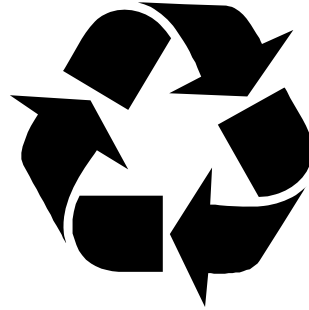


ENVIRONMENTAL BIOLOGY

BIO 105



LAB MANUAL

**DEPARTMENT OF BIOLOGY
WEST CAMPUS
PIMA COMMUNITY COLLEGE**

Revised 2008

ARIZONA WATER PUBLIC HEARING

One of the biggest environmental and socio-political issues of our time is the conflict over water, and the "water wars" (often literally) will only intensify in the future as demands for water increase globally. In southern Arizona, we have been using water (surface and ground water) faster than it replenishes due to urban expansion and increasing agricultural demand. The Central Arizona Project (CAP) was built to import water from the Colorado River to southern Arizona to meet these rising demands. Did we need to build the CAP? If yes, how should we use it? If no, how should we meet our future water needs without CAP?

Therefore, the ***Driving Question*** for the controversy to be held in class is:

How should Arizona meet its future water needs?

This lab will examine the many complex issues involved in "Arizona's Water Crisis.". Students will be randomly assigned into one of the five special interest groups or into the panel in this role-playing exercise. Each group will be supplied with information regarding major arguments given by their interest group (note: most of the information for this lab was derived from Frank Welsh's book, *How to Create a Water Crisis*, Johnson Books, Boulder, CO, 238 p., 1985; feel free to add additional information you obtain). Groups will argue their case before the impartial panel of US citizens chosen at random and without prior bias.

The groups represented will be:

1. BUREC - The Federal Bureau of Reclamation.
 2. NATAMER - A coalition of Native American groups.
 3. AGRIBIZ - Farmers and ranchers.
 4. CITYCIT - A citizens group from cities.
 5. ENVIRO! - An environmental group.
 6. PANEL - The ones to be convinced.
- MODERATOR - Your instructor, who will maintain order.

The Procedure:

Each student will be randomly assigned into one of the six groups.

Each special interest group will discuss their fact sheet and other information they acquire and develop a 10 minute presentation to convince the panel of the "rightness" of their cause. No comments from other groups will be allowed during presentations.

After these presentations, there will be a 10 minute "recess" when each group will develop a maximum 5 minute presentation to rebut arguments presented by the other groups.

Following rebuttals, the panel has 5 min. to prepare for and 5-10 min to ask questions of the groups.

The panel then will recess for 10 minutes to render a unified decision. The decision then will be presented to everyone, and a roundtable discussion will follow.

CENTRAL ARIZONA PROJECT (CAP): AN INTRODUCTION

DEFINITIONS:

Aquifer: water-saturated layer of earth beneath the surface that can yield an economically significant amount of water.

Natural Recharge: The resupply of groundwater by water percolating down from the surface.

Water Mining: Removal of groundwater in excess of the natural recharge rate.

Acre-foot = The amount of water required to flood an acre one-foot deep in water -- 325,851 gallons.

TUCSON WATER SUPPLY/USE

1990 water use by Tucson = 100,000 acre-feet/yr = a one-square-mile lake 156 feet deep.

Estimated water use by Tucson in 2010 = 200,000 acre-feet/yr

Estimated annual recharge to the aquifer = 45,000 acre-feet/yr

Tucson's allocation of CAP water = 148,420 acre-feet/yr

CAP FACTS

Construction: 1973-1991 by U. S. Bureau of Reclamation

Cost: \$3.6 billion; 70% to be reimbursed to Federal Government

Quantity of Water: 1.5 million acre-feet/yr from the Colorado River (at Lake Havasu) to central and southern Arizona

The CAP Aqueduct: runs 335 miles and is brought uphill 2900 feet by 14 pumps.

CAP HISTORY:

1922: CAP first proposed

1969: CAP approved

1973: Groundbreaking for CAP

1985: CAP water arrives in Phoenix

1991: CAP water arrives in Tucson

RELEVANT LAWS:

Law of Nature: water runs downhill

Law of People: water runs uphill [to money].

State Law:

- a. First person to claim surface water to beneficial use, owns the water as a property right.
Known as the prior appropriation law.
Note: "beneficial use" has meant, until recently, human use for monetary gain.
- b. If a water right is not put to beneficial use for a period of 5 years, it is lost and can be claimed by others.
- c. Arizona Revised Statute 45-141 gives the following priority of water uses (in descending order):
domestic, municipal, irrigation, stock watering, power and mining uses, and wildlife.
- d. State Groundwater Code of 1980 prohibits mining groundwater (using groundwater faster than it is recharged) after 2025.

Federal Law:

- a. The federal government owns the water which is on public land or land held by the federal government in trust for Native Americans.
- b. 1908 Winters Decision by the US Supreme Court implied at the time of the establishment of an Indian reservation that enough water be reserved for the reservation's purposes.

1922 Compact

- a. The average flow of the Colorado River was determined (from data in the 1920's) to be 15 million acre feet (maf) per year. A Univ. of Arizona study found the average to be 13.5 maf per year (according to their research, the last time the average was 15 maf was in the 1600s).
- b. The water shall be divided equally (7.5 maf each) between Upper Basin States (CO, WY, UT, NM) and Lower Basin States (AZ, NV, CA). Actually, the Upper Basin States must release 75 maf over a ten year period, allowing the actual amount for any particular year to be greater or less than 7.5 maf. Thus, there is no guarantee of 7.5 maf each year. In a drought, the Upper Basin states could release just Mexico's allotment and use all the rest, as long as they release enough during the wet years to make up the ten year commitment.

Note: in 1981 the river flow was only 8 maf. At that time the Upper Basin States were unable to divert all their allotment for their use. Now, with new reservoir projects completed, the Upper Basin states will have the capacity to divert their full allotment.

c. Allotment (in maf) among Lower Basin States: CA = 4.4, AZ = 2.8, NV = 0.3

Note: historically, CA has used more than its allotment because the other states have not used all of their allotment.

1934 Treaty with Mexico guaranteed 1.5 maf to Mexico. (half this allotment must come from the Lower Basin States' 7.5 maf, and half from the Upper Basin State's 7.5 maf).

Evaporation from Reservoirs: The US Geological Survey says 1.3 maf/year evaporates off Lower Basin reservoirs. This is subtracted from the 7.5 maf allocated to Lower Basin States.

1963 Suit between CA and AZ: Supreme Court said, if the flow is less than 7.5 maf, then CA, NV, and AZ must proportionately reduce their shares.

In 1964 AZ guaranteed that CA would get its 4.4 maf, no matter what, forever.

Note: this binding deal was made to secure a favorable CA vote in the US Senate for CAP. AZ Senators also voted for the Upper Basin water projects to secure the vote of the Upper Basin Senators for CAP.

Thus, the math:

Lower Basin Allotment	7.50 maf
Mexico	-0.75 maf
Evaporation	-1.30 maf
California	-4.40 maf
Arizona	-2.80 maf
Nevada	<u>-0.30 maf</u>
TOTAL	-2.05 maf

Out of who's allotment does this 2.05 maf shortfall come? Remember: Mexico and California are guaranteed their amounts. What if the average flow really is 13.5 maf per year as current data suggest (not the 15 maf/yr used in the 1922 Compact)? What happens during dry years? These are questions looming in the future.

FACT SHEET -- BUREC

One hundred years ago, the arid southwest was a wasteland. It supported little agriculture and few people. Recognizing this waste of a natural resource, and realizing that only water could transform the southwest into a productive, populated area, the US Congress took action.

In 1902, Senator Newlands of Nevada guided through Congress the Reclamation Act. The purpose was to irrigate and reclaim the desert wastelands of the southwest. The Bureau of Reclamation was created in the Department of Interior to achieve this goal.

Projects were originally funded by the sale of high value public lands. Since most of the valuable land has been homesteaded, the national goal of land reclamation is now funded from Congressional appropriations of tax money. The idea is that taxpayers lend BurRec money and these loans are repaid by the increased products sold by the Bureau -- usually electricity or water. All our projects undergo a rigid cost/benefit study and are not undertaken unless the benefits outweigh the costs.

The 1902 Act allows federal help to farmers resident on 160 acres of land. Reclamation farmers pay no capital costs for imported water for first ten years, and then have 40 years to repay at no interest. We're here to help the little guy and preserve the small American farm.

It has become evident to the US Congress, that there is also a severe water need in the urban southwest. Texas Congressman Jim Wright spoke for the Congress and the American people when he said, "The United States of America, the richest and most powerful nation in the world, is running out of its most indispensable commodity. The commodity is clear, usable water..." President Reagan's Sec'y of Interior, James Watt, stated "The biggest crisis we will face in the years ahead is water."

The BuRec, having solved the water problem of southwestern agriculture, has been directed by the US Congress to solve this crisis. The BuRec has the prime responsibility for water in the west and our sister institution, the Army Corp of Engineers, has the responsibility in the east. In 1981, Congress had authorized 934 water projects needing about \$60 billion for the two agencies

After a thorough study and cost/benefit analysis of the water needs of AZ, and at the insistence of AZ Senators, Congress authorized the Central Arizona Project (CAP) in 1968. CAP will transport water over 300 miles. It is the nation's most expensive water project, with a 1983 capital cost of \$3.6 billion.

The AZ State Water Plan (Az Water Commission) was completed in 1975. It verified the BuRec's study and said Central Arizona's renewable water can support only 3.7 million people. AZ water law also states that there can be no water mining after the year 2025. Water must be imported if AZ cities are to thrive and grow.

Tucson is the third largest city in the US entirely dependent on groundwater, and after 2025 it can't be mined. Tucson needs CAP to keep from drying up and blowing away, and fortunately CAP water will arrive this year. The Tucson dedication for CAP was held on October 4, 1991.

We have employed thousands of workers during this construction phase which has helped AZ weather the recession, and there will be many permanent maintenance jobs for the future.

There is a minor problem in getting the CAP on line. We announced 9/7/91 that "It may take four years and cost up to \$150 million to repair or replace numerous siphons in the CAP." A Tucson newspaper commented, "the Bureau suspects corrosion of reinforcing steel wire embedded in siphons which might be the result of poor quality mortar, improper application of the mortar, damage caused during construction, corrosive elements in the soil, or a combination of all four factors. Congressional action is needed. The plan involves prepaying about \$164 million for original aqueduct construction, and the purchase of land and water rights in western Maricopa County as part of a settlement of Indian water rights claims."

There are well-meaning but misinformed folks who continue to express a concern about our ability to supply water to southwestern agriculture and urban areas in the future. They cite too little water in the Colorado River to support all the importation projects being constructed in the West. BuRec has analyzed these concerns with a thorough study and cost/benefit analysis. No worries. We can bring water to the Southwest from other regions of the country or continent where fresh water is so abundant it is pouring out major rivers to be wasted into the ocean. Here are some of the solutions we are considering:

1. We can acquire 2.4 million acre feet (maf) of fresh water from the Snake River in Oregon-Idaho for \$2.1 billion.
2. We could import 15 maf of fresh water from the Columbia River in Oregon-Washington for \$18.6 billion
3. We have had under consideration, with our Canadian friends to the north, a major water allocation project called the North American Water and Power Alliance (NAWAPA). This project would create vast amounts of electricity and bring fresh water from Canadian rivers as far north as the Yukon and MacKenzie. These billions of af of water would be available for a cost of \$500 billion. AZ would be currently allocated 110 maf from NAWAPA, which should be enough water to last well into the 21st Century.

FACT SHEET -- NATAMER

Native Americans did not recognize property rights. We shared the land and the water as a gift to all people. Since the arrival of non-natives, non-Indian legislators have made the laws regarding Indian water rights and non-Indian lawyers have argued both sides of water rights issues. And this is called Indian water law.

There are 16 tribes in AZ on 19 reservations. More native Americans than any other state. In 1980, the median income of native Americans in AZ was estimated at \$8000 (40% of statewide median). In the same year, 60% of Az Indians were classified as poor. Why?

One hundred years ago, the leading farmers in the Southwest were the Pima. They fed and cared for the CA pioneers. They were peaceful, generous, friendly. Early settlers described "irrigated land 15 to 20 miles in all directions, when they crossed the Pima lands." The Pima were given arms and also provided troops to the US Army to protect the settlers, who were, at the time, building canals to divert the upstream water away from the Indian land below.

Hear our fathers speak, "Until the past few years we have always had plenty of water to irrigate our farms and never knew what want was. We always had grain stored up for a full year's supply. We were happy and contented. Since the white man came and built the big canals and ditches, we have no water for crops. The government refuses to give us food and we do not ask for it. We only ask for water for we prefer to earn our own living if we can...."

What about the prior appropriation law? It is obvious we were here first. But you say we did not register for the water in the white man's courthouses. We were not familiar with your laws and did not believe one person could own and divert water from another.

On our reservations, there is now too little water. Your own law (Winters decision) says we were guaranteed water for our use on the reservation. Where is the water? It has been diverted off what little land was given to us as reservations.

This is an example of how Indians have been treated. One hundred years ago, the ancestors of the 400 residents of the Fort McDowell Indian Reservation were a nation of several thousand. All of central and western AZ was the home of the Yavapai, but today the reservation measures 10 by 4 miles. The gov't and settlers tried unsuccessfully to move the Yavapai from their reservation to gain what little water and lands the Indians still had. In 1968, Congress authorized the Orme Dam, which would flood 2/3 of the reservation. We know about your dams -- they flood what little arable land you reserved for native Americans. The Pick-Sloan Plan (1940-1960) of BuRec and Corp of Engineers flooded 200,000 acres of the best Indian farm land in the US. The Sioux, Creek, and Yankton reservations lost all their farm land. Indians who were healthy and rich, were overnight forced back on gov't handouts -- by the gov't. Sioux historian Vine Deloria says, "The Plan was, without doubt, the single most destructive act ever

perpetrated on any tribe by the US." Probably no one in this room ever heard of this destruction of so many of our people and so much of native American culture -- in this century -- but how many of you have heard of the Battle of the Little Big Horn, where only a few soldiers died, after first attacking Indians? In 1973, BuRec people came to the Ft. McDowell reservation to tell the residents about a deal. If the people left, the tribe would receive \$30 million, (about \$70,000 per person), but the Indians said "just leave us alone. "The Congress answered with a law saying they would condemn our land if we did not leave it.

The Pima went to the courts. As the water interests saw we had a legal right, and the courts might rule in our favor, the amount of CAP water allocated to Pimas increased. In 1968, less than 100,000 af was granted, but by 1980 more than 300,000 af. had been allocated.

You should give all CAP water to Indians. We, as Indians, wouldn't have to repay the federal government a cent for the CAP water, AZ would get CAP water at no cost to AZ. But, perhaps, you don't think of us as Arizonans and could not imagine buying water from the Pima for your cities.

We would prefer not having CAP water. It is an uncertain supply -- we would again suffer because others have a more firm supply of our old surface and groundwater. And CAP is polluted (did you ever think of where the sewage from Las Vegas goes?) We have an answer. There are more than a billion af of water in groundwater storage to a depth of 1200 feet underground. This is more than 1000 times the annual water supply of CAP. Much of the water is under federal lands, where the Winters Decision applies. Give this water back to us, and you keep CAP.

Oh, yes. The story is not finished yet. In September, 1991, BuRec was trying to get authorization from Congress to purchase Indian land and water rights in the Harquahala Valley in western Maricopa County.

FACT SHEET -- AGRIBIZ

Agriculture is the traditional and historic foundation of the economy of AZ. The farmers and ranchers settled this land. Through sweat and suffering they made the land productive, and created an economic base on which towns and cities could grow. Long before there were urban dwellers in AZ, there were cowboys, ranch wives, and farmers. Irrigated agriculture has been a fundamental aspect of farming and ranching in these arid lands. The canals of the Ho-ho-kam served as guides for our grandfathers when they dug irrigation ditches. Water, and water diversion, has been the basis of our agricultural success and the success of AZ's original society and economy.

Rural AZ remains based in agriculture. If the cities steal the water which is legally ours, most of the state would be destroyed. Maybe the population of AZ is dominantly urban today, but most of the area is rural and agricultural.

Since the farmers were the earliest settlers, they claimed the water for agricultural needs. Both surface water (springs, streams, rivers) and ground water (wells) was legally and properly claimed. AZ water law, by the Kent decree, defined this water as a property right for the settlers since they were the first to put it to beneficial use.

As you know, if the water is not beneficially used for five years, someone else can claim the water. This "use it or lose it" water law does not allow us farmers to conserve water. If we conserve it, we could lose it. Without water for our land, most of its value is gone. We have to protect our farm -- our investment -- just as you would the value of your home.

Even with this use it or lose it requirement, farmers are good citizens and understand the need for water conservation. AZ farmers use ultra-modern methods to irrigate. They level fields using lasers so that flood irrigating will distribute the water evenly over the land. This increases water efficiency by 90%.

We have been asked to use a drip irrigation system (instead of flooding fields), but it is simply too expensive. It costs more than \$1000/acre to install a drip irrigation system, and if we can get water at \$10/acre foot (af) the savings of one or two af of water will not pay. Some farmers are putting in the system anyway, because they are concerned about the waste of their most precious resource.

AZ farmers are also evaluating experimentally, and beginning to use, urban wastewater. Human waste has fertilizers built-in, such as phosphate (37 pounds/af in Tucson) and nitrogen (76 pounds/acre foot). For health reasons, however, we would use wastewater only on non-edible crops.

The AZ Cotton Growers Association has run numerous newspaper ads ("AZ Needs Water") to encourage water conservation on farms and ranches. These ads describe steps folks can take to reduce home water use, such as low-flow shower heads or low-volume tanks on toilets.

Farmers have lined most of the farm ditches in the state at a cost of more than \$50 million thus reducing water loss to infiltration.

So farmers are doing their best. Within the constraints of water law and the needs of agriculture, farmers are running an environmentally sound and economical operation in AZ.

Food, second only to water, is the staff of life. Water used in agriculture is of prime importance to us all. The world is hungry. American agriculture is among the most efficient in the world. We need the water to keep it efficient and feed the hungry. Supply and demand helps to control the prices you pay at the market. If we maintain our food supply, the costs will be less for us all.

We have heard urban folks say that small farms are not efficient. This is not true. A BuRec study shows the greatest potential economy of scale, for a one- or two-person farm, is between 320 and 660 acres, depending on the crop. The average size of a successful farm in an irrigation district near Tucson, where water economy is practiced, is 250 acres. Small farms do pay.

BuRec water diversion, storage, and importation projects have been the federal government's policy for almost 100 years. Whether this policy should have been instigated or not can be debated, but the fact is it exists and is our nation's plan. The BuRec was founded on the premise of aiding the small farmer in settling the West. Brave men and women endured hardship, drought, bankruptcy, and banks to create the farms of AZ.

Today, the American Congress has funded BuRec for the construction of CAP to bring water to the cities, just as BuRec supplied us farmers in the past. AZ congressmen, businessmen, and citizens have asked for this project. If you are having second thoughts about CAP, please don't get tempted to take away the farmer's and rancher's water. We may not be many, anymore, or even a significant part of today's service economy, but our parents and grandparents took the risks, and we still do today. Water is vital to our style of life. A homogenized world of concrete, steel, and asphalt is a sterile world. Biologists will tell you, diversity is what builds strength and stability. If Spotted Owls and Bald Eagles are worth preserving, so is the western ranch and farm.

FACT SHEET -- CITYCIT

Our concern is simple. We want abundant, cheap water. Our solutions for this concern are equally simple. We want to mine groundwater since it is cheap, abundant, and good quality. We want the water now allocated to agriculture since it is cheap, wasted, and of little economic value to the state as presently used. CAP is expensive and we don't want it.

Let's examine the facts for each of these solutions:

MINE THE GROUNDWATER

In 1980, the AZ legislature, to get continued federal funding for CAP, had to prove that there was a water shortage in AZ. They did it with a stroke. They said no mining the groundwater, and immediately created a human-made crisis! Ridiculous!

There is 1.19 billion acre-feet (af) of water stored in the ground in AZ. This is equal to more than twice the storage in all the major surface reservoirs in the entire US (there is 400 million af in the largest 1500 man-made reservoirs in our country). AZ is wealthy in water, it's just hidden from view underground.

There is enough water in the top 700 feet below Phoenix (105 million af) to take care of the present population for almost two centuries.

Black & Veatch (a private engineering firm hired by a large Tucson bank) says the recoverable underground water in the Tucson basin would last 230 years at the maximum projected needs for the year 2000. Add in Avra Valley groundwater, and that will last another 180 years. Altar Valley has even more. All told, there is a 550 year supply (without wastewater reuse, CAP, or artificial groundwater recharge). Tucson will hardly dry up and blow away!

Water stored just in Central AZ (priced at the cost of CAP water) is worth more than \$50 billion. (The entire 1980 AZ state budget was less than \$2 billion). U of A economist, Wm Martin says, "leaving the same amount of water in the aquifer forever is like leaving money in a bank forever without collecting interest. Neither action produces any benefit."

So, we need water because a political law was passed denying mining. And the law was passed just to get Federal money. Ridiculous. There's plenty of water (We sit atop a vast reservoir) and at much less cost than CAP. Laws, politics, and greed cause the water crisis -- not the lack of water.

Here's a test of logic: Pump CAP water 2100 feet uphill and pay for 230 miles of canals, pipes etc. or pump up same height in a well (with little extra pipe, etc.) Which is cheaper??

REALLOCATE AGRICULTURAL WATER

Ag was the historic foundation of the economy in the early days of AZ, but not today. In 1950, 16% of the economy was agricultural. In 1980, only 2% was still agricultural. It is even less today. Today, our economy is based on the service industry (particularly tourism) and manufacturing.

In 1980, the 2% return from agriculture was using 89% of the state's water. In other words, all other uses of water contributed 98% to the economy, but consumed only 11% of the water. This is not a fair use of the state's water supply.

"If all Arizona's agricultural water had been reallocated in 1970 to urban areas, Arizona could have a population of over 25 million people. This is without the CAP."(Kahn, Hudson Institute) (The population of Arizona today is a little over 3 million people.) A broader study by Colo. State Univ. concluded that without irrigated water, the western US could easily support fifty times its present population.

Farmers are on welfare! They get some of the largest handouts of almost any segment of our economy. There is virtually no free market in agricultural goods. We, as consumers, pay higher prices for subsidized food and then, as taxpayers, we also have to pay for the subsidy! Grossly unfair to the vast majority who are not on a farm being coddled by the government.

Let's examine the subsidies:

1. "Set aside" lands -- Farmers are paid not to grow crops. Why subsidize marginal desert land if almost 20% (82 million acres) of farm land was "set aside" and taxpayers pay farmers not to grow? In 1983, the taxpayer subsidies to farmers about equaled the farmers income from growing food!
2. Lower property taxes -- The assessed value of farm land is about 20% of the real value. So the farmer pays very little tax on his/her land, compared to the city person. (Thus, a farmer can afford to keep marginal land. Because you usually must buy the farm to acquire the water right, this makes it more expensive to buy a water right.)
3. Lower water rates -- This occurs in several ways:
 - a) A project (like the Salt River Project outside Phoenix) supplies water and electricity to ag and urban dwellers. Ag is charged less for water and urban is charged more for electricity to cover the ag water costs.
 - b) Farmers are charged much less than the real cost of BuRec imported water. This happens in two ways:
 1. Federal taxpayers pay about 60% of the cost (capital subsidy), and city folks pay the interest cost of the loan
 2. Farmers also pay little of the operating cost (operating subsidy)

The BuRec is a taxpayer rip-off (unless you are a farmer). The Bureau says it borrows money from the taxpayer to build a water project and that the loan is repaid with interest by the water and electricity sold by the project. Since the cost/benefit ratio is worked out for each project, and it can't be constructed unless it returns more than it costs, every project should be a sound investment. Sounds good. Now the facts.

Very few projects ever break even! After 27 years, one BuRec reservoir recovered 4% of the cost. The Corps of Engineers will require 1,500 years to repay their Willamette Project in Oregon. The federal General Accounting Office (GAO) reported that in a recent year 12 million af of water was unsold in water projects. Sound bad? It gets worse. BurRec essentially gives interest free loans to water projects (irrigators pay no interest, city users pay 3% -- explain that one?) so not only do we taxpayers not get most of our original money back, we make almost no interest either. How would you like an interest-free loan you don't have to repay? Go see the friendly Bur Rec.

Now, lets pop a few myths:

1. Myth: BuRec is for the small farmer because the law limits federal subsidized water to 160 ac.

Fact: BuRec sidesteps the law by including all who live on the farm (spouse, kids, grandkids, co-owners) and multiplying by 160. In 1980, 344 owners of BuRec irrigated land individually owned more than 1280 acres with an average holding of 2752 acres. Dr. Power (U of Mont) evaluated CAP. The average receiving farm is 400 acres and receives an average capital gift of \$2 million. This does not even reflect the operating subsidy. BuRec is ignoring the 160 acre limitation to the favor of big business and the detriment of the small farmer. A BuRec report shows that 48% of reclamation land is controlled by 9% of the landowners. BuRec is probably destroying the small farmer -- not helping.

2. Myth: We need to grow food in our desert to feed the hungry.

Fact: World hunger is not the result of too little global food production -- there is enough food for all today.. The problem is in the politics, economics and distribution of the food.

3. Myth: The south is King Cotton

Fact: The cotton-picking south has only eight percent of the nation's cotton acreage. Sixteen percent of the cotton acreage is in AZ, CA, and NM. Why? Studies prove it is because of subsidized water. If irrigators in AZ paid the real price for their water (instead of the taxpayer paying the bill) there would be an average loss of \$36 to \$96/bale in the SW, and it would still be grown in the South where there is abundant water. The BuRec destroyed the cotton industry in the south by misallocating taxpayer money to subsidize the southwestern farmer.

4. Myth: Food is cheaper at your market because of Az ag.

Fact: Almost none of the food produced in AZ is eaten in AZ. In fact, most irrigated crops are not food (U of A). We don't have to irrigate marginal western desert lands.

5, Myth: Farmers are concerned about conserving water.

Fact: Farmers, who are so wasteful of water that they have to use pumps around the clock to lower the water table and dry out their over-irrigated fields in the Buckeye Irrigation Dist (west of Phoenix), have had the gall to run ads in newspapers to tell us city folk how to save a few gallons in our homes!

6. Myth: The Nat'l Reclamation Association speaks for the public regarding western water use.

Fact: The Nat'l Rec. Assoc. is a powerful lobby to justify the water and power subsidies to the west. It is made up of the recipients of the subsidy. The fox is in charge of the chicken coop.

So, we urban folk, the majority of the taxpayers, want to put an end to the mismanagement of AZ water resources by the BuRec for the subsidized benefit of the a farmers in AZ. We want the water we paid for to come to us in the cities.

STOP CAP

It is obvious that with water mining we have abundant water. If we reallocated a small percent of agricultural water to urban use (we paid for the water), there is even more abundant water. There is absolutely no need for us in the cities to have to pay the large increases in our water bills because of CAP. It is a rip-off of the many by the few. Stop CAP.

FACT SHEET -- ENVIRO!

Our concerns are simple. Conserve: in urban and agricultural areas. Don't mine a non-renewable resource -- groundwater. Don't import environmentally degrading and expensive Colorado River water. Take care of precious habitat and species, and respect Native American rights. Wise use will give us sufficient water of good quality, in a beautiful environment, and at a great savings.

CONSERVE

Agriculture consumes 89% of western water. Cut back this use by only 7%, and all western US water needs are met without any importation. In AZ, a reduction of 8% of ag. water would almost equal the needs from all other uses.

Alfalfa is a water hog; it uses 28% of the state's water annually. Just change this one crop and we could easily save 8% of the state's water. For instance, alfalfa uses 74 in/acre/year. Lettuce uses 8 in/acre/yr.

Even with a central AZ population of 9 million people, there should be about 700,000 acre-feet (af) of surplus water available for agriculture. This is enough to irrigate 200,000 acres of current crops.

With conservation and some replacement of agricultural crops, there is plenty of water in AZ. Hay grown in AZ uses the same amount of water as all the CAP importation. Can't we do without the hay and save the costs -- environmental and economic -- of CAP?

Conservation is best achieved by pricing. Water is twice as expensive in Tucson as Phoenix. Is it coincidental that water use is half as much in Tucson as Phoenix? Charge the same cost for water to farmers as urban dwellers. CAP water is priced at \$141/af (and this is probably incorrect due to all the federal subsidies). Groundwater costs from \$10 to \$50/af. Let there be a free market in water and a "scarce" resource will be economically allocated. Water is a property right. Folks rent or lease houses or cars -- why not rent or lease water rights from farmers. If they can earn more by leasing their water, then the free market will distribute water more fairly.

Conservation can also be achieved by reducing evaporation. For instance, cover the open irrigation ditches and canals (including CAP) -- this is a dry state! Large quantities of water are lost to evaporation in open canals. AZ farmers are so proud about lining the bottoms of their ditches. The \$50 million spent on lining was mostly covered by taxpayers through grants by the Small Reclamation Projects Act. And is it a loss when water infiltrates below the ditches? Infiltration is artificial recharge for the groundwater. It's the cover which is important -- evaporation is a loss.

Evaporation also increases salinity. CAP will deliver polluted water to Tucson, largely due to evaporative losses. More water is evaporated from the Colorado River Reservoirs below Utah than will

be delivered in CAP. Water hardness will far exceed (50% greater) that of surface water in Tucson. US health standards recommend 500 ppm for hardness, when no other supplies are available. It is also the World Health Organizations "highest desirable" concentration. Groundwater in Phoenix and Tucson is generally below 500 ppm. CAP water is at least 750 ppm. CAP will deliver polluted water to Tucson, which we'll have to dilute with high-quality ground water!

The recommended limit for sulfate in drinking water is 250 ppm. US Geological Survey says 200-300 ppm "will have a laxative effect on some." CAP water will contain at least 350 ppm!

Tucson has estimated that the salt in CAP water will cost Tucsonans \$30-\$45/yr per household. Water heaters, pipes, and plumbing fixtures are coated with scale, more detergent must be used, and there is poorer-tasting water. Possible health effects include potential hazards to kidneys, creation of gallstones, and hardening of the arteries with resultant high blood pressure and/or heart disease. And we are paying a premium for this water?!

We must also recycle water. Authorities say 60-70% of the total water supplied to houses or farms becomes waste water. Tucson reuses about 50% of its waste water by watering golf courses and recharging ground water. If recycled water is used, there is no need for a CAP engineering solution to an imaginary water shortage.

DON'T MINE THE WATER

Water withdrawn from the ground in excess of annual recharge lowers the water table. This is like spending money from your bank account in excess of earnings. The balance goes down. With AZ water, it could take centuries or millennia to replace. Mining groundwater robs the future. It is spending our grandchildren's bank account. Mining results in eventual depletion of the reservoir, with possible damaging results such as reduction of reservoir capacity (because of collapse of pore space), land surface subsidence (collapse of pore space), and an increase of salinity (pulling salty water out of small pores after all the good water is removed from the large pores).

Groundwater in storage under Phoenix is being mined thirty times the natural recharge. Statewide, 46% of water consumed is by water mining, and most of that is by agriculture. The amount of water used by just cotton in AZ is about equal to all the water mined in the state. Quit cotton, and we're self sufficient.

The State Groundwater Code recognized in 1980 the danger of mining groundwater and prohibits mining after the year 2025. This time interval should be long enough to allow us to shift away from mining to conservation and lower agricultural use.

The State Water Plan (1975) said only 3.7 million people could be supported by renewable water (only surface water and recharged groundwater) but they used the highest water use rates possible. If the

per person urban use was lowered to "only" 200 gallons/person/day (gpcd), population could be 5.6 million. In Tucson, we used over 200 gpcd in 1974, but today our average use is less than 160 gpcd. Phoenix used 300 gpcd in 1980, and is still over 200 gpcd, but they could use water harvesting and drought tolerant plants like we have learned to do. U. of A. professor Wm Martin said in 1984, "it is reasonably easy to use 130 gpcd." If we used 140 gpcd, existing renewable water could support 9.5 million people. Reduce to 100 gpcd and we can support 13 million with renewable (remember -- rainwater) supply.

Az surface water supply	2,300,000 acre-ft
annual recharge	<u>300,000 acre-ft</u>
total renewable	2,600,000 acre-ft

from: AZ Water Commission Data

If all western states could reduce to 150 gpcd, then:

<u>State</u>	<u>Supportable Pop.(millions)</u>	<u>1990 Pop.(millions)</u>
AZ	19.7	3.7
NM	13.3	1.5
NV	27.1	1.2
CO	39.8	3.3
WY	39.2	0.5
UT	38.2	1.7
CA	296.6	29.8

ENTIRE US Population in 1990 = 250 million

Renewable water can be supplemented into groundwater by using artificial recharge. Flood runoff can be caught in unlined retention reservoirs and the water allowed to percolate downward into the water table. Wastewater can be artificially recharged the same way. During passage through pore spaces in the rocks, the water can be cleansed of most organic waste. This is the same principle, on a larger scale, as a cesspool-- effectively cleaning water at very low cost and adds it to groundwater storage.

SAY NO TO CAP

Bureau of WreckTheNation, as it is called by enviro! members, has visited incredible environmental destruction on western rivers and lands. It is a self-serving bureaucracy that wishes to expand its budget, power, and staff at the cost of the nation. Its pet project, CAP, is an unnecessary wasteful environmentally damaging uneconomical political boondoggle to enrich the few at the expense of most. CAP represents the problem, not the solution.

What is the CAP? Authorized by Congress in 1968, it will have more than 300 miles of aqueduct, use 547,000 kilowatts of energy, and have canals deeper than a 2-story house and wider than an 8-lane freeway. AZ doesn't have to start the repayment until it is completed. U of A Ag economists showed CAP was unnecessary because 90% of water was for agriculture, which returned 10% of the state's personal income. A bad investment. Therefore, BuRec shifted its emphasis to one in which water was being supplied to alleviate the water "crisis" of the cities. US taxpayers will pay over 60% of the cost. While much of the capital cost will be paid by Az., irrigators pay no interest on their portion of the federal loan. Municipal & Industrial (M & I) users repay 50-yr loans at 3.342%. A 3% interest rate for 50 years about equals the amount of the loan. 6% triples it. At today's rates, what a gift by the taxpayers to AZ! Taxpayers must pay 7-10% to borrow the money to loan to AZ M & I users at a return of 3%. Only the gov't (and defunct savings and loans) could do that! It will cost taxpayers more than \$1.7 billion!

The operating costs will be paid by AZ and will be more than \$70 million per year. -- and more than \$1.5 billion to repay capital costs. In the mid-seventies, it cost Tucsonans about \$20/af to pump groundwater, and CAP water was figured to cost \$141/af. Some bargain!

In 1977, an Interior Dept. study figured the return on CAP cost/benefit would be 58 cents for every dollar spent. A U of MT prof calculated it would actually be closer to 35 cents on the dollar. Some taxpayer investment!

The Sec'ty of Interior (the Boss of BuRec), in 1977, said to Pres. Carter, "because of its scope, expense, and environmental degradation we have identified the CAP" as one of the least meritorious of the Bureau of Reclamation projects."

Dr. Kelso, U of A, stated, "In sum, the AZ water problem is more a problem of the lack of man-made institutions (policies) for developing and transferring water than a problem of physically short supplies. At least, the problem can be resolved more cheaply for many years to come if it is approached through institutional (policy) reform relating to water transfer rather than through development and/or importation of additional water supplies. The water problem in Arizona is a "man-problem" rather than a "nature problem"."

BE STEWARDS OF EARTH

There were only seven pairs of successful nesting Bald Eagles in the SW US in the early '80's. Three would have been flooded by CAP's Orme reservoir. Hundreds of nests of Great Blue Herons also would have been drowned by the reservoir. The Audubon Society brought suit against BuRec. The combination of national publicity about the Bald Eagles, the law suit, and Indian opposition to the destruction of their reservation, caused the BuRec to halt, at least temporarily, the dam construction.

Conservationists have always warned about the interlocking of environmental issues. CAP water importation will have a serious energy impact to the SW. Water does not flow downhill to Phoenix or Tucson from the Colorado River. CAP water must be pumped uphill for 2100 feet to reach Tucson. CAP will use electricity from the Navajo generating station in Page, AZ. This plant is a coal-burner and has recently been cited by the EPA as the primary cause for air quality degradation at Grand Canyon National Park.

So CAP will consume 547,000 kilowatts of energy and pollute northern AZ air as well.

Pumping groundwater also requires energy. But water in Tucson is only pumped up 400 feet, compared to 2100 feet for CAP. Even that math should be understood by BuRec!

CAP construction has seriously marred the surface of AZ. Dams, reservoirs, canals, ditches, and pipelines all affect the land. Sadly, this can't be altered now.

So -- we don't need to either mine groundwater or have CAP. There is more than enough water in AZ. Future needs can easily be supplied by conservation measures such as shifting farm crops to less water consumptive use or by recycling water. We should abandon CAP -- leave it as a monument to stupidity and to remind Americans of the folly of western water management. It can memorialize the water "crisis" -- caused by the greed of some and indifference of many.

News Flash! BurRec announced 9/7/91 that "It may take four years and cost up to \$150 million to repair or replace numerous siphons in the CAP." A Tucson newspaper commented, "the Bureau suspects corrosion of reinforcing steel wire embedded in siphons which might be the result of poor quality mortar, improper application of the mortar, damage caused during construction, corrosive elements in the soil, or a combination of all four factors. Fork over more bucks!

PANEL

Your job is to read the CAP Introduction, to carefully listen to the presentations, and to render a unified decision on what should be done (a) at the time the decision was actually being made and (b) at the present time, and why. Your job includes establishing a set of criteria upon which you will base your decision BEFORE the hearing. You should not let any previous bias affect your decision, nor should you let theatrics or forensics affect your judgment. You are to render a fair, impartial and reasonable judgment that addresses the major arguments presented to you. The future of Arizona depends on you!

Time Line:

- Preparation: e.g. establish process by which you will render a unified decision
- Hear 10 min Presentations: each of you should take careful notes
- 10 min. Recess to Discuss Questions You Need to Ask of Groups for Clarification
- Hear 5 min Rebuttals
- Ask Questions of Groups for 10 min. after preparing for 5 min. (if needed). You are in charge of managing the time -- you may have to control how long a group answers one of your questions.
- 10 min Recess to Formulate Panel's Judgment and Rationale
- Present Judgment and Rationale

HOME ECOSYSTEM LAB

In this lab you will be asked to analyze data you collect on your household production of solid waste, water use, energy use, and food consumption. The class will be divided into four groups randomly: one studies water, the second studies energy, the third studies solid waste, and the fourth studies food sources. Each group member will be responsible for completing the whole data collection sheet and submitting it to the instructor on the due date.

Each group is responsible for a classroom presentation that summarizes its data, gives background information on the topic, and describes methods for reducing the use of water, energy, or the production of solid waste. **Every** member of the group is expected to participate in the 60 minute group presentation. Everyone is expected to be present during other groups' presentations.

When considering topics for each member to cover, pick topics that will be of interest to you, your group, and the rest of the class (most importantly). Consider covering your topic at the personal, local, national, and global scales. Be sure to include a brief summary of the group's data.

Suggestions for effective group presentations:

- Exchange names and phone numbers
- Establish a group outline for the presentation as soon as possible and assign people to develop each section
- Determine the amount of time for each person's presentation and elect a timekeeper to stop people from going over their allotted time.

Initial sources of information include Tucson Water Dept., Tucson Electric Power Company, Tucson Clean and Beautiful.

Grades will be given on an individual basis: see Grading Rubrics in syllabus.

Participation at all class meetings is important and graded.

Your Group _____

Other Members:

NAME

CONTACT INFO

WATER

INTRODUCTION

Water! Free for the asking. Just turn on the faucet and we have all the pure, cool water we could use. But -- we all know that isn't really so. Water doesn't just appear from the faucet. It has been imported to the home at great engineering, environmental and dollar cost. It is pumped up, dammed, ditched, piped, filtered, treated, and pumped before it reaches the faucet. Water is taken for granted by most urban dwellers, but it is the most precious commodity for life. We can survive many days without food, but try to survive three summer days in the Tucson sun without water!

Water of high quality is not an infinite resource. Here in Tucson, water has been supplied to the community from the groundwater reservoir. At present, the ground water is being pumped out 2.5 times faster than it is being replenished. The water table has been in sharp decline and has dropped as much as 190 feet in some areas of Tucson. Some Tucson water supply wells have an annual decline of water table of 2 to 6 feet per year. This excess of discharge to recharge results in higher costs for pumping water, land subsidence (a new U.A. study showed some Tucson sites have been sinking as much as 2 inches per year), compaction of the groundwater reservoir with loss of well capacity, and a degradation of water quality due to sucking out mineral-saturated water from smaller and smaller pore spaces as the water table drops.

A long-range water management program, required by the 1980 Arizona Groundwater Code, mandates water managers develop a balanced water budget by 2025. Just like the managing of your home money budget, there are only two avenues to follow to balance a budget. You either reduce outgo or increase inflow. To reduce water use, a city may enact mandatory conservation requirements. To increase supply, the urban area may import water or recycle its waste water. Tucson has done all of these, and is a national leader in water resource management.

The city has enacted a number of ordinances to effect water conservation. Ultra-low-flow toilets have been required since January 1990 in all new and retrofit construction. Low-flow faucets and shower heads have been required in new and retrofit construction since 1989.

To increase water supply, Tucson has helped fund the Central Arizona Project (CAP), a major canal to import water from the Colorado River. Our monthly water bill already reflects a surcharge to help repay for this federally constructed project. This project will deliver over 80% of our water needs by 1992. Colorado River water, however, is more than three times as hard as our well water. Our future water bills will reflect both the costs of importation and the extra treatment.

Tucson is an urban leader in the use of recycled (effluent) water. For example, Pima Community College uses recycled water on its sports fields and many of the city's golf courses use effluent. The city also operates an effluent recharge facility to percolate recycled water into the groundwater reservoir. Some contaminants are filtered out in this process, and the cleansed water recharges the groundwater.

Floods from heavy storms have been considered an urban hazard and the water has been channelized to direct flood water quickly out of the urban area with the least damage. Tucson has an integrated water management program which now views floodwaters as a possible water supply rather than only as a hazard. Catching storm water runoff in large unlined basins allows this water to percolate downward and recharge the groundwater reservoir.

DETERMINING YOUR HOME WATER USE

Your assignment is to calculate the total water use in your home. You are given a worksheet for your calculations. Use this worksheet, because it will be the basis for a study to be made in the laboratory.

It will not be easy to derive the figures needed for this assignment, but the more time and effort you put into the assignment to make the figures as accurate as possible, the more you will learn about home water use.

A few hints:

1. To measure the amount of water which flows through a faucet, shower head or hose, take a bucket (juice container, milk carton, wastebasket, etc.) of a known volume (number of quarts, gallons, etc.). Have a friend or family member hold a watch (digital seconds, second hand, timer on a digital watch, etc.) and the instant you turn on the faucet full force they start timing. The moment it is filled, you shout full (or some such) and they tell you how many seconds it took to fill the known volume. Then calculate that into gallons per minute.
2. To get the volume of a toilet tank, disregard the water in the bowl. Take off the top of the tank. Hold up the float valve, and scoop out water into your known container. Measure the number of containers (and the last partial one) to determine the number of gallons.
3. Read the instruction booklet which comes with your home appliances (washing machine, dishwasher, etc.) to determine the water use or call an appliance store and ask what the water use is for your model. If you do not use an appliance during the time of your study, estimate how often your household uses the appliance and convert to a per day basis (e.g. if you do the wash every other week and you use 280 gal, then you would record 280 divided by 14 divided by the number of people in your home to calculate gallons per person per day).
4. Impress on your family or friends (if you share your living area) that you are doing a serious scientific analysis of water consumption. Leave a sheet of paper in the bathroom and kitchen for them (and you) to note the number of flushes, length of time faucets are on, length of showers, etc.
5. You are calculating the total gallons of water use per day in virtually all the categories on the worksheet. Note that this requires you to calculate the total water used by all family members. For instance, you need to know the total number of times all the toilets in your house are flushed -- or the total number of minutes per day a faucet is run by all family members. Later you will convert to a per person basis.
6. Outside use is usually not daily, or even weekly. Measure a use, if possible, or if you don't have a use during the assignment week, estimate the use. On your worksheet, convert weekly (or longer time interval) uses into minutes/day by the appropriate division.
7. Remember -- you are trying to account for every drop of water for an entire week. This accounting will not only be useful for the lab analysis, but it should be interesting for you to see how much water is used in your home, and where it is used.

Abbreviations used:

gpd = gallons per day gpm = gallons per minute

gpcd = gallons per capita (person) per day

Some data you might find helpful if you can't determine them using the above methods:

average toilets use 5-7 gallons/flush

showers use 5-10 gpm; faucet sinks use 5 gpm; garden hose uses 10 gpm

dishwasher uses 25 gallons/load; laundry uses 45 gallons per load

slow leak or drip (one drop/second) is 5.4 gpd; steady 1/16" stream is 100 gpd

WORKSHEET FOR HOME WATER USE

NAME: _____

DATES: _____ NUMBER OF DAYS: _____
DIVIDE TOTALS BY THE NUMBER OF DAYS AND NUMBER OF PEOPLE TO

CONVERT EVERYTHING TO GALLONS PER PERSON PER DAY

INSIDE USE

Bathroom

Toilet Use

Number of gallons per flush _____gals/flush

Number of flushes/day X _____ flushes

Total toilet: = _____gallons per person per day

Shower and Tub Use

1. Shower _____gals/min

a) Total number of minutes X _____min/day

Total shower use: = _____gpd

2. Tub _____gals

a) number of times/day X _____baths/day

Total tub use: = _____gpd

Total shower and tub: _____gpd

Bathroom Sink Use

1. Faucet _____gals/min

2. Hand washing _____Total minutes with faucet on

3. Tooth brushing _____Total minutes with faucet on

4. Shaving _____Total minutes with faucet on

5. Other use _____Total minutes with faucet on

Total minutes _____ X _____gals/min = _____gpd

6. Drips and leaks + _____gpd

Total sink: = _____gpd

Kitchen and Cleaning Water Use

Kitchen Sink Use

1. Faucet at kitchen sink _____gals/min
b) Washing _____ Total min.
c) Drink water _____ Total min. (inc. time waiting for cold/hot water)
d) Garbage disposal _____ Total min.
a) Food prep _____ Total min.
d) Other _____ Total min
- Total minutes _____ X _____gals/min = _____gpd

2. Drips and leaks + _____gpd

Total kitchen sink use: = _____gpd

Dishwasher

1. Per wash _____gals.

Total dishwasher use: = _____gpd

Laundry

1. Gallons per load _____gals/load

2. Loads/week X _____ loads/week

= _____gals/**week**

gal/week/7 = /7 _____gallons per **day**

Total laundry use: = _____gpd

Washing floors, windows, etc. _____gals/day

Total household cleaning: _____gpd

OUTSIDE USE

Hoses

1 Garden hose uses _____gallons per minute (gpm)

Minutes/day X _____minutes

= _____gpd

2. Leaks and drips + _____gpd

Total hose use: = _____gpd

Lawn Sprinklers (not connected to hose)

1. Sprinkling system _____gpm

2. Number of minutes/day X _____minutes

Total lawn sprinkler use: = _____gpd

SUMMARY OF ALL HOME USES

Toilet _____ gallons per person per day (gpd)
 Shower and tub _____ gpd
 Sink _____ gpd
Total Bathroom _____ gpd _____ % of **inside** use that goes to bathroom

Kitchen sink _____ gpd
 Dishwasher _____ gpd
 Laundry _____ gpd
 Household cleaning _____ gpd
Total Kitchen & Cleaning Water _____ gpd

TOTAL INSIDE USE _____ gpd _____ % of **total water** used inside

Hose _____ gpd
 Lawn sprinkler _____ gpd
TOTAL OUTSIDE USE _____ gpd _____ % of **total water** used outside

TOTAL ALL HOME USES _____ gallons per person per **day**
 X 30 = _____ gallons per person per **month**

SUMMARY AND EXPENSE

Total gallons per person per day	
Total gallons per person per month	
CCFs* per person per month (gal/748)	
Cost of water (from Table 1 below)	\$

*(one CCF = 100 cubic feet of water = 748 gallons; **always round up** – e.g. 10.1 = 11 CCFs)

Table 1. Single Family Residential Cost of Water in Tucson (effective July 12, 2004). For other rates see <http://www.ci.tucson.az.us/water/rates.htm>.

CCFs	\$ costs/CCF	Example: if you use 19.2 CCFs (rounds up always)	Note: your bill will include a monthly service charge and a CAP charge of \$0.05 per ccf.
1-15	1.17	1-15 is 15 X \$1.17 = \$17.55	
16-30	4.09	16-20 is 5 X \$ 4.09 = \$20.45	
31-45	5.78	Total = \$38.00 usage charge for the water	
46+	8.03	plus \$1 for CAP charge	

INTRODUCTION

Certainly one of the big "stories" in the home ecosystem is told about energy. Energy comes into the ecosystem through a thick electric wire or a thin copper pipe in a form that can be readily utilized by our appliances and devices. Energy to be used to videotape a favorite program, wash our clothes, cool our food, or power the myriad of other energy-consuming events that form a background in the modern busy household. According to Gershon and Gilman (1992), 17% of all US energy is consumed by households. Along with that energy use comes about 8000 pounds of carbon dioxide per person and 15 pounds per person of smog and acid deposition.

Do we take such energy use for granted? Are appliances that could be run at lower energy-consumption levels casually run at higher levels? Are lights/appliances that could be turned off (= 0 energy consumption) left on for no real reason? Only you can answer these questions and the "nuts and bolts" quantitative questions about your home ecosystem energy consumption. Here's your chance!

Identify the energy-consuming devices in your home. Name the device and check whether it uses electricity or gas.

DEVICE	ELECTRIC	GAS
SPACE COOLING		
_____	_____	_____
_____	_____	_____
_____	_____	_____
SPACE HEATING		
_____	_____	_____
_____	_____	_____
_____	_____	_____
ENTERTAINMENT		
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
COOKING		
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

(Continued)

DEVICE	ELECTRIC	GAS
CLEANING		
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
WORK-RELATED APPLIANCES		
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
REFRIGERATOR/FREEZER		
_____	_____	_____
_____	_____	_____
PERSONAL CARE AND MAINTENANCE		
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
OUTDOOR MAINTENANCE		
_____	_____	_____
_____	_____	_____
_____	_____	_____
OTHER (SPECIFY)		
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

WORKSHEET FOR HOME SOLID WASTE

NAME _____

INTRODUCTION

Almost everything you buy and bring home, will sooner or later end up as household solid wastes. Next time you look in your trash can, think about the chain of events and the cost in energy and matter that has already been invested in these materials -- the raw materials were extracted from the earth, transported, manufactured, transported again to the retail store, and bought and carried home by you. Then think about what happens to these solid wastes after they leave your home -- they are picked up and carried to a landfill where they take up space. Throughout the acquisition, production, use, and storage the materials may also be a source of toxic wastes that mingle with our air, water, and soil.

Most of us don't think that much about the garbage we produce at home. The chain of events leading up to and following our use of a product is not considered or is taken for granted. Garbage, however, is becoming a hot topic. The science of garbology has arisen, spearheaded in part by U of A. researchers. What we're finding is that the landfills of today will be the "gold mines" of tomorrow.

So here is your chance to be a practicing garbologist. You will collect quantitative data on the garbage (solid waste) your home ecosystem generates. Then you will determine ways in which your addition to the teetering piles of garbage may be reduced. Remember the three Rs -- reduce, reuse, and recycle. Have Fun!

How many people are in your household? _____

How many days did you collect garbage? _____

Save and sort your garbage into the following categories. Determine the volume of each type of garbage as accurately as possible by saving each category in a separate container of known volume. Determine the weight of each type of garbage in each category. Also, for each type of garbage, and for all types combined, calculate what percentage you recycled or composted (% R/C) (if none write "none").

<u>Waste Type</u>	<u>Vol.</u>	<u>%</u>	<u>Wt.</u>	<u>%</u>	<u>% R/C</u>
NEWSPAPERS	_____	_____	_____	_____	_____
OTHER PAPER	_____	_____	_____	_____	_____
ALUMINUM	_____	_____	_____	_____	_____
OTHER METAL	_____	_____	_____	_____	_____
GLASS	_____	_____	_____	_____	_____
RECYCLABLE PLASTICS	_____	_____	_____	_____	_____
BATTERIES AND TOXICS	_____	_____	_____	_____	_____
CLOTHING AND OTHER REUSE ITEMS	_____	_____	_____	_____	_____
ORGANIC WASTE FROM KITCHEN	_____	_____	_____	_____	_____
ORGANIC WASTE FROM YARD	_____	_____	_____	_____	_____
ALL OTHER GARBAGE	_____	_____	_____	_____	_____
<u>TOTALS</u>	_____	_____	_____	_____	_____

Please Specify Other Garbage by listing below

HOME ECOSYSTEM LAB: BIODIVERSITY

You might be surprised at the biodiversity we have here in the Tucson region, and in the plants and animals you use every day. Each member of the group should choose one of the options below or get approval for another option not listed.

- 1) Survey of the plants and animals in the Tucson area. In addition to the general information, choose at least one plant and one animal to go into more depth.
- 2) Survey of the endangered plants and animals in our region and their threats. In addition to the general information, choose at least one plant and one animal to go into more depth.
- 3) Survey of the introduced species of plants and animals in our region and their impacts. In addition to the general information, choose at least one plant and one animal to go into more depth.
- 4) Survey of the plants and animals you use on a regular basis (diet, medicines, clothing, housing, etc.). In addition to the general information, choose at least one plant and one animal to go into more depth.

Turn in an outline of your survey. You will present the information using PowerPoint.

WASTEWATER TREATMENT

SEQUENCE OF EVENTS AT ROGER ROAD PLANT

1. **Screen:** large objects are screened out and trucked to landfill.
2. **Grit Chamber:** heavy objects settle out, are air-lifted out, and trucked to landfill.
3. **Primary Sedimentation Tanks:** lighter suspended solids settle to the bottom and grease floats on top and both are pumped to the **Sludge Thickeners**.
4. **Biotowers:** colonies of aerobic (oxygen-needing) bacteria and other organisms growing on specially designed plastic media consume the organic waste from the primary effluent.
5. **Secondary Sedimentation Tanks:** suspended solids (including organisms washed out of the biotowers) settle to the bottom and grease floats on top and both are pumped to the **Sludge Thickeners**.
6. **Chlorine Contact Chambers:** secondary effluent is chlorinated to kill remaining organisms.

[Some of the water is diverted here to go to the city for further treatment and use for irrigation]

7. **De-Chlorination (Tertiary Treatment):** chlorine is removed from effluent with sodium metabisulfate and released into the Santa Cruz River directly or pumped for irrigation (after receiving additional tertiary treatment).
8. **Sludge Thickeners:** sludge from the sedimentation tanks is thickened by removal of some water.
9. **Digesters:** heated tanks where the solids are broken down by anaerobic bacteria (live only without oxygen). Methane gas is produced by the bacteria and is used to power the treatment plant.
10. **Ina Road Centrifuge:** sludge from digesters is pumped 5.3 miles to be centrifuged (removes more water) and then a price is paid for disposal to the agricultural industry (used to fertilize non-food crops such as cotton).
















LAND USE PLANNING




Many communities have experienced rapid population and commercial growth. Often this growth has taken place in an unplanned or at least little-planned manner. The result has been termed urban sprawl. Although the need for good land use planning is well-known, conflicts among various special interest groups and the incompatibility of certain land uses makes the job very difficult. In this lab we will simulate two alternatives for "planning" development as new land comes up for sale on the outskirts of a city.

ALTERNATIVE 1: THE AUCTION (Source: The National Audubon Society)

A 242 acre parcel of land near Sprawlsville -- including 100 acres of prime farmland, 42 acres of wooded ravine along a lake shore, and 100 acres of forest -- is up for sale following the death of the landowner (see map). The 525,000 inhabitants of Sprawlsville (growing at 2% per year) obtain all their drinking water from the lake adjacent to the land. Five special interest groups have gathered for the auction. After being placed into one of the five groups, you are to work with your other group members (no collaborating among groups) in deciding which land parcels you need to purchase to meet your special interests as stated on your card.

The auction shall be conducted in the following manner. Opening bids shall be \$10,000 for each parcel, and subsequent bids shall be entered in multitudes of \$1,000. The top bidder on a parcel shall have the option of purchasing adjacent parcels (not including diagonal parcels) at the same price.

 City					 9 acres	 Lake
					 8 acres	
					 9 acres	
					 9 acres	
					 7 acres	

 = 10 acres of forest;
  = 10 acres of Farmland;
  = 7-9 acres of wooded ravine
 Heavy black line is existing road to be expanded to 4-lane highway

ALTERNATIVE 2: PROPOSALS SUBMITTED TO BOARD OF COUNTY COMMISSIONERS

A one square mile (640 acres) parcel of desert, near Tucson, is available for the city's use. **Step 1:** read the background information for Tucson and Pima County, and then list some possible uses of the vacant desert. **Step 2:** create a land use plan for the area. **Step 3:** present your land use plan in three minutes or less to the class. The best plan will be chosen.

- Population in year 2000: 844,000 in Pima County (with 27% growth from 1990-2000), and 487,000 in Tucson with 20% growth from 1990-2000. Only 5 other cities of Tucson's size or larger grew at a faster rate in the U.S.
- The urban and suburban boundaries are extending rapidly.
- The rapid population growth is accompanied by demands for more housing, more schools, more jobs, additional city services, and recreational areas.
- Traffic congestion is increasing rapidly.
- The land in question is pristine Sonoran desert habitat containing many native plant and animal species and likely some rare species too.
- The land abuts against the Tortolita Mountain Preservation Park.
- New developments must have a 100-year assured water supply.
- The present landfills and sewage treatment plants are nearing maximum capacity.
- The citizens of Tucson, Tortolita, and Pima County are concerned about the maintenance of a scenic regional environment.
- The County Board of Commissioners is the authority for land zoning, and many citizens' groups are being formed to influence zoning decisions.

