UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket Nos. 52-040 & 52-041
	)	
(Turkey Point Units 6 and 7)	)	

NRC STAFF PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW REGARDING CONTENTION 2.1

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June 15, 2017

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NRC STAFF PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW FOR CONTENTION 2.1 (Impacts of Deep Well Injection of Four Constituents in Cooling Tower Blowdown)

I. INTRODUCTION

1.1 This initial decision rules on all outstanding issues associated with the challenge in Contention 2.1 to the NRC Staff's (Staff) analysis of environmental impacts from deep well injection of four chemical constituents in the wastewater that would be used in the cooling towers of proposed Turkey Point Units 6 & 7. This proceeding concerns the Florida Power & Light's (FPL or Applicant) application for two combined licenses (COL) to build and operate two nuclear power plants at the Turkey Point site near Homestead, Florida. As described in more detail below, Mark Oncavage, Dan Kipnis, Southern Alliance for Clean Energy, and National Parks Conservation Association (collectively, Joint Intervenors) raised Contention 2.1 against the Staff's analysis in its draft environmental impact statement (DEIS) in accordance with the NRC Rules of Practice in 10 C.F.R. Part 2. As reformulated, Contention 2.1 states:

> [T]he DEIS is deficient in concluding that the environmental impacts for FPL's proposed deep injection wells will be "small." The chemicals ethylbenzene, heptachlor, tetrachloroethylene, and toluene in the wastewater injections at concentrations listed in DEIS Table 3-5 may adversely impact the groundwater should they migrate from the Boulder Zone to the Upper Floridan Aquifer.

Florida Power & Light Co. (Turkey Point Units 6 and 7), LBP-16-3, 83 NRC 169, 186 (2016). On May 2-3, 2017, we held an evidentiary hearing on Contention 2.1 at the Council Chambers, Homestead City Hall, 100 Civic Court, Homestead, Florida.

1.2 The Staff's final environmental impact statement (FEIS) documents the bases for the Staff's determination that the environmental impacts from deep well injection of the four chemical constituents listed in Contention 2.1 are small As described below, compared to the DEIS, the FEIS includes significant additional information to address Contention 2.1. The Joint Intervenors did not challenge the new information in the FEIS by seeking to amend Contention 2.1, and neither FPL nor the NRC Staff sought resolution of Contention 2.1 based on the additional information in the FEIS through a motion for summary disposition or a motion to dismiss. At the hearing, we therefore stated Contention 2.1 in terms of the FEIS.[1]

1.3 Based on our review of the entire evidentiary record in this proceeding, as set forth below, we find that, with respect to the specific issues raised by reformulated Contention 2.1, the Staff FEIS adequately discussed the reasonably foreseeable environmental impacts from deep well injection of heptachlor, ethylbenzene, toluene, and tetrachloroethylene (the Constituents) in injected wastewater. Based on our findings of fact and conclusions of law, we conclude that the NRC Staff has carried its burden of demonstrating that the FEIS complies with the National Environmental Policy Act of 1969, as amended (NEPA), and the NRC regulations in 10 C.F.R. Part 51 in regard to the impacts of the Constituents.

II. BACKGROUND

A. Facts Underlying Contention 2.1

2.1 As factual background for our decision, we recite the following facts regarding the operation of the proposed units and relevant to Contention 2.1: FPL intends to use reclaimed

[1] Official Transcript of Proceedings, Florida Power & Light Co. Hearing, Docket Nos. 52-040-COL & 52-041-COL at 596, line 22, through 597, line 6 (May 2-3, 2017) (Tr.).

wastewater in cooling towers to remove waste heat from the circulating water system and reject that heat to the atmosphere. Joint List of Undisputed Facts (FPL-064), ¶ 28. Under normal operating conditions with both units using 100 percent reclaimed water, the delivery rate from the Miami-Dade Water and Sewer Department, South District Wastewater Treatment Plant (South District Plant) to the reclaimed water-treatment facility would be approximately 50,481 gallons per minute. *Id*., ¶ 29, citing FEIS (NRC-008A) at 3-30. The reclaimed wastewater will be obtained from the South District Plant, which is approximately 9 miles north of the Turkey Point site. *Id*., ¶ 30. The wastewater will travel through 9 miles of pipeline from the South District Plant to the Turkey Point site. *Id*., ¶ 31. From the on-site treatment facility, the wastewater will go to the makeup water reservoir, and then to the Unit 6 and 7 cooling towers. *Id*., ¶ 32. A portion of the reclaimed wastewater will evaporate in the cooling towers in the process of removing heat from the service water system, with the remainder (the "blowdown" and other plant wastewater) ultimately going to the blowdown sump and from the blowdown sump to the injection wells.[2] *Id*., ¶ 33. The blowdown, which will total approximately 18-18.6 Mgd (million gallons per day) when operating on reclaimed water, will then be injected into the Boulder Zone via injection wells. *Id*., ¶ 34, citing FEIS (NRC-008A) at 3-32. The Boulder Zone is currently used for treated municipal wastewater injection at the South District Plant. *Id*., ¶ 35.

[2] Concentrations of minerals in the circulating water system *(i.e*., the system that circulates water through the condenser tubes and through the cooling towers then back to the condenser tubes) increase as a result of the evaporative heat removal process. To maintain the heat removal efficiency, the water with higher concentrations of minerals is diverted out of the circulating water system to the blowdown sump, and makeup water, which includes the reclaimed water, is added to the circulating water system. *See* Pre-filed Direct Testimony of Mr. Paul Jacobs (FPL-001), ¶ 16 at 007. In addition to blowdown water from the cooling towers, wastewater from the sanitary waste-treatment plant, wastewater-retention basin, and liquid radioactive waste-treatment system would be discharged to the Boulder Zone via the injection wells. FEIS (NRC-008A) at 3-32. Specifically, effluent from the sanitary waste-treatment plant would be discharged to the blowdown sump where it would be mixed with cooling-tower blowdown before being discharged to the Boulder Zone through the deep-injection well system. *Id*. at 2-17. Similarly, the turbine building would have a drain system that discharges to a wastewater-retention basin connected to the blowdown sump, and the wastewater in the retention basin would be treated and then discharged to the blowdown sump. *Id*. at 3-20. Finally, treated liquid radioactive waste from operations at proposed Turkey Point Units 6 and 7 would also be discharged to the plant sump prior to ultimate release to the Boulder Zone via the deep injection wells. *Id*. at 5-115.

FPL intends to drill twelve additional deep injection wells at the Turkey Point site. *Id*., ¶ 36. FPL intends to construct six dual-zone monitoring wells. *Id*., ¶ 37. The six dual-zone monitoring wells would be located between each pair of the twelve deep-injection wells. *Id*., ¶ 38. Each dual-zone monitoring well would be positioned about 75 feet from its pair of injection wells. *Id*., ¶ 39.

2.2 The Joint Intervenors, FPL, and the NRC Staff agree that the values listed in Table 3-5 of the FEIS (NRC-008A) for the concentrations of heptachlor, tetrachloroethylene, toluene, and ethylbenzene in the wastewater obtained from the South District Plant for use in the Turkey Point Unit 6 & 7 cooling towers are as follows: Heptachlor, 0.000023 milligrams per liter (mg/L); Tetrachloroethylene, 0.00359 mg/L; Toluene, 0.00174 mg/L; and Ethylbenzene, below the method detection limit. *Id*., ¶ 40. In addition, the parties agreed that "[t]he values listed in Table 3-5 of the FEIS for ethylbenzene, heptachlor, tetrachloroethylene, and toluene are conservative and reliable." *Id*., ¶ 41.

B. General Procedural History

2.3 On June 30, 2009, pursuant to the Atomic Energy Act of 1954, as amended (AEA), and the Commission's regulations, FPL submitted an application for combined licenses (COLs) for two nuclear power reactors to be located adjacent to the existing Turkey Point Units 1 through 5, at the Turkey Point site near Homestead, Florida (Application).[3] The Application included an Environmental Report, which provided the Applicant's assessment of the

[3] *See* Letter from M. K. Nazar, FPL, to M. Johnson, Office of New Reactors, NRC, dated June 30, 2009 (ADAMS Accession No. ML091830589). The Application designated the proposed units as Turkey Point, Units 6 & 7. Application Rev. 0, Part 1 at 1 (ML091870846).

environmental impacts of the proposed action, as required by 10 C.F.R. §§ 52.80(b) and 51.50(c).[4]

2.4 On June 18, 2010, the NRC published a Notice of Hearing and Opportunity to Petition for Leave to Intervene, which provided members of the public sixty days from the date of publication to file a petition for leave to intervene in this proceeding.[5] On August 16, 2010, the Village of Pinecrest petitioned to intervene or, in the alternative, participate in the proceeding as an interested governmental entity.[6] On August 17, 2010, in response to the Notice of Hearing, Joint Intervenors filed a petition to intervene in this proceeding.[7]

2.5 On March 5, 2015, the NRC published a notice of availability of a draft Environmental Impact Statement (DEIS).[8] On April 13, 2015, in response to the March 5, 2015, notice of availability of the DEIS, the City of Miami submitted its petition, which proposed three environmental contentions.[9] On May 8, 2015, the Applicant and the NRC Staff filed their respective answers to the Petition.[10] On June 10, 2015, the Board issued an

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[4] *See* Application, Rev. 6, Part 3 (ER) (ML14311A285). The ADAMS Accession number for the ER depends on the revision number being cited. The most recent substantive revision to the ER is Revision 6 (ML14311A285) (ER Revision 7 merely points to ER Revision 6).

[5] *See* Florida Power & Light Company, Combined License Application for the Turkey Point Units 6 & 7, Notice of Hearing, Opportunity for Leave to Petition to Intervene and Associated Order Imposing Procedures for Access to Sensitive Unclassified Non-Safeguards Information and Safeguards Information for Contention Preparation," 75 Fed. Reg. 34,777 (June 18, 2010) (Notice of Hearing).

[6] *See* Petition by the Village of Pinecrest, Florida, for Leave to Intervene in a Hearing on [FPL's] [COL] Application For Turkey Point Units 6 & 7, or in the Alternative, Participate as a Non-Party Local Government (Aug. 16, 2010) (ADAMS Accession No. ML102280601).

[7] *See* Joint Intervenors' Petition for Intervention (Aug. 17, 2010) (ADAMS Accession No. ML102300582).

[8] DEIS (NRC-007A-B).

[9] *See* Petition by the City of Miami, Florida, for Leave to Intervene in a Hearing on [FPL's] Combined Construction and Operating License Application for Turkey Point Units 6 & 7, or in the Alternative, Participate as a Non-Party Local Government (Apr. 13, 2015).

[10] *See* [FPL's] Answer Opposing [City of Miami Petition] (May 8, 2015). *See also* NRC Staff Answer to [City of Miami Petition] (May 8, 2015).

Order denying the Petition on the grounds that the City of Miami failed to proffer an admissible contention, but granting the City of Miami's request to participate as an interested local governmental body pursuant to 10 C.F.R. § 2.315(c).[11]

2.6 As stated above, the Board reformulated Contention 2.1 in 2016. *Turkey Point*, LBP-16-3, 81 NRC 169 (granting in part and denying in part FPL's Motion for Summary Disposition of Contention 2.1). The NRC Staff issued and published a notice of availability of the FEIS on October 28, 2016.[12] On December 2, 2016, the NRC published a supplement to the FEIS.[13] Compared to the DEIS, the FEIS includes significant additional information relating to Contention 2.1.[14] The Intervenors did not amend their complaint at any time after October 2016 to challenge the extensive additions and clarifications Staff made to address the impact of deep well injection of wastewater in the FEIS.

C. Evidentiary Filings and Hearing

2.7 On March 1, 2017, the initial statements of position were filed by the parties and NRC Staff.[15] On March 8, 2017, the NRC Staff and FPL each filed a motion to strike or

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[11] *Florida Power & Light Co.* (Turkey Point Units 6 and 7), LBP-15-19, 81 NRC 815, 828 (2015).

[12] The NRC Staff published the FEIS in four volumes (NUREG-2176, Volumes 1, 2, 3, and 4 (ADAMS Accession Nos. ML16300A104, ML16300A137, ML16301A018, and ML16300A312)). *See* 81 Fed. Reg. 76,392 (Nov. 2, 2016) (NRC-008A-D).

[13] *See* 81 Fed. Reg. 90,875 (Dec. 15, 2016) (ML16337A147) (NRC-049).

[14] *Compare* FEIS (NRC-008A) § 2.3.1.2 at 2-53 to 2-58 *with* DEIS (NRC-007A) § 2.3.1.2 at 2-53 to 2-57; FEIS (NRC-008A) § 5.2.1.3 at 5-20 to 5-29 *with* DEIS (NRC-007A) § 5.2.1.3 at 5-16 to 5-18; FEIS (NRC-008A) § 5.2.3.2 at 5-39 to 5-42 *with* DEIS (NRC-007A) § 5.2.3.2 at 5-27 to 5-2; *see also* FEIS (NRC-008D), Appendix E, at E-109 to E-115, E-190 to E-192, E-202 to E-203, E-211 to E 213 (responding to public comments on the DEIS relating to Contention 2.1) .

[15] The filings were as follows: Joint Intervenors' Initial Written Statement of Position on NEPA Contention 2.1 (Inadequate Evaluation of Groundwater Impacts) (March 1, 2017 (ADAMS Accession No.ML17060A814) (Joint Intervenors' Statement of Position); The City of Miami's (City) Initial Statement of Positions and Direct Testimony for Contention 2.1 (March 1, 2017) (ADAMS Accession No. ML17060A883) (City Initial Statement of Position); FPL's Initial Statement of Position in the Contested Hearing for Contention 2.1 (March 1, 2017) (ADAMS Accession No. ML17060B053) (FPL Initial Statement of Position); and NRC Staff Initial Statement of Position (March 1, 2017) (ADAMS Accession No. ML17060B051) (Staff Initial Statement of Position).

exclude portions of the direct testimony and affidavit filed by the City of Miami.[16] The motion was granted in large part on March 15, 2017. [17]

2.8 On May 2 – 3, 2017, the Board convened an evidentiary hearing on Contention 2.1.[18] On June 15, 2017, the NRC Staff, the Joint Intervenors, and FPL filed proposed findings with regard to Contention 2.1. At issue in this proceeding is the narrow question of whether the FEIS is deficient in concluding that the environmental impacts from FPL's proposed deep injection wells on the Upper Floridan aquifer and its users will be "small."

III. LEGAL AND REGULATORY REQUIREMENTS

A. General NEPA Requirements

3.1 The contention at issue in this proceeding arises under NEPA and the NRC's regulations in Part 51 that implement that statute. 42 U.S.C. §§ 4321 *et seq*; 10 C.F.R. Part 51. NEPA requires that an agency prepare an Environmental Impact Statement (EIS) before approving any major Federal action that will significantly affect the quality of the human environment. 42 U.S.C. § 4332(2)(C). The NRC requires its Staff to prepare an EIS prior to issuing a COL. 10 C.F.R. § 51.20(a)(2).

3.2 Under NEPA, the NRC is required to take a "hard look" at the environmental impacts of a proposed action, as well as consider reasonable alternatives to that action, before taking that action. *See Louisiana Energy Servs., L.P.* (Claiborne Enrichment Center), CLI-98-3, 47 NRC 77, 87-88 (1998). However, this "hard look" is tempered by a "rule of reason" that requires agencies to address only impacts that are reasonably foreseeable. *See, e.g., Long*

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[16] NRC Staff Motion in Limine to Exclude Portions of the City of Miami Prefiled Testimony or in the Alternative Strike Portions Thereof (Mar. 8, 2017) (ADAMS Accession No. ML17067A559); [FPL's] Motion to Strike Portions of the City of Miami's Initial Statements of Position and Direct Testimony for Contention 2.1 at 1 (Mar. 8, 2017) (ADAMS Accession No. ML17067A570).

[17] *See* Memorandum and Order (Ruling on Motions to Strike or Exclude) (unpublished) at 2 (March 15, 2017) (ADAMS Accession No. ML17074A581).

[18] *See* Turkey Point Hearing Transcript (May 2, 2017) ADAMS Accession No. ML17125A325).

Island Lighting Co. (Shoreham Nuclear Power Station, Unit 1), ALAB-156, 6 AEC 831, 836 (1973). Agencies must make "a good faith effort…to describe the reasonably foreseeable environmental impact" of a proposed action, as well as alternatives and their reasonably foreseeable environmental impact, and the irreversible and irretrievable commitment of resources which the action involves." *Id.* (quoting *Scientists' Inst. for Pub. Info., Inc. v. Atomic Energy Comm'n,* 481 F.2d 1079, 1092 (D.C. Cir. 1973)).

3.3 Along the same line, NEPA requires that an agency consider only "reasonably foreseeable" indirect effects of a proposed licensing action and "does not call for certainty or precision, but an *estimate* of anticipated (not unduly speculative) impacts." *See Louisiana Energy Services, L.P.* (National Enrichment Facility), CLI-06-15, 63 NRC 687, 698 (2006); *Louisiana Energy Servs. L.P*. (National Enrichment Facility), CLI-05-20, 62 NRC 523, 536 (2005) (emphasis in original). Moreover, "NEPA gives agencies broad discretion to keep their inquiries within appropriate and manageable boundaries." *Louisiana Energy Servs., L.P.*, CLI-98-3, 47 NRC at 103. Similarly, environmental impacts should be discussed in proportion to their significance. 10 C.F.R. § 51.45(b)(1). Furthermore, as long as the agency's approach to its environmental analysis is reasonable, NEPA does not require the use of the "best scientific methodology." *See Entergy Nuclear Generation Co. and Entergy Nuclear Operations, Inc*. (Pilgrim Nuclear Power Station), CLI-10-11, 71 NRC 287, 315-16 (2010). As NEPA does not require certainty or precision or the use of the best methodology, the Staff need not prove, and this Board need not find, that the Staff's approach is absolutely precise or performed with the best methodology. *See Louisiana Energy Servs., L.P.*, CLI-05-20, 62 NRC at 536 (stating that NEPA does not require certainty or precision); *Pilgrim*, CLI-10-11, 71 NRC at 315 (stating that NEPA does not require use of the best methodology).

3.4 In addition, NEPA must be construed "in the light of reason if it is not to demand virtually infinite study and resources." *Pilgrim*, CLI-10-11, 71 NRC at 316 (quoting *Natural Res. Def. Council v. Hodel*, 865 F.2d 288, 294 (D.C. Cir. 1988)). An EIS is not intended to be a

research document reflecting the latest technology, data, and methods. *See Pilgrim*, CLI-10-11, 71 NRC at 315 (quoting *Town of Winthrop v. FAA*, 535 F.3d 1, 11-13 (1st Cir. 2008)). Because there "will always be more data that could be gathered," agencies "must have some discretion to draw the line and move forward with decisionmaking." *Id.*

3.5 Using the approach outlined in regulations promulgated by the Council on Environmental Quality, 40 C.F.R. § 1508.27, the NRC promulgated a three-level standard system to guide its categorization of impact significance in environmental reviews (*i.e*., SMALL, MODERATE, and LARGE). As defined in 10 C.F.R. Part 51, App. B, Table B-1 n.3, an impact is SMALL if "environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource."

B. Burden of Proof

3.6 An applicant generally has the burden of proof in a licensing proceeding. 10 C.F.R. § 2.325; *see Metro. Edison Co*. (Three Mile Island Nuclear Station, Unit 1), ALAB-697, 16 NRC 1265, 1271 (1982). However, in cases involving NEPA contentions, the burden shifts to the NRC, because the NRC, not the applicant, has the burden of complying with NEPA. *See, e.g., Duke Power Co.* (Catawba Nuclear Station, Units 1 & 2), CLI-83-19, 17 NRC 1041, 1049 (1983). Nevertheless, because "the Staff, as a practical matter, relies heavily upon the Applicant's ER in preparing the EIS, should the Applicant become a proponent of a particular challenged position set forth in the EIS, the Applicant, as such a proponent, also has the burden on that matter." *Louisiana Energy Servs., L.P.* (Claiborne Enrichment Center), LBP-96-25, 44 NRC 331, 338-39 (1996), rev'd on other grounds by Louisiana Energy Servs., L.P. (Claiborne Enrichment Center) CLI-97-15, 46 NRC 294 (1997), citing *Pub. Serv. Co. of New Hampshire* (Seabrook Station, Units 1 and 2), ALAB-471, 7 NRC 477, 489 n.8 (1978).

3.7 In order to advance a claim under NEPA, the intervenor must allege, with adequate support, that the NRC Staff has failed to take a "hard look" at one or more significant environmental questions, meaning that the Staff has unduly ignored or minimized pertinent

environmental effects of the proposed action. *Duke Energy Corp.* (McGuire Nuclear Station, Units 1 & 2; Catawba Nuclear Station, Units 1 & 2), CLI-03-17, 58 NRC 419, 431 (2003) (discussing what an intervenor must allege, with adequate support, to litigate a NEPA claim). As the Commission has stated, "[o]ur Boards do not sit to 'flyspeck' environmental documents or to add details or nuances. If the ER (or EIS) on its face 'comes to grips with all important considerations' nothing more need be done." *Exelon Generating Co*. (Early Site Permit for Clinton ESP Site), CLI-05-29, 62 NRC 801, 811 (2005) (quoting *Systems Energy Resources, Inc.* (Early Site Permit for Grand Gulf Site), CLI-05-4, 61 NRC 10, 13 (2005)).

C. Legal Standards for Expert Witnesses

3.8 An expert opinion is admissible if it (1) assists the trier of fact, and (2) is rendered by a properly qualified witness. *Louisiana Power & Light Co.,* (Waterford Steam Electric Station, Unit 3) ALAB-732, 17 NRC 1076, 1091 (1983); *see Garside v. Osco Drug, Inc*., 895 F.2d 46, 50 (1st Cir. 1990) ("Expert opinion is admissible and may defeat summary judgment only where it appears that the affiant is competent to give an expert opinion."). Opinions of an expert witness that are based on scientific principles acquired through training or experience, and data derived from analyses or by perception, are admissible as evidence. *Philadelphia Elec. Co.* (Limerick Generating Station, Units 1 & 2), ALAB-819, 22 NRC 681, 720 & n.52 (1985); *see* Fed. R. Evid. 702. In addition, a party bears the burden of demonstrating that its witness is qualified to serve as an expert. *Duke Energy Corp.* (Catawba Nuclear Station, Units 1 and 2), CLI-04-21, 60 NRC 21, 27 (2004). "A witness may qualify as an expert by knowledge, skill, experience, training, or education to testify [i]f scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue." *Id.* at 27-28 (internal quotation marks omitted, alteration in original).

IV. FINDINGS OF FACT

4.1 With the undisputed facts regarding the proposed operation of Turkey Point Units 6 & 7 set forth above in mind, on May 2-3, 2017, we took testimony from five panels of

witnesses at the hearing in Homestead, Florida. In questioning the five panels, we explored the following five topics:

> 1. The ability of the hydrogeological layer unit above the Boulder Zone to prevent wastewater from migrating upward to the Upper Floridan Aquifer (UFA); the likely extent of horizontal and vertical migration of wastewater after it is injected into the Boulder Zone, and the predicted velocity of such migration;
>
> 2. The ability of well-construction procedures and technology to prevent upward migration of wastewater to the UFA due to faulty well construction or well deterioration over time;
>
> 3. Whether upward migration of wastewater would likely be detected before reaching the UFA;
>
> 4. The impact of the four contaminants on human health if wastewater were to reach the UFA at the concentration values reported in FEIS (NRC-008A) Table 3-5; and
>
> 5. The derivation of the concentration levels of the four contaminants in Table 3-5; whether concentrations of any of these contaminants could be less than the values listed in Table 3-5 when discharged into the Boulder Zone; the effect of horizontal and vertical migration on the concentration levels of these four contaminants, and any other factors that could impact the concentration levels of these contaminants after being discharged.

4.2 Because the testimony on topic 4, the concentrations of the four constituents in the cooling-tower blowdown to be injected into the Boulder Zone, and topic 5, how those concentrations might change, is dispositive of Contention 2.1, we present our findings on those topics first. We denote this as "the concentration component" of Contention 2.1. We present our findings on the other three topics in order following our findings on the concentration component of Contention 2.1. We denote these other three topics as the "confinement component" of Contention 2.1. As a preliminary matter, however, we assess the qualifications of the witnesses offered by the parties as experts in this proceeding and otherwise describe the evidentiary record.[19]

[19] All citations to the hearing transcript in this decision are to the transcript as corrected by our Order. Order (Adopting Transcript Corrections) (unpublished) (May 31, 2017) (ADAMS Accession No. ML17151A280).

A. Evidentiary Record

1. Expert Witnesses

4.3 The parties in this proceeding put forth the testimony of nine witnesses. The Board finds that all of the witnesses are qualified as expert witnesses in the subject matters on which they provided testimony.

a. Joint Intervenors' Witness

4.4 The Joint Intervenors presented one expert witness in their direct and rebuttal pre-filed testimony. The Joint Intervenors' witness is Mr. Mark A. Quarles. We find that Mr. Quarles is well-qualified as an expert in the subject matters in which he provided testimony except for toxicology, in which we find him qualified as an expert only by experience, as described below.

4.5 Mr. Quarles is the Principal/Owner of Global Environmental, L.L.C., an environmental consulting company in Nashville, Tennessee. Pre-filed Initial Testimony of Mark A. Quarles Regarding Joint Intervenors' Contention 2.1 (INT-022) (Quarles Direct Testimony), A1. Mr. Quarles is a licensed Professional Geologist in the State of Tennessee. *Id*. He has approximately thirty years of experience as an environmental consultant, most of it relating to hydrogeologic investigations. *Id*. In regard to Contention 2.1, Mr. Quarles reviewed the FEIS (NRC-008A-D), relevant portions of the DEIS (NRC-007A-B), and relevant portions of the Environmental Report submitted to the NRC by FPL (NRC-030). *Id*., A4. In particular, he reviewed relevant technical studies related to groundwater migration that are referenced in the FEIS (NRC-008A-D). *Id*. Mr. Quarles has a Bachelor's of Science in Environmental Engineering Technology from Western Kentucky University, and a Master's of Business Administration from Vanderbilt University. INT-001 at 5.

4.6 While we find Mr. Quarles well-qualified to testify as an expert on hydrogeology based on his education, experience, and his status as a Licensed Professional Geologist, we cannot find him well-qualified as an expert on toxicology. At hearing, Mr. Quarles testified that

he did not have a degree in toxicology. Tr. 804, lines 22-23. He also testified that he "routinely use[d]" drinking water standards in "determining the level of risk to humans, animals, that sort of thing." Tr. 804, line 25 to 805, lines 1-3. He further testified that "doing this sort of thing for a living, you're exposed to some degree of use of numeric standards for human and ecological effect." Tr. 805, lines 4-7. Mr. Quarles's experience, as he, himself described at hearing and in his *curriculum vitae,* does not demonstrate that he is well-qualified by experience as an expert on toxicology. *See* INT-001. Accordingly, we find that Mr. Quarles is qualified as an expert on toxicology only by some experience, and we will assign weight to his testimony commensurate with his qualifications.

b. Applicant's Witnesses

4.7 The Applicant presented a total of four expert witnesses in its direct and rebuttal pre-filed testimony. The Applicant's witnesses are: (1) Dr. Christopher Teaf, (2) Dr. Robert Maliva, (3) Mr. Paul Jacobs, and (4) Mr. David McNabb. We find that all four of the Applicant's expert witnesses are well-qualified as experts in the subject matters on which they provided testimony.

4.8 Dr. Christopher Teaf is the Director of Toxicology for Hazardous Substance & Waste Management Research, Inc., and has served as faculty at Florida State University (FSU) since 1979 and as Director and Associate Director of the Center for Biomedical & Toxicological Research at FSU. Pre-Filed Direct Testimony of Dr. Christopher M. Teaf (FPL-004) (Teaf Direct Testimony) at 001. Dr. Teaf is also Board-certified as a Fellow of the Academy of Toxicological Sciences, an international professional organization. *Id.* at 002. As it relates to this proceeding, Dr. Teaf was retained by FPL to address whether wastewater from Turkey Point operations would exert "small," or even detectable, effects on the underground source of drinking water. *Id.* Dr. Teaf has a Bachelor's degree in Biology from Pennsylvania State University, a Master's degree in Biological Science from Florida State University, and a Ph.D. in Toxicology from the University of Arkansas for Medical Sciences. *Id.* at 001.

4.9 Dr. Robert Maliva is a Principal Hydrogeologist at WSP | Parsons Brinkerhof, where he manages and provides technical leadership on alternative water supply and disposal projects, such as injection well systems. Pre-Filed Direct Testimony of Dr. Robert G. Maliva (FPL-003) (Maliva Direct Testimony) at 001. Dr. Maliva has worked as a hydrogeologist and principal hydrogeologist specializing in the geology of Florida for a variety of companies since 1992, where he managed water supply, injection well, and aquifer storage and recovery projects and also researched carbonate sedimentology and diagenesis. *Id.* at 002. Dr. Maliva is a registered Professional Geologist in Florida and Texas. *Id.* at 003. As it relates to this proceeding, Dr. Maliva performed independent confinement analysis for the Turkey Point site, in support of the project's NRC license application, and provided testimony to address whether there will be human or ecological exposure to wastewater injected in the proposed Class I injection wells at the Turkey Point site. *Id.* Dr. Maliva has a Bachelor's degree in Biological and Geological Sciences from the State University of New York at Binghamton, a Master's degree in Geology from Indiana University Bloomington, and a Ph.D. in Geology from Harvard University. *Id.* at 001.

4.10 Mr. Paul Jacobs is the Supervising Engineer at FPL for the Turkey Point Units 6 & 7 nuclear projects. Pre-Filed Direct Testimony of Mr. Paul Jacobs (FPL-001) (Jacobs Direct Testimony) at 001. In that role, Mr. Jacobs is the engineering lead for the preparation of licensing documents submitted in support of obtaining federal and state permits, and also supports responses to requests for additional information from the NRC, as well as state and local agencies. *Id.* Mr. Jacobs has 45 years of experience in the power generation industry as a design engineer, consulting engineer, and independent business owner. *Id.* at 002. He also did engineering work at the Indian Point Nuclear Plant facility, J.A. Fitzpatrick Nuclear Plant, the Susquehanna Nuclear Station, and the Comanche Peak Nuclear Power Plant. *Id.* Mr. Jacobs is certified as a professional engineer in the State of California, and is a member of the American Nuclear Society and the American Society of Mechanical Engineers. *Id.* In this

proceeding, Mr. Jacobs provided testimony on background information regarding FPL's proposed Turkey Point nuclear power plant and summarized the processes for obtaining, using, and disposing of water associated with the circulating water system for the proposed plant. *Id.* Mr. Jacobs has a Bachelor of Science degree in Nuclear Engineering from the State University of New York, Maritime College, and has taken graduate courses towards a master's degree in nuclear engineering from New York University. *Id.*

4.11 Mr. David McNabb is president of McNabb Hydrogeologic Consulting, Inc., is a licensed professional geologist in the State of Florida, and has worked as a geologist in Florida for 24 years. Pre-Filed Direct Testimony of Mr. David McNabb (FPL-002) (McNabb Direct Testimony) at 001. Throughout his career, Mr. McNabb focused on the siting, design, construction oversight, testing, and permitting of deep injection wells in Florida, specifically "Class I" injection wells such as those proposed at Turkey Point. *Id.* at 002. Regarding his involvement in the Turkey Point Units 6 and 7 project, Mr. McNabb provided design, permitting and construction oversight services for a 3,230 foot deep exploratory well (EW-1) and a dual-zone monitor well, at the Turkey Point Units 6 & 7 (Turkey Point) proposed site, among other work. *Id.* Mr. McNabb also provided testimony on how data from EW-1 indicates that wastewater from Turkey Point will be confined in, or near, the Boulder Zone and is extremely unlikely to contaminate the underground source of drinking water, as well as on how the design of Turkey Point's injection wells will contribute to such confinement, and how well monitoring programs put in place by Turkey Point will enable FPL and the FDEP to address the unlikely scenario of leaks or migration of Turkey Point wastewater into the Underground Source of Drinking Water (USDW). *Id.* at 003.

c. Staff's Witnesses

4.12 The Staff presented a total of three expert witnesses in its direct and rebuttal pre-filed testimony. The Staff witnesses are (1) Dr. Ann L. Miracle, (2) Daniel O. Barnhurst, and (3) Paul D. Thorne. The Staff also offered the testimony of Alicia Williamson-Dickerson to sponsor

the DEIS (NRC-007A-B) and the FEIS (NRC-008A-D and NRC-049) into evidence, but did not offer Ms. Williamson-Dickerson as an expert, and she did not testify at the hearing. We find that all three of the Staff's expert witnesses are well-qualified as experts in the subject matters on which they provided testimony.

4.13 Dr. Ann L. Miracle is a scientist in the Environmental Assessment Group, Earth Systems Science Division, Energy and Environment Directorate at the Pacific Northwest National Laboratory (PNNL). NRC Staff Testimony of Ann L. Miracle, Daniel O. Barnhurst, Paul D. Thorne, and Alicia Williamson-Dickerson Concerning Contention NEPA 2.1 (Impacts of Deep Well Injection of Four Constituents in Cooling-Tower Blowdown) (NRC-002-R2) (Staff Direct Testimony), A1(a) (ALM). Dr. Miracle was a technical reviewer for the evaluation of the potential environmental impacts to aquatic ecological resources related to the proposed Turkey Point Units 6 and 7 and its associated facilities, including an assessment of toxicological impacts to aquatic resources. *Id*., A3(a). Dr. Miracle assisted in the preparation of the Staff DEIS, issued in February 2015 (NRC-007A-B), and the Staff FEIS (NRC-008A-D), issued on October 28, 2017. Dr. Miracle has a Bachelor of Arts in Biology from the University of Virginia, a Master of Science in Molecular Genetics from the University of Florida, and a Doctor of Philosophy in Molecular Immunology from the University of South Florida. NRC-003 at 1. While Dr. Miracle's doctorate is in molecular immunology, she has experience in environmental toxicology. Tr. 804, lines 13-15. Dr. Miracle has written on topics in environmental toxicology regarding chemical exposures and their effects in fish, and toxicogenomics in regulatory ecotoxicology. NRC-003 at 4-5. Dr. Miracle has worked as an aquatic ecologist on six NRC Environmental Impact Statements. *Id*. at 1. She also worked for the U.S. Environmental Protection Agency to develop molecular screening criteria for aquatic species in environmental risk assessments. *Id.*

4.14 Mr. Daniel O. Barnhurst is a licensed Professional Geologist employed as a hydrologist in the Division of Site Safety and Environmental Analysis, Office of New Reactors,

NRC. NRC-002-R2, A1(b). He evaluated the potential groundwater impacts in the EIS from building and operating the proposed Turkey Point Units 6 and 7 and associated facilities. *Id*., A3(b). He prepared groundwater hydrology sections of both the Staff DEIS, issued in February 2015 (NRC-007A-B), and the Staff FEIS, issued in October 2016 (NRC-008A-D). *Id.* As it relates to this contention, Mr. Barnhurst evaluated the potential impacts to groundwater quality from the proposed injection of station blowdown water and other liquid waste streams into the Boulder Zone, which is located at depths of approximately 2,900 to 3,500 ft. in the Lower Floridan aquifer. *Id*. Mr. Barnhurst has more than 14 years of experience in hydrogeological applications, including hydrogeochemistry, aquifer characterization, numerical modeling (including groundwater flow, contaminant fate, and transport modeling), and design and optimization of monitoring well networks. NRC-004 at 1. Before coming to the NRC, Mr. Barnhurst did substantial work analyzing the long-term impacts on groundwater quality and quantity at the Department of Energy's Savannah River Site. *Id*. Since coming to the NRC in 2008, Mr. Barnhurst has performed hydrological safety and environmental impact analyses relating to the construction and operation on new nuclear reactors. *Id*. During the last five years he has worked almost exclusively performing hydrological evaluations for seven Environmental Impact Statements. *Id*. Mr. Barnhurst has a Bachelor's of Science in Environmental Geology and a Master's of Science in Geology from Brigham Young University. *Id*.

4.15 Mr. Paul D. Thorne is a Senior Research Scientist employed in the Earth Systems Science Division at the Pacific Northwest National Laboratory. Staff Direct Testimony (NRC-002-R2), A1(c). He assisted the NRC Staff in its evaluation of potential groundwater impacts from building and operating the proposed Turkey Point Units 6 and 7 and associated facilities. *Id*., A3(c). Mr. Thorne assisted in the preparation of the Staff DEIS (NRC-007A-B), issued in February 2015, and the Staff FEIS (NRC-008A-D), issued in October 2016. *Id.* As it relates to this contention, he assisted the NRC Staff in assessing the potential impacts to

groundwater quality from the proposed injection of station blowdown water and other liquid waste streams into the Boulder Zone. *Id*. Mr. Thorne has over 35 years of experience in hydrogeology. NRC-005 at 1. His current work focuses on understanding and modeling hydrogeologic systems and analyzing fluid flow in the subsurface. *Id*. He also has considerable experience in testing wells up to 1000 meters deep to determine aquifer flow and storage properties. *Id*. He has built numerous geologic models that support numerical modeling of fluid flow, contaminant transport, and seismic hazards modeling. *Id*. Mr. Thorne has also contributed to development of innovative aquifer testing techniques. *Id*. He has developed hydrogeologic models used to predict migration at superfund sites and has experience addressing uncertainty in conceptual models of groundwater flow and contaminant transport. *Id*. Mr. Thorne has supported the NRC on issues related to groundwater protection at radioactive waste sites and to determine environmental impacts of planned nuclear power plants. Mr. Thorne has a Bachelor's of Science in Chemistry and Mathematics from the University of Utah, and a Master's of Science in Hydrology and Hydrogeology from the University of Arizona. *Id*.

2. Key Exhibits

4.16 Before the hearing, the Joint Intervenors filed 24 exhibits (INT-000 through INT-023),[20] including the pre-filed direct and rebuttal testimony of their witness.[21] FPL filed 64 exhibits (FPL-000R through FPL-063),[22] including the pre-filed direct and rebuttal testimony of

[20] Final Resubmitted List of Exhibits for Joint Intervenors' Initial Written Statement of Position on Contention 2.1 and Prefiled Testimony of Mark A. Quarles Regarding Joint Intervenors' Contention 2.1 (INT-000-R).

[21] Prefiled Initial Testimony of Mark A. Quarles Regarding Joint Intervenors' Contention 2.1 (INT-022) (Quarles Direct Testimony); Pre-filed Rebuttal Testimony of Mark A. Quarles Regarding Joint Intervenors' Contention 2.1 (INT-023) (Quarles Rebuttal Testimony).

[22] FPL Hearing Exhibits (FPL-000R).

its witnesses.[23] The NRC Staff filed 55 exhibits (NRC-001-R2 through NRC-008D; NRC-010 through NRC-014; NRC-017 through NRC-024; NRC-025; NRC-026; NRC-028 through NRC-033; NRC-035; NRC-037 through NRC-041; NRC-043 through NRC-053, and NRC-055 through NRC-064),[24] including the pre-filed direct and rebuttal testimony of its witnesses.[25]

4.17 Aside from the direct and rebuttal testimony, one key exhibit was NUREG-2176, Environmental Impact Statement for Combined Licenses (COLs) for Turkey Point Nuclear Plant Units 6 and 7 (Final Report) (Oct. 2016) (NRC-008A-D), which the Staff published in four volumes. A second key exhibit was the ATSDR, Division of Toxicology and Environmental Medicine ToxFAQs (complied for ethylbenzene (2007), tetrachloroethylene (2014), and heptachlor (2007)) (INT-016), which compiles toxicology data for three of the four constituents that are the subject of Contention 2.1. A third key exhibit was the Report on the Construction and Testing of Class V Exploratory Well EW-1 at the Florida Power & Light Company Turkey Point Units 6 & 7 (INT-010A-E; FPL-005; NRC-056), which documents the data on the subsurface at the Turkey Point site and FPL's interpretation of that data. Other key exhibits include regional studies of the geology in South Florida, including four studies performed by the

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[23] Pre-Filed Direct Testimony of Mr. Paul Jacobs (FPL-001) (Jacobs Direct Testimony); Pre-Filed Direct Testimony of Mr. David McNabb (FPL-002) (McNabb Direct Testimony); Pre-Filed Direct Testimony of Dr. Robert G. Maliva (FPL-003) (Maliva Direct Testimony); Pre-Filed Direct Testimony of Dr. Christopher M. Teaf (FPL-004) (Teaf Direct Testimony); Pre-Filed Rebuttal Testimony of Mr. David McNabb (FPL-060) (McNabb Rebuttal Testimony); Pre-Filed Rebuttal Testimony of Dr. Robert G. Maliva (FPL-061) (Maliva Rebuttal Testimony); and Pre-Filed Rebuttal Testimony of Dr. Christopher M. Teaf (FPL-062) (Teaf Rebuttal Testimony).

[24] NRC Staff Hearing Exhibits (NRC-001-R2). The NRC Staff did not use nine exhibit numbers in the range up to NRC-064.

[25] NRC Staff Testimony of Ann L. Miracle, Daniel O. Barnhurst, Paul D. Thorne, and Alicia Williamson-Dickerson Concerning Contention NEPA 2.1 (Impacts of Deep Well Injection of Four Constituents in Cooling-Tower Blowdown) (NRC-002-R2) (Staff Direct Testimony); NRC Staff Rebuttal Testimony Of Ann L. Miracle, Daniel O. Barnhurst, and Paul D. Thorne Concerning Contention 2.1 (Impacts of Deep Well Injection of Four Constituents in Cooling-Tower Blowdown) (NRC-072) (Staff Rebuttal Testimony). The Staff submitted its witnesses' testimony as part of a panel rather than individually, with attribution of each answer to one or more witnesses as indicated by their respective initials. We adopt a similar approach, and identify the Staff testimony by the initials of the testifying witness.

United States Geological Survey (USGS) (K. Cunningham, primary author) (INT-006 through INT-009); a study by R. Reese and E. Richardson (INT-011); a study by V. Walsh and R. Price (INT-012); a study by R. Starr (INT-013); and a study by R. Maliva (INT-014), who testified on behalf of FPL. The Joint Intervenors, FPL, and the Staff separately offered each of these studies as exhibits. The parties submitted some exhibits in multiple parts due to their size.

B. Board Findings on the Concentration Component of Contention 2.1.

1. Concentrations of the Constituents in FEIS (NRC-008A) Table 3-5 (Panel 4)

4.18 Joint Intervenors assert in Contention 2.1 that the presence of four chemical constituents (ethylbenzene, toluene, heptachlor and tetrachloroethylene) in the wastewater that will be injected into the Boulder Zone will have an adverse impact on the quality of the groundwater in the Upper Floridan aquifer and may be harmful to human health. The NRC Staff found, as documented in the FEIS and as explained by NRC Staff witnesses, that the levels of the four chemical constituents in the wastewater will be low enough so as not to adversely affect public health. FPL's witnesses also explained why the levels of the four chemical constituents in the wastewater will be below EPA standards for safe drinking water. Joint Intervenors' expert witness, Mr. Quarles, argued that even trace amounts of these chemicals could cause harm, but conceded at the evidentiary hearing that he could not point to any evidence on the record that the impacts of any of the four chemical constituents will have an environmental impact that is greater than SMALL. Tr. 807, lines 19-21; Tr. 808, lines 1, 4-5; Tr. 844, line 8. Indeed, at the evidentiary hearing, Mr. Quarles, Joint Intervenors' designated expert, conceded that the concentrations of ethylbenzene and toluene in the injected wastewater will have no known or anticipated adverse effects on human health. Tr. 806, line 14; Tr. 807, line 12 (Mr. Quarles). As such, the Board considers those two constituents as no longer being at issue in Contention 2.1, and after considering the entire evidentiary record, including the evidence presented and testimony from all expert witnesses at the evidentiary hearing, the Board finds the testimony of NRC Staff's and FPL's toxicology experts to be the most persuasive regarding the impacts of

the constituent levels. Because the issues raised and addressed in Panels 4 and 5 are so interrelated, we provide our findings on the issues addressed by those panels in the same section after the testimony given by all the parties in Panels 4 and 5 are summarized.

a. Joint Intervenors' Testimony

4.19 As noted above, Joint Intervenors raised concerns in Contention 2.1 with the concentrations of four chemical constituents, ethylbenzene, toluene, heptachlor, and tetrachloroethylene, in the wastewater. Joint Intervenors argue that the four chemicals, at concentration levels in FEIS (NRC-008A) Table 3-5, will have adverse effects on human health. Joint Intervenors' expert witness, Mr. Mark Quarles, testified in his initial pre-filed testimony that these four constituents "could cause potential adverse harms to the groundwater in the Upper Floridan Aquifer." Quarles Direct Testimony (INT-022), A20 at 17. There, and in his pre-filed rebuttal testimony, Mr. Quarles stated that, even at very low concentrations, these constituents can be harmful if consumed. *Id.*; Pre-filed Rebuttal Testimony of Mark A. Quarles Regarding Joint Intervenors' Contention 2.1 (INT-023) (Quarles Rebuttal Testimony), A21 at 15. Mr. Quarles testified that heptachlor, ethylbenzene and tetrachloroethylene are possible or probable human carcinogens. *Id.* at 17-18. He said that, "[e]ven at minute concentrations, tetrachloroethylene can cause nausea, liver damage, impaired heart function, and death, while heptachlor can negatively affect the immune and nervous systems." *Id.*, A21 at 18 (citing ATSDR Tox FAQs, INT-016). No specific effects of ethylbenzene or toluene were mentioned.

4.20 At the evidentiary hearing, however, Mr. Quarles testified that the concentrations of ethylbenzene and toluene in the injected wastewater will have no known or anticipated adverse effects on human health. Tr. 806, line 14; Tr. 807, line 12 (Mr. Quarles). Mr. Quarles also acknowledged that the evidence Joint Intervenors submitted to support their assertion that minute levels of heptachlor and tetrachloroethylene pose a public health risk does not support that assertion. Tr. 812, lines 24-25; Tr. 839, line 15 (Mr. Quarles). Mr. Quarles also testified at the hearing that he is not aware of any evidence in the record that states that levels of the

constituents below the EPA Maximum Contaminant Levels pose a risk to public health. Tr. 806, line 14; Tr. 807, line 12; Tr. 812, line 13; Tr. 843, line 22.

4.21 Mr. Quarles's pre-filed testimony regarding EPA Maximum Contaminant Level Goals also differed from his testimony concerning these goals during the evidentiary hearing. In pre-filed testimony, Mr. Quarles testified that the Maximum Contaminant Level Goals, a standard set by EPA in which the level has no known adverse effect on human health, should be used to determine potential health impacts instead of the Maximum Contaminant Levels. Quarles Direct Testimony (INT-022), A21 at 17-18. Mr. Quarles also testified in his Rebuttal Testimony that EPA's Maximum Contaminant Levels are a good benchmark for determining the risk to public health, but said Maximum Contaminant Level Goals should also be used because the Maximum Contaminant Levels are "not based purely on public health." Quarles Rebuttal Testimony (INT-023), A20 at 14. At the evidentiary hearing, however, Mr. Quarles testified that he was not aware of an instance where Maximum Contaminant Level Goals have been used as a regulatory standard rather than the Maximum Contaminant Levels. Tr. 840, line 16. Mr. Quarles also acknowledged that a Maximum Contaminant Level Goal of zero cannot be measured with current technology. Tr. at 865, line 18 (Mr. Quarles).

b. Applicant's Testimony

4.22 In its Testimony, FPL's expert witness, Dr. Christopher Teaf, stated that the concentration of ethylbenzene, toluene, heptachlor and tetrachloroethylene in the wastewater "*will have no detectable impact on sources of drinking water or the [Upper Floridan Aquifer] with regard to human health, even if the wastewater is directly injected into the drinking water or the [Upper Floridan Aquifer].*" Teaf Direct Testimony (FPL-004), ¶ 15 at 5 (emphasis in original). Dr. Teaf also stated that Joint Intervenors' claims that minute concentrations of the four chemical constituents can cause harm to human health "indicates a fundamental misunderstanding and/or ignorance of the effects caused by these substances, and the doses at which potential effects may, or may not, occur." *Id.*, ¶ 55 at 20. Dr. Teaf testified that any harm

caused by any of the four constituents at issue here "resulted from concentrations far in excess of those set forth in FEIS Table 3-5." *Id.*, ¶ 15 at 5.

4.23 In response to Joint Intervenors' statement that Maximum Contaminant Level Goals should have been used to determine the effects of the four constituents on human health, FPL pointed to a statement made by the EPA: "[Maximum Contaminant Level Goals (MCLGs)] are non-enforceable public health goals. MCLGs consider only public health and not the limits of detection and treatment technology effectiveness. Therefore, they sometimes are set at levels which water systems cannot meet because of technological limitations." Pre-filed Rebuttal Testimony of Dr. Christopher M. Teaf (FPL-062) (Teaf Rebuttal Testimony), ¶ 12 at 4-5 (citing "How EPA Regulates Drinking Water Contaminants" (FPL-057) at 004). Indeed, Dr. Teaf testified that it is "not technically possible to detect whether a true zero concentration has ever been attained and treatment systems may not be able to effectively remove chemicals in their entirety from public water supplies due to technology limitations." *Id*. 10 at 4 (citing FPL-057 at 004; "National Oil and Hazardous Substances Pollution Contingency Plan" (FPL-059) at 109-110).

4.24 Dr. Teaf testified that "using MCLGs alone to determine the environmental impact of the constituents is completely inconsistent with how qualified professionals in the human health risk assessment field make such determinations" and that "detection of a chemical above the MCLG but below the MCL does not indicate a meaningful human health risk." *Id.*, ¶ 13 at 5. Dr. Teaf argued that Maximum Contaminant Levels are the standards that qualified professionals in the toxicology field use, and that because the four chemical constituents are below their Maximum Contaminant Levels, there would be no adverse impact on public health. *Id.,* ¶ 14 at 5.

c. NRC Staff Testimony

4.25 In its pre-filed Testimony, the NRC Staff argued that the concentrations of the four chemical constituents in the wastewater were below EPA Drinking Water Standards and

were, therefore, not harmful to human health. Staff Direct Testimony (NRC-002-R2), A38 at 22-23 (ALM, DOB). The EPA has set the Maximum Contaminant Levels (MCLs) for the four constituents as follows: ethylbenzene, 0.7 mg/L; heptachlor, 0.0004 mg/L; toluene, 1.0 mg/L; and tetrachloroethylene, 0.005 mg/L. 40 C.F.R. § 141.61(a), (c). The Staff testified that samplings of wastewater taken at the South District Waste Water Treatment Plant, as listed in Table 3-5 of the FEIS (NRC-008A), showed that the concentration levels of the four constituents were as follows: ethylbenzene, below Method Detection Limit; heptachlor, 0.000023 mg/L; toluene, 0.00174 mg/L; and tetrachloroethylene, 0.00359 mg/L. FEIS (NRC-008A) at 3-39; Staff Direct Testimony (NRC-002-R2), A30 at 18 (ALM, DOB); A34 at 20 (ALM, DOB); A35 at 21 (ALM, DOB). As testified to by the Staff, the sampling data shows that all four constituents are below the safe drinking water standards established by the EPA. In fact, ethylbenzene was not detected in the wastewater at all.

4.26 The NRC Staff further testified in pre-filed testimony that the Underground Injection Control requirements set forth by the EPA in 40 C.F.R. § 146.15 require injected wastewater to be subjected to high-level disinfection treatment, which treats wastewater to "a level that is no longer a threat to [underground sources of drinking water]." Staff Direct Testimony (NRC-002-R2), A42 at 24 (DOB, PDT); A52 at 29 (DOB, PDT); A67 at 37 (DOB, PDT); Underground Injection Control Program Revision to the Federal Underground Injection Control Requirements for Class I Municipal Disposal Wells in Florida, 70 Fed. Reg. 70,513, 70,523 (Nov. 22, 2005) (NRC-021). The NRC Staff further testified that additional sampling of wastewater in 2013 and 2014, after high-level disinfection was implemented at the South District Wastewater Treatment Plant, showed that the concentration of each of the four constituents in the reclaimed wastewater at the South District Plant was below the laboratory Method Detection Limit. FEIS (NRC-008A), Table 3-5 note b; EPA Method 624 (NRC-038), at 19; Staff Direct Testimony (NRC-002-R2), A29 at 17 (ALM, DOB). This means that after high-level disinfection was implemented at the South District Wastewater Treatment Plant, the concentrations of the

constituents in the wastewater were below the level at which the laboratory could reliably quantify them. *Id*. In response to Joint Intervenors' claims that any concentration of ethylbenzene, heptachlor, and tetrachloroethylene in the wastewater will have adverse effects on human health, the NRC Staff testified that the fact sheets upon which Joint Intervenors base their claim do not support this conclusion and that there is no evidence that minute concentrations of ethylbenzene, heptachlor, and tetrachloroethylene will have an adverse impact on human health. NRC Staff Rebuttal Testimony of Ann L. Miracle, Daniel O. Barnhurst, and Paul D. Thorne Concerning Contention 2.1 (Impacts of Deep Well Injection of Four Constituents in Cooling-Tower Blowdown) (NRC-072) (Staff Rebuttal Testimony), A7, A8, A9 at 4-5 (ALM).

4.27 As noted above, because the issues raised and addressed in Panels 4 and 5 are so interrelated, we will be dealing with the findings on both of those panels in the same section at the conclusion of our summary of the testimony of Panel 5.

2. Further Treatment of Wastewater that will Lower Concentration Levels (Panel 5)

4.28 NRC Staff and FPL argue that the concentrations of the four chemical constituents are likely to be even lower than the levels listed in FEIS (NRC-008A) Table 3-5 due to the wastewater receiving high-level disinfection treatment and going through the cooling process before being injected into the Boulder Zone. In its prefiled testimony, FPL witness Mr. Jacobs described the high-level treatment that the FDEP requires the wastewater at Turkey Point to receive prior to injection. Jacobs Direct Testimony (FPL-001), ¶ 9 at 4. Mr. Jacobs explained that this treatment will be effective in further lowering the concentrations of the four constituents in the wastewater. *Id*., ¶ 11 at 5. NRC Staff witnesses also described this process in their pre-filed testimony, and testified at the evidentiary hearing that the cooling process at the Turkey Point site would reduce the chemical concentrations to even lower values. NRC Staff Direct Testimony (NRC-002-R2), A8 at 6 (DOB, PDT), A29 at 17 (ALM, DOB), A56 at 30-31 (ALM, DOB), A60 at 33 (DOB, PDT); Tr. 857-860 (Judge Burnett questioning Mr. Barnhurst). In

fact, the NRC Staff explained to the Board at the evidentiary hearing that the sampling data taken after high-level disinfection and the cooling process showed that the levels of all four constituents were undetectable. Tr. at 845, lines 1-3 (Dr. Miracle). Joint Intervenors argued in their prefiled testimony and at the hearing that high-level disinfection is not always effective in diluting the constituent levels in the wastewater. Quarles Rebuttal Testimony (INT-023), A16 at 11; Tr. at 867, lines 2-10 (Mr. Quarles). Joint Intervenors also renewed their objection at the evidentiary hearing that the sampling data used by FPL was unreliable; however, the reliability of FPL's sampling data was stipulated to by all parties earlier in this proceeding. Joint List of Undisputed Facts (FPL-064), ¶ 41. After considering the entirety of the evidentiary record, including the evidence presented and testimony from all expert witnesses at the evidentiary hearing, the Board finds the testimony of NRC Staff's and FPL's experts to be the most persuasive regarding the effects of high-level disinfection and the cooling process on the concentration levels of the four constituents in the wastewater.

a. Joint Intervenors' Testimony

4.29 Joint Intervenors testify that high-level disinfection is not designed to treat volatile and semi-volatile organic compounds such as heptachlor, ethylbenzene, toluene, and tetrachloroethylene. Quarles Rebuttal Testimony (INT-023), A16 at 11. Mr. Quarles states that, "[t]he presence of volatile and semi-volatile organic constituents in the South District Plant's wastewater discharge in the past shows that the traditional wastewater treatment processes and industrial pre-treatment programs are not always effective in eliminating such contaminants from the treated wastewater effluent that would be discharged to Turkey Point." *Id.*, A18 at 12. Mr. Quarles also states that the sampling data taken from the wastewater after application of high-level disinfection, which shows that the levels of the four constituents are below detection limits, does not necessarily establish that the high-level disinfection is reducing the levels of the constituents. This is because, according to Mr. Quarles, the data is based on four wastewater samples, which "were collected as 40 milliliter grab samples that are only a reflection of water

quality of that minute volume at the mere few seconds that it took for FPL to fill the sample vials. As such, the samples may not reflect the actual maximum concentration during any given day." *Id.; see also* Tr. 864, lines 1-25 (Mr. Quarles). Further, Mr. Quarles says, "the fact that the high-level disinfection process may work by happenstance on occasion to remove [the contaminants] does not establish its consistent effectiveness." Quarles Rebuttal Testimony (INT-023), A18 at 12.

b. Applicant's Testimony

4.30 According to FPL's witnesses, the wastewater will undergo enhanced treatment at the South District Wastewater Treatment Plant. Jacobs Direct Testimony (FPL-001), ¶ 9 at 4. After it arrives at the Turkey Point site, Mr. Jacobs testified that treatment of the wastewater "will involve flow equalization, continuous water quality monitoring, flow metering, dechlorination, nitrification, chemical phosphorous removal, clarification, pH adjustment, deep filter bed denitrification, chlorination, and water quality monitoring." *Id.*, ¶ 11 at 5. Regarding sampling data, FPL refutes Joint Intervenors' claim that the "grab samples" were insufficient. At the hearing, Dr. Teaf testified that approximately 20 samples were taken on six different dates, and all samples reflected that none of the four constituents were detected in the wastewater. Tr. 868, lines 9-11(Teaf). Dr. Teaf went on to testify that Joint Intervenors' "concern about the variability is rendered much less persuasive by the complete consistency of non-detect for 2013 in those different samples that were collected." *Id.*, lines 13-16.

c. NRC Staff Testimony

4.31 The NRC Staff testified that it is likely that the concentration of the constituents in the wastewater at the point of injection at Turkey Point Units 6 & 7 will be lowered after high-level disinfection due to the cooling process. FEIS (NRC-008A), Table 3-5; Staff Direct Testimony (NRC-002-R2), A61 at 33 (DOB PDT), A63 at 34-35 (DOB, PDT). The cooling process is explained at length in the Staff's testimony, and was discussed during the evidentiary hearing as well. Staff Direct Testimony (NRC-002-R2), A8 at 6 (DOB, PDT), A29 at 17 (ALM,

DOB), A56 at 30-31 (ALM, DOB), A60 at 33 (DOB, PDT); Tr. 857-860 (Judge Burnett questioning Mr. Barnhurst). The Staff testified that, once the wastewater is on site at Turkey Point, it will undergo an evaporative cooling process and dilution. Staff Direct Testimony (NRC-002-R2), A60 at 33 (DOB, PDT). The Staff testified that, as a result of this cooling process, the contaminants in the wastewater will go through the process of volatilization, which transfers contaminants from the aqueous phase directly to the gaseous phase. *Id.*, A61 at 33 (DOB, PDT). According to the NRC Staff, volatilization will be effective in removing the low concentrations of three of the contaminants (ethylbenzene, toluene, and tetrachloroethylene) as the water circulates four times through the cooling towers at temperatures greater than 110° Fahrenheit. *Id.* The Staff states that greater than 98% of the three chemicals in the wastewater may be removed. *Id.*, A62 at 34 (DOB, PDT).

4.32 The NRC Staff asserts that the additional processes that will be used to treat the reclaimed wastewater will also be effective in reducing or degrading the levels of heptachlor. The NRC Staff explains that heptachlor is broken down primarily through chemical hydrolysis, which is strongly influenced by the temperature of the cooling system. Staff Direct Testimony (NRC-002-R2), A63 at 34-35 (DOB, PDT). The Staff testifies that volatilization and photodegradation are also methods to reduce the concentrations of heptachlor, and both processes will occur while the water cycles through the cooling system. *Id.* The Staff also indicates that the concentration of heptachlor could be further reduced by as much as 50% in one to three days as a result of these additional processes before injection. *Id.*

3. Findings on Panels 4 and 5

4.33 As noted above, because the issues raised and addressed in Panels 4 and 5 are so interrelated, we will be dealing with the findings on those panels in the same section. One of the fundamental tenets of Contention 2.1 is Joint Intervenors' claim that the chemical concentrations of ethylbenzene, heptachlor, toluene and tetrachloroethylene in the wastewater, as listed in Table 3-5 of the FEIS (NRC-008A), may adversely impact human health by affecting

the quality of the groundwater around the Turkey Point site. After considering the entire evidentiary record, including all of the evidence presented and the testimony at the evidentiary hearing, we agree with the Staff and with FPL that it is highly unlikely that the levels of the chemical constituents in the wastewater will pose a risk to public health even at the point of injection. We also agree that the Staff's analysis in the FEIS of the potential impacts of these chemical constituents in the wastewater was adequate.

4.34 After weighing all evidence on the record, the Board makes the following findings: 1. All four chemical constituents in the wastewater will be below the Maximum Contaminant Levels (MCLs) established by the EPA to protect public health; 2. Joint Intervenors' claim that trace amounts of constituents in the wastewater can adversely affect human health is unfounded; 3. The levels of the constituents are likely to be even lower than reported in FEIS Table 3-5 due to high-level disinfection; and 4. Staff's NEPA analysis is adequate and fully supported by the evidence presented in this proceeding.

a. <u>The Constituent Levels are Below EPA Maximum Contaminant Levels</u>

4.35 While the NRC regulates the release of radiological constituents in plant effluent, responsibility for regulation of non-radiological pollutant discharges into receiving waters, including chemical constituents in the injected effluent, "rests by statute with the Environmental Protection Agency." 10 C.F.R. § 51.10(c); Staff Direct Testimony (NRC-002-R2), A25 at 15 (DOB, PDT). The Board recognizes the EPA Safe Drinking Water standards as the regulatory benchmark against which the quality of the groundwater will be measured. The EPA Drinking Water Standards are established in accordance with the Safe Drinking Water Act (42 U.S.C. § 300f et seq.; (NRC-067)). The EPA sets Maximum Contaminant Levels (MCLs), which are enforceable standards for regulated contaminants in drinking water intended to be protective of human health. *Id.*; Staff Direct Testimony (NRC-002-R2), A20 at 12 (DOB, PDT, ALM). The levels are based on epidemiological and toxicological studies that determine safety levels for a contaminant, and standards are set at levels that have no known adverse effect on human

health. Staff Direct Testimony (NRC-002-R2), A26 at 16 (ALM)). Both FPL and the Staff testified in their respective testimony, as described above, that concentrations of these four constituents at levels below the federal Maximum Contaminant Levels will not adversely affect public health. Staff Direct Testimony (NRC-002-R2), A38 at 22-23 (ALM, DOB); Teaf Direct Testimony (FPL-004), ¶ 15 at 5.

4.36 No evidence has been presented that calls into question the applicability of the EPA's Maximum Contaminant Levels to the concentrations of the four constituents at issue in Contention 2.1, or the EPA's determination that concentrations of these constituents that fall below these Maximum Contaminant Levels will not adversely affect public health. No evidence has been presented to support a finding that trace amounts or amounts too small to measure can harm human health. Based on the evidentiary record as a whole, including the evidence and testimony presented at the hearing, the Board finds that the concentrations of the four chemical constituents at issue in Contention 2.1 (ethylbenzene, heptachlor, toluene, and tetrachloroethylene) are below the EPA's Maximum Contaminant Levels for these contaminants.

4.37 The Maximum Contaminant Levels for ethylbenzene, tetrachloroethylene, and toluene are set forth in 40 C.F.R. § 141.61(a), while the Maximum Contaminant Level for heptachlor is set forth in 40 C.F.R. § 141.61(c). The EPA has set the Maximum Contaminant Levels for the four constituents as follows: ethylbenzene, 0.7 mg/L; heptachlor, 0.0004 mg/L; toluene, 1.0 mg/L; and tetrachloroethylene, 0.005 mg/L. 40 C.F.R. § 141.61(a), (c). Sampling of wastewater taken at the South District Waste Water Treatment Plant, as listed in Table 3-5 of the NRC Staff's FEIS, reports that the concentration levels of the four constituents were as follows: ethylbenzene, below Method Detection Limit; heptachlor, 0.000023 mg/L; toluene, 0.00174 mg/L; and tetrachloroethylene, 0.00359 mg/L. FEIS (NRC-008A) at 3-39; Staff Direct Testimony (NRC-002-R2), A30 at 18 (ALM, DOB); A34 at 20 (ALM, DOB); A35 at 21 (ALM, DOB).

4.38 The parties stipulated that the concentration levels in Table 3-5 of the FEIS (NRC-008A), which were collected through FPL sampling methods, are conservative and reliable. Joint List of Undisputed Facts (FPL-064), ¶ 41. Despite Mr. Quarles' objection to FPL's grab samples during the evidentiary hearing, we find that the sampling methods conducted by FPL were reliable. Dr. Teaf testified at the hearing that, over a period of two years, over 20 samples were taken on six different dates and the results were consistent each time. Tr. at 868, lines 8-11 (Dr. Teaf). We agree that the concern about the reliability of the data is rendered much less persuasive by the consistent concentration levels that were measured in the samples. *Id.* at lines 12-17 (Dr. Teaf). This, in addition to the fact that Joint Intervenors stipulated to the reliability of the constituent values (Joint List of Undisputed Facts (FPL-064), ¶ 41) provides sufficient support for the Board's findings that the values listed in Table 3-5 can be relied upon here. As such, based on the sampling data, we find that the levels of all four chemical constituents are below the set EPA Maximum Contaminant Levels and, therefore, we find that the levels of the four constituents are below the level at which no known or anticipated adverse effect on the health of a person would occur.

b. Trace Amounts of Constituents will not Adversely Affect Human Health

4.39 While the Board has concluded that the levels of the four chemical constituents in the injected wastewater will not pose a risk to public health, we must also address Joint Intervenors' assertion that even a trace amount of these constituents in the wastewater is potentially dangerous for human consumption. Quarles Direct Testimony (INT-022), A21 at 17-18. Joint Intervenors argue that the Maximum Contaminant Level Goals (MCLGs), a standard set by EPA in which the level has no known adverse effect on human health, should be used to determine potential health impacts instead of the Maximum Contaminant Levels. *Id.* We are not persuaded that this is the correct approach. Both Dr. Teaf and Dr. Miracle, experts in toxicology, testified that qualified professionals in the field of toxicology would typically use Maximum Contaminant Levels and not the Maximum Contaminant Level Goals to assess

environmental impacts from these constituents. Tr. 811, line 1 (Dr. Teaf) and line 4 (Dr. Miracle). Mr. Quarles agrees that this is standard practice. Tr. 811, lines 7-9 (Mr. Quarles).

4.40 Even if we were to take Joint Intervenors' suggestion that the Maximum Contaminant Level Goals should be used to assess the potential impacts of the constituents, the Board notes that ethylbenzene and toluene meet the Maximum Contaminant Level Goals. 40 C.F.R. § 141.50(b); FEIS (NRC-008A), Table 3-5; Staff Rebuttal Testimony (NRC-072), A5 at 3 (ALM). Indeed, at the evidentiary hearing, Mr. Quarles, Joint Intervenors' designated expert, conceded that the concentrations of ethylbenzene and toluene in the injected wastewater will have no known or anticipated adverse effects on human health. Tr. 806, line 14; Tr. 807, line 12 (Mr. Quarles). As such, the Board considers those two constituents as no longer being at issue in Contention 2.1.

4.41 As for heptachlor and tetrachloroethylene, the Board is not convinced by Joint Intervenors' position that, because the levels of these two constituents exceed the Maximum Contaminant Level Goals set for them, the constituents are potentially harmful to human health. Both NRC Staff and FPL expert witnesses testified that the levels of these two constituents, which are indeed below the EPA Maximum Contaminant Levels, will not have any anticipated adverse effects on human health. Staff Rebuttal Testimony (NRC-072), A5 at 3-4 (ALM); Direct Testimony of Dr. Teaf (FPL-004), A15 at 8; A25 at 11. Further, Mr. Quarles admits that the evidence Joint Intervenors submitted to support their assertion that minute levels of heptachlor and tetrachloroethylene pose a public health risk does not, in fact, support that assertion. When asked about Joint Intervenors' exhibit INT-016, (Agency for Toxic Substances and Disease Registry Frequently Asked Questions, (INT-016) at 5-6), Mr. Quarles acknowledged that the document did not say that heptachlor can negatively affect the immune and nervous system at the concentration listed in FEIS (NRC-008A) Table 3-5, saying the document "does not give a specific concentration." Tr. 812, lines 24-25 (Mr. Quarles). Regarding tetrachloroethylene, Mr. Quarles conceded that the relevant ATSDR ToxFAQ document "does not in fact say that

adverse health consequences can come from minute concentrations" of tetrachloroethylene. Tr. 839, lines 9-11 (questioning by Judge Hawkens); line 15 (Mr. Quarles).

4.42 Moreover, Mr. Quarles was unable to point to any evidence in the record that supports Joint Intervenors' assertion that minute concentrations of heptachlor or tetrachloroethylene in the wastewater would adversely impact public health. Tr. 812, line 11; Tr. 837, line 13; Tr. 843, line 22 (Mr. Quarles). This, along with the other considerations mentioned above, leads the Board to conclude that the concentrations of ethylbenzene, heptachlor, toluene and tetrachloroethylene in the wastewater, as listed in Table 3-5 of the FEIS, will not adversely impact human health by affecting the quality of the groundwater around the Turkey Point site. The concentration levels are below the EPA Maximum Contaminant Levels and are undetectable after high-level disinfection. FEIS (NRC-008A), Table 3-5. The evidence in the record provides no support for the Joint Intervenors' argument that the levels of the chemical constituents in the wastewater would adversely impact human health. The Board finds accordingly.

c. Constituent Levels are Likely to Be Even Lower Due to High-Level Disinfection and the Cooling Process

4.43 As discussed above, the evidentiary record provides a strong basis to support findings that the level of constituents in the wastewater is below the EPA's Maximum Contaminant Levels for safe drinking water. While this alone is reason enough for the Board to find that the wastewater injected into the Boulder Zone will be of a quality that is not harmful to public health, there is further evidence that the injected wastewater will be safe. The Florida Department of Environmental Protection implements the EPA's Underground Injection Control (UIC) Program at the state level. 40 C.F.R. § 146.15. The UIC requirements set forth by the EPA in 40 C.F.R. § 146.15 require injected wastewater to be subjected to high-level disinfection treatment, which treats wastewater to "a level that is no longer a threat to [underground sources of drinking water]." *See also* Staff Direct Testimony (NRC-002-R2), A42 at 24 (DOB, PDT); A52

at 29 (DOB, PDT); A67 at 37 (DOB, PDT); Underground Injection Control Program Revision to the Federal Underground Injection Control Requirements for Class I Municipal Disposal Wells in Florida, 70 Fed. Reg. 70,513, 70,523 (Nov. 22, 2005) (NRC-021). Additional sampling of wastewater in 2013 and 2014, after high-level disinfection was implemented at the South District Wastewater Treatment Plant, shows that each of the four constituents were not only below the EPA Maximum Contaminant Levels, but they were also below the laboratory Method Detection Limit, which means that the concentrations of the constituents were below the level at which the laboratory could reliably quantify them. FEIS (NRC-008A), Table 3-5 note b; EPA Method 624 (NRC-038), at 19; NRC Staff Testimony (NRC-002-R2), A29 at 17 (ALM, DOB). The weight of this evidence persuades the Board that the injected wastewater would not adversely impact public health because the four chemical constituents at issue in Contention 2.1 cannot even be detected in the wastewater after high-level disinfection and before the additional cooling process at the Turkey Point plant, with its associated volatilization, before injection. With this in mind, the Board finds that it cannot reasonably conclude that Joint Intervenors have demonstrated by the weight of the evidence that the constituent levels in the wastewater will adversely affect human health.

4.44 Moreover, the record indicates that it is also likely that the concentration of the constituents in the wastewater at the point of injection at Turkey Point Units 6 & 7 will be lowered further after high-level disinfection and the cooling process. FEIS (NRC-008A), Table 3-5; Staff Direct Testimony (NRC-002-R2), A61 at 33 (DOB PDT), A63 at 34-35 (DOB, PDT); Jacobs Direct Testimony (FPL-001), ¶ 11 at 5. The cooling process is explained at length in the Staff's testimony, and was discussed during the evidentiary hearing as well. Staff Direct Testimony (NRC-002-R2), A8 at 6 (DOB, PDT), A29 at 17 (ALM, DOB), A56 at 30-31 (ALM, DOB), A60 at 33 (DOB, PDT); Tr. 857-860 (Judge Burnett questioning Mr. Barnhurst). The process is also summarized with NRC Staff's testimony for Panel 5 above. In short, the record reflects that, once the wastewater is on site at Turkey Point, it will undergo an evaporative

cooling process and dilution. Staff Direct Testimony (NRC-002-R2), A60 at 33 (DOB, PDT). The contaminants in the wastewater will also go through the process of volatilization, which transfers contaminants from the aqueous phase directly to the gaseous phase. *Id.*, A61 at 33 (DOB, PDT). The evidence shows that volatilization will be effective in removing the low concentrations of three of the contaminants (ethylbenzene, tetrachloroethylene, and toluene) as the water circulates four times through the cooling towers at temperatures greater than 110° Fahrenheit. *Id.* The Staff states that greater than 98% of the three chemicals in the wastewater may be removed. *Id.*, A62 at 34 (DOB, PDT).

4.45 According to the evidence before the Board, the additional processes that will be used to treat the reclaimed wastewater will also be effective in reducing or degrading the levels of heptachlor. The NRC Staff explains that heptachlor is broken down primarily through chemical hydrolysis, which is strongly influenced by the temperature of the cooling system. *Id.*, A63 at 34-35 (DOB, PDT). During the cooling process, water temperatures will increase to as much as 110° degrees Fahrenheit, thus increasing the rate of hydrolysis and decreasing the concentration of heptachlor. *Id.* Volatilization and photodegradation are also methods to reduce the concentrations of heptachlor, and both processes will occur while the water cycles through the cooling system. *Id.* The Staff also indicates that the concentration of heptachlor could be further reduced by as much as 50% as a result of these additional processes before injection. *Id.* The Board recounts this evidence and describes the cooling process here in order to further establish its confidence that the wastewater injected into the Boulder Zone as a result of operations at Turkey Point Units 6 & 7 will not have an adverse impact on human health. The evidence before us indicates that the cooling process will lower the concentrations in the wastewater even further than the levels noted in FEIS (NRC-008A) Table 3-5. *Id*. As discussed above, the Board finds those levels to be protective of human health. As such, evidence that the levels are likely to be even lower as a result of additional processes before injection strengthens the Board's confidence in the NRC Staff's findings.

4. NRC Staff Met its Obligations Under NEPA

4.46 Finally, with regard to the chemical constituent levels in the wastewater, the Board finds that Staff's NEPA analysis is adequate and fully supported by the evidence presented in this proceeding. As set forth in the FEIS (NRC-008A-D), the Staff found that the impacts of the chemical constituents in the wastewater on human health will be SMALL. As noted previously, this means that the "environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource." 10 C.F.R. Part 51, App. B, Table B-1 n.3. Consistent with NEPA's rule of reason, NEPA does not call for certainty or precision, but an *estimate* of anticipated (not unduly speculative) impacts." *See Louisiana Energy Services, L.P.* (National Enrichment Facility), CLI-06-15, 63 NRC 687, 698 (2006); *Louisiana Energy Servs. L.P.* (National Enrichment Facility), CLI-05-20, 62 NRC 523, 536 (2005) (emphasis in original). As such, the Staff need not prove, and this Board need not find, that the Staff's approach is absolutely precise or performed with the best, most stringent methodology. Agencies "must have some discretion to draw the line and move forward with decisionmaking." *See Pilgrim*, CLI-10-11, 71 NRC at 315 (quoting *Town of Winthrop v. FAA*, 535 F.3d 1, 11-13 (1st Cir. 2008)).

4.47 After looking at the record before us, the Board concluded that the four chemical constituent levels would not adversely impact human health when injected into the Boulder Zone because the effects would be so minor that they would not noticeably alter the attributes of the water in the Boulder Zone. This is the very definition of SMALL. It would therefore be incongruous for us to determine that Staff's finding that the impacts of injection on groundwater quality would be SMALL is unreasonable. In fact, Joint Intervenors' expert witness, Mr. Quarles, conceded at the evidentiary hearing that he could not point to any evidence on the record that the impacts of any of the four chemical constituents will have an environmental impact that is greater than SMALL. Tr. 807, lines 19-21; Tr. 808, lines 1, 4-5; Tr. 844, line 8.

4.48 We also find, as a matter of law, that the Staff's review complies with NEPA. Joint Intervenors' argument that Staff should have used Maximum Contaminant Level Goals to determine impact levels rather than Maximum Contaminant Levels would undermine NEPA's rule of reason. *See, e.g., Long Island Lighting Co.* (Shoreham Nuclear Power Station, Unit 1), ALAB-156, 6 AEC 831, 836 (1973) (agencies must only address impacts that are reasonably foreseeable). First, FPL testified and Mr. Quarles acknowledged that current detection technology is not able to measure a zero-level concentration on constituents. Teaf Rebuttal Testimony (FPL-062), ¶ 10, 12 at 4-5 (citing "How EPA Regulates Drinking Water Contaminants" (FPL-057) at 004; "National Oil and Hazardous Substances Pollution Contingency Plan" (FPL-059) at 109-110)). As such, it would be unreasonable under NEPA to require that these levels be met because it is impossible to prove that they have been met. Accordingly, the Board does not agree with Joint Intervenors that the Maximum Contaminant Level Goals should be the standard used for an impact determination.

4.49 Further, as noted above, agencies are not required under NEPA to be absolutely precise or to use the best methodology; there must come a point where the agency uses the information before it to make a decision. *Pilgrim*, CLI-10-11, 71 NRC at 315. As established in prefiled testimony and at the evidentiary hearing, the EPA's Maximum Contaminant Levels are protective of human health, and are the standards used by toxicologists in making impact determinations. (42 U.S.C. § 300f et seq.; (NRC-067)); Staff Direct Testimony (NRC-002-R2), A20 at 12 (DOB, PDT, ALM); Tr. 811, line 1 (Dr. Teaf) and line 4 (Dr. Miracle). We therefore find that the Staff's use of the Maximum Contaminant Levels instead of the Maximum Contaminant Level Goals to determine environmental impacts is reasonable. We also find that Staff made proper use of all the information before it to come to a supportable, reasonable conclusion regarding impacts. The evidence on the record supports the finding that Staff based its impact determination on reliable and conservative data. There is no evidence, and indeed no claim, that Staff failed to make use of reasonably available technology or more precise data in

measuring concentration levels in the wastewater. NRC Staff evaluated and analyzed conservative and reliable data (Joint List of Undisputed Facts (FPL-064), ¶ 41) from the South District Wastewater Treatment Plant and further considered the effects of high-level disinfection and the cooling process on the concentrations of the constituents in the wastewater. All data considered by the Staff supports the conclusion that the impacts will be SMALL.

4.50 After reviewing the substantial record before us, we conclude that the FEIS complies with NEPA and with NRC's regulations in 10 C.F.R. Part 51. We find that the Staff has taken the requisite hard look at the direct environmental impacts of the proposed injection of wastewater into the Boulder Zone, and has documented its analyses and conclusions in a manner consistent with NEPA's requirements.

C. Board Findings on the Confinement Component of Contention 2.1.

1. Ability of the Middle Confining Unit to Prevent Upward Migration; the Likely Extent of Migration; and the Predicted Velocity of Migration (Panel 1)

4.51 The primary issue about which we questioned Panel 1 was the ability of the Middle Confining Unit at the Turkey Point site to prevent upward migration of injected water containing the four constituents from the Boulder Zone to the Upper Floridan aquifer. In this regard, and as described below, the Joint Intervenors asserted that the data gathered at the site were inadequate to characterize the subsurface and address the confining ability of the Middle Confining Unit. Accordingly, the Joint Intervenors asserted that additional studies, namely seismic reflection tests, were necessary for adequate site characterization. In support of these positions, the Joint Intervenors offered their interpretation of regional studies of geology and the causes of migration at wells at locations in South Florida other than the Turkey Point site. As explained in more detail below, we have considered and weighed all the evidence of record on these topics, and conclude that the NRC Staff has carried its burden to demonstrate that the Middle Confining Unit is a competent layer to prevent upward migration of injected wastewater from the Boulder Zone to the Upper Floridan aquifer at the Turkey Point site.

a. Data from EW-1 on Subsurface Conditions at the Turkey Point Site

i. Joint Intervenors' Testimony

4.52 In regard to the topic of Panel 1, the Joint Intervenors' expert, Mr. Mark A. Quarles, summarized his views by testifying that the NRC has failed to provide a reasonable amount of technical support for the conclusions in the FEIS that upward migration is "extremely unlikely" to occur from the underground injection of wastewater at the Turkey Point site. Quarles Direct Testimony (INT-022), A7. In this regard, Mr. Quarles testified that a key problem was that the NRC did not obtain nearly enough information about the specific characteristics of the Turkey Point site to make such comparisons. *Id*., A9 at 6. Specifically, Mr. Quarles testified that the FEIS relied on a single deep borehole test that provides very little information about the Turkey Point site characteristics. *Id*.

4.53 Mr. Quarles also testified that what little information is provided by the borehole test indicates that the layers of bedrock that were believed to be confining layers were actually quite permeable. *Id*. Specifically, Mr. Quarles testified that the FPL data obtained from EW-1 shows low percent bedrock recoveries, high percent porosity of bedrock intervals, and inconclusive straddle packer testing of bedrock intervals. *Id*., A10 at 7. Mr. Quarles testified that all three of these characteristics indicate an ineffective confinement layer because they suggest significant fractures and weathering that may allow substantial vertical and horizontal migration of injected wastewater. *Id*.

4.54 In regard to percent recovery, Mr. Quarles testified that the percent recoveries ranged from 8 to 92.9 percent, with an average of approximately 54 percent recovery. *Id*., A11 at 8. He testified further that such a low average percent recovery indicates that there is a significant amount of voids in the bedrock. *Id*.

4.55 In regard to porosity, Mr. Quarles testified that porosity measurements collected at EW-1 ranged from 27.5 to 43.4 percent and averaged 37 percent. *Id*., A12. Mr. Quarles testified that these numbers mean that up to 43.4 percent of the entire bedrock core section

consists of voids. *Id*. He testified further that some core samples could not even be tested because "some of the core samples did not contain enough intact pieces to perform each of the laboratory analyses." *Id*. Mr. Quarles concluded that the percent porosity measurements indicate a significant amount of voids in the bedrock, and that they do not support a conclusion that upward migration is "extremely unlikely" to occur at the Turkey Point site. *Id*.

4.56 In regard to straddle packer tests, Mr. Quarles testified that eight of the thirteen tests that were attempted within a designated "confinement unit" (1,930 to 2,915 feet) actually failed and were "[t]erminated due to packers not isolating test interval." *Id*., A13 at 9. In connection with these tests, Mr. Quarles testified that the bedrock strata within the packer and above/below the packers could be hydraulically connected through voids and fractures in the bedrock. *Id*. Mr. Quarles concluded that such conditions would be consistent with the conditions that were demonstrated by low bedrock "percent recovery" tests and also by bedrock "percent porosity" results. *Id*.

4.57 At the hearing, in response to our questions, Mr. Quarles testified that the data for the Turkey Point site in NRC-056, showed that 38 percent of the values of hydraulic conductivity (the rate at which water moves through geologic strata) were "in the 10^{-4} [centimeters per second] range which according to publications, that's indicative of a flow rate of a silty sand which is arguably not very confined." Tr. 654, lines 4-7 (Mr. Quarles). Dr. Kennedy then asked, "Does that mean there was 62 percent if it was 10^{-6}?" and Mr. Quarles replied "That does." Tr. 654, lines 14-16.

ii. Applicant Testimony

4.58 Mr. McNabb testified regarding the data he collected for the Turkey Point site at a deep exploratory well, EW-1. McNabb Direct Testimony (FPL-002), ¶¶ 6 (referencing FPL-005), 8, 9, 11-28, and 31. Mr. McNabb described the data from EW-1 as proving the presence of a 1,465 foot confining zone at the Turkey Point site. *Id*., ¶ 31. Mr. McNabb testified that the data from EW-1 is sufficient to support the existence of a confining layer at each injection well at the

Turkey Point site. *Id.*, ¶ 33. In particular, he testified that "[t]he geology of Southeast Florida does not vary significantly over short distances, i.e., within a few miles." *Id*. Mr. McNabb testified that wastewater injected into the Boulder Zone at Turkey Point will not move significantly upward into the Underground Source of Drinking Water (USDW). *Id.*, ¶ 32. Dr. Maliva testified that he analyzed the data from EW-1 and arrived at the same conclusion. Maliva Direct Testimony (FPL-003), ¶¶ 32-36. Dr. Maliva modeled groundwater movement at the Turkey Point site and concluded that there is a very low likelihood that injected wastewater will migrate vertically into the Underground Source of Drinking Water (USDW). *Id.*, ¶¶ 32, 37-45.

4.59 In his rebuttal testimony, Mr. McNabb responded to Mr. Quarles's testimony that asserted inadequacies in the EW-1 data. Pre-Filed Rebuttal Testimony of Mr. David McNabb (FPL-060) (McNabb Rebuttal Testimony), ¶¶ 8-15, 17, 22. Mr. McNabb addressed bedrock recovery, porosity, straddle packer tests, and vertical conductivity and described why the available data were adequate to establish confinement. *Id*. Dr. Maliva provided similar testimony in regard to the asserted inadequacies in the EW-1 data, and arrived at the same conclusions as Mr. McNabb. Pre-Filed Rebuttal Testimony of Dr. Robert G. Maliva (FPL-061) (Maliva Rebuttal Testimony), ¶¶ 13-17. At the hearing, Dr. Maliva explained how sonic logs allow identification of layers of higher porosity, and explained how hydraulic conductivity can be derived from sonic logs. Tr. 657, lines 12-23 (Dr. Maliva, responding to Dr. Burnett's question). At the hearing, Mr. McNabb testified that "bit-drop" would be an indication of encountering a void during the drilling process. Tr. 704, lines 9-12 (Mr. McNabb). Mr. McNabb explained that the lack of bit drop during the drilling of EW-1, together with the geophysical log data and the caliper log, indicate that the presence of voids is extremely unlikely in EW-1. Tr. 704, line 6, through Tr. 705, line 12 (Dr. Burnett questioning Mr. McNabb).

iii. Staff Testimony

4.60 By way of background, we first recite the Staff general description of the Floridan aquifer system in South Florida. Neither the Joint Intervenors nor the Applicant dispute this general description, rather, the dispute is about the confining ability of the Middle Confining Unit at the Turkey Point site. Similarly, for background, we include Staff testimony below to describe how certain well testing is performed. No party disputes how the tests are performed, rather, the parties disagree on how the test results should be interpreted.

4.61 In their Direct and Rebuttal testimony, Staff witnesses Mr. Daniel O. Barnhurst (DOB) and Mr. Paul D. Thorne (PDT), both of whom are hydrogeologists, discussed the ability of the Middle Confining Unit at the Turkey Point site to prevent upward migration of the injected cooling-tower blowdown from the Boulder Zone to the Underground Source of Drinking Water in the Upper Floridan aquifer. The Staff described the Floridan aquifer system as consisting of three major units. Staff Direct Testimony (NRC-002-R2), A70. The Staff indicated that, from shallowest to deepest, these are: 1) the relatively permeable Upper Floridan aquifer, 2) a less permeable formation known as the Middle Confining Unit, and 3) the highly permeable Lower Floridan aquifer (LFA). *Id*.; FEIS (NRC-008A) at 2-53. The Staff testified that the Middle Confining Unit in south Florida is often composed of three distinct rock layers, namely: an upper low-permeability confining zone known as MC1, a permeable zone called the Avon Park Permeable Zone within the Avon Park Formation, and a deeper low permeability confining zone known as MC2. Staff Direct Testimony (NRC-002-R2), A70 (DOB, PDT), citing NRC-040 at 17. The Staff testified that at the Turkey Point site, the Upper Floridan aquifer is 1010 ft. below ground surface, the top of the Middle Confining unit is 1,450 ft. below ground surface and it is 1465 ft. thick. *Id*., A16 (DOB, PDT), citing FEIS (NRC-008A) at 2-53 to 2-55. The Staff testified that the Boulder Zone occurs at a depth of 3030 ft. below ground surface at the Turkey Point site. *Id*. In regard to the Avon Park Permeable Zone (APPZ), the Staff explained that at least one study mapped that zone as becoming thinner to the south in Florida. *Id*., A96 at 60 (DOB,

PDT), citing NRC-040 at 51. The Staff testified that the Avon Park Permeable Zone was not identified in the EW-1 borehole at the Turkey Point site and may be missing at this location. *Id.* The Staff testified further that if the Avon Park Permeable Zone is missing at Turkey Point Units 6 and 7, then the thickness of the confining units is increased. *Id*., A96 at 61.

4.62 The Staff testified that FPL obtained data from an exploratory well at the site, EW-1, to characterize the geology there. *Id*., A107 (DOB, PDT). The Staff testified that this testing included analysis of drill cuttings, rock cores, geophysical logging, and packer flow testing of selected intervals. *Id*. The Staff testified that geophysical log data includes caliper, gamma ray, spontaneous potential, dual-induction, borehole compensated sonic, video, flowmeter, fluid conductivity, and temperature data. *Id*.

4.63 In regard to core samples, the Staff testified that rock cores are cylindrical samples of rock removed from a borehole by a specialized cylindrical drill bit. *Id*., A109 at 66 (DOB, PDT). The Staff testified further that cores can show features such as fracturing or rock dissolution and can be tested for physical and chemical properties. *Id*. The Staff testified that samples are also sent to a laboratory so that grainsize, porosity and permeability may be measured. *Id*. The Staff testified that at EW-1, FPL collected 20 samples from 10 cores from a depth of 1,721 ft. to 2,679 ft. in order to characterize the lower Middle Confining Unit. *Id*., A109 at 66-67. The Staff testified that core recovery was as high as 95.4 percent and averaged around 50 percent of the cored depth. *Id*. at 67. The Staff indicated that this data was evaluated as part of the data collected from EW-1 to characterize the Middle Confining Unit. *Id*.

4.64 In regard to geophysical logging, the Staff testified that geophysical logging uses a sensor traveling through a borehole to measure the physical properties of the surrounding rock or soil. *Id*., A110 (DOB, PDT). The Staff explained further that down-hole geophysical measurements thus provide information about subsurface properties such as density, rock type, electrical properties, and the presence of fractures. *Id*. The Staff testified that this information is used to correlate geological formations from one borehole to another. *Id*. The Staff testified

that the caliper log measures the diameter of the borehole. *Id*. The Staff explained that the closer the borehole is to the size of the drilling bit, the more competent the formation is at that depth. *Id*. The Staff testified further that sonic logs are used to determine rock porosity and are particularly useful in evaluating the integrity of confining layers within the Floridan aquifer system. *Id*.

4.65 In regard to packer tests, the Staff testified that such tests involve isolating a section of a borehole by placing a plug at each end of the interval to be tested, and then injecting or removing fluid from the isolated borehole section under controlled conditions and measuring both flow rates and pressure responses. *Id*., A111 at 67 (DOB, PDT). The Staff explained that the resulting data are analyzed to determine flow properties such as permeability and porosity. *Id*. The Staff testified that at EW-1, pumping tests of packer-isolated intervals from 1,930 to 1,950 ft., 1,970 to 1,992 ft., and 2,058 to 2,080 ft. below the drill pad resulted in low specific capacity values of 0.03, 0.003 and 0.05 gpm/ft., respectively. *Id*. The Staff explained that specific capacity is calculated from a packer flow test by dividing the flow rate while pumping from the isolated section of the borehole by the stabilized drawdown (change in water level). *Id*. The Staff testified that in some tested zones, a large drawdown resulted from a low pumping rate, indicating low hydraulic conductivity. *Id*. The Staff described the packer test of the interval 1970 to 1992 ft. below the drill pad and stated that it resulted in over 145 ft. of water level drawdown while pumping at 0.5 gpm. *Id*., A111 at 67-68. The Staff testified that other similar intervals include those beginning at 2,058, 2,220, 2,400, and 2,478 ft. *Id*., A111 at 68, citing NRC-056, Table 6, at 21.

4.66 In regard to sonic logs, the Staff evaluated return velocities in sonic logs obtained at well EW-1 and found sections of the Middle Confining Unit to have log signatures and transit times consistent with unfractured rock. *Id*., A115 at 70 (DOB, PDT), citing FEIS (NRC-008A) at 5-25. The Staff found that the zone from around 1,900 to 2,900 ft. below the ground surface (bgs), which had been identified as the lower confining unit (MC2) within the Middle Confining

Unit, demonstrated travel times that were typically low with little relative variability. *Id*., citing NRC-071, Appendix L BHC9.

4.67 In the Staff Rebuttal Testimony, (NRC-072), the Staff responded to Mr. Quarles's testimony asserting that the data on core recovery, porosity, and straddle packer testing suggested that the Middle Confining Unit was not an adequate confining layer. Staff Rebuttal Testimony (NRC-072), A13-A15 (PDT, DOB). In regard to core recovery data, the Staff testified that core recovery may be low due to a number of reasons that have nothing to do with the presence of voids or open fractures in the bedrock. *Id*., A13. The Staff testified that mechanical stresses created by the drilling process can cause the core sample to break apart and fall out of the core barrel. *Id*. The Staff also testified that the core barrel can also become plugged during drilling, resulting in low core recovery. *Id*. Accordingly, the Staff concluded that low percent recovery of core may be caused by factors other than voids or fractures in the rock being cored, contrary to Mr. Quarles's assertion. *Id*.

4.68 In regard to porosity, the Staff testified that porosity is the measure of void space in a sample. *Id*., A14 at 10 (PDT, DOB). The Staff explained that effective porosity is the measure of interconnected void space capable of conducting water. *Id*. The Staff gave the example of pores in a sponge that are connected, and the sponge is highly permeable. *Id*. The Staff gave a contrasting example of closed-cell foam, which is a highly porous material, but the pores are not connected, and its permeability is low. *Id*. The Staff explained that the ability of porous media to transmit water is indicated by hydraulic conductivity. *Id*. The Staff testified that testing of the recovered core samples showed that there are layers within the confining unit with vertical hydraulic conductivity less than 10^{-5} cm/sec, which is typical for dolomite and indicates effective confining properties within the Middle Confining Unit. *Id*., A14 at 10-11, citing NRC-056, Table 5 at 19.

4.69 In regard to straddle packer testing, the Staff testified that the successful straddle packer flow tests performed at the EW-1 borehole indicate that the tested intervals from 1930 to

1952 ft., 1970 to 1992 ft., 2058 to 2080 ft., and 2220 to 2242 ft. demonstrated very low permeability. *Id*., A15 (PDT, DOB), citing NRC-056 at 19-22. The Staff testified that the additional seven tests that failed do not undermine or negate the successful tests. *Id*.

4.70 Based on the tests described above, the Staff testified that the EW-1 data indicate that the zone from 1,980 to 2,915 ft., is the lower confining interval of the Middle Confining Unit and is composed of layers of limestone, dolomitic limestone and dolomite. Staff Direct Testimony (NRC-002-R2), A112 (DOB, PDT). The Staff testified further that vertical hydraulic conductivities of 16 core samples from this interval were measured and the hydraulic conductivities were as low as 1.6×10^{-6} cm/sec. *Id*., citing FEIS (NRC-008C) at G-50. The Staff explained that this hydraulic conductivity is within the range indicated by monitoring and modeling performed by Maliva et al to allow minimal migration, as discussed in NRC-002-R2, A97-A98. *Id*., citing FEIS (NRC-008A) at 2-58. The Staff also testified that the harmonic mean of the measured hydraulic conductivities was 5.54×10^{-6} cm/sec. *Id*., citing FEIS (NRC-008C) at G-50. The Staff testified that the harmonic mean is the most appropriate hydraulic conductivity value for fluid flow perpendicular to a layered system. *Id*., citing Freeze and Cherry (1979) (NRC-058) at 33.

4.71 The Staff also testified that FPL obtained data from a dual zone monitoring well (DZMW-1) to characterize the site. Staff Rebuttal Testimony (NRC-072), A12 (PDT, DOB). The Staff testified that, in general, upon conversion of an exploratory well to an injection well, injection testing is performed and response is measured within the receiving formation (here, the Boulder Zone) and at dual zone monitoring wells installed within and above the confining formation (here, the Middle Confining Unit) to evaluate the receiving formation's capacity to accept injected waste and the confining formation's capacity to confine injected waste. Staff Direct Testimony (NRC-002-R2), A79 at 43-44 (DOB, PDT). In regard to the injection test performed on EW-1, the Staff testified that "[t]he only measurable pressure response observed in either monitored interval [of DZMW-1] was attributable to tidal influence," and not to a lack of

confinement within the MCU. *Id*., A117 at 71 (DOB, PDT), citing NRC-063 at 2. To sum up the testing FPL performed at the exploratory injection well, EW-1, and the associated dual zone monitoring well, DZMW-1, the Staff testified that the "tests included every test recommended by Mr. Quarles in his 2nd Affidavit [INT-003, ¶ 33, first filed in this proceeding on February 17, 2012] (at 6 and 7) to be performed at the Turkey Point site and included additional testing." Staff Rebuttal Testimony (NRC-072), A12 at 7-9.

4.72 At the hearing, the Staff testified that the geology in southeast Florida does not vary greatly over short distances. Tr. 698, lines 12-19 (Mr. Barnhurst), citing NRC-062. In response to our question, the Staff explained that a "short distance" in this context would be on the order of the size of the Turkey Point site, i.e., "a couple thousand feet." Tr. 701, lines 12-18 (Mr. Barnhurst). Mr. Barnhurst testified that he "wouldn't expect to see based on the evaluation of geology in Southeast Florida significant difference in the geologic units beneath the site over distances on that magnitude" or "even within the distance that modeling indicates that groundwater may move horizontally, which is less than four miles." Tr. 701, lines 19-24. In addition, Mr. Barnhurst testified that, based on the literature, the geological variance that could reasonably be expected is that the Middle Confining Unit "becomes thicker and it becomes more confining" in Southeast Florida. Tr. 698 lines 24-25.

iv. Board Findings Regarding the Data from EW-1

4.73 The heart of Contention 2.1 in regard to the subjects explored in our questioning of Panel 1 is whether the data obtained from EW-1 and DZMW-1 are sufficient to characterize the geology at the Turkey Point site. If these data are adequate, the Staff analysis of them satisfies the Staff's burden to take a "hard look" at the environmental impacts of upward migration of cooling-tower blowdown injected into the Boulder Zone at Turkey Point. In regard to the overall stratigraphy of the site, we find that the Staff has carefully evaluated all the information available to it and clearly described the stratigraphy of the site in the FEIS (NRC-008A-D). We also find that characterization of the subsurface at the Turkey Point site based on

the EW-1 and DZMW-1 data is consistent with other local and regional data discussed in the FEIS. Our conclusions are based on the testimony and exhibits set forth above, including the Staff Direct Testimony (NRC-002-R2), A16 (DOB, PDT), citing FEIS (NRC-008A) at 2-53 to 2-55, A70 (DOB, PDT), citing NRC-040 at 17, and FEIS (NRC-008A), Figure 2-19. Moreover, the Joint Intervenors' witness, Mr. Quarles, testified that "when you look at traditional USGS type documents and such, there are two confining layers. MC1 is traditionally located above the Avon Park Permeable Zone and the MC2 being below the APPZ in the Lower Floridan Aquifer." Tr. 648, lines 12-16 (Mr. Quarles, describing the Middle Confining Unit). This testimony is consistent with the Staff overall description of the strata underlying the Turkey Point site.

4.74 In regard to the data obtained from EW-1, our findings rest, in part, on two Board observations regarding the evidence of record: First, while Mr. Quarles identified a variety of issues with specified data from EW-1, he was silent regarding the data upon which the Staff actually relied. For example, Mr. Quarles did not challenge any aspect of the *successful* packer tests, which both FPL and the Staff identified in their respective testimony, as set forth above. For example, in one instance documented in the EW-1 report, a packer test was successfully performed over the same interval where an earlier test had failed. The Board notes that the successful test indicated parameters consistent with confinement, as discussed above. This indicates that the tests did not fail simply due to lack of confinement, as Mr. Quarles asserted. Thus, the validity and probity of the EW-1 data upon which the Staff relied was uncontested.

4.75 Second, while Mr. Quarles testified that geological characteristics may vary within a span of only a few feet, as described above, he did not testify that there was any evidence of such variation at the Turkey Point site. To the contrary, Mr. McNabb testified that "[t]he geology of Southeast Florida does not vary significantly over short distances, i.e., within a few miles." McNabb Direct Testimony (FPL-002), ¶ 33. Given Mr. McNabb's extensive experience drilling and evaluating deep injection wells in South Florida and his demeanor at the hearing, we find his testimony persuasive. Similarly, Mr. Barnhurst testified that the geology in

southeast Florida does not vary greatly over short distances (Tr. 698, lines 12-19 (Mr. Barnhurst), citing NRC-062) and that a "short distance" in this context would be on the order of the size of the Turkey Point site, i.e., "a couple thousand feet" (Tr. 701, lines 12-18 (Mr. Barnhurst)). Mr. Barnhurst testified that he "wouldn't expect to see based on the evaluation of geology in Southeast Florida significant difference in the geologic units beneath the site over distances on that magnitude." Tr. 701, lines 19-22. Given Mr. Barnhurst's experience, his grasp of the literature on the geology of South Florida, as displayed in his testimony and at hearing, and his demeanor at the hearing, we find his testimony in this regard persuasive. The FPL and Staff evidence on this point is consistent, and, in view of the foregoing, outweighs the Joint Intervenors' evidence.

4.76 In view of our two observations above regarding the data from EW-1 and DZMW-1, and based on our thorough review of all the evidence of record on the subject of those data, and in view of other local and regional data discussed in the FEIS (discussed below), we find that the Staff has carefully evaluated those data, determined which of them are probative of the subsurface conditions at the Turkey Point site, and clearly described the Staff reasoning in the FEIS (NRC-008A-D). We also find that the FPL and Staff analyses of these data establish that the Middle Confining Unit is a competent confining unit at the Turkey Point site, and that significant upwelling of injected cooling tower blowdown is not likely at the Turkey Point Units 6 and 7 site. Our conclusions in regard to the data obtained from EW-1 and DZMW-1 are based on the testimony and exhibits set forth above, including the Staff Direct Testimony (NRC-002-R2), A79, A97-98, A107, A108 (citing NRC-056), A109-112, A115, A117 (all answers sponsored by DOB, PDT); the Staff Rebuttal Testimony (NRC-072), A12 (DOB, PDT); the McNabb Direct Testimony (FPL-002), ¶¶ 6 (referencing FPL-005), 8, 9, 11-28, 31 and 33; the Maliva Direct Testimony (FPL-003), ¶¶ 32-36; McNabb Rebuttal Testimony (FPL-060), ¶¶ 8-15, 17, and 22; and the Maliva Rebuttal Testimony (FPL-061), ¶¶ 13-17.

b. Need for Seismic Reflection Tests in View of Regional Studies

i. Joint Intervenors' Testimony

4.77 Mr. Quarles testified that a second key problem was that the FEIS incorrectly relies on broad generalizations about the "low-permeability" of the "confining units" that supposedly will contain the injected contaminants. Quarles Direct Testimony (INT-022), A9 at 6, citing FEIS (NRC-008A) at 2-47. As support for this proposition, Mr. Quarles testified that deep injection wells at other sites in South Florida had experienced "unexpected vertical intrusions of contaminated water into the drinking water supply[.]" *Id*., A9 at 6. Mr. Quarles testified that there were 18 such intrusions, which were the subjects of several regional studies. *Id*., A17, at 15, citing INT-015 at 4-12; *Id*., A18 at 16. Mr. Quarles testified that such events prompted seismic-reflection studies that now show the presence of faults and collapsed karst structures that may provide pathways for rapid upward migration of contaminated wastewater. *Id*. In his testimony, Mr. Quarles cited several studies in support of this thesis. *See id*., A15 at 10-13, citing Cunningham (INT-006, INT-007, and INT-009); A16 at 14-15, citing Reese and Richardson (INT-011), Walsh and Price (INT-012), and Starr (INT-013).

4.78 Mr. Quarles testified that only by conducting a comprehensive, site-specific investigation that includes, among other analyses, seismic-reflection tests, could the NRC rule out vertical transport of injected wastewater into the drinking water aquifer. *Id*., A9 at 6. Mr. Quarles testified that the seismic-reflection technique greatly improves upon methods that rely solely on investigations of boreholes, because it provides a much broader, three-dimensional picture of a site than a single – or even multiple – vertical boreholes. *Id*., A15 at 10. Mr. Quarles testified regarding the Cunningham studies (INT-006, INT-007, INT-008, and INT-009) that used seismic reflection testing at the South District Plant, in the Biscayne Bay, and at other locations in Florida. Quarles Direct Testimony (INT-022), A15 at 10-13. He testified that such studies have identified karst collapse and tectonic features that have the potential for producing a breach in confining layers. *Id*., A15 at 11. At the hearing, Mr. Quarles indicated that a single

bore hole was inadequate because "I could move three feet to the left and I could drill a boring and I could get into a six foot open conduit, three feet to the left." Tr. 693, lines 4-7 (Mr. Quarles). Mr. Quarles testified that the seismic evaluation gives you the best opportunity to find these natural pathways of fractures and faults prior to your selection of site. Tr. 692, lines 11-13 (Mr. Quarles). Mr. Quarles concluded by testifying that "[s]o today, you want to use the best technology which would be combining, incorporating of seismic." Tr. 694, lines 2-4 (Mr. Quarles).

ii. Applicant testimony

4.79 In his testimony, Dr. Maliva described the geology of the Floridan Aquifer System in South Florida. Maliva Direct Testimony (FPL-003), ¶¶ 25 (citing FEIS (NRC-008A), Figure 2-19), 26, 27, and 29-31. Dr. Maliva's testimony in this regard is identical to or consistent with the Staff description of the Floridan Aquifer System set forth above. At the hearing, Dr. Maliva testified that the Avon Park Permeable Zone, which had in some studies had been interpreted as being part of the Upper Floridan aquifer, was not part of the Upper Floridan, but is part of the Middle Confining Unit. Tr. 643, lines 4-20 (Dr. Burnett questioning Dr. Maliva).

4.80 Dr. Maliva also addressed Mr. Quarles's testimony that faults or natural conduits are responsible for vertical migration at the South District Plant and Mr. Quarles's associated testimony on regional hydrogeological studies. Maliva Rebuttal Testimony (FPL-061), ¶¶ 24, 26-28, 30-32, 35. In particular, Dr. Maliva explained the limitations in the studies Mr. Quarles cited, and testified that relevant portions of those studies did not apply to the Turkey Point site. *Id*., ¶¶ 26-28, 30-32. Further, Dr. Maliva testified that even at the South District Plant, wastewater did not migrate into the Upper Floridan aquifer. *Id*., ¶ 35, citing FPL-063 at 009.

4.81 In his rebuttal testimony, Dr. Maliva also addresses the seismic reflection tests Mr. Quarles urges. *Id*., ¶¶ 18-25. Dr. Maliva described how seismic reflection tests are performed, and explained that seismic profiles, through the geometry of the mapped reflectors, can reveal faults, folds, collapse structures, flat-lying strata, and other structural and

sedimentological features. *Id*., ¶ 18. Dr. Maliva testified that the existence of faults and other geologic features (e.g., folds and collapse structures), however, is not indicative of groundwater migrating upward. *Id*., ¶ 19 at 007. He explained that such features could be more permeable, equally permeable, or less permeable than the adjacent un-impacted strata. *Id*., ¶ 19 at 007-008. Specifically, Dr. Maliva testified that some faults are actually impermeable and act to seal off aquifers and hydrocarbon reservoirs. *Id*., ¶ 19 at 008. Dr. Maliva testified further that no inferences can be made on the vertical migration of water from the presence of subsurface faults and other geological features identified in seismic-reflection surveys. *Id*. Dr. Maliva addressed the USGS (Cunningham) studies, and testified that they do not help identify whether or not wastewater will migrate. *Id*., ¶ 21 at 008. Specifically, Dr. Maliva testified that seismic reflection data do not provide information on the hydraulic properties of strata. *Id*., ¶ 22. Dr. Maliva concluded that there is no technical justification for performing seismic-reflection surveys at the Turkey Point site, because there is no evidence that the ancient (several million years old) subsurface deformation features reported by the USGS are hydraulically active (i.e., water flow features). *Id*., ¶ 25. Mr. McNabb also testified that seismic reflection analysis does not provide data related to the confining characteristics of the rock or groundwater flow. McNabb Rebuttal Testimony, ¶ 16.

iii. Staff Testimony

4.82 The Staff responded to Mr. Quarles's testimony regarding upwelling at other deep well injection sites in Florida. Staff Rebuttal Testimony (NRC-072), A27-A28 (DOB, PDT). The Staff testified that Mr. Quarles is incorrect regarding the cause of known instances of vertical migration and the Staff's evaluation of such. *Id*., A28 at 22 (DOB, PDT). The Staff testified that, contrary to Mr. Quarles's opinion, the Staff discussed the potential for other pathways for vertical migration, such as a flow through the matrix of the Middle Confining Unit and flow through natural pathways through the Middle Confining Unit, as well as faults or fractures, extensively in the FEIS. *Id*., A28 at 22-23, citing FEIS (NRC-008A), § 5.2.1.3

"Potential Causes of Upwelling of Injected Wastewater through the Middle Confining Unit" at 5-23 through 5-26, and "Extent of Injected Wastewater Migration at the Turkey Point Site" at 5-26 through 5-29; FEIS (NRC-008A), § 5.2.3.2 "Groundwater-Quality Impacts" subsection "UIC Impacts" at 5-39 to 5-42.

4.83 The Staff also testified that the cause of upwelling at the South District Wastewater Treatment Plant site has never been determined to be "just as likely to be the geological characteristics of the site." *Id*., A28 at 23 (DOB, PDT). The Staff explained that while every study acknowledged that upward migration through natural features was possible, studies including McNeill 2002 (NRC-064) at 3, Maliva et al 2007 (NRC-043) at 1395, Dausman et al 2010 (NRC-047) at 147, and Walsh and Price 2010 (NRC-046) at unnumbered 15, indicate that upwelling at the South District Wastewater Treatment Plant most likely resulted from well-related issues and none of the upwelling at any site has reached the Upper Floridan aquifer. *Id*., A28 at 23 (DOB, PDT); A27 (DOB, PDT) citing NRC-008A at 5-23; Staff Direct Testimony (NRC-002-R2), A94, citing NRC-046 unnumbered at 15, and NRC-043 at 2 (DOB, PDT).

iv. Board Findings on the Need for Seismic Reflection Testing at Turkey Point

4.84 Given our findings above that the data from EW-1 and DZMW-1 were sufficient to characterize the subsurface of the Turkey Point site and that this characterization is consistent with other local and regional data discussed in the FEIS, we find that no further data, including data from seismic reflection testing, are necessary to characterize the subsurface of the Turkey Point site. Our analysis of seismic reflection testing could end here. Nonetheless, we address the evidence regarding the regional hydrogeologic studies and seismic reflection testing itself. In regard to the regional studies of hydrogeology to which the Joint Intervenors refer as undercutting the Staff analyses and conclusions, we find that the Staff carefully evaluated each study (and others), and clearly describe the studies and associated Staff analyses and conclusions in the FEIS (NRC-008A-D). Our basis for these conclusions is the testimony and exhibits set forth above, including Staff Rebuttal Testimony (NRC-072), A28 at 22-23 (DOB,

PDT), citing FEIS (NRC-008A), § 5.2.1.3 "Potential Causes of Upwelling of Injected Wastewater through the Middle Confining Unit" at 5-23 through 5-26, and "Extent of Injected Wastewater Migration at the Turkey Point Site" at 5-26 through 5-29; FEIS (NRC-008A), § 5.2.3.2 "Groundwater-Quality Impacts" subsection "UIC Impacts" at 5-39 to 5-42.

4.85 We also find that the limitations associated with seismic reflection testing would limit its usefulness in characterizing the Turkey Point site. Our conclusion in this regard is based on the testimony and exhibits identified above, including Staff Rebuttal Testimony (NRC-072), A19 and A21-A23 (PDT, DOB), and Maliva Rebuttal Testimony (FPL-061), ¶¶ 18-25. Accordingly, we find seismic reflection studies need not be performed for the Turkey Point site, consistent with the NEPA "rule of reason." *See Pilgrim*, CLI-10-11, 71 NRC at 316.

4.86 In sum, in view of the foregoing, based on all the evidence of record, we find that the Staff has satisfied its burden. Specifically, we find that the Staff has adequately evaluated the confining ability of the Middle Confining Unit and the need for seismic reflection testing at the Turkey Point site. We therefore find that the Staff has adequately evaluated these topics as they relate to the potential environmental impacts of upward migration of cooling-tower blowdown injected into the Boulder Zone in regard to the confining ability of the Middle Confining Unit.

2. <u>The ability of well-construction procedures and technology to prevent upward migration of wastewater to the UFA due to faulty well construction or well deterioration over time (Panel 2)</u>.

4.87 Joint Intervenors assert that well construction issues may lead to upward migration of water injected into the Boulder Zone. The Applicant contends that Joint Intervenors have ignored improvements in modern well construction, including backplugging, and the adoption of best practices by the industry and the Applicant. Joint Intervenors disagree with the Applicant's and NRC Staff's testimony supporting the FEIS conclusion that explains how well construction issues that in the past may have led to upward migration at other sites will be avoided at Turkey Point Units 6 and 7 by the implementation of modern well construction

procedures. After a review of the entire record, the Board finds that the well-construction procedures and technology that FPL will apply to the injection wells are adequate to prevent upward migration of wastewater to the Upper Floridan aquifer due to faulty well construction or well deterioration over time, and that the FEIS adequately describes the basis for the Staff conclusion on this subject.

a. Joint Intervenors' Testimony

4.88 In Joint Intervenors' Prefiled Direct Testimony, with respect to well construction and migration, Mr. Quarles asserted that:

> Vertical migration of wastewater from the Boulder Zone and into the Upper Floridan aquifer can be caused by a leaking geologic confining layer, the absence of a geologic confining layer, by faulty well construction, and by a well construction that deteriorates over time to allow leakage.

Quarles Direct Testimony (INT-022), A25 at 21. During the hearing on Contention 2.1, on the subject of well construction for Panel 2, under direct questioning by the Board, Mr. Quarles consistently expressed concern regarding "faulty well construction," which Mr. Quarles defined as including grout placement and balancing; calculating the depth of protective casing; and mechanical integrity testing. Tr. 731, line 11 to Tr. 734, line 8 (Judge Kennedy questioning Mr. Quarles).

4.89 With regard to modern well construction techniques and regulatory monitoring requirements, Mr. Quarles acknowledged that FPL intends to follow best practices. Tr. 730, line 23 to Tr. 731, line 10 (Mr. Quarles). Mr. Quarles also acknowledged in his testimony that he does not consider the state comprehensive requirements (Florida Department of Environmental Protection regulations) for injection wells and the industry best practices to prevent leakage to be inadequate or deficient. Tr. 758, lines 2 to 13 (Judge Hawkens questioning Mr. Quarles). Next, Mr. Quarles conceded that, in regard to mechanical integrity tests, his testimony had been wrong, if in fact the cement bond log had been done to the full length of the boring. Tr. 765, line 16 to Tr. 766, line 3. Finally, in response to Judge Kennedy's question: "Does that alleviate your

concern over the mechanical integrity testing then?" Mr. Quarles responded: "It does." Tr. 766, line 4 to 6 (Judge Kennedy questioning Mr. Quarles).

b. Applicant's Testimony

4.90 The Applicant contends that properly constructed injection wells do not create vertical conduits for fluid migration. McNabb Rebuttal Testimony (FPL-060), ¶ 21 at 8. Mr. McNabb testified that current construction techniques remove all risk of creating a vertical conduit during construction by backplugging all pilot holes that go through the confining unit with cement and careful cementing of casings in place. *Id*. Specifically, Mr. McNabb testified that injection well systems that have leaked were constructed more than 25 years ago, when pilot holes remained open, and this could act as a direct conduit for injected fluid to move upwards. *Id*. Mr. McNabb explained that currently, pilot holes going through the confining unit are backplugged with cement, which removes that risk. *Id*. Mr. McNabb testified that the proposed wells will be constructed in accordance with techniques that have been proven to prevent leaks, and the wells will be monitored in accordance with well-established industry practice and applicable regulations. *Id*., ¶ 23.

4.91 In an exchange with Judge Kennedy, Mr. McNabb confirmed that "modern well technology" refers to well construction procedures and technologies credited to prevent wastewater migration from the Upper Floridan Aquifer. *See* Tr. 725, lines 13 to 22 (Mr. McNabb). Mr. McNabb then testified that "[t]he proper construction techniques will prevent fluid migration. And those techniques, what's changed when we say modern what we're really getting at there is, we are backplugging our pilot holes through a confinement, with cement." Tr. 725, line 22 to Tr. 726, line 2 (Mr. McNabb). In a subsequent exchange with Judge Kennedy on backplugging, testing and continuous pressure monitoring, Mr. McNabb testified that FPL continuously monitors the pressure in the annulus between the final casing and the injection tubing, as required by State of Florida regulations, and that if the final casing or injection tubing

were to "pop a hole," FPL would know instantly because they would immediately see a decrease in pressure. Tr. 753, line 20 to Tr. 754, line 12 (Mr. McNabb).

4.92 Dr. Maliva testified that: "As part of the mechanical integrity testing procedure, FPL is required to do a cement bond log, which evaluates whether the cement is bonded to both the casing and the formation." Tr. 754, lines 13 to 22 (Dr. Maliva). Dr. Maliva explained that the cement bond log, which is evaluated as part of the mechanical integrity testing, as well as temperature logging during the cementing, will reveal gaps or anything in the cement. *Id*. Dr. Maliva concluded:

> This whole process is very rigorously overseen by the FDEP as well as by the engineers. There's continuous onsite supervision. … as far as issues like cementing the pilot hole, that is required in the technical specifications that are prepared. So it's not something that is left to the option of the well driller.

Tr. 737, lines 13 to 21 (Dr. Maliva).

c. NRC Staff Testimony

4.93 The NRC Staff testified that, to the extent Mr. Quarles asserts that well construction issues may lead to upward migration of water injected into the Boulder Zone, the FEIS explains why well construction issues that may have previously led to upward migration at other sites will be avoided at the Turkey Point site. Staff Direct Testimony (NRC-002-R2), A79 at 44; FEIS (NRC-008A) at 5-22. The Staff testified that no upwelling related to well construction is expected at the Turkey Point Units 6 and 7 site because under newer well construction techniques, the pilot hole is cemented before the actual well is drilled. Staff Direct Testimony (NRC-002-R2), A79 (DOB, PBT); FEIS (NRC-008A) at 2-56. According to the Staff, the wells will be tested during operation to ensure their mechanical integrity. Staff Direct Testimony (NRC-002-R2), A79 (DOB, PDT). The Staff further testified that monitoring and testing requirements will of the UIC program will help ensure that wells are properly installed and operating. *Id*., A128 at 78. Specifically, the Staff testified that well casing pressure is monitored continuously during operation, and this pressure indication would allow FPL to shut

down the well and take corrective action if a well should fail during operation. Staff Rebuttal Testimony, A44 (DOB, PDT). In the FEIS, the NRC Staff determined that the proposed monitoring of injection well construction and operation is sufficient to detect incorrect well construction or well failure during operation in a timely manner. FEIS (NRC-008A) at 5-22, 5-41.

4.94 On the subject of well construction, Mr. Barnhurst, in response to a question from Judge Kennedy, clarified the NRC Staff role with respect to injection wells. Specifically, in response to questions about the NRC Staff's oversight role with respect to cementing the injection well, Mr. Barnhurst responded that as part of the process of preparing the FEIS, Staff visited the site, talked to FPL about different requirements they were required to follow, reviewed the applicable sections of the Florida Administrative Code, and verified FPL's permit from the State of Florida confirming that the work had been to the satisfaction of the State of Florida. Tr. 739, line 24 to Tr. 741, line 9 (Mr. Barnhurst). Mr. Thorne testified that the Staff, during the process of developing the EIS, met with people from the Florida Underground Injection Control program, made sure to understand the applicable requirements and the well design and technology FPL would use, reviewed FPL's daily drilling reports for EW-1, and verified that FPL provided adequate seals to prohibit upwelling. Tr. 742, Lines 4-19 (Mr. Thorne).

d. Board Findings on Well Construction and Operation (Panel 2)

4.95 This portion of the confinement component of Contention 2.1 concerns the potential for injection well construction issues or well failure to result in the upward migration of wastewater. After reviewing the evidentiary record, for the reasons set forth below, we find that the FEIS conclusion that modern well-construction procedures and technology will likely prevent the upward migration due to injection well construction issues or injection well failure is well supported.

4.96 In the FEIS (NRC-008A), the Staff explains why well construction issues that may have previously led to upward migration at other sites will be avoided at the Turkey Point Units 6 and 7 site. FEIS (NRC-008A) at 5-21 to 5-23. The Staff based its conclusion on the Applicant's use of "modern well technology" – the Staff credited current well construction procedures and technologies to prevent wastewater migration into the Upper Floridan aquifer due to well failure or construction issues. FEIS (NRC-008A) § 5.2.1.3 "Boulder Zone," including subsections entitled "Composition of Injected Wastewater" (FEIS (NRC-008A) at 5-20 to 5-21), "Evaluation of Confinement of Injected Wastewater in the Saline Lower Floridan Aquifer" (FEIS (NRC-008A) at 5-21 to 5-23), "Extent of Upwelling at Deep Well Injection Facilities" (FEIS (NRC-008A) at 5-23), and "Potential Causes of Upwelling of Injected Wastewater through the Middle Confining Unit" (FEIS (NRC-008A) at 5-23 to 5-26). At the hearing, the Joint Intervenors did not challenge the adequacy of these well construction procedures. After a series of questions and responses centered on well construction, testing and monitoring (Tr. 751, line 9 to Tr. 758, line 20), Mr. Quarles acknowledged that he did not see requirements for well construction and operation as "being inadequate or deficient." *Id.*

4.97 Additionally, Joint Intervenors did not present evidence to challenge the effectiveness of the monitoring and testing requirements of the UIC program which will help ensure that wells are properly installed and operating. Staff Direct Testimony (NRC-002-R2), A128 at 78 (DOB, PDT). Specifically, the Staff testified that well casing pressure is continuously monitored during operation, and this pressure indication would allow FPL to shut down the well and take corrective action if a well should fail during operation. Staff Rebuttal Testimony (NRC-072), A44 (DOB, PDT). In preparing the FEIS, NEPA requires application of a "rule of reason" to environmental analyses. *See Louisiana Energy Servs.*, CLI-05-20, 62 NRC at536. We find that the Staff has performed a reasonable analysis here. If State of Florida comprehensive requirements for the injection wells are followed, industry best practices are used, and post-operation well monitoring implemented, as described in the FEIS, the Joint

Intervenors offer no evidence, other than speculation, that well construction issues would occur at Turkey Point Units 6 & 7. Nothing in the record leads this Board to a conclusion different than that set forth in the FEIS on the ability of well-construction procedures and technology to prevent upward migration of wastewater to the UFA due to faulty well construction or well deterioration over time. Accordingly, we find for the NRC Staff on portion of Contention 2.1.

3. Whether Upward Migration of Wastewater Would Likely be Detected Before Reaching the UFA (Panel 3)

4.98 Here, Joint Intervenors disagree with FPL's and the NRC Staff's respective prefiled and oral testimony supporting the conclusion in the FEIS that FPL's monitoring systems, as required in part by the Florida Department of Environmental Protection Injection Control permit process, would likely detect leaking or migrating wastewater before it reaches the Upper Floridan Aquifer. In connection with monitoring wells operated together with deep injection wells at other sites in South Florida, the Joint Intervenors offer testimony (including their interpretation of regional studies of deep injection wells) to the effect that monitoring wells have previously not been successful in detecting such migration. For the reasons set forth below, we find that the weight of the evidence supports a finding that monitoring wells could detect upward migration of injected wastewater before it reaches the Underground Source of Drinking Water (USDW) in the Upper Floridan aquifer. We find further that the Staff conclusions in the FEIS regarding upward migration are adequate and well-supported.

a. Joint Intervenors' Testimony

4.99 In Joint Intervenors' Prefiled Direct Testimony, Mr. Quarles states that 40 percent of FPL fluid could contaminate the Upper Floridan aquifer. Quarles Direct Testimony (INT-022), A20, citing Second Affidavit of Mark A. Quarles (INT-003), ¶ 36. Mr. Quarles also asserts that rapid transport along "isolated conduits" results in less dilution because the flow is concentrated along discrete vertical pathways resulting in a higher percentage of injected wastewater reaching the "drinking water aquifer." Quarles Direct Testimony (INT-022), A25 at 21.

Mr. Quarles testified that FPL's monitoring system is unlikely to detect such rapid upward migration. *Id*., A28.

4.100 Mr. Quarles also challenges the Staff's determination in the FEIS that upwelling would be "extremely unlikely." *Id*., A7. Specifically, Mr. Quarles stated that: first, while the FEIS claims it can draw conclusions about the Turkey Point site by comparing it to "hydrogeological conditions and parameters at the sites at which upwelling occurred" (FEIS 5-21), the NRC did not obtain nearly enough information about the specific characteristics of the Turkey Point site to make such comparisons; second, the FEIS incorrectly relies on broad generalizations about the "low-permeability" of the "confining units" that supposedly will contain the injected contaminants; third, the FEIS incorrectly minimizes the significance of known instances of upward migration of contaminated wastewater in the area of the Turkey Point site; and, fourth the FEIS incorrectly attributes the known instances of vertical migration of contaminated wastewater to faulty wells, rather than geologic conduits such as faults and collapsed karst structures. *Id*., A9. According to Mr. Quarles, the four technical studies cited by Staff in support of the potential for vertical flow through geologic pathways on which the FEIS relies do not support Staff's conclusions. *Id*., A8 note 1. Instead, Mr. Quarles asserted that the studies acknowledge that geologic characteristics of a given site are just as likely to be the cause of vertical migration. *Id*. In regard to monitoring systems, Mr. Quarles appears to be saying that such systems at other locations were unable to detect upward migration under circumstances that appear similar to those at Turkey Point. *See id*., A25, A28. During the hearing, Mr. Quarles testified that the presence of vertical conduits may further complicate early release detection. Tr. 789, lines 8 – 18 (Mr. Quarles).

b. Applicant's Testimony

4.101 Dr. Maliva testified that there are many barriers that will prevent migration, including the confining strata between the injection zone and the Upper Floridan Aquifer; the horizontal distance between the injection well site and the nearest potable water supply well; the

direction of groundwater flow; dilution of the wastewater and the biodegradation of the chemical constituents; and, water treatment that occurs before wastewater is injected and after potable water is drawn from the Upper Floridan Aquifer. Maliva Rebuttal Testimony (FPL-061), ¶ 36. He also testified to the successful collection of monitoring well data at the East Central Regional Wastewater Treatment Plant, which indicated that leakage from an injection well remained over 650 feet below the base of the Underground Source of Drinking Water (USDW). *Id*., ¶ 23. Dr. Maliva testified that monitoring data from the South District Plant indicated upward migration was localized an occurred rapidly. Maliva Direct Testimony (FPL-003), ¶ 66. Mr. McNabb testified that an additional barrier was the monitoring of the area around the injection wells. McNabb Rebuttal Testimony (FPL-060), ¶19. Mr. McNabb testified that it was his opinion that the monitoring programs that FPL is required by regulation to put in place will enable FPL and FDEP to respond to leaks, if any, in a timely fashion. McNabb Direct Testimony (FPL-002), ¶ 8. Mr. McNabb explained the monitoring well program in detail in his testimony. *Id*., ¶¶ 44-46.

4.102 In response to a question from Judge Kennedy, Dr. Maliva described the FPL monitoring program to detect injection well failures and potential wastewater migration, confirming that: "[FPL] monitor[s], the injection well[s].

> Continuous flow rate monitoring, continuous annular pressure monitoring, continuous wellhead operating pressure monitoring; the waste stream that goes into the injection well is sampled weekly (before reducing sampling at the 6 month mark if the FDEP concurs); the injection well is sampled weekly for roughly 10, 12 parameters; and, water levels of both zones are continuously monitored.

See Tr. 768, line 1, to Tr. 771, line 1. Dr. Maliva testified that there is no endangerment issue in that endangerment is defined as causing a violation of the primary drinking water standards – here, the injected wastewater has been treated to a higher degree than required so that it already meets the federal standards; in the very unlikely event that it did migrate it would not result in endangerment. *See* Tr. 790, line 3, to Tr. 792, line 12 (Dr. Maliva).

c. NRC Staff Testimony

4.103 First, the NRC Staff disagrees with Mr. Quarles's testimony that the injected wastewater may reach the "drinking water aquifer" because the Upper Floridan Aquifer is not a drinking water aquifer. Staff Rebuttal Testimony (NRC-072), A39 (DOB, PDT). The Staff testified that although the Upper Floridan aquifer is characterized as an Underground Source of Drinking Water (USDW), this characterization does not mean that the Upper Floridan Aquifer is used for drinking near the site or without further treatment. *Id*. The NRC Staff testified that the Upper Floridan aquifer near the Turkey Point Units 6 and 7 site is not used for drinking water or without further treatment. *Id*.

4.104 Next, the NRC Staff disagrees with Joint Intervenors' assertion that the Staff found upwelling to be "extremely unlikely." The Staff testified that the FEIS does not support Mr. Quarles's testimony and that he has inaccurately paraphrased and selectively quoted the Staff's conclusions. Staff Rebuttal Testimony (NRC-072), A39 (DOB, PDT). The Staff determined the most likely scenario for the movement of injected effluent in the Boulder Zone by reviewing extensive literature and conducting confirmatory analyses of modeling done by FPL. *See* Staff Rebuttal Testimony (NRC-072), A40. The results of this analysis were set forth in Appendix G of the FEIS. FEIS (NRC-008C), Appendix G. Based on its analysis, the Staff found that upward migration of injectate from the Boulder Zone would likely be less than 300 feet into the base of the Middle Confining Unit. Staff Rebuttal Testimony (NRC-072), A40 (DOB, PDT). *See also* FEIS (NRC-008C), Appendix G at G3.3. The NRC Staff testified - and the FEIS acknowledged - that upward migration into the Middle Confining Unit is possible and the Staff provided a maximum expected migration extent in FEIS, Appendix G.3.3. Staff Rebuttal Testimony (NRC-072), A39 (DOB, PDT); FEIS (NRC-008C) at Appendix G.3.3.

4.105 To evaluate the likelihood that injected wastewater would remain confined in the saline aquifers below the Upper Floridan underground sources of drinking water (USDW) aquifer, the Staff considered the injection well testing and groundwater monitoring requirements

of the Florida Department of Environmental Protection's Underground Injection Control program. FEIS (NRC-008A) at 5-17 to 5-18. The Staff further explained that upward migration through the Middle Confining Unit and into the Upper Floridan aquifer, which is the Underground Source of Drinking Water (USDW), is "extremely unlikely," and that if leakage associated with an injection well did occur, the monitoring wells required by the Florida Department of Environmental Protection's Underground Injection Control program could detect the leak. FEIS (NRC-008A) at 5-26; Staff Direct Testimony (NRC-002-R2), A78, A79 (DOB, PDT). The Staff also described how data from monitoring wells had been used to test hypotheses regarding upward migration at the South District Plant. Staff Rebuttal Testimony (NRC-072), A33 (DOB, PDT)

4.106 In summarizing the Staff's position on the subject of potential upwelling, Mr. Barnhurst testified that while each of the studies that evaluated the potential causes of upwelling at the South District makes a statement that the upwelling could result from a natural feature, where upwelling occurred, it more likely resulted from a well-related issue. Tr. 747, lines 18 to 23 (Mr. Barnhurst). Based on the studies Mr. Barnhurst reviewed, particularly Dausman (NRC-047), he concluded that "[t]here was no evidence for pathways at the South District." Tr. 748, lines 18 to 25 (Mr. Barnhurst). Mr. Barnhurst also quoted Dausman for the proposition that upwelling at the South District Plant most likely resulted from "flow through a channelized pathway caused by well construction." Tr. 748, lines 15-17. In responding to an extended discussion between Mr. Quarles, Dr. Maliva, and the Board on the differing approaches to injections taken by the Florida Department of Environmental Protection (FDEP) and the EPA, Mr. Barnhurst testified that if you treat [the wastewater] to that [the FDEP] level, that even if it migrates, it's below a level which would threaten any source of groundwater. Tr. 799, line 1, to Tr. 800, line 18 (Mr. Barnhurst).

d. Board Findings Regarding Monitoring Wells (Panel 3)

4.107 Panel 5 testified on whether upward migration of leakage from the proposed deep injection wells, if it occurred, would be detected by the monitoring wells before the leakage reaches the Upper Floridan aquifer. For the reasons set forth below, and upon review of all the evidence in the record on this topic, the Board finds the FPL and Staff prefiled and oral testimony persuasive in supporting the FEIS's conclusion that the FPL dual-zone monitoring wells installed and operated in accordance with the State of Florida requirements for such wells can reasonably be expected to allow the detection of upward migration resulting from leaks in the proposed deep injection wells before such leakage reaches the Underground Source of Drinking Water (USDW) in the Upper Floridan aquifer.

4.108 The Staff evaluated incidents of upwelling in several sections of the FEIS. In FEIS Section 5.2.1.3, the Staff evaluated upwelling in the Boulder Zone, the Saline Lower Floridan Aquifer, and the Middle Confining Unit. The Staff's analysis can be found in FEIS Boulder Zone subsections entitled "Composition of Injected Wastewater" (FEIS (NRC-008A) at 5-20 to 5-21), "Evaluation of Confinement of Injected Wastewater in the Saline Lower Floridan Aquifer" (*id.* at 5-21 to 5-23), the "Extent of Upwelling at Deep Well Injection Facilities" (*id*. at 5-23), "Potential Causes of Upwelling of Injected Wastewater through the Middle Confining Unit" (*id*. at 5-23 to 5-26), the "Extent of Injected Wastewater Migration at the Turkey Point Site" (*id*. at 5-26 to 5-29), and "Groundwater-Quality Impacts" subsections "UIC Impacts" (*id*., § 5.2.3.2 at 5-39 to 5-42).

4.109 The NRC Staff demonstrated persuasively that upward flow of injected wastewater would be inhibited by the more than 1,465 ft. thick sequence of predominately low-permeability rocks that lie between the Boulder Zone and the underground sources of drinking water, and the dip of the base of the Middle Confining Unit in southeast Florida. FEIS (NRC-008A) at 5-21 to 5-23. The FEIS at Appendix G.3.3.2 documents the Staff determination that no impact would occur to the Upper Floridan aquifer even if more than 90

percent of the injected wastewater as rapidly migrated from the Boulder Zone through the Middle Confining Unit to the Upper Floridan aquifer. *See* FEIS (NRC-008C), Appendix G at G.3.3.2; Staff Direct Testimony (NRC-002-R2), A38 to A58.

4.10 Finally, the Board finds no support in the evidentiary record for Mr. Quarles's assertion that the Staff, in its FEIS, concluded that upward migration at the Turkey Point site is "extremely unlikely." Quarles Direct Testimony (INT-022), A7. Mr. Quarles testified that:

> [T]he NRC has failed to provide a reasonable amount of technical support for the conclusions in the FEIS that (1) upward migration is "extremely unlikely" to occur from the underground injection of wastewater at the Turkey Point site.

Id. The FEIS does not support Mr. Quarles's testimony nor does the Board find Mr. Quarles testimony persuasive; he has inaccurately paraphrased and selectively quoted the FEIS conclusions. Contrary to Mr. Quarles assertions, the NRC Staff acknowledged that upward migration into the Middle Confining Unit is possible, and the Staff even provided a maximum expected migration extent in FEIS Appendix G.3.3. *See* FEIS (NRC-008A) at 5-26. Further, the FEIS documented a number of modeling scenarios evaluating the potential maximum extent of migration through a competent (non- fractured) Middle Confining Unit and impact that would occur to the Upper Floridan if rapid migration occurred along a connected pathway through the entire Middle Confining Unit. FEIS (NRC-008C), Appendix G, § G.3.3.2.

4.111 NEPA obligates the NRC to describe the environmental effects of the proposed action. We find that, with respect to this issue, the NRC Staff has met its burden. We find the FEIS thoroughly describes and evaluates the injection environment and analyzes what is most likely to happen to the injected wastewater.

4.112 The Staff, in the FEIS, concluded that, while some vertical migration may occur, site conditions at Turkey Point will prevent significant migration and that any significant upward movement of effluent would be inhibited by the more than 1400ft low-permeability rock of the Middle Confining Unit, thus making movement of the effluent into the Upper Floridan aquifer

extremely unlikely. The Staff and FPL testified that in order for the Applicant to obtain an Underground Injection Control permit by the Florida Department of Environmental Protection, the Applicant must show that the data from all 12 injection wells demonstrates that the Middle Confining Unit offers confinement of injected fluids. Staff Direct Testimony (NRC-002-R2), A80; FEIS (NRC-008A) at 5-26 and Appendix G (NRC-008C) at G.3.3. The Staff's testimony, FPL's testimony and the FEIS taken together demonstrate that any upwelling of wastewater injectate will be minimal and detected. We find that the FEIS persuasive in supporting the conclusion that any lack of data indicating upward migration from monitoring wells at other sites was most likely due to improper well installation that allowed leakage to bypass the monitored zones. Having considered the entire evidentiary record, including the FEIS, other exhibits, and witness testimony, the Board finds that the FEIS conclusion that the Middle Confining Unit can reasonably be expected to confine fluids and that any upwelling of wastewater injectate will be minimal, detected, and remediated, is reasonable and well-supported.

V. CONCLUSIONS OF LAW ON CONTENTION 2.1

5.1 The Licensing Board has considered all of the evidence presented by the parties on Contention 2.1. Based upon a review of the entire record in this proceeding and the proposed findings of fact and conclusions of law submitted by the parties, and based upon the findings of fact set forth above, which are supported by reliable, probative, and substantial evidence in the record, the Board has decided all matters in controversy concerning this contention and reaches the following conclusions.

5.2 With respect to the environmental impacts of deep well injection of reclaimed wastewater in the form of cooling-tower blowdown, the FEIS identifies and adequately considers the direct, indirect, and cumulative impacts associated with the potential impacts of heptachlor, toluene, ethylbenzene, and tetrachloroethylene in the injected water. We find that the Staff has taken the requisite "hard look" at the direct environmental impacts of the constituent levels in the wastewater that will be injected into the Boulder Zone, and has documented its analyses and

conclusions in a manner consistent with NEPA's requirements. In particular, we conclude that the Staff has given the "hard look" required by NEPA to the effects of the four constituents in the injected water assuming that water is discharged directly to the Underground Source of Drinking Water (USDW) in the Upper Floridan aquifer. We further conclude that the Staff has given the requisite "hard look" to regional studies of stratigraphy in South Florida and their significance with respect to the Turkey Point site, and appropriately disclosed those studies and the Staff analyses of them in the FEIS. We also conclude that the Staff has given the "hard look" required by NEPA to the data obtained from EW-1 regarding the subsurface conditions at the Turkey Point site, and deep injection well construction techniques, operating procedures, and associated monitoring wells, and appropriately disclosed the information and associated Staff analysis and conclusions in the FEIS. Therefore, we conclude that the FEIS complies with NEPA and with the NRC regulations in 10 C.F.R. Part 51, in that the Staff has taken the requisite hard look at the direct, indirect, and cumulative environmental impacts of the proposed

action, and has documented its analysis and conclusions in a manner consistent with NEPA's requirements. As such, we conclude that Contention 2.1 must be denied.

Respectfully submitted,

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Dated at Rockville, Maryland
this 15th day of June, 2017