Bay-Delta Resources

- **Bay-Delta and Conveyance: Managing Risks and Water Supply Reliability**

Summary

This report provides an overview of the Bay-Delta system, risks to water supply, and potential risk management actions, such as the Delta Conveyance Project, that would improve the water supply reliability of the State Water Project and Metropolitan.

Purpose

Informational

Attachments

Attachment 1: GM Memo dated January 18, 2024

Attachment 2: GM Memo dated March 20, 2024

Attachment 3: GM Memo dated May 16, 2024

Attachment 4: Responses to Director requests for information

Detailed Report

Background

As described in a presentation to the One Water and Stewardship Committee in September 2024, the State Water Project, which is owned by the state of California and operated by its Department of Water Resources (DWR), provides a critical water supply to the Southern California region by providing approximately 30 percent of Metropolitan's imported supplies on a long-term average. The State Water Project infrastructure spans over 705 miles throughout the state, originating in the Northern Sierras with termini in the Bay Area, central coast and southern California. The State Water Project, with its existing storage and conveyance facilities, currently delivers low salinity water to approximately 27 million Californians, of which 19 million are within Metropolitan's service area. Given the size and importance of the State Water Project to the state, and Metropolitan's service area, staff is providing monthly updates to the Metropolitan Board from September 2024 through December 2024. These updates include:

- September 2024: State Water Project overview
- October 2024: Importance of the Bay-Delta, the State Water Project, and the potential value of adding a 45-mile conveyance facility to the State Water Project, known as the Delta Conveyance Project
- November 2024: Information Board Letter regarding continued funding to plan, permit, and advance design of the Delta Conveyance Project
- December 2024: Action Board Letter regarding continued funding to plan, permit, and advance design of the Delta Conveyance Project.

Collectively, these updates are intended to provide the Board with information to assist it in its decision-making process regarding funding for continued pre-construction planning and design of the Delta Conveyance Project. In 2024, the Board will only be asked to consider an investment to support the contiuation of the project's planning and design phases. The Board would not make a final decision regarding participation in the implementation of the Delta Conveyance Project until 2027.

Importance of the Delta, Specific Risks to the State Water Project

The Sacramento-San Joaquin Delta (Delta) is the hub of California's water distribution system. Two-thirds of California's water originates in the Sierra Nevada mountains, eventually flowing through the Delta. Deliveries from the State Water Project support more than 27 million people and about 750,000 acres of farmland. The water conveyance system, both natural and man-made, is critical to the health of local communities and the success of California's economy.

The Delta is formed by the confluence of the Sacramento and San Joaquin Rivers. In the Delta, freshwater from the rivers mingles with saltwater from the San Francisco Bay and Pacific Ocean's tides, forming the largest estuary on the west coast of North America. The Delta and Suisun Marsh contain more than 1,100 miles of levees and 140 leveed islands and tracts.

Many factors affect the Delta and its ability to support the variety of water users that depend on it. Seismic risk in the Delta threatens the levee system that protects Delta communities, the ecosystem, recreation, and through-Delta water supply conveyance. The United States Geologic Survey[1] has determined there is a 72 percent chance of an earthquake of magnitude 6.7 or greater in the Bay-Delta area at some point in the next 20 years. A major seismic event in the Delta could lead to levee collapse, resulting in the intrusion of salt water into the central and south Delta and impairment of water supplies. DWR, Metropolitan, and other Delta water users have continued to make investments in emergency preparedness – including levee improvements and modernization, material stockipiles, and continued maintenance of the freshwater pathway.

In addition, ongoing changes to regulations and permits issued under the Federal and California Endangered Species Acts, the Federal Clean Water Act, and the Porter Cologne Water Quality Control Act continue to degrade the water supply reliability of the State Water Project and Central Valley Project. DWR has determined that the reliability of the State Water Project has declined 21 percent over the last two decades,[2] largely as a result of increased regulation. Metropoltian continues to invest in the best available science both directly and indirectly through the State Water Contractors. Recent changes to the Fall X2 requirement that have the potential to improve water supply conditions for Metropolitan are based, in part, on scientific research that Metropolitan staff have been integral in advancing.

Furthermore, the effects of climate change such as less snow, more rain, more frequent and intense droughts with wetter wet years, sea level rise, and increasing water temperatures, threaten the Delta ecosystem and its ability to meet the water needs of California's agricultural and urban communities, both within and south of the Delta. Changes to precipitation and runoff patterns as a result of climate change have been occurring and are expected to intensify over the coming decades. Recent hydrologic modeling performed by the Department of Water Resources forecasts additional runoff in the winter as a result of more intense storms and less runoff in the spring due to a reduced snowpack. To meet the challenges of climate change, Metropolitan continues to evaluate new groundwater storage, in-service-area conveyance improvements, surface storage opportunities and the Delta Conveyance Project.

Delta Conveyance Project

Since 2019, DWR has led the planning efforts for the Delta Conveyance Project to improve the reliability of the State Water Project given historical and future risks. The Delta Conveyance Project includes the construction of two new intakes on the Sacramento River in the north Delta, an underground tunnel, forty-five (45) miles in length and thirty-six (36) feet in diameter, and a pumping plant to lift water from the terminus of the pipeline into

[1] United States Geological Survey. Earthquake Outlook for the San Francisco Bay Region.
[2] California Department of Water Resources. Delivery Capability Report 2023.

the Bethany Reservoir at the beginning of the California Aqueduct. The Delta Conveyance Project would modernize the State Water Project, improve water supply reliability, and mitigate much of the seismic and climatic risks.

How it works

The Delta Conveyance Project will operate in conjunction with the existing State Water Project facilities. The Delta Conveyance Project allows for dual conveyance, through existing south Delta facilities and through two new north Delta screened intakes and associated facilities. Moving water through the south Delta export facilities would be prioritized before utilizing the northern intakes. The modeling performed for the Environmental Impact Report (EIR) shows that: (1) approximately 20 percent of State Water Project diversions will occur at the north Delta intakes while 80 percent will be diverted through the existing southern facility, and (2) the additional diversions at the north Delta intakes can occur during wet conditions while still protecting fisheries, water quality and other beneficial uses of water in the Delta. The Delta Conveyance Project would augment the State Water Project's ability to capture flows when they are available and improve the flexibility of the State Water Project.

Benefits

The Delta Conveyance Project could afford the State Water Project a wide range of benefits, including, but not limited to:

- Operational flexibility that results in water supply reliability improvement. The performance of the State Water Project was modeled with and without the Delta Conveyance Project under multiple future climate scenarios, and results tabulated in the 2024 Benefit Cost Analysis of the DCP. [3] On average, the modeling results showed that the Delta Conveyance Project would increase State Water Project exports by approximately 400 thousand acre feet (TAF) per year.
- Water quality improvement of direct deliveries. Salinity levels at the northern intake are significantly lower than the salinity levels at the existing southern facility, and would assist Metropolitan in meeting its water quality goals.
- Seismic reliability improvements. Exports through the Delta are at risk if the levees fail during a seismic event. The new intakes and tunnel will be designed to withstand significant seismic events such that the Delta Conveyance Project would be able to provide water even if there were massive levee failures in the Delta.

Water year 2024 has been classified as an above normal year, but despite abundant water supply, south Delta exports were highly constrained due to fishery concerns at the south Delta export facility. Consequently, the State share of San Luis Reservoir has been unable to fill and hovering at approximately half capacity throughout the current water year due to these constrained exports. If the Delta Conveyance Project had been online in water year 2024, an additional 941 TAF could have been diverted[4] through the northern Delta intakes during high flow events, improving water supply while minimizing impacts to fish in the south and central Delta, and DWR's portion of San Luis Reservoir would have been filled as early as March.

Costs

On May 17, 2024, the Delta Conveyance Design and Construction Authority (DCA) released an updated cost estimate for the Delta Conveyance Project. The DCA estimated the cost to be $20.1 billion in 2023 (undiscounted) dollars. The potential fiscal impact to Metropolitan and a unit cost comparison of other projects being evaluated by Metropolitan will be discussed in the November 2024 update.

Challenges

DWR is currently addressing permitting and numerous challenges to the Delta Conveyance Project, including but not limited to:

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[3] California Department of Water Resources. Benefit Cost Analysis of the Delta Conveyance Project.
[4] California Department of Water Resources. Theoretical DCP Diversions 2024.

- State Water Resources Control Board Water Rights Process
- Delta Plan Consistency Certification
- Litigation (i.e., Bond Validation and ten cases challenging DWR's Final EIR, project approval and pre-construction geotechnical testing under the California Environmental Quality Act, Delta Reform Act and other environmental laws.)

Lastly, the Delta Conveyance Project by itself would not completely mitigate the risks to the State Water Project. Investments in through-Delta conveyance and other water supplies such as Metropolitan's Pure Water Southern California program, Sites Reservior project, additional storage and demand management programs will continue to be evaluated regardless of the Board's ultimate decision on participation in the Delta Conveyance Project.

Metropolitan Board Actions and Information Updates Related to the Delta Conveyance Project

In December 2020, the Metropolitan Board of Directors authorized execution of a Funding Agreement with DWR through which Metropolitan committed to its 47.2 percent share of the Delta Conveyance Project planning and pre-construction costs. This percentage share equated to $160.8 million to support planning and pre-construction of the project. With funds provided by Metropolitan and other State Water Project contractors, DWR completed the Final EIR, approved the Delta Conveyance Project, submitted permit applications under the Clean Water Act and federal and state Endangered Species Acts, submitted a water rights change petition to the State Water Resources Control Board, completed preliminary design, and prepared a cost estimate update and benefit-cost analysis. Funds committed in 2020 will cover expenditures planned through calendar year 2025.

However, post 2025, DWR must complete additional planning, pre-construction activities and design, and is requesting additional funding for calendar years 2026 and 2027. The additional funding will allow DWR to finalize key pre-construction efforts, such as the water rights hearing, Delta Plan consistency certification, geotechnical investigations, and advancement of preliminary design. The outcome and information from these key pre-construction activities will be used to update the cost estimate and project benefits and costs prior to the Board's decision regarding participation in the Delta Conveyance Project in 2027.

By securing the last tranche of planning funding from potential project participants in 2024, DWR aims to complete the necessary permitting, preliminary design and engineering work ahead of potential participants making final decisions. Providing DWR with the funding to complete key remaining work will avoid schedule delays, cost increases due to escalation, and maintains continuity of key staff. The DCA has estimated that each year of delay is the equivalent of increasing costs on the order of $500 million per year.

Since the funding action taken in December 2020, Metropolitan's Board has received a total of 17 oral committee updates on the Delta Conveyance Project, with the most recent in June 2024. There have been several requests from directors for additional information. Attached are the memorandums that have been provided to the Board in response to those requests.

<u>Funding Request</u>

DWR has indicated that approximately $300 million of additional investment is needed from potential project participants to fund preconstruction work planned through 2027. Assuming up to 47.2-percent share for Metropolitan, the forecasted funding agreement amendment between Metropolitan and DWR would be up to $141.6 million for calendar years 2026 and 2027.

If the Delta Conveyance Project moves forward and bonds are issued to finance implementation, the pay-go planning costs for each participant would be reimbursed. A board action in 2024 to fund the continuation of planning and design for 2026 and 2027 does not commit Metropolitan to participate in the Delta Conveyance Project. The Board retains the authority for future consideration of Metropolitan's ultimate support and participation, which is not anticipated until 2027.

THE METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

Date: January 18, 2024

To: Board of Directors

From: Adel Hagekhalil, General Manager

Subject: GM Tech Memo to Board – 2070 requested analysis

At the January 8, 2024, One Water & Stewardship meeting, a request was made to provide a DWR technical memo related to item 6a Update on Delta Conveyance Project.

The DWR Technical Memorandum: ***CalSim 3 Results for 2070 Climate Change and Sea Level Projections and Sensitivity Analysis*** can be accessed here:

https://www.deltaconveyanceproject.com/delta-conveyance-project-can-help-protect-water-supply-reliability-looking-decades-ahead

If you have any questions, please contact Nina Hawk at (916) 650-2660 or nhawk@mwdh2o.com.

Information Provided by Clicking the Link Above

California’s water delivery infrastructure needs modernization. The system was built in the 20th century based on the certainty that snow would fall in the winter, be stored in the mountains as snowpack, then melt in the spring into our rivers and reservoirs. While rain and snow amounts may have been erratic in decades past, that pattern of precipitation was fairly reliable.

Those patterns are no longer happening. With climate change, we are seeing a new weather pattern with more precipitation falling as rain and less as snow, and more water flowing through the rivers in the winter months. Because this water is not available to be captured in the spring, water managers must find a way to catch it in the winter for use later in the year or risk losing it altogether.

This is what the Delta Conveyance Project will do: capture and move the water when it is available.

An important question for decision-makers is how effective this modernized infrastructure will be in improving reliability of the State Water Project many decades in the future.

That is why we are using modeling to better understand and plan for the future.

While future changes to other water infrastructure, land use or the regulatory environment are likely as a response to the changing climate, the specifics of these potential changes are unknown. Available models do not predict the future, but they can help us to understand, visualize or simulate what may happen, and can be helpful to compare scenarios.

The 2070 modeling done for the Delta Conveyance Project looks at seven possible future “no project” scenarios (if the DCP were not implemented) that examine potential climate change, sea level rise, and responses to those changes (such as land use or regulatory changes) — all based on the best available science from the most trusted sources. It then compares the scenarios to provide a range of possible no project outcomes to help decision-makers with planning decades ahead.

A single climate scenario (known as the “2070 Median”) was crafted to use in the scenario comparisons, based on 64 projections of climate change from available General Circulation Model (GCM) output. GCMs are the most advanced tools available for simulating changes to the climate at global scale based on increasing greenhouse gas. These models represent processes in the atmosphere, ocean, and land surface.

Seven possible no project scenarios for 2070 conditions were developed that collectively include climate change (2070 Median scenario), 1.8 feet and 3.5 feet of sea level rise, land fallowing/demand reduction, reduced exports, and emergency drought actions.

The modeling shows that State Water Project Delta exports are severely impacted under all seven of the scenarios for no project 2070 conditions with a possible reduction in annual average SWP exports of 0.43 to 0.68 million acre-feet (MAF) compared to existing conditions. When the Delta

Conveyance Project is added to the seven no project scenarios, the SWP exports are expected to be restored, by negating some or all of this reduction. The modeling shows that the range of changes in annual average SWP exports would be a reduction of 0.24 MAF or an increase of 0.02 MAF with the Delta Conveyance Project under 2070 Conditions compared to the existing conditions.

While modeling does not and cannot behave as a crystal ball, careful and conservative modeling can provide useful comparative context. Read the "CalSim 3 Results for 2070 Climate Change and Sea Level Projections and Sensitivity Analysis" with this important background in mind.

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Date: March 20, 2024

To: Board of Directors

From: Adel Hagekhalil, General Manager

Subject: Additional Information on the Delta Conveyance Project

At the January 8, 2024, One Water and Stewardship Committee meeting several director requests were made related to Item 6a, Update on Delta Conveyance Project (project). Attached is a document that captures information responsive to those director requests. The attached document includes information related to the Final Environmental Impact Report's response to public comments and project objectives and benefits. Metropolitan staff will provide additional project information, including the project cost estimate and the associated benefit-cost analysis at a future One Water and Stewardship Committee meeting.

Information Contained in the Attachment to
Office of the General Manager Memo to the Metropolitan Board Date: March 20, 2024 Subject: Additional Information on the Delta Conveyance Project (Attachment)

At the January 8, 2024, One Water & Stewardship Committee meeting several director requests were made related to item 6a Update on Delta Conveyance Project. The following information provides an overview of the Delta Conveyance Project Final EIR response to comments process, and links to all of the common and individual responses to comments on the Draft EIR included in Volume 2 of the Final EIR. In addition, a brief discussion of the Delta Conveyance Project objectives and benefits is provided along with links to materials produced by DWR that help highlight the different project benefits. Metropolitan staff will provide additional project information, including project cost estimate and the associated benefit-cost analysis at a future One Water & Stewardship Committee meeting.

Delta Conveyance Project Final EIR Response to Comments

DWR released the Draft EIR for public review on July 27, 2022, and the public comment period closed on December 16, 2022. DWR treated all comment letters received before January 1, 2023, as timely, those letters have been reviewed, considered, and responded to in the Final EIR. DWR received approximately 675 unique letters and communications from federal, state, and local/regional agencies; California Native American Tribal governments; elected officials; nongovernmental organizations; and members of the public. After reviewing letters and communications, DWR identified approximately 7,356 discrete comments.

DWR made a good-faith effort to ensure that all comments were identified, considered, and responded to in Volume 2 of the Final EIR. Substantive comments raising significant environmental issues were addressed through a combination of Common Responses and unique individual responses. DWR's response to comments approach is described in more detail in the Final EIR Volume 2, Chapter 1: *Introduction and Approach to Responses to Comments*.

Volume 2, Chapter 3: *Common Responses* provides a high-level summary of the 17 Common Responses developed by DWR for the Final EIR. Common Responses are broad technical or policy discussions that cover a specified range of issues. DWR crafted Common Responses for similar comments received from multiple agencies, organizations, entities, or members of the public, or because multiple but related subtopics could be addressed by one topical Common Response. Each Common Response summarizes the common comments to which DWR is responding and provides a detailed discussion of each issue raised. Links to each of the 17 Common Responses can be found in the table below. CR 1: CEQA Process, General Approach to Analysis, and Other Environmental Review Issues	CR 10: Surface Water Quality and Groundwater Resources
CR 2: Public Outreach Activities	CR 11: Terrestrial Biological Resources and Compensatory Mitigation Plan

CR 3: Alternatives Development and Description	CR 12: Agricultural Resources
CR 4: No Project Alternative Description and Analysis	CR 13: Recreation and Recreational Opportunities
CR 5: Public Water Agencies' Water Management Practices	CR 14: Transportation
CR 6: Climate Resilience and Adaptation	CR 15: Air Quality and Greenhouse Gases

THE METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

Date: May 16, 2024

To: Board of Directors
Member Agency Managers

From: Adel Hagekhalil, General Manager

Subject: Delta Conveyance Cost Estimate and Benefit Cost Analysis

Today, the California Department of Water Resources released a Cost Estimate and Statewide Benefit Cost Analysis for the proposed Delta Conveyance Project. Below are DWR's press release, a new DWR brochure on the economic value of the project, the cost estimate and benefit cost analysis documents, and Metropolitan's press statement.

- DWR Press Release (link)
- DWR: Facts About the Economic Value of the Delta Conveyance Project (pdf)
- Total Project Cost Memorandum (pdf)
- Benefit Cost Analysis of the DCP (pdf)
- Metropolitan's press statement (link)

Metropolitan is at a critical juncture in developing its long-term water supply and financial strategies. Given the importance of these DCP analyses in our future decision-making processes, Metropolitan has invited the Executive Director of the Delta Conveyance Design and Construction Authority, Graham Bradner, and Berkeley Research Group Vice Chairman Dr. David Sunding to provide a comprehensive update on the project cost and benefits to Metropolitan's Board at the June 2024 One Water and Stewardship Committee.

Attachments

Delta Conveyance Project

Modernizing California's Water Infrastructure | 2024

Facts About the Economic Value of the Delta Conveyance Project

Benefits, Costs, Commitments, and Innovations

The Delta Conveyance Project is one of California's most important climate adaptation projects. Extreme weather is leading to more rain, less snow, and a limited ability to capture and move water. The Delta Conveyance Project will protect supplies by capturing water when it is plentiful to better endure dry years and adapt to extreme weather. It protects against the threat posed by earthquakes, sea level rise and levee failure. And it helps resolve conflicts in the south Delta to both protect fish and provide needed water supply.

Need for Protecting the State Water Project

The State Water Project captures and moves water all over California, from the Bay Area to the Mexico border and communities in between. It is an affordable source of high-quality, clean, and safe water for 27 million Californians and 750,000 acres of agriculture. If the State Water Project service area were a nation, it would represent the eighth largest economy in the world. And it is an important foundation for an entire suite of water supply and resiliency programs implemented by local public water agencies.

Economic Benefits

The Delta Conveyance Project passes the benefit-cost test. It enables water needs to be satisfied and water supply reliability to be maintained. It protects against a declining baseline of supplies, allows SWP to adapt against climate change, guards against earthquake risks, and helps resolve conflicts in the south Delta by improving operational flexibility.

Cost Estimate

An updated cost estimate was prepared by the Delta Conveyance Design and Construction Authority (DCA), using a detailed and rigorous approach, the cost of the project is estimated to be $20.1B in real 2023 (undiscounted) dollars. A preliminary cost assessment conducted in 2020, early in the design process, showed the project would cost about $16B, which accounting for inflation to 2023 would result in a similar cost. This demonstrates that even as details are added, and refinements are made to the program, costs are holding steady. The DCA is also evaluating potential design or construction innovations that would help manage costs for the program.

Benefits Outweigh Costs

After adjusting to account for the value of money over time (see page 3 regarding "discounting"), the benefits are $37.96 billion and the costs are $17.26 billion. This results in a benefit-cost ratio of 2.2, meaning that the benefits outweigh the costs and every dollar spent generates $2.20 in benefits.

The project passes the benefit-cost ratio test, making the project economically viable and robust under all future scenarios analyzed.

Benefits are quantified in four different areas: Urban water supply reliability, agricultural water supply, water quality, and seismic reliability.

The primary benefit of the DCP is that the project protects against the expected effects of climate change and sea level rise, avoiding future shortages and maintaining water supply reliability.

Understanding Benefits

Urban Water Supply Reliability:

- More SWP deliveries under wetter periods allow agencies to:
  - Fill storage more frequently
  - Enter drought periods with higher reserves
  - Impose fewer periods of mandatory rationing
  - Reduce severity and frequency of shortages
- Urban economic benefits measured as consumers' willingness to pay (WTP) to avoid shortages.

Agricultural Water Supply

- Agricultural value of water based on the UC Davis Statewide Agricultural Production model and water market transaction data from Nasdaq Veles CA Water Index.

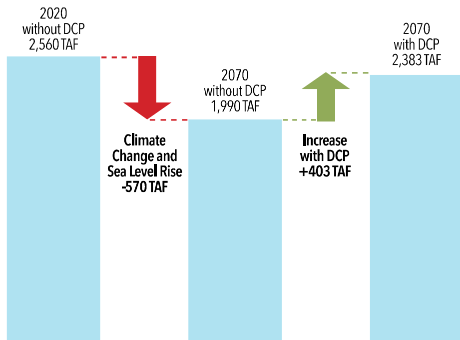
Water Quality:

- Lower salinity improves water quality.
- For urban agencies, this improves taste, the useful life of appliances, the cost of water softening, for example.
- For agricultural agencies, the cost is based on reducing requirements for additional irrigation water needed to flush salts from the root zone of crops.

Earthquake Disruption:

- Avoiding potentially significant disruption to statewide water supply caused by earthquakes saves time, saves money and protects water quality.

State Water Project Deliveries:



Missed Opportunity

If the Delta Conveyance Project were operational during the big winter storms of winter 2021-2022, January 1 through May 9, 2024, a significant amount of water could have been captured and moved.

Winter 2021-2022	January 2023	Jan 1–May 9, 2024
Amount of water that could have been captured:		
236,000 acre-feet	228,000 acre-feet	909,000 acre-feet
That's enough water to supply:		
Over 2.5 million people for one year	Over 2.3 million people for one year	Over 9.5 million people for one year
or		
Nearly 850,000 households for one year	Nearly 800,000 households for one year	Over 3.1 million households for one year

Assumptions that influence benefits and costs:

- Yield: assumed to provide about 403,000 acre-feet annually on average
- The cost of the project: assumed to be $20.1 billion in undiscounted 2023 dollars
- Real discount rates: between 2% and 1.4% (Federal Office of Management and Budget, Circular A-4 guidance)
- Environmental mitigation: $960 million
- Construction period: 15 years
- Life span of the project: 100 years

Summary of Benefits and Costs

	Main Cost Estimate	Cost with DCA Recommended Innovation Savings
	Present Value of Future Benefits	
	2023 ($M)	2023 ($M)
Urban Water Supply and Reliability	$33,300	$33,300
Agricultural Water Supply and Reliability	$2,268	$2,268
Urban Water Quality	$1,330	$1,330
Agricultural Water Quality	$90	$90
Seismic Reliability Benefits (Water Supply)	$969	$969
Seismic Reliability Benefits (Water Quality)	$2	$2
Total Benefits	**$37,960**	**$37,960**
	Present Value of Future Costs	
	2023 ($M)	2023 ($M)
Construction Costs	$11,486	$10,723
Other Project Costs	$3,021	$2,852
Community Benefit Program	$153	$153
Environmental Mitigation	$735	$735
O & M Costs*	$1,697	$1,697
Environmental Impacts after Mitigation	$167	$167
Total Costs	**$17,259**	**$16,327**
Benefit-Cost Ratio	**2.20**	**2.33**

*O&M Costs: includes operations and maintenance costs for project facilities

Understanding Discounting and the "Time Value of Money"

How does a Benefit-Cost Analysis account for inflation?

Inflation is the general increase in the price of goods and services over time, and it poses a challenge for benefit-cost analysis. To ensure a consistent comparison, all future costs and benefits reflect 2023 prices, a method known as using "real prices" in economic terms. This approach removes the distorting effects of inflation, allowing present-day expenditures to be directly comparable to future benefits and providing a clear basis for evaluating a project's economic viability.

How would unexpected inflation affect the analysis?

If inflation impacts future costs and benefits similarly, changes in the inflation rate will not affect the conclusions of the benefit-cost analysis. However, if inflation disproportionately affects costs or benefits, it could skew the analysis. This is unlikely for the DCP, where benefits tied to water rates and costs associated with construction expenses generally escalate in tandem.

Why does the Benefit-Cost Analysis account for the time value of money (e.g. discount future costs and benefits)?

The time value of money is a recognition that money available today is worth more than the same amount in the future because it can be used immediately—to pay for things or to invest and earn more money. This concept is crucial, especially in long-term projects like the DCP, which assumes a 15-year construction period starting in 2029 followed by a 100-year operational project life.

How is the real discount rate applied?

The 'real discount rate' used in this process is determined based on federal guidance and calculated by taking the returns on treasury bills and subtracting the rate of inflation. This discounting process, distinct from the previously discussed use of real prices to account for inflation, helps prioritize projects that offer the best economic returns over their lifecycle, ensuring efficient allocation of resources.

Why is the cost of the project lower in the Benefit-Cost Analysis and higher in the cost estimate?

The cost estimate and benefit-cost analysis are equivalent but expressed differently. The cost estimate is presented in real 2023 dollars. The benefit-cost analysis is shown as "present value." Present value accounts for various distortions to the value of money over time, including inflation and the potential for investment and it is calculated using a "discount" rate.

Other Important Considerations:

Climate change

Climate change and sea level rise are expected to significantly reduce future SWP deliveries. Future precipitation and runoff are forecasted using multiple climate scenarios that show an annual loss of more than half a million acre-feet by 2070. The primary benefit-cost analysis assumes 1.8 feet of sea level rise by 2070. Multiple sensitivity analyses test robustness of this assumption. In each of the scenarios tested, the benefits of the project significantly exceed costs.

Transfers and Trading

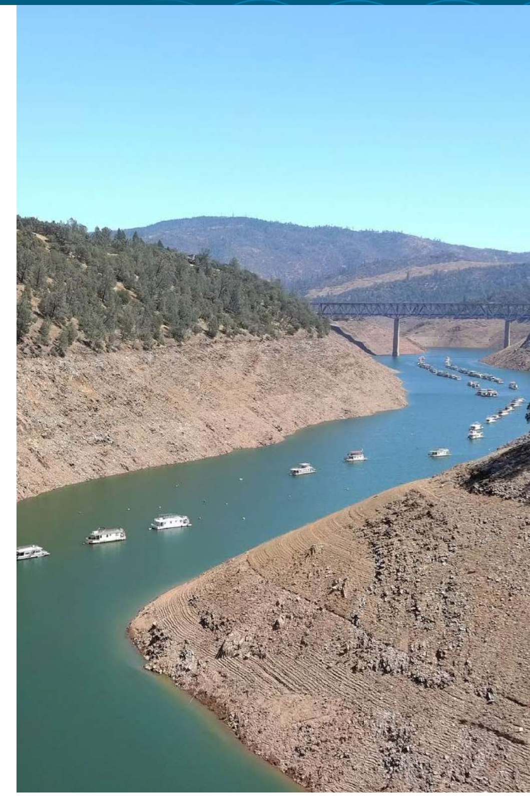
If there are water years that a Public Water Agency's supplies exceed local needs, they may choose to transfer those supplies and the associated costs, consistent with water law and existing water supply contracts. This flexibility will allow PWAs to preserve water supplies for local needs and to transfer those excess supplies—and costs—to other parts of the state, particularly those with limited access to drinking water.

Unmitigated Environmental Impacts

Some environmental impacts are expected to be significant and unavoidable. Where possible, the cost of those impacts has been considered and included. This results in a cost of about $153 million for lost agricultural land, air quality, noise, and transportation impacts.

Cost of Doing Nothing

Failing to implement the Delta Conveyance Project has real financial consequences resulting from climate change, sea level rise and seismic events.



Some benefits of the Delta Conveyance Project are not monetized in the benefit-cost analysis and yet are compelling for decision-makers:

- Increased operational flexibility: Resolving conflicts in the south Delta between fish and water supply goals.
- Community Benefits Program: $200 million investments for high-priority local Delta projects, in addition to local business utilization, job training, and infrastructure leave-behinds that have potential to provide benefits that are ultimately likely to represent values beyond this funding commitment.
- Job creation: The project will create 5,000 high-paying jobs.
- Groundwater supplies: Protecting affordable surface water supplies relieves pressure on dwindling or constrained groundwater sources.

Cost Estimate: Conservative, Comprehensive, Based on Industry Standards

DWR approved the Bethany Alignment of the Delta Conveyance Project in December 2023 after concluding the project Environmental Impact Report (EIR). This approved project provided the basis for an updated cost estimate.

The estimate is comprehensive, conservative, and reflects industry standard methodologies. It:

- Is based on the 6,000 cubic feet per second Bethany Reservoir Alternative as outlined in the project Final EIR
- Includes construction costs and other costs, like planning, management, land, mitigation, power and community benefits
- Uses cost estimating approach that builds up based on labor, equipment, materials, and schedule
- Uses a thorough reconciliation process with independent cost-estimating teams and resolves cost differences
- Assumes a reasonable 30% contingency to account for uncertainties

Methodology: A More Rigorous Approach

The updated cost estimate uses a more rigorous approach for concept-level designs. It:

- Uses engineering documentation in drawings and technical reports
- Develops costs based on unit rates, quantities, and durations
- Replaces most cost "allowances" with actual estimates and material price quotes
- Uses better understanding of ground conditions, schedule, and risks

The cost estimate has been prepared by the Delta Conveyance Design and Construction Authority, a joint powers agency comprised of the participating Public Water Agencies responsible for funding, and ultimately building, the project.

Total Project Costs Summary*

Feature	Total Cost ($M)
Construction Costs	
Intakes	$1,714
Main Tunnels	$6,353
Pumping Plant and Surge Basin	$2,536
Aqueduct Pipe and Tunnels	$563
Discharge Structure	$99
Access Logistics and Early Works	$253
Communication	$13
Restoration	$17
Construction Subtotal	**$11,548**
Contingency (30%)	$3,464
Total Construction Costs	**$15,012**

Feature	Total Cost ($M)
Other Project Costs	
DCO Oversight	$426
Program Management Office	$668
Engineering/Design/Construction Management	$2,167
Permitting and Agency Coordination	$67
Total Panning/Design/Construction Management	**$3,328**
Land	$158
DWR Mitigation	$960
Power	$415
CCWD Settlement Agreement	$47
Community Benefits Program	$200
Total Other Costs	**$1,780**

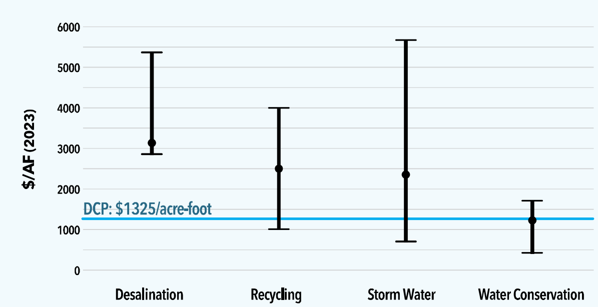
*Costs are in undiscounted 2023 dollars.

Total Project Costs = $20,120

Cost Category	Total Project Cost Estimate ($M)	Total Project Cost with Seconday Innovations Estimate ($M)
Construction Costs	$15,012	$14,008
Other Project Costs	$5,108	$4,886
Total Project Costs	**$20,120**	**$18,894**

Comparing the Delta Conveyance Project to Alternative Supplies

The per-acre cost of the Delta Conveyance Project is less than the costs of most other types of supplies. Alternative supplies also lack the ability to provide an equivalent scale of supply and are not able to protect the long-term stability of State Water Project supplies. While a full suite of options is being considered for California and local water purveyors, the Delta Conveyance Project is the most viable and irreplaceable.



Innovations Identify Significant Cost Savings

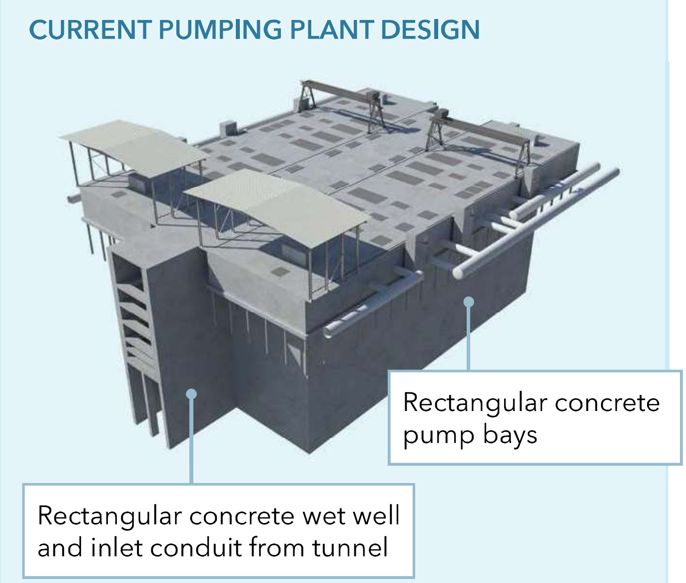
Value engineering is a part of the design phase of a project. It is used to cut costs, save time, reduce risk, or reduce community or environmental disturbances. The approved project represents a conservative configuration for analysis of impacts. An initial review of potential design and construction innovations shows an opportunity to reduce costs by about $1.2 billion.*

Innovation Example

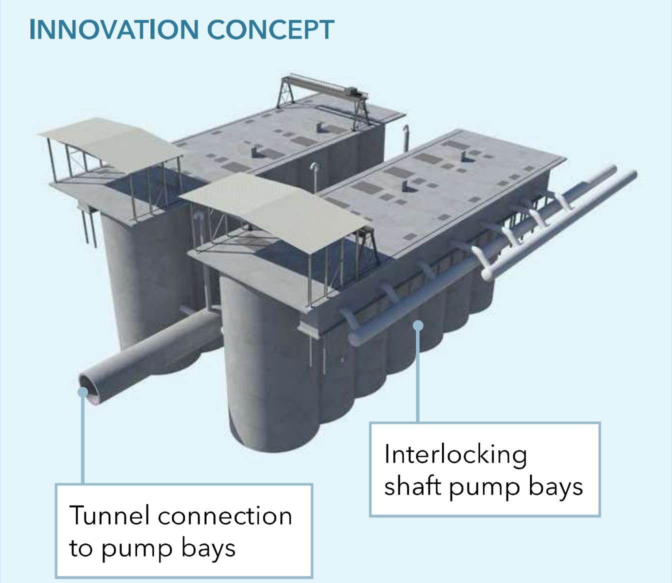
In the Engineering Project Report, the Bethany Reservoir Pumping Plant (BRPP) is a below-ground structure with vertical rectangular diaphragm walls and consists of dry-pit pump bays housing the pumping plant equipment and piping plus an adjoining rectangular concrete wet well and wet well inlet conduit connected to the tunnel reception shaft located along the center of the overall structure.

This innovation would replace the vertical, deep box diaphragm wall arrangement with interlinking shafts of diaphragm wall construction that would house the pumping plant equipment and piping and a tunnel that would replace the wet well and wet well inlet conduit, greatly reducing construction quantities and expediting schedule due to construction sequence improvements.

CURRENT PUMPING PLANT DESIGN



INNOVATION CONCEPT



INNOVATION ADVANTAGES:

- Reduces construction quantities (soil excavation, concrete, rebar)
- Shortens construction schedule by 981 days
- Reduces direct construction cost by $138,720,000
- No changes to above-ground site configuration and surface features

*Does not represent changes to the approved project description.

For More Information

For more information on cost, benefits, funding and financing of the State Water Project and the Delta Conveyance Project, view this FAQ or use the QR code.

For more about the Delta Conveyance Project, visit: **water.ca.gov/deltaconveyance**

For more about the project permitting process, visit: **deltaconveyanceproject.com**

For more information about project design and engineering, visit: **dcdca.org**

DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

Total Project Cost Summary Memorandum

Document History

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Contents

Delta Conveyance Design and Construction Authority
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Subject	**Total Project Cost Summary**
Project feature	Projectwide
Prepared for:	Delta Conveyance Project (DCP) File
Prepared by:	Delta Conveyance Design and Construction Authority (DCA)
Copies to	California Department of Water Resources (DWR) / Delta Conveyance Office (DCO)
Date/Version	May 14, 2024 / Version 2
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Executive Summary

The Delta Conveyance Design & Construction Authority (DCA) prepared this memorandum to document the updated estimate of total project costs for the Bethany Reservoir Alignment of the Delta Conveyance Project. The updated estimate is being prepared to support strategic and feasibility evaluations being performed by the California Department of Water Resources (DWR) and participating Public Water Agencies. This document includes the rationale, assumptions, pricing sources, and other inputs to the estimating process that were used to develop the total project cost estimate.

The estimate is presented in 2023 dollars and is “undiscounted”, an economic term meaning the value does not account for the time value of money. Reporting the estimate in 2023 dollars provides a base cost that allows DWR and participating Public Water Agencies to perform further economic analyses of costs and benefits in a manner that ensures consistency and comparability.

Total project costs include construction and other program costs associated with the following primary features:

- Two intakes (maximum 3,000 cfs each)
- Main Tunnel & Shafts
  - 36-foot-inside-diameter tunnel, 45 miles long
  - 11 Shafts including two double-launch shafts
- A 6,000-cfs Bethany Reservoir Pumping Plant (BRPP)
- Aqueduct from the BRPP to Bethany Reservoir
  - Includes four 15-foot-diameter pipelines
  - Tunneled crossing of Jones Penstocks and the Bethany Conservation Easement
- Discharge Structure to Bethany Reservoir
- Logistics works for access, levee improvements, power, utilities, communication, and site restoration

The total project cost estimate has been prepared in accordance with Association for the Advancement of Cost Engineering (AACE) guidelines and considers items such as labor, materials, equipment, level of effort, and other relevant cost items for a defined scope of work as described in the Environmental Impact Report (EIR) prepared by DWR and the supporting Engineering Project Report (EPR) prepared by the DCA. The updated cost estimate includes an appropriate level of contingency and risk treatment costs to manage uncertainty at the current conceptual stage of project development.

Following project approval, DWR directed DCA to consider potential design or construction innovations to further reduce community or environmental disturbances, schedule, and/or costs or improve constructability. This evaluation resulted in a set of potential reasonable and credible innovations which indicate potential savings when compared to the total project cost estimate. The innovations discussed herein do not represent changes to the project description presented in the EPR and analyzed in the EIR, but rather provide an indication of how normal design development processes can help manage costs for large infrastructure projects. As the innovation concepts advance, DWR will determine and document the need for any revisions to the project description, which will be used by DWR to determine if additional reviews will be required under CEQA and/or for project permitting.

Table ES-1 summarizes the total project costs for the 6,000-cfs Bethany Reservoir Alignment and potential reduced total project costs associated with the innovation concepts.

Table ES-1. Delta Conveyance Project Summary of Total Project Costs

Cost Category	Total Project Cost Estimate ($M[a])	Total Project Cost with Innovations ($M[a])
Construction Cost	$15,012	$14,008
Other Program Costs[b]	$5,108	$4,886
Total Project Cost	**$20,120**	**$18,894**

[a] Costs are in 2023 dollars and are undiscounted.

[b] Other Program Costs represent: Planning, Design, Construction Management, Land Acquisition, Environmental Mitigation, Settlement Agreement, and Community Benefits.

The total project cost estimate presented is primarily intended to support project financial and economic analysis and to provide guidance for further project development. The final costs of the project once constructed will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors.

1. Introduction

On December 21, 2023, California Department of Water Resources (DWR) approved the Delta Conveyance Project (DCP) and selected the Bethany Reservoir Alignment for further engineering, design, and permitting necessary to be completed prior to initiating implementation. DWR completed extensive environmental review and certified the Environmental Impact Report (EIR) (DWR, 2023) as compliant with the California Environmental Quality Act (CEQA).

This memorandum provides an estimate of total costs for the project to support strategic and feasibility evaluations being performed by DWR and participating Public Water Agencies. The updated cost estimate is presented in two primary categories: (1) Construction Costs, and (2) Other Program Costs. The costs presented are inclusive of all activities and work required for the project and provide the rationale, assumptions, pricing sources, and other inputs to the estimating process used to develop the cost estimate.

The estimate is presented in 2023 dollars, which provides a base cost that allows DWR and participating Public Water Agencies to evaluate potential costs and benefits using their own agency-specific approaches and methodologies and avoids potential conflicts with DCA escalation assumptions.

2. Project Scope of Work

This section describes the facilities and elements of work included in the estimate. The project scope of work aligns with the 6,000-cfs Bethany Reservoir Alignment as presented in the *Delta Conveyance Final Draft Engineering Project Report, Bethany Reservoir Alternative* (DCA, 2022) and updates to the Engineering Project Report (EPR) issued in November 2023 (DCA, 2023).

2.1 Layout

Figure 2-1 shows the following proposed conveyance facility features:

- **Intake C-E-3 and Intake C-E-5:** Two 3,000-cfs intakes located along the Sacramento River
- **Main Tunnel and Shafts:** 36-foot-inside-diameter tunnel, approximately 45 miles long, connecting C-E-3 and C-E-5 to the Bethany Reservoir Pumping Plant (BRPP) with 11 shafts along the alignment used for launching, reception, and maintenance (including the Surge Basin shaft)
- **Surge Basin Shaft and Surge Basin:** The Surge Basin Shaft is used as a reception shaft connecting the Main Tunnel to the Surge Basin and providing connection to the BRPP wet well inlet conduit
- **Bethany Reservoir Pumping Plant:** A 6,000-cfs pumping plant with wet well and dry pit structures housing 14 vertical centrifugal end suction type pumps
- **Aqueduct**: Four 15-foot-diameter parallel pipelines approximately 2.5 miles long each, which include 2 tunneled sections and vertical shafts at the connection to the Discharge Structure
- **Discharge Structure:** Located at Bethany Reservoir to discharge flow delivered from the Aqueduct into Bethany Reservoir which delivers water to the California Aqueduct
- **Logistics Works**: Includes access, levee improvements, power, utilities, communication, and site restoration to support construction of the project

Figure 2-1. Schematic of Project Features

Figure 2-2 shows the total alignment extending from the Intake facilities to the discharge structure facilities in Bethany Reservoir for delivery to the existing State Water Project.

The 6,000-cfs-project includes two river intake facilities on the Sacramento River, with on-bank intake structures and sedimentation basins that connect to the main tunnel via drop shafts. The main tunnel would be 36-foot-inside-diameter and approximately 45 miles long and would be constructed as four reaches driven in opposite directions from the Twin Cities Complex and Lower Roberts Island double-launch shafts. The tunnel drives would end at reception shafts at Intake 3, Terminous Tract, and the Surge Basin located at the BRPP. The other shafts would be used as maintenance shafts during tunnel construction and for future project operations and maintenance. The Surge Basin and BRPP at the southern end of the alignment connect to a four-pipeline aqueduct and discharge structure at Bethany Reservoir.

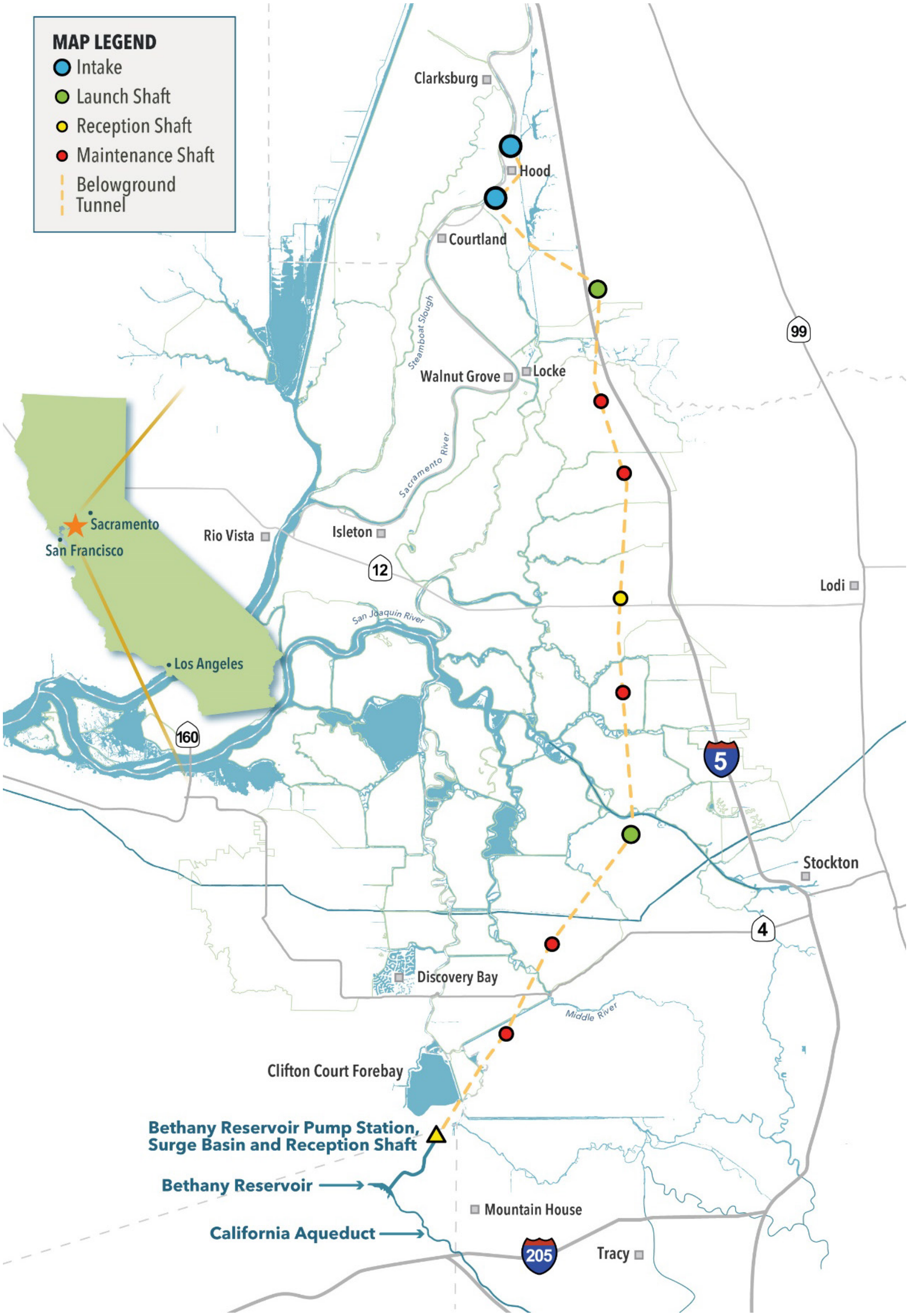

Figure 2-2. Project Map

Data Source: DCA, DWR

2.2 Project Schedule

A project schedule was developed to represent major phases of the project that includes permits, procurement, design, construction, and startup. The schedule was developed by estimating the duration of time required to complete the design and construction of each major project element along with the logical sequencing of activities required to complete the entire project such that testing and startup can occur in years 2043 and 2044 with the project becoming fully operational at the beginning of year 2045. Figure 2-3 shows the overall DCP schedule and logical sequences of the major project elements.

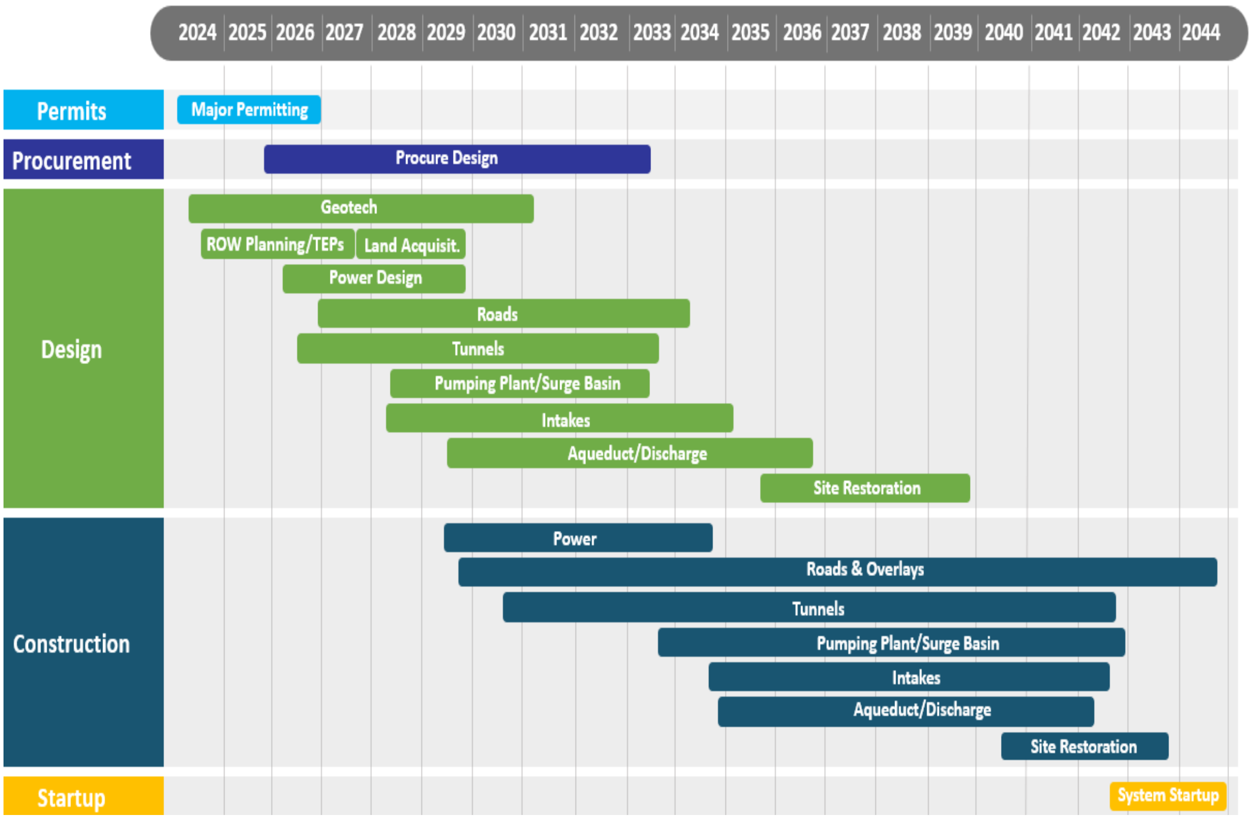

Figure 2-3. Delta Conveyance Project Schedule

3. Methodology and Estimate Classification

Total project costs for this estimate are divided into two categories: Construction Costs and Other Program Costs. The methodology used for developing the estimate and the estimate classification are presented below.

3.1 Methodology

The construction cost estimate has been prepared with quantities taken from drawings and other information contained in the EPR documents and, where applicable, has been adjusted to reflect the commitments described in the EIR. The construction cost estimate has been prepared with a crew-based estimating approach that uses materials, labor, and equipment crew estimates to complete work activities at the lowest level of detail for the anticipated method of construction as described in the EPR and EIR. Because of the scale and complexity of the project, a rigorous estimating approach was used to develop the construction costs which included development of concept level drawings and technical memorandums, obtaining deterministic costs for unit rates and materials, replacing most of the cost allowances with actual estimates and material price quotes, and estimating the work based on the current understanding of subsurface ground conditions.

The other program costs were developed by considering the planning, design, and construction management labor costs (soft costs) and include all anticipated activities associated with delivering the project. Soft costs were developed by estimating the labor and level of effort over a given duration of time to complete the work, and other associated costs with these activities. The other program costs category of the estimate also includes costs for land, mitigation, power, the Contra Costa Water District (CCWD) Settlement Agreement, and the Community Benefits Program, which can be a mixture of direct, indirect, and labor costs.

Details of the construction costs are further presented in Section 4 and details of the other program costs are further presented in Section 5.

3.2 Estimate Classification

The DCA used the guidance provided in *17R-97: Cost Estimate Classification System Recommended Practice* (AACE, 2020) to determine the class of estimate. Based on the design stage and maturity, the project construction cost estimate generally categorizes as a Class 4 estimate, although some areas are considered Class 5. Appendix A, *Basis of Estimate-Construction Costs,* attached to this memorandum includes an Estimate Maturity Checklist that qualitatively evaluates the design maturity for individual project features. According to AACE 17R-97, estimate classification progresses down from Class 5 to Class 1 as project definition improves coinciding with improved expected accuracy (see Figure 3-1).

AACE guidelines provide anticipated accuracy ranges based on general and industry-specific benchmarking and empirical data. The total project cost estimate provides the DCA's opinion of the most probable cost. Due to the uncertainty associated with ground conditions along the tunnel alignment and industry experience with underground tunneling projects, DCA has assigned an accuracy range between +80% and -55% to the current cost estimate, but the far ends of the range have a much lower probability of occurrence than the most probable value. As illustrated on Figure 3-1, the accuracy range is expected to decrease as project definition improves and the estimate classification shifts towards Class 1.

The Class 4 estimate for the DCP is primarily presented to support project financial and economic analysis and to provide guidance for further project development. In general, the end use of cost estimates evolve over time – as the project definition increases from early conceptual design stages to final design, the end usage shifts from supporting strategic evaluations to funding authorizations and budgets to project control purposes. The final costs of the project once constructed will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors.

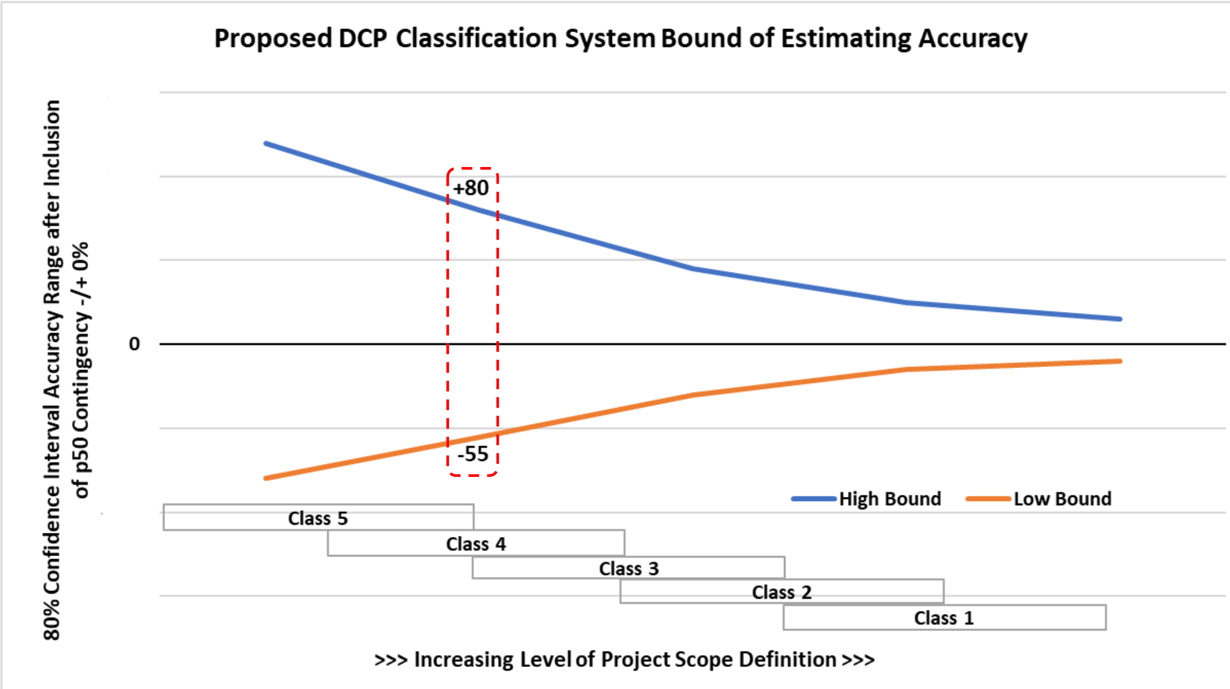

Figure 3-1. DCA Estimate Class within Range of Accuracy Modified from AACE 17R-97

4. Construction Cost Estimate

This section presents the construction cost estimate for the project including summaries of the major components and items considered while developing the estimate. Appendix A provides a more detailed breakdown and understanding of the construction cost estimate.

- **Cost Basis** – A variety of elements serve as the cost basis for the construction cost estimate, such as material prices, labor rates, equipment rates, productivity of construction crews, schedule, indirect costs, sales tax, contractor markup and profit, and other add-on costs (such as insurance and bonds). The estimate does not include escalation for the construction period and for future start dates. The prices in this estimate are in 2023 dollars.
- **Allowances** – Allowances are resources included in the estimate to cover the costs of known but undefined requirements for an individual activity or work item. The estimate recognizes the following allowances associated with the project:
  - Allowance for all diesel/gas-powered equipment to become zero emissions by 2035
  - Allowance for testing and commissioning of mechanical and electrical equipment before the systemwide commissioning
- **Risk Treatment Costs** – Risk treatment costs are included to account for identified risks associated with design and construction of the project and reflect potential costs beyond those developed by direct interpretation of the concept designs. Risk treatment costs also help manage potential risks by reducing threats and improving opportunities and have been developed based on industry standards, professional judgement and experience, and an assessment of uncertainties and potential risks for each major project feature.
- **Contingency** – In addition to risk treatment costs for each project feature, an overall construction contingency is applied to all project features beyond those directly accounted for in the estimate.

Contingency is an amount added to a construction cost estimate to account for uncertain items, conditions, or events that are likely to result in additional project costs. An assessment of project design maturity (i.e. approximately 10% level of design maturity overall) was completed along with an assessment of potential risks to determine the appropriate amount of contingency. An overall estimated construction cost contingency of 30% was included in the total project cost estimate.

4.1 Summary of Construction Estimate

Table 4-1 summarizes the construction costs and the risk treatment costs for each project feature. The 30% contingency is then applied to the summation of the estimated construction and risk treatment costs which results in an overall construction cost estimate for the project. Appendix A provides more details and a breakdown of the construction cost estimate.

Table 4-1. Summary of Construction Costs

Feature	Construction Estimate ($M[a])	Risk Treatment ($M[a])	Total Cost ($M[a])
Intakes	$1,660	$54	$1,714
Main Tunnels and Shafts	$6,018	$335	$6,353
Pumping Plant & Surge Basin	$2,496	$40	$2,536
Aqueduct Pipe & Tunnels	$541	$22	$563
Discharge Structure	$95	$4	$99
Access Logistics & Early Works	$241	$12	$253
Communication	$13	-	$13
Restoration	$17	-	$17
Subtotal Construction Costs [b]	**$11,081**	**$467**	**$11,548**
Construction Contingency (30%)			$3,464
Total Construction Cost Estimate [b]			**$15,012**

[a] Costs are in 2023 dollars and are undiscounted.
[b] The Total Construction Cost estimate excludes provision of electrical power supply and associated infrastructure to deliver power to work sites – these costs are included with the Other Program Costs.

5. Other Program Costs

In addition to construction costs, there are a series of other program costs that need to be included in the total project cost estimate. These have been grouped into two sub-categories:

1) Planning, design, and construction management costs (soft costs)
2) Other costs

Following is a summary of these other program costs.

5.1 Planning, Design, and Construction Management Costs

Planning, design, and construction management costs (soft costs) include labor and other direct and indirect costs associated with delivering the project. These represent what is often referred to as non-construction professional services-related costs, or soft costs, of the project. Table 5-1 summarizes the categories and elements that represent the planning, design, and construction management activities.

Table 5-1. Planning, Design, Construction Management Cost Basis Categories

2023 Cost Basis Categories – Planning/Design/Construction Management
DWR Permitting & Oversight: • Engineering Standards Compliance • Program Controls Monitoring (Schedule and Budget) • Invoice Processing and Payment • Startup and Commissioning Support • Ongoing Environmental Permitting & Compliance Monitoring
DCA Permits & Agency Coordination: • Permit Coordination • Agency Coordination • Mitigation Monitoring & Reporting Coordination
DCA Program Management: • Executive Office (Human Resources, Legal, Finance, Program Office Direct Costs) • Program Management Leadership • Program Support (Assurances, Program Controls, Contracts/Procurement, Community Engagement)
DCA Engineering, Design, and Construction Management: • Engineering (Design Project Management/Technical Support, Construction Project Management/Technical Support, Geotechnical Exploration, Survey, Property Acquisition/Right-of-Way, Startup/Commissioning, Supplemental Programmatic Technical Services – Value Engineering, Hydraulic Modeling) • Design (Project Management, Basis of Design Reports, 30% Design, 60% Design, 90% Design, 100% Design, Independent Technical Review Coordination, Engineering Services During Construction, Startup/Commissioning Support) • Construction Management (Construction Project Management, Construction Oversite Services, Startup/Commissioning Support)

5.2 Other Costs

Other costs include items such as land acquisition, mitigation requirements, power, the settlement agreement and community benefits that are included as part of the overall cost of the project. Table 5-2 shows the different categories for these other costs.

Table 5-2. Other Cost Basis Categories

2023 Cost Basis Categories – Other Costs
Land: • Easements • Land Purchase
DWR Mitigation: • Tribal Monitoring • Mitigation Plans • Habitat Restoration Projects • Other Significant Mitigation
Power: • Design Services for Power Provided by Utility • Procurement/Construction of Infrastructure to Provide Power (SMUD, PG&E, WAPA) • Power Utilization Cost During Construction
Contra Costa Water District Settlement Agreement: • Agreed Cost Share (50-cfs pumping capacity)
Community Benefits: • Allowance for Community Benefits Program

The following points summarize the development and basis of the other costs:

- **Land Acquisition** – The land acquisition estimate is based on an estimate of costs to purchase the property and right-of-way to construct and operate the project. In addition to the property and rights-of-way costs, the estimate includes relocation assistance, utility relocation land costs, legal, and consulting fees.
- **Mitigation** – This estimate covers the environmental mitigation requirements outlined in the EIR and provided by DWR. These costs include items for Tribal monitoring, mitigation plan development, habitat mitigation (including compensatory mitigation), and other significant mitigation, as described in the EIR.
- **Power** – This item includes the costs for the design, procurement, and construction of the electrical infrastructure required to bring power to each project site from the major power utility companies in the project area. This item also includes the estimated cost associated with the electrical power consumption during construction. Primarily, this includes electrical consumption costs at the Intakes, Pumping Plant, and the Twin Cities Complex and the Lower Roberts Island double-launch shafts, where power is supplied for the tunnel boring machines. It also includes the power used during the commissioning and start-up of the overall conveyance system.
- **Contra Costa Water District (CCWD) Settlement Agreement** – This item includes the agreed cost share of $47 million for a 50-cfs pump station to be located at the Union Island Maintenance Shaft to transfer water to CCWD's existing facilities on Victoria Island.
- **Community Benefits Program** – This item is an allowance of $200 million to fund a community benefits program that would provide tangible benefits to local communities potentially effected by DCP construction approximately equal to 1% of the total project cost. Total actual benefits to the

community associated with implementation of the project are ultimately likely to represent a value beyond this funding commitment due to additional benefits associated with project leave behinds, job training and employment, local business participation, and other local and regional economic gains.

5.3 Summary of Other Program Costs

Table 5-3 summarizes the estimated cost associated with the other program costs. As noted in the table, an appropriate contingency between 15% to 30% has been added to each item based on whether it was a services-related or construction-related cost.

Table 5-3. Other Program Costs

Item	Estimated Cost ($M[a])
Planning, Design, Construction Management (Soft Costs)	
DWR Permitting & Oversight[b]	$426
DCA Program Management Office[b]	$668
DCA Engineering Management / Detailed Design / Construction Management[b]	$2,167
DCA Permitting and Agency Coordination[b]	$67
Other Costs	
Land[c]	$158
Mitigation[b,c]	$960
Power[c]	$415
CCWD Settlement Agreement	$47
Community Benefits Program	$200
Total Other Program Costs	**$5,108**

[a] Costs are in 2023 dollars and are undiscounted.

[b] Other Program Costs including soft costs and portions of the mitigation costs include a 15% contingency.

[c] Land and the construction related elements of Mitigation and Power costs include a 30% contingency.

6. Total Project Cost Summary

Table 6-1 summarizes the total project cost estimate for the project.

Table 6-1 Total Project Cost Summary

Feature	Total Cost ($M[a])	Percent of Construction (%)
Construction Costs		
Intakes	$1,714	Not Applicable
Main Tunnels	$6,353	
Pumping Plant & Surge Basin	$2,536	
Aqueduct Pipe & Tunnels	$563	
Discharge Structure	$99	
Access Logistics & Early Works	$253	
Communication	$13	
Restoration	$17	
Construction Subtotal	**$11,548**	
Contingency (30%)	$3,464	
Total Construction Cost	**$15,012**	
Other Program Costs		
DCO Oversite	$426	2.84%
Program Management Office	$668	4.45%
Engineering / Design /Construction Management	$2,167	14.44%
Permitting and Agency Coordination	$67	0.45%
Total Planning/Design/Construction Management	**$3,328**	**22.17%**
Land	$158	Not Applicable
DWR Mitigation	$960	
Power	$415	
CCWD Settlement Agreement	$47	
Community Benefits Program	$200	
Total Other Costs	**$1,780**	
TOTAL PROJECT COSTS	**$20,120**	

[a] Costs are in 2023 dollars and are undiscounted.

7. Total Project Costs with Innovations

Following project approval, DWR directed DCA to further evaluate several project features presented in the EPR/EIR and consider potential design or construction innovations to improve constructability or further reduce community or environmental disturbances, schedule, and/or costs. This evaluation resulted in a set of potential innovations at this early conceptual stage of the project that are considered by the DCA to be reasonable and credible based on industry experience. The innovations discussed herein do not represent changes to the project description presented in the EPR and analyzed in the EIR, but rather provide an indication of how normal design development processes can help manage costs for large infrastructure projects. As the innovation concepts advance, DWR will determine and document the need for any revisions to the project description, which will be used by DWR to determine if additional reviews will be required under CEQA and/or for project permitting. Appendix B summarizes the considered innovations.

Innovation concepts were initially developed by the DCA through a screening process that evaluated compatibility and appropriateness given the current level of project definition. The resulting 19 innovation concepts were then advanced into initial concept design to support an analysis of potential cost savings compared to those taken from drawings and other information contained in the EPR and EIR documents.

Table 7-1 presents the estimated construction cost savings for the combined set of innovations, grouped by project feature, reflecting reductions in construction quantities, crews, and equipment. The total construction cost savings includes a proportionally scaled portion of risk treatment cost (see Table 4-1).

Table 7-1 Construction cost savings from recommended combined set of innovations

Feature	Construction Cost Savings ($M[a])	Risk Treatment Cost Savings ($M[a,b])	Total Construction Cost Savings ($M[a])
Intakes	$35	$1	$36
Tunnels & Shafts	$211	$12	$223
Pumping Plant & Surge Basin	$370	$6	$376
Aqueducts	$75	$3	$78
Discharge Structure	$40	$1	$41
Logistics	$18	$1	$19
Total	**$749**	**$24**	**$773**

[a] Costs are in 2023 dollars and are undiscounted.

[b] Risk treatment cost savings are estimated as a scaled proportion of construction cost savings relative to the Total Project Cost estimate for the Bethany Reservoir Alignment as depicted in the EIR/EPR.

Table 7-2 compares the total project cost estimate described in Section 6 to a potential total project cost estimate associated with these early innovation concepts. The cost reductions associated with the innovations (see Table 7-1) only account for potential reductions in construction costs including risk treatment costs. In order to provide an indication of the potential full cost savings of innovations as described in Appendix B, contingencies and other program costs were applied proportionally to the revised construction costs. The costs for land acquisition, mitigation, power, the CCWD settlement agreement, and the community benefits program were not adjusted from the total project cost estimate described in Section 6 of this memorandum.

Table 7-2. Summary of Total Project Cost and Total Project Cost with Innovations

Feature	Total Project Cost ($M[a])	Percent of Construction (%)	Total Project Cost with Innovations ($M[a])
Construction Costs			
Intakes	$1,714	Not Applicable	$1,678
Main Tunnels	$6,353		$6,130
Pumping Plant & Surge Basin	$2,536		$2,160
Aqueduct Pipe & Tunnels	$563		$485
Discharge Structure	$99		$58
Access Logistics & Early Works	$253		$234
Communication	$13		$13
Restoration	$17		$17
Construction Subtotal	**$11,548**		**$10,775**
Contingency (30%)	$3,464		$3,233
Total Construction Cost	**$15,012**		**$14,008**
Other Program Costs			
DCO Oversite[b]	$426	2.84%	$398
Program Management Office[b]	$668	4.45%	$623
Engineering/ Design /Construction Management[b]	$2,167	14.44%	$2,022
Permitting and Agency Coordination[b]	$67	0.45%	$63
Total Planning/Design/Construction Management[b]	**$3,328**	**22.17%**	**$3,106**
Land	$158	Not Applicable	$158
DWR Mitigation	$960		$960
Power	$415		$415
CCWD Settlement Agreement	$47		$47
Community Benefits Program	$200		$200
Total Other Program Costs	**$1,780**		**$1,780**
TOTAL PROJECT COSTS	**$20,120**		**$18,894**

[a] Costs are in 2023 dollars and are undiscounted.

[b] DCO Oversite, Planning, Design, and Construction Management costs are assumed to be the same percentage of construction as the total project cost estimate.

As shown in Table 7-2, reductions in construction effort associated with a set of reasonable and credible innovations identified at this early stage of design has the potential to reduce the total cost of the project by $1.23B, or approximately 6%. Cost savings shown in Table 7-2 are limited to just those derived from changes in construction cost and proportional reductions in risk treatment costs and labor associated with planning, design, and construction management. Potential additional cost savings associated with innovations that were not considered in the analysis include:

- Reduced schedule durations for individual project features could reduce overhead costs and escalation impacts associated with individual components of the project.
- Reduced schedule durations for project features that affect the overall project schedule (i.e. “critical path” features) could potentially expedite the overall project construction timeline resulting in reduced overhead costs and escalation impacts. Expediting the overall project schedule could also bring the project into operation sooner.
- Innovations may reduce the impact of uncertainty within the cost estimate currently captured by risk treatment costs and project contingencies.
- Innovations may reduce the land required for construction and operations of the project, which could reduce land acquisition costs.
- Innovations may reduce the impacts of construction and operations, which could reduce mitigation requirements associated with the project.

The potential benefits of the identified innovations or future innovations should be further analyzed as project definition improves. Additional benefits of potential design or construction innovations to improve constructability or further reduce community or environmental disturbances, schedule, and/or costs savings associated with potential innovations could be realized but would require further analyses in coordination with DWR.

8. References

AACE International (AACE). 2020. 17R-97: Cost Estimate Classification System Recommended Practice. August 7.

California Department of Water Resources (DWR). 2023. Delta Conveyance Project Final Environmental Impact Report. December 2023. SCH# 2020010227.

Delta Conveyance Design and Construction Authority (DCA). 2022. Delta Conveyance Final Draft Engineering Project Report. Bethany Reservoir Alternative. May 2022.

Delta Conveyance Design and Construction Authority (DCA). 2023. Delta Conveyance Final Draft Engineering Project Report Update Bethany Reservoir Alternative. November 2023.

Appendix A
Bethany Reservoir Alignment Basis of Estimate – Construction Costs

Subject	**Bethany Reservoir Alignment Basis of Estimate – Construction Cost**
Project Feature	Project-wide
Prepared For:	Delta Conveyance Project (DCP) File
Prepared By:	Delta Conveyance Design and Construction Authority (DCA)
Copies To	California Department of Water Resources (DWR) / Delta Conveyance Office (DCO)
Date/Version	May 8, 2024 / Version 2
Reference No.	EDM_PW_CE_MEM_Bethany-Construction-Cost-BoE_001324_V02_D_20240508

1. Introduction

This memorandum prepared by the Delta Conveyance Design and Construction Authority (DCA) describes construction cost development methods and procedures for the Delta Conveyance Project Bethany Reservoir Alignment (Project). The documentation includes the rationale, assumptions, pricing sources, and other inputs to the estimating process used by the team in development of the construction cost estimate.

1.1 Purpose

The purpose of this document is to provide a construction cost estimate for the project as defined in the Final Environmental Impact Report (EIR) prepared by the California Department of Water Resources (DWR) and the supporting Engineering Project Report (EPR) prepared by the DCA. This document is in the form of a Basis of Estimate (BOE) and describes how construction costs have been developed for the Bethany Reservoir Alignment (6,000-cubic-foot-per-second [cfs] capacity) with the rationale, assumptions, pricing sources, and other inputs to the estimating process DCA used to develop the cost estimate. This estimate is presented in 2023 dollars and is "undiscounted", meaning the value does not account for the time value of money.

This BOE complies with Association for the Advancement of Cost Engineering International (AACE) *34R-05: Basis of Estimate Recommended Practice* (AACE, 2021). The estimate has been prepared using a standard process for a defined scope, as discussed within this report. DCA understands the assumed facility arrangements are at a conceptual planning level. As design development progresses, any potential changes are expected to be within the expected range of accuracy of the construction estimate.

Section 15 summarizes the total construction cost, and Attachments 1 and 2 provide more detailed breakdowns of the cost components.

Contingency has not been included and is being developed separately as part of the project cost management process.

This BOE is limited to the development of construction costs and excludes other program costs, such as planning, design, and construction management labor costs (soft costs), or other activities associated with delivering the project beyond the direct construction costs. This document also excludes the costs for providing electrical power and transmission to support the project, because those costs are being coordinated with the utility provider. All of these other program costs will be reported separately in the total project cost summary document, and thus are not included in this BOE.

1.2 Organization

This document is organized as follows:

- Introduction
- Project Scope of Work
- Estimate Methodology
- Estimate Classification
- Design Basis
- Planning Basis (Schedule)
- Cost Basis
- Allowances
- Assumptions
- Exclusions and Exceptions
- Program Risks
- Risk Treatment Costs
- Contingency
- Estimate Checking and Review
- Summary
- References
- Document History and Quality Assurance

1.3 Background

DCA completed Engineering Project Reports (EPRs) that presented conceptual engineering information for three potential conveyance alignments for the project: Central alignment, Eastern alignments, and Bethany Reservoir alignment (DCA, 2022a and DCA, 2022b). Updates to these reports were prepared in late 2023 (DCA, 2023a and DCA, 2023b). On December 21, 2023, DWR approved the project and certified the Environmental Impact Report (EIR) (DWR,2023). Based upon an extensive environmental review, as documented in the EIR, DWR selected the Bethany Reservoir Alignment for further engineering, design, and permitting.

This report provides the BOE for construction costs associated with the Bethany Reservoir Alignment for the 6,000-cfs flow capacity, as presented in the EPR and EIR.

1.4 Approach

This BOE complies with AACE *34R-05: Basis of Estimate Recommended Practice* (AACE 2021). It has been developed using a buildup of quantities for the key features where drawings and quantity information are available. Other less-defined elements of work have been developed with stochastic methods using judgment and experience, and these have been added to the estimate either as built-up or allowance items. The structure of the estimate assigns the work elements into a work breakdown structure (WBS) based on anticipated works contracts that are broadly based on the main discipline features and key site locations. The feature and WBS groupings are subject to revision as the project definition is further developed.

This BOE presents the key elements in a general north to south sequence, followed by the early site development and logistics works. Section 3 provides details about the construction estimate methodology. Note the following comments regarding the estimate:

- The estimate was prepared using 2023 prices.
- A preliminary set of construction activities has been developed in conjunction with the cost estimate for assessment of activity durations and interfaces.
- Lump sum allowances are included for elements of work where no design information was available or if the estimates were provided for items not included in the DCA scope.

2. Project Scope of Work

This section describes the facilities and elements of work included in this BOE. The project scope of work aligns with the 6,000-cfs Bethany Reservoir Alignment as presented in the *Delta Conveyance Final Draft Engineering Project Report, Bethany Reservoir Alternative* (DCA 2022b) and updates to the EPR issued in November 2023 (DCA 2023).

2.1 Layout

Figure 2-1 shows the following proposed conveyance facility features:

- **Intake C-E-3 and Intake C-E-5:** Two 3,000-cfs intakes located along the Sacramento River.
- **Main Tunnel and Shafts:** 36-foot internal diameter tunnel, approximately 45 miles long, connecting C-E-3 and C-E-5 to the Bethany Reservoir Pumping Plant (BRPP) with 11 shafts, inclusive of the surge basin shaft, along the alignment used for launching, reception, and maintenance.
- **Surge Shaft and Surge Basin:** Shaft is used as a reception shaft connecting the Main Tunnel to the Surge Basin and providing connection to the BRPP wet well inlet conduit.
- **Bethany Reservoir Pumping Plant:** A 6,000-cfs pumping plant with wet well and dry pit structures housing fourteen vertical centrifugal end suction type pumps.
- **Aqueduct**: Four 15-foot-diameter parallel pipelines approximately 2.5 miles long each, which include 2 tunneled sections and vertical shafts at the connection to the Discharge Structure.
- **Discharge Structure:** Located at Bethany Reservoir to discharge flow delivered from the Aqueduct.
- **Logistics works**: Including access, power, and utilities.

Figure 2-1. Schematic of Project features

The total alignment is illustrated on the project map (Figure 2-2), extending from the Intake facilities to the discharge facilities in Bethany Reservoir for delivery to the existing State Water Project.

The 6,000-cfs-project includes two river intake facilities on the Sacramento River, with on-bank intake structures and sedimentation basins that connect to the main tunnel via drop shafts. The main tunnel at 36-foot-inside-diameter (ID) and approximately 45 miles long, would be constructed as four reaches driven in opposite directions from the Twin Cities Complex and Lower Roberts Island double launch shafts. The tunnel drives would end at reception shafts at Intake 3, Terminous Tract, and the Surge Basin located at the BRPP, with all other shafts used as maintenance shafts during construction of the tunnel and for future project operations and maintenance. The Surge Basin and BRPP at the southern end of the alignment connect to a four-pipeline aqueduct and the discharge structure at Bethany Reservoir.

Figure 2-2. Project Map

Data Source: DCA, DWR

2.2 Features

2.2.1 Intakes

The intakes, C-E-3 (Intake 3 [or B per the EIR]) and C-E-5 (Intake 5 [or C per the EIR]), and associated sedimentation facilities are designed to divert up to 6,000 cfs (3,000 cfs maximum per intake) from the Sacramento River. Each intake consists of the following major components:

- Intake structure
- Thirty fish screens (T-screen option)
- Thirty 60-inch-diameter discharge pipes from Intake to Sedimentation basin
- Sedimentation basin
- Flow control and isolation gate structure
- Four sediment drying lagoons
- Appurtenant features

The two intake sites, along with sedimentation basin facilities, are located in the northern Delta along the Sacramento River near the town of Hood.

Figure 2-3 provides a conceptual rendering of one of the on-bank intake and sedimentation facilities. The intakes have on-bank cylindrical tee fish screens. The various control gates would be used to comply with the approach velocity of 0.2 foot per second (fps) at the fish screens and the 3,000 cfs maximum flow per intake. The sedimentation basins would be designed to remove sand-sized settleable solids before entering the conveyance system.

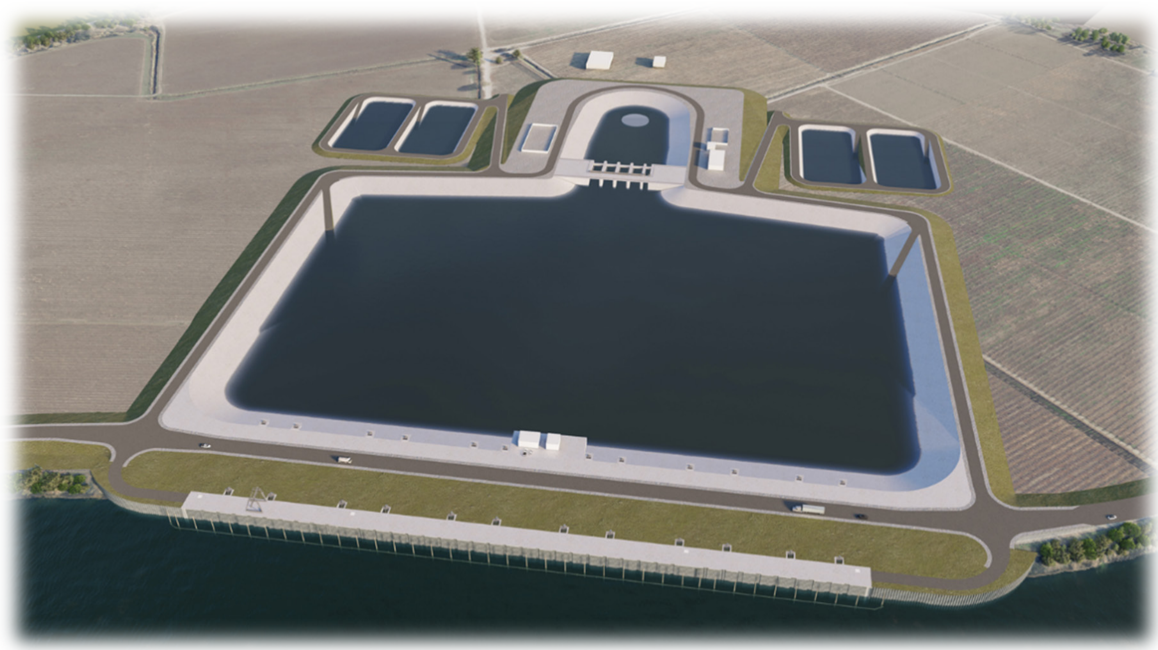

Figure 2-3. Conceptual On-bank Intake and Sedimentation Facilities

2.2.2 Tunnel and Shafts

The single main tunnel alignment is a 36-foot-ID tunnel, approximately 45 miles long and composed of four tunnel reaches. Each tunnel reach is driven between a launch and a reception shaft using a tunnel boring machine (TBM). From Figure 2-2, there are two double launch shafts and three reception shafts. The launch shafts consist of two double launch shafts with interlocking 115-foot-ID shafts, named the Twin Cities Double Launch Shaft, and the Lower Roberts Island Double Launch Shaft. The reaches heading south from the Twin Cities Double Launch Shaft and north from the Lower Roberts Island Double Launch Shaft terminate into the Terminous Tract Reception Shaft with a 70-foot ID. The reach heading north from the Twin Cities Double Launch Shaft terminates at the C-E-3 Intake Reception Shaft with an 83-foot ID; this shaft also serves as an outlet shaft for Intake 3. The fourth tunnel reach, heading south from Lower Roberts Island Double Launch Shaft, terminates into the Surge Basin Reception Shaft with a 120-foot ID.

Between each launch and reception shaft, intermediate maintenance shafts, each at a 70-foot ID, are provided approximately every 5 miles, for a total of 6 maintenance shafts (Figure 2-2). These shafts are provided for TBM maintenance and temporary access during construction. The C-E-5 Intake Maintenance Shaft also serves as an outlet shaft for Intake 5 and is sized at 83-foot-ID.

The average shaft depth is approximately 180 feet, with an average tunnel invert depth of approximately 140 feet below existing grade (refer to the EPR conceptual drawings for detailed dimensions). These shafts would be constructed to a top elevation about 25 to 45 feet above existing grade for flood protection during tunnel construction and during operations. The shafts are also constructed to a top elevation to maintain the maximum water surface elevation expected within the shaft during a surge event caused by sudden stoppage of the pumping station.

Tunnel construction includes installing 6-foot-long precast concrete segmental lining rings. Each ring would consist of seven segments plus the key, with a thickness of about 18 inches.

2.2.3 Bethany Reservoir Pumping Plant Complex

The BRPP Complex covers all the works within the project area north of Kelso Road and before the aqueduct continues south toward the Bethany Reservoir. The main features included in the BRPP Complex include the Surge Basin Reception Shaft, Surge Basin, BRPP, inlet conduit connecting the reception shaft to the wet well within the BRPP, and the main deep box pumping plant with the aqueduct pipes between the box and the aqueduct interface at Kelso Road.

2.2.3.1 Surge Basin Reception Shaft

The Surge Basin Reception Shaft is a 120-foot-ID and 205-foot-deep structure that would first serve as the Main Tunnel reception shaft from the southern Lower Roberts Island Double Launch Shaft reach. Once the TBM is removed and the tunnel reach completed, the shaft would be modified to become the Surge Basin overflow structure and the connection to the inlet conduit to the pumping plant. The Main Tunnel connects to the base of the shaft and the inlet wet well conduit connects on the opposite side, approximately 65 feet higher in elevation.

2.2.3.2 Surge Basin

The Surge Basin structure is an open-top, rectangular, below-ground-level basin. The top of the basin would be at existing grade and the bottom elevation (top of floor slab) at about 30 or 40 feet below the ground surface (Figure 2-4).

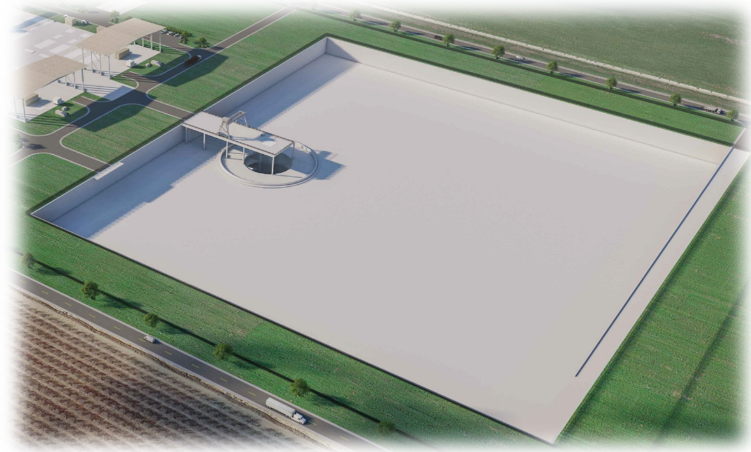

Figure 2-4. Surge Basin (Bethany)

The Surge Basin would be located immediately to the east of Mountain House Road and would contain an access ramp that would connect to an access road to Mountain House Road to facilitate the removal of the TBM and vehicle access during the construction and operation of the Surge Basin.

The Surge Basin would normally be empty and would be used during infrequent hydraulic transient-surge events created by power failure or sudden stoppage to the pump station. Under these conditions, surge flows in the Main Tunnel would flow into the Surge Basin through the Surge Basin Reception Shaft. A circular weir wall with gates would be located around the top outlet of the shaft to allow water to overflow into the Surge Basin and prevent these overflows from immediately re-entering the tunnel.

The Surge Basin would include a gantry crane on a bridge structure between the southern edge of the basin and the vertical reception shaft. The bridge structure would include a removable panel, centered over the reception shaft, and a rail-mounted gantry crane that would be used to install portable submersible pumps and connect discharge piping into the reception shaft to dewater the tunnel.

2.2.3.3 Inlet Wet Well Conduit

The inlet wet well conduit would convey water from the Surge Basin Reception Shaft to the BRPP wet well. The inlet wet well conduit would be approximately 400 feet long, and 60 feet wide. Two sets of isolation bulkhead gates and openings would be provided in the inlet wet well conduit to isolate water flowing through the conduit and entering the BRPP wet well during inspection or maintenance, with double isolation provisions for the safety of the workers. The overhead-mounted gantry crane on the Surge Basin bridge structure would be used to install and remove the bulkhead panels.

2.2.3.4 Pumping Plant

The BRPP facilities would be adjacent to the surge basin (refer to Figure 2-5). The pumps lift water from a wet well hydraulically connected to the surge shaft via the inlet wet well conduit. The pumps would be operated to maintain the flow rate supplied into the tunnel at the northern Sacramento River intakes. The desired flow of the pumping plant would range from a minimum of 600 cfs to a maximum of 6,000 cfs, which would be achieved with fourteen 500-cfs pumps (12 duty pumps and 2 standby pumps).

The major components of the BRPP include the below-ground pumping plant and wet well, above-ground water surge tanks (open to atmosphere), electrical building, heating and air conditioning mechanical equipment yard, transformer yard, electrical substation adjacent to the electrical building, standby engine generator building, equipment storage building, offices, welding shop, machine shop, storage area, and a walled enclosure/storage facility and two separate dry-pit pump bays adjacent to the wet well.

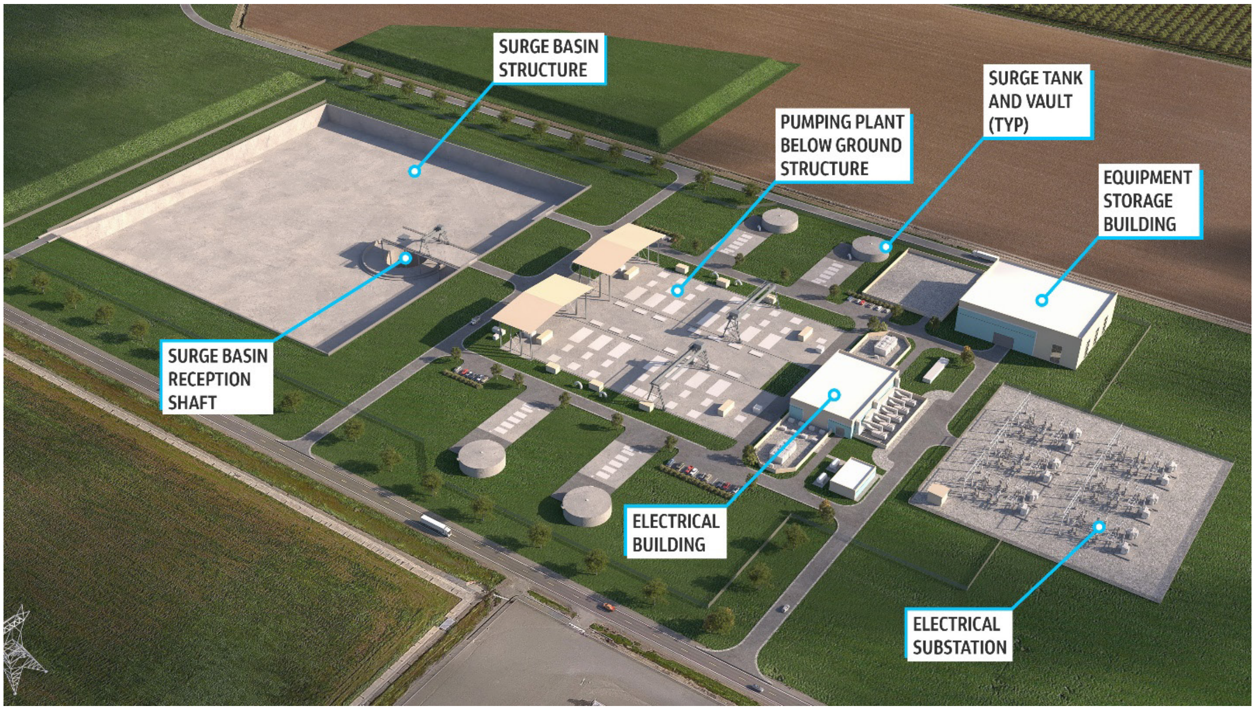

Figure 2-5. Bethany Reservoir Pumping Plant

2.2.4 Aqueduct

For the Bethany Reservoir Alignment, the aqueduct would convey water from the BRPP to Bethany Reservoir Discharge Structure located along the bank of the existing State Water Project Bethany Reservoir. The Bethany Reservoir Aqueduct would consist of four pressurized 180-inch-ID welded steel pipes. Each pipeline would convey up to 1,500 cfs. The aqueduct pipelines would be constructed using open-cut and backfill trench methods, except where the aqueduct pipelines crossed beneath the existing C. W. “Bill” Jones Pumping Plant discharge penstocks and the existing Bethany Reservoir Conservation Easement near Bethany Reservoir, where tunneling methods would be used for aqueduct construction (Figure 2-6).

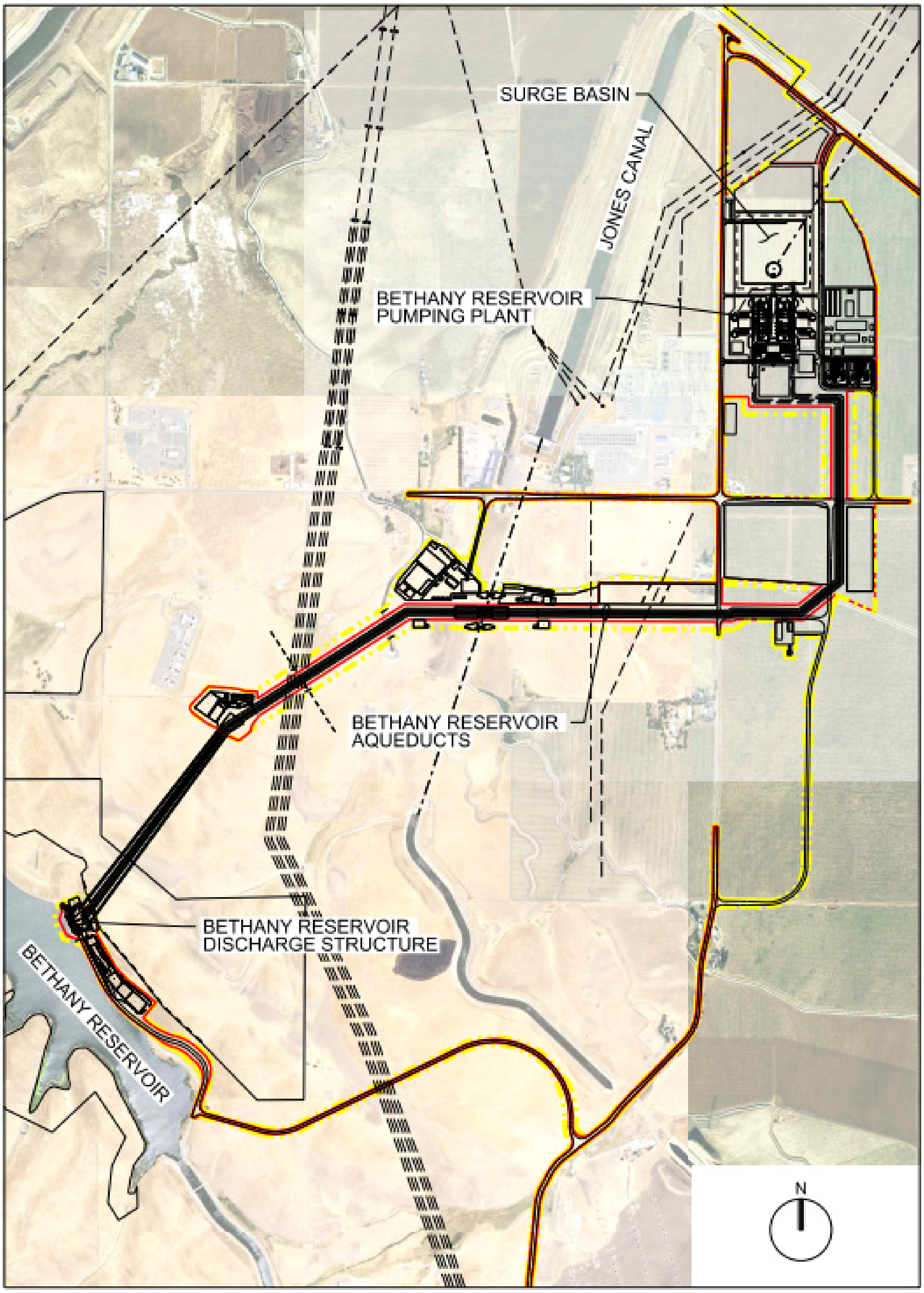

Figure 2-6. Bethany Aqueduct pipeline

2.2.5 Early Works Access Logistics

This section describes the works identified to support the main works contracts. These items include provision of access, levee protection, power, and utilities that would be available at the start of a main construction activities. The work elements defined in this section include roads and rail.

2.2.5.1 Early Works – Logistics – Roads and Levee

Early works for roads include the following provisions:

- Sacramento County Roads
  - Employee Park & Ride facility at Hood Franklin Road
  - Hood Franklin Road Snodgrass Slough bridge widening
  - Intakes 3 & 5 access roads
  - Lambert Road widening
- Twin Cities Complex Access Roads and Levees
  - Dierssen Road paving
  - Franklin Boulevard improvements at Dierssen Road
  - Twin Cities Road widening (East)
  - Twin Cities Complex ring levee
- San Joaquin County Roads
  - New Hope Tract Blossom Road widening
  - Canal Ranch access road construction
  - Terminous Tract Highway 12 widening
  - King Island access road construction
  - Lower Roberts Island access road construction
  - Lower Roberts Island levee protection work
  - Upper Jones Tract access road construction
  - Union Island access road
- Bethany Complex Access Roads
  - Byron Highway Lindemann Rd intersection
  - Byron Highway frontage road
  - Kelso Road widening
  - Mountain House Road widening
  - Mountain House Road shaft access
  - Mountain House Road by-pass
  - Bethany Reservoir access road
- Bethany Reservoir Access Road
  - Bethany Reservoir access road

2.2.5.2 Early Works – Logistics – Rail

Early works for rail include the Lower Roberts Island Rail Yard construction and extension of the rail line from the Port of Stockton.

2.2.6 Early Works Power and Utilities

2.2.6.1 Power

Power supplies to the main works sites are not included in the base construction cost estimate because this provision is being developed by DWR in coordination with the power providers (SMUD, PG&E, WAPA). These costs will be included in the other program cost element of the total project cost estimate. The power costs for each individual project do include the costs for both temporary and permanent requirements at each project site, as necessary.

2.2.6.2 Utilities

Work to provide or protect utilities is included in the mobilization and site preparation estimates for each contract. This includes:

- General allowances where no details are available
- Water supply to Bethany Complex
- Protection works for the East Bay Municipal Utility District (EBMUD) aqueduct tunnel

2.2.7 Systemwide

2.2.7.1 Communications and Control

Systemwide communications systems include fiberoptic cable for each site. Control panel equipment at each facility is included within the individual feature projects.

2.2.7.2 Testing and Commissioning

Testing and commissioning for the project, which follows all construction, is not included in this construction estimate but is included in the total project cost estimate. An allowance for contractor participation and assistance with testing and commissioning equipment within each facility is included in the feature project costs.

3. Estimate Methodology

This estimate has been prepared with quantities taken from drawings and other information contained in the EPR documents and, where applicable, adjusted to reflect the conclusion set out in the EIR. The cost estimate has been prepared using the Heavy Construction Systems Specialists (HCSS) Heavy Bid estimating software platform. This is a crew-based estimating system that uses labor and equipment crew estimates to complete work activities for the anticipated method of construction and anticipated durations. Because of the scale and complexity of the project, a more rigorous estimating approach was used to develop the construction costs which included development of concept level drawings and technical memorandums, obtaining deterministic costs for unit rates and materials, replacing most of the cost allowances with actual estimates and material price quotes, and estimating the work based on the current understanding of subsurface ground conditions.

Surface facilities include the Intakes, Surge Basin, BRPP, Aqueduct pipelines, and Discharge Structure. Early works for access logistics and levee protection are also included in the surface works estimate and are separated into the individual work packages required.

Tunnel and shaft estimates have been prepared for the main 36-foot-internal-diameter tunnels, the pipejack tunnels at the intakes, and the tunneling and shaft work required for the aqueduct section from the BRPP to the Discharge Structure located at the Bethany Reservoir.

The WBS in Table 3-1 has been used to code cost items and is based on an assumed number of works contracts with associated construction elements. This WBS is used to assess the number of contractor setups required for the overall estimate. The contract grouping and total number of contracts are subject to change as the project develops.

Table 3-1. Work Breakdown Structure, and Estimate Coding

Feature Code	Feature Name	Contract Code	Contract Name
1	Intakes	13	Intake 3 Facilities
		15	Intake 5 Facilities
2	Tunnels and Shafts	21	Reach 1 Shafts & Tunnel (Twin Cities to Intake 3)
		22	Reach 2 Shafts & Tunnel (Twin Cities to Terminous)
		23	Reach 3 Shafts & Tunnel (Lower Roberts to Terminous)
		24	Reach 4 Shafts & Tunnel (Lower Roberts to Bethany Complex)
3	Pumping Plant	33	BRPP, Surge Basin, and Reception Shaft
5	Aqueduct	55	Bethany Aqueduct including Tunnels and Shafts
6	Discharge	66	Bethany Discharge Structure
7	Logistics	71	Sacramento County Access Roads – Intakes Access Roads and Park & Ride
		72	Twin Cities Advanced Sitework – Access Roads & Levees
		73a	Lower Roberts Island Access Roads and Park & Ride
		73b	State Route 12 Road
		74a	Bethany Complex Access Roads – Byron Hwy & Interchange
		74b	Bethany Complex Access Roads – BRPP area & Roundabout
		75	Bethany Reservoir Access Road
		76	Projectwide Road Maintenance
		77	Lower Roberts Island Rail & Rail Yard
		78	Lower Roberts Island Levee improvements advanced work
8	Communications & Power	83	SCADA Projectwide
		86	Power (SMUD)
		87	Power (PG&E)
		88	Power (WAPA)

Table 3-1. Work Breakdown Structure, and Estimate Coding

Feature Code	Feature Name	Contract Code	Contract Name
9	Environmental	91	Bouldin Island Compensatory Mitigation
		92	I-5 Pond Compensatory Mitigation
		93	Projectwide Restoration & Site Establishment

SMUD = Sacramento Municipal Utility District
PG&E = Pacific Gas and Electric Company
WAPA = Western Area Power Administration

4. Estimate Classification

DCA used the guidance provided in *17R-97: Cost Estimate Classification System Recommended Practice* (AACE, 2020) to determine the class of estimate. The engineering information available for these estimates is assessed to determine the maturity class of estimate as shown in Table 4-1. Based on this information, the project construction cost estimate falls generally within Class 4, although with some areas still at Class 5. The Class 4 designation should be considered an overall classification level; individual project features would have different levels of design maturity that contribute to this judgement.

Table 4-1. Estimate Maturity Checklist

General Project Information	Class 5 Initiation	Class 4 Planning
Project Scope Description	Preliminary	**Advanced** [a]
Plant Capacity	Assumed	**Advanced** [a]
Site Location	Assumed	**Specific** [a]
Site Layout	None required	**Preliminary** [a]
Earthwork Quantities	None required	**Preliminary** [a]
Process Selection and Criteria	None required	**Preliminary** [a]
Design Discipline Criteria and Standards	None required	**Preliminary** [a]
Equipment Lists	**None required** [a]	Preliminary
Geotechnical Information	**None required** [a,b,c]	**Preliminary** [a,b,c]
Permitting Requirements	**Assumed** [a]	Preliminary
Site Environmental Survey	**None required** [a,b]	**Preliminary** [a,b]
Site Hazards Survey	**None required** [a]	Preliminary
Aerial Photography	None required	**Preliminary** [a]
Site Survey	**None required** [a,b]	**Preliminary** [a,b]
Building Programming	**None required** [a]	Preliminary
Architectural Material Boards	None required	**None required** [a]
Traffic Plan	None required	**None required** [a]
Acoustical Study	None required	**None required** [a]
Contract Packaging Strategy	**None required** [a]	Advanced

Table 4-1. Estimate Maturity Checklist

General Project Information	Class 5 Initiation	Class 4 Planning
Equipment Procurement Approach Calculations	**None required** [a] None required	Preliminary **Preliminary** [a]
Project Schedule	Assumed	**Preliminary** [a]
Project Risk Log	Assumed	**Preliminary** [a]

Notes:
[a] **Bold and underline** text represents the current class of information available.
[b] Information levels may vary for project features where both columns are **bold and underline**
[c] Majority of tunnel alignment has no Geotechnical information

The accuracy of the estimate is proportionally impacted by considering different project elements such as underground tunneling requirements, the project's location in an environmentally sensitive area, limited geotechnical information, permitting requirements, a site environmental survey, and a site hazards survey. The additional uncertainty associated with defining these elements should also be reflected in the project risk management approach and associated consideration of contingency costs allowance that are not included in this construction cost estimate.

Figure 4-1 shows the class location of this estimate within the varying limits of accuracy. The range of accuracy will decrease as the class of estimate becomes more definitive (decreasing class number) from left to right according to AACE 17R-97 (AACE, 2020). The construction cost estimate provides the DCA's opinion of the most probable cost. Due to the uncertainty associated with ground conditions along the tunnel alignment and industry experience with underground tunneling projects, DCA has assigned an accuracy range between +80% and -55% to the current cost estimate. The zero axis represents the current total construction estimate including appropriate contingency with the 80% confidence interval range represented by percentage increase or decrease on that value.

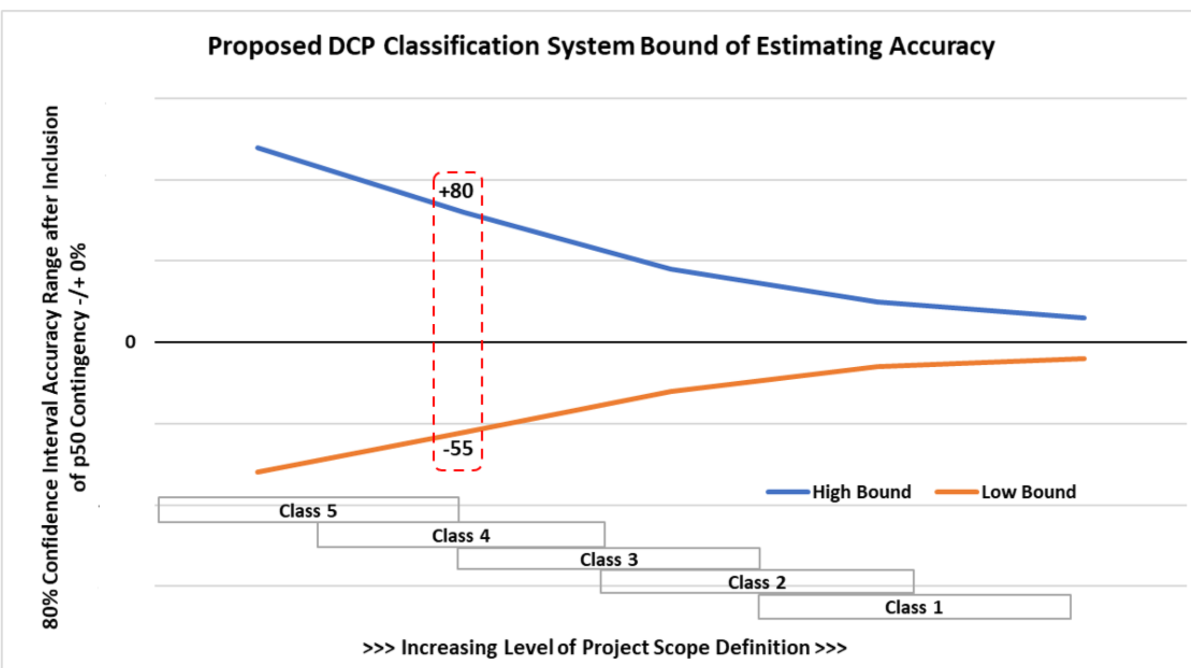

Figure 4-1. DCA Estimate Class within Range of Accuracy Modified from AACE 17R-97

The Class 4 estimate for the DCP is primarily presented to support project financial and economic analysis and to provide guidance for further project development. The final costs of the project once constructed will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors.

5. Design Basis

The scope of the project used for this estimate is as defined in the EPRs (DCA 2022a, 2022b) and the EPR Update (DCA 2023a, DCA 2023b). These documents contain summaries for the Central and Eastern Alignments and for the Bethany Reservoir Alignment, as well as concept-level engineering drawings and supporting technical memoranda. This BOE document only considers the 6,000-cfs capacity option for the Bethany Reservoir Alignment together with the tee-screen option for the intake structures.

6. Planning Basis

This section describes the basis for developing the sequence of activities used in conjunction with the construction estimate. The sequence has been used to support the development of duration-related costs in the estimate. Refer to the construction portion of the DCP summary schedule presented in Figure 6-1.

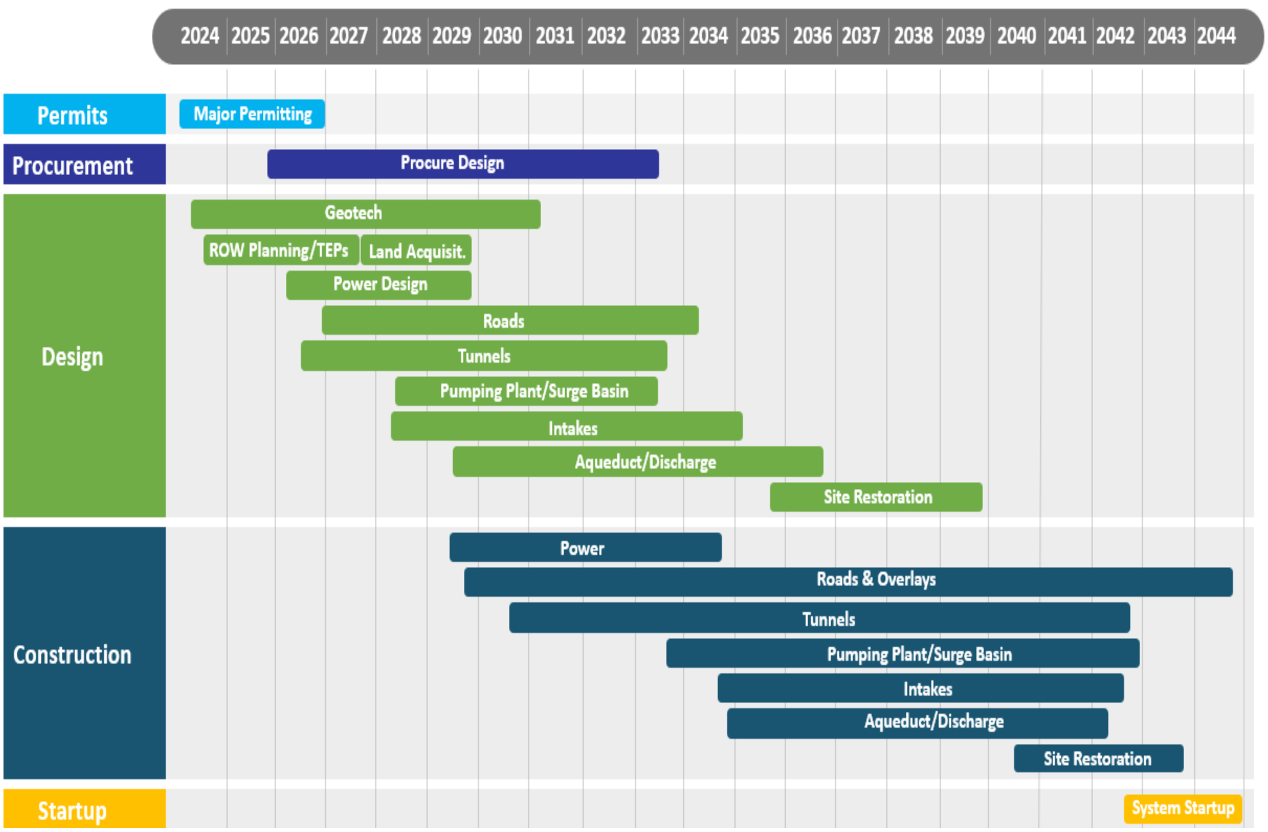

Figure 6-1. Delta Conveyance Project Summary Schedule

6.1 Preconstruction Activities

For this BOE, the preconstruction activities are assumed to include all activities required to achieve the start of early works construction, followed by main works construction.

6.2 Construction Sequence

Preliminary construction sequences were developed using the activities from the HCSS estimate. The estimate includes the allocated resources required to perform each task to complete the work. These tasks would include labor, equipment, materials, and, in some cases, subcontracts. The estimators calculated the time that would be required to perform each individual task for a given crew. The arrangement of activities is based on this effort, and depending on the type of work performed, the durations were adjusted to reflect likely work sequences. The durations were also adjusted to accommodate multiple crews working concurrent where necessary.

7. Cost Basis

Following is a summary of the cost element considerations. In general, all costs are based on 2023 dollars reflecting local area rates.

- Material Prices – material prices in the estimate are using 2023 prices. Concrete prices are based on supply from commercial or onsite batch plants and the estimate considers the cost of construction and operations of the batch plant to be included in the concrete unit rates.
- Labor Rates – labor rates are based on prevailing wage rate determination for the local area with fringe benefits and are fully burdened to include tax, insurance, and overtime, and are adjusted for the anticipated shift pattern. Typical fringes vary and may include health & welfare, pension, vacation & holiday, and training.
- Equipment Rates – equipment rates are sourced from established and industry accepted databases reflecting the nature of the work, such as U.S. Army Corps of Engineers and Equipment Watch Cost Reference Guide, or from quotes obtained from suppliers. Rates used could be overall hourly hire rates, or operating rates and ownership costs if the equipment is purchased.
- Productivity – crews were developed for each type of work based on either labor or equipment-based production, and generally using a 5-days-per-week, 24-hour schedule for tunneling and some shaft work elements, and single 10-hour shifts for other surface works.
- Indirect Costs – indirect costs are generally project specific overhead costs that are not associated with a specific work element. Their value can be spread over the project duration and often determined by the duration of the works. Typical types of indirect cost include:
  - Management and supervision salaries
  - Engineering salaries
  - Administrative salaries
  - Automobile and other miscellaneous expenses
  - General plant and facilities costs
- Sales Tax – sales tax rates of 9.25% were used on equipment and materials required for the project. Duty fees were applied where applicable.
- Escalation – the estimate does not include escalation for the construction period and for future start dates. The prices are in 2023 dollars.

- Contractor Mark-up and Profit – industry accepted contractor overheads and profits reflective of the nature of the work are applied.
- Add-on Costs – insurance, bonds, and other add-on costs are included in the estimates.

8. Allowances

Allowances are resources included in estimates to cover the costs of known but undefined requirements for an individual activity, work item, account, or subaccount. This estimate recognizes the following allowances associated with the project:

- Allowance for all diesel-/gas-powered equipment to become zero emissions by 2035.
- Allowance for testing and commissioning of mechanical & electrical equipment before the systemwide commissioning.

With the development of the design, these allowances would become incorporated into future revisions of the main estimates and design drawings.

9. Assumptions

As is normally the case, certain assumptions were made to reflect the conceptual level of design development. These assumptions may be related to the scope of the work where the design documents do not provide full details, or related to the pricing where the buildup of the cost may require specific experience-based assumptions. As the design progresses, these assumptions will be confirmed or refined.

10. Exclusions and Exceptions

Exclusions and exceptions are costs that might normally be considered part of the estimate but have not been included because they are not part of the scope or are included in other non-construction parts of the project. This construction estimate does not include the following items.

- Construction cost contingency
- Electrical power supply and associated infrastructure to deliver power to work sites, which are being incorporated in the overall project estimate as part of the other program costs noted below
- Other program-related costs, including:
  - DWR oversight costs
  - DWR EIR mitigations costs
  - DCA planning, design, and construction management costs
  - DCA permitting and other administrative cost
  - Power costs (power supply to the work sites and consumption during construction)
  - Land-right-of-way costs
  - Settlement Agreements
  - Community Benefits Program

11. Program Risks

A program-level evaluation of potential risks is ongoing and will be used to identify areas of potential additional costs and potential saving opportunities.

12. Risk Treatment Cost

Risk treatment costs have been assessed as part of the risk evaluation process and are considered for each feature type. These risk treatment costs are considered containment costs to help manage potential risks by reducing threats and improving opportunities and are included in this construction cost estimate assigned to each project element based on the associated features and value of the project. Attachment 3 provides details about this distribution.

13. Contingency

As noted above, the construction estimates presented in this document include risk treatment costs but do not include contingency. Contingency is an amount added to a construction cost estimate to account for uncertain items, conditions, or events that are likely to result in additional project costs. An assessment of the construction contingency would be derived by an assessment of the current state of design development, evaluation of program risks and judgement. Together, these assessments would be used to establish an appropriate construction contingency amount that would be added to the construction cost. Contingency is included and documented as part of the total project cost estimate.

14. Estimate Checking and Review

The estimating review and validation process included the following:

- Internal checks by the estimating team
- Design review with estimating team and design team
- Independent estimate and reconciliation with the DCA program management support team
- Management review with executive managers within DCA

As indicated above, the DCA program management support team completed an independent check estimate. A reconciliation process was completed comparing the DCA's Engineering Design Management team's estimate to the check estimate following industry recognized guidelines (Sundaram, 2024).

Using the EPR (2022b) and updates to the EPR (2023b) to prepare both estimates, a cost comparison was performed at the project level of the WBS. The independent check did not include some elements of work, such as the compensatory mitigation and power supply projects. Items with significant variances were reconciled through a series of meetings between the lead estimators for the relevant features, and appropriate modifications to the estimate were agreed upon. Through this process, an overall reconciled cost difference was obtained.

15. Summary

Table 15-1 summarizes the updated 2023 construction cost estimate. More detailed summaries are provided in Attachments 1 and 2, which show the buildup of cost types and bid items respectively.

Table 15.1. Bethany Reservoir Alternative – Direct Construction Cost Estimate Summary

Feature	Contract/Element	Construction Estimate ($M[a])	Risk Treatment ($M[a])	Total Construction Cost ($M[a])
Intakes	13- Intake 3 Facilities	855	28	882
	15- Intake 5 Facilities	806	26	832
Main Tunnels	21- Reach 1 Shafts & Tunnel (Twin Cities to Intake 3)	1,033	60	1,093
	22- Reach 2 Shafts & Tunnel (Twin Cities to Terminous)	1,735	95	1,830
	23- Reach 3 Shafts & Tunnel (Lower Roberts to Terminous)	1,292	69	1,362
	24- Reach 4 Shafts & Tunnel (Lower Roberts to Bethany Complex)	1,958	111	2,068
Pumping Plant	33- BRPP, Surge Shaft and Basin	2,496	40	2,536
Aqueduct	55- Bethany Aqueduct Pipeline, Tunnels and shafts	541	22	563
Discharge	66- Bethany Reservoir Discharge Structure	95	4	99
Access Logistics	71- Sacramento County Access Roads – Intakes and Park & Ride	30	1.6	32
	72- Twin Cities Advanced Sitework – Access Roads & Levees	20	1.0	21
	73a – San Joaquin County Access Roads Lower Roberts Island and Park & Ride	46	2.3	48
	73b – State Route 12 Access Road – Terminus Site	2	0.1	2
	74a – Bethany Complex Access Roads – Byron Hwy & Interchange	60	3.1	63
	74b – Bethany Complex Access Roads – BRPP area & Roundabout	21	1.1	22
	75- Bethany Reservoir Access Road	10	0.5	11
	76- Projectwide Road Maintenance	25	1.3	26
	77- Lower Roberts Island Rail & Rail Yard	16	0.8	17
	78- Lower Roberts Island Levee improvements advanced work	10	0.5	11
Communication	83- SCADA Projectwide	13	-	13

Table 15.1. Bethany Reservoir Alternative – Direct Construction Cost Estimate Summary

Feature	Contract/Element	Construction Estimate ($M[a])	Risk Treatment ($M[a])	Total Construction Cost ($M[a])
Restoration	93 - Projectwide Restoration & Site Establishment	17	-	17
	Total Direct Construction[b, c, d]	**11,081**	**467**	**11,548**

[a] Costs are in 2023 dollars and are undiscounted
[b] Total excludes provision of electrical power supply and associated infrastructure to deliver to work sites
[c] Total includes Risk Treatment costs
[d] Total excludes contingency

Note that Attachments 1 and 2 include costs for several compensatory mitigation projects that have not been included in Table 15-1. The estimates for these elements are as follows:

- Bouldin Island Compensatory Mitigation = $36.4 M
- I-5 Pond Compensatory Mitigation = $54.3 M

The costs associated with these compensatory mitigation projects will be incorporated in the total project cost estimate as part of the DWR Mitigation other program cost item.

16. References

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17. Document History and Quality Assurance

The reviewers listed here have completed an internal quality control (QC) review and approval process for deliverable documents that is consistent with procedures and directives identified by the Engineering Design Manager and the DCA.

Rev.	Date	Version Description	Approval Names and Roles			
			Prepared by	Internal QC Review by	Consistency Review by	Approved for Submission by
0	02/29/2024	Initial submission	Martin Ellis / Cost & Schedule Lead	Shaun Firth / QC Reviewer	Adam Murdock / Engineering Design Manager	Terry Krause / Engineering Project Manager
1	04/01/2024	Revised draft	Martin Ellis / Cost & Schedule Lead	Shaun Firth / QC Reviewer	Adam Murdock / Engineering Design Manager	Terry Krause / Engineering Project Manager
2	05/08/2024	Revised draft	Martin Ellis / Cost & Schedule Lead	Shaun Firth / QC Reviewer	Adam Murdock / Engineering Design Manager	Terry Krause / Engineering Project Manager

Attachment 1
Project Cost Summary Table

Bethany Reservoir Alternative Basis of Estimate - Construction
Attachement 1 - Estimate Cost Summary

A	B	C	D	E	F	G	H	I	J
PROJECT	**Man Hours**	**Labor cost**	**Permanent Materials**	**Construction Materials**	**Equipment Cost**	**Subcontractor Costs**	**Estimate Total**	**Risk Mitigation Total**	**Project Total**
13 - Intake 3 Facilities	2,884,849	$ 278,941,337	$ 277,487,055	$ 203,171,550	$ 94,090,290	$ 1,135,019	$ 854,825,251	$ 27,647,192	$ 882,472,443
15 - Intake 5 Facilities	2,728,882	$ 263,386,005	$ 263,306,867	$ 188,741,805	$ 88,988,082	$ 1,105,663	$ 805,528,421	$ 26,052,808	$ 831,581,230
21 - Reach 1 Shafts & Tunnel (Twin Cities to Intake 3)	1,330,971	$ 208,433,785	$ 495,859,696	$ 100,900,590	$ 195,745,000	$ 31,669,380	$ 1,032,608,451	$ 60,335,345	$ 1,092,943,796
22 - Reach 2 Shafts & Tunnel (Twin Cities to Terminous)	2,414,995	$ 366,966,472	$ 826,724,333	$ 160,733,395	$ 328,889,339	$ 51,463,336	$ 1,734,776,876	$ 95,159,675	$ 1,829,936,551
23 - Reach 3 Shafts & Tunnel (Lower Roberts to Terminous)	1,894,724	$ 283,279,054	$ 604,771,308	$ 121,429,839	$ 245,863,385	$ 37,069,474	$ 1,292,413,060	$ 69,221,103	$ 1,361,634,163
24 - Reach 4 Shafts & Tunnel (Lower Roberts to Bethany Complex)	2,980,572	$ 440,657,237	$ 948,104,596	$ 183,589,965	$ 324,296,568	$ 61,089,231	$ 1,957,737,597	$ 110,583,877	$ 2,068,321,474
33 - Bethany Pumping Plant, Surge Shaft and Basin	7,486,564	$ 751,954,884	$ 845,359,805	$ 435,342,562	$ 338,840,061	$ 124,242,938	$ 2,495,740,250	$ 40,000,000	$ 2,535,740,250
55 - Bethany Aqueduct Pipeline, Tunnels and shafts	938,518	$ 111,073,090	$ 273,393,252	$ 73,923,203	$ 62,803,909	$ 19,630,952	$ 540,824,406	$ 21,775,643	$ 562,600,049
66 - Bethany Discharge Structure	370,460	$ 36,061,254	$ 31,644,354	$ 19,553,873	$ 7,976,161	$ 27,732	$ 95,263,374	$ 3,724,357	$ 98,987,731
71 - Sacramento County Access Roads - Intakes, Batch plant & P&R	84,485	$ 7,282,941	$ 14,374,707	$ 6,029,690	$ 2,251,437	$ 351,000	$ 30,289,775	$ 1,561,699	$ 31,851,474
72 - Twin Cities Advanced Sitework - Access Roads & Levees	72,988	$ 7,048,034	$ 5,081,051	$ 3,459,007	$ 3,794,908	$ 855,136	$ 20,238,135	$ 1,043,450	$ 21,281,586
73a - Lower Roberts Island Access Roads & P&R	151,484	$ 13,625,048	$ 15,167,853	$ 13,648,528	$ 2,781,566	$ 351,000	$ 45,573,995	$ 2,349,732	$ 47,923,727
73b - State Route 12 Access Road - Terminus Site	2,565	$ 234,710	$ 1,444,662	$ 3,354	$ 125,497	$ -	$ 1,808,224	$ 93,230	$ 1,901,453
74a - Bethany Complex Access Roads - Byron Hwy & Interchange	228,472	$ 19,988,238	$ 20,213,517	$ 15,819,619	$ 3,149,309	$ 326,311	$ 59,496,993	$ 3,067,583	$ 62,564,576
74b - Bethany Complex Access Roads - PP area & Roundabout	24,229	$ 2,289,023	$ 13,704,118	$ 105,916	$ 1,656,647	$ 3,309,643	$ 21,065,347	$ 1,086,100	$ 22,151,447
75 - Bethany Reservoir Access Road	11,712	$ 1,125,293	$ 6,115,714	$ 108,273	$ 1,493,524	$ 1,462,662	$ 10,305,466	$ 531,336	$ 10,836,801
76 - Projectwide Road Maintenance	30,688	$ 2,794,080	$ 17,525,833	$ 3,748,997	$ 1,007,134	$ -	$ 25,076,044	$ 1,292,886	$ 26,368,930
77 - Lower Roberts Rail & Rail Yard	28,237	$ 2,492,579	$ 8,904,451	$ 2,974,747	$ 1,103,423	$ 829,732	$ 16,304,932	$ 840,660	$ 17,145,592
78 - Lower Roberts Levee improvements advanced work	35,303	$ 3,575,866	$ 2,492,965	$ 1,789,996	$ 2,386,736	$ 98,457	$ 10,344,020	$ 533,323	$ 10,877,344
83 - SCADA Projectwide	49,851	$ 5,784,645	$ 1,039,279	$ 2,411,342	$ 4,213,011	$ -	$ 13,448,276	$ -	$ 13,448,276
93 - Projectwide Restoration & Site Establishment	87,807	$ 7,978,351	$ 2,042,640	$ 121,547	$ 6,854,544	$ -	$ 16,997,083	$ -	$ 16,997,083
Grand Total	**23,838,357**	**$ 2,814,971,925**	**$ 4,674,758,056**	**$ 1,537,607,798**	**$ 1,718,310,532**	**$ 335,017,666**	**$ 11,080,665,979**	**$ 466,900,000**	**$ 11,547,565,979**

PROJECT	Man Hours	Labor cost	Permanent Materials	Construction Materials	Equipment Cost	Subcontractor Costs	Estimate Total	Risk Mitigation Total	Project Total
91 - Bouldin Island Compensatory Mitigation	172,384	$ 16,222,171	$ 4,958,073	$ 8,309,306	$ 6,949,439	$ -	$ 36,438,989	$ -	$ 36,438,989
92 - I-5 Pond Compensatory Mitigation	252,751	$ 24,490,107	$ 3,832,616	$ 12,862,323	$ 12,989,515	$ 98,457	$ 54,273,017	$ -	$ 54,273,017
Grand Total	**425,135**	**$ 40,712,278**	**$ 8,790,688**	**$ 21,171,629**	**$ 19,938,954**	**$ 98,457**	**$ 90,712,006**	**$ -**	**$ 90,712,006**

Note: Contractors indirect costs and mark ups are distributed and included with cost columns C through G for each project identified in column A

Attachment 2
Estimate Bid Item Summary Cost Table

Bethany reservoir Alternative Basis of Estimate - Construction
Attachement 2 - Estimate Bid Item Prices

Project/Contract	Bid Item	Unit	Quantity	Total 2023$
13 - Intake 3 Facilities				
	113317105 - Mobilization / Site Setup Intake 5 Pipe Jacking	LS	1	346,670
	113317110 - Purchase 60" WSP AWWA C300	LF	7650	6,166,818
	113317115 - Off Load 60" WSP AWWA C300	LF	7650	12,469
	113317136 - Plant & Equipment	LS	1	6,883,773
	113317137 - Indirects	MO	12	3,549,342
	113317139 - Demob & Clean Up	LS	1	231,114
	113317220 - Setup Akkerman MTBM Equipment	EA	30	286,308
	113317230 - Pipe Jack 60" WSP AWWA C300	LF	7650	1,334,466
	113317231 - Weld 60" AWWA C300 Joints	EA	383	350,545
	113317232 - Pipe Reception Pit	EA	30	361,657
	113317235 - Muck Excavation & Truck Haul Off	CY	5562	250,568
	133001000 - Int 3 Ph M Contractors Profit & Burden	LS	1	112,728,000
	133002000 - Int 3 Environmental Protection	LS	1	14,635,224
	133002100 - Int 3 Tire Wash Station	EA	1	53,845
	133003000 - Int 3 Ph 1Contractor Mobilization	LS	1	1,024,164
	133005000 - Int 3 Ph M Contractor Mngt & Admin., Technica	MO	85	91,029,164
	133007000 - Int 3 Ph M Contractor's Temporary Facilities	LS	1	16,506,406
	133008000 - Int 3 Ph M Lost Labor Time	LS	1	2,091,140
	133009000 - Int 3 Ph M Cont Temporary Facility Operations	MO	85	21,200,533
	133010000 - Int 3 Owners Office Facilities	LS	1	217,191
	133013000 - Int 3 Ph 1 Erect Rebar & Metal Fab Shop	SF	8000	2,973,727
	133014000 - Int 3 Ph M Dismantle Metal & Rebar Fab Shop	LS	1	417,403
	133016000 - Int 3 Ph M Operate Metal & Rebar & Fab Shop	TON	36682	6,726,071
	133305000 - Int 3 Ph 1 Site Work	LS	1	57,693,487
	133306000 - Int 3 Ph 2 Site Work	LS	1	80,397,434
	133307000 - Int 3 Ph 2 Cofferdam	LS	1	29,152,086
	133308000 - Int 3 Ph 2 Erect Work Trestle	LF	1034	6,969,554
	133309000 - Int 3 Ph 3 Final Site Work	LS	1	43,574,192
	133311000 - Int 3 Ph 2 Jet Grout Under Intake	CY	102600	14,273,606
	133313000 - Int 3 Ph 2 Excavate Inside Intake Cofferdam	CY	74978	3,277,784
	133314000 - Int 3 Ph 2 Install Training Wall Anchors & Backfil	LS	1	7,458,395
	133315000 - Int 3 Ph 2 Drilled Piers	EA	1215	85,622,077
	133317000 - Int 3 Ph 2 Tremie Concrete Under Intake Structure	CY	8547	3,466,176
	133319000 - Int 3 Ph 2 Dewater Intake C'dam & Place Xbra	LS	1	8,251,635
	133319500 - Int 3 Ph 2 Prep & Leveling Slab Concrete	CY	2142	2,285,765
	133321000 - Int 3 Ph 2 Intake Structural Concrete	CY	30673	41,241,753
	133322000 - Int 3 Ph 2 Intake Gate Shaft & outlet Structures	EA	30	14,066,767
	133322600 - Int 3 Ph 3 Jack 60" Dia Pipe	LF	0	-
	133323000 - Int 3 Ph 2 5'x5' Gates, Frames & Opera	EA	60	9,724,118
	133324000 - Int 3 Ph 2 8'x8' Gates, Frames & Opera	EA	30	5,908,178
	133324400 - Int 3 Ph 2 Set Guides for Screens & Stoplogs	LF	2700	850,757
	133324500 - Int 3 Ph 2 Intake Stoplogs	EA	5	1,545,074
	133325000 - Int 3 Ph 3 Fish Screens & Panels	LS	30	43,620,484
	133327000 - Int 3 Ph 3 Intake Structure MEP	LS	1	12,173,390
	133329000 - Int 3 Ph 3 Finish Out	LS	1	3,431,129
	133355000 - Int 3 Ph 2 Sediment Basin Drilled Piers	EA	400	6,949,828
	133357000 - Int 3 Ph 2 Radial Gate Flow Control Structure	CY	20908	22,732,867
	133359000 - Int 3 Ph 3 Sediment Basin Radial Gates & Stoplogs	LS	1	22,915,022
	133361000 - Int 3 Ph 3 Sediment Basin MEP & Finish Work	LS	1	1,895,589
	133901100 - Int 3 Ph 3 Purchase & Store Equip for Ops	LS	1	4,746,799
	133901400 - Int 3 Ph 3 Start up and Commissioning	LS	1	3,390,000
	21400510 - Build Slurry Wall Receiving Shaft at Intake C-E-3	LS	1	16,316,309
	21400515 - Reach 1 Receiving Shaft at Intake C-E-3	LS	1	11,518,400
13 - Intake 3 Facilities Total				854,825,251

Project/Contract	Bid Item	Unit	Quantity	Total 2023$
15 - Intake 5 Facilities				
	115517145 - Mobilize / Site Setup Intake 3 Pipe Jacking	LS	1	346,670
	115517150 - Purchase 60" WSP AWWA C300	LF	7980	6,432,838
	115517155 - Offload 60" WSP AWWA C300	LF	7980	11,651
	115517176 - Plant & Equipment	LS	1	6,803,413
	115517177 - Indirects	MO	12	3,547,146
	115517190 - Demob & Clean Up	LS	1	231,114
	115517260 - Setup Akkerman MTBM Equipment	EA	30	286,308
	115517270 - Pipe Jack 60" WSP AWWA C300	LF	7980	1,392,031
	115517271 - Weld 60" AWWA C300 Joints	EA	399	365,189
	115517272 - Pipe Reception Pit	EA	30	361,657
	115517274 - Muck Excavate & Haul Off	CY	5825	262,533
	155001000 - Int 5 Ph M Contractors Profit & Burden	LS	1	105,768,000
	155002000 - Int 5 Ph M Environmental Protection	LS	1	13,685,133
	155002100 - Int 5 Tire Wash Station	EA	1	53,845
	155003000 - Int 5 Ph 1Contractor Mobilization	LS	1	1,024,164
	155005000 - Int 5 Ph M Contractor Mngt & Admin., Technica	MO	85	85,290,142
	155007000 - Int 5 Ph M Contractor's Temporary Facilities	LS	1	17,974,141
	155008000 - Int 5 Ph M Lost Labor Time	LS	1	1,898,080
	155009000 - Int 5 Ph M Cont Temporary Facility Operations	MO	85	21,200,533
	155010000 - Int 5 Owners Office Facilities	LS	1	522,238
	155015000 - Int 5 Ph 1 Erect Rebar & Metal Fab Shop	SF	8000	2,973,727
	155015100 - Int 5 Ph M Dismantle Metal & Rebar Fab Shop	LS	1	417,403
	155016000 - Int 5 Ph M Operate Metal & Rebar & Fab Shop	TON	35354	6,485,757
	155205000 - Int 5 Ph 1Site Work	LS	1	51,387,815
	155206000 - Int 5 Ph 2 Site Work	LS	1	67,764,500
	155207000 - Int 5 Ph 2 Cofferdam	LS	1	28,067,147
	155208000 - Int 5 Ph 2 Erect Work Trestle	LF	1064	6,969,554
	155209000 - Int 5 Ph 3 Final Site Work	LS	1	40,738,041
	155211000 - Int 5 Ph 2 Jet Grout Under Intake	CY	34200	7,052,349
	155213000 - Int 5 Ph 2 Excavate Inside Intake Coffertam	CY	74978	3,277,784
	155214000 - Int 5 Ph 2 Install Training Wall Tiebacks & Backfi	LS	1	7,076,782
	155215000 - Int 5 Ph 2 Drilled Piers	EA	1215	83,374,231
	155217000 - Int 5 Ph 2 Tremie Concrete Under Intake Stru	CY	8547	3,466,176
	155219000 - Int 5 Ph 2 Dewater Intake C'dam & Place Xbra	LS	1	8,264,383
	155219500 - Int 5 Ph 2 Prep & Leveling Slab Concrete	CU	2142	2,285,765
	155221000 - Int 5 Ph 2 Structural Concrete	CY	30256	40,649,033
	155222000 - Int 5 Ph 2 Intake Gate Shaft & outlet Structures	EA	30	13,671,165
	155222600 - Int 5 Ph 3 Jack 60" Dia Pipe	LF	0	-
	155223000 - Int 5 Ph 2 5'x5' Gates, Frames & Opera	EA	60	9,724,118
	155224000 - Int 5 Ph 2 8'x8' Gates, Frames & Opera	EA	30	5,908,178
	155224400 - Int 5 Ph 2 Set Guides for Screens & Stoplogs	LF	2700	850,757
	155224500 - Int 5 Ph 2 Intake Stoplogs	EA	5	1,545,074
	155225000 - Int 5 Ph 3 Fish Screens & Panels	EA	30	43,620,484
	155227000 - Int 5 Ph 3 Intake Structure MEP	LS	1	12,173,390
	155229000 - Int 5 Ph 3 Finish Out	LS	1	2,978,442
	155255000 - Int 5 Ph 2 Sediment Basin Drilled Piers	EA	400	6,949,828
	155257000 - Int 5 Ph 2 Radial Gate Flow Control Structure	CY	20723	22,262,756
	155259000 - Int 5 Ph 2 Sediment Basin Radial Gates & Stoplogs	LS	1	22,914,901
	155261000 - Int 5 Ph 3 Sediment Basin MEP & Finish Work	LS	1	1,896,305
	155901100 - Int 5 Ph 3 Purchase & Store Equip for Ops	LS	1	1,802,531
	155901400 - Int 5 Ph 3 Startup & Commissioning Support	LS	1	3,300,000
	21600530 - Build Slurry Wall Pass Through Maint. Intake C-E-5	LS	1	15,809,869
	21600535 - Pass Through Maintenance Shaft Intake C-E-5	LS	1	12,413,351
15 - Intake 5 Facilities Total				**805,528,421**
21 - Reach 1 Shafts & Tunnel (Twin Cities to Intake 3)				
	21100425 - Twin Cities Reach 1 Launch Shaft Construction Site	LS	1	7,377,330
	21300440 - Reach 1 Tunnel	LF	42849	1,006,146,367
	21300445 - Remove TBM	EA	1	2,086,446
	21300450 - Remove Shaft Utilities & Conveyor Belt	LS	1	357,683
	21300455 - Remove Tunnel Conveyor Belt	LS	1	798,168
	21300460 - Remove Tunnel Utilities & Cleanup	LS	1	787,025
	21300462 - Instrumentation Shafts & Tunnel	LS	1	10,185,045
	21300465 - Indirects Reach 1	LS	1	-
	21300470 - Plant & Equipment Reach 1	LS	1	-
	22200531 - RTM Pads	LS	1	4,870,387
21 - Reach 1 Shafts & Tunnel (Twin Cities to Intake 3) Total				**1,032,608,451**

Project/Contract	Bid Item	Unit	Quantity	Total 2023$
22 - Reach 2 Shafts & Tunnel (Twin Cities to Terminous)				
	22100515 - Twin Cities Reach 2 Launch Shaft Construction Site	LS	1	8,191,815
	22200519 - Build Slurry Wall Reach 2 Launch Shaft	LS	1	27,082,082
	22200520 - Reach 2 Launch Shaft Twin Cities	LS	1	22,846,607
	22200523 - RTM Pads	LS	1	4,870,387
	22300530 - Reach 2 Tunnel 36 Foot	LF	66807	1,580,495,955
	22300535 - Remove TBM	LS	1	2,086,446
	22300540 - Remove Shaft Utilities & Conveyor Belt	LS	1	357,683
	22300545 - Remove Tunnel Conveyor Belt	LS	1	1,076,394
	22300550 - Remove Tunnel Utilities & Cleanup	LS	1	1,057,297
	22300552 - Instrumentation Shafts & Tunnel	LS	1	17,823,829
	22300555 - Reach 2 Indirects	LS	1	-
	22300560 - Reach 2 Plant & Equipment	LS	1	-
	22500610 - Build Slurry Wall Pass Through New Hope Shaft	LS	1	14,675,297
	22500615 - Pass Through Maintenance Shaft New Hope	LS	1	12,828,242
	22500621 - Furnish & Place Shaft Cover	LS	1	355,200
	22500630 - Pass Through Maint Shaft New Hope Work Area	LS	1	7,399,057
	22600625 - Build Slurry Wall Pass Through Canal Ranch Tract	LS	1	14,397,806
	22600630 - Pass Through Maintenance Canal Ranch Tract	LS	1	12,970,273
	22600636 - Furnish & Place Shaft Cover	LS	1	370,049
	22600640 - Pass Through Maint. Shaft Canal Ranch Tract Work A	LS	1	5,365,801
	731710000 - New Hope Tract Road	MI	0.28	167,919
	731770000 - Canal Ranch Tract	MI	1.17	212,496
	760000000 - Project Wide Road Maintenance	LS	1	146,241
22 - Reach 2 Shafts & Tunnel (Twin Cities to Terminous) Total				**1,734,776,876**
23 - Reach 3 Shafts & Tunnel (Lower Roberts to Terminous)				
	23100005 - Lower Roberts Reach 3 Launch Shaft Construct Site	LS	1	13,642,772
	23300020 - Reach 3 Tunnel 36 Foot	LF	49975	1,169,490,462
	23300025 - Remove TBM	LS	1	2,082,941
	23300030 - Remove Shaft Utilities & Conveyor Belt	LS	1	357,683
	23300035 - Remove Tunnel Conveyor Belt	LS	1	1,319,639
	23300040 - Remove Tunnel Utilities & Cleanup	LS	1	1,300,542
	23300042 - Instrumentation Shafts & Tunnel	LS	1	12,731,306
	23300045 - Reach 3 Tunnel Indirects	LS	1	-
	23300050 - Reach 3 Tunnel Plant & Equipment	LS	1	-
	23400014 - Terminous Tract Slurry Wall Reception Shaft	LS	1	11,858,585
	23400015 - Terminous Tract Reception Shaft	LS	1	12,807,556
	23400021 - Furnish & Place Shaft Cover	LS	1	370,049
	23400095 - Terminous Tract Reception Shaft Construction Site	LS	1	8,427,432
	23500096 - Build Slurry Wall Pass Through Maint.Kings Island	LS	1	14,735,734
	23500097 - Pass Through Maint Shaft Kings Island	LS	1	13,257,462
	23500103 - Furnish & Place Shaft Cover	LS	1	370,049
	23500110 - Pass Through Maint. Kings Island Work Area	LS	1	7,001,664
	24200127 - RTM Pad	LS	1	22,114,325
	731870000 - Kings Island Access Road	MI	3	544,858
23 - Reach 3 Shafts & Tunnel (Lower Roberts to Terminous) Total				**1,292,413,060**
24 - Reach 4 Shafts & Tunnel (Lower Roberts to Bethany Complex)				
	24100115 - Lower Roberts Reach 4 Launch Shaft Construct Site	LS	1	15,952,706
	24200118 - Slurry Wall Reach 4 Launch Shaft Lower Roberts	LS	1	27,922,450
	24200120 - Reach 4 Launch Shaft Lower Roberts	LS	1	23,184,163
	24200121 - RTM Pad	LS	1	22,114,325
	24200125 - Furnish & Install Shaft Cover	LS	1	370,049
	24300125 - Reach 4 Tunnel 36 Foot	LF	76697	1,767,845,909
	24300130 - Remove TBM	LS	1	2,037,822
	24300135 - Remove Shaft Utilities & Conveyor Belt	LS	1	357,683
	24300140 - Remove Tunnel Conveyor Belt	LS	1	1,157,476
	24300145 - Remove Tunnel Utilities & Cleanup	LS	1	1,209,130
	24300150 - Reach 4 Tunnel Indirects	LS	1	-
	24300155 - Reach 4 Tunnel Plant & Equipment	LS	1	-
	24300190 - Instrumentation Shafts & Tunnels	LS	1	20,370,090
	24500199 - Build Slurry Wall Pass Through Upper Jones Tract	LS	1	15,173,003
	24500200 - Pass Through Shaft Upper Jones Tract	LS	1	13,476,934
	24500206 - Furnish & Place Shaft Cover	LS	1	370,049
	24500220 - Pass Through Shaft Upper Jones Tract Work Area	LS	1	5,499,181
	24600225 - Build Slurry Wall Pass Through Union Island	LS	1	15,344,697
	24600230 - Pass Through Shaft Union Island	LS	1	13,647,623
	24600235 - Furnish & Place Shaft Cover	LS	1	370,049
	24600240 - PassThrough Shaft Union Island Work Area	LS	1	8,450,304
	731820000 - Upper Jones Tract Road	MI	2	441,979
	731880000 - Union Island Access Road	MI	2	2,441,978
24 - Reach 4 Shafts & Tunnel (Lower Roberts to Bethany Complex) Total				**1,957,737,597**

Project/Contract	Bid Item	Unit	Quantity	Total 2023$
33 - Bethany Pumping Plant, Surge Shaft and Basin				
	24400205 - Slurry Wall Reach 4 Reception Shaft Surge Basin	LS	1	19,917,361
	24400210 - Reach 4 Tunnel Reception Shaft Surge Basin	LS	1	25,071,914
	331001000 - Pump Plant/Surge Basin Contractors Profit & Burden	LS	1	338,442,637
	331002000 - Environmental Protection - Pump Plant/Surge Basin	LS	1	13,894,039
	331007000 - SB Temp. Construction Facilities Build	LS	1	3,612,219
	331007500 - Lost Labor Time - Pump Plant/Surge Basin	LS	1	5,906,869
	331015000 - Dismantle Rebar & Metal Fab Shop	SF	8970	369,428
	331103000 - Mobilize Pump Plant/Surge Basin Contractor	LS	1	1,737,286
	331105000 - Pump Plant Contractor Mngt & Admin., Technica	MO	84	128,709,210
	331109000 - Pump Plant Temp. Faciltities Build	LS	1	11,981,994
	331110000 - Owners Office Facilities	LS	1	522,238
	331112500 - Temporary Fire/EMT Station	LS	1	1,370,115
	331115000 - Pump Plant/SB Temporary Facility Operate	MO	84	28,419,811
	331117500 - Pump Plant/SB Erect Rebar & Metal Fab Shop	SF	8970	3,761,077
	331117800 - Pump Plant/Surge Basin- Rebar Shop Operation	TON	92633	43,999,895
	331120000 - Construction Water Supply from Banks Canal	LS	1	5,225,302
	331400000 - PP Substation Civil & Structural Work	LS	1	8,894,969
	332005000 - Surge Basin Clear & Grub/Demolition	LS	1	252,672
	332010000 - Surge Basin E xcavation & Demo'n	LS	1	12,294,677
	332015000 - Surge Basin Ramp Construction	LS	1	1,586,680
	332105000 - Pump Plant Initial Earthwork	LS	1	4,952,147
	332105100 - Pump Plant Final Site Work	AC	38	6,619,979
	332105200 - Pumping Plant SWPPP	ACRE	130	17,360,409
	332115000 - Diaphragm Wall Construction	SF	1221343	455,364,278
	332120000 - Excavate Pump Plant Phase 1 Below Floor El 42.0	CY	224000	6,819,266
	332121000 - Excavate Pump Plant Phase 2 Below Floor El 3.0	CY	129422	4,053,741
	332122000 - Excavate Pump Plant Phase 3 Below Floor El (-)22	CY	129422	4,457,492
	332123000 - Excavate Pump Plant Phase 4 Below Floor El (-)47	CY	129422	5,054,542
	332125000 - Excavate Pump Plant Phase 5 Below Floor El (-)72.0	CY	75911	3,304,984
	332126000 - Excavate Pump Plant Phase 6 Below Floor El (-)86.2	CY	105778	4,770,500
	332130000 - Excavate Pump Plant Inlet Conduit All Levels	CY	141423	6,659,150
	332135000 - Excavate PP Mech(E-W) & Elect(N-S) Rooms	0	260817	4,474,294
	332136000 - Excavate Surge Vault & Tank Inlet	CY	106053	9,373,773
	332145000 - 36" Drilled Piers Pump Plant & Surge Vaults	EA	154	4,717,654
	332150000 - 15' Dia Bethany Res. Pipe to Conn. with AQUE.PIPE	LF	6608	46,098,923
	332175000 - Remove Sec of Diaph. Walls - WW, Pipe. Elect. Cond	SF	11493	569,923
	333010000 - 36" Diaphragm Walls	SF	422000	93,426,542
	333020000 - Tiebacks	EA	1088	6,774,041
	333030080 - Rebar in Surge Basin Drilled Shafts	TON	16269	42,268,607
	333035000 - Drilled Tiedown Shafts	0	2589	155,203,479
	333100000 - PP Storage Areas & Yards	SF	11000	29,560
	333105000 - Generator Building	SF	3500	3,651,656
	333106000 - HVAC Mechanical Equipment Yard	SF	10200	2,043,848
	333110000 - Foundation Slab @ El. -110.50	CY	51543	38,251,986
	333111000 - Intermediate Slab @ El. -86.25	CY	18436	15,188,003
	333112000 - Intermediate Slab @ El. -72.00	CY	18436	15,419,969
	333113000 - Intermediate Slab @ El. -47.00	CY	18846	16,821,433
	333114000 - Intermediate Slab @ El. -22.00	CY	18436	16,018,288
	333115000 - Operation Deck Conc. @ El. 3.00	CY	18436	14,650,915
	333116000 - Roof Deck Concrete @ El. 47.00	CY	18508	16,933,124
	333116500 - PC Concrete Hatches @ El. 47.00	CY	2557	3,414,757
	333119000 - Concrete - Interior Column Facing	CY	6174	9,428,343
	333120000 - Structure Concrete Vert. Wall Liners	CY	38680	45,441,186
	333121000 - Interior Conc. Walls (Stairwells, Doghouses, etc.)	CY	23723	61,259,752
	333122000 - Pump Plant Conc. Fill around Pump Inlets/Housing	CY	3460	2,935,223
	333123000 - Mechanical Room Conc. Inv. Slab @ El. 3.00	CY	4988	4,610,843
	333124000 - Mechanical Room Conc. Walls	CY	4497	6,336,645
	333125000 - Mechanical Room Conc. Roof Slab	CY	4584	5,931,378
	333130000 - Surge Tanks Valve Vault - Inv. Slab Conc.	CY	2152	2,066,302
	333131000 - Surge Tanks Valve Vault - Conc. Walls	CY	2944	5,094,036
	333132000 - Surge Tanks Valve Vault - Conc. Roof Slab	CY	780	1,883,459
	333135000 - Surge Tanks - Inv. Slab Conc.	CY	1628	1,687,956
	333136000 - Surge Tanks - Conc. Walls	CY	1501	3,251,783
	333137000 - Surge Tanks - Conc. Roof Slab	CY	764	1,966,906
	333140000 - Wet Well Inlet Conduit Invert Slab	CY	9472	7,439,373
	333141000 - Wet Well Inlet Conduit Intermediate. Slabs	CY	16720	15,357,998
	333142000 - Wet Well Conduit Walls	CY	19367	26,010,244
	333143000 - Wet Well Conduit Top Deck Conc. @ El. 3.00	CY	4021	3,900,148
	333143100 - Isolation Gates - Wetwell Conduit	LS	1	7,910,626
	333144000 - Pump Plant Miscellaneous Metals	LS	1	13,475,089
	333145000 - 500 CFS Pumps & Motors (14 ea)	EA	14	92,767,168
	333147000 - 108" Dia. Steel Pipe, Valves, to 15' Dia. RW Conn.	LF	2700	90,556,635
	333149000 - PP Wet Well Bulkheads	LS	1	17,324,228
	333150000 - Pump Plant Overhead Gantry Cranes	LS	1	7,069,575

Project/Contract	Bid Item	Unit	Quantity	Total 2023$
33 - Bethany Pumping Plant,	333152000 - Service Elevators	EA	6	5,041,636
	333155000 - Pump Plant Structural Canopies (2 ea)	SF	30000	1,174,825
	333157000 - Wet Well Dewatering Pumps	EA	2	22,243,603
	333160000 - HVAC Mechanical Systems	LS	1	5,464,433
	333165000 - Valve Vault Piping & Valves	LS	1	26,509,076
	333166000 - Surge Tank Piping & Valves	LS	1	2,110,917
	333190000 - PP Electrical Building - Civil & Structural Work	SF	45500	20,929,321
	333195000 - PP Equipment Storage Building	SF	45800	15,653,055
	334010000 - Surge Basin Concrete Slabs	LS	1	78,043,685
	334020000 - Surge Basin Structures	LS	1	2,269,020
	334030000 - Surge Basin Gantry Crane Bridge	LS	1	5,139,366
	334040000 - Dewatering System	LS	1	3,229,175
	334050000 - Surge Basin Site Restoration	LS	1	830,208
	336120005 - PP Substation - Electrical Distribution	LS	1	80,751,532
	336120007 - Pump Plant Buildings - Electrical	LS	1	57,717,516
	336140009 - Pump Plant - Electrical System	LS	1	15,992,669
	336150005 - Pump Plant - Site Electrical System	LS	1	26,640,940
	336160005 - SCADA System - Pump Plant Only	LS	1	1,875,715
	337111000 - Start-up & Commissioning - Pumping Plant	LS	1	9,701,000
33 - Bethany Pumping Plant, Surge Shaft and Basin Total				2,495,740,250
55 - Bethany Aqueduct Pipeline, Tunnels and shafts				
	552001000 - Aqueduct Pipes - Contractors Profit & Burden	LS	1	53,493,856
	552005000 - Mobilization - DCA AQUEDUCT PIPES - Section 1	LS	1	278,056
	552006000 - Dewatering Treatment & Disposal	LS	1	518,776
	552006500 - Traffic Control	LS	1	342,448
	552006700 - Environmental Protection - Aqueduct Pipe Contract	LS	1	8,918,594
	552007000 - Lost Labor Time - Aqueduct Pipe Inst. Contract	LS	1	309,892
	552008000 - NEW DISCHARGE STRUCTURE - Site Preparation	LS	1	5,559,113
	552010000 - Clear & Grub - Section 1	AC	81	758,296
	552015000 - Strip & Stockpile Topsoil - Section 1	LF	6307.8	837,837
	552020000 - Trench Excavation - Section 1	CY	317497	2,606,962
	552025000 - Place Trench Stabilization Material - Section 1	CY	15412	1,109,584
	552030000 - Furnish Pipe Support Cradles - Section 1	EA	1448	841,462
	552035000 - Backfill - Section 1	LS	1	27,171,889
	552040000 - Compact and Finish - Section 1	LS	1	251,289
	552045000 - Dewatering - Section 1	LS	1	973,591
	552047000 - Add Dewatering Wells @ Kelso, BBID, Mtn. House Rd.	LS	1	613,279
	552050000 - General Support Crew - Section 1	LS	1	2,033,906
	552055000 - Site Restoration & DeMobilization - Section 1	LS	1	29,588
	553005000 - Mobilization - DCA AQUEDUCT PIPES - Section 2	LS	1	278,056
	553006000 - Dewatering Treatment & Disposal	LS	1	518,776
	553006500 - Traffic Control	LS	1	342,448
	553010000 - Clear & Grub - Section 2	AC	62	477,340
	553015000 - Strip & Stockpile Topsoil - Section 2	LS	1	497,282
	553020000 - Trench Excavation - Section 2	CY	189000	1,525,153
	553025000 - Place Trench Stabilization Material - Section 2	CY	7892	624,128
	553030000 - Furnish Pipe Support Cradles - Section 2	LS	1	429,818
	553035000 - Backfill - Section 2	LS	1	15,953,684
	553040000 - Compact and Finish - Section 2	LS	1	150,501
	553045000 - Dewatering - Section 2	LS	1	747,796
	553046000 - Bridges at Jones Penstocks	LS	1	1,911,129
	553047000 - Bridges at BBID	LS	1	1,429,741
	553048000 - Bridges at Gas LIne Crossing	LS	1	1,429,741
	553050000 - General Support Crew - Section 2	LS	1	1,207,632
	553055000 - Site Restoration & DeMobilization - Section 2	LS	1	29,588
	555010000 - Purchase and Transport Pipes	LS	1	147,200,051
	555015000 - Unload & Store Pipes at Storage Yard	LS	1	3,182,620
	555020000 - Installation of Pipes at Open Cut	LF	9971.5	6,126,287
	555040000 - Internal Lining	LF	57200	20,447,646
	555045000 - Cathodic Protection	LS	1	647,036
	555050000 - Installation of Pipes at Crossings	LF	920	34,135,119
	555055000 - Installation of Pipes at Tunnels & Shafts	LF	3408.5	25,204,308
	555056000 - Install Pipe at Disch Structure Vertical Shafts	EA	4	2,169,775
	555060000 - General Support Crew	LS	1	3,257,427
	555065000 - Geotechnical Monitoring and Instrumentation	LS	1	351,536
	555070000 - Indirect Cost - Section 1, 2, Tunnels & Shafts	LS	1	10,256,608
	85101000 - Mobilize Portals	LS	1	1,702,180
	85102000 - Excavate East Penstock Portal	CY	160245	2,738,587
	85102500 - Excavate West Penstock Portal	CY	224321	3,227,979
	85103000 - Excavate Conservation Easement Portal	CY	239336	4,116,579
	85103100 - Portal Headwall Cut Support	LS	1	518,086
	85103150 - Staging Areas Portals	LS	1	3,023,838
	85103500 - Plant & Equipment	LS	1	-
	85104000 - Indirect Cost	LS	1	-

Project/Contract	Bid Item	Unit	Quantity	Total 2023$
55 - Bethany Aqueduct Pipel	85201000 - Mobilize Tunnels & Shafts	LS	1	662,974
	85201500 - Site Setup Tunnels & Shafts	LS	1	404,143
	85202000 - Excavate Jones PenstockTunnel 1	LF	200	1,721,806
	85202500 - Excavate Jones Penstock Tunnel 2	LF	200	1,721,806
	85203000 - Excavate Jones Penstock Tunnel 3	LF	200	1,721,806
	85203500 - Excavate Jones Penstock Tunnel 4	LF	200	1,721,806
	85203550 - Staging Areas Penstock Tunnels	LS	1	3,023,838
	85204000 - Excavate Conservation Easement Tunnel 1	LF	3064	22,994,554
	85204500 - Excavate Conservation Easement Tunnel 2	LF	3064	22,994,554
	85205000 - Excavate Conservation Easement Tunnel 3	LF	3064	24,496,527
	85205500 - Excavate Conservation Easement Tunnel 4	LF	3064	24,496,527
	85205550 - Staging Areas Conservation Easement Tunnels	LS	1	6,047,676
	85205600 - Shaft Access Excavation	LS	1	2,392,667
	85206000 - Excavate Shaft 1	LS	1	5,601,227
	85206500 - Excavate Shaft 2	LS	1	5,601,227
	85207000 - Excavate Shaft 3	LS	1	5,601,227
	85207500 - Excavate Shaft 4	LS	1	5,601,227
	85207550 - Staging Areas Shafts	LS	1	1,511,919
	85208000 - Plant & Equipment	LS	1	-
	85208500 - Indirect Cost	LS	1	-
55 - Bethany Aqueduct Pipeline, Tunnels and shafts Total				**540,824,406**
66 - Bethany Discharge Structure				
	663005000 - Discharge Structure - Contractors Profit & Burden	LS	1	13,411,795
	663010000 - Mobilize for Bethany Reservoir Discharge Structure	LS	1	212,419
	663011000 - Discharge Structure Contr. Management Tech.	MO	24	13,248,456
	663015000 - Discharge Structure - Temp. Faciltities Build	LS	1	2,736,027
	663016000 - Discharge Structure - Temporary Facility Operate	MO	24	2,371,824
	663016500 - Lost Labor Time - Beth. Discharge Structure Cont.	LS	1	280,827
	663016700 - Environmental Protection - Disch. Struct.	LS	1	5,144,531
	663018000 - SITE WORK - Bethany Discharge Structure	LS	1	2,108,963
	663019000 - Cofferdam @ Discharge Structure	LS	1	5,446,342
	663021000 - Slab 1 East Section - Discharge Structure	CY	9342	6,620,099
	663022000 - Slab 2 Middle Section - Discharge Structure	CY	6593	4,761,282
	663023000 - Slab 3 West Section - Discharge Structure	CY	3420	2,784,841
	663026000 - Conc. Structural Walls - Bethany Discharge Struct.	CY	11400	16,010,938
	663050000 - Soil Nail Retaining Wall	SF	7689	1,172,630
	663055000 - Radial Gates & Stoplogs - Bethany Disch. Struct.	LS	1	15,089,082
	663060000 - Embankment Fill from Site Excavation	FCY	38266	145,435
	663062000 - Discharge Structure - Mech./Elect.	LS	1	2,591,734
	663064000 - Stop Log Struct. and Fuel Storage	LS	1	393,648
	663070000 - Discharge Structure - Finish Out	LS	1	732,501
66 - Bethany Discharge Structure Total				**95,263,374**
71 - Sacramento County Access Roads - Intakes, Batch plant & P&R				
	711001000 - Contractors Overhead and Profit	LS	1	4,393,006
	711002000 - Contractor Site Management & Facilities	MO	18	6,574,060
	711003000 - Mobilization	LS	1	169,935
	711120000 - Hood Franklin Road	MI	2.5	54,059
	711130000 - Intakes Access Road	MI	3.93	11,125,403
	711140000 - Intake #3 Access Road	MI	0.18	392,734
	711150000 - C-E-5 Intake Access Road	MI	1	2,032,299
	711315000 - Employee Park & Ride - Hood Franklin	LS	1	1,893,570
	711460000 - Lambert Road Widening	MI	3.39	3,654,711
71 - Sacramento County Access Roads - Intakes, Batch plant & P&R Total				**30,289,775**
72 - Twin Cities Advanced Sitework - Access Roads & Levees				
	721001000 - Contractors Overhead and Profit	LS	1	3,134,787
	721002000 - Contractor Site Management & Facilities	MO	8	3,463,476
	721003000 - Mobilization	LS	1	135,252
	721410000 - Twin Cities Site Development & Ring Levee	LS	1	9,742,205
	721420000 - Diersen Road Paving	MI	0.8	835,203
	721430000 - Franklin Blvd Improvements at Dierrsen	MI	0.49	1,277,522
	721470000 - Twin Cities Road Widening (East)	MI	1.01	1,649,690
72 - Twin Cities Advanced Sitework - Access Roads & Levees Total				**20,238,135**

Bethany reservoir Alternative Basis of Estimate - Construction
Attachement 2 - Estimate Bid Item Prices

Project/Contract	Bid Item	Unit	Quantity	Total 2023$
73a - Lower Roberts Island Access Roads & P&R				
	711313000 - Employee Park & Ride - Charter Way	LS	1	1,064,525
	731001000 - Contractors Overhead and Profit	LS	1	11,158,598
	731002000 - Contractor Site Management & Facilities	MO	28	11,585,468
	731003000 - Mobilization - Both	LS	1	169,935
	731830000 - Lower Roberts Island Road	MI	5.93	21,595,469
73a - Lower Roberts Island Access Roads & P&R Total				**45,573,995**
73b - State Route 12 Access Road - Terminus Site				
	731730000 - Highway 12 /Terminous Tract Widening	MI	0.82	1,808,224
73b - State Route 12 Access Road - Terminus Site Total				**1,808,224**
74a - Bethany Complex Access Roads - Byron Hwy & Interchange				
	741001000 - Contractors Overhead and Profit	LS	1	12,753,303
	741002000 - Contractor Site Management & Facilities	MO	45	19,625,790
	741003000 - Mobilization	LS	1	197,246
	741900000 - Byron Hwy Frontage Rd	MI	1.18	2,511,984
	741910000 - Byron Hwy	MI	1.05	4,816,936
	741920000 - Byron Hwy - Lindermann Rd Interchange	MI	1.82	19,591,735
74a - Bethany Complex Access Roads - Byron Hwy & Interchange Total				**59,496,993**
74b - Bethany Complex Access Roads - PP area & Roundabout				
	741930000 - Mountain House Shaft Access Road	MI	2.4	7,470,635
	741940000 - Kelso Road Widening	MI	1.48	2,343,254
	741950000 - Mountain House Road Widening	MI	3.74	6,854,429
	741970000 - Mountain House By-pass Rd	MI	0.78	4,397,029
74b - Bethany Complex Access Roads - PP area & Roundabout Total				**21,065,347**
75 - Bethany Reservoir Access Road				
	741960000 - Bethany Road	MI	1.57	9,782,459
	751001000 - Contractors Overhead and Profit	LS	1	72,569
	751002000 - Contractor Site Management & Facilities	MO	1	112,880
	751003000 - Mobilization	LS	1	21,242
	751960000 - Bethany Road	MI	0.16	316,315
75 - Bethany Reservoir Access Road Total				**10,305,466**
76 - Projectwide Road Maintenance				
	133305000 - Int 3 Ph 1 Site Work	LS	1	220,565
	155205000 - Int 5 Ph 1Site Work	LS	1	181,351
	760000000 - Project Wide Road Maintenance	LS	1	24,674,129
76 - Projectwide Road Maintenance Total				**25,076,044**
77 - Lower Roberts Rail & Rail Yard				
	770000000 - Lower Roberts Rail & Rail Yard	LS	1	16,304,932
77 - Lower Roberts Rail & Rail Yard Total				**16,304,932**
78 - Lower Roberts Levee improvements advanced work				
	781410000 - Lower Roberts Levee Improvement advanced work	LS	1	10,344,020
78 - Lower Roberts Levee improvements advanced work Total				**10,344,020**
83 - SCADA Projectwide				
	836160020 - Bethany Complex Communications (Contra Costa/Almed	MI	52.59	13,448,276
83 - SCADA Projectwide Total				**13,448,276**

Project/Contract	Bid Item	Unit	Quantity	Total 2023$
93 - Projectwide Restoration & Site Establishment				
	133901500 - Int 3 Ph 2 Site Restoration	ACRE	110	1,450,973
	133901600 - Int 3 Establishment Period	YR	5	703,974
	155901500 - Int 5 Ph 2 Site Restoration	ACRE	120	1,450,201
	155901600 - Int 5 Establishment Period	YR	5	582,668
	221015000 - Twin Cities - Launch Shaft Site Restoration	LS	1	6,398,179
	223015000 - Lower Roberts Island - Launch Shaft Site Restore	LS	1	2,289,747
	334050000 - Surge Basin Site Restoration	LS	1	302,759
	334050010 - Surge Basin Establishment Period	YR	5	155,383
	721410000 - Twin Cities Site Development & Ring Levee	LS	1	2,197,919
	781410000 - Lower Roberts Levee Improvement advanced work	LS	1	1,465,279
93 - Projectwide Restoration & Site Establishment Total				**16,997,083**
Grand Total				**11,080,665,979**

Project/Contract	Bid Item	Unit	Quantity	Total 2023$
91 - Bouldin Island Compensatory Mitigation				
	911017000 - Mitigation Bouldin Island Site B-1	LS	1	25,682,772
	911018000 - Mitigation Bouldin Island Site B-2	LS	1	5,627,733
	911019000 - Mitigation Bouldin Island Site B-3	LS	1	5,128,484
91 - Bouldin Island Compensatory Mitigation Total				**36,438,989**
92 - I-5 Pond Compensatory Mitigation				
	921015000 - Mitigation I-5 Pond 6	LS	1	17,319,832
	921016000 - Mitigation I-5 Ponds 7&8	LS	1	32,490,700
	921017000 - SR 12 Wildlife Crossing Culvert	LS	1	4,462,485
92 - I-5 Pond Compensatory Mitigation Total				**54,273,017**
Grand Total				**90,712,006**

Attachment 3
Risk Treatment Costs

Bethany reservoir Alternative Basis of Estimate - Construction
Attachement 3 - Distribution of Risk Treatment Costs

PROJECT	Total	Risk Treatment Cost	Percentage of total

HCSS bid item name (All)

Sum of Bid Total

PROJECT	Total	Risk Treatment Cost	Percentage of total
13 - Intake 3 Facilities	$ 854,825,251	$ 27,647,192	3%
15 - Intake 5 Facilities	$ 805,528,421	$ 26,052,808	3%
21 - Reach 1 Shafts & Tunnel (Twin Cities to Intake 3)	$ 1,032,608,451	$ 60,335,345	6%
22 - Reach 2 Shafts & Tunnel (Twin Cities to Terminous)	$ 1,734,776,876	$ 95,159,675	5%
23 - Reach 3 Shafts & Tunnel (Lower Roberts to Terminous)	$ 1,292,413,060	$ 69,221,103	5%
24 - Reach 4 Shafts & Tunnel (Lower Roberts to Bethany Complex)	$ 1,957,737,597	$ 110,583,877	6%
33 - Bethany Pumping Plant, Surge Shaft and Basin	$ 2,495,740,250	$ 40,000,000	2%
55 - Bethany Aqueduct Pipeline, Tunnels and shafts	$ 540,824,406	$ 21,775,643	4%
66 - Bethany Discharge Structure	$ 95,263,374	$ 3,724,357	4%
71 - Sacramento County Access Roads - Intakes, Batch plant & P&R	$ 30,289,775	$ 1,561,699	5%
72 - Twin Cities Advanced Sitework - Access Roads & Levees	$ 20,238,135	$ 1,043,450	5%
73a - Lower Roberts Island Access Roads & P&R	$ 45,573,995	$ 2,349,732	5%
73b - State Route 12 Access Road - Terminus Site	$ 1,808,224	$ 93,230	5%
74a - Bethany Complex Access Roads - Byron Hwy & Interchange	$ 59,496,993	$ 3,067,583	5%
74b - Bethany Complex Access Roads - PP area & Roundabout	$ 21,065,347	$ 1,086,100	5%
75 - Bethany Reservoir Access Road	$ 10,305,466	$ 531,336	5%
76 - Projectwide Road Maintenance	$ 25,076,044	$ 1,292,886	5%
77 - Lower Roberts Rail & Rail Yard	$ 16,304,932	$ 840,660	5%
78 - Lower Roberts Levee improvements advanced work	$ 10,344,020	$ 533,323	5%
83 - SCADA Projectwide	$ 13,448,276	$ -	0%
93 - Projectwide Restoration & Site Establishment	$ 16,997,083	$ -	0%
Grand Total	**$ 11,080,665,979**	**$ 466,900,000**	4%

Appendix B
Total Project Costs with Innovations

Title:	**Project Wide Innovations Summary**
Prepared for:	Delta Conveyance Project (DCP) File
Prepared by:	Delta Conveyance Design and Construction Authority (DCA)
Copies to:	Files
Date/Version:	May 8, 2024 / Version 1
Reference no.:	EDM_PW_CE_MEM_Projectwide-Innovations-Summary_001325_V01_D_20240508

1. Introduction

1.1 Context and Purpose

On December 21, 2023, California Department of Water Resources (DWR) approved the Delta Conveyance Project (DCP) and selected the Bethany Reservoir Alignment for further engineering, design, and permitting necessary to be completed prior to initiating implementation. DWR completed extensive environmental review and certified the Environmental Impact Report (EIR) (DWR, 2023) as compliant with the California Environmental Quality Act (CEQA).

Following project approval, DWR directed DCA to further evaluate several project features presented in the Bethany Reservoir Alignment Engineering Project Report (EPR) and consider potential design or construction innovations to further reduce community or environmental disturbances, schedule, and/or costs or improve constructability. This evaluation resulted in a set of potential innovations that at this early conceptual stage of the project are considered by the DCA to be reasonable and credible based on industry experience. The innovations discussed herein do not represent changes to the project description presented in the EPR and analyzed in the EIR, but rather provide an indication of how normal design development processes can help manage costs for large infrastructure projects.

As the innovation concepts are further advanced, DWR will review the innovation concepts to determine and document if the innovation concepts would result in a change in the project description presented in the EPR and analyzed in the EIR. The results of these reviews will be used by DWR to determine if additional reviews will be required under the CEQA and for project permitting.

1.2 Summary of Innovations

This memorandum summarizes the process used to identify and select innovation concepts for evaluation and compares the potential cost and schedule savings to the project as described in the EIR/EPR. A summary of these innovations and their assessment related to cost and schedule is shown in Table 1-1.

Table 1-1. Summary of Innovations

Innovation ID	Innovation Title	Potential Cost Savings[a] ($M[b])	Potential Schedule Savings[c] (Days)
Intakes			
INV-I2	Intake Fish Screen Barrier System	$ 1.07	14
INV-I3	Raise Intake 3 and 5 Tee Screen Elevation	$ 4.13	28
INV-I4/I5	Intake Structure Configuration	$ 29.81	26
Tunnels and Shafts			
INV-T1	Provide Separate Access to Double Launch Shafts	($ 0.63)	No Change
INV-T2	Tunnel Lining Optimization	$ 45.85	No Change
INV-T3	Planning for Semi Continuous Mining	$ 70.35	184
INV-T4	Optimizing Tunnel Profile and Shaft Sizes	$ 95.43	192
Pumping Plant and Surge Basin			
INV-P1	Optional Pumping Plant Belowground Configuration	$ 138.72	981
INV-P3	A) Surge Basin Slab Uplift Resistance B) Surge Basin Wall Configuration	P3A: $ 178.44 P3B: $ 52.39	P3A: 280 P3B: 237
Aqueducts			
INV-A1/A5	Reduce Pipe Diameter and Trench Section	$ 60.38	79
INV-A4	Bethany Conservation Easement Tunnel/Shaft Considerations	$ 14.36	222
Discharge Structure			
INV-D1	Reconfigure Discharge Structure Retaining Wall	$ 1.39	No Change
INV-D2	Refine Bethany Reservoir Discharge Structure Configuration	$ 38.50	554
Hydraulics and Operations			
INV-H1/H2	Reduce Diameter of Intake Shafts and Maintenance Shafts	$ 40.11	No Change
Logistics			
INV-L1	Eliminate Rail-Served Materials Depot – Lower Roberts Island	$ 16.30	128
INV-L2	Hood Franklin Road Intersection Innovation	$ 2.05	No Change

[a] Potential Cost Savings refers to reductions associated with potential innovations compared to the Construction Cost estimate for the Bethany Reservoir Alignment as depicted in the EPR. Values in () represent a potential increase in costs.

[b] Costs are in 2023 dollars and are undiscounted.

[c] Schedule savings represent the number of physical construction days that could be saved for the feature studied. The potential schedule savings would reduce the overall project schedule only if the schedule for that feature impacts the overall project critical path.

As shown in Table 1-1, each innovation concept is identified with an ID number and grouped by project feature (i.e. Intakes, Tunnels and Shafts, etc.). The innovation concepts presented in Table 1-1 are mutually exclusive and have been analyzed as independent concepts except for the following:

- Innovation T4 considers the cost differential associated with adjusting the tunnel profile and assumes the reduced shaft diameter included with innovation H1/H2.
- Innovation A4 considers a revised profile of the tunnel under the Bethany Reservoir Conservation Easement and incorporates the reduced diameter of the aqueduct pipelines as presented in innovation A5.

A summary of the potential cost savings by major project feature is presented in Table 1-2.

Table 1-2. Potential cost savings from combined set of innovations

Feature	Potential Construction Cost Savings[a] ($M[b])	Potential Risk Treatment Cost Savings[a,c] ($M[b])	Total Potential Cost Savings[a] ($M[b])
Intakes (I2, I3, I4, I5)	$35	$1	$36
Tunnels & Shafts (T1, T2, T3, T4, H1/H2)	$211	$12	$223
Pumping Plant & Surge Basin (P1, P3)	$370	$6	$376
Aqueducts (A1, A4, A5)	$75	$3	$78
Discharge Structure (D1, D2)	$40	$1	$41
Logistics (L1, L2)	$18	$1	$19
Total	**$749**	**$24**	**$773**

[a] Potential Cost Savings refers to reductions associated with potential innovations compared to the construction cost estimate for the Bethany Reservoir Alignment as depicted in the EPR. Values in () represent a potential increase in costs.

[b] Costs are in 2023 dollars and are undiscounted.

[c] Risk treatment cost savings are estimated as a scaled proportion of construction cost savings relative to the Total Project Cost estimate for the Bethany Reservoir Alignment as depicted in the EIR/EPR.

As shown in Table 1-2, the innovations evaluated for the tunnels and shafts and the pumping plant and surge basin present the greatest potential savings and make up the majority of the combined innovation savings. The potential benefits of the identified innovations or future innovations should be further analyzed as project definition improves. Additional benefits of potential design or construction innovations to improve constructability or further reduce community or environmental disturbances, schedule, and/or costs savings associated with potential innovations could be realized but would require further analyses in coordination with DWR.

2. Development and Screening of the Innovations

The purpose of identifying and developing innovations at this early stage of conceptual design was to demonstrate the potential project benefits associated with industry innovation, constructability improvements, and eventual value engineering activities that will likely occur in future design phases. Initially, 167 innovative ideas were identified with potential to improve the project. The DCA analyzed the ideas and categorized them into 51 potential innovations that were then advanced through additional feasibility-level analyses and reviewed in a series of workshops with DCA and DWR staff. The result of this screening and evaluation process was the identification of 19 reasonable innovation concepts that could result in potential cost and/or schedule reductions, which are summarized in this memorandum.

3. Analysis of the Innovations

The DCA determined a variety of potential improvements, or innovations, to the EPR conceptual design based on additional engineering and design consideration and additional geotechnical subsurface information not available at the time of completing the EPR conceptual design. When deciding which innovations might be considered for further evaluation, the innovation concept was compared to the EPR conceptual design in terms of cost and schedule.

3.1 Cost Considerations

To evaluate the cost savings, a high-level concept design and subsequent cost estimate for the innovations was compared to the baseline construction cost estimate for the project described in the EPR/EIR. For some innovations, the basic design remained the same, but with a change to the quantities, and hence cost. For other innovations, new potential construction approaches associated with the concepts were evaluated and compared using the same unit costs as presented in the baseline construction cost estimate to determine the potential construction cost savings.

Cost evaluations resulted in either a cost increase, cost decrease, or minimal change compared to the baseline cost estimate prepared for the EPR concept design. The cost evaluation also considered how each innovation could either reduce or optimize construction materials, labor hours, and construction sequencing to ultimately reduce the cost and schedule duration while still meeting the overall functional requirements of the project. The construction cost savings presented for the innovations include the same cost basis used to develop the baseline construction cost estimate as related to materials, labor and equipment, taxes, contractor markup and profit, and other add on costs such as insurance and bonds. This analysis does not re-evaluate risk treatment costs associated with design and construction of the project features, but rather applies a proportionally scaled portion of the risk treatment costs as described for the baseline construction cost estimate for the project.

Innovation construction cost savings presented in this memorandum do not currently include contingency. However, it is recommended that the same contingency be applied to the innovation construction costs savings as used for the baseline total project cost estimate when comparing the cost impacts. Innovations may reduce the impact of uncertainty within the cost estimate currently captured by risk treatment costs and project contingencies and should be further evaluated in the future.

Labor costs associated with design and construction of the project features were not re-evaluated for this evaluation, so any comparison with the baseline total project cost estimate should use a proportionally scaled labor cost to indicate the total costs of the project including potential innovations. Cost savings discussed in this memorandum do not include effects related to the reduced schedule durations for each individual construction project nor for the reduction of the overall project schedule. Labor cost and schedule cost savings should be further evaluated during future design stages.

3.2 Schedule Considerations

Each innovation was individually assessed to determine the impact on the construction schedule compared to the EPR schedule. Where quantities of materials changed, the same production rates were applied to ascertain new activity durations. Where new activities were introduced, production rates from similar activities were used wherever possible to determine the new activity duration.

The schedule savings referenced in this memorandum are in terms of construction days for each individual feature and not overall project schedule. The potential schedule savings for each individual feature would reduce the overall project schedule only if the schedule for that feature impacts the overall project critical path. An evaluation of overall project schedule savings should be completed as part of future design phases.

4. Description of the Innovations

This section summaries each innovation and compares it with the EPR design, including an assessment of the impacts on potential cost and schedule.

4.1 Intakes

4.1.1 INV-I2 Intake Fish Screen Barrier System

EPR Concept	
The EPR concept for the fish screen barrier system at the intakes included a combination of thirty three 24-inch-diameter pipe piles with approximately 1,015 feet of floating fabricated steel log booms affixed in front of the piles spaced at approximately 35 feet.	
Innovation Concept	
This innovation concept includes a combination of twelve 24-inch-diameter piles with approximately 995 feet of floating HDPE log booms in between the piles using proprietary vendor-fabricated floating “pile sliders” attached to each pile spaced at 100 feet maximum	
Cost Savings:	$1,070,000
Schedule Savings:	14 construction days

4.1.2 INV-I3 Raise Intake 3 and 5 Tee Screen Elevation

EPR Concept	
The EPR concept for both Intake 3 and Intake 5 places the bottom of the tee screens at EL -13 feet, which provides approximately 8.6 feet of submergence below the design (low) water surface elevation at Intake 5, and approximately 8.7 feet of submergence at Intake 3. The minimum recommended tee screen submergence is one half of the screen diameter, or 4 feet for the current 8-foot-diameter tee screen units. At the same time, the EPR concept places the screen sill at EL -17 feet, which is equal to the average river bottom elevation.	
Innovation Concept	
This innovation proposes to increase the separation between the river bottom and the bottom of the Intake 5 tee screens by up to 4.6 feet (up to 4.7 feet at Intake 3) and reduce the screen submergence to the minimum 4 feet. The height of the structure is reduced by up to 4.6 feet (up to 4.7 feet at Intake 3).	
Cost Savings:	$4,133,000
Schedule Savings:	28 construction days

4.1.3 INV-I4 and INV-I5 Intake Structure Configuration

EPR Concept	
The EPR intake structure configuration concept includes thirty 60-inch-diameter discharge pipes, each with a separate gate structure located along the discharge pipe alignment near the sedimentation basins.	
Innovation Concept	
Combined, these two innovations include replacing the thirty 60-inch-diameter discharge pipes with fifteen 84-inch-diameter discharge pipes and combines the gate box structures with the intake structure. In addition, structural elements are added to each bay of the intake structure to resist tunnel jacking forces from construction of each of the 84-inch-diameter discharge pipes.	
Cost Savings:	$29,810,000
Schedule Savings:	26 construction days

4.2 Tunnels and Shafts

4.2.1 INV-T1 Provide Separate Access to Double Launch Shafts

EPR Concept	
In the EPR, access to the raised launch shaft pads is via ramps that are shared by two potential contractors, each responsible for driving a tunnel from the double shaft in opposite directions.	
Innovation Concept	
This innovation adds two additional ramps together with a slightly larger top of pad area that would enable each contractor to access their respective halves of the double launch shaft and with an effective dividing wall between them. Reorganization of the equipment and access routes would mean that each contractor could be entirely responsible for maintaining their own construction roads.	
Cost Savings:	($630,000)
Schedule Savings:	No change to schedule

4.2.2 INV-T2 Tunnel Lining Optimization

EPR Concept	
The reinforcement details for the tunnel lining in the EPR concept was based on the maximum net pressure that could be encountered for the entire 45-mile-long tunnel being applied to all tunnel reaches. The design accounted for internal and external water pressure but assumed no soil loads acting on the tunnel to counteract the internal pressures.	
Innovation Concept	
This innovation reduces the amount of reinforcement required in the tunnel lining by considering the maximum net internal pressure that will be encountered within each tunnel reach individually and accounting for an effective soil pressure to counteract the internal pressures.	
Cost Savings:	$45,850,000
Schedule Savings:	Reduced construction time but no impact to the overall schedule

4.2.3 INV-T3 Planning for Semi-continuous Mining

EPR Concept	
The EPR assumed tunnel excavation using a TBM with separate phases for excavation and tunnel lining installation. In this manner, a full precast concrete segmental tunnel lining ring is installed before the TBM rams push the machine forward from the leading edge of the lining to excavate the next section.	
Innovation Concept	
This innovation concept considers the latest TBM technology that allows a TBM to thrust forward from a partially completed segmental lining ring such that excavation and lining installation can happen concurrently.	
Cost Savings:	$70,350,000
Schedule Savings:	101 construction days for Reach 1 160 construction days for Reach 2 118 construction days for Reach 3 184 construction days for Reach 4

4.2.4 INV-T4 Optimize Tunnel Profile and Shaft Sizes

EPR Concept	
The tunnel profile in the EPR slopes continuously from north to south at a constant slope of about 0.01% and is excavated to a depth of approximately 200 feet. The diaphragm walls and final linings of the shafts are shown as 5 feet and 3 feet thick respectively and the shafts invert slabs are 30 feet thick.	
Innovation Concept	
This innovation considers optimizing the vertical tunnel profile and the configuration of the reception and maintenance shafts by reducing the depth of the tunnel between Intake No. 3 and the Stockton Deep Ship Channel Crossing and then increasing the depth of the tunnel from Lower Roberts Island Launch Shaft to the Surge Basin Reception Shaft to provide clearance underneath the future East Bay Municipal Utility District (EBMUD) Mokelumne Aqueducts Resiliency Project (MARP) tunnel. It also considers reducing diameter of the reception and maintenance shafts along with the thickness of the diaphragm walls, final lining and invert slab of the reception and maintenance shafts.	
Cost Savings:	$95,430,000
Schedule Savings:	192 construction days

4.3 Pumping Plant and Surge Basin

4.3.1 INV-P1 Optional Pumping Plant Belowground Configuration

EPR Concept	
In the EPR, the Bethany Reservoir Pumping Plant (BRPP) is a below ground structure with vertical rectangular diaphragm walls and consists of dry-pit pump bays housing the pumping plant equipment and piping plus an adjoining rectangular concrete wet well and wet well inlet conduit connected to the reception shaft located within the Surge Basin. Separate dry pit pump structures would be connected to both sides of the wet well that would be located along the center of the overall structure.	
Innovation Concept	
This innovation would replace the vertical, deep box diaphragm wall arrangement with interlinking shafts of diaphragm wall construction that would house the pumping plant equipment and piping and a tunnel that would replace the wet well and wet well inlet conduit	
Cost Savings:	$138,720,000
Schedule Savings:	981 construction days

4.3.2 INV-P3A/B- Surge Basin Base Slab Uplift Resistance/Surge Basin Wall Configuration

EPR Concept	
In the EPR, uplift resistance to the surge basin base slab is provided by an array of six-foot diameter passive (not pre-stressed) drilled shafts. The surge basin perimeter walls are constructed using concrete diaphragm walls consisting of an upper structural section with two rows of tieback anchors and a lower unreinforced, cut off wall section.	
Innovation Concept	
This innovation considers tiedown anchors for the base slab instead of the drilled shafts (P3A) and a conventional tied-back sheetpile/concrete wall system for the surge basin walls (P3B).	
Cost Savings:	$230,830,000
Schedule Savings:	P3A: 280 construction days P3B: 237 construction days

4.4 Aqueducts

4.4.1 INV-A1 and INV-A5 Reducing Pipe Diameter and Trench Section

EPR Concept	
The EPR concept includes four 180-inch-diameter parallel aqueduct pipelines installed from the BRPP to the Bethany Reservoir Discharge Structure with the parallel pipes spaced at 30 feet on center constructed partially below ground (0.7 x pipeline diameter) and partially above ground (0.3 x pipeline diameter) backfilled with Controlled Low Strength Material (CLSM) from the bottom of the excavated trench to the ground surface and soil cover to 6 feet above the top of pipes.	
Innovation Concept	
This innovation reduces the diameter of the four aqueduct pipelines to 166-inch-diameter, and spaces the pipelines at 21 feet on center while maintaining the backfill and soil cover dimensions.	
Cost Savings:	$60,380,000
Schedule Savings:	79 construction days

4.4.2 INV-A4 Bethany Conservation Easement Tunnel/Shaft Considerations

EPR Concept	
In the EPR, the Bethany Conservation Easement tunnels and Bethany Reservoir Discharge Structure shafts were designed for a 180-inch-diameter pipeline. The tunnel had a constant 0.65% gradient and the shafts consisted of four circular shafts with an internal diameter of 55-feet.	
Innovation Concept	
This innovation considers the reduced aqueduct pipeline diameter proposed in INV-A5 to reduce the size of the excavated tunnel and shafts. It also considers raising the gradient of the tunnel which reduces the depth of the discharge structure shafts and reduces the diameter of the shafts from 55-feet to 32-feet.	
Cost Savings:	$14,360,000
Schedule Savings:	222 construction days

4.5 Discharge Structure

4.5.1 INV-D1 Reconfigure Discharge Structure Retaining Wall

EPR Concept	
In the EPR, shoring during construction of the discharge structure to support hillside excavation would be required and would provide a 10-foot minimum buffer from the closest edge of the Bethany Reservoir Conservation Easement. It was assumed that the shoring system included a combination of soil-nail reinforced wall and excavations sloped between 2H:1V and 1.5H:1V.	
Innovation Concept	
This innovation involves construction of a steepened slope excavation, with soil nail reinforcement to decrease the total area of the cut and volume of excavation. This will also increase the ten-foot buffer from the Bethany Reservoir Conservation Easement and provide an access road for maintenance.	
Cost Savings:	$1,387,000
Schedule Savings:	No change

4.5.2 INV-D2 Refine Bethany Reservoir Discharge Structure Configuration

EPR Concept	
The discharge structure concept in the EPR includes four 55-foot-diameter shafts and four separate channels to convey flow from each shaft to the Bethany Reservoir. Each flow channel would be isolated from the reservoir when not in operation using two radial gates.	
Innovation Concept	
This innovation proposes raising the discharge elevation of each aqueduct pipeline just above the crest of the dam spillway which provides isolation from the reservoir and eliminates the need for the isolation radial gates.	
Cost Savings:	$38,500,000
Schedule Savings:	554 construction days

4.6 Hydraulics and Operations

4.6.1 INV-H1 and INV-H2 Reduce Diameter of Intake Shafts and Maintenance Shafts

EPR Concept	
The EPR design includes 83-foot-diameter shafts at Intake Structures 3 and 5 and five 70-foot-diameter maintenance shafts.	
Innovation Concept	
This innovation reduces the shafts at Intake 3 and Intake 5 to 70-foot-diameter and reduces the maintenance shafts to 66-foot-diameter.	
Cost Savings:	$40,110,000
Schedule Savings:	No change to schedule

4.7 Logistics

4.7.1 INV-L1 Eliminate Rail-Served Materials Depot – Lower Roberts

EPR Concept	
The EPR included new rail access to Lower Roberts Island from the Port of Stockton's rail network via a new bridge over Burns Cut and a new rail-served materials depot on Lower Roberts Island.	
Innovation Concept	
This innovation maintains the construction of the Burns Cut bridge while deferring the construction of the rail-served materials depot on Lower Roberts Island as a future option.	
Cost Savings:	$16,305,000
Schedule Savings:	128 construction days

4.7.2 INV-L2 Hood Franklin Road Intersection Innovation

EPR Concept	
The EPR concept involves the widening of an existing bridge over Snodgrass Slough on Hood-Franklin Road to accommodate left and right turn pockets onto the Intake Haul Road from Hood-Franklin Road leading to the two intake construction sites.	
Innovation Concept	
This innovation involves the installation of a single-lane roundabout that would eliminate the need to widen the bridge and would provide efficient traffic movement.	
Cost Savings:	$2,050,000
Schedule Savings:	No change to schedule

5. Summary and Future Considerations

Compared to the EPR project description, the proposed set of 19 combined innovations are estimated to reduce the construction cost of the project by up to $773M (without contingency) and save a combined total of 2,925 construction days on the various projects. These proposed innovation concepts are recommended for further study as the project develops. Further evaluation of these potential innovations should be fully coordinated with other innovations, environmental impact considerations, risk elements, and other changes that might result from additional future project development.

6. References

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Benefit-Cost Analysis of the Delta Conveyance Project

Prepared by David Sunding, Ph.D.

and Oliver Browne, Ph.D.

May 16, 2024

BRG
Berkeley Research Group

Table of Contents

Figures

Tables

Executive Summary

This report presents the results of a benefit-cost analysis for the Delta Conveyance Project (DCP), a plan to modernize the State Water Project (SWP)'s conveyance infrastructure in the Sacramento-San Joaquin River Delta (Delta). The SWP plays a crucial role in supplying water resources to 27 million Californians. Businesses in the area served by the SWP produce $2.3 trillion in goods and services annually, making it the world's eighth-largest economy. The SWP delivers an average of 2.56 million acre-feet of water annually to urban and agricultural customers in the Bay Area, Central Valley, Central Coast, and Southern California. However, by 2070, climate change and sea-level rise are expected to reduce SWP deliveries by approximately 22%, or 546 thousand acre-feet per year (TAF/yr). In addition, the SWP faces an ongoing risk of service disruptions following seismic events near the Delta; these events could cause outages and reduce the quality of water exports from the SWP south of the Delta.

The DCP's intended purposes are to mitigate climate and seismic risks for the SWP and provide water managers with additional operational flexibility in the Delta. The DCP would add new intake facilities in the North Delta to divert water from the Sacramento River and a tunnel to convey water to the South Delta for export to the SWP's urban and agricultural customers. The DCP would increase SWP deliveries by approximately 17%, or 403 TAF/yr, largely offsetting the anticipated reduction in water deliveries due to climate change. The DCP would also be less vulnerable to earthquakes near the Delta, meaning that SWP supplies could continue largely uninterrupted following seismic events.

A benefit-cost analysis is a rigorous method for evaluating the economic viability of a project—specifically, by forecasting a project's expected future benefits and costs. The present value of future benefits and future costs is calculated relative to a no-project alternative. Present values are calculated using real discount rates that reflect the time-value of money. As detailed in recent federal guidance (OMB Circular A-94), we adopt a real discount rate that starts at 2% in 2020, reflecting current inflation-adjusted Treasury bond rates, and gradually decreases to 1.4% by 2140 to reflect long-run uncertainties. The benefit-cost ratio is calculated by dividing the present value of future benefits by the present value of future costs. As discussed later in this report, for the DCP, we calculate a benefit-cost ratio of 2.20 and show that this ratio is robust with respect to a number of alternative assumptions regarding climate change, sea-level rise, SWP operations, and project costs. The approach to benefit-cost analysis taken in this report is consistent with the approaches described in the Department of Water Resources (DWR) Economic Analysis Guidebook and with State of California and federal guidelines for economic analysis of water resource–related investments.

The benefits and costs of the DCP are estimated in the context of forecast changes in water supply and demand. Climate change and sea-level rise are expected to significantly reduce future SWP deliveries. Future precipitation and runoff are forecast using an ensemble of climate scenarios selected by DWR's Climate Change Technical Advisory Group. Then, project deliveries are simulated using CalSim 3, a resource planning model that simulates operations of the SWP and Central Valley Project (CVP) under different hydrologic conditions. The project timeline, based on DWR's most recent expectations, involves preconstruction from 2026 to 2028, construction from 2029 to 2044, and an evaluation of economic benefits for a century of operations from 2045 to 2145.

Benefits of the DCP

This report quantifies the benefits of the DCP in four areas: urban water supply reliability, agricultural water supply, water quality, and seismic reliability.

1) Urban water supply reliability

The primary benefit of the DCP is that it would reduce the anticipated increase in the frequency of water supply shortages for SWP's urban contractors caused by climate change and sea-level rise. The frequency and size of future water supply shortages are assessed using information provided by State Water Contractors, as described in their respective urban water management plans (UWMPs) or, for the Metropolitan Water District, in the Integrated Resource Plan (IRP). These models are used to estimate the frequency and magnitude of shortages for each contractor, with and without the project and under various future climate assumptions. This approach to estimating water supply reliability is consistent with the Delta Independent Science Board's 2020 review of approaches to water supply reliability estimation.[1]

The economic impact of future water shortages for urban customers is estimated using economic models that measure consumer welfare, a measure of well-being for urban water customers resulting from the reliability of their urban water supply loss. The estimates of consumer welfare loss use a standard model from the academic literature.[2] Calibration of this model is based on retail water rates and utility-specific estimates of customer demand sensitivity. Over the project's lifetime, the present value of improved water supply reliability (i.e., the DCP's ability to mitigate the effects of forecast climate change and sea-level rise) is estimated to be worth more than $33.3 billion in 2023 dollars.

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[1] Delta Independent Science Board. 2016. *Review of Water Supply Reliability Estimation Related to the Sacramento-San Joaquin Delta*. Report to the Delta Stewardship Council. June. Sacramento, CA. Available: https://deltacouncil.ca.gov/pdf/isb/products/2022-06-16-isb-water-supply-reliability-review.pdf.

[2] See, for example, Brozovic et al. 2007, Buck et al. 2016, or Buck et al. 2023 for examples of this approach.

Buck, S., M. Auffhammer, S. Hamilton, and D. Sunding. 2016. Measuring Welfare Losses from Urban Water Supply Disruptions. In *Journal of the Association of Environmental and Resource Economists*, 3(3), 743–778.

Buck, Steven, Mehdi Nemati, and David Sunding. Consumer Welfare Consequences of the California Drought Conservation Mandate. In *Applied Economic Perspectives and Policy,* 45, No. 1 (2023):510–533.

2) *Agricultural water supply*

The benefits of improved agricultural water supply reliability are estimated using two approaches. First, a willingness-to-pay approach is used, based on the Statewide Agricultural Production (SWAP) model, a regional model of irrigated agricultural production in California's Central Valley developed by researchers at the University of California, Davis that simulates the economic decisions of farmers. This estimate reflects the long-term value of water to agricultural customers in the Central Valley. Second, we use a market-based approach, valuing the incremental water supplies produced by the DCP at average market prices, as measured by the Nasdaq Veles California Water Index. This estimate reflects the ability of farmers to extract additional value by selling water to other urban or agricultural users during short-term periods of scarcity. Averaging estimated benefits across these two approaches, the present value of the DCP's future agricultural water supply benefits is $2.3 billion in 2023 dollars.

3) *Water quality*

The DCP is expected to lead to a modest improvement in the average quality of water exported south of the Delta. The benefits of improved water quality in the urban sector are estimated using the Salinity Economic Impact Model (SEIM) developed by the U.S. Geological Survey (USGS). The present value of benefits from improved urban water quality in Southern California is worth $1.33 billion in 2023 dollars. The benefits of improved water quality in the agricultural sector of the San Joaquin Valley and Southern California are estimated using models that calculate the value of a reduced yield impact and irrigation water requirements due to reduced salinity in the agricultural water supply. The present value of improved agricultural water quality is expected to be around $0.09 billion in 2023 dollars.

Anticipated operation of the DCP would lead to changes in salinity in the Delta; the impacts of these changes are assessed as being "less than significant" in the project's environmental impact report (EIR); however, costs associated with potential increased Delta salinity are accounted for under the costs of remaining environmental impacts after mitigation. Overall, the benefits of improved salinity for downstream agricultural water contractors significantly outweigh the cost of the small increase in salinity in the Delta region. The project would also provide additional operational flexibility to help SWP operations adapt to water regulations in the Delta, the benefits of which are not explicitly quantified in this report.

4) *Seismic reliability*

The project would also provide significant economic benefits by acting as an insurance policy against the risk of water supply interruptions during a major seismic event in the San Francisco Bay or Delta region. The DCP's benefits in terms of improved seismic reliability are estimated using a seismic scenario described in the Delta Flood Emergency Management Plan (DFEMP). This scenario describes a 500-year seismic event that causes up to 50 levee breaches in the Delta, flooding 20 islands. Under the recovery scenario that we consider for such an event, exports from the Delta are expected to cease for between six and 448 days. After that period, exports resume but with impaired water quality for between five to 103 additional days. The DCP is engineered to withstand such an event and remain operational. The benefits of continued water deliveries during such an event are estimated by assuming that either the DCP operates at capacity for the duration of the seismic impacts or that it operates at a minimum level to meet health and safety requirements. Depending on the specific scenario, the benefits of DCP operations during the seismic event range from $60 million to $53 billion. Averaging across the scenarios considered and accounting for the annual likelihood of such an event, we estimate the present value of seismic benefits from DCP operations to be around $1 billion in 2023 dollars.

We estimate total benefits with a present value of $33.8 billion. Some benefits of the DCP are not explicitly quantified in this report. For example, this report does not quantify the project's benefits in terms of increased operational flexibility in the Delta or the benefits associated with the Community Benefits Program, which will invest in local communities. The DCP is also expected to relieve pressure on groundwater supplies in the Central Valley and increase the average storage levels of the state’s major reservoirs, the impacts of which are not quantified in this report.

Costs of the DCP

In addition to considering benefits, this report quantifies the costs associated with construction of the DCP. Three types of costs are considered in this report: the project costs associated with development and construction of the project, the operations and maintenance (O&M) costs associated with operating the project over its 100-year lifespan, and the costs associated with any remaining environmental impacts after mitigation.

1) Construction costs and related expenditures

The Delta Conveyance Design and Construction Authority (DCA) produced two cost estimates for the DCP. The primary cost estimate reflects the project's current specifications, as detailed in the EIR, estimated at $20.1 billion before discounting. In addition, a secondary estimate, referred to as the “project-wide innovations and savings estimate,” evaluates the financial impact of potential design modifications and construction innovations. These innovations aim to enhance cost efficiency and feasibility without changing core project specifications, potentially reducing costs and construction timelines while minimizing environmental impacts. Before discounting, the secondary estimate stands at $18.9 billion.

After applying discount rates, the present value of the primary and secondary estimates is $15.4 billion and $14.5 billion, respectively. These figures are based on 2023 dollars and include various cost components:

- **Construction costs** for the intakes, tunnels, pumping plants, and other infrastructure, including a 30% contingency, worth $11.5 billion or $10.7 billion in present-value terms for the primary and secondary estimates, respectively.
- **Other project costs** include those associated with planning, design, construction management, land acquisition, and power use as well as the cost of a settlement agreement with the Contra Costa Water District, worth $3.0 billion or $2.9 billion in present-value terms for the primary and secondary estimates, respectively.

- **Costs for** a **community benefits program,** worth $200 million undiscounted or $153 million in present-value terms.
- **Costs for the mitigation of environmental impacts** identified in the EIR, worth $960 million undiscounted or $735 million in present-value terms. Expected environmental impacts and approaches to mitigation are identified in the project's EIR.

2) Operations and maintenance costs

Projected O&M costs for the DCP are detailed in a memorandum authored by the DWR and the DCA.[3] This cost forecast included facility O&M, materials, power, capital equipment replacement and refurbishment, and the management of project restoration sites. In 2023 dollars, estimated annual O&M costs are $52.6 million, amounting to a present value of $1.7 billion over the project's 100-year operational span from 2040 to 2140.

3) Remaining environmental impacts after mitigation.

Most environmental impacts identified as significant in the EIR can be mitigated to levels where they are considered less than significant after mitigation. However, some environmental impacts identified in the EIR are anticipated to have significant and unavoidable impacts after the implementation of proposed mitigation measures. In an appendix to this report, each significant and unavoidable impact is considered, and where appropriate, economic tools are used to estimate the economic costs associated with these impacts. Our assessment also estimates costs associated with an increase in Delta salinity, included despite being "less-than-significant" impacts in the EIR, in order to provide a complete account of all salinity-related impacts alongside the previously discussed water quality benefits. The costs of environmental impacts that remain significant after mitigation are calculated in the following areas:

- Lost agricultural land
- Air quality impacts
- Noise impacts
- Transportation impacts
- Reduced water quality in the Delta

The costs of other impacts—specifically, in terms of aesthetic and visual resources, paleontological resources, and tribal cultural resources—are not estimated because there is no appropriate economic methodology to do so. For the impacts that are quantified, the present value of future costs is $167 million in 2023 dollars. These impacts may disproportionately affect specific populations adjacent to the construction project.

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[3] California Department of Water Resources. 2024. *O&M Annual Cost Estimate Basis for Bethany Reservoir Alternative*. April.

Benefit-Cost Ratios and Sensitivity Analyses

Table 1 summarizes the primary DCP benefit-cost estimate. We estimate the present value of the benefits of the DCP to be $37.96 billion in 2023 dollars, and we estimate the present value of the costs of constructing and operating the DCP to be $17.26 billion in 2023 dollars. Based on these estimates, we find the proposed DCP project has a benefit-cost ratio of 2.20. Under the cost estimate with project-wide innovations and savings, the benefit-cost ratio is higher, at 2.33.

Table 1 also shows estimates per acre-foot of the benefits and costs of the DCP. These estimates per acre-foot are calculated using a levelized cost-of-water approach that accounts for the timing of future SWP deliveries.[4] Based on this approach, we estimate levelized benefits of $2,918 per acre-foot, along with levelized costs of $1,327 per acre-foot and $1,255 per acre-foot, respectively, in the primary and secondary cost estimates.

The primary benefit-cost analysis shown in Table 1 is referred to as the 2070 median scenario with 1.8 feet of sea-level rise. This scenario considers changes in precipitation and runoff from a median climate change projection, based on an ensemble of global climate models for the period 2056–2085.[5] The primary scenario assumes 1.8 feet of sea-level rise by 2070, based on guidance from the California Ocean Protection Council for the likely range of sea-level rise under a high emissions scenario.[6] To test the robustness of the estimated benefit-cost ratio to these assumptions, a number of sensitivity analyses are also considered that make alternative assumptions in terms of future precipitation and runoff, sea-level rise, and adaptation measures to reduce operational risks associated with climate change. Across all the sensitivity analyses considered, the incremental deliveries of the proposed project are at least 395 TAF/yr on average, highlighting that the proposed project is robust to different assumptions about climate change and sea-level rise. In each of these sensitivity scenarios, the benefits of the project significantly exceed costs with benefit-cost ratios between 1.54 and 2.69.

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4 Levelized cost of water is calculated with the formula $LCOW = \frac{\sum_{t=1}^{n}\frac{C_t}{(1+r_t)^t}}{\sum_{t=1}^{n}\frac{Q_t}{(1+r_t)^t}}$ where C_t is the cost associated with the DCP at time t, Q_t is the volume of additional SWP deliveries as a result of the DCP at time t, and r_t is the discount rate at time t. This methodology is described in more detail here:
Fane, Simon, J. Robinson, and S. White. The Use of Levelized Cost in Comparing Supply and Demand-Side Options. In *Water Science and Technology: Water Supply,* 3, No. 3 (2003):185–192.

5 See California Department of Water Resources “CalSim 3 Results for 2070 Climate Change and Sea-Level Projections and Sensitivity Analysis.”

6 See California Ocean Protection Council. 2018. *State of California Sea-Level Rise Guidance: 2018 Update*. Sacramento: CA.

Table 1: Summary of Benefits and Costs

	Main Scenario	
	Primary Cost Estimate	**Costs w. Project-wide Innovations & Savings**
	Present Value of Future Benefits	
	$ Millions, 2023	$ Millions, 2023
Urban Water Supply and Reliability	$33,300	$33,300
Agricultural Water Supply and Reliability	$2,268	$2,268
Urban Water Quality	$1,330	$1,330
Agricultural Water Quality	$90	$90
Seismic Reliability Benefits (Water Supply)	$969	$969
Seismic Reliability Benefits (Water Quality)	$2	$2
Total Benefits	**$37,960**	**$37,960**
	Present Value of Future Costs	
	$ Millions, 2023	$ Millions, 2023
Construction Costs	$11,486	$10,723
Other Project Costs	$3,021	$2,852
Community Benefit Program	$153	$153
Environmental Mitigation	$735	$735
O&M Costs	$1,697	$1,697
Environmental Impacts after Mitigation	$167	$167
Total Costs	**$17,259**	**$16,327**
Levelized cost per AF	*$1,327*	*$1,255*
Benefit-Cost Ratio	**2.20**	**2.33**

Sources and Notes:

- Construction Costs include 30% contingency.
- Other Project Costs include project design, management, oversite, land, power, and Contra Costa Water District Settlement Agreement cost shares.
- Benefits and costs evaluated under the 2070 median climate scenario with 1.8 feet of sea-level rise. All benefits and costs are net present values in millions of 2023 dollars.
- A declining discount rate of 2% (2023–2079), 1.9% (2080–2094), 1.8% (2095–2105), 1.7% (2106–2115), 1.6% (2116–2125), 1.5% (2127–2134), 1.4% (2135–2140) is used in accordance with Office of Management and Budget guidance.

1. Introduction

1.1. BACKGROUND ON DELTA CONVEYANCE

The Sacramento-San Joaquin River Delta (Delta) is an expansive network of waterways in Northern California at the confluence of the Sacramento and San Joaquin Rivers. The Delta serves as a critical junction for the distribution of water from the wetter northern and eastern parts of the state to the drier coastal and southern regions through two major water conveyance projects: the State Water Project (SWP) and the Central Valley Project (CVP).[7] Water conveyed south through the SWP is used to supply residential, agricultural, commercial, and industrial customers in California, including in the South of the San Francisco Bay Area, in the Central Valley, in the Central Coast, and in Southern California. The SWP supports a service area that includes 27 million people with a gross domestic product (GDP) equivalent to the world's eighth-largest economy ($2.3 trillion). Within this service area, the SWP currently deliveries approximately 2.56 million acre-feet of water annually to urban and agricultural customers. However, the SWP infrastructure that moves this water through the Delta is outdated and at risk due to climate change, sea-level rise, and seismic activity. Climate change and sea-level rise are expected to reduce SWP water deliveries by about 22% by 2070. Rising sea levels threaten to increase saltwater intrusion, which can compromise local ecosystems and the quality of water available for export. Furthermore, climate change is expected to bring more extreme weather patterns, including both severe droughts and intense storms. This unpredictability adds stress to existing ecological constraints on storage and conveyance, potentially reducing future deliveries and making their timing more uncertain. Furthermore, the Delta's systems of aging levees, some of which date back to the gold rush era, are vulnerable to failure. A major seismic event in the Delta could lead to numerous levee failures, significantly compromising the conveyance system in the area. This would pose a direct risk to water supply and water quality throughout the region.

The construction of additional conveyance infrastructure in the Delta has been extensively studied in a number of different proposals over several decades. The Department of Water Resources' (DWR's) 1957 California Water Plan suggested a "Trans-Delta System" to convey water; a peripheral canal was part of the original proposal for the SWP. During the 1980s, Governor Brown passed legislation providing for the addition of a peripheral canal in the Delta as part of the CVP. This proposal was extensively studied; however, the legislation was subsequently repealed in a voter referendum in 1982.

[7] The SWP is a complex system of reservoirs, aqueducts, power plants, and pumping stations. It supplies water to more than 27 million people and irrigates about 750,000 acres of farmland. Planned, built, operated, and maintained by DWR, the SWP is the nation's largest State-owned water and power generator and user-financed water system.
The CVP, managed by the Federal Bureau of Reclamation, serves primarily agricultural users in California's Central Valley. It includes 20 dams and reservoirs, 11 power plants, and 500 miles of major canals, playing a critical role in the region's agricultural productivity.

In 2009, the Bay Delta Conservation Plan proposed by Governor Schwarzenegger studied alternative Delta conveyance facilities, including twin tunnels with a capacity of 9,000 cubic feet per second. A modified version of this proposal, called Cal WaterFix, was proposed in 2015 during Governor Brown's third term. The current Delta Conveyance Project (DCP) proposal considers a single tunnel with a capacity of 6,000 cubic feet per second, along with a new route close to Interstate 5 and a connection to Bethany Reservoir on the California Aqueduct. Authors of this report have been involved in economic analyses for each of these proposals since 2009. Each analysis has used similar methodologies and has consistently found that the benefits of the proposed project exceed its costs, with comparable results in terms of estimated economic benefits.[8]

1.2. THE PURPOSE OF THE DELTA CONVEYANCE PROJECT

The purpose and objectives of the proposed DCP are described in Chapter 2 of the project's environmental impact report (EIR).[9] The purpose of the DCP is to develop new diversion and conveyance facilities in the Delta to protect the reliability of SWP deliveries, in light of anticipated future climate change and sea-level rise. Operation of these conveyance facilities will help achieve several related objectives by addressing sea-level rise, minimizing the impact of major earthquake events on SWP and potentially CVP deliveries, and protecting the ability of the SWP to deliver water and provide further operational flexibility. If approved, these updates would improve climate resiliency and the reliability of the state's largest source of safe, affordable, and clean water for 27 million Californians and 750,000 acres of farmland, with continued support for local water supply projects, such as local storage, recycling, groundwater recharge, and water quality management projects.

1.3. THE DELTA CONVEYANCE PROJECT

The DCP would modernize the water transport infrastructure in the Delta by adding new facilities in the North Delta to divert water and a tunnel to convey water to the South Delta. The proposed project is described in Chapter 3 of the project's EIR. This analyzes the costs and benefits associated with the preferred project alternative proposed in the EIR—specifically, Alternative 5. Other alternatives outlined in the EIR and additional planning documents are not included in this evaluation.

Key components of the DCP entail upgrading existing SWP infrastructure and establishing two intakes on the Sacramento River, alongside a 45-mile-long tunnel and a pumping station to channel water into Bethany Reservoir on the California Aqueduct. The tunnel, designed with launch, reception, and maintenance shafts, runs

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[8] Sunding, David L. 2018. *Economic Analysis of Stage I of the California WaterFix*. Prepared for the California Department of Water Resources. September 20, 2018.

Hecht, Jonathan, and David Sunding. 2013. *Bay Delta Conservation Plan Statewide Economic Impact Report*. August 2013.

[9] Delta Conveyance Project. 2023. *Certified Final Environmental Impact Report*. Permits and Regulatory Compliance. Available: https://www.deltaconveyanceproject.com/planning-processes/california-environmental-quality-act/final-eir/final-eir-document. Accessed: April 2024. Hereinafter "DCP EIR."

along the eastern perimeter of the Delta, strategically avoiding the central Delta region. The proposed conveyance facilities would have a capacity of 6,000 cubic feet per second. Figure 1 presents a map of the infrastructure that would be built for conveyance in the preferred alternative.

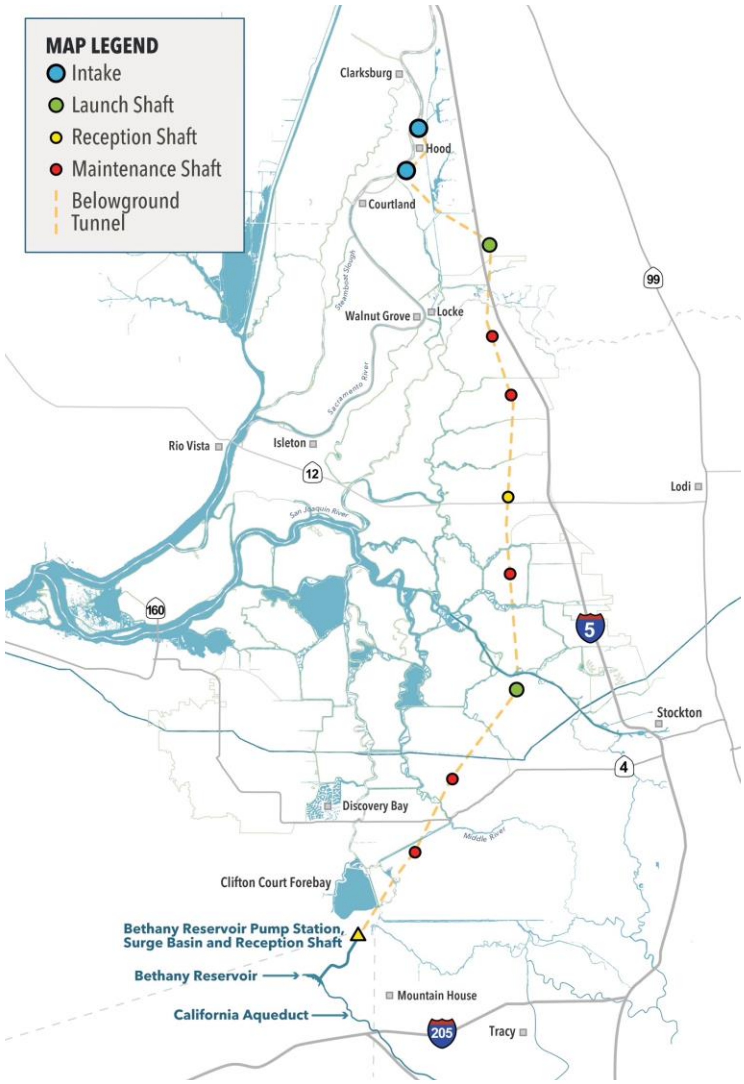
Once the water reaches existing aqueducts and water facilities in the South Delta, it can be conveyed through existing infrastructure to SWP contractors in the Bay Area, Central Coast, Central Valley, and Southern California. These infrastructure enhancements would provide DWR with the flexibility to capture, transport, and store water in accordance with regulatory standards, ensuring its availability during periods of limited supply.

The DCP’s increased conveyance capacity will enable increased deliveries of project water to State Water Contractors south of the Delta. The increase in deliveries from the DCP will partially offset the expected reduction in deliveries caused by future climate change and sea-level rise.

The seismic reliability of the DCP ensures the continuous conveyance of water, even during seismic events that might otherwise cause significant disruptions to conveyance operations throughout the Delta. The seismic design criteria adopted for the 45-mile DCP tunnel is based on what is designated as the Maximum Design Earthquake (MDE), an extreme seismic event estimated to happen once every 2,475 years.

Following DWRs currently timeline, in our analysis, preconstruction activities take place between 2026 and 2028. Construction is expected to occur between 2029 and 2044, with subsequent economic benefits estimated over the 100-year operational period from 2045 to 2145.

Figure 1: Map of the Proposed Delta Conveyance Project



Sources: Map of the Delta Conveyance Project, January 2024

2. Framework for Benefit-Cost Analysis

2.1. INFLATION, DISCOUNT RATES, AND RISK

In benefit-cost analysis, as well as in other economic and financial analyses, it is standard to analyze all benefits and costs using "real prices." For the purposes of this report, all figures are expressed in 2023 dollars. This means that, regardless of the year in which a cost or benefit occurs, the value of the cost or benefit is assessed as if it were occurring in 2023. This is done to account for inflation, the general increase in the price of goods and services over time. Because the upfront investment and benefit streams occur in different years, it is important to measure costs and benefits at different times in comparable units. Using 2023 prices removes the distorting effects of inflation, allowing present-day expenditures to be directly comparable to future benefits and providing a clear basis for evaluating a project's economic viability.

Unexpected inflation should not significantly change the outcome of our benefit-cost analysis. If inflation affects future costs and benefits similarly, changes in the inflation rate will not affect the conclusions of the benefit-cost analysis. Unexpected inflation could skew the project's benefit-cost ratio but only if the inflation experienced disproportionately affects costs relative benefits, or vice versa. This is unlikely for the DCP because the benefits are largely tied to water rates, and costs are associated with construction expenses, whose prices generally move in tandem.

In addition to inflation, benefit-cost analyses must also account for the time-value of money, which recognizes that money available today is worth more than the same amount in the future because it can be used immediately (e.g., to pay for things or to invest and earn more money). This concept is crucial, especially in long-term projects like the DCP, which assumes a 15-year construction and commissioning period starting in 2029 followed by a 100-year operational project life.

To account for the time-value of money, future benefits and costs are discounted at a rate called the "real discount rate." This is standard in benefit-cost analysis and other infrastructure benefit-cost planning and regulatory analyses. [10] The benefits of money invested at the beginning of the project unfold over 100 years, and the discounting factor incorporates the forgone opportunity cost of the money had it not been invested into the DCP but rather received the risk-free rate of return on savings in a heavily traded market.[11]

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[10] The White House. 2023. *Biden-Harris Administration Releases Final Guidance to Improve Regulatory Analysis*. November 9, 2023. Available: https://www.whitehouse.gov/omb/briefing-room/2023/11/09/biden-harris-administration-releases-final-guidance-to-improve-regulatory-analysis/. Hereinafter "OMB Circular A-94."

[11] OMB Circular A-94.

Office of Management and Budget (OMB) Circular A-94 recently updated the guidance on the use of discount rates in benefit-cost analysis. Circular A-94 identifies the real, inflation-adjusted return on long-term government debt is a good measure of the discount rate. The updated long-run discount rate starts at 2% from 2023 to 2079 and gradually falls to 1.4% from 2064 to 2172, reflecting both the social rate of time preference and the expected growth of capital.[12]

It is important to separately account for uncertainty and risk when performing benefit-cost analysis. To account for uncertain but positively correlated discount rates, economists recommend assigning probabilities to future discount rates, resulting in declining certainty-equivalent discount rates.[13] Because the discount rate captures only the risk-free interest rate, other risks are explicitly accounted for in the benefit-cost analysis (e.g., by simulating a distribution of hydrologic outcomes when assessing the project's water supply benefits, based on historic rainfall patterns and climate change).

The outcome of a benefit-cost analysis is an estimated benefit-cost ratio, the ratio of the discounted present value of benefits to the discounted present value of costs. In this analysis, a project should be considered economically viable if the benefit-cost ratio exceeds some hurdle rate, which is set above one. This hurdle rate is a policy decision that reflects social expectations for the required return on investment. A benefit-cost ratio greater than one does not necessarily mean that the benefits exceed the costs for all parties affected by the project. A more detailed analysis is required to assess the distribution of impacts across different groups because the benefits and costs may not be uniformly distributed.

2.2. DWR AND OTHER AGENCY GUIDANCE

The approach for this benefit-cost analysis is guided by DWR's Economic Analysis Guidebook. The DWR published the guidebook in 2008 as a resource to help DWR economists perform economic analyses through its discussion of economic analysis guidelines, methods, and models, among other topics. [14] In the guidebook, it is preferred that analyses be performed in a manner that is also consistent with the federal Principles, Requirements, and Guidelines (PR&Gs), except where State of California (State) interests might differ from federal interests or where the PR&Gs are considered outdated. As such, the approaches in this report have been made consistent with the federal PR&Gs, despite the fact there is no federal component to this project.

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[12] OMB Circular A-94.

[13] Arrow, Kenneth J., Maureen L. Cropper, Christian Gollier, Ben Groom, Geoffrey M. Heal, Richard G. Newell, William D. Nordhaus, Robert S. Pindyck, William A. Pizer, Paul R. Portney, Thomas Sterner, Richard S. J. Tol, and Martin L. Weitzman. 2014. Should Governments Use a Declining Discount Rate in Project Analysis? In *Review of Environmental Economics and Policy,* Volume 8, No. 2. Available: https://www.journals.uchicago.edu/doi/full/10.1093/reep/reu008. Accessed: December 6, 2023.

[14] California Department of Water Resources. 2008. *Department of Water Resources Economic Analysis Guidebook*. January 2008, pp. vii–viii. Hereinafter "CADWR Guidebook."

The guidebook advocates for an economic evaluation "of all economic costs for structural and non-structural alternatives. These costs include capital, operations, maintenance, and mitigation. Non-monetary costs and benefits must also be taken into account. In addition, identifying how the costs and benefits are allocated among involved parties is an important component of any plan." [15]

The DWR guidebook identifies three common economic analysis methods:

1. **Cost-effectiveness analysis** is used to compare multiple alternatives for achieving an identical set of objectives and identify which alternative achieves those objectives at the lowest cost.
2. **Benefit-cost analysis** estimates all the benefits and costs of a proposed project and compares them to a no-project alternative. In a benefit-cost analysis, a project is considered economically viable if the ratio of a project's benefits to its costs is larger than some proposed hurdle rate that is greater than one.
3. **Socioeconomic impact analysis** considers the distribution of benefits and costs of a proposed project among different parties.

This report contains only a benefit-cost analysis. It does not determine which of the proposed project alternatives is least costly, and it does not consider the distributional impacts of the proposed project.

The DWR guidebook also emphasizes the importance of incorporating risk and uncertainty into any economic analysis. In this context, risk describes situations where the probability of various outcomes can be measured or estimated, whereas uncertainty arises in scenarios where these probabilities are unknown or unquantifiable. For example, estimating the future distribution of precipitation and hydrologic inflows is a key part of our analysis. In this context, risk is described by our estimates of the probability of a future dry year, with low precipitation and inflows based on historical years. There is remaining uncertainty about the extent of future climate change, which we model by simulating a range of different climate scenarios and examining the robustness of our estimates to different climate assumptions.

2.3. CLIMATE ASSUMPTIONS

This report analyzes a range of possible future climate scenarios to give a full picture of the robustness and uncertainty in estimated benefits and costs. The primary benefit-cost analysis scenario considers changes in precipitation and runoff using a median climate change projection, based on an ensemble of global climate models for the period 2056–2085. The primary scenario assumes 1.8 feet of sea-level rise by 2070, based on guidance from the California Ocean Protection Council for the likely range of sea-level rise under a high emissions scenario. In separate sensitivity analyses, we also consider lesser degrees of climate change, either under existing conditions or 2040 climate conditions. We also consider scenarios with greater and lesser degrees

[15] CADWR Guidebook, p. 3.

of sea-level rise. For a comparison across climate scenarios, refer to the Sensitivity Analyses section of the report.

To simulate the 2070 climate scenarios, meteorologic and hydrologic boundary conditions were developed with 10 Coupled Model Intercomparison Project 5 global climate projections. Historical meteorological data perturbed with the differences observed in the ensemble of selected global climate projections are used to estimate future climate conditions, including runoff, surface water evaporation, and evapotranspiration. Ten hydrologic scenarios are used, each representing one General Circulation Model (GCM). The 10 projections were selected from the 64 datasets of Locally Constructed Analogs, based on three metrics of projected change: the mean annual streamflow, a coefficient of variation of streamflow, and the average annual temperature. The inclusion of projected variability in annual streamflow served as an important factor because it is identified as an important driver affecting California's water supply.[16]

Because much of the land in the Delta is below sea level and it relies on more than 1,000 miles of levees for protection against flooding, taking into consideration future sea-level rise scenarios is crucial for analysis.[17] The projections for sea-level rise in the San Francisco Bay considered for this analysis are based on the California Ocean Protection Council's guidance as of 2018.[18] The modeling takes a probabilistic approach, assigning likelihoods of occurrence for potential sea-level rise heights and rates tied to a range of emissions scenarios. The median scenario of sea-level rise is estimated to be 1.8 feet by 2070. The model also produces estimates under extreme scenarios. A 3.5-foot sea-level rise with a probability of occurrence being less than 0.5% is considered in the Sensitivity Analyses section, corresponding to a medium-high risk aversion scenario. Sea-level rise estimates are trained on the Delta hydrodynamic model, then inputted into CalSim 3 through the Artificial Neural Network to simulate the delivery and salinity outputs considered for this analysis. [19]

2.4. PROJECT DELIVERIES

The future deliveries under both the project alternative and no-project baseline are simulated with the CalSim 3 model. The climate models discussed in the previous section simulate future precipitation and runoff. The results are then inputted into the CalSim 3 model to simulate future water supply scenarios, water quality estimates, reservoir levels, groundwater levels, and more. CalSim 3's modeled output with the DCP operations, given environmental and regulatory constraints and demand forecasts, compared to the no-project future

[16] DCP EIR, Appendix 30A.

[17] DCP EIR, Appendix 5A, Section B.

[18] California Ocean Protection Council, 2018. *State of California Sea-Level Rise Guidance: 2018 Update*. Sacramento: CA.

[19] DCP EIR, Appendix 30A.

baseline serve as the basis of the benefit analysis. The allocation of deliveries is based on the existing Table A allocations among contractors that joined the Agreement in Principle.

CalSim 3 is a resource planning model that simulates operations of the SWP and CVP under different hydrologic conditions. The model was developed jointly by DWR and U.S. Bureau of Reclamation.

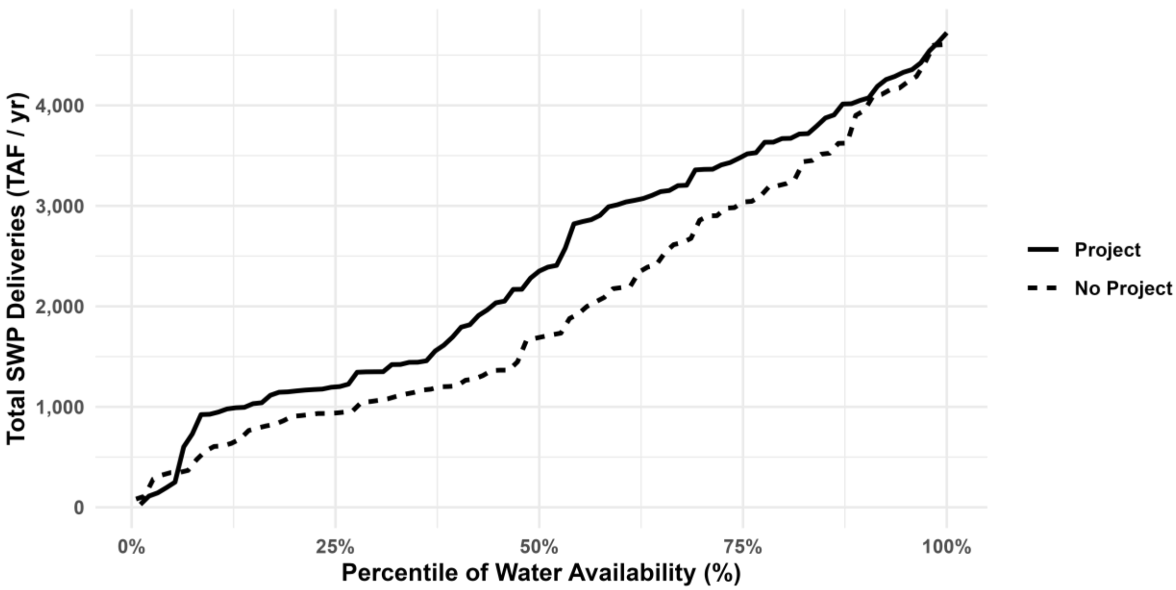
CalSim 3 uses linear programming on monthly timesteps to make water allocation and management decisions.[20] The 94 years of historical hydrology from 1921 to 2015, including unimpaired inflows and rainfall runoff, water demands, return flows, and groundwater recharge from precipitation and irrigation, are used to simulate a distribution of outputs, including river and streamflows, reservoir storage, Delta channel flows, exports, and project deliveries. The water supply and quality measures for Delta exports are of particular interest in analyzing the benefits of DCP.

The simulation of future SWP deliveries under both no-project and with project conditions is shown in Figure 2, below. Without DCP, the SWP deliveries range from 150 thousand acre-feet (TAF) to more than 4,000 TAF. The highly variable deliveries are a result of the variable climate conditions of California, characterized by interchanging drought and wet years. The average delivery under the 2070 median climate scenario, with 1.8 feet of sea-level rise without DCP, is 1,990 TAF.

With DCP, the average additional deliveries would be around 403 TAF per year (TAF/yr) compared to a no-project scenario. The additional water deliveries would be substantial during below normal and above-normal water years. However, during extreme drought and the wettest water years, DCP would not substantially increase SWP deliveries. As shown in Figure 2, in the bottom 10th percentile and above the 95th percentile, project deliveries are almost identical to no-project baseline scenarios.

[20] DCP EIR, Appendix 5B.

Figure 2: Total State Water Project Deliveries with and without DCP



Sources and Notes: Based on CalSim 3 simulations of SWP deliveries to all contractors under the 2070 median climate change scenario, with 1.8 feet of sea-level rise and 94 simulations of historical hydrology.

2.5. FRAMEWORK FOR ESTIMATION OF WELFARE BENEFITS

Two approaches are commonly used to estimate benefits: those based on market prices and those based on estimating consumers' willingness to pay (WTP). The DWR Economic Analysis Guidebook and the federal PR&Gs identify both approaches as appropriate methodologies for economic analysis, depending on the context.

In a market-based approach, estimates of benefits are based on market prices; this is frequently considered the gold standard in economics because the estimates are a straightforward way to measure and reflect actual market activity. However, markets may not exist or prices might not be observable for benefits in many settings. For example, during droughts and seismic events, utilities typically do not increase prices to ration the water supply, instead relying on unpriced conservation programs and rationing. Furthermore, because extreme droughts and major earthquakes are rare, data may not be available to identify market prices in such contexts. Furthermore, WTP is typically highest during extreme shortages resulting from such rare events. Similarly, water quality is typically not priced in the market but has significant implications for consumer welfare. Finally, many environmental impacts, such as reduced air quality or increased noise and traffic impacts, are not explicitly priced in the market. In these cases, instead of adopting a market approach, benefits are estimated by calculating a consumer's hypothetical WTP, the maximum price the consumer would be willing to pay for a good or service. In these situations, WTP can be estimated by observing behavior in adjacent markets or estimating an economic model of consumer demand.

2.6. SENSITIVITY ANALYSES

To evaluate the robustness of the DCP's economic benefits provided by the DCP under uncertain climate trajectories, a sensitivity analysis is performed under different assumptions of future climate scenarios. Three time periods are considered: 2040 median, 2040 central tendency (CT), and 2070 median.

The two 2040 climate assumptions differ mainly in the ensemble of general circulation models that were used to represent climate change in 2040.[21] For the 2040 CT scenario, 20 GCM projections are selected by the DWR Climate Change Technical Advisory Group, consisting of 10 GCMs that each consider two future emission scenarios, or Representative Concentration Pathways (RCPs). The 2040 median scenario consists of 10 GCM projections selected by the DWR Climate Change Program. Both 2040 climate scenarios show similar flow patterns, as flow in December–March increases and in April–July decreases consistently. Both 2040 scenarios also assume 1.8 feet of sea-level rise, which has a probability of occurrence of less than 0.5%.

Because DCP becomes operational only after 2040, and benefits unfold for the next 100 years, the 2070 climate scenarios are more relevant for analyzing the benefits. For 2070, the analysis considers both the median climate scenario of 1.8 feet, which has a probability of occurrence of 66%, and the extreme scenario of 3.5 feet, which has a probability of occurrence of less than 0.5%. In addition, further operational assumptions and scenarios with adaptation measures are included to avoid operational constraints associated with conveyance and the operation of the system's major reservoirs.[22]

Table 2 compares the deliveries across all seven scenarios considered. The incremental deliveries from the DCP are robust to a wide range of climate assumptions, showing that the project is robust to differing degrees of assumed climate change. Furthermore, deliveries in the 2070 project scenario are similar to non-project deliveries in 2020. As such, the project can be viewed as mitigating 50 years of future climate change by bringing future levels of water supply reliability closer to current levels.

[21] DCP EIR, Appendix 30A.

[22] California Department of Water Resources. n.d. *CalSim 3 Results for 2070 Climate Change and Sea Level Projections and Sensitivity Analysis.*

Table 2: Scenarios Considered in Sensitivity Analyses

Scenario	Main Scenario	Sensitivity Analyses 1	Sensitivity Analyses 2	Sensitivity Analyses 3	Sensitivity Analyses 4	Sensitivity Analyses 5	Existing Conditions
	2070 Median w. 1.8' SLR	2070 Median w. 1.8' SLR & Adaptation	2070 Median w. 3.5' SLR	2070 Median w. 3.5' SLR & Adaptation	2040 Median w. 1.8' SLR	2040 Central Tendency w. 1.8' SLR	2020 EC
	[TAF / Yr]						
No Project	1,990	2,019	1,876	1,920	2,098	2,314	2,560
Project	2,393	2,416	2,281	2,315	2,505	2,751	3,014
Difference	403	397	404	395	406	437	454

Sources and Notes: All modeled deliveries are measured in thousand acre-feet and averaged over 94 simulations with historical hydrology. In 2070, analysis is conducted under the median climate scenario along with multiple sea-level rise scenarios and whether adaptation measures are adopted. In 2040, both the median climate scenario and central tendency are considered for analysis. The 2020 EC scenario represents estimated deliveries under existing climate conditions.

3. Urban Water Supply Benefits

A key benefit of the DCP is the increase in water supply reliability for the SWP's urban customers. The SWP supplies water to urban customers in Southern California, the Central Coast, the Central Valley, and the Bay Area.[23] The reliability of the urban water supply has critical implications for public health and safety in urban areas, ensuring consistent access to clean water for drinking, cooking, and sanitation. Water is also critical for daily business operations in the state's commercial and industrial sectors; water supplied south of the Delta by the SWP services an area that accounts for more than half of California's GDP. Business interruptions from disruptions in water supply, if significantly large and sustained, can affect the growth and stability of the local economy.[24]

The DCP will provide additional water supply that will increase reliability by reducing the frequency and magnitude of shortages during dry periods. This section gives an overview of our approach to estimating the economic benefits of reduced water shortage welfare losses for urban customers resulting from the construction of the DCP. Further details on our approach are provided in Appendix B. For each SWP contractor with urban customers, we estimate urban water supply reliability benefits using the following steps:

1. The level of demand and price sensitivity are forecast for different types of urban water supply customers, including residential, commercial, and industrial customers.
2. Future shortages are forecast for each type of urban customers with and without the DCP.
3. The economic cost of future shortages is estimated for each type of urban customers with and without the DCP.
4. The reliability benefits of the DCP are based on the difference in the economic cost of future shortages with and without the project.

3.1. DEMAND FORECASTS FOR URBAN CUSTOMERS

Our estimates of the benefits of improved urban water supply reliability are based on forecasts of water demand and water conservation for each State Water Contractor. These forecasts are based on each contractor's Urban Water Management Plan (UWMP) or, in the case of Metropolitan Water District (MWD), its Integrated Resource Plan (IRP). Agencies are required to produce these plans every five years to ensure

[23] There are currently 17 participants in the Agreement in Principle: Alameda Zone 7, Alameda County WD, Santa Clara Valley, Empire West Side ID, Kern County WA, SLO FCWCD, Antelope Valley-East Kern, Santa Clarita Valley, Coachella Valley, Crestline Lake Arrowhead, Desert WA, MWDSC, Mojave, Palmdale, San Bernadino Valley, San Gabriel, San Gorgonio Pass, Ventura County.

[24] Boarnet, Marlon, Wallace Walrod, David L. Sunding, Oliver R. Browne. 2022. *The Economic Impacts of Water Shortages in Orange County*. July 2022.

adequate water supplies are available to meet existing and future water needs under California's 2009 Water Conservation Act (SB X7-7). Demand and conservation forecasts are based on various economic, demographic, and climatic characteristics and produced following best management practices under consultation with local communities. Different agencies take different approaches to forecasting future demand; however, these approaches cover the full spectrum of urban water use, including residential, commercial, industrial, institutional, and unmetered water uses.[25]

In the 2020 UWMPs and MWD's 2020 IRP, agencies project water demands out to 2045. For our analysis, we use these agency-produced forecasts for 2045 and assume no growth in demand during the period for which we simulate DCP operations, 2045 to 2145.

3.2. SHORTAGE ESTIMATES FOR URBAN CUSTOMERS

For urban customers, we define water shortages as the difference between a baseline level of demand, as forecast in urban water management plans, and the actual volume of water made available to customers, based on the realized hydrology in a particular year. In this sense, any reductions in demand relative to the forecast baseline are considered a shortage. The term "shortage" is used to include reductions in consumer demand during drought conditions, including voluntary reductions in response to media campaigns, along with savings from management policies that restrict the scope of when and how water can be used; responses to drought surcharges; and other forms of demand curtailment.

Shortages are estimated using reliability models provided by State Water Contractors, principally an extended version of MWD's IRP Simulation Model (IRPSIM), a supply-and-demand mass balance simulation model that was developed for MWD as a basis for its IRP. IRPSIM forecasts demand using a sales model and simulates supply according to local supplies and imports, SWP supplies, Colorado River Aqueduct supplies, and MWD's storage portfolio. Outputs from the CalSim 3 model are used as inputs in IRPSIM to forecast SWP deliveries. The model accounts for climate change by adjusting inflows from other imported supplies. IRMSIM simulates MWD's

[25] Most agencies consider only a single demand scenario in forecasting their future water supply reliability; however, MWD considers four scenarios in its IRP that consider different future demand and supply assumptions. The four scenarios assume different levels of demand and imported water supply, ranging from a scenario with falling demand and stable imports to a scenario with growing demands and reduced imports. The key differences between these scenarios are assumed climate change, regulatory requirements, and economic conditions For further details, see "2020 IRP – Regional Needs Assessment," The Metropolitan Water District of Southern California, April 2022.
In this analysis, we consider the IRP's Scenario D, which is characterized by growing demand and reduced imports. This scenario most closely comports with our other assumptions pertaining to climate change and population growth. It is described in the IRP as follows: "This scenario is driven by severe climate change impacts to both imported and local supplies during a period of population and economic growth. Demands on Metropolitan are increasing due to rapidly increasing demands and diminishing yield from local supplies. Efforts to develop new local supplies to mitigate losses underperform. Losses of regional imported supplies are equally dramatic."

storage portfolio by considering operational constraints, put-and-take capacities, contractual arrangements, and other operational considerations. [26]

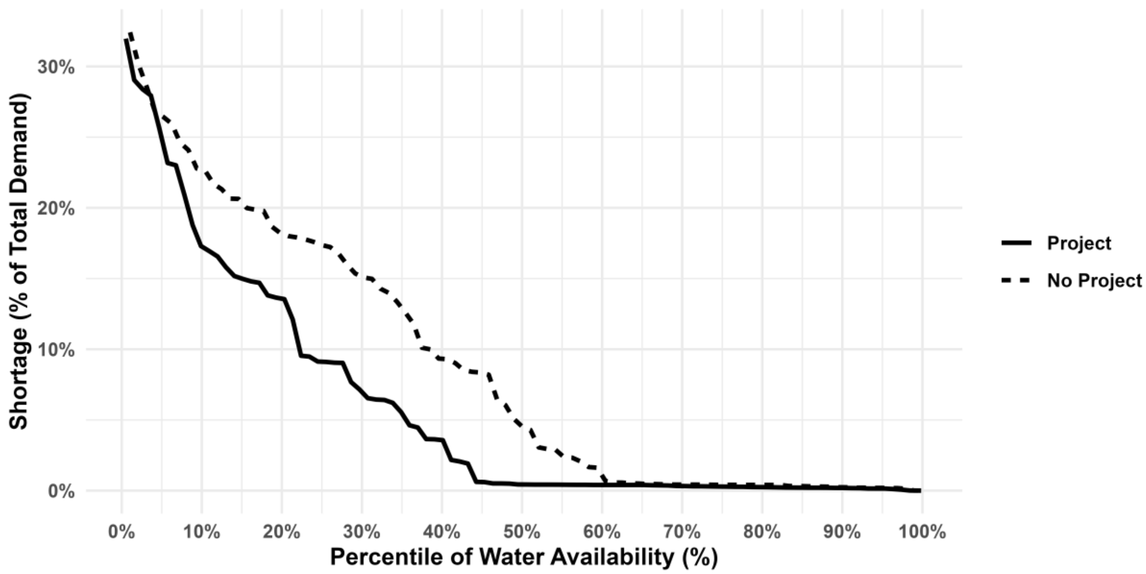
For each year of demand, IRPSIM simulates supply, based on each year of the historic hydrologic trace, adjusted for climate change. This results in 96 trials, based on historical hydrologic data, beginning in 1922. IRPSIM then calculates a distribution of outcomes, allowing MWD to evaluate probabilities of surpluses and shortages and further forecast the magnitude and frequency of shortages. This report uses an extended version of IRPSIM that simulates supply and shortages for most urban State Water Contractors, except the Santa Clara Valley Water District, which provided separate hydrologic modeling for this report that follows a similar methodology, as described in its UWMP.[27] Shortages are forecast with and without the DCP, based on demand levels in 2045. Levels of reliability are assumed to remain constant for the duration of the DCPs operating life between 2045 and 2145.

Based on this modeling, the frequency and magnitude of shortages are estimated for 2070 under the median climate change scenario, with 1.8 feet of sea-level rise. Figure 3 summarizes the results. The vertical axis shows the shortages as a percentage of total demand, ranging from 0% to 32%. The horizontal axis shows the frequency of shortages by arranging simulated hydrologic years from the driest (0%) to the wettest (100%). In the no-project scenario, by 2070, there are demand shortages in 61% of all years. Construction of the DCP increases the water supply such that there are shortages in only 44% of all years. In the no-project scenario, there is an average shortage of 9% of total demand. Construction of the DCP reduces the size of the average shortage to only 5% of total demand.

[26] MWD 2020 IRP.

[27] Santa Clara Valley Water. 2021. *2020 Urban Water Management Plan*. June 2021.

Figure 3: Shortage as a Percentage of Total Urban Water Demand



Sources and Notes: Based on MWD's IRPSIM modeling. The distribution represents 96 simulated shortages under a wide range of historical hydrology and the 2070 median climate scenario with 1.8 feet of sea-level rise.

3.3. ECONOMIC COSTS OF URBAN WATER SHORTAGES

Estimates of the economic costs of urban water shortages are based on an economic model of consumers' WTP to avoid water supply interruptions. Water supply reliability benefits are estimated using a WTP-based approach rather than a market-based approach. Utilities usually rely on non-price mechanisms such as conservation campaigns and water use restrictions to manage demand rather than charging elevated drought rates during droughts. As a result, a market-based approach that estimates water supply reliability benefits only, based on customer rates, would understate the water supply benefits during droughts, which are expected to become frequent due to future climate change and significantly mitigated by construction of the proposed DCP.

To estimate district-specific price elasticities of demand, we rely on econometric models that are estimated in Buck et al. (2016).[28] This paper constructs a panel dataset of average monthly water consumption and average rates over five years that covers 75 urban water utilities, including State Water Contractors in the South Bay and

[28] Buck, Steven, Maximilian Auffhammer, Stephen Hamilton, and David Sunding. 2016. Measuring Welfare Losses from Urban Water Supply Disruptions. In *Journal of the Association of Environmental and Resource Economists,* 3, No. 3 (2016): 743–778.

Southern California. The authors then perform a log-log panel regression of average monthly water use on water rates and household income. This regression also controlled for weather fluctuations, seasonal effects, and utility-specific and secular trends. The result is an estimate of how changes in price and income affect demand for water, based on relative changes across utilities over time. The paper finds that water demand is less elastic for lower-income consumers. For example, across all State Water Contractors, the average price elasticity of demand is -0.18, meaning that a 10% increase in rates would induce only about a 1.8% reduction in water use. This average estimate varies, based on income; customers in higher-income communities typically have more discretionary water uses, such as larger yards with more landscape irrigation, and so can reduce consumption in a less costly manner during drought. In contrast, lower-income consumers who depend heavily on water for basic needs such as drinking and sanitation experience larger welfare losses to reduce their consumption by a similar amount.

Based on the econometric relationships estimated in this paper, we construct an estimate of the price elasticity of demand for each urban State Water Contractor participating in the DCP and for each member agency of the MWD. The estimates presented in this paper have been updated with current water rates and household income data for each water agency.

Using an economic model described further in Appendix B, we apply a formula that estimates welfare losses based on the size of the shortage, the marginal cost of SWP deliveries, and the estimated price elasticity of demand. The derived welfare loss function exhibits a declining marginal utility of water, meaning the larger the welfare loss per unit of shortage, the larger the magnitude of the shortage. This behavior implicitly captures complexities in water consumption behavior; for example, when shortages are small, customers can reduce water use relatively cheaply by reducing outdoor irrigation, leading to relatively small unit welfare losses. However, as shortages become more severe, consumers must reduce water use in more costly ways that might directly affect daily household activities or business operations, leading to much larger unit welfare losses. This behavior is also consistent with drought management plans that utilities are required to put in place to identify the least costly way to meet different levels of conservation.

For each year we simulate, we calculate welfare losses for 96 trials, based on the historical hydrologic trace between 1922 and 2018. Average welfare losses across all simulations are then calculated separately for each district participating in the DCP using customer-specific elasticity estimates and retail water rates.[29] Significant costs are associated with forecast shortages due to forecast reductions in supply as a result of climate change; in the no-project scenario, more than 61% of all years are expected to have water shortages, leading to annual welfare losses of more than $1.1 billion.

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[29] Note that currently the reliability estimates are calculated only for Metropolitan Water District and Santa Clara Valley Water. Estimates of welfare losses are then extrapolated to all other agencies. However, the final economic analysis will incorporate water district–specific estimates that will be produced once modeling of district specific shortages becomes available.

3.4. WATER SUPPLY RELIABILITY BENEFITS

The quantified economic benefits of the DCP in terms of improved water supply reliability are based on the change in the frequency and size of water shortages between the project and no-project scenarios. As previously discussed, the costs of shortages are calculated for each State Water Contractor and MWD customer using an economic model that estimates customer welfare losses from shortages, based on the frequency and size of shortages in each district and district-specific rates and demand elasticities. The economic benefits of the DCP for urban customers are estimated as the difference in the welfare losses from shortages between the project and no-project scenarios. Using this approach, the present value of improved water supply reliability is estimated to be worth, on average, more than $33.3 billion in 2023 dollars over the project's lifetime. These benefits amount to an average value of $2,560 for every additional acre-foot of water supplied to urban customers from the DCP's operations. However, there is significant variability in the benefits of these deliveries, depending on the prevailing hydrologic conditions. In the driest 5% of years, additional deliveries from the DCP have an average value of between $6,000 and $9,000 per acre-foot.

4. Agricultural Water Supply Benefits

The DCP is estimated to deliver, on average, an additional 148.5 TAF/yr of water to agricultural contractors. Agricultural State Water Contractors may use the additional water supplied by the DCP to grow crops, to recharge or otherwise offset deficits in groundwater extraction, or to sell to other customers in urban sectors.

We take two approaches to estimating water supply benefits to agricultural users. The first approach is a demand-based approach that uses a planning model to estimate the shadow value of water in the Central Valley, based on unmet demands for water of agricultural activity in the Central Valley. The second approach is a market-based approach, based on an index of the prices for water transfers in the Central Valley.

4.1. VALUATION OF WATER USE IN AGRICULTURE – SWAP MODEL

The benefits of agricultural water supply are estimated using a WTP approach that identifies the "shadow price" of water, based on a model of agricultural production in the Central Valley. The SWAP is a multi-region, multi-input and output economic optimization model that simulates agricultural production in California.[30] The model is widely used for policy analysis and planning purposes by the state and federal agencies.

SWAP simulates the behavior and decisions of farmers under the assumption of profit maximization in a static competitive market subject to resource, technical, and market constraints. With 37 regions in the model, 27 of which are in the Central Valley, SWAP provides detailed data coverage and production estimates for agricultural water supply and cost changes. The SWAP model takes account of water supplies (SWP and CVP, other local supplies, and groundwater) into production cost-effectiveness optimization by adjusting the crop mix, water resource availability, and land fallowing.[31]

The SWAP model is widely used in recent studies. It is considered an appropriate and conservative approach for estimating DCP's agricultural water supply benefits. Based on the SWAP model, the marginal value of agricultural water is $301 per acre-foot in 2023 dollars.

[30] UC Davis Center for Watershed Sciences. n.d. *SWAP Model*. Available: https://watershed.ucdavis.edu/project/swap-model.

[31] UC Davis Center for Watershed Sciences. n.d. *A Brief Overview of the SWAP Model*. Available: https://watershed.ucdavis.edu/doc/water-economics-and-management-group/brief-overview-swap-model.

4.2. VALUATION OF WATER USE IN AGRICULTURE – MARKET APPROACH

In addition to a WTP based approach for estimating the benefits of the SWP for the agricultural sector, we also adopt a market-based approach. To provide a comprehensive valuation of marginal agricultural water value, we estimate the water supply benefits of the DCP. The water transfer includes voluntary buying and selling of a quantifiable allocation between a willing seller and buyer; the price of water set in the water bidding process reflects people's perceived marginal value of water.

This analysis relied on the empirical Nasdaq Veles California Water Index. Developed in conjunction with Westwater Research and Veles Water, the index reflects the commodity value of water at the source, not accounting for transportation costs or losses.[32] The price data are aggregated from the five largest and most actively traded markets in California, with Southern California being the most active market.[33] The water is priced weekly and on a per-acre-foot basis, reflecting the prevailing market price for water transactions. The Nasdaq Water Index price is a spot price that reflects the short-term value of water; to estimate a long-run value for agricultural water, we average the historical weekly prices over the entire history of the water index from September 2019 to April 2024. Using this approach, the marginal value of water use in agriculture is $646 per acre-foot in 2023 dollars.

In the benefit-cost analysis, we assess the value of additional SWP deliveries in the agricultural sector, based on the average of the prices estimated using the WTP and the market-based approaches, a value of $474 per acre-foot in 2023 dollars. With an average additional delivery of 148.5 TAF/yr to the agricultural water users, the estimated total benefit is $68.5 million per year.

[32] Nasdaq. 2024. *Nasdaq Veles California Water Index*. Available: https://www.nasdaq.com/solutions/nasdaq-veles-water-index. Accessed: December 8, 2023.

[33] Ibid.

5. Water Quality Benefits

Construction of the DCP will reduce the salinity of water supplies exported south of the Delta to customers in both the urban and agricultural sectors. This improvement in water quality will be a result of some SWP deliveries being conveyed through the proposed tunnels directly to the Banks Pumping Plant where they will be exported through the California Aqueduct rather than being conveyed through more saline parts of the Bay Delta.

Chapter 9 of the EIR quantifies the impacts of the operations of the DCP on a number of different water quality dimensions in the Delta and the Delta's export service area. Water quality is evaluated under project and no-project scenarios using Delta Simulation Model II (DSM2). Based on this modeling, construction of the DCP would reduce the average salinity of Delta exports by 22 milligrams per liter (mg/l), from 237 mg/l under the project scenario to 215 mg/l under the no-project scenario. Note that this average conceals the significant variability of the change in water quality, which is highly correlated with the volume of export volumes and seasonal flows.

The DCP's operations will improve water quality for SWP contractors on two dimensions. First, the DCP will improve the water quality of exports themselves. Secondly, it will lead to a substitution toward relatively higher-quality SWP water and away from lower-quality sources such as groundwater or water imported from the Colorado River.

5.1. WATER QUALITY FOR URBAN WATER CUSTOMERS

The benefits of improved water quality due to the DCP are estimated in the SWP's Southern California service area and evaluated using the Salinity Economic Impact Model (SEIM).[34] The SEIM, a product of a collaborative effort between the Bureau of Reclamation and MWD, is designed to evaluate the economic impact of salinity changes in Southern California and the broader Lower Colorado River service area.

Within Southern California, the SEIM model estimates economic impacts for each of the 15 subregions, accounting for region-specific water supply conditions and economic variables. For each subregion, estimates of salinity costs are based on demographic data, water deliveries, total dissolved solids (TDS) concentrations, and sector-specific cost relationships. To simulate the overall salinity of urban water, SEIM explicitly accounts for the distribution and blending of different water sources within each region, including local surface water and groundwater, desalinated seawater, and the water from the Colorado Aqueduct, along with water delivered through the Delta to the East and West Branch Aqueducts of the SWP. The weighted average salinity in terms of

[34] Metropolitan Water District of Southern California and Bureau of Reclamation. 1999. *Salinity Management Study, Final Report.*

TDS is estimated in terms of mg/l for each region. Economic impacts are calculated for different end uses of water, including residential, commercial, industrial, utilities, groundwater, recycling, and wastewater, based on region-specific demand estimates for each end use.

In the residential sector, the SEIM assesses the damage caused by salinity through its reduction in the useful life of household appliances like water heaters, faucets, and washing machines. It also models the costs of avoidance strategies, such as the installation of water softeners and the purchase of bottled water. In the commercial sector, the SEIM estimates the share of regional water use in sanitary, cooling, landscape irrigation, kitchen, laundry, and other uses; estimates of economic impacts are based on a unit price in each use category. Similarly, in the industrial sector, estimates of economic impacts are based on the total volume of water used in each sector and sector-specific estimates for the cost of demineralization and softening as well as for specific industrial applications such as cooling towers and boiler feed.

To estimate the salinity benefits from the construction of the DCP, estimates of the salinity of project water exported from the Banks Pumping Plant into the California Aqueduct from the DSM2 model are inputted into the SEIM under the project and no-project scenarios. The SEIM then estimates the salinity deliveries on the West Brach Aqueduct and East Branch Aqueduct of the SWP in Southern California.

Table 3 summarizes the annual urban water quality benefits estimated by the SEIM model. Based on this modeling, improvements in water quality as a result of DCP operations lead to an annual benefit of more than $41 million in terms of reduced economic impacts as a result of improved water quality. These benefits are accounted for primarily by benefits to residential customers, improved quality for recycled water, and reduced impacts on groundwater resources. Note that this estimate does not include estimates of the benefits to agricultural customers, which are accounted for separately in the next section. This estimate also does not include benefits to urban customers outside of Southern California, who are not accounted for in this model.

5.2. WATER QUALITY FOR AGRICULTURAL WATER CUSTOMERS

The analysis of water quality benefits to agriculture also focuses primarily on the impact of reduced salinity on water treatment costs and yield losses. Crop production and yield are greatly affected by the salinity of the crop's root zone. High salinity in the crop's root zone creates unfavorable osmotic pressure for the plants to absorb water.[35] This hindered water absorption induces physiological drought within the plant, even if the soil contains abundant water.[36] The salinity threshold for yield losses is below 10 decisiemens per meter (dS/m) for most crops grown in the region. Some sensitive crops such as alfalfa, beans, and maize start to experience yield

[35] University of California Salinity Management. 2024. Crop Salinity Tolerance and Yield Function. Available: https://ucanr.edu/sites/Salinity/Salinity_Management/Effect_of_soil_salinity_on_crop_growth/Crop_salinity_tolerance_and_yield_function/.

[36] Ibid.

losses below two dS/m.[37] Salt-tolerant crops such as cotton and barley also start to experience declining yields when the soil's electrical conductivity reaches eight dS/m.

Irrigation using river or groundwater that contains salts is the primary man-made cause of soil salination. After irrigation water is applied to the soil, the water gradually evaporates or absorbed by a plant, leaving the dissolved salts in the soil. To reduce the salinity level in the soil, farmers adopt a common practice of applying excess irrigation water that drains the salt downward past the root zone, called leaching. The more saline the irrigation water is, the more excess water is required for leaching the salt away from the plant's root zone.

For the salinity benefit to agricultural water users, we calculated the amount of irrigation water savings from leaching due to reduced salinity with the DCP project alternative. Detailed crop coverage data are obtained from the U.S. Department of Agriculture (USDA). For each crop, the irrigation requirements and leaching fractions to lower the salinity level below yield loss thresholds are used to calculate the annual leaching savings in each water district benefiting from the DCP. Overall agricultural irrigation water use would be reduced by nearly 6,000 acre-feet annually. Along with the agricultural water cost estimates produced by the SWAP model and the water transfer market, the annual savings on irrigation water amounts to more than $3 million. The breakdown of agricultural water quality benefits is summarized in Table 3, below. The San Joaquin Valley benefits the most from agricultural water quality improvement, at nearly $2.9 million annually, while Southern California's annual benefit is nearly $300,000.

Because the EIR assessment predicted a slight increase in salinity in the Delta, we also estimate the costs of increased salinity on agricultural water users in the Delta. The CalSim 3 model predicts an increase in electrical conductivity of 0.008 dS/m on average across the Delta. Although deemed "less than significant" in the EIR, we still quantified the costs of increased Delta salinity and incorporated them in the analysis of remaining environmental impacts after mitigation. Overall, the benefits of improved salinity to downstream agricultural water contractors significantly outweigh the cost of the small increase in salinity in the Delta region.

Similar to the urban water quality analysis, this water quality analysis provides a conservative estimate of total DCP water quality benefits. Because this analysis focuses only on salinity improvement, it does not explicitly price many other measures of water quality improvements, such as reductions in pollutants, pathogens, and man-made chemicals that pose health risks.

[37] Ibid.

Table 3: Water Quality Benefits

Urban Water Quality Benefits	Millions of 2023 $
Residential	$12.0
Commercial	$4.3
Industrial	$0.6
Utilities	$0.1
Groundwater	$15.8
Recycled Water	$8.4
Total	$41.2
Agricultural Water Quality Benefits	
Southern California	$0.3
San Joaquin Valley	$2.9
Total	$3.2
Total Annual Water Quality Benefits	$44.4

Sources and Notes: Urban water quality benefits based on SEIM model simulations.
Agricultural water quality benefits based on soil leaching water savings analysis.

5.3. WATER QUALITY IN THE DELTA

The EIR evaluates construction and operation of the project on a number of dimensions of water quality, including on boron, mercury, nutrients, organic carbon, dissolved oxygen, selenium, pesticides, trace metals, and total suspended solids and turbidity relative to existing conditions and concludes that the impact on water quality from construction of the project alternatives would be less than significant.[38] Operation of the proposed project facilities has the potential to affect water quality through differences in Delta inflows from the Sacramento River, relative to existing conditions, resulting in increased proportions of the other Delta inflow waters (such as eastside tributaries, the San Francisco Bay, and the San Joaquin River) in some regions of the Delta.[39] The EIR concludes that changes in bromide, chloride, and electrical conductivity (EC) would be less than significant.

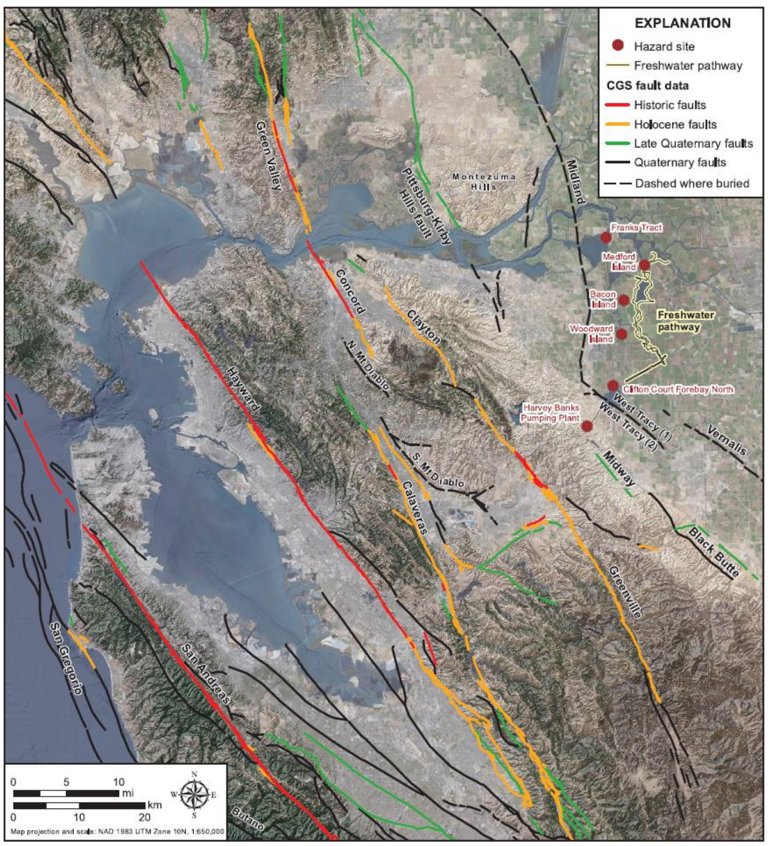
[38] DCP EIR, Chapter 9.

[39] Ibid.

6. Improvements to the Seismic Reliability of the SWP

A key objective of the DCP is to mitigate the impact of seismic events on the Delta's water conveyance infrastructure. By adding redundancy to the current conveyance infrastructure, DCP will help mitigate the impact of seismic events on the quantity and quality of water delivered south of the Delta. Therefore, it would minimize the potential for adverse public health and safety impacts from a major earthquake.

Figure 4: Major Fault Lines near the Delta



Sources and Notes: "Delta Flood Emergency Management Plan – Supplement C, " California Department of Water Resources, October 2018.

There are many active faults surrounding the Delta. Figure 4 displays active faults and historical seismicity near the Delta. The USGS analyzed the earthquake potential of the faults in the Bay Area. The Hayward-Rodgers Creek fault poses the highest probability of generating an earthquake of magnitude 6.7 or greater in the following 30 years, at 27%. The estimates of maximum magnitude range from 6.5 to 7.3. Other than the Hayward-Rodgers Creek fault, there are a couple of smaller faults adjacent to or below the Delta. The West Tracy fault, passing beneath the Clifton Court Forebay at the southwestern part of the Delta, is estimated to have a maximum magnitude of 6.25 to 6.75. The Midland fault that passes beneath the western margin of the Delta has the potential to produce an earthquake of magnitude 7.1. The Greenville fault, the easternmost part of the San Andreas fault system and located southwest of the Banks Pumping Plant, has the potential to generate earthquakes ranging from 6.6 to 7.2.[40]

Active faults, along with land subsidence and poor, highly organic soils that are subject to liquefaction and settlement, make earthquakes the greatest risk associated with flooding. A large earthquake in the San Francisco Bay Area could cause levees in the Delta to breach, leading to an inundation of brackish water in areas where existing SWP and CVP pumping plants operate in the southern Delta. Historically, levee failure and breaches have occurred for various reasons. In the past century, there were 161 breaches of Delta levees. Despite there being few breaches since the 2000s, the Upper Jones Tract levee failure in 2004 demonstrated that there are still significant breach risks.[41]

In any major seismic event with significant brackish water invasion, conveyance through the Delta will most likely be impossible for an extended period. A major seismic event could also damage the SWP and CVP conveyance infrastructure in the Delta. Cessation of conveyance through the Delta for any extended period of time would pose major reliability challenges to State Water Contractors south of the Delta. This could lead to shortages significantly more severe than those posed by dry-year events.

DCP project facilities are designed to withstand at least a 500-year return-period earthquake while maintaining system operational capability. For some more complex or difficult-to-repair facilities, a much higher return period event is assumed for design. Building the DCP serves as an insurance policy that would allow at least some water to continue to be delivered south of the Delta in the event of a major earthquake.

It is difficult to precisely quantify the likelihood and water supply impacts of different seismic events that may occur. These impacts will depend on the location, magnitude, and nature of the seismic event; the number and location of levee failures; and the response to repairing failed levees. Furthermore, the economic costs of water supply interruptions from a major seismic event will also depend on other factors, including the hydrologic and economic conditions that influence the water demand. Rather than attempting to provide a comprehensive analysis of the likelihood and impacts of the full range of hypothetical seismic events that could occur in the Delta region, we instead describe a hypothetical seismic scenario and estimate the impacts and economic costs associated with this scenario.

[40] Wong, Ivan G., Patricia Thomas, Nora Lewandowski, and Dennis Majors. 2021. Seismic Hazard Analyses of the Metropolitan Water District Emergency Freshwater Pathway, California. In *Earthquake Spectra,* Volume 38(2), 981–1020, 2022, DOI: 10.1177/87552930211047608.

[41] California Department of Water Resources. 2018. *Supplement C – Water Project Export Disruptions for Multiple-Island Breach Scenarios Using the Delta Emergency Response Tool.* May 2018.

The Delta Emergency Response Tool (ERT) is used to simulate Delta levee failures and help forecast impacts and develop response mitigation strategies. The ERT allows a user to test various response strategies to each simulated scenario and helps support decision-making. The ERT simulated 11 base scenarios, ranging from four to 20 breached islands, of which Scenario 1 represents a 500-year earthquake. Scenario 1 simulated a 20 island/ 50 breach event, with a total flooded volume of 1,296 TAF.[42] Figure 5 shows the specific breach locations. Export disruption and water quality are modeled under a range of hydrologic conditions, including specific scenarios involving severe flood and drought conditions. Eight different response strategies were simulated in an incremental approach, and for each strategy, ERT modeled the distribution of export disruption time, Delta recovery time, and response cost across 20 hydrologic simulations for each response strategy. Out of the eight responses, the Middle River Corridor Strategy results in a shorter disruption time than the basic strategy and a lower cost compared to the cumulative strategy.[43] The cost of restoring the seismic damage consists of three parts: breach repair cost, island dewatering cost, and barrier repair cost. For the Middle River Corridor Strategy, the costs are $1.4 billion, $35 million, and $31 million, respectively.[44]

The Middle River Corridor Strategy attempts to construct a freshwater pathway from the northern Delta to the pumps in the southern Delta. It accomplishes this by prioritizing the repair of levees along the Middle River and installing channel barriers to isolate the corridor from the rest of the Delta. Without the DCP, under the Middle River Corridor Strategy, the export disruption ranges from six days to 448 days, with an average of 203 days. The Delta recovery time, defined as the time required for the Delta water quality to recover to the level with no breach, ranges from 11 days to 498 days, with an average of 306 days. Under the DCP alternative, we considered two scenarios for analysis: DCP operating at 6,000 cubic feet per second (cfs) capacity and DCP operating at 500 cfs health and safety levels. These scenarios reflect the maximum and minimum balance at which DCP might be able to operate under the seismic event; however, the exact operation is uncertain and affected by other infrastructure.

Table 4 outlines benefits under the DCP alternative for different disruption and DCP operation scenarios. Assuming the DCP operating at the minimum health and safety levels, the average avoided water supply disruption benefits amount to $2.36 billion, and the improved water quality benefits amount to $2.65 million. Assuming the DCP operating at capacity during an earthquake event, the average avoided water supply disruption benefits amount to $28.4 billion, and improved water quality benefits amount to $31.6 million. Assuming a 500-year return period, the net present value of the DCP is estimated to be $1.8 billion when it operates at capacity and $152 million when it operates at health and safety levels. The overall seismic benefit

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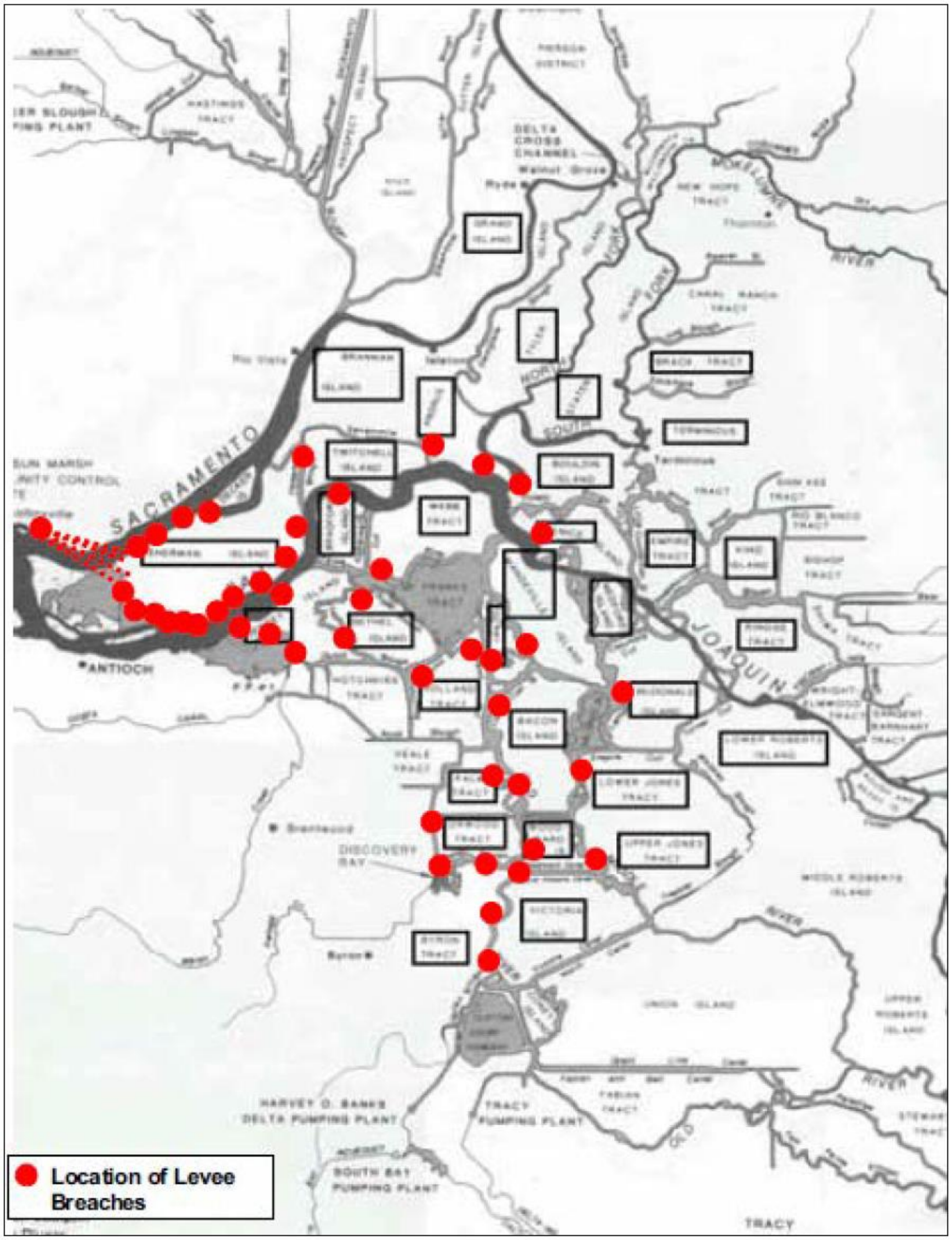
[42] Ibid.

[43] The assumptions of the seismic analysis, based on the ERT, is significantly more conservative compared to an economic analysis this team previously produced for the WaterFix project. The previous analysis assumed more breaches and islands flooded and a significantly more probable earthquake event with a 100-year return period.

[44] Ibid.

estimate takes into account the full range of scenarios by averaging the net present-value estimates under various export disruption, Delta recovery duration, and DCP operating scenarios.

Figure 5: Seismic Scenario Levee Locations



Sources and Notes: Seismic scenario with 50 levee breaches and 20 flooded islands. "Delta Flood Emergency Management Plan – Supplement C, "California Department of Water Resources, October 2018.

Table 4: Benefit Summary under Seismic Disruption Scenarios

Scenario	Export Disruption Days	Delta Recovery Days	Benefits during Seismic Event ($ millions, 2023) Water Supply Benefits	Benefits during Seismic Event ($ millions, 2023) Water Quality Benefits	Net Present Value w. 500-year Return Period ($ millions, 2023) Water Supply Benefits	Net Present Value w. 500-year Return Period ($ millions, 2023) Water Quality Benefits
DCP Operates at Health & Saftey Levels (500 CFS)						
Minimum Disruption	6	11	$63.3	$0.5	$4.1	$0.2
Average Disruption	203	306	$2,141.3	$5.3	$138.1	$0.3
Maximum Disruption	448	498	$4,725.6	$10.9	$304.9	$0.7
Average			**$2,310.1**	**$5.6**	**$149.0**	**$0.4**
DCP Operates at Capacity (6,000 CFS)						
Minimum Disruption	6	11	$759.5	$6.3	$49.0	$0.4
Average Disruption	203	306	$25,695.7	$63.3	$1,657.8	$4.1
Maximum Disruption	448	498	$56,707.7	$130.4	$3,658.5	$8.4
Average			**$27,721.0**	**$66.7**	**$1,788.4**	**$4.3**

Sources and Notes: Benefits calculated under the 20 island / 50 breach scenario with the Middle River Corridor response strategy.

All benefits valued in millions of 2023 dollars.

7. Other Benefits not Explicitly Valued

The analysis of benefits in the previous four sections concentrates solely on those that can be reliably measured and quantified. However, the DCP is expected to yield additional benefits that are not included in this analysis, primarily because the necessary data to quantify them are unavailable.

- The DCP creates **redundancy in the Delta conveyance** that will enhance short-term operational flexibility in the Delta. At certain times, this additional flexibility may allow short-term actions to be undertaken to either increase SWP deliveries (e.g., Article 21 water) or improve water quality. However, this benefit-cost analysis relies on CalSim 3 modeling that has a monthly time step and therefore lacks the granularity to quantify these short-term operational benefits. Therefore, these benefits are underestimated in our current modeling analysis. For example, if the DCP had been operational between January 1 and March 9, 2024, DWR estimates that an additional 909 TAF of water could have been captured by the DCP due to fishery-related regulatory constraints in the South Delta. These constraints are not reflected in our current modeling, resulting in an understatement of program benefits.[45]
- The costs estimate for the DCP includes a **Community Benefits Program,**[46] which is anticipated to fund a variety of specific local projects such as enhancing public safety, improving water and air quality, and developing educational programs and recreational facilities like parks and walking trails. However, this analysis has not attempted to quantify any benefits arising from these investments.
- The DCP could play a role in the **conservation of groundwater resources** in the Central Valley and other parts of California. The increase in SWP deliveries will be a substitute for groundwater in the SWP service area. To the extent that the DCP leads to a reduction in groundwater demand, it will help agencies achieve the goals under the Sustainable Groundwater Management Act (SGMA). A reduction in groundwater demand could also lead to higher groundwater levels and consequently reduced pumping costs. These benefits have not been quantified in this analysis.

[45] See California Department of Water Resources. 2024. *Missed Opportunity*. March 2024. Available: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Delta-Conveyance/Public-Information/DCP_Missed-Opportunity.pdf.

[46] California Department of Water Resources. 2022. *Community Benefits Program Overview*. June 2022.

8. Project Costs

The DCA has produced two cost estimates for the DCP. The primary cost estimate, based on the project's specifications outlined in the EIR, projects the total design and construction cost at approximately $20.1 billion in undiscounted 2023 dollars. A secondary estimate, referred to as the "project-wide innovations and savings estimate," considers potential cost reductions through design, construction, and management innovations that do not alter the core project specifications. These innovations lower construction costs by $1.2 billion, bringing the estimate to $18.9 billion. These cost estimates are broken down in Table 5, below.[47]

The cost estimates cover various phases and components of the project. Construction costs, which include major works on tunnels, aqueducts, intakes, and a pumping plant, are detailed in both estimates. For example, in the primary estimate, construction costs include $1.7 billion for two 3,000 cfs intakes, $6.4 billion for tunnels and shafts, and $3.2 billion for the pumping plant and related structures, with a 30% contingency adding another $3.5 billion. The secondary estimate slightly reduces these costs due to the anticipated innovations.

In addition to construction costs, other significant expenses include design, planning, and management, which total $3.3 billion in the primary estimate and $3.1 billion in the secondary cost estimate with project-wide innovations.

Other costs, totaling $1.78 billion, are the same in both the primary and secondary cost estimates. These expenses cover land acquisition, environmental mitigation, power, a settlement agreement with the Contra Costa Water District, and a community benefits program. Further details on the environmental mitigation and community benefits programs are provided in the sections below.

Construction is scheduled to take place between 2029 and 2044, with the highest rate of spending focusing on the tunnels and aqueducts occurring between 2035 and 2040. Before 2029, expenditures are mainly for project design, planning, and land acquisitions. The project's cumulative cost trajectory is displayed in Figure 6 below.

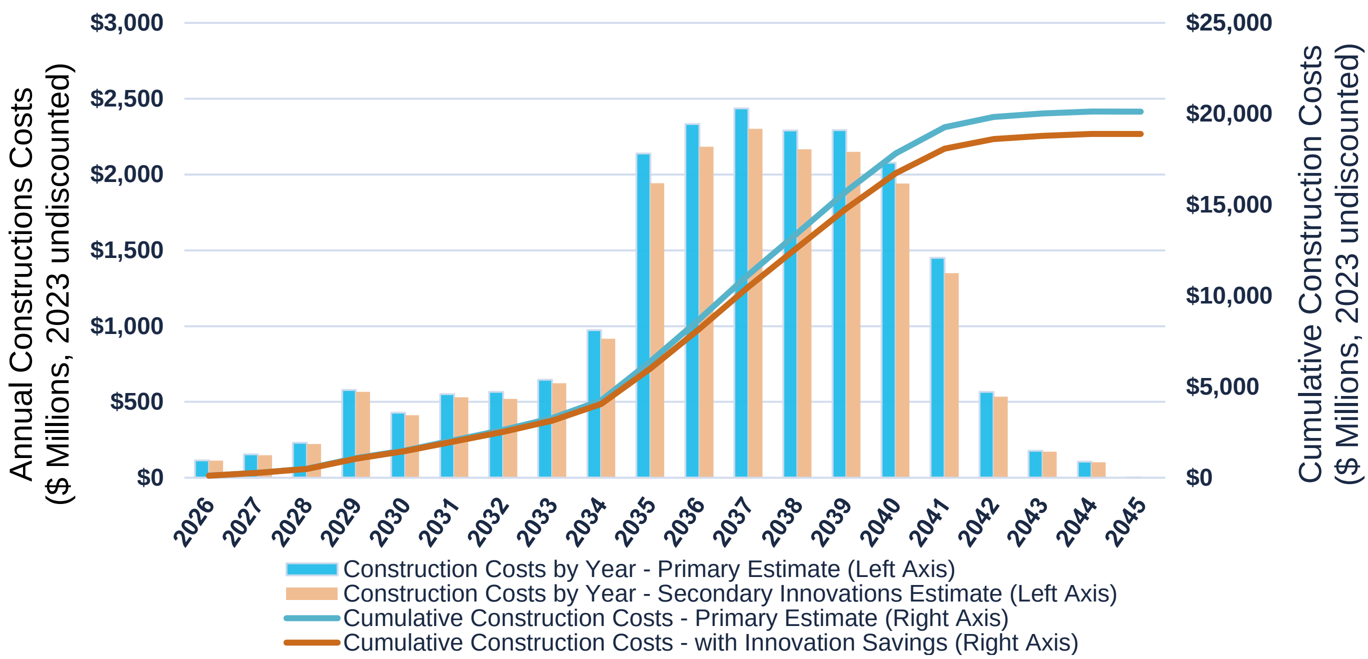
[47] Note that these are undiscounted and not directly comparable to the costs presented in Table 1 and Table 8.

Table 5: Project Construction Costs

Cost Category		Primary Cost Estimate	Costs w. Project-wide Innovations & Savings
Construction		$ Millions, 2023	
Intakes		$1,714	$1,678
Main Tunnels		$6,353	$6,130
Pumping Plant & Surge Basin		$2,536	$2,160
Aqueduct Pipe & Tunnels		$563	$485
Discharge Structure		$99	$58
Access Logistics & Early Works		$253	$234
Communication		$13	$13
Restoration		$17	$17
	Construction Subtotal	**$11,548**	**$10,775**
	Contingency (30%)	$3,464	$3,233
Total Construction Cost		**$15,012**	**$14,008**
Other Project Costs			
DCO Oversite		$426	$398
Program Management Office		668	$623
Engineering/ Design /Construction Management		$2,167	$2,022
Permitting and Agency Coordination		$67	$63
Total Planning/Design/Construction Management		**$3,328**	**$3,106**
Land		$158	$158
DWR Mitigation		$960	$960
Power		$415	$415
CCWD Settlement Agreement		$ 47	$47
Community Benefits Program		$200	$200
Total Other Costs		**$1,780**	**$1,780**
	Grand Total	**$20,120**	**$18,894**

Sources and Notes: Costs measured in millions of undiscounted 2023 dollars and not escalated to the time of construction. For the secondary cost estimate, the planning, design, and construction management costs are assumed to be the same percentage of construction as the primary cost estimate. Cost estimate provided by the DCA.

Figure 6: Construction Costs by Year



Sources and Notes: DCA Cost Estimate, March 2024

8.1 ENVIRONMENTAL MITIGATION COSTS

The design and construction of the DCP incorporate environmental commitments and best management practices to minimize the environmental impacts of the project's construction and operation, as required under the California Environmental Quality Act (CEQA). The project's EIR evaluates its environmental and socio-economic impacts on more than 20 different areas. The report proposes mitigation measures to meet requirements under CEQA (i.e., the project adopts feasible mitigation measures where available to reduce significant impacts to a "less-than-significant" level). The DCA budgets $960 million for proposed mitigation measures to meet these requirements. These costs include items for tribal monitoring, mitigation plan development, habitat mitigation (including compensatory mitigation), and other significant mitigation, as described in the EIR.

For some environmental impacts identified in the EIR, it is not feasible to mitigate impacts to less-than-significant levels. In these cases, compensatory measures and resource specific mitigation are considered.[48] The

[48] DCP EIR.

costs associated with remaining environmental impacts that cannot be mitigated to less-than-significant levels are estimated in Section 10 and Appendix C and incorporated into the benefit-cost analysis.

8.2 COMMUNITY BENEFITS PROGRAM

The proposed DCP includes a $200 million Community Benefits Program to support local communities affected by the project, beyond what's required by CEQA and other laws. This program will collaboratively provide resources to those most affected, including tribal groups, local residents, government agencies, non-governmental organizations, and other Delta stakeholders.[49]

The program consists of two main parts:

- The **Delta Community Fund** aims to finance projects that preserve and enhance the Delta's cultural, historical, recreational, agricultural, and economic aspects through community-led initiatives. It will support projects related to water and air quality, public safety, recreation, habitat conservation, cultural celebrations, economic growth, transport and communication infrastructure, agriculture, education, and levee maintenance.
- The **Economic Development and Integrated Benefits Program** will focus on economic growth by hiring locally and involving businesses in construction of the DCP. It also includes plans to build or repurpose construction features for community use.

[49] EIR, Appendix 3G, California Department of Water Resources.

9. Operation and Maintenance Costs

The DCP's annual operations and maintenance (O&M) costs were estimated by the DCA and DWR to be approximately $52.6 million per year in undiscounted 2023 dollars. This estimate includes DWR's O&M labor, materials, equipment refurbishments and replacements, power, and restoration sites during the first 100-year lifespan of the proposed project.[50] Table 6 breaks down the annual DCP O&M costs for each component listed in the formula above.

The facility O&M cost is calculated with the labor rates of relevant civil engineers, mechanical engineers, electrical engineers, and hydroelectric plant technicians and contractors. The material costs include periodic activities such as sediment removal and disposal, repaving, and sealing roadways and parking lots. The power cost associated with moving water through the DCP system is estimated using CalSim 3 monthly modeling, averaging over all water year types, including critical and dry years. The O&M costs associated with restoration sites, including farmland, levee, channel margin, tidal, and other habitats, consist of ground and vegetation management, access work, monitoring, and other restoration needs.

Table 6: Operation and Maintenance Costs

	Annual O&M Costs
Category	$ Millions, 2023
Water Facility Costs	
Facility O&M	$17.5
Material Cost	$0.5
Power Cost	$2.7
Capital Equipment Refurbishment	$4.8
Capital Equipment Replacement	$18.7
Restoration sites Costs	
Restoration sites O&M Cost	$84
Total Annual O&M Costs	**$52.6**

Sources and Notes: Average annual power cost only includes the energy needed to convey 621,266 AF of water through the tunnel from the North Delta Intake to an average South Delta elevation. It does not include the energy needed to move additional water through the entire SWP system. From DWR's O&M annual cost estimate basis for Bethany reservoir alternative memorandum.

[50] California Department of Water Resources. 2024. *O&M Annual Cost Estimate Basis for Bethany Reservoir Alternative*. April 2024.

10. Remaining Environmental Impacts after Mitigation

This section provides a brief overview of the estimation of the costs associated with environmental impacts identified as being “significant” or “significant and unavoidable” after mitigation in the project’s EIR. Additional details on these impacts and the process for estimating the associated costs is provided in Appendix C. Of the 223 areas for environmental and socio-economic impacts reviewed in the EIR, impacts on eight of these areas are identified as being “significant and unavoidable” after proposed mitigation measures. For four of these areas, aesthetic, cultural, paleontological, and tribal impacts, we do not attempt to assign any costs to the remaining economic impacts because there is not a generally accepted economic best practice for valuing costs of those nature. In four remaining areas, we estimate the costs of remaining environmental impacts following best practices form the economics literature:

- Lost agricultural land in the Delta
- Construction-related air quality impacts
- Construction-related noise impacts
- Construction-related transportation impacts

To ensure our assessment considers all salinity impacts of the DCP, including both benefits and costs, this section also quantifies the costs related to increased salinity for agricultural water users in the Delta, even though the EIR found this increase to be insignificant.

In terms of lost agricultural land, the construction of the DCP will result in both permanent and temporary effects on certain land parcels in the Delta. To value the loss of farmland, we rely on average market or rental prices by county and crop type. In present-value terms, the total cost of the farmland conversion is estimated to be $22.6 million, of which $2.9 million is associated with temporary farmland conversion and the remaining $19.7 million is associated with permanent farmland conversion. Of the permanent impacts, the crop types with the highest value of converted land are alfalfa, grapes, and almonds.

Project construction will increase airborne emissions across three California air districts: Sacramento Metropolitan Air Quality Management District (SMAQMD), San Joaquin Valley Air Pollution Control District (SJVAPCD), and the Bay Area Air Quality Management District (BAAQMD). These increased emissions will impose social costs to affected areas, which we quantify using estimates published by the U.S. Environmental Protection Agency (EPA). Applying these social cost metrics to total estimated pollution emissions attributable to the DCP, we estimate a total social cost of $48.7 million in present-value terms. Note that this section does not estimate the impacts of greenhouse gas emissions associated with construction and operation of the DCP because these emissions will be offset by a proposed mitigation program that is included in the project’s costs.

DCP construction is also expected to create noise nuisance in the local areas surrounding construction sites. The impact of construction noise on residents can best be quantified using the hedonic pricing method. Based on a review of relevant literature, we assume a temporary 14% drop in residential home prices for approximately 800 homes affected by project noise for the duration of the noise impacts.[51] This temporary price drop is applied to average housing values in the relevant property and rental markets. In present-value terms, we estimate a total of $6 million in remaining noise impacts across the construction period after mitigation measures are undertaken. This estimate does not include the cost of the mitigation measures, such as window replacement and temporary relocation, whose costs are accounted for as part of the project's environmental mitigation costs.

Finally, DCP construction will most likely affect 120 road segments. To calculate the economic impact of the travel delays on these road segments, we consider historical traffic data and each roadway's speed limit. Then, by approximating the average speed of travel on a congested roadway, we obtain the increased travel time resulting from DCP construction. Multiplying this by a range of opportunity costs for time lost due to traffic, we estimate the social cost to be $78.8 to $105.3 million, with a midpoint of $84.7 million in present-value terms.

The estimated impact of increased salinity on Delta yields, calculated in present-value terms, is $68.53 million due to the higher demand for irrigation water. Modeling from the EIR indicates this increase to be an average change in EC of 0.008 dS/m across the Delta. Although this change in salinity is deemed "less than significant" in the EIR, these costs are still incorporated into our analysis. Similar to cost discussion in Section 5.2, the costs of increased salinity are based on the additional water requirements to leach soils and manage salinity levels. Using detailed crop coverage data from the USDA, the calculation included the irrigation requirements and leaching fractions necessary to maintain salinity below the thresholds that cause yield loss.

Table 7, below, summarizes the total cost of the remaining environmental costs after mitigation quantified in this report. The total cost of these impacts after mitigation is $248 million in present-value terms, or $167 million in discounted terms.

Table 7: Costs of Remaining Environmental Impacts after Mitigation

Total Costs	$ Millions, 2023
Agriculture	$25.9
Air Quality	$61.3
Noise	$7.7
Transportation	$84.7
Delta Salinity	$68.5
Total	**$248.1**

Sources and Notes: All costs measured in millions of 2023 undiscounted dollars. See Appendix C for cost breakdown within each category.

[51] We use the low end of the 14% to 18% range estimated by a 2016 study on housing price impacts from railroad noise.

11. Benefit-Cost Ratio and Sensitivity Analysis

11.1. BENEFIT-COST RATIO ESTIMATE

Table 1, shown in the executive summary, presents the results from our main benefit-cost scenario. The primary estimate, based on a 2070 median climate scenario with 1.8 feet of sea-level rise, shows an overall benefit of $38.0 billion, measured in discounted 2023 dollars. The majority of this benefit comes from urban water supply, valued at $33.3 billion (87%). Agricultural water supply benefits, the second-largest component, are valued at $2.3 billion. The DCP also significantly enhances water quality, providing $1.3 billion in benefits for urban customers and $90 million for agricultural customers. In addition, by adding redundancy to the existing water supply infrastructure, the expected benefits for a 500-year earthquake include $969 million for reduced water supply disruption and $2 million for improved water quality.

On the cost side, two scenarios are considered: the primary scenario, based on the costs of building the project as currently described in the EIR, and a secondary scenario, incorporating project-wide innovations and savings. When discounted to present values, the total costs in the primary scenario, including construction, other project costs, the Community Benefit Program, environmental mitigation, O&M costs, and the costs of remaining environmental impacts, amount to $17.3 billion. The secondary scenario, with project-wide innovations and savings, the total costs amount to $16.3 billion. The levelized cost of water from the DCP is calculated by discounting the total costs of the project over its lifetime and then dividing this by the discounted total volume of water deliveries. In the primary scenario, this results in a cost of $1,327 per acre-foot, while in the secondary scenario, which includes project-wide innovations and savings, the cost is $1,255 per acre-foot.[52]

The benefit-cost ratio is calculated by dividing the present value of total benefits by the present value of total costs. In the primary scenario, we find a benefit-cost ratio of 2.20, and in the secondary scenario, the ratio is 2.33. This means that for every dollar spent on the DCP, the expected benefits are worth $2.20 in the primary scenario and $2.33 in the secondary scenario. Under either cost estimate, the benefits of the project significantly exceed the costs.

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[52] Levelized cost of water is calculated with the formula $LCOW = \frac{\sum_{t=1}^{n} \frac{C_t}{(1+r_t)^t}}{\sum_{t=1}^{n} \frac{Q_t}{(1+r_t)^t}}$ where C_t is the cost associated with the DCP at time t, Q_t is the volume of additional SWP deliveries as a result of the DCP at time t, and r_t is the discount rate at time t.

This methodology is described in more detail here:
Fane, Simon, J. Robinson, and S. White. 2003. The Use of Levelized Cost in Comparing Supply and Demand Side Options. In *Water Science and Technology: Water Supply* 3, No. 3 (2003):185–192.

11.2. SENSITIVITY ANALYSES

Table 8 compares the results from the main benefit-cost scenario to five sensitivity scenarios. The primary estimate, as discussed in Section 2.3, is based on a 2070 median climate scenario with 1.8 feet of sea-level rise. The sensitivity analyses compare benefits of the project under various climate, sea-level rise, and adaptation scenarios.

Sensitivity analysis 1, which incorporates adaptation measures into the main scenario, estimates total benefits and a benefit-cost ratio of $38.0 billion and 2.20, respectively. The adaptation assumptions in Scenario 1 include improved SWP operations. However, their impact on contractors is mixed (i.e., relaxed water quality standards and the fallowing policy enhance water supply reliability, while Delta export restrictions diminish it). Overall, benefits still exceed costs, and the net impact of the adaptation assumptions is nearly zero.

Sensitivity analyses 2 and 3 assume an extreme sea-level rise of 3.5 feet and find higher benefits due to the low DCP deliveries and water supply reliability in the no-project scenario. Scenario 2 has benefits of $45.4 billion and a benefit-cost ratio of 2.63. Scenario 3, which adds the adaptation assumptions, has benefits of $42.3 billion and a benefit-cost ratio of 2.45.

Sensitivity analyses 4 and 5 are based on 2040 climate scenarios and therefore reflect less severe climate change and water scarcity. Analysis 4, using a median ensemble of climate models, finds benefits of $30.6 billion and a benefit-cost ratio of 1.78, while Analysis 5, using a CT ensemble, finds benefits of $26.6 billion and a benefit-cost ratio of 1.54.

Across all scenarios, the benefits of the DCP range from $26.5 billion to $45.4 billion, consistently exceeding costs and passing the benefit-cost ratio test. The DCP is economically viable and robust under various future climate scenarios, with the greatest benefits seen in the extreme 2070 median scenario, with a 3.5-foot sea-level rise. Even in the 2040 scenarios, the benefits still outweigh the costs.

Table 8: Sensitivity Analysis

	Main Scenario	Sensitivity Analyses				
		1	2	3	4	5
	2070 Median w. 1.8' SLR	2070 Median w. 1.8' SLR & Adaptation	2070 Median w. 3.5' SLR	2070 Median w. 3.5' SLR & Adaptation	2040 Median w. 1.8' SLR	2040 Central Tendency w. 1.8' SLR
$ Millions, 2023	**Benefits**					
Urban Water Supply and Reliability	$33,300	$33,395	$40,847	$37,729	$25,940	$21,642
Agricultural Water Supply and Reliability	$ 2,268	$ 2,221	$2,211	$2,165	$2,317	$2,520
Urban Water Quality	$ 1,330	$ 1,330	$1,330	$1,330	$1,330	$1,330
Agricultural Water Quality	$ 90	$ 90	$90	$90	$90	$90
Seismic Reliability Benefits (Water Supply)	$969	$969	$969	$969	$969	$969
Seismic Reliability Benefits (Water Quality)	$ 2	$ 2	$2	$2	$2	$2
Total Benefits	$37,960	$38,008	$45,449	$42,285	$30,648	$26,553
	Costs					
Construction Costs	$11,486	$11,486	$11,486	$11,486	$11,486	$11,486
Other Project Costs	$ 3,021	$ 3,021	$3,021	$3,021	$3,021	$3,021
Community Benefit Program	$153	$153	$153	$153	$153	$153
Environmental Mitigation	$735	$735	$735	$735	$735	$735
O&M Costs	$ 1,697	$ 1,697	$1,697	$1,697	$1,697	$1,697
Environmental Impacts after Mitigation	$167	$167	$167	$167	$167	$167
Total Costs	$17,259	$17,259	$17,259	$17,259	$17,259	$17,259
Benefit-Cost Ratio	**2.20**	**2.20**	**2.63**	**2.45**	**1.78**	**1.54**

Sources and Notes: All benefits and costs are measured in millions of discounted 2023 $. A declining discount rate is used from 2% to 1.4%, consistent with guidance from OMB. The primary estimate considers the 2070 median climate with 1.8 feet of sea-level rise. The sensitivity analyses vary in terms of climate assumptions, sea-level rise, adaptation measures introduced to reduce operational risks for the State Water Project

12. Conclusions

This report has conducted a benefit-cost analysis of the proposed DCP. The project’s benefits are estimated in terms of water supply reliability and water quality, in light of anticipated climate change, future sea-level rise, and seismic risks. The project’s costs are estimated in terms of capital and O&M costs as well as the costs of mitigated and unavoidable environmental impacts. We consider the difference in the total benefits and costs between a scenario in which the proposed project is built and a no-project scenario. We estimate a benefit-cost ratio of 2.20.

In addition to the primary estimate of the benefit-cost ratio, a number of sensitivity analyses are conducted that consider various scenarios for climate and sea-level rise. The additional deliveries under the project scenario relative to the no-project scenario are similar across all sensitivity analyses, and consequently, the benefit-cost ratio remains above 1.5 in all scenarios. The DCP's benefits tend to increase in scenarios with more extreme climate change, assuming the project continues to deliver similar incremental water supplies.

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Appendix B: Additional Details on Estimation of Urban Water Supply Reliability Benefits

This appendix provides additional details on the methodology that is used to estimate the urban water supply reliability benefits. These benefits are estimated using a framework that is described in several peer-reviewed academic papers including Brozovic et al. (2007), Buck et al. (2016), and Buck et al. (2023) and the text in this appendix has been closely adapted from those works.[53]

B.1. FRAMEWORK FOR CONSUMER WELFARE LOSS ANALYSIS

Urban consumers are evaluated using a measure of willingness to pay to avoid observed water supply reductions. This same approach is adopted in other works in the recent peer-reviewed literature including Brozovic et al. (2007), Buck et al. (2016), and Buck et al. (2023). Under this approach, welfare losses are measured as the area under an estimated demand curve and above estimated marginal costs. Figure B-1 shows a visual illustration of this area representing the consumer welfare losses experienced in response to water supply disruptions. The demand curve in Figure B - 1 depicts a constant-elasticity demand curve, a curve in which a one percentage change in water prices leads to a constant percentage change in consumption of water at any baseline level of consumption. In this figure the welfare loss from a reduction in water supply from Q^* to Q^R is equal to the area shaded in grey. This welfare loss has two components: 1) a consumer welfare loss equal to the triangle that is shown with an arrow on the figure and 2) a loss in revenue for the utility that is equal to the square below the triangle or $P^*(Q^* - Q^R)$. The remainder of this sub-section uses economic theory to formalize this approach to estimating consumer welfare losses.

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[53] Brozović, Nicholas, David L. Sunding, and David Zilberman. 2007. Estimating Business and Residential Water Supply Interruption Losses from Catastrophic Events. In *Water Resources Research,* 43, No. 8 (2007).

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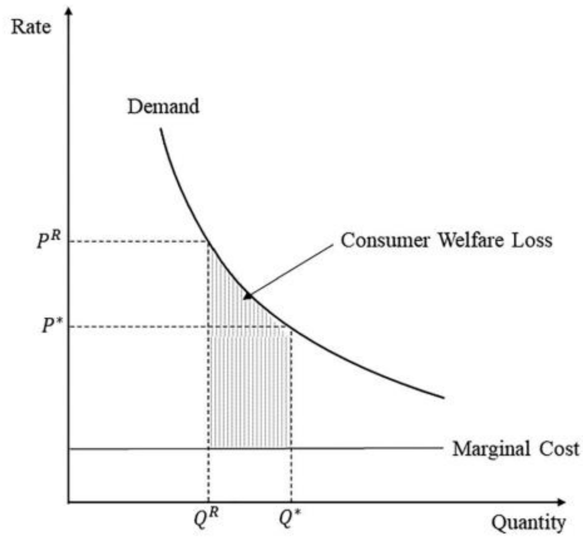
Figure B - 1: Depiction of Welfare Losses under Demand Curve



Source: Buck, Steven, Mehdi Nemati, and David Sunding. "Consumer Welfare Consequences of the California Drought Conservation Mandate." *Applied Economic Perspectives and Policy* 45, no. 1 (2023): 513.

The severity of the water supply disruption in region i at time t is denoted as $z_{it} \in [0;\ 1]$, where $z_{it} = 0$ corresponds to a complete outage and $z_{it} = 1$ corresponds to the baseline level of service. Let $f_{it}(z_{it})$ represent the probability density function of residential water disruption z_{it} in region i at time t and let $W_i(z_{it})$ denote consumer willingness to pay to avoid a supply disruption z_{it} in region i at time t. For a period of duration T until baseline water service is reestablished, consumer willingness to pay to avoid a cumulative service disruption across sectors I regions and T periods is given by:

$$W = \sum_{t=1}^{T} \sum_{i=1}^{I} \int_0^1 W_i(x) f_{it}(x) dx$$

with x as the variable denoting the values z_{it} can assume. For a given region and time, the computation of $W_i(z_{it})$ involves integrating the area under a demand curve for a supply disruption level of z_{it}. Specifically, willingness to pay to avoid a supply disruption of magnitude z_{it} in region i at time t can be defined as:

$$W_i(z_{it}) = \int_{Q_i(z_{it})}^{Q_i^*} P_i(x) dx,$$

where $P_i(Q_i)$ is the (inverse) demand function for residential water in region i, $Q_i^* = Q_i(z_{it} = 1)$ is the baseline quantity of water delivered to residences in region i prior to a supply disruption, and $Q_i(z_{it})$ is the quantity of supply available after a water supply disruption in region i at time t.

Consumer willingness to pay to avoid a (contemporaneous) water supply disruption of a given magnitude i is calculated for each region by constructing an aggregate demand curve to represent the residential water segment. For utilities with a uniform pricing structure, $P_i^* = P_i(Q_i^*)$ is the volumetric rate paid by residential homeowners under baseline conditions prior to the water supply disruption in region i. For regions with an increasing block pricing (IBP) structure, P_i is the marginal rate paid by a representative residential consumer in region i corresponding to the tier on which the last unit of household water consumption occurred.

Ratepayer welfare losses that result from water supply disruption in a given market are mitigated to the extent that delivering a smaller quantity of water reduces the system-wide cost of water service. The ratepayer welfare loss that occurs in region i following a water supply disruption is therefore the difference between the measure in the first equation and the avoided cost of service. If water service is characterized by constant unit cost at the prevailing baseline price level, P_i, then the avoided cost of service is $P_i^*\left(Q_i^* - Q(z_{it})\right)$, and the ratepayer welfare loss following a water supply disruption of a given magnitude reduces to the usual consumer surplus triangle.

Let $c_i(z_{it})$ denote the avoided unit cost of service in region i at time t. Accordingly, the contemporaneous ratepayer welfare loss in region i of a given magnitude water supply disruption is given by:

$$L_i(z_{it}) = \int_{Q_i(z_{it})}^{Q_i^*} P_i(x) - c_i(x)dx$$

Once again, notice that the contemporaneous welfare loss in this equation corresponds with a consumer surplus measure in the case where $c_i(z_{it}) = P_i^*$. In this case, the equation reduces to:

$$L_i(z_{it}) = \int_{Q_i(z_{it}}^{Q_i^*} P_i(x)dx - P_i^*(Q_i^* - Q(z_{it}))$$

The expression for losses in the above equation is a lower bound on the economic loss experienced by ratepayers and corresponds to the case of marginal cost pricing. For a period of duration T until baseline water service is reestablished, the ratepayer welfare loss in the residential (R) sector resulting from a cumulative service disruption across I regions and T periods is given by:

$$L^R = \sum_{t=1}^{T} \sum_{i=1}^{I} \int_0^1 L_i(x) f_{it}(x)dx$$

where $L_i(z_{it})$ is defined in the previous equation. We note that L^R represents aggregate expected losses across I regions between the current period and period T, which reflects the value of a perfectly reliable supply.

B.2. ECONOMETRIC MODEL OF WATER DEMAND

To operationalize the theory in Section B.1, we need to estimate the function $P_i(Q_i)$. A key parameter in estimating $P_i(Q_i)$ is the price-elasticity of demand. We rely on estimates of demand elasticity produced in Buck et al. (2016).[54] This paper estimates utility-specific demand elasticities from a panel of utility service area level water price and consumption data. The main challenge in this estimation is avoiding simultaneity bias, typically addressed by including year fixed effects and considering utility fixed effects to control for unobserved time-invariant characteristics. The study avoids the endogeneity issue, common with increasing block price schedules, by using the median tier price of each utility's tiered pricing schedule and instrumenting this price with lagged prices. Additionally, the research considers different pricing structures, like uniform pricing and increasing block pricing (IBP), as they may affect the estimated price elasticity of demand. The study addresses the complications introduced by increasing block pricing by using an instrumental variables approach where price tiers are used as instruments for the median price.

The authors estimate a regression consumer demand on water rates using the following equation:

$$\ln(q_{it}) = \beta_1 \ \widetilde{\ln(p_{it})} \ + \beta_2 \widetilde{\ln(p_{it})} \ \ln(y_{it}) + \mu_i + \tau_t + \xi_{it}$$

Where q_{it} is average consumption in utility i at time t. $\widetilde{\ln(p_{it})}$ is an instrumented measure of median rates, y_{it} is median household income within the utility service area, μ_i are utility fixed effects, τ_t are year and month fixed effects and ξ_{it} are controls for weather. Using this approach, the authors produce the regression estimates shown below in Table B - 1.

In the paper, these estimated coefficients are subjected to a number of robustness checks regarding impact of increasing block pricing, drought, and other omitted variables and found to be reliable. Since the data in this paper is dated, in the next section we recalculate utility-specific demand elasticity estimates based off of the most recent data on each utility's rates, income, and demand.

[54] Buck, S., M. Auffhammer, S. Hamilton, and D. Sunding. 2016. Measuring Welfare Losses from Urban Water Supply Disruptions. In *Journal of the Association of Environmental and Resource Economists*, 3(3), 743–778.

Table B - 1: Econometric Estimate of Water Demand from Buck et al. (2016)

	OLS (1)	OLS (2)	IV (3)	OLS (4)	IV (5)
ln(Price)	0.173	-0.100***	-0.143***	-0.591***	-0.637***
	(0.120)	(0.033)	(0.046)	(0.194)	(0.242)
ln(Price) x ln(Income)				0.110**	0.113**
				(0.041)	(0.050)
Observations	453	453	453	453	453
Weather controls	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Utility fixed effects	No	Yes	Yes	Yes	Yes

Note.—Standard errors clustered at the water utility level reported in parentheses.
* p < .10.
** p < .05.
*** p < .01.

Source: Buck, S., Auffhammer, M., Hamilton, S., & Sunding, D. (2016). "Measuring Welfare Losses from Urban Water Supply Disruptions," *Journal of the Association of Environmental and Resource Economists*, 3(3), 743-778.

B.3. ESTIMATION OF WELFARE LOSSES

This subsection describes the derivation of the function that is used to estimate welfare losses from water shortages. This derivation is presented in more detail in Buck et al. (2016). We assume a constant elasticity of demand specification:

$$P_i = A_i Q_i^{1/\varepsilon_i}$$

for $i = 1 \ldots n$, where ε_i is the price elasticity of water demand in region i and A_i is a constant. Let P_i and Q_i, respectively, denote the retail water price and quantity of water consumed by residential households in region i under baseline conditions. For a given water supply disruption with an available level of water given by $Q_i(z_{it}) < Q_i^*$, it is helpful to define the relationship between these quantities in terms of the percentage of water rationed in region i at time t, r_{it}, as

$$Q_i(z_{it}) = (1 - r_{it})Q_i^*.$$

Based on the preceding equations, the welfare loss following a supply disruption of magnitude z_{it} in region i at time t can be calculated as:

$$L_i(z_{it}) = \frac{\varepsilon_i}{1+\varepsilon_i} P_i^* Q_i^* \left[1 - (1-r)^{\frac{1+\varepsilon_i}{\varepsilon_i}}\right] - \int_{Q_i(z_{it})}^{Q_i^*} c_i(x)dx.$$

Under the assumption of a flat marginal cost curve, we can rewrite this equation in terms of average loss per unit of shortage:

$$\frac{L_i}{Q_i^* r_{it}} = \frac{\varepsilon_i}{1+\varepsilon_i} P_i^* \left[1 - (1 - r_{it})^{\frac{1+\varepsilon_i}{\varepsilon_i}} \right] / \, r_{it} - c_i,$$

where c_i is a constant per unit marginal cost. This makes clear that conditioned on a supply disruption r_i, the welfare implications of a supply disruption in a particular region depends on heterogeneity in (i) price elasticities, (ii) initial prices, and (iii) the variable cost of water service, where ii and iii provide insight into the extent to which fixed costs are bundled into volumetric rates.

Using the above equations, we calculate welfare losses from shortages for State Water Contractors and Metropolitan Water District customers under both the project and no-project scenarios. In our calculations, P_i is each districts' median-tier water rate. Where possible we rely on forecast rates for the year 2045 that are produced as part of the district's planning process. Otherwise, current rates are used based on the most recent available data. It is assumed that there is no increase in real rates for the duration of our estimate. Where a State Water Contractor is a wholesaler that serves multiple retailers, a median rate is calculated across all retailers. Baseline Demand, Q_{it}^*, is based on each demand forecast produced by each district as part of their resource planning process. Shortages, r_{it}, are calculated based on district specific reliability modeling. Long-run variable costs for water deliveries, c_i, are calculated based on data reported in the State Water Project's Bulletin 132-19.[55]

Due to the constant elasticity of demand assumption, welfare losses in our model are unbounded as shortages become increasingly large. In the model, we have limited consumer welfare losses at a marginal value of $10,000 per acre-foot, which is approximately equal to the costs of providing emergency water supplies to residential and commercial customers via truck.[56]

[55] California Department of Water Resources. n.d. *Bulletin 132, Management of the California State Water Project.*

[56] Brozović, Nicholas, David L. Sunding, and David Zilberman. 2007. Estimating Business and Residential Water Supply Interruption Losses from Catastrophic Events. In *Water Resources Research*, 43, No. 8 (2007).

Appendix C: Additional Details on Costs of Remaining Environmental Impacts after Mitigation

This appendix provides further details on the estimation of the costs of remaining environmental impacts after mitigation provided in Section 10 of the report. The Environmental Impact Report is a comprehensive study that identifies the significant environmental and social impacts associated with the construction of the Delta Conveyance Project. It assesses impacts in over twenty areas and identifies mitigation measures to offset them. After mitigation, remaining environmental impacts are quantified or identified as 'Less than Significant.' The proposed mitigation project will be financed by the environmental mitigation costs discussed in Section 0 and incorporated into the DCA's cost estimates. Several environmental impacts are still identified as being significant after mitigation efforts, particularly in terms of lost agricultural land in the delta region and construction-related air quality, noise, and transportation impacts.

C.1. LOST AGRICULTURAL LAND IN THE DELTA

The EIR identifies parcels of land that would be affected by construction of DCP and categorizes impacts to them as either permanent or temporary. Permanent impacts are described as "resulting from the physical footprint of project facilities" and as "land that cannot be returned to farmland."[57] Impacts that would last for the duration of construction, but for which there also exists post-construction uncertainty were additionally designated as permanent. Temporary impacts are those which would be "largely limited to the duration of construction activities at a given site but could be returned to active farmland after cessation of construction activities."[58]

To value permanent loss of farmland, we rely on the average market prices for farmland by county and crop type. Temporary loss of farmland is valued using the annual rental price by county and crop type. Non-agricultural land impacted by construction, such as seasonal wetlands and miscellaneous grasses, are excluded from the analysis. To value affected cropland, we rely on appraisal values calculated in the "Trend in Agricultural Land and Lease Values" report provided by the California chapter of the American Society of Farm Managers and Rural Appraiser, the largest professional association for rural property land experts. If an appraisal value was not available for an affected crop type and county, we rely on the average value of Delta farmland. In the case of almond croplands, we rely on the mean value per acre across irrigated and well-watered almond cropland. Appraisal values for relevant croplands are presented in Table C-1 below.

[57] DCP EIR, 15–25.

[58] Ibid.

Table C-1: Value of Cropland in Project Area

Crop Type	County	Low Value ($ per Acre)	High Value ($ per Acre)	Mid Value ($ per Acre)
[A]	[B]	[C]	[D]	[E]
Almonds	San Joaquin, Contra Costa, Sacramento	$19,145	$58,499	$38,822
Rangeland Grazing Only	San Joaquin, Contra Costa, Sacramento	$638	$ 3,191	$1,915
Rangeland (perm plant potential)	San Joaquin, Contra Costa, Sacramento	$5,318	$ 9,573	$7,445
Walnuts	San Joaquin, Contra Costa, Sacramento	$19,145	$37,227	$28,186
Wine Grapes	San Joaquin, Contra Costa, Sacramento	$23,400	$42,545	$32,972
Cherries	San Joaquin, Contra Costa, Sacramento	$26,591	$38,290	$32,440
Delta	San Joaquin, Contra Costa, Sacramento	$15,954	$19,145	$17,550
Row Crops	Santa Clara	$26,591	$63,817	$45,204

Sources and Notes:
[A]: These are the crop types with available information in the 2022 ASFMRA report, and values converted to 2023 dollars.
[B]: Note that ASFMRA combines counties into agricultural regions. San Joaquin, Contra Costa, and Sacramento fall into the Northern San Joaquin region, whereas Alameda County is placed in the Central Coast region.
[C] – [D]: The ASFMRA lists a high and a low value for each type of farmland.
[E]: The mid value is just the average of the high and low values listed in the 2022 ASFMRA report.

To value the cost of temporary impacts, we rely on rent values provided by the United States Department of Food and Agriculture's National Agricultural Statistics Service (NASS). NASS rent values are characterized as irrigated and non-irrigated; we calculate a mean across both types. Rental prices are presented below in Table C-2. We calculate the cost of temporary impacts as the product of rental value per acre and the total temporary affected acreage by county. We assume all temporarily affected fields are affected for the entire duration of construction, thereby potentially overestimating the cost of lost farmland.

Table C - 2: Summary of Rent by County for Irrigated and Non-Irrigated Farmland

County	Irrigated Land Rent ($ per Acre)	Non-Irrigated Land Rent ($ per Acre)	Average Land Rent ($ per Acre)
[A]	[B]	[C]	[D]
Alameda	1,414.62	21.27	717.94
Contra Costa	344.61	19.15	181.88
Sacramento	264.84	40.95	152.90
San Joaquin	447.78	36.69	242.24

Sources and Notes:
All rent measured in 2023 dollars.
[A]: Affected counties as described in DCP EIR.
[B],[C]: From the United States Department of Agriculture National Agricultural Statistics Service.
[D]: ([B] + [C]) / 2.

We assume all permanent impacts begin in the first year of construction. Due to discounting, this assumption yields a relatively high estimate of total costs. Acreage impacted is inclusive of the farmland that will be affected by construction of mitigation measures such as on Bouldin Island and within I-5 Ponds 6, 7, and 8.

Using the mean value for the appraisal of farmland and the average value between the rent prices of irrigated and non-irrigated farmland in the four counties, the total undiscounted cost of the farmland conversion is estimated to be $25.94 million, as shown in Table C-3. Of this total, $3.99 million is associated with temporary farmland conversion and $21.96 million are associated with permanent farmland conversion. Of the permanent impacts, the crop types with the highest value of converted land are alfalfa, grapes, and almonds.

Table C - 3: Summary of Costs Associated with Conversion of Farmland

Construction Year	Cost of Temporary Acres Impacted	Cost of Permanent Acres Impacted	Total Cost
($ millions, 2023)			
CY1	$0.249	$21.950	$22.199
CY2	$0.249	$0.000	$0.249
CY3	$0.249	$0.000	$0.249
CY4	$0.249	$0.000	$0.249
CY5	$0.249	$0.000	$0.249
CY6	$0.249	$0.000	$0.249
CY7	$0.249	$0.000	$0.249
CY8	$0.249	$0.000	$0.249
CY9	$0.249	$0.000	$0.249
CY10	$0.249	$0.000	$0.249
CY11	$0.249	$0.000	$0.249
CY12	$0.249	$0.000	$0.249
CY13	$0.249	$0.000	$0.249
CY14	$0.249	$0.000	$0.249
CY15	$0.249	$0.000	$0.249
CY16	$0.249	$0.000	$0.249
Total	**$3.991**	**$21.950**	**$25.941**

C.2. CONSTRUCTION-RELATED AIR QUALITY IMPACTS

This section evaluates the social cost of construction with respect to four pollutants: reactive organic gases (ROG), nitrogen oxides (NO_X), particulate matter less than 10 microns in diameter (PM_{10}), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). Project construction will increase emissions across three districts: Sacramento Metropolitan Air Quality Management District (SMAQMD), San Joaquin Valley Air Pollution Control District (SJVAPCD), and the Bay Area Air Quality Management District (BAAQMD). In particular, construction will increase PM_{10} in excess of SMAQMD and SJVAPCD thresholds and increase NO_X emissions above thresholds set in all three districts. Note that this section does not estimate the impacts of greenhouse gas emissions associated with the construction and operation of the DCP because these emissions will be offset by a proposed mitigation programs that are included in the project's costs.

Both nitrogen oxides and particulate matter are associated with negative impacts on human health. Short-term NO_x exposure is associated with respiratory symptoms, especially in people with asthma. Longer-term exposure is associated with development of asthma.[59] In addition to its health effects, NO_x is associated with acid rain, global warming, and nutrient overload. Particulate matter refers to microscopic solids or liquid droplets which are small enough to be inhaled. Particulates less than 10 micrometers in diameter can be inhaled deep in the lungs and absorbed into the bloodstream.[60] Because smaller particulates can be absorbed more deeply into the lungs and bloodstream, $PM_{2.5}$ poses a greater health risk than PM_{10}.

Due to the health risks posed by air pollutants, the DCP incorporates mitigation plans to reduce the impact of project-related emissions. DWR will enter into agreements with the affected air districts to provide offset fees. DWR will establish programs to fund emissions reduction projects which include but are not limited to alternative fuel school busses and transit public vehicles, diesel engine retrofits, electric vehicle rebates, and video-teleconferencing systems and telecommuting start-up costs for local businesses. DWR will additionally fund compensatory mitigation plans which restore wetlands and tidal habitats on Bouldin Island and in the North Delta Arc. A more complete discussion of mitigation plans is found in Chapter 23 of the EIR.

Table C - 4 presents baseline levels of annual pollution and the expected increase across the four studied air quality districts. Project-related pollution constitutes less than a 1% increase in pollution levels in all pollutants and counties except for a 2.2% increase in NO_X emissions in SMAQMD. No significant changes in pollution levels are predicted in Yolo-Solano Air Quality Management District for any of the studied pollutants.

[59] U.S. Environmental Protection Agency. n.d. *Basic Information about NO_2*. Available: https://www.epa.gov/no2-pollution/basic-information-about-no2#Effects. Accessed: December 6, 2023.

[60] U.S. Environmental Protection Agency. n.d. *Particulate Matter (PM) Basics.* Available: https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#effects. Accessed: December 6, 2023.

Table C - 4: Annual Air Quality Changes between no project and project scenarios (Tons/Year)

		ROG	NOX	CO	PM 10 Total	PM2.5 Total	SO2
Sacramento Metropolitan Air Quality 1 Management District							
Baseline Emissions	[1]	18,849	12,676	75,887	11,779	3,927	303
Increased Emissions	[2]	21	278	603	108	24	0
Percent Increase	[3]	0.1%	2.2%	0.8%	0.9%	0.6%	0.0%
Yolo-Solano Air Quality Management District							
Baseline Emissions	[1]	8,329	6,453	21,864	12,136	2,508	164
Increased Emissions	[2]	0	0	4	0	0	0
Percent Increase	[3]	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bay Area Air Quality Management District							
Baseline Emissions	[1]	89,976	81,997	331,062	32,730	13,600	8,424
Increased Emissions	[2]	14	147	505	220	34	0
Percent Increase	[3]	0.0%	0.2%	0.2%	0.7%	0.3%	0.0%
San Joaquin Valley Air Pollution Control District							
Baseline Emissions	[1]	117,136	83,384	248,244	97,495	25,130	2,347
Increased Emissions	[2]	15	153	255	120	22	0
Percent Increase	[3]	0.0%	0.2%	0.1%	0.1%	0.1%	0.0%
Total							
Baseline Emissions	**[1]**	**234,290**	**184,511**	**677,057**	**154,140**	**45,165**	**11,238**
Increased Emissions	**[2]**	**50**	**578**	**1,367**	**448**	**80**	**0**
Percent Increase	**[3]**	**0.0%**	**0.3%**	**0.2%**	**0.3%**	**0.2%**	**0.0%**

Sources and Notes:
[1]: California Air Resources Board, “Emissions by Air District,” accessed September 2022.
[2]: Environmental Impact Report for the Delta Conveyance Project, Chapter 23B, Table 23-22.
[3]: [2] / [1].

To quantify the social cost of increased pollutants, we apply EPA estimates of social cost per ton. The EPA estimates the social costs of air pollution using BenMAP-CE. The BenMAP-CE model first estimates health impacts using inputs from the published epidemiological literature: air quality changes, population levels, baseline incidence rates, and health effect estimates. The model calculates economic values from these estimates using cost-of-illness and willingness-to-pay metrics. Cost-of-illness reflects expenses associated with pollution-related illness, while willingness-to-pay reflects the more comprehensive toll of pollution related illness, incorporating individuals’ reduction in quality of life beyond medical expenses. This analysis relies specifically on BenMAP social cost estimates in the refineries sector: values in 2023 dollars per ton are presented in Table C - 5 below.

Table C - 5: Social Cost of Pollutants

		Social Cost ($ / ton)
ROG	[1]	$14,556
NOX	[2]	$102,016
PM 10	[3]	$12,315
PM2.5	[4]	$465,781
SO2	[5]	$64,425

Sources and Notes:
Social cost reported in 2023 $/ton.
[1], [2], [4], [5]: EPA BenMAP Emissions by Sector.
[3]: Regulatory Impact Analysis of the Proposed Reciprocating Internal Combustion Engines NESHAP.
[3], [4]: For PM10 and PM2.5, social costs are determined using values reported for exhaust.

Applying these social cost metrics to total estimated pollution emissions attributable to the DCP, we estimate a total social cost of $61.29 million.[61] Annual social costs are presented in Table C - 6 below. This estimate is likely an upper bound for two reasons. First, the DCP EIR evaluates its emissions estimates to be an upper bound on expected emissions; if actual increased emissions are lower, then the corresponding social cost will be closer to zero. Second, EPA BenMAP social cost estimates have increased in recent years to reflect a more comprehensive account of social costs. Past EPA estimates have been only looking at the social costs of $PM_{2.5}$ precursors, while the current estimates use both $PM_{2.5}$ precursors and ozone precursors. This causes an increase in social costs of NO_x and ROGs. In a comparable analysis conducted for an earlier version of the project in 2013, the social cost of NO_x was estimated to be $13,691; the current social cost is more than seven times this amount.[62] Because the total costs are driven primarily by increases in NO_x emissions, the change in estimated cost/ton explains 81% of the total social cost of increased air pollution; using the values in the 2013 report, we find a total social cost of $7.1 million.[63] This comparison is not intended to trivialize the impact of air pollutants in the project air districts, but rather to give context to the magnitude of the estimated social cost.

[61] Measured in undiscounted 2023 dollars and assuming preliminary field investigation year (PFIY 1) will begin 2 years from the time of this analysis.

[62] The original input was $11,000; the value in text is adjusted to 2023 dollars.

[63] The 2013 values for social cost are adjusted for inflation. As in the main analysis, we assume a 2% discount rate and that the preliminary field investigation year (PFIY 1) will begin 2 years from the time of this analysis.

Table C - 6: Total Annual Social Cost of Project-Related Air Pollution

Construction Year	Total Social Cost ($ Millions, 2023)
PFIY1	$0.64
PFIY2	$0.64
PFIY3	$0.64
CY1	$1.22
CY2	$0.73
CY3	$1.14
CY4	$4.23
CY5	$9.40
CY6	$10.59
CY7	$8.86
CY8	$6.60
CY9	$6.59
CY10	$6.38
CY11	$2.80
CY12	$0.61
CY13	$0.22
CY14	$0.00
Total	**$61.29**

Notes:
Costs are reported in millions of undiscounted 2023 $. PFIY 1 is assumed to begin two years from the time of this analysis.

C.3. CONSTRUCTION-RELATED NOISE IMPACTS

Construction of the Delta Conveyance Project is expected to increase noise in the local areas surrounding construction sites. The project will primarily impose noise nuisances during the construction of permanent project features over a period of 12 to 14 years. Heavy equipment noise will occur at project sites, and construction of levee improvements, bridges, and other project developments will also generate localized noise disruptions. A more complete description of expected noise impacts can be found in Chapter 24 of the EIR.

Excess noise is a nuisance to local residents. In addition to quality-of-life impacts, excess noise may incur economic costs if, for example, work from home is disrupted or outdoor recreation businesses are negatively affected. The economic value of this nuisance is challenging to quantify; two individuals may experience different burdens from the same level of noise, and the ultimate noise impact itself can depend on factors such as home insulation. To quantify the overall burden of excess noise on a locality, we depend on an econometric method called hedonic pricing. The hedonic pricing method uses the value of related market goods to estimate the value of non-market goods. More specifically, the hedonic pricing method uses statistical techniques to infer the value of environmental attributes, such as noise levels, by comparing values of properties that have a given environmental attribute and those that do not. If houses are comparable across characteristics other than the attribute of interest (in this case, noise), then differences in the market price can be attributed to differences across this attribute.

Common sources of disruptive noise levels include roadways, general construction, airports, railroads, and industrial activity. Roadways are not a close comparison point because they primarily impose ambient noise. Typical construction projects may also be an inappropriate comparison point because the longevity of the DCP construction imposes higher costs than would short-term construction projects. While a perfect comparison is elusive, noise from railroad activity is analogous to DCP construction-related noise because both impose irregular noise impacts and are long-term nuisances. For this analysis, we thus rely on hedonic values derived from a study of housing price differences attributable to railroad proximity. Walker (2016) finds a 14% to 18% decline in residential property values in Memphis, Tennessee, if the property is exposed to sixty-five decibels or greater of railroad noise.[64] The study finds no impact on commercial property values.

Relying on this study, we assume a 14% impact on housing values due to increased noise. We apply this cost metric to average California housing values in both the property and rental markets.[65] The duration of noise disruption varies by location. Of the seventeen locations discussed in the EIR, five experience disruptions lasting five hours to one week, and an additional three locations are not located near any residences. These eight locations are excluded from the social cost analysis. Of the remaining nine locations, five experience disruptions lasting one month to 3.5 years. For these locations, we apply the cost metric to an estimated average California monthly rental price for the duration of the disruption. For the four locations experiencing nine or more years of disruptions, we apply the cost metric to the full property value.

The results of the analysis are presented in Table C - 7 below. We estimate an undiscounted cost of $8.7 million in noise impacts. These estimates assume that disruptive noise begins in the first year of construction. Note that the EIR finds that if all eligible property owners participate in the proposed the Noise Control Plan proposed in the EIR, the impacts would be less than significant.

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[64] Walker, Jay. 2016. Silence is Golden: Railroad Noise Pollution and Property Values. In *The Review of Regional Studies*, 45 (2016), 75–89.

[65] Local housing prices in the affected areas are lower than average California housing values. To conduct a socially equitable analysis, we rely on statewide averages. We assume a home value of $788,679 and a rental value of $7,886.79, or 1% of a home’s value.

Table C - 7: Social Cost of Project-Related Noise

Location/ Site	Construction Activity	Duration	Number of Residences Daytime	Damages with Local Average House Values ($ millions, 2023)
Intakes Construction	Pile Driving	42 Months	117	$3.21
	Nighttime concrete pours	2 Months	147	$0.19
	Heavy Equipment	12 years	9	$0.59
Tunnel Shaft Construction	Lower Roberts Island Levee Improvements	1 month	19	$0.01
	Lower Roberts Island RTM Stockpile	9 years	5	$0.33
	Upper Jones Tract Maintenance Shaft Buildout	9 years	1	$0.09
Bethany River Complex Construction	Bethany Reservoir Pumping Plant, Surge Basin and Aqueduct Buildout	13 years	12	$1.70
	Bethany Reservoir Pumping Plant, Surge Basin and Aqueduct night concrete pours	2 months	0	$0.07
Bridges, New Access Roads, Road Improvements, and Park-and-Ride Lots	Construction	1.5 months	450	$0.79
Total				**$6.97**

Notes:
Costs are reported in millions of undiscounted 2023$. The number of residences includes both daytime and nighttime residences. Twin cities complex is shown in this table as there are no adjacent residences that might experience noise impacts.

C.4. CONSTRUCTION-RELATED TRANSPORTATION IMPACTS

This section estimates the costs associated with construction induced traffic delays associated with the construction of the DCP. The costs as estimated based on total time delays estimated in the EIR and U.S. Department of Transportation (DOT) estimates of the opportunity cost of such delays to road users.

The EIR identifies 120 road segments, ranging from local roads to interstate highways, which are likely to be impacted by DCP construction based on the regional and local travel routes of construction workers and estimated truck traffic delivering project materials to and from project features.[66]

[66] Not all segments would be included in the adopted EIR project. For this project, construction access would not be allowed along SR 160 and River Road or along SR 4 between Old River and Middle River. See DCP, Appendix 20A 20A-1.

For each segment, baseline roadway traffic estimates from 6 AM to 7 PM for 2020 were developed using data collected from 2015 to 2019 and adjusted upward to estimate 2020 traffic absent Covid-19 impacts.[67] Within a road segment's range of traffic flows, we assume the upper end during rush hour (7AM to 10 AM and 4 PM to 7 PM) and the lower end during non-rush hour periods.

To estimate the economic impact of travel delays resulting from the construction of the Delta Conveyance Project, we first calculate the speed at which vehicles travel on a congested roadway using the following equation (Singh 1999):

$$Congested\ Speed = \frac{Free\ Flow\ Speed}{1 + 0.20[(\frac{Volume}{Capacity})^{10}]}$$

We assume free flow speed to be the roadway's speed limit. We assume capacity corresponds to a LOS E grade.[68] We estimate baseline volume using the EIR volume estimates discussed above. Average time to traverse the segment in each hour of the day is estimated using the congested speed and length of the segment.[69] Finally, the cumulative time spent across drivers on a given segment is calculated using average time to traverse and the total estimated volume of traffic on the segment during that hour.

The EIR identifies two segments that will deteriorate below acceptable LOS standards during morning and evening commute periods because of construction in listed years. For these segments during these hours, the traffic volume increases to the threshold of LOS E. This assumption constitutes an extreme upper bound, as we assign traffic impacts to the entire year, whereas the EIR expects the maximum volume to be reached only one to two weeks per year. To account for traffic increases which do not result in deterioration below LOS acceptable standards, remaining DCP-related trips are assumed to be distributed across road segments proportionally to the share of baseline traffic on each road segment.

Using the distribution of DCP-related trips across segments and hours, we calculate congested speed with project construction and compare this value to that under the baseline scenario to find the increased travel time resulting from the construction of the Delta Conveyance Project.

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[67] DCP, Appendix 20A 20A-16.

[68] The certified final EIR conducts a level-of-service (LOS) analysis to qualitatively evaluate the level of comfort and convenience associated with driving on a segment at a given time. Segments are assigned a letter grade, wherein LOS A reflects free-flow conditions and LOS F reflects stop-and-go conditions.

[69] To illustrate, if the congested speed is 60 mph and the segment is 60 miles long, then average time to traverse is one hour. This step implicitly assumes that each vehicle will be on the roadway segment for the entire length of the segment. Although this assumption might result in an overestimation of time spent on congested roadways, data are not available on how long each vehicle remains on each roadway segment. Because most segments are freeways and highways, and the average segment is relatively short (3.07 miles), this assumption is reasonable.

To estimate the economic value of increased local travel time under DCP construction, we rely on an opportunity cost methodology. The opportunity cost of a travel delay is the value of the time lost because of additional time spent in traffic. The value of this time differs depending on what the time would have been used for had it not been spent in traffic. As construction will affect both business and personal travel, the value chosen for the opportunity cost of time spent in traffic is representative of both leisure and work. The total delay time is multiplied by estimates of the opportunity cost of a traveler's time used by DOT to assign a monetary value to delay times in regulatory analyses. DOT develops and periodically updates the value of travel time to be used in analyses of proposed regulations. This value is widely used by transportation agencies to estimate the time burden of proposed regulations, including those promulgated by DOT, the Transportation Security Administration, and the U.S. Coast Guard. DOT's 'all purpose' estimate of the value of time is used in the calculation, which is a weighted average of the value of time for both business and leisure trips based on historical rates of each type of trip. DOT estimates an intercity low value of $26.52 and a high value of $35.45.[70]

Using a high and low price for the opportunity cost of time lost in traffic, we develop a range for the total cost associated with the traffic impacts of construction. These results are presented in Table C-8 below. The additional traffic caused by construction incurs an undiscounted social cost of $78.9 million to $105.4 million incurred between 2024 and 2035. Annual costs stemming from traffic delays peak during year six of construction and taper off afterward due to discounting and decreased construction activity.

The estimates presented here constitute an upper bound of total transportation costs. 86.5% of the total time lost in traffic because of construction occurs on the five segments which the EIR states will experience LOS E conditions because of the project during morning and evening commute periods. We assume that these segments will experience LOS E conditions on every construction day of the affected years, but segments are likely to only be affected for a few weeks of the year.

[70] California Department of Transportation. 2016. *Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis*. Values are converted from 2016 dollars to 2023 dollars.

Table C - 8: Costs Associated with Traffic Impacts

Construction Year	Traffic Impact, Day of Construction (hours / day)	Construction Time (days)	Yearly Traffic Impact (hours)	DOT Value of Travel Time Savings ($ / hour)			Yearly Traffic Impact ($ millions, 2023)		
				Low	Mid	High	Low	Mid	High
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]
1	23.11	325	7,517.66	$26.52	$28.47	$35.45	$0.20	$0.21	$0.27
2	23.11	325	7,517.66	$26.52	$28.47	$35.45	$0.20	$0.21	$0.27
3	115.64	325	37,613.03	$26.52	$28.47	$35.45	$1.00	$1.07	$1.33
4	161.95	325	52,675.62	$26.52	$28.47	$35.45	$1.40	$1.50	$1.87
5	2,394.28	325	778,740.48	$26.52	$28.47	$35.45	$20.65	$22.17	$27.60
6	2,451.04	325	797,200.68	$26.52	$28.47	$35.45	$21.14	$22.70	$28.26
7	2,394.28	325	778,740.48	$26.52	$28.47	$35.45	$20.65	$22.17	$27.60
8	1,348.98	325	438,754.71	$26.52	$28.47	$35.45	$11.63	$12.49	$15.55
9	104.07	325	33,848.93	$26.52	$28.47	$35.45	$0.90	$0.96	$1.20
10	80.93	325	26,322.62	$26.52	$28.47	$35.45	$0.70	$0.75	$0.93
11	23.11	325	7,517.66	$26.52	$28.47	$35.45	$0.20	$0.21	$0.27
12	23.11	325	7,517.66	$26.52	$28.47	$35.45	$0.20	$0.21	$0.27
						Total	**$78.86**	**$84.67**	**$105.42**

Sources and Notes:
All Yearly Traffic Impact costs measured in millions of undiscounted 2023 $.
[A]: From DCP EIR Appendix 20A Figure 20A-11. Vehicle Trips per Day for DCP project alternative.
[B]: From Total Daily Time lost in Traffic by Year for each Impacted Segment.
[C]: From DCP EIR Appendix 20A, p. 30.
[D]: [B] x [C].
[E] – [G]: From Department of Transportation's 2016 Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis.
[H]: [D] x [E].
[I]: [D] x [F].
[J]: [D] x [G].
[K]: [H] / (1.02 ^ ([A] + 1)).
[L]: [I] / (1.02 ^ ([A] + 1)).
[M]: [J] / (1.02 ^ ([A] + 1)).

C.5. OTHER IMPACTS

The DCP's EIR provides a comprehensive assessment of the impacts of the construction and operation of the project on over twenty different resources. Some of these impacts are identified in the EIR as being less than significant without any mitigation measures.[71] Other resources are identified having impacts from the DCP; however, these impacts are less than significant after the adoption of mitigation measures.[72] Impacts on the following resources are identified in the EIR as being less than significant after the adoption of mitigation measures.[73]

The following impacts are identified in the EIR as being significant and unavoidable, however they are not quantified in this report because there are not appropriate economic tools to estimate a monetary value of their impacts:

- Aesthetic and Visual Resources (Chapter 16)
- Cultural Resources (Chapter 19)
- Paleontological Resources (Chapter 29)
- Tribal and Cultural Resources (Chapter 32)

[71] Specifically, these resources and their respective chapters in the EIR are:
Groundwater, Ch.8; Water Quality, Ch.9; Geology and Seismicity, Ch.10; Land Use, Ch.14; Recreation, Ch.16; Public Utilities and Services, Ch.21; Energy, Ch.22; Mineral Resources, Ch.27.

[72] Groundwater, Ch.8 ; Water Quality, Ch.9; Geology and Seismicity, Ch.10; Land Use, Ch.14; Recreation, Ch.16; Public Utilities and Services, Ch.21; Energy, Ch.22; Mineral Resources, Ch.27.

[73] Flood Protection, Ch.7; Soils, Ch.11; Fish and Aquatic Resources, Ch.12; Terrestrial Biological Resources, Ch.13; Hazards, Hazardous Materials, and Wildfire, Ch.25; Public Health, Ch.26.

Responses to Director's Questions Received Following Bay-Delta Presentation to OWS Committee - October 2023

1) **How much levee strengthening has been done for the West and East Freshwater pathways?**
There are approximately 90 miles of levees along the freshwater pathway south of the San Joaquin River. Approximately 48 miles (53%) have been improved to State Bulletin 192-82 levee compliance (i.e., 1 in 300-year event criteria). The cost for full compliance with Bulletin 192-82 along the freshwater pathway is estimated to cost $131 million. The cost to further improve the levees up to the proposed modern levee standard (i.e., able to withstand earthquake and sea level rise) is estimated at $400 to 700 million. (This is a conservative estimate of costs.)

2) **What would be the delivery capabilities through those freshwater pathways under different conditions?**
The Middle River pathway is capable of taking about 7,000 cfs under emergency conditions. The combined Middle River and Old River pathways can accommodate full CVP and SWP flows of about 11,000 cfs. DWR has indicated in the latest Delta Flood Emergency Management Plan that they will use combined Old River and Middle River pathways interactively during emergency operations, depending upon on the ground conditions.

3) **What is the remaining asset value of the SWP investment?**
The State Water Project (SWP) is an ongoing state-owned water system without an end life. While Metropolitan does finance the SWP, Metropolitan does not own the assets associated with it. The SWP is a user-financed water system based on beneficial use and is planned, built, operated, and maintained by the Department of Water Resources. Through 2023, Metropolitan has invested ~$29.9B (2023 dollars), but this is not a depreciable asset.

4) **What is the cost per acre-foot yield from the SWP?**
The acre-foot cost of SWP supplies varies depending on the volume of supplies available. In drier years, the dollar cost per AF is much higher due to fixed costs and reduced hydroelectric generation to offset variable power costs.
   - *During low allocations such as 2014, the $/AF cost was $1,174/AF (nominal dollars). In high allocation years such as 2019, the $/AF cost was $450/AF (nominal dollars).*
   - *The long-term average cost of Metropolitan's SWP supplies in 2023 dollars is $674/AF through 2023.*
   - *Based on the latest Bulletin-132 report from DWR, projected forward at a 60% SWP allocation, the average $/AF cost is $730/AF through 2035.*