August 13, 2017

To: Fiona Sanchez, Irvine Ranch Water District

From: Richard McCann, Partner

RE: Estimate of Benefits from the Kern Fan Groundwater Storage Project

Introduction

This technical memo outlines the data and methodological approach for calculating the economic benefits of Irvine Ranch Water District’s (IRWD) and Rosedale Rio Bravo Water Storage District’s (Rosedale) proposed Kern Fan Groundwater Storage Project in support of a grant application for the Water Storage Investment Program (WSIP).

Overview

The Kern Fan Integrated Groundwater Storage Project (Project) will provide ecosystem and water quality benefits for the Delta and its tributaries by recharging and storing up to 100,000 acre-feet (AF) of unallocated State Water Project (SWP) Article 21 water in the Kern County groundwater basin for subsequent extraction and recovery to offset SWP Table A demands during periods of need. Deliveries of unallocated Article 21 water would be made on behalf of Irvine Ranch Water District (IRWD) as a landowner in Dudley Ridge Water District (DRWD) and Rosedale as a sub-unit of the Kern County Water Agency. During droughts or times of need when available supplies are reduced, stored groundwater will be recovered from the Project via 12 new extraction wells and conveyed to points of use in DRWD, IRWD and Rosedale’s service areas. Approximately 25 percent of the stored water would be held as SWP system water that would be used for ecosystem benefit purposes. This 25 percent of the water would be made available for ecosystem benefits through operational exchanges which would be facilitated through a Coordinated Operating Agreement that would executed between the project partners and DWR. The project will provide several public and non-public benefits, including water supply, groundwater improvement, environmental benefits, and emergency response benefits. Based on guidelines provided in the California Water Commission’s WSIP Technical Reference and project information provided by IRWD, Cramer Fish Sciences and MBK Engineers, M.Cubed completed estimates of the economic benefits in these four benefit categories. Estimates of the net present value (NPV) of total benefits in 2015 dollars are outlined in Table 1.

Table 1. Summary of Benefit Estimates

<table>
<thead>
<tr>
<th>Category</th>
<th>Type of Benefit</th>
<th>NPV of Benefits (2015$ millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-public Benefits</td>
<td>Water Supply Benefits</td>
<td>$47.7</td>
</tr>
<tr>
<td></td>
<td>Groundwater</td>
<td>$4.3</td>
</tr>
<tr>
<td>Public Benefits</td>
<td>Environmental Benefits—Salmon recovery</td>
<td>$21.0</td>
</tr>
</tbody>
</table>
Environmental Benefits—Incidental Wetland Habitat $39.8
Emergency Response—Extended drought $5.1
Emergency Response—Delta failure $59.9
Total Benefits $177.8

Project benefits are expected to begin in 2026, and continue throughout the 50-year life of the project, through 2075. We calculate net present value at the project start in 2026. The net present value calculation uses a discount rate of 3.5%, as directed in the WSIP Technical Reference.

Benefits

Non-Public Benefits--Water Supply

Water Supply benefits are non-public benefits that will accrue to IRWD, Rosedale, and Dudley Ridge, and their service area customers. According to modeling by MBK Engineers, the project will provide an annual expected value of 4,500 acre-feet of additional water supply in the 2030 future condition, and 4,100 acre-feet in the 2070 future condition. IRWD and Rosedale estimate that approximately two-thirds of all storage will be used for non-emergency water supply, and will be called on in below normal, dry, and critical water years. Three-quarters of the total water supply will be available to Rosedale and Dudley Ridge, and the remaining one-quarter will be available to IRWD.

We use the alternative cost approach to estimate the water supply benefits of the project. The water supply benefit is divided between agricultural (75%) and urban users (25%), which face different alternative costs of water. We use the Delta Export unit value provided in the Technical Reference as the value of an alternative water supply for Rosedale and Dudley Ridge. Delta export values are provided for 2030 and 2045, which we re-weight according to the water year types during which IRWD and Rosedale are expected to recover stored groundwater according to MBK Engineers. These weights are available for 2030 and 2070. We therefore use water cost anchor points of 2030, 2045, and 2070—2030 unit values weighted at 2030 recovery levels, 2045 unit values weighted at 2030 recovery levels and 2045 unit values weighted at 2070 recovery levels. We interpolate between these points to find unit values for 2026 to 2075, according to the methodology laid out in the Technical Reference. For IRWD, the alternative supply cost is the Tier 1 untreated rate from Metropolitan Water District, which was $676 per AF in 2015. To be conservative, we use the 2015 rate as the 2030 future condition and inflate the rate according to the escalation of Delta Export values from 2026 to 2070. Applying the 3.5% discount rate to the stream of alternative water supply costs, we arrive at the total net present value of water supply benefits of $47.7 million.

Non-Public Benefits--Groundwater

To evaluate the groundwater benefit, we use the alternative cost approach to estimate how much it would cost to purchase the same volume of water for groundwater recharge in Kern County as that provided by the project.

According to groundwater policy in Kern County, a portion of banked groundwater is not recovered by the banking entity, but remains in the ground and bolsters local groundwater levels. In Kern County, 12.5% of groundwater stored is not recovered, and 60% of that amount is estimated to be recharge, net of evaporative losses. For the purpose of recharging groundwater, we consider the alternative cost to be the Delta Export costs provided in the WSIP Technical Guidance. We weight those costs according to water year type frequency according to the San Joaquin River Water Year Index to arrive at 2030 and 2070 future condition values. Interpolating between these points, we find a net present value of $4.3 million at the project start, in 2015 dollars.
Public Benefits—Environmental—Salmon Recovery

We use the benefit value for two runs of Chinook Salmon provided in the WSIP Technical Guidance to calculate the environmental benefit of salmon recovery based on a willingness-to-pay valuation.

The project will create increased environmental flows in dry and critical years by offsetting State Water Project Table A water demands and making that water available for instream flows from Lake Oroville, along the Feather and Sacramento Rivers, and in the Delta estuary. Based on water modelling carried out by MBK Engineers, Cramer Fish Sciences recommended pulse flows on the Feather River to maximize benefits to Winter and Spring run Chinook Salmon. Cramer Fish Sciences modelled the number of fish that would be restored in the 2030 and 2070 future conditions. To avoid double counting of benefits, we adjusted these number downward by one-sixth to account for MBK Engineer’s finding that using 20,000 acre-feet of water in response to a Delta Emergency in year 30 of the project life would reduce water available for environmental flows from 6 pulses to 5 pulses over the life of the project. We calculate the annual expected number of additional Chinook for 2030 and 2070, and interpolate between the two points, and extrapolate backwards to 2026. The WSIP Technical reference recommends a benefit of $100,000 per fish per year for Winter and Spring-run Chinook. We apply this value to the stream of future additional Chinook to calculate a net present value of $23.1 million.

We also used the alternative cost approach to calculate the environmental benefit of Salmon recovery. This approach is based on the cost of procuring a similar volume of water in dry and critical years for environmental flows. In order to provide similar environmental flows in the absence of the project, IRWD and Rosedale would need to purchase replacement water for urban and agricultural use, respectively, to exchange for SWP Table A water that would not be stored and available without the project. For this purpose, Metropolitan’s Tier 1 rate is the reasonable alternative cost of urban water. We hold IRWD’s current Tier 1 rate of $676 per acre-foot constant through 2030 then inflate the rate using the change in Delta export costs. For agricultural water, the reasonable alternative is Delta deliveries. We use the Delta export unit values from the Technical Reference, weighted for the hydrologic year types (dry and critical) when environmental pulses are expected to take place. Using the alternative cost approach, we find a benefit of $21.0 million.

According to the Technical Guidance, the lesser value from the willingness-to-pay approach and the alternative cost approach should be used as the final benefit calculation. In this case, the two estimates are very close, which lends some confidence to the estimate. We use the lesser benefit estimate of $21.0 million from the alternative cost approach as the final benefit number.

Public Benefits—Environmental—Incidental Wetland Habitat

The water storage project will provide incidental wetland habitat for migratory birds during the years that IRWD takes and stores Article 21 water. During those years, the 1,280 acres that comprise the project will be inundated with water to percolate into the groundwater basin. The ponds will provide temporary habitat to migratory bird species along the Pacific Flyway.

To estimate the benefits associated with this habitat, we used the alternative cost approach. Providing similar habitat in Kern County would require purchasing 1,280 acres of land, building the infrastructure to inundate the property, and providing the same volume of water to flood the fields. To estimate the land value we use the actual price of land that has been provided by assessors to IRWD for the project--$24,000 per acre. This is a current estimate, so we deflate that price to 2015 dollars using a Consumer Price Index for California from the California Department of Finance, to get a land value of $22,771 in 2015 dollars. This is in line with agricultural land values published in the American Society of Farm Managers and Rural Appraisers’ Trends in Agricultural Land and Lease Values,1 which vary from $22,000 to $26,000 for

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cropland in northeast and central Kern County in 2016. To be conservative and avoid the risk of double counting benefits, we do not include the cost of the infrastructure to bring water from SWP turnouts to the project site. The alternative source of water for providing temporary wetland habitat in the area is Delta export water. Since the project would only take Article 21 water in wet years, we use the Delta Export unit value for wet years provided in the WSIP Technical Guidance, which ranges from $204 in 2030 to $414 in 2045. We interpolate between these values and leave prices beyond 2045 at $414 to be conservative. Taking the net present value of this stream of benefits results in a total benefit of $39.8 million at the project start.

Public Benefits—Emergency Response—Extended Drought

A major benefit of the project is that it provides water to IRWD, Rosedale, and Dudley Ridge in the event of extreme drought, when other water resources are at their most expensive. Groundwater stored as part of the project will be available to call on during a drought emergency or as an alternative supply in the case of a local supply outage. The WSIP technical Guidance outlines that emergency response benefits should be monetized using avoided costs or alternative costs. Here we use the alternative cost approach. According to the Technical Guidance an emergency is defined as a critical year that occurs in the 3rd or later year of consecutive drought.

One-third of the water supply created by the project will be dedicated to emergency response. Using the 4,500 acre-feet per year of expected water in the 2030 future condition and the 4,100 acre-feet per year of expected water in the 2070 future condition, we calculate the water supply expected to be dedicated to emergency response in 2030 and 2070. Interpolating between these two points and extrapolating to the beginning of the project in 2026, we arrive at the volume of water supply available for emergency response in each year of the project life. Alternative costs are based on the lowest cost alternative agricultural water for Rosedale and Dudley Ridge, and urban water for IRWD. According to Rosedale, $800 was a typical price for an acre-foot of water during the recent multi-year drought. Prices for agricultural water have reached as high as $2,000 in the Central Valley in the recent drought, however, to be conservative, we use the $800 value provided by Rosedale. For the urban supply, the alternative source is imported water from Metropolitan Water District. However, in addition to the normal Tier 1 rate of $676 per acre-foot, IRWD would have to pay a $1,480 per acre-foot penalty for exceeding their allocation in an emergency scenario, bringing the total cost to $2,156 per acre-foot. To be conservative we apply this 2015 rate to emergency water supplies for years from the start of the project through 2030. After 2030, we inflate the water supply according to the Delta Export Unit Values provided in the technical guidance. Applying the agricultural emergency rate to the 75% of the emergency water supply available to Rosedale and Dudley Ridge and the urban emergency rate to the 25% of the emergency water supply available to IRWD, we arrive at annual emergency supply alternative costs. However, according to historical hydrologic year data provided by MBK Engineering, a critical year in the 3rd year or later of a multi-year drought has only occurred in 6 of the 81 years on record-- a 7% probability of occurrence. We apply this probability to the entire stream of alternative costs and take the net present value at the project start to arrive at a benefit of $5.0 million.

Public Benefits—Emergency Response—Delta Failure

A separate emergency response benefit of the project is the water supply it can provide in the event of a levee failure in the Delta that curtails water project deliveries. We analyze this benefit using an alternative cost approach.

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The WSIP Technical Guidance explains that an emergency response to Delta Failure should be assumed to occur once, 30 years into the project operation period—2056 for this project. In the event of interrupted flows through the Delta, IRWD’s alternative supply will be water purchases from Metropolitan Water District. We also assume that the alternative cost of water to agricultural users in Rosedale and Dudley Ridge would be the urban rate because agricultural users would need to outbid urban suppliers for available agricultural water. We therefore use Metropolitan’s Tier 1 rate of $676 per acre-foot in addition to a $2,960 penalty for water use over 115% of IRWD’s allocation. To be conservative, we use current water costs in the year 2030 and inflate those costs in step with the unit values provided in the technical guidance, assuming that costs will increase by a factor of 2.3 on average from 2030 to 2045. Costs are held constant after 2045. According to analysis carried out by MBK Engineers, according to historical hydrology, the project is likely to have 20,000 acre-feet of water available for emergency response after 30 years of operation. Multiplying the 20,000 acre-feet by the urban emergency water rate in 2056, we arrive at a total benefit estimate. The net present value of this benefit in 2026 is $59.9 million.

MBK Engineering also explored how using the 20,000 acre-feet of water 30 years into the project life would affect other project benefits. They found that the only impact is that environmental pulse flows north of the Delta would be reduced from 6 pulses over the life of the project, to 5. To avoid double counting of benefits, we adjusted the environmental benefit to account for this change.