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BEFORE THE

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

HEARING IN THE MATTER OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND UNITED STATES BUREAU OF RECLAMATION REQUEST FOR A CHANGE IN POINT OF DIVERSION FOR CALIFORNIA WATER FIX	TESTIMONY OF JOHN BEDNARSKI (EXHIBIT DWR- 75)

I, John Bednarski, do hereby declare:

I. INTRODUCTION

My name is John Bednarski. I am an expert in the BDCP/California WaterFix (CWF) project conceptual engineering design. I am the manager of the Water Supply Initiatives Section at the Metropolitan Water District of Southern California (MWD) and since 2011, I have participated with DWR in the conceptual design and overall engineering program management of the California WaterFix (CWF). My Statement of Qualifications was previously submitted in this hearing as Exhibit DWR-17.

I have reviewed the testimony of the opposing parties with respect to the engineering project description for the CWF and alleged impacts to other users of water due to the proposed engineering or construction methods. Specifically, this testimony rebuts certain statements raised in testimony to this Board by 1) Delta Flood Control Group (DFCG) witness Gilbert Cosio, 2) East Bay Municipal Utilities District (EBMUD) witness Xavier J. Irias, 3) Local Agencies of the North Delta (LAND) witnesses Russel Van Loben

Sels and Richard Elliot, and 4) Pacific Coast Federation of Fishermans Associations and Institute for Fisheries Resources (PCFFA) witness Deirdre Des Jardins.

II. SUMMARY

My rebuttal testimony is submitted to correct the omissions and misrepresentations presented during the Part 1B hearing with respect to the feasibility of tunnel design and construction methods; impacts to existing levees, existing and planned infrastructure projects, and existing water diversions; and engineering assumptions for sea level rise. My testimony is organized and summarized under the following headings:

- Large-Diameter Tunnel Projects Have Been Successfully Completed Throughout The World. Testimony before this Board has suggested that the CWF tunnels are of unproven design and construction methods, which could lead to unanticipated negative consequences during construction of the tunnels. A series of large-diameter tunnel projects were surveyed and similarities to the proposed CWF tunnels were identified. In each of these cases, successful outcomes were achieved without incurring risk or injury to project stakeholders.
- Levees Will Not Be Compromised by Construction. Mr. Cosio's testimony alleges that pile driving and other CWF-related construction activities will compromise existing levees. Mr. Cosio presented no analysis or investigations to confirm that observed structure issues were caused by construction activities. On the contrary, DWR and other agencies have driven piles for a number of projects in the Delta with no damage observed to levees or related structures.
- Existing and Planned Infrastructure Projects Will Not Be Compromised By Construction. Mr. Irias' testimony alleges that the CWF tunnels will compromise existing and planned infrastructure in the Delta. He claims that both construction and operation of the CWF tunnels will place risks upon such present and future infrastructure. Large-diameter tunnel projects are being constructed world-wide without damaging existing infrastructure. Provisions can be made during design of the CWF tunnels to mitigate or eliminate any of the potential issues that Mr. Irias

identified in his testimony. A comprehensive tunnel leakage assessment was conducted by DWR and the results indicated that leakage into, and out of the tunnels will be negligible under the current CWF configuration and operating conditions.

- Water Supplied By Existing Diversions Affected By Construction Will Be Maintained. Testimony by Mr. Van Loben Sels and Mr. Elliot have incorrectly characterized the disposition of two existing water diversions. Both witnesses claimed "permanent' impacts to their diversions, when in fact, the impacts are temporary. Furthermore, DWR has previously committed to maintaining diversion flow and quality during construction.
- The CWF Engineering Design Correctly Accounts for Sea Level Rise.
Testimony by Ms. Des Jardins alleges that the CWF conceptual engineering design estimates for 18 inches of sea level rise are not realistic when compared to sea level rise estimates for Port Chicago. In fact, the CWF conceptual engineering design used a conservatively high estimate of 55 inches of sea level rise at the Golden Gate Bridge. However, projected sea level rise decreases moving further upstream, such that the 55-inch estimate at the Golden Gate Bridge translates to 18 inches at the intake locations.

III. LARGE DIAMETER TUNNEL PROJECTS HAVE BEEN SUCCESSFULLY COMPLETED THROUGHOUT THE WORLD

Testimony before this Board has suggested that the CWF tunnels are of unproven design and construction methods, which could lead to unanticipated negative consequences during construction of the tunnels. DFCG's witness Mr. Cosio complains about construction impacts to levee stability due to such activities as construction of tunnel shafts, pile driving, and dewatering impacts. (Exhibit DFCG-1, page 6, lines 19-20; pages 9-11, pages 15-17.) EBMUD's witness Mr. Irias gave extensive testimony regarding potential construction impacts to EBMUD facilities crossing the Delta (both current and future facilities), including that the CWF tunnels would cause direct interference with structures, undermining and settlement, soil settlement due to lower groundwater levels, lateral earth movement, seepage into the CWF tunnels, and other impacts. (Exhibit EBMUD-153, page 14, lines 1-17 [summarizing alleged impacts].) Specific claims of impacts from construction of the CWF to levees and to infrastructure projects are addressed in later sections of this testimony. This section addresses the feasibility of large-scale tunnel projects generally.

As part of engineering program for the CWF, the engineering team performed a survey of recent large diameter tunnel projects throughout the world. One of the main objectives was to identify design, construction, and project management issues those projects faced in order to anticipate and manage any similar issues with the CWF tunnels. The projects surveyed are all well documented, recently completed (or substantially completed) large diameter tunnel projects. With the exception of one hard-rock tunnel, the remaining were all soft ground or mixed ground tunnels mined with tunnel boring machines, which is the same design condition for the CWF tunnels.

At the outset, it is important to put the proposed diameter of the CWF project in perspective. At a proposed 45-feet outside diameter (OD), the 2 main CWF tunnels are indeed large, but well within the size range of other recent large diameter tunnel boring machine (TBM) projects. Exhibit DWR-6, page 6 graphically shows the bored diameter of 10 tunnel projects of approximately 40-feet OD and larger. The largest project is a 58-feet OD, putting the CWF tunnels well within the size range in which tunneling with TBMs has been planned or proven in the field.

In addition to strictly comparing the size of the CWF tunnels to other large tunnels throughout the world, the engineering team conducted a detailed survey of recently completed, or substantially completed large tunnel project. The tunnel projects that were surveyed as part of the CWF engineering effort are:

- Eurasia Tunnel (Turkey)
- Lee Tunnel (London)
- Port of Miami Tunnel (Florida)

- East Side Access Tunnel (New York)
- Blue Plains Tunnel (District of Columbia)
- Bay Tunnel (San Francisco, California)
- Willamette River Combined Sewer Outfall Tunnel (Portland, Oregon)
- Gotthard Base Tunnel (Switzerland)
- SR-99 Alaskan Way Replacement Tunnel (Seattle, Washington)

Each of project and the challenges they faced are briefly described below.

A. EURASIA TUNNEL

The Eurasia tunnel project is a transportation tunnel that crosses underneath the Bosporus straits, which historically is the division between Europe and Asia. The tunnel is 40 feet inside diameter (ID), which is very similar in size to the proposed CWF tunnels. The Eurasia tunnel project was completed in December 2016, three months ahead of schedule and within budget.

The potential for water seepage was a key technical challenge for the Eurasia Tunnel, since it passes about 300 feet under the Bosporus straits. Water pressure at that point was about 165 pounds per square inch. In contrast, the water pressure at tunnel depth for the CWF tunnels is 60 pounds per square inch (psi). The Eurasia Tunnel also faced complex geology with potential for seismic deformations. The tunnel also crossed an earthquake fault, which was facilitated by installing a seismic joint inside the tunnel. The construction went smoothly and the tunnel went into operation last year. This project won the International Tunnel Association project of the year in 2015.

B. LEE TUNNEL

The Lee Tunnel is part of a multi-tunnel effort that makes up the Thames tideway project in London. The Lee Tunnel is a 23.6 feet ID combined storm overflow (CSO) tunnel that is 160-feet deep. It is part of a series of tunnels linked together to capture surface storm runoff to divert it to treatment before flowing into the Thames River.

The Lee tunnel is a complex project that was completed in December 2015 on schedule and slightly under project budget and received the prestigious Concrete Society

Award in Great Britain.

Construction of the project in urban London greatly added to the overall project complexities. The project faced issues with worksite availability and logistics, working in the vicinity of a river as well as historic buildings and structures, contaminated soils and groundwater, and also offloading and removing the tunnel material that came out of the tunnels.

C. PORT OF MIAMI TUNNEL

The Port of Miami Tunnel is a transportation tunnel project that was recently completed on time and on budget, and opened to traffic in 2014.

At approximately 40-feet ID, the Port of Miami Tunnels are very similar in size to the proposed CWF tunnels. These were twin tunnels at a depth of 120 feet, passing underneath the Port of Miami. Ground conditions for this project were very challenging. The tunnels were mined through very soft limestone material as well as coral, requiring extensive grouting work prior to tunneling. Due to robust geotechnical investigations, the contractor was able to employ additional extensive grouting once the contract was underway to ensure successful tunneling. The success of geotechnical exploration program coupled with an extensive ground improvement program (grouting) minimized project risks and led to successful completion of the project without incident to the construction team or adjacent infrastructure.

D. EASTSIDE ACCESS TUNNEL

The Eastside Access project was a complicated large project with several tunnel components. The project was conceived to enhance the connectivity of the Long Island Railway to Penn Station. The Queens Bored Tunnel component is the focus of the tunnel survey for the CWF. This project consists of four 19-feet diameter rail tunnels, located about 60-feet below ground.

Several technical challenges were due mostly to very shallow ground cover and existing infrastructure. The tunnels crossed underneath active railway lines, with abrasive ground conditions and many cobbles and boulders. Due to the poor ground conditions and shallow tunnel cover, a technique referred to as ground freezing was used to stabilize difficult soil conditions prior to tunneling. Additional challenges were also faced due to small work areas, minimal room for safe havens, and labor shortages. Despite these challenges, Queens bored tunnel project was completed successfully without interruption to rail service and without damaging existing infrastructure.

E. BLUE PLAINS TUNNEL

The Blue Plains Tunnel is part of DC Water's Clean Rivers Project to reduce combined storm overflows into the area's rivers. The Blue Plains Tunnel is one of five tunnels in the overall project. This tunnel was completed successfully along with a second tunnel, the Anacostia Tunnel. The Blue Plains Tunnel is 23-feet ID, 160-feet deep, and 4.5 miles long. It was completed in 2015, ahead of schedule and under budget.

This project overcame unique challenges. These challenges included tunneling immediately adjacent to a river, so the ground conditions were fully saturated, a similar condition that will be experienced with the proposed CWF tunnels. The project tunneled underneath existing infrastructure, without causing ground settlement or structure deformation/damage. In 2013, the project won the Technical Innovation of the Year award at the International Tunnel Association. Additionally, in 2016, the tunnel project received the Engineering News Record (ENR) 2016 Best Project Award for the Mid-Atlantic Region for Water/Environment. In both cases, the awards acknowledged a primary accomplishment of the tunnel project was the "practically undetectable" ground movement associated with the project.

F. BAY TUNNEL

The Bay Tunnel is part of the San Francisco Public Utilities Commission (SFPUC) Water Supply Improvement Program to upgrade the entire SFPUC system water delivery system for enhanced seismic reliability and other reliability issues.

The Bay Tunnel is the second largest project within the overall program, which contains approximately 85 individual projects. The tunnel consisted of a 15-feet ID tunnel, 5 miles long, and 100-feet deep. The tunnel is unique for a couple of reasons. This tunnel was the first tunnel bored under the San Francisco Bay. Secondly, the tunnel was constructed as a single continuous 5-mile drive with no intermediate shafts, thus very similar to the proposed 8-mile tunnel drives proposed for the CWF tunnels.

Notable challenges facing the Bay Tunnel included variable ground conditions, crossing under levees, contaminated soil, disposal of tunnel material, and high groundwater pressure at 50 psi (similar conditions to CWF tunnels). The project was completed in October 2014 on time and within budget.

G. WILLAMETTE RIVER COMBINED SEWER OUTFALL TUNNEL

The Willamette River Combined Sewer Outfall (CSO) Tunnel is a project in Portland to comply with requirements to collect and treat storm discharges into waterways. This is a very large project consisting of two tunnels and two tunnel contracts; one on the east side and one on the west side of the Willamette River. One tunnel is 14-feet ID, 120-feet deep, and 3.5 miles long; the other is 22-feet ID, 150-feet deep, and 6 miles long.

Issues facing this project were challenging ground conditions, with rocks, cobbles and boulders, and also the need to perform soil modification deep down in the tunnel shaft. Other challenges included TBM breakout and subcontract changes. Despite these challenges the project was completed in 2012, eight months ahead of schedule and under budget. In 2012, the success of the project was recognized as one of five finalists for the 2012 Outstanding Civil Engineering Achievement (OCEA) Award by The American Society of Civil Engineers (ASCE).

H. GOTTHARD BASE TUNNEL

The Gotthard Base tunnel is the longest tunnel in the world. The project consists of twin rail tunnels, each one 35 miles long and about 6,500 feet underneath the Swiss Alps. While this project is a hard rock tunnel, whereas the CWF will be mined through soft and mixed ground, it is comparable to the CWF in overall size and scope. The Gotthard Base Tunnel was constructed over a 17-year period. The two main rail tunnels, additional smaller tunnels were constructed to accommodate safety, ventilation, and cross-passage requirements. In total, the project has bored 95 miles of tunnel. The hard rock, squeezing ground conditions caused the TBMs to get stuck several times. Squeezing ground conditions are not anticipated with the CWF project. The project was completed in 2016 within schedule.

I. SR-99 ALASKAN WAY REPLACEMENT TUNNEL

The SR-99 Alaskan Way Replacement Tunnel is a transportation tunnel project in Seattle. The tunnel will replace the elevated viaduct that runs along the waterfront in downtown Seattle. At the time this project was conceived, it was the largest diameter TBM tunnel project in the world, at 57-feet OD and 53-feet ID. The project is currently experiencing about a two-year delay due to several challenges associated with the tunnel boring equipment as well as management and contracting issues that are not relevant here.

The mining for this project started in 2013. At about 1,000 feet into the job the TBM broke down. It took approximately two years to fix the situation. The repair required mining a large pit to gain access to the TBM, pulling off the cutter head, replacing the main bearing, and reassembling the TBM in place.

The project is now making excellent mining progress. The tunnel is approximately 95% mined at this time and the project's new management team expects that they will finish mining this tunnel by June 2017.

The unprecedented size of the TBM, at the time, may have contributed to the delay. When this TBM was designed, it was about 30 percent larger than any other TBM ever deployed. (See Exhibit DWR-6, page 6.) From publically available information, it is estimated that approximately 100 tons of additional steel were put into the TBM when it was repaired. Consequently, it is believed that the TBM was initially under-designed when first constructed, and structural issues with the cutterhead and main bearing lead to many of the problems experienced on the project. In contrast, the CWF is within the size range of many recent successful projects and will benefit from advancements in large diameter TBM design that have already proven successful within the 45-foot OD design range. Since the Seattle TBM has been restarted following repair, it has performed very well. There have been no reports of ground deformation, surface settlement or damage to surface infrastructure as a result of tunneling since the repairs took place.

J. IMPLICATIONS FOR THE CWF TUNNELS

Based on the survey above, several common issues emerge and will be planned for in the design of the CWF tunnels. Foremost, good geotechnical information is the key for success on any tunnel project. CWF team has learned that there is no way for an owner to get out of ultimate responsibility for the ground conditions. Therefore, a thorough geotechnical investigation is planned for the program, and these investigations will be some of the earliest work to start on the program. Secondly, the need for a proactive risk identification and management program. For CWF's program management team, the Design and Construction Enterprise (DCE), risk management is proposed to be positioned very high in the organization, reporting directly to the program director. Finally, utilization of well tested and thoroughly understood tunneling technologies will minimize the risks of unforeseen tunneling events. As discussed earlier in this testimony, the CWF plans to utilize well proven tunnel technologies that have been thoroughly tested at the size intended for the planned project.

Based on the comparison to the highly successful large diameter TBM projects in this survey, the CWF tunnels do not pose any special or unusual challenges that would hinder similar successful completion. In fact, Mr. Irias in his cross-examination testimony (pg 52 line 23) stated that he could not foresee any reason that the tunnels could not be successfully completed. (Part 1B Hearing Transcript, Vol. 26, 52:23.) Additionally, Mr. Irias stated that for his agency's own aqueduct rehabilitation project, EBMUD would be implementing a tunnel concept to replace the currently above-ground portion of the aqueduct that spans nearly 17 miles from Interstate 5 in Stockton to Bixler in the west. (Exhibit EBMUD-153, page 8, lines 3-5.) EBMUD is contemplating a 21-foot diameter tunnel, to be bored with a pressurized face tunnel boring machine, a similar technology to the CWF tunnel plans. (*Id.*, page 8 lines 7-9.) Indeed, many of the surveyed existing projects faced numerous technical and logistical challenges that are not expected with the CWF tunnels. The lessons learned from world-wide tunnel projects will be employed by the

DCE. It is anticipated that this thorough planning and design philosophy, embraced by the CWF effort so far during the environmental planning process, will carry forward to future design phases and construction.

IV. LEVEES WILL NOT BE COMPROMISED BY CONSTRUCTION

Mr. Gilbert Cosio, Jr. claims in his testimony that CWF will increase the likelihood of levee failures in the Delta (DFCG-1, page 8, lines 6 through 9). However, he did not provide any engineering analyses to substantiate the above claim. Specifically, he did not provide any analysis or data to support his claims that the proposed CWF construction activities such as pile driving, floodway obstructions, and truck traffic would cause adverse impacts to the levees (DFCG-1, page 8, lines 18 through 28; page 9, lines 1 through 16).

A. PILE DRIVING WILL NOT ADVERSELY AFFECT LEVEES

Mr. Cosio claims that pile construction for the CWF will damage the levees and structures in the North Delta (DFCG-1, page 11, lines 16 and 17). However, Mr. Cosio's testimony did not include engineering analyses or pile driving project case histories to support the above claim. He cited a residential development project in Contra Costa County that used soil densification. Mr. Cosio stated in his testimony that a sandy levee located approximately three miles from the residential project site experienced settlement and foundations of two structures on the levee cracked. (DFCG-1, page 8, lines 23 through 26). However, during cross examination, Mr. Cosio indicated that no analyses or investigations were performed to confirm that observed structure foundation cracks and levee settlements were due to the soil densification work. His testimony was merely based on the conclusion that timing of soil densification coincided with observation of levee settlement and foundation cracks. (Part 1B Hearing Transcript, Vol. 25, 250:3-9.)

Several intakes and other facilities such as non-physical fish barriers, fish release facilities, a fish research laboratory, and a power plant have been constructed successfully in and around the Delta using both vibratory and impact pile driving methods without damaging nearby levees. Several hundred piles were driven to construct cofferdam and foundations at each of the following intake sites: Alternative Intake on the Victoria Canal owned by Contra Costa Water District (approximately 390 piles), Freeport intake on the Sacramento River owned by the Freeport Regional Water Authority (approximately 520 piles), and Sankey Diversion Facility on the Sacramento River owned by the Natomas Mutual Water Company (approximately 270 piles). In each of these cases, no damage to levees and related structures were observed.

DWR also has used driven piles for several projects in the Delta. DWR drove numerous piles during the construction of the non-physical fish barriers on Georgiana Slough and at the Head of Old River, and the Skinner Fish Research laboratory near the Clifton Court forebay. Approximately 2,000 concrete piles were driven using impact hammers for the construction of Cosumnes Power Plant, which is owned by Sacramento Municipal Utility District and located approximately 1,800 feet from the Rancho Seco Nuclear Plant in Sacramento County. In each of these cases, no damage to levees or related structures were observed. One of DWR's witnesses on the engineering panel, Mr. Pirabarooban worked on some of the above projects. His roles on these projects were:

- Georgiana Slough non-physical fish barrier: Senior Engineer responsible for design and construction
- Skinner fish research laboratory: Reviewer for foundation design
- Cosumnes power plant: One of the geotechnical engineers responsible for foundation design and construction

Engineering consultants who designed the Freeport Intake and Sankey Diversion Facility also performed the conceptual engineering for the proposed CWF intakes. The CWF approach to construction is similar to these other referenced successful projects. Consequently, the Engineering Team anticipates that all work will be constructed without damaging levees or related structures.

Based on our conversations with geotechnical and construction engineers who worked on the above referenced projects, the levees and other structures located near these facilities did not experience settlements exceeding the thresholds established or failures during pile driving. Mr. Cosio also confirmed during cross examination that there were no levee issues resulting from the Freeport intake construction. (Part 1B Hearing Transcript, Vol. 25, 230:10-12.)

DWR will be implementing well accepted engineering practices, similar to the approaches taken in the successful engineering projects identified above. The projects identified above collected subsurface data and performed geotechnical engineering analyses to select the appropriate pile types and installation methods. Detailed settlement monitoring programs were implemented before and during the construction to ensure that construction induced settlements do not exceed the thresholds established to protect existing levees and other structures located near the project sites.

DWR has committed to the same approaches identified above and will perform detailed engineering analyses, including geotechnical studies, to determine the appropriate pile types and installation methods during design for the proposed CWF facilities. (Exhibit SWRCB-102, Appendix 3B, Environmental Commitment 3B.2.1.1.) DWR has also committed to implement monitoring programs before and during construction to protect the levees and other sensitive structures located in the immediate vicinity of the project sites. (*Id.*, Environmental Commitment 3B.2.1.2.)

For the CWF, installing sheet piles will be required to construct cofferdams at intakes, Clifton Court Forebay (CCF), and the Head of Old River (HOR) gate site. Based on the cofferdams constructed in and around the Delta for intakes referenced below in the past, it is expected that vibratory hammers would be used to drive approximately seventy percent of the required pile depths and impact hammers would be used to drive the remaining thirty percent of pile depths. Vibratory hammers were successfully used to construct cofferdams for the Freeport intake and Sankey Diversion facility. Vibratory hammers are generally used as alternatives to impact hammers to minimize vibration and noise.

To support the intake structure foundations, HOR gate, barge unloading facilities, and control structures near CCF, either driven piles or cast-in-drilled hole (CIDH) piles, also known as drilled shafts would be needed. As the name implies, the CIDH piles are constructed in drilled holes and do not require pile driving. During the next engineering phase, additional geotechnical data will be collected and the type of pile needed to support these facilities will also be determined. To estimate construction impacts for the worst case scenario, driven piles that require impact driving were assumed to be used to support these structures for the EIR/EIS and Biological Assessment impact analyses. (Exhibit DWR-656, Appendix 3.E, Table 3.E-2.) If the CIDH piles are chosen to support intake foundations, HOR gate, and control structures, impact pile driving needed will be reduced significantly and would be limited to the installation of approximately 30 percent depth of cofferdam piles. (*Ibid.*)

B. ENCROACHMENTS INTO THE RIVER CHANNEL WILL NOT ADVERSELY AFFECT LEVEES

The following corrects misrepresentations or omissions in responses provided by Mr. Cosio during cross examination on October 28, 2016 regarding Section 408 permitting from the U.S. Army Corps of Engineers (USACE) and the encroachments into the river channel (Part 1B Hearing Transcript, Vol. 25, 223:21- 25, 224:1-12, 255-257:-17). Mr. Cosio indicated during cross examination that USACE would conduct a textbook analysis during their evaluation of DWR’s proposed modifications to the levees. Mr. Cosio implied that during this analysis, the USACE reviewers may not, in many cases, be aware of local conditions that pertain to Delta. (Part 1B Hearing Transcript, Vol. 25, 224:6-12.) Mr. Cosio also indicated that the USACE review would focus primarily on flood elevation issues, and not on how the actual details of the proposed modifications would potentially change the existing river flow patterns, sediment deposition, etc. (Part 1B Hearing Transcript, Vol. 25, 257:13-17.)

Mr. Cosio is incorrect as to the scope and level of detail of USACE’s permitting process. The USACE has decades of experience in protecting human safety in the Delta, particularly with respect to levees under their jurisdiction. Construction of the proposed CWF intakes includes alteration to the levee sections that are part of the Sacramento River Flood Control project. Sacramento River Flood Control project levees (also known as federally constructed project levees) are under the jurisdiction of USACE and Central Valley Flood Protection Board (CVFPB).

USACE's Engineering Circular, EC 1165-2-216 (Exhibit DWR-657) provides policy and procedural guidance for processing Section 408 permits. Section 408 authorizes the Secretary of the Army to grant permission for an alteration if the Secretary determines that the activity will not be injurious to the public interest and will not impair the usefulness of the project. (*Id.*, Section 6.) EC 1165-2-216 requires among other things that an applicant for a Section 408 permit show that the proposed alteration will not limit the ability of the project to function as authorized and will not compromise or change any authorized project conditions, purposes or outputs. All technical analyses required for facility design, including geotechnical, structural, hydraulic and hydrologic, real estate, and operations and maintenance requirements, must be conducted. The technical adequacy of the design must be reviewed. The design review will be performed at various design phases by USACE District and Regional Offices, and Headquarters. In addition to the USACE's internal reviews, a safety assurance review by an independent panel of experts will be performed as part of the permitting process. To meet the above permit requirements, DWR will have to show in the permit application that proposed alterations to the levee sections and construction activities including encroachment into the river channel and pile driving will not compromise the existing levees. The CWF will not result in substantial adverse changes in water surface profiles, and as a general rule, such substantial adverse changes would not be approved.

As stated in Section V of my Part 1A testimony (Exhibit DWR-57), DWR requested CVFPB to initiate Section 408 permitting process with USACE in December 2015. (Exhibit DWR-203.) DWR will prepare and submit permit application along with engineering plans, hydraulic and geotechnical analyses, and other relevant documents to USACE through CVFPB as required by USACE's Engineering Circular, EC 1165-2-216. (Exhibit DWR-57, page 24, lines 26 and 27 [Written Testimony of John Bednarski]; Exhibit DWR-657 [Engineering Circular, EC 1165-2-216].) This process, coupled with the proposed CWF design and its environmental commitments and mitigation measures, will ensure that project encroachments into the river channel will not adversely affect levees.

C. TRUCK TRAFFIC WILL NOT ADVERSELY AFFECT LEVEES

Mr. Cosio claimed in his testimony that truck traffic will cause significant levee damage each year during construction. (Exhibit DFCG-1, page 17, lines 15 through 17.) His testimony did not include engineering analyses or other evidence to support the above claim. First, it is important to correct his misleading statement that "[t]he main roadways (County roads and State highways) used by [CWF] construction trucks in, out, and around the Delta are located on of levees." (*Id.*, page 17, lines 5 through 7). Among the highways identified for construction traffic (State Routes 4, 12, 160 and Interstate 5), SR-160 is the only highway that is located on top of levees. Since July 2010, DWR has been working with Caltrans through an interagency agreement on improvements needed for State Routes 4, 12, and 160 for constructing the CWF facilities. This work has identified the need to improve ingress and egress from the project sites to ensure safe passage of construction-related traffic. This work has also identified the need to consider alternate methods to deliver some of the very large equipment loads due to size or weight limitations on some of the existing State highway infrastructure.

Highways in the Delta were constructed in the early and mid-20th century. These highways have carried over several hundred thousands of truck traffic over their life time and are not expected to exhibit significant settlement due to potential truck traffic from CWF construction. For example, the average daily truck traffic on SR-160 at the Hood-Franklin Road (near the CWF intakes) was 68 in year 2014. (Exhibit DWR-658, page 165.) Over the last fifty years, the SR-160 near the CWF intakes would have carried about 730,000 truck traffic assuming an average of 40 daily truck traffic (though the average daily truck traffic was 68 in 2014, a lower count of 40 was assumed to account for variations in the truck traffic over the years). Given this historic usage, SR-160 is expected to easily withstand the anticipated increase in truck traffic due to the CWF.

As stated in my Part 1A testimony (Exhibit DWR-57, page 26, lines 13 through 28), to the extent possible CWF construction truck traffic will be kept off the levees that are not highway-rated. In the planning phases of the CWF, approximately 6 miles of levee roads (excluding SR-160) were identified for use for construction site access. Prior to construction, existing conditions of levee roads that are identified as potential haul routes and expected to carry significant construction truck traffic will be assessed, monitored and documented through field reconnaissance and engineering surveys. Based on the initial assessment from field reconnaissance and engineering surveys, geotechnical exploration and analyses will be performed for levee sections that need further evaluations. (Exhibit SWRCB-102, Appendix A, Environmental Commitment 3B.2.1.) Should the geotechnical evaluations indicate that certain segments of existing levee roads need improvements to carry the expected construction traffic loads, DWR is committed to carry out the necessary improvements to the affected levee sections or to find an alternative route that would avoid the potential deficient levee sections. As discussed in the Final EIR/EIS, Chapter 19 - Transportation, Mitigation Measure Trans- 2c, all affected roadways would be returned to preconstruction condition or better following construction. (Exhibit SWRCB-102.) Implementation of this measure will ensure that construction activities will not worsen pavement and levee conditions, relative to existing conditions.

V. EXISTING AND PLANNED INFRASTRUCTURE PROJECTS WILL NOT BE COMPROMISED BY CONSTRUCTION

In the testimony of Mr. Xavier Irias, he claims construction of the CWF will adversely affect existing and planned aqueducts and existing powerlines due to tunneling during construction and due to tunnel seepage and leakage. Specifically with respect to existing aqueducts, Mr. Irias' written testimony expresses concern that CWF tunnel construction will undermine, cause settlement and reduce ground support for the foundation piles of the Mokelumne Aqueduct. (Exhibit EBMUD-153, page 16, lines 4-27; page 17, lines 1-5.) His concern is that loss of foundation support may structurally damage the Aqueduct and potentially result in loss of water supply to EBMUD customers. Mr. Irias proposed geotechnical investigations and the development of a ground treatment plan to mitigate impacts to the Mokelumne Aqueduct. (*Id.*, page 21, lines 16 through 27; page 22, lines 1 through 11.) However, the CWF project is already committed to performing extensive geotechnical studies. (Exhibit SWRCB-102, Chapter 3, Section 3.6.1.10.) Through these studies and the environmental commitments (*id.*, Appendix 3B, Section3B.2.1 Geotechnical Studies), the CWF project will develop the required ground treatment plan, and ground settlement monitoring and response plan to mitigate impacts to the Mokelume Aqueduct. DWR is committed to collaboratively working with EBMUD to establish existing baseline conditions and measurements near and around where the CWF tunnel crosses the Mokelumne Aqueduct and proposed Delta Tunnel, work on the ground treatment, ground settlement monitoring and response plans, contract specifications and TBM maintenance procedures to safely allow CWF tunnel to cross under the Mokelumne Aqueduct.

In written testimony by Mr. Xavier Irias, he expressed concern that seepage into the CWF tunnel during the life of project could carry soil particles resulting in piping and erosion that may cause voids, settlement, and/or potential sinkholes and have an impact on the existing Mokelumne Aqueducts or proposed Delta Tunnels. (Exhibit EBMUD-153, page 18, lines 3 through 15.) During verbal testimony Mr. Irias also expressed this concern but was primarily focused on seepage during construction and when the tunnel is empty, such as for maintenance shut-downs. (Part 1B Hearing Transcript, Vol. 26, 29:1-22.) Mr. Irias did not provide any tunnel leakage analysis to support his concern. To address this concern the Engineering Team commissioned consultant ARUP North America, Ltd. to prepare a technical memorandum to assess potential leakage rates from the California Water Fix tunnel. (Exhibit DWR-659.)

With respect to the concern of seepage during construction, or if the tunnel is unwatered for future maintenance, the technical memorandum notes that segmental lining gaskets will avoid the flow of any small particles into the tunnel. This is similar to a typical transportation tunnel, and there is a long track record of large diameter tunnels in similar ground conditions that do not see a loss of ground. A typical specification is to require no visible water inflow above springline, and damp patches only (no flowing water) below springline. (Exhibit DWR-659, page 14.)

During tunnel operations, Table 2 of the technical memorandum notes that inflow would occur for the lengths of tunnel where the internal water pressure is lower than the external groundwater pressure, and outflow, or leakage, would occur where the internal water pressure is higher than the external pressure. So overall, for all the tunnels taken together (reaches 1 to 7), the sections subject to inflow will have a total inflow of 3.7 cubic feet per second (cfs), and the sections subject to leakage will have a total leakage of 0.7 cfs; overall the entire system has an estimated inflow of only 3 cfs. These inflow and leakage rates are considered minimal and insignificant for 73.5 miles of tunnels. The technical memorandum provided three significant conclusions:

1. The permeability of the liner has a significant effect on the calculated leakage rates. Leakage rates are noticeably more sensitive to liner permeability than that of ground permeability. The elevation of the tunnel makes almost no difference to the leakage rates.
2. Under the low differential pressures which will occur with the current alignment and design water pressures, radial cracking is not expected, and the liner permeability will be a function of the concrete, as well as the circumferential and radial joints.
3. The net load on the segmental lining is anticipated to be external, with the confining pressure of the soil and external groundwater providing a higher load than the internal water pressure. This will maintain the segmental lining in compression (avoiding higher permeability due to micro-cracking) and also keep the gaskets sealed.

The Engineering Team plans to further evaluate tunnel leakage rate during the preliminary and final design stages once additional geotechnical and hydrogeological data is available.

In addition to the conclusions above the technical memorandum also made a number of recommendations and steps to minimize leakage that correlate with good practices taken to limit inflows in segmentally lined tunnels. These recommendations are summarized here and include:

1. Specification of a high quality concrete, with low permeability. This will also meet the goal of having a concrete with high durability.
2. Careful detailing of inserts, such as the plastic sockets used for grout holes.
3. Specification (and enforcement) of tight build tolerances for the segmental lining. A well-built lining will have better alignment at gaskets and will avoid concrete damage, which will reduce leakage potential.
4. Establish field quality control measures field to ensure good segment build include dimensional checks on each ring assembled, to ensure that the tunnel diameter is within tolerance; and careful development and monitoring of the grout mix, pump pressure and injection volume to ensure complete filling of the annular void with a grout that provide stability to the lining and minimize displacement after erection.
5. Design gasket details and segment connections and specify adequate annular void grouting to ensure the gaskets remain adequately compressed when the internal water pressure is applied.

For the long term tunnel integrity DWR is committed to developing a maintenance and inspection program that will ensure that on a regular basis the interior of the tunnel is inspected and maintained to specified standard. The program will also include ground surface monitoring.

In written testimony Mr Irias expressed concern that the new transmission lines may have adverse impacts on the existing Mokelumne Aqueducts. (Exhibit EBMUD-153, page, 19 lines 25 through 27; page 20, line 1 and 2.) Specifically, the concern is that foundations for the proposed CWF transmission lines located near the existing Mokelumne Aqueducts may adversely impact the Mokelumne Aqueducts' foundations or the surrounding levee system from ground movements and settlement. As previously noted, the CWF project is already committed to performing extensive geotechnical studies. (Exhibit SWRCB-102, Chapter 3, Section 3.6.1.10.) Through these studies and the CWF environmental commitments (*id.*, Appendix 3B, Section3B.2.1 Geotechnical Studies, Section 3B.2.4

Electrical Power Line Support Placement) will develop the required ground treatment plan, and ground settlement monitoring and response plan to mitigate impacts to the Mokelume Aqueduct. CWF is committed to collaboratively working with EBMUD to establish existing baseline conditions and measurements near and around where the CWF power lines crosses the Mokelumne Aqueduct and to locate powerline supports to minimize or avoid impacts to the Mokelumne Aqueduct or levees.

Mr. Irias expressed concern the CWF power transmission lines will cause AC induced interference and potentially lead to corrosion of the Mokelumne Aqueduct and cause operator safety issues. (Exhibit EBMUD-153, page 20, lines 3 through 11.) In verbal testimony Mr. Irias testified ”We recognize right now the plan is for the power transmission facilities to mostly be parallel to the twin tunnels, which means crossing both our existing and future. And that would tend to -- if that remains, that would be a lesser concern than if it were going parallel” which is related to the AC induced interference issue. (Part 1B Hearing Transcript, Vol. 26, 32:13-21.) Furthermore, the CWF project is committed to designing the transmission lines per Environmental Commitments, AMMs and CMs (Exhibit SWRCB-102, Appendix 3B, Section 3B.2.3, Electrical Power Guidelines, Section 3B.4.30, AMM 30 Transmission Line Design and Alignment Guidelines) and to use best management and design practices which would include applicable National Association of Corrosion Engineers standards. CWF is also committed to working collaboratively during preliminary and final design to design and construct a temporary grounding and corrosion protection system to minimize impacts to the Mokelumne Aqueduct while the temporary transmission lines are in use.

Mr. Irias expressed concern the CWF power transmission lines present a fall hazard. (Exhibit EBMUD-153, page 20, lines 12 through 17.) This is concern is addressed by CWF Environmental Commitments, AMMs and CMs (Exhibit SWRCB-102, Appendix 3B, Section 3B.2.3 Electrical Power Guidelines, Section 3b.4.30 AMM 30 Transmission Line Design and Alignment Guidelines), which provides methods to mitigate these impacts.

VI. WATER SUPPLIED BY EXISTING DIVERSIONS AFFECTED BY CONSTRUCTION WILL BE MAINTAINED

LAND witness Mr. Russel Van Loben Sels claimed during his direct testimony on November 10, 2016 that the existing diversion (S021406) shown on Slide 21 of Exhibit DWR-2 errata will probably be permanently affected. (Part 1B Hearing Transcript, Vol. 28, 49:1-11.) He incorrectly stated that this diversion identified as S021406 would be permanently effected because the pump for the existing diversion will be removed and fish screens will occupy the pump site. As shown in Exhibit DWR-2 errata, slide 7 (also Exhibit DWR-660) the footprint for the proposed intake structure that houses the fish screens do not extend to the area where Mr. Van Loben Sels's diversion is located.

Another witness for LAND, Mr. Richard Elliot also incorrectly claimed that his existing diversion S016915 located downstream of the proposed Intake 3 structure will be permanently removed (Part 1B Hearing Transcript, Vol. 28, 58:19-20, 59:11-17).

As described in my Part 1A written testimony, the existing diversions that are located upstream or downstream of the intake structures and within the State Route 160 realignment footprint will not require relocation and are considered to be temporarily affected. The diversions that are located within the intake structure footprints and require relocation are considered to be permanently affected. (Exhibit DWR-57, page 13, lines 11 through 17; see also Exhibit DWR-660.) Construction activities associated with realignment of SR 160 that would temporarily affect both Mr. Van Loben Sels's diversion S021406 and Mr. Elliot's diversion So16915 are estimated to take between 12 and 18 months. For permitted diversions that are impacted, including these two, the Project will ensure that water deliveries are maintained in the quantities consistent with the applicable water rights. Additional information regarding the measures that would be implemented to mitigate the impacts are presented in my Part 1A written testimony. (Exhibit DWR-57, pages 13 through 15.)

VII. THE CWF ENGINEERING DESIGN CORRECTLY ACCOUNTS FOR SEA LEVEL RISE

Testimony by Ms. Des Jardins alleges that the CWF conceptual engineering design estimates for 18 inches of sea level rise are not realistic. (Exhibit PCFFA-81errata, page 8, lines 16-19.) Ms. Des Jardins cites to sea level rise estimates for Port Chicago for 2030 and 2060 to show that the 18-inch sea level rise estimate used for the intake locations and cited in the Conceptual Design Report are low in comparison. A fact that is missing in Ms. Des Jardins' comparison is that sea level rise estimates decrease as one moves from sea level upstream, and the estimates she cites for Port Chicago are irrelevant to the proposed CWF intake locations on the Sacramento River.

For the CWF conceptual design, an analysis was done in 2009 to establish the design flood water surface elevations and flood protection elevations for the facilities. (Exhibit DWR-661.) This analysis used a conservatively high estimate of 55 inches of sea level rise at the Golden Gate Bridge. (*Id.*, page 7.) However, projected sea level rise decreases moving further upstream, such that the 55-inch estimate at the Golden Gate Bridge cannot simply be added to the estimated flood water surface elevation at the facility locations. (*Id.*)

The Conceptual Design Report explains how sea level rise is estimated at 18 inches at the intake locations, and how this estimate was added on top of the 200-yr flood level estimate plus an allowance for free board and, as applicable, wind-driven waves to develop the flood protection elevations for the intakes. (Exhibit DWR-212, pages 50-51.) These estimates will be reviewed and updated during the next engineering phases.

VIII. CONCLUSION

Based on the foregoing, I believe that the engineering design and construction for the CWF will not result in any of the alleged injuries addressed in this testimony or otherwise significantly adversely affect other users of water.

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Executed on this 22nd day of March, 2017 in Los Angeles, California.

John V. Bednarski