**Exhibit A**
**Scope of Work**
**Colorado River Water Availability Study Continuation**
**January 2013**

## BACKGROUND

The State of Colorado (State), Colorado Water Conservation Board (CWCB or Board), and the Interbasin Compact Committee (IBCC) are currently implementing three major initiatives, among several other initiatives in which the State plays a role (see table on page 3), to evaluate State water supply and demand imbalances and methods to manage those imbalances through water supply projects and strategies. One initiative involves IBCC Scenario Planning and Portfolio Strategies, another is the implementation of SWSI 2010 recommendations, the update to SWSI in 2016 and the development of a State Water Plan and the other initiative involves the Colorado River Water Availability Study (CRWAS). The IBCC processes involve planning activities with the State Basin Roundtables (BRTs) to identify statewide supply and demand imbalances and use a Portfolio Tool to identify general regional solutions. Although this process provides viable data, methods, and tools to plan at a regional and statewide level, it does not spatially describe where water supply and demand imbalances occur on a tributary, water user or provider scale. The CRWAS process will work closely with the BRTs to use data, methods, and tools to complement the large scale of the IBCC process by using Colorado Decision Support System (CDSS) analyses to add future water supply and demands and evaluate corresponding imbalances in specific locations at the local level. This Scope of Work includes tasks to combine the IBCC and CRWAS demands, processes, and strategies to unite local-level and State-level water supply planning and evaluation activities.

The State General Assembly enacted legislation between fiscal years 2007, 2008 and 2012 authorizing, funding, and directing the CWCB to evaluate water availability in the Colorado River Basin and its tributaries (local) through CRWAS. Legislative direction on CRWAS includes working directly with the BRTs to:

- Continue CDSS model development,
- Evaluate water demand alternatives developed through the BRT and IBCC planning efforts,
- Quantify available water to meet any supply and demand imbalances, and
- Perform a risk management analysis on Colorado River Basin issues.

## INTRODUCTION

Key objectives of CRWAS are to quantify water supply and demand imbalances based on BRT input, investigate strategies developed by the BRTs and IBCC to manage those imbalances, and investigate options to manage risks associated with the imbalances and strategies. This will be implemented at the local level (Task 2) and the State level (Task 3) as the risks and options to manage those risks differ depending on the geographic extent. Examples of risks associated with local supply and demand imbalances that must be managed at the local level include tradeoffs between consumptive and non-consumptive needs; or building storage projects where water is available only in high-flow years or less available under projected climate conditions. Risks that must be managed at the State level include maintaining compliance with the Colorado River Compact. This Scope evaluates local-level and State-level planning objectives while minimizing unnecessary technical overlap between complementary efforts.

The three technical tasks outlined below address the directives for CRWAS. When combined with knowledge gained from complementary studies, CRWAS will provide technical basis (analytical methods, technical data, and practical recommendations) to assist the State and water stakeholders to develop mutually beneficial decisions. CRWAS activities are largely technical in nature, and ongoing complementary efforts (e.g., IBCC, BRT and SWSI planning activities) require a solid technical basis for making long-term water management decisions. The tasks outlined below will be managed through the CWCB Interstate Federal and Water Information (IFWI) Section working closely with the AECOM team. The CWCB Water Supply Planning (WSP) Section (which is currently supporting IBCC, BRT and SWSI planning activities) will be consulted on specific tasks noted herein to minimize unnecessary technical overlap.

1. **Application of Local, State, and Interstate Studies to CRWAS Technical Analysis** – This task will provide concise technical comparisons of multiple studies (see table on page 3) investigating Colorado River Basin water supply and demand strategies. The comparisons will be used to identify how the studies' technical objectives, analytical methods, and results can be applied to local-level and State-level technical analyses planned for Tasks 2 and 3. Knowledge gained from this task will help to minimize unnecessary technical overlap between complementary efforts. This task will start immediately and coincide with key milestones of the multiple studies as they are completed.

2. **Technical Analysis of Local-Level Issues** – This task will use knowledge gained from Task 1 and from CRWAS Phase I to expand CDSS model development and implementation activities by formulating future local-level water supply, water demand, and water rights planning scenarios and evaluating how those scenarios are managed through future water supply strategies. The scenarios and strategies evaluated in this task will be developed by the CWCB IFWI Section and the AECOM team through coordination with the BRTs and the CWCB WSP Section, who are actively identifying qualitative water planning scenarios and strategies. Reclamation is also investigating imbalances and future supply options in coordination with the Colorado River basin states through Colorado River Basin Water Supply and Demand study. Information from the Reclamation study will also be considered. This task will translate that qualitative information into quantitative analyses to understand local-level supply and demand scenario imbalances and evaluate viable project-specific strategies to mitigate those imbalances. This task will also evaluate BRT and IBCC options to manage inherent local risks associated with planned management strategies. Results of the task will provide local-level information needed for State-level technical analyses planned for Task 3.

3. **Technical Analysis of State-Level Issues** – This task will use knowledge gained from Tasks 1 and 2 to expand local-level risk management strategies to the State level. This task will include defining and planning evaluation of strategies to manage risk to allow Colorado to continue developing their water allocated under the Colorado River Compact, while maintaining compliance with the Compact.

## Task 1 – Application of Local, State, and Interstate Studies to CRWAS Technical Analysis

**Objective:**

The following table lists studies investigating Colorado River Basin water supplies, water demands, water rights, and water projects at the local, State, and interstate scale. The studies vary in geographic extent, objectives, analytical

methods, and results; but each have potential to inform and support CRWAS technical analysis and State planning objectives. The AECOM team is involved with over half of the studies in direct technical analysis or review roles.

| Scale | Sponsor | Study |
|---|---|---|
| Interstate | Reclamation | Colorado River Water Supply and Demand Study |
| | Upper Basin | Demand Management Study |
| | | Agricultural Consumptive Water Use Study |
| State | CWCB | Colorado River Water Availability Study Phase I |
| | | Colorado River Water Availability Study Continuation |
| | | Colorado River Compact Compliance Study |
| | IBCC | Scenario Planning and Adaptive Management |
| | | Water Supply Subcommittee efforts |
| Local | BRTs | Flaming Gorge Project Exploration |
| | | Aspinall Reservoir Operations Study |
| | | Project and Methods Study |
| | | Other BRT Studies |
| | CRWCD | Curtailment Modeling Study |
| | FRWC | Water Supply Planning efforts |
| | Multiple | Colorado River Water Bank Study |

To date, there has not been formal/structured coordination between all these studies. The objective of this task is to identify how the studies' technical objectives, analytical methods, and results can be applied to local and State-level technical analyses planned for Tasks 2 and 3, and to understand how the efforts may present benefits and/or concerns to CRWAS and the State. An example of benefits to the State includes CWCB IFWI Section and AECOM team coordination with the BRTs and the CWCB WSP Section to unite local-level and State-level water supply planning and evaluation activities. Knowledge gained from this task will help to minimize unnecessary technical overlap between complementary efforts.

**Approach:**

1.1 The AECOM team will complete the following tasks with respect to each of the studies listed above.

- Review study scopes and documentation.
- Meet with designated study leaders and/or study technical teams.
- Summarize study objectives, data needs, analytical methods, and results.
- Identify studies that may provide benefit or concerns to CWCB and CRWAS.
- Compare corresponding similarities and differences of study objectives, analytical approaches, and results.
- Summarize corresponding comparisons, benefits and concerns, and recommendations to CWCB on how the studies, in their current status, can be used to support Tasks 2 and 3 technical analyses.

1.2 A member of the AECOM team will attend strategic WSP Section, BRT, and IBCC meetings to understand technical details of local and State-scale water supply and demand scenarios and strategies and portfolios being developed by the BRTs. The technical details expected to come from these meetings will be used to

support Tasks 2 and 3 technical analyses. Attendance will be determined selectively (as approved by CWCB) based on meeting agendas and the importance to CRWAS objectives.

It is expected that scopes and key documentation of the studies will be provided to the AECOM team and that CWCB deliverable reviews and comments will be limited to two iterations with the AECOM team.

**Deliverables:**

1.1 An "interim" technical memorandum summarizing general study comparisons, benefits and concerns, and providing recommendations to CWCB on how the studies, in their current status, can be used to support Tasks 2 and 3 technical analyses. A "final" technical memorandum updated to reflect any changed status or results of the studies at the time of completion of the CRWAS schedule.

1.2 A technical memorandum summarizing general themes of key WSP Section, BRT, and IBCC meetings and corresponding recommendations on how meeting outcomes will be used for Tasks 2 and 3 technical analyses.

## Task 2 – Technical Analysis of Local-Level Issues

**Objective:**

As noted in the Scope Background, IBCC and CRWAS initiatives differ in geographic scale, data, methods, and tools used for their evaluations. Task 1 above provides BRT and IBCC coordination and State recommendations on how the BRT and IBCC Scenario Planning and Portfolio Strategy process (and several other studies) may be used for this task's technical analyses. Input from the BRT and IBCC process will be used to investigate future local-level water supply and demand imbalances and solution strategies by translating qualitative, large-scale BRT and IBCC information into quantitative CDSS analysis at a tributary and water user scale. Results of the task will provide local-level information needed for State-level technical analyses planned for Task 3. Analyses associated with this task include investigating methods to manage risk associated with future local-level supply and demand imbalances.

The objectives of each subtask below are to work with the BRTs to:

- Task 2.1 – Identify where future supply and demand imbalances are likely to exist at the local level.
- Task 2.2 – Incorporate BRT and IBCC strategies to meet imbalances.
- Task 2.3 – Investigate options to manage risk inherent to Task 2.1 imbalances and Task 2.2 strategies.
- Task 2.4 – Provide online applications to allow the public to view corresponding task data.

**Approach:**

2.1 Identify Supply and Demand Imbalances at the local Level

The AECOM team will build on CRWAS Phase I and BRT and IBCC efforts to investigate local-level water supply and demand imbalances by developing and modeling a set of future supply, demand, and water rights scenarios. Scenarios will be developed by reconciling viable combinations of future supply and demand scenarios

quantified through recent and ongoing CRWAS Phase I and BRT and IBCC Scenario Planning activities and initiatives. The scenarios will then be modeled with CDSS to identify where and when supply and demand imbalances occur. This will provide the basis to investigate strategies to meet those imbalances and methods to manage risk inherent to those strategies in Task 2.2.

These activities include iterative coordination between the BRTs, CWCB IFWI and WSP Sections, and the AECOM team to assure that the efforts help meet BRT objectives with solid technical support and modeling capabilities from the AECOM team. The AECOM team will meet with BRTs prior to modeling efforts to present approaches, solicit feedback, and gain support on establishing viable sets of demand and supply scenarios. This task will coincide with ongoing activities being completed by the BRTs.

a) Develop Supply Alternatives: The alternate hydrology developed in CRWAS Phase I (i.e. water supply alternatives) will be used as the initial set of supply alternatives for this task. The AECOM team will use knowledge gained from Task 1 to identify the CRWAS Phase I supply alternatives that are compatible with the five BRT and IBCC Scenario Planning supply alternatives and the 112 future supply alternatives developed through Reclamation's Colorado River Water Supply and Demand Study. A set of supply alternatives will be recommended to the CWCB and BRTs for use with the CDSS modeling.

b) Develop Demand Alternatives: The two (High and Low) BRT and IBCC Scenario Planning water demand alternatives will be used as the initial set of demand alternatives for this task. For informational purposes, the AECOM team will use knowledge gained from Task 1 to understand if and how these two water demand alternatives correspond to the six demand alternatives (i.e., "storylines") developed through Reclamation's Colorado River Water Supply and Demand Study. The FRWC will be consulted to help identify any other demand alternatives that may be analyzed, including preferred methods to represent future Front Range water demands and transbasin diversions in the CDSS. The AECOM team will disaggregate basin- and county-level demands to specific diversion locations. The assumptions and locations associated with disaggregation will be presented to the BRTs to solicit feedback and support to establish a set of demand alternatives.

c) Develop Water Rights Alternatives: The CDSS surface water model (StateMod) allocates water to meet demands based on water right priorities. Future demands will be compared to water rights, and water rights will be assigned to new and increased future demands for CDSS modeling, again in coordination with the BRTs. A set of water rights alternatives will be recommended to the CWCB and BRTs for CDSS modeling.

d) Evaluate Alternate Supply and Demand Scenarios: Alternate supply and demand scenarios represent unique combinations of supplies from Task 2.1a and demands from Task 2.1b. The AECOM team will use CDSS tools to represent and execute supply and demand scenarios established above to identify imbalances or shortages (i.e. "gaps") to demands. The BRTs identified critical reaches for non-consumptive uses; however, many of those needs have not been quantified. For non-consumptive uses, metrics will be used to identify how increased consumptive water demands affect physical flow and water available at key reach locations defined through coordination with the BRTs. Supply and demand imbalances will be summarized and categorized based on physical, legal, or structural (capacity) limitations. Model results will be summarized and presented to the BRTs and steps "a" through "d" will be reassessed in an iterative process with the BRTs to ultimately focus in on spatial supply and demand imbalances to be used as the basis to develop practical strategies in Task 2.2 below.

e) Implement CDSS Model Enhancements: The iterative BRT feedback process described above will likely identify local tributaries with water rights that are currently not explicitly represented in the CDSS model, but that may be required for the BRTs to develop strategies to meet the supply and demand imbalances. The AECOM team will use the knowledge gained from steps "a" through "d" above and recommend to the State and BRTs (through the iterative feedback process) CDSS enhancements to improve representation of the basin. The AECOM team will implement CWCB-approved enhancements. If new tributaries are represented, the AECOM team will review calibration and adjust, as necessary, to assure the base model adequately represents current conditions. CDSS model documentation will be updated, as necessary, to reflect base model revisions. Model updates recommended in Phase I will also be incorporated as appropriate.

## 2.2 Strategies to Meet Imbalances

After local-level supply and demand imbalances are identified in Task 2.1 before representing new supply strategies in CDSS, the AECOM team will work with the BRTs in a similar iterative feedback process to implement strategies to manage the imbalances in the CDSS models. This will involve coordination with the BRTs and CWCB WSP Section to complement ongoing efforts to establish Identified Projects and Processes (IPPs) and large-scale strategy portfolios. The AECOM team will coordinate with BRTs to present approaches, solicit feedback, and gain support for the following tasks.

- Translate viable BRT portfolios (including IPPs) into representative CDSS model criteria, relying on the water availability results from Task 2.1 supply and demand scenarios to further refine specific locations of strategies;
- Combine model criteria with Task 2.1 supply and demand alternatives to develop a set of CDSS model scenarios, and meet with BRTs and WSP Section to present and solicit feedback on the proposed CDSS model scenarios;
- Implement CDSS refinements that are consistent with the agreed-upon CDSS model scenarios;
- Execute CDSS simulations of the established model scenarios;
- Summarize model results and recommendations of strategies to meet supply and demand imbalances;
- Meet with BRTs to present results and recommendations and adjust strategies if/as needed.

## 2.3 Local Risk Management Analysis

The AECOM team will work with Colorado River stakeholders as appropriate to develop a common definition and purpose of local-level risk management using study information compiled in Task 1 and analysis of imbalances and strategies developed in Tasks 2.1 and 2.2. As this task requires input from various ongoing processes, details of the task approach are currently preliminary and will be refined as additional input is received. The following tasks will be implemented by the IFWS Section and the AECOM team in coordination with the BRTs and WSP Section.

- Propose a common definition and purpose of local-level risk management and examples of risk by water interests. Examples of risks associated with local supply and demand imbalances that must be managed at the local level include between consumptive and non-consumptive needs or building storage projects where water is available only in high-flow years or less available under projected climate conditions.
- Once a common definition and purpose of local-level risk management is defined, identify local-level risk management options that can be analyzed qualitatively and determine appropriate methods for analysis.
- Incorporate local-level risk management options that can be analyzed quantitatively using the updated CDSS models from Tasks 2.1 and 2.2 and other potential risk management tools, and develop a risk management analysis plan.

2.4 Data Viewing Applications

- Update the CRWAS Data Viewer database to allow online access to Task 2.1 and Task 2.2 model data and results.
- The Reclamation study team developed specialized methods to review and summarize thousands of simulations for the Colorado River Water Supply and Demand Study. Investigate the use of the software (Tableau) and display options to analyze specific results at defined locations to supplement the capabilities of the CRWAS Data Viewer, and develop corresponding CWCB recommendations.
- If determined useful by CWCB staff, develop custom database analysis graphics using Tableau.

It is expected that BRT scenarios and portfolios will be provided to the AECOM team in a form that the team can extract sufficient detail to develop viable model criteria, refinements, and scenarios, and that CWCB deliverable reviews and comments will be limited to two iterations with the AECOM team.

**Deliverables:**

2.1 A technical memorandum and presentation recommending, to the BRTs and CWCB, a set of supply, demand, and water rights scenarios and corresponding CDSS enhancements. A technical memorandum and presentation summarizing model results of spatial supply and demand imbalances and impact of the scenarios on BRT water supply planning objectives. A set of corresponding CDSS model input and output files and updated documentation.

2.2 A technical memorandum and presentation recommending, to the BRTs and CWCB, a set of strategy scenarios and corresponding CDSS enhancements. A technical memorandum and presentation summarizing model criteria, refinements, and simulation results summarizing model results of strategies to meet supply and demand imbalances. A set of corresponding CDSS model input and output files.

2.3 A technical memorandum summarizing general comparisons and recommendations to CWCB on common local-level risk management definition and purpose, examples, and plan to analyze risk management.

2.4 Updated model information made available through the CRWAS Data Viewer. A technical memorandum and presentation providing recommendations and examples to use Tableau to present and analyze select information from Task 2.1 and 2.2 modeling efforts. A set of Tableau input files.

## Task 3 – Technical Analysis of State-Level Issues

**Background:**

CRWAS Phase I initially included a task to estimate water available for Colorado to develop under the Colorado River Compact and the Upper Colorado River Basin Compact based on various supply scenarios, including climate projected hydrology. On-going studies, including Reclamation's Colorado River Supply and Demand Study, have begun to identify "signposts" that indicate that observable conditions can predict, in advance, that the flows at Lees Ferry may be depleted below 75 MAF over a 10-year period. Because these signposts can be used to anticipate a potential Compact compliance issue in real-time, the need to investigate probabilities related to Compact compliance (originally expected for completion in CRWAS Phase I) has been reduced. This study will not investigate

or predict water available for future development under the Colorado River Compact; instead it will investigate management options that can be implemented if and when signposts indicate a potential Compact compliance risk. This study may implement sensitivity analysis to explore the potential key future development strategies and how those strategies would be implemented according to potential future risks.

**Objective:**

The AECOM team will work with Colorado River stakeholders as appropriate to develop a common definition and purpose of State-level risk management using information compiled in Task 1 and developed in Task 2. Task 2 includes steps to work closely with BRTs to evaluate supply and demand imbalances, strategies to meet imbalances, and options to manage corresponding risk at the local level. This task will expand those activities to the State level focused on developing clarity in the evaluation of options to manage demands and risk to maintain compliance with the Colorado River Compact while allowing Colorado to continue to develop their water allocation. As this task requires input from various ongoing processes, details of the task approach are currently preliminary and will be refined as additional input is received. Timing of this task will coincide with results of demand management projects being implemented by others.

**Approach:**

3.1 Define definition, purpose, examples, and programs associated with State-level risk management concepts.

This task will first determine what the terms “demand management” and “risk management” mean to stakeholders with respect to maintaining compliance with the Colorado River Compact, ultimately to establish a common understanding of risk management for purposes of this study. Based on review of input from the State and stakeholders, the AECOM team suggests the following working definitions, purpose, and examples of specific risks and strategies associated with the risk management process to be used as points of departure.

<u>Definition and Purpose</u>

- *Demand Management:* During periods of sustained low natural flows, the States of the Upper Division will collectively and individually manage consumptive use to maintain compliance with the Colorado River Compact. This process of “demand management” is intended to avoid an “imposed curtailment” that would presumably follow a shortfall to the flow requirement of Article III(d) of the Colorado River Compact. Demand management presumably will involve “proactive curtailment” of consumptive use by the individual states. *CRWAS is not evaluating demand management options, which are being assessed by others*.
- *Risk Management:* Though less disruptive than an imposed curtailment, proactive curtailment will nevertheless impose disruption on water supplies within each state. Colorado will presumably adopt “risk management” actions intended to minimize and mitigate impacts of a proactive curtailment.

<u>Potential Examples of Risk</u>

- Cost of conservation and reuse
- Reliability of municipal supplies
- Interference or harm by new transbasin projects
- Harm to west slope economies, environment, and culture

Potential Examples of Risk Management Tools

- Development of new storage
- Re-operation of existing storage
- Water rights acquisition
- Acquisition with lease-back provisions
- Water conservation
- Water re-use
- Water banks
- Interruptible supply arrangements
- Insurance or related approaches
- Land and water trusts
- NGO or local government acquisition programs

Definitions, purposes, and example risks and strategies will be compared to highlight similarities and differences. A common definition, purpose, and example risks and actions will be proposed in consultation with State staff.

3.2 Develop a plan to analyze risk management.

Individual risk management tools must be feasible, effective, and accepted and must comply with Colorado law. The same is true for risk management strategies, which are combinations of tools in an overarching protocol. This task will involve evaluating individual risk management tools and formulating and evaluating candidate risk management strategies. The final scope of this task will be developed in consultation with CWCB staff. The following discussion provides a general description of the task as a point of departure for that consultation.

- *Review previous evaluations:* The first step in this analysis will be to compile and summarize existing studies of individual risk management tools. Many risk management tools have been or are being evaluated by other planning or academic studies. These evaluations will be compiled into a technical memorandum.

- *Refine evaluations:* Using the existing studies as a starting point, refine the evaluation of risk management tools. The attributes to be evaluated and the evaluation metrics will be developed in consultation with State staff and, as appropriate, stakeholders. Some tools, such as insurance and related approaches may require interaction with academic experts. Legal issues with tools will be evaluated through consultation with State staff. These evaluations will be compiled into a technical memorandum.

- *Formulate and evaluate candidate strategies:* Based on relative attributes of individual tools, formulate coherent strategies that address the spectrum of risk and provide acceptable levels of risk reduction and mitigation. Evaluate these candidate strategies against risk scenarios. The risk scenarios and evaluation metrics will be developed in consultation with State staff and the IBCC state process, and the appropriate, stakeholders. The candidate strategies and evaluations will be compiled into a technical memorandum.

**Deliverables:**

3.1 Common definitions, purpose, examples, and programs associated with State-level risk management concepts.

3.2 Technical memoranda summarizing previous evaluations, tools, and candidate strategies for risk management.

## Task 4 – Project Management

The CWCB IFWI Section will manage the Study for CWCB through the IFWI PM, Ray Alvarado. The AECOM team will work closely with the CWCB IFWI Section. The AECOM team Project Manager (PM), Blaine Dwyer, will manage project contract and subcontract elements and submit to the CWCB IFWI Section monthly invoices (including subconsultant invoices and status and summaries of budget, retainage, primary activities, and comments and concerns). The AECOM team Project Coordinator (PC), Matt Brown, will support the PM and provide regular communication and coordination with the CWCB and AECOM PMs for comprehensive project and team planning.

**Exhibit D**
**Task Budgets**
**Colorado River Water Availability Study Continuation**
**January 2013**

| **Task Description** | **Cost** |
|---|---|
| 1 – Application of Local, State, and Interstate Studies to CRWAS Technical Analysis | $ X |
| 2 – Technical Analysis of Local-Level Issues | $ X |
| 3 – Technical Analysis of State-Level Issues | $ X |
| 4 – Project Management | $ X |
| **Total all Tasks** | **$ X** |

**Exhibit E**
**Task Schedule**
**Colorado River Water Availability Study Continuation**
**January 2013**

| Task Description | Start* | End* |
|---|---|---|
| 1 – Application of Local, State, and Interstate Studies to CRWAS Technical Analysis | X/X/XX | X/X/XX |
| 2 – Technical Analysis of Local-Level Issues | X/X/XX | X/X/XX |
| 3 – Technical Analysis of State-Level Issues | X/X/XX | X/X/XX |
| 4 – Project Management | X/X/XX | X/X/XX |

* Start and end dates based on contract notice to proceed date. Schedules are expected to evolve based on availability of coordinating entities and individuals and timing of coordinating studies and activities.