

Appendix 6

**Technical Report: Modeling Approach to Support Responses to Flow-Related
Recommendations (HDR Engineering, Inc. and Stephen Grinnell, P.E.)**

Modeling Approach to Support Responses to Flow-Related Recommendations

Yuba River Development Project
FERC Project No. 2246

Prepared by HDR Engineering, Inc. & Stephen Grinnell, P.E.

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Modeling Approach to Support the Yuba County Water Agency's Response to Flow-Related Recommendations

HDR Engineering, Inc., (HDR) has prepared this technical report at the request of the Yuba County Water Agency (YCWA or Licensee), licensee for the Yuba River Development Project, Federal Energy Regulatory Commission (FERC or Commission) Project Number 2246 ("Project"), to support YCWA's responses to recommendations filed with FERC in response to FERC's June 26, 2017 *Notice of Application Accepted for Filing, Soliciting Motions to Intervene and Protests, Ready for Environmental Analysis, and Soliciting Comments, Recommendation, Preliminary Terms and Conditions, and Preliminary Fishway Prescriptions* (REA Notice).

1. Need for Modeling

The United States Department of Agriculture, Forest Service (FS); United States Department of the Interior (DOI), Fish and Wildlife Service (FWS); DOI, Bureau of Land Management (BLM); United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS); California Department of Fish and Wildlife (CDFW); and Foothills Water Network (FWN) (individually referred to as Commenter and collectively as Commenters in this technical report) each filed comments with FERC in response to the REA Notice. Their comment letters included Federal Power Act (FPA) Section 4(e) conditions and FPA Section 10(j) and Section 10(a) flow-related recommendations that, if implemented, would change flows in Project-affected reaches, which in turn could affect storage in the Project's New Bullards Bar Reservoir, water temperatures, water deliveries and Project generation and value.

The FS, FWS, CDFW, NMFS and FWN did not file with FERC in their comment letters model runs of their full flow proposals or of their individual recommendations, with the exception that at page 109 of its comment letter, CDFW states that it, FWS, and non-governmental organizations (NGOs) "*used the Licensee's operations model to consider the quantitative impacts to Licensee's reservoir storage, water deliveries, and power generation*" for flow proposals in the lower Yuba River. CDFW states that it provides the results of its runs of YCWA's models on pages 109 through 120 of its comment letter, but did not file the actual model runs. YCWA can not verify, and subsequently accept, the results of CDFW's model runs for the lower Yuba River without examining each of CDFW's model runs. Nor can YCWA assess the recommendations and conclusions reached by the FSS, FWS, CDFW, NMFS and FWN in their comment letters without modeling their flow-related recommendations.

Therefore, to assess these flow-related recommendations in their entirety, YCWA requested that HDR develop flow scenarios using the relicensing Water Balance and Operations Model (Ops Model) and water temperature models (Temp Model) that were included in YCWA's June 5, 2017, Amendment to Final License Application (Amended FLA), to which YCWA filed errata with FERC in July and September 2017.

This technical report describes HDR's approach to this modeling and provides the models and each model run referred to by YCWA in its Response.

2. Modeling Approach

2.1 Operations Modeling

HDR modified the Ops Model from the Amended FLA to reflect the measures included in the comment letters. No other modifications to the Ops Model were made.

2.1.1 Complete Flow Analysis

Upon review of the comment letters, HDR found that the flow-related recommendations in the FWS, CDFW and FWN comment letters are essentially the same. HDR made a single run of the Ops Model incorporating the flow-related recommendations from these comment letters.

HDR's review of the FS comment letter revealed that, with the exception of flows below New Bullards Bar Dam that the FS proposes as a Section 10(a) recommendation and which is identical to FWS and CDFW Section 10(j) recommendations, YCWA and the FS are in agreement on flow-related measures. Therefore, HDR did not make an Ops Model run for the FS' flow-related recommendations.

Similarly, HDR found that the BLM makes only two flow-related recommendations and they are both the same as those proposed by the FWS and CDFW as Section 10(j) recommendations. Therefore, HDR did not make an Ops Model run for the BLM's flow-related recommendations.

HDR found that NMFS does not make any recommendations regarding flows upstream of Englebright Dam, but makes significant recommendations for flow-related items below Englebright Dam. To obtain a realistic assessment of NMFS' flow-related recommendations, HDR included in the NMFS Ops Model run any upstream FS Section 4(e) flow-related condition or any flow-related conditions where YCWA, FS, FWS, CDFW and FWN agreed on the conditions, assuming that each of these would be in the new license.

As a result of the above, HDR made four Ops Model runs, which are referred to in this technical report as "Complete Flow Analysis." Table 2-1 provides a listing of what was included in each of HDR's four Complete Flow Analysis Ops Model runs.

Table 2-1. Complete Flow Analysis Ops Model runs made by HDR.

| Flow-Related Measure | Condition Used in Complete Flow Analysis Ops Model Run ¹ | | | |
|---|---|---|--|--|
| | Base Case (Article in Existing FERC License) | YCWA Proposed Condition in its Amended FLA | FWS, CDFW and FWN Recommendation in their Comment Letters ³ | NMFS Recommendation in its Comment Letter |
| Our House Diversion Dam: Water Year Types | Art. 33 | | YCWA WR2 FWS p.34 CDFW 2.1 FWN p. 3 | |
| Our House Diversion Dam: Minimum Flows | Art. 33 | | YCWA AR1 FWS p. 34 CDFW 2.3 FWN p. 3 | |
| Our House Diversion Dam: Spill Recession | None | | YCWA AR2 FWS p.38 CDFW 2.9 FWN p. 4 | |
| Lohman Ridge Tunnel: Tunnel Closures | None | YCWA AR11 | FWS 10 CDFW 2.13 FWN XII | YCWA AR11 (same as FS' Section 4(e) condition) |
| Our House Diversion Dam: Boating Flows | None | | YCWA RR2 FWS p. 35 CDFW (no comment) FWN p. 5 | |
| Log Cabin Diversion Dam: Water Year Types | Art. 33 | | YCWA WR2 FWS p.34 CDFW 2.1 FWN p. 3 | |
| Log Cabin Diversion Dam: Minimum Flows | Art. 33 | | YCWA AR1 FWS p. 34 CDFW 2.3 FWN p. 3 | |
| Log Cabin Diversion Dam: Spill Recession | None | | YCWA AR12 CDFW 2.10 FWS p. 35 FWN p. 5 | |
| New Bullards Bar Dam: Water Year Types | Art. 33 | | YCWA WR2 FWS p.34 CDFW 2.1 FWN p. 3 | |
| New Bullards Bar Dam: Minimum Flow | Art. 33 | YCWA AR10 | FWS 11 CDFW 2.4 FWN VII | Base Case |
| New Bullards Bar Dam: Spill Recession | None | YCWA AR4 CDFW 2.11 ² FWN p. 4 ² | FWS 12 ² | Base Case |
| New Bullards Bar Dam: Flood Control Operations | | | Art. 46 YCWA WR6 FWN p. 3 CDFW (no comment) FWN (no comment) | |
| Narrows 2 Facilities: Water Year Types | Art. 33 | YCWA WR3 | FWS 18 ³ CDFW 2.2 ³ FWN VI ³ | Base Case |
| Narrows 2 Facilities: Minimum Flows | Art. 33 | YCWA AR3 | FWS 1 CDFW 2.5 FWN I | NMFS 2 |
| Narrows 2 Facilities: Ramping and Flow Fluctuations | Art. 33 | YCWA AR9 | FWS 16 & 17 CDFW 2.12 FWN I | NMFS 1 |

Table 2-1. (continued)

| Flow-Related Measure | Condition Used in Complete Flow Analysis Ops Model Run ¹ | | | |
|--|--|--|--|---|
| | Base Case (Article in Existing FERC License) | YCWA Proposed Condition in its Amended FLA | FWS, CDFW and FWN Recommendation in their Comment Letters ³ | NMFS Recommendation in its Comment Letter |
| New Bullards Bar Reservoir: Minimum Pool | Art. 34 Art 34 YCWA WR5 FWS (no comment) CDFW (no comment) FWN p. 3 | | | |
| Ops Model Run Name as Used in This Response | Scenario 11 | Scenario 12 | Scenario 13 | Scenario 14 |
| Total = 4 Complete Flow Analysis Ops Model Runs | | | | |

¹ Where the conditions are the same among Ops Model runs, they are shown in a single cell. The notation refers to the relevant article in the existing FERC license, proposed condition in YCWA's Amended FLA, and the relevant recommendation number or page number in the FWS's, CDFW's, FWN's and NMFS's comment letters.

² FWS' Comment Letter included a New Bullards Bar spill cessation recommendation different than YCWA's proposed condition, with which CDFW and FWN agreed. The FWS' recommendations had some minor differences from YCWA's proposed measure AR4, primarily that YCWA only make reductions in flow according to the spill cessation recommendation using the New Bullards Bar Dam spillway gates. YCWA's modeling of proposed measure AR4 only included the spillway gates for the spill cessation, even though the low-level outlet or proposed flood control outlet could potentially be used. Accordingly, no revisions to the model approach were made for the FWS' recommendation, but YCWA addresses FWS' recommendation in this Response.

³ The FWS, CDFW, and FWN all made recommendations regarding the determination of the Narrows 2 Facilities WY types that differed from YCWA's proposed condition WR3. The recommended changes would have a very minor, if any, effect on Ops Model results, so the recommendation was not modeled, but YCWA addresses these recommendations in this Response.

HDR used the output of the Complete Flow Analysis Ops Model runs in YCWA's generation cost post-processor, which was included in the Amended FLA, to estimate the resulting effect of the Complete Flow Analysis on Project generation and energy value, including ancillary services. Table 2-2 provides the results of that analysis for each of the four Complete Flow Analysis Ops Model runs.

Table 2-2. Complete Flow Analysis Ops Model runs generation-related costs for YCWA's proposed flow-related conditions, FWS/CDFW/FWN's flow-related recommendations, and NMFS's; flow-related recommendations, as compared to the Base Case.

| Alternatives | Average Annual Generation | | | Average Annual Project Value | | |
|---------------------------------------|-----------------------------------|-------------------------|-----------------|------------------------------|----------------------------|----------------------------|
| | Generation (MWhr/yr) ¹ | Change (%) Compared to: | | Project Value (\$/yr) | Change (\$) Compared to: | |
| | | Base Case | YCWA's Proposal | | Base Case | YCWA's Proposal |
| Base Case | 1,418,046 | -- | -- | \$51,388,294 | -- | -- |
| YCWA's Proposed Conditions | 1,374,114 | -3.1% | -- | \$50,289,775 | -\$1,056,085 | -- |
| FWS's, CDFW's & FWN's Recommendations | 1,340,279 | -5.5% | -2.4% | \$49,134,299 | -\$2,161,909 | -\$1,105,824 |
| NMFS's Recommendation | 1,371,998 | -3.2% | -0.1% | \$49,803,699 | -\$1,584,595 | -\$486,076 |
| | | | | | (\$64,257,857 over 30 yrs) | (\$33,174,716 over 30 yrs) |
| | | | | | (\$47,537,849 over 30 yrs) | (\$14,582,270 over 30 yrs) |

Source: Scenario 11, Scenario 12, Scenario 13, Scenario 14 in Attachment A to this technical report.

¹ MWh/yr = megawatt hours per year.

As part of its simulation, the Ops Model computes water supply deliveries to YCWA contractors and water rights holders along the Yuba River near Daguerre Point Dam. If New Bullards Bar Reservoir storage is forecasted to fall below a defined threshold, shortages in water supply deliveries are applied to protect New Bullards Bar Reservoir storage. Table 2-3 shows the effects of the Complete Flow Analysis Ops Model runs on water supply deliveries for the calendar years in which there were water supply delivery shortages for the modeling period of record. There were no water supply delivery shortages for any of the scenarios in years not shown in the table.

Table 2-3. Water years in the period of record (1970 through 2010) in which water delivery demand would not be met under the Base Case, YCWA's Complete Flow Proposed Condition, FWS/CDFW/FWN Complete Flow Recommendation, and NMFS Complete Flow Recommendation, and the amount of shortage by year.

| Calendar Year | Schedule Year Type ¹ | Annual Water Delivery Demand | Amount of Annual Water Delivery Demand Not Met (i.e., Annual Shortage) | | | | | | | |
|--|---------------------------------|------------------------------|--|-----|-------------------------------|-----|-------------------------------------|-----|--------------------------------|-----|
| | | | Base Case | | YCWA Complete Flow Analysis | | FWS/CDFW/FWN Complete Flow Analysis | | NMFS Complete Flow Analysis | |
| | | | (ac-ft) | (%) | (ac-ft) | (%) | (ac-ft) | (%) | (ac-ft) | (%) |
| 1970 | 1 | 291,197 | 0 | 0% | 0 | 0% | 86,749 | 30% | 86,809 | 30% |
| 1977 | 7 | 305,081 | 139,644 | 46% | 133,653 | 44% | 132,052 | 43% | 139,699 | 46% |
| 1997 | 1 | 291,197 | 0 | 0% | 0 | 0% | 26,395 | 9% | 34,018 | 12% |
| 2004 | 1 | 305,141 | 0 | 0% | 0 | 0% | 61,877 | 20% | 41,873 | 14% |
| 2007 | 2 | 305,081 | 0 | 0% | 0 | 0% | 23,564 | 8% | 9,238 | 3% |
| Number of Years Water Delivery Demand Not Met | | | 1 out of 41 years (2%) | | 1 out of 41 years (2%) | | 5 out of 41 years (12%) | | 5 out of 41 years (12%) | |

¹ Based on North Yuba Index and as of May 31 in that year. Schedule 1 years are the wettest WYs and Schedule 7 years (i.e., Conference Years) are the driest WYs.

2.1.2 Incremental Analysis

HDR assessed the commenters' individual flow-related recommendations that were different than YCWA's proposed conditions by making two Ops Model runs. The first Ops Model run was with the commenter's recommendation while all other elements in the Ops Model were held at Base Case, as described in Table 2-1. The second Ops Model run was with YCWA's proposed condition, if YCWA made a similar proposal as the commenter's proposal, while all other elements in the Ops Model were held at Base Case. This provided an 'apples-to-apples' comparison of the two proposals. These are referred to as "Incremental Analysis" in this report.

Table 2-4 lists the 14 Incremental Analysis Ops Model runs made by HDR.

Table 2-4. Individual recommendation Ops Model runs made by YCWA.

| Flow-Related Measure | FWS's, CDFW's, FWN's and NMFS's Recommendation | YCWA's Proposed Condition |
|---|--|---------------------------|
| Narrows 2 Facilities – Minimum Streamflows & Winter Pulse | FWS 1, CDFW 2.5 & FWN I (Scenario 1) | YCWA AR3 (Scenario 7) |
| Narrows 2 Facilities – Minimum Streamflows - Minimum Flow | FWS 1, CDFW 2.5 & FWN I (Scenario 2) | YCWA AR3 (Scenario 7) |

Table 2-4. (continued)

| Flow-Related Measure | FWS's, CDFW's, FWN's and NMFS's Recommendation | YCWA's Proposed Condition |
|--|---|---------------------------------|
| Narrows 2 Facilities – Minimum Streamflows - Winter Pulse | FWS 1, CDFW 2.5 & FWN I (Scenario 3) | YCWA AR3 (Scenario 7) |
| Narrows 2 Facilities – Minimum Streamflows & Ramping and Flow Fluctuations | FWS 1, 16 & 17; CDFW 2.5 & 2.12; & FWN I (Scenario 4) | YCWA AR3 & AR9 (Scenario 8) |
| New Bullards Bar Dam Minimum Streamflow | FWS 11, CDFW 2.4 & FWN VII (Scenario 5) | YCWA AR10 (Scenario 9) |
| Lohman Ridge Diversion Tunnel Closure – Spring Only | FWS 10, CDFW 2.13 & FWN XII (Scenario 6(spring)) | YCWA AR11 (Scenario 10(spring)) |
| Lohman Ridge Diversion Tunnel Closure – Fall Only | FWS 10, CDFW 2.13 & FWN XII (Scenario 6(fall)) | YCWA AR11 (Scenario 10(fall)) |
| Lohman Ridge Diversion Tunnel Closure – Spring and Fall | FWS 10, CDFW 2.13 & FWN XII (Scenario 6) | YCWA AR11 (Scenario 10) |
| Total = 14 Incremental Analysis Ops Model Runs | | |

Notes: Model scenarios use Base Case measures except for the specific measure indicated. All Ops Model runs are included in Attachment A to this report.

HDR used the output of the Incremental Analysis Ops Model runs in YCWA's generation cost post-processor to estimate the resulting effect of the Incremental Analysis on Project generation and energy value, including ancillary services. Table 2-5 provides the results of that analysis for each of the 14 Incremental Analysis Ops Model runs. Note that these results are not additive.

Table 2-5. Incremental Analysis Ops Model runs generation-related costs for YCWA's proposed flow-related conditions, FWS/CDFW/FWN's flow-related recommendations, and the NMFS' flow-related recommendations, as compared to the Base Case.

| Alternatives | Average Annual Generation | | | Average Annual Project Value | | |
|--|-----------------------------------|-------------------------|-----------------|------------------------------|---|--|
| | Generation (MWhr/yr) ¹ | Change (%) Compared to: | | Project Value (\$/yr) | Change (\$) Compared to: | |
| | | Base Case | YCWA's Proposal | | Base Case | YCWA's Proposal |
| NARROWS 2 FACILITIES – MINIMUM STREAMFLOWS & WINTER PULSE | | | | | | |
| YCWA AR3 (Scenario 7) | 1,417,936 | 0.0% | -- | \$51,387,886 | -\$408 (-\$12,255 over 30 yrs) | -- |
| FWS 1, CDFW 2.5 & FWN I (Scenario 1) | 1,417,426 | 0.0% | 0.0% | \$51,012,558 | -\$375,737 (-\$11,272,103 over 30 yrs) | -\$375,329 (-\$11,259,863 over 30 yrs.) |
| NARROWS 2 FACILITIES – MINIMUM STREAMFLOWS - MINIMUM FLOW | | | | | | |
| YCWA AR3 (Scenario 7) | 1,417,936 | 0.0% | -- | \$51,387,886 | -\$408 (-\$12,255 over 30 yrs) | -- |
| FWS 1, CDFW 2.5 & FWN I (Scenario 2) | 1,417,169 | -0.1% | -0.1% | \$50,998,030 | -\$390,264 (-\$11,707,920 over 30 yrs) | -\$389,856 (-\$11,695,680 over 30 yrs.) |

Table 2-5. (continued)

| Alternatives | Average Annual Generation | | | Average Annual Project Value | | |
|---|--------------------------------------|---------------------|--------------------|------------------------------|---|--|
| | Generation (MWhr/yr) ¹ | Change Compared to: | | Project Value (\$/yr) | Change Compared to: | |
| | | Base Case | YCWA's Proposal | | Base Case | YCWA's Proposal |
| NARROWS 2 FACILITIES – MINIMUM STREAMFLOWS - WINTER PULSE | | | | | | |
| YCWA AR3 (Scenario 7) | 1,417,936 | 0.0% | -- | \$51,387,886 | -\$408 (-\$12,255 over 30 yrs) | -- |
| FWS 1, CDFW 2.5 & FWN I (Scenario 3) | 1,418,210 | 0.0% | 0.0% | \$51,403,138 | \$14,844 (\$445,310 over 30 yrs) | \$15,252 (\$457,550 over 30 yrs) |
| NARROWS 2 FACILITIES – MINIMUM STREAMFLOWS & RAMPING AND FLOW FLUCTUATIONS | | | | | | |
| YCWA AR3 & AR9 (Scenario 8) | 1,418,505 | 0.0% | -- | \$51,396,874 | \$8,580 (\$257,390 over 30 yrs) | -- |
| FWS 1, 16 & 17; CDFW 2.5 & 2.12; & FWN I (Scenario 4) | 1,418,272 | 0.0% | 0.0% | \$51,062,826 | -\$325,469 (-\$9,764,061 over 30 yrs) | -\$334,049 (-\$10,021,461 over 30 yrs) |
| NMFS Condition 1 & 2 (Scenario 15) | 1,414,916 | -0.2% | -0.2% | \$50,842,942 | -\$545,352 (-\$16,360,567 over 30 yrs) | -\$553,932 (-\$16,617,967 over 30 yrs) |
| NEW BULLARDS BAR DAM MINIMUM STREAMFLOW | | | | | | |
| YCWA AR10 (Scenario 9) | 1,414,838 | -0.2% | -- | \$ 51,295,124 | -\$93,170 (\$2,795,104 over 30 yrs) | -- |
| FWS 11, CDFW 2.4 & FWN VII (Scenario 5) | 1,394,008 | -1.7% | -1.5% | \$50,744,913 | -\$643,381 (\$19,301,423 over 30 yrs) | \$550,211 (\$16,506,319 over 30 yrs) |
| LOHMAN RIDGE DIVERSION TUNNEL CLOSURE – SPRING ONLY | | | | | | |
| YCWA AR11 (Scenario 10(spring)) | 1,400,014 | -1.3% | -- | \$50,970,241 | -\$418,053 (\$12,541,605 over 30 yrs) | -- |
| FWS 10, CDFW 2.13 & FWN XII (Scenario 6(spring)) | 1,384,984 | -2.3% | -1.0% | \$50,624,761 | -\$763,533 \$22,906,002 over 30 yrs) | -\$345,480 (\$10,364,397 over 30 yrs) |
| LOHMAN RIDGE DIVERSION TUNNEL CLOSURE – FALL ONLY | | | | | | |
| YCWA AR11 (Scenario 10(fall)) | 1,409,906 | -0.6% | -- | \$51,133,367 | -\$254,927 (\$7,647,808 over 30 yrs) | -- |
| FWS 10, CDFW 2.13 & FWN XII (Scenario 6(fall)) | 1,405,773 | -0.9% | -0.4% | \$50,995,113 | -\$393,181 (\$11,795,435 over 30 yrs) | -\$138,254 (\$4,147,627 over 30 yrs) |
| LOHMAN RIDGE DIVERSION TUNNEL CLOSURE – SPRING AND FALL | | | | | | |
| YCWA AR11 (Scenario 10) | 1,391,874 | -1.8% | -- | \$50,715,314 | -\$672,980 (\$20,189,400 over 30 yrs) | -- |
| FWS 10, CDFW 2.13 & FWN XII (Scenario 6) | 1,372,711 | -3.2% | -1.4% | \$50,231,580 | -\$1,156,714 (\$34,701,520 over 30 yrs) | -\$484,734 (\$14,512,020 over 30 yrs) |

Source: All Ops Model runs can be found in Attachment A to this report.

¹ MWh/yr = megawatt hours per year.

HDR considered conducting a parallel incremental analysis that would start with the FWS/CDFW/FWN, NMFS Complete Flow Analysis or YCWA Amended FLA Complete Flow Analysis scenario, and replace the flow-related condition or recommendation with the Base Case measure. However, due to the different starting points and the cumulative nature of some of the measures, a direct comparison between incremental scenarios would not be appropriate, so the second incremental approach was not conducted.

2.2 Temperature Modeling

HDR ran the Temp Model used for YCWA’s Amended FLA using the results of the Ops Model runs for the Complete Flow Analysis, with the exception of the FWS’s, CDFW’s, and the SWRCB’s recommendation regarding use of the upper intake of the New Colgate Power Tunnel, which is discussed below. Table 2-6 provides a list of the eight Temp Model runs made by HDR.

Table 2-6. Temperature Model runs made by HDR.

| Flow-Related Measure | FWS’, CDFW’s, FWN’s and NMFS’ Recommendation | YCWA’s Proposed Condition |
|--|---|-----------------------------|
| Narrows 2 Facilities – Minimum Streamflows | FWS 1, CDFW 2.5 & FWN I (Scenario 2) | YCWA AR3 (Scenario 7) |
| Narrows 2 Facilities – Minimum Streamflows & Ramping and Flow Fluctuations | FWS 1, 16 & 17; CDFW 2.5 & 2.12; & FWN I (Scenario 4) | YCWA AR3 & AR9 (Scenario 8) |
| New Bullards Bar Dam Minimum Streamflow | FWS 11, CDFW 2.4 & FWN VII (Scenario 5) | YCWA AR10 (Scenario 9) |
| Lohman Ridge Diversion Tunnel Closure – Spring and Fall | FWS 10, CDFW 2.13 & FWN XII (Scenario 6) | YCWA AR11 (Scenario 10) |
| TOTAL = 8 Temp Model Runs | | |

Source: Ops Model Runs with the same Scenario numbers, as indicated in Table 2-3, included in Attachment A to this report.

To address FWS’s, CDFW’s and SWRCB’s recommendations regarding use the upper and lower New Colgate Powerhouse intake, HDR modified the Temp Model to allow for the simulation of use of the upper intake for part of the year and the lower intake for part of the year.

The upper temperature model (UTM) simulates Project features upstream of Englebright Reservoir. Temperature output from the UTM are used as input to the Englebright Temperature Model (ETM). In turn, output from the ETM is used as input to the Lower Temperature Model (LTM). The UTM and LTM are HEC-5Q models, and the ETM is a CE-QUAL-W2 model. See Technical Memorandum 2-6 in Appendix E6 of Exhibit E in YCWA’s Amended FLA for more details regarding the Temp Models.

The UTM simulates New Bullards Bar Reservoir, including releases to the New Colgate Powerhouse. There are two powerhouse intakes, a lower intake with a centerline elevation of 1,627.5 feet, and an upper intake with a centerline elevation of 1,808 feet. Current operation by YCWA is to only use the lower intake to ensure cold water releases to the Yuba River year round. The model platform used for the UTM, HEC-5Q, has restrictions on its release mechanisms that did not apply for the standard UTM configuration, but to use the UTM to simulate releases from both the upper and lower intakes, it was necessary to reconfigure the UTM, most importantly, instead of taking spills from the top level of the reservoir, spill temperatures are equal to North

Yuba River inflow temperatures. Figure 2-1 illustrates both the standard UTM configuration and the modified UTM configuration.

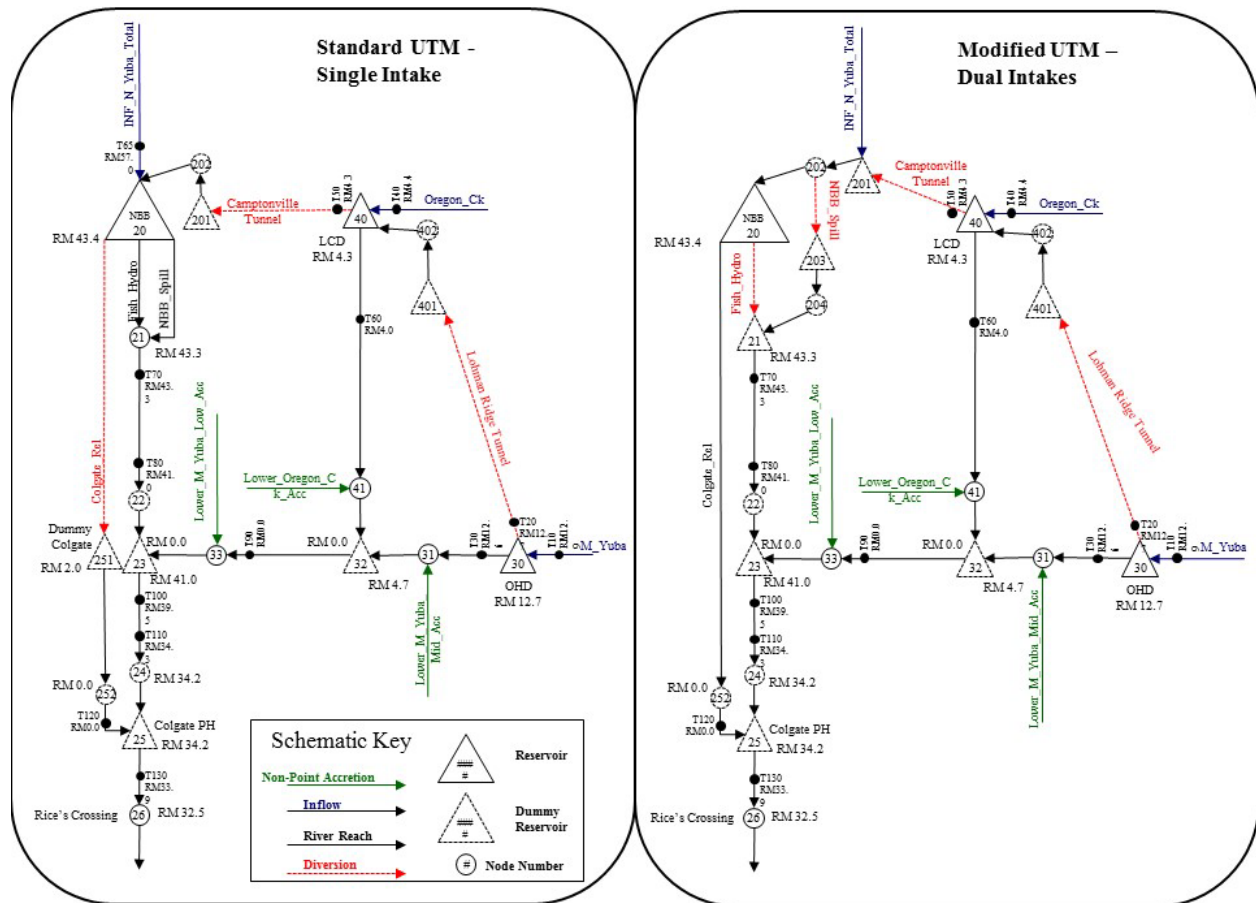


Figure 2-1. UTM schematics for the single and dual intake models.

The removal of the spill affects reservoir conditions in New Bullards Bar and resulting downstream temperatures during spill conditions. The UTM includes surface mixing resulting from the spill-associated inflow volume that would not occur when spills are diverted around the reservoir. However, in non-spill years, model outputs are reasonably representative of operations and conditions.

During development of the UTM, calibration focused exclusively on the lower intake. No historical data using the upper intake were available. Calibration results using the lower intake to downstream release temperatures were very good, although, the UTM tends to under-represent surface warming. Using the lower intake only, the UTM indicates greater warming of the metalimnion and hypolimnion (upper and middle temperature zones in New Bullards Bar Reservoir) from drawdown of upper layers. These deviations do not impact model results using only the lower intake, but do reduce HDR's confidence in UTM results for water temperatures from the upper intake.

These modifications to the Temp Model precluded direct comparison to the normal Temp Model output; in addition to simulating the FWS, CDFW, and FWN Complete Flow Analysis using both intake portals, HDR ran several other scenarios to provide appropriate context for results from the dual intake model output, but using just the lower intake rather than both intakes. Table 2-7 provides a list of Temp Model runs made using the dual-intake Temp Model. One scenario was run using the lower intake only (current operations), and the other was run using the FWS, CDFW, and SWRCB recommended operations for both intakes. Since the water operations of the both scenarios are identical, any differences in downstream water temperatures would be due to the operations of the New Colgate Powerhouse intakes.

Table 2-7. Temperature Model runs made by YCWA using the Dual-Intake Temp Model.

| Flow-Related Recommendations Modeled in Dual-Intake Temp Model – Lower Intake Only | Flow-Related Recommendations Modeled in Dual-Intake Temp Model – Dual Intakes |
|---|--|
| YCWA Amended Final License Application (Scenario 12.1) | YCWA Amended Final License Application (Scenario 12.2) |
| Total = 2 Dual-Intake Temp Model Runs | |

Source: Ops Model Runs Scenario 12, included in Attachment A to this report.

3. Availability of Models and Modeling Results

HDR’s Ops Model, Temp Model and Dual-Intake Temp Model models, each model run, and a summary of each run are provided as an attachment to this technical report, filed with FERC under a separate cover due to their file size. For each Ops Model run, the summary includes effects, as compared to the Base Case, on: 1) water supply deliveries; 2) New Bullards Bar Reservoir operations and storage; 3) flows at various river nodes; and 4) Project peak and off-peak energy generation. For each Temp Model and Dual-Intake Tem Model run, the summary includes mean daily water temperatures and monthly average water temperature, and temperature exceedance plots at various river nodes. All results are presented in Word, Excel and DSS format, as appropriate. The attachment also includes the updated Ops Model.

Attachment A

Due to the size and/or format of the material in this attachment, YCWA has filed with the Commission these materials on a digital versatile disc (DVD) as part of YCWA's October 2017 *Response to Comments, Recommendations, Preliminary Terms and Conditions, and Preliminary Fishway Prescriptions*. YCWA included for context on the DVD a *.pdf copy of YCWA's *Modeling Approach to Support Responses to Flow-Related Recommendations* (i.e., report text).

Copies of the material in this attachment on DVD may be obtained upon request by contacting:

Curt Aikens
General Manager
Yuba County Water Agency
Office: 530.741.6278 x115
caikens@ycwa.com
www.ycwa.com

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