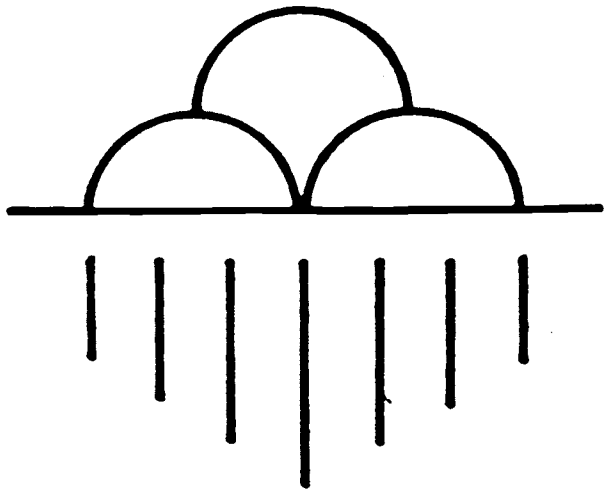
HIGH CAPACITY GREYWATER REUSE SYSTEM



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INTRODUCTION

Due to the increasing need of reducing utility costs there is a growing interest in reusing "greywater" in landscape irrigation. Greywater is the return water flow of washers, bathtubs, showers and lavatory sinks. Wastewater from the toilets and kitchen sinks are excluded from greywater. Thus greywater does not have a very high organic loading and requires little or no treatment before it can be used for garden and landscape irrigation.

The reuse of greywater greatly reduces the water needs of a family. It also reduces the energy required to pump and pressurize the lines that deliver the water. Perhaps even more significantly greywater reuse reduces the capacity needed in both the sewer lines and sewer treatment plants.

The use of greywater instead of a diminishing groundwater resource reduces the guilt factor of those who enjoy having some shade, lawn and vegetables even though they are living in a arid environment.

WATER AND SEWER FLOW SAVINGS

Various estimates as to the amount of water classified as greywater have been made. The results of one study made for the southwest is summarized in Figures 1 & 2. These figures show that 51% of the wastewater load is made up of easily reusable greywater, i.e. bathtub and shower and the clothes washer. Figure 1 shows a 65% irrigation use of total consumption. This figure is only about 40 % in Tucson at the present time. The rate structure of the Tucson Water Department is structured to discourage outside irrigation. Figure 2 shows the past and projected water use, the consumptive use and the sewage load. The consumptive use is primarily made up of the irrigation use. In Tucson this use would be much less than indicated in Figure 2 but still a significant amount of the total domestic water used.

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For the Tucson area Table 1 gives the water and sewer flows for a household of 3 and 6 persons. The difference between the water and sewer flows is the consumptive use which is primarily outside irrigation.

TABLE 1
TUCSON WATER AND SEWER FLOWS*
WITHOUT GREYWATER REUSE

	3/people/house			6/people/house		
	Dec-Feb Mar-Apr	Nov	May-Sept	Dec-Feb Mar-Apr	Nov	May-Sept
Water: CCF/mo	10	15	20	18	23	28
$/mo	8.10	13.90	19.70	15.94	21.23	31.22
Sewer: CCF/mo	8	8	8	16	16	16
$/mo	5.40	5.40	5.40	10.44	10.44	10.44

*CCF is a hundred cubic feet which is equal to 748 gallons.

If a greywater reuse system were instituted that used only bath and wash water the water and sewer flows and resulting charges would be reduced to those given in Table 2.

TABLE 2
TUCSON WATER AND SEWER FLOWS
WITH GREYWATER REUSE.

	3 People/House			6 People/House		
	Dec-Feb Mar-Apr	Nov	May-Sept	Dec-Feb Mar-Apr	Nov	May-Sept
Water: CCF/mo	8	12	16	16	18	20
$/mo	6.42	10.06	15.06	13.98	15.94	19.70
Sewer: CCF/mo	4	4	4	8	8	8
$/mo	2.88	2.88	2.88	5.44	5.44	5.44

*CCF is a hundred cubic feet which is equal to 748 gallons.

If the values in Table 2 were subtracted from the values in Table 1 the net reduction in water and sewer flow could be computed and the monetary savings of reduced water and sewer bills determined. This information is given in Table 3

TABLE 3
TUCSON WATER AND SEWER SAVINGS, 1984
WITH GREYWATER REUSE

	Dec Jan Feb	Nov Mar Apr	May thru Oct	Annual Total	Dec Jan Feb	Nov Mar Apr	May thru Oct	Annual Total
Water:								
CCF/mo	2	3	4		2	5	8	
$/mo	1.68	3.30	4.64		1.96	5.29	11.52	
$/per*	5.04	9.90	27.84	42.78	5.88	15.87	69.12	90.87
Sewer:								
CCF/mo	4	4	4		8	8	8	
$/mo	2.52	2.52	2.52		5.00	5.00	5.00	
$/per*	7.56	7.56	15.12	30.24	15.00	15.00	30.00	60.00
Annual Total Savings				$73.02				150.87

*The sums in the period are obtained by summing up the months in the heading above each column.

The total annual savings for a family of 3 is $73.02 and for a family of 6 the savings is $150.87. These savings will increase every year since Tucson Water has already announced that rates will continue to go up about 7% per year to cover the cost of importation of CAP water and the expansion of the system. The cost of the high capacity greywater reuse system is given in Table 4.

TABLE 4
COSTS OF HIGH CAPACITY GREYWATER REUSE SYSTEM

400 Gallon Asbestos Cement or Fiberglass Tank	$125.00
10 GPM 3/4 inch Submersible Pump	50.00
40 GPM 1 1/2 inch 1/3 hp Submersible Sump Pump	110.00
Miscellaneous Plumbing and Electrical Supplies	50.00
Labor/Backhoe	150.00
Total	$485.00

At 12% interest the annual payments = $85.80

In Table 5 the annual cash flow calculations of the reuse system is given.

TABLE 5
ANNUAL CASH FLOW CALCULATIONS FOR
HIGH CAPACITY GREYWATER REUSE SYSTEM

Year	Fixed Payment	Savings 3/House	Savings 6/House
1985	$85.80	($13.68)	$65.07
1986	85.80	(8.63)	75.67
1987	85.80	(3.23)	86.93
1988	85.80	2.55	99.02
1989	85.80	8.73	111.96
1990	85.80	15.35	125.80
1991	85.80	22.43	140.62
1992	85.80	30.01	156.46
1993	85.80	38.11	173.46
1994	85.80	46.79	191.57
1995	0	141.87	296.78
1996	0	151.80	317.56

By the year 1995 the system would be paid off with at least another twenty years or more of service before the tank needs to be replaced. The pump may have to be replaced periodically but since it would be run only 30 to 40 minutes per week or 34 hours per year it should last 15 years or more.

Table 5 indicates that the installation of a greywater recycling system is a cost effective thing to do particularly for the larger family.

HIGH CAPACITY FLOOD IRRIGATION SYSTEM

In addition to the monetary savings there are some conveniences of having a high capacity flood irrigation system. With a high capacity flood irrigation system that delivers five times the amount of water in a ordinary hose irrigation can be accomplished in minutes instead of hours. In 10 or 15 minutes the lawn and shrubery can be irrigated the homeowner can turn his complete attention to other tasks or relaxation without the nagging worry of attending to running water whether it be a automatic sprinkler system or a timed trickle system. Either one of these sytems require a much longer "worry time" than a flood irrigation system.

If a flood irrigation system is properly installed and sufficient flow rate is used it can be an effective system for the irrigation of grass or a garden. The secret to success is leveling the area to be irrigated to a "dead level" condition. This leveling can be accomplished by various means including the use of a 2x4 inch board and a carpenters level. A laser leveler is also available that would automatically control the cutting depth of a scraper on a small tractor so that a "dead level" condition could be easily established. Shrubs and trees could be irrigated using bubblers.

If flood irrigation is the primary mode in urban irrigation then it is easy to collect runoff from roofs, driveways and other paved surfaces, even streets onto your lawn, trees and shrubs. These simple waterharvesting techniques will provide an extra irrigation whenever it rains. This use of runoff would reduce urban flooding. It would also provide

leaching necessary to maintain a proper salt balance in the greywater irrigation system.

Much has been written in the media in the Tucson area about the improved efficiency of drip and sprinkler irrigation as compared to flood irrigation. A well maintained drip and sprinkler system may be more effecient than a poorly designed and maintained flood irrigation system. However sprinkler and drip systems require much more maintenance than a flood irrigation system. If a rodent puts a hole in a drip line or a sprinkler head malfunctions all annual savings for the year can be quickly eliminated. Furthermore the drip or low pressure sprinkler system might save considerable water as long as the shrubs are small but as the vegetation grows additional drippers or sprinklers are needed. In a flood irrigation system as the vegetation grows to cover the basin in which a bubbler is placed surface evaporation is decreased and water use approaches that of the drip system.

The flood irrigation system looks more wasteful than the sprinkler or drip system because the water can be seen on the surface before it infiltrates. However if the lawn or garden is level very small (less than one inch) irrigations can be applied. During the time of ponding in a vegetated area such as a lawn the evaporation from the open water reduces or eliminates the evaptranspiration that would normally be occuring from the grass so not much more water is evaporated due to the flood irrigation. Finally if more water is applied than needed to satisfy the needs of the plant it will infiltrate below the root zone and eventually given enough time and quantity it will reach the groundwater table. Thus not all excess water applied by any irrigation system is completely lost to the local hydrologic system.

WATER QUALITY

The basic principal behind the high capacity greywater reuse system is to use a large enough tank to provide adequate water for irrigation but not too large that aeration and oders become a problem. The philosophy is to use the water as rapidly as possible before it goes septic

or anaerobic. Greywater has a relatively low organic loading which extends the aerobic storage time. The 400 gallon tank appears to be small enough that the water remains relatively fresh. Even when it is not being used the water is allowed to overflow and return to the sewer. The overflow is taken from the bottom of the tank so that continual mixing of the greywater is achieved.

No other treatment, screening etc. appear to be necessary. The system works on the premise that no one would mind running their own wash water or shower water directly on their lawns, trees or shrubs. In effect the high capacity greywater reuse system allows the homeowner to do that in a controlled non offensive manner.

The suitability of greywater for irrigation is very dependent on the type of detergent that is used primarily in the family wash machine. Some detergents contain boron and other harmful ingredients. Others however contain phosphates that can be beneficial to plants. If the greywater reuse system is combined with a water softener it offers greater possibilities with regard to the type of soap that can be used. For example with a water softener pure ivory soap can be used. The use of this biodegradable soap avoids any possibility of harmful effects as compared with using a detergent. With a water softener ivory soap can compete very well as far as cleaning ability.

The water softener exchanges sodium for calcium and magnesium. In very hard water with high clay soils this exchange might significantly reduce the infiltration capacity of the soil. It is doubtful that in soils normally encountered in the Tucson area that the use of softened water on vegetation would be harmful. Many homes that are retrofitted with softeners have used softened water for landscape irrigation for years with no ill effects (Lindsay, 1984). If softened water proved to be a problem the calcium and magnesium removed in the softening process could periodically be used on the soil by connecting the regenerating outlet of the water softener to the greywater recycling tank.

For households that do not have water softeners ammonia phosphate could be used as a water softener combined with

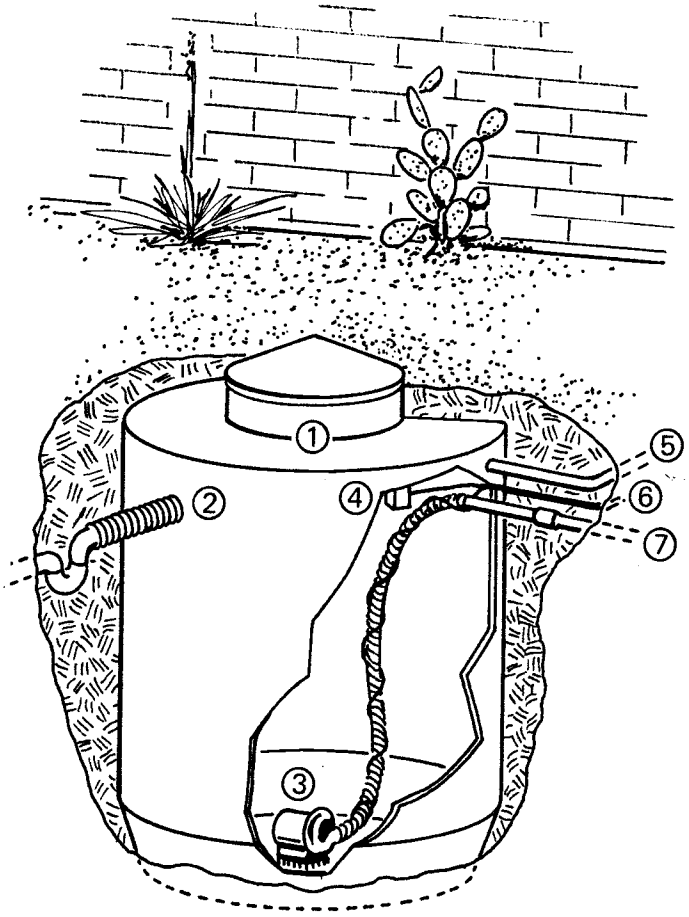

Figure 3 – HIGH CAPACITY GREYWATER REUSE SYSTEM

1. Asbestos, Cement or Fiberglass Tank, approximately 400 gallons with removable manhole size lid.
2. Overflow to Sewer, 2 inch flex line with P-Trap.
3. 1½ inch 40 gpm submersible sump pump.
4. Level indicator sensor.
5. 2 inch greywater plastic feed line.
6. Electric line and sensor line
7. 1½ inch irrigation supply line.

the use of ivory or a reduced amount of suitable detergent. The author used this method for awhile prior to obtaining a water softner. The ammonia phosphate/ivory soap method did not get white clothes quite as bright as using a water softener but it was satisfactory on colored clothes

DESCRIPTION OF SYSTEM

The high capacity greywater recycling system is shown in Figure 3. Most aspects of this system has been constructed and tested at the residence of the author this past year. It has performed very well. The greywater has been used primarily on gardens and orchards.

The tank is just below ground level with the lid exposed for easy access. The figure show the plumbing and electrical wiring required. It shows a sensor which would be connected to a indicator light in the utility room which would indicate the level of the tank. The control switch to the pump could also be located in the utility room. Inexpensive remote radio contoled switches similar to those used in opening garage doors could also be used. The submersible pump would be located in the bottom of the tank and connected to the outlet with a flex hose. This would simplify plumbing and provide easy access to the pump for maintenance. The overflow to the sewer is also shown. A water trap is used to prevent sewer odors from venting through the tank.

SUMMARY

The proposed high capacity greywater reuse system will provide many benefits including monetary over the present methods of no onsite use of greywater. It will reduce both water and energy needs. Since landscape irrigation is the principal cause of peak use of water the use of greywater recycling will help "beat the peak". It will also reduce costs of sewer lines and wastewater treatment plants. It will reduce the time required by a homeowner to irrigate.

The Mayor of Tucson appeared on Television (Channel 9) and was asked if he thought the "beat the peak" program was successful. He replied that his grass was dead and his trees were dying so the program must be working. A drive around Tucson will reveal that the Mayor is not alone, most lawns are dead and many trees are dying.The use of greywater recycling systems as described in this report

will allow Tucsonians to "beat the peak", and reduce water use at a reasonable cost without having to let their grass and trees die.

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