Benefit Calculation, Monetization, and Resiliency Tab

Attachment 9: Benefit Cost Analysis

Attach the benefit and cost analysis for the proposed project. If the analysis is located in another document, identify the location. See regulations section 6004(a)(6).

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Tables

STATUS:	FINAL	PREPARER:	N CARLSON	PHASE:	1 VERSION: B
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Acronyms and Abbreviations

B/C	benefit cost
BCA	benefit-cost analysis
IDC	interest during construction
NODOS	North-of-the-Delta Offstream Storage
NPV	net present value
OM&R	operations, maintenance, and replacement
PBR	public benefit ratio
project	Sites Reservoir Project
WSIP	Water Storage Investment Program

Findings

The benefit-cost analysis (BCA) determined that the Sites Reservoir Project (project) would result in total public benefits with a present value of $3,506 million in 2015 dollars. If it receives its requested $1,662 million in Water Storage Investment Program (WSIP) funding and the entire $730 million of its potential Federal funding, **the Sites Reservoir project would have a public benefit ratio (PBR) of 2.11 and an overall benefit-cost (B/C) ratio of 1.52**. This does not account for the significant non-monetized benefits.

The project's high PBR indicates that WSIP funding of the project would be a highly cost-effective investment. Similarly, the project's B/C ratio indicates that the project is economically feasible and will result in major net benefits from the total expenditures necessary for its construction and future operations.

As discussed extensively in Sites_A5 Documentation under the BENEFIT CALCULATION, MONETIZATION, AND RESILIENCY TAB and summarized below, the PBR and B/C ratio results are considered highly conservative based on the selected monetization approaches and the assumptions used by the benefit valuation analysis. The project's B/C ratio would increase to more than 2.2 and its PBR to over 3.6 if the alternative cost approach for the project's ecosystem improvements and agricultural supply benefits. Use of WSIP Unit Fish values for the project's anadromous fish benefits are estimated to further increase the project's PBR to over 4.5.

Approach

BCA is a widely used analysis tool for evaluating a project's expected future economic performance. Two key metrics are commonly used to represent and evaluate BCA results: the B/C ratio and the net present value (NPV).

Benefit-Cost Ratio

The B/C ratio is the present (or annualized) value of all project benefits divided by the corresponding value of all costs. The ratio measures the factor by which benefits exceed (or are below) costs. A project with a ratio value greater than 1.0 is considered economically feasible. The B/C ratio is a useful way to compare the relative benefits of projects that may differ in time and/or scale. The overall B/C ratio of a proposed project (considering all costs, benefits, and impacts) is the measure of the project's economic feasibility.

Net Present Valuation

NPV is the present value of all costs subtracted from the present value of all benefits. Projects with values greater than $0.00 are considered economically beneficial. The NPV is a useful way to determine the overall dollar value of a project's expected future net benefits.

Public Benefit Ratio

The WSIP Application requires calculation of a project's PBR. The PBR is the present value of the net monetized public benefits divided by the total requested WSIP cost share.

The BCA data, calculations, and results for Sites Reservoir are provided below. In accordance with WSIP Technical Memorandum guidance, benefits and costs were annualized using a 3.5 percent discount rate applied to the project's operations over the remaining 93 years of the study period (i.e., 2030 to 2122).

Benefits

Table A9-1 shows Sites Reservoir's estimated benefits on an average annual basis for the 93-year study period. As discussed above, the average annual benefits are based on the NPV of the project's future benefits using the WSIP-required 3.5 percent discount rate.

Table A9-1. Annual Benefits Summary (2015$, $Millions/year)

Beneficiary	Benefit Value	Benefit Value Adjusted [a]
WSIP Public Benefits	**$122.0**	**$123.6**
Ecosystem improvement	$110.9	$112.0
Anadromous fish & other aquatic	$57.0	$57.7
Incremental Level 4 refuge	$23.8	$23.8
Oroville coldwater pool	$21.0	$21.0
Yolo Bypass	$9.1	$9.5
Recreation	$6.8	$6.8
Flood control	$4.4	$4.9
Non-Proposition 1 Eligible Benefits	**$194.9**	**$194.9**
Water supply	$175.4	$175.4
M&I water supply	$114.1	$114.1
Agricultural water supply	$50.2	$50.2
Recaptured water supply	$11.1	$11.1
Hydropower (system)	$19.5	$19.5
Total Benefits	**$316.9**	**$318.5**

[a] Adjusted to incorporate the additional $44.7 million (present value) of project benefits obtained during project construction (2026-29).

Overall, Sites Reservoir is estimated to result in $316.9 million in total annual benefits. However, when adjusted for the $44.7 million in ecosystem improvement and flood reduction benefits between 2026 and 2029, Sites Reservoir is estimated to result in $318.5 million in total annual benefits. The project's WSIP public benefits are expected to total $123.6 million (adjusted), which is equivalent to 38.8 percent of the project's $318.5 million in total benefits.

The WSIP Technical Report guidelines require that each benefit category reporting the present value of its expected net monetized benefits over the planning horizon, in 2015 dollars, be discounted to the start of project operations using the required 3.5 percent discount rate. Net monetized benefits are benefits minus any impacts caused by the proposed project or other costs (other than project costs) that are required to realize the benefit. Table A6-1 in Sites_A6 Annual Benefits Table under the BENEFIT CALCULATION, MONETIZATION, AND RESILIENCY TAB provides the complete benefit estimates on a yearly basis over the full study period.

The Sites Reservoir analysis's use of CALSIM II modeling and its conservative approach in its physical benefit quantification and benefit monetization approach ensure that all necessary costs or impacts were previously incorporated and consequently were "netted out" so that the benefit valuation results (discussed in detail in Sites_A5 Documentation under the BENEFIT CALCULATION, MONETIZATION, AND RESILIENCY TAB) represent the project's net monetized benefit and do not require any additional adjustment to subtract for any project impacts or other costs.

Costs

Two sets of development costs are shown, and each is used to derive its corresponding BCA results. The first is an unadjusted capital cost that includes the full interest during construction (IDC) that could be expected for the project's 8-year construction schedule. As such, it results in a higher (and therefore financially more conservative) total development cost for the project than if the adjusted (but arguably more realistic) estimate of the development cost discussed below is used.

The adjusted capital cost approach incorporates the IDC reduction that would be gained from expected WSIP and Federal project construction funding. As discussed in Allocation of Total Costs (file name: Sites_A10 Allocation under the BENEFIT CALCULATION, MONETIZATION, AND RESILIENCY TAB), consistent with the Draft North-of-the-Delta Offstream Storage (NODOS) Feasibility Study, Sites Reservoir could potentially obtain up to $730 million in Federal funding. For the WSIP analysis, WSIP funding of $1,662 million is requested. Assuming that both WSIP and Federal funding would be disbursed as construction expenses are incurred, the project would gain a significant reduction in its IDC because it would carry a much lower amount of capital debt over its 8-year construction period. As such, it results in a lower and arguably more realistic estimate of the project's total development cost than the unadjusted capital cost estimate.

Table A9-2 shows Sites Reservoir's estimated capital cost on an average annual basis for the 93-year study period. As discussed above, the average annual benefits are based on the NPV of the project's future benefits using the WSIP-required 3.5 percent discount rate.

Both the unadjusted (i.e., without WSIP or Federal funding) and the adjusted capital cost (i.e., with WSIP and Federal funding) are shown.

Table A9-2. Annual and Total Capital Cost Summary
(2015$; $Millions/year)

Cost Item	Project (Unadjusted IDC)	Project (with IDC saving)
Construction	$4,747	$4,747
Interest during construction (IDC)	$798	$429 [a]
Total Capital Cost	**$5,545**	**$5,176**
Capital amortization (3.5%; 93 years)	$195.5	$182.5
Operations, maintenance, and replacement	$26.6	$26.6
Total Annual Cost	**$222.1**	**$209.1**

[a] Adjusted for $369 million in expected IDC savings from WSIP and Federal funding during project construction.

The total development cost of Sites Reservoir is estimated to be $5.5 billion without any IDC savings. This cost corresponds to an annualized capital cost of $195.5 million. As a result, the total annual cost is estimated to be $222.1 million when the projected $26.6 million annual operations, maintenance, and replacement (OM&R) cost is added.

If the project's Federal funding and requested WSIP amounts are obtained, its IDC cost is estimated to decrease from $797.6 million to $429.0 million. This decrease would result in $368.5 million in IDC savings, which would be equivalent to a $13.0 million reduction in the project's future annualized cost. As a result, the total development cost for the project with WSIP and Federal construction funding is $5,176 million and its annualized cost would total $209.1 million.

Benefit-Cost Analysis Results

Table A9-3 shows the BCA results for the project both with and without the expected IDC savings that would be obtained from future WSIP and Federal construction funding.

Table A9-3. Benefit-Cost Analysis Results (2015$, $Millions/year)

Results	Project (Unadjusted IDC)	Project (with IDC saving)
Benefit-cost ratio	1.43	1.52
Net benefit (annual)	$96.4	$109.4
Total net benefit (net present value)	$2,735	$3,104

Sites Reservoir is projected have at least a B/C ratio of 1.43 and result in total net benefits with an NPV of $2,735 million, which would be equivalent to annual net benefits of $96.4 million.

If Sites Reservoir receives its requested $1,662 million in WSIP funding and the full $730 million of its potential Federal funding, the project would have a B/C ratio of 1.52 and result in total net benefits with a net present value of $3,104 million, which would be equivalent to annual net benefits of $109.4 million.

Public Benefit Ratio Results

Sites Reservoir is projected to result in total public benefits with a present value in 2015 dollars of $3,506 million over the 100-year study period. These benefits are equivalent to an annualized average of $123.7 million. Ecosystem improvements account for over 90 percent of the project public benefits and far surpass the 50 percent WSIP funding requirement.

As shown in Table A9-4, based on the project's requested WSIP funding amount of $1,662 million, the PBR for the Sites Reservoir project is 2.11.

Table A9-4. Public Benefit Ratio Results (2015$, $Millions/year)

Results	Project (with IDC Saving)
Total public benefits (annual)	$123.6
Total ecosystem Improvement benefits (annual)	$112.0
Ecosystem improvement as % of public benefit	90.6%
Total public benefits (NPV)	$3,506
WSIP funding request	$1,662
PBR	**2.11**

This value indicates that WSIP funding for the project would be a highly cost-effective investment. As discussed in Sites_A5 Documentation under the BENEFIT CALCULATION, MONETIZATION, AND RESILIENCY TAB, this result presumes that WSIP funding for the project would encourage Federal funding participation of up to $730 million. The Federal contribution significantly reduces the WSIP funding request necessary to achieve the currently proposed public benefit levels.

As shown in Table A9-5, in the absence of any Federal funding for the project, WSIP funding of $2,392 million would otherwise be necessary to similarly fully fund the project's currently planned public benefits. Under these circumstances, the PBR for the Sites Reservoir project would be reduced to 1.47.

Table A9-5. Public Benefit Ratio Results: No Federal Participation
(2015$, $Millions/year)

Results	Project (with IDC saving)
Total public benefits (annual)	$123.6
Total ecosystem Improvement benefits (annual)	$112.0
Ecosystem improvement as % of public benefit	90.6%
Total public benefits (NPV)	$3,506
WSIP funding request	$2,392
PBR	**1.47**

Evaluation of Results

As discussed extensively in Sites_A3 Physical Monetized under the BENEFIT CALCULATION, MONETIZATION, AND RESILIENCY TAB, the Sites Reservoir benefit valuation analysis was very conservative in its benefit monetization. This was due to the selected monetization approaches and the assumptions generally applied in the analysis of the project's future ecosystem improvement and agricultural water supply benefits.

Except for the anadromous fish benefits, WSIP unit water values were used to determine the future economic benefits for the other ecosystem improvements and agricultural water supplies. The WSIP unit values were only adjusted to include the estimated conveyance energy costs for the deliveries. It is arguable that other non-energy conveyance costs and carriage water losses might both also be added to further increase the unit values. In any case, no such escalation of the WSIP unit benefit values has been applied by the Sites Reservoir economic benefit analysis.

As shown in Sites_A3 Physical Monetized under the BENEFIT CALCULATION, MONETIZATION, AND RESILIENCY TAB, the WSIP unit water benefit values were substantially lower than the estimated alternative cost benefits values based on Shasta Lake Expansion. It is arguable that use of the alternative cost valuation is more representative of the project's future benefit since Sites Reservoir would provide new and permanent additional water supplies and net new benefits that otherwise could not be obtain from water transfer from other current water users (as the WSIP unit water values implicitly presume). Furthermore, it is highly unlikely that the water transfers implicit in the WSIP unit water values could actually occur—or be achieved—in a manner that would result in comparable water quantities and reliability as that provided by the project. The significantly higher value reflects the lack of other options for generating a similar large and permanent quantity of benefits.

Third party effects are another important factor contributing to WSIP unit values' under-representation of the benefits for a very large water storage project (such as Sites Reservoir). There are likely major third-party effects (e.g., externalities or related adverse effects on employees and other businesses in related economic sectors) that are not incorporated or represented in the WSIP unit water values, which focus on the compensation to water sellers.

Even the higher benefit values obtained from the alternative cost estimates for Shasta Lake Dam raise are also considered likely to be conservative and under-represent Sites Reservoir's actual benefit values. As discussed in Sites_A3 Physical Monetized under the BENEFIT CALCULATION, MONETIZATION, AND RESILIENCY TAB, the development cost estimates used from recent USBR feasibility analysis likely do not factor in either the full costs that would be necessary for project development or the schedule delays necessary for it to be completed. Both factors would contribute to higher alternative cost benefit values

for Sites due to their increased costs and/or reduced present values of its benefits. It was projected that Sites Reservoir would provide limited anadromous fish beginning in 2026 and its full benefits in 2030. A later completion date for raising Shasta will result in greater fish population and habitat declines during the interim period that would in turn reduced the comparative value of its subsequent ecosystem improvements. Finally, there are also reasons to believe that the 2030 Shasta Lake storage conditions assumed by WSIP in its baseline are overly optimistic and therefore when compared to the project operations, the project's quantified benefits are underestimated.

As a result of the conservative nature of the Sites Reservoir benefit valuations, the PBR and B/C ratio results shown in Tables A9-4 and A9-5 should therefore be recognized as very conservative. The project's B/C ratio would increase to more than 2.2 and its PBR to over 3.6 if the alternative cost approach for the project's ecosystem improvements and agricultural supply benefits is used to monetize those benefits. Use of WSIP Unit Fish values for the project's anadromous fish benefits were estimated to further increase the project's PBR to over 4.5.