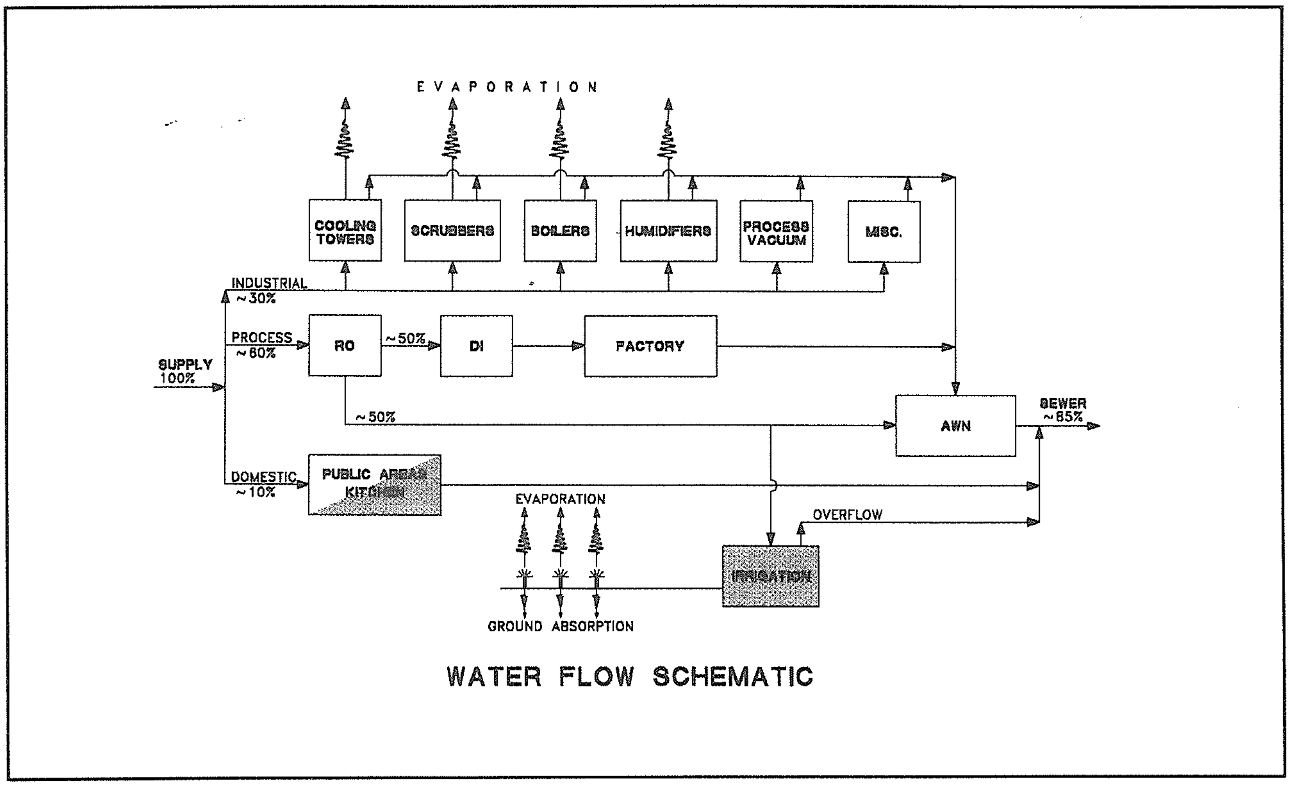

Figure 1. Intel's current water flow.

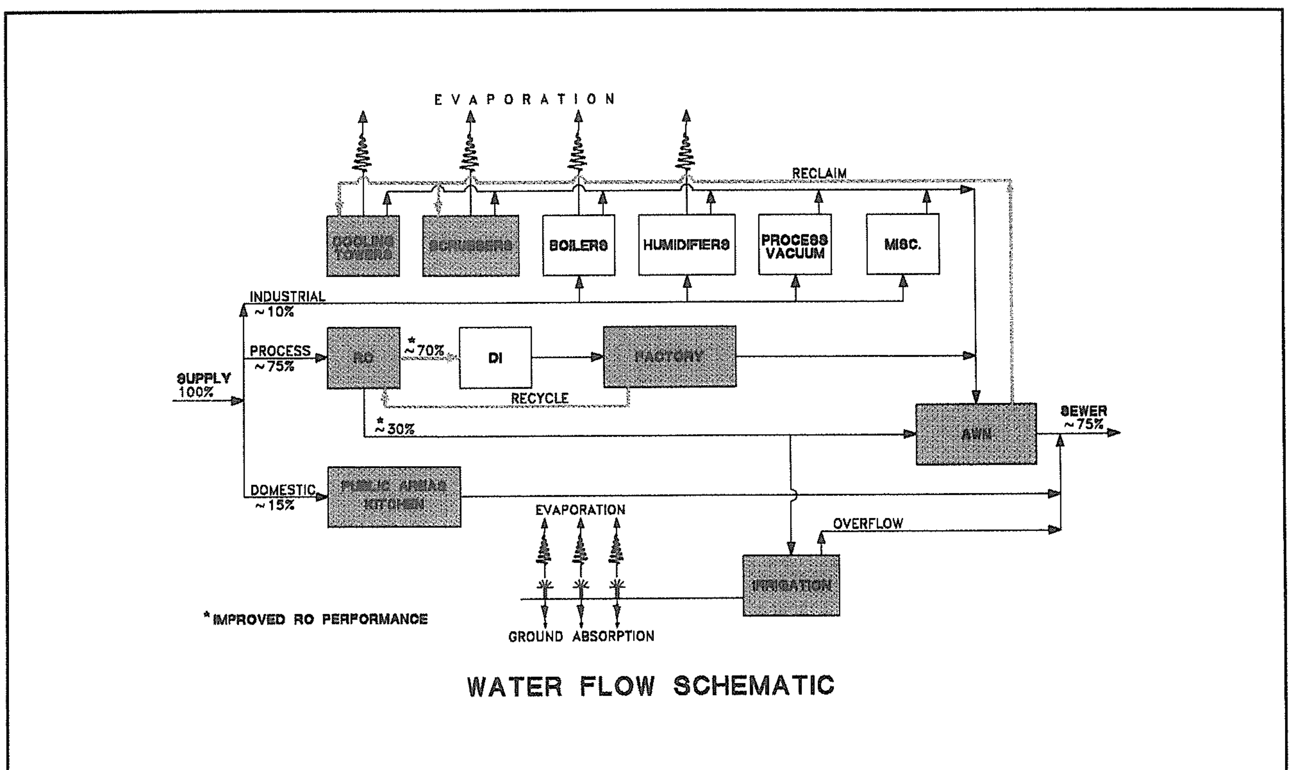

Figure 2. Intel's projected water conservation flow.