A Comprehensive Water Quality Study of Endocrine Disrupting Chemicals, Carcinogens, Pesticides, Pharmaceuticals, and Other Contaminants of Emerging Concern in the Florida Everglades.

Presented by: Save the Water™

A 501 (C) (3) nonprofit organization

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1. Project Abstract

Safe water may be the most pressing concern of our time. Water is life. In South Florida, however, we lack comprehensive monitoring of toxic chemicals present in water, such as carcinogens and endocrine disrupting chemicals, namely, pesticides, pharmaceuticals, and industrial chemicals. For example, endocrine disrupting chemicals are being studied but have been associated with health problems that impact fetal development, brain development, and thyroid function. Endocrine disrupting chemicals have been linked to infertility, obesity, prostate and breast cancer, and diabetes. While some monitoring has published findings, this limited monitoring fails to give a full picture of risks to the Everglades. Eight million people depend on the Everglades. Thus, accurate information about toxic chemicals in the Everglades protects current and future generations.

Save the Water™ is the only organization trying to establish baseline water quality in the Everglades. Save the Water™ has over 80 volunteers, including several with expertise in fields essential to this work, such as analytical chemistry, analytical laboratory management, chemical engineering, chemistry, industrial water treatment, drinking water treatment, and project management. *Our central hypothesis* is that contaminants dangerous to humans have entered the Everglades and are either untested or underreported. *This contribution is significant* because there will be an accurate baseline mapping the existing water quality, so future changes in contaminant load will be easily detected. Also, this mapping will inform decisions and actions about water quality to protect the ecosystem against contamination from dangerous chemicals. The study's results could also be used to determine the impacts of chemicals of emerging concern in future toxicity studies.

To test this hypothesis, we propose to launch a laboratory with the latest water analytical chemistry developments to assess samples collected from multiple sites. At first, our sampling sites will include 26 existing sites monitored by South Florida Water Management District plus 74 more sites for a total of 100 sites. Water samples will be analyzed for more than 2,700 chemicals in the Save the Water™ accredited laboratory. Depending on which chemicals or chemical classes are found, the chemicals will be considered for categorization by order of toxicity. *Our specific aims* are to collect data on water and sediments in the Everglades and to make that data public. Six times a year, two samples will be collected at 100 collection points. Thus, the collections will result in 1200 water samples. After the first year, we will publish our findings and repeat this process with improvements in subsequent years. We will assess the data and make that data available to the scientific community and the public. After the project's fifth year, we aim to expand testing. After the first three years, we expect to be financially self-sustaining and to continue the monitoring indefinitely. Our findings will contribute to the critical and perhaps life-changing knowledge about chemicals of emerging concern, carcinogens, and endocrine disrupting chemicals, such as pesticides. The project necessitates a total of $10,538,337 for the first three years.

2. Statement of Need

2.1 Describe the problem to be addressed

The problem is simple: there is no sentinel of the water quality of the Everglades. The only source of fresh drinking water in South Florida is not being monitored for toxic chemicals as population and industry continue to grow in the watershed. First, in the recent past, dangerous chemicals, discussed elsewhere in this proposal, have been identified and shown to cause adverse health effects on some aquatic species. Endocrine disruption in alligators is well documented.[1,2] Second, statistics as of 2013 show that approximately 1,000 people move into the State of Florida every day.[3] As the population grows, more consumers place a higher demand on water resources and discharge more waste into the environment. Given the first and second points, this could spell disaster for the growing population of South Florida.

The Everglades is a marsh of tropical vegetation that is particular to South Florida and unlike any other body of water in the world. Its average depth of 3 feet with a flow of 34 meters per day is uniquely susceptible to contamination and bioaccumulation.[4] The shallow, slow-moving waters provide the perfect conditions for the settlement of contaminants. The Florida Everglades is designated a national treasure, a World Heritage site, and an international biosphere reserve.[5,6] In other words, it is the most famous wetland on Earth. The diversity of tropical aquatic life, native and some invasive, are thriving in this rare ecosystem.

The Everglades is being attacked by the increasing population and the accompanying environmental stress associated with growth. An increase in population requires more chemicals, which means more hazards. More chemicals in the cocktail may amplify the harmful effects of pollution exponentially because of synergy, additive impacts, or "radiation actions such as sunlight or electromagnetic fields that can change the effects of chemicals, such as pesticides, and metal trace elements on health."[7] As a literature review explained, "[c]ollectively, these studies constitute proof of concept that low doses for humans are not harmless when in mixture."[8]

The chemical cocktail effect contributes to the problem

Since the cocktail effect is so critical, a glimpse of the universe of potentially harmful chemicals is necessary. The U.S. Environmental Protection Agency (EPA) currently identifies thousands of individual chemicals as contaminants of emerging concern (CECs), including endocrine disrupting chemicals. But no organization has been testing for these chemicals in the Everglades.[9] The United States Geological Survey provides a useful definition of CECs as harmful chemicals or microorganisms, stating: "any synthetic or naturally occurring chemical or any microorganism that is not commonly monitored in the environment but has the potential to enter the environment and cause known or suspected adverse ecological and/or human health effects."[10]

The EPA has issued four Contaminant Candidate Lists (CCLs) of unregulated chemicals known or anticipated to occur in public water systems that may warrant future regulation. Additionally, the EPA has issued four Unregulated Contaminant Monitoring

Rules (UCMRs) designed to gather data about CECs by establishing monitoring requirements for public water sources. There are lists of Persistent organic pollutants (POPs), carcinogens, and endocrine disrupting chemicals.

The number of CECs is significant. An overview of the categories of CECs include their purpose, use, or other characteristics. The categories include the following:

- Pesticides
- Pharmaceuticals (prescription and over-the-counter)
- Personal care products
- Plasticizers
- Flame retardants

The following categories describe the nature of CECs:

- surfactants, "which can be used in detergents to aid grease removal and in cosmetics as an emulsifier"[10]
- synthetic hormones, "which mimic the action of natural hormones"[10]

Thus, CECs pervade modern life.

Florida's thriving industries contribute to the problem

Furthermore, people, farmland, and factories crowd the watershed that feeds the Everglades, causing water contamination in several ways. First, people produce millions of gallons of sewage that is ridden with many dangerous chemical contaminants. This sewage is not thoroughly treated but is discharged into Florida waterways.[11] People also create a large volume of trash that is dumped into landfills, which in many cases leach contaminants into the groundwater.[12] Some trash ends up in our waterways by careless locals and tourists.[13]

Second, agricultural lands are part of Florida's geographical mosaic.[14] The net farm income for Florida in 2016 was $2,063,448,000. Florida ranked ninth in the United States for net farm income.[15] Florida's top three agricultural commodities were miscellaneous commodities, oranges, and cane for sugar. The next two agricultural commodities were cattle/calves and dairy products/milk.[15]

Nationwide, 90% of pesticide use is from agriculture.[16] Current farming practices require fertilizers and pesticides. The resulting problem is discharge of over 45 pesticides,[17] some of which are considered likely carcinogens and endocrine disrupting chemicals. [18, 19]

Third are other industries critical to Florida's economy. Agriculture ranks second. The first is tourism, which depends in part on the beauty of Florida's natural resources.[20] The third-ranking industry is international trade, as about 40% of all United States exports to Central and South America pass through Florida."[20] Another source, however, ranked

phosphate mining third.[21] The aerospace and aviation industry ranked fourth.[20] Of particular importance to monitoring endocrine disrupting chemicals, the life sciences achieved the fifth industry. More than 200 medical and pharmaceutical manufacturing companies are based in Florida.[20]

All products have three stages at which they can enter the environment and the water: during manufacture, during use, and at disposal.[10,22] Some products, such as pesticides, contribute to pollution during all three stages of the products' cycle.[23, 24, 25]

Despite the volume of production and potential for pollution, current drinking water treatment facilities do not remove many dangerous chemicals, including CECs and pesticides. It is uncertain which of these types of chemicals, if any, are removed by current municipal technologies that have not added tertiary treatment or cannot add such treatment because of cost.

Hurricanes and heavy rains contribute to the problem

Despite this lack of treatment, in recent years, the solution to large hurricane predictions and high volumes in Lake Okeechobee, the main lake in the hydrologic system, has been to lower the lake level by discharging excess water into the Gulf of Mexico and the Atlantic Ocean.[26] These discharges have caused reductions in oysters, increases in bacteria that threaten fish, and pollution of coastal fishing grounds in both of these enormous bodies of water despite their great depth and wave action.[27,28,29,30] We believe these discharges will damage the Everglades if allowed to flow south through the ecosystem. At this shallow depth and slow water flow, the conditions are perfect for contaminants to precipitate and to accumulate in the sediment. Added to this recipe is the bioaccumulation of persistent organic pollutants (POPs), which is well documented in the literature.[31, 32] These chemicals biodegrade slowly in the environment. Some have the potential to persist for hundreds of years, thus making the pollution almost impossible to control now and creating a problem for future generations.

Now, the Florida Everglades watershed is at its limit. The only consistent source of drinking water for the southern part of the State of Florida is in danger.[33, 34, 35] The proposed Comprehensive Everglades Restoration Plan (CERP) will cause many different sources of water and some sediment to remix and then to flow south to Florida Bay.[36] Generally speaking, restoration is a good goal, but only as long as we continually monitor the water and sediment quality of the ecosystem before, during, and after the restoration. On top of this, all across the United States, there is both an aging and a shortage of professionals trained in serving as water operators for drinking water and wastewater treatment facilities. As a result, we may be facing a gap in current water operators in the future.[37] Therefore, more than ever, we must be vigilant to ensure that the restoration plan does not transport and distribute throughout the ecosystem dangerous POPs, pesticides, endocrine disrupting chemicals, carcinogens, and other CECs.

2.2 General description of harms caused by endocrine disrupting chemical

After its first harbinger statement in 2009, the Endocrine Society published a second statement in 2015 acknowledging that contamination of our environment with endocrine

disrupting chemicals (EDCs) alters gene-environment interactions via physiological, cellular, molecular, and epigenetic changes. This contamination affects not only individuals but also their offspring. Causal links between exposure to EDCs and manifestation of disease by multiple studies and strongest correlation have been established for: "1) obesity and diabetes; 2) female reproduction; 3) male reproduction; 4) hormone-sensitive cancers in females; 5) prostate; 6) thyroid; and 7) neurodevelopment and neuroendocrine systems."[18] In this section, however, we will narrow the focus to metabolic disorders (including obesity and diabetes), reproductive health, and thyroid functions.

Metabolic disorders

Data now suggest that exposure to substances can increase the incidence of metabolic disorders such as obesity, type 2 diabetes mellitus (DM), and cardiovascular disease. Obesogens are xenobiotic chemicals that can disrupt normal developmental and homeostatic controls and can stimulate adipogenesis. Increased urinary bisphenol A (BPA) concentrations and increased serum phthalates are linked to increased incidence of obesity, waist circumference, and insulin resistance.[18] EDCs can promote adiposity, which is the condition of being severely overweight,[38] by activation of PPARγ.[18]

> Because PPARγ is a pivotal molecule in the regulation of adipogenesis [being severely overweight], any EDC acting as an agonist on this receptor will cause adipocyte expansion after increasing the number of fat cells.[18]

Thus, EDCs can increase adipogenesis, which is the forming of fat, in preadipocyte cell lines.[18, 39] Some EDCs have estrogen mimetic properties on estrogen receptors and a variety of other mechanisms,[18] which may decrease the body's protections against certain insulin-related diseases, such as diabetes.[8]

Several prospective studies have linked EDCs to type 2 diabetes in the general population.[18] Specifically mentioning African Americans and Latinos, a recent study by Dr. Sargis suggested that EDCs "not only increase diabetes risk but do so disproportionately in vulnerable populations."[40] Those EDCs include dichlorodiphenyldichloroethylene (DDE), polychlorinated biphenyls (PCBs), organochlorine pesticides, hexachlorobenzene (HCB), and dioxins.[18] Studies have also corroborated evidence of a link between (1) increased incidence of high blood pressure and cardiovascular disease and (2) BPA exposure.[18]

Type 2 diabetes. A general link between EDCs and type 2 diabetes has been shown. Despite that link, no study has linked an individual toxin exposure as a causal agent for type 2 diabetes.[18] That said, evidence is emerging that metabolic disorders such as type 2 diabetes could originate from endocrine disruption, including environmental exposure.[8]

Type 1 diabetes. Type 1 diabetes mellitus occurs because of the destruction of beta cells in the pancreas. Unlike the lack of direct evidence showing an EDC as a causal agent of diabetes 2, intrauterine exposure to BPA has shown association with increased incidence of type 1 diabetes.[18]

Reproductive health

Limited data are available on intrauterine ovarian development with relation to exposure to EDCs.[18] Despite that limit, studies confirm that pesticides alter gene expression, impair follicle growth, increase atresia (which is an absence of a normal opening or failure of a structure to be tubular), and reduce oocyte quality in the postnatal ovary.[18,41] The effect on the ovary is believed to be transgenerational. BPA exposure has been linked to precocious puberty, but this link has not been consistently shown in all studies. EDCs affect ovarian steroidogenesis, leading to irregular menstrual cycles, sub-fertility, or infertility. A small number of studies have suggested that EDC exposure may alter uterine structure and function affecting fertility. There is a link associated with endometriosis, preterm labor, premature menopause, and EDC exposure.[18] Endometriosis is a condition in which tissue that normally lines the inside of the uterus grows outside the uterus.[42]

Research on EDCs and male reproductive function is suggestive of links between exposures and a range of disorders that include the following:

- developmental abnormalities such as cryptorchidism and hypospadias
- poor semen quality
- increased risk of testicular germ cell cancer

Despite those links, causal connections cannot be established with the limited data.[18]

Thyroid

The Food and Drug Administration has approved perchlorate use as a food contact substance. Perchlorate is commonly known for its use in rocket fuel, explosives, and fireworks. Perchlorate is also commonly known as a contaminant of nitrate-based fertilizer. “Perchlorate blocks iodine uptake in the thyroid gland”[18] and can cause decreased thyroid hormone production.[18] Particularly in pregnant women with little iodine intake, it can cause fetal neurological impairment. The HOME study has shown gestational exposure to chemicals such as per- and polyfluoroalkyl substances (PFAS), polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and organochlorine pesticides (OCPs) leads to low birth weight in infants. “Research in rodents consistently shows that PCB exposure leads to a reduction in serum total and free T4.”[18] T4 is thyroxine, which is the main hormone produced by the thyroid gland.”[43]

Cognition and brain

A mother’s exposure to EDCs such as PCBs and higher BPA levels can lead to lower IQ levels, poorer reading comprehension, behavioural problems, heightened anxiety, and depressive tendencies. In addition, higher BPA levels in maternal urine were associated with behavioral problems and increases in anxiety and depressive behaviors. Phthalate metabolites are also a problem when in a child’s environment. “The Mount Sinai Children's Environmental Health study showed that increased concentrations of low molecular weight phthalate metabolites were associated with poorer performance on a battery of behavioral

tests."[18]

2.3 Lists of contaminants of primary concern

Currently, the EPA regulates 53 organic contaminants and 16 inorganic compounds under the National Primary Drinking Water Regulations because of their potential for health risk.[44] An additional 97 unregulated compounds that the EPA has identified as known or anticipated to occur in public water systems appear in the latest Contaminant Candidate List, finalized on November 17, 2016.[45] The EPA has elected to require monitoring under the Unregulated Contaminant Monitoring Rule of another 30 chemicals/chemical compounds.[46] The federal agency also lists 60 pollutants and parameters with recommended maximum concentrations to avoid significant risk to the species in marine environments under the National Recommended Water Quality Criteria.[47] Separately, the Stockholm Convention lists 28 chemicals and chemical classes as persistent organic pollutants (POPs) because of their resistance to environmental degradation, wide distribution, and toxicity to humans and wildlife.[48]

On top of these concerns, a literature review by Mnif et al. (2011)[49] states that there are 105 pesticides that can be identified as endocrine disrupting chemicals. Numerous pesticides and chemicals with known endocrine-disrupting or carcinogenic effects have been measured in the Florida Everglades ecosystem.[50,51] Some of the pesticides that have been found are discussed in this proposal. Because of the numerous pesticides and lack of or infrequent monitoring, especially of unregulated pesticides, however, many more may also be present.

2.3.1 Potential sources of pollutants

Several potential sources of pollutants risk the water quality in South Florida. First, the Everglades Agricultural Area (EAA), located on the south end of Lake Okeechobee and adjacent to the Everglades Protection Area, consists of roughly 700,000 acres of farmland. The farmland is mostly dedicated to sugarcane production, but there are also smaller acreages for sod and winter vegetable production.[52] Because of this significant agricultural presence, pesticides used in EAA farmland are a potentially large source of pollutants in the Everglades water system, especially if water flow south from Lake Okeechobee is increased.

Many pesticides used heavily in Florida agriculture are associated with significant long-term adverse health effects. According to survey data collected from 2007–2009,[17] aldicarb was the second-most-used insecticide in Florida with 869,100 lbs applied. Next, chlorothalonil was the second-most-used fungicide with 800,900 lbs applied. Third, endosulfan was the third-most-used insecticide with over 171,000 lbs applied in that two-year period. Atrazine was the eighth-most-used pesticide with 36,400 lbs applied.[18] At least one study of farming communities in Red River Valley, Minnesota, concluded that use of fungicides by a male applicator parent can significantly reduce the number of healthy male births, thus changing the male to female sex ratio in humans.[53]

2.3.2 Contaminants measured in the Everglades system

South Florida Water Management District (SFWMD) has been monitoring South Florida canals routinely from 1984 to present. According to that program, the most common pesticides in surface water were atrazine and ametryn, although the metabolites of dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethylene (DDE), and dichlorodiphenyldichloroethane (DDD) were the most frequently detected pesticides in sediment samples.[54] A later study of sediment monitoring data from 1990 to 2002 found that chlordane, DDT, DDE, DDD, and endosulfan were of particular risk to aquatic species.[55]

Other studies have found yet other pesticides in the Everglades. A 1997 study found detectable levels, up to 1.60 ppm, of dieldrin in great egret eggs from the EAA and Lake Okeechobee. The same study also detected polychlorinated biphenyls (PCBs) in a single white ibis tissue sample.[56] This finding is significant because PCBs bioaccumulate, resist chemical and biological degradation, and persist in the environment.[57]

There have been many environmental concerns with organochlorine pesticides as they tend to be persistent, toxic, and prone to bioaccumulate.[58] Aldrin, dieldrin, endrin, heptachlor, chlordane, and DDT are all organochlorine pesticides. Although these pesticides have been banned in the European Union and the United States, they persist in the environment and so will continue to present risks to wildlife and human health.[59, 60, 61]

In more recent studies, endosulfan has attracted attention as a threat to aquatic species in the Everglades region. A 2010 study by Rand et al. (2010)[62] identified surface water measurements (at SFWMD sampling sites) where concentrations of endosulfan, also an organochlorine insecticide, exceeded EPA national recommended water quality criteria (WQC). The same study also used measurements of endosulfan and its metabolite endosulfan sulfate in fish tissue to demonstrate the existence of sites in South Florida with potential acute and chronic risks of endosulfan to freshwater organisms.[62]

Three years later, a 2013 study observed both surface water and sediment concentrations of endosulfan that exceeded WQC as well as elevated levels of endosulfan sulfate in fish tissue.[36] Endosulfan's endocrine-disrupting effects have been shown to include competitive binding to androgen receptors and stimulation of estrogen receptor production.[49] Endosulfan is highly toxic to aquatic invertebrates, with lethal concentrations reported in some instances. Also, exposure to endosulfan has been "[l]inked to congenital physical disorders, mental retardation and deaths in farm workers and villagers in developing countries in Africa, southern Asia and Latin America."[48, 63]

2.3.3 Finding these pesticides consistently in the Everglades is significant because of their adverse health effects

This section briefly discusses some of the pesticides found in the Everglades or used near the Everglades to illustrate some of the threats these substances pose. The following are chemicals that have been shown to be in the Everglades from previous studies. Ninety countries recognize three of the following (DDT, aldrin/dieldrin, aldicarb) as part of the persistent organic pollutants known as the "dirty dozen."[64]

Persistent organic pollutants, also known as POPs, do not biodegrade in the environment. As a result, these pollutants bioaccumulate in the food chain.[64] Through the Stockholm Convention, seventeen years ago over 90 countries committed to reducing or eliminating production, use, and/or release of these key POPs. One potential pathway for exposure in humans is drinking contaminated water. "In people, reproductive, developmental, behavioral, neurologic, endocrine, and immunologic adverse health effects have been linked to POPs."[64]

The dirty dozen POPs found in the Everglades

Although banned for agricultural use in the United States in 1972,[18] **DDT** and its metabolites DDE and DDD can still be found in soil, sediment, and animal tissue. DDT thus demonstrates the long-term risk of persistent organic pollutants that do not degrade readily in the environment. In 2015, the International Agency for Research on Cancer (IARC) classified DDT as probably carcinogenic to humans (Group 2A).[65] Furthermore, DDT and its metabolites have endocrine disrupting effects.[49] DDT, DDE, and DDD "have been associated with endocrine-related diseases such as testicular tumors, endometrial cancer, pancreatic cancer, type 2 diabetes mellitus (T2D), and breast cancer."[18]

Also on the dirty dozen list, **aldrin and dieldrin** are broad-spectrum insecticides that are contact, ingestion, "and inhalation poisons. Aldrin is readily converted to dieldrin, which is considered one of the most persistent of all pesticides."[66] Widely used in agriculture for over 20 years, their use was suspended by EPA in 1974.[66] The IARC lists dieldrin as a probable carcinogen (Group 2A).[67] "A significant association was found between increased prostate cancer rates and ambient pesticide exposure (residential and soil/dust drift) to a group of organochlorines with known EDC actions: dieldrin, endosulfan…"[18]

The third chemical on the dirty dozen list found in the Everglades, **aldicarb** is an insecticide and nematicide, which is a pesticide that targets nematode worms. Aldicarb is also a cholinesterase inhibitor and neurotoxicant.[68] Not approved for use in the European Union, it is currently subject to a phase-out by the EPA with all use to end by August 2018. It has been observed to inhibit 17 beta-estradiol and progesterone activity.[49] Aldicarb and its metabolites, aldicarb sulfoxide and aldicarb sulfone, are moderately persistent and mobile and are able to reach groundwater.[69] Consequently, aldicarb present in the Everglades could endanger drinking water by seeping into the Biscayne Aquifer.[70]

Other pesticides and carcinogens found in the Everglades

Atrazine is a herbicide frequently used on Florida sugarcane, including sugarcane in the Everglades Agricultural Area.[18,71] It has endocrine disrupting effects.[49] Atrazine "and its metabolites are…the most commonly detected pesticide in US surface waters, including drinking water."[18]

Chlordane, which EPA banned in 1988, is listed as a possible carcinogen (Group 2B) by the IARC.[72] Its known endocrine disrupting effects include increased levels of progesterone, cortisol, and estradiol, and decreased levels of testosterone.[49] "A separate study reported an association between chlordane exposure (cis-nonachlor and trans-nonachlor) and TGCC [human testicular germ cell cancer]…"[18]

Chlorothalonil is a broad-spectrum fungicide that the IARC classifies as a possible carcinogen (Group 2B)[72] and that the EPA classifies as a likely human carcinogen (Group 2B).[73] Research indicates that it can also activate proliferation of androgen-sensitive cells.[49] Normal, non-cancerous prostates depend on normally functioning androgen, which "regulates the total prostatic cell number."[74] There is also some concern about chlorothalonil's bioaccumulation. It "is considered to be more toxic to aquatic organisms."[59]

2.3.4 Other chemicals as endocrine disrupting chemicals and carcinogens

Please see Appendix B for the following lists:

- Endocrine Disrupting Chemicals List
- Carcinogens Chemical List

2.4 Description of Everglades and its unique characteristics

2.4.1 Everglades as a unique water body in the world

Globally, the Everglades is recognized as a unique ecosystem. At least nine different habitats have been identified as making up the Everglades, including hardwood hammock, pinelands, mangrove, coastal lowlands, freshwater slough, freshwater marl prairie, cypress, marine, and estuarine.[75] These widely varying habitats provide a home for a uniquely diverse array of plants and animals and place the hydrology of the Everglades in a class of its own.

When compared to other wetlands, the Everglades is unique in that it depends on a lake, rainfall, and groundwater for recharging its water, unlike other wetlands that depend on river flooding, such as the Pantanal of Brazil.[76] The Everglades are also unique in Florida for its slow-moving water sheet flow.[77]

2.4.2 An overview of Everglades history

Construction of Canals and Levees

Since A.D. 300, people have been fundamentally changing the hydrology of the Everglades by using canals and levees. The indigenous people Ortona and later the Calusa and Tequesta peoples employed shallow canals to connect villages to coastal trading.[26] After the indigenous peoples' constructions, as early as 1881, there were plans to drain the Everglades.[78] By the early 20th century, four major drainage canals were dredged in the Everglades: West Palm Beach, Hillsboro, North New River, and Miami. The years 1915 to 1928 witnessed the construction of Tamiami Trail canal and levee. Together with drainage efforts, this large canal and levee substantially changed the Everglades' hydrology. This resulted in lower water levels throughout the Everglades and disruption of the natural north-south water flow. Hurricanes claimed several thousands of lives in 1927, 1928, and 1947-48.[26] The loss of life "underscored the need for a comprehensive water-management system."[26]

Mid-Twentieth Century

In 1948, the U.S. Congress authorized the Central and Southern Florida Project (C&SF Project) for Flood Control and Other Purposes to manage the water. The project had the following purposes:

- To control floods
- To supply water to urban areas and agricultural areas
- To address saltwater intrusion
- To manage uncontrollable mulch fires that were caused by drainage [26]

During the C&SF Project, canals were built to drain and to reclaim the wetlands. The canals were also intended to direct water to southeastern Florida in order to recharge the aquifer that supplies well fields for the urban population.[26]

Although the C&SF Project achieved many of its goals, it did so by constructing levees, pumps, and canals, which further exacerbated the Everglades' ecological problems. This construction further disrupted sheet flow and diverted freshwater from wetlands and southern estuaries. The construction redirected the freshwater to northern estuaries instead.[26]

In 1974, a general study modeled how pesticides move through the environment. The types of environments that were considered for the modeling included freshwater aquatic and estuarine/marine environments,[79] which are found in the Everglades.

1979–1993 — Before Adoption of the Best Management Practices

Water years as counted in reports such as the South Florida Environmental Report start on May 1st and end April 30th.[9] South Florida Water Management District (SFWMD) started monitoring pesticides in 1976.[9] In 1984, the district set up a "routine pesticide monitoring program."[9]

During this period, the total phosphorus load reached its highest concentrations and greatly varied at inflow and interior marsh sites. During the 1980s, extreme weather conditions and low water levels resulted in the water levels in the Everglades being shallow and the total phosphorus load remaining high.[9]

1994–2004 — Implementation of the Best Management Practices

The Everglades deteriorated so much so that, in 1988, the United States sued Florida.[80] Monitoring phosphorus in the Everglades must comply with the Settlement Agreement of July 11, 1991, which ended the Everglades lawsuit. The Federal government, the State of Florida, and the SFWMD entered the agreement. The subsequent Consent Decree was modified in 1995. The decree specifies the interim and long-term phosphorus concentration levels for the Arthur R. Marshall Loxahatchee National Wildlife Refuge.[81]

By 2000, Congress authorized the Comprehensive Everglades Restoration Plan (CERP) to remediate some of the ecological damage. The CERP aims to restore "a more natural flow through the Everglades" while still providing water to South Florida's cities and farms.[26] During this time, the initial stormwater treatment areas were built and became operational. Implementation of the best management practices was increasing.[9]

2005–2015 — Best Management Practices Optimized and Enhanced

The period from 2005 to 2015 can be characterized as the period when best management practices were optimized and enhanced. Also, several different restoration projects were and continue to be implemented.[9]

During this period, there were numerous environmental challenges, namely hurricanes during WY2005 and WY2006 such as Hurricane Wilma. The storm events resulted in concentrated inflow of phosphorus and damaged the stormwater treatment areas. For many months, stormwater treatment area nutrient removal was decreased. There were also marsh dry outs during WY2007, WY2008, and parts of WY2009.[9]

Current (2016–Present)

Currently, the Everglades Protection Area consists of marsh areas, canals, and levees. These areas have inflow and outflow control structures that span almost 2.5 million acres (10.1 trillion square meters) of former Everglades marsh.[9] Sources of the Everglades Protection Area surface water inflows include the following:

- rainfall
- “surface water inflows regulated by water control structures from agricultural tributaries”[9]
- Lake Okeechobee
- “urbanized areas to the east”[9]

Nowadays, humans control the timing and distribution of surface inflows from the Everglades Protection Area. These operational decisions are based on several factors:

- natural and environmental system requirements
- water supply for urbanized and natural areas
- aquifer recharge
- flood control [9]

There is currently no data to indicate that canals help the Everglades’ ecological system. To the contrary, research indicates that factors that contribute to its ecological degradation are results of the C&SF Project canals, including drainage and water impoundment.[26] Canals and levees ease the path for invasive, non-native species that alter the ecological system in the Everglades.

> Despite the fact that canals are a long-standing feature of the Everglades, our understanding of how they function as habitat for aquatic fauna and how this may be similar or different from natural habitats is still very limited.[26]

The key takeaway is that this enduring feature, namely the maze of canals and levees, of the Everglades is not well understood and is harmful to the water quality.

2.4.3 Overview of hydrology

Regionally in South Florida, hydrology is “driven by rainfall, rainfall-generated runoff, groundwater recharge and discharge, and evapotranspiration.”[82] The general hydraulic gradient runs north to south, from the upper Kissimmee Basin to the Everglades. The current hydraulic and hydrologic system includes impoundments, canals, and water control structures. It also includes wetlands and lakes.[82]

Surface water runoff serves as the source water for direct and indirect recharge of groundwater, lake and impoundment storage, and replenishments of wetlands. "Water supply releases are made for various beneficial uses that include water supply for municipal and industrial use, irrigation for agriculture, deliveries to ENP (Everglades National Park], salinity control, estuarine management, and other environmental releases."[82] Groundwater serves as the main water source for municipal water. That groundwater is “sensitive to surface recharge through direct rainfall, runoff, or canal recharge.”[82] Excess water takes three actions:

- runs to the coasts or
- "is stored in lakes, detention ponds, wetlands, impoundments, and aquifers"[82] or
- "is discharged to the coast to estuaries and the ocean"[82]

The disposal of excess water necessitates continual monitoring of the Everglades because contaminants may be in the excess water.

Main storage is Lake Okeechobee

Lake Okeechobee serves as the centerpiece of water storage in the regional water management system.[82] It stores excess water and provides water during drought. The lake's total storage capacity is 3.54 million acre-feet. Yet, it has an average lake level of only 14.02 ft NGVD29.[82] The following water bodies receive Lake Okeechobee's outflows:

- Everglades Agricultural Area
- St. Lucie River and Estuary
- Caloosahatchee River and Estuary
- Lake Worth Lagoon
- Everglades Storm Treatment Area[82]

At various times during WY2017, 972,904 ac-ft of environmental water was released from Lake Okeechobee to the Caloosahatchee River. The flows from the lake to that river were 127% of WY2016 flows and 223% of historical flows.[82] The stormwater treatment area discharges into the Everglades Protection Area.[82]

The following are the principal hydrologic components in the SFWMD:

- Upper Kissimmee Chain of Lakes
- Lake Istokpoga
- Lake Okeechobee
- Everglades Agricultural Area
- Caloosahatchee and St. Lucie River basins
- Upper East Coast (UEC)
- Lower East Coast (LEC)
- Water Conservation Areas (WCAs)
- Lower West Coast (LWC)
- Everglades National Park[82]

The Kissimmee Chain of Lakes supplies water to Lake Okeechobee.[82]

Diverting water and its consequences

By 2010, about 6.4 billion liters (1.7 billion gallons) of water were discharged from the South Florida Water Management District (SFWMD) into the Atlantic Ocean and Gulf of Mexico each day.[26] Since canal construction, over 50% of the wetlands have been lost. Perhaps more significant, the entire water table of the Everglades has been lowered. These losses have had several results:

- Loss of peat soils
- Loss of coastal water well fields from saltwater intrusion
- Salinization of formerly low-salinity wetlands[26]

To add to this, water diversion has its own consequences. For example, diversion of water from Shark River Slough and Taylor Slough has reduced freshwater into Florida Bay "and led to hypersalinity in biologically vital coastal estuaries."[26] Canals disrupt natural sheet flows, subjecting the ecological system to unnatural pulses. The unnatural pulses deluge natural habitats, disperse fish concentrations, and significantly change salinity in estuaries. This flooding results in estuarine species' mortality. For example, the species diversity and numbers decreased in coastal Biscayne Bay.[26]

Levees and canals also increase the groundwater-surface water interactions, bringing salinity from deep groundwater to biologically sensitive surface water. The deep water that levees create cannot support "a diverse assemblage of plant communities."[82] Given the ecological harms, Harvey recommended removing canals and levees from the Everglades Protection Area to reduce "potential for rapid, long-distance transport of aquatic pollutants (nutrients, pesticides, etc.)."[26]

Moreover, extraordinary weather conditions exacerbate these historical issues. "During December 2015 and January 2016, South Florida experienced an extraordinary rainfall event resulting in rainfall totals 400% above historic values."[14] Because of this rise in water levels in Water Conservation Area 3-A (WCA-3A) and the severe impact on natural resources, the Florida Department of Environmental Protection issued an emergency final order that authorized SFWMD and the US Army Corps of Engineers to "undertake immediate actions to deviate from permitted water management practices and move high water from WCA-3A to ENP through Shark River Slough."[14] After that rainy season, beach goers in South Florida noticed brown water at the beaches.[83] Perhaps all the consequences of diverting high volumes of waters in the Everglades are not yet fully understood.

Groundwater and its relationship with the Everglades

Underground, various aquifers respond quickly to rainfall and surface water conditions. The average annual rainfall for the Everglades region is 53 inches. A relatively low gradient of regional topography means that water must be pumped to move it. For FY1995–1996 through FY2014–2015, the average pumping volume was 2.9 million acre-feet. In the Everglades, the number of pumps has increased since 1996 from 20 to over 70, with

various temporary pumps and uncertified or unoperational pumps also changing that number.[82] This shallow water table is vulnerable to changes and serves as the supply for municipal water.

The SFWMD integrates groundwater for water supply. The district has four major water resource planning components, all of which rely on surficial aquifers. Of these, the Biscayne aquifer is critical for two parts, the Lower East Coast (LEC) and Upper East Coast (UEC). By comparison, the Lower West Coast (LWC) relies on three aquifer systems, namely, the surficial aquifer system, the intermediate aquifer system, and the Floridan aquifer system. The Lower Tamiami is part of the surficial system, but the sandstone and mid-Hawthorne aquifers are part of the intermediate system. To contrast these two, the Kissimmee Basin relies on the Floridan aquifer system. The Kissimmee Basin is a superficial or shallow aquifer and a deep aquifer.[82]

2.4.4. Pathways of contaminants into the water

There are many identifiable water contaminants, such as pesticides, endocrine disrupting chemicals, and carcinogens. But the consequences of their mixture and long-term impacts over a human's lifetime or on a habitat are not well known, even at low doses or exposures.

Possible pathways for water contaminants

Perhaps as an oversimplification, the Everglades is a dissected water system. Some sections are more predisposed to agricultural runoff. That runoff includes a cocktail of pesticides, some of which double as carcinogens. These sections are also susceptible to nutrient loads that degrade the ecosystem. Thirty percent of what remains of the original area that made up the Everglades has been converted into water conservation areas, but those areas are surrounded by urban and agricultural lands.[84]

Movement of chemicals in the environment

As early as 1974, researchers observed: "Literally millions of chemicals and combinations of chemicals are now manufactured and isolated, formulated, used, and ultimately disposed of in the environment."[79] In 1974, water was explicitly identified as an environmental control that permitted pesticides to move in the environment through convective mass transport and inter-particle diffusion.[79]

Pesticides can enter the environment either because of direct application of pesticides into water to control pests or runoff from soil.[85] Agricultural runoff continues to be identified as a threat to water. A recent literature review of peer-reviewed articles focusing on insecticides concluded that agricultural insecticides threaten surface waters on a global scale.[86] The same massive literature review extrapolated data from other

peer-reviewed studies and identified parts of South Florida that regularly exceeded regulatory threshold levels for insecticides in crop areas.[86]

As early as 1974, the Gillett study determined that one pathway for pesticides and other chemicals that have landed on animals to contaminate water is through death and decay.[79] The Gillett study postulated that the "most complex" and "probably most significant"[79] compartment for a chemical entering the terrestrial environment is by soil and water, through various pathways, including the following:

- At the surface through sorption from the atmosphere
- Condensation
- Settling and falling out
- Precipitation, including material that has been washed off of plant surfaces
- Excretion, exfoliation, and decay of animal tissues
- Defoliation, withering, litterfall, and decay of plants
- Erosion
- Volatilization
- Photochemical and chemical alteration
- Ingestion by organisms
- Leaching[79]

Surface water movement into groundwater and groundwater movement into surface water are other pathways for pesticides and other chemicals.[79] Pesticides and other chemicals can travel into streams, lakes, and estuaries from groundwater.[79] More recent sources mention some of these pathways as means of possible pesticides' contamination in water.[87]

2.4.5 Nutrient loads can have devastating consequences for the Everglades

Although both phosphorus and nitrogen are essential to aquatic life, the flora and fauna in the Everglades are adapted to nutrient-poor conditions.[9] As a result, "relatively small additions of nutrients, especially phosphorus, have dramatic effects on the ecosystem."[9] The key takeaway is that nutrient runoff from surrounding agricultural areas can devastate the diverse habitats in the Everglades.

Phosphorous

As discussed, high levels of phosphorus have caused litigation. There is a north-south gradient of total phosphorus (TP), which results from phosphorus-rich canal discharges. These canal discharges are primarily from agricultural runoff that enters northern portions of the Everglades Protection Area.[9] Because phosphorus is critical to natural, biological communities, there are long-term goals of 10 µg/L TP for the Everglades Protection Area.[9] One of the notable consequences of the canals and levees has been

delivering agricultural nutrients, particularly phosphorous, into wetlands via the canal system.[26] Because of that, Everglades canals have been found to have 30 times the amount of phosphorous historically occurring in the Everglades. Phosphorus concentrations are highest in the northern Everglades.[26]

Nutrient load and ecological processes change through the marsh as a function of distance from the levee.[26]

- Most impacts: WCA2, which gets water directly from the EAA, has the most pronounced vegetation change resulting from phosphorous.
- Impacts in marsh areas: Arthur R. Marshall Loxahatchee National Wildlife Refuge (LNWR) gets nutrient-enriched discharges from EAA, which tend to be limited to marsh areas.
- ENP has elevated concentrations compared to "references in the interior of the park"[26]

The higher levels of phosphorus have led to transformations, such as the following:

- Filamentous algal species that thrive in nutrient-enriched waters replacing naturally occurring periphyton/*Utricularia* mats
- The shift from sawgrass-dominated vegetation to cattail-dominated vegetation

The shift to cattail vegetation, in turn, has a domino effect. Cattail limits the light, affecting the ecology in various ways:

- Reducing the periphyton growth further
- Decreasing available oxygen
- Resulting in changes in "invertebrate and fish community structure"[26]

By contrast, since 1979, orthophosphate, an inorganic and soluble form of phosphorus, has decreased in the Everglades Protection Area. Because biological organisms readily use orthophosphate, it "has the greatest and most rapid effect on the Everglades ecosystem."[9]

Nitrogen

A second influential nutrient is nitrogen. In addition to being surrounded by agricultural areas, highways also bound and traverse the Everglades Protection Area, contributing to atmosphere total nitrogen (TN) deposition. But TN in the atmosphere is not measured, as testing is extremely expensive.[14] When present in elevated concentrations, nitrogen damages freshwater ecosystems.[9] Elevated concentrations of nitrogen cause several concerns:

- Eutrophication of freshwater systems
- The effect on the oxygen content of receiving waters
- Its "potential toxicity to aquatic invertebrate and vertebrate species"[9]

Total nitrogen exhibited a north-south concentration gradient, with higher concentrations near agricultural areas and Lake Okeechobee.[9]

According to the 2016 South Florida Environmental Report, the total nitrogen load (TN) into the Everglades Protection Area represented a 20% decrease when compared to the previous year.[88] By contrast, the next year's report in 2017 about WY2016 indicated a TN increase of "approximately 36 percent compared to the previous year."[14] According to the 2017 report, "This increase is most likely attributed to increases in surface water flows and atmospheric inputs."[14] The 2018 South Florida Environmental Report did not make these kinds of water year to successive water year comparisons but did note a long-term downward trend in TN in the Everglades Protection Area.[9] The 2018 report observed that the downward trend may be "the result of improved nutrient removal effectiveness" of the Everglades Protection Area Storm Treatment Areas, particularly during low water conditions.[9]

The total nitrogen may be naturally occurring and not anthropogenic. Two observations support this conjecture. First, the nitrogen in the marsh has a strong relationship with total organic carbon. Second, relatively low nitrogen oxide (NOx) concentrations were observed.[9]

2.4.6 Pesticides measured at 15 sites biannually by SFWMD

As previously stated, Florida has a prosperous agricultural industry. By 2010, pesticide use in the United States tipped the scales at over 1 billion pounds annually. Worldwide, that volume jumps to 5.6 billion.[89]

Because of the adverse and immediate effects of pesticides on aquatic and human health, the 2017 South Florida Environmental Report declined to use the US Environmental Protection Agency's 10% excursion frequency to assess pesticides in the Everglades. Instead, pesticides were evaluated for that report with the assumption that "Class III criteria values represent instantaneous maximum concentrations for which any exceedance constitutes a non-attainment of designated use."[9]

As a result, pesticides that were detected were either designated a potential concern when over the method detection level (MDL) or as a concern if over chronic toxicity values.[9] The researchers explained the unknown risks of pesticides and possible chemical reactions in the Everglades as possibly harmful, stating:

> Pesticides classified as concern have a high likelihood of resulting in an impairment of the designated use of the water body. Classification of a pesticide as a potential concern signifies that the constituent is known to be present within the basin at concentrations reasonably known to be below levels that can result in adverse biologic effects but may result in a problem at some future date or in interaction with other compounds.[9]

As a consequence, in the 2018 South Florida Environmental Report, a "no concern" finding was made only when pesticides were not detected at sites within a designated area.[9]

SFWMD monitors pesticides on a biannual basis. "Pesticide monitoring is conducted across the entire District at 15 sites on a biannual basis."[9,14] For the 2018 South Florida Environmental Report, 62 pesticides were monitored.[9] By the 2018 South Florida Environmental Report, the current Everglades Protection Area monitoring program for pesticides consisted of 19 sites on a biannual basis.[9]

According to the South Florida Environmental Reports for 2016, 2017, and 2018, "[n]o pesticides or pesticide breakdown products exceeded their respective toxicity guideline concentrations, and no parameters exceeded state water quality standards."[9,14, 88] Nonetheless, the 2016, 2017, and 2018 reports observed that "several pesticides and pesticide breakdown products were detected above their method detection limit (MDL)."[9,14,88]

The 2016 South Florida Environmental Report pegged the number of pesticides that were detected at levels exceeding their MDL at 11.[88] The other observed pesticides above their MDLs that were specified were as follows:

Table 1. Table of pesticides observed above their method detection limits (MDL)

	SFEP 2016[88]	SFEP 2017[14]	SFEP 2018[9]
2,4,5-T (Trichlorophenoxyacetic acid	x		
2,4-D (dichlorophenoxyacetic acid)	x	x	x
ametryn	x	x	x
atrazine	x	x	x
atrazine desethyl	x	x	
diuron	x	x	x
imidacloprid	x	x	x
metolachlor	x	x	
metribuzin	x	x	x
norflurazon	x		
silvex	x	x	

WY2017 was the fourth consecutive year in which pesticide or pesticide breakdown products were detected at concentrations above their MDLs but did not exceed state water quality criteria.[9]

Carcinogens. Atrazine, which is a pesticide as well as a carcinogen, has been a recurring problem in the Everglades based on monitoring.[84]

Methylmercury. Methylmercury is an extremely poisonous form of mercury that results from the action of aquatic biota on inorganic mercury in aquatic systems such as oceans, lakes, and rivers.[90] Methylmercury poisoning causes brain and nervous system damage. Poisoning has occurred when people ate fish from water contaminated by methylmercury.[91] Methylmercury does not appear on the EPA list for carcinogens.[73] Nonetheless, it is considered toxic to humans.[84] Excess sulfate, which comes mainly from

the surrounding agricultural areas, “stimulates the conversion of mercury to its toxic form.”[84]

Another rising concern in water contamination is the release of methylmercury by industrial wastewater and mercury emitted from various sources such as metallic mercury, dental amalgams, and ambient air, which causes congenital diseases. Methylmercury contaminates seafood. Pregnant women end up consuming such seafood. For individuals suffering from Minamata disease, this was how mercury “penetrated the brains of the fetuses through the placenta and damaged the central nervous system, causing symptoms similar to cerebral palsy.”[92] The U.S. Environmental Protection Agency has set a 0.1 microgram/kg per day reference daily dose (RfD) for methylmercury for pregnant women. Several rice cereals are also listed as contaminated with methylmercury.[93] The RfD is based on a pregnant woman's intake of mercury and its transfer to the fetus. We still need more research and data to conclude and understand the effects of mercury on the fetus.

2.5 Absence of consistent measuring of endocrine disrupting chemicals in water sources

Endocrine disrupting chemicals (EDCs) are found in a multitude of products, such as pesticides, pharmaceuticals, flame retardants, and plastic additives. These chemicals can be found as residues or contaminants in food and other products and may be released from the products that contain them. Although we have a conceptual framework for testing and assessing EDCs,[94] there is still a need to develop new methods of testing and analyzing many other areas of the endocrine system. There are also gaps in knowledge about the exposure to and the effects of EDCs.[95]

Over the last decade, scientific understanding of the relationship between environment and health has advanced rapidly, so there is now stronger evidence that the trends of many endocrine-related disorders in humans are increasing. The especially vulnerable periods during fetal and postnatal life are when EDCs, either alone or in mixtures with other chemicals, have a severe and often irreversible effect on developing organs, whereas the same exposures in adults may have lesser or no effect. Many adult diseases originate during fetal development, but the causes remain unexplained.[49]

Perhaps because of these unknown aspects, internationally agreed and validated test methods for identifying EDCs only expose a limited range of the known spectrum of endocrine-disrupting effects. This deficiency increases the chance that harmful effects on humans and wildlife are being overlooked. For many endocrine-disrupting effects, agreed and validated test methods do not yet exist. For a broad range of the impacts on human health, such as female reproductive disorders and hormonal cancers, there are no viable laboratory models. This deficiency seriously hampers progress in understanding the full scale of the risks.[96]

Many areas around the United States suffer from water contamination from fertilizers and pesticides, some of which have been banned in regions for 20 years.[97] In Wisconsin, for example, atrazine was found at twice the federally recommended health level, indicating high concentrations.[97] In addition to regulating reproductive systems, the endocrine system regulates blood sugar, metabolism, and development of the brain and nervous systems. Although rules to limit EDCs have been proposed, the debate on their limitations in the agricultural sector continues today. Most studies on EDCs have focused predominantly on chemicals that interact with estrogen, androgen, and thyroid hormone systems. A growing body of studies, however, indicate that environmental chemicals can interfere with other parts of the endocrine system. The presence of pesticide byproducts and the cumulative exposure to pesticides' multi-residue play a central role in disrupting hormonal balance. In many cases, pesticide by-products can exhibit more harmful effects than their parent compounds.[98] Yet, risk assessment methods to accurately assess these real-life environmental exposures do not exist.[8]

2.6 Consequences of pesticides in water sources: reduced birth rates in aquatic life

Because of their capacity to bioaccumulate, pesticides present in aquatic ecosystems can have a profound effect on wildlife. For example, a 1983–1986 study found that alligator egg viability rates from each of Lakes Apopka, Griffin, Jesup, and Okeechobee to be well below what was considered normal for alligators.[1] Lake Apopka had the lowest hatching success of all areas studied and had a high percentage of egg clutches with complete failure. Additionally, from 1980 to 1987, a significant decline in the Lake Apopka alligator population was observed.

A chemical spill at a nearby pesticide manufacturing plant called Tower Chemical Company may have catalyzed these effects on Lake Apopka alligators. The pesticides that the company manufactured included dicofol and DDT. However, no one could determine the extent to which this spill contributed to the observed levels of DDT in alligators because of another contributor, namely, the long-term agricultural application of DDT on nearby farms. Elevated levels of DDT and its metabolites in Lake Apopka catfish, bass, and panfish were reported in the early 1960s,[1] and there were reports of elevated levels of toxaphene in bullhead catfish in the early 1980s.[99]

3. Describe the Population That Will Be Served

3.1 About 8.1 million people would be served

The South Florida Water Management District (SFWMD) manages the water resources for the southern half of Florida. The district's region covers 16 counties from

Orlando to the Florida Keys. It serves a resident population of about 8.1 million.[81] According to the U.S. Census Bureau, the estimated total population of Florida in 2017 was 20.98 million.[100] Therefore, SFWMD is responsible for managing water for about 38.6% of the entire state's population. In real numbers, this population outnumbers the population of each of Florida's 39 sister states, each having a total population of less than eight million.[100]

Although a lot of literature focuses on human developmental periods when examining the effects of exposure to endocrine disrupting chemicals, men and women also suffer effects from exposure to endocrine disrupting chemicals during adulthood, "such as weight gain ('obesogens') and/or insulin resistance and hyperinsulinemia ('diabetogens')."[18] Lifelong exposure to the cocktail of chemicals and endocrine-disruptors "may predispose individuals to pathologies such as T2D [Type 2 diabetes] or thyroid dysfunction."[18]

Included in the SFWMD's geographic region are the Kissimmee River and its floodplain, Lake Okeechobee, South Florida's coastal estuaries, and the Everglades.[81]

Table 2. Summary table for population to be served

Total Population for Geographic Area	**8.1 million**
Age Group	**Number**
Children under 5	1,133,684
Children under 18	4,143,100
Newborn babies	About 225,018

3.2 Over a million vulnerable infant and child populations would be served

According to scientific literature, fetuses, babies, and young children are the most vulnerable people to exposure to endocrine disrupting chemicals, of which pesticides are a subset.[18,49,101] For example, there are long-term effects on male and female reproductive systems. Both men and women of reproductive age may suffer ill effects from fetal exposure to certain endocrine disrupting chemicals, including malignant tumors in the uterus, and testicular cancer.[18,101] For example, four studies showed a positive association between DDE and testicular germ cell cancer.[18]

Population statistics for fetuses are not available. Therefore, the estimates for newborns can serve as a proxy for fetuses. There were a total of 225,018 reported births in all of Florida in 2016.[102]

Table 3. Low estimate table of births by county of residence of mother, 2016

Counties Entirely within the Everglades [103]	**Births by County by Residency of Mother 2016**
Miami-Dade	32,679
Monroe	733
Broward	22,563
Collier	3,323
Palm Beach	14,963
Hendry	570
Lee	6,751
Martin	1,273
Glades	66
Highlands	938
Okeechobee	485
Indian River	1,245
St. Lucie	2,998
Total (low estimate)	88,587

Table 4. High estimate table of births by county of residence of mother, 2016

Counties that are Partially within the Everglades	Estimated Population of Newborns
Osceola	4,329
Polk	7,805
Orange	16,649
Charlotte	1,037
Total of counties partially within the Everglades	29,820
Total (partial counties + complete counties) high estimate	118,407

In Florida, the U.S. Census Bureau estimates that 5.5% of the Florida population was under five years old as of July 1, 2016.[100] Based on the estimates of the U.S. Census Bureau, this would mean that the population of children under five is estimated to be over one million.

3.3 Over 4 million adolescents and children are especially vulnerable populations that would be served

Endocrine disrupting chemicals may also have a more adverse effect when the exposure occurs during adolescence, as humans rapidly develop during this time.[101] "Childhood and puberty are also periods of rapid change in endocrine-dependent organ systems and are beginning to be recognized as additional sensitive periods."[18] For puberty, the same is true of another toxic water contaminant: carcinogens. When considering persons under 18 years of age in Florida, that percentage jumps to an estimated 20.1%.[100] Applying this percentage to the U.S. Census Bureau's total population for Florida, this population is about 4.1 million.[100]

Adolescent females are particularly vulnerable to carcinogens. Professor of Epidemiology and Nutrition at T. H. Chan School of Public Health and Professor of Medicine at the Harvard School of Medicine Walter Willett explains, "[B]reast tissue is particularly vulnerable to carcinogenic influences at younger ages."[104] Which is to say, carcinogenic exposure to children and adolescents can be linked to breast cancer. Adolescent females

are also uniquely vulnerable to exposure to carcinogens. This unique vulnerability seems to be due to specific biological changes in the cervix during adolescence.[105]

Cancer

Despite advances in the knowledge about EDCs, how much EDCs exacerbate health risks remains unclear. Take the risk of cancer, for example. A recent study by researchers at Cambridge University has shown support of causal links between early onset of puberty and increased risks of "various sex-steroid-sensitive cancers in men and women."[106] The study found drastic increases to certain cancer risks for each year puberty occurred earlier in the child, as described by a news report:

> They found that for every one year earlier a person goes through puberty, their chances of going on to develop breast cancer increase by 6 per cent. Meanwhile the risk rises 28 per cent for endometrial cancer, 8 percent of [sic] for ovarian cancer and 9 per cent for prostate cancer.[107]

Added to those statistics is the fact that pesticides and other endocrine disrupting chemicals have been associated with early onset of puberty. The Endocrine Society has noted the complexity of the risks, stating, "The extent and nature of long-term consequences depend on the interaction of genes and environment and involve many variables, including the developmental window of exposure, the individual's metabolism, and his or her genetic background."[18]

For the female reproductive system, some studies on animals have proposed that endocrine disrupting chemicals have implications in disorders such as ovulation and lactation, breast cancer, endometriosis, benign breast disease, and uterine fibroids.[18, 101] The laboratory results suggest similar effects on humans, although more studies are necessary to confirm this. For example, although future studies must confirm the results, one study of humans has suggested a link between exposure to the pesticide heptachlor "and a longer luteal phase length and a drop in estradiol/progesterone metabolites after ovulation."[18] Women were 51.1% of the population of Florida.[100] Numerically, that would be over four million people served—about the estimated population of Oregon.[100]

3.4 Other sections of the population are vulnerable based on the US EPA's identified list of pesticides that are likely carcinogenic to humans.

The Office of Pesticide Programs at the U.S. Environmental Protection Agency lists 50 pesticides as "likely to be carcinogenic to humans."[73] For one carcinogen, a high exposure group is children one or two years old.[108] Some evidence supports acute risk in

aiding potential side effects from a pesticide that is also listed as a carcinogen, namely, sodium acifluorfen, for females 13 to 50 years old.[109]

Male workers at production factories

A study has shown that the production of a carcinogenic pesticide, namely carbaryl, affects the quality of sperm and semen of male workers in production factories.[110]

4. Program Description

4.1. Describe program

Save The Water™ (STW™) is establishing analytical and research laboratories to provide scientifically valid and legally defensible data on water contaminants. STW™ will achieve recognition and international acceptance for data production under ISO/IEC 17025 standards by obtaining certification under the National Environmental Laboratory Accreditation Program (NELAP).[111] EPA established NELAP to set a national program for laboratories to provide quality data that is recognized as accurate and consistent with the global community.[112] The NELAP process includes all the stakeholders:

- States
- Federal agencies
- Local governments
- Indian tribes
- The regulated industry
- The laboratories that service the industry
- Environmental interest groups[112]

NELAP is now administered by The NELAC Institute (TNI) under the EPA.[112] By requiring internal and independent audits of quality systems, passing performance testing, and maintaining a quality manual with standard operating procedures, NELAP accreditation helps ensure the production of legally defensible data.

The STW™ laboratories will initially certify for drinking water and non-potable water[113] in accordance with detection limits and federal regulations, namely standard operating procedures mandated in 40 CFR 136 under the Clean Water Act and 40 CFR 141 under the Safe Drinking Water Act. The testing will include the following:

- Heavy metals
- Pesticides
- Herbicides
- Bacteria
- Petroleum and industrial contaminants
- Common water quality analyses

STW™ plans to expand into other areas of study that affect water, including hazardous waste, sediments, and biosolids. The State of Florida's Department of Health is authorized as an administrative body under the NELAP program.[113] Therefore, STW™ laboratories will obtain primary accreditation through the state.

Being a full-service facility that maintains required quality systems, equipment, safety, proper waste control, and good customer service requires the skills and dedication of experienced scientists and technicians. These individuals understand that water is life and that steps they take to ensure accurate and precise data on water contaminants will affect humans, plants, and animals that depend on clean water. Analyses will be performed only by properly trained, knowledgeable laboratory professionals under STW™'s ethical guidelines and mission goals.

4.2 Sampling sites

The sites will be selected by priority and proximity. Priority will be based on current contamination levels of pesticides as reported by the SFWMD. By contrast, proximity will be based on locations of suspected contamination discharges. Areas where manufacturers of products that necessarily work with dangerous, toxic chemicals as well as areas where CERP is currently working will be selected. The number of sampling sites will increase as information is gathered to maximize the area of the Everglades covered by the study.

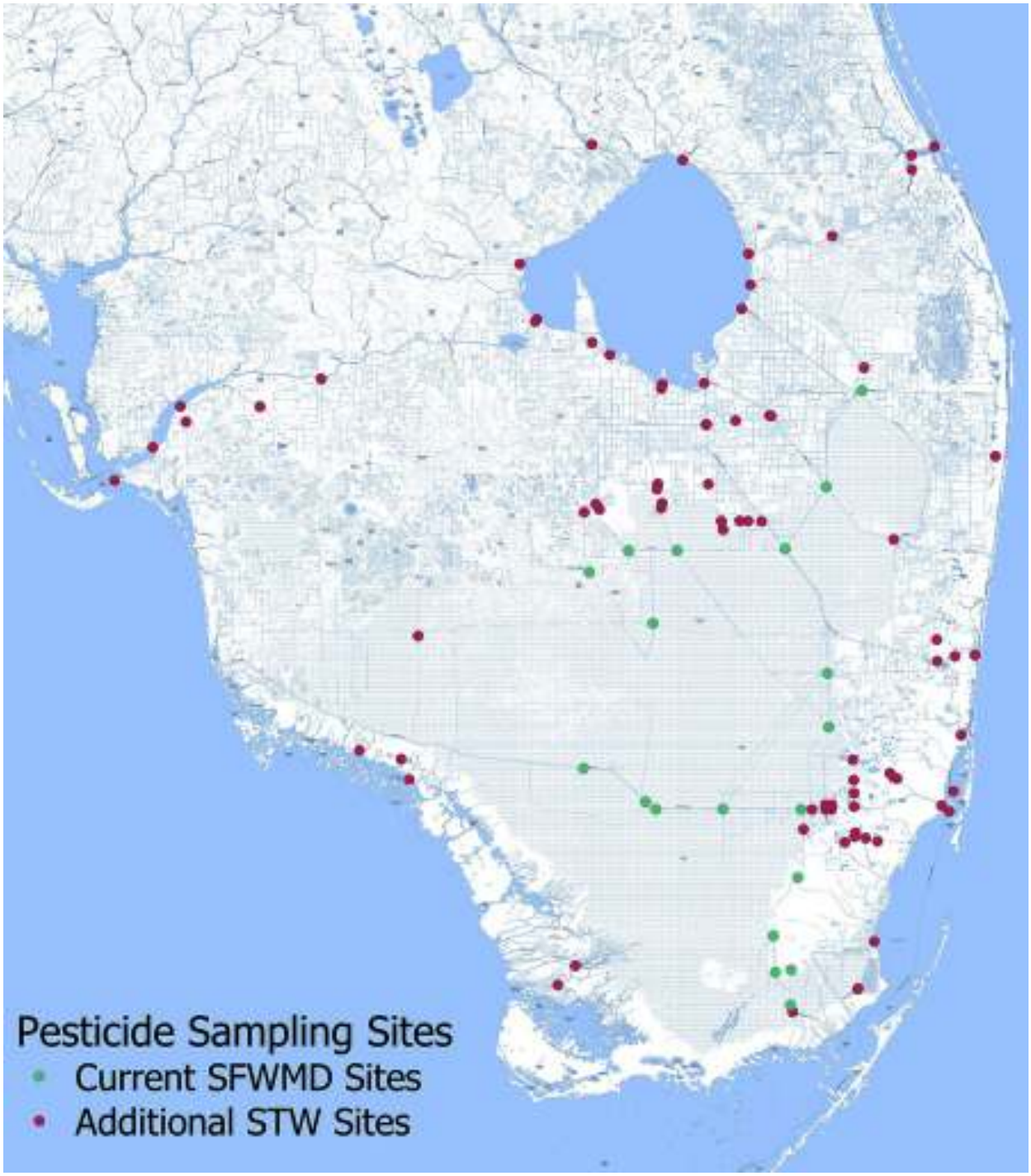


Figure 1. Map

STW™ plans to monitor the 26 sites tested by the SFWMD and 74 additional sites for pesticides and other toxic chemicals. As stated, SFWMD states that "Pesticide monitoring is conducted across the entire District at 15 sites on a biannual basis."[14] In WY2017, the pesticide "monitoring program consists of 19 sites and is conducted on a biannual basis."[9]

4.3 Sampling procedures

Sample collection procedures will be performed according to standard methods described in the EPA's approved sample collection methods. Grab samples and automated sampling methods will be used as required. Chain-of-command and quality assurance protocols will be followed. Samples will be packed in ice when required and transported to the laboratory via STW™ or common carrier.

5. Describe program implementation

5.1 Hire key personnel

Within the first three months of operation, the Laboratory Manager and Quality Assurance Officer will be hired. They will be responsible for hiring section chemists and other key lab staff and will direct startup operations. Project personnel will have the appropriate education and experience to be qualified to perform their assigned analytical duties.[114] As required under NELAP, the Laboratory Manager and Quality Assurance Officer will:

- Determine initial and ongoing personnel qualifications
- Identify training needs
- Coordinate or provide access to appropriate training opportunities
- Verify the acquisition of needed knowledge and skills through personnel evaluations system and annual training and/or demonstrations of capability for the laboratory staff

Responsibilities of all laboratory personnel will be defined under the quality system.

5.2 Write quality manual and SOPs

The Quality Assurance Manual defines the policies, procedures, and documentation that assure analytical services continually meet a standard of quality that is designed to give clients data of defined quality and, where applicable, demonstrate regulatory compliance. It sets the standard under which all laboratory operations are to be performed including the laboratory's organization, objectives, and operating philosophy.

Standard Operating Procedures (SOPs) are used to ensure consistent application of common methods. SOPs are written procedures that detail how to accurately reproduce laboratory processes.

5.3 Purchase equipment and supplies

The laboratory will ensure that purchased supplies and equipment meet necessary quality standards by using only approved suppliers and products. All equipment and software used for testing and sampling will be able both to achieve the accuracy required and to comply with the environmental test method specified in the laboratory SOP. Only

authorized and trained personnel will operate the equipment. All support equipment will be maintained in proper working order with records of all repair and maintenance activities. These include, but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, temperature measuring devices, volumetric dispensing devices, and thermal/pressure sample preparation devices.

Primary equipment, including the gas chromatographs, inductively coupled argon plasma spectrometer, liquid chromatograph, and autoanalyzer spectrophotometer, will be segregated and maintained in separate work areas to prevent contamination.

5.4 Set up labs

Laboratory space will be arranged to minimize cross-contamination between incompatible areas of the laboratory. Alarmed doors will remain locked during non-working hours. On top of that, police will monitor the area outside. All laboratory areas will be air-conditioned with humidity controls. Ventilation hoods will be constantly operating and periodically checked according to safety procedures, which also detail safety inspections and training. Should power be disrupted, a backup system will automatically provide electricity to key equipment including sample storage refrigerators and emergency lighting. Equipment, sample preparation areas, and consumables will be segregated.

5.5 Develop methods for SOPs

All procedures will be validated before being put into use. All methods used by the laboratory will be industry-accepted, published or well-documented by EPA, Standard Methods, or international standards. A **demonstration of capability** (DOC) will be performed. The DOC is a procedure to establish the ability of the analyst to generate data of acceptable accuracy and precision.

5.6 Obtain accreditation under Florida NELAP

The National Environmental Laboratory Accreditation Program (NELAP) is administered by The NELAC (Conference) Institute (TNI). STW™ will use the promulgated 2009 TNI Standard in Florida unless a different standard is adopted.[113] TNI has granted the Florida Department of Health accrediting authority for all in-state laboratories seeking certification.[113] TNI is a national organization. Its purpose is to foster the generation of environmental data of known and documented quality through an open, inclusive, and transparent process that is responsive to the needs of the community. TNI is dedicated to the vision that all entities generating environmental data in the United States be accredited to the national standard.[115]

5.7 Begin analyzing samples and implement quality compliance monitoring

STW™ will begin analyzing real environmental samples only after demonstrations of the performance of equipment, personnel, and quality systems have been accepted under NELAP through the Florida Department of Health. The program requires continued monitoring of quality compliance both internally and externally.

5.8 Acquire commercial clients through marketing

Our Sales and Marketing teams will work together to create and to execute omni-channel marketing campaigns to a variety of clients that require water analysis. The campaigns will be limited to the area for the market area and laboratory accreditation. Various local, state, and federal permit holders are also prospective clients.

Prospective clients are identified using multiple government and private websites such as the EPA website and the State of Florida website. Contacts for each client company will be vetted through LinkedIn and company website research. If LinkedIn does not provide enough information or contacts, we will source contacts via lists purchased through an outside vendor. The market will be approached by proximity, meaning that we will seek clients close to the laboratory and spread out as more clients are needed to meet sales goals. The state-of-the-art laboratory is capable of analyzing parameters to comply with both the Safe Drinking Water Act (SDWA) and the Clean Water Act (CWA).[116,117]

These omni-channel campaigns will include paid search, search engine marketing, social media, direct mail, outbound, and email elements. The messaging will address a prospect's pain points and reasons to buy Save the Water™'s services. One of our main value drivers will be our competitive prices resulting from lower overhead costs.

Our omni-channel campaigns will start with a direct mail piece that is quickly followed by an outbound call to the customer. If we are unable to reach the prospect via the phone, we will attempt a follow-up contact through email. When the direct mail piece drops, our social media, paid search, and search engine marketing elements will go live in an effort to capture any online search traffic related to our mail piece.

The campaigns will be optimized on a regular basis through actionable analytics, provided by monthly reporting and applications such as Google Analytics. This will ensure that budgeted marketing dollars are re-allocated and utilized in an appropriate manner.

6. What will be accomplished

The following goals will be accomplished:

- Implement, equip, and staff a full-service, state-of-the-art environmental laboratory certified under the National Environmental Laboratory Accreditation Program[118]
- Establish quality assurance guidelines for laboratory and field operation procedures recognized under ISO 17025
- Conduct a comprehensive, continuous, and everlasting water quality study of the Florida Everglades
- Analyze water, drinking water, certain biological samples, and—eventually—test sediments for a large number of Contaminants of Emerging Concern that may be present currently[119]

- Create a baseline and map of current contaminants in the Everglades from the data generated by the laboratory
- Monitor continuously for increases in concentration of chemical contaminants
- Identify new contaminants entering the Everglades
- Alert the public and authorities of changes that may impact water quality by publishing papers with the results of the study
- Alert CERP of any changes in water quality while the program is implemented to prevent cross-contamination of clean areas
- Become financially self-supporting after the first three years of funding
- Become the world's authority in water quality eventually

What are the desired outcomes?

The desired outcome is to protect the Florida Everglades from contamination evermore by monitoring water quality through a state-of-the-art water analytical laboratory that can financially support the Everglades study and is thus self-sustaining. STW™ aims to offer fiscally responsible, environmental analytical services to implement diversified humanitarian projects with the proceeds. The laboratory will adopt procedures to optimize equipment and scientific talent, which will benefit water quality and related sciences.

Through application of the policies and procedures outlined in the quality manual and SOPs, the laboratory assures that it is impartial and that personnel are free from undue commercial, financial, or other pressures that might influence their technical judgment.[120] The laboratory is responsible for carrying out testing activities that meet the requirements of the TNI/NELAC Standard and that meet the needs of the client.[120]

7. Goals and Objectives

7.1. Objectives in measurable terms

The central objective is to set up a state-of-the-art water analytical laboratory to continually monitor the water and sediment quality of the Florida Everglades forever. STW™ believes that this objective is required to ensure the future preservation of the ecosystem.

7.1.1 Operational goals and objectives

The **first-year goals** are: to set up the laboratory at Cambridge Innovation Center (CIC) Miami, to purchase equipment, to employ personnel, and to commence accreditation work. The first year includes three planning goals: developing field operations, logistics, and procedures for sample collection. Through its water quality research, the STW™ laboratory will motivate and support further studies that examine the effects of contaminants on wildlife and humans.

Second year goals are the following:

- commence the sampling and analytical work
- map the contaminating chemicals present in the water and sediments
- establish a present-day baseline of contaminants
- monitor changes in contaminant concentrations and new chemicals entering the ecosystem

During the second year of operation, the STW™ laboratory will analyze:

- Contaminants and priority pollutants delineated in the regulations promulgated pursuant to the Clean Water Act,[121] including the following:
    - 40 CFR 136, EPA 200.7/200.8—Metals
    - 40 CFR 136, EPA 612—Chlorinated Hydrocarbons
    - 40 CFR 136, EPA 608—Organochlorine Pesticides and PCBs
    - 40 CFR 136, EPA 604—Phenols
    - 40 CFR 136, EPA 610—Polynuclear Aromatic Hydrocarbons
    - 40 CFR 136, EPA 601/602—Purgeable Aromatics and Hydrocarbons
    - 40 CFR 136, EPA 606—Phthalate Esters
    - 40 CFR 136, EPA 614—Organophosphorus pesticides
    - 40 CFR 136, EPA (various)—Wet Chemistry
    - 40 CFR 136, EPA 300.0—Anions
- Contaminants and priority pollutants delineated in the regulations promulgated pursuant to Safe Drinking Water Act,[122] including the following:
    - 40 CFR 141, EPA 200.7/200.8—Metals
    - 40 CFR 141, EPA (various)—Wet Chemistry
    - 40 CFR 141, EPA 300.0—Anions
    - 40 CFR 141, EPA 501—Trihalomethanes
    - 40 CFR 141, EPA 502/524—Purgeable and Volatile Hydrocarbons
    - 40 CFR 141, EPA 505/525—Organohalide Pesticides and PCBs
    - 40 CFR 141, EPA 515—Chlorinated Herbicides
    - 40 CFR 141, SM 9221B—Total Coliform Bacteria
    - 40 CFR 141, EPA 245.1—Mercury by Cold Vapor Analysis
    - 40 CFR 141, EPA 547—Glyphosate
    - 40 CFR 141, EPA 508—Chlorinated Pesticides
- Compliance requirements for NPDES permit holders:
    - Federal, state, and county permit holders that discharge water to publicly owned water treatment works (POTW), surface water, or injection wells are required by law to periodically submit water analyses of the discharges. Depending on the industry or permit, parameters and frequency of testing vary. Analysis must be performed by an accredited laboratory and follow

chain-of-command sample handling procedures as well as quality assurance programs.

Third-year operations will expand into categorizing by order of toxicity and health effects endocrine-disrupting chemicals[123] and carcinogens, as well as testing for any additions by the SDWA, CCL, and UCMR.[124] Also in the third year, we will commence researching analytical methods to develop more sensitive procedures to detect CECs at lower concentrations in water. We will author and publish scientific papers to disseminate knowledge of water analytical chemistry.

The **fourth-year goals** include commencing data evaluation for the next phase which will apply toxicology studies on the most dangerous chemicals found. During the fourth year, monitoring operations will continue. Universities currently conducting toxicology studies will be contacted for collaboration on studies of these chemicals.

The **fifth year** of the STW™ laboratory will continue the Everglades Water Quality Study, maintain all operations, and increase the customer base for water analytical work. From the first quarter to the third quarter, STW™ laboratory will apply and become accredited for Superfund-RCRA 40 CFR 261 as well as Sludges 40 CFR 503. Large projects such as Superfund sites and environmental catastrophes, such as oil spills, mine spills, and coal ash ponds spills, will be offered our laboratory services. Laboratory and field equipment will be reviewed and updated as necessary.

7.2 Financial goals

To financially support the Florida Everglades Water Quality Study permanently, STW™ plans to start marketing and selling in the first year of operations analytical services for water, water extracts, and sediments to markets in Florida and the Caribbean. These markets are underserved and are in need of a state-of-the-art water analytical laboratory. To accomplish this, funding for operations is necessary through the third year.

At the the end the third year of sales, the cumulative cash is projected at $2,300,000 from services rendered to National Pollutant Discharge Elimination System (NPDES) permit holders using the same laboratory, equipment, and staff. As workloads increase, a second Gas Chromatograph/Mass Spectrophotometer (GC/Ms) will be added; all equipment can operate overnight without personnel assistance. Funds generated from the third year and cash flow from the fourth year will suffice to sustain the fifth and later years financially.

7.3 Ultimate operational and financial goals

By the fourth year, the STW™ laboratory will be in full operation servicing numerous clients. The laboratory will continue water research and perform studies for the Everglades Water Quality Study. The laboratory will be financially self-sufficient and be able to cover all expenses through services rendered to clients. At that point, the laboratory will embark on self-funded research and humanitarian projects.

8. Timeline - Table 5

Everglades Study Time Table

	1st Year			
	Q 1	Q 2	Q 3	Q 4
Personnel	Hire QA Manager	Hire Lab Director	Hire Scientists & Techs.	
Marketing & Sales	Hire Manager and Sales			
Field Personnel	Hire Manager		Hire Sampling Team 1	Hire Sampling Team 2
Facility	Obtain Facility			
Lab Equipment	Order Lab Equipment	Equipment Delivery		
Field Equipment			Purchase Field Equip	Purchase Field Equip
Supplies	Purchase Supplies		Purchase Supplies	Purchase Supplies
Accreditation			Apply 40 CFR 136, 40 CFR 141	Certify 40 CFR 136, 40 CFR 141
Project				

	2nd Year			
	Q 1	Q 2	Q 3	Q 4
Personnel				
Marketing & Sales				
Field Personnel			Hire Sampling Team 3	
Facility				
Lab Equipment	Purchase 2nd ICP/MS	2nd ICP/MS Delivery		
Field Equipment			Purchase Field Equip	
Supplies	Purchase Supplies	Purchase Supplies	Purchase Supplies	Purchase Supplies
Accreditation				Recertify 40 CFR 136, 40 CFR 141
Project	Start Analyzing Water 40 CFR 136, 40 CFR 141, EDs, Pesticides, Carcinogens			

	3rd Year			
	Q 1	Q 2	Q 3	Q 4
Personnel				
Marketing & Sales	Hire 1 Add Salesperson			
Field Personnel	Hire Sampling Team 4			
Facility				
Lab Equipment				
Field Equipment	Purchase Field Equip			
Supplies	Purchase Supplies	Purchase Supplies	Purchase Supplies	Purchase Supplies
Accreditation				Recertify 40 CFR 136, 40 CFR 141
Project	CWA/SDWA Categorize Contaminants/Improve Sensitivity/Publish Papers			

	4th Year			
	Q 1	Q 2	Q 3	Q 4
Personnel				
Marketing & Sales				
Field Personnel				
Facility				
Lab Equipment				
Field Equipment				
Supplies	Purchase Supplies	Purchase Supplies	Purchase Supplies	Purchase Supplies
Accreditation				Recertify 40 CFR 136, 40 CFR 141
Project	Continue 2nd & 3rd Years Work Start Toxicology Studies			

	5th Year			
	Q 1	Q 2	Q 3	Q 4
Personnel				
Marketing & Sales	Hire 1 Add Salesperson			
Field Personnel				
Facility				
Lab Equipment				
Field Equipment				
Supplies	Purchase Supplies	Purchase Supplies	Purchase Supplies	Purchase Supplies
Accreditation	Apply 40 CFR 261, 40 CFR 503	Continue 40 CFR 261 40 CFR 503	Certify 40 CFR 261, 40 CFR 503	Recertify 40 CFR 136, 40 CFR 141
Project	Continue All Projects with Certifications for 40 CFR 136, 40 CFR 141, 40 CFR 261, 40 CFR 503			

9. Financial Projections

The project funding will be used to establish an accredited environmental laboratory to provide continuous monitoring of the water quality of the Florida Everglades. Save the Water™ aims to be the authority in water quality in the Florida Everglades and the world. The STW™ laboratory will also be able to offer water analytical services to NPDES permit holders in the southern half of the State of Florida and the Caribbean Islands. The STW™ laboratory will also have the sample volume capacity to perform analytical contracts for other environmental projects such as Superfund sites, natural disasters, or man-made disasters.

Funding is required for the first three years based on our projections. First-, second-, and third-year funding required are $2,771,608, $3,575,079, and $4,191,651 respectively. A total of $10,538,337 is needed in funding for three years. At the start of the fourth year, cumulative cash in the bank is projected at $2,105,099. By that year, the STW™ laboratory will be financially self-sufficient to continue to perform the Everglades Water Quality Study permanently as well as continue laboratory operations and analytical methods research. From the fifth year forward, because of the additional accreditations, funds will suffice to support further monitoring and research.

The numbers show that the organization is ahead of the curve in financials and is able to continue operations and the Everglades Water Quality Study permanently.

The Budget in Appendix D provides itemized dollar expenditures and sales for the first five years. The figures show average monthly, quarterly, and yearly expenditures as well as sales projections and cash flow. Sales projections were purposely estimated at the lowest possible dollar amounts to show a conservative projection.

The budget contains detailed expenditures for facilities, equipment, supplies, laboratory and sample collection staff, general administrative expenses, and reserve funds. Sales projections and cash flow are calculated quarterly. Appendix D.

10. Evaluation

The Everglades Water Quality Study will be evaluated on an ongoing basis to show fulfillment of goals, to document success, and to measure the impact on the population served. The evaluation plan is designed to guarantee that specific measures will be used to:

- Monitor the project systematically and on a continuing basis
- Assess the quality of the project
- Align the goals and expected outcomes in order to guarantee detailed assessment and success

STW™ will form an Evaluation Team to monitor progress during the entire length of the project. The team will collect project data on a quarterly basis and provide reports by the middle of the following quarter. This process will allow STW™ to make appropriate adjustments. Quarterly reports will be available to all stakeholders such as staff, partners, funders, and population served. The quarterly reports will document progress towards goals and outcomes as well as provide transparency. The Evaluation Team will provide both formative (process) and summative (outcome) evaluation measures addressing the project goals and expected outcomes. Evaluations of the Everglades Water Quality Study will be conducted throughout the five-year period.

10.1 Formative Evaluation

The two main purposes of the formative evaluation will be the following:

- to monitor progress to help all staff and project partners to meet the project timeline
- to encourage ongoing improvements

The main formative evaluation questions are the following:

- Has the project met the goals and objectives as detailed in the timeline?
- Have the staff and project partners effectively used the quarterly reports to monitor progress and to make improvements?
- Have the staff and project partners efficiently collaborated when collecting and analyzing the data and disseminating the findings?

The formative data will be collected as follows:

Table 6. Formative Evaluation

Objective	Responsible Person or Team	Timeline	Evaluation Measure
Implement, equip and staff a full-service, state-of-the-art environmental laboratory certified under the NELAC	Laboratory Director	Year 1	Receive laboratory accreditation.
Establish Quality Assurance guidelines for laboratory and field operation procedures recognized under ISO 17025	Laboratory Director	Year 1	Receive laboratory accreditation.
Push sales with organizational support to meet sales projections of $300,000 by the end of Year 2 and establish customers	Marketing & Sales	1st Quarter of Year 2	$300,000 by end of Year 2
Create a baseline and map of current contaminants in the Everglades from the data generated by the laboratory	Laboratory Director; Laboratory Staff; Publishing Group	Year 2	Map or other paper communicating the baseline to the public, project partners, authorities, and other stakeholders
Conduct a comprehensive and continuous water	Laboratory Director; Laboratory Staff; Research and Engineering	Year 2 to Year 5	Data collected from study

quality study of the Florida Everglades			
Analyze water, drinking water, and certain biological samples for a large number of Contaminants of Emerging Concern	Research & Engineering; Laboratory Director; Publishing	Year 2 to Year 5	Publish findings reviewed by scientific peers
Monitor continuously for increases in concentration of current chemical contaminants	Research & Engineering; Laboratory Director; Laboratory Staff	Year 2 to Year 5	Published data
Alert CERP of any changes in water quality while the program is implemented to prevent cross-contamination of clean areas	President; Executive Team; Board; Publishing	Year 2 to Year 5	Letters and other communications to the CERP if appropriate
Alert the public and authorities of changes that may impact water quality by publishing papers with the results of the study	Marketing & Sales; Research & Engineering; Publishing	Year 3	Publications; outreach; letters to authorities; white papers; information on websites
Analyze water and drinking water for UCMR and CCL	Laboratory Director; Laboratory Staff; Research and Engineering	Year 3	Findings to include more contaminants

Achieve sales objectives and have enough cash in the bank to pay for the next year's operating costs by the fourth quarter	Marketing & Sales	End of Year 3	Bank account meets projected needs of Year 4
Identify new contaminants entering the Everglades	Research & Engineering; Laboratory Director; Laboratory Staff; Publishing	Year 3 to Year 5	Published data
Associate with universities conducting toxicology studies to further the knowledge of the most dangerous chemicals by co-sponsoring toxicology studies depending on the risk that some chemicals may pose.	Research & Engineering; Education; Publishing	Year 4	Existence of collaborative relationships with universities; publication of findings in peer-reviewed journals
Adjust the number of sample collection sites from 100 to a higher or lower number for the Everglades Water Quality Study as required. The requirement will depend on changes or expansion to the CERP or suspected sites of contamination that	Laboratory Director; laboratory staff	Year 4	Changes in sample collection sites, if appropriate

will come to our attention			
Become financially self-supporting after the first three years of funding	CFO; Laboratory Director; Marketing & Sales	Year 4	Budget that shows self-sustaining project
Research expansion. From the first quarter to the third quarter, apply and become accredited for Superfund-RCRA 40 CFR 261, and Sludges 40 CFR 503	Laboratory Director; Laboratory Staff; Research & Engineering	Year 5	Accreditation for Superfund-RCRA and Sludges
Test sediments for Contaminants of Emerging Concern	Research & Engineering; Laboratory Director	Year 5	Published findings reviewed by scientific peers
Maintain sales and service of clients obtained during years 1, 2, and 3, and expand sales and marketing for the new accreditation capability of the laboratory to superfund sites, mine and oil spills, environmental and natural disasters.	Marketing & Sales	Year 5	Lab revenues of $3,546,836, with additional funds applied to humanitarian projects

10.2 Summative Evaluation

The three main purposes of the summative evaluation will be the following:

- to assess the success of the project implementation
- to demonstrate that project goals were fulfilled
- to provide benefits to the target population

Unlike the formative evaluation, this part of the evaluation will be conducted at the five year mark.

The following are the main summative evaluation questions:

- Did the project meet objectives and expected outcomes?
- How has the project benefited the target population?

The summative data will be collected as follows:

Table 7. Summative Evaluation Table

Objective	Responsible	Timeline	Evaluation Measure
Conduct a complete review of the Everglades Water Quality Study and adjust as necessary to steer and to set future attainable long-term goals.	Laboratory Director; Laboratory staff; Research & Engineering	End of Year 4	Information to issue report
Issue a report that will be useful to both the scientific community as well as the general population to assess the water quality of the Everglades.	Laboratory Director; Laboratory Staff; Research & Engineering; Marketing & Sales; Publishing	End of Year 4	A report available to all stakeholders and any interested individuals
Adopt procedures to optimize equipment and scientific talent, which will benefit water quality and related sciences.	Laboratory Director; Research & Engineering	Year 4 or 5	Use of procedures and equipment by other organizations
To protect the Florida Everglades from contamination for future generations by monitoring water quality through a state-of-the-art water analytical laboratory that can financially support the Everglades study	CFO; Laboratory Manager; Research and Engineering	Year 5	Budget shows the project is self-sustaining (i.e. either 0 or positive finances and cash flow)

and is thus self-sustaining			
Offer fiscally responsible, environmental analytical services to implement diversified humanitarian projects with the proceeds.	Research & Engineering; Marketing & Sales	Year 5	Clients who buy services

11. Staff and Organizational Information

11.1. Staff names, qualifications, skills, etc.

The following professionals are key persons supporting the Everglades Water Quality Study. Overall, the organization has over 80 volunteers who also contribute as needed.

Frank Ramos, ***President, Research & Engineering Lead*** — Frank founded Save the Water™ to harness his experience in the chemical industry to address global pollution issues through water science research and contamination removal. He brings more than fifty years of experience in the chemical industry associated with industrial wastewater treatment system design, management, development, marketing, and research. Frank has designed proprietary water treatment equipment and filtration products for various applications which include the following:

- industrial water treatment system, drinking water from a contaminated source
- hydraulic environmental sampling
- mobile environmental laboratory
- multi-technology canal or river sludge treatment system
- slaughterhouse waste treatment system
- bioremediation of hydrocarbon contamination
- biological wastewater treatment

During his decades-long professional career, Frank served as the Research Assistant and the International Sales Representative with the world-renowned environmental scientist and founder of Electrox, Inc., the late Dr. Leland Cole, in many assessment and remediation projects. Frank's expertise has been required from many environmental

projects including the proposed clean-up of the Gowanus Canal Project in New York City. His expertise extends to environmental assessments of contaminated sites for applications of remediation technologies, pilot plant design, equipment design and manufacture, and project management. As a result of his experience, Frank was invited by President Clinton to: the White House Conference on Trade and Investment in Central and Eastern Europe held in Cleveland in January 1995; and to the White House Conference for Trade and Investment in Ireland held in Washington, D.C. in May 1995. Frank held the position of Technical Director of World 2000 Environmental Services, Inc., where he was directly responsible for all technologies applied in assessments and remediation contracts. While at World 2000 Environmental Services, Inc., Frank also proposed clean-up technologies for the oil spills in Kuwait after the Gulf War.

Research & Engineering Group

Sudesna Banerjee, ***Director, Research & Engineering*** — Sudesna has completed a Bachelor of Science with a degree in Chemical Engineering. She has over nine years of work experience primarily in the chemical, petrochemical, mineral, refinery, concrete, water, and wastewater treatment industry. Sudesna has experience in process design engineering, engineering procurement, and project coordination. Her previous projects include plant revamps, de bottlenecking and expansions, auxiliary facilities, and technical services. In July of 2006, Sudesna began her professional career in engineering with Development Consultants' Pvt. Ltd. She has also worked with companies such as Foster Wheeler as a Sr. Process Engineer. At STW,™ Sudesna manages the Research & Engineering Group's operations which include Research & Development of proprietary water treatment technologies such as the eFlox,™ eNox,™ FloNox,™ and AOT™. In addition, she manages the team of engineers and scientists working on all Research and Design (R&D) projects. Lastly, among many other managerial duties, Sudesna oversees the publication of R&E Quarterly Reports.

Richard Sheets, ***Research & Engineering Associate Director, Laboratory sample collection coordinator and AOT™ Technology Director*** — Richard brings over 42 years of environmental experience to the Save the Water™ Everglades Water Quality Study team. His 34 years of executive laboratory experience includes geotechnical, sediment, leaching, and treatability testing. He founded and served as Vice President of Soil Technology, a 5000 ft^2 state-of-the-art geotechnical, sediment leachability and treatability lab for 20 years. These tasks covered work on most major United States ports and harbors as well as clients with the top A&E Engineering firms performing the EPA characterization testing Tier 1-3 testing as well as the U.S. Army Corps of Engineers testing for redevelopment and expansion. On one Port of Seattle project, Richard was responsible for a value engineering saving of over $20 M on a $ 70 M brownfield Superfund site. Richard also brings extensive experience in quality control, field sampling, and advanced oxidation technology.

Mark Murphy, ***Research & Engineering Associate: Everglades Grants Project*** — Mark has led the study of water quality for over 35 years as an environmental laboratory manager. Both by following industry approved standards and developing new methods, he has established new laboratories, trained personnel, set up quality assurance and state-of-the-art equipment to meet the needs and requirements of government, commercial, and

private clients. The National Environmental Laboratory Accreditation Program has recognized Mark as an official Technical Director and Quality Assurance Manager for laboratory chemistry and microbiological testing. He has professional experience in organic, inorganic, and classical wet chemistry as well as microbiology, and radioactivity. This unique mix of experiences gives him the ability to direct analyses for heavy metals, pesticides, volatile and semivolatile compounds, E. coli, Enterococcus, and other bacteria. Mark can also direct analyses for alpha, beta, and gamma emitting radionuclides and the full range of wet chemistry tests defined in Standard Methods for the Examination of Water and Wastewater. Additionally, Mark has published research in extremely low level phosphorus determinations, a method for measuring optical brighteners, and studies for enhanced microbial remediation of marine oil spills using peroxides. He has also set up the following:

- mobile response laboratories
- a teaching lab on a remote Pacific island nation
- a commercial nuclear power plant lab
- an EPA contract lab
- an environmental research university lab
- a lab for a scientific investigation company which discovered chromium in imported crayons and lead smelter metal contamination in a Dallas neighborhood

Mark comes to STW™ with an investigative spirit and high ethical standard for environmental data production and customer service. His experience in meetings and trainings for state and federal agencies brings a steady and common sense approach to protecting the environment and meeting STW™'s mission.

Seyed Armin Madani, ***Research & Engineering Project Leader: Process Design*** — Armin has a bachelor's degree and a master's degree in Civil Engineering from the University of Tehran. He also graduated from the University of Louisiana at Lafayette in December 2015 with a master's degree in Petroleum Engineering. Now, Armin works as a Wastewater Process Design Engineer at Oil Center Research, LLC while he volunteers with the Save the Water™ as a Project Leader on the eFloc™ design project. Before coming to Save the Water,™ Armin had interned with Siemens and Oil Center Research among other experiences both inside and outside of the university. These technical and practical experiences are helping him lead the eFloc™ design team to achieve its milestones. While at the university, Armin had many related courses in water and wastewater treatment fields in his civil engineering and petroleum engineering programs. In addition, he wrote his Petroleum Engineering master thesis on optimizing the efficiency of oil water separation in hydrocyclones. Armin also has competencies in computer skills such as Matlab, Fortran programming, AutoCAD, and SolidWorks.

Maryam Keramati, ***Research & Engineering Project Leader: Process Design (News Report)*** — Maryam is a graduate from the University of New Haven. She received her master's degree in Environmental Engineering. She started volunteering with Save the Water™ at an associate level in September 2017. For her work, Maryam received a silver star performer award of the quarter. After that, she was promoted to a project leader in January 2018. Before coming to Save the Water.™ Maryam had several research

internships and experiences both inside and outside of the university. The practical experience is helping her work both within a team and individually to achieve a goal with milestones. Maryam also had many related academic courses: water and wastewater treatment; fate and transport of aqueous waste; engineering hydrology; open channel hydraulics; environmental law and legislation; and chemistry—general, organic, physical, and polymer. She also has competencies in computer skills such as C programming, Matlab, and AutoCAD.

John Datino, ***Research & Engineering Project Leader: Engineering*** — John started his technical training in the U.S. Navy and became a qualified Submarine Engineer. He has merits in the Nuclear Power Program as a machinist mate specializing in desalination and distillation of potable and feed water. He also earned a certification as a Steam Plant Operator and Mechanic while in the Navy. His training includes: operating seawater evaporation units for the production of boiler feed and drinking water for ships out to sea, designing mechanical devices, reading and drawing schematics for the production and operation of water systems, and training as a chemist for primary (nuclear) and secondary (steam plant) operations.

John also worked for Mobil Oil for 15 years in water and oil systems. This professional experience includes five years of water filtration pumps and related systems maintenance experience, and ten years of operating experience as the manager of product manufacturing and distribution positions. John was always concerned with the environmental safety of the equipment and proper operating procedures. He also served for eight years at Mobil Oil Corporation as the Retail Sales Manager, the supervisor responsible for 120 people.

Recently, to continue his commitment to education, he pursued a college degree in Environmental Science and Toxicology with a special emphasis on water purification, storage, and distribution for major metropolitan areas. John has been a supporter of STW™ since 1999 and has provided engineering collaboration and financial support.

Gloria Anaya, ***Research & Engineering Project Leader: Researchers & Scientists*** — Prior to joining Save the Water™, Gloria served as the Laboratory Director of Control and Analysis of Alcoholic Beverages for the Secretary Finance of Cundinamarca, Colombia. She was also a Professor of Organic Chemistry for the majors of marine biology and food engineering at the Universidad Jorge Tadeo Lozano, Colombia. Before that, she was the Technical Assistant Manager of Aquimin (LTDA) Laboratories—industrial cleaning products—in Colombia. Gloria graduated with a Chemistry degree from the Universidad Nacional de Colombia in Santa Fe de Bogotá, Colombia. In addition to her university coursework, she took special courses: Total Quality Control, Gas Chromatography, Atomic Absorption, Alcohol Beverage Control, and Educational Techniques. Gloria has been associated with STW™ since 2000. She has contributed scientific knowledge and has attended conferences on behalf of the organization. She is currently scheduled to be in charge of the wet chemistry of the STW™ laboratory.

Stefan Kell, ***Research & Engineering Associate: Process Design*** — Stefan joined Save the Water™ in 2017. He holds a master's degree in physics and a bachelor's degree in mathematics. Stefan has publications in his field in peer-reviewed journals. His work

experience spans 8 years. Stefan's professional experience includes ensuring high quality data for the City of New York.

David O' Connell, ***Research & Engineering Associate: Mechanical Engineering*** — David has a bachelor's degree and a master's degree in mechanical engineering. He currently works as a mechanical engineer. Among his various responsibilities, David monitors and ensures the work is completed on schedule and within budget. He also brings great people skills as he served as a campaign coordinator in a student election. David is proficient in MATLAB, C++, ANSYS, and AutoCAD.

Key staff in the organization

Swati Meshram, ***Executive Vice President and Chief Operations Officer*** — Swati was born and raised in India. She holds degrees in architecture, music, environmental planning, and urban planning. She earned her doctorate in Urban and Regional Planning from the Institute of Development Studies from the University of Mysore, India. After living in Florida for 12 years, she currently resides in California. Swati has overall work experience spanning 12 years, including significant experience as an urban planner. She is working as an associate planner for the City of Buena. Since July 2015, Swati has been with Save the Water™. She started as Associate Director in the Social Media Group and has since served as Director of Science and Engineering, and Vice President of Operations. These roles have led up to her current position, Executive Vice President/Executive Director.

Steve Falk, ***Chief Financial Officer*** — Steve is a partner in an accounting firm. He is a certified public accountant. His firm provides a range of services to businesses in the United States and overseas. He provides a range of services including the following:

- Business development
- Tax planning
- Financial and operational analysis
- Business acquisitions
- Sales and financial budgeting

Steve has also served as the chief financial officer for the twelfth largest private water utility in New York State. His long career includes experience as a financial and operational manager for the AIG Insurance Group, Manufacturers Hanover Trust Co., and Chase Bank. Steve managed an internal lease portfolio with over $3 billion in assets.

Raina Dsouza, ***Executive Assistant to President*** — For nearly 12 years, Raina has worked in customer service, mobile advertising, and the media industry. She has a bachelor's degree in biology and chemistry. Now she is working towards getting a degree in nursing. She has been helping Frank Ramos, president of the organization, in completing the laboratory safety manuals, organizing board meetings, and other day-to-day tasks.

Namratha Mysore, ***Executive Assistant to Executive Vice President*** — Namratha brings over 8 years of experience in a diverse range of fields, including volunteer project coordination, online tutoring, recruitment, and business processing. She has been

responsible for managing a team of volunteers. Her work experience includes a stint in the banking industry. Namratha is also well trained and experienced in the latest software tools and technologies.

Key lead staff in the organization

Samia A. Wahab, ***Director of Education*** — Samia has over 20 years of experience in the field of education. She joined STW™ in 2016. She oversees the Day in the Life of a Scientist (DILOS)™ program. Now, she is creating innovative educational resources for the STW™ website. Samia is the Founder and Director of the Center for Education Policy Analysis, a think tank focused on education research, practice, and policy issues. Previously, she worked as an Educational Consultant in the Chicago metropolitan area. As a consultant, Samia worked with administrators to create school improvement plans and facilitated professional development programs for teachers. She earned a Doctor of Education degree in Curriculum Studies from DePaul University in Chicago, a Master of Arts in Instructional Technology and Media from Columbia University in the City of New York, and a Master of Arts in Education Policy from the University of Chicago. Her research interests include education policy and educational technology. She serves as the Social Media Chair on the board of the Chicago Women's Alliance of the University of Chicago, an Auxiliary Board Member of the Columbia University Club of Chicago, and an Associate Committee Member of the Chicago Foundation for Education. In her free time, she enjoys volunteering as a spelling bee judge and a science fair judge.

Anita Pinto, ***Associate Director of Fundraising*** — Anita has over 14 years of experience in the semiconductor industry. She is currently leading new projects in the Fundraising Team. Anita is equipped with an exceptionally diverse set of skills which includes software and process methodology, risk management, learning agility, and interpersonal effectiveness. She is also currently pursuing a Data Science certification Program at Columbia University in the City of New York. Anita is looking forward to using her newly acquired skills in Data Analysis/Visualization with the results and data from the STW™ laboratory.

Arpita Pal, ***Director of Human Resources*** — Arpita holds a master's degree in Business Administration and Bachelors of Commerce with Honors from the University of Calcutta, India. She has over 8 years of experience in human resource management. During her professional tenure, Arpita has worked with teams across India, China, United Arab Emirates, and the United States of America. She helped organizations in the sectors of information technology, internet, online gaming, and other software technology. Arpita helped organizations accelerated transformation through leadership, strategic talent strategy models, talent acquisition, capability development, global talent management, robust compensation and benefits, organization development, diversity inclusion, and engagement programs. She also worked with organizations to apply workforce analytics to implement strategic predictive decision making. Arpita has also worked to build a culture of high performing teams which are agile, lean, and innovative.

As the Director of Human Resources at Save the Water,™ Arpita is responsible for acquiring, developing, and retaining high performing talent through an innovative workplace strategy. She also provides strategic leadership by analyzing business

requirements and people-needs to translate them into people-friendly human resources solutions that make Save the Water™ a great place to volunteer.

Marie Pachy, ***Director of Marketing & Social Media*** — Right after graduating from college, Marie witnessed contamination of drinking water while volunteering for a nongovernmental organization in Africa. Since then, Marie has gained 10 years of experience in project management, marketing research, and branding. Now, she feels more passionate than ever about helping promote organizational events and awareness efforts to bridge the research and education gap about water issues, which is instrumental in solving the water crisis.

Steve Kalthoff, ***Director of Technology*** — Steve has over 10 years of experience in IT tech support and as a webmaster. He has been awarded recognition for his work. Steve serves as a lead developer and webmaster in his current employment. In addition, he serves as a lead designer for an internal platform at his current position. Steve is well informed to provide appropriate assessment of technical issues and tailor security methods.

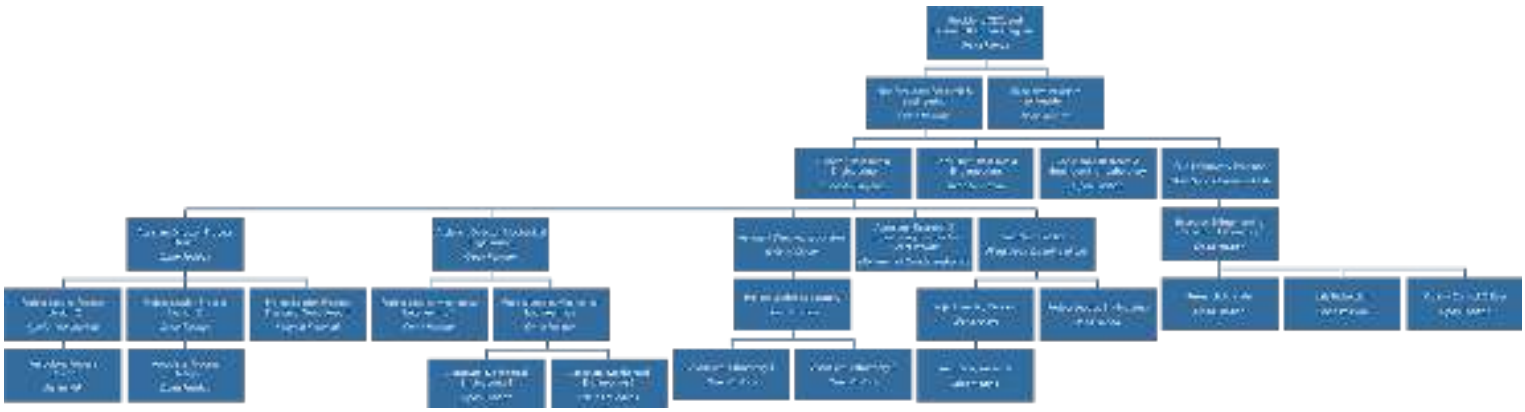
April Day, ***Director of Publishing*** — In 2002 when she worked in an environmental law office, April was first introduced to water issues, including water contamination and the need for monitoring. After that, she attended law school. While a student, April served as an articles editor for the *Columbia Journal of Environmental Law*. Professional experience has made her aware of water regulations in different parts of the United States, the water contamination from Superfund sites when the sites are not monitored properly, and the health problems caused by water that fails to meet federal and state regulations.

Contributor to Grant Proposal

Geetanjali Kale, M.D., M.B.B.S., ECFMG Certified ***Friend of Save the Water™*** — Geetanjali has acquired 10 years of publishing and research experience, which she has carried over to help in assisting the knowledge of our team. She specializes in endocrinology and has won awards for her professional medical standing. On top of all these impressive accolades, she served as a member of the Diabetes Task Force at JFK Medical Center.

11.2. Organization structure and capacity to support program

Figure 2. Organogram



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This proposal was prepared by the volunteers of Save the Water™ who are a tremendous group of scientists and professionals with the same understanding and vision of the vital role water plays in our lives. This group of dedicated individuals also have the knowledge and conviction that water contamination is a significant, complex problem and that Save the Water™ can do something about it. We all believe that we can make a difference in water quality for the benefit of all species on the planet.

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13. Appendices

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