HUMAN HEALTH AND ECOLOGICAL IMPACT ANALYSIS OF THE HILLSBOROUGH COUNTY RESOURCE RECOVERY FACILITY EXPANSION

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ACRONYMS

ACI	activated carbon injection
APC	air pollution control
BACT	best available control technology
CAA	Clean Air Act
DEP	Florida Department of Environmental Protection
EPA	U.S. Environmental Protection Agency
FF	fabric filter
FIFRA	Federal Insecticide Fungicide and Rodenticide Act
LCA	life cycle analysis
MACT	Maximum Achievable Control Technology
MW	megawatts
MSW	municipal solid waste
MWC	municipal waste combustor
NOx	nitrogen oxides
PCBs	polychlorinated biphenyls
PCDD/PCDFs	polychlorinated dibenzo-p-dioxins and dibenzofurans
PPSA	Florida Electrical Power Plant Siting Act
PSD	Prevention of Significant Deterioration
RCRA	Resource Recovery and Conservation Act
RRF	resource recovery facility
RTF	Recycling Task Force
SDA	spray dryer absorber
SIP	State Implementation Plan
SNCR	selective non-catalytic reduction
SWMD	Hillsborough County Solid Waste Management Department
TECO	Tampa Electric Company
TEQs	2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxic equivalents
TPD	tons per day
TSCA	Toxic Substance Control Act
USCOM	U.S. Conference of Mayors
WERT	Waste to Energy Research Council
W-T-E	waste to energy

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EXECUTIVE SUMMARY

Hillsborough County is proposing to expand the solid waste processing capacity of its existing Resource Recovery Facility from 1,200 to 1,800 tons per day. Hillsborough County requested CPF Associates, Inc., an independent scientific research and consulting organization, to evaluate the potential for negative human health or ecological impacts associated with the expansion. CPF's evaluation was conducted by: (a) researching the scientific and regulatory literature regarding waste-to-energy facilities, (b) analyzing site-specific information concerning the proposed expansion project, including the information presented in the County's Power Plant Siting Act permit application, and (c) performing standardized risk assessment calculations and analyses. The results of CPF's analysis show that the proposed expansion project is unlikely to have a negative impact on human health or the environment if constructed and operated as stated in the County's permit application.

1.0 INTRODUCTION

1.1 The Proposed Expansion

Hillsborough County owns a 1,200 ton per day (TPD) resource recovery facility (RRF), which is operated as part of the County's Integrated Solid Waste Management System. The RRF, comprised of three 400 TPD combustion units, incinerates municipal solid waste (MSW), produces steam, and converts the steam to electricity, which is sold to the Tampa Electric Company. Due to residential and commercial growth in the County since the RRF became operational in 1987, the 1,200 ton per day capacity of the existing plant has become inadequate. The County Commission has concluded that it should increase the RRF's capacity to 1,800 tons per day. The proposed RRF expansion project would involve the addition of a new 600 ton per day boiler and certain ancillary equipment.

1.2 Objectives Of This Analysis

The permit process for the proposed fourth unit at the RRF will require the submittal of a number of application documents. These include a Site Certification Application to comply with the Florida Electrical Power Plant Siting Act (PPSA), and an application for a permit under the Prevention of Significant Deterioration (PSD) program to comply with the Clean Air Act. PPSA approval to construct the fourth unit will be determined by the State of Florida's Siting Board (i.e., Governor and Cabinet). The PSD permit will be issued by the Florida Department of Environmental Protection (DEP).

The Human Health and Ecological Impact Analysis presented in this document was performed to address questions related to human and environmental health that may arise during the course of the permit processes. This analysis is not a formal requirement of the permit processes for the County's expansion project, but was conducted to ensure that issues of potential concern related to the proposed RRF expansion were evaluated.

This Human Health and Ecological Impact Analysis was performed by CPF Associates, Inc., a Washington, D.C.-based scientific and regulatory consulting firm. Appendix A provides biographies of the CPF scientists who participated in this effort.

1.3 Methods Of This Analysis

This analysis consists of several parts. First, information regarding the operation of Hillsborough County's Solid Waste Management System, including the existing RRF and the proposed RRF expansion, was obtained and reviewed. Second, information about the regulatory context of waste-to-energy facilities is

evaluated and the implications investigated for the proposed Hillsborough expansion. Following these activities, a scientific literature search and review was conducted to obtain information relevant to the analysis, including general information about analogous facilities and specific information about the west Florida environment. Hillsborough County's engineer, CDM, was requested to perform survey work to obtain site-specific information that was pertinent to the analysis. CDM also conducted air dispersion and deposition modeling to address the behavior of the RRF's stack emissions in the environment. The results of the modeling were used as inputs to a health risk assessment.

Risk assessment is an important tool that can be used to evaluate the probability of adverse effects from various types of activities or situations. This well-recognized method of analysis can assist in identifying the probability of adverse health effects occurring as a result of exposure to chemicals. It is also often used in a regulatory context, in which risk assessment results are compared to regulatory target risk levels. The U.S. Environmental Protection Agency (EPA), and numerous other regulatory and research organizations, including the National Academy of Sciences, have developed guidelines for the performance of risk assessments. These guidelines were followed in the assessment of the proposed expansion of the Hillsborough County RRF.

2.0 THE GENERAL CONTEXT OF WASTE-TO-ENERGY

In 2003, Americans generated 236.2 million tons of municipal solid waste (MSW) for a generation rate of 4.45 pounds per person per day (EPA 2005). Approximately 23.5% of this material was recycled and 7.1% was composted. The remaining 69.4% required disposal. The majority of the waste slated for disposal was landfilled (55.4%) and another 14% was combusted for energy recovery. This latter option is known as waste-to-energy, trash-to-energy, or resource recovery.

All methods of waste management involve some potential human health or environmental risks. In the United States, regulatory programs have been implemented to minimize the risks from MSW management activities. This section explores the use of waste-to-energy and places it in context at the federal, state, and county levels, with an emphasis on those regulatory factors relevant to the protection of human health and the environment.

2.1 Federal Regulations and Policies

At the national level, there are currently 89 waste-to-energy plants operating in 27 states (Norris 2005). They generate about 2,700 megawatts of electricity from the processing of 95,000 tons of MSW each day. The electricity generated meets the energy needs of about 2.3 million homes and may be viewed as a replacement for about 48 million barrels of oil each year.

At the federal level, the primary regulatory agency is the Environmental Protection Agency (EPA), which regulates both the management of MSW and the air emissions from waste-to-energy plants. The primary vehicles for regulation are the Resource Recovery and Conservation Act (RCRA) and the Clean Air Act (CAA).

RCRA defines solid and hazardous wastes and sets up an overall management strategy. Among other things, RCRA forbids the disposal of hazardous and medical wastes at MSW disposal sites. This ensures that hazardous and medical wastes will not be combusted at the Hillsborough RRF. RCRA also delegates specific regulatory programs for the management of MSW to the states. The federal role in this context is to establish minimum criteria that describe the best practicable environmental controls and monitoring requirements for solid waste disposal facilities. Other specific federal regulations that impact waste disposal in waste-to-energy plants include the Toxic Substance Control Act (TSCA), which bans the disposal of polychlorinated biphenyls (PCBs) with MSW, and the Federal Insecticide Fungicide and Rodenticide Act (FIFRA), which regulates the disposal of pesticides and pesticide containers. RCRA

regulates the ash that is generated during the MSW combustion process at a resource recovery facility.

The CAA is the other primary vehicle for the regulation of waste-to-energy plants at the federal level. There are several provisions of the CAA that apply to the Hillsborough RRF, such as those regulating the prevention of significant deterioration (PSD) of air quality. In this case, the provisions of the CAA that are most relevant to the protection of human health and the environment are the New Source Performance Standards (NSPS) for new large MSW combustors, such as the Hillsborough RRF, which are contained in Subpart Eb of 40 CFR Part 60 ("Standards of Performance" for Large Municipal Waste Combustors for which Construction is commenced after September 20, 1994) (EPA 1995).

The overall objective of the NSPS in Subpart Eb is to ensure that emissions from waste-to-energy plants do not occur at levels that could pose a public health threat. The NSPS requires the implementation of Maximum Achievable Control Technology (MACT) to limit the amount and number of pollutants that may be emitted from a large MSW combustor. In the CAA, MACT is defined as the maximum degree of reduction in emissions of designated air pollutants, taking into consideration various factors. In the case of MSW combustors, the designated pollutants subject to MACT include dioxins and furans, cadmium, lead, mercury, particulate matter, hydrogen chloride, sulfur dioxide, nitrogen oxides, and fugitive ash emissions. In addition to the MACT controls on these specific pollutants, the NSPS require the use of good combustion practices (combustion efficiency) and imposes requirements for facility siting, operator training and certification, compliance and performance testing, and reporting and recordkeeping. Under the CAA, the State of Florida has a federally-approved State Implementation Plan (SIP) and the State has been delegated the authority to issue a permit under the NSPS Subpart Eb.

EPA (2002) examined the reductions in pollutant emissions from large waste-to-energy facilities as a result of the implementation of the NSPS. The following table compares emissions in the year 2000 to the year 1990 (Table 2-1).

Table 2-1
Reduction in Emissions Associated with NSPS

Pollutant	Reduction in %
Dioxins/furans	99.7
Mercury	95.1
Cadmium	93.0
Lead	90.9
Hydrochloric acid	94.3
Sulfur dioxide	86.7
Particulate matter	89.8

Based on these data, EPA (2002) concluded that the "performance of the MACT retrofits has been outstanding." The Agency also noted that "since 1990 (pre-MACT conditions), dioxin/furan emissions have been reduced by more than 99 percent, and mercury emissions have been reduced by more than 95 percent." Since the potential for public health impacts usually is proportional to the amount of emissions, these significant reductions in WTE emissions should provide a positive impact on public health.

In 2003, EPA concluded that the use of MACT at WTE facilities allows municipal solid waste to be used "as a clean, reliable, renewable source of energy." Further, EPA noted that WTE plants in the U.S. "produce 2800 megawatts of electricity with less environmental impact than almost any other source of electricity." (EPA 2003).

2.2 State Regulations and Policies

Increases in Florida's population have resulted in large increases in MSW generation. In 2000, for example, a total of 25.7 million tons of MSW were collected in Florida (DEP 2002). This represents a substantial increase (32%) from 1991, when the corresponding amount was 19.5 million tons. The per capita generation rates have also increased 6%, from 8.3 pounds per person per day in 1991 to 8.8 pounds per person per day in 2000. Hillsborough County ranks fourth in the state in waste generation rates. The largest component of Florida's MSW stream is paper (newspapers, corrugated paper, other paper) at 24.8%, followed by construction and demolition debris (23.2%) and yard trash (14%). In 2000, 5.56 million tons of MSW were processed by incineration, 7.05 million tons by recycling, and 14.87 million tons by landfilling.

Waste to energy capacity in Florida has grown from one plant in 1982 to 13 operating plants in 2002 (DEP 2002) with a total capacity of 19,176 tons per day. These plants generate about 534 megawatts of electricity daily. The waste-to-energy capacity in Florida is greater than any other state in the US. The primary reasons for the success of waste-to-energy in Florida are the vulnerability of groundwater resources to potential leachate emissions from landfills and the lack of suitable landfill space. In addition, the energy crisis of the mid-1970s led to increased reliance on alternative energy technologies. Current shortages and high costs of fossil fuels underscore the desirability of waste-to-energy compared with oil or natural gas. The largest operating waste-to-energy plant in the state is the Pinellas County Resource Recovery Facility (3,150 tons per day), followed by the Miami-Dade County Resources Recovery Facility, and Broward County's two resource recovery facilities.

The State of Florida regulates waste-to-energy plants under Chapter 403 of the Florida Statutes and Florida Administrative Code Chapter 62, which provides for the implementation of the NSPS (Subpart Eb 40 CFR 60). Under Florida law, a WTE facility must seek approval under the PPSA if the Facility will generate 75

MW or more electricity. A WTE facility that generates less than 75 MW may seek approval under the PPSA or seek individual permits. In either case, a WTE facility is subject to comprehensive and detailed review procedures to determine whether the facility will comply with all applicable local, state, and federal environmental regulations.

2.3 Non-governmental Organization Activity

Several non-governmental organizations have addressed questions regarding the utility of waste-to-energy facilities. In 2005, the U.S. Conference of Mayors (USCOM) adopted a resolution that supported the use of waste-to-energy as a component of a comprehensive solid waste disposal management strategy. The USCOM cited waste-to-energy as safe, environmentally sound, and efficient and noted significant benefits with respect to energy diversity and security in addition to the environmental benefits.

The Waste to Energy Research Council[1] (WERT) has sponsored a significant amount of research regarding the environmental, energy, and policy implications of waste-to-energy. WERT-sponsored research (published by Themelis & Millrath (2004)) reviewed the available information and concluded that waste-to-energy should be considered as a component of a renewable energy portfolio. The benefits of waste-to-energy cited by these researchers include low emissions, diversion of waste from landfilling, no impact on recycling rates, and energy generation.

2.4 Hillsborough County

Hillsborough County is located on the central west coast of Florida. The 2004 population was 1,115,960. About 2/3 of the population lives in unincorporated areas and the remainder in the incorporated cities of Tampa, Temple Terrace, and Plant City. The Hillsborough County Solid Waste Management Department (SWMD) is responsible for the operation of an Integrated Solid Waste Management System that provides for the collection, transportation, and disposition of solid waste within the County[2]. The SWMD service area consists of the unincorporated area of the County, but various services also are provided to Tampa and Temple Terrace. Facilities under the SWMD include (a) the current 1,200 ton per day waste-to-energy plant, (b) a Class I landfill, (c) two solid waste transfer stations, (d) solid waste collection, yard waste processing and community collection centers, (e) a household hazardous waste collection program, and (f) a waste tire processing program. In addition, the County operates several recycling programs, including drop-off recycling centers and programs for used oil recycling, scrap metal recycling, lead acid battery recycling, and waste reduction.

[1] www.columbia.edu/cu/wtert
[2] www.hillsboroughcounty.org/solidwaste/disposition/home.cfm

The current waste-to-energy plant, known as the Hillsborough County Resource Recovery Facility (RRF), has been in operation since October 1987. The facility has 39 MW of electrical generating capacity and has a daily power output of about 29 MW (equivalent to the amount of electricity generated with 1,200 barrels of oil). Air pollution control equipment currently used at the plant consists of (a) a spray dryer absorber (SDA) to remove large particles, sulfur dioxide and acid gases, (b) a fabric filter (FF) to remove small particles, (c) an activated carbon injection (ACI) system to remove mercury, and a selective non-catalytic reduction (SNCR) system to reduce nitrogen oxide (NOx) emissions. Continuous monitors installed at the outlet of the boilers and inlet to the FFs are used to ensure proper combustion conditions and operation of emission controls.

The proposed RRF expansion project will increase the MSW processing capacity to 1,800 tons per day and the electrical generation capacity to 47 MW. Air pollution control equipment for the proposed fourth MWC unit will be similar to that used in the existing 3 MWC units: SDA, FF, ACI, and SNCR, in conjunction with continuous emission monitors. One notable exception is that the proposed fourth unit will use an "enhanced" SNCR system that will be capable of controlling NOx to lower levels than the existing three units. Section 3 of the PPSA application and the County's PSD application discuss these devices in greater detail and demonstrate that these systems reflect best available control technologies (BACT). Section 6 of the PPSA application demonstrates that the new MWC unit, as well as the proposed four-unit facility, will comply with the emissions requirements of the NSPS. Given these facts, it is anticipated that the facility will be able to meet EPA's environmental and public health goals with respect to pollutant emissions.

3.0 HUMAN HEALTH AND ENVIRONMENTAL IMPACTS OF WASTE-TO-ENERGY

A number of health studies and risk assessments have been conducted for waste combustion facilities. Arguably, the most important of these studies was the National Academy of Sciences/National Research Council's report on waste incineration and public health (NAS/NRC 2000) which reviewed all of the information then available on potential associations between incinerator emissions and public health[3]. Other studies, including numerous human health and environmental risk assessments have been conducted on specific facilities. These studies indicate that stack emissions from a modern MSW waste-to-energy plant regulated under the NSPS will not cause adverse health effects if it is designed and operated in accordance with current state and federal regulations. This section presents information from the scientific literature regarding potential environmental and health impacts associated with waste-to-energy plants and other waste combustion facilities.

3.1 Environmental Studies at Waste-to-Energy Plants

Monitoring studies have been conducted around numerous waste-to-energy plants and these have shown that emissions from a modern facility do not produce measurable changes in environmental chemical concentrations or the levels of chemicals in animal tissues. Samples have been collected from ambient air, soil, cow's milk, vegetation, and human blood and milk.

The EPA conducted an intensive study of ambient air quality in the area of a 240 ton per day waste-to-energy plant in Rutland, Vermont (EPA 1991). Ambient air monitoring locations for dioxins and particulate matter were selected based on wind patterns in the facility area and air dispersion modeling. The EPA concluded from the monitoring results that the facility was not the primary source of dioxins in ambient air in the vicinity of the facility. The study also found no correlation between the amount of waste combusted and ambient air particle concentrations.

Soil sampling for dioxins was conducted by scientists from the Ontario Ministry of Environment in the vicinity of a municipal solid-waste combustor in Hamilton, Ontario (McLaughlin et al. 1989). The soil sampling, conducted after 10 years of facility operation, was initiated due to airborne dioxin emissions in excess of Provincial guidelines. The 14 soil samples included 3 control sites and the predicted point of maximum impact. The authors concluded that there was no measurable change in surface soils in the plant vicinity as a result of stack emissions.

[3] This report dealt with hazardous waste and medical waste incineration in addition to MSW combustion.

Scientists from Cornell University and the Horticultural Research Institute of Ontario analyzed vegetation around a municipal solid waste combustor for metals and PCBs (Bache et al. 1991). The incinerator had been in operation for approximately 7 years prior to sample collection. Statistical analyses of the sampling results indicated that PCBs and 5 of the 6 metals evaluated, including mercury, were not significantly higher than background concentrations.

The Connecticut Agricultural Experiment Station analyzed cow's milk samples for chlorinated dibenzodioxins and furans near a new waste-to-energy plant before and 1 year after the facility went into operation (Eitzer 1995). The data showed no statistically significant differences between pre-operational and post-operational concentrations.

The State of Massachusetts conducted a study of metal concentrations in soil around the SEAMASS waste-to-energy plant in Rochester after the facility had been operating for several years (MDEP 1996). The combustor's emissions had no detectable effect on mercury concentrations in either air or soil around the facility.

Scientists from the Institute of Toxicology in Germany collected samples of blood and human milk from persons living 8 or more years in the vicinity of a municipal solid waste combustor that had been in operation for 13 years (Deml et al. 1996). The authors concluded that living in the vicinity of the incinerator did not result in a higher body burden for dioxins and furans.

The topic of global climate change has emerged as an important environmental issue of the 21st Century. In essence, scientists believe that increased emissions of greenhouse gases associated with human activity may result in changes in the earth's climate. The most discussed consequence of this is the phenomenon of global warming – i.e., the temperature of the atmosphere will increase to the extent that there could be impacts to both the human and natural environments. Human impacts could range from a rise in coastal waters to a shift in the ability of various regions to produce crops. The potential impact of waste to energy on greenhouse gas emissions relative to other waste management activities such as landfilling has been evaluated by several scientists (Batchelor et al. 2002, Eschenroeder 2001, Thorneloe et al 2002). These studies show that waste-to-energy is associated with a reduced environmental impact compared to landfilling when potential effects on the global climate are concerned. There are several reasons for this result, however, the most significant reasons are the fact that waste-to-energy plants emit carbon dioxide, which has less of an impact on global climate than the methane emitted from landfills, and that waste-to-energy displaces the need to generate electricity from fossil fuels.

An alternative mode of evaluating health and environmental impacts is through life cycle analysis (LCA). LCA looks at the entire life cycle of a product or

process. For example, it could be used to compare recycling, waste-to-energy, and landfilling for the management of different components of MSW such as paper, various plastics and other materials. Although full scale LCAs have not been performed for MSW, the available data (Dewuld & van Langenhove 2002) suggest that waste-to-energy is similar to recycling with respect to the energy impacts of the life cycle of combustible materials.

3.2 Epidemiologic Studies

Researchers at the University of North Carolina studied whether living near waste combustion plants increases the occurrence of respiratory health effects (Shy et al. 1995). The study focused on people living near a biomedical waste incinerator, a waste-to-energy plant, and an industrial furnace fueled by liquid waste. The authors concluded that there was no difference in acute or chronic respiratory symptoms or lung function between the communities living near the waste combustors and the comparison communities. The also concluded that particle and acid gas emissions from the three waste combustors contributed trivial amounts to air concentrations in adjacent neighborhoods. In a follow-up study (Hu et al. 2001), the authors again found no significant associations between exposures for any of the waste combustion facilities and lung function tests. One result for the waste-to-energy facility did show a statistically significant relationship for lung function but this result was only observed for one of the three years of the study and when using only one of the four different types of exposure estimation methods.

The National Academy of Sciences (NAS/NRC 2000) evaluated available epidemiological data regarding waste incineration and health effects in surrounding communities and concluded that waste combustion facilities that are in compliance with EPA's Maximum Achievable Control Technology (MACT) requirements pose minimal or negligible risks to surrounding communities. NAS also noted that for modern, well-controlled waste combustors, risk assessments show that potential cancer effects even for the most highly exposed persons in the surrounding areas are generally small to negligible.

Two recent health studies have been published in Europe. Although European standards for waste-to-energy plants are similar to those in the United States, there are differences with respect to the implementation dates, methods of calculating the emissions, and the emission levels themselves. Thus, the European studies should be used only in a supporting or confirmatory sense to the U.S. studies. Rabl and Spadaro (2002) reviewed the potential for human health and environmental impact assuming all MSW was incinerated under the new European regulations that were promulgated in December 2000. These authors looked at several different indicators of environmental performance including:

- Increase in chemical concentration compared to background,

- Increase in chemical concentration compared to health guidelines,
- Health risks of various pollutants compared to each other,
- Increased damage cost (monetary value of health impacts) compared to the cost of incineration itself,
- Difference in emissions compared to other emission sources, and
- Difference in years of life lost due to MWCs compared to other risks of everyday life.

They concluded that the health impacts of MSW incinerators were insignificant using any of these comparisons as long as the European standards were met.

Enviros/University of Birmingham (2004) undertook a systematic review of epidemiological studies of the public health effects of waste incinerators. Specifically, these investigators looked at evidence for ill-health in people who might possibly be affected by emissions from MSW processes. They concluded that health effects in people living near waste management facilities were either generally not apparent or the evidence was not consistent or convincing.

3.3 Recent Environmental Monitoring Studies

Detailed environmental monitoring studies have been undertaken at two Covanta waste-to-energy facilities – the Montgomery County facility in Dickerson, Maryland, and the Union County facility in Rahway, New Jersey. Since Covanta operates the Hillsborough County RRF, the information gained from these studies can yield useful insights about Covanta's operations and the Hillsborough County facility.

The Montgomery Country facility consists of three 600 TPD combustion units. The air pollution control equipment and electrical generating capacity of the Montgomery County facility are similar to those at the Hillsborough County facility. Each unit has a separate flue and is equipped with a dry scrubber and fabric filter baghouse, direct lime injection into the furnace, ammonia injection at the top of the furnace, and activated carbon injection at the scrubber inlet (Rao et al. 2003). The Montgomery County facility has been operating since 1995. Although the population of Montgomery County is approximately 800,000 people, the land use around this facility is semi-rural, and includes residential units, agricultural (including dairy) operations, and fishery resources. Roy F. Weston, Inc. was contracted by Montgomery County to conduct an ambient air monitoring study (Weston 1998) and a non-air monitoring study (Weston 2000).

Weston (1998) evaluated both air toxics and meteorologic data before the facility went into operation (pre-operation) and after the facility had been operating for approximately two years (post-operational). Air toxics monitoring included dioxins/furans, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, formaldehyde, arsenic, cadmium, chromium, lead, mercury, and nickel. Particulate matter was also monitored. Numerous long-term and short-term

measurements were obtained. The number of post-operational measurements ranged from 20 for PCBs to 79 for dioxins and furans. The primary monitoring site was situated near the maximum point of annual ground-level air and dry deposition concentrations, as predicted by air dispersion/deposition modeling. Weston concluded that no major differences in air quality were observed at any operating sites when pre-operational and post-operational measurements were compared. Additionally, Weston concluded that the facility did not have a significant impact on air quality in the surrounding region.

The non-air media report (Weston 2000) evaluated chemical concentrations in soil, earthworms, cow's milk, forage/hay, vegetables, surface water and sediment, and fish tissue. The monitoring locations were selected based on local meteorology, air modeling, and the results of a human health risk assessment. Pre-operational sampling was conducted in 1994 and post-operational sampling was conducted in 1996 and 1998. The samples were analyzed for dioxins/furans, PAHs, PCBs, arsenic, beryllium, cadmium, chromium, lead, mercury, and nickel. The results showed that there were no statistically significant or consistent patterns detected between the pre-operational and post-operational phases of the study. Many of the environmental media sampled during the post-operational phase had concentrations approximately equivalent to or less than the pre-operational conditions. In some media, the concentrations increased; however, the investigators felt that this change was a reflection of scientific uncertainty rather than an actual impact. The study concluded that the operation of the facility had not caused unacceptable increases in target compound concentrations.

The Union County, New Jersey facility is a 1,440 TPD resource recovery facility that has been operating since 1994 in Rahway. The land use around the facility is highly industrial, dominated by heavy industry and transportation uses. The Union County Utilities Authority contracted with Paulus, Sokolowski and Sartor, Inc. (PSS) and HDR Environmental Engineering, Inc. (HDR) to conduct on-going monitoring studies in the air and other media around this facility (PSS 1993, PSS 1997, HDR 1998). As with the Montgomery County facility, these studies consisted of both pre- and post-operational monitoring. The chemicals of potential concern included PCBs, dioxin (2,3,7,8-TCDD), arsenic, beryllium, cadmium, chromium, lead, mercury, and nickel. In addition to ambient air, soil, sediment, surface water, food crops (lettuce, radishes, tomatoes) and fish have been evaluated periodically, both pre- and post-operationally. The post-operational data show that the chemicals of potential concern are present at levels consistent with those anticipated for an urban industrial environment. Additionally, the reports suggest that the post-operational samples are consistent with the pre-operational samples. This program is continuing.

The results of these two recent studies, based on operating Covanta facilities similar to the Hillsborough County RRF, show that the RRF facilities do not cause any discernable impact on the local environment with respect to the chemicals

that are considered to be the most significant trace components of waste-to-energy emissions. These results are consistent with the results that are reported elsewhere in the literature. They suggest that similar results would likely be obtained in Hillsborough County.

3.4 Risk Assessments

Risk assessments are formal scientific evaluations of information regarding the potentially hazardous effects of exposure to chemicals in the environment. Risk assessments of waste-to-energy facilities are often used to determine if these facilities are capable of meeting regulatory or statutory goals with respect to protection of human health and the environment. Although risk assessments of waste-to-energy plants have been performed for several decades, they have become standardized since the early 1990s (Hattemer-Frey & Travis 1991, CARB 1990). This standardization allows risks associated with different regulatory schemes and air pollution control technologies to be extrapolated from plant to plant. Most recently, risk assessors have further standardized the process by relying on EPA guidelines for performing hazardous waste incinerator risk assessments (EPA 1998a). These assessments are based on a highly standardized approach that allows regulators to readily use their results to make environmental health decisions.

The results of recent comprehensive risk assessments conducted for the waste-to-energy facilities in Montgomery County, Maryland, the City of Spokane, Washington, and Lee County, Florida, also provide insight into the potential risks associated with the Hillsborough County facility (Rao et al. 2003, Pioneer 2001, Clement 1992, CPF 2002). These risk assessments are pertinent because these facilities are state-of-the-art plants operated in accordance with the NSPS, as is the Hillsborough County facility.

3.4.1 Montgomery County, Maryland

The Montgomery County facility risk assessment relied on measured stack emission rates since 1995 and on-site meteorological data to calculate potential risks through multiple exposure pathways for 19 selected chemicals of potential concern, including PCDD/PCDFs and mercury. As noted above, this facility is operated by Covanta and it has similar electrical generating capacity and equipment as the Hillsborough facility. Risks for the Montgomery County facility were calculated for a typical resident at two maximum impact locations, as well for a subsistence farmer, a subsistence fisherman, and a pond fishing scenario. The excess lifetime cancer risks were calculated to range from 14 to more than 400 times less than the one in 100,000 (1E-5) target cancer risk level. The predominant compounds contributing to the cancer risks were PCDDs/PCDFs. The non-cancer hazard index values were calculated to be equivalent to or below a target hazard index value of 1, with mercury accounting for the majority of the risk results. Based on the risk assessment, it was concluded that no adverse

non-cancer health effects are expected, and that cancer risks are lower than 1 in one million, as a result of exposure to facility-related emissions (Rao et al. 2003).

3.4.2 Spokane, Washington

The Spokane, Washington facility is comprised of two MWC units, each capable of managing roughly 800 TPD of municipal solid waste. The air pollution controls on each unit consist of lime slurry spray dryer absorbers followed by fabric filter baghouses. A carbon injection system also is used. An anhydrous ammonia, thermal DeNox, selective non-catalytic system is also used for nitrogen oxides control.

The risk assessment utilized 10 years of measured emissions data to calculate potential risks through multiple exposure pathways at a maximum off-site impact point. Risks were evaluated at this point for a typical resident, a subsistence farmer, a subsistence fisher and infants. The results were determined to be below Washington state target risk levels (i.e., a non-cancer hazard index below 1 and an excess lifetime cancer risk below one in one hundred thousand). The predominant chemicals contributing to the non-cancer risk results were hydrogen chloride via inhalation and methyl mercury via ingestion of fish. The predominant compounds contributing to the cancer risks were PCDDs/PCDFs due to ingestion of animal products.

3.4.3 Lee County, Florida

The risk assessment performed for the Lee County Solid Waste Energy Recovery Facility (ERF) is particularly relevant to the proposed Hillsborough RRF expansion for a number of reasons. There are similarities between these two facilities in waste stream composition, emission controls, land use, climate, and state regulatory programs. In addition, the Lee ERF project involved a 600 TPD expansion of an existing facility, unlike the Montgomery County or Spokane projects, which were newly constructed. In addition, the Lee County and Hillsborough County combustion facilities are both operated by Covanta. These similarities mean that the Lee County risk assessment, which will be presented in the remainder of this section, is uniquely applicable to the Hillsborough County project and can indicate the likelihood of potential risks associated with the Hillsborough County proposal.

Municipal solid waste from Lee County and Hendry County is processed at the Lee County Solid Waste Energy Recovery Facility, which began operation in 1994. Lee County proposed to add a third combustion unit to the ERF to accommodate excess municipal solid waste that is being generated. A series of studies over more than a 10 year period were used in the Lee County ERF risk assessment process.

Two studies conducted in 1992 evaluated the potential human health and

ecological impacts of the currently operating Lee County ERF. These studies concluded that construction and operation of the facility would not adversely affect humans or threatened or endangered species. Lee County also initiated a biological monitoring program in 1993 to determine if operation of the facility was correlated with mercury levels in aquatic life. The program results suggest that mercury concentrations in aquatic life in the area are generally similar to the levels typical of South Florida and not associated with operation of the ERF.

The risk assessment for the expanded facility relied on air dispersion and particle deposition modeling conducted to calculate air concentrations and deposition rates associated with the proposed ERF (i.e., operation of the two existing units plus the proposed third unit). This information was then used in EPA environmental fate and transport models to calculate chemical concentrations in soil, produce, surface water, beef and fish. Air concentrations were calculated for all of the chemicals regulated under the facility's air permit. Mercury and polychlorinated dibenzodioxin and dibenzofuran (PCDD/PCDF) concentrations were calculated for the other environmental media. The model inputs included a substantial amount of local site-specific data. Overall, the models and input assumptions are expected to provide conservative (i.e., health protective) calculations of potential environmental concentrations.

The calculated environmental concentrations associated with stack emissions from the proposed three-unit Lee County ERF were compared with typical environmental levels. These comparisons showed that the environmental concentrations associated with the proposed three-unit ERF are consistent with or below typical environmental concentrations, thus the proposed expansion will not measurably increase the typical concentrations of chemicals in the environment.

The human health risk assessment was conducted following current EPA guidance and is summarized below:

- Potential human health risks were evaluated in two types of risk assessments. An inhalation risk assessment was performed for all chemicals currently regulated under the facility's air permit using permit limit-based emission rates. A more refined multiple pathway risk assessment was also performed for mercury and PCDDs/PCDFs using emission rates based on long-term stack gas measurements.

- In the inhalation risk assessment, inhalation exposures were calculated for two hypothetical groups of people, an adult resident and a child resident. In the multiple pathway risk assessment, exposures were calculated for 12 different hypothetical groups of people, including adults, children and infants. The exposure pathways considered in the multiple pathway assessment were inhalation, soil ingestion, ingestion of produce, beef and fish, and ingestion of breast-milk.

- A variety of evaluations were performed in the human health risk assessment. Chronic long-term excess lifetime cancer risks were found to be at least 10 times lower than EPA's combustion risk assessment target risk level of $1x10^{-5}$ (one in 100,000) and did not exceed Florida's common target risk level of $1x10^{-6}$ (one in 1,000,000). Chronic long-term noncancer effects were predicted not to occur, with a large margin of safety (i.e., calculated exposures were at least 10 times lower than the common regulatory noncancer target exposure levels). An analysis of short-term acute inhalation adverse effects showed that these effects will not occur with a large margin of safety (i.e., calculated short-term air concentrations were at least 100 times lower than health-based reference air concentrations).

An ecological risk assessment was also conducted in accordance with EPA guidelines and is summarized below.

- The ecological assessment focused on mercury and PCDDs/PCDFs which, among the compounds present in MSW combustion facility emissions, are expected to be of greatest potential concern to aquatic and terrestrial wildlife of the area.

- The ecological risk assessment evaluated potential impacts to wildlife species that were considered to be at greatest risk based on habitat use, exposure potential and population status. The species selected for evaluation consisted of aquatic life, the wood stork, the snail kite, the white pelican, and the river otter.

- Adverse impacts to aquatic and terrestrial wildlife were predicted not to occur, with a large margin of safety (i.e., exposures to ecological receptors were at least 10 times lower than comparison toxicity reference values).

In conclusion, the risk assessment showed that potential risks from stack emissions from the expansion of the Lee County ERF, in its proposed configuration with three combustion units, were below regulatory and other target risk levels for both human health and ecological receptors. Additionally, the environmental concentrations in air, soil, surface water, beef and fish associated with emissions from the proposed three-unit ERF facility were calculated to be consistent with or below typical environmental levels and would not measurably increase the typical concentrations of chemicals in the environment.

3.4.4 Lessons Drawn from Risk Assessments

Although there are site-specific differences among these three facilities, there are many common threads both from risk assessment and regulatory points of view. First and foremost, all three of these facilities were designed to comply with the

NSPS. All contain state-of-the art emission controls that are designed to fit the criteria for maximum achievable control technology. Since EPA's overall objective in promulgating the NSPS was protection of human health and the environment, it should be anticipated that facilities compliant with the NSPS would have a negligible environmental health impact. Second, the risk assessments show that the risks associated with operating these facilities are below risks of concern to regulatory and public health agencies. Third, the results of the risk assessments show that, although the risks are low, they are dominated by exposure to dioxins and furans as potential human carcinogens and mercury as a neurotoxin. Last, the risk assessments also show that indirect exposure pathways, such as the consumption of fish, are the most significant sources of exposure, regardless of the absolute value of the risks.

7.0 SUMMARY AND CONCLUSIONS

7.1 Introduction

This document presents a Human Health and Ecological Impact Analysis that was performed to address questions related to human and environmental health that may arise during the course of the permit process for the proposed fourth municipal solid waste combustion unit at Hillsborough County's RRF. This study is not a formal requirement of the permit process for the fourth MWC unit, but was conducted to ensure that issues of potential concern related to the proposed unit were evaluated.

This study was performed by CPF Associates, Inc., a Washington, D.C.-based scientific and regulatory consulting firm with over 20 years experience in evaluating the potential impacts of municipal solid waste management technologies.

7.2 Previous and Ongoing Studies

Studies of the potential human health and ecological impacts of the waste-to-energy facilities have been widely conducted and were reviewed in this report. These studies indicate that stack emissions from a modern municipal solid waste (MSW) waste-to-energy plant will not cause adverse health effects if it is designed and operated in accordance with current state and federal regulations.

7.3 Regulatory and Operational Evaluation

The combination of regulatory and operational requirements in place for W-T-E facilities at the Federal and State levels collectively ensures that that a modern W-T-E facility, including the Hillsborough County RRF, will operate in a manner protective of human health and the environment. The safety of the Hillsborough Facility is, in particular, enhanced as a result of EPA's New Source Performance Standards (NSPS) and associated emission limits in conjunction with requirements from the State of Florida, including a more stringent emission limit for mercury. In addition, Hillsborough County has a very aggressive recycling program and solid waste management program that reduces the introduction of unwanted materials in the solid waste to better control emissions.

The Hillsborough Facility is, and will be, equipped with Best Available Control Technologies, the same technologies that are in place at the Lee County W-T-E facility. These technologies include spray dryer absorbers with fabric filters to remove particles, sulfur dioxide and acid gases; activated carbon injection to remove mercury; and selective non-catalytic reduction to reduce NOx emissions. The air pollution control equipment combination of spray dryer absorber, fabric

filter and activated carbon injection has also been shown to reduce emissions of dioxins and furans.

7.4 Human Health Risk Assessment

The human health risk assessment presented in this report evaluated potential risks associated with operation of four waste combustion units at the Hillsborough County RRF (three existing units and the proposed fourth unit). The risk assessment was performed following EPA guidance, including but not limited to EPA's 1998 *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities*. Where possible, the risk assessment also incorporated site-specific information.

Potential human health risks were evaluated in a refined multiple pathway risk assessment for mercury and PCDDs/PCDFs, the compounds that have been shown to dominate risk assessment results for WTE facility emissions. The multiple pathway risk assessment relied on emission rates based on stack gas measurements. The multiple pathway risk assessment calculated exposures for 12 different hypothetical receptors: four adult receptors, four child receptors and four breast-fed infant receptors. For example, the four hypothetical child receptors were: child resident, child of an adult beef farmer, child of an adult who fishes in the Palm River, and child of an adult who fishes in a typical pond. Each adult or child receptor was hypothesized to be simultaneously exposed through multiple pathways (e.g., the child resident was exposed via inhalation, soil ingestion, and ingestion of locally-grown produce). Each adult receptor was also assumed to be the mother of a breast-fed infant.

The risk evaluations that were performed in the risk assessment included chronic long-term excess lifetime cancer risks, the potential for chronic non-cancer health effects, a margin of exposure approach that compares calculated doses of PCDDs/PCDFs to typical background U.S. exposure levels, and a comparison of PCDD/PCDF infant exposures to a background infant intake level. The findings of the risk assessment were as follows:

- All of the excess lifetime cancer risks were at least 10 times below EPA's target cancer risk level of $1x10^{-5}$ and did not exceed Florida's target risk level of $1x10^{-6}$. The total excess lifetime cancer risks ranged from $8x10^{-8}$ for the hypothetical child resident or child of a beef farmer to $1x10^{-6}$ for the hypothetical adult pond fisher scenario.

- All of the noncancer hazard index values were at least 20 times below the target hazard index of 1.0. The highest hazard index result was 0.05 for the adult pond fisher scenario.

- The maximum average daily doses to PCDDs/PCDFs were 50 times below EPA's current estimate of background PCDD/PCDF exposure of 1

pg TEQs/kg-day. As a result, TEQ exposures to people due to emissions from the proposed four-unit RRF will not cause a measurable change in typical background exposures.

- Hypothetical infant exposures to PCDDs/PCDFs due to breast-milk ingestion were more than 100 times below the target exposure level of 60 pg TEQs/kg-day identified by EPA. These results show that infant TEQ exposures due to emissions from the proposed four-unit facility will not cause a measurable change in typical breast-fed infant TEQ exposure levels.

7.5 Ecological Risk Assessment

The ecological risk assessment evaluated potential effects of modeled emissions on ecological receptors within the RRF area. The ecological risk assessment followed EPA guidelines for ecological risk assessment and combustion facility ecological assessment, including but not limited to EPA's 1999 *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* and incorporated regional-specific information on wildlife habitats and species use to identify species and habitats of concern. The ecological assessment focused on mercury and PCDDs/PCDFs as these compounds have been shown to dominate W-T-E facility risk assessment results.

The ecological risk assessment focused on potential impacts on the natural communities of the Palm River and freshwater ponds. The assessment focused on three indicator species, aquatic life, the wood stork, and the river otter, that were considered to be at greatest risk based on habitat use, exposure potential and population status and were considered to represent three broad classes of wildlife (aquatic life, piscivorous birds and piscivorous mammals).

Potential risks were evaluated by calculating hazard quotients which reflect the ratio of a predicted exposure level to a toxicity reference value (TRV) derived for the protection of fish or wildlife species. The ecological risk assessment showed that the hazard quotients for aquatic life and the selected terrestrial species were all less than the target level of 1.0 by at least a factor of 25. These results indicate that aquatic and terrestrial wildlife are not predicted to be at risk from adverse effects of exposures to chemicals released during the operation of the Hillsborough County ERF.

7.6 Conclusions

The Human Health and Ecological Impact Analysis presented in this document showed that potential risks from emissions from the Hillsborough County RRF, in its proposed configuration with four combustion units, were below regulatory and other target risk levels for both human health and ecological receptors. These conclusions are consistent with previous studies performed for other waste-to-

energy combustion facilities in the U.S. and are considered to be a reflection of implementation of regulations, and strict operational and emission controls that are used for this type of facility. Based on this analysis, the proposed modification to the RRF is not anticipated to have an adverse impact on human health or the environment.