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BENEFIT/COST ANALYSIS MODEL FOR ARIZONA SURFACE WATER PROTECTION PROGRAM

[picture – selection pending approval]

Prepared for:

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Introduction, study purpose and direction

ADEQ rulemaking requirements include establishing criteria for the economic, social and environmental costs and benefits for listing or delisting waters for state-level protection, and for setting standards for non-WOTUS and other waters of the state. Accordingly, this assignment is understood by the consulting team (Consultants) to focus on services pertaining to modeling the economic costs and benefits associated with decisions for adopting water quality standards[1] for non-WOTUS waters and other waters of the state, and for listing or delisting waters for protection within a new Surface Water Protection Program. A parallel consideration in this assignment is recognizing, in at least a qualitative sense, the social effects associated with waterbody actions. Appendix A, Rulemaking and BCA relationships, summarizes generalized rule-making requirements and related components of the benefit/cost analysis (BCA).

Pursuant to ADEQ's direction, the Consultants used a national study[2] published by EPA and the Department of the Army, which analyzed economic effects of changes in the definition of WOTUS, as a general framework for the Arizona-specific BCA model. The EPA document includes national and state-level costs as well as estimates for benefits, along with a proposed framework for evaluating benefits at smaller levels of geography. Whereas the ADEQ BCA model generally reflects the scope, methodology and data sources used in the EPA document, the EPA framework was adapted and supplemented by the Consultants to address the types of policy actions that are most likely to occur in Arizona. These adaptions are described in more detail in subsequent sections of this report.

To expedite the framework for the BCA with respect to this assignment, ADEQ identified three different "case study" classes of waterbodies that could involve designation as non-WOTUS protected surface waters, along with specific waterbodies to represent each class, as shown below:

Class 1 – Sky Island Stream. Representative Water – Stronghold Canyon, Cochise County

> Sky Islands are isolated mountain ranges in southeastern Arizona. These mountains contain a number of perennial or intermittent surface waters that have no significant nexus to a traditionally navigable water. The streams will die out in the deserts surrounding the sky island but are still important components of Arizona's overall hydrology.

Class 2 – Isolated Lakes. Representative Water – Pintail Lake, near Show Low

> Allen Severson Memorial Wildlife Area/Pintail Lake is known in abbreviated form as "Pintail Lake." This wildlife area is actually a man-made wetland created from treated wastewater, and is recognized nationally as one of the first of its kind in the country.

Class 3 – Ecologically, Culturally, or Historically significant water. Representative Water – Quitobaquito Pond, Organ Pipe Cactus National Monument in Pima County

[1] The Consultants' understanding with respect to "standards" in this particular assignment is that standards can relate to a designation or other status of a waterbody but that modeling efforts addressed herein are not expected to include quantified changes in standards for specific contaminants or a quantified interpretation of any such changes in terms of benefits and costs. However, BCA modeling methods can be structured to recognize potential future measures and/or changes pertaining to standards.

[2] *Economic Analysis For The Proposed Revised Definition of WOTUS Rule.* 2021. The study, referred to as "the EPA document" in this report, is a joint effort of the Environmental Protection Agency (EPA) and the Department of the Army.

As a part of Organ Pipe Cactus National Monument, the National Park Service, in 1961, removed all old structures from the Quitobaquito Pond site, drained and deepened the pond, and constructed improvements to accommodate visitors and help protect the area.

This report addresses the application of a BCA process using the three classes of waterbodies above, while also referencing conditions that could apply to Arizona waterbodies in general. The BCA model described in this report is included as a separate submittal to ADEQ in spreadsheet format. The model addresses all three case-study water bodies within a single modeling framework.

Subsequent sections in this report are titled as follows:

EXECUTIVE SUMMARY

WORKING WITH ANALYSIS GUIDANCE IN EPA DOCUMENT

CONSIDERATION OF OTHER BENEFIT/COST MODELING IN ARIZONA

WATERBODY CLASS-SPECIFIC CONDITIONS AND CONSIDERATIONS; BENEFIT/COST CATEGORIES IN ANALYSIS FRAMEWORK

MODEL PROCESS AND STRUCTURE

SOCIAL BENEFIT/COST CONSIDERATIONS AND CATEGORIES RELATED TO WATERBODY ACTIONS

BCA MODEL SUMMARY RESULTS

A series of Appendices are also attached, addressing various technical issues.

Executive summary

The three case-study waterbodies provide a contrasting and otherwise informative set of examples by which to illustrate various aspects of how the BCA model is structured, the influence of the surrounding population base, the range of results generated, and the sensitivity of these results to certain basic data variables. In addition to a quantitative analysis based on the data available for various cost and benefit factors, the model incorporates a framework for addressing additional, qualitative aspects of a BCA for Arizona waterbodies. These qualitative components add context to the quantified portion of the BCA and reflect potential elements of a BCA that could be considered for quantitative treatment in some later iteration/refinement of the modeling process. Including these qualitative discussions also helps illustrate certain limitations in the current modeling process.

The quantitative elements of the BCA model synthesize the following types of information:

- Key characteristics of the three case-study waterbodies for which the BCA process will be performed and which influence the application of various cost and benefit factors.
- Number of households within "local" and "non-local" areas with respect to each of the three case-study waterbodies – defined as 50-mile radius rings and 100 to 150-mile outer ring "donuts," for local and non-local areas, respectively, to which benefits factors are applied. Other demographic data were also assembled for each waterbody's local area for purposes of environmental justice considerations.
- Quantified cost and benefit factors to apply to the waterbodies and to the households in the two types of analysis areas.
- Factors for updating cost and benefit estimates derived (by others) in preceding years and for discounting streams of costs and benefits estimated to occur over a subsequent 20-year period.
- Cost and benefit totals for each waterbody, and the ratio of benefits to costs.
- Demographic conditions applicable to Environmental Justice considerations, within each of the three local analysis areas.

Qualitative aspects of the BCA are summarized in a series of tables that discuss the broad implications of additional benefit and cost categories not quantified in the current model, Environmental Justice observations based on the quantified demographic data, and the sensitivity of model results to various quantified variables, including how results compared to certain Arizona-specific cost and benefit estimates in the EPA document.

Summarized quantified benefit and cost relationships for the three water bodies are shown in the following table. (Note that the willingness-to-pay (WTP) concept[3] is discussed in additional detail in subsequent sections of this report.)

Cost and Benefit Factors	Class 1 - sky island stream - Cochise Stonghold Cyn.	Class 2 - isolated lake - Pintail Lake & marshes	Class 3 - unique waterbody - Quitobaquito Pond
Size (acres or acre-equivalents (Class 1))	21.76	65.00	0.50
Forested?	Yes	Yes	No
Costs and benefits over a 20-yr. period, discounted			
Costs			
404 permits	$9,344	$9,344	$9,344
Mitigation			
ADEQ Admin	$62,641	$111,067	$74,938
Total	**$71,985**	**$120,411**	**$84,282**
Benefits, from willingness-to-pay (WTP) factors			
Local	$5,509,181	$7,840,675	$3,151
Non-local	$8,635,112	$54,780,036	$4,066
Total	**$14,144,293**	**$62,620,711**	**$7,216**
Arizona component	$14,982,646	$68,136,424	$8,045
Benefit/cost comparison			
Total benefits, Arizona	$14,982,646	$68,136,424	$8,045
Total costs	$71,985	$120,411	$84,282
Benefits/costs (first number in ratio: __ to 1)	208.1	565.9	0.10

Affected populations (number of households) within local and non-local areas of the three case-study areas are shown below.

Affected households	Cochise Stonghold	Pintail Lake & marshes	Quitobaquito Pond
Local: Current	72,184	47,219	6,934
Local: Projected	74,867	47,718	9,483
Non-local: Current	986,121	2,089,641	61,461
Non-local: Projected	1,263,692	2,688,637	95,823
Total Local and Non-Local			
Current	1,058,305	2,136,860	68,395
Projected	1,338,559	2,736,355	105,306
Arizona component	1,319,865	2,700,399	105,306

[3] As described in more detail later in the report, willingness-to-pay (WTP) is a common measure for economic valuation of non-market goods (such as protected waterbodies). WTP is essentially the dollar amount a household within a waterbody's impact area would be willing to pay (on either a one-time or annual basis, depending on how the analysis is framed) to protect the waterbody.

Of the three case-study waterbodies, Stronghold Canyon and Pintail Lake both have benefit/cost ratios well in excess of 1. Quitobaquito Pond has the opposite condition – a very low B/C ratio, of 0.1. This very small waterbody was assigned a small area for non-local affected households, compared to the other cases, and the populations in both local and non-local areas are particularly small due to the remoteness of the waterbody. consequently, minimal benefit values were generated in the model partly due to those conditions. A more meaningful issue, however, is that the "willingness-to-pay" (WTP) approach to estimate benefits does not encompass a way of capturing the value for the vital role of the pond in protecting rare and endangered species.

The EPA document includes figures for Arizona that represent annualized costs and benefits over a 20-year projection period, based on their estimates of average annual increases in wetland acreage that would receive protected status or other attention. With this information, it is possible, in theory, to compare the EPA findings with the results of the ADEQ BCA model, on a per-acre and/or per-household basis. The cost components of the BCA model with respect to the three case study waterbodies are understood to be, perhaps, atypically minimal, given the somewhat protected nature of the three waterbodies and their physical settings. On a per-acre basis, the EPA cost figures for Arizona are considerably higher. Benefit factors per-household and per-acre in EPA are also considerably higher than what is reflected in the BCA model. To some extent, this could be based on how EPA allocated varying benefit amounts by waterbodies' settings, defined local versus non-local populations, or other factors in their modeling process that are not replicable by the Consultants. Regardless of such effects, one conclusion from this comparative review is that the BCA model results are conservatively derived.

Based on the discussions in this report concerning the EPA approach to quantifying benefits, and the Consultants' use of benefit factors for the BCA model derived from a study relied upon heavily by EPA in their document, the Consultants do not recommend at this time an upward adjustment in the model's benefit factors based on the comparison with EPA figures.

Working with analysis guidance in EPA document

As noted above, a national analysis completed by EPA in 2021 was used as a framework or template for the Arizona-specific BCA model. In addition to including specific data resources relevant to the Arizona model, the EPA document provides insight into the conceptual foundations for this type of analysis.

Benefit/cost analysis for environmental protection policies is inherently challenging due to the "non-market" nature of many environmental resources. Whereas the *costs* of environmental regulation tend to be readily quantifiable (or at least reasonably estimable) by the affected parties, the *benefits* often relate to "goods and services" (e.g., clean recreational water and healthy fish populations) that are not traded in markets and therefore are not subject to market-based pricing.

Since the economic value of non-market environmental resources – how much the public would be willing to pay for them (or to improve their quality) – is not revealed in market prices, academic economists have developed a variety of methods for valuing non-market goods. In practice these valuation techniques have been applied in a wide range of circumstances where it is desirable to quantify resource values in dollar terms. Although the conceptual validity of these valuation methodologies is recognized (and sometimes also called into question) in academic, legal and policymaking contexts, in practice they are often costly and procedurally challenging to correctly apply, are difficult for the public to understand, and are subject to wide variations in resulting benefit values.

Given these challenges, the concept of **benefit transfer** (BT) – deriving benefit values from previously completed studies and applying them in new but similar contexts – has substantial appeal to public agencies faced with the need to complete a diverse range of benefit/cost studies. The concept was applied in the EPA document cited above. However, this approach comes with challenges of its own, including finding case studies that align with the local policy under consideration.

In addition to the specific challenges associated with BT studies, environmental BCA's in general are subject to the following key complexity: The need to distinguish between the total value of a resource versus the marginal value of an incremental change in that resource. Similarly to the approach taken in the EPA document that is key to this assignment, BCA studies frequently focus on the total value to society of a particular environmental resource in a particular region (e.g., the total value of protecting recreational waters in a particular state or county). This information can be useful for benchmarking purposes, but it has a somewhat different purpose from the types of questions that ADEQ needs to address within its economic modeling process, which is focused on the effects of designating a specific water body to one category or another (or possibly to incremental changes resulting from a specific change in a specific water quality standard).[4]

Partly in response to the analytical challenges summarized above, ADEQ requested, for purposes of this assignment, that the Consultants follow the benefit and cost estimating procedures outlined in the EPA document cited above. This approach offered the following three types of advantages:

1. The EPA document reflects acceptance of both a) the sometimes-contentious BT approach to estimating benefits related to waterbody decisions, and b) the "bounds," at least for now, of the categories of benefits and costs to apply to waterbody benefit/cost analyses in Arizona;

[4] Consistent with the EPA document on which the Arizona BCA framework is based, the initial BCA model developed by the Consultants focuses primarily on impacts associated with overall protection of waterbodies; it does not address the effects of specific water quality standards. However, references to water quality standards are included in this report as "placeholders" for potential future augmentations of the ADEQ model to address a broader range of water protection policies.

2. The document summarizes very recent analytical decision-making by EPA (which is generally comparable on a national scale to the types of actions Arizona may enact at the state level); and
3. Use of this material provides ADEQ with defensible frameworks for analyses conducted for waters of the state.

Applying the material in the EPA document also required some interpretation by the Consultants. First, the nationwide and state-by-state approaches that EPA takes in its analyses must be understood in terms of how they apply to individual waterbodies within any particular state. Within the EPA document, the cost analysis is limited to public and private costs associated with the Section 401 program.[5] In particular, three categories of costs are addressed: a) administrative costs to the affected state agency for Section 401 reviews; b) direct costs (to private permittees) of Section 404 USACE permits; and c) direct costs (also assumed to be borne by private permittees) of implementing mitigation measures required under Section 404 permits. Costs are quantified at the state level for the 404 program, based on estimates of the number of permits that would be generated by changes in definition of waters, and then the direct costs (to permitees) of permits and related mitigation measures, and also additionally related administrative costs to the State (401). EPA provides information on cost estimates related to the 404 program, and this information is used within ADEQ's BCA modeling framework under the assumption that the cost estimates on a per-unit (or per-permit) basis would be generally applicable to Arizona, even if the programs are not administered by the state. As with the stream of benefits over time, costs incurred in future years are discounted to the present.

These cost factors may be minimally relevant to the three case study examples (or to other types of water protection policies for which ADEQ needs to prepare a BCA). Since one of the case study sites is within a national monument, one is a relatively isolated mountain stream, and one relies on treated wastewater, activities requiring a Section 404 permit would be unlikely or very limited in these areas irrespective of changes in the definition of waters. Nevertheless, the concepts and approach described above are reflected in the BCA model in limited amounts, and can be applied to Arizona waters generally. (As documented elsewhere in this report, the default cost factors derived from the EPA document have been supplemented by Arizona-specific data supplied by ADEQ. These data encompass ADEQ's administrative costs for a wide range of rulemaking activities [see Appendix D] – beyond the EPA's limited focus on the Section 401 program.)

The relationship of the BCA model to EPA methodology for the treatment of costs and benefits accruing over time

In the EPA document, "annualized" costs (per-household and total) were produced for each state based on an assumed number of permits per wetland acre (and with an assumed annual increase of permits and acres), with costs projected over a 20-year analysis horizon. Benefits were treated similarly, incorporating estimates of the number of households within a "local" (as opposed to non-local) relationship to the universe of a state's (annually increasing) wetlands. The 20-year "cash flows" of both costs and benefits were then discounted to a present value, and subsequently converted to an annualized figure – expressing that "bundle" of costs and benefits over 20 years as a year-by-year amount. The annualizing process makes sense as a way to normalize findings within a system-wide analysis (where protective policies are likely to be applied to a number of new sites/projects in a given year), such as that applicable to an entire state and then a series of states, extending over some period of

[5] Under Section 401 of the Clean Water Act (CWA), a federal agency may not issue a permit or license to conduct any activity that may result in any discharge into waters of the United States unless a Section 401 water quality certification is issued, or certification is waived. States and authorized tribes where the discharge would originate are generally responsible for issuing water quality certifications. In cases where a state or tribe does not have authority, EPA is responsible for issuing certification.

time.[6] When dealing with individual projects, within the framework of the ADEQ BCA model, the discounting of future cost and benefit payments and receipts to present values continues to be relevant, but the annualizing process is unnecessary.

The ADEQ BCA model incorporates the 20-year period used by EPA (a reasonable cost and benefit time horizon related to individual projects), as well as the EPA's assumed 3% discount rate, which is appropriate for representing a household's trade-off of present and future dollars, without consideration for inflation.[7] (The discounting concept applied here is the same as in any financial analysis, where the intent is to recognize that dollars/benefits received, or costs incurred, in the future are worth less to the affected party than if those things happened in the present.) In this regard, cost and benefit figures over time are expressed in the ADEQ model in 2022 dollars, with no increase due to inflation.

Estimates of benefits based on a Benefits Transfer approach

The EPA report focuses on assigning monetary values to benefits associated with wetland expansion/preservation, specifically through a meta-analysis of multiple wetland valuation studies that together provide insights into estimates of the public's willingness-to-pay (WTP)[8] for wetland preservation, using a BT (benefits transfer) approach.[9] The nature of this type of meta-analysis combines many different conditions and considerations, which are specific to each study's location, wetland conditions, study vision, etc. and so results tend to vary among the series of studies analyzed. The derived estimates can then be both generalized and also viewed in terms of the influence of the differing various individual conditions on monetary valuation. The Consultants applied various procedures to reinterpret the WTP findings presented in the EPA document (as well as the source study that EPA relied heavily upon to produce the WTP estimates – Moeltner et al.[10]), and incorporated them into the ADEQ BCA model. The following conditions were key to this reinterpretation process:

1. Moeltner (2019, Table 5), produced actual dollar amounts of willingness to pay per household, per acre, for each of four key types of wetlands contexts, for which meaningful differences in households' WTP were identified in the study analysis (shown in order of most to least WTP amount): 1) Local, forested, 2) Local, non-forested, 3) Non-local, forested, and 4) Non-local, non-forested.
2. EPA used the same four categorical distinctions in their generation of state-level estimates of WTP (EPA document, Appendix C, page 126, with amounts shown in Appendix D) but did not publish the actual figures.

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[6] When dealing with individual projects, within the framework of the ADEQ BCA model, the discounting of cost and beneift streams over time is relevant, but annualizing the discounted amounts serves no particular purpose, since there is no system-wide comparison to consider, but rather the cost and benefit relationship for a particular waterbody (in which case the annualizing process is conceptually confusing). The EPA figures do, however, provide an estimate of total benefits for the state (expressed in terms of the dollar amounts the public would be willing to pay for specified annual acreages of wetlands protected), which can serve as a way to compare the estimates produced by the ADEQ BCA model.

[7] The EPA document also gives figures using a 7% discount rate.

[8] Given the non-market nature of environmental "goods" (such as protected wetlands and waterbodies), willingness-to-pay cannot be observed through normal market metrics (i.e., prices). As such, economists have developed various methodologies for measuring WTP for non-market goods, including survey methods ("contingent valuation") in which the public is directly queried about WTP for the protection of specific environmental resources.

[9] Under the BT approach, WTP estimates from previous studies are "transferred" to new analyses and policy decisions. Since the contexts for the resources evaluated in the previous studies are usually not exactly comparable to the resources/setting being evaluated in the new analysis, BT analyses rely on regression analyses to define the specific variables that influence the public's WTP for a particular resource. This regression analysis is intended to allow the data from the previous studies to be meaningfully applied in other contexts.

[10] Klaus Moeltner et al. Waters of the United States: Upgrading wetland valuation via benefit transfer. *Ecological Economics*, *164* (2019).

3. The database EPA used to generate their numbers was very similar to that used in the Moeltner study, except for being supplemented by seven additional cases generated within two Canadian studies.
4. Other variables within the regression formulas used in both the Moeltner and EPA studies, representing benefits such as recreation ("cultural") and fish consumption ("provisioning"), as well as variations in household income, could in theory have been treated similarly to the four contextual conditions named above, i.e., by analytically distinguishing their contribution to the overall WTP amount. This could help refine WTP estimates as they relate to specific waterbodies. However, on closer examination of the regression results from the meta-analysis, such distinctions could not be justified on the basis of statistical validity of the individual variables of interest in the estimating equation.

Based on the preceding discussion, the Consultants adopted the approach represented in point #1 above, using the Moeltner-study values produced for the four household-location contexts as inputs for the BCA model. This approach captures the major distinctions in WTP estimates as they would apply to specific cases. The Consultants acknowledge, however, that the figures derived as described above and used in the present BCA model should be considered "placeholders" for future refined WTP estimates for Arizona waterbodies. These estimates would be derived either through new, ideally Arizona-based studies set up specifically for this purpose, or through additional/expanded meta-analysis work if and when additional studies become available. These later analyses could also generate supplemental data to support expanded distinctions within WTP estimates, pertinent to other specific benefit categories of interest (beyond the four household-location distinctions adopted from EPA), such as various forms of recreation.

There are other possible ways to interpret and adapt the WTP findings of the EPA document to the BCA model. For example, the individual studies that were used in the meta-analysis to derive EPA's WTP estimates could be reviewed to reselect one or more studies or sets of studies that would appear to apply more directly to Arizona conditions and any specific variables of particular interest. The findings from the most appropriate study or studies would then be analyzed, recorded and applied to the model. However, because one of the main reasons for the meta-analysis is to purposefully combine results from many different studies (and generally, the more the better), which also lessens the chance for any one study to overly influence the results, paring down the group of studies analyzed works against this advantage. Also, these kinds of studies (addressing individual waters) are particularly sensitive to details of how they were structured, how questionnaires[11] were developed and administered, and the contextual relationship between waterbody and the interview subjects. Lacking a first-hand knowledge of these kinds of things adds uncertainty to the "transferability" of findings from any particular WTP study. One other issue is the potential for conveying a sense of confidence in a WTP estimate, through the kinds of manipulations described above, when the underlying data and processes still fall short of providing a strong statistical foundation.

Finally, for purposes of this assignment, certain waters of the state, including one of the case study examples, may not necessarily meet the official (federal or Arizona) definition of "wetlands." – which are the exclusive focus of the EPA's benefits analysis. Nevertheless, the value of a wetland to the public is assumed to be similar enough to the case study situations, and other potentially affected waters in Arizona, to allow the use of EPA's benefit modeling procedure (adapted as noted herein) to derive Arizona estimates. A key point of this is that EPA, and the Consultants initially by default, are dealing with two different, even if overlapping, broad classes of waters,[12]

[11] As noted previously, valuation studies for non-market environmental goods often rely on direct surveys of the public to assess WTP for contemplated environmental improvements. The structure of the questionnaires for these surveys is critical to the usefulness and statistical validity of the derived responses.

[12] From *Supplementary Material to the Economic Analysis for the Proposed "Revised Definition of 'Waters of the United States'" Rule.* U.S. Environmental Protection Agency and Department of the Army. November 18, 2021. [Part] E. ARIZONA (page 6). Definition of Waters of the State: All waters within the jurisdiction of the state including all perennial or intermittent streams, lakes, ponds, impounding reservoirs, marshes, watercourses, waterways, wells, aquifers, springs, irrigation systems,

definitionally: for costs (any jurisdictional water) and for benefits (wetlands, again by default based on the BT meta-analysis EPA used to derive its estimates in the EPA document).

General limitations and other reinterpretations of EPA's benefit and cost treatments

Benefits

EPA acknowledges certain limitations in its relatively constrained approach to identifying benefits resulting from protecting the quality of water. Moreover, a specific/individual waterbody being evaluated may provide unique environmental and economic benefits beyond the EPA-calculated values for "typical" wetlands. Topics EPA mentions as left unaddressed[13] include: the benefits of wetland carbon sequestration, the ability of wetlands to help allay the future effects of climate change, such as severe weather events, and the ability of wetlands to reduce soil erosion and retain flood waters (p. 86). Further, it should be emphasized that the EPA document – which exclusively addresses the benefits associated with protection of *wetlands* – specifically does not address benefits associated with drinking water standards.

Costs

Cost considerations mentioned in the EPA report (*but not quantified* except for 401-related costs as they relate to the 404 program) are summarized in the following statement:

> "The definition of 'waters of the United States' has a substantial effect on the implementation of other Clean Water Act (CWA) programs, including the section 303(c) water quality standards program, the section 311 oil spill prevention program, the section 401 water quality certification program, and the section 402 NPDES permit program. A revised definition of 'waters of the United States' would affect these CWA programs at both the federal and state level. Potential effects may vary based on a state's authority under their own state law to address aquatic resources and their capacity to address these aquatic resources through non-regulatory efforts" (EPA document Executive Summary page xiv).

In general, however, certain costs of implementing environmental protection policies tend to be more readily quantifiable than the benefits, in part because some costs are typically experienced as administrative costs to regulatory agencies and direct "out of pocket" expenses by affected/regulated parties who are often in a position (in terms of access to internal proprietary business data, etc.) to accurately estimate these cost impacts.

Consideration of other benefit/cost modeling in Arizona

Overview

At ADEQ's direction, the Consultants reviewed a series of Arizona-related documents within ADEQ's developing on-line library. Among the purposes to be served through this review was to recognize the potential contribution that other economic analyses conducted for programs of interest to state agencies could have for the BCA format (present and future) for Arizona waters. Items noted as having "future" applicability are not included in the

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drainage systems, and other bodies or accumulations of surface, underground, natural, artificial, public or private water situated wholly or partly in or bordering on the state. Definition of Wetlands: An area that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. A wetland includes a swamp, marsh, bog, cienega, tinaja, and similar areas.

[13] In one discussion stating that they "omit known sources of benefits that are inherently difficult to quantify" (EPA document, p. xi).

present BCA model, but are listed here as topics that could be added later to expand the scope and enhance the overall functionality of the model. These findings are summarized in Table 1 below. The annotated bibliography resulting from this analysis is attached as Appendix B.

TABLE 1. OTHER ARIZONA STUDIES WITH POTENTIAL BCA APPLICATION, PRESENT AND FUTURE

BCA topic	#[a]	Potential applicability to benefit/cost estimating procedures	Present/ future
Translating BCA findings on direct effects to secondary benefits and costs	2	Uses IMPLAN system to translate *direct* economic effects of some action into *secondary* effects, reflecting the multiplier effects of actions through the economic system. The practice represented by this modeling tool, widely used in economic impact assessments, would be a logical eventual extension of cost and benefit estimating for Arizona waterbodies	Future
B/C factors related to unique waterbody	3	Guidance on identifying factors that need to be considered in comprehensive economic analyses related to a unique water designation (Buehman Canyon Creek)	Present
Benefits related to spending by recreationists	4, 5	Both studies provide some quantified data for visitor expenditures. The reference cited for document #4, entitled "*The 1987-1988 Use Study of Arizona State Parks Visitors,*" for the Arizona State Parks Board in 1989, provides an additional relevant data	Future and potential present[b]
Visitor expenditures related to birdwatching and riparian environments	7	Tracking how visitor spending distributes within a finite region of natural attractions; potential to help define affected areas (Southeast Arizona)	Future and potential present

a. Document reference number, as per Appendix B.

b. It may be appropriate, for some waterbodies that are strongly associated with, for example, a specialized recreational activity, to incorporate analyses related to such activities, where data and findings have been articulated in previous studies. In such cases, the potential for double-counting must be recognized, if a multi-factor analysis tool is also in use. See Table 3.

Other BCA considerations including evolving BCA concepts

ADEQ might consider, for future BCA studies, focusing on the potential impacts of an *individual policy variable* (e.g., a proposed change in a single standard for a specific contaminant). This makes sense from a policy standpoint but does not necessarily align with the way that the public/consumers think about the value of water quality. For example, rather than thinking of a single water quality standard in insolation, consumers are likely to think of "good" or "safe" drinking water as a "package" based on multiple standards and qualities. Moreover, the availability of previous studies from which a BT analysis could be constructed is likely to be limited for specific contaminants/topics.

Conceptual issues that are likely to continue into the future include the fact that there are "camps" of proponents of alternate ways to think about environmental benefits and costs. These groups tend to frame the issue broadly, for example by using the term "ecosystem services" to help emphasize the comprehensive nature of this topic. Proponents of different concepts also invent new terminology. For example, "nature-based solutions," and "nature's contributions to people."[14] As the authors of this cited work point out, these concept titles, with their

[14] Hayley Stevenson, Graeme Auld, Jen Iris Allan, Lorraine Elliott, and James Meadowcroft. The Practical Fit of Concepts: Ecosystem Services and the Value of Nature. *Global Environmental Politics* 21:2, May 2021, https://doi.org/10.1162/glep_a_00587. Massachusetts Institute of Technology. Downloaded from http://direct.mit.edu/glep/article-pdf/21/2/3/1911391/glep_a_00587.pdf on 10 June 2021.

different shades of meaning around the same theme, can help define a theoretical concept even though they do not necessarily articulate a workable concept in terms of, for example, translating specific conceptual conditions to dollar values.

Waterbody class-specific conditions and considerations; benefit/cost categories in analysis framework

Variations in conditions among the three case-study waterbody classes used in this analysis call attention to differing potential benefit and cost categories that could apply to each. Table 2 summarizes various conditions and categories of benefits and costs as they apply to the three cases. While Table 2 introduces the complexity of the variety represented by the three cases, Table 3 elaborates on how various cost and benefit categories begin to translate into an analysis framework, present and potential future.

TABLE 2. BENEFIT AND COST CATEGORIES IN RELATION TO 3 CASE STUDY CLASSES

	Case Study Classes		
	1. Stronghold Canyon	**2. Pintail Lake**	**3. Quitobaquito Pond**
Conditions			
Wetlands	This stream may be technically intermittent; for purposes of this analysis it is assumed to be *permanent.* The stream is estimated by ADEQ to be 3.59 miles in length. Based on an assumed buffer of 25 feet, both sides from center (per EPA), this stream length equates to 21.76 acres of protected wetlands	Pintail Lake and South Marsh (both artificial). Pintail is 3 ponds, 50 acres of water, and nesting islands; South Marsh fluctuates from 15 to 50 acres of flooded meadow and is a resting and feeding area. Water source is secondary treated effluent from City of Show Low.	½-acre pond, with spring
Natural environment context	Within Coronado National Forest[c]	Part of Allen Severson Memorial Wildlife Area, in Apache-Sitgreaves National Forests[c]	In Organ Pipe Cactus National Monument[c]
Other notable nearby visitor destinations	Wilcox Playa (wildlife viewing); Amerind Museum; ghost towns of Gleeson and Courtland, also Pearce (partially occupied)	White Mountains resorts and recreational assets; Fool Hollow Lake	Old mines and visitor improvements and other attractions within Monument; Sonoyta, Mexico
Cultural context	Uniqueness of "sky islands"; historic association with Cochise (Chiricahua Apache)	Developed in 1979 as the first waterfowl marsh utilizing treated wastewater in Arizona	Native American religious site; The Organ Pipe Cactus Biosphere Reserve, part of a UNESCO initiative to focus research and conservation efforts at certain locations
Benefit Categories			
Recreation, direct water:			
Fishing (recreational)	Assumed not applicable	Assumed not applicable	Assumed not applicable
FBC (swimming, other immersive)	Limited potential	Assumed not applicable	Assumed not applicable
PBC (partial-body contact, incl. boating		Assumed not applicable	Assumed not applicable
Recreation, in area, direct or			

	Case Study Classes		
	1. Stronghold Canyon	**2. Pintail Lake**	**3. Quitobaquito Pond**
indirect assoc. with water:			
Birding (bird habitat)	X	X	X
Other wildlife viewing	X	X	X
Hunting	X	X	
Camping	X		Within National Monument
Hiking, Backpacking	X	X	X
Rock climbing	X		
Equestrian	X		
Habitat, aquatic	X	X	X
Habitat, wildlife (in area)	X	X	X
Habitat, special/rare and endangered species	None identified through review of named species in relevant webpages/documents	None identified through review of named species in relevant webpages/documents	Sonoyta mud turtle[a]; Quitobaquito pupfish[a]; Quitobaquito spring snail[b]; Desert caper plant; Caper butterfly; Sonoran pronghorn[a]; Lesser Long-nosed Bat[a]
Appreciative value, a.k.a. nonuse or passive use[g]	X	X	X
Fish consumption	?		
Local related or potentially related business community (local merchant receipts)	Businesses serving immediate area: Recreational, hospitality/retreat. Surrounding communities: Tombstone, Wilcox, Benson, Saint David, Sunsites	Surrounding communities: Show Low; Pinetop-Lakeside	Surrounding communities: Ajo
Affected populations			
Local area: households selected in 50-mile radius circle (by Census block group)	X	X	X
Supplemental local populations		Seasonal residents	A portion of destination visitors to Organ Pipe Cactus NM
Non-local area household selection	150-mile outer ring, less 50-mile inner ring	150-mile outer ring, less 50-mile inner ring	100-mile outer ring, less 50-mile inner ring (to reflect small size of waterbody)

	Case Study Classes		
	1. Stronghold Canyon	**2. Pintail Lake**	**3. Quitobaquito Pond**
Cost Categories			
404 permits	Per ADEQ	Per ADEQ	Per ADEQ
Mitigation costs	unknown	unknown	unknown
ADEQ-provided administrative costs, aggregated from multiple task categories	X	X	X
Property values	Unlikely to be relevant, due to public land surrounding	Unlikely to be relevant, due to public land surrounding	Unlikely to be relevant, due to public land surrounding

a. Listed endangered species.
b. Candidate threatened/endangered species.
c. Federally managed areas with an extensive range of camping and other outdoor recreational activities available.

Table sources include for US Forest Service relevant websites and linked documentation, Arizona Game and Fish Department, Organ Pipe Cactus National Monument website, Google Maps, and other data, McClure Consulting LLC.
https://www.fs.usda.gov/recarea/coronado/recreation/hiking/recarea/?recid=25334&actid=50
https://www.azgfd.com/wildlife/viewing/wheretogo/allenseverson/
https://www.nps.gov/orpi/index.htm

TABLE 3. MATRIX OF COST AND BENEFIT CATEGORIES AND MODELING STRUCTURES

Benefit and Cost category	Affected parties	Applicable to Class case #:			Alignment with EPA BCA estimating variables of:	Adaptation to ADEQ model variables, other BCA analysis	Potential supplemental or future analyses	Key resource
		1	2	3				
Benefit categories								
Recreation, direct water:	Local/non-local populations				Willingness to pay (WTP) estimating equation, "cultural"	Embodied within WTP estimates adapted from EPA document, but highly generalized[d] Any particular category could be addressable as benefit subcategory where deemed to be particularly influential (and therefore likely to generate benefits which exceed the generalized EPA factors) to local economy[c]	EPA WTP function addresses only indirectly; benefit estimates from national and local recreation studies could be updated and tailored to specific categories of recreational use/users. Avoid double-counting with generalized WTP figures	EPA document; Moeltner (2019); See Table 1, studies on recreational benefits
• Fishing (recreational)				X				
• FBC (swimming, other immersive)		X		X				
• PBC (partial-body contact, incl. boating		X	X	X				
Recreation, in area, direct or indirect assoc. with water	Local/non-local populations; specific users for which the use, spending, and/or other data might be available				WTP equation, "cultural"	Embodied within WTP estimates adpated from EPA document, but highly generalized[d] Any particular category could be addressable as benefit subcategory where deemed to be particularly influential to local economy[c]		
• Birding (bird habitat)		X	X	X				
• Other wildlife viewing		X	X	X				
• Hunting		X	X					
• Camping		X		X				
• Hiking		X	X	X				
• Backpacking		X		X				
• Rock climbing		X						
• Equestrian		X						
Habitat, aquatic	Local/non-local households (appreciative and other values)	X	X	X	WTP equation, "cultural"[a] and "provisional"	Embodied within WTP estimates adapted from EPA document	EPA WTP function addresses only indirectly[d]	
Habitat, wildlife (in area)		X	X	X				
Habitat, rare and endangered species				X	WTP equation, "cultural"[a]	Addressable as benefit subcategory where deemed to be particularly influential		

Benefit and Cost category	Affected parties	Applicable to Class case #:			Alignment with EPA BCA estimating variables of:	Adaptation to ADEQ model variables, other BCA analysis	Potential supplemental or future analyses	Key resource
		1	2	3				
						to local economy[c]		
Cultural observances	Assumed to apply to indigenous community members			X	Could be indirectly represented within WTP equation, "cultural," but EPA document does not address with respect to indigenous communities (see footnote 21, pages 4-5)	Addressed qualitatively, along with quantification (estimates) of populations that may be particularly affected, as special component of EJ considerations		GIS population selection; Primary interviews
Local merchant receipts	Local merchants and local/ non-local customer base				Not addressed	Addressable as benefit subcategory where deemed to be particularly influential to local economy[c]	Recommended for consideration	Business databases; Primary interviews
Appreciative value, a.k.a. nonuse or passive use[g]	Local/non-local households	X	X	X	Embodied in WTP equation, with some differentiation according to one ecological setting distinction: forested or nonforested, and one geographic-proximity measure: local or non-local	Embodied within WTP estimates adapted from EPA document	Expression through a WTP function could be continuously monitored as additional studies and/or investigations of such studies progress[e]	EPA document and Moeltner (2019)
Agricultural:	Farmers, ranchers, and consumers of products				Not addressed: EPA document notes the exclusion of irrigation and other agricultural uses from WOTUS considerations, per NWPR	Addressable as benefit subcategory where deemed to be particularly influential to local economy		Agriculture in Arizona's Economy (Bibliog. #2); *Arizona Agricultural Statistics* [annual],
• Irrigation								
• Livestock watering				X				

Benefit and Cost category	Affected parties	Applicable to Class case #:			Alignment with EPA BCA estimating variables of:	Adaptation to ADEQ model variables, other BCA analysis	Potential supplemental or future analyses	Key resource
		1	2	3				
								USDA, National Agricultural Statistics Service
Fish consumption	Anglers	?		X	WTP estimating equation, "provisioning"	[above]	Potentially	Arizona Dept. of Fish and Game Study (2002); Recreation studies
Cost categories								
404 permits	Permitees				404 permit costs	EPA estimate factors[b] are assumed to be representative for AZ; additional guidance on, for example, the number of permits associated with any particular waterbody are provided by ADEQ	Likely to be continuously refined over time	EPA doc
Mitigation costs	Permitees				Mitigation costs related to permits	EPA estimate factors,[b] assumed to be representative for AZ; potential other guidance from ADEQ as per above	Ongoing refinement	EPA doc
ADEQ administrative costs, aggregated from multiple categories	ADEQ staff	X	X	X	401 administrative costs	ADEQ internal estimates by "checklist" categories, for their application to analyses individually	Ongoing refinement through additional detail	ADEQ worksheet
Property values (could also be benefit category)	Property owners in close proximity				Not addressed	Not quantified	May be appropriate in some cases	Census, private real estate data firms

Benefit and Cost category	Affected parties	Applicable to Class case #:			Alignment with EPA BCA estimating variables of:	Adaptation to ADEQ model variables, other BCA analysis	Potential supplemental or future analyses	Key resource
		1	2	3				
Program cost categories in EPA document "not quantified": 303(c), 311, 402[f]	Various industries				Not addressed	Not quantified	Unknown	

Table Notes:

a. Benefit category assumed to be embodied in this variable, but could not be directly confirmed.
b. As applied to state-level estimates in EPA document.
c. Or otherwise is particularly relevant and not expected to be represented sufficiently within another benefit category (including a WTP function), and within which care must be exercised to avoid double-counting of expenditures that could be embodied in other benefit categories, from WTP or other compilation of special-use expenditures (e.g. recreationists' spending related to some specific activity).
d. Advances in quantifying could occur through future WTP studies and/or expenditure studies of relevant participants.
e. These analyses may be specific to Arizona, or to elsewhere in the US or Canada.
f. These program titles are: section 303(c) water quality standards, section 311 oil spill prevention, and section 402 NPDES permits.
g. This may include "cultural" values such as historic significance.

Class 1 – Sky Island Stream: Stronghold Canyon, in Cochise County
Class 2 – Isolated Lakes: Pintail Lake, near Show Low
Class 3 – Ecologically, Culturally, or Historically significant water: Quitobaquito Pond, Organ Pipe Cactus National Monument, in Pima County

Model process and structure

The working BCA model for ADEQ, in the form of a Microsoft Excel workbook, is a companion piece to this report. Components of the model are outlined within this section.

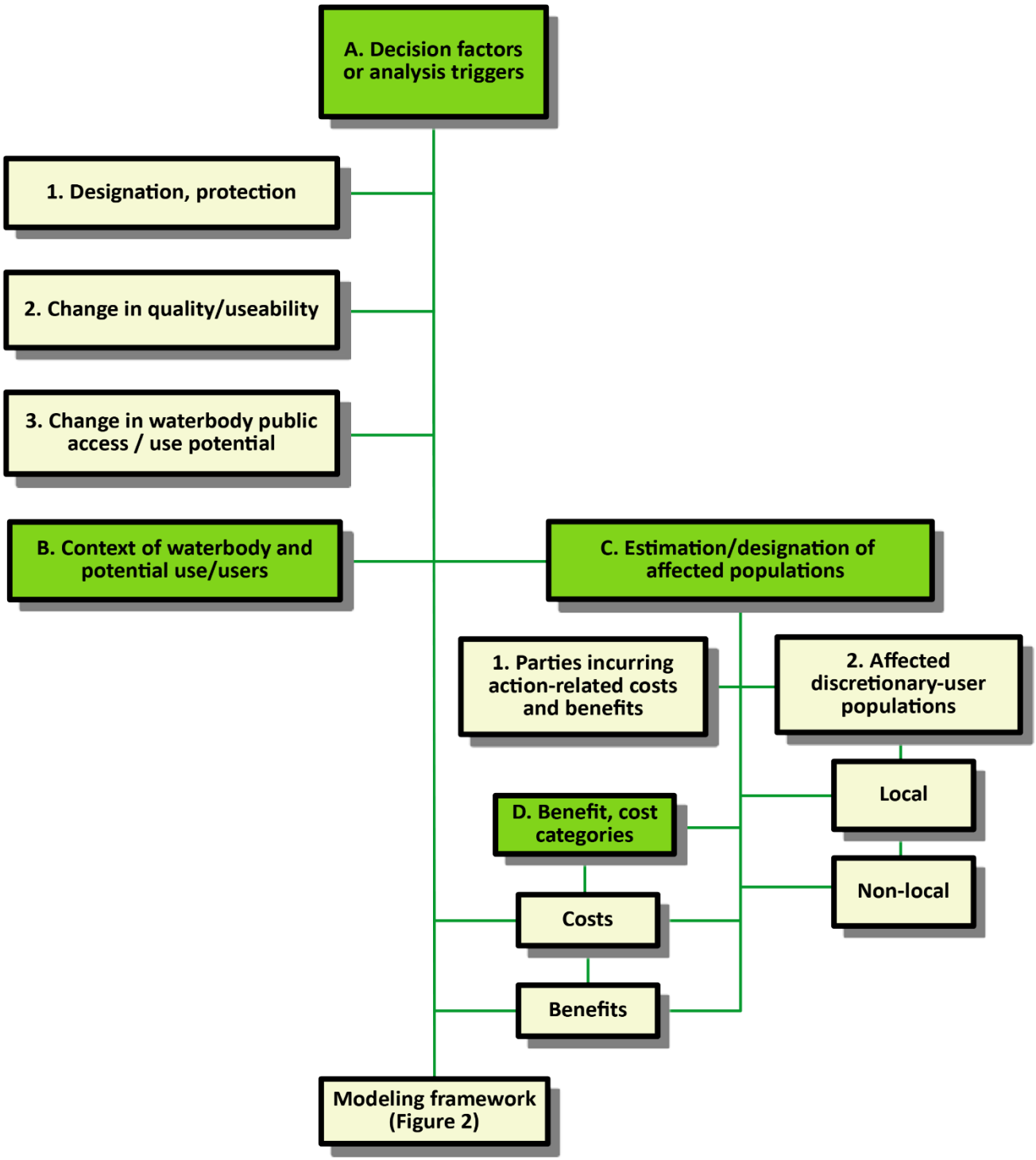
Analysis scoping

The overall modeling process includes both an initial scoping exercise, Figure 1, and the working BCA model, summarized on Figure 2. Both the scoping exercise and working model are structured in response to other material in this report, and especially Tables 2 and 3, preceding, which address a range of considerations and benefit/cost categories pertaining to the three case study classes and also Arizona waterbodies in general. Figure 1 illustrates the following procedural steps related to scoping the benefit/cost analytical process:

- Identify the basis and context for the BCA relative to a particular waterbody.
- Align the purposes of the BCA with different types of potentially affected populations.
    - Action-related parties, if identifiable, and their "out-of-pocket" cost and benefit categories
    - Discretionary users:
        - Specialized user subsets (e.g. recreationists), if any
        - Other regular-use parties
        - Other segments of the population assumed to have primarily appreciative value.
- Identify benefits for discretionary users as measured through benefit transfer measures (and potentially other measures in the future) applicable to defined user categories.
- Investigate potential costs and their associated user types.

The scoping process is summarized in Figure 1, and described in additional detail following the figure.

FIGURE 1. ANALYSIS SCOPING FLOWCHART



Key components of Figure 1 are outlined below, with a numbering system that reflects the figure elements. The outline addresses universal issues relative to a BCA for Arizona water bodies, beyond the scope of topics that apply to any one or all of the three case study classes:

A. Decision factors or action "triggers" that would initiate an accounting of costs and/or benefits

1. Designation of a waterbody, giving it a status that preserves, protects, or enhances its level of usability, which may or may not include items 2 or 3 below.
2. Change[15] in quality sufficient to create the potential for change of use for new/expanded uses to occur, which could involve any of the following activities, roughly in order of lower to higher quality standards and use intensity:
    - Irrigation, presumably as an incidental and not primary use.
    - Support for/augmentation of ancillary uses adjacent to waters or where waters are recognizably integral to the overall area experience. Ancillary uses could include any or all non-water-based recreational activities, including hiking, birding and other wildlife watching, hunting, camping, etc.
    - Boating, which implies some level of aesthetic acceptability as well as regulatory sanction.
    - Fishing and other aquatic habitat protection.
    - Various cultural/ceremonial activities.
    - Full body contact.
    - Drinking water.
    - Habitat protection/restoration, including for rare and endangered species.
3. Change in public access to, and/or use potential of, a waterbody, due to:
    - Regulatory/jurisdictional change, including change in designation or in other protection status.
    - Change in related infrastructure, facilitating access for specific activities.

B. Contextualizing the analysis setting

1. Assessing how waterbody use would be affected by surrounding conditions, including: other associated locational assets, jurisdictional boundaries (especially those related to tribal communities), accessibility (physical and with respect to information about), and climate conditions and other defining characteristics. This assessment could affect the following:
    - How affected-population (households) areas are selected.
    - Possible adjustments to benefit and cost factors, or at the least notations as to how observed conditions might affect estimates under some refined estimating procedures that may be applicable in the future.
2. Assessing potential for cultural considerations, and implications. This assessment would be based on the following types of considerations:
    - Presence of indigenous populations within a selected "local" market area (and the process of selecting the local area would also involve recognizing the potential for including such populations).

[15] In some cases, the "change" might not be an *improvement* in water quality but might instead be a protective measure that *maintains an existing level of quality* (i.e., protecting it from deterioration that would potentially occur in the absence of designation).

Compiling data for the local market area would also include specific recognition of other minority groups as part of the process of incorporating Environmental Justice considerations into the analysis. (This topic is also addressed in a subsequent section of the report.)

- Contact with cultural representatives (as available) in indigenous communities within the local market area and perhaps also in the "first tier" circle beyond the selected market area.
- Internet/literature search for indications of possible cultural linkages to waterbody or surrounding area, on the part of any Arizona American Indian tribe/nation.
- Discussions with umbrella organizations serving Arizona indigenous communities, such as the Intertribal Council of Arizona (ITCA) to identify any databases referencing relevant cultural/sacred sites.

C. Designation and estimation of affected populations

1. Assess whether available uses are associated with one or more specific subsets of the population, e.g. recreationists:

   - Compile the bases/sources for identifying such users and considering their "market area."
   - Identify potential parties that would interact with the waterbody in ways that would tend to incur *action-related* costs and benefits.

2. Select affected populations (# households): local and non-local:

   - Establish methodology, select variables, etc. including using a GIS system for household-area selection, which is compatible with EPA guidance as described below:
     - For the BCA model, the Consultants followed a concept in the EPA document, Appendix H, detailing how EPA would modify its methods for deriving two of the variables in the estimating equations related to WTP: 1) affected number of households, and 2) household incomes for this affected group (for this version of the model, applicable to Environmental Justice issues). In this modified method, a geographic information system (GIS) is used to select the areas in which households are assumed to have either a "local" or "non-local" (but still relevant) relationship to any given wetland or set of wetlands. This allows for more precise delineations of potentially affected households, including extension of any specific wetland/analysis area across state boundaries.
     - To determine the number of households in local and non-local areas for the case study waterbodies, the BCA model uses a GIS system to select Census block group areas based on two concentric circles, and aggregate the household data for the inner circle and the outer ring (the non-local area). Areas for the three case study classes are shown on Figure 3. The outer ring, 150 miles for Stronghold Canyon and Pintail Lake, was set at 100 miles for Quitobaquito Pond, reflecting the smaller size of that waterbody.

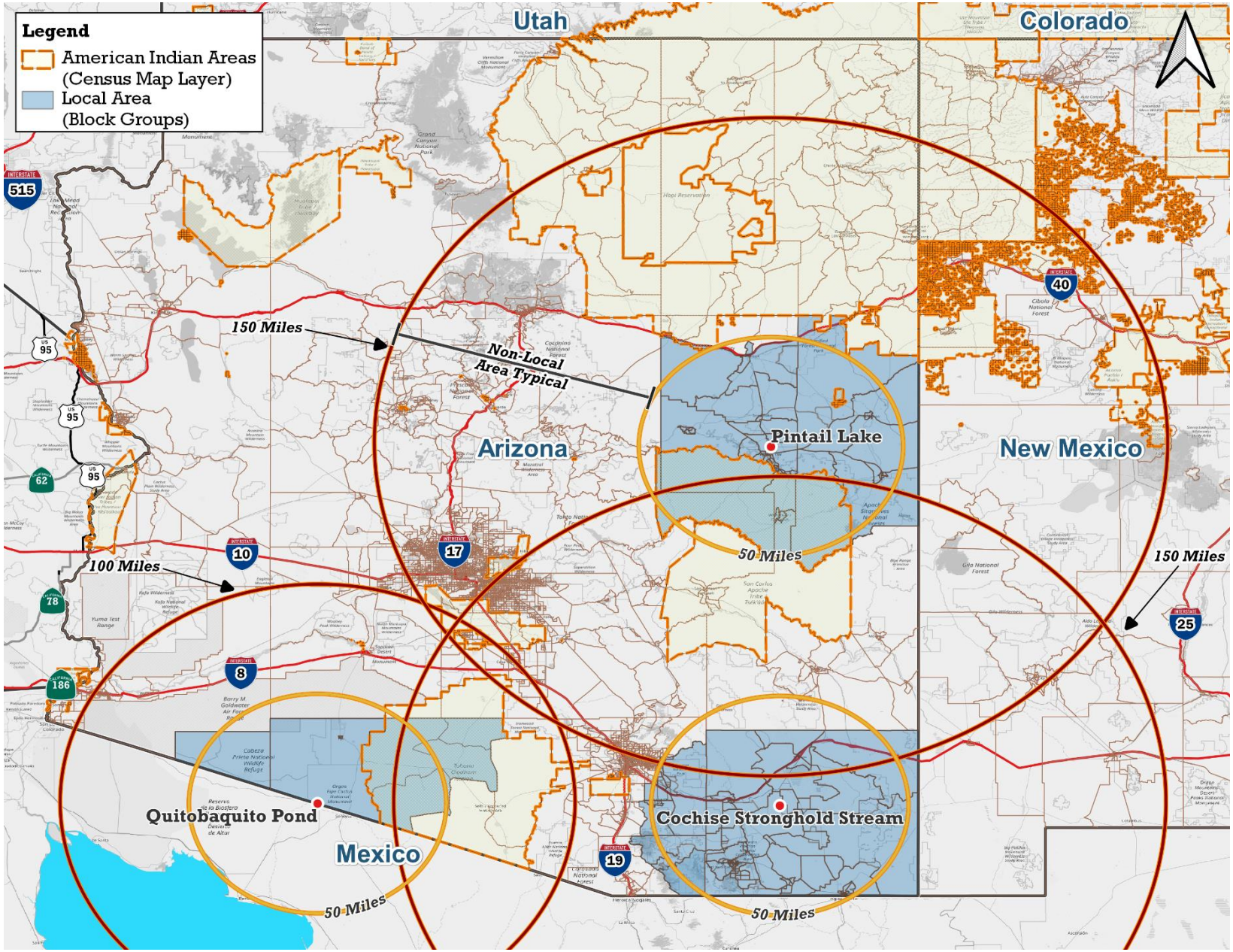
       Projected future households were also estimated, so that benefits extending over time would reflect population change. Projections were available at the county level for both Arizona and New Mexico.[16] Households selected in the GIS system were assigned to counties, and the county-level projections used to estimate the 20-year future household count (with the assumption that

[16] Arizona Department of Administration, Office of Employment & Population Statistics, 12/28/2018. Arizona State and County Population Projections: 2018 To 2055, Medium Series. University of New Mexico, Geospatial & Population Studies. UNM GPS Preliminary County Projections V2020.

projected changes were uniform across the entire county). For the case study examples, some counties exhibited negative growth for the analysis period. To project benefits over the 20-year analysis period, one-half of the projected increase in households was added to the base year number to represent the average number over the analysis period.[17]

[17] Depending on the location of a protected waterbody, the non-local (and possibly even the local) areas benefitting from the waterbody may extend into adjacent states (e.g., New Mexico, as in 2 of the 3 case study examples in this report) given standardized distances that households are assumed to be willing to travel (for example) to enjoy recreational areas. In these cases, the relevant area of the adjacent state is included in the household count used to calculate WTP for protected waters. Within the analysis, benefits accruing to Arizona households are provided as a separate subtotal. In cases where a waterbody's theoretical impact area (based on a fixed radius) extends south of the U.S. border into Mexico, the area south of the border is not include in the household calculations (since the border and related travel restrictions are presumed to effectively preclude these households from deriving significant benefits from protected waterbodies in the U.S.).

FIGURE 3. LOCAL AND NON-LOCAL AREA SELECTIONS FOR 3 CASE-STUDY CLASSES



- The White Mountain region has a substantial seasonal population, which represents an additional 16,630 households in the area on a part-time basis. Within the modeling process, this seasonal household segment is assumed to be relevant to the "local area" associated with Pintail Lake. The number of seasonal households is derived from Census data on vacant housing by type, with the relevant type being "held for seasonal, recreational, or occasional use." Households in these units are not counted as part of the resident total, so they are an additional segment of the local "buying" population, and this segment must also be factored downward to represent the proportion of the year they are in residence locally. No attempt has been made to project the growth of this segment.

  To estimate the proportion of the year within which seasonal residents affect the local economy, data on restaurant/bar sales by month for Navajo County[18] were reviewed to determine the pattern of sales above a baseline level, including the proportion of those sales amounts in relation to the total annual sales. On the basis of this review, a factor of 25% was applied to the seasonal household count (i.e., only one-quarter of the seasonal households (using housing units as a proxy) were counted as additional). Note that the 25% factor does not necessarily mean that one family/party is staying in the unit for three months of the year; there could be multiple parties with varying periods of use, adding up to the equivalent of 25% of a permanent household.
- Destination visitors to Organ Pipe Cactus National Monument that may also visit or otherwise become aware of Quitobaquito Pond constitute another component of local-area benefiting households. In the BCA model, this number is intended to represent only the visitors who are "materially involved" in the monument, through overnight camping, trail use, etc., and the estimate is further factored downward to reflect the fact that the pond is in a remote location within the Monument. Levels of visitation (for recreational visitors) have been relatively low in recent years, compared to figures in the 2000-2010 period, and consequently the visitor component has been projected to increase over time, in the model.

3. Compile data for affected discretionary-user populations (# households):

   - Define an appropriate market area for use categories associated with the waterbody; that is, the maximum practical distance from which potential users could be assumed to come to the waterbody.
     - For Local involvement assumed to constitute "regular use."
     - For Non-local involvement that may primarily consist of "appreciative value," and infrequent or even no physical attendance.

     A variety of considerations had a bearing on the selection and size of these areas, including similar concepts discussed in the EPA document (Appendix H), the size of analogous areas in the BT meta-analysis source documents used by Moultner et al. (2019) and subsequently by EPA, and the Consultants experience with delineating trade areas associated with various types of economic activity. Ultimately, these selections are a matter of judgment about apparent reasonableness.

4. Relate considerations of defining and measuring the affected households to EPA guidance:

   - Selected households fall into two major categories: local and non-local. The non-local areas (selected by a circle from the waterbody center point) have some overlap among the separate case study waters (and this is likely to be a typical condition within Arizona waterbodies analyzed); but because the benefits are based on number of acres or some equivalent measure of the waterbodies, each

[18] Northern Arizona University Economic Policy Institute, Gross Sales by County by Sector, 2019-2021. https://in.nau.edu/wp-content/uploads/sites/212/Gross-Sales-County-2021-vs.-2019.pdf

selected set of households is treated as unique to its related waterbody, or to multiple waterbodies if that is the case, and therefore not subject to double-counting considerations.

D. Categories of costs and benefits

1. Define the universe of currently quantifiable direct cost and benefit categories, initially determined by those identified in EPA documentation. As discussed above, designations of affected populations (households) according to their Local or Non-local relationship to the waterbody is an important distinction, as the level of WTP benefit estimates applicable to each group varies accordingly. Another key characteristic affecting households' WTP with respect to the analyzed water body is whether its setting is "forested" or "non-forested."
2. Assess the potential for *action-related* costs and benefits to arise based on the combination of specific waterbody and actions related thereto, by compiling the bases/sources for identifying and quantifying action-related costs and benefits.

Defining characteristics of the BCA quantitative model

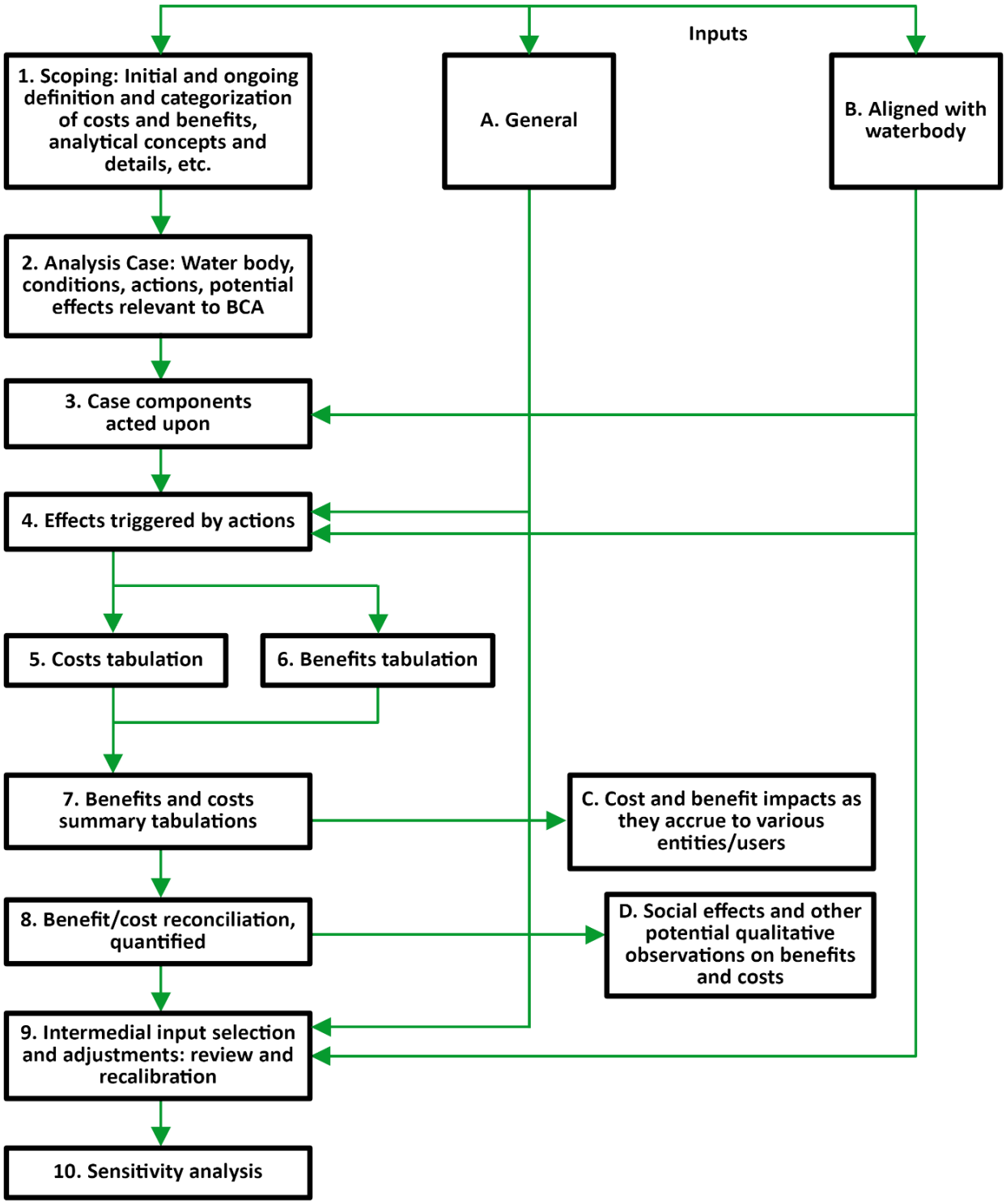
The model is designed to:

- Illustrate how different cases, conditions, etc. fit into a framework having multiple commonalities along with distinct components.
- Both summarize a process and link, conceptually and computationally, to submodels and databases that relate to the whole.
- Be user-friendly, "transportable," and adaptable.
- Encompass complexity and still remain comprehensible and media-manageable.

Physical structure and key components:

The model is based on an Excel workbook with multiple tabs, with submodels/databases linking to the main table series. Figure 2 provides readers of this report, and potential model users, with an overview of the model structure and components.

FIGURE 2. BASIC MODEL STRUCTURE



Key components of the model are described below (letters and numbers match the diagram labeling and are therefore not necessarily sequential).

Item A. Inputs, general, may include:

- Standards by water type, if/as applicable to current or future modeling efforts, and relationships to uses, etc.
- Per-user (or per-something-else, depending on possible future analytical direction) dollar values tied to specific water use types, such as specific recreation activities, etc. (Note: the current BCA model does not include these types of distinctions; all "use" benefits are assumed (at this stage of the ADEQ BCA model development) to be a part of the overall WTP for wetlands protection, as defined by the EPA document. The concept is included here due to the inherent limitations of EPA's WTP formulation as currently documented.)
- Cost factors: permitting or other compliance (dollars by permit or some other unit), for public and private entities; ADEQ administrative costs based on categories shown in Appendix D, estimated by ADEQ staff for each of the three case studies classes, for use in the BCA model (and this "checklist" concept could generally be applied to also indicate links to other related costs such as permitting, etc. where applicable); possible user charges per unit by type; and consideration of other factors such as health impacts (as burden), as applicable or practical at this level of analysis (current or future). Factors may be directly quantifiable in economic terms, and/or indirectly quantifiable in economic terms or as social effects (as relevant).
- Benefit categories:
    - Directly quantifiable economic benefits, as WTP dollar values on a per-household, per-acre basis.
    - Benefits applicable, as dollars on some unit basis, to participants in specific activities, recreational or other.
    - Benefits indirectly quantifiable in economic terms, or identifiable and addressed on qualitative terms only, including economic and social effects (as relevant).
- Discount rates to apply to future costs and the stream of annual benefits both local and non-local households would experience (based on the WTP approach).

Item B. Inputs, aligned with WTP categorical distinctions:

- Distinctions include: forested, non-forested, and possible other categories, and other conditions specific to the waterbody (all as applicable to current or future modeling formats, with some categories as placeholders for quantitative analysis that may occur in the future, but that in the interim might be recognized for qualitative discussion only).
- Cost factors: any variation from general factors based on specifics of waterbody; opportunity costs.
- Selection of local and non-local affected households, as described in relation to Figure 1 Scoping.

Item 9. Recalibration, as appropriate:

- Maintaining "adding up"[19] integrity in the course of producing benefit and cost estimates related to any single waterbody. This is accomplished primarily by examining estimates for individual waterbodies in comparison with Arizona-wide estimated annualized totals for costs and WTP benefits, which would be initially informed by EPA documentation of estimated state-level costs and benefits.

[19] See the Glossary (Appendix C) for an explanation of the "adding up" condition applied to this type of analysis.

Item 10. Sensitivity analysis component:

- Reviewing how the overall model structure relates to the specific analysis conditions in ways that could tend to over- or underestimate costs and/or benefits.
- Considering whether and to what extent results of a BCA could be unduly skewed or otherwise unusually sensitive, based on some modeling input or some particular characteristic of the waterbody being analyzed. This would be addressed initially by reviewing: 1) market area designations, 2) identified cost and benefit categories, and 3) cost and benefit factors applied to the estimating model. If warranted by the review, inputs and factors may then be modified, modified model results examined for effects of the sensitivity testing, and modeling components adjusted if necessary, along with accompanying notations.

Item C. Affected entities:

- For benefits: geographic and demographic general description of affected households that are both "local" and "non-local" with respect to waterbody.
- For costs: types of entities affected, with costs allocated among them to extent possible.

Item D. Social effects:

- Documenting Environmental Justice conditions. Data on disadvantaged minority populations within local and non-local market areas are compiled as part of the documentation of demographic conditions within these areas, which at a minimum, for all populations, includes number of households and household incomes as well as racial/ethnic designations by geographic sub-area (determined and illustrated through a GIS system that will also be the tool applied to data compilation). (EJ considerations are discussed in additional detail in a subsequent section.)
- Categories that may be quantified in the future, but in the interim addressed qualitatively as discussed in the following section.

Social benefit/cost considerations and categories related to waterbody actions

General

The model structure described in Figure 2 represents primarily the *quantitative* segment of the analysis. The analysis structure includes recognition of *qualitative* components of the BCA assessment, including:

- Benefit and cost elements that might be quantified in future ADEQ BCA frameworks, but might be only qualitatively addressed in the interim, as discussed below and indicated in Tables 2 and 3.
- Environmental Justice considerations, as discussed in the following sections.

What social conditions are likely to relate to the kinds of economic considerations in waterbody benefit/cost analyses? In the context of the BCA framework for waterbodies, given that quantification of effects is limited to certain categories by practical necessity, other effects that could in theory be *quantified*, and may be so in some future time, could in the meantime be *recognized as a social effect* if relevant. For example, when permit and mitigation costs are tied to an action that decreases the usability of a waterbody, former users will have a loss of utility and will likely attempt to find a substitute location, if possible. For those in close proximity, substitute locations would likely impose additional burdens (including costs), and could also result in the social (and economic) burden of dealing with decreased property values.

Degradation of a waterbody could also have a negative effect on the social cohesion of a community in close proximity. Conversely, social benefits tied to waterbody improvements/preservation could include an increase (or stabilizing effect) in social cohesion and property values, for communities in proximity.

Environmental Justice considerations, methods of addressing, including the particular case of indigenous communities

The concept of Environmental Justice (EJ), as a component of social impacts, is relevant to actions affecting waterbodies. EJ is commonly understood to apply to disadvantaged minority populations. At EPA, where the concept of Environmental Justice is integral to policy-making, EJ is specifically defined as applying to "people of color, low-income, and indigenous communities." (See Appendix E for other details on EPA and EJ.) Indigenous communities, in relation to Arizona waterbodies as well as other environmental considerations, are particularly relevant to EJ considerations, based in part on the unique characteristics of Indian Country, including the following:

- Tribal nations are sovereign entities, having complicated relationships with federal, state, and local governments in the US. While actions of these jurisdictions can directly affect indigenous communities, not all of the representational, legal, policy, and other protections of these jurisdictions can be assumed to apply to indigenous communities, or if they do apply, in the same way (or through the same mechanisms) as for non-native areas. Consequently, typical ways of addressing EJ issues in non-native communities cannot be automatically assumed to fulfill the needs of indigenous peoples.
- Many indigenous communities and their populations have historically been economically disadvantaged, and to the extent this is still the case, it would be another reason for EJ considerations to apply.
- Economic principles applied to BCA processes typically reflect "the economy" of the non-native world, which might or might not be fully representative of the economy of any particular indigenous community. This is a matter for analysts to be aware of, and which might be incorporated more formally into BCA processes for waterbodies at some future time.
- For indigenous community members, natural features, including waterbodies (which may or may not be completely "natural"), may embody cultural or religious significance in addition to utilitarian values.

BCA model summary results

Selected tables from the ADEQ BCA model (also included in the separate electronic workbook) are reproduced in this section. The table titles and description of contents shown below.

#	Table title	Topics, for each of 3 case study waterbodies
	Tables of quantified data	
4	Key project descriptive variables	Size of waterbody and other descriptive information
5	Applicable quantified cost and benefit categories, over time, discounted	Enumeration of costs and benefits by primary categories; linkages to computational tables and databases
6	Benefit/cost comparison	Figures leading up to and including the benefit/cost ratio
7	Affected households	Enumeration of households in designated local and nonlocal areas, including special population segments such as seasonal, etc.; links to computational tables
8	Potential Environmental Justice components and characteristics, for	Demographic data pertinent to Environmental Justice considerations; links to population databases

#	Table title	Topics, for each of 3 case study waterbodies
	Local areas; Arizona	
	Tables of primarily non-quantified, qualitative observations on findings	
9	Categories for potential future elaboration	Cost and benefit topics that may be quantified at a later date and could be addressed qualitatively in the interim, including references to relevancy to the case study waters
10	Social costs and benefits effects quantifiable, with some addressed qualitatively in interim	Topics treated similarly to Table 6 and also having a potential social dimension; summary of Environmental Justice indicators
11	Sensitivity review	Implications of variation in characteristics of the three case study waterbodies for analysis results; notes on comparisons of BCA model results with EPA document findings for Arizona

Tables 4 through 8 summarize key characteristics and the quantities associated with estimated costs, benefits, affected households within two different WTP categories, and populations associated with environmental Justice considerations – for the three case study classes.

TABLE 4. KEY PROJECT DESCRIPTIVE VARIABLES

Descriptive Variable	Class 1 - sky island stream	Class 2 - isolated lake	Class 3 - unique waterbody
Name	Cochise Stonghold	Pintail Lake & marshes (1)	Quitobaquito Pond
Size (acres or acre-equivalents (Class 1))	21.76	65	0.5
Forested?	Yes	Yes	No
Primary distinguishing characteristics	Stream, isolated segment	Lake and marshland; bird habitat	Pond; threatened/ endangered species

1. Consists of Pintail Lake and South Marsh (both artificial). Pintail is 3 ponds, 50 acres of water, and nesting islands; South Marsh fluctuates from 15 to 50 acres of flooded meadow. A total of 65 acres is applied to the BCA model.

TABLE 5. APPLICABLE QUANTIFIED COST AND BENEFIT CATEGORIES, OVER TIME, DISCOUNTED

Cost and Benefit Categories	Cochise Stonghold	Pintail Lake	Quitobaquito Pond
Costs			
404 permits	$9,344	$9,344	$9,344
Mitigation			
ADEQ Admin	$62,641	$111,067	$74,938
Total	**$71,985**	**$120,411**	**$84,282**
Benefits			
Local WTP factors	$0.29	$0.29	$0.07
Local, forested			
Current	$457,695	$658,144	
Projected	$5,051,486	$7,182,530	
Local, non-forested			
Current			$228
Projected			$2,923
Non-local WTP factors	$0.030	$0.030	$0.009
Non-local, forested			
Current	$646,321	$4,091,597	
Projected	$7,988,791	$50,688,439	
Non-local, non-forested			
Current			$274
Projected			$3,792
Total Local and Non-local			
Current	$1,104,017	$4,749,741	$501
Projected	$13,040,277	$57,870,970	$6,715
Total	**$14,144,293**	**$62,620,711**	**$7,216**
Arizona component	$14,982,646	$68,136,424	$8,045

TABLE 6. BENEFIT/COST COMPARISON

	Cochise Stonghold	Pintail Lake	Quitobaquito Pond
Total benefits, Arizona	$14,982,646	$68,136,424	$8,045
Total costs	$71,985	$120,411	$84,282
Benefits/costs	208.14	565.87	0.10

TABLE 7. AFFECTED HOUSEHOLDS

Household Categories	Cochise Stonghold	Pintail Lake	Quitobaquito Pond
Local residents, permanent			
Current	72,184	30,586	1,934
Projected	74,867	31,085	2,199
Local residents, seasonal, factored for temporary status			
Current		16,633	
Projected		16,633	
Local, destination visitor households			
Current			5,000
Projected			7,284
Non-local			
Current	986,121	2,089,641	61,461
Projected	1,263,692	2,688,637	95,823
Total Local and Non-local			
Current	1,058,305	2,136,860	68,395
Projected	1,338,559	2,736,355	105,306
Arizona component	1,319,865	2,700,399	105,306

TABLE 8. POTENTIAL ENVIRONMENTAL JUSTICE COMPONENTS AND CHARACTERISTICS, FOR LOCAL AREAS; ARIZONA

Percent of Population by Category	AZ	Cochise Stonghold	Pintail Lake	Quitobaquito Pond
Race				
White alone	73.8%	82.7%	69.4%	42.9%
Black or African American alone	4.5%	4.0%	1.4%	0.2%
American Indian and Alaska Native alone	4.3%	1.0%	21.2%	47.8%
Asian alone	3.3%	1.9%	0.4%	0.0%
Native Hawaiian and Other Pacific Islander alone	0.2%	0.2%	0.1%	0.0%
Some other race alone	6.9%	2.7%	3.5%	3.4%
Two or more races	7.0%	7.5%	4.1%	5.7%
Not Hispanic or Latino	68.5%	69.7%	85.0%	74.8%
Hispanic or Latino	31.5%	30.3%	15.0%	25.2%
Households Below Poverty Level	12.8%	12.0%	18.0%	28.2%

Summaries of qualitative observations for selected variables related to the analysis, for the three case studies, are shown on Tables 9 through 11. Material on these tables represents typical commentary on waterbody topics that are intended to add perspective to the BCA process.

TABLE 9. CATEGORIES FOR POTENTIAL FUTURE ELABORATION

Cost and Benefit Category	Cochise Stronghold	Pintail Lake	Quitobaquito Pond
Cost categories			
User charges	Not addressed	Not addressed	Not addressed
Benefit categories			
Recreation, direct water:			
Fishing (recreational), FBC (swimming, other immersive), PBC (partial-body contact, incl. boating	?	No fishing or body contact	Limited if any ??
Recreation, in area, direct or indirect assoc. with water:			
Hunting, Camping, Hiking, Backpacking, Rock climbing, Equestrian, Birding	Waterbody meaningfully enhances experience	Waterbody meaningfully enhances experience	Activities available in National Monument; minimal connection with waterbody
Fish consumption	?	No	Limited if any
Habitat: aquatic, wildlife, rare and endangered	Relevant	Relevant	Rare/endangered key aspect of waterbody
Cultural observances/significance	Historic connection	Historically notable use of wastewater	Indigenous ceremonial connection
Local/closest merchants and receipts	A few businesses are directly involved in immediate area	Very close to Show Low businesses	Few if any businesses in close proximity

TABLE 10. SOCIAL COSTS AND BENEFITS EFFECTS QUANTIFIABLE, WITH SOME ADDRESSED QUALITATIVELY IN INTERIM

Cost and Benefit Effects	Cochise Stronghold	Pintail Lake	Quitobaquito Pond
Cost effects, if degradation of waterbody asset were to occur			
Loss of utility/usefulness			Use by local tribal members is very important
Social, household burden of dealing with decreased property	Negligible issue here	Negligible issue here	Negligible issue here
Diminishment of social cohesion of a community	Minimal issue here	Minimal issue here	Potentially major issue given ceremonial significance of waterbody
Benefit effects			
Enhanced utility	Maintaining the asset is assumed to be sufficient		
Enhanced personal wealth and (potentially unpredictable) social effects of increased property values	Negligible issue here	Negligible issue here	Negligible issue here
Enhanced social cohesion of a community	Maintaining the asset is assumed to be sufficient		
Environmental justice (see Table 8)	Local population demographic profile is similar to state as a whole	Local population demographic profile exhibits high % of American Indian population and relatively high poverty level compared to AZ	Local population demographic profile exhibits very high % of American Indian population and very high poverty level, compared to AZ

TABLE 11. SENSITIVITY REVIEW

Sensitivity Issue	Cochise Stronghold	Pintail Lake	Quitobaquito Pond
Analysis issues by waterbody	Translation of stream length to acreage is based on 50' buffer factor mentioned in EPA but not definitively verified as applicable to WTP concept	As largest waterbody of 3 cases, plus location relative to populated areas in state, benefits far exceed other 2 waterbodies, based on methods applied	Very small waterbody was assigned small areas for local & non-local affected households, so minimal benefit #s. WTP approach does not capture value for vital role in protecting rare and endangered species
Comparisons to EPA document	The cost components of the BCA model with respect to the three case study waterbodies are understood to be, perhaps, atypically minimal, given the somewhat protected nature of the waterbodies and their settings. The EPA cost figures for Arizona are considerably higher. Benefit factors per-household and per-acre in EPA are also considerably higher than what is reflected in the BCA model.		
	While it is theoretically possible to compare the EPA results with the results of the ADEQ BCA model, on a per-acre and/or per-household basis, EPA figures can vary from the BCA model due to how EPA allocated varying benefit amounts by waterbodies' settings, local versus non-local populations, etc., or other factors in their modeling process that are not replicable by the Consultants. Regardless of such effects, one conclusion from this comparative review is that the BCA model results are conservatively derived. Based on other discussions in this report, including comments on EPA's approach to quantifying benefits, the Consultants do not recommend at this time an upward adjustment in the model's benefit factors based on the comparison with EPA figures.		

Appendix A. Rulemaking and BCA relationships

GENERALIZED RULE-MAKING REQUIREMENTS[20]	BENEFIT/COST MODELING FRAMEWORK
Identification of the rulemaking and summary of the economic, small business and consumer impact statement	Analyses would typically include summaries of results, including by affected parties
An identification of the persons who will be directly affected by, bear the costs of or directly benefit from the rule making	Affected populations are specifically identified within the analysis, partly in order to quantify per-household effects where possible, and to identify potential environmental justice communities. As it relates to environmental justice (and also, more generally, to impacted private parties such as businesses), it is understood that comprehensive BCA may include the need for direct consultations with affected communities/entities.
A benefit/cost analysis addressing the following:	
• The probable costs and benefits to the implementing agency and other agencies directly affected by the implementation and enforcement of the rule making	Agency costs are one of the identified quantified cost categories (the existing model incorporates general factors from the EPA document as well as Arizona-specific data supplied by ADEQ)
• The probable costs and benefits to a political subdivision of this state directly affected by the implementation and enforcement of the rule making	Although not generally included as part of the initial analysis framework, political subdivisions would largely be part of an expanded, future analysis in which secondary effects (e.g., indirect and induced costs and benefits as documented through an IMPLAN model) would be considered along with direct effects. Such analyses typically include a fiscal component.
• The probable costs and benefits to businesses directly affected by the rule making	Although not generally included as part of the initial analysis framework, part of the recommended potential future expansion of the B/C analysis is to identify businesses that interact directly with affected waterbody users and estimate their costs, sales, etc. resulting from the action
A general description of the probable impact on private and public employment in businesses, agencies and political subdivisions of this state directly affected by the rule making. (Includes reference to private persons and consumers who are directly affected by the rule-making.)	As per the preceding items, future analyses that would include the use of tools such as IMPLAN would incorporate estimates of employment as well as dollars relating to direct costs, sales, etc.
A statement of the probable impact of the rule making on small businesses	See above, relative to economic B/C effects
A statement of the probable effect on state revenues	See above, relative to B/C effects for political subdivisions
A description of any less intrusive or less costly alternative methods of achieving the purpose of the rule making	The B/C analysis framework provides a basis for quantitatively comparing the effects of various components of costs and benefits
A description of any data on which a rule is based, data validity, etc.	Analyses would typically include documentation of data sources, reasons for using particular sources, etc.

[20] *Generalized Rule-Making Requirements* in the table are distilled from the following document in ADEQ's online resource library: *GREAT RESOURCE 2017-06-20 EIS info and examples of water and air bookmarked.*

Appendix B. Annotated Bibliography

1. Arizona Administrative Register

Summary: The Administrative Register (Register) is a legal publication published by the Administrative Rules Division that contains information about rulemaking activity in the state of Arizona. The issues referenced below include code sections being amended and introduced to Chapter 11, which involves the Department of Environmental Quality Water Quality Standards.

Study Resource: These publications mainly refer to and make reference to topics that contribute to the Economic, Small Business, and Consumer Impact Statements. The studies referred to and referenced in this publication provide a brief summary of tourism, agriculture, or other benefits as well as cost categories or data produced from the findings. The following items are addressed in individual registers cited below:

Arizona Administrative Register (1995). Notice of Proposed Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 1, Issue 50.

Publication Study Resource: Proposed new section to the modification of water quality standards on the grounds of net ecological benefit based on the following criteria:

1. The discharge of effluent creates or supports an ecologically valuable aquatic; wetland, or riparian habitat in an area where such resources are limited
2. The cost of treatment to comply with a water quality standard is so high that it is more cost effective to eliminate the discharge of effluent rather than upgrade treatment
3. It is feasible for a point source discharger to completely eliminate the discharge of effluent
4. The environmental benefits associated with the discharge of effluent under a modified water quality standard exceed the environmental costs associated with elimination of the discharge and destruction of the effluent dependent ecosystem
5. All practicable point source control discharge programs, including local pretreatment, waste minimization, and source reduction programs are implemented
6. The discharge of effluent under a modified water quality standard will not cause or contribute to a violation of a water quality standard that has been established for a downstream surface water
7. The discharge of effluent will not produce or contribute to the concentration of a pollutant in the tissues of aquatic organisms or wildlife that is likely to be harmful to humans or wildlife through food chain concentration.

Arizona Administrative Register (1996). Notice of Final Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards For Surface Waters – Economic Small Business and Consumer Impact Statement, Volume 2, Issue 20.

Publication Study Resource: The adopted Net Ecological Benefit rule provides a benefit to the owners of wastewater treatment plants that support or create effluent dependent waters because it provides a mechanism for relief from a water quality standard that otherwise might force costly treatment plant upgrades. The adopted rule also provides ecosystem benefits in that it provides a regulatory incentive to maintain and preserve in-stream flows in areas where riparian and aquatic resources are limited. The continued discharge of effluent may provide net ecological benefits, even though an applicable water quality standard is not being met. Examples of possible ecological benefits include:

A. Enhancement, expansion or restoration of aquatic and riparian habitat for native, threatened or endangered aquatic species, or for migratory waterfowl

B. Provision or enhancement of habitat or food sources for native, threatened and endangered species that are terrestrial

C. Enhancement of species diversity

D. Enhancement or restoration of riparian values (e.g. cottonwood/willow habitat, improved bird and wildlife habitat)

Arizona Administrative Register (2001). Notice of Proposed Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 7, Issue 11.

Publication Study Resource: Proposed decision criteria for *Social and economic impact of Tier 3 antidegradation protection:* The Director may take into consideration the potential social and economic impact of a unique water classification and the establishment of Tier 3 antidegradation protection, including:

a. Impact of a prohibition of new point source discharges and expansion of existing point source discharges, including possible limits on discharges to the tributaries of a proposed unique water and possible impacts on growth and development.

b. Impact of possible future restrictions on land use activities in a unique water's watershed, including cattle grazing, timber harvesting, mining, recreation, and agriculture.

c. The impact of stricter requirements for §401 certification of federal permits and licenses, including NPDES and §404 permits.

d. Impact on private property rights and the potential for regulatory "takings."

e. Ecosystem and preservation values.

Arizona Administrative Register (2002). Notice of Final Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 8, Issue 13.

Arizona Administrative Register (2008). Notice of Final Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 14, Issue 52.

Arizona Administrative Register (2016). Agency Certificate Notice of Final Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 22, Issue 36.

Publication Study Resource: ADEQ proposed to eliminate the requirement that a discharger have a plan to eliminate the discharge under active consideration as part of what must be demonstrated. Communities and developers should benefit by eliminating an extra burden in seeking to use high quality effluent to create aquatic and riparian ecosystems.

Arizona Administrative Register (2017). Notice of Final Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 23, Issue 6.

Publication Study Resource: Estimated costs and benefits to consumers and the public mentioned in recreation activities (e.g., Ironman at Tempe Town Lake), fishing activities, and agricultural productivity.

Arizona Administrative Register (2019). Notice of Final Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 25, Issue 5.

Publication Study Resource: See notes regarding interface with AOT studies under *Agriculture in Arizona's Economy* and *The Economic Contributions of Water-related Outdoor Recreation in Arizona*, below.

2. Agriculture in Arizona's Economy

Summary: This report explores agriculture's contribution to the Arizona economy by examining the entire agribusiness system in Arizona.

Study Resource: The economic contribution analysis was conducted using input-output modeling and the premiere software for this type of analysis, IMPLAN Version 3.1. IMPLAN is a modeling system of a regional economy that is based on national averages of production conditions. This model was refined based on the best available data to more accurately reflect production conditions in Arizona.

Applicability to current benefit/cost estimating procedures: Uses IMPLAN system to translate *direct* economic effects of some action into *secondary* effects, reflecting the multiplier effects of actions through the economic system. The practice represented by this modeling tool, widely used in economic impact assessments, would be a logical eventual extension of cost and benefit estimating for Arizona water bodies.

Kerna, A., & Frisvold, G. (2014). Agriculture in Arizona's Economy: An Economic Contribution Analysis. *Department of Agricultural & Resource Economics. University of Arizona*.

3. Buehman Canyon Creek – Economic Benefits of Unique Water Designation Study of Buehman Canyon Creek

Summary: This study reviews the economic benefits of Buehman Canyon Creek for the consideration of determining the water body as a unique water designation.

Study Resource: Provides guidance on factors that need to be considered in a comprehensive examination of costs and benefits in the economic impact statement for proposed unique water designation.

Applicability to current benefit/cost estimating procedures: This study mentions economic benefits that are quantifiable, but does not include the data methodology used to support the economic benefits associated with the proposed unique water designation for Buehman Canyon Creek.

Colby, B.G. (1996) Buehman Canyon Creek – Economic Benefits of Unique Water Designation Study – March 1996. *Arizona Department of Environmental Quality*.

4. The Economic Benefits of Recreation in Rural Arizona

Summary: This report provides a summary analysis of tourism and recreation as factors influencing the state's economy and local economy's withing the state.

Study Resource: This report summarizes park recreation tourism economic benefits, the benefits to rural areas, and the need to develop more facilities to access recreation lands. Drawing from the published survey of visitors of Arizona State Parks conducted between 1987-1988, visitors were asked how much money their group spent during their trip within 50 miles of the state park they were visiting, average expenditures were produced per visitor group per trip and were applied to park attendance counts to document total expenditures spent within 50 miles of state parks by visitors in 1987.

Applicability to current benefit/cost estimating procedures: The reference cited for this document, entitled "*The 1987-1988 Use Study of Arizona State Parks Visitors,*" for the Arizona State Parks Board in 1989, provides some quantified data for visitor expenditures that lends itself to capturing economic benefits of this type.

Spear, S. (1989) Rural Arizona… The Economic Benefits of Recreation, A Summary Analysis of Tourism and Recreation as Factors Influencing State and Local Economies. *Arizona State Parks Board Statewide Planning Section.*

5. The Economic Contributions of Water-related Outdoor Recreation in Arizona

Summary: A study of outdoor recreational activity on or along the water to estimate the level of participation in the state and the contributions from these activities to the county and state economies.

Study Resource: The analysis is structured around estimating three sets of metrics: participation, spending, and economic contributions. Participation estimates for this study relied largely on two data sources to characterize outdoor recreation on or along the water. Economic Contributions were estimated by combining spending estimates with data that models economic sector interactions in a given geography. Expenditure data were collected for different categories (e.g., groceries, fuel, equipment, etc.) as part of the OIA survey, which enabled allocation of spending to specific economic sectors. These data were then run through an IMPLAN™ model of the Arizona statewide economy using software produced by MIG, Inc. The resulting county-level and water-specific estimates reflect the contribution that outdoor recreation in those locales has on the statewide economy. Appendix A in the document provides additional background information on economic contributions.

Applicability to current benefit/cost estimating procedures: See notes on IMPLAN under *Agriculture in Arizona's Economy*. The Arizona Office of Tourism (AOT) sponsors periodic generalized studies related to Arizona visitors, including types of activities, expenditures, economic impacts, etc. To the extent that benefit/cost modeling of water bodies/designations is expanded into specific consideration of benefits related to riparian-focused activities, these location/activity-specific studies (#4 as well as this one) can add to the specificity of benefits associated with activities of particular interest.

Southwick Associates (2019). The Economic Contributions of Water-related Outdoor Recreation in Arizona: A Technical Report on Study Scope, Methods, and Procedures. *Audubon Arizona*.

6. Socioeconomic consequences of mercury use and pollution

S*ummary:* In the past, human activities often resulted in mercury releases to the biosphere with little consideration of undesirable consequences for the health of humans and wildlife. This paper outlines the pathways through which humans and wildlife are exposed to mercury.

Study Resource: This paper examines the life cycle of mercury from a global perspective and then identifies several approaches to measuring the benefits of reducing mercury exposure, policy options for reducing Hg emissions, possible exposure reduction mechanisms, and issues associated with mercury risk assessment and communication for different populations. This study also briefly reviews the methods used to quantify the benefits to human health associated with reduced mercury exposure, which include Benefit-cost Analysis and the Cost-effectiveness Analysis.

Applicability to current benefit/cost estimating procedures: This paper does not include any quantifiable data used in its review of the Benefit-cost Analysis or Cost-effectiveness Analysis.

Swain, E. B., Jakus, P. M., Rice, G., Lupi, F., Maxson, P. A., Pacyna, J. M., ... & Veiga, M. M. (2007). Socioeconomic consequences of mercury use and pollution. *Ambio*, 45-61.

7. Nature-based Tourism and the Economy of Southeastern Arizona

Summary: This study documents expenditures in the Sierra Vista area by visitors to the San Pedro Riparian National Conservation Area (RNCA) and by bird watchers at Ramsey Canyon Preserve. Information on visitor

expenditures, characteristics and preferences is reported, along with implications for nature-based tourism in southeastern Arizona. This study examined visitation to only two natural areas and so economic impacts reported here represent only a portion of the impacts of visitor spending associated with all nature preserves located in southeastern Arizona. The study indicates that 95% of visitors to Ramsey Canyon and the San Pedro RNCA go to at least one other site in southern Arizona on a typical visit to the area, and make expenditures in communities located near these sites.

Study Resource: The expenditure analysis indicates the importance of an overnight stay for communities to experience significant economic benefits from visitors.

Applicability to current benefit/cost estimating procedures: See notes regarding interface with AOT studies under *The Economic Contributions of Water-related Outdoor Recreation in Arizona*, above.

Crandall, K., Leones, J., & Colby, B. G. (1992). *Nature-based Tourism and the Economy of Southeastern Arizona: Economic Impacts of Visitation to Ramsey Canyon Preserve and the San Pedro Riparian National Conservation Area, Final Report*. Department of Agricultural and Resource Economics, the University of Arizona.

8. Notes on inclusion of source studies and data preparation for wetlands meta-data

Summary: This memorandum provides reasons for excluding specific wetland valuation studies from the meta-data that was used in the meta-analysis for estimating national benefits in the *Economic Analysis for the Proposed "Revised Definition of 'Waters of the United States'" Rule* (U.S. EPA and Army, 2021).

Study Resource: Provides an overview of valuation scenarios considered in literature and the assumptions made to fill in data gaps for each study used for wetlands meta-data.

Applicability to current benefit/cost estimating procedures: Provides a critical meta-analysis of literature and studies that support estimating national benefits in the *Economic Analysis for the Proposed "Revised Definition of 'Waters of the United States'" Rule* (U.S. EPA and Army, 2021).

ICF. 2021. Notes on inclusion of source studies and data preparation for wetlands meta-data. Memorandum to Todd Doley and Steve Whitlock. November 22, 2021.

9. Using Meta-Analysis for Large-Scale Ecosystem Service Valuation: Progress, Prospects, and Challenges

Summary: This article discusses prospects and challenges related to the use of meta-regression models (MRMs) for ecosystem service benefit transfer, with an emphasis on validity criteria and post-estimation procedures given sparse attention in the ecosystem services literature. Includes a meta-analysis of willingness to pay for water quality changes that support aquatic ecosystem services, and the application of the model to estimate water quality benefits under alternative riparian buffer restoration scenarios in New Hampshire's Great Bay Watershed. These illustrations highlight the advantages of MRM benefit transfers, together with the challenges and data needs encountered when quantifying ecosystem service values.

Study Resource: The illustrated case study discussed in this paper helps to demonstrate how evaluations of issues can help clarify the suitability of Meta-Regression Modeling (MRM) predictions for benefit transfers.

Applicability to current benefit/cost estimating procedures: This illustrates benefit transfers using scenarios of potential water quality, setting variables, geospatial and socioeconomic data for benefit transfer scenarios, the data methodology, indexing calibration, WTP estimate predictions per household, and the challenges for Large-Scale Ecosystem Service Valuations.

Johnston, R. J., & Bauer, D. M. (2020). Using meta-analysis for large-scale ecosystem service valuation: progress, prospects, and challenges. *Agricultural and Resource Economics Review*, *49*(1), 23-63

10. Economic Analysis for the Proposed "Revised Definition of 'Waters of the United States'" Rule

Summary: This Economic Analysis (EA) assesses the potential impacts of the proposed changes to the definition of "waters of the United States" based on the potential effects to Clean Water Act (CWA) programs that rely on that definition.

Study Resource: Provides an overview of economic analysis under the primary and secondary baselines for the CWA. The paper discusses the multiple components of the secondary baseline assessment, and provides estimates of the benefits and costs associated with this assessment, by states and for the US.

Applicability to current benefit/cost estimating procedures: This report provides broad guidance for estimating costs and benefits, key components of which, including benefits based on WTP, and various cost categories, were incorporated into a recommended BCA modeling structure for ADEQ.

U.S. Environmental Protection Agency and Department of the Army. (2021). *Economic Analysis for the Proposed "Revised Definition of 'Waters of the United States'" Rule*. https://www.epa.gov/system/files/documents/2021-11/revised-definition-of-wotus_nprm_economic-analysis.pdf

11. Supplementary Material to the Economic Analysis for the Proposed "Revised Definition of 'Waters of the United States'" Rule

Summary: This document includes the Compendium of State and Tribal Regulations for CWA programs by state that corresponds to the *Economic Analysis for the Proposed "Revision Definition of 'Waters of the United States'" Rule* report cited above.

Study Resource: See *Economic Analysis for the Proposed "Revision Definition of 'Waters of the United States'" Rule* report cited above.

Applicability to current benefit/cost estimating procedures: Adds additional context to the approach EPA used in preparing estimates of costs and benefits, as addressed in *Revised Definition of 'Waters of the United States Rule*.

U.S. Environmental Protection Agency and Department of the Army. (2021). *Supplementary Material to the Economic Analysis for the Proposed "Revised Definition of 'Waters of the United States'" Rule*. https://www.epa.gov/system/files/documents/2022-01/epa-hq-ow-2021-0602-0087_content.pdf

12. Upgrading Wetland Valuation via Benefit Transfer

Summary: This study uses updated meta-data on wetland valuation to illustrate how a state-of-the-art meta-regression framework that is consistent with economic theory can be adapted to generate benefit transfer predictions for incremental changes in wetland acreage over space and time. This study also applies this framework to estimate losses in benefits for realistic changes in wetland acreage for some sub-watersheds, as can be expected under the proposed re-definition of the "Waters of the United States" to be protected under the Clean Water Act (CWA).

Study Resource: This study provides an illustration of how recent advances in meta-analytic methods could be applied to value changes in wetland acreage regionally or nationally.

Applicability to current benefit/cost estimating procedures: This study compiles an updated meta-data set on willingness to pay (WTP) to preserve or restore wetlands in the United States, drawing from 17 primary valuation

studies as current as 2016. This study also takes advantage of recent advances in meta-regression modeling and computation of predicted benefits via the econometric framework proposed in the previous Moeltner 2019 study within the context of valuing surface water quality changes via Benefit Transfers (BT).

Moeltner, K., Balukas, J. A., Besedin, E., & Holland, B. (2019). Waters of the United States: Upgrading wetland valuation via benefit transfer. *Ecological Economics*, *164*, 106336.

Appendix C. Glossary of terms used in this document

Action-related [referring to costs and benefits and associated parties]: A category of out-of-pocket expenses, or proceeds derived, resulting from some interaction with the waterbody or related aquatic assets.

Adding up: A constraining function in Benefit Transfer analysis in which analysts maintain the intent to limit WTP estimates applicable to any one waterbody so that they are consistent with estimates applicable to incremental increases in the size, number, etc. of analyzed waterbodies – in other words, so that individual WTP totals are not greater than a WTP estimate that would apply to all relevant waterbodies collectively within a given geographic area.

Appreciative value: The value placed on a waterbody due partially or entirely to the satisfaction (appreciation) of knowing that it exists (or serves certain purposes through its existence), and where physical contact or proximity may be infrequent or even nonexistent. Also sometimes referred to as "nonuse" or "passive use" of a waterbody-type resource.

Benefit transfer (BT): The analytical method of projecting benefits documented through a study conducted for one place and time to, usually, some other place and time. In the context of this document, BT applies to studies estimating users willingness-to-pay (WTP to have some waterbody asset at some level of usability.

Discretionary-user populations: 1) Recreationists, directly related to a waterbody or indirectly related to it as part of an overall environment being experienced; 2) Persons whose involvement with a waterbody may primarily consist of "appreciative value," and infrequent or even no physical attendance; and 3) Persons with a cultural or ceremonial relationship with the waterbody.

Local and non-local market (user) areas: Terminology from EPA documentation referring to 1) an affected population (in number of households) with some degree of proximity to an analyzed waterbody (local), and 2) a more-remote (non-local), regional-scale population (# households) that attaches some value to the analyzed waterbody based primarily on being aware of its existence, and not dependent on physical proximity.

Regular use [of waterbody]: Waterbody use activities associated with a localized population having relatively convenient access.

Willingness to pay (WTP): A technique applied, generally in survey research, to derive value estimates for some asset for which direct payments are not applicable. For example, a waterbody is not likely to be accessed by means of a gated entrance where a fee is extracted; so users of the waterbody are queried, through a survey process, as to what they would be willing to pay to access it (or to simply have it existing and serving various purposes).

WOTUS: Waters of the United States.

Appendix D. ADEQ project capacity worksheet for application to estimating waterbody management administrative costs

Project Prioritization Matrix	Product or Service (Widget)	Number of Widgets Produced	Avg. Touch Time per Widget, hr	First Pass Yield, %	Avg. Rework Touch Time/ Widget, hrs.	Total Rework Time, hrs.	Total Touch Time, hrs. (incl. rework)
Total							**16,323.6**
GIS Support	Basic infrastructure and upkeep	10	1.5	95%	0.3	3.0	18.0
Standards Review/Development	Develop background information for each pollutant in Appendix A	2259	4.8	80%	1.0	2182.2	13,093.2
Standards Review/Development	Appendix B review for each designated use	60	1.6	80%	0.3	19.2	115.2
Water Quality Sampling	Effectiveness monitoring	15	7.0	80%	1.4	21.0	126.0
WOTUS Determinations	Jurisdictional evaluations	400	4.0	80%	0.8	320.0	1,920.0
Impaired Waters	Analyzing data for impaired	5	2.0	80%	0.4	2.0	12.0
Administrative Functions	VS Budget Management	30	1.0	80%	0.2	6.0	36.0
Administrative Functions	General Legal Question, 1 Page Memorandum (Includes Research)	1	6.0	80%	1.2	1.2	7.2
Administrative Functions	General Legal Question, 2-5 Page Memorandum (Includes Research)	1	16.0	80%	3.2	3.2	19.2
Administrative Functions	General Legal Question, 5+ Page Memorandum (Includes Research)	1	30.0	80%	6.0	6.0	36.0
Administrative Functions	Policy Analysis, 1 Page Memorandum (Includes Research)	1	8.0	80%	1.6	1.6	9.6
Administrative Functions	Policy Analysis, 2-5 Page Memorandum (Includes Research)	1	24.0	80%	4.8	4.8	28.8
Administrative Functions	Policy Analysis, 5+ Page Memorandum (Includes Research)	1	40.0	80%	8.0	8.0	48.0
Administrative Functions	Drafting, Regulatory (Rule Language, Per Rule, Includes Research)	14	16.0	80%	3.2	44.8	268.8
Administrative Functions	Stakeholder Event, Planning (Website Updates, Meeting Invites, Internal Approval, etc.)	4	24.0	80%	4.8	19.2	115.2
Administrative Functions	Stakeholder Event, Deliverables (Presentations, handouts, etc.)	4	8.0	80%	1.6	6.4	38.4
Administrative Functions	Legal Research, General	10	4.0	80%	0.8	8.0	48.0
Administrative Functions	Legal Research, State Statutes or Rules	10	8.0	80%	1.6	16.0	96.0
Administrative Functions	Legal Research, Federal Statutes or Rules	5	16.0	80%	3.2	16.0	96.0
Administrative Functions	Legislative or Regulatory Supporting Documents (Flowcharts, EIS, Studies, State by State Analysis, etc.)	5	32.0	80%	6.4	32.0	192.0

Appendix E. EPA and Environmental Justice

EJ concepts in EPA policy-making are summarized in the following excerpts from EPA webpages:

> "EPA's [environmental justice] goal is to provide an environment where all people enjoy the same degree of protection from environmental and health hazards and equal access to the decision-making process to maintain a healthy environment in which to live, learn, and work."[21]

EPA has developed an Environmental Justice mapping and screening tool called EJScreen, which combines environmental and demographic indicators in maps and reports. Material below is taken from their documentation of this tool, as noted:

> "EJScreen allows users to access high-resolution environmental and demographic information [at the Census block group level] for locations in the United States, and compare their selected locations to the rest of the state, EPA region, or the nation. The tool may help users identify areas with:
>
> - People of color and/or low-income populations
> - Potential environmental quality issues
> - A combination of environmental and demographic indicators that is greater than usual
> - Other factors that may be of interest"[22]
>
> EJScreen uses an "EJ Index" that combines demographic factors in a particular location with a single environmental factor relevant to that location, and consequently has the capability to show each environmental indicator and each demographic indicator, one at a time. There are eleven EJ Indexes (with names such as, for example, Traffic Proximity, Lead Paint, Hazardous Waste Proximity) in EJScreen reflecting 12 environmental indicators.[23]

One of the indexes, titled "Wastewater Discharge," deals specifically with water issues. Generally, however, this tool would appear to have limited application for recognizing environmental justice considerations within the BCA modeling framework related to this assignment. The indexing approach, with its focus on combining hazards with demographic data, actually complicates the primary intent of environmental justice related to the recommended benefit/cost modeling, which is to identify, initially, minority (including indigenous) and low-income populations that could be affected by waterbody decisions. This identification step then provides additional specific context within which to consider affected populations in relation to anticipated waterbody actions.

[21] https://www.epa.gov/environmentaljustice
[22] https://www.epa.gov/ejscreen/purposes-and-uses-ejscreen
[23] https://www.epa.gov/ejscreen/environmental-justice-indexes-ejscreen