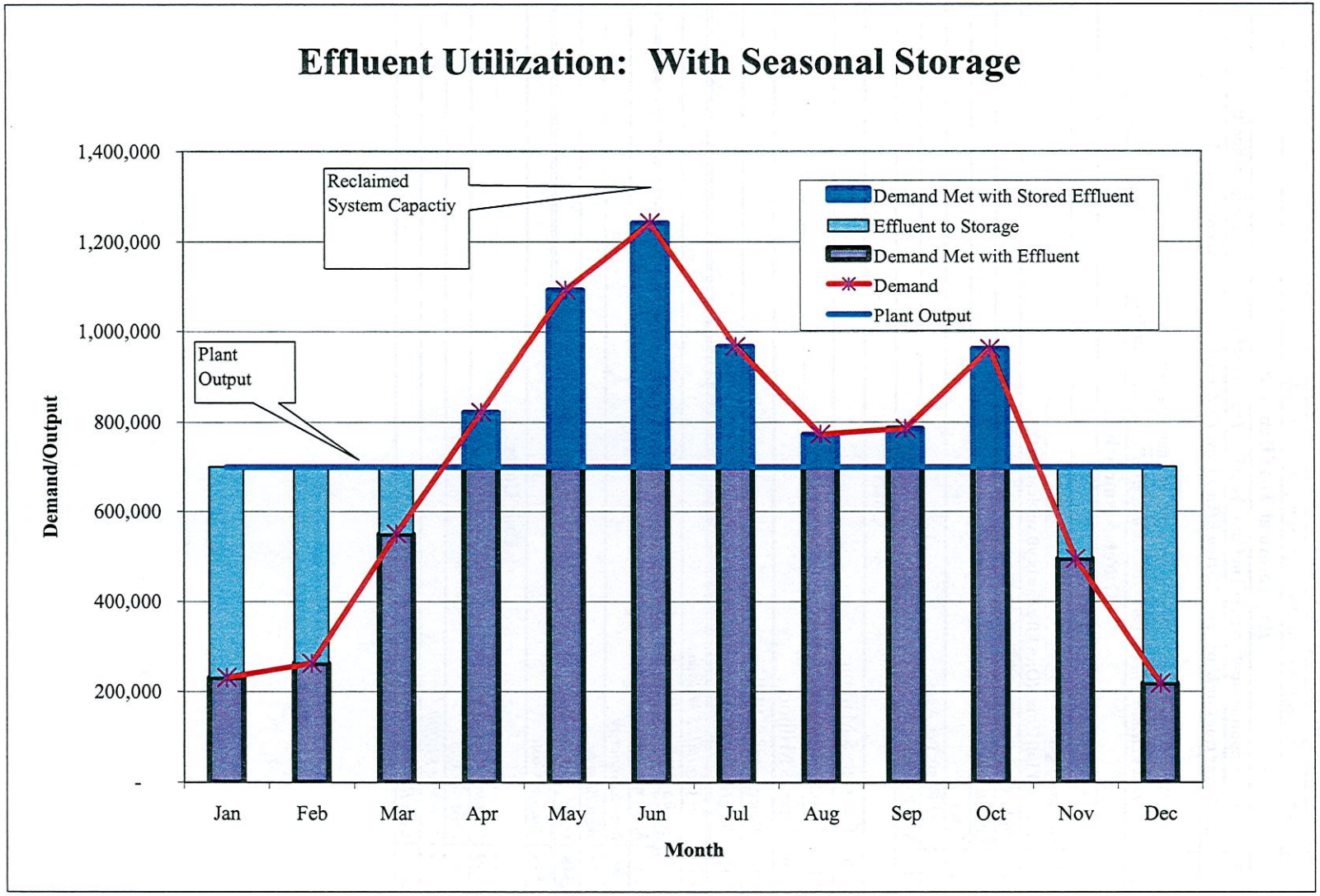
Conceptual Level Reclaimed System for Two Plant Sizes
Blue Ribbon Panel
May 7th 2010
27th

Assumptions & Results	
700,000	Gallons per day treated effluent
784	*Acre Feet Per Year Effluent*
85	Effluent Generated Per Capita
8,235	*Population (Gallons per day generated divided by effluent per capita)*
2.48	Persons Per Household (Pima County)
3,321	*Households (Population divided by persons per household)*
Hypothetical Turf Demand	
4	Annual Evapotranspiration (ETo) in Cubic Feet Per Year (Turf Requirement or Application Rate)
196.0	*Max Acres that Could be Served Given Effluent and ET (Acre feet of effluent divided by ETo)*
0.25	Max Daily ET in Inchdes: Used to estimate maximum day demand.
1,330,639	*Max Daily Demand in Gallons Given Max Day ET and Acres of Turf*
Other Assumptions	
1.50	Recharge Rate in Feet Per Day
$ 0.10	Energy Cost Per kWh
2.00	Assumed Lift Zones(One lift zone is 90 vertical feet)
2.00	High Water Storage = 2 if yes, 1 if no
6.0%	Interest Rate
20	Term
$7,500	Land Costs Per Acre
12	Inch Pipe Size
Costs	
$ 0.86	Booster: $ Million
$ 3.00	Reservoirs: $ Million
$ 1.99	Pipe: $ Million
$ 1.94	Recharge: $ Million
$ 0.40	Recovery Well(s): $ Million
$ 8.17	*Total Capital: $ Million*
$ 712,667	*Annual Debt Service*
$ 79,787	*Maintenance*
$ 308,555	*Booster Energy*
$ 354,384	*Well Energy*
$ 742,726	*O&M*
$ 1,455,393	*Annual Cost*
Unit Costs	
$ 1,856	*Cost per Acre Foot*
$ 4.27	*Cost per Ccf*
$ 5.70	*Cost Per $1,000*
$ 36.52	*Cost Per Household Per Month*

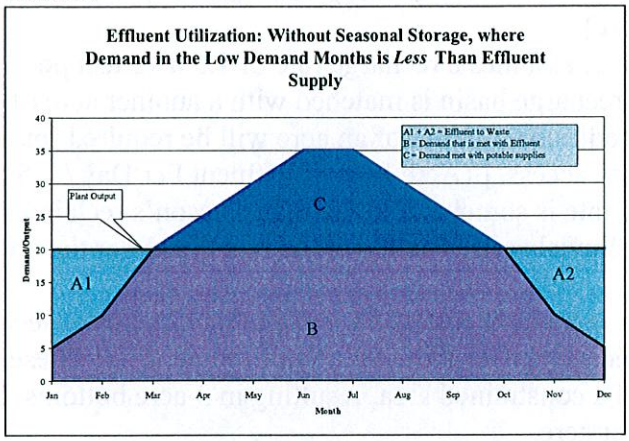
Assumptions & Results	
2,000,000	Gallons per day treated effluent
2,240	*Acre Feet Per Year Effluent*
85	Effluent Generated Per Capita
23,529	*Population (Gallons per day generated divided by effluent per capita)*
2.48	Persons Per Household (Pima County)
9,488	*Households (Population divided by persons per household)*
Hypothetical Turf Demand	
4	Annual Evapotranspiration (ETo) in Cubic Feet Per Year (Turf Requirement or Application Rate)
560.1	*Max Acres that Could be Served Given Effluent and ET (Acre feet of effluent divided by ETo)*
0.25	Max Daily ET in Inchdes: Used to estimate maximum day demand.
3,801,824	*Max Daily Demand in Gallons Given Max Day ET and Acres of Turf*
Other Assumptions	
1.50	Recharge Rate in Feet Per Day
$ 0.10	Energy Cost Per kWh
2.00	Assumed Lift Zones(One lift zone is 90 vertical feet)
2.00	High Water Storage = 2 if yes, 1 if no
6.0%	Interest Rate
20	Term
$7,500	Land Costs Per Acre
12	Inch Pipe Size
Costs	
$ 1.30	Booster: $ Million
$ 9.17	Reservoirs: $ Million
$ 1.99	Pipe: $ Million
$ 5.53	Recharge: $ Million
$ 1.13	Recovery Well(s): $ Million
$ 19.12	*Total Capital: $ Million*
$ 1,666,547	*Annual Debt Service*
$ 203,237	*Maintenance*
$ 881,586	*Booster Energy*
$ 1,012,525	*Well Energy*
$ 2,097,348	*O&M*
$ 3,763,895	*Annual Cost*
Unit Costs	
$ 1,680	*Cost per Acre Foot*
$ 3.86	*Cost per Ccf*
$ 5.16	*Cost Per $1,000*
$ 33.06	*Cost Per Household Per Month*


Effluent Utilization: With Seasonal Storage
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
-
Demand/Output
Reclaimed
System Capactiy
Plant
Output
Demand Met with Stored Effluent
Effluent to Storage
Demand Met with Effluent
Demand
Plant Output
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

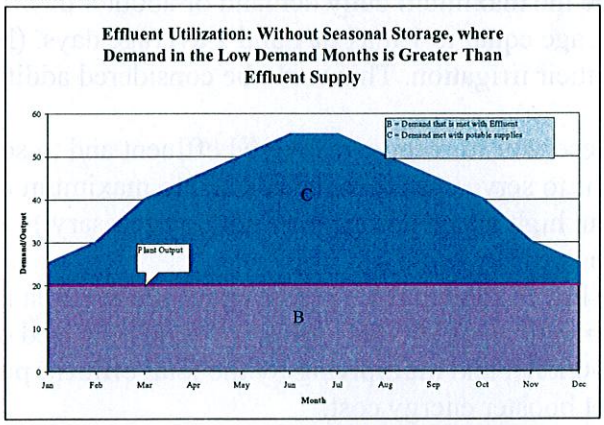
Alternative: No Recharge and Recovery Facilities for Seasonal Storage:

The cost of recharge and recovery facilities for seasonal storage and pumping sized to meet peak demand, which may be needed to maximize the use of *all* available effluent, could be avoided, if excess effluent is discharged under the AZDPEZ. That is, if the reclaimed system were sized to the output of the plant, then the cost of the reclaimed system could be reduced substantially. Three cases are presented below where seasonal storage would not be needed one of which results in optionally discharged to waste.

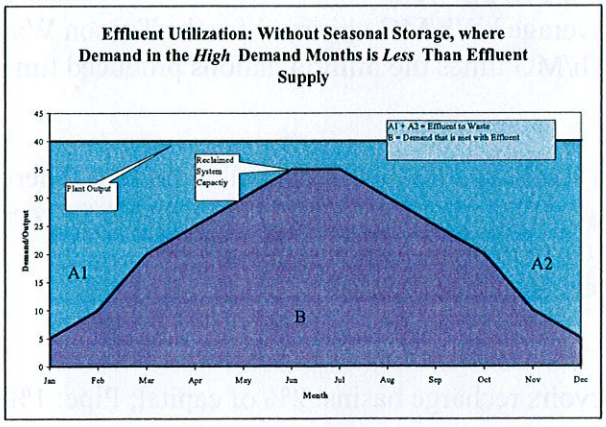
Case 1.



Case 2:



Case 3:



Basic Assumptions Regarding Reclaimed System:

1. **Demand:** Annual Demand equals effluent supply.
2. **Evapotranspiration (ETo):** We used an ET0 of 4 acre feet per acre. This is less than what golf courses are applying in the Tucson area but is generally more than schools and parks. Other areas of the state may have higher or lower ETo.
3. **Acres of Turf:** Acres of turf is equal to the number of acre feet per year generated by the plant divided by the annual ETo.
4. **Maximum Day Demand:** Given the acres of turf, we used a maximum daily ETo of a quarter of an inch. This is somewhat lower than the maximum ETo in Tucson and may be higher or lower elsewhere in the state. [(0.25 Eto/12 inches)*7.48 gallons per cubic foot*acres of turf * square feet per acre]
5. **Recharge Area:** Land area for recharge assumes a recharge rate of 1.5 acre feet per day and to accommodate drying each acre of recharge basin is matched with a another acre of basins that will not be receiving water. An additional quarter of an acre will be required for every acre of recharge basin to accommodate access. [(Acre Feet of Effluent Per Day / 1.5 Acre Feet Per Day)*2*1.25] This recharge rate is somewhat lower than Tucson's reclaimed recharge basins, which is located in alluvial soils. The lower the rate the larger the area required.
6. **Recharge Basin Costs:** Based on the estimated cost of $8 million for 12 acres of recharge basins for the Tucson Water reclaimed system or about $0.66 million per acre! These basins are being constructed in somewhat of a constrained area, resulting in 3 acre bottoms. Larger basins could cost substantially less per acre.
7. **Booster(s) and reservoir sizing:** Boosters and reservoirs were sized to the maximum day demand. So, total storage equal to twice the maximum daily demand or about 4 days of average daily demands. High water storage equal to 1 max day and 2 average days. (Most golf courses draw from a lake to serve their irrigation. This could be considered additional storage for the reclaimed system.)
8. **Number of Reservoirs:** Assume one reservoir to receive recovered effluent and to serve the booster and another high water reservoir to serve customers each sized to maximum day demand. (If customers have storage than high water storage may not be necessary.)
9. **Number of Boosters:** Assumes one booster.
10. **Booster Energy:** Assumes a two zone lift. A zone in the Tucson Water service area is 90 feet. Using the Tucson Water Plan assumptions of $90/MG for a two zone lift based on $0.07/Kwh and adjusting that up to $.10/kWh and multiplying by the total effluent pumped in MG to get total booster energy to get booster energy cost.
11. **Recovery Wells:** Assume a 1 MGD well. Divide maximum day by 1 MGD to get number of wells. Assume a well cost $300,000 for a 1 MGD well.
12. **Recovery Well Pumping:** Using the average kWh/MG observed for the Tucson Water recovery wells and multiplying the kWh/MG times the million gallons produced times $0.10/kWh to get total recovery costs.
13. **Land Cost:** $7,500 per acre.
14. **Distance from Waste Water Plant to Recharge Basins:** Assumed to be zero. There could be substantial additional conveyance cost if location near plant is not suitable for recharge and recovery or is not large enough to accommodate a recharge facility.
15. **Distance to Customer(s) from Booster:** Assumed 3 miles.
16. **Pipe Size:** Assumed 12 inch.
17. **Interest Rate:** 6%; **Term:** 20 years.
18. **Annual Maintenance:** Boosters, reservoirs recharge basins: 2% of capital; Pipe: 1%.