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

December 23, 2014

Mr. Thomas D. Gatlin
Vice President, Nuclear Operations
South Carolina Electric & Gas Company
Virgil C. Summer Nuclear Station
Post Office Box 88, Mail Code 800
Jenkinsville, SC 29065

SUBJECT: VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1 - STAFF ASSESSMENT OF RESPONSE TO 10 CFR 50.54(f) INFORMATION REQUEST – FLOOD-CAUSING MECHANISM REEVALUATION (TAC NO. MF1112)

Dear Mr. Gatlin:

By letter dated March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information pursuant to Title 10 of the *Code of Federal Regulations*, Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The request was issued as part of implementing lessons-learned from the accident at the Fukushima Dai-ichi nuclear power plant. Enclosure 2 to the 50.54(f) letter requested licensees to reevaluate flood-causing mechanisms using present-day methodologies and guidance.

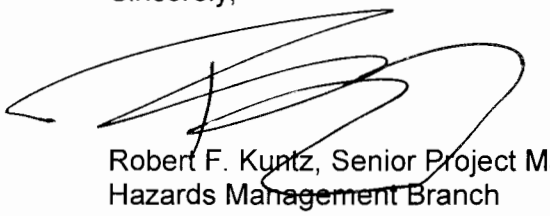
By letter dated March 12, 2013, South Carolina Electric & Gas Company responded to this request for Virgil C. Summer Nuclear Station, Unit 1. This response was supplemented by letters dated August 22, 2013, March 26, 2014, and November 24, 2014.

The NRC staff has reviewed the information provided and, as documented in the enclosed staff assessment, determined that you provided sufficient information in response to the 50.54(f) letter. Because some reevaluated flood-causing mechanisms were not bounded by your current plant design-basis hazard, the NRC staff anticipates submittal of an integrated assessment in accordance with Enclosure 2, Required Response 3, of the 50.54(f) letter.

In addition, the staff has identified two issues that resulted in open items. These open items are documented and explained in the attached Staff Assessment, and will be addressed as part of the integrated assessment.

If you have any questions, please contact me at (301) 415-3733 or email at Robert.Kuntz@nrc.gov.

Sincerely,



Robert F. Kuntz, Senior Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No. 50-395

Enclosure:
Staff Assessment of Flood Hazard
Reevaluation Report

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO FLOODING HAZARD REEVALUATION REPORT

NEAR-TERM TASK FORCE RECOMMENDATION 2.1

VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1

DOCKET NO. 50-395

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) "Conditions of license" (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 "Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident" (NRC, 2011b)[1]. Recommendation 2.1 in that document recommended that the staff issue orders to all licensees to reevaluate seismic and flooding for their sites against current NRC requirements and guidance. Subsequent Staff Requirements Memoranda associated with Commission Papers SECY-11-0124 (NRC, 2011c) and SECY-11-0137 (NRC, 2011d) directed the NRC staff to issue requests for information to licensees pursuant to 10 CFR 50.54(f).

Enclosure 2 to the 50.54(f) letter (NRC, 2012a) requested that licensees reevaluate flood hazard for their respective sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits (ESPs) and combined licenses (COLs). The required response section of Enclosure 2 specified that NRC staff would provide a prioritization plan indicating Flooding Hazard Reevaluation Report (FHRR) deadlines for individual plants. On May 11, 2012, the staff issued its prioritization of the FHRRs (NRC, 2012b).

If the reevaluated hazard for all flood-causing mechanisms is not bounded by the current plant design-basis flood hazard, an Integrated Assessment will be necessary. The FHRR and the responses to the associated Requests for Additional Information (RAIs) will provide the hazard input necessary to complete the integrated assessment report as requested in Enclosure 2 of the 50.54(f) letter.

By letter dated March 12, 2013 (SCE&G, 2013a), South Carolina Electric & Gas (SCE&G, the licensee) provided the FHRR for the Virgil C. Summer Nuclear Station (VCSNS), Unit 1. The VCSNS, Unit 1 FHRR (SCE&G, 2013a) was supplemented by letter dated August 22, 2013 (SCE&G, 2013b). In connection with the FHRR supplemental response, the licensee identified and committed to certain interim actions. The NRC staff issued RAIs to the licensee on January

[1] Issued as an enclosure to Commission Paper SECY-11-0093 (NRC, 2011a).

30, 2014 (NRC, 2014b). The licensee responded to the RAIs by letter dated March 26, 2014 (SCE&G, 2014b).

Because a reevaluated flood-causing mechanism is not bounded by the current plant design-basis hazard, the staff anticipates submittal of an integrated assessment. The staff will prepare an additional staff assessment report to document its review of the Integrated Assessment.

2.0 REGULATORY BACKGROUND

2.1 Applicable Regulatory Requirements

As stated above, Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their respective sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for ESPs and COLs. This section describes present-day regulatory requirements that are applicable to the FHRR.

Section 50.34(a)(1), (a)(3), (a)(4), (b)(1), (b)(2), and (b)(4), of 10 CFR, describes the required content of the preliminary and final safety analysis reports (FSARs), including a discussion of the facility site with a particular emphasis on the site evaluation factors identified in 10 CFR Part 100. The licensee should provide any pertinent information identified or developed since the submittal of the preliminary safety analysis report in the FSAR.

Section 50.54(f) of 10 CFR states that a licensee shall at any time before expiration of its license, upon request of the Commission, submit written statements, signed under oath or affirmation, to enable the Commission to determine whether or not the license should be modified, suspended, or revoked. The 50.54(f) letter of March 12, 2012 (NRC, 2012a), requested licensees reevaluate the flood-causing mechanisms for their respective sites using present-day methodologies and regulatory guidance used by the NRC for the ESP and COL reviews.

General Design Criterion 2 in Appendix A of 10 CFR Part 50 states that structures, systems, and components (SSCs) important to safety at nuclear power plants must be designed to withstand the effects of natural phenomena such as earthquakes, tornados, hurricanes, floods, tsunamis, and seiches without loss of capability to perform their intended safety functions. The design bases for these SSCs are to reflect appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area. The design bases are also to have sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

Section 50.2 of 10 CFR defines the design-basis as the information that identifies the specific functions that an SSC of a facility must perform, and the specific values or ranges of values chosen for controlling parameters as reference bounds for design which each licensee is required to develop and maintain. These values may be (a) restraints derived from generally accepted "state of the art" practices for achieving functional goals, or (b) requirements derived from an analysis (based on calculation, or experiments, or both) of the effects of a postulated accident for which an SSC must meet its functional goals.

Section 54.3 of 10 CFR defines the "current licensing basis" (CLB) as: "the set of NRC requirements applicable to a specific plant and a licensee's written commitments for ensuring compliance with and operation within applicable NRC requirements and the plant design-basis (including all modifications and additions to such commitments over the life of the license) that are docketed and in effect." This includes 10 CFR Parts 2, 19, 20, 21, 26, 30, 40, 50, 51, 52,

54, 55, 70, 72, 73, 100 and appendices thereto; orders; license conditions; exemptions; and technical specifications as well as the plant-specific design-basis information as documented in the most recent final safety analysis report. The licensee's commitments made in docketed licensing correspondence, which remain in effect, are also considered part of the CLB.

Present-day regulations for reactor site criteria (Subpart B to 10 CFR Part 100 for applications on or after January 10, 1997) state, in part, that the physical characteristics of the site must be evaluated and site parameters established, such that potential threats from such physical characteristics will pose no undue risk to the type of facility proposed to be located at the site. Factors to be considered when evaluating sites include: the nature and proximity of dams and other man-related hazards (10 CFR 100.20(b)), and the physical characteristics of the site, including the hydrology (10 CFR 100.21(d)).

2.2 Enclosure 2 to the 50.54(f) Letter

The 50.54(f) letter (NRC, 2012a) requests all power reactor licensees and construction permit holders reevaluate all external flooding-causing mechanisms at each site. The reevaluation should apply present-day methods and regulatory guidance that are used by the NRC staff to conduct ESP and COL reviews. This includes current techniques, software, and methods used in present-day standard engineering practice. If the reevaluated flood-causing mechanisms are not bounded by the current plant design-basis flood hazard, an integrated assessment will be necessary.

2.2.1 Flood-Causing Mechanisms

Attachment 1 to Recommendation 2.1, Flooding (Enclosure 2 of the 50.54(f) letter) (NRC, 2012a) discusses flood-causing mechanisms for the licensee to address in itsFHRR (SCE&G, 2013a). Table 2.2-1 lists the flood-causing mechanisms the licensee should consider. Table 2.2-1 also lists the corresponding Standard Review Plan (SRP) (NRC, 2007) sections and applicable interim staff guidance (ISG) documents containing acceptance criteria and review procedures. The licensee should incorporate and report associated effects per NRC Japan Lessons-Learned Directorate (JLD) JLD-ISG-2012-05 (NRC, 2012d) in addition to the maximum water level associated with each flood-causing mechanism.

2.2.2 Associated Effects

In reevaluating the flood-causing mechanisms, the "flood height and associated effects" should be considered. The ISG for performing the integrated assessment for external flooding, JLD-ISG-2012-05 (NRC, 2012d) defines "flood height and associated effects" as the maximum stillwater surface elevation plus:

- wind waves and run-up effects
- hydrodynamic loading, including debris
- effects caused by sediment deposition and erosion
- concurrent site conditions, including adverse weather conditions
- groundwater ingress
- other pertinent factors

2.2.3 Combined Effects Flood

The worst flooding at a site that may result from a reasonable combination of individual flooding mechanisms is sometimes referred to as a "Combined Effects Flood." Even if some or all of these individual flood-causing mechanisms are less severe than their worst-case occurrence, their combination may still exceed the most severe flooding effects from the worst-case occurrence of any single mechanism described in the 50.54(f) letter. (See the SRP, Section 2.4.2, Area of Review (NRC, 2007).) Attachment 1 of the 50.54(f) letter) describes the "Combined Effect Flood" [1] as defined in American National Standards Institute/American Nuclear Society (ANSI/ANS) 2.8-1992 (ANSI/ANS, 1992) as follows:

> For flood hazard associated with combined events, American Nuclear Society (ANS) 2.8-1992 provides guidance for combination of flood causing mechanisms for flood hazard at nuclear power reactor sites. In addition to those listed in the ANS guidance, additional plausible combined events should be considered on a site specific basis and should be based on the impacts of other flood causing mechanisms and the location of the site.

If two less severe mechanisms are plausibly combined per ANSI/ANS-2.8-1992 (ANSI/ANS, 1992) and SRP, Section 2.4.2, Areas of Review (NRC, 2007), then the staff will document and report the result as part of one of the hazard sections. An example of a situation where this may occur is flooding at a riverine site located where the river enters the ocean. For this site, storm surge and river flooding should be plausibly combined.

2.2.4 Flood Event Duration

Flood event duration was defined in the ISG for the integrated assessment for external flooding, JLD-ISG-2012-05 (NRC, 2012d), as the length of time during which the flood event affects the site. It begins when conditions are met for entry into a flood procedure, or with notification of an impending flood (e.g., a flood forecast or notification of dam failure), and includes preparation for the flood. It continues during the period of inundation, and ends when water recedes from the site and the plant reaches a safe and stable state that can be maintained indefinitely. Figure 2.2-1 illustrates flood event duration.

2.2.5 Actions Following the FHRR

For the sites where the reevaluated flood probable maximum flood (PMF) elevation is not bounded by the current design-basis flood PMF elevation for all flood-causing mechanisms, the 50.54(f) letter (NRC, 2012a) requests licensees and construction permit holders to

- Submit an Interim Action Plan with the FHRR documenting actions planned or already taken to address the reevaluated hazard(s)
- Perform an Integrated Assessment subsequent to the FHRR to (a) evaluate the effectiveness of the current design basis (i.e., flood protection and mitigation systems), (b) identify plant-specific vulnerabilities, and (c) assess the effectiveness of existing or planned systems and procedures for protecting against and mitigating consequences of flooding for the flood event duration

---

[1] For the purposes of this Staff Assessment, the terms "combined effects" and "combined events" are synonyms

If the reevaluated PMF elevation is bounded by the current design-basis PMF elevation for all flood-causing mechanisms at the site, licensees are not required to perform an integrated assessment at this time.

3.0 TECHNICAL EVALUATION

The NRC staff has reviewed the information provided for the flood hazard reevaluation of VCSNS, Unit 1. The licensee conducted the hazard reevaluation using present-day methodologies and regulatory guidance used by the NRC staff in connection with ESP and COL reviews. The staff's review and evaluation is provided below.

To provide additional information in support of the summaries and conclusions in the VCSNS, Unit 1 FHRR (SCE&G, 2013a) the licensee made calculation packages available to the staff via an electronic reading room. When the staff relied directly on any of these calculation packages in its review, these calculation packages are docketed, and are cited, as appropriate, in the discussion below. Certain other calculation packages were found only to expand upon and clarify the information provided on the docket, and so are not docketed or cited.

The staff requested additional information from the licensee to supplement the VCSNS, Unit 1 FHRR (SCE&G, 2013a) by letter dated January 30, 2014 (NRC, 2014b). The licensee provided this additional information by letter dated March 26, 2014 (SCE&G, 2014b), which is discussed in the appropriate sections below.

The elevation[2] of nominal site grade at the VCSNS, Unit 1 plant is 435.0 feet (ft) (132.6 m) National Geodetic Vertical Datum of 1929 (NGVD29) (SCE&G, 2010a; SCE&G, 2013a). Unless otherwise stated, all elevation values in this document are reported using NGVD29. Table 3.0-1 provides the summary of controlling reevaluated flood-causing mechanisms, including associated effects that the licensee computed to be higher than the elevation of nominal site grade.

3.1 Site Information

The 50.54(f) letter includes the SSCs important to safety, and the Ultimate Heat Sink, in the scope of the hazard reevaluation. Per the 50.54(f) letter (NRC, 2012a), Enclosure 2, Requested Information, Hazard Reevaluation Report, Item a, the licensee included pertinent data concerning these SSCs in its FHRR (SCE&G, 2013a).

The 50.54(f) letter (NRC, 2012a), Enclosure 2 (Recommendation 2.1: Flooding), Requested Information, Hazard Reevaluation Report, Item a, describes site information to be contained in the FHRR. The staff reviewed and summarized this information as follows.

3.1.1 Detailed Site Information

The VCSNS site is located in Fairfield County, in central South Carolina (Figure 3.3-1). The city of Columbia, South Carolina is located approximately 26 miles (42 km) southeast of the VCSNS site. Associated and nearby water storage impoundments include Monticello Reservoir and Parr Shoals Reservoir (also called Parr Reservoir).

---

[2] The licensee's flood hazard reevaluation studies were conducted using mostly conventional units of measure. The value presented by the licensee (usually in conventional units) is followed by the equivalent in the other units (usually metric), in parentheses. Because the units' conversion may cause loss of precision, the first measurement is definitive.

Parr Shoals Reservoir is located approximately 1 mile (1.6 km) to the west of the VCSNS site, and is formed by Parr Shoals Dam (also called Parr Dam), which is located approximately 2.5 miles (4.0 km) southwest of the VCSNS site. Parr Shoals Dam and Reservoir are owned and operated by SCE&G. The Parr Shoals Dam normal pool elevation is 266.0 ft (81.08 m) (SCE&G, 2010a).

Monticello Reservoir is located adjacent to and north of the VCSNS site, impounding drainage from approximately 17 square miles (44 square kilometers). Monticello Reservoir is formed by the Frees Creek Dams, consisting of one main dam and three saddle dams (Figure 3.3-1). The Frees Creek Dams have crest elevations of 434.0 ft (132.3 m). The Frees Creek Dams provide water to the plant through a Service Water Pond (SWP) that adjoins the plant (Figure 3.3-2).

The SWP is formed by three dams (north, east, and south) and an embankment (west). The North, East, and South Dams have crest elevations of 438.0 ft (133.5 m), and the West Embankment crest elevation is 435.0 ft (132.6 m). Elevation of the VCSNS plant grade adjacent to the West Embankment is also 435.0 ft (132.6 m). The Monticello Reservoir and SWP pool elevations fluctuate between 420.5 ft and 425.0 ft (128.2 m and 129.5 m) during normal operations.

3.1.2 Design-Basis Flood Hazards[3]

The current design-basis flood elevations are presented by the licensee in Section 4.1.2 of the FHRR. The current design-basis flood levels are summarized by flood-causing mechanisms in Table 3.1-1.

3.1.3 Flood-related Changes to the Licensing Basis

The licensee noted in its FHRR that there have been no flood-related changes or changes to flood protection measures beyond the flood protection measures in place for the current design-basis.

3.1.4 Changes to the Watershed and Local Area

The staff independently inspected recent U.S. Department of Agriculture (USDA), National Agriculture Imagery Program (USDA, 2013) imagery and confirmed that the only apparent changes within the watershed and local area were those associated with the plant site itself, as stated in the VCSNS, Units 2 and 3 combined license application (COLA) FSAR (SCE&G, 2010b).[4] Lands within the watershed otherwise consist primarily of forest and fields.

3.1.5 Current Licensing Basis Flood Protection and Pertinent Flood Mitigation Features

Attachment A to the VCSNS, Unit 1 FHRR (SCE&G, 2013a) included a detailed list of features that were credited as flood protection during the flooding walkdown. Features listed include condition of riprap at dams, berms and embankments, many grading features associated with the site storage tanks, and sealing of many building interior and exterior wall surfaces and roofs.

---

[3] In the FHRR, the licensee used the terms "design-basis" and "licensing basis" interchangeably. Because the references to current licensing basis were to various elevations that were specific to each flood hazard, the staff assumes in this document that the licensee intended the term "current licensing basis" in its FHRR to refer to the "current design basis" since this is what the 50.54(f) letter, Enclosure 2, requested. The staff will thus use the term "current design-basis", as appropriate, throughout this document.

4 FSAR for the combined license application (COLA) for VCSNS Units 2 and 3 (SCE&G, 2010b)

In the current licensing basis, no flood mitigation features are credited (SCE&G, 2013a)[5]. The credited flood protection features appear in five groups: dams (and berms), grade, exterior building walls, floor slabs, and roofs. Monticello Reservoir and the SWP are prevented from flooding the site in the current licensing basis during probable maximum precipitation (PMP) and PMF events by minimum top of dam and top of berm elevations. Relative to grade, the site was designed to provide overland flow away from the site during PMP/PMF event flows and thus preventing the flooding of buildings, exterior equipment, and systems. Influx of water to buildings is prevented through use of waterproofing membranes, waterstops at joints, and sealed penetrations. Roof systems protect buildings from infiltration from local intense precipitation (LIP) during a PMP event. During current licensing basis PMP or PMF events, no flooding occurs on the site; therefore, flood duration is not an issue in the current licensing basis. No formal flood warning system is in place at the VCSNS site because, relative to flood protection, the site is the equivalent of a dry site, as defined in NRC Regulatory Guide 1.102 (NRC, 1976) in the current licensing basis (SCE&G, 2013a). Extreme weather events are monitored and warning is provided through the following procedures: EPP-015, "Emergency Plan Procedure, Natural Emergency," and OAP-109.1, "Operations Administrative Procedure, Guidelines for Severe Weather."

3.1.6 Additional Site Details to Assess the Flood Hazard

The VCSNS, Unit 1 FHRR (SCE&G, 2013a) stated that a new topographic survey was performed in the summer of 2012 using photogrammetric methods accurate to within 0.1 ft (0.03 m) (horizontal and vertical). This new survey defines the as-built condition of the plant site, and was used for the VCSNS, Unit 1 FHRR (SCE&G, 2013a) reanalysis work. The topographic survey was used to develop a new digital terrain model (DTM), and the DTM was used in the licensee's FLO-2D Pro (FLO-2D) analyses.

3.1.7 Plant Walkdown Activities

Requested Information Item 1.c and Attachment 1 to Enclosure 2, Step 6, in the 50.54(f) letter (NRC, 2012a), requires licensees to report any relevant information from the results of the plant walkdown activities associated with Enclosure 4 of the 50.54(f) letter (NRC, 2012a). Enclosure 4 of the 50.54(f) letter (NRC, 2012a), requested that licensees plan and perform plant walkdown activities to verify that current flood protection systems are available, functional, and implementable. Requested Information Item 1.c, and Step 6 of Attachment 1 to Recommendation 2.1, Flooding (Enclosure 2 of the 50.54(f) letter (NRC, 2012a) asked the licensee to report any relevant information from the results of the plant walkdown activities.

By letter dated November 26, 2012, SCE&G provided its flood walkdown report for VCSNS, Unit 1 (SCE&G, 2012). The walkdown report was supplemented by letter dated January 31, 2014, containing RAI responses (SCE&G, 2014a). The staff prepared a staff assessment report, dated June 6, 2014 (NRC, 2014a), to document its review of the walkdown report. The staff concluded that the licensee's implementation of flooding walkdown methodology met the intent of the walkdown guidance.

---

5 In its FHRR, the licensee incorporated the VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b) by reference.

3.2 Local Intense Precipitation and Associated Site Drainage

The VCSNS, Unit 1 FHRR (SCE&G, 2013a) reported that the reevaluated flood hazard, including associated effects, for LIP is based on a stillwater-surface elevation that varies, depending on location, from 436.6 ft to 437.5 ft (133.1 m to 133.4 m). This flood-causing mechanism is described in the licensee's current design-basis. The current design-basis hazard for the LIP and associated site drainage hazard is a stillwater-surface elevation of 436.15 ft (132.94 m).

Because the VCSNS, Units 2 and 3 site is adjacent to VCSNS, Unit 1, the staff determined that neither the present standard methods nor values associated with estimating the PMP have changed since the staff's review of the FSAR for the combined license application for VCSNS, Units 2 and 3 (SCE&G, 2010b), and that such methods and values are applicable in the VCSNS, Unit 1 FHRR (SCE&G, 2013a).

The staff reviewed the flooding hazard from LIP and associated site drainage, including associated effects, against the relevant regulatory criteria based on present-day methodologies and regulatory guidance.

3.2.1 Site Drainage and Elevations

Sections 4.1.1.2 and 4.3.1 of the VCSNS, Unit 1 FHRR (SCE&G, 2013a), report that the western side of the plant has experienced significant development since original licensing, which includes, "new structures, roads, parking lots, gravel laydown yards, storm drainage systems, and site grading." The associated grading work is reported by the licensee to have raised the original contours in most cases. The resulting site grade slopes have been altered such that runoff from precipitation now flows toward, where previously runoff flowed away from, the main plant buildings. The licensee reports that another factor contributing to the change in direction of runoff is that in some cases the elevations of storm drain inlets have been raised. These changes are reflected in the modeling that was performed by the licensee and reviewed by staff, as discussed below.

The licensee reevaluated flooding hazards from LIP and site drainage. Flooding concerns are associated with the capacity of the site grade to route and convey rainwater away from SSCs. The VCSNS, Unit 1 Updated Final Safety Analysis Report (UFSAR) (SCE&G, 2010a) includes a discussion of flooding in site drainage systems. Storm sewers drain water to the west and south of the site and away from Monticello Reservoir and the SWP, except for a small area near the SWP, as described in the VCSNS, Unit 1 UFSAR (SCE&G, 2010a). The VCSNS, Unit 1 UFSAR (SCE&G, 2010a) stated that safety-related equipment is protected up to elevation 436.5 ft (133.0 m) and that the maximum water level expected during a LIP event is 436.15 ft (132.94 m), which is the current design-basis flood elevation associated with the LIP event.

Given the significant role that elevation data play in defining slopes and flow paths, the staff requested that the licensee provide a description of the methods used to incorporate elevation measurements into the FLO-2D analyses. The licensee provided a detailed description of the elevation data sources, data uncertainty and the methods used to incorporate the elevation data into the analysis of the flood generated by a LIP event (SCE&G, 2014b, RAI 2 response).

The licensee stated that an aerial survey was undertaken to collect elevation points within the VCSNS, Unit 1 plant area (SCE&G, 2014b, RAI 2 response). The licensee used the elevation dataset to develop the FLO-2D model for LIP flooding analysis. The licensee stated that the

gridded elevation dataset had a spatial resolution of about 10 ft (3.0 m) and vertical accuracy of 0.25 ft (0.076 m). The licensee refined this gridded elevation dataset to a resolution of 3 ft (0.9 m) within the plant area (SCE&G, 2014b, RAI 2 response). Outside of the plant area, the licensee stated that the accuracy was 0.72 ft (0.22 m). The licensee stated that the elevation inaccuracies in this area, which is distant from the plant area, were insignificant due to the relatively low fraction of total area that it represented in the LIP flooding analysis (SCE&G, 2014b, RAI 2 response).

3.2.2 Local Intense Precipitation Depths

The current design-basis flood elevation from LIP is based on a 6-h PMP depth of 29.83 in (75.77 cm). This is described in the VCSNS, Unit 1 FHRR (SCE&G, 2013a), which cites the VCSNS Unit 1 UFSAR (SCE&G, 2010a, Table 2.4-5). Table 3.2-1 in this Staff Assessment provides temporal distribution sequence for the PMP that the licensee used in calculating the current design-basis flood elevation.

The reevaluated flood hazard is based, however, on a different PMP, the 1-mi^2 (2.6-km^2), 1-h PMP. The VCSNS, Unit 1 FHRR (SCE&G, 2013a) stated that this PMP depth is about 19.0 in (48.3 cm).

The staff confirmed that the 1-mi^2 (2.6-km^2), 1-h duration precipitation value is appropriate based on its review of the National Oceanic and Atmospheric Administration Hydrometeorological Report (HMR) No. 52 (NOAA, 1982, Figure 24), the VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b), and the VCSNS, Units 2 and 3 Final Safety Evaluation Report (FSER) (NRC, 2013).

The staff reviewed additional information in reaching this confirmation. In particular, the staff reviewed information provided by the South Carolina State Climatology Office (SCSCO, 2013) and found that no 24-h precipitation totals were recorded between 1890 and 2013 exceeded the PMP associated with the 1-mi^2 (2.6-km^2), 1-h duration (SCSCO, 2013). The staff found that the largest 24-h precipitation amount was reported to be 14.80 in (37.59 cm), which is consistent with the VCSNS, Units 2 and 3 FSER (NRC, 2013). The historical record precipitation at this site is therefore bounded by the PMP estimated from HMR No. 52, for the 1-mi^2 (2.6-km^2), 1-h duration rainfall value of 19.0 in (48.3 cm).

3.2.3 Modeling of Flood Levels

To estimate runoff and perform hydrologic routing, the licensee used the FLO-2D software application (SCE&G, 2013a; FLO-2D Software, Inc. 2009). The licensee used the 1-mi^2 (2.6-km^2), 1-h duration rainfall value of 19.0 in (48.3 cm) as input to the FLO-2D application.

Given the significant role that the FLO-2D model performs in the licensee's analysis of the PMF caused by LIP, the staff requested that the licensee provide FLO-2D input files. The licensee provided a detailed description of the application of the FLO-2D model along with the model input files (SCE&G, 2014b, RAIs 1 and 2 responses). The staff reviewed model input configurations and the manner in which results of the FLO-2D analysis were used to predict water-surface elevations.

The VCSNS, Unit 1 FHRR (SCE&G, 2013a) stated that the roofs of safety-related buildings were designed to store up to 4 inches (10 cm) of precipitation. The licensee did not describe how or if this design feature was incorporated into the LIP analysis and did not characterize similar design features of non-safety-related buildings. The staff reviewed the licensee's FLO-

2D application and found that all precipitation falling on building roofs was retained on the roofs and did not enter the flow domain adjacent to the buildings. Water retained on building roofs would reduce the discharge adjacent to, and downstream of, the buildings. The portion of runoff from the plant site into the SWP, with coincident wind setup and wave runup discussed later relative to streams and rivers in Section 3.3.4, is also impacted indirectly by the roof drainage issue in the FLO-2D model. This issue should be addressed as **Integration Assessment Open Item No. 1**.

The licensee's reevaluation yielded a PMF water-surface elevation of 436.6 ft to 437.5 ft (133.1 m to 133.4 m) (SCE&G, 2013a), which is higher than the current design-basis stillwater-surface elevation of 436.15 ft (132.94 m). Elevation 436.6 ft (133.1 m) is at the east side, and elevation 437.5 ft (133.4 m) is at the west side of the powerblock (SCE&G, 2014b).

3.2.4 Flood Event Duration

The VCSNS, Unit 1 FHRR (SCE&G, 2013a) did not address flood warning time or the duration of inundation resulting from LIP flooding.

The staff requested additional information from the licensee (NRC, 2014b) to supplement its FHRR (SCE&G, 2013a). The licensee's response (SCE&G, 2014b, RAI 6 response) stated that existing modeling indicates that most ponded water drains from the site within 7 hours. Warning time, based on meteorological warnings, is expected to be more than 24 hours.

The staff notes that longer duration PMP events that deliver greater precipitation volumes, such as the 72-h PMP, generate greater volumes of runoff. Shorter-duration PMP events that have higher rates of precipitation, such as the 1-hour PMP, may however result in much shorter warning times and higher water levels. Therefore, the staff determined that, as part of the integrated assessment , the licensee should evaluate a range of rainfall durations associated with the LIP events (e.g., 1-, 6-, 12-, 24-, 48-, 72-hour PMPs) to determine the controlling scenario(s) (see NRC, 2012d). This should include a sensitivity analysis to identify potentially limiting scenarios when considering flood height, relevant associated effects, and flood event duration parameters. This is **Integrated Assessment Open Item No. 2**.

3.2.5 Conclusion

The staff confirmed the licensee's conclusion that the reevaluated flood hazard for LIP and associated site drainage is not bounded by the current design-basis flood hazard; therefore, the licensee should include LIP and associated site drainage within the scope of the integrated assessment.

The information on flooding from LIP and associated site drainage that is specific to the data needs of the integrated assessment is described in Section 4 of this staff assessment. Two issues will be resolved as Integrated Assessment Open Items, as discussed above.

3.3 Streams and Rivers

The licensee reported in its FHRR (SCE&G, 2013a) that the probable maximum flood elevation, including associated effects, for site flooding from streams and rivers is 437.0 ft (133.2 m), which the licensee found would occur at the North Berm of the plant site adjacent to the Monticello Reservoir. This is based on a stillwater elevation of 431.07 ft (131.39 m), which was computed starting from a maximum normal operating water elevation of 425.0 ft (129.5 m), plus 6.07 ft (1.85 m) contributed by direct PMP and runoff, plus 5.93 ft (1.81 m) from wind setup and

wave runup (SCE&G 2014c). Wind setup and wave runup are computed to impinge on the North Berm for a duration of approximately 72 seconds during the assumed event (SCE&G, 2014b).

This flood-causing mechanism is described in the licensee's current design-basis. The current design-basis PMF elevation for site flooding from streams and rivers is 436.6 ft (133.1 m), which was computed starting from a maximum normal operating water elevation of 425.0 ft (129.5 m), plus 4.1 ft (1.2 m) resulting from 48-h PMP, plus wave runup of 7.5 ft (2.3 m). The licensee stated in its 1 FHRR (Gatlin, 2013a) that the "PMF elevation for Monticello Reservoir at the North Berm is above the [current design-basis] PMF elevation of 436.6 ft (133.1 m), but still below the berm top elevation of 438.0 ft (133.5 m)."

3.3.1 Additional Information

The VCSNS, Unit 1 FHRR (SCE&G, 2013a) included a description of the PMP associated with the PMF in streams and rivers by reference to the PMP reported in the VCSNS, Unit 1 UFSAR (SCE&G, 2010a). The VCSNS, Unit 1 FHRR (SCE&G, 2013a) also describes the precipitation losses (such as infiltration) associated with the PMF in streams and rivers by reference to the VCSNS, Unit 1 UFSAR (SCE&G, 2010a).

3.3.2 Flooding Scenarios and Associated Effects

The VCSNS, Unit 1 site in relation to the Broad River Basin is shown in Figure 3.4-1; the locations of additional hydrologic features and dams near the site are shown in Figure 3.3-1. The relative positions of the Monticello Reservoir and the SWP are shown in Figure 3.3-2.

The licensee considered PMF from the following rivers and stream: the Monticello Reservoir, the SWP shown on Figure 3.3-2, and the Broad River. The licensee did not develop runoff and stream-course models associated with the PMF for the Monticello Reservoir and the SWP given the nature of the areas they drain; the licensee's analyses are essentially water-storage analyses.

The staff found no associated effects identified or anticipated by the licensee from hydrodynamic loading including debris, sediment deposition or erosion, concurrent site conditions (including adverse weather other than the associated PMP), or groundwater ingress (SCE&G, 2013a; SCE&G, 2014b, RAI 7 response).

3.3.3 Monticello Reservoir

The licensee stated in its FHRR, by reference to the VCSNS, Unit 1 UFSAR (SCE&G, 2010a),that because about 70 percent of the Frees Creek drainage basin is inundated by Monticello Reservoir, a water storage analysis is appropriate. The licensee conservatively added a precipitation runoff volume from the portion of the watershed not inundated by the Monticello Reservoir to the precipitation volume that falls directly onto Monticello Reservoir. The initial precipitation loss and the subsequent infiltration rate during the PMP event were set at 1.0 in/h (2.5 cm/h) and 0.10 in/h (0.3 cm/h), respectively over the Frees Creek watershed. The licensee assumed no outflow from Monticello Reservoir via the Fairfield Pumped Storage Facility; this assumption would result in a conservative estimation of the water-surface elevation in the reservoir.

The FHRR, by reference, used computations performed in the VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b), where SCE&G used a 72-h PMP depth of 4.1 ft (1.2 m) for estimation

of the PMF peak stillwater-surface elevation in Monticello Reservoir. SCE&G used a precipitation loss rate of 0.06 in/h (0.018 cm/h) and a stage-volume relationship to determine the rise in the stillwater-surface elevation in Monticello Reservoir; the resulting PMF stillwater-surface elevation for Monticello Reservoir was 431.0 ft (131.4 m), which was reported in the FHRR through reference to the VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b) based on an initial pool elevation set at the maximum normal operating water elevation of 425.0 ft (129.5 m). Because the use of a maximum operating reservoir level is conservative, the staff found that it is reasonable to set the initial pool elevation to the maximum operating elevation of the reservoir as stated in the VCSNS, Unit 1 FHRR (SCE&G, 2013a).[6]

The VCSNS, Unit 1 FHRR (SCE&G, 2013a), described an analysis to reevaluate the potential PMP-related flooding from the Monticello Reservoir and stated that, when wind-wave effects were considered, the maximum water-surface elevation would be 437.0 ft (133.2 m). The reevaluated PMF water-surface elevation, 437.0 ft (133.2 m) (SCE&G, 2013a), is higher than the current design-basis value presented in the VCSNS, Unit 1 UFSAR (SCE&G, 2010a) at 436.6 ft (133.1 m).[7]

The staff reviewed the licensee's description of its Monticello Reservoir drainage area PMF calculation in the FHRR (SCE&G, 2013a). Given the significant role that the Monticello Reservoir plays in the licensee's analysis of the PMF from rivers and streams, and the need to review the formulation of the model's complex spatially, and temporally distributed input, the staff requested that the licensee provide a detailed description of the analysis it completed to support its conclusions. The licensee provided a detailed description of the PMF estimation in the Monticello Reservoir drainage area (SCE&G, 2014b, RAI 3 response). The licensee described the process by which the 72-h PMP depth of 47.7 in (121 cm) was determined to result in an estimated maximum water-surface elevation in Monticello Reservoir at the North Berm of 437.0 ft (133.2 m) when wave action is considered (SCE&G, 2013a).[8] All of these water surface elevations are below the 438.0 ft (133.5 m) crest elevation of the North Berm (See Figure 3.3-2).

---

[6] In the VCSNS, Units 2 and 3 FSER (NRC, 2013), the staff independently determined a slightly more conservative 72-h PMP depth of 4.2 ft (1.3 m). In the VCSNS Units 2 and 3 FSER (NRC, 2013), the staff assumed a 0.06-in/h (0.018 cm/h) precipitation loss rate. The staff also computed an effective PMP depth and added the precipitation volume associated with the portion of the Frees Creek watershed that was not inundated by Monticello Reservoir as if it was direct precipitation to Monticello Reservoir, minus the volume assumed lost due to infiltration. The staff determined the PMF stillwater-surface elevation for Monticello Reservoir was 431.6 ft (131.6 m), which was reported in the VCSNS Units 2 and 3 FSER (NRC, 2013) based on an initial pool elevation of 425.0 ft (129.5 m). In the VCSNS, Unit 1 FHRR (SCE&G, 2013a), the licensee reports a PMP stillwater-surface elevation of 429.1 ft (130.8 m) based on an initial pool elevation of 425.0 ft (129.5 m). This determination is consistent with that discussed in the VCSNS Unit 1 UFSAR (SCE&G, 2010a).

[7] But, lower than that provided in the VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b) at 437.9 ft (133.5 m).

[8] The peak water-surface elevation previously reported in the VCSNS, Units 2 and 3 FSER (NRC, 2013) was 437.9 ft (133.5 m).

3.3.4 Service Water Pond

In the VCSNS, Unit 1 FHRR (SCE&G, 2013a), the SWP is described as a Seismic Category 1 impoundment that serves as the Ultimate Heat Sink for VCSNS, Unit 1. The SWP is adjacent to Monticello Reservoir (Figure 3.3-2). The SWP is separated from Monticello Reservoir by two islands and three Seismic Category 1 dams, which have crest elevations of 438.0 ft (133.5 m) on three sides. The crest elevation of the West Embankment is 435.0 ft (132.6 m). The West Embankment adjoins the VCSNS, Unit 1 plant yard grade, and therefore represents the land elevation value critical for assessment of the PMF maximum water-surface elevation in the SWP.

The licensee stated that water is supplied to the SWP from Monticello Reservoir by a pipe configured with a butterfly isolation valve. This isolation valve is kept closed during normal operations.

The FHRR states that the SWP normal pool elevation is 422.0 ft (128.6 m). Under normal operational conditions the pool elevation ranges from 420.5 ft to 425.0 ft (128.2 m to 129.5 m). The staff confirmed that the description of the SWP is consistent with that provided in the VCSNS, Unit 1 UFSAR (SCE&G, 2010a).

Given the control of the SWP pool elevation by the operation of the SWP isolation valve on the interconnecting pipe between the SWP and Monticello Reservoir, the staff requested that the licensee provide a detailed description of conditions leading to the valve's operation, frequency of operation, and any assumptions related to the state of the isolation valve used in the reevaluation of the PMF for the SWP (NRC, 2014b). The licensee provided a detailed description of the operation of the SWP isolation valve, frequency of operation, and the assumptions used by the licensee related to the state of the valve in its analysis of the PMF (SCE&G, 2014b, RAI 4 response).

The VCSNS, Unit 1 FHRR (SCE&G, 2013a) included a description of the runoff and stream-course models associated with the PMF flooding in streams and rivers related to LIP runoff from the plant area as it drains into the SWP. In response to the NRC's RAI (NRC, 2014b), the licensee described its analysis of water levels in the SWP resulting from the PMP on the site plus associated effects (SCE&G, 2014b, RAI 5 response). The SWP receives a portion of the LIP runoff from the plant area as mentioned in Section 3.2.3 above, and the issue within the FLO-2D model, related to lack of roof drainage, impacts the portion of runoff from the plant site to the SWP.

The VCSNS, Unit 1 FHRR (SCE&G, 2013a), referenced a full description of the coincident wind-wave effects associated with the PMF flooding in streams and rivers, contained in the VCSNS, Unit 1 UFSAR (SCE&G, 2010a). The VCSNS, Unit 1 FHRR (SCE&G, 2013a) Section 4.1.2.2.2.2, stated that the VCSNS, Unit 1 UFSAR (SCE&G, 2010a) PMF including wind effects would result in a SWP water-surface elevation of 433.6 ft (132.2 m). The FHRR maximum water-surface elevation including wind-wave activity estimates are based, in part, on the stillwater-surface elevation in the SWP. The VCSNS, Unit 1 FHRR (SCE&G, 2013a) Section 4.2.2.2, stated that the reevaluated PMF elevation for the SWP at the West Embankment was determined to be 428.3 ft (130.5 m).

The licensee used the FLO-2D model to estimate LIP and runoff from the site into the SWP and the associated rise in the stillwater-surface elevation. As discussed in Section 3.2.3 of this Staff Assessment, the staff requested additional information related to FLO-2D and the modeling of

roof drainage. Therefore, the staff does not confirm the licensee's conclusions about reevaluated flood levels in the SWP. This issue will be addressed as Integration Assessment Open Item No. 1.

3.3.5 Broad River

The FHRR stated that no significant changes occurred in the Broad River watershed upstream of the VCSNS, Unit 1 site since the PMF analysis for the VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b) was performed, in which it was concluded that PMF-related flooding on the Broad River would not produce a maximum water-surface elevation greater than about 145 ft (44.2 m) below the VCSNS, Units 2 and 3 site grade. The VCSNS, Unit 1 site grade is 35.0 ft (10.7 m) higher in elevation than the VCSNS Units 2 and 3 site grade. In the VCSNS, Units 2 and 3 FSER (NRC, 2013), the staff determined that a peak water-surface elevation at Parr Shoals Reservoir would be about 291.5 ft to 303.0 ft (88.85 m to 92.35 m). The VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b), the VCSNS, Units 2 and 3 FSER (NRC, 2013), and the VCSNS, Unit 1 FHRR (SCE&G, 2013a) consistently concluded that PMF flooding on the Broad River would not produce water-surface elevations approaching the elevation of the VCSNS, Unit 1 nominal site grade.

3.3.6 Conclusion

The staff confirmed the licensee's conclusion (SCE&G 2014c) that the reevaluated hazard for flooding from streams and rivers is not bounded by the current design basis flood hazard when combined with wind setup and wave runup; therefore, the licensee should include flooding from streams and rivers with wind setup and wave runup from Monticello Reservoir within the scope of the integrated assessment. The NRC Staff expects that the resulting scope of the integrated assessment addressing this mechanism will be limited, as discussed in Section 4.1 of this Staff Assessment.

Information on flooding from streams and rivers that is specific to the data needs of the integrated assessment is described in Section 4 of this Staff Assessment. The staff could not confirm the licensee's conclusion about the reevaluated hazard for flooding from the SWP because the SWP PMF elevation is based on the outcome of the LIP analysis that should be addressed in response to Integrated Assessment Open Item 1.

3.4 Failure of Dams and Onsite Water Control/Storage Structures

The VCSNS, Unit 1 FHRR (SCE&G, 2013a) reported that the reevaluated hazard, including associated effects, for site flooding due to failure of dams and onsite water control and storage structures results in a water-surface elevation that is "greater than 145 ft [44.2 m] below the VCSNS plant site" (SCE&G, 2013a) or at an elevation of about 280 ft (85 m). This flood-causing mechanism is described in the licensee's current design-basis. The current design-basis PMF elevation for site flooding due to failure of dams and onsite water control/storage structures is 280 ft (85 m) at Parr Shoals Reservoir and the Broad River adjacent to the VCSNS, Unit 1 site.

The FHRR adopted the conclusions for flooding at the VCSNS site caused by failures of upstream dams on the Broad River that were analyzed and presented for the VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b). Figure 3.4-1 shows the existing and proposed significant

dams upstream of Parr Shoals Reservoir on the Broad River. The VCSNS Units 2 and 3 COLA FSAR (SCE&G, 2010b) approach for assessing dam failures included assuming that Parr Shoals Dam held all the water from upstream dams, PMF floodwaters, and that Parr Shoals Reservoir was subject to wind-wave effects.

The staff reviewed the VCSNS, Unit 1 FHRR (SCE&G, 2013a) and found that the combined Broad River dam failure peak water-surface elevation at Parr Shoals Reservoir would be 376.8 ft (114.8 m), which is much lower than the nominal VCSNS, Unit 1 site grade elevation of 435.0 ft (132.6 m). The peak water-surface elevations associated with dam failures on the Broad River upstream of the Parr Shoals Reservoir, as reported in the VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b), the VCSNS, Units 2 and 3 FSER (NRC, 2013), and the VCSNS Unit 1 FHRR (SCE&G, 2013a), consistently indicate that this phenomenon does not pose a potential for inundation at the VCSNS, Unit 1 site.

The staff confirmed the licensee's conclusion that the reevaluated flood hazard for failure of dams and onsite water control or storage structures is bounded by the current design basis flood hazard.

3.5 Storm Surge

The VCSNS, Unit 1 FHRR (SCE&G, 2013a) reported that the reevaluated probable maximum flood elevation, including associated effects, for site flooding due to the wind setup and wave runup aspects of storm surge is 437.0 ft (133.2 m) when combined with the PMF in the streams and rivers analysis. This flood-causing mechanism is described in the licensee's current design-basis.

This reevaluated PMF elevation exceeds the current design-basis PMF elevation for site flooding due to storm surge of 436.6 ft (133.1 m). The licensee stated that water level increases due to storm surge were included in the PMF determinations in the Monticello Reservoir and the SWP; no further analysis was performed specifically for storm surge without the PMP. The plant site is protected by the North Berm to elevation 438.0 ft (133.5 m).

In summary, the staff confirmed the licensee's conclusion that flooding from storm surge does not inundate the site. However, this hazard mechanism exceeds the current design-basis. The Staff notes that this hazard mechanism is combined with the streams and rivers flooding hazard. Therefore, the treatment of the storm surge analysis in the Integrated Assessment should be combined with the streams and rivers Integrated Assessment (see Section 3.3.6). Likewise, since the site is protected by the North Berm, the staff expects the resulting scope of the integrated assessment addressing the mechanism to be limited.

3.6 Seiche

The licensee reported in its FHRR (SCE&G, 2013a) that the reevaluated hazard, including associated effects, for site flooding from seiche does not inundate the plant site. This flood-causing mechanism is described and screened out in the licensee's current design-basis. The licensee stated that as both VCSNS, Units 2 and 3 and VCSNS, Unit 1 are on the same site and share the same major hydrologic features, and since the VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b) applied present-day methodologies and guidance, the same rationale is applicable to VCSNS, Unit 1 FHRR.

By reference to VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b) Section 2.4.5.5, the licensee stated in itsFHRR that the longitudinal wave period for Monticello Reservoir is 21

minutes and the transverse period is approximately 10 minutes. The licensee concluded that since these periods are much greater than wave periods associated with this type of system, wind generated wave amplification is not possible and no further analysis was performed.

As referenced in the FHRR by the licensee, in the VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b), the licensee provided information related to the seiche flooding on the Monticello Reservoir. The licensee determined that the topography between the Monticello Reservoir and the VCSNS sites made it implausible for seiches on the reservoir to inundate the VCSNS, Unit 1 site.

The staff reviewed the topography of the site and confirmed that, if a seiche was to occur, it would be implausible for water to overtop the dam on the Monticello Reservoir and inundate the VCSNS, Unit 1 site. The staff independently verified topographic information in VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b) Section 2.4.1. The staff further examined the capacity of the Mayo Creek to carry a substantial portion of the volume of the Monticello Reservoir in the event of levee failure and found that such an event would not inundate the VCSNS site. The staff determined that the release of water from the Monticello Reservoir due to seiches would be minimal in comparison and, therefore, finds that VCSNS site flooding from these phenomena is implausible.

The normal pool elevation in the Parr Shoals Reservoir is about 266.0 ft (81.08 m) (SCE&G, 2010a). The staff determined that any seiches in the Parr Shoals Reservoir would not overtop Parr Shoals Dam. Based on the maximum recorded seiche heights from around the world, the staff confirmed the licensee's conclusion that it was implausible for seiches on the Parr Shoals Reservoir to flood the VCSNS site.

The staff confirmed the licensee's conclusion that the reevaluated hazard for flooding from seiche is bounded by the current design-basis flood hazard.

3.7 Tsunami

The VCSNS, Unit 1 FHRR (SCE&G, 2013a) stated that the reevaluated hazard, including associated effects, for site flooding due to tsunami does not inundate the plant site. This flood-causing mechanism is described and screened out in the licensee's current design-basis. By reference to the VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b), the licensee in its FHRR assessed the potential for oceanic tsunamis to flood the VCSNS, Unit 1 site and concluded that none existed due to the distance from and elevation of the site relative to the Atlantic Ocean.

By reference to the VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b) Section 2.4.3 the licensee stated in its FHRR that the site elevation and surrounding flat to rolling terrain result in seismically induced floods due to landslides posing no threat in the site area. The licensee further stated that the possibility of slope failure resulting in a landslide which could produce a flood wave was remote due to the low topography in the area surrounding the Monticello Reservoir.

The licensee performed additional investigation into the potential for landslide generated waves for the Monticello Reservoir (SCE&G, 2013a, Section 4.2.2.7). The licensee stated that the plant site is just inside the southeast limit of "moderate susceptibility/low incidence" on the USGS Landslide Overview Map of the Conterminous United States (Radbruch-Hall et al., 1982). Susceptibility to landsliding was defined by the USGS as the probable degree of response of rocks and soils to natural or artificial cutting or loading of slopes, or to anomalously high

precipitation. High, moderate, and low susceptibility are delimited by the same percentages used in classifying the incidence of landsliding. The licensee stated that geographic areas southeast of the boundary are rated low landslide incidence (less than 1.5 percent of the area involved in landslides).

The licensee reviewed the watershed for ground elevation and surface slope (SCE&G, 2013a, Section 4.2.2.7). Of the entire watershed area, approximately 40 percent is the reservoir water surface. From maximum operating water surface elevation of 425.0 ft (129.5 m), the upland areas extend as high as elevation 515 ft (157 m) but predominantly range between 440 ft and 480 ft (134 m and 146 m). The upland area slopes vary from a high of 10 percent on the western side to less than 10 percent, averaging closer to 5 percent, on the eastern side of the reservoir. In conclusion, the licensee states in its FHRR that a landslide which could produce a flood wave is implausible.

The staff determined that given the site's distance from the Atlantic Ocean and the nominal site grade elevation, it is implausible for an oceanic tsunami to cause flooding at the VCSNS site. The staff also considered a landslide of the embankment around the Monticello Reservoir. The staff determined that this is not a plausible cause of flooding of the VCSNS site, because the postulated slide would cause the Monticello Reservoir to drain away from the VCSNS site into the Parr Shoals Reservoir.

The staff confirmed the licensee's conclusion that the reevaluated hazard for flooding from tsunami is bounded by the current design-basis flood hazard at the VCSNS, Unit 1 site.

3.8 Ice-Induced Flooding

The VCSNS, Unit 1 FHRR (SCE&G, 2013a) stated that the reevaluated hazard, including associated effects, for ice-induced flooding does not inundate the plant site. This flood-causing mechanism is not described in the licensee's current design-basis.

The VCSNS, Unit 1 FHRR (SCE&G, 2013a) states that "due to a combination of the temperate local climate and the fact that plant cooling increases the surface temperature of the Monticello Reservoir and the SWP, additional analysis of ice effects was not performed." (SCE&G, 2010b). The reevaluated flood hazard from ice induced flooding is consistent with the current design-basis.

The staff searched the U.S. Army Corps of Engineers (USACE) Cold Regions Research and Engineering Laboratory Ice Jam Database (USACE, 2013) for current and historical ice jams in the vicinity of the VCSNS (near Columbia, SC) and found no current or historical ice jams within 100 mi (161 km) or within the state of South Carolina. Additionally the staff independently reviewed temperature data from the Columbia area. The staff reviewed daily data records from the National Climate Data Center gage ID GSOD 72310013883 covering the time period from 1973 to 2013 and notes that the longest period of sustained sub-freezing temperatures was 2 days.

The staff confirmed the licensee's conclusion that the reevaluated hazard for ice-induced flooding of the site is bounded by the current design-basis flood hazard.

3.9 Channel Migrations or Diversions

The VCNS, Unit 1 FHRR (SCE&G, 2013a) stated that the reevaluated hazard, including associated effects, for site flooding from channel migrations or diversions does not inundate the

plant site. This flood-causing mechanism is not described in the licensee's current design-basis.

The staff describes its evaluation of site flooding from channel migrations or diversions, including associated effects, considering the relevant regulatory criteria based on present-day methodologies and regulatory guidance below.

The VCSNS, Unit 1 FHRR (SCE&G, 2013a) references to Section 2.4.9 of the VCSNS, Units 2 and 3 COLA FSAR (SCE&G, 2010b), which states that channel diversion effects at the VCSNS site could not flood the site because the water elevations of the Monticello Reservoir and SWP are controlled (as a pumped-storage and re-regulation facility). The staff reviewed basin topography and topology for evidence of shoreline movement. No indication of shoreline movement was identified. The staff found no nearby streams or tributaries that could threaten the site. The staff also independently reviewed the USGS Landslide Overview Map of the Conterminous United States (Radbruch-Hall et al., 1982) and confirmed from this publication that landslide incidence is less than 1.5 percent, and that landslide susceptibility is the same as or lower than this incidence. The staff determined that the possibility of channel migration or diversions as induced by either topographic characteristics or geographic features by-way-of landslide is remote.

The staff confirmed the licensee's conclusion that the reevaluated hazard for flooding from channel migrations or diversions is bounded by the current design-basis flood hazard.

4.0 INTEGRATED ASSESSMENT AND ASSOCIATED HAZARD DATA

The staff confirmed that, for certain of the flooding mechanisms, the reevaluated hazard is not bounded by the current design-basis flood hazard. Therefore, the staff concludes that an Integrated Assessment is necessary, and that it should consider the following flood-causing mechanisms: LIP, and flooding in streams and rivers with wind setup and wave runup from Monticello Reservoir as a combined effect.

Section 5 of JLD-ISG-2012-05 (NRC, 2012d) describes the flood hazard parameters needed to complete the integrated assessment. The staff reviewed the following subset of these flood hazard parameters to conclude that the flood hazard information is appropriate input to the integrated assessment:

- Flood height and associated effects (see Table 4.0-2), as defined in JLD-ISG-2012-05 (NRC, 2012d)
- Flood event duration (see Table 4.0-1), including warning time and intermediate water surface elevations that trigger actions by plant personnel, as defined in JLD-ISG-2012-05 (NRC, 2012d)

4.1 Flood Height and Associated Effects

The licensee estimated maximum water-surface elevations using its FLO-2D analysis (SCE&G, 2013a, 2014b). The staff found that, in the licensee's FLO-2D application, precipitation was modeled as being retained on building roofs rather than discharged to the ground surface near the structure or an adjacent area, which could result in underestimation of the maximum water-surface elevation. Because the LIP flooding mechanism is being evaluated as part of an integrated assessment, the staff determined that this numerical modeling issue and appropriate

roof drainage conservatism should be resolved as part of the integrated assessment. This is Integrated Assessment Open Item No. 1.

Also, the staff could not confirm the licensee's conclusion about the reevaluated hazard for flooding from the SWP, because the SWP PMF elevation is based on the outcome of the LIP flood elevation that should be addressed in response to Integrated Assessment Open Item No. 1. The staff requested additional information from the licensee (NRC, 2014b) about flood height and associated effects for flooding mechanisms that trigger an Integrated Assessment. The licensee responded by letter dated March 26, 2014 (SCE&G, 2014b, RAI 7 response).

The streams and rivers flood-causing mechanism was combined with the storm surge flood-causing mechanism (wind setup and wave runup). This combined effect flood reevaluation is not bounded by the current design-basis, and results in an increase in the elevation of water impinging upon a flood protection structure (i.e., North Berm of the plant site at Monticello Reservoir). The staff has observed that the increase in the combined effect flood has resulted in a reduction of margin that is quantitatively minor (0.4 ft (0.1 m)) and characterized by brief and intermittent impingement of waves on a passive low-head flood protection feature (a 3 ft (1 m) berm). For this reason, the staff expects that the resulting scope of the integrated assessment addressing this mechanism will be limited. Considerations as part of this limited scope component of the integrated assessment addressing this mechanism may include confirmation of the capability of the flood protection structure to withstand the increase in wave height through crediting of existing engineering evaluations, and a confirmation that periodic berm topographic surveys (SCE&G, 2013b) and rip-rap inspection/correction will be performed.

4.2 Flood Event Duration

Section 3.2.5 of this Staff Assessment discusses flood event duration. As noted in that section, the integrated assessment should include sensitivity studies for a range of rainfall durations associated with LIP events. This is integrated Assessment Open Item No. 2.

4.3 Conclusion

Based upon the preceding analysis, with the exception of identified action items and subject to the additional review of flood event duration parameters under the integrated assessment, staff confirmed that the reevaluated flood hazard information defined in the sections above is appropriate input to the integrated assessment. As described in the 50.54(f) letter (NRC, 2012a), the licensee should submit the integrated assessment no later than two years from the date of the VCSNS, Unit 1 FHRR (SCE&G, 2013a). Subsequent to the issuance of the 50.54(f) letter the NRC issued a letter (NRC, 2014c) revising the requirement to submit an integrated assessment for FHRR's submitted before June 2013, which includes VCSNS, Unit 1. The revised requirement extended the request for an integrated assessment by 6 months. Thus, the licensee's Integrated Assessment submittal is due to the NRC by September 12, 2015.

5.0 CONCLUSION

The staff has reviewed the information provided for the reevaluated flood-causing mechanisms of VCSNS, Unit 1. Based on its review, the staff concludes that the licensee conducted the hazard reevaluation using present-day methodologies and regulatory guidance used by the NRC staff in connection with ESP and COL reviews.

Based upon the preceding analysis, the NRC staff confirmed that the licensee responded appropriately to Enclosure 2, Required Response 2, of the 50.54(f) letter (NRC, 2012a), dated March 12, 2012. In reaching this determination, staff confirmed the licensee's conclusions or determined that (a) the reevaluated flood hazard results for LIP, and flooding from streams and rivers with wind setup and wave runup at Monticello Reservoir as a combined effect are not bounded by the current design-basis flood hazard, (b) an integrated assessment including LIP at the plant site with associated effects at the SWP, and flooding from streams and rivers with wind setup and wave runup from Monticello Reservoir as a combined effect is expected to be submitted by the licensee, and (c) the reevaluated flood-causing mechanism information is appropriate input to the Integrated Assessment, as described in JLD-ISG-2012-05 (NRC, 2012d), with the exception of items noted in Section 4.0.

The staff identified Integrated Assessment Open Items related to the FLO-2D roof drain analysis and associated SWP impact, and the assumptions to establishing conservative LIP flood durations and related flood warning times. The Integrated Assessment Open Items are summarized in Table 5.0-1. Therefore, the NRC is not providing finality on the flood parameters related to the LIP and associated site drainage and SWP impact as part of this staff assessment.

6.0 REFERENCES

Note: ADAMS Accession Nos. refers to documents available through NRC's Agencywide Documents Access and Management System (ADAMS). Publicly-available ADAMS documents may be accessed through http://www.nrc.gov/reading-rm/adams.html.

U.S. Nuclear Regulatory Commission (NRC) Documents and Publications:

NRC (U.S. Nuclear Regulatory Commission), 1976, "Flood Protection for Nuclear Power Plants," Regulatory Guide 1.102, Revision 1, September 1976. Available online at http://www.nrc.gov/reading-rm/doc-collections/reg-guides/power-reactors/rg/.

NRC (U.S. Nuclear Regulatory Commission), 2007, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition", NUREG-0800, 2007. ADAMS stores the Standard Review Plan as multiple ADAMS documents, which are most easily accessed through NRC's public web site at http://www.nrc.gov/reading-rm/basic-ref/srp-review-standards.html.

NRC (U.S. Nuclear Regulatory Commission), 2011a, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," Commission Paper SECY-11-0093, July 12, 2011, ADAMS Accession No. ML11186A950.

NRC (U.S. Nuclear Regulatory Commission), 2011b, "Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident," Enclosure to SECY-11-0093, July 12, 2011, ADAMS Accession No. ML11186A950.

NRC (U.S. Nuclear Regulatory Commission), 2011c, "Recommended Actions to be Taken without Delay from the Near-Term Task Force Report," Commission Paper SECY-11-0124, September 9, 2011, ADAMS Accession No. ML11245A158.

NRC (U.S. Nuclear Regulatory Commission), 2011d, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," Commission Paper SECY-11-0137, October 3, 2011, ADAMS Accession No. ML11272A111.

NRC (U.S. Nuclear Regulatory Commission), 2011e, "Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United State of America," NUREG/CR-7046, November 2011, ADAMS Accession No. ML11321A195.

NRC (U.S. Nuclear Regulatory Commission), 2012a, letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation and Michael R. Johnson, Director, Office of New Reactors, to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, March 12, 2012, ADAMS Accession No. ML12053A340.

NRC (U.S. Nuclear Regulatory Commission), 2012b, letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation, to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, May 11, 2012, ADAMS Accession No. ML12097A510.

NRC (U.S. Nuclear Regulatory Commission), 2012c, "Guidance for Performing a Tsunami, Surge, or Seiche Hazard Assessment," Japan Lessons-Learned Project Directorate, Interim Staff Guidance JLD-ISG-2012-06, DRAFT Interim Staff Guidance, Revision 0, October 18, 2012, ADAMS Accession No. ML12271A036.

NRC (U.S. Nuclear Regulatory Commission), 2012d, "Guidance for Performing the Integrated Assessment for External Flooding," Japan Lessons-Learned Project Directorate, Interim Staff Guidance JLD-ISG-2012-05, Revision 0, November 30, 2012, ADAMS Accession No. ML12311A214.

NRC (U.S. Nuclear Regulatory Commission), 2013, "Guidance for Assessment of Flooding Hazards Due to Dam Failure," Japan Lessons-Learned Project Directorate, Interim Staff Guidance JLD-ISG-2013-01, Draft for Public Comment, April 2013, ADAMS Accession No. ML13057A863.

NRC (U.S. Nuclear Regulatory Commission), 2014a, "Staff Assessment of Flooding Walkdown Report, Virgil C. Summer Nuclear Station, Unit 1 Staff Assessment of the Flooding Walkdown Report Supporting Implementation of Near-Term Task Force Recommendation 2.3 Related to the Fukushima Dai-ichi Nuclear Power Plant Accident (TAC No. MF0285)., ADAMS Accession No. ML14141A461.

NRC (U.S. Nuclear Regulatory Commission), 2014b, "Virgil C. Summer Nuclear Station, Unit 1 (VCSNS) Request for Additional Information [Regarding Recommendation 2.1 Flood Hazard Reevaluation Report] ... ," (TAC No. MF1112), ADAMS Accession No. ML14023A740.]

NRC (U.S. Nuclear Regulatory Commission), 2014c, letter from William M. Dean, Director, Office of Nuclear Reactor Regulation, to All Power Reactor Licensees on the Enclosed List, November 21, 2014, ADAMS Accession No. ML14303A465.

Codes and Standards

ANSI/ANS (American National Standards Institute/American Nuclear Society), 1992, ANSI/ANS-2.8-1992, "Determining Design Basis Flooding at Power Reactor Sites," American Nuclear Society, LaGrange Park, IL, July 1992.

Other References:

Duke Energy, 2013, William States Lee III Nuclear Station Combined License Application Part 2, Final Safety Analysis Report, Revision 7, May 2013, ADAMS Accession No. ML13144A716.

FLO-2D Software Inc., 2009, FLO-2D® v.2009 Reference Manual, FLO-2D Software, Inc., Nutrioso, Arizona.

NOAA (National Oceanic and Atmospheric Administration), 1978, "Probable Maximum Precipitation Estimates, United States, East of the 105th Meridian," NOAA Hydrometeorological Report No. 51, June 1978. Available online at http://www.nws.noaa.gov/oh/hdsc/studies/pmp.html.

NOAA (National Oceanic and Atmospheric Administration), 1982, "Application of Probable Maximum Precipitation Estimates, United States, East of the 105th Meridian," NOAA Hydrometeorological Report No. 52, August 1982. Available online at http://www.nws.noaa.gov/oh/hdsc/studies/pmp.html.

SCE&G (South Carolina Electric and Gas Company), 2010a. *V. C. Summer Nuclear Station, Unit 1, Updated Final Safety Analysis Report, Chapter 2.* Jenkinsville, South Carolina.

SCE&G (South Carolina Electric and Gas Company), 2010b. *V. C. Summer Nuclear Station, Units 2 and 3, COL Application. Part 2, Final Safety Analysis Report*. Revision 3, Jenkinsville, South Carolina. ADAMS Accession No. ML102440523.

SCE&G (South Carolina Electric and Gas Company), 2012. "Verification Walkdown Report for VCSNS Plant Flood Protection Features," Engineering Services Technical Report TR02060-001, Revision 0, November 21, 2012, ADAMS Accession No. ML12348A398.

SCE&G (South Carolina Electric & Gas Company), 2013a, "SCE&G's Flood Hazard Analysis Reevaluation Report," March 7, 2013 [Attachment 1 to letter from T.D. Gatlin to NRC dated March 12, 2013, Subject: Virgil C. Summer Nuclear Station (VCSNS) Unit 1, Docket No. 50-395, Flooding Hazard Reevaluation Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Flooding Aspects of Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, March 12, 2013, ADAMS Accession No. ML13073A114.]

SCE&G (South Carolina Electric & Gas Company), 2013b, Letter from T.D. Gatlin, (SCE&G) to NRC dated August 22, 2013, Subject: Virgil C. Summer Nuclear Station (VCSNS) Unit 1, Docket No. 50-395, ... Supplemental Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Flooding Aspects of Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident

SCE&G (South Carolina Electric and Gas Company), 2014a, "SCE&G Response to Request for Additional Information," January 31, 2014 [Enclosure 1 to letter from Thomas D. Gatlin dated January 31, 2014. Subject: Virgil C. Summer Nuclear Station (VCSNS) Unit 1, Docket No. 50-395 ... Response To NRC Request for Additional Information Associated with Near-Term Task Force Recommendation 2.3, Flooding Walkdowns, January 31, 2014, ADAMS Accession No. ML14035A227.]

SCE&G (South Carolina Electric & Gas Company), 2014b, "SCE&G Response to Request for Additional Information," March 26, 2014 [Enclosure 1 to letter from Thomas D. Gatlin to NRC dated March 26, 2014, Subject: Virgil C. Summer Nuclear Station (VCSNS) Unit 1, Docket No. 50-395, ... Response to NRC Request for Additional Information Associated with Near-Term Task Force Recommendation 2.1, Flooding Reevaluation, ADAMS Accession No. ML14093A320].

SCE&G (South Carolina Electric & Gas Company), 2014c, "SCE&G Clarification to Recommendation 2.1, Flooding Reevaluation Submittal," November 24, 2014, Subject: Virgil C. Summer Nuclear Station (VCSNS) Unit 1, Docket No. 50-395, ... Clarification to Recommendation 2.1, Flooding Reevaluation Submittal, ADAMS Accession No. ML14329B257.

SCSCO (South Carolina State Climatology Office), 2013, "South Carolina Maximum 24-Hour Precipitation 1890-2013," http://www.dnr.sc.gov/climate/sco/ClimateData/cli_table_24hr_max_pcpn.php, accessed November 21, 2013.

U.S. Department of Agriculture (USDA), 2013, "National Agriculture Imagery Program," http://gis.apfo.usda.gov/gisviewer/.

USACE (U.S. Army Corps of Engineers). 1966. "Computation of Freeboard Allowances for Waves in Reservoirs," Engineer Technical Letter No. 1110-2-8. Washington, D.C.

USACE (U.S. Army Corps of Engineers), 2013, "Ice Jam Information Clearinghouse," Engineering and Research Development Center, U.S. Army Corp of Engineers, (http://icejams.crrel.usace.army.mil/).

Radbruch-Hall, Dorothy H., Colton, Roger B., Davies, William E., Lucchitta, Ivo, Skipp, Betty A., and Varnes, David J., 1982, *Landslide Overview Map of the Conterminous United States*, U.S. Geological Survey Professional Paper 1183, available at http://pubs.usgs.gov/pp/p1183/pp1183.html.

Table 2.2-1: Flood-Causing Mechanisms and Corresponding Guidance

Flood-Causing Mechanism	SRP Section(s) and JLD-ISG
Local Intense Precipitation and Associated Drainage	SRP 2.4.2 SRP 2.4.3
Streams and Rivers	SRP 2.4.2 SRP 2.4.3
Failure of Dams and Onsite Water Control/Storage Structures	SRP 2.4.4 JLD-ISG-2013-01
Storm Surge	SRP 2.4.5 JLD-ISG-2012-06
Seiche	SRP 2.4.5 JLD-ISG-2012-06
Tsunami	SRP 2.4.6 JLD-ISG-2012-06
Ice-Induced	SRP 2.4.7
Channel Migrations or Diversions	SRP 2.4.9

Notes:

SRP is the Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition (NRC, 2007)

JLD-ISG-2012-06 is the "Guidance for Performing a Tsunami, Surge, or Seiche Hazard Assessment" (NRC, 2012c)

JLD-ISFG-2013-01 is the "Guidance for Assessment of Flooding Hazards Due to Dam Failure" (NRC, 2013)

Table 3.0-1: Summary of Controlling Flood-Causing Mechanisms

Reevaluated Flood-Causing Mechanisms and Associated Effects that May Exceed the Powerblock Elevation*	Elevation (NGVD29)
Local Intense Precipitation and Associated Drainage	436.6 ft to 437.5 ft (133.1 m to 133.4 m) (Maximum surface water elevation during 1-h PMP at main plant buildings and doors – see FHRR 4.2.1.2)
Streams and Rivers	437.0 ft (133.2 m) (Maximum 72-h PMF elevation for Monticello Reservoir combined effect including storm surge at North Berm of plant – see FHRR 4.2.2.1)
Storm Surge	See Streams and Rivers for combined effect

*Flood Height and Associated Effects as defined in JLD-ISG-2012-05 (NRC, 2012d). No associated effects are anticipated from debris, sediment deposition or erosion, concurrent site conditions (including adverse weather other than the associated PMP), or groundwater ingress (SCE&G, 2013a; SCE&G, 2014b).

Table 3.1-1: Current Design Basis (CDB) Flood Hazard

Flooding Mechanism	CDB Stillwater Level, NGVD29	CDB Associated Effects*	CDB Flood Level, NGVD29	Reference
Local Intense Precipitation and Associated Drainage	436.15 ft (132.94 m) based on maximum hour within 6 hr PMP**	None	436.15 ft (132.94 m) based on maximum hour within 6 hr PMP	FHRR (SCE&G, 2013a) Sections 4.3.1 and 4.1.2.1.1. UFSAR (SCE&G, 2010a) Section 2.4.3.1.3
Streams and Rivers (including wave runup from Storm Surge)	429.1 ft (130.8 m), including 4.1 ft (1.25 m) from 48-h PMP on initial reservoir elevation of 425.0 ft (129.5 m)	7.5 ft (2.3 m) from wave runup	436.6 ft (133.1 m)	FHRR (SCE&G, 2013a) Section 4.1.2.2.1 UFSAR (SCE&G, 2010a) Section 2.4.3.6.2
Failure of Dams and Onsite Water Control/Storage Structures	<290 ft (88.4 m) No threat of flooding at site	No Impact Identified	<290 ft (88.4 m), Parr Shoals Reservoir / Broad River, No threat of flooding at site	FHRR (SCE&G, 2013a) Section 4.2.2.4
Storm Surge	See Streams and Rivers for combined effect	See Streams and Rivers for combined effect	See Streams and Rivers for combined effect	Included in Streams and Rivers as combined effect
Seiche	No Impact Identified	No Impact Identified	No Impact Identified	FHRR (SCE&G, 2013a) Section 4.2.2.6 UFSAR (SCE&G, 2010a) Section 2.4.5.5
Tsunami	No Impact Identified	No Impact Identified	No Impact Identified	FHRR (SCE&G, 2013a) Section 4.2.2.7
Ice-Induced	No Impact Identified	No Impact Identified	No Impact Identified	FHRR (SCE&G, 2013a) Section 4.2.2.8
Channel Migrations or Diversions	No Impact Identified	No Impact Identified	No Impact Identified	FHRR (SCE&G, 2013a) Section 4.2.2.9

* No associated effects are identified from debris, sediment deposition or erosion, concurrent site conditions (including adverse weather other than the associated PMP), or groundwater ingress.

** 436.15 ft (132.94 m) stillwater level represents nominal plant grade of 435.0 ft (132.6 m) with floodwater depth of 1.15 ft (0.350 m).

Table 3.2-1. Distribution Sequence for 6-hr Point PMP

Hour	Amount of Precipitation
1	2.98 in (7.57 cm)
2	3.58 in (9.09 cm)
3	4.47 in (11.4 cm)
4	11.34 in (28.80 cm)
5	4.18 in (10.62 cm)
6	3.28 in (8.33 cm)
Total	29.83 in (75.77 cm)

Source: SCE&G (2010a, Table 2.4-5)

Table 4.0-1: Flood Event Duration for Reevaluated Flood-Causing Mechanisms*

Flood-Causing Mechanism	Site Preparation for Flood Event	Period of Site Inundation	Recession of Water from Site	Total Event Duration
Local Intense Precipitation and Associated Drainage	>24 h (Assuming all claimed warning time is used for site preparation}	7 h (At Power Block West)	17 h	>48 h (Resulting from 1-h PMP)
Streams and Rivers (Monticello Reservoir flooding)	> 24 h warning time (Implied by local intense precipitation analysis; Monticello Reservoir is immediately adjacent to site, and warning time would be same as for local intense precipitation)	0 h (No site inundation; licensee analysis indicates that wind setup and wave runup impinge on North Berm flood protection feature for 72 seconds)	0 h (No site inundation)	N/A (No site inundation from 72-h PMP including wind setup and wave runup)
Storm Surge	See Streams and Rivers for combined effect	See Streams and Rivers for combined effect	See streams and Rivers for combined effect	See streams and Rivers for combined effect

* Elements of flood event duration are shown in Figure 2.2-1. Values may change pending outcome of Integrated Assessment Action Item No. 2.

Table 4.0-2: Reevaluated Flood-Causing Mechanisms and Associated Effects Hazards

Reevaluated Flood-Causing Mechanism*	Stillwater Elevation	Associated Effects**	Reevaluated Flood Hazard Elevation (NGVD29)	Reference
Local Intense Precipitation and Associated Drainage	436.6 ft to 437.5 ft (133.1 m to 133.4 m)	None	436.6 ft to 437.5 ft (133.1 m to 133.4 m) (East side to west side of power block, from 1-hr PMP of 19 in [48 cm]) (Water depths of 1.6 ft to 2.5 ft [0.49 m to 0.76 m])	Maximum surface water elevation during PMP at main plant buildings and doors – see FHRR (SCE&G, 2013a, Section 4.2.1.2)
Streams and Rivers (Resulting from 72-hr PMP) including wind setup and wave runup from Monticello Reservoir	431.07 ft (131.39 m) (Includes effects of 6.07 ft [1.85 m] as direct PMP and basin runoff)	5.93 ft (1.81 m) wind setup and wave runup	437.0 ft (133.2 m) at North Berm (Remains below North Berm crest elevation of 438.0 ft [133.5 m] NGVD29)	Maximum PMF elevation for Monticello Reservoir at North Berm of plant – see FHRR (SCE&G, 2013a, Section 4.2.2.1) and RAI 3 response (SCE&G, 2014b)
Storm Surge	See Streams and Rivers for combined effect	See Streams and Rivers for combined effect	See Streams and Rivers for combined effect	See Streams and Rivers for combined effect

* Values may change pending outcome of Integrated Assessment Action Items.

** No associated effects are anticipated from debris, sediment deposition or erosion, concurrent site conditions (including adverse weather other than the associated PMP), or groundwater ingress (SCE&G, 2013a; SCE&G, 2014b)

Table 5.0-1: Integrated Assessment Open Items

Integrated Assessment Open Items: The Integrated Assessment Open Items set forth in the Staff Assessment and summarized in the table below identify certain matters that will be addressed in the integrated assessment submitted by the licensee. These items constitute information requirements, but do not form the only acceptable set of information. A licensee may depart from or omit these items, provided that the departure or omission is identified and justified in the integrated assessment. In addition, these items do not relieve a licensee from any requested information described in Part 2, Integrated Assessment, of the March 12, 2012, 10 CFR 50.54(f) letter, Enclosure 2.

Open Item No.	SA Section Nos.	Subject to be Addressed
1	3.2.3 4.1	The licensee is requested to resolve the staff-identified numerical modeling issue associated with the LIP (and related SWP flooding; see Section 4.1). This issue relates to runoff from rooftops being removed from the numerical model domain rather than discharging to the ground surface near the structure or an adjacent area.
2	3.2.5 4.2	The licensee is requested to evaluate a range of rainfall durations associated with the LIP flood hazard (e.g., 1-, 6-, 12-, 24-, 48-, 72-hour PMPs). This evaluation should identify potentially limiting scenarios with respect to warning time, flood height, relevant associated effects, and flood-event duration parameters.

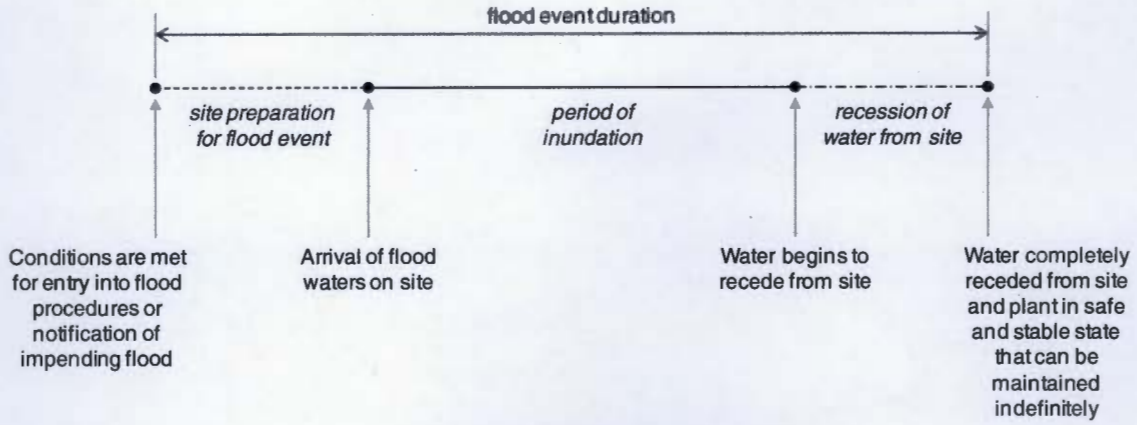
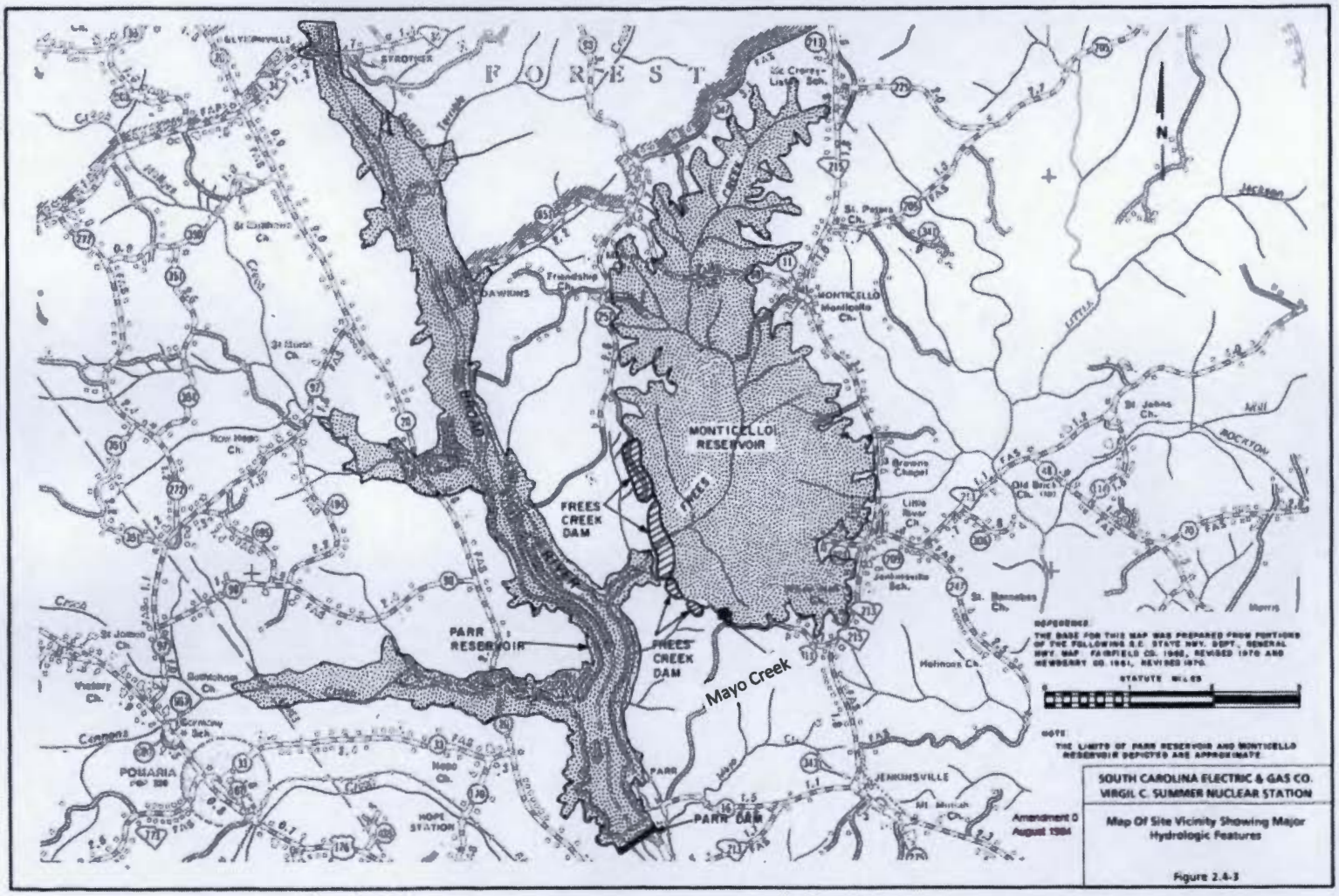
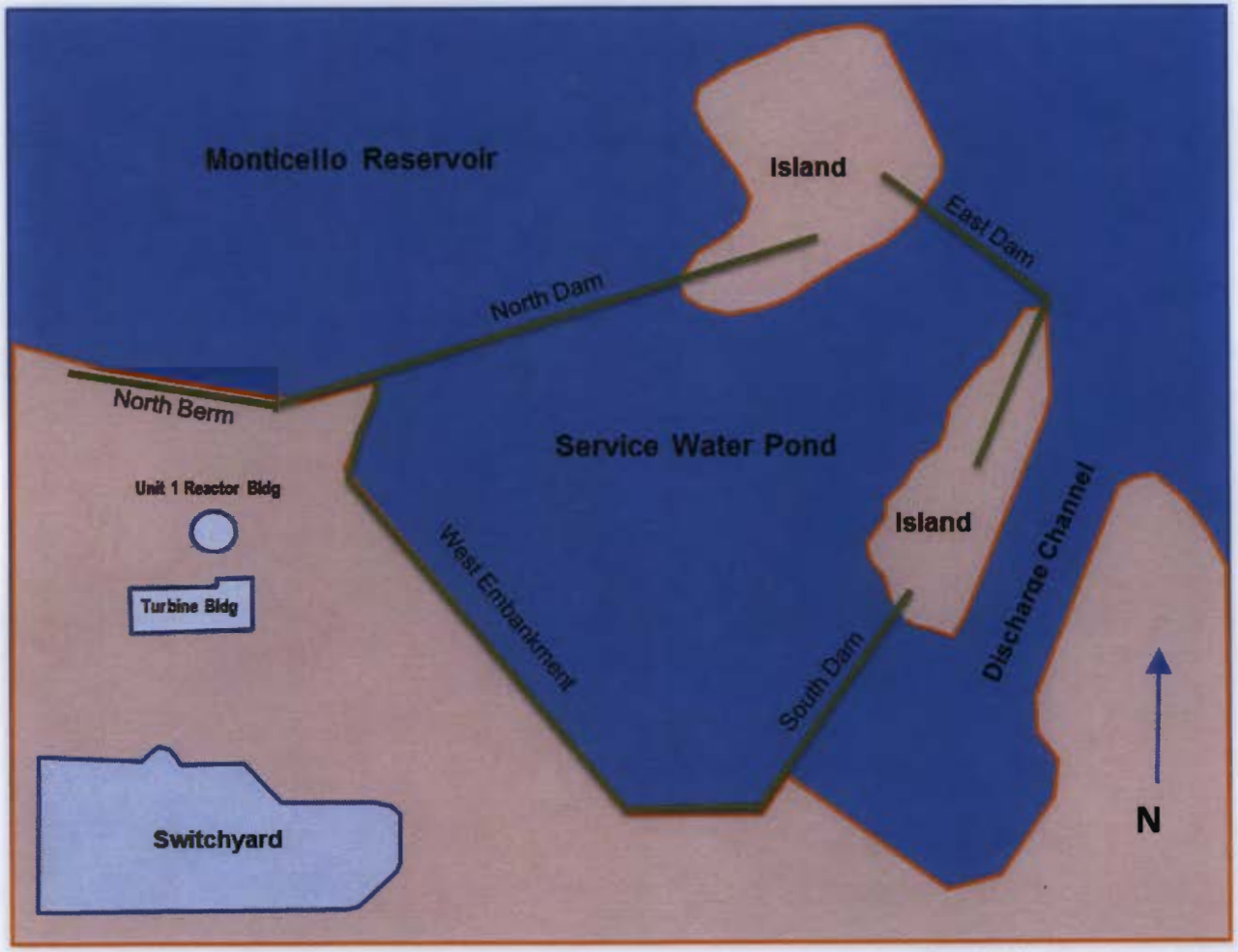


Figure 2.2-1: Flood Event Duration



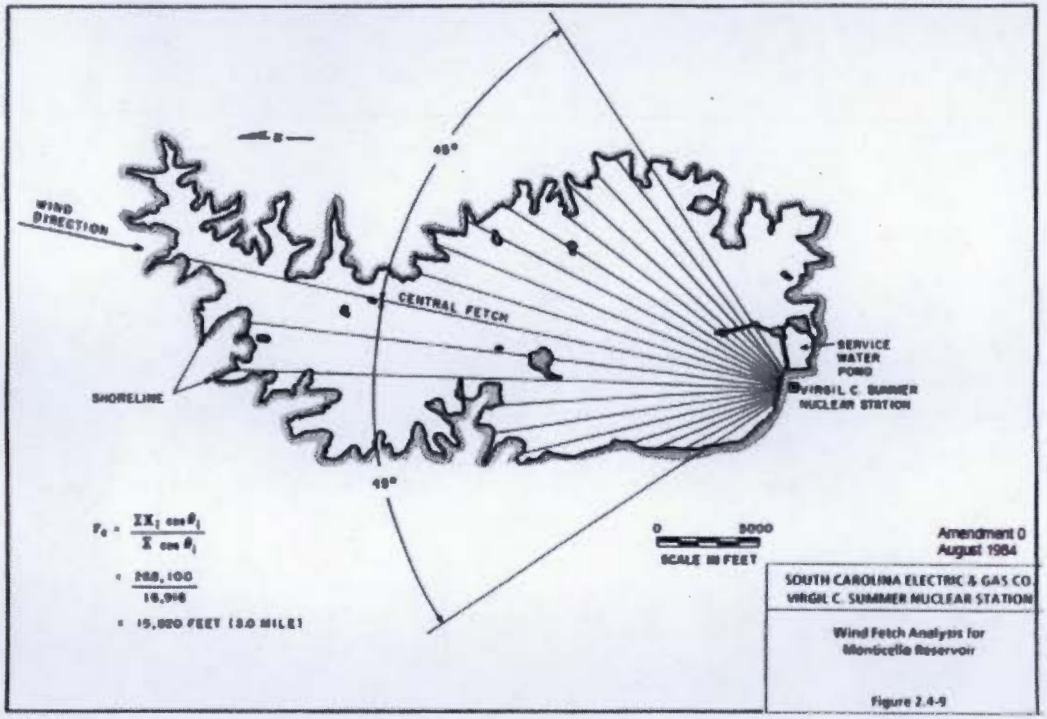
Source: SCE&G (2010a, Figure 2.4-3)

Figure 3.3-1. VCSNS Unit 1 Site Location Relative to Monticello Reservoir, Frees Creek, and Broad River



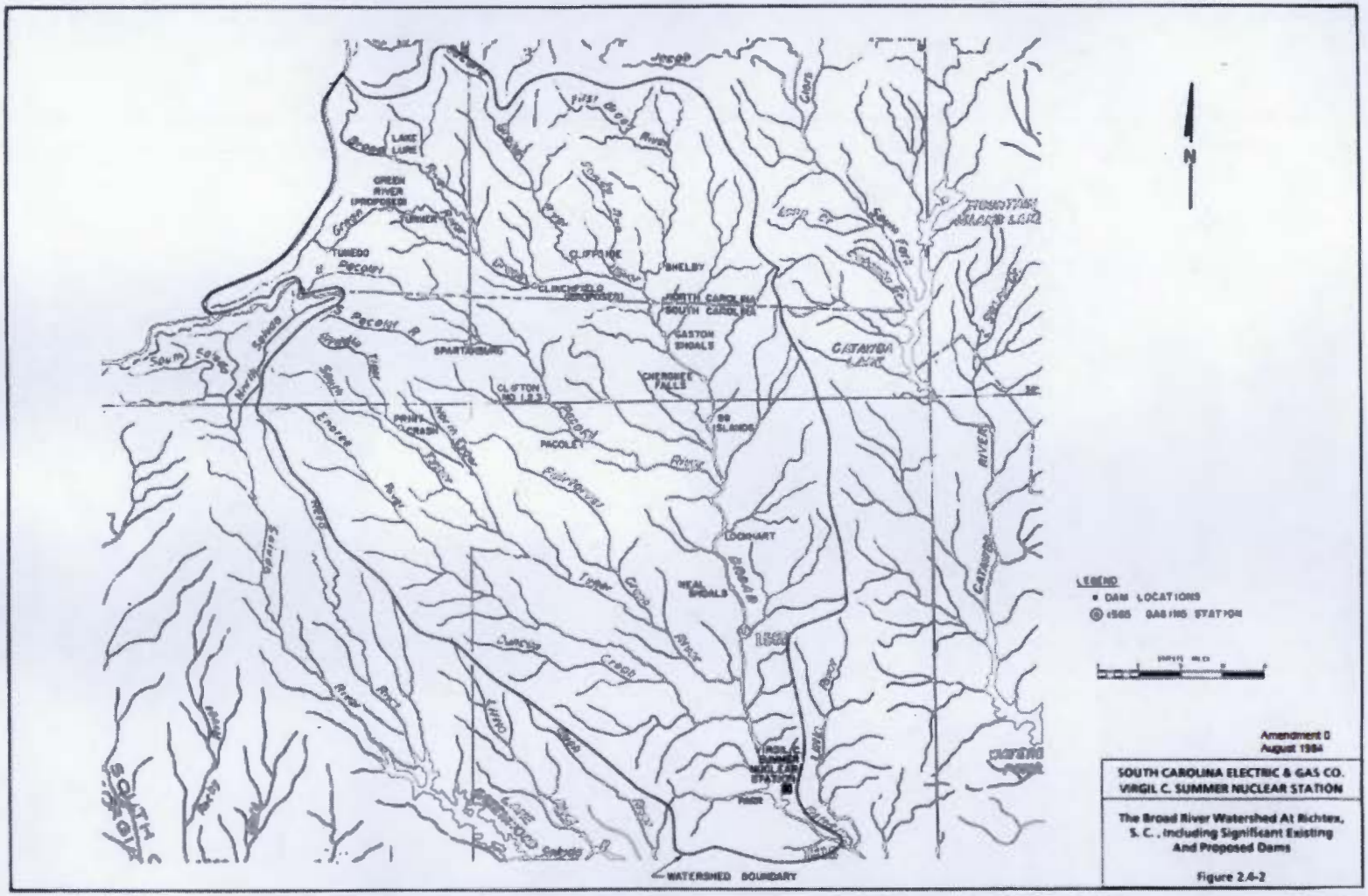
After SCE&G (2010, Figure 2.4-1)

Figure 3.3-2. Service Water Pond and Monticello Reservoir



Source: SCE&G (2010a, Figure 2.4-9)

Figure 3.3-3. Monticello Reservoir Wind Fetches Directed at VCSNS



Source: SCE&G (2010a, Figure 2.4-2)

Figure 3.4-1. Existing and Proposed Significant Dams within the Broad River Watershed

In addition, the staff has identified two issues that resulted in open items. These open items are documented and explained in the attached Staff Assessment, and will be addressed as part of the integrated assessment.

If you have any questions, please contact me at (301) 415-3733 or email at Robert.Kuntz@nrc.gov.

Sincerely,

/RA/

Robert F. Kuntz, Senior Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No. 50-395

Enclosure:
Staff Assessment of Flood Hazard
Reevaluation Report

cc w/encl: Distribution via Listserv

DISTRIBUTION:

PUBLIC	RidsNroDsea Resource	RidsNrrDorlLpl2-1 Resource
JHMB R/F	RidsNrrSummer Resource	RidsNrrLASLent Resource
VHall	BHarvey	RidsOgcMailCenter Resource
KErwin	CCook	SWhaley
RKuntz	ARivera-Varona	SFlanders
LQuinn-Willingham	ACampbell	

ADAMS Accession No.: ML14356A002 ***via email**

OFFICE	NRR/JLD/JHMB/PM	NRR/JLD/LA	NRO/DSEA/RHM1*
NAME	RKuntz	SLent	CCook (ARivera-Verona for)
DATE	12/23/14	12/22/14	12/1914
OFFICE	NRR/DORL/LPL2-1/PM*	NRR/JLD/JHMB/BC*	NRR/JLD/JHMB/PM
NAME	SWilliams	SWhaley	RKuntz
DATE	12/19/14	12/23/14	12/23/14

OFFICIAL RECORD COPY