

2006 South Central Texas Regional Water Plan Water Management Strategy Summary Sheet

<p>Unit Cost (\$/acft/yr) 0 to 1,600</p> <p>Quantity (acft/yr) 0 to 150,000</p> <p>Impact (ac) 0 to 30,000</p>	<p>Name: <i>Rainwater Harvesting</i></p> <p>Description: Collecting rainfall from roofs and storing the runoff to meet daily household water needs.</p> <p>Decade Needed: 2000 – 2060: Applicable to areas of the region that depend upon the Trinity Aquifer.</p> <hr/> <p style="text-align: center;">Cost, Quantity of Water, and Land Impacted</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Unit Cost of Water:</td> <td style="width: 20%; text-align: center;">\$17,982 to \$10,320</td> <td style="width: 10%; text-align: center;">\$/acft/yr</td> <td style="width: 40%;">Treated Water on Site</td> </tr> <tr> <td>Quantity of Water:</td> <td style="text-align: center;">0.0574 to 0.10</td> <td style="text-align: center;">acft/yr</td> <td style="text-align: center;">Per Household</td> </tr> <tr> <td>Land Impacted:</td> <td style="text-align: center;">0</td> <td style="text-align: center;">acres</td> <td></td> </tr> </table> <hr/> <p style="text-align: center;">Additional Considerations per Regional Water Planning Guidelines</p> <p>Environmental Factors: No significant effects.</p> <p>Impacts on Water Resources: None anticipated.</p> <p>Impacts on Agricultural & Natural Resources: None anticipated.</p> <p>Other Relevant Factors per SCTRWPG: With financing for 30 years, may be able to include cost of installation in home mortgages.</p> <p>Comparison of Strategies to Meet Needs: Costs vary by site, but are relatively high in comparison to conventional water supply strategies. Based upon \$14,213 installed cost and no operating expenses.</p> <p>Interbasin Transfer Issues: Not applicable.</p> <p>Third-Party Impacts of Voluntary Transfers: Not applicable.</p> <p>Regional Efficiency: This on-site water supply technology contributes to meeting municipal needs in remote areas that cannot be easily and economically served via other water management strategies.</p> <p>Water Quality Considerations: None anticipated with proper rainwater harvesting system operation and maintenance.</p>	Unit Cost of Water:	\$17,982 to \$10,320	\$/acft/yr	Treated Water on Site	Quantity of Water:	0.0574 to 0.10	acft/yr	Per Household	Land Impacted:	0	acres	
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4C.30 Rainwater Harvesting

4C.30.1 Description of Water Management Strategy

In several parts of the South Central Texas Regional Planning Area, rainwater harvesting systems have been constructed with success. This water management strategy will consider the capture and storage of rainwater from roofs of homes for both potable and non-potable purposes for dwellings located in areas that are presently supplied by the Trinity Aquifer (parts of Uvalde, Medina, Bexar, Kendall, Comal, and Hays Counties), which is experiencing water level declines and causing local residents to consider development of additional water supplies.¹

A rainwater harvesting system collects water as it runs off roofs into gutters that convey it into a cistern or storage tank. This harvested rainwater can then be used for household potable use, landscape irrigation, or other uses. For most uses of water derived from rainwater harvesting systems, the basic system components are as follows:

- Catchment Area/Roof;
- Gutters and Downspouts;
- Leaf Screens and Roof Washers;
- Storage Facilities (Cisterns, Man-made Aquifers, and Drumsticks);
- Conveyance Facilities; and
- Water Treatment.

Each system component is described briefly below.

Catchment Area: The catchment area is the surface on which the rain that will be collected falls. This report will focus on roofs as catchment areas although channeled gullies along driveways or other impermeable surfaces may be used as catchment areas for water to be used for non-potable purposes, such as irrigation.

Gutters and Downspouts: Gutters are the components that catch the rain from the roof catchment surface, and downspouts transport the runoff to a cistern, manmade aquifer, or a “drumstick” for storage.

Leaf Screens and Roof Washers: Leaf screens of one-fourth inch mesh wire in a metal frame should be installed along the entire length of the gutters to keep leaves and debris from entering the storage components. In addition, a roof washer system is needed to collect and dispose of the “first flush” of water from a roof to divert dirt, debris, and contaminants, such as

¹ Although the costs may be applicable in other parts of the South Central Texas Region, the precipitation information is only applicable in the areas overlying the Trinity Aquifer.

bird droppings from the system. A simple roof washer can be made using a 6 to 8 inch diameter pipe (PVC can be used) which has a valve and clean out at the bottom. This type of roof washer extends from the gutter to the ground. The gutter downspout and top of the roof washer pipe are fitted and sealed so water will not flow out the top. Once the roof washer pipe has filled with “first flush” runoff, the remainder of water flows to the downspout and is conveyed to the storage component (cistern, man-made aquifer, or drumstick).

Storage Facilities: The cistern, which is a storage vessel designed to store accumulated rainfall for use during periods of low or no rainfall, represents the largest investment in a rainwater harvesting system and may be placed above or below ground. Its construction may use a variety of materials to fit different needs and budgets.

Another potential storage component is a manmade aquifer. A manmade aquifer can be constructed by lining an excavation with a pond liner and backfilling it with round, uniformly graded gravel. Depending on the nature of the soil and the liner, one or two layers of geotextile may be required to protect the liner. A geotextile layer is placed over the gravel and then a lawn, parking lot, or tennis court can be constructed on top. The capacity of a manmade aquifer is determined by the volume of the excavation and the amount of void space between the stones and can be estimated by calculating 40 to 50 percent of the gross volume within the liner. In the South Central Texas Planning Area, a manmade aquifer would require large excavations, which may not be feasible for existing facilities with outdoor structures or trees with extensive root systems.²

The drumstick storage method is constructed by auguring a deep hole and under-reaming it. A corrugated metal pipe with a welded end cap is placed into the hole and grouted in place. Although not as cost-effective as the manmade aquifer, the drumstick is more suitable when space is limited. For example, if a site is covered with trees that have canopies that nearly touch, the drumstick can be installed between the drip lines of adjacent trees in order to avoid root damage.³

Conveyance Facilities: The conveyance facilities transport the stored water to its point of use. The conveyance facilities may be a simple pipe in gravity feed systems, although most systems will also require a pump to maintain proper pressure in faucets.

² Givler, L. David, “Storage Innovations: Methods for Making Rainwater Harvesting More Cost-Effective.”

³ Ibid.

Water Treatment: If water is used inside the house, water treatment facilities are needed, and the extent of treatment depends upon the nature of the use of the water. For example, potable use requires more treatment than use for toilet flushing. The water treatment facilities may be simple filters or a more complex system including disinfection and buffering.

4C.30.2 Available Yields for Rainwater Harvesting Systems

The amount of rainwater that can potentially be harvested for later use depends on the size and texture of the catchment area on which the rain falls and quantities of rainfall. Each of these factors is explained below.

To determine the square footage of a catchment area of a building, use only the building's footprint. The actual area of roof material will be greater due to the roof slope. However, the slope does not affect the amount of rainfall falling on the roof. A smoother, cleaner, and more impervious roofing material contributes to better water quality and greater quantity. While loss may be negligible for pitched metal roofs, concrete or asphalt roofs average slightly less than 10 percent loss, and built up tar and gravel roofs average a maximum of 15 percent loss. Losses can also occur in the gutters and storage. Regardless of roofing material, many designers assume as much as a 25 percent loss of annual rainfall.⁴

That part of the South Central Texas Region located over the Trinity Aquifer has historically received between 24 inches and 36 inches of rain per year. A catchment area of 1,500 square feet receiving 24 inches of rainfall per year could collect as much as 16,830 gallons of water, while the same catchment area receiving 36 inches of rainfall per year could collect as much as 25,245 gallons of water (Table 4C.30-1). A catchment area of 2,500 square feet receiving 24 inches of rainfall per year could collect as much as 23,375 gallons of water, while the same catchment area (2,500 square feet) receiving 36 inches of rainfall per year could collect as much as 42,075 gallons of water per year (Table 4C.30-1).

A water conserving household that has low-flow plumbing fixtures such as 1.6 gallons-per-flush toilets and 2.75 gallons-per-minute shower heads, now required by the Texas Plumbing Fixtures Act of 1991, might use 55 gallons or less of water per day per person for indoor purposes. However, for the purposes of designing a rainwater collection system, a more conservative figure of 75 gallons per person per day for indoor use is advised to ensure adequate

⁴ Texas Water Development Board and the Center for Maximum Potential Building Systems, "Texas Guide to Rainwater Harvesting," 1996.

year-round indoor water supply.⁵ Given this assumption, average daily indoor use would be about 200 gallons for a family averaging 2.62 persons per dwelling, which is the average of cities located in the Trinity Aquifer area of the South Central Texas Region (2.62 persons x 75 gallons/day = 196, rounded to 200). The longest period without rainfall over the past 50 years was approximately 65 days for this part of the South Central Texas Planning Region.⁶ If the household's average daily water use is multiplied by 100 (giving a safety factor of 35 days over the longest period without rainfall of the last 50 years), the total amount of storage capacity required to provide water through a period of no rainfall lasting 100 days would be 20,000 gallons. It can be seen from Table 4C.30-1 that a home having 2,500 square feet of catchment area may be able to provide this amount of water, while a home having 1,500 square feet of catchment area would not be able to rely solely on a rainwater harvesting system to supply its occupant's water needs during a period of 100 days without rainfall.

Since the largest need for non-potable water for uses such as lawn watering generally occurs during the time of lowest rainfall and highest temperature, a rainwater harvesting system designed to meet these needs would have to capture water prior to the summer irrigation season of the study area. Thus, the size of the rainwater storage system may be prohibitive for using rainfall as the sole source of water for lawn irrigation in large or water intensive landscapes. This can be illustrated by the following example. The landscaped area to be irrigated in this example consists of 2,500 square feet, and it has been determined through consultation with landscape specialists that the plants should receive a minimum of one inch of rain per week to be healthy from June through September.

The 2,500 square feet of landscaped area will require 1,558 gallons of water to equal one inch of rain per week (Table 4C.30-2), so for 16 weeks (June through September) the water requirement will be 24,928 gallons (16 weeks x 1,558 gallons). In this example, it is assumed that only half of the average summer rainfall will occur, thus providing a safety factor. For the City of Boerne, the total average rainfall for June through September is approximately 12.46 inches; thus the assumption is that only 6.23 inches of rain will actually fall during the

⁵ Ibid.

⁶ Doxsey, W. Laurence, "Rainwater Harvesting."

**Table 4C.30-1.
Annual Rainfall Yields in Gallons for
Various Roof Sizes and Rainfall Amounts***

Roof Size (square feet)	Annual Rainfall (inches)					
	20	24	28	32	36	40
1,000	9,350	11,220	13,090	14,960	16,830	18,700
1,100	10,285	12,342	14,399	16,456	18,513	20,570
1,200	11,220	13,464	15,708	17,952	20,196	22,440
1,300	12,155	14,586	17,017	19,448	21,879	24,310
1,400	13,090	15,708	18,326	20,944	23,562	26,180
1,500	14,025	16,830	19,635	22,440	25,245	28,050
1,600	14,960	17,952	20,944	23,936	26,928	29,920
1,700	15,895	19,074	22,253	25,432	28,611	31,790
1,800	16,830	20,196	23,562	26,928	30,294	33,660
1,900	17,765	21,318	24,871	28,424	31,977	35,530
2,000	18,700	22,440	26,180	29,920	33,660	37,400
2,100	19,635	23,562	27,489	31,416	35,343	39,270
2,200	20,570	24,684	28,798	32,912	37,026	41,140
2,300	21,505	25,806	30,107	34,408	38,709	43,010
2,400	22,440	26,928	31,416	35,904	40,392	44,880
2,500	23,375	28,050	32,725	37,400	42,075	46,750

* Table includes a 25 percent loss factor due to roofing material texture, evaporation, and inefficiencies in the collection process.

lawn irrigation season (Table 4C.30-3). Pro-rated from Table 4C.30-1, 6.23 inches of rainfall would result in approximately 5,825 gallons of water captured from a 1,500 square foot roof for the period June through September. The amount of water that needs to be collected for landscape irrigation can be found by subtracting the rainfall (5,825 gallons) from the required amount (24,928 gallons), and in this case is found to be 19,103 gallons. This difference is the amount of rainwater that must be in storage prior to June for use as landscape irrigation water if actual rainfall is equal to one-half of the average rainfall for the June through September period.

If this amount of storage is added to the amount required for potable uses, the required capacity of the system would be about 39,103 (20,000 for potable use from Page 4C.30-4 plus 19,103) gallons. In instances where there is a limiting factor in the capacity of a rainwater

harvesting system, such as cost or space, a smaller system could perhaps be installed and used entirely for either potable or non-potable uses. For example, a rainwater harvesting system used in conjunction with water received from a municipal water system might fulfill a part of outdoor water requirements such as lawn and garden irrigation. Similarly, a rainwater harvesting system used in conjunction with an existing well could augment or enhance the quality of mineralized well water for purposes such as washing, or provide back-up water when underground water sources are low. However, in the Trinity Aquifer part of the South Central Texas Region, a larger rainwater harvesting system would be capable of providing most of the water needs for a household, although significant cost in constructing the system would be involved.

Table 4C.30-2.
Annual Rainfall Yield in Gallons for
Various Landscape Sizes for Rainfall Events

Landscaped Area (square feet)	Rainfall (inches)								
	0.25	0.50	0.75	1.00	2.00	3.00	4.00	5.00	6.00
1,000	156	312	468	623	1,247	1,870	2,493	3,117	3,740
1,100	171	343	514	686	1,371	2,057	2,743	3,428	4,114
1,200	187	374	561	748	1,496	2,244	2,992	3,740	4,488
1,300	203	405	608	810	1,621	2,431	3,241	4,052	4,862
1,400	218	436	655	873	1,745	2,618	3,491	4,363	5,236
1,500	234	468	701	935	1,870	2,805	3,740	4,675	5,610
1,600	249	499	748	997	1,995	2,992	3,989	4,987	5,984
1,700	265	530	795	1,060	2,119	3,179	4,239	5,298	6,358
1,800	281	561	842	1,122	2,244	3,366	4,488	5,610	6,732
1,900	296	592	888	1,184	2,369	3,553	4,737	5,922	7,106
2,000	312	623	935	1,247	2,493	3,740	4,987	6,233	7,480
2,100	327	655	982	1,309	2,618	3,927	5,236	6,545	7,854
2,200	343	686	1,029	1,371	2,743	4,114	5,485	6,857	8,228
2,300	358	717	1,075	1,434	2,867	4,301	5,735	7,168	8,602
2,400	374	748	1,122	1,496	2,992	4,488	5,984	7,480	8,976
2,500	390	779	1,169	1,558	3,117	4,675	6,233	7,792	9,350

**Table 4C.30-3.
Monthly Average
Rainfall in Boerne**

<i>Month</i>	<i>Average Rainfall (inches)</i>	<i>Month</i>	<i>Average Rainfall (inches)</i>
January	1.83	July	2.17
February	2.13	August	2.73
March	1.76	September	3.53
April	2.89	October	3.52
May	4.52	November	2.39
June	4.03	December	1.83

For purposes of illustrating the applicability of the rainwater harvesting option, it was assumed that this option would only be relevant for the counties that rely upon the Trinity Aquifer. Table 4C.30-4 summarizes the estimated number of households potentially applicable to this option.

**Table 4C.30-4.
Number of Potential Applications
of Rainwater Harvesting in Region**

<i>County</i>	<i>Potential Households for Rainwater Harvesting</i>					
	<i>2010</i>	<i>2020</i>	<i>2030</i>	<i>2040</i>	<i>2050</i>	<i>2060</i>
Bexar ¹	3,175	3,614	4,006	4,325	4,611	4,865
Comal ²	4,211	5,715	7,427	9,104	10,841	12,710
Hays ²	4,677	6,719	8,323	9,929	11,842	13,336
Kendall ²	1,390	1,957	2,558	3,062	3,475	3,879
Medina ²	1,816	2,133	2,429	2,684	2,933	3,156
Uvalde ²	1,113	1,223	1,315	1,387	1,435	1,471

¹ Assumes Northern Bexar County only. One-half percent of projected county population and 2.57 persons per household, which is the average of all cities in the region.
² Assumes 10 percent of projected county population and 2.57 persons per household, which is the average of all cities in the region.

An estimate of the unit (per household) annual yield can be made from average rainfall in each county and the yield rates in Table 4C.30-1, assuming an average roof footprint size. Table 4C.30-5 shows the annual per household yield for each county.

**Table 4C.30-5.
Estimated per Household Yield from Rainfall Harvesting**

County	Annual Rainfall (inches)	Harvesting Yield Based on 2,500 Square Feet of Roof Footprint	
		gallons/yr	acft/yr
Bexar	29.1	34,011	0.10
Comal	33.6	39,270	0.12
Hays	34.3	40,088	0.12
Kendall	32.2	37,634	0.12
Medina	28.5	33,309	0.10
Uvalde	24.1	28,167	0.09

From the average annual yield for each county and the estimated number of households in each county for each incremental planning year, an estimate of the total yield can be made (Table 4C.30-6).

**Table 4C.30-6.
Total Estimated Yield from Rainwater Harvesting in Region**

County	Year					
	2010 (acft/yr)	2020 (acft/yr)	2030 (acft/yr)	2040 (acft/yr)	2050 (acft/yr)	2060 (acft/yr)
Bexar	317	361	401	432	461	487
Comal	505	686	891	1,092	1,301	1,525
Hays	561	806	999	1,192	1,421	1,600
Kendall	167	235	307	367	417	466
Medina	182	213	243	268	293	316
Uvalde	100	110	118	125	129	132
Totals	1,833	2,412	2,959	3,477	4,023	4,526

4C.30.3 Environmental Issues

No apparent negative impacts on the environment resulting from rooftop rainwater harvesting are expected. Traditionally, impervious cover results in excessive run-off in storm events, which can lead to erosion, flooding, and contamination of lakes and streams from non-

point source pollution. Rooftop rainwater harvesting would be expected to mitigate these potential effects by capturing and storing rooftop run-off. Demand on the regional aquifer and surface water resources would be decreased and the minimal construction procedures would be of negligible consequence.

4C.30.4 Approximate Cost of a Rainwater Harvesting Systems in the Region

A rainwater harvesting system designed as an integrated component in the construction of a new building is generally more cost-effective than retrofitting a system onto an existing building. This is because many of the shared costs (roof and gutters) can be designed to optimize system performance. In addition, the investment can be amortized over time.

Rainwater harvesting systems designed to fulfill all the water needs of a home can be as costly, and perhaps more expensive, than the cost of drilling a conventional well, which ranges from approximately \$5,000 to \$15,000 in the Trinity Aquifer area.^{7,8} However, with careful planning and design, the cost of a rainwater system can be less than the cost of a well in some cases – especially if the well water must be softened and treated to remove dissolved minerals, and the rainwater system is owner-built, which is a viable option for people with available time and basic skills.

Many factors affect the cost of a rainwater harvesting system, such as the capacity of the system, construction material, method of storage, and size of pump needed to supply adequate pressure for faucets. However, it is hard to generalize about the cost of a rainwater harvesting system because each system will be unique, and because of the large number of options for the construction material and type of cistern, which is the largest cost component in a rainwater harvesting system. Cost estimates range from \$1.65 per gallon for a 4,000 gallon capacity underground concrete cistern to \$1.20 per gallon for a 25,000 gallon capacity underground concrete cistern, while the costs for an aboveground fiberglass cistern range from \$1.12 for a 4,000 gallon capacity tank to \$0.65 for a 25,000 gallon capacity tank (Table 4C.30-7).⁹ New methods for water storage such as the manmade aquifer and drumstick may prove more cost-effective (Table 4C.30-7). According to the Texas Water Development Board, most rainwater

⁷ Texas Water Development Board (TWDB) and the Center for Maximum Potential Building System, “Texas Guide to Rainwater Harvesting,” 1996.

⁸ Environmental Home Program, “Why Harvest Rainwater?”

⁹ Givler, L. David, “Storage Innovations: Methods for Making Rainwater Harvesting More Cost-Effective.”

harvesting systems have an approximate construction cost of \$1.08 per gallon of collection capacity.¹⁰

In order to determine a cost per unit of yield for comparison with other options, certain assumptions are required for storage capacity and other engineering features. In the following example, costs are estimated for a rainfall harvesting facility to only irrigate landscaping during a prolonged period of no rainfall. Therefore, the tank size should be approximately equal to the volume of water needed for 1.0 inch of rainfall per week for 12 weeks for a landscaped area of 2,500 square feet. Referring to Table 4C.30-2, this volume of water would be 1,558 gallons

**Table 4C.30-7.
Storage System Cost Comparison**

Capacity (Gallons)	Underground Concrete (per gallon)	Aboveground Fiberglass (per gallon)	Drumstick¹ (per gallon)	Manmade Aquifer (per gallon)
4,000	\$1.65	\$1.11	\$1.94	\$0.68
15,000	\$1.32	\$0.70	\$0.90	\$0.68
25,000	\$1.20	\$0.65	N/A	\$0.65

¹ No price is provided for the 25,000 gallon drumstick option because such capacity may not be feasible with a single installation.

Source: Givler, L. David, "Storage Innovations: Methods for Making Rainwater Harvesting More Cost-Effective."

per week, or about 18,700 gallons per season. Another assumption is that the irrigation system is already installed and that the storage tank and irrigation pump or distribution header (if it is a gravity system) are located near the home. The assumptions are summarized as follows:

- Storage Tank Capacity - 20,000 gallons
- Piping from roof to tank – 25 feet of 4-inch diameter PVC pipe
- Piping from tank to irrigation system – 10 feet of 2-inch PVC pipe

Costs can be estimated from Table 4C.30-7 plus an allowance for the pipe, connections, and valves. The costs are summarized in Table 4C.30-8. For an installation cost of \$14,213 for this example and assuming no maintenance costs and 6 percent financing for 30 years, the annual cost is \$1,032. For a yield of 0.0574 acft/yr (18,700 gallons), the cost is estimated to be \$55.19 per 1,000 gallons of yield (\$17,982 per acft).

¹⁰ TWDB and the Center for Maximum Potential Building Systems, Op. Cit., 1996.

Another generalized approach to estimating the cost of rainfall harvesting is presented in Table 4C.30-9. In this table the data from Table 4C.30-5 are used with the same annual cost in the example above. The yields presented in Table 4C.30-5 and shown below represent the total annual capture from a 2,500 square foot roof footprint for each county addressed.

4C.30.5 Implementation Issues

The unit costs presented above are consistent with costs of actual installations. The relatively small yield, which can be developed from rainfall harvesting, makes the unit costs quite high in relation to unit costs for public water systems of cities of the area. The maximum annual water quantity from a residence in the region is 40,088 gallons for a roof footprint of 2,500 square feet (Table 4C.30-5). This is the equivalent of less than 43 gallons per person per

**Table 4C.30-8.
Summary of Rainfall Harvesting Example Installation**

Component	Unit Cost	Total Cost
20,000-gal above ground fiberglass storage tank	\$0.70	\$14,040
25 feet of 4" PVC, installed	\$2.16	\$54
10 feet of 2" PVC	\$1.08	\$11
Appurtenances	—	\$108
Total		\$14,213

**Table 4C.30-9.
Estimated Annual Cost of Rainfall Harvesting**

County	Annual Yield*		Annual Unit Cost	
	gallons/year	acft/year	\$ per 1,000 gallons	\$ per acft
Bexar	34,011	0.10	\$29.47	\$10,022
Comal	39,270	0.12	\$25.52	\$8,352
Hays	40,088	0.12	\$25.00	\$8,353
Kendall	37,634	0.12	\$26.63	\$8,352
Medina	33,309	0.10	\$30.08	\$10,022
Uvalde	28,167	0.09	\$35.58	\$11,136

* See Table 4C.30-5. Based on 2,500 square feet of roof footprint and average annual rainfall in each county.

day of water supply. However, for low density housing areas, and widely spaced individual housing units, it may be an acceptable water supply method. Furthermore, an installed rainwater harvesting system could perhaps be supplemented during long dry periods by hauling treated water from a nearby public supply. However, obviously water and tank trucks from a nearby public supply would have to be available.

Another implementation issue involves the health and safety of the users. The State of Texas does not currently regulate the indoor or outdoor household use of rainwater unless the system is backed up by publicly supplied waterlines. If a backup system is used, to avoid any cross-connections, an air gap must exist between the public water and rainwater. In addition to this requirement, the Health Department requires that all cisterns be covered so that the rainwater system does not contribute to mosquito breeding.

**Table 4C.30-10.
Evaluations of Rainwater Harvesting
to Enhance Water Supply Yield**

Impact Category	Comment(s)
a. Quantity reliability and cost of treated water	<ul style="list-style-type: none"> Quantity directly dependent on rainfall Extremely high unit cost
b. Environmental factors	<ul style="list-style-type: none"> none
c. State water resources	<ul style="list-style-type: none"> No apparent negative impacts on other water resources
d. Threats to agriculture and natural resources in region	<ul style="list-style-type: none"> none
e. Recreational	<ul style="list-style-type: none"> none
f. Comparison and consistency equities	<ul style="list-style-type: none"> Cost model based on individual units
g. Interbasin transfers	<ul style="list-style-type: none"> Not applicable
h. Third party social and economic impacts from voluntary redistribution of water	<ul style="list-style-type: none"> Not applicable
i. Efficient use of existing water supplies and regional opportunities	<ul style="list-style-type: none"> Very high
j. Effect on navigation	<ul style="list-style-type: none"> none