Economic Evaluation of the Cadiz Groundwater Storage and Dry Year Supply Project, Metropolitan Water District of Southern California

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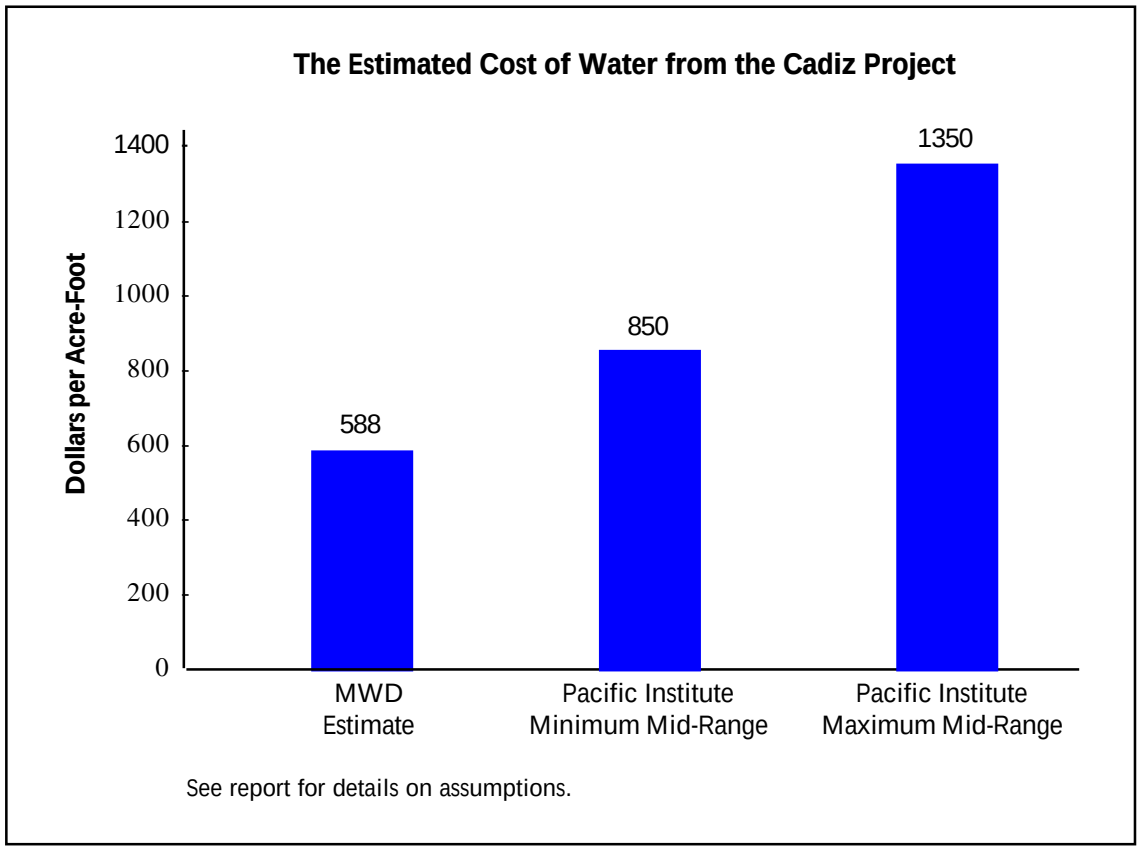

About the Pacific Institute

The Pacific Institute for Studies in Development, Environment, and Security is an independent, non-profit center created in 1987 to conduct research and policy analysis in the areas of environment, sustainable development, and international security. Underlying all of the Institute's work is the recognition that the pressing problems of environmental degradation, regional and global poverty, and political tension and conflict are fundamentally interrelated, and that long-term solutions require an interdisciplinary perspective. The Institute strives to improve policy through sound research and consistent dialogue with action-oriented groups from the international to local level.

About This Report

Proposals for meeting California water needs are always controversial, as are the analyses of the costs and benefits of those proposals. One of the greatest uncertainties in studies of water is the cost of new water supply. Estimates of project cost depend on a wide range of uncertain factors, including water yields, the cost of money, expected capital costs for construction, the amortization period, and other factors. Often, the values chosen in analyses reflect the preferences and priorities of the analyst rather than the most reasonable values given uncertainty. Errors and omissions are often common as well, leading to unreliable or incorrect estimates.

Several historical and recent examples of inadequate cost projections should give those working in this field pause. Last year, an economist at the U.S. Army Corps of Engineers blew the whistle on biased cost-benefit studies for projects along the Missouri and Mississippi rivers, leading to calls for reform of the process. Closer to home, the actual cost of the Diamond Valley reservoir was considerably higher than originally estimated.

There is an old saying that there are few things more uncertain than the weather. Cost estimates might warrant that distinction. Nonetheless, like the man with the imaginary chicken in the old joke — "I know the chicken is imaginary, but I keep it because I need the eggs" — we continue to work hard at estimating the cost of water-supply projects, despite the uncertainty involved, because of the importance of avoiding making inappropriate or unnecessarily expensive choices.

This report addresses a recent estimate of the cost of water from the Cadiz storage and water supply project. Using the same data as project proponents, supplemented by generally available information, we offer an independent assessment of these costs. In preparing this assessment, we found that the estimate prepared by consultants to the Metropolitan Water District made a number of inappropriate or biased assumptions for at least four cost parameters. Changing these assumptions changes the range of cost estimates for the Cadiz project quite significantly. We believe that there is a high probability that the cost of water from the Cadiz project will be significantly higher than the consultant's estimate. This, in turn, should raise questions for policymakers and consumers about how to proceed with the project. What will be the ultimate cost of Cadiz water? The answer to this depends on decisions still to be made, and on information that is still incomplete. We hope that this report will help to ensure that public policy based on more accurate and complete information has a fighting chance.

Peter H. Gleick, Ph.D.
President

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Synopsis

This report summarizes the Pacific Institute's economic evaluation of the Cadiz groundwater storage and transfer project. The evaluation is consistent with and elaborates on the analysis previously submitted by Professor Charles Howe of the University of Colorado at Boulder, a highly experienced water resources economist, in response to the draft Environmental Impact Report. It also updates the statements made by Gary Wolff, Principal Economist and Engineer at the Pacific Institute, in oral testimony before the Metropolitan Board of Directors on April 9 and 10, 2001.

Our minimum mid-range estimate of the cost of water from the project is more than 45% higher than that estimated by Metropolitan staff because favorable assumptions were used by staff for four cost estimating inputs,[1] rather than more neutral, middle of the road assumptions. Our minimum[2] mid-range cost estimate for the Cadiz project is about $850 per acre-foot as opposed to a staff estimate of less than $600 per acre-foot. This is obviously important from a rate-payer perspective.

Perhaps more importantly, however, these adjustments imply that the cost of water from the Cadiz project with 300,000 acre-feet or less of native groundwater take will probably be more than $1,050 per acre-foot, far in excess of other storage projects available to Metropolitan. That is, the project does not seem to make financial sense as a "storage only" project.

Because the quantity of native groundwater transferred is to be determined by a groundwater monitoring program during implementation of the project, Metropolitan is being asked to invest at least $120 million in a project that could be found, at a later time, to be economically undesirable.

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Method of Analysis

Our analysis is based on information available in the public record or provided by Metropolitan staff. A summary of the assumptions and calculations used in our analysis is attached. At least eight significant physical or economic cost factors are uncertain. (Contractual and business related uncertainties are also discussed in the report by Ernst & Young, described below). The significant physical and economic cost factors are:

[1] These are: quantity of native groundwater taken, quantity of Colorado River water that can be stored, the cost of obtaining water to be stored, and energy cost.

[2] We say "minimum" because two potentially significant cost factors — future environmental mitigation and groundwater treatment costs — are not included in our mid-range cost estimate. These costs are discussed, but are not appropriate to include prior to completion of the environmental impact statement.

1. Hydrologic uncertainty associated with historical variation in yearly and longer-term weather patterns. This in turn affects the pattern of puts and takes that satisfies Metropolitan's operational opportunities and requirements.

2. Future adjustments in the fair market value of native groundwater.

3. Quantity of native groundwater that can be taken within environmental constraints.

4. Quantity of Colorado River water that can be stored.

5. The cost of obtaining water to be stored.

6. The cost of electricity (approximately 90% of the estimated operation and maintenance cost of the Cadiz project is for electricity).

7. The cost of treating extracted water to satisfy stricter, future State or Federal water quality standards.

8. The cost of mitigating any environmental impacts that do occur despite efforts to avoid such impacts. (Many water projects have had long-term environmental impacts that were unforeseen initially, or occurred despite best efforts to prevent them).

Metropolitan staff have estimated that water from the Cadiz project will cost, on average, about $200 per acre-foot more than the District is paying for wholesale water today (around $400 per acre-foot).

Metropolitan staff and consultants have used reasonable mid-range assumptions for items 1 and 2, but unreasonably favorable assumptions for items 3-8. Our evaluation assigns reasonable mid-range values to cost items 3-6. We do not assign a mid-range value to cost items 7 and 8 because doing so would be premature prior to completion of the environmental impact report. That is, we present conservative results that are applicable even if cost items 7 and 8 turn out to be insignificant. However, we discuss all eight cost factors, below.

Metropolitan staff previously estimated a uniform unit cost of $588 per acre-foot for water from the Cadiz project. Uniform unit cost estimates are the way economists compare the cost per acre-foot of water from a project that will deliver water in different years at different prices with the cost per acre-foot of water being paid today. The uniform unit cost estimate adjusts for the time value (earning potential) of money. This means that Metropolitan staff have estimated that water from the Cadiz project will cost, on average, about $200 per acre-foot more than the District is paying for wholesale water today (around $400 per acre-foot). The staff cost estimating procedure is documented in "Cadiz Groundwater Storage and Dry Year Supply Program, Agreed Upon Procedures" (Ernst & Young, January 2001). Ernst & Young used the draft Economic Terms and Responsibilities available in January, but subsequently stated that their results also apply to the Economic Terms and Responsibilities approved in April.

Before examining the impact of realistic mid-range cost assumptions for items 3-6, we created a base case economic analysis (spreadsheet attached) built around the assumptions documented in Ernst & Young (2001), but updated to reflect the Economic Terms and Responsibilities approved in April. Our base case cost estimate is $575 per acre-foot, very near the staff estimate of $588 per acre-foot. This confirms that our analysis is an "apples to apples" comparison with staff analysis. *We emphasize, however, that our base case is used only as a reference point. Calling it the "base case" does not imply that it is correct or likely to occur.*

Individual Cost Factors

The eight cost estimating assumptions identified above are evaluated one by one in this section of our report. When a change in cost assumption from that used by Metropolitan staff or in our base case is appropriate, we describe the additional cost that results from changing only that assumption. The impact of combinations of changes in cost assumptions is discussed in the next section.

1. Hydrologic Uncertainty

The usual and appropriate way to address uncertainty is to evaluate the range of favorable and unfavorable scenarios, and then to average them. This is precisely what Metropolitan staff did to address hydrologic uncertainty (e.g., the pattern and timing of wet and dry years). The staff estimate of $588 per acre-foot is the average of 77 hydrologic scenarios.

Annual water rate increases in the 1990s in Southern California exceeded inflation by about 3.5%. In comparison, our mid-range cost estimate for water from the Cadiz project -- in current dollars -- is more than double (200%) the current wholesale price of water.

2. Future Adjustments in the Fair Market Value of Groundwater

Staff and Ernst & Young investigated the impact of increases in fair market value (FMV) of native groundwater. They investigated 3%, 5%, and 8% annual increases in the nominal price to Metropolitan of native groundwater. These percentages include inflation assumed at a rate of 3% per year: that is, they represent increases equal to the rate of inflation, and 2% and 5% greater than the rate of inflation. The $588 per acre-foot estimate is based on 3% inflation and a 3% increase per year in the nominal price of native groundwater: That is, the estimate assumes Metropolitan's contractual price for native groundwater rises at the rate of inflation.

We compared these assumptions with historical water price and inflation data for Southern California. Figure 3 of the 1999 Black & Veatch California Water Charge Survey shows a Southern California rate trend that amounts to 5.5% per year, compounded, from 1991 to 1999. During that same period the change in the Los Angeles-Riverside-Orange County Consumer Price Index (All Urban Consumers) was about 2% per year, compounded. This implies that water rate increases in the 1990s in Southern California exceeded inflation by about 3.5% (5.5 - 2.0).

These historical data indicate that the assumed inflation rate of 3% was unfavorable to the project because the actual historic rate of inflation was lower (i.e., 2% is lower than 3%). On the other hand, they also suggest that the assumption that 50% of the change in FMV is equal to the rate of inflation was favorable to the project, because the actual adjustment in FMV that would have taken place based on historic data is 0.75% higher than the rate of inflation (i.e., 1/2 of 5.5% is 2.75%, which minus 2% is 0.75%) We analyzed a variety of combinations of inflation rate and possible future changes in FMV, and concluded that the staff assumptions for this cost factor were reasonable mid-range assumptions based on

historical data. Of course, the historical rate of inflation and historical changes in water prices in Southern California may be a poor predictor of future inflation or future price changes. Historical data is merely the best data available at this time.

3. Quantity of Native Groundwater that Can be Transferred

The staff estimate and base case assume 1.5 million acre-feet of native groundwater can be transferred. This is not a reasonable mid-range estimate, but is at the favorable end of the range of quantities of native groundwater that various parties have said may be available. We used a mid-range estimate of 0.9 million acre-feet: the average of 1.5 and 0.3 million. This adjustment alone increases the estimated cost of water from the Cadiz project by about $45 per acre-foot. *As discussed in the section below, "Combinations of Cost Factors," it has a much larger financial impact than the impact in the Ernst & Young (January 2001) analysis of reduced transfer of native groundwater.*

Net take of native groundwater requires that it be taken prior to storage of Colorado River water or after stored water is removed. Operationally, net take of native groundwater is therefore not possible every year of the 50-year project life.

We used 6,000 acre-feet per year as the lower end of the range of transfers: the amount currently extracted by Cadiz for agricultural operations. This is also the sustainable yield estimated from a variety of credible sources, as documented in comments on the draft environmental impact statement. This amounts to no more than 0.3 million acre-feet over the 50 year time period. It probably overstates the amount of native groundwater that can actually be taken once storage operations begin, if 6,000 acre-feet per year is the sustainable yield, because recharge that occurs during "storage years" will probably be lost at least in part to evaporation before it can be captured for transfer.

We established the upper end of the range of native groundwater take as an average of 30,000 acre-feet per year; a total of 1.5 million acre-feet over 50 years. This figure is based on an operational constraint that applies even if the 60,000 acre-feet per year sustainable yield estimate provided by consultants to Cadiz, Inc. were accurate. Net take of native groundwater requires that it be taken prior to storage of Colorado River water or after stored water has been removed. Operationally, net take of native groundwater is therefore not possible every year of the 50-year project life. Our upper end assumption of 1.5 million acre-feet is equivalent to 60,000 acre-feet per year in 25 of the 50 years of the project life (perhaps after Colorado River water has been stored and then removed). Transfer of 1.5 million acre-feet of native groundwater is probably the maximum quantity of transfer that would be operationally possible, if recharge were 60,000 AF/ year, given that Metropolitan plans to store as much Colorado River water as can be stored prior to 2017.

4. The Cost of Water to be Stored

Metropolitan cannot store water and meet current demands in any year without obtaining additional water that year. The staff estimate of $588 per acre-foot and our base case estimate of $575 per acre-foot assume zero cost of the water to be stored. This is clearly inaccurate. Metropolitan staff informed us that the minimum variable cost for additional water from the State Water Project in wet years has been around $90 per acre-foot. Since the Colorado River Aqueduct (CRA) flows

full at present, any storage along the CRA requires additional water to be procured from the State Water Project (or taken from other storage facilities).

A higher but equally valid estimate of the cost of the water to be stored is $154 per acre-foot. This is the payment Metropolitan offers to large customers or member agencies that can reduce water use by at least 10 acre-feet per year. It is reportedly based on an internal calculation of the avoided costs of conservation: that is, the variable cost per acre-foot that Metropolitan avoids when demand decreases by an acre-foot. This is the same as the cost of obtaining and delivering an extra acre-foot, which is essentially what is required when an acre-foot is stored somewhere in the Metropolitan system, then brought back from storage at a later time.

Consequently, we used the average of $90 and $154 ($122) for our mid-range cost estimate. This is much more realistic than the staff and Pacific Institute (PI) base case assumption of $0 per acre-foot for the water to be stored. This adjustment alone causes the cost of water from the Cadiz project to increase by about $33 per acre-foot. As discussed below, it has a much larger financial impact as less native groundwater is available, because stored water becomes a larger percentage of total water from the project as the quantity of native groundwater transferred declines.

As noted by several Board Members at the April 10th meeting, the currently ongoing Integrated Resource Planning (IRP) process -- if applied to the Cadiz project -- might find that the Cadiz project is not economically attractive relative to other conjunctive use opportunities.

In addition, this cost will probably not affect alternative conjunctive use projects equally. For example, the cost of obtaining water to be stored may be much higher for the Cadiz and Hayfield projects as compared with the Arizona or Coachella Valley projects, because the latter projects would not reduce water at the discharge end of the Colorado River Aqueduct in storage years, and therefore would not require replacement water from the State Water Project. Colorado River Water stored before it is placed in the CRA will probably have a much lower cost than State Water Project water, an issue that apparently has not been evaluated. As noted by several Board Members at the April 10th meeting, the currently ongoing Integrated Resource Planning (IRP) process — if applied to the Cadiz project — might find that the Cadiz project is not economically attractive relative to other conjunctive use opportunities.

5. Quantity of water that can be stored

The staff and base case estimates assume 1,000,000 acre-feet can be stored. This is the upper end of the range identified in the Environmental Planning Technical Report, Project Feasibility and Facilities Report (Black & Veatch, November 1999). Storage capacity as low as 500,000 acre-feet was also considered reasonable by Black & Veatch. A mid-range estimate of 750,000 acre-feet[3] is more appropriate than the assumption used, and in itself

[3] In fact, an as yet unpublished evaluation of storage capacity by John Bredehoft found that 750,000 acre-feet of storage was the maximum storage capacity, not the middle of the reasonable range. But we use the middle of the Black & Veatch range because it is a credible source as well.

increases the absolute cost of water from the Cadiz project by about $35 dollars per acre-foot. As discussed below, this factor also has a much larger financial impact as native groundwater quantity declines because the fixed costs of the project must be spread over fewer and fewer acre-feet, total.

In addition, this adjustment makes the Cadiz project less attractive relative to other conjunctive use projects. If storage capacity of the Cadiz project is smaller than 1,000,000 acre-feet, the cost estimates for other conjunctive use projects are unaffected. As noted by several Board Members at the April 10th meeting, the IRP process could conceivably find that the Cadiz project is not economically attractive relative to other conjunctive use opportunities.

Each additional cent per kwh, alone, adds about $25 to the cost of an acre-foot from the Cadiz project.

6. The Cost of Electricity

The staff estimate and base case assume electricity at rates that are no longer available in California: $0.045 per kilowatt-hour (kwh). Presumably this was realistic when Black & Veatch estimated project costs in 1999, but it is not realistic today given that power for the Cadiz project must be purchased on the spot market (Black & Veatch, 1999) or generated by Metropolitan in new energy production facilities. New electricity, at least in the next few decades, will not cost $0.045 per kwh. Consequently the staff and base case analysis are unreasonably favorable.

It is difficult to estimate the long-term mid-range cost of electricity for the project. Nine cents per kwh was a typical retail electric price prior to our current crisis. It is far lower than Metropolitan apparently paid recently for marginal kilowatt hours for pumps on the CRA (over $0.40 per kwh), and slightly higher than the ten to twenty year contracts for new natural gas power plants signed by the State of California since the current crisis began ($0.06 to $0.07 per kwh, plus transmission and distribution costs). Since transmission and distribution costs amount to well more than $0.02 or $0.03 per kwh, our assumption that power could be delivered to the appropriate pumping station(s) for $0.09 per kwh may be too low. But because project economics are very sensitive to the cost of energy, we have been careful to avoid a mid-range assumption that may be overly pessimistic.

Each additional cent per kwh, alone, adds about $25 to the cost of an acre-foot from the Cadiz project. Since we used $0.09 per kwh as a mid-range cost estimate, the change in the cost of energy assumption, alone, increases the cost of water from the Cadiz project by about $110 per acre-foot.

Again, this cost factor does not affect the Cadiz and other conjunctive use projects equally. For example, higher electricity costs affect the Cadiz project much more than the Hayfield project because Hayfield is much closer to the CRA; and therefore requires less energy for pumping. This is yet another reason that the IRP process might find that the Cadiz project is economically unattractive relative to other conjunctive use opportunities.

7. Future Water Treatment Costs

Native groundwater in the Cadiz and Fenner Basins contains levels of arsenic and chromium that are in excess of Federal and State drinking water standards that have already been proposed. It is likely that more stringent standards for arsenic and chromium will be adopted in the next few years. Over the 50-year time horizon of the project, it seems certain that extracted water (whether stored or native) will require some level of treatment. The staff and base case estimates, however, implicitly assume that any water treatment costs during this period will be small enough to be borne by Cadiz, Inc., as required under the approved Economic Terms and Responsibilities.

Over the 50-year time horizon of the project, it seems certain that extracted water (whether stored or native) will require some level of treatment.

This cost factor is potentially very large, and also applies to a storage-only project since stored water will commingle with native groundwater or may leach naturally occurring minerals from soil and rock. Currently proposed standards might require reverse osmosis treatment: with current costs in the range of $500-$600 per acre-foot. Even if treatment by RO were not required until 2017, the real cost of water from the Cadiz project would increase by $500 to $600 per acre-foot at that time.

Even though Cadiz is contractually required to pay for treatment of extracted water, a requirement for RO treatment — or any significant treatment requirement — would almost certainly bankrupt the Cadiz corporation, shifting water treatment costs to Metropolitan. Nonetheless, rather than arbitrarily selecting a mid-range or expected cost of treatment, we omit this cost factor in our mid-range cost estimate. Given the enormous uncertainty about future water treatment costs, we felt it was better to present a conservative mid-range economic analysis that does not quantify this cost factor. After all, less stringent chromium or arsenic standards than those currently proposed may be adopted, and less costly treatment techniques would then be feasible.

Whether this cost factor affects the Cadiz project more or less than other conjunctive use projects depends on the quality of native groundwater and the nature of geologic materials at other sites. It is certainly not true – as some Metropolitan staff have claimed — that all underground storage projects have the same financial exposure (risk profile) with respect to future water treatment costs.

8. Mitigation of Environmental Impacts

The staff and base case analyses assume that environmental impacts can be mitigated for $2 million, in total. This may be correct or incorrect. It is speculative at least until the Environmental Impact Report is completed. However, it is worth noting the potential environmental impacts that have been raised in comments and that could lead to significant mitigation costs. These include air quality impacts, impacts to the threatened desert tortoise, impacts on springs on which desert bighorn sheep depend, and water quality impacts from outward migration of brine from under Bristol and Cadiz Lakes. While estimates for the cost of most of these impacts cannot be made at present, it is useful to note that the cost of

mitigating airborne dust impacts from drying out of Owens Lake is currently estimated to be $60 million. Like the future cost of water treatment, the future cost of mitigation may be large.

Although reasonable estimates of mitigation costs cannot be made at this time, it is important to note that uncertainty in this cost factor affects the cost of the project asymmetrically: good news cannot reduce project costs significantly, but bad news can increase project costs significantly. Since environmental impacts and their mitigations are very project specific, there is again no reason to believe that this cost factor for the Cadiz project would apply equally to alternative conjunctive use projects.

Combinations of Cost Factors

Our analysis demonstrates that the project is probably economically undesirable unless it includes significant transfers of native groundwater.

The sum of the cost impact of each point identified above is not equal to their impact collectively. For example, less native groundwater increases the cost of the project, but reduces the cost increase caused by upward movement of the Fair Market Value for native groundwater. Our minimum mid-range cost estimate of about $850 per acre-foot accounts for these interactions.

In addition, estimates of the cost of the project over the range of native groundwater transfers – after combinations of cost factors are accounted for – differ significantly from the estimates prepared by Ernst & Young in January 2001. Ernst & Young (January 2001) analyzed the impact of more or less native groundwater using unrealistically low values for the cost of procuring water to be stored and the cost of electricity, and an unrealistically high value for the quantity of water to be stored. Once these three cost factors are adjusted to mid-range values, the cost of water from the Cadiz project becomes very high – over $1,000 per acre-foot – when native groundwater transfer is limited.

Table 1 and Figure 1 compare three estimates of the cost of water from the Cadiz project at six levels of native groundwater take varying from 0 acre-feet to 1,500,000 acre-feet. The Ernst & Young (January 2001) and Pacific Institute (PI) Base Case estimates are very similar, and give the impression the Cadiz project is competitive with the Arvin and Semitropic projects. The much more realistic Pacific Institute mid range estimate, however, shows in sharp contrast that the Cadiz project does not compare well with the Arvin or Semitropic projects unless a significant amount of native groundwater can be taken. For example, at 900,000 acre-feet of native groundwater transfer the Cadiz project ($840) is estimated to cost more than the Semitropic project ($797) and is much more expensive than the Arvin project ($491).

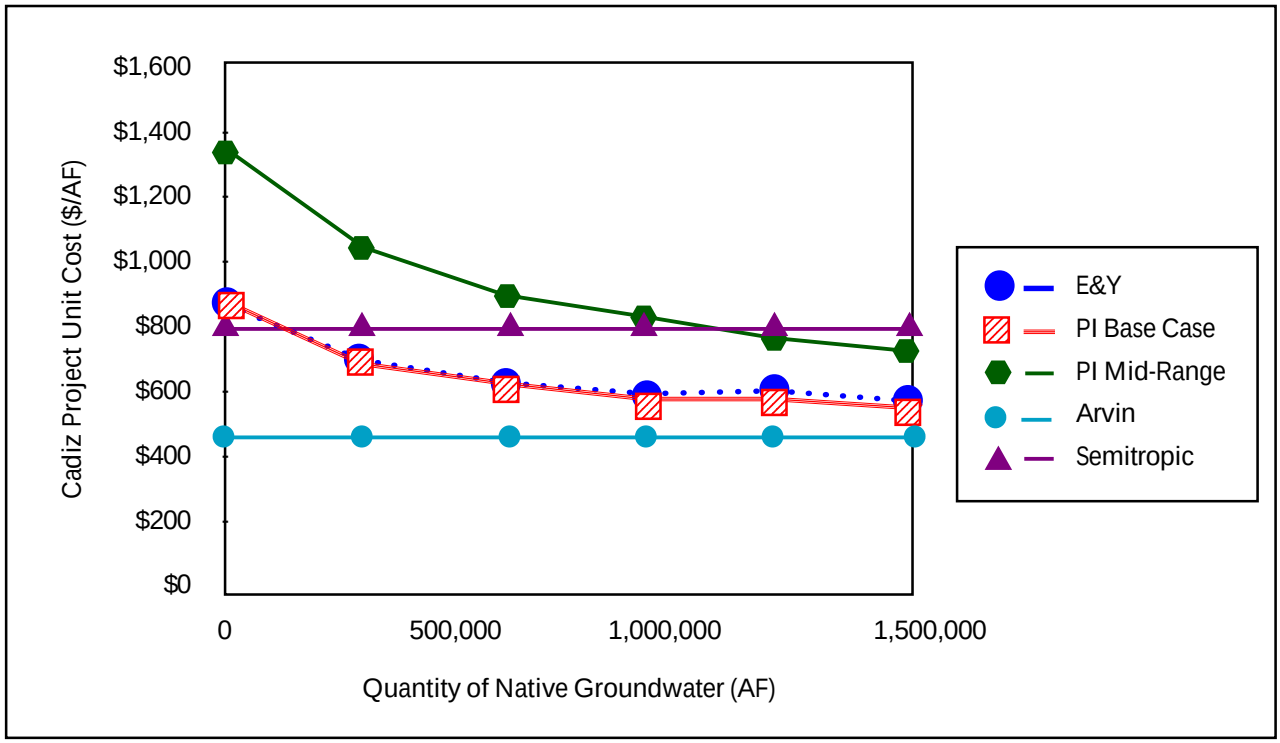
At 300,000 acre-feet of native groundwater, we estimate that water from the Cadiz project will cost more than $1,050 per acre-foot, *excluding* future water treatment costs and environmental mitigation costs. At 0 acre-feet of native groundwater — a direct storage-only comparison with the Arvin and Semitropic projects — we estimate that water from the Cadiz project will cost more than $1350 per acre-foot. Although Cadiz must turn over the

Table 1: Sensitivity of the Cadiz, Arvin-Edison, and Semitropic Project Cost Estimates to the Quantity of Native Groundwater Available at the Cadiz Site

	Cadiz Project Cost Estimates			Other Project Costs From E&Y (no native groundwater)	
GW Quantity (acre-feet)	E&Y ($/af)	PI Base Case ($/af)	PI Mid-Range ($/af)	Arvin ($/af)	Semitropic
0	$870	$820	$1,350	$491	$797
300,000	$715	$711	$1,055	$491	$797
600,000	$656	$653	$919	$491	$797
900,000	$625	$617	$840	$491	$797
1,200,000	$605	$593	$789	$491	$797
1,500,000	$588	$575	$754	$491	$797

Notes:
1. Ernst & Young (E&Y) estimates were interpolated from pages 6-8 and 6-9 of the Cadiz Groundwater Storage and Dry Year Supply Program, Agreed Upon Procedures (January 2001)
2. Pacific Institute (PI) Mid-Range Column is the mid-range estimate of $840/af adjusted to reflect the range of native groundwater that various parties claim will be available for export

Figure 1: Sensitivity to Quantity of Native Groundwater Transferred



6,000 acre-feet of native groundwater it is currently using if necessary to provide 300,000 acre-feet of transfer water to Metropolitan, the proposed contract also limits actual quantities of transfer water to those which are consistent with environmental protection. The operational issue raised previously suggests that it is possible, and likely if 6,000 acre-feet per year is the sustainable yield of the Fenner and Cadiz Basins, that less than 300,000 acre-feet of native groundwater will be available to Metropolitan for transfer.

Conclusions

There is a good reason to question the economics of the currently proposed contract with Cadiz Inc. absent a detailed, credible field assessment of the sustainable yield of native groundwater.

The absolute cost of the Cadiz project is likely to be much higher than the $588 per acre-foot estimate presented by Metropolitan staff because four unreasonably favorable assumptions are embedded in that estimate. (Items 3-6 in the list of cost factors, above.) A reasonable, minimum, mid-range estimate of cost that uses appropriate values for cost factors 3-6 is about $850 per acre-foot, or about 45% higher than the staff estimate.

Furthermore, at least five cost factors will not have an equal effect on the Cadiz project and alternative projects: cost of water to be stored, quantity of water that can be stored, energy cost, water treatment cost, and environmental mitigation costs. The relative attractiveness of the Cadiz project and alternative projects may change significantly if they are thoroughly compared and contrasted through the IRP process.

Finally, if 300,000 or less acre-feet of native groundwater are available for transfer, water from the Cadiz project is estimated to cost from $1,050 to $1,350 per acre-foot. This is at least 2.5 times Metropolitan's current average cost of water; at least 2.0 times the staff estimate of the cost of water from the Arvin project; and at least 1.25 times the staff estimate of the cost of water from the Semitropic project. There is good reason to question the economics of the currently proposed contract with Cadiz Inc. absent a detailed, credible field assessment of the sustainable yield of native groundwater, and analysis of Cadiz, Inc.'s capacity to pay for future water treatment. *Because the quantity of native groundwater transferred is to be determined by a groundwater monitoring program during implementation of the project, Metropolitan is being asked to invest at least $120 million in a project that could be found, at a later time, to be economically undesirable.*

Appendix A: Summary of Cost Estimating Assumptions

The base case assumptions were based on information in the Economic Terms and Responsibilities approved in April; the Environmental Planning Technical Report, Project Feasibility and Facilities Report (Black & Veatch, November 1999); the Cadiz Agreed Upon Procedures (Ernst & Young, January 2001); and staff reports or telephone conversations with Metropolitan staff. Key assumptions are listed below, with their relevant source:

Base Case Assumptions	Source
Put & Take pre-payments and payments	April Terms
Groundwater pre-payments and payments	April Terms
Capital and Equipment Replacement Costs	Black & Veatch
O&M Costs in Put, Take, and Idle Modes	Black & Veatch
Energy cost is 85-93% of O&M cost	Black & Veatch
Spot Market Energy cost of $0.045/ kwh (1999)	Black & Veatch
Discount Rate of 6%	Ernst & Young
Inflation Rate of 3%	Ernst & Young
Native groundwater transfer of 1,500,000 AF	Ernst & Young
Groundwater price of $230/ AF	April Terms
FMV adjustment of 3%	Ernst & Young
Storage capacity of 1,000,000 AF	Ernst & Young
Zero payment for water to be stored	staff
Mitigation costs of $2 million, included in capital cost	Black & Veatch
Extracted water treatment cost paid by Cadiz	April Terms

Mid-Range Estimate Changes From Base Case	Source
900,000 acre-feet of native groundwater	Average of reasonable range (0.3 to 1.5 million acre-feet)
$122 per acre-foot for water to be stored	Average of two Metropolitan sources; staff on the marginal operating cost of water from the State Water Project; and the avoided cost water conservation payment available to large customers.
Groundwater storage capacity of 750,000 acre-feet	Middle of Black &Veach Range (0.5 - 1.0 million AF).
Electricity at $0.09 per kwh	Retail rate before the current crisis, and consistent with 10 year or longer-term contracts signed by the Governor recently for electricity from new natural gas plants. Note that the March 2001 staff report shows spot market electricity for the CRA has increased 12-fold in the last year.

Appendix B: Economic Analysis Spreadsheet, Base Case

Cadiz Base Case Uniform Unit Cost Estimate ($/af): $575

Cost Estimating Inputs:

Met Cap + Loan Exp	$80,600,000	Water Treatment ($/af)	$0		
Electricity ($/kwh)	$0.045	Environ. Mitigation ($)	$0		
GW Price ($/af)	$230	Stored Water Procurement Cost	$0		
GW FMV Adjustment	3.00%	Native GW Take(af)	1,499,983	100	(% of 1.5 mill)
O&M Put@150,000af	$3,800,000	Cost of Funds	6.0%		
O&M Take@150,000af	$8,000,000	CPI for Put & Take Fees	3.0%		
O&M Idle (fixed)	$450,000	Equipment Replacement	$400,000		
Put Fee ($/af)	$50	Loss of Stored Water	10%		
Take Fee ($/af)	$40	Max GW Storage (af)	1,000,000	100	(% of 1 mill.)

Year	Discount Factor	Inflation Factor	Put (af)	Storage Take (af)	GW Take (af)	Total Take (Disc. af)	GW Payments ($)	Year	Capital & Eq. Replacement ($)	Put & Take Payments ($)	O&M Put Costs ($)	O&M Take Costs ($)	O&M Idle Costs ($)	Total Ann. (Nom. $)	Total Ann. (Disc. $)
2001	1.0000	1.0000	0	0	0	0	$0	2001	$80,600,000	$54,000,000	$0	$0	$0	$134,600,000	$134,600,000
2002	0.9434	1.0300	0	0	0	0	$0	2002		$0	$0	$0	$0	$0	$0
2003	0.8900	1.0609	131,132	0	0	0	$6,900,000	2003		$0	$3,524,321	$0	$0	$10,424,321	$9,277,609
2004	0.8396	1.0927	85,108	17,325	25948	34,878	$6,900,000	2004		$0	$2,355,995	$2,521,897	$0	$11,777,893	$9,888,946
2005	0.7921	1.1255	84,663	753	5735	5,079	$6,900,000	2005		$0	$2,413,987	$389,456	$0	$9,703,443	$7,686,036
2006	0.7473	1.1593	84,215	22,948	26416	35,173	$6,900,000	2006		$0	$2,473,249	$3,052,075	$0	$12,425,324	$9,284,925
2007	0.7050	1.1941	78,318	7,792	31247	26,972	$6,900,000	2007		$3,223,941	$2,369,067	$2,486,112	$0	$14,979,120	$10,559,689
2008	0.6651	1.2299	79,381	7,740	30156	24,688	$15,274,841	2008		$3,320,659	$2,473,258	$2,485,723	$0	$23,554,481	$15,665,075
2009	0.6274	1.2668	55,588	21,065	46351	40,976	$15,733,086	2009		$3,420,279	$1,783,903	$4,554,697	$0	$25,491,965	$15,993,974
2010	0.5919	1.3048	42,384	11,312	36844	27,834	$16,205,079	2010		$3,522,888	$1,400,972	$3,351,075	$0	$24,480,013	$14,489,682
2011	0.5584	1.3439	33,911	23,649	49883	39,739	$16,691,231	2011		$3,628,574	$1,154,530	$5,270,446	$0	$26,744,781	$14,934,146
2012	0.5268	1.3842	32,034	12,052	40156	26,868	$17,191,968	2012		$3,737,431	$1,123,345	$3,854,298	$0	$25,907,042	$13,647,506
2013	0.4970	1.4258	33,518	21,195	52078	35,361	$17,707,727	2013		$3,849,554	$1,210,646	$5,571,721	$0	$28,339,649	$14,083,937
2014	0.4688	1.4685	23,359	13,610	41325	25,118	$18,238,959	2014		$3,965,041	$869,021	$4,302,608	$0	$27,375,630	$12,834,763
2015	0.4423	1.5126	21,654	30,961	57883	37,926	$18,786,128	2015		$4,083,992	$829,758	$7,167,174	$0	$30,867,053	$13,652,527
2016	0.4173	1.5580	18,824	16,922	46835	25,897	$19,349,712	2016		$4,206,512	$742,955	$5,297,671	$0	$29,596,850	$12,349,731
2017	0.3936	1.6047	5,988	74,269	99558	65,503	$19,930,203	2017		$0	$243,428	$14,876,870	$0	$35,050,500	$13,797,499
2018	0.3714	1.6528	3,980	23,377	46610	25,123	$20,528,109	2018		$0	$166,651	$6,169,485	$0	$26,864,245	$9,976,425
2019	0.3503	1.7024	3,624	69,234	82026	50,567	$21,143,952	2019		$0	$156,297	$13,733,868	$0	$35,034,117	$12,273,985
2020	0.3305	1.7535	2,897	26,208	40364	21,137	$21,778,271	2020		$0	$128,691	$6,225,835	$0	$28,132,797	$9,298,255
2021	0.3118	1.8061	2,196	61,545	73364	40,146	$22,431,619	2021		$0	$100,478	$12,995,235	$0	$35,527,332	$11,077,590
2022	0.2942	1.8603	1,385	27,273	47657	21,239	$23,104,568	2022	$744,118	$0	$65,272	$7,434,233	$0	$31,348,190	$9,221,240
2023	0.2775	1.9161	730	50,988	68605	31,773	$23,797,705	2023		$0	$35,435	$12,221,470	$0	$36,054,609	$10,005,338
2024	0.2618	1.9736	197	29,057	53174	20,767	$24,511,636	2024		$0	$9,850	$8,655,466	$0	$33,176,952	$8,685,635
2025	0.2470	2.0328	0	44,540	72423	27,787	$25,246,985	2025		$0	$0	$12,680,624	$0	$37,927,609	$9,367,306
2026	0.2330	2.0938	0	23,677	46096	15,705	$26,004,394	2026		$0	$0	$7,791,422	$0	$33,795,817	$7,874,379
2027	0.2198	2.1566	0	37,233	62654	21,138	$26,784,526	2027	$0	$0	$0	$11,488,823	$0	$38,273,349	$8,412,866
2028	0.2074	2.2213	1,948	14,643	50488	13,202	$27,588,062	2028		$0	$109,619	$7,715,988	$0	$35,413,669	$7,343,660
2029	0.1956	2.2879	0	22,862	53253	14,443	$28,415,704	2029		$0	$0	$9,287,766	$0	$37,703,470	$7,375,935
2030	0.1846	2.3566	0	10,892	49256	10,900	$29,268,175	2030		$0	$0	$7,559,611	$0	$36,827,786	$6,796,816
2031	0.1741	2.4273	0	8,769	40105	8,357	$30,146,220	2031		$0	$0	$6,326,935	$0	$36,473,155	$6,350,346
2032	0.1643	2.5001	0	7,140	34372	6,701	$31,050,607	2032		$0	$0	$5,535,111	$0	$36,585,718	$6,009,381
2033	0.1550	2.5751	0	4,402	22840	4,153	$0	2033		$0	$0	$3,741,355	$0	$3,741,355	$579,751
2034	0.1462	2.6523	0	896	21429	3,251	$0	2034		$0	$0	$3,158,047	$0	$3,158,047	$461,663
2035	0.1379	2.7319	0	0	21429	2,955	$0	2035		$0	$0	$3,122,240	$0	$3,122,240	$430,593
2036	0.1301	2.8139	0	0	16225	2,111	$0	2036		$0	$0	$2,434,929	$0	$2,434,929	$316,797
2037	0.1227	2.8983	0	0	3951	485	$0	2037		$0	$0	$610,725	$0	$610,725	$74,961
2038	0.1158	2.9852	0	0	1948	226	$0	2038		$0	$0	$310,145	$0	$310,145	$35,913
2039	0.1092	3.0748	0	0	1299	142	$0	2039		$0	$0	$213,021	$0	$213,021	$23,270
2040	0.1031	3.1670	0	0	0	0	$0	2040		$0	$0	$0	$1,425,162	$1,425,162	$146,871
2041	0.0972	3.2620	0	0	0	0	$0	2041		$0	$0	$0	$1,467,917	$1,467,917	$142,714
2042	0.0917	3.3599	0	0	0	0	$0	2042	$1,343,960	$0	$0	$0	$1,511,955	$2,855,914	$261,942
2043	0.0865	3.4607	0	0	0	0	$0	2043		$0	$0	$0	$1,557,313	$1,557,313	$134,750
2044	0.0816	3.5645	0	0	0	0	$0	2044		$0	$0	$0	$1,604,033	$1,604,033	$130,937
2045	0.0770	3.6715	0	0	0	0	$0	2045		$0	$0	$0	$1,652,154	$1,652,154	$127,231
2046	0.0727	3.7816	0	0	0	0	$0	2046		$0	$0	$0	$1,701,718	$1,701,718	$123,630
2047	0.0685	3.8950	0	0	0	0	$0	2047		$0	$0	$0	$1,752,770	$1,752,770	$120,131
2048	0.0647	4.0119	0	0	0	0	$0	2048		$0	$0	$0	$1,805,353	$1,805,353	$116,731
2049	0.0610	4.1323	0	0	0	0	$0	2049		$0	$0	$0	$1,859,513	$1,859,513	$113,427
2050	0.0575	4.2562	0	0	0	0	$0	2050		$0	$0	$0	$1,915,299	$1,915,299	$110,217
2051	0.0543	4.3839	0	0	0	0	$0	2051		$0	$0	$0	$1,972,758	$1,972,758	$107,098
2052	0.0512	4.5154	0	0	0	0	$0	2052	-$451,542	$0	$0	$0	$2,031,940	$1,580,398	$80,941

Sum of Takes, w/Losses, Discounted			794,320	Sum of Discounted Expenditures	$456,454,771
Sum of Puts, 0 Loss	827,034				
Sum of Takes, w/Losses, Nominal		744,329	1,499,983	2,244,312	