# RISK ASSESSMENT OF PER- AND POLYFLUOROALKYL SUBSTANCES ON WESTERN SNOWY PLOVER IN ORMOND BEACH WETLANDS, OXNARD, CALIFORNIA

by

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# ABSTRACT

Ormond Beach wetland complex in Oxnard, California, houses one of the few remaining intact dune-transition, zone-marsh systems on the west coast. The threatened Western Snowy Plover (*Anarhynchus nivosus nivosus C.*) uses this dune-transition zone during their nesting season. Ormond Beach is bordered on either side by Port Hueneme Naval Base and Point Mugu Naval Air Station, both of which used Aqueous Film Forming Foam, introducing Per- and polyfluoroalkyl substances (PFAS) to the groundwater and local ecosystems. This assessment was conducted to assess the extent of exposure and impact of PFAS on the Western Snowy Plover, due to the proximity of the Ormond Bech wetland complex to these naval bases. First, I accessed historic PFAS groundwater data from the Point Mugu Naval Air Station and Port Hueneme Naval Base and used theoretical groundwater models to assess the potential groundwater transport from the bases to the groundwater fed sections of the wetland complex. I found that there are potentially substantial effects to the Ormond Beach wetland complex and the Western Snowy Plovers that nest there from both perfluorooctane sulfonic acid (PFOS) and perfluorobutate sulfate (PFBS). With a Risk Quotient (RQ) for PFOS of 575, I recommend that additional data be obtained from the Ormond Beach wetland complex to understand PFAS exposure and further risk levels of these wetlands. Second, I reviewed the current federal and state policy and regulatory framework addressing PFAS contamination, highlighting the Environmental Protection Agency's PFAS Action Plan, the Department of Defense's amendments, and overall and California based state-level initiatives. Despite significant progress in human health targeted policy, legislative gaps remain in managing PFAS proliferation and cleanup protocols, necessitating ongoing vigilance and adaptability from local and federal governments. Last, I conducted a stakeholder analysis of Ormond Beach to inform mitigation challenges. The Ormond Beach wetland complex involves diverse stakeholders, including federal agencies, local governments, conservation organizations, and private landowners. These complementary objectives revealed a substantial PFOS risk (Risk Quotient = 575) to Western Snowy Plovers at Ormond Beach with minimal legislative guidance on potential mitigation or remediation.

# INTRODUCTION

## Background

Ormond Beach is a six square kilometer area composed of agriculture, industry, and estuarine wetlands (Chakraborti & Bays 2023). An approximately three-kilometer beach extends from Port Hueneme Naval Base (PHNB) to the northwestern boundary of Point Mugu Naval Air Station (PMNAS), which encompasses Mugu Lagoon in Oxnard, California. With more than four square kilometers of wetlands, the complex houses six threatened or endangered species and six species of concern (Coastal Conservancy 2006). Ormond Beach is considered a wetland of high conservation priority due to the intact dune-transition zone marsh system, creating a buffer against sea level rise and providing habitat for several State and federally protected species (Coastal Conservancy 2016).

Due to the unique dune-transition zone marsh system present at Ormond Beach, the US EPA listed species, the Western Snowy Plover (*Charadrius nivosus nivosus*) nest along the high tide mark between the months of March and September (California Audubon 2023). These plovers typically lay clutches of three eggs between April and July, nesting in shallow scrapes on open sand or occasionally under vegetation or objects (Lafferty et al. 2006). Many nests fall prey to predators, wind-blown sand burial, or human disturbances during the approximately 27-32 day incubation period (Neuman et al. 2004). Recreational activities and other forms of human disturbance, including urban development, have decreased the plovers' 72 breeding or wintering locations to only 28 (Hornaday et al. 2007).

Ormond Beach receives contaminated surface and groundwater from multiple sources, including the Port Hueneme Naval Base and Point Mugu Naval Air Station, which border either

side of the wetlands complex. Under Department of Defense (DoD) direction, both bases historically used fuel-based fire suppressant Aqueous Film Forming Foam (AFFF), which contained a combination of perfluorooctane sulfonate (PFOS) and other Per- and Polyfluoroalkyl Substances (PFAS) (Figure 1) (Houtz et al. 2013). Studies conducted by DoD, researchers for DoD, and researchers at U.S. Air Force installations validate the presence of PFAS in environmental compartments and transportation of PFAS from location beneath AFFF training areas to surface water, sediment, and groundwater (Suki 2020; Lanza et al. 2017; Gewurtz et al. 2014). PFAS are now measured in the soil and surface water at and near military bases to understand and address potential PFAS contamination (Divine et al. 220; Bell et al. 2021).

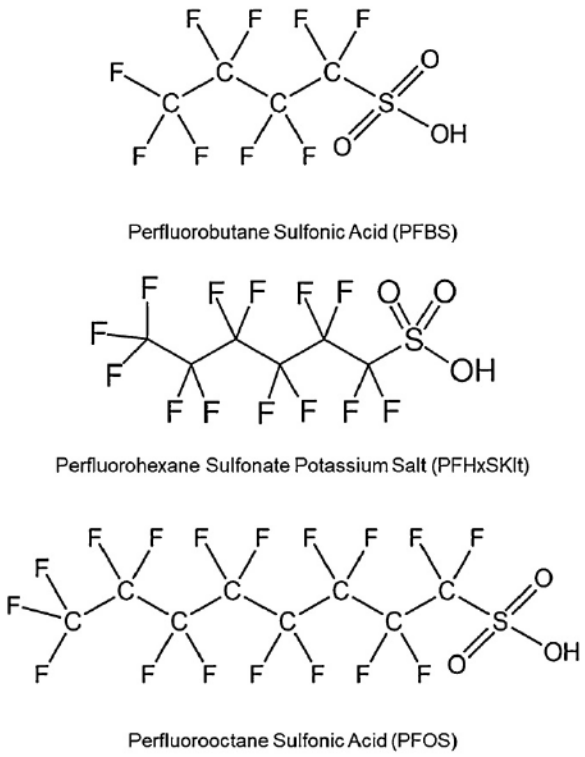


Figure 1. Chemical structures of three alkyl acids: perfluorobutane sulfonate (PFBS), perfluorohexan-1-sulphonic acid (PFHxS), and perfluorooctane sulfonate (PFOS). (Huang et al. 2019)

PFAS, including perfluorobutane sulfonate (PFBS) and perfluoroalkyl carboxylic acids (PFCAs), are a large group of synthetic organofluorine aliphatic compounds used since the 1940s to make fluoropolymer coatings (Arslan & El-Din 2021). PFAS contain fluorinated carbon chains and a charged functional group, resulting in ampiphilic compounds presenting both hydrophobic and lipophobic characteristics that have led to their use in surfactants, fire-retardants, lubricants, paints, polishes, and textiles (Zhang et al. 2021).

PFAS are an emergent group of contaminants of concern due to potential health impacts on children and reproductive health (Anderko & Penna 2020). Extremely persistent and somewhat mobile in environmental media, these chemicals have been detected globally in nearly all environmental compartments and biota (Lettoof et al. 2023; Li et al. 2022; Anderko & Penna 2020; Brusseau et al. 2020). Due to the proliferation of and recalcitrance of PFAS, there is growing interest in the potential effects of PFAS to environmental health (Suki 2020).

Recent research indicates wetland areas may act as a passive remediation approach for contaminant-impacted surface water (Awad et al. 2022). Wetlands, often used in the remediation of hazardous materials, may experience effects on their ecological health from these materials (Avila et al. 2021). As hazardous materials and contaminants affect the ecological health and surface water of wetlands, wetland biota are influenced by these environmental stressors. Wetland biota include benthic invertebrates, soil invertebrates, insects, waterfowl, and predatory animals that feed on them (Pascoe 1993).

The Ormond Beach complex involves land ownership by various entities, each with their own jurisdictional compliance obligations concerning environmental pollutants. Additionally, a complex web of stakeholders is involved in the regulation, mitigation, and distribution of PFAS

pollutants in and around the area. The key stakeholders of Ormond Beach include the United States Environmental Protection Agency (US EPA), the DoD, the State of California, the City of Oxnard, the Nature Conservancy, the California State Water Quality Board, and multiple private entities. While some private parties and the DoD remain responsible for potential ongoing PFAS contamination of Ormond Beach, other landowners, including the Nature Conservancy, are working to mitigate the existing contamination. This dichotomy between landowner and stakeholder interests underscores the necessity for a comprehensive strategy in collaborating to address the environmental and health concerns of PFAS contamination while balancing the diverse interests and obligations of all the involved parties.

## Objectives

My study has three objectives. First, I aim to delineate the potential environmental health risk posed by water contaminated with PFAS in non-discrete exposure areas within the Ormond Beach wetland complex, specifically concerning the Western Snowy Plover. Second, I investigate current policy and regulatory frameworks regarding PFAS contamination, with a focus on their efficacy in protecting vulnerable species and ecosystems. Third, I conducted a stakeholder analysis to assess the roles of multiple landowners and stakeholders including regulatory agencies, conservation organizations, and local entities to investigate potential responsible parties for addressing and mitigating any PFAS contamination of the Ormond Beach Wetland complex. Overall, these complementary objectives provide a comprehensive understanding of potential PFAS contamination, PFAS related risks, and examine potential mitigation strategies in and around Ormond Beach.

# CHAPTER TWO

# ENVIRONMENTAL RISK ASSESSMENT

## Problem Formulation

The Ormond Beach wetland complex extends between the Port Hueneme Naval Base and the Point Mugu Naval Air Station, both of which historically used the PFAS-containing AFFF that contaminated the groundwater in and around the bases with PFAS (Houtz et al. 2013). The Western Snowy Plover (*Anarhynchus nivosus nivosus C.*), a threatened species, uses the dune transition zone marsh system of Ormond beach during nesting months (USFWS 2007). According to the California Department of Fish and Wildlife (2023), approximately one third of the wetlands within Ormond Beach are groundwater fed, potentially allowing for PFAS contaminated water to interact with fauna residing in and around these wetlands. Therefore, I hypothesized that the Western Snowy Plovers that nest at the Ormond Beach wetlands complex is exposed to distinct forms PFAS to an extent that is deleterious to their health. To understand the potential risk to the Western Snowy Plovers that nest at the Ormond Beach wetlands complex from exposure to PFAS chemicals, I reviewed the available groundwater and exposure limit data.

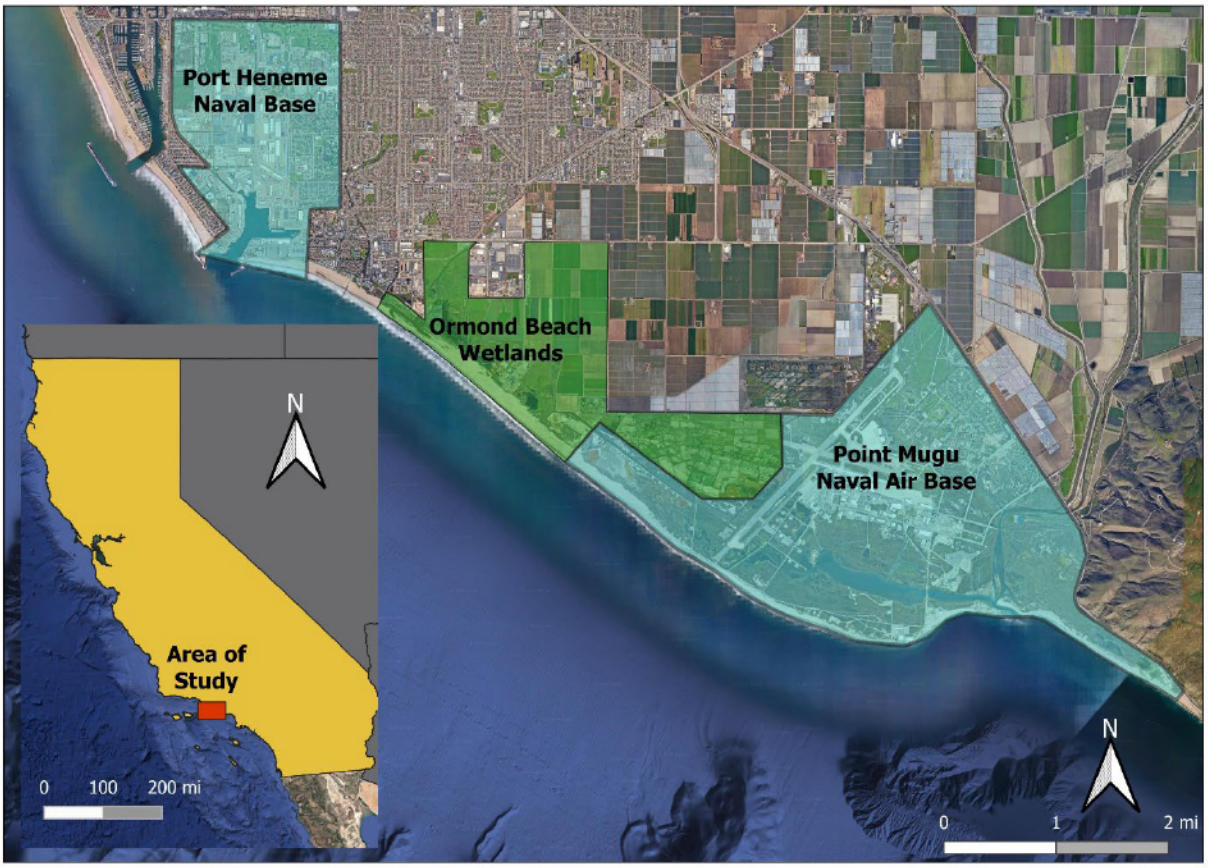


Figure 2. The Ormond Beach Wetlands and its proximity to the Port Hueneme Naval Base and Point Mugu Naval Air Base. An area map is shown in the lower left corner depicting the area of study within the greater California region.

## Hazard Identification

Because PFAS resist degradation and bioaccumulate, exposure to these chemicals magnifies through the food web. Western Snowy Plovers (*Charadrius nivosus nivosus C.*), a small insectivore shorebird, use the dune-transition zone-marsh system as a nesting area and are listed as a threatened species under the Endangered Species Act (USFWS 2007). Western Snowy Plovers historically experienced loss of habitat and nesting grounds, limiting availability of viable nesting areas greatly reducing their population (Hornaday et al. 2007).

As the plovers reside, nest, and feed on riverine and benthic microinvertebrates in and around contaminated wetland waters, they are exposed to PFAS via dietary ingestion, water ingestion, air exposure, and dermal exposure (Divine et al. 2020). Avian exposure to PFAS results in PFAS-induced eggshell thinning, reduced hatching success, and impaired chick development (Suki 2020). Effects of exposure to PFAS on adult avian species beyond reproductive health are not yet thoroughly evaluated and are not considered for this analysis.

The current literature regarding the prolonged impacts of PFAS has stemmed largely from experimental studies involving laboratory animals. Among the primary outcomes of PFAS's toxic effects are decreased reproductive health and disruption of thyroid functions, coupled with its potential to induce carcinotoxicity (Anderko & Penna 2020). Both PFOS and PFOA have shown moderate acute toxicity after oral or inhalation administration (Peritore et al 2023). Limited research is available regarding the direct toxicity of PFAS to threatened and endangered species, and their exposure to PFAS; therefore, I used surrogate species when establishing avian risk-based values. The common surrogate species for PFAS effects to the Western Snowy Plover is the Tree Swallow (*Tachycineta bicolor V.*) (Divine et al. 2020).

Studies from the US EPA and DoD established a Risk Quotient (RQ) for PFAS for birds at Chronic Risk as Estimated Environmental Concentrations (EEC) / Minimum Chronic Lethal Concentration 50 (MCLC50) (Bean et al. 2023). The MCLC50 for Tree Swallows is 1.1 mg/L for PFBS and 0.0006 mg/L for PFOS (Divine et al. 2020). My risk assessment uses the MCLC values from the 2020 DoD report for the Tree Swallow as a surrogate species. It also uses the current US EPA guidelines on risk quotient analysis for endangered species with current DoD measurements of PFAS contamination in and around the Ormond Beach wetland complex.

Methods

It should be noted that there are currently no available data on PFAS presence in the Ormond Beach wetland complex; however, there are DoD procured data for groundwater at both Point Mugu Naval Air Station (PMNAS) and Port Hueneme Naval Base (PHNB). Because the Ormond Beach wetland complex is comprised of groundwater-fed wetlands alongside estuarian and surface water wetlands, the DoD data were input into the Ventura Regional Groundwater Flow Model (VRGFM) to estimate the presence of two PFAS (perfluorooctane sulfonate [PFOS] and perfluorobutane sulfonate [PFBS]) in Ormond Beach (United Water Conservation District 2018; Sullivan 2018; DoD 2019). The VRGFM is a hydrogeologic, conceptual, numerical groundwater flow model created by the United Water Conservation District of Ventura County to more accurately represent all major hydrostratigraphic units within the Ventura County watersheds. The model was created with multidecadal well data and has suffered from lost historic data; therefore, for my assessment, all data from VRGFM are purely theoretical and are used to understand potential presence and effects of exposure at this site.

The VRGFM indicates potentially 5.2% of groundwater from PMNAS and 31.8% of groundwater from the PHNB would be available for resurfacing under the Ormond Beach wetland complex. Approximately 324 acres of Ormond Beach's 1,012 acres of wetlands are groundwater-fed (Fish and Wildlife 2023). Assuming 5.2% of contaminated groundwater from PMNAS and 31.8% of groundwater from PHNB entered the 324 acres of Ormond Beach's groundwater-fed wetlands, there is potential for a minimum of 324 acres of contaminated surface water.

The DoD reported 19 distinct PFAS chemicals present in groundwater at PMNAS in 2018, with PFOS levels of 30,477 ppt and PFBS levels of 1,614 ppt (Sullivan 2018). The DoD

also reported two distinct PFAS chemicals present in groundwater at PHNB with PFOS levels of 1,080,000 ppt, PFOA levels of 102,460 ppt, and PFBS levels of 0 ppt in 2018 (DoD 2019). Although PFOA was identified in the groundwater at both PMNAS and PHNB, there are currently no known MCLC50 measurements for this chemical; therefore, it was excluded from my study.

Noting that 5.2% of groundwater from PMNAS containing 30,477ppt of PFOS and 1,614ppt of PFBS and 31.8% of groundwater from PHNB containing 1,080,000ppt of PFOS enters the groundwater fed wetlands at Ormond Beach, it was assessed that the Ormond Beach wetlands complex potentially contains PFOS levels of 345,026 ppt or 0.345026 mg/L (PFOS = [30,477 ppt*5.2%] + [1,080,000 ppt*31.8%]) and PFBS levels of 84 ppt or 0.000084 mg/L (PFBS = [1,614 ppt*5.2] + [0 ppt * 31.8%]).

Table 1. Comparison of concentration (ppt) of contaminates and percent of groundwater entering Ormond Beach wetlands complex for each of the DoD naval stations.

| DoD Location | Concentration (ppt) of PFOS | Concentration (ppt) of PFBS | % of groundwater entering Ormond Beach wetlands complex |
|---|---|---|---|
| PMNAS | 30,477 ppt | 1,614 ppt | 5.2% |
| PHNB | 1,080,000 ppt | 0 ppt | 31.8% |

PFOS = (Concentration (ppt) from PMNAS * % groundwater from PMNAS) + (Concentration (ppt) from PHNB * % groundwater from PHNB)

PFOS = (30,477*0.052) + (1,080,000*0.318)

PFOS = 345,026 ppt OR 0.345026 mg/L

PFBS = (Concentration (ppt) from PMNAS * % groundwater from PMNAS) + (Concentration (ppt) from PHNB * % groundwater from PHNB)

PFBS = (1,614*0.052) + (0*0.318)

PFBS = 84 ppt OR 0.000084

Figure 3. The equations used to calculate potential levels of PFOS and PFBS in ppt at the Ormond Beach wetlands complex.

## Results and Discussion

Exposure Assessment. The current known pathways of PFAS chemicals for aquatic avian insectivores include dietary ingestion, water ingestion, air exposure, and dermal exposure (Divine et al. 2020). With these exposure pathways, the surrogate species, Tree Swallows, have a known MCLC50 for PFOS of 0.00060 mg/L. Using the aforementioned potential surface water contamination, the Western Snowy Plover has a PFOS Risk Quotient (RQ) of 575 (RQ = [0.345026 mg/L]/[0.00060 mg/L]). The surrogate species also have a known MCLC50 for PFBS of 0.00047 mg/L, resulting in a RQ of 0.0000076 (RQ = [0.000084 mg/L]/[1.1 mg/L]).

Risk Characterization. In accordance with the risk presumptions and levels of concern established by the US EPA for chronic aviary risk, the Ormond Beach wetlands complex presents a significant risk and level of concern for potential PFOS exposure with postulated deleterious effects to Western Snowy Plover health as any RQ greater than 1.0 are assumed to signify potential health risks and PFOS exposure presents a RQ at 575. Alternatively, there is little to no

potential risk to exposure from PFBS with a RQ far below the 1.0 threshold with the RQ of 0.0000076. Odegard et al. (2023) notes, "Lab and field studies suggest that exposure to [PFOS] may be harmful to avian reproduction and that insectivorous birds feeding in aquatic habitats may have an increased risk." Given the Western Snowy Plover's status as a threatened species with diminished birth rates, the pronounced potential for PFOS exposure at the Ormond Beach wetlands complex necessitates immediate attention. This situation should be researched and mitigation measures implemented at these wetlands.

Uncertainty

The VRGFM results are theoretical and may not accurately predict the actual amount of groundwater influence PMNAB and PHNB have on the Ormond Beach wetland complex. As noted by the United Water Conservation District (2018), "USGS guidance notes that non-unique configurations of model parameters can produces reasonably good calibration statistics, but not necessarily yield a good model." Due to agricultural influence in Ventura County, it can be assumed that groundwater levels are subject to variability; therefore, the results of this model are also subject to variability. To mitigate this level of uncertainty, I recommend that PFAS testing be conducted at the Ormond Beach wetlands complex.

In addition, the DoD RBSL and NOAEL levels are calculated with the surrogate species, Tree Swallows, and may not accurately depict Western Snowy Plover exposure factors or effects. To help mitigate this uncertainty, further inquiry is recommended to assess plover average size, weight, and dietary habits to accurately calculate PFAS exposure and effects to this species. It is further recommended that monitoring programs are implemented at the Ormond Beach wetlands

complex to measure PFAS (specifically PFOS) presence in surface water and dietary components of the Western Snowy Plover.

## Conclusion

The potential chronic PFAS exposure risks to the Western Snowy Plover at the Ormond Beach wetlands complex highlights a significant environmental concern. Using the VRGFM and DoD base groundwater data, this study calculated potential PFAS concentrations, revealing a concerning RQ of 575 for PFOS, which significantly exceeds the threshold of concern of 1.0. This level of potential exposure indicates serious implications for the overall health and reproductive success of the plovers. It is of note that the reliance on theoretical groundwater models and use of surrogate species data introduce uncertainty that necessitates further PFAS testing and research within the wetlands complex to further refine the risk assessment.

# CHAPTER THREE

# POLICY REVIEW

Due to the pervasive nature of PFAS contamination, the regulatory landscape surrounding PFAS has evolved rapidly over a short span of time. Both federal and state governments are writing and passing legislation to reduce PFAS production, limit further environmental contamination, and establish frameworks for remediation (DFARS 2024; Safer States 2024; US EPA 2024h; Moyer 2021; US EPA 2019). For the land managers of the Ormond Beach wetland complex and other PFAS impacted lands, navigating the patchwork of current legislation is paramount to potential contamination cleanup efforts.

## Federal Regulatory Framework for PFAS Management

In 2019, the US EPA introduced a PFAS Action Plan representing a comprehensive strategy to address the human and environmental challenges of PFAS contamination (US EPA 2019). This multifaceted plan encompasses research efforts to better comprehend PFAS toxicity and exposure pathways, develop regulatory standards for PFAS in environmental media, and collaborate with other governing agencies to facilitate PFAS monitoring and remediation efforts. Through the PFAS Action Plan, the US EPA seeks to mitigate the adverse effects of PFAS contamination on human health and the environment while promoting sustainable management practices to prevent future proliferation of PFAS (US EPA 2024h). In October 2021, the US EPA announced its PFAS Strategic Roadmap, a report that sets a timeline by which the US EPA plans to take specific actions toward PFAS limitations and remediation (US EPA 2023a).

In April 2024, the US EPA announced the final National Primary Drinking Water Regulation (NPDWR) for six specific PFAS chemicals, marking a significant milestone in addressing PFAS contamination (US EPA 2024a). The finalized NPDWR establishes legally enforceable Maximum Contaminant Levels (MCLs) for six distinct PFAS chemicals, including PFOA and PFOS, as well as a Hazard Index MCL for PFAS mixtures to account for the combined and co-occurring levels of these PFAS in drinking water (US EPA 2024b). The MCLs establish a legally enforceable maximum allowable concentration of the distinct PFAS chemicals in drinking water systems (US EPA 2024h). This final rule requires public water utility providers to monitor the six listed PFAS chemicals and complete initial monitoring within three years (by 2027), provide ongoing compliance monitoring, and produce a public disclosure of the PFAS levels under penalty of noncompliance (US EPA 2024c). Water suppliers have until 2029 to implement solutions if PFAS levels exceed MCLs, and from 2029, drinking water providers with PFAS violations must take corrective action and notify the public. These measures are expected to prevent PFAS exposure for around 100 million people, potentially reducing PFAS-related illness (US EPA 2024b). Enforcement of these statutes is supported by $1 billion in funding under the Bipartisan Infrastructure Law for PFAS testing and treatment measures (US EPA 2024d).

In addition to the US EPA's regulatory efforts, the DoD has initiated protocol to manage and limit PFAS contamination through the Department of Defense Acquisition Regulations Systems (DFARS) (DFARS 2023). On September 29, 2023 and again on October 10, 2024, the DoD implemented pivotal amendments to its standing DFARS rule to align with section 322 of the National Defense Authorization Act (NDAA) for Fiscal Year 2020, mandating the cessation

of DoD procurement of AFFF containing over one part per billion of PFAS after October 1, 2023, unless exemptions are applicable (DFARS 2024; DFARS 2023). The amendment reflects DoD's commitment to transitioning to PFAS-free firefighting agents, with provisions requiring the publication of military specifications for such agents by October 1, 2023 (DARS 2023). The rule introduces provisions at DFARS 223.74 and DFARS 252.223–7009 that dictate guidelines for contracting officers and contractors regarding prohibited PFAS concentrations in AFFF. These regulations extend to contracts at or below the Simplified Acquisition Threshold of $250,000 and encompass commercial services and products, including Commercially Available Off-the-Shelf items (DFARS 2024). Through restricting DoD employees and contractors from the purchase or use of PFAS containing items, the DoD anticipates a dramatic reduction of PFAS contamination at military installations and surrounding communities. Despite potential economic implications, the DoD expects minimal contractor impact, emphasizing the availability of fluorine-free firefighting alternatives and prior efforts to reduce AFFF usage (DFARS 2024). The DoD has issued this interim rule, effective November 25, 2024, to meet statutory deadly while remaining open to public feedback for consideration in shaping the final rule (DFARS 2024).

State-Level Initiatives

Although the federal laws governing PFAS are implemented throughout all states, some states have implemented their own, more stringent regulations on PFAS. Policies regarding PFAS regulation are becoming increasingly prevalent at the state level, with 275 policies introduced throughout 34 states and 140 policies adopted throughout 28 states (Safer States 2024). Moyer (2021) suggests the legislative and administrative actions of New Jersey, Michigan, Minnesota, and New Hampshire are the most robust state-level initiatives in

addressing PFAS contamination. Policies specifically addressing PFAS in drinking water include enforceable drinking water standards in several states (i.e. MA, MI, NH, NJ, NY, VT, and ME) and proposed standards (AZ, IA, KY, and RI). An additional 21 states have adopted notification levels for PFAS in drinking water and passed legislation to reduce the presence of PFAS from the source, banning products such as firefighting foam and packaging containing PFAS (US EPA 2024e). In 2021, Maine became the first state to pass legislation prohibiting the sale of PFAS-containing products, with exceptions for essential use by 2030 (State of Maine Legislature LD 1503).

The State of California has passed 14 bills limiting the use, distribution, and consumption of PFAS chemicals, with seven proposed bills currently before the California State Assembly (Safer States 2024). In February 2024, State Senator Nancy Skinner proposed State Bill 903 (State of California SB 903). This bill would mimic the Maine legislation prohibiting the sale of PFAS-containing products, with exceptions for essential use by 2030, with an additional goal of adopting regulations to enact the bill by January 2027. Although the bill did not pass during the May 16, 2024 Senate hearing, it was placed on suspense file with the expectation that the bill be amended to provide a less restrictive timeline (State of California Legislature SB 903). Despite SB 903 not being passed, eight of the 14 enacted bills in California restrict the sale and distribution of consumer products containing PFAS chemicals in multiple market sectors, including juvenile products, food packaging, and cosmetic products (State of California 2022; State of California 2021a; State of California 2021b).

Challenges and Gaps in Legislation

Despite the extensive use of PFAS over the past several decades, there remains a significant gap in understanding how to manage the proliferation of these chemicals effectively. The variety of PFAS compounds complicates efforts to enforce restrictions and establish cleanup protocols. Although the US EPA has taken commendable steps toward addressing this challenge, much groundwork remains before the full extent of the harm PFAS inflicts on human and environmental health can be fully understood. The current emphasis in PFAS regulation focuses on improving drinking water standards; however, no federal or state initiatives address the broader environmental implications of PFAS. Additionally, no standards are currently in place for the cleanup and removal of these chemicals.

## Conclusion

The legislation regarding PFAS contamination and distribution is rapidly evolving, with significant developments occurring at both federal and state levels. The US EPA's PFAS Action Plan and subsequent drinking water regulations set a precedent in addressing this pervasive environmental challenge. Concurrently, the DoD's amendments phasing out PFAS-containing materials demonstrates its commitment to reducing contamination sources. At the state level, a patchwork of more stringent regulations is emerging, leading a strong effort to reduce and eliminate PFAS contamination for public health. As the full extent of PFAS contamination is realized, the regulatory landscape regarding these chemicals must also evolve to assure ongoing vigilance and adaptability from local and federal governments.

This regulatory framework sets a challenging environment for addressing PFAS contamination on a site-specific basis at sites like Ormond Beach. Federal regulations, including the US EPA's drinking water standards and the DoD's DFARS amendments, apply nationwide

and directly affect federal entities akin to the naval bases at Point Mugu and Port Hueneme. These regulations create a baseline for PFAS management; however, they do not address site-specific concerns regarding existing contamination. State-level legislation in California apply to state-owned lands within the Ormond Beach complex and may influence remediation efforts on these parcels as they continue to be developed.

# CHAPTER FOUR

# STAKEHOLDER ANALYSIS

The pervasive nature of PFAS contamination begets a complex web of stakeholders with interests directly impacted by the creation and enforcement of regulatory statutes. The Ormond Beach wetlands involve a range of stakeholders with varying interests, including economic benefit, ecological restoration, and public engagement. These stakeholders include federal, state, and local government entities, private landowners, and conservation organizations. Each stakeholder plays a distinct role in the ongoing preservation, restoration, and potential contamination of the wetlands.

## Government Entities

Federal Government. Several federal agencies play crucial roles in PFAS regulation and mitigation efforts. As discussed in Chapter 2, the US EPA remains the leading authority over contamination limitation and remediation for PFAS. The United States Fish and Wildlife Services (USFWS) supports the US EPA in managing endangered species recovery as well as wetland conservation under the Endangered Species Act and the North American Wetlands Conservation Act (16 U.S. Code § 1531 to 1544; 16 U.S. Code §4401). Given the presence of and potential deleterious effect to the endangered Snowy Plovers at Ormond Beach, the US EPA and the USFWS have vested interests in the potential PFAS contamination at this site.

The DoD is among the largest consumers and historical users of regulated PFAS-containing materials, primarily through AFFF (Suski 2020). The DoD has undertaken extensive investigations into PFAS presence across military bases and conducted potential risk assessments

of ecosystems (10 U.S. Code § 2714). For the 2025 fiscal year, the DoD approved $1.6 billion for the cleanup of PFAS-contaminated sites, more than doubling the previous year's budget (US Congress 2024). Through the PMNAB and PHNB, the DoD has a significant role in PFAS contamination at Ormond Beach.

State Government. The State of California's ownership of multiple parcels within the Ormond Beach complex introduces significant complexity to potential remediation efforts. As both a landowner and regulatory authority, the state plays a dual role in the management and restoration of the site. The California Environmental Quality Act (CEQA) serves as the regulatory framework for governing environmental impact assessment and mitigation for proposed projects at Ormond under state agencies (Cal Pub. Res. Code § 21000-21189 et seq.). Should remediation of the Ormond Beach wetlands commence, all efforts will be subject to CEQA compliance measures, including documentation, reporting, and a public review process (Ouellette & Tehrani 2019).

The California state-level agencies involved in contaminant regulation and environmental protections include the California Department of Fish and Wildlife (CDFW) and the California State Coastal Conservancy (Conservancy). The CDFW bears the responsibility of managing and protecting the State's diverse fish, wildlife, and plant resources (CDFW 2024). With six threatened and endangered species present at Ormond Beach, the CDFW's investment and role are particularly significant. It must be noted, however, that current ongoing restoration efforts at Ormond Beach under the Ormond Beach Restoration and Public Access Project was determined by CDFW to "qualify as a statutorily exempt restoration project under CEQA due to the environmental preservation and restoration goals of the project (Cal. Pub. Res. Code, §

21080.56, subd. (e)). The statutorily exempt restoration project status indicates that future restoration and mitigation projects on this site may also qualify for CEQA non-exempt status.

The Conservancy provides technical assistance and grant funding to local communities, nonprofit organizations, and parties involved in the implementation of multi-benefit projects involving ecosystem restoration along the California coast (Cal. Pub. Res. Code § 30300 et seq.). In 2023, the Conservancy began the Ormond Beach Restoration and Public Access Project Plan with the goal of "balancing habitat restoration and protection of sensitive plant and animal species with improved and increased public access [to Ormond Beach]" (State Coastal Conservancy 2023).

The California State Water Quality Board Region 4 – Los Angeles (SWQBR-LA) ensures all surface water resources within its jurisdiction remain uncontaminated (Cal. Sats. 1949, ch. 1550). Should remediation occur, all activities must be reported to the board, and the project must demonstrate that it is not impacting or decreasing water quality at or around the project site. In addition to general activity reporting, under the 2022 Construction General Permit, should the mitigation or remediation efforts impact greater than 1 acre of soil, the responsible party must apply for a Stormwater Pollution Prevention Plan (SWPPP) (US EPA 2022). Under these regulations, a qualified SWPPP reporter must be on-site weekly to assess potential water impacts of the project and report their findings to SWQBR-LA.

Local Government. Owning over 70% of the parceled land of Ormond Beach, the City of Oxnard (City) serves as the predominant landowner (Ventura County Assessor 2024). The City currently lacks legislation to address hazards to environmental health; however, due to engagement with concerned citizens, the City has begun taking steps to address these concerns

(City of Oxnard 1982). In 2017, the City initiated the process of amending its Local Coastal Program (LCP) (City of Oxnard 2017). The updated LCP, expected to be ready for California Coastal Commission review and approval in 2027, aims to incorporate measures addressing environmental health and community concerns (City of Oxnard 2024). While the City works toward an amended LCP, its involvement in Ormond Beach is paramount, as these policies and regulations will directly influence the management practices implemented on the land.

The County of Ventura complements the City of Oxnard in addressing environmental impacts to Ormond Beach through the coordination with state and federal agencies on compliance measures. The County owns the Ventura County Game Preserve, a 300-acre preserve that aims to conserve local, native flora and fauna within the Ormond Beach wetlands complex (Audubon Society 2024).

Non-Governmental Organizations

Conservation Groups. Conservation non-governmental organizations have emerged as strong advocates for wildlife protection and wetland conservation in the Ormond Beach wetlands complex. The Audubon Society's participation in the protection of bird species like the Snowy Plover underscores the importance of specialized conservation efforts for vulnerable species (Venutra Audubon 2024). Their expertise in avian ecology and habitat requirements provides valuable insights into the future management of the Ormond Beach ecosystem. The Society started a “Snowy Plover Guardians” program in 2015, during which members of the Audubon Society stood watch over Snowy Plover hatchlings and eggs to ensure their protection during this critical period of plover development (Ventura Audubon 2015). The local chapter also conducts Shorebird Recovery walks along the wetlands at Ormond Beach, during which participants

receive education on the species that live, nest, and overwinter in and around the wetlands (Ventura Audubon 2024).

The Sierra Club's advocacy for more extensive environmental protection measures concerning PFAS contamination represents a holistic approach to environmental conservation (Natural Resources Defense Council and Sierra Club Illinois Chapter 2021). Their involvement in Ormond Beach helps to contextualize local issues within broader environmental concerns, potentially influencing policy decisions at multiple levels of government. The Sierra Club is not currently involved in outreach at Ormond Beach; however, the club was an outspoken party regarding the closing of the Halaco Superfund site (Commission 2009).The Sierra Club continues to provide members updates on remediation efforts and offers collaboration with other environmental organizations for members to become involved at Ormond (Sierra Club 2023).

The Surfrider Foundation's focus on coastal protection complements the efforts in addressing PFAS contamination in marine environments. Their expertise in coastal ecosystems and marine pollution could prove invaluable in developing comprehensive strategies for managing PFAS contamination in the Ormond Beach area. To date, the Surfrider Foundation has organized outreach opportunities for members of the foundation and the local community to clean litter from the beach and learn about the unique ecosystem of the wetlands (Surfrider Foundation 2024).

Landowners and Residents. Private sector stakeholders include the Clarence W. Haack Trust and Royal Pacific International Incorporated, as former and current owners of the Halaco Energy plant, respectively (Ventura County Assessor 2024). These entities have significant responsibilities regarding the Superfund site adjacent to the wetlands (US EPA 2024f). Ormond

Beach Power LLC, a combined entity of the Haack Trust and Royal Pacific International, has ongoing interests and responsibilities related to the former Halaco site (US EPA 2022b).

Local communities, including residents and frequent visitors to the Ormond Beach wetlands, may be concerned about potential health risks from PFAS exposure through dermal contact and other pathways. Additionally, the degradation of local environments, such as wetlands, can have broader impacts on community well-being.

### Collaborative Efforts and Future Prospects

Despite conflicts of interest among stakeholders, there are several opportunities for collaboration in addressing PFAS contamination. The DoD's commitment to identifying and mitigating PFAS contamination on its sites demonstrates a willingness to engage in remediation efforts (Coyle et al. 2021). Collaboration between the DoD, local environmental groups, and state regulatory agencies in targeting and addressing PFAS concerns could lead to more effective and comprehensive solutions.

Although the challenges are significant, integrating PFAS mitigation efforts with ongoing Superfund cleanup activities at the Halaco site may provide a more holistic approach to environmental remediation at Ormond Beach. This strategy could leverage existing resources and expertise, leading to more efficient and effective outcomes for the wetland's ecosystem and the surrounding community.

### Parties Liable for Remediation Costs and Efforts

The interplay between federal and state legislation discussed in Chapter 3 establishes the complex regulatory framework for addressing PFAS contamination at Ormond Beach. California's existing environmental laws will likely necessitate a thorough assessment and

potential remediation of PFAS contamination at the site. California's historical tendency to adopt stricter environmental standards than federal regulations suggest the possibility of more stringent PFAS limits in the future (Aragon-Correa et al. 2020).

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund, provides the legal basis for assigning liability in cases of hazardous substance contamination (Mintz 2012). The US EPA's recent designation of PFOA and PFOS as hazardous substances under CERCLA in April 2024 significantly strengthens the agency's ability to compel responsible parties to conduct cleanup efforts (US EPA 2024g).

Under CERCLA, liability is typically assigned to four categories of potentially responsible parties: current site owners and operators, past site owners and operators at the time of disposal, generators and parties that arranged for disposal or treatment, and certain transporters of hazardous substances (Brighton et al. 2024; Stahl et al. 2023). This framework suggests that several potential parties are liable for cleanup and mitigation efforts within the Ormond Beach wetland complex.

The US Airbases Point Mugu and Port Hueneme, known contributors to PFAS contamination, would likely bear significant cleanup responsibility. The DoD oversees these military installations and has already allocated substantial funds for PFAS remediation at its sites nationwide (US Congress 2024). Manufacturers of PFAS-containing products used by the DoD, particularly those used in AFFF, could face liability as generators or arrangers for disposal (US EPA 2024g).

As the majority owner of the wetlands, the City of Oxnard may face liability as a current owner under CERCLA; however, the US EPA's enforcement discretion policy suggests that

municipal entities may not be primary targets for enforcement actions (Marcos 2021). Under such, the State of California and the County of Ventura, both owners of portions of the wetlands, would also not be primary focuses for enforcement actions (Davison 1998). The Nature Conservancy, as the second-largest landowner, could potentially face liability as a current owner of the wetlands; however, its status as a conservation organization and its goals of preserving and restoring the wetlands may influence the US EPA's approach to enforcement (Barr 1990).

Historical industrial operations, such as the former Halaco Energy plant, now a Superfund site, may be liable as past owners or operators. The Clarence W. Haack Trust, Royal Pacific International Incorporated, and Ormond Beach Power LLC should be considered potential responsible parties due to their associations with Halaco Energy (US EPA 2024g; Ventura County Assessor 2024).

It is important to note that CERCLA liability is generally "joint and several", meaning any responsible party can be held liable for the entirety of cleanup costs, regardless of their contribution to the contamination (Oswald 1995). This ensures cleanup occurs regardless of if responsible parties are insolvent or cannot be identified. However, the US EPA's enforcement discretion policy, issued alongside the CERCLA designation of PFOA and PFOS, indicates a nuanced approach to liability identification (Marcos 2021). The agency has stated its intent to focus enforcement on parties who significantly contributed to PFAS releases, including manufacturers and industrial users, while potentially avoiding enforcement on certain parties, including farmers, municipal landfills, and local fire departments where reasonable factors do not support seeking cleanup costs (Barr 1990).

In the context of Ormond Beach, this policy suggests that the US EPA may prioritize enforcement actions against the naval bases and any identifiable PFAS manufacturers or major industrial users in the area (Marcos 2021). Despite their status as current landowners, the City of Oxnard and The Nature Conservancy may be excused from remediation requirements due to their municipal and conservation roles respectively (Barr 1990).

## Recommendations

To effectively address the complex stakeholder landscape and multifaceted challenges regarding PFAS contamination at the Ormond Beach wetland complex, I recommend that a clear delineation of responsibilities among stakeholders is established. While delineation of responsibilities occurs, I also recommend that stakeholder needs and consensus are noted and addressed. Given the intricacies of these relationships, establishing a coordinated framework for action is crucial. The ongoing amendment of Oxnard's LCP presents a valuable opportunity to formalize these collaborative efforts and clarify responsibilities.

Consideration of environmental health and economic factors must be balanced and guide decision-making processes. Robust community engagement and education efforts should be prioritized to ensure local residents understand the potential health risks of PFAS exposure and the importance of ongoing conservation of the wetlands. Programs like the Audubon Society's "Snowy Plover Guardians: and Shorebird Recovery walks serve as models of how to blend public education with conservation efforts. Furthermore, integrating PFAS mitigation strategies with the ongoing Superfund cleanup activities at the Halaco site could provide a more holistic and effective approach to environmental remediation at Ormond Beach.

## Conclusion

The complex nature of PFAS contamination necessitates a multi-stakeholder approach to address its environmental and health impacts effectively. At Ormond Beach, the interplay between federal agencies like the US EPA and DoD, state and local governments, conservation groups, landowners, and local communities is crucial in shaping the response to PFAS contamination. It is of note that the challenges in addressing intricate stakeholder and jurisdictional complexities inherent in addressing PFAS contamination is not unique to the Ormond Beach area, but one that extends beyond this specific location to numerous sites across the country, especially those areas near DoD sites with AFFF use (Suki 2020; Lanza et al. 2017; Houtz et al. 2013). The Ormond Beach case study underscores the ubiquitous nature of PFAS contamination and the legal and stakeholder complexities inherent to these areas; thus, highlighting the need for collaborative, multi-jurisdictional approaches to mitigate contaminations in diverse settings with overlapping ownership and regulatory frameworks.

Collaborative actions addressing environmental issues at Ormond Beach are already underway. In April 2023, the City of Oxnard, alongside the Nature Conservancy and the Commission, initiated efforts to seek national wildlife refuge status for Ormond Beach. If successful, this move would transfer management of approximately two and a half square kilometers of coastal wetlands to the U.S. Fish and Wildlife Service, altering the dynamics of local governance and environmental management in the area (City of Oxnard 2023).

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