MokeWISE Program Draft Memorandum:
Water Availability Analysis Methodology

Revision Date: 20 May 2014

Table of Contents

Methodology for Assessing Water Supplies

This section summarizes the proposed approach for establishing supplies from the following sources:

- Mokelumne River
- Other Surface Water
- Groundwater
- Agricultural Drainage Water
- Recycled Water
- Stormwater
- Water Conservation / Demand Management
- Desalination

All sources except for the Mokelumne River use the term available water. As it is used in MokeWISE, the term 'available water' is defined as water which is not being used for a defined purpose and is thus available to be used for projects or programs. The term 'unallocated water,' which is defined below, is used in the context of the Mokelumne River.

The proposed methodology will be reviewed by external peer reviewers as well as the Mokelumne Collaborative Group (MCG) and revised based on comments received prior to being implemented.

Mokelumne River

Previous efforts have evaluated the possibility of expanding use of Mokelumne River supplies through arrangements such as an in-river exchange or banking Mokelumne supplies in the Eastern San Joaquin Groundwater Basin. Before such opportunities can be explored, potential unallocated water from the Mokelumne River must be quantified. The proposed methodology to quantify and assess potentially unallocated water is described below.

Unallocated water, as it is used in MokeWISE, is defined as that quantity of water in the Mokelumne River that is not diverted pursuant to a riparian or pre-1914 appropriative water right and that is not required to be in the river pursuant to a prescribed regulatory requirement.

Task 1. Quantify flow in the Mokelumne River under varying conditions. The first step in determining how much water may be supplied for a project is to establish a shared understanding of how much water the model shows would have been in the river at different locations over the period of record (1953 – 2010), assuming existing channel losses, diversions, and instream flow requirements established by the FERC requirements for

Project 137, the Lodi Decrees and the Joint Settlement Agreement (JSA). This task involves utilizing the MOCASIM model to simulate in-river flow conditions using the hydrology for the period of record. Appendix A presents additional information on the MOCASIM model, including how the demands and flow requirements are prioritized.

Flows will be simulated for two conditions: a current and future baseline. The current baseline will be used to approximate in-river flows under current diversion levels. The future baseline will be used to approximate in-river flows under future projected levels of diversion based on existing planning documents.

Channel losses and instream flows required by the FERC requirements for Project 137, Lodi Decrees and JSA are automatically accounted for by the model logic based on hydrologic and storage conditions, as described in Appendix A. In contrast, diversions must be determined on a case-by-case basis and are a primary input to the model.

Based on discussions with the Modeling Workgroup of the MCG, the diversions assumed for each baseline will be defined as follows.

- Existing baseline: 2010 level of Mokelumne River diversions. 2010 diversions will be simulated based on historical diversions as shown in the table below.
- Future baseline: 2040 level of Mokelumne River diversions. 2040 diversions will be simulated based on projected diversions as shown in the table below. The inherent uncertainty in these numbers is understood.

Appendix A details how these diversions will be distributed both throughout the year and in varying year types.

Table 1: Diversion Assumptions for Current (2010) and Projected (2040) Baselines

Agency	2010 Baseline Diversions (AFY)	2040 Baseline Diversions (AFY)
Amador Water Agency (AWA)[1]	8,155	13,925
Calaveras County Water District (CCWD)[2]	2,030	2,030
Calaveras Public Utility District (CPUD)[3]	1,299	2,542
East Bay Municipal Utility District (EBMUD)[4]	241,920	257,600
Jackson Valley Irrigation District[5]	3,850	2,800
North San Joaquin Water Conservation District (NSJWCD)[6]	3,021	20,000
Woodbridge Irrigation District (WID)[7]	72,000	72,000
TOTAL	332,275	370,897

[1] 2010 diversions reflect 97% of historic and projected reported total water use in the AWA 2010 Urban Water Management Plan (UWMP), as 97% of supply is surface water from the Mokelumne River. Projected 2040 diversions are extrapolated from the AWA 2010 UWMP, which reports projected demands through 2030.

[2]Historic and projected diversions reflect actual and projected data presented in the CCWD 2010 UWMP. It should be noted that projected 2040 use could change significantly in future years, and projections are expected to increase in the 2015 UWMP. However, these are the best available projections currently.

[3]CPUD diversions are confirmed by CPUD and are based on the 2008 Master Plan and 2008-2013 usage summary.

[4]EBMUD 2010 and 2040 diversions based on information provided by the EBMUD Water Resources Division for Mokelumne Supplies.

[5]JVID shares a 5,000 AF right under CAWP with AWA and can currently take up to 3,850 AF. AWA anticipates increasing their portion of the right from 1,250 AF to 2,200 AF, which will decrease JVID's portion to 2,800 AF by 2040.

[6]NSJWCD 2010 diversion reflects actual diversions in 2010. Projected 2040 diversions based on existing capacity and projected demand.

[7]WID can currently take 60,000 AFY, plus additional spill (which is used for irrigation). In recent years, WID has reported diverting 72,000 AFY. The additional spill is obtainable under WID's pre 1914 water rights (1886), which entitle it to take 414 cubic feet per second (cfs) and additionally under the State Water Resources Control Board (SWRCB) Applications 5807 and 10240 and licenses 5945 and 8214, respectively, subsequent to EBMUD's Pardee filings but prior to the Camanche filings. The combined licenses, together with the pre-1914 rights, are limited to 414 cfs.

Model outputs will be compiled and presented in tabular and graphical formats.

Task 2. Quantify daily flow regime under current and future baseline conditions developed in Task 1. The MOCASIM model simulates flows on a daily timestep for the upper watershed and a monthly timestep for the lower watershed. Based on discussions with the MCG Modeling Workgroup, it was determined that, in order to understand the timing of high flow events and potential conveyance capacity needed to capture high flows, it will be necessary to estimate daily streamflow values in the lower watershed. As such, monthly hydrographs will be recreated for the period of record for flows downstream of Camanche Reservoir and applied to the MOCASIM output to estimate daily streamflow.

Daily streamflow from USGS gage 11323500 (Mokelumne River below Camanche Dam) will be processed to develop monthly and daily hydrographs from 1953 through 2010 (the period of record).

Task 3. Define amount of water remaining in the river both a monthly and a daily basis after accounting for diversions[1], channel losses, and instream flow requirements[2] for the historical period of record in the MOCASIM model (1953 – 2010), under both current and future baseline conditions[3]. Following completion of Tasks 1 and 2, Task 3 will evaluate flows remaining in the river, over and above diversions, channel losses, and instream flow requirements established by the FERC requirements for Project 137, the Lodi Decrees and JSA on a daily basis for the historical period of record in the MOCASIM model (1953 – 2010).

Future conditions which may reduce unallocated supply will also be considered.

Other Surface Water

While Delta supplies are currently fully subscribed and the potential to directly obtain additional Delta supply is limited, short-term and long-term transfer opportunities may be available through agencies not fully utilizing Delta supplies or upstream Delta water allocations. The recommended methodology to assess available Delta water supplies is as follows.

Task 1. Consult work previously conducted on transfer opportunities. East Bay Municipal Utility District (EBMUD), San Joaquin County, and other agencies will be consulted to determine what has been reviewed regarding short- and long-term transfer opportunities. These opportunities will be used as a starting point for engaging in dialogue with appropriative water right holders in the Delta who may not be using the full amount of their appropriative water right to the full capacity and may have some to sell. For example, there may be water available for use under WID's Delta right that could be taken, or under a right by the City of Stockton.

---

[1] Refer to Table 1: Diversion Assumptions for Current (2010) and Projected (2040) Baselines

[2] Instream flow requirements include those established by the FERC requirements for Project 137, Lodi Decrees, JSA and flow requirements added pursuant to State Water Resources Control Board (SWRCB) permits and licenses.

[3] This analysis shall offer no opinion, legal or otherwise, on the status or effect of existing or pending water rights held or applied for by parties participating in the MCG.

Task 2. Determine water available for short-term transfer. A short-term transfer is any transfer of one year or less. The State Water Resources Control Board (SWRCB) reported that the amount of available Through Delta Water Transfers in 2013 was 277,283 acre feet (AF), as seen in the table below. This table is provided solely to illustrate the type of transfers that may be available. The purpose of this task is to analyze transfer opportunities to estimate the likely amount of transfer water that would be realistically available. Additionally, the analysis will consider the frequency and timing for which short-term transfers may be available based on SWRCB historic date. Agencies involved in transfers and corresponding transfer volumes are shown in the table below (taken from the SWRCB website: http://www.swrcb.ca.gov/waterrights/water_issues/programs/water_transfers/docs/transfersrstable.pdf).

2013 Through-Delta Water Transfers

Participant	Application Number	Watershed Transferred From	Quantity (acre-feet)	Districts or Agencies Receiving Transfer Water	Date Received	Date Noticed	Comment Deadline	Deadline for Order Approval if No Comments Received	Deadline for Order Approval if Comments Received	Comment Received	Date Order Issued
Placer County Water Agency	18085, 18087	Sacramento	20,000	Westlands	4/23/2013	5/3/2013	6/3/2013	6/7/2013	6/27/2013	yes	6/27/2013
Pelger Mutual Water Company	12470B	Sacramento	1,730	San Luis & Delta Mendota	4/30/2013	5/3/2013	6/3/2013	6/14/2013	7/5/2013	yes	7/1/2013
Department of Water Resources/	14443	Trinity/Delta/	196,000	Santa Clara, Metropolitan	5/1/2013	5/7/2013	6/6/2013	6/17/2013	7/5/2013	yes	7/1/2013
U.S. Bureau of Reclamation**	22 applications	San Joaquin		Oak Flat, Del Puerto, Kern County							
(joint petition)				Kern Tulare, San Luis, Arvin Edison							
				Westlands, Castaic Lake							
Tule Basin Farms	10030	Sutter Bypass	3,520	Kern County, Dudley Ridge,	5/1/2013	5/7/2013	6/6/2013	6/17/2013	7/5/2013	yes	7/1/2013
				Empire-West Side							
Garden Highway Mutual Water	1699	Feather River	5,000	Kern County, Dudley Ridge,	5/1/2013	5/7/2013	6/6/2013	6/17/2013	7/5/2013	yes	7/1/2013
Company				Empire-West Side							
Eastside Mutual Water Co.	11274	Sacramento	1,100	San Luis & Delta Mendota	5/3/2013	5/8/2013	6/7/2013	6/17/2013	7/8/2013	yes	7/1/2013
Reclamation District No. 1004	27	Sacramento	7,175	San Luis & Delta Mendota	5/3/2013	5/8/2013	6/7/2013	6/17/2013	7/8/2013	yes	7/1/2013
Pleasant Grove-Verona Mutual	7641A	Sacramento	2,000	San Luis & Delta Mendota	5/6/2013	5/9/2013	6/10/2013	6/20/2013	7/10/2013	yes	7/1/2013
Water Company	7641C		500	(combined total of 8,100 af)							
	15858		1,000								
	15856A		1,572								
	15856B		1,420								
	15856C		1,624								
	15606		412								
Conaway Preservation Group	12073B	Sacramento	8,000	San Luis & Delta Mendota	5/6/2013	5/8/2013	6/7/2013	6/20/2013	7/10/2013	yes	7/1/2013
David & Alice te Velde Revocable	3423	Sacramento	1,320	San Luis & Delta Mendota	5/8/2013	5/15/2013	6/14/2013	6/24/2013	7/12/2013	yes	7/2/2013
Family Trust	4901		4,000	(combined limit of 4,000 af)							
	4902		1,480								
Merced Irrigation District	1224	Merced River	15,000	San Luis Water District &	7/12/2013	7/18/2013	8/19/2013	8/26/2013	9/15/2013	yes	9/13/2013
				Westlands Water District							
Merced Irrigation District	1224	Merced River	1,500	San Luis National Wildlife Refuge	7/17/2013	7/24/2013	8/23/2013	8/31/2013	9/20/2013	yes	9/13/2013
		Total	**277,283**								

** Involves water moved South of Delta prior to submittal of transfer petitions

Water obtained through short-term transfers from water users upstream of the Delta could be taken out by EBMUD through the Freeport intake and conveyed to the watershed through the Folsom South Canal and the Mokelumne Aqueducts. Woodbridge Irrigation District (WID) and Stockton also have possible transfer opportunities, and at a potentially lower cost than Freeport.

Task 3. Determine water available for long-term transfer. Long-term transfer arrangements are possible to develop. For example, EBMUD is currently working with Placer County Water Agency to develop a long-term transfer agreement. This work was initiated in 2013 and is expected to be complete by 2017. To determine water available through long-term transfers, the first step is to identify agencies that have already been engaged in transfers and exchanges by reviewing the recent transfers and talking with the SWRCB about others engaged in long-term transfers. After identifying these agencies, meetings with individual agencies would be needed to determine the volume of available supply that may be available long-term as an incremental supply. Future conditions which may reduce available supply will also be considered. In addition, the analysis will consider the frequency and timing of such available supply. If institutional or other approval requirements associated with transfers are assessed, the ability of that supply to be conveyed will be considered.

Task 4. Evaluate other exchange and Delta water opportunities. Other upstream Delta exchange opportunities may be available, such as transfers with agencies that have current water rights and are seeking funding assistance to implement or expand recycled water delivery. Delta water may also be available in years when it is not fully subscribed. For example, in 2011, the Delta was in surplus. Use of additional recycled water by upstream agencies can allow additional water to be diverted at an intake such as Freeport. For example, Yuba City is one potential agency to target for investigation of exchanges, given their plans to expand recycled water usage combined with their funding needs and this task would include a coordination meeting with them to further understand plans and identify opportunities. Additionally, Urban Water Management Plans (UWMPs) and Recycled Water Master Plans (RWMPs) from upstream agencies can be reviewed to determine whether other agencies are in a similar position of planning to expand water recycling to offset potable supplies. Once agencies and projects have been identified, the volume of exchange water can be estimated.

Groundwater

The proposed process for understanding available groundwater supply in the Mokelumne Watershed and adjacent areas involves collecting information about the basins' current conditions based on existing studies and information. The following tasks summarize the approach to assessing groundwater supply availability.

Task 1. Document existing groundwater conditions. Information about the current conditions of the groundwater basins underlying the project area (including both Western Calaveras and Amador Counties, and Eastern San Joaquin County groundwater basins) will be collected from available groundwater management plans, UWMPs, groundwater models, other groundwater resource evaluations, and relevant agencies. In evaluating the available groundwater information, including information about current groundwater levels, data gaps will also be identified and reported.

Agricultural Drainage Water

Agricultural drainage water is excess irrigation water collected from agricultural field drainage systems.

Task 1. Quantify supplies from agricultural drainage. Traditionally, agricultural drainage water may have been a source, but due to more efficient agricultural irrigation practices, it is no longer considered a viable available source. While it is recognized that there may be a need to flush agricultural soils in the future due to salt build-up, thereby creating agricultural drainage water, these practices are not currently being implemented and the quantity and quality of water required for this purpose is unknown. This Task involves collecting data from the State and Regional Water Quality Control Boards to review the amount of agricultural drainage water and determine whether it is a viable potential source of supply.

Recycled Water

Treated wastewater is currently available in Lodi and Stockton and could be used for landscape or agricultural irrigation and other uses which would offset groundwater use or Mokelumne River or Delta supplies. Other areas with collected and treated wastewater flows that could be utilized for irrigation or other potable offset purposes include EBMUD's Upcountry recreation areas, areas throughout Amador and Calaveras Counties, and other smaller towns such as Jackson, Mokelumne Hill, and Ione. Additionally, a recycled water exchange is a potential through EBMUD; by implementing expanded recycled water, EBMUD could potentially offset use of Mokelumne River supply.

The following tasks will be completed to evaluate potential recycled water use.

Task 1. Determine the volume of treated wastewater within the watershed. Recycled water is produced from treated wastewater. As such, the first step in the analysis is to identify the wastewater treatment plants (WWTPs) within the watershed, their current treatment processes and whether they meet Title 22 standards, and the amount of treated wastewater discharged by the WWTPs. The identified WWTPs, processes, and flows will be summarized in a table.

Task 2. Identify recycled water volume used currently and planned for future use. There are several recycled water projects underway in the watershed, and plans for more. In this task, the existing and planned recycled water projects (and corresponding flows) will be identified and cataloged. Data will be collected from existing RWMPs including the Stockton-Lodi RWMP and Amador Water Agency's Regional Reclamation Study (as well as other RWMPs identified by stakeholders) and relevant 2010 UWMPs to understand existing and planned future recycled water projects. Existing utilized recycled water flows and planned recycled water project flows will be documented in the table described in Task 1.

Recycled water projects which are already planned to meet 20x2020 requirements will be noted as these projects will not create additional water available in the future for beneficial uses.

Task 3. Identify opportunities and constraints for using recycled water. In this task, opportunities and constraints will be identified that impact the use of additional recycled water. For example, the City of Stockton under the Section 1485 water right must discharge treated wastewater in order to maintain its full water right, since the water right is based on the amount of treated effluent discharged from the wastewater treatment plant, effectively limiting the potential benefit of recycled water by impacting surface water rights.

Constraints associated with recycled water use include the level of wastewater treatment required and potential impacts to instream flows through reduced discharge. For example, if a WWTP is only treating to the secondary level, then recycled water of the appropriate quality (Title 22 Standards) may not be currently available; however, the opportunity may exist to upgrade treatment and produce higher quality and therefore more usable recycled water. In contrast, increasing recycled water use may reduce discharges and therefore have potential impacts to instream flows. The analysis will also qualitatively consider constraints on this source, including any adverse downstream impacts and potential treatability.

Task 4. Identify exchange opportunities with recycled water. EBMUD may have the ability to utilize recycled water downstream or outside of the Mokelumne watershed, offsetting Mokelumne supplies. In this task, EBMUD exchange opportunities will be explored to determine if there is potential to expand recycled water use beyond that currently planned by EBMUD to offset Mokelumne supplies.

Task 5. Summarize available recycled water findings. In this final task, the amount of available recycled water will be estimated through a volumetric balance of the flows documented in tasks 1-4. This estimated volume will be considered the available recycled water flow.

Stormwater

There is a significant amount of rainfall within the Mokelumne watershed. Much of this precipitation becomes overland flow and infiltrates into the land surface, or becomes overland flow and makes its way to the watercourses and eventually the Mokelumne River. The stormwater runoff component that is not currently captured or infiltrated may be able to be utilized for beneficial use. To quantify the available stormwater, the following tasks will be completed.

Task 1. Identify areas with the greatest concentration of impervious area. Areas with the greatest concentrations of impervious surfaces with stormwater that could potentially and realistically be captured will be identified by review of aerial maps. For more urban areas, an average percentage of impervious area will be determined. Smaller communities will be assumed to have 0.25 times the impervious area of the more urban areas.

Task 2. Determine the average annual rainfall on impervious areas within the watershed. First, average annual precipitation in the watershed will be quantified using local weather data available from California Data Exchange Center (CDEC) and California Irrigation Management Information System (CIMIS).

In general, only precipitation that falls on impervious areas is available for capture and use. Impervious areas are streets, roads, parking lots, populated areas, some of which may be impacted by contaminants such as Volatile Organic Compounds (VOCs), and others that collect stormwater through a network of stormdrains which eventually discharge to local creeks or the river. Precipitation reaching pervious areas will tend to infiltrate and supplement the groundwater supply, and therefore will not be readily captured for alternate use.

However, not all precipitation on impervious surfaces will be able to be captured. Some precipitation will be lost to infiltration, transpiration, evaporation, and depression storage; while other precipitation will exit the system through overland flow runoff due to lack of stormdrain infrastructure. Runoff percentages will be estimated based on the type of drainage area from the Caltrans Highway Design Manual (Table 819.2B) and applied to the flow estimate. A percentage of other losses will be assumed at 50% and applied to the overall volume estimate.

This information will be used in conjunction with rainfall data to estimate the portion of precipitation falling on impervious areas and therefore potentially available for capture.

Task 3. Evaluate mechanisms/programs and other constraints that may affect stormwater capture volumes. The final step is to determine the type of program to be implemented to capture stormwater: either large-scale capture and treatment projects, or small-scale onsite capture programs (such as rain barrels).

Large-scale programs would be located in urban areas at high-volume stormdrain outlets, and would include capture, storage, treatment (as necessary), and reuse of the collected stormwater flows. The number of collection areas targeted would affect the total volume of capture.

The other potential option for stormwater capture would be a smaller-scale option utilizing low impact development (LID) principles and implementing onsite systems such as rain barrels and cisterns. Onsite rain barrels at the residential level could be widely implemented if incentives are offered to homeowners, and rainwater captured and used onsite for irrigation or other uses would constitute a one-to-one exchange for potable supply in some cases. The scale of program roll-out would factor into the total volume of capture.

The analysis will also qualitatively consider constraints on this source, including any adverse downstream impacts, potential treatability, and water rights issues.

Task 4. Identify existing stormwater programs. The City of Lodi and other watershed agencies have stormwater programs underway, some of which address stormwater capture. Under this task, stormwater programs within the project area will be reviewed and catalogued. If available, estimates of stormwater supplies captured and available for reuse through these programs will be documented.

Water Conservation / Demand Management

Cities, agencies and districts throughout the project area are implementing aggressive conservation programs as outlined in their 2010 UWMPs and Agricultural Water Management Plans (AWMPs). For example, Woodbridge Irrigation District (WID) recently implemented a drip irrigation conversion program. Through this program, WID has made available 6,000 acre-feet per year (AFY) of Mokelumne River supply to the City of Lodi at a cost of $200/AF. The funds secured from this transfer were used to fund the Woodbridge Diversion Dam replacement. Conserved water is a direct one-to-one offset of potable supplies. In this task, the amount of water being conserved through implementation of conservation Best Management Practices (BMPs) will be estimated for the watershed. Water conservation and demand management projects which are already planned to meet 20x2020 requirements will be noted as these projects will not create additional water available in the future for beneficial uses.

Task 1. Identify conservation BMPs and the level of implementation within the watershed. The first step in estimating conserved water volume is to coordinate with agencies within the watershed to identify the level to which BMPs within the 2010 UWMPs and relevant AWMPs are being implemented. Following this understanding an estimate of current conservation will be developed.

Task 2. Identify expanded opportunities for conservation. The next step is to identify additional opportunities to maximize conservation. In this task, the BMPs not being implemented will be catalogued and a basic feasibility determination will be made based on cost-effectiveness and implementability considerations. The potential volume of conservation achievable through each non-implemented BMP will be estimated utilizing studies and information from existing sources such as the California Urban Water Conservation Council (CUWCC). Both urban and agricultural BMPs will be evaluated.

Particular attention will be paid to the appropriateness of agricultural water conservation measures. For example, conversion to drip and sprinkler irrigation is not suited for all crop types. Additionally, another common on-farm water conservation method - tail water return systems - may have the unintended consequence of removing a recharge source for groundwater thus not resulting in a supply benefit. Finally, implementing agricultural water conservation in areas overlying an overdrafted groundwater basin may have the unintended consequence of reduced groundwater recharge. As such, it will be important to identify the potential impacts in conjunction with benefits when assessing the appropriateness of various conservation BMPs.

The analysis will also qualitatively consider constraints on this source, including any adverse downstream impacts and potential treatability.

Desalination

Groundwater demineralization (which uses desalination plant technology on a smaller scale) should be assessed for feasibility within the watershed. Additionally, a regional desalination project has been initiated in the Bay Area which presents an opportunity for collaboration and potential water supply through exchange. The preliminary approach for assessing desalinated supplies is as follows.

Task 1. Identify potential groundwater demineralization opportunities. In this task, groundwater quality data will be collected and reviewed to identify areas of brackish or saline groundwater that may present demineralization opportunities. Relevant agencies within the watershed will also be consulted. Areas with water that is too saline to be used will be identified to determine whether the supplies may be used with demineralization.

Constraints including disposal of the waste stream resulting from desalination and the resulting effect on salinity intrusion will be qualitatively addressed in the discussion.

Task 2. Assess regional desalination partnerships. The Bay Area Regional Desalination project is currently underway, evaluating feasibility of a regional desalination facility in the San Francisco Bay Area. EBMUD is already a partner on the regional desalination project. As such, an exchange opportunity may be available through participation in this effort.

Task 3. Quantify potential supplies from demineralization and desalination. The scale of a demineralization opportunity will be estimated by analyzing nearby demineralization projects with similar groundwater basin characteristics, such as the Livermore-Amador Valley Demineralization Plant operated by Zone 7 Water Agency. The size of a potential demineralization plant will determine the potential available supply yield. For estimating desalination supplies, regional desalination planning documents will be reviewed to determine the estimated volume of desalinated water that is available for transfer or exchange.