

EXHIBIT WR-11
TESTIMONY OF JEFFREY YEAZELL

My name is Jeffrey Yeazell. I am a Professional Engineer registered in California, and a Water Resource Control Engineer with the State Water Resources Control Board (State Water Board), Division of Water Rights (Division). I have worked in the Division since August 2013, and my primary duties have included collecting, organizing, and maintaining water supply and demand data, and conducting water availability analyses based on the data. A copy of my resume is Prosecution Team Exhibit WR-12.¹

My testimony, provided herein, identifies my personal knowledge of the evidence, actions, and rationale for the recommendation of Division staff that a Cease-and-Desist Order (CDO) be issued against West Side Irrigation District (WSID) and that an Administrative Civil Liability complaint (ACLC) be issued against Byron-Bethany Irrigation District (BBID).

My primary function during Water Year 2015 (October 1, 2014, through September 30, 2015) was to conduct water availability analyses for various scenarios as directed by my supervisors Brian Coats, Kathy Mrowka, and John O'Hagan.

The purpose of these analyses was to determine whether Division staff should recommend water curtailments in particular watersheds during 2015. I was primarily responsible for collecting and evaluating the relevant data, and my witness statement primarily describes that process.

The ultimate result of the water availability analyses for 2015 was a determination that there was not sufficient water available to satisfy two particular categories of right: Post-1914 appropriative rights, and Pre-1914 appropriative claims of right dating back through 1903. The data I collected, organized, and analyzed to assist in these determinations produced graphs comparing water supply to relevant demand in the various watersheds. These graphs demonstrated the lack of sufficient water going forward through the water year and formed the basis for the notices that went out to certain right holders in certain watersheds advising of the lack of water, as explained in the testimony of Brian Coats (WR-9) and Kathy Mrowka (WR-7). My testimony focuses on the specific data analyzed and how water availability graphs were generated.

¹ Prosecution Team Exhibits are referred to as WR-[exhibit number].

The resulting graphs from two analyses relevant to this hearing are identified as Exhibits WR-47 and WR-48. Exhibit WR-47 illustrates the supply/demand analysis in the Sacramento River Basin and Delta used in the decision making process to support issuing the May 1, 2015, Notice of Water Unavailability. Exhibit WR-48 illustrates the supply/demand analysis for the Sacramento River Basin, San Joaquin River Basin, and Delta used in the decision making process to support issuing the June 12, 2015, Notice of Water Unavailability. Exhibit WR-46 illustrates a similar supply/demand analysis used in the decision making process to support the April 23, 2015, Notice of Water Unavailability, although that Notice is not relevant to the WSID CDO or the BBID ACLC. Exhibits WR-46 through WR-48 are all true and correct copies.

In my witness statement, the term 'Diversion' refers to reported water diversions of the various right holders, as explained in the testimony of Brian Coats (WR-9). 'Demand' refers to the diversion amounts used in the water availability analyses after the reported diversions have been adjusted, as described below and in the testimony of Brian Coats. The steps I took to develop the demand data set, collect the water supply data, and create the water supply/demand graphs are described below.

DEVELOPMENT OF WATER DEMAND DATA SET

Data Collection

For water availability analyses in Water Year 2015, I collected and organized data relating to the supply of water to the relevant watersheds and compare it to the relevant demand of the water right holders. I developed the Water Rights Use Data Set (WRUDS). The current form of the WRUDS is a Microsoft Excel Workbook (the *WRUDS Workbook*). It is a living document, and is modified as additional information is made known to Division staff. The version of the WRUDS workbook used for the water availability analysis associated with the May 1, 2015, Water Unavailability Notices is named 'WRUDS_DB 2015-04-06.xlsx' (Exhibit WR-68 is a true and correct copy). The version used for the water availability analysis associated with the June 12, 2015, Water Unavailability Notices is named '20150615_info_order_demand.xlsx' (Exhibit WR-51 is a true and correct copy). Copies of both workbooks were provided to WSID and BBID in the Division's Public Record Act request disclosure. The purpose of WRUDS is to provide a single source of demand information that can be queried through filters and worksheet calculations to generate subsets and summaries of data to help answer questions posed by Division staff and Management relating to the availability of water to satisfy the various categories of water rights.

Water right information is maintained in the State Water Board's Electronic Water Rights Information Management System (eWRIMS) and eWRIMS Report Management System (RMS). eWRIMS is a computer database developed by the State Water Board to track information on water rights in California. It contains information on Annual Reports and Statements of Water Diversion and Use that have been filed by water diverters, as well as registrations, certificates, and water right permits and licenses that have been issued by the State Water Resources Control Board and its predecessors. RMS has an online portal that is used by diverters to submit information regarding their diversion and use of surface water. eWRIMS and RMS are referred to collectively hereafter as 'eWRIMS.' Currently, statement holders (those with Riparian² and/or Pre-1914 claims of right) are required to submit monthly diversion and use data every three years. Permittees and Licensees (those having or are in the process of obtaining Post-1914 Appropriative rights) are required to submit monthly diversion and use data on an annual basis (California Water Code Sections 5101 and 5104; California Code of Regulations, Title 23, Sections 910, 920, 925, and 929). The Division relies on this submitted information to be true and accurate to the best of the diverters' knowledge.

Monthly diversion and use data reported by right holders were downloaded from the Water Board's eWRIMS/RMS databases for the years 2010 through 2013 as a comma-separated values (CSV) electronic file ('erims data request 022615.csv,' true and correct copy included as Exhibit WR-70, and referred to herein as the 'eWRIMS raw data file'). The eWRIMS raw data file was provided by the Division of Water Rights Reporting and Fees Unit on February 26, 2015. A copy of this raw data was provided to WSID and BBID as a zip-compressed file as part of the Division's Public Record Act request disclosure.

The raw data file contains data for the entire state. In anticipation that 2015 water shortage notices may be issued in the same areas as those issued in 2014, I extracted the data for water rights within the Sacramento, San Joaquin, Eel River, Russian River, and Legal Delta watershed³ areas for separate analysis.⁴ Water rights that were inactive or revoked, or otherwise not active, as well as stock pond, livestock, and other similar minor water right types were removed from the data set.

² In this document, Riparian claims of right include claims that are reported in eWRIMS as solely Riparian as well as claims that are reported as both Riparian and Pre-1914.

³ A watershed is the area of land that includes a particular river or lake and all the rivers and streams that flow into it.

⁴ Ultimately, notices of water unavailability were not issued in the Eel and Russian River watersheds in 2015.

Quality Control Review

The eWRIMS raw data file (Exhibit WR-70) contained records identified by Point-of-Diversion (POD).⁵ Whereas Riparian and Pre-1914 claims have a single POD associated with each claim, Post-1914 water rights can have multiple PODs, and, therefore, multiple records in the raw data file for the same water right. The records contain identical data in all fields except the POD identification number field (a unique POD identification number is assigned to each POD in EWRIMS). WRUDS was designed to use the Application ID (for Post-1914 rights) and Statement ID (for Riparian and Pre-1914 claims) as the unique identifier for each water right. For Post-1914 rights with multiple PODs that were located in the same watershed, all but one record were removed so that one representative record for each right remained. For rights with multiple PODs located in more than one watershed, the watershed in which the majority of the PODs resided was designated as the primary watershed associated with that water right. In case of a tie, the primary watershed was assigned by alphabetical order. Prior knowledge of POD locations and diversion types were considered when assigning the watershed, when applicable.

Each right was assigned an Analysis Area that identifies the evaluation area to which the water right was assigned. The following table shows which watersheds were assigned to each area:

Analysis Area	Watershed(s)
Sacramento	American River, Ball Mountain, Bear River, Butte Creek, Cache Creek, Colusa Basin, Cortina, Eastern Tehama, Feather River, Marysville, McCloud River, Mountain Gate, Pit River, Putah Creek, Redding, Shasta Bally, Shasta Dam, Stony Creek, Tehama, Upper Elmira, Upper Sacramento, Valley American, Valley Putah Cache, Whitmore, Yuba River
San Joaquin	Ahwahnee, Delta-Mendota Canal, Gopher Ridge, Lower Calaveras, Mariposa, Merced River, Middle Sierra, Middle West Side, Mountain Gate, North Diablo Range, North Valley Floor, San Joaquin Valley Floor, Stanislaus River, Tuolumne River, Upper Calaveras, San Joaquin Delta South of Mossdale Bridge
Legal Delta	Sacramento Delta, San Joaquin Delta North of Mossdale Bridge, Suisun diversions within Legal Delta boundary
Eel	Eel River
Russian	Russian River

⁵ A Point of Diversion is a place on a body of water from which water is removed.

In general, the monthly demand for each water right was calculated as the average monthly diversion over the four years of data. For example, the June diversions reported by West Side Irrigation District under License 1381 were 3,442 acre-feet in 2010, 3,182 acre-feet in 2011, 3,320 acre-feet in 2012, and 3,163 acre-feet in 2013, resulting in an average monthly diversion for June of 3,277 acre-feet. The same calculation was applied for each of the other 11 months.

In developing the demands used in the water availability analyses, consideration was given to likely over-reporting errors, power-only diversions, and potential duplicate reporting, as described below.

Over-reporting: In the eWRIMS dataset, some Post-1914 appropriative right-holders have reported diverting over 1,000,000 times their Face Value, and some Riparian and/or Pre-1914 claimants have reported diverting over 40,000 times an assumed worst-case water duty of eight acre-feet/acre. In order to compensate for over-reporting, I wrote equations in the *WRUDS Workbook* that would make the following adjustments to the average monthly diversions for each water right, if needed:

- Post-1914 Appropriative Rights: If the annual average diversion (the sum of the 12 monthly average diversions) was greater than the associated Face Value (the total annual amount of diversion authorized by the Post-1914 permit or license), a reasonableness factor was calculated by dividing the annual average diversion by the Face Value. The monthly average diversions were then divided by the reasonableness factor to provide the monthly demands, whose sum equals the Face Value. For instance, using the data in the 'WRUDS 2015-04-06' tab (the first tab) of Exhibit WR-68, WSID's annual average diversion was calculated to be 21,173 acre-feet. The annual Face Value of WSID's license is 27,000 acre-feet (see Exhibit WR-112, Amended License 1381 for Diversion and Use of Water); therefore, no adjustment to WSID's monthly average demand was necessary and the monthly average diversions were used as-is for the monthly demands for the water availability analyses.
- Riparian/Pre-1914 Claims: There are no Face Values associated with Riparian and/or Pre-1914 claims; however, many of them have net acreage reported in their eWRIMS record. The net acreage is the amount of land in acres that is available for farming, and therefore, irrigation. If the annual average diversion resulted in a water duty (the amount of irrigation water required to mature a particular type of crop) greater than eight (8) acre-feet/acre (the annual average diversion divided by the net acreage), the monthly diversions were reduced proportionally so that the average annual demand would provide the 8 acre-foot/acre annual water duty.

These two adjustments were only applied on water rights that had a face value or net acreage value greater than zero.

Power-Only Diversions: For each water right in the data set that listed Power as a beneficial use, I reviewed the right's information available in the EWRIMS system, such as permits, licenses, initial and supplemental statements, to establish whether the beneficial use could be considered solely for power (other minor beneficial uses, such as domestic for 10 people, were also considered power-only). If the use was considered power only, it was flagged as such in the Power Only field of the 'WRUDS' worksheet. If the water right only had point(s) of direct diversion, a non-consumptive use was assumed, and the Diversion Factor was set to 'None,' which instructed the worksheet, through Excel cell formulas, to set the monthly demands to zero. An example of a non-consumptive use would be a hydropower plant diverting water from a river, running it through the turbines to generate electricity, then releasing the water back into the river—no water was permanently removed from the river system. If the water right had diversion to storage or a combination of diversion to storage and direct diversion, a variable consumptive use was assumed, and the Diversion Factor was manually set to 'Net.' This would instruct the worksheet to compare the amount diverted and the amount stored. If, in a given month, the amount diverted was greater than the amount used, the difference was considered as a consumptive use, and was entered as the demand for that month. If the amount diverted was less than the amount used, a release of stored water was assumed, and the demand was entered as zero for that month.

Duplicates: Water rights were tested for potential duplicate reporting. If more than one water right had the identical owner name, and each of the twelve monthly average diversions were identical, the rights were flagged as potential duplicates in the Duplicate Flag field. Annual reports were reviewed in eWRIMS for evidence supporting duplicate reporting. If the evidence was compelling, such as the diverter explicitly stated that the amounts are duplicates, then all but one right were flagged as true duplicates in the Duplicate Result field. The demand was kept for the un-flagged duplicate and the demand was removed for the remaining duplicates by setting the Diversion Factor to 'None,' which instructed the worksheet to set the monthly demands to zero. If the potential duplicate group of rights were determined not to be duplicates, the demand was not removed, and the value 'N' was entered into the Duplicate Result field to signify it was reviewed. The Duplicate Notes field provides brief justifications of how the potential duplicates were handled.

Other Adjustments

If adjustments to demands and/or other fields in a water right record were needed other than those described above, the record was duplicated on the 'Manual Additions' worksheet, and then the original record was removed from the 'WRUDS' worksheet. The appropriate fields were then modified, comments regarding the adjustments were entered in the Notes field, and the record was then copied back to the main 'WRUDS' worksheet. For example, Statement S008720, located in the Upper Sacramento watershed, reported excessive diversion amounts for the indicated Domestic and Fire Protection purposes of use (138,000 acre-feet reported as diverted in 2013, as compared to an estimated average household domestic use of 0.4 acre-feet).⁶ The net acreage for this diversion is listed as zero acre-feet in EWRIMS (and, therefore, also in the raw data file), so the evaluation formulas written into the 'WRUDS' worksheet did not catch this discrepancy (the potential for excess irrigation is only evaluated if the net acreage is greater than zero). On further review of the claim's Initial Statement, Division staff determined that the diversions from this POD were negligible, and therefore removed from the demand data set.

Data was also adjusted to reflect comments raised by stakeholders. See the written testimony of Brian Coats (WR-9).

Information Order 2014 Demand

After the 'WRUDS' worksheet using the 2010-2013 averaged data was created, I incorporated the 2014 demands provided by the Riparian/Pre-1914 diverters subject to Informational Order WR 2015-0002-DWR (Information Order; WR-30). The Information Order was sent to 1,061 Statement holders representing the top 90% of reported Riparian and Pre-1914 demand in the Delta, and the top 90% of reported Riparian and Pre-1914 demand in the Sacramento and San Joaquin watersheds. The order required, among other items, that those diverters report their actual diversions for 2014 and forecasted diversions for 2015. For those diverters that reported, the 2014 values replaced the 2010-2013 averaged demands in the WRUDS data set. The basis of the informational order is described in the testimony of Brian Coats (WR-9). The 2014 Information Order demands were incorporated differently for the WRUDS data sets associated with the May 1 and June 12 notices, as described below.

⁶ Source: Aquacraft, Inc. Water Engineering and Management, *California Single Family Water Use Efficiency Study*, June 1, 2011 (Exhibit WR-71 Page 26 [page 25 of the document]; WR-71 is a true and correct copy of the entire document; the Hearing Team's hard copies contain only the relevant page. I obtained and reviewed this document after my November 13, 2015, deposition.

May 1, 2015 Notice: The 'order_div_2014' worksheet (the sixth tab in Exhibit WR-68) contains the combined Riparian and Pre-1914 monthly diversion amounts for 2014 as reported by the 1,025 responses, out of the 1,061 Riparian and Pre-1914 claims that were issued the order. For the May 1 water availability analyses, there was no need to separate the two senior diversion types. The formulas written in to columns EV through FG (January through December Monthly Demands) of the 'WRUDS 2015-04-06' worksheet (the first tab of Exhibit WR-68) replace the demand values with those from the 'order_div_2014' worksheet if the INFO_ORDER and RESPONDED fields (columns S and T) are both flagged 'Y.'

June 12, 2015 Notice: The 'IO Riparian 2014' and 'IO Pre-14 2014' worksheets (the 7th and 8th tabs in Exhibit WR-51) contain the monthly Riparian and Pre-1914 2014 demands, respectively, as reported by the diverters who responded to the order. I added two fields to the 'WRUDS' worksheet to track the status of the rights that were subject to the Information Order: the Information Order field is flagged if a diversion is subject to the Information Order, and the Information Order Response field is flagged if a response was received. I merged the 'IO Riparian 2014' and 'IO Pre-14 2014' worksheets into the 'IO Demands' worksheet, and populated it so that it contained the same fields and matching values for each record in the 'Demands' worksheet excluding the monthly diversion and use amounts. Instead, the average demands are replaced by the 2014 Information Order diversions. If a diverter reported both riparian and Pre-1914 diversions, two records for that right would appear in the 'IO Demands' worksheet, one with the Riparian field flagged, and the other with the Pre-1914 field flagged. I then removed the associated records from the 'WRUDS' worksheet and replaced them with the updated records from the 'IO Demands' worksheet.

WATER SUPPLY AVAILABLE FOR DIVERSION

I maintained a Microsoft Excel workbook of daily Full Natural Flows (FNFs) reported on the State of California Department of Water Resources' (Department's) CDEC website, and FNF forecasts provided by the Department on a monthly basis from February through May each year (see written testimony of Stephen E. Nemeth, Kathy Mrowka, and Brian Coats). The workbook is named 'WY 2014-2015 CDEC Supply Tables.xlsx' (Exhibit WR-72 is a true and correct copy), referred to herein as *CDEC Supply Tables*, a copy of which was provided in the Division's Public Record Act request disclosure. It is a living document, and was modified as additional information is made available by the Department and/or on the CDEC website. In the water availability analyses, full natural flows represent the supply of water

available to the diverters. The intent of this workbook was to provide one localized clearing house for the supply data I collected for use in the water availability analyses.

Daily Full Natural Flows

The DWR calculates daily FNFs for many river stations in California and posts the data to the CDEC web site at frequent intervals (from daily to one or two times a week). For the daily Full Natural Flow (FNF) data used in the analyses, I transcribed the latest available values from the CDEC source web pages to the appropriate table in CDEC Supply Tables (Exhibit WR-72). I checked previous data to make sure there haven't been any changes, and if so, updated the tables to reflect those changes. The CDEC stations I monitored and their corresponding URLs on the CDEC web site are listed below.

Stations in the Sacramento River watershed:

- Sacramento River at Bend Bridge (BND): http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=BND
- Oroville Dam (Feather R.) (ORO): http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=ORO
- YRS - Yuba R. Near Smartville (YRS): http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=YRS
- Folsom Lake (American R.) (FOL): http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=FOL

Stations in the San Joaquin River watershed:

- Mokelumne R. - Mokelumne Hill (MKM, aka PAR): http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=MKM
- Goodwin Dam (Stanislaus R.) (GDW): http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=GDW
- Cosumnes R. at Michigan Bar (MHB): http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=MHB
- Friant Dam (Millerton) (San Joaquin R.) (MIL): http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=MIL
- Merced R. Near Merced Falls (MRC, aka MMF): http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=MRC
- Tuolumne R. - La Grange Dam (TLG): http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=TLG

As an example, a copy of the page at the URL for the Sacramento River at Bend Bridge Station (BND) is shown in Exhibit WR-148 (true and correct copy of Daily FNF for Sacramento at Bend Bridge, available at http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=BND). Clicking on the 'Daily' link for the Full Natural Flow Sensor Description brings up the page showing the full natural flows in cfs for the previous 30 days (Exhibit WR-149 is a true and correct copy of Most Recent 30 Days (as of November 4, 2015) of Daily FNF for Sacramento at Bend Bridge, available at <http://cdec.water.ca.gov/cgi-progs/queryDaily?BND>). I checked the equivalent page for each station on a regular basis and added newly reported data to the *CDEC Supply Tables* workbook (Exhibit WR-72). I also checked to see if any previously reported values have changed and updated those in the *CDEC Supply Tables* workbook,

accordingly. The daily FNFs for the four Sacramento River watershed stations are stored on the 'CDEC Daily FNF – Sac' worksheet, and the daily FNFs for the seven San Joaquin river watershed stations are stored on the 'CDEC Daily FNF – SJ' worksheet (the first and second tabs in Exhibit WR-72). To determine the daily FNFs for the San Joaquin River watershed, I added the individual daily FNFs for Stations MKM, MHB, TLG, GDW, MRC, and MIL, and recorded the resulting values into Column L (SJ 6-RIVER FNF) on the 'CDEC Daily FNF – SJ' worksheet in the *CDEC Supply Tables* workbook (Exhibit WR-72). The same procedure was done for the four Sacramento River watershed stations BND, ORO, YRS, and FOL on the 'CDEC Daily FNF – Sac' worksheet in Exhibit WR-72. The combined daily FNF of the four stations is summed in Column H (SAC 4-RIVER FNF) on the 'CDEC Daily FNF – Sac' worksheet.

Occasionally, negative daily FNFs were reported by CDEC (see written testimony of Stephen E. Nemeth, WR-17). When negative FNFs were encountered, I replaced them with zero values before doing any further calculations. This adjustment is in favor of the diverters, because it increases the amount of available water.

Full Natural Flow Monthly Forecasts

From February to May, the Department of Water resources provides Water Year Forecast Breakdowns for the major tributaries of the Sacramento and San Joaquin Rivers. Exhibit WR-73 presents the May 1, 2015, Sacramento River Water Year Forecast Breakdown, and Exhibit WR-74 presents the May 1, 2015, San Joaquin River Water Year Forecast Breakdown. Each forecast provides actual monthly FNFs in thousand-acre-feet (taf) from October through the month prior to the publication date (April, in this example). For the succeeding months, FNF forecasts at 10-, 25-, 50-, 75-, 90-, and 99-percent exceedance levels are provided, as determined by the Department. The FNF forecasts are used to provide an idea of what FNFs could be expected in future months. Refer to the written testimony of Stephen E. Nemeth (WR-17) for a description on how the FNF forecasts are determined.

The 'B120 – May 2015 Forecast' worksheet (the eighth tab) in the *CDEC Supply Tables* workbook (Exhibit WR-72) contains various calculation summaries for the 50-, 90-, and 99-percent exceedance forecasts from the May 1, 2015, Sacramento River and San Joaquin River Water Year Forecast Breakdowns (Exhibits WR-73 and WR-74, respectively). This worksheet is the source for the FNF forecast data used in the water availability analyses. The summaries include, for each of the three exceedance or forecast levels: total FNF in acre-feet by month for each basin (BND, ORO, YRS, FOL for the Sacramento River basin, and MHB, PAR, GDW, TLG, MMF, and MIL for the San Joaquin River basin). The DWR does not

provide 90- and 99-percent exceedance forecasts for MHB and PAR, so the 50-percent exceedances were used instead, effectively increasing the forecasted FNF slightly. Cells A114 through F125 calculate the ratio of the Sacramento and San Joaquin basin FNF forecasts at the 90% exceedance level to their combined FNF forecast values. This FNF ratio estimates the percentage contribution to the Delta in a given month, and is used to estimate prorated Delta demands in the water availability analyses.

WATER AVAILABILITY ANALYSES: GENERATION OF THE GRAPHS

The general water availability analysis method compares the supply of water available in terms of FNF to the demand by month. If demand exceeds supply in a given month, a water shortage is indicated. The analyses are not intended to be hydrologic models, but tools to compare supply and demands within defined analysis areas, and to estimate at what priority year demand would exceed supply for a given month.

The deliverables I provided for the 2015 water availability analyses were time-series graphs built in Microsoft Excel. Two slightly different approaches/methods were used in the Post-1914 analysis for the May 1, 2015, notices of water unavailability (which applied to WSID) and the Pre-1914 analysis for the June 12, 2015, notices of water unavailability (which applied to BBID). Below, I describe the water availability analysis processes used to support Division staff's recommendation to issue the May 1, 2015, notices of water unavailability, followed by the water availability analysis processes used to support Division staff's recommendation to issue the June 12, 2015, notices of water unavailability for Pre-1914 claims with priority dates 1903 and junior.

Water Availability Analysis For The May 1, 2015, Notices of Water Unavailability

The Excel workbook containing the analysis for the Sacramento River and Legal Delta used to support the issuance of the May 1 notices to Post-1914 appropriate right holders, including WSID, is named 'Sacramento Basin Charts With WRUDS 2015-05-01.xlsx,' a copy of which was provided in The Division's Public Record Act request disclosure, and a true and correct copy is included as Exhibit WR-75. WSID's POD for License 1381 (Application ID A000301), with a priority date of April 17, 1916, is located within the Legal Delta watershed.

To begin building the supply/demand graph, I created a new Excel workbook and copied a snapshot of the WRUDS worksheet from WRUDS Workbook, as it existed at the time of analysis (May 1, 2015), into it. I then created three new worksheets within the workbook, described below:

Senior Demand (second tab in workbook): An Excel pivot table that subtotals the monthly Riparian demands from the WRUDS worksheet by analysis area (in this example, by the Sacramento and Legal Delta areas).

Pre-1914 Demand (third tab in workbook): An Excel pivot table that selects the Pre-1914-only monthly demands from the WRUDS worksheet based on filter conditions (in this example, by the Sacramento and Legal Delta areas), and calculates the cumulative Pre-1914 demands by priority year.

Junior Demand (fourth tab in workbook): An Excel pivot table that selects the Post-1914 permit and license monthly demands from the WRUDS worksheet based on filter conditions (in this example, by the Sacramento and Legal Delta areas), and calculates the resulting cumulative Post-1914 demands by priority year.

I then determined the demands to include in the analysis by applying filters (described below) to the three tables described above. The extracted monthly demands were then summarized and totaled by water right type on the 'Prorated Demand' worksheet. The Sacramento Riparian demand was filtered from the 'Senior Demand' pivot table (the second tab in Exhibit WR-75) by setting the Area filter to include 'Sacramento,' the Water Right Type filter to 'Statement of Div and Use,' the Riparian Flag to 'Y,' and the Pre-1914 Flag to 'All.' The resulting monthly Riparian demands (57,476 acre-feet for June) were copied into the corresponding monthly cells for Sacramento (Row 4) in the 'Prorated Demand' worksheet (the fifth tab in Exhibit WR-75). To obtain the Riparian demand for the Legal Delta, the Area filter was set to 'Legal Delta,' with no changes to the other filters. The resulting monthly Riparian demands (51,152 acre-feet for June) were copied into the corresponding monthly cells for the Delta (Row 5) in the 'Prorated Demand' worksheet.

The Sacramento Pre-1914 demand was filtered from the 'Pre-14 Demand' pivot table (the third tab in Exhibit WR-75) by setting the Area filter to include 'Sacramento,' the Water Right Type filter to 'Statement of Div and Use,' the Riparian Flag to '(blank),' and the Pre-1914 Flag to 'Y.' The resulting monthly Pre-1914 demands (380,716 acre-feet for June) were copied into the corresponding monthly cells for Sacramento (Row 12) in the 'Prorated Demand' worksheet. To obtain the Riparian demand for the Legal Delta, the Area filter was set to 'Legal Delta,' with no changes to the other filters. The resulting monthly Riparian demands (250,923 acre-feet for June) were copied into the corresponding monthly cells for the Delta (Row 13) in the 'Prorated Demand' worksheet.

The Sacramento Post-1914 demand was filtered from the 'Junior Demand' pivot table (the fourth tab in Exhibit WR-75) by setting the Area filter to include 'Sacramento,' and the Water Right Type filter to 'Appropriative.' The resulting monthly Post-1914 demands (1,392,613 acre-feet for June) were copied into the corresponding monthly cells for Sacramento (Row 20) in the 'Prorated Demand' worksheet. To obtain the Post-1914 demand for the Legal Delta, the Area filter was set to 'Legal Delta,' with no changes to the other filters. The resulting monthly Riparian demands (308,101 acre-feet for June) were copied into the corresponding monthly cells for the Delta (Row 21) in the 'Prorated Demand' worksheet.

After the monthly Riparian, Pre-1914, and Post-1914 demands were entered into the Prorated Demand worksheet, the Delta demands were prorated by an FNF ratio. The FNF ratio represents the Sacramento River Basin's FNF contribution as a percentage of the combined Sacramento and San Joaquin FNF inflow into the Delta. The 90% exceedance forecasted FNFs from the May 1, 2015, Sacramento River and San Joaquin River Water Year Forecast Breakdowns (Exhibits WR-73 and WR-74, respectively) were used to calculate the FNF ratios (see the written testimony of Brian Coats). The FNF ratios were calculated on the 'B120 – MAY 2015 Forecast' worksheet (the eighth tab) in Exhibit WR-72, and are shown in cells E129 to E140 of the worksheet. These monthly FNF ratios were copied into the corresponding monthly cells in rows 6, 14, and 22 of the 'Prorated Demand' worksheet, which were then multiplied by the respective Delta riparian demands in rows 5, 13, and 21, to get the prorated Delta riparian, Pre-1914, and Post-1914 demands in rows 7, 15, and 23. The Sacramento and prorated Delta demands were then added together in rows 8, 16, and 24. For June, the total Riparian demand was 97,392 acre-feet (cell E8), the total Pre-1914 demand was 576,523 acre-feet (cell E16), and the total Post-1914 demand was 1,633,039 acre-feet (cell E24). These demands were then transferred to the 'Prorated Chart Data' worksheet (the sixth tab) in Exhibit WR-75, where the monthly values in acre-feet were converted to daily values in cubic feet per second (cfs) in order to plot on the graph on the 'Prorated Chart' worksheet (the seventh tab) in Exhibit WR-75.

Supplements to the Full Natural Flow forecasts were made on the 'Prorated Demand' worksheet (the fifth tab) in Exhibit WR-75, as follows: Minor tributary contributions from the Sacramento Valley Floor, Putah Creek, Stony Creek, East and West-Side Sacramento Valley, and Bear River were obtained from DWR's 2007 Unimpaired Flow Data Report (Exhibit WR-76 is a true and correct copy). A copy of this report was provided to WSID and BBID as part of the Division's Public Record Act request disclosure. The monthly estimates for water year 1997 were entered into corresponding rows 42 through 48 on the 'Prorated Demand' worksheet, summed, and converted from acre-feet to cfs. These FNF supplements

were added to the corresponding 90% and 99% exceedance FNF forecast values (Columns N through Q on the 'Prorated Demand' worksheet), which were then plotted on the Prorated Chart graph (the Seventh tab in Exhibit WR-75).

The final deliverable for the water availability analysis associated with the May 1, 2015, Notice of Water Unavailability for Post-1914 diversions in the Sacramento River and Legal Delta watersheds is the graph shown in Exhibit WR-47. The chart shows that by May 1, 2015, available supply was insufficient to meet the demands of Post-1914 appropriative rights throughout the Sacramento River watersheds and the Delta.

Water Availability Analysis For The June 12, 2015, Notices of Water Unavailability

The Excel workbook containing the analysis for the combined Sacramento River, San Joaquin River, and Legal Delta analysis associated with the June 12, 2015, notices to diverters with Pre-1914 claims of right 1903 and junior, including BBID, is named '20150610_sacsjcombined.xlsx.' A copy of this workbook was provided in the Division's Public Record Act request disclosure, and a true and correct copy is included as Exhibit WR-77. The POD for BBID's Pre-1914 claim identified by Application ID S021256, with a priority date of May 18, 1914, is located within the Legal Delta watershed, which is within the analysis area.

To begin building the supply/demand graph, I created a new Excel workbook and copied a snapshot of the 'WRUDS 2015-06-15' worksheet from the '20150615_info_order_demand.xlsx' workbook (Exhibit WR-51) as it existed at the time of analysis (June 9, 2015) into it. This worksheet is named 'WRUDS 2015-06-09.' I then created the following five new worksheets within the workbook, described below:

Removed Demand (Second tab in workbook): This table contains a list of diversions in the Cache Creek and Putah Creek watersheds that were removed from the demand for this analysis. The cell formula in Column B of the WRUDS 2015-06-09 worksheet would return the value 'N' if the corresponding APP_ID was in the Removed Demand list, indicating that it should not be included in the total demand.

Delta Combined Senior Demand (Third tab in workbook): This table contains the subset of demands in the Legal Delta, with the following modification: the demands for those rights reporting separate Riparian and Pre-1914 diversions in the Information Order were combined and treated as Riparian demands. This was done because stakeholders in the Delta indicated they would divert under their Riparian claims if their Pre-1914 claims were curtailed. See written testimony of Brian Coats.

Delta Pre-1914 Pivot (Fourth tab in workbook): An Excel pivot table that selects the Pre-1914-only monthly demands from the Delta Combined Senior Demand worksheet and calculates the cumulative Pre-1914 demands by priority year.

Riparian Demand Pivot (Fifth tab in workbook): An Excel pivot table that subtotals the monthly Riparian demands from the WRUDS worksheet by watershed for the analysis are excluding the Legal Delta.

Pre-1914 Demand Pivot (Sixth tab in workbook): An Excel pivot table that selects the Pre-1914-only monthly demands from the WRUDS worksheet based on filter conditions for the analysis are excluding the Legal Delta, and calculates the cumulative Pre-1914 demands by priority year.

I then determined the demands to include in the analysis by applying filters to the three tables described above. The extracted monthly demands were then summarized and totaled by water right type on the 'Senior Demand Summary' worksheet (the seventh tab) in Exhibit WR-77. The Sacramento Riparian demand was filtered from the Riparian Demand Pivot (fifth) tab by setting the Analyze filter to 'Y,' the Area filter to 'SACRAMENTO,' the Water Right Type filter to 'Statement of Div and Use,' the Riparian Flag to 'Y,' and the Pre-1914 Flag to 'All.' The resulting monthly Riparian demands (56,102 acre-feet for June) were copied into the corresponding monthly cells for Sacramento (Row 3) in the 'Senior Demand Summary' worksheet. The San Joaquin Riparian and demand was filtered from the 'Riparian Demand Pivot' (fifth) tab by setting the Analyze filter to 'Y,' the Area filter to 'SAN JOAQUIN,' the Water Right Type filter to 'Statement of Div and Use,' the Riparian Flag to 'Y,' and the Pre-1914 Flag to 'All.' The resulting monthly Riparian demands (132,625 acre-feet for June) were copied into the corresponding monthly cells for San Joaquin (Row 4) in the 'Senior Demand Summary' worksheet. The Riparian demand for the Legal Delta was obtained from the 'Delta Combined Senior Demand' tab by setting the RIPARIAN filter (Column N) to 'Y.' The resulting monthly Riparian demands (183,578 acre-feet for June) were copied from the totals row in Columns EY through FE into the corresponding monthly cells for the Delta (Row 5) in the 'Senior Demand Summary' worksheet.

After the Riparian demands were collected, and recorded on the 'Senior Demand Summary' worksheet, the total Pre-1914 demands were determined using the 'Delta Pre-1914 Pivot' (the fourth tab) and the 'Pre-1914 Demand Pivot' (the sixth tab) worksheets in Exhibit WR-77. These pivot tables took the monthly demands from the 'WRUDS 2015-06-09' worksheet (the first tab in Exhibit WR-77) and created a running total by priority year for each month (March through September in this case). The total monthly Pre-1914 demand, therefore, are the values in the last row of the pivot table. The Sacramento

Pre-1914 demand was filtered from the 'Pre-1914 Demand Pivot' table by setting the Analyze filter to 'Y,' the Area filter to 'SACRAMENTO,' the Water Right Type filter to 'Statement of Div and Use,' the Riparian Flag to '(blank),' and the Pre-1914 Flag to 'Y.' The resulting total monthly Pre-1914 demands (388,838 acre-feet for June) were copied into the corresponding monthly cells for Sacramento (Row 10) in the 'Senior Demand Summary' worksheet. The San Joaquin Pre-1914 demand was obtained in the same manner, except by setting the Area filter to 'SAN JOAQUIN.' The resulting total monthly Pre-1914 demands (147,303 acre-feet for June) were copied into the corresponding monthly cells for San Joaquin (Row 11) in the 'Senior Demand Summary' worksheet. To obtain the Pre-1914 demand for the Legal Delta, it was filtered from the 'Delta Pre-1914 Pivot' table by setting the Riparian Flag to '(blank)' and the Pre-1914 Flag to 'Y.' The resulting total monthly Pre-1914 demands (48,247 acre-feet for June) were copied into the corresponding monthly cells for the Delta (Row 12) in the 'Senior Demand Summary' worksheet.

The cumulative Pre-1914 demands through the priority year of 1902 were compiled in the same manner as described above; however the demands at that priority year were used, rather than the total Pre-1914 demands. From the 'Pre-1914 Demand Pivot' worksheet (the sixth tab) in Exhibit WR-77, the resulting June demand through 1902 was 292,975 acre-feet for Sacramento, and 124,862 acre-feet for San Joaquin. From the 'Delta Pre-1914 Pivot' worksheet (the fourth tab) in Exhibit WR-77, the resulting June demand through 1902 was 16,732 acre-feet for the Delta. The Pre-1914 demands through 1902 for Sacramento, San Joaquin, and the Delta were copied into rows 17,18, and 19, respectively, of the 'Senior Demand Summary' worksheet (the seventh tab of Exhibit WR-77).

These demands were then transferred to the 'Senior Chart Data' worksheet (the eighth tab) in Exhibit WR-77, where the monthly values in acre-feet were converted to daily values in cubic feet per second (cfs) in order to plot on the graph on the 'Senior Chart' worksheet (the tenth tab) in Exhibit WR-77.

Supplements to the Full Natural Flow forecasts were made on the 'FNF Adjustments' worksheet (the eighth tab) in Exhibit WR-77. Riparian return flows were credited at ratios provided in the Board's 1977 drought report. For example, The June Riparian demand was 132,625 acre-feet (cell E3). The June return flow credit in the 1977 drought report was 0.1, providing a return flow of 13,262 acre-feet (cell E5). A 40-percent return flow credit was applied to the Delta Riparian and Pre-1914 demands. For example, the combined Riparian and Pre-1914 Demand for June was 231,825 acre-feet (cell E11). The Delta return flow credit provides a return flow of $0.4 \times 231,825$, or 92,730 acre-feet (cell E13).

The return flow credits were added to the minor tributary contributions from the San Joaquin Valley floor, Sacramento Valley Floor, Putah Creek, Stony Creek, East and West-Side Sacramento Valley, and Bear River, obtained from DWR's 2007 Unimpaired Flow Data Report (Exhibit WR-79). The monthly estimates for water year 1997 were entered into corresponding rows 17 through 24 on the 'FNF Adjustments' worksheet. The total return flow credit (row 28) was converted from acre-feet to cfs. These FNF adjustments were added to the corresponding 90% and 99% exceedance FNF forecast values (Columns Q through R on the 'Prorated Demand' worksheet).

The 'Senior Chart Data' worksheet (the ninth tab in Exhibit WR-77) collects the demand data from the 'Senior Demand Summary' worksheet, the adjusted FNF forecast data from the 'FNF Adjustments' worksheet, and the daily FNF data from the *CDEC Supply Tables* workbook (Exhibit WR-72). Monthly values in acre-feet are converted into daily values in cfs, and provides the source data to generate the supply/demand graph.

The final deliverable for this water availability analysis associated with the June 12, 2015, Notice of Water Unavailability for Pre-1914 diversions with priority dates 1903 and junior in the Sacramento, San Joaquin, and Legal Delta watersheds is the graph shown in Exhibit WR-48. The chart shows that by June 12, 2015, available supply was insufficient to meet the demands of appropriative rights with priority dates of 1903 and later throughout the Sacramento, and San Joaquin River watersheds and the Delta.

CLOSING REMARKS

I have described the processes undertaken to develop two key water availability analyses and resulting graphs used to support Division staff's recommendation to issue the May 1 and June 12, 2015, notices of water unavailability. The same general methodologies were applied to generate supply/demand graphs for various other scenarios, including Exhibits WR-46 through WR-48 described above; Exhibit WR-52, 2015 Combined Sacramento/San Joaquin River Basin Senior Supply/Demand Analysis, August 19, 2015; Exhibit WR-53, 2015 Combined Sacramento/San Joaquin River Basin Senior Supply/Demand Supporting Analysis Spreadsheet, August 21, 2015 (WR-53 is very similar to WR-77, they differ only in that WR-53 has been updated slightly. WR-53 is the current version posted to the State Water Board's Drought webpage); Exhibit WR-54, 2015 Sacramento River Basin Supply/Demand Analysis with Proportional Delta Demand, October 30, 2015; Exhibit WR-56, 2015 Sacramento River Basin Senior Supply/Demand Analysis With North Delta Demand, as of September 10, 2015; Exhibit WR-58, 2015 San Joaquin River Basin Senior Supply/Demand Analysis With Proportional Delta Demand, October 27, 2015; and Exhibit

WR-59, 2015 Upper San Joaquin River to Merced River Supply/Demand Analysis, October 16, 2015. The Exhibits referenced in this paragraph are all true and correct copies.

Other exhibits and databases generated in 2015: Exhibit WR-49, 2010-2013 Average Demand Dataset as of February 20, 2015; Exhibit WR-50, 2015 Informational Order Demand Dataset without calculations, April 8, 2015; Exhibit WR-55, 2015 Sacramento River Basin Supply/Demand Analysis with Proportional Delta Demand Supporting Analysis Spreadsheet, Updated November 2, 2015; Exhibit WR-57, the 2015 Sacramento River Basin Senior Supply/Demand Analysis With North Delta Demand, as of June 12, 2015, Supporting Analysis Spreadsheet; Exhibit WR-78, 2015 San Joaquin River Basin Senior Supply/Demand Analysis With Proportional Delta Demand, August 19, 2015 (PRA file 20150821_sjprorated.pdf); Exhibit WR-81, the 2015 Delta Demand Analysis, Senior Demand Having 1902 and Prior Claims (Mean Daily Flow at Vernalis), dated October 7, 2015 (PRA file 20151007_Delta-Vernalis 1902 and Senior Demand Alternate.pdf). The Exhibits referenced in this paragraph are all true and correct copies.