UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 18, 2017

Mr. Edward D. Halpin
Senior Vice President, Generation
and Chief Nuclear Officer
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P.O. Box 56
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SUBJECT: DIABLO CANYON POWER PLANT UNIT NOS. 1 AND 2 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (CAC NOS. MF7919 AND MF7920; EPID L-2016-JLD-0007)

Dear Mr. Halpin:

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f), (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). Concurrent with the reevaluation of flood hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events" (ADAMS Accession No. ML12054A735). In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis flood hazard or the most recent flood hazard information, which may not be based on present-day methodologies and guidance, in the development of their mitigating strategies.

By letter dated April 6, 2017 (ADAMS Accession No. ML17096A766), Pacific Gas and Electric Company (the licensee) submitted the mitigation strategies assessment (MSA) for Diablo Canyon Power Plant, Unit Nos. 1 and 2 (Diablo Canyon). The MSAs are intended to confirm that licensees have adequately addressed the reevaluated flooding hazard(s) within their mitigating strategies for beyond-design-basis external events. The purpose of this letter is to provide the NRC's assessment of the Diablo Canyon MSA.

The NRC staff has concluded that the Diablo Canyon MSA was performed consistent with the guidance described in Appendix G of NEI 12-06, Revision 2, as endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-01, and that the licensee has demonstrated that the mitigation strategies, if appropriately implemented, are reasonably protected from reevaluated flood hazards conditions for beyond-design-basis external events. This closes out the NRC's efforts associated with CAC Nos. MF7919 and MF7920.

If you have any questions, please contact me at 301-415-1132 or at via electronic mail at Joseph.Sebrosky@nrc.gov.

Sincerely,

Joseph M. Sebrosky, Senior Project Manager
Beyond-Design-Basis Management Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Enclosure:
Staff Assessment Related to the
Mitigating Strategies for Diablo Canyon

Docket Nos. 50-275 and 50-323

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STAFF ASSESSMENT RELATED TO THE
MITIGATION STRATEGIES FOR
DIABLO CANYON POWER PLANT UNIT NOS. 1 AND 2
AS A RESULT OF THE REEVALUATED FLOODING HAZARDS REPORT
NEAR-TERM TASK FORCE RECOMMENDATION 2.1- FLOODING
CAC NOS. MF7919 AND MF7920

1.0 INTRODUCTION

By letter dated March 12, 2012, (NRC, 2012a) the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f), (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (NRC, 2011b). Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses.

Concurrent with the reevaluation of flood hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (NRC, 2012b). That order requires holders of operating reactor licenses and construction permits issued under 10 CFR Part 50 to modify the plants to provide additional capabilities and defense-in-depth for responding to beyond-design-basis external events, and to submit to the NRC for review a Final Integrated Plan (FIP) that describes how compliance with the requirements of Attachment 2 of the order was achieved. In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis flood hazard or the most recent flood hazard information, which may not be based on present-day methodologies and guidance, in the development of their mitigating strategies.

The NRC staff and industry recognized the difficulty in developing and implementing mitigating strategies before completing the reevaluation of flood hazards. The NRC staff described this issue and provided recommendations to the Commission on integrating these related activities in COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flood Hazards," dated November 21, 2014 (NRC, 2014). The Commission issued a staff requirements memorandum (SRM) on March 30, 2015 (NRC, 2015), affirming that the Commission expects licensees for operating nuclear power plants to address the reevaluated flood hazards, which are considered beyond-design-basis external events, within their mitigating strategies.

Nuclear Energy Institute (NEI) 12-06, Revision 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," (NEI, 2016) has been endorsed by the NRC as an appropriate methodology for licensees to perform assessments of the mitigating strategies against the reevaluated flood hazards developed in response to the March 12, 2012, 50.54(f) letter. The guidance in NEI 12-06, Revision 2, and Appendix G in particular, supports the proposed Mitigation of Beyond-Design-Basis Events rulemaking. The NRC's endorsement of NEI 12-06, including exceptions, clarifications, and additions, is described in NRC Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-01, Revision 1, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (NRC, 2016a). Therefore, Appendix G of NEI 12-06, Revision 2, describes acceptable methods for demonstrating that the reevaluated flooding hazard is addressed within the Diablo Canyon Power Plant, Unit Nos. 1 and 2 (Diablo Canyon) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated March 30, 2016 (NRC, 2016b), the NRC issued an interim staff response (ISR) letter for Diablo Canyon. The ISR letter provided the reevaluated flood hazards that exceeded the current design basis (CDB) for Diablo Canyon and were suitable input for the mitigating strategies assessment (MSA) (i.e., the mitigating strategies flood hazard information (MSFHI) described in NEI guidance document NEI 12-06). For Diablo Canyon, the mechanism listed as not bounded by the CDB in the letter (ISR flood levels) was local intense precipitation (LIP).

By letter dated April 6, 2017 (PG&E, 2017b), Pacific Gas and Electric Company (PG&E, the licensee) submitted its MSA for Diablo Canyon. The MSA is intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events.

For LIP the period of maximum water level elevation at certain doors and the period of inundation are not bounded by the FLEX design-basis (DB). In its MSA, the licensee documented the measures that have been or will be taken to address the LIP event that is not bounded by the CDB. This includes a commitment to provide instructions for placing water-activated flood barriers prior to blocking open one door if flood water is present, and to stage these barriers in the control room with other FLEX equipment.

3.0 TECHNICAL EVALUATION

3.1 Mitigating Strategies under Order EA-12-049

The NRC staff evaluated the Diablo Canyon strategies as developed and implemented under Order EA-12-049, as described in the Diablo Canyon final integrated plan (FIP) provided by PG&E in a letter dated July 28, 2016 (PG&E, 2016b). The NRC staff's safety evaluation is dated December 28, 2016 (NRC, 2016d). The safety evaluation concluded that the licensee has developed guidance and proposed design that, if implemented appropriately, will adequately address the requirements of Order EA-12-049.

The Diablo Canyon units are Westinghouse pressurized water reactors with dry ambient pressure containments. A brief summary of the licensee's FLEX strategies for the Diablo Canyon units is as follows:

- For Phase 1, the heat sink for core cooling is provided by the four steam generators (SGs), which would be fed simultaneously by the unit's turbine driven auxiliary feedwater (TDAFW) pump with inventory initially supplied from the condensate storage tank. Steam release for the SGs to the atmosphere would be accomplished via the main steam safety valves or the main steam atmospheric dump valves. The licensee calculates that the CST water volume is sufficient to remove residual heat from the reactor for approximately 17 hours. Prior to depletion of the CST, an operator transfers the TDAFW pump suction to the seismically qualified fire water storage tank (FWST). One FWST is common to both units. The licensee calculates that the FWST water volume is sufficient to remove residual heat for an additional 12.5 hours.

Due to loss of ventilation and cooling systems from the extended loss of alternating current (ac) power that is assumed, doors to the control room, cable spreading room and battery charger/inverter rooms are blocked open to achieve passive ventilation in these rooms. No actions are required during Phase 1 for spent fuel pool (SFP) makeup because the time to boil is sufficient to enable deployment of Phase 2 equipment. Adequate SFP inventory exists to provide radiation shielding for personnel well beyond the time of boiling.

- For Phase 2, the strategy for core cooling uses a combination of a common diesel-driven raw water reservoir (RWR) pump and a diesel-driven emergency auxiliary feedwater (EAFW) pump to continue to supply cooling water to the SGs. The common diesel-driven RWR pump will take suction from the RWR and provide water to the FLEX suction header. The EAFW pump will draw water from the FLEX suction header and inject water into the unit's SGs.

  Reactor coolant system (RCS) inventory control and boration are accomplished with a combination of prestaged and portable equipment stored in the auxiliary building and the FLEX primary and secondary storage facilities. The Phase 2 strategy for SFP cooling is to initiate SFP makeup in each unit using flexible hoses that deliver RWR water from the FLEX suction header.

- For Phase 3, the equipment from a National Strategic Alliance for FLEX Emergency Response (SAFER) Response Center (NSRC) will be transported to a staging area. The RCS cooling and heat removal involves repowering and reestablishing one primary cooling train for RCS (one residual heat removal pump and one component cooling water pump) by use of a 4160Vac generators supplied by the NSRC. The strategy also includes deploying two portable diesel-driven emergency auxiliary seawater pumps (one for each unit) to restore the ultimate heat sink function.

  In the MSA, the licensee indicated that deployment of the NSRC equipment can be through airlift or via ground transportation. Debris removal for the pathway between the site and the NSRC receiving staging areas may be required. However the licensee's plans included the ability to airlift equipment from the various pre-identified staging areas to the site.

3.2 Evaluation of Current FLEX Strategies

By letter dated April 6, 2017 (PG&E, 2017b), the licensee submitted its MSA for Diablo Canyon. The MSA is intended to confirm that licensees have adequately addressed the reevaluated flooding hazard(s) within their mitigating strategies for beyond-design-basis external events. For Diablo Canyon, the MSA addresses the LIP flood hazard.

As part of its April 6, 2017 (PG&E, 2017b), submittal the licensee provided additional detailed modeling of the LIP event. The submittal included a revision to the LIP model and also provided information related to flood event duration (FED) and associated effects (AEs). The staff's assessment of this new information can be found in Sections 3.2.1, 3.2.2 and 3.2.3, of this document, respectively. The licensee's assessment of current FLEX strategies included a discussion that, with the exception of one modification, the current FLEX strategies can be implemented in a LIP event. The staff's assessment of the current FLEX strategies against the LIP event, without the proposed modification, can be found in Section 3.2.4 of this document. The licensee's proposed modification includes the use of a water-activated flood barrier around a door prior to blocking it open to provide ventilation to the control room, cable spreading room, and battery charger/inverter rooms. The staff's assessment of the licensee's proposed modification can be found in Section 3.3 of this document.

3.2.1 Evaluation of Revision to Local Intense Precipitation Flooding Hazard

3.2.1.1 Confirmation of the Flood Hazard Elevations in the MSA

The analysis made in connection with the potential flood hazards at the Diablo Canyon determined that the site has a limited susceptibility to external flooding. In its FHRR (PG&E, 2016a), and after reviewing all possible flood-causing mechanisms, the licensee stated that the only potentially-unbounded external flood-causing mechanism at this reactor site is due to LIP. The licensee identified multiple potential flow path locations around each of the two reactor units and other important structures by which LIP-related flood water could potentially impact safe operation of the reactor complex; the licensee determined that the LIP-related flooding at about 40 locations [hereafter referred to as “points of interest (POI)”] within the powerblock. Figure 3.2-1 provides a site map showing structures and features associated with the Diablo Canyon site. In connection with this FHRR determination, the licensee reported the maximum reevaluated flood hazard depths due to LIP ranged from 0.06 to 0.68 feet (ft.) at the identified POIs. The NRC staff reviewed the computer model prepared in connection with the FHRR to simulate the LIP flood event, and confirmed the information reported on the location and magnitude of potential flooding. The staff determined as part of the FHRR review that the licensee's analysis was reasonable and the projected LIP flood elevations acceptable for use in future assessments (NRC, 2017).

For the purposes of the MSA for this reactor site (PG&E, 2017b), the licensee revised its earlier FHRR LIP model (PG&E, 2016a) by performing additional, more-detailed, modeling of the flood in the powerblock and its immediate environs. The results from that re-analysis, described in the MSA (PG&E, 2017b) and the associated Calculation Package 9000042281 (PG&E, 2017a), indicated that predicted water surface elevations (WSEs) described in the FHRR had decreased at all POIs first reported in the FHRR by an average of 0.07 ft. The licensee also reported that results from the revised LIP flooding model now predict flood water levels at 21 new POIs above the threshold level on what was described as the “[elevation] 140-ft. sundeck” – an elevated rooftop area on various plant buildings – with corresponding flood depths in the range of 0.01 ft. to 1.01 ft. The reason given for the reporting of new POI locations is that the licensee's earlier FHRR LIP analysis did not capture the details of building rooftops. Using the audit process, performed in accordance with a generic audit plan dated December 5, 2016 (NRC, 2016c), the NRC staff reviewed the licensee's refined MSA LIP model for Diablo Canyon.

3.2.1.2 The Refined MSA LIP Model

The licensee's refined LIP model relied on the FLO-2D Pro (Build 16.06.16) computer code (FLO-2D, 2016). This computer code, which is a two-dimensional numerical model, was used to evaluate the maximum WSEs across the footprint of the powerblock, as well as the depths and velocities of those flood waters. This information was in turn used to estimate the hydrostatic and hydrodynamic loads as reported in the MSA. The licensee stated that its refined LIP flood analysis is consistent with the Hierarchical Hazard Assessment (HHA) process described in NUREG/CR-7046 (NRC, 2011a). The staff considers the selection of FLO-2D for LIP modeling to be reasonable and consistent with current regulations and present-day engineering practice. In submitting its MSA, the licensee provided the calculation documents with FLO-2D input/output files supporting its refined LIP model (PG&E, 2017a).

Certain features of the licensee's refined LIP model remained fundamentally unchanged from the version used for the purposes of the FHRR. The geometry of the model boundary was the same; the resolution of the computational domain was again based on a uniform 10-ft by 10-ft. square grid system (PG&E, 2017a). See Figure 3.2-2. The licensee continued to rely on applicable U.S. Geological Survey (USGS) quadrangle maps that includes the reactor site, as well as site-specific light detection and ranging data to develop topographic elevations for the various features and locations within the model grid. The staff previously determined that the grid resolution and topographic data sources relied on for model grid elevation data were reasonable and consistent with present-day engineering practice.

In the matter of rainfall input, the licensee relied on the same site-specific probable maximum precipitation (ssPMP) estimate as had been previously used for the purposes of the FHRR (PG&E, 2016a). The licensee-estimated 6-hour 1-mi^2 ssPMP value was 5.9 inches (in.) with a 1-hour ssPMP value of 4.5 in.; these rainfall values remain unchanged from those reported in the earlier FHRR LIP computer model (see Table 3.2-1). The staff previously relied on a parametric sensitivity analysis to establish that the licensee's ssPMP values are acceptable. In connection with that earlier review, the staff previously determined that the FLO-2D setup including ssPMP values and their loading scheme are reasonable as they follow the applicable guidelines described in NUREG/CR-7046 (NRC, 2011a).

The licensee previously stated that more than 70-percent of the modeling domain ground surface is covered by asphalt, concrete, and some other type of impervious material (PG&E, 2016a). Consistent with the types of surface materials present, the licensee selected a Manning's roughness coefficient (*n*-values) of 0.022 for asphalt and 0.035 for concrete or other surface materials (PG&E, 2017a). The staff confirmed that the n-values selected by the licensee for use in the refined LIP model are reasonable as they are within the range of values recommended by the FLO-2D *User Manual* (FLO-2D, 2014).

A number of improvements to the licensee's refined LIP model were introduced as compared to the version supporting the FHRR (PG&E, 2016a). In the calculation package supporting the refined LIP model (PG&E, 2017a), the licensee described the reason for making certain changes was to address, in part, an earlier staff information need request prepared in connection with the review of the initial (2015) version of the FHRR (PG&E, 2015). The licensee also self-identified a number of other LIP modeling issues that could potentially lead to more realistic modeling results (PG&E, 2017a). The changes/improvements made by the licensee to the refined LIP model are as follows:

- Adjusting slopes and elevations of building roofs to ensure rainfall drainage/runoff into the roof drain and storm drain systems [included changes to area reduction factor (ARF) coefficients within the FLO-2D computer model].
- Adjusting elevations at outflow boundary points to ensure drainage and avoid artificial backwater effects within the powerblock.
- Corrections in missing features of the vehicle barrier system (VBS) and other as-built features within the reactor powerblock.
- Manual adjustments of missing FLO-2D flow paths within the modeling domain consistent with the topography and other as-built features within the powerblock (includes corrections for missing flow areas and continuation of curbed features). See Figure 3.2-3.
- Elevation adjustments for curbing that was judged during a site walk-down not to represent a barrier to surface water flow.
- Fix the grid point elevations where simulated flood elevation seems "anomalously" higher, especially at a location between the combined laundry/radwaste buildings and the reactor containment structures.

3.2.1.3 Specific Improvements to the Refined LIP Model

The staff noted three key improvements to the licensee's refined LIP model that merit some brief discussion.

Roof Drainage: The licensee conservatively ignored all runoff losses in the FHRR version of the LIP model such as initial and constant losses in order to maximize the volume of runoff contributing to the flood-related WSE estimate (PG&E, 2016a). The licensee also assumed that all drainage system components such as gravity storm drain systems, culverts, or inlets located within the powerblock were nonfunctional or completely blocked. It was further assumed that roof runoff from buildings and other elevated structures was discharged directly onto the ground, without delay, again in order to maximize the peak volume of rainfall contributing to the WSE estimate; the functioning of parapets, gutters, and drain pipes was not credited by the licensee in the FLO-2D model.[1] Based on these assumptions, the licensee, though noted that its earlier FLO-2D simulation results prepared in connection with the FHRR could produce transient water depths of as much as 0.5 ft. on building rooftops (PG&E, 2017a).

In the refined LIP model submitted as part of the MSA (PG&E, 2017a), rooftop drainage from the respective reactor containment structures, the Fuel Handling Building, and the Auxiliary Building was now preferentially conveyed to the ground by means of multiple-piped conveyance systems to discharge outlets nearest the buildings in question, thereby increasing the runoff volume at certain locations within the powerblock. This was achieved by adjusting roof slopes and using the areal reduction factors (ARFs) for the structures in question. In particular, the ARF can control the direction of surface flow from building rooftops to adjacent ground surfaces but not vise verse. Readjusting parapets and building elevations, and roof slopes was also judged by the licensee to improve the realism of the simulation, taking into account as-built conditions. This change reflects an enhancement over the modeling configuration previously described in the FHRR (PG&E, 2016a).

The staff confirmed, by examining topographic and plant layout maps of the site, that the delineation of the ARFs in the refined LIP model matches the footprints of powerblock buildings and structures.

Below-Grade Flood Routing: A second enhancement to the licensee's refined LIP model involves taking credit for how rainwater is managed by the powerblock's storm water management system. In the licensee's earlier FHRR LIP model (PG&E, 2016a), the site's engineered drainage system was not credited for reducing the volume of runoff present within the powerblock footprint during a thunderstorm; in the refined LIP model (PG&E, 2017a), the licensee decided to rely on this engineering feature and evaluated the extent to which this passive system could moderate the amount of rainwater present on the ground surface and then evaluated that impact on estimated WSEs at the various POIs. By accounting for the storm water management system in the refined LIP model, there was the potential to change the magnitude and locations of flood heights within the powerblock due to possible changes in runoff flow paths.

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[1] The licensee previously assumed that the roof drain pipes are unlikely to be blocked by sediment/debris as there are inlet guards that prevent debris from entering the roof drain system and interfering with its functioning. Moreover, there is no natural ground surface pathway that would convey debris to travel to the tops of buildings and other important structures thereby leading to the clogging or obstruction of drainage inlets (PG&E, 2017b). Hatches located on building faces or on rooftops were also assumed to be impervious to water ingress as those features typically have seals along the edges of their perimeters. Note that the terms "hatch" or "hatches" in this calculation refer to openings that are imperious.

To better understand how the site's drainage system might affect the magnitude and location of flood heights within the powerblock, the licensee exercised the *Storm Water Management [Computer] Model* (SWMM – EPA, 2015) feature of the FLO-2D computer code. While the FLO-2D computer code can perform overland flood routing computations within the powerblock, at grade, the SWMM computer code can conjunctively evaluate the contribution of the engineered components of the drainage system below-grade during the storm. The SWMM computer code, developed by the U.S. Environmental Protection Agency (EPA, 2015), contains various hydraulic modeling capabilities that can route runoff and external inflows through a network of pipes, channels, storage/treatment units, and diversion structures. When the SWMM feature is activated, the FLO-2D computer code can exchange flow information between the respective above-grade/below-grade interfaces (e.g., drain inlets, manholes, headwall outlets) – represented as "nodes" in the FLO-2D model. The FLO-2D computer code performs hydraulic surface flow routing calculations while the SWMM solves closed-conduit hydraulics and flow routing for a given storm drainage network.

The hydrodynamic routing feature in the FLO-2D computer code can account for channel storage, backwater, entrance/exit losses, flow reversal, and pressurized flow. With this form of routing analysis, it is possible to represent pressurized flow in the model when a conduit reaches flow capacity, such that flows can exceed the full normal flow value. Flooding occurs when the water depth at a node exceeds the maximum available depth, and the excess flow can pond atop the node and re-enter the drainage system. Based on the review of the licensee-provided FLO-2D input and output files, NRC staff determined that the configuration and setting of the drain systems in the refined model are adequate as they followed the guidelines provided by the FLO-2D manual (FLO-2D, 2014).

Area of Higher Topographic Relief to the East of Reservoir Road: In its earlier review the LIP model supporting the FHRR (PG&E, 2016a), the NRC staff had noted that the eastern boundary of the LIP model appeared to have been artificially terminated at the location of an access road traversing the reactor site (the so-called "Reservoir Road"). To the east of this road is a contiguous parcel of land dominated by a topographic promontory that overlooks the reactor site at its most distal point; the slope of this land parcel dips in the general direction of the powerblock. Resting atop this promontory, whose nominal elevation is 312.9 ft. North American Vertical datum (NAVD88), are the reactors Raw Water Storage Reservoirs, two switchyards, and the independent spent fuel storage installation (Figure 3.2-4). Based on an inspection of the USGS topographic map that included the power plant site, the NRC staff noted during the FHRR review that there is the potential for runoff associated with this watershed to concentrate along Reservoir Road following a LIP event. The runoff could overtop the roadway and continue to travel in the direction of the powerblock, or preferentially follow the roadway down-gradient away from the powerblock. The size of the parcel of land in question was not insignificant; if accounted for in the LIP model, it would expanded the size of the modeling domain by about 34 percent.[2] The NRC staff's concern was that the introduction of additional runoff into the site, not associated with the precipitation within the powerblock footprint *per se* may lead to higher WSEs at some of the critical POIs identified by the licensee.

The scenario just defined above was not explicitly examined by the licensee in connection with its earlier FHRR analysis (PG&E, 2016a). Consequently, in its review of that document, the NRC staff independently examined what impact runoff from the parcel of land east of Reservoir Road might have on the WSEs reported by the licensee (NRC, 2017). The results of the NRC staff's independent analysis indicated that, there was an average of 0.04 ft. increase in water

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[2] The staff also evaluated certain as-built features within the powerblock potentially capable of influencing surface water flow along Reservoir Road such as non-continuous curbs and berms. These features were previously unaccounted for in the licensee's FHRR LIP model (PG&E, 2016a).

depth at the 40 POIs identified by the licensee in the FHRR with a maximum increase of 0.14 ft. Consequently, the staff determined that any runoff contribution from the area to the east of Reservoir Road could be considered *di minimis* or inconsequential.

In submitting its MSA (PG&E, 2017b), the licensee explicitly examined how the parcel of land in question might influence WSEs predicted by the refined LIP model. The licensee used the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) computer code (USACE, 2010) to analyze peak flow rates for the area corresponding to this watershed. Key features of the licensee's refined analysis are summarized below.

The licensee commenced its analysis by bifurcating the contiguous watershed into two smaller subbasins (areas), and then constructed a HEC-HMS model for each of those two subbasins without connection. A HEC-HMS model was also generated for Reservoir Road (including its adjacent swale) by the licensee to analyze the flow capacity of the roadway. See Figure 3.2-4. The following describes the main features of the licensee's HEC-HMS computer model related to the additional slope area:

- To calculate the runoff attributed to the watershed, each of the two subbasins were subdivided into smaller, 50-ft.-wide rectangular segments. Using the area of one of these 50-ft-wide segments (the segments were not always of equal length), and an end-loaded temporal distribution for the ssPMP estimate, a peak runoff estimate was calculated for each 50-ft segment using the Soil Conservation Service (SCS, 1986) unit hydrograph method. The maximum runoff value estimated for the first 50-ft segment was then added to the value obtained for each subsequent segment. In this step-wise manner, it was possible to obtain the total cumulative run-off estimate that the roadway would receive from the watershed.

- Manning's equation was then used to calculate the maximum flow capacity for Reservoir Road itself treating it as an open channel type of conveyance system. In calculating the conveyance capacity, the licensee combined the cross-sectional area of the roadway assuming a 6-in.-high curb, as well as some allowance for the swale adjacent to the road. Conservatively, the licensee did not credit the additional flow capacity potentially offered by the presence of the 3-ft.-high VBS that extends over the length of Reservoir Road. The VBS has forklift access holes at its base that would be ineffective in containing water. The licensee also noted that an additional 2 ft. of potential containment height was excluded from the cross sectional length of the roadway at the location designated "Shldr." (i.e., shoulder).

- Having calculated the incremental runoff volumes for each 50-ft. land segment, as well as the flow capacity for the roadway itself, the licensee then performed a calculation to estimate the down-gradient location (distance) on Reservoir Road at which the cumulative runoff flow would exceed the conveyance capacity of the roadway; the runoff value at the location estimated corresponds to the additional runoff flux that would need to be accounted in the LIP analysis.

Based on the analytical approach described above, the approximate location on the roadway where the licensee expected the overflow to occur is shown in Figure 3.2-4. An elevation for this location was obtained from a topographic survey of the site. The location where overtopping could be expected along Reservoir Road is essentially at the end of the powerblock footprint and at an elevation below that of important reactor structures and systems. At this location, the expected flow direction for runoff is predicted by the licensee to be southwest toward the Pacific Ocean, and away from the powerblock (yellow arrow on Figure 3.2-4). The licensee thus concluded that runoff from the parcel of land to the east of Reservoir Road would not contribute additional floodwater flux (runoff) into the powerblock.

As part of its MSA review, the staff reviewed the licensee's HEC-HMS computer model to better understand what impact, if any, runoff from the parcel of land to the east of Reservoir Road might have on estimated WSEs at known POIs within the powerblock. The staff's review confirmed the licensee's position that the runoff contribution from the watershed to the east on estimated flood levels within the footprint of the powerblock is inconsequential.

3.2.1.4 Re-evaluated WSEs due to LIP

The licensee identified multiple potential locations around each of the two reactor units and other structures by which flood water could potentially pond near the structures in question. In Table 1 of the MSA (PG&E, 2017b), the licensee identified POIs for which LIP-related flood waters exceed the threshold elevation of some of the door openings. Those POIs include both safety-related and non-safety-related buildings and structures. Key monitoring locations around the two reactor units and turbine building identified by the licensee are shown in Figures 3.2-5a and 3.2-5b. In its refined LIP analysis, the licensee identified a total of 61 POIs potentially susceptible to water ingress; 21 more than reported in the revised FHRR (PG&E, 2016a). Those additional POIs occur along what the licensee referred to as the "[elevation] 140-ft sundeck." See Figures 3.2-6a–c.

The licensee compared the estimated flood depth height to the threshold elevations of door sills, inlets, and hatches at each of the POIs identified. The maximum flood depths reported exceeded the heights of several door/hatch/inlet heights for safety-related structures (PG&E, 2017b). Overall, the licensee reported the reevaluated flood hazard at the POIs of interest identified in the MSA range in depth from 0.01 to 1.01 ft. Table 3.2-2 summarizes the WSEs attributed to the licensee's refined LIP flood reevaluation. Maximum inundation depths within the powerblock due to LIP are depicted in Figure 3.2-7. The maximum inundation depth of 1.01 ft. was calculated to occur at the monitoring location Door # 589, along the elevation 140-ft sundeck, with a maximum WSE of 141.7 ft. NAVD88. See Figure 3.2-6b. The licensee acknowledged that there was a temporal aspect to those flood depths that varied by location when the drainage characteristics and geometry of the powerblock were taken into account.

The NRC staff reviewed the licensee-provided LIP FLO-2D model input and output files and confirmed the maximum flood elevations reported in the MSA letter. Previously, the licensee described 40 POIs in the FHRR for which there was LIP-related flooding. In its MSA, the licensee is now identifying a total of 61 POIs, including both safety-related and non-safety-related buildings, for which door threshold elevations were exceeded by LIP flood water. The staff compared the WSEs estimated for the purposes of the MSA to those WSEs previously estimated in the 2016 version of the FHRR at about 40 common POIs. On average, the revised maximum WSEs at the 40 common POIs is now estimated to be about 0.07 ft. lower than that previously reported in the FHRR (PG&E, 2016a); however, the flood levels estimated at those locations, on average, continue to exceed the elevations of the respective door openings by about 0.22 ft. See Table 3.2-3.

The NRC staff checked the results of the LIP flood modeling used in the MSA using the FLO-2D input and output files provided by the licensee. The staff found that: (a) mass balance errors were acceptably small, (b) flow pathways and areas of inundation appeared reasonable, (c) flow velocities were reasonable, and (d) no indication of numerical instabilities nor unexpected supercritical flow conditions were identified near potential flooding pathways. Based on these results, the staff determined the licensee's revised FLO-2D LIP simulations used in the MSA report are consistent with present-day guidelines and regulatory requirements.

Overall, the staff determined the refined LIP analysis reported in the MSA letter (PG&E, 2017) is acceptable for use in the MSA, and for other assessments associated with the 50.54(f) letter related to flooding.

3.2.2 Evaluation of Flood Event Duration

The staff reviewed information provided by the licensee (PG&E, 2017a and 2017b) regarding the FED parameters needed to perform the MSA for flood hazards not bounded by the CDB at Diablo Canyon. The FED parameters for the flood-causing mechanisms not bounded by the CDB are summarized in Table 3.2-4.

The licensee did not report a warning time for LIP-related flooding in the MSA as they stated no actions are required to respond to a LIP event (PG&E, 2017b). The staff notes the licensee has the option to use NEI 15-05 (NEI, 2015) to estimate warning time for LIP as needed.

The maximum WSEs generated during the LIP event occurred at multiple POIs within the reactor powerblock; those POIs and their corresponding elevations are described in Table 1 of the licensee's MSA submittal (PG&E, 2017b). In that letter, the licensee described the duration of inundation due to the LIP event at the respective POIs. In the FHRR (PG&E, 2016a), the licensee previously relied on a 6-hr precipitation event for the purposes of LIP analysis. In light of the grading of the site and existing surface water drainage system within the powerblock previously described in the FHRR, the staff found that the maximum 8.8-hr estimate for inundation duration is reasonable to use for the purposes of the MSA. In its MSA submittal (PG&E, 2017b), the licensee reported that the time necessary for the flood waters to recede from critical site POIs within the powerblock to negligible levels takes approximately 9 hours; the licensee further notes that the LIP event is not expected to negatively impact the operation of safety-related equipment at the site.

Based on this review, the staff determined that the licensee's FED parameters for LIP are reasonable and acceptable for use in the MSA and for other assessments associated with the 50.54(f) letter related to flooding.

3.2.3 Evaluation of Associated Effects

The staff reviewed the information provided by the licensee regarding AE parameters for flood hazards not bounded by the CDB (PG&E, 2017b). The AE parameters related to water surface elevation (i.e., stillwater elevation with wind waves and runup effects) were previously reviewed by staff, and were transmitted to the licensee via an Interim Response Letter (NRC, 2016). The AE parameters not directly associated with water surface elevation are discussed below and are summarized in Table 3.2-5.

For the LIP flood-causing mechanism, the licensee stated that the associated effects of LIP flooding are considered minimal due to the shallow flow depths and associated low-flow velocities for a LIP event within the protected area (PG&E, 2017b). The staff confirmed this statement by reviewing the FLO-2D input and output files furnished by the licensee. The staff found that the estimated inundation depths and flow velocities by the licensee are acceptable and that the modeling is reasonable for use in the MSA. The staff agrees with the licensee's conclusion that the AE parameters for LIP are either minimal or will have no impact on the safety-related plant facilities.

The staff reviewed the potential for debris load at the reactor site. Aerial photographs were examined and it was determined that there were no significant sources of material (trees, vegetation, etc.) that would contribute to debris loads at the site. In light of the small inundation depths and low flood water velocities anticipated, the staff found that the debris, sediment, and hydrostatic loads would be minimal. Consequently, the licensee's evaluation of AE parameters are reasonable for use as part of the MSA review.

Based on this review, the staff determined the licensee's methods were appropriate and the provided AE parameters are reasonable for use in the MSA, and for other assessments associated with the 50.54(f) letter related to flooding.

3.2.4 Effect on Mitigating Strategies of Revision to Local Intense Precipitation Flooding Hazard

As noted above, the staff concludes that the LIP reevaluated flood information (including levels, FED and AEs) provided in the licensee's April 6, 2017, letter is acceptable for use in the licensee's mitigation strategies assessment. The staff reviewed the licensee's MSA in accordance with NEI 12-06, Rev. 2, Section G.4.1, "Assessment of Current FLEX Strategies." In accordance with this guidance the MSA should address whether the FLEX strategies can be implemented based on the ISR as revised by the flood information provided in the April 6, 2017, licensee letter.

The licensee's MSA provided a table comparing the LIP reevaluated hazard to the FLEX design-basis and noted that the FLEX design-basis can accommodate the LIP reevaluated hazard with the exception of two areas: maximum stillwater elevation, and the flood period of inundation. The licensee concluded that the associated effects related to a LIP event are:

- hydrodynamic loading (including debris),
- wind waves and run-up effects
- effects caused by sediment deposition and erosion

The licensee calculated hydrodynamic and hydrostatic loading for each door and concluded that they were insignificant. The staff agrees with this assessment based on the LIP levels and minimal flow velocities. The staff also agrees with the licensee's assessment that waves/run-up is considered minimal given the calculated LIP flood heights. In addition, the staff agrees with the licensee's assessment, that based on the shallow flow depths and low flow velocities, effects caused by sediment deposition and erosion from a LIP event need not be evaluated in detail. Therefore, the staff concludes that LIP associated effects have been properly considered by the licensee and no changes to the mitigation strategies are necessary because of LIP-related associated effects.

The flood heights from the LIP event vary at different Diablo Canyon door locations due to the site-specific terrain and watershed pathways. The water depth above the door thresholds varies between 0 ft. and 1.01 ft. for the 76 doors that the licensee modeled. The duration of the time-dependent water depths varies between 0 hours and 8.8 hours. The licensee's calculation demonstrated that water intrusion from flooding would not prevent safety-related structures, systems or components (SSCs) from performing their intended function. This is partly based on the assumption that approximately 339,000 gallons of water would be conveyed to the auxiliary building sump and pipe tunnels. The Diablo Updated Safety Analysis Report notes that from an internal flood protection perspective a volume of 345,000 gallons in the auxiliary building pipe tunnel for sump overflow storage is available to receive water from flooding. Therefore, there is adequate volume to store water resulting from the LIP event.

The licensee evaluated the FLEX strategies sequence of events timeline for an extended loss of ac power and loss of ultimate heat sink (ELAP/LUHS). The evaluation included a table that summarized a review of the 30 FLEX time sensitive actions (TSA). As documented in the table, the only FLEX TSA that is impacted by the LIP event in such a way that FLEX strategies cannot be implemented as currently developed is TSA 14, "Doors to control room, cable spreading room, and battery charger/inverter rooms are blocked open." This TSA involves blocking open several doors to provide a ventilation pathway to control heatup in vital areas. This action is evaluated in Section 3.3 of this document.

The staff has reviewed the licensee's assessment and concludes that, with the exception of TSA 14, the FLEX TSAs are not impacted or are minimally impacted by a LIP event such that implementation of the FLEX strategy could reasonably be accomplished. The reasons that the staff considers that these FLEX strategies can be accomplished during a LIP event include: 1) LIP inundation levels at the affected area are non-existent (e.g., control room) or are minimal, or 2) local actions in areas around the turbine building and auxiliary building would be able to be accomplished because the maximum inundation levels in these areas throughout the LIP event would be less than 1.01 ft. For example, the Phase 1 FLEX implementation includes a plant cooldown and depressurization. Exterior actions to perform this action are limited to the manual operation of steam dump valves. The estimate start time for operation of the valves is 28 minutes after the ELAP/LUHS. The access for manually operating the steam dump valves would likely be through Door 521. Ponding at this door would be below the threshold when this TSA is started, therefore, opening the door to pass through will not results in water entering the building. Therefore, the staff agrees with the licensee's assessment that flooding would not impact accessibility or operation of the steam dump valves.

Deployment and staging of the first Phase 2 FLEX equipment is not expected to start until 10 hours after the ELAP/LUHS event. The LIP maximum water depth above the surface in the vicinity of Phase 2 FLEX equipment deployment locations is 0.45 ft., with maximum inundation duration of 8.8 hours. Consequently, water will have receded prior to deployment and staging of Phase 2 FLEX equipment. Therefore, the staff concludes that Phase 2 FLEX equipment can be deployed successfully during a LIP event. Regarding Phase 3 FLEX deployment, as stated above debris removal for the pathway between the site and the NSRC receiving staging areas may be required. However the licensee's plans included the ability to airlift equipment from the various pre-identified staging areas to the site. Therefore, the staff concludes that the MSA for Phase 3 FLEX deployment is acceptable.

Based on the FLEX design-basis height and the LIP reevaluated flood height, the staff concludes that, with the exception of TSA 14, the FLEX strategies are protected in accordance with the guidance found in Section G.4.1 of NEI 12-06, Rev 2. The evaluation of the LIP impact on TSA 14 can be found in Section 3.3 of this document.

3.3 Evaluation of Modified FLEX Strategies

The staff reviewed the licensee's proposed modification to address FLEX TSA 14 of its MSA in accordance with NEI 12-06, Rev. 2, Section G.4.2, "Assessment for Modifying FLEX Strategies." If the FLEX strategies cannot be implemented as designed due to the impact of the ISR this section provides guidance to determine if the FLEX strategies can be modified to address the impacts from the ISR.

As discussed above, TSA 14 involves blocking open several doors to control heat buildup in vital areas. The time constraint for this action is completion by 1.5 hours. A total of six doors are directed to be opened that could experience flooding from the LIP event to provide a ventilation pathway including either door 354 or 355 (operations has the option to open either of these doors based on conditions). Door 354 and 355 are located at ground level on the east side of the auxiliary building. At the time the six doors would be required to be opened only doors 354 or 355 would still be inundated. To address this issue the licensee proposed a modification to the FLEX strategies to revise the procedures, if flood waters are present, to direct the sole use of Door 355 and to require placement of water-activated flood barriers prior to blocking open the door. The licensee's MSA included a commitment to complete the necessary changes to plant procedures, conduct validation, stage water-activated flood barriers, and update the FLEX preventative maintenance program by the future required compliance date of the draft final mitigation of beyond design basis event rule, as it would be set by the Commission.

The staff finds that proposed FLEX modification acceptable. The staff further concludes, that with the modification to install a water activated flood barrier prior to blocking open door 355, the licensee has demonstrated that the mitigation strategies, if appropriately implemented, are reasonably protected from reevaluated flood hazard conditions in accordance with the guidance found in Section G.4.1 of NEI 12-06, Rev 2.

4.0 AUDIT REPORT

The NRC staff previously issued a generic audit plan dated December 5, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16259A189), that described the NRC staff's intention to conduct audits related to MSAs and issue an audit report that summarizes and documents the NRC's regulatory audit of the licensee's MSA. Staff activities have been limited to performing the reviews described above. Because this staff assessment appropriately summarizes the results of those reviews, the NRC staff concludes that a separate audit summary report is not necessary, and that this document serves as the final audit report described in the December 5, 2016, letter.

5.0 CONCLUSION

The NRC staff has reviewed the information provided in the Diablo Canyon MSA related to current FLEX strategies, as evaluated against the reevaluated flood hazard(s) described in Section 2 of this staff assessment, and found that:

- impacts to the FLEX strategies have been adequately identified;
- with the exception of TSA 14, a revised sequence of events and FLEX procedures are not required to account for the reevaluated LIP flood hazard such that the FLEX strategies could be implemented as currently designed;
- the proposed modification to TSA 14 to include water activated flood barriers, if flood waters are present, prior to blocking open door 355 is acceptable, and
- the licensee has provided an adequate description and justification of flood protection features necessary to implement the FLEX strategy to account for the reevaluated LIP flood hazard.

Therefore, the NRC staff concludes that the licensee has demonstrated the capability to deploy modified FLEX strategies against a postulated beyond-design-basis event for the LIP flood-causing mechanism, including AEs and FED, as requested in the COMSECY-14-0037, and affirmed in the corresponding SRM. The NRC staff has reviewed the information presented in the MSA by PG&E for Diablo Canyon. The NRC staff confirmed that the licensee's flood hazard MSA was performed consistent with the guidance in Appendix G of NEI 12-06, Revision 2, as endorsed by JLD-ISG-2012-01, Revision 1. Based on the licensee's appropriate hazard characterization, methodology used in the MSA evaluation, and the description of its combination of strategies (i.e., current FLEX strategy and modified FLEX strategy); the staff concludes that the licensee has demonstrated that the mitigation strategies, if appropriately implemented, are reasonably protected from reevaluated flood hazard conditions.

6.0 REFERENCES

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Table 3.2-1. Refined LIP values distributed for 6-hour duration at the DCPP site

Duration (hr)	0	.25	.5	.75	1	2	3	4	5	6
LIP Depth (in.)	0	2.5	3.6	4.1	4.5	5.1	5.4	5.6	5.8	5.9

Source: PG&E, 2016a

Table 3.2-2. Simulated Maximum Flood Elevations (in feet) near the Access Doors within the Diablo Canyon Powerblock Area that Exceed the Threshold Elevation

Building Area	Door/Unit No.	Grid Elevation (NAVD88)	Door Sill Elevation (NAVD88)	MSA Inundation Depth Above Door Sill	Max MSA WSE (NAVD88)
Unit 1 (North)					
A-2	A2.1	87.17	87.19	0.14	87.33
	BU101	87.17	87.19	0.08	87.27
A3	BU102	87.16	87.19	0.16	87.35
	BU103	87.14	87.19	13	87.32
	A3.1	87.14	87.19	0.19	87.38
	A3.2	87.16	87.19	0.20	87.39
	A3.3	87.14	87.19	0.12	87.31
	BU104/5	87.16	87.19	0.16	87.35
Others	101-1	87.47	87.49	0.18	87.67
	102-1	87.42	87.49	0.17	87.66
	119-1	87.47	87.49	0.21	87.70
	122-1	87.46	87.49	0.42	87.91
	192-1	87.47	87.49	0.41	87.90
	191-1	87.48	87.49	0.24	87.73
	194-1	87.46	87.49	0.22	87.71

Building Area	Door/Unit No.	Grid Elevation (NAVD88)	Door Sill Elevation (NAVD88)	MSA Inundation Depth Above Door Sill	Max MSA WSE (NAVD88)
Unit 1 (North)					
	363-1	117.47	117.49	0.07	117.56
	361-1	117.47	117.49	0.34	117.83
	360-1	117.48	117.49	0.34	117.83
	355-1	117.45	117.49	0.39	117.88
	354-1	117.48	117.49	0.39	117.88
	C1-1	87.46	87.49	0.11	87.60
C	129	87.47	87.49	0.10	87.59
	130	87.46	87.48	0.10	87.58
	C1.2	87.46	87.49	0.04	87.53
Unit 2 (South)					
B2	BUD108-2	87.16	87.19	0.12	87.31
	BUD105-2	87.17	87.19	0.10	87.29
	BUD106-2	87.33	87.39	0.20	87.59
	B2.1	87.46	87.49	0.13	87.62
B1	B1.1	87.45	87.49	0.07	87.56
	B1.2	87.48	87.49	0.11	87.60

Building Area	Door/Unit No.	Grid Elevation (NAVD88) (1)	Door Sill Elevation (NAVD88) (2)	MSA Inundation Depth Above Door Sill (3)	Max MSA WSE (NAVD88) (4)
Unit 2 (South)					
Others	101-2	87.46	87.49	0.28	87.77
	102-2	87.47	87.49	0.28	87.77
	119-2	87.47	87.49	0.30	87.79
	122-2	87.47	87.49	0.30	87.79
	192-2	87.48	87.49	0.39	87.88
	191-2/191A-2	87.49	87.49	0.30	87.79
	194-2	87.42	87.49	0.30	87.79
	360-2	117.44	117.49	0.40	117.89
	361-2	117.45	117.49	0.40	117.89
	363-2	117.47	117.49	0.03	117.52
140 ft. Sundeck (Rooftop)					
Rooftop	521	140.73	141.02	0.18	141.20
	525	140.74	140.69	0.51	141.20
	540	140.69	140.86	0.03	140.89
	541	140.69	140.86	0.04	140.90
	565	140.69	140.69	0.20	140.89
	575	140.69	140.69	1.01	141.70
	587	140.69	140.69	0.52	141.21
	588	140.69	140.86	0.84	141.70
	589	140.69	140.69	1.01	141.70
	523-2	140.69	140.86	0.79	141.65

Building Area	Door/Unit No.	Grid Elevation (NAVD88)	Door Sill Elevation (NAVD88)	MSA Inundation Depth Above Door Sill	Max MSA WSE (NAVD88)
140 ft. Sundeck (Rooftop)					
	530-2	140.69	141.19	-0.29	140.90
	540-2	140.69	140.86	0.02	140.88
	541-2	140.69	140.86	0.01	140.87
	565-2	140.69	140.69	0.18	140.87
	575-2	140.69	140.69	0.97	141.66
	584-2	140.69	140.69	0.62	141.31
	585-2	140.69	140.86	0.79	141.65
	586-2	140.69	140.69	0.96	141.65
	Louver Control Room – North	140.69	141.19	0.01	141.20
	Louver Control Room – South	140.69	141.19	0.02	141.21

Source: PG&E, 2017a: PG&E, 2017b. Note that for the WSE values taken from PG&E calculation package (PG&E, 2017a) the staff converted them into the NAVD88 datum.

TABLE 3.2-3. Comparison of the Maximum WSEs for LIP (in feet) between FHRR and MSA at Common Points of Interest that Exceed the Threshold Elevation

Building Area	Door/Unit No.	MAXIMUM WSE (NAVD88)		DIFFERENCE BETWEEN MSA and FHRR
		FHRR (PG&E, 2016a)	MSA[3] (PG&E, 2017a)	
Unit 1 (North)				
A-2	A2.1	87.42	87.33	-0.09
	BU101	87.27	87.27	0.00
A3	BU102	87.36	87.35	-0.01
	BU103	87.33	87.32	-0.01
	A3.1	87.40	87.38	-0.02
	A3.2	87.40	87.39	-0.01
	A3.3	87.31	87.31	0.00
	BU104/5	87.35	87.35	0.00
N/A	101-1	87.71	87.67	-0.04
	102-1	87.69	87.66	-0.03
	119-1	87.93	87.70	-0.23
	122-1	88.12	87.91	-0.21
	192-1	88.17	87.90	-0.27
	191-1	88.05	87.73	-0.32
	194-1	88.04	87.71	-0.33
	363-1	117.59	117.56	-0.03
	361-1	117.88	117.83	-0.05
	360-1	117.88	117.83	-0.05
N/A	355-1	117.94	117.88	-0.06

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[3] Values taken from PG&E calculation package (PG&E, 2017a) that supported the licensee's MSA and converted to NAVD88 values.

Building Area	Door/Unit No.	MAXIMUM WSE (NAVD88)		DIFFERENCE BETWEEN MSA and FHRR
		FHRR (PG&E, 2016a)	MSA[3] (PG&E, 2017a)	
	354-1	117.94	117.88	-0.06
C	C1-1	87.62	87.60	-0.02
	129	87.61	87.59	-0.02
	130	87.55	87.58	0.03
Unit 2 (South)				
C	C1.2	87.73	87.53	-0.20
B2	BUD108-2	87.33	87.31	-0.02
	BUD105-2	87.31	87.29	-0.02
	BUD106-2	87.55	87.59	0.03
	B2.1	87.60	87.62	-0.02
B1	B1.1	87.56	87.56	0.00
	B1.2	87.62	87.60	-0.02
N/A	101-2	87.81	87.77	-0.04
	102-2	87.81	87.77	-0.04
	119-2	87.92	87.79	-0.13
	122-2	88.00	87.79	-0.01
	192-2	88.08	87.88	-0.2
	191-2/191A-2	87.97	87.79	-0.18
	194-2	87.95	87.79	-0.16
	360-2	117.95	117.89	-0.06
	361-2	117.95	117.89	-0.06
	363-2	117.51	117.52	0.01

TABLE 3.2-4. REEVALUATED FLOOD HAZARDS FOR FLOOD-CAUSING MECHANISMS FOR USE IN THE MSA

FLOOD-CAUSING MECHANISM	STILLWATER ELEVATION (FT. MSL)	WAVES/ RUNUP	REEVALUATED HAZARD ELEVATION (FT. MSL)	REFERENCE
Local Intense Precipitation and Associated Drainage	Varied (see Table 3.2-3)	Minimal	Varied (see Table 3.2-3)	PG&E (2017b, Table 1)

Note: Reported values are rounded to the nearest one-tenth of a foot.

TABLE 3.2-5. FLOOD EVENT DURATIONS FOR FLOOD-CAUSING MECHANISMS NOT BOUNDED BY THE CDB

FLOOD-CAUSING MECHANISM	TIME AVAILABLE FOR PREPARATION FOR FLOOD EVENT	DURATION OF INUNDATION OF SITE	TIME FOR WATER TO RECEDE FROM SITE
Local Intense Precipitation and Associated Drainage	Use NEI 15-05 (NEI, 2015) for estimating warning time.	8.5 hours	11 hours

Source: PG&E (2017b)

TABLE 3.2-6. ASSOCIATED EFFECTS PARAMETERS NOT DIRECTLY ASSOCIATED WITH TOTAL WATER HEIGHT FOR FLOOD-CAUSING MECHANISMS NOT BOUNDED BY THE CDB

	FLOODING MECHANISM
Associated Effects Parameter	**LOCAL INTENSE PRECIPITATION**
Hydrodynamic loading at plant grade	Minimal
Debris loading at plant grade	Minimal
Sediment loading at plant grade	Minimal
Sediment deposition and erosion	Minimal
Concurrent conditions, including adverse weather	Minimal
Groundwater ingress	Minimal
Other pertinent factors (e.g., waterborne projectiles)	Minimal

Source: PG&E (2017b)

Figure 3.2-1. **Site map showing structures and features associated with the Diablo Canyon Nuclear power plant site.**

Figure 3.2-2. **Site map with showing the boundary of the refined FLO-2D LIP model (outside red line) and surface-based features within the powerblock such as levees and the VBS (also depicted as red lines).** Source: PG&E (2017b).

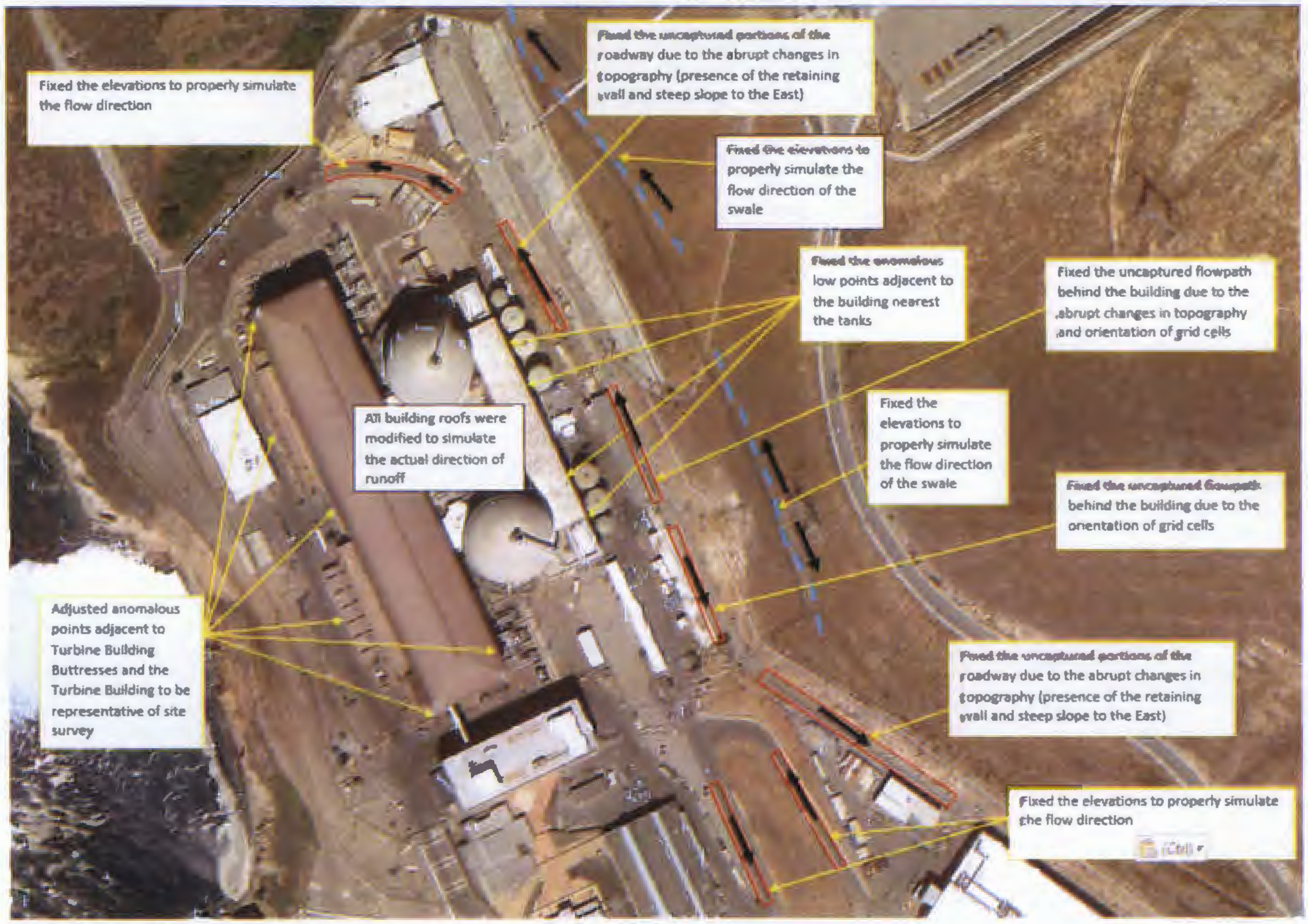

Figure 3.2-3. **Figure showing locations within the Diablo Canyon powerblock where manual adjustments were made to the refined FLO-2D computer code used to model LIP at the reactor site.** Source: PG&E (2017a)

Figure 3.2-4. **Additional watershed areas east of the Reservoir Road evaluated to determine their contribution to LIP water surface elevation estimates. Location of overtopping area estimated by the licensee using the HEC-HMS computer code.** Source: PG&E (2017a)

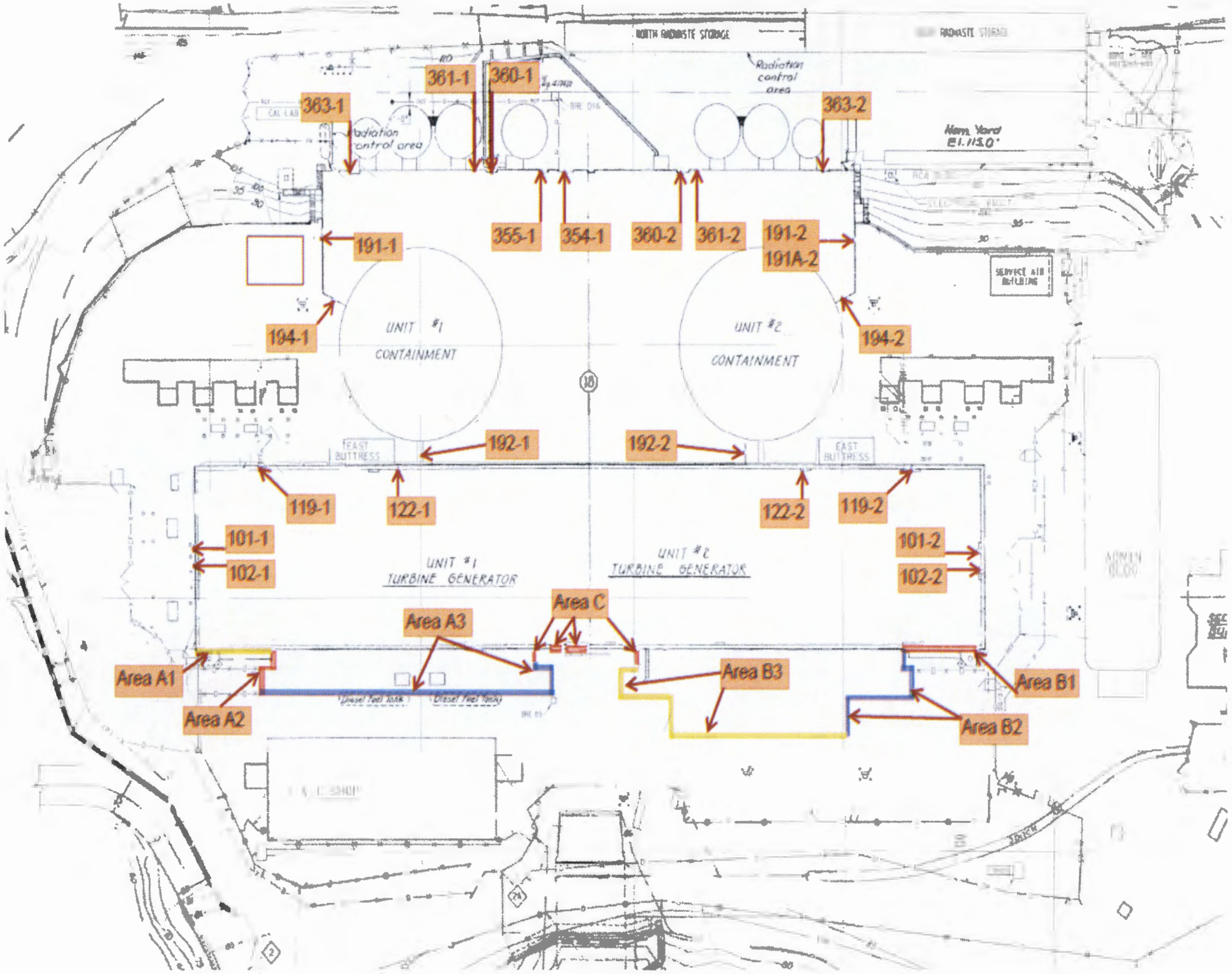

Figure 3.2-5a. **Door and other opening locations shown in relation to safety and non-safety-related structures at the Diablo Canyon nuclear power plant site.**
Source: PG&E (2017a)

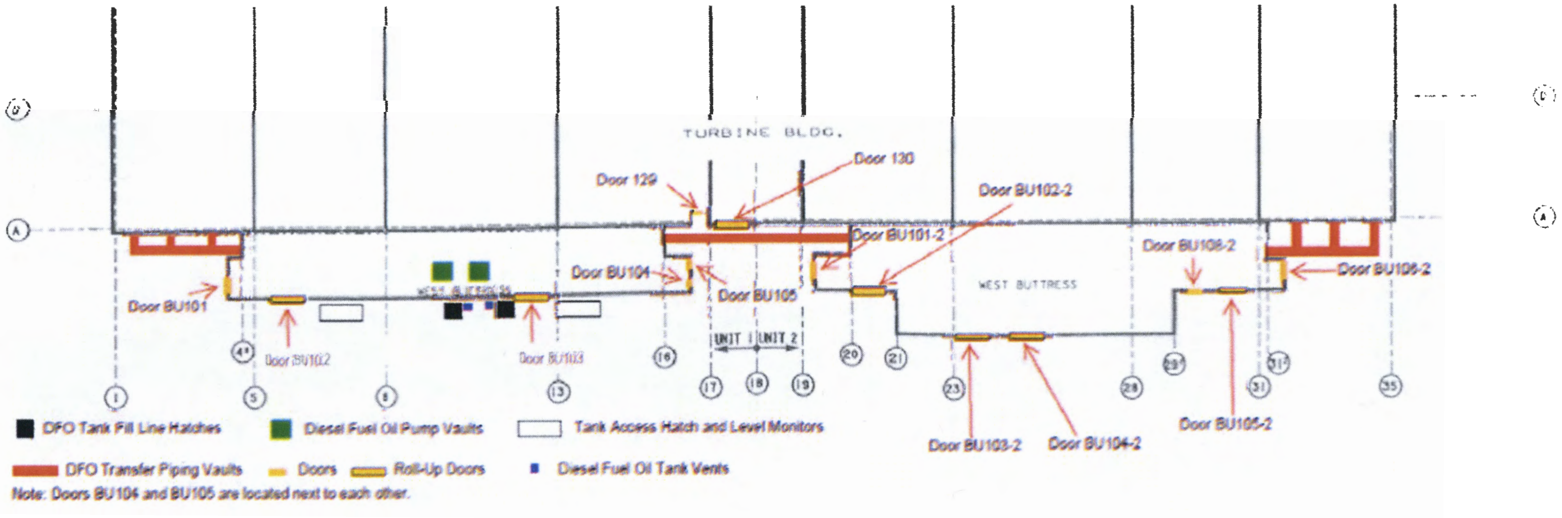

Figure 3.2-5b. **Door and other opening locations shown in relation to safety and non-safety-related structures at the Diablo Canyon nuclear power plant site (continued).** Source: PG&E (2017a)

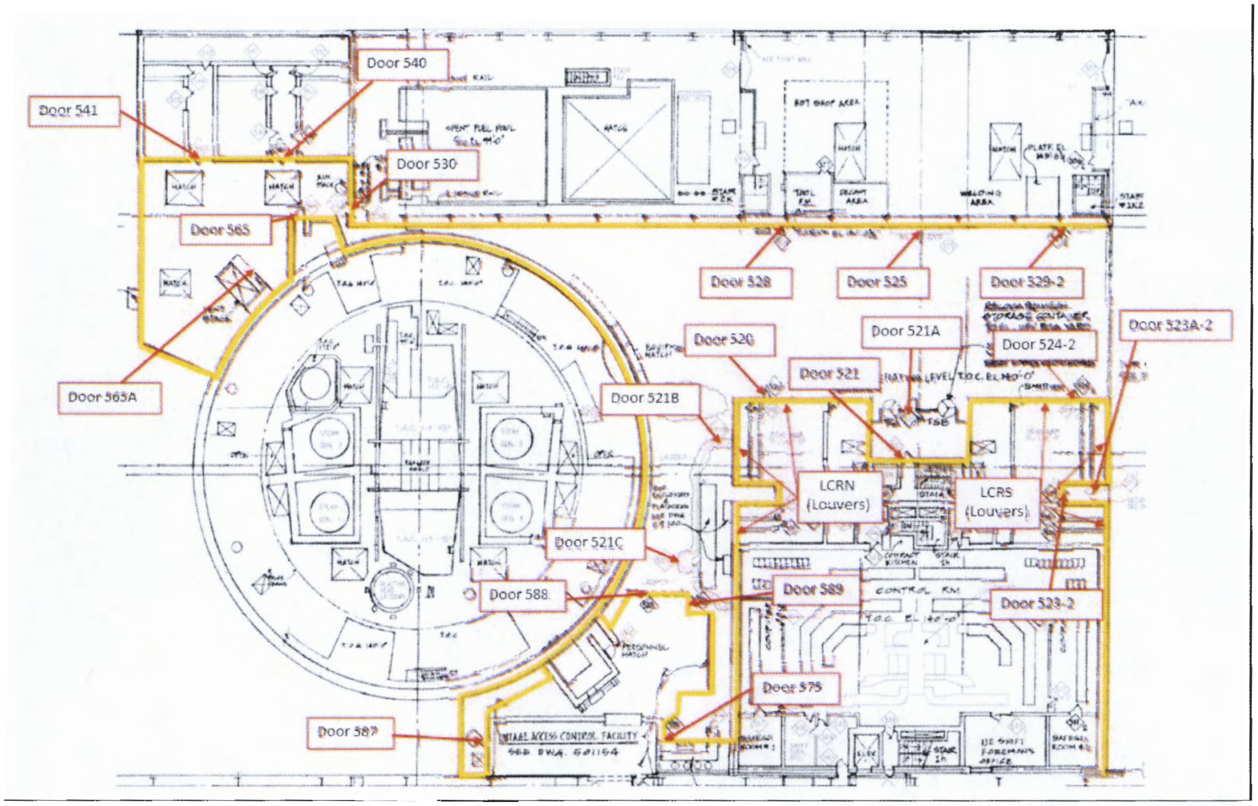

Figure 3.2-6a. **Door and other opening locations shown in relation to safety and non-safety-related structures at the Diablo Canyon nuclear power plant site at the 140-ft. sundeck elevation.** Source: PG&E (2017a)

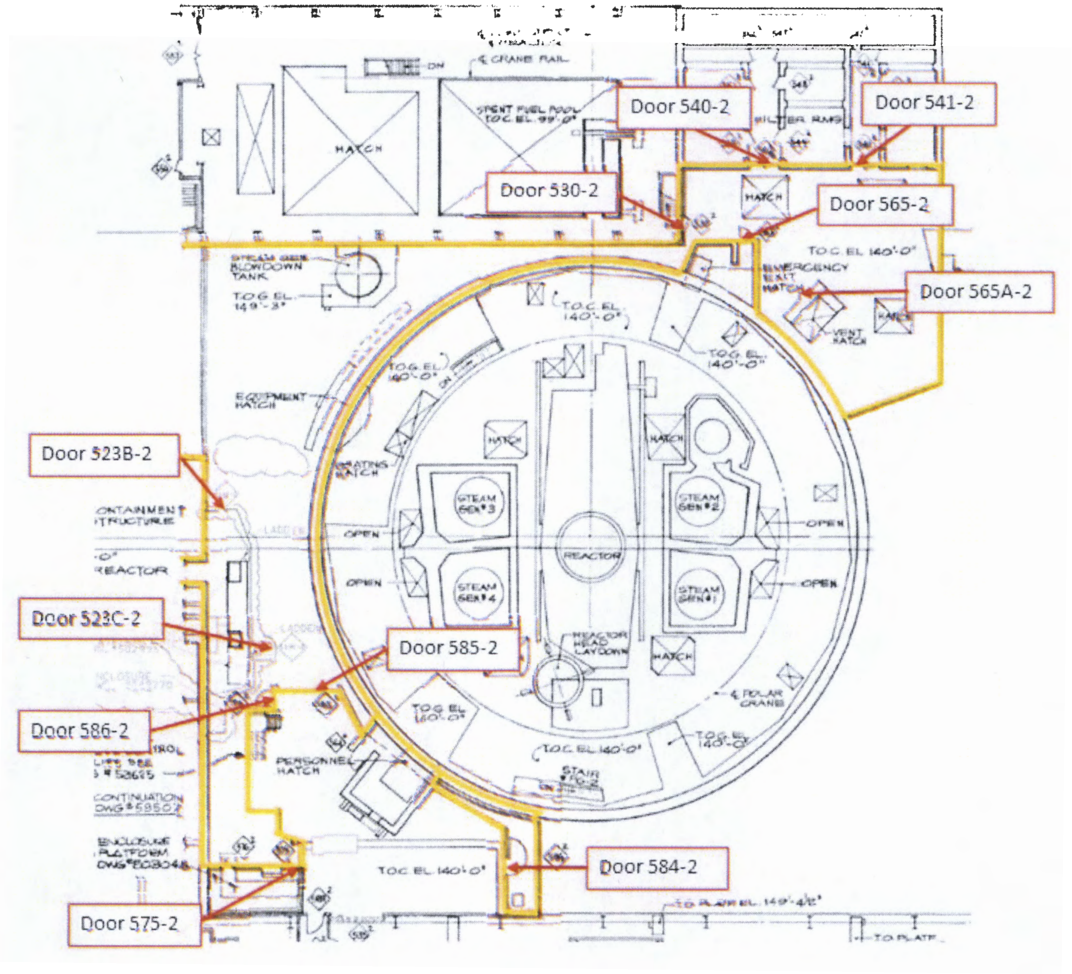

Figure 3.2-6b. **Door and other opening locations shown in relation to safety and non-safety-related structures at the Diablo Canyon nuclear power plant site at the 140-ft. sundeck elevation (continued).** Source: PG&E (2017a)

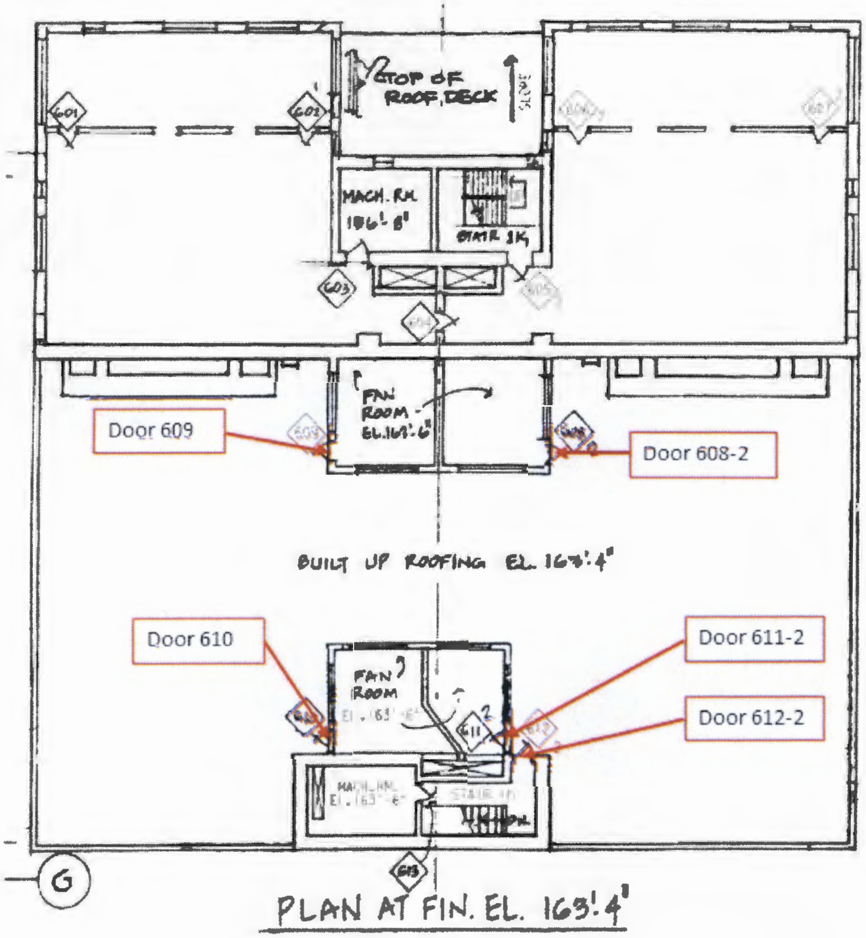

Figure 3.2-6c. **Door and other opening locations shown in relation to safety and non-safety-related structures at the Diablo Canyon nuclear power plant site at the 140-ft. sundeck elevation (continued).** Source: PG&E (2017a)

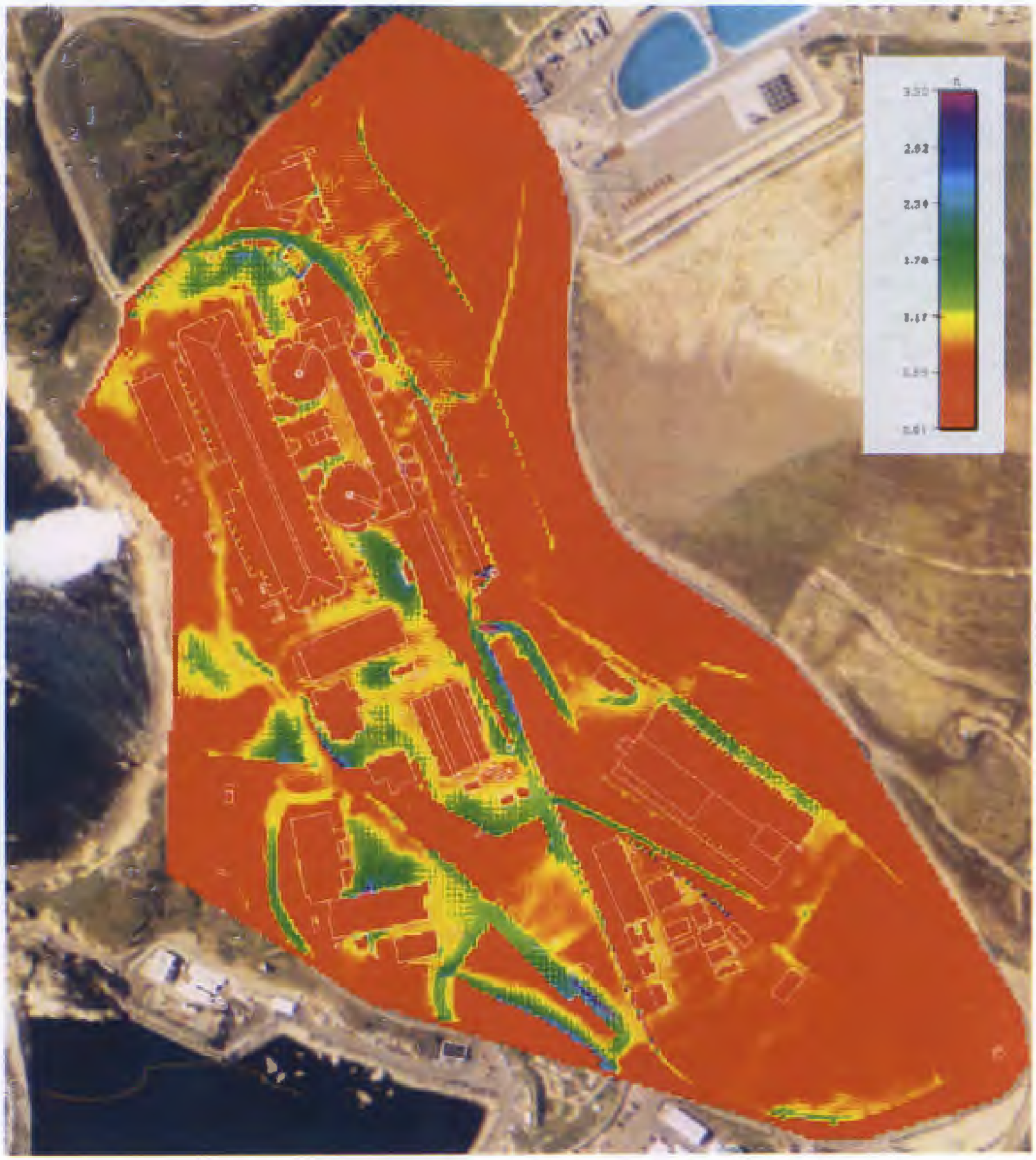

Figure 3.2-7. Map showing the maximum inundation depths for the revised LIP flood-causing mechanism using the FLO-2D computer code.
Source: PG&E (2017a)

SUBJECT: DIABLO CANYON POWER PLANT UNIT NOS. 1 AND 2 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (CAC NOS. MF7919 AND MF7920; EPID L-2016-JLD-0007) DATED December 18, 2017

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DATE	11/29/17	11/22/17	11/29/17	11/6/2017	11/6/2017
OFFICE	NRO/DSEA/RHM2/BC*	NRR/DLP/PBMB/BC	NRR/DLP/PBMB/PM		
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