An Integrated Tool for Local Government to Track Materials Management and Progress toward Sustainability Goals

Timothy Townsend, Professor
Department of Environmental Engineering Sciences, University of Florida

ABSTRACT

Florida, like many states in the US, has an interest in incorporating Sustainable Materials Management (SMM) principles into waste management planning and policy. Two previous Hinkley Center projects, *Florida Solid Waste Management: State of the State* (FY16/17) and *Looking Beyond Florida's 75% Recycling Goal: Development of a Methodology and Tool for Assessing Sustainable Materials Management Recycling Rates in Florida* (FY18/19) have worked to develop methods that allow policy makers to look at waste (materials) management performance beyond simply tracking tons. Alternative performance metrics (based on sustainability indicators) in the first project focused on greenhouse gas (GHG) emissions and energy use, while the second (ongoing) project is expanding these indicators to include categories such as water use, landfill capacity utilization and job creation. For the most part, the Florida solid waste community (local governments, regulatory agencies, businesses, waste management industry) is interested in the concept of moving beyond tons for goal setting and tracking progress. But the question always posed is, "how do we integrate this concept into real practice?"

The Hinkley Center recognized that the Florida Waste Composition Calculation Model, or WasteCalc tool serves as an ideal platform to incorporate SMM. Currently, most Florida counties use WasteCalc to estimate their collected waste composition. Recently, the author and his research team worked with the Florida Department of Environmental Protection (FDEP) to improve WasteCalc. We updated some of the material estimating algorithms and re-calibrated it using recent Florida waste composition studies however more work remains to refine the model and to incorporate SMM.

In SMM it is important to evaluate the economic, social, and environmental impacts of a decision. Results from the Hinkley Center FY18/19 project can be used in conjunction with WasteCalc to produce estimates of these impacts. Another important SMM principle is reducing consumption of materials. Examples of activities that lead to less materials consumed include reusing products or instructing consumers to change their purchasing habits. Many of these activities are referred to as source reduction activities which may be defined as changes in design, manufacture, purchase or use of materials that reduces the amount of materials entering the waste stream. A need exists to incorporate measuring and tracking source reduction activities in Florida. We propose to develop a comprehensive tool that includes: 1) the WasteCalc functions and refined functions; 2) metrics to measure environmental, social, and economic impacts developed from the FY18/19 project; and 3) a method to measure Florida source reduction activities.

PRINCIPAL INVESTIGATOR

The investigator for the proposed research is Timothy Townsend, a Professor in the Department of Environmental Engineering at the University of Florida.

Address: 2320 Surge Area Dr. BLD 226
Box 116450
University of Florida
Gainesville, Florida 32611-6450

Phone: 352 392 0846 (office)
352 494 8605 (cell)
Email: ttown@ufl.edu
Website: http://townsend.essie.ufl.edu

Dr. Townsend's area of specialization is solid and hazardous waste management and engineering. He has been researching and teaching in the discipline of solid and hazardous waste management since 1990. He teaches engineering courses on solid and hazardous waste management, landfill design, recycling and beneficial use of waste materials to both undergraduate and graduate students. His research areas include sustainable materials management in policy, recycling of waste materials, sustainable landfill design and operation, landfill leachate and gas management, construction and demolition debris, electronic waste, waste leaching, and waste management in developing countries.

BACKGROUND AND PERTINENT LITERATURE

In this section we provide an overview of the WasteCalc model, findings of the two previous Hinkley Center studies, a discussion on the importance of source reduction on environmental impacts, and an overview of the proposed tool. In the Overview of WasteCalc Section we describe the history of the model and its current form. We propose to refine the current WasteCalc to a more comprehensive tool that includes: 1) the existing functions; 2) metrics to measure environmental, social, and economic impacts developed from the FY18/19 project; and 3) a method to measure Florida source reduction activities. The metrics developed from the FY 18/19 project and a discussion of source reduction activities are provided below.

Overview of WasteCalc

An item of interest on the Hinkley Center's 2019 research agenda is to incorporate SMM principles into FDEP's WasteCalc model. WasteCalc is an online tool used to estimate the composition of municipal solid waste (MSW) generated in Florida counties. It is a useful tool for counties for estimating their waste composition when the actual waste composition data is not available. The first version of WasteCalc was released in 2002 many counties rely on it to estimate annual collected MSW composition and mass. County estimates are compiled and published in FDEP solid waste annual reports; these reports include county and state MSW disposition, composition, and recycling rates. The University of Florida recently worked with FDEP to update WasteCalc to include newer (2002-present) waste composition studies from a number of counties. Figure 1 presents the counties that participated in waste composition studies used in the initial version of WasteCalc (referred to as the 2002 WasteCalc model). Whereas, Figure 2 presents the studies used to update WasteCalc. Figure 3 and 4 present a schematic of the inputs, equations used in each model, and the outputs for the 2002 WasteCalc model and the updated WasteCalc model, respectively. Figure 5 shows a screen capture of the input screen from the updated WasteCalc model. We propose to use this model as a platform to build the comprehensive tool.

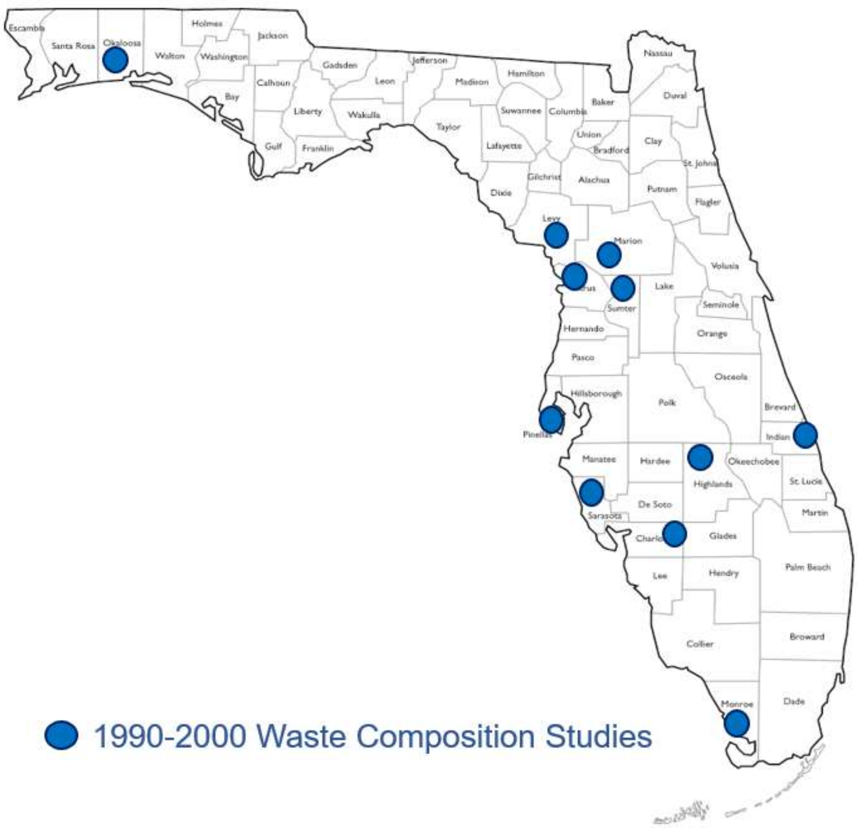

Figure 1: Map of Florida that shows the waste composition studies and their locations used in the original 2002 WasteCalc model.

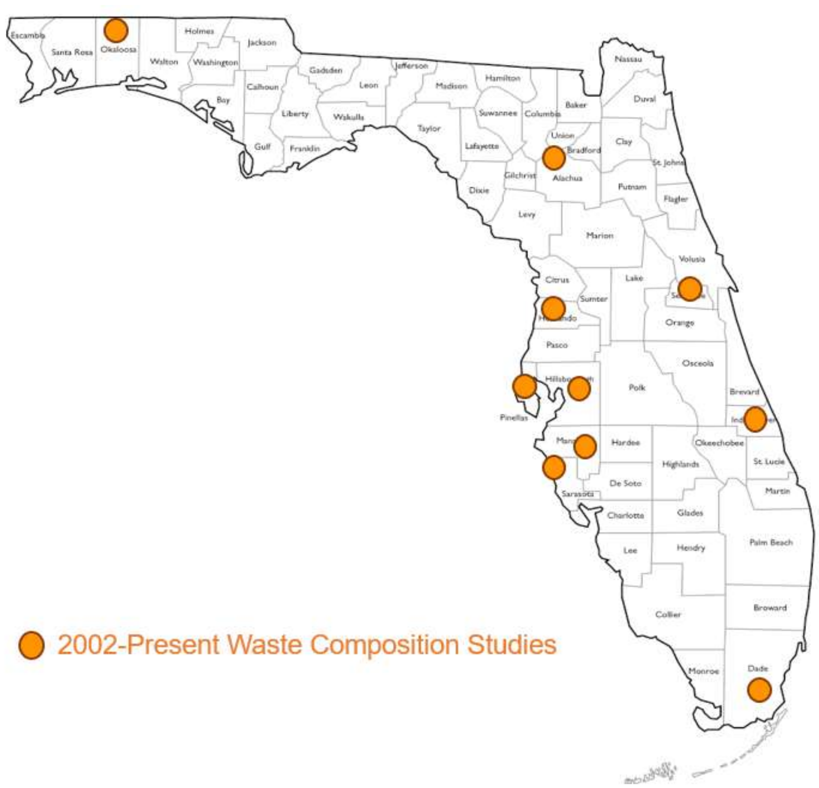

Figure 2: Map of Florida that shows the waste composition studies and their locations used in the updated WasteCalc model.

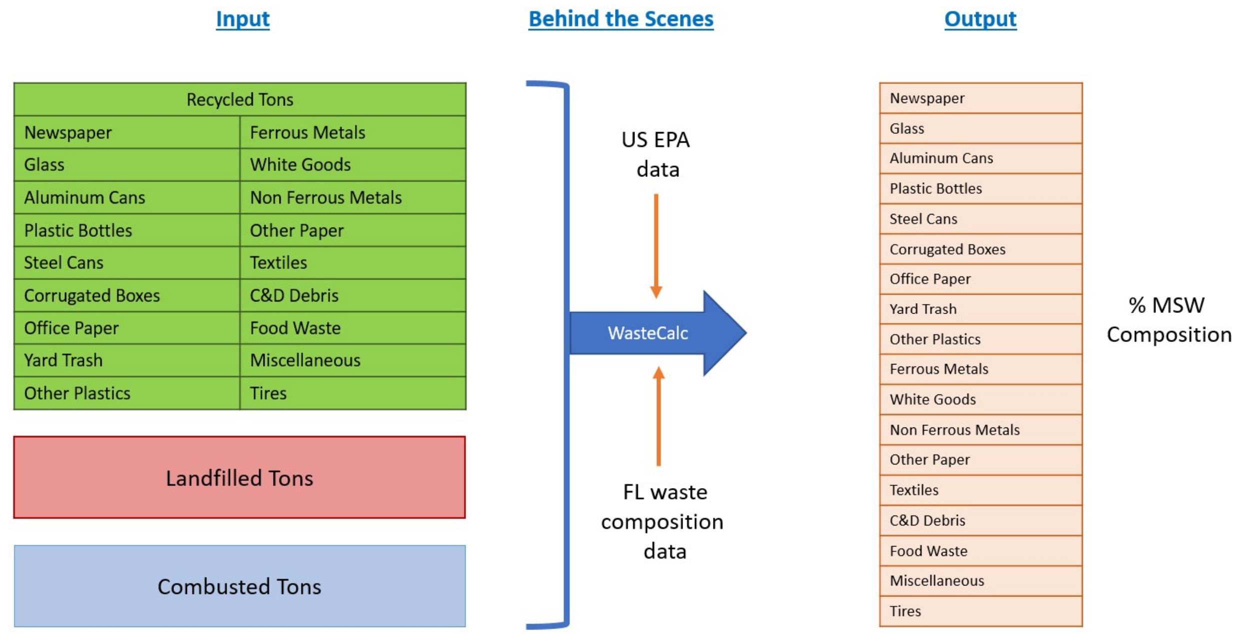

Figure 3: Schematic that shows the inputs, equations used in each model (referred to as behind the scenes), and outputs of the original 2002 WasteCalc model.

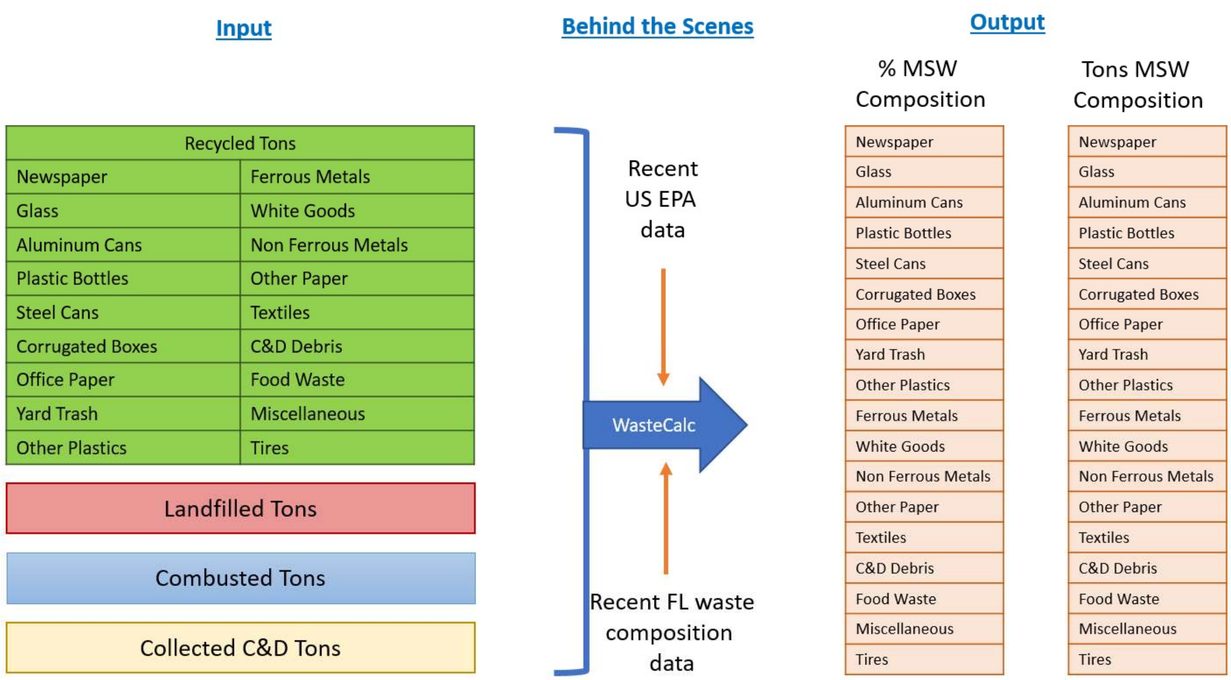

Figure 4: Map of Florida that shows the waste composition studies and their locations used in the updated WasteCalc model.

WASTECALC		
1	Current Year:	2019 ▾
2	Enter County:	▾
3	Enter County Population:	
4	Enter MSW Landfilled (in tons):	
5	Enter Collected C&D (in tons)*:	
6	Enter MSW Net Combusted by WTE (in tons):	
Enter Your Most Recent Recycling Data		
7	Newspaper	
8	Glass	
9	Aluminum Cans	
10	Plastic Bottles	
11	Steel Cans	
12	Corrugated Boxes	
13	Office Paper	
14	Yard Trash	
15	Other Plastics	
16	Ferrous Metals	
17	White Goods	
18	Non Ferrous Metals	
19	Other Paper	
20	Textiles	
21	C&D Debris	
22	Food Waste	
23	Miscellaneous	
24	Tires	

Submit Reset

Figure 5: Example screen capture of the input screen from the updated WasteCalc model, which users use to calculate their county's waste composition study.

Key Findings from Hinkley Center Studies

As part of the FY16/17 project we included in our methodology a means to account for the greenhouse gases (GHG) emissions and energy benefits associated with a reduction in per-capita waste generation (by component) over time (this also required that we account for any per-capita waste increase). Table 1 shows the generation rate for materials in Florida in 2008 and 2015 and whether they have been source reduced or generated relative to 2008. When we compared the materials generated per person in Florida in 2008 and 2015, there was a net benefit with respect to GHG emissions and energy, and this magnitude of this benefit was relatively large signifying source reduction/generation's impact.

Table 1. Estimated 2008 and 2015 Florida solid waste generation rate in tons per person and comparison of whether a material is source reduced (generated less of since 2008) or source generated (generated more of since 2008). Source reduced materials are highlighted in red in the last column.

MSW Material	2008 Generation Rate (Tons/Person)	2015 Generation Rate (Tons/Person)	Source reduced or generated since 2008?
Newspaper	0.0768	0.0508	Source Reduced
Glass	0.0423	0.0433	Source Generated
Aluminum Cans	0.0120	0.0097	Source Reduced
Plastic Bottles	0.0238	0.0230	Source Reduced
Steel Cans	0.0172	0.0154	Source Reduced
Corrugated Paper	0.1369	0.1276	Source Reduced
Office Paper	0.0433	0.0309	Source Reduced
Yard Trash	0.1699	0.1769	Source Generated
Other Plastics	0.0610	0.0725	Source Generated
Ferrous Metals	0.1484	0.1221	Source Reduced
White Goods	0.0286	0.0176	Source Reduced
Non Ferrous Metal	0.0377	0.0250	Source Reduced
Other Paper	0.1091	0.1101	Source Generated
Textiles	0.0480	0.0379	Source Reduced
C&D Debris	0.3999	0.4867	Source Generated
Food	0.0923	0.1001	Source Generated
Miscellaneous	0.1490	0.1557	Source Generated
Tires	0.0198	0.0120	Source Reduced
Process Fuel	0.0325	0.0275	Source Reduced
Total	**1.648**	**1.644**	Source Reduced

A key finding of the FY16/17 project was that to minimize costs and maximize GHG emissions and energy use savings decision makers should prioritize recycling of metal, paper, and plastic products because recycling those materials generated a greater environmental benefit than recycling other materials[1,2]. In some cases, the GHG emissions and energy use results were contradictory. For example, when food waste is composted there is a GHG emissions benefit but not an energy use benefit. This finding from the 16/17 project motivated the 18/19 project, where we are currently creating a tool that estimates other life cycle impact categories beyond GHG emissions and energy use to be used as a metric to measure solid waste systems[2]. This tool will provide a method for counties to estimate other types of footprints (e.g., water use, landfill space savings, jobs produced) so county decision makers can better understand the various impacts their decisions may have.

The Importance of Source Reduction

Although source reduction and materials reuse (waste prevention) is listed as the most preferred waste management practice in the solid waste management hierarchy, its benefits largely go unrecognized when waste management progress is only tracked using a recycling rate based on tons.

An important outcome of this project is that to truly measure SMM progress, better methods are needed to track source reduction measures. In truth, much of the benefit attributed to source reduction between 2008 and 2015 resulted from a decline in the amount of newspaper in the waste stream (Table 1). This occurrence, of course, did not result from any planned source reduction effort, but from society's move from paper to digital consumption of information[3,4]. But it does highlight the need for additional research to account appropriately for per-capita source reduction (or increase). Two things that specifically need to be incorporated into the comprehensive tool include: (i) accounting for materials such as electronic devices in the waste stream (even though volumes may be low compared to other materials, life cycle impacts may be large); and (ii) to better track existing source reduction efforts (and thus perhaps to promote new efforts).

Overview of the Proposed Tool

We believe that an update to WasteCalc (under whatever name it may be called in the future) that incorporates SMM should retain the existing utility of the model, but should also include (i) multiple life cycle categories beyond GHG emissions and energy, (ii) should provide a mechanism (with appropriate guidance) for local governments to include source reduction activities, and (iii) expand the universe of waste components considered to account for the changing waste stream in Florida. The additional life cycle categories are currently under investigation and development in the FY18/19 project and can be incorporated into the model in a manner similar to GHG emissions and energy. More research is needed on the extent of source reduction activities currently in place in Florida and how best to quantify benefits and integrate them into the model. Example of existing source reduction activities that will be assessed as part of this study include clothing donation, donation centers and thrift shops, auto parts recycling, and medical device refurbishment. The proposed tool's contents are presented in a schematic in Figure 6.

OBJECTIVES

The objectives of this research are to refine the current WasteCalc to a more comprehensive tool that includes:

1. Refinements to the model in a manner that retains its existing functionality;
2. Incorporate SMM using metrics to measure environmental, social, and economic impacts developed from the FY18/19 project, include new waste categories, and provide a means to better integrate source reduction activities.
3. Develop necessary support materials for future users and developers.

METHODOLOGY

The research team will work closely with FDEP and local governments to develop, test and refine model enhancements. We envision that the working group associated with the FY16/17 and FY18/19 Hinkley Center projects will be integrated into this effort. The specific methods to meet the above identified objectives are as follows:

Task 1. Research on Source Reduction and Materials Reuse.

Source reduction and materials reuse is one area that will be specifically expanded as part of the model. The FDEP currently requires facilities that recycle 600 or more tons annually to register as a certified recycler and submit records of the type of materials and the mass of materials recycled. While some county recycling coordinators may try to identify and track source reduction activities such as donation centers and thrift shops, these activities often go uncounted, and other reuse activities may not be identified altogether.

In this task, we will meet with FDEP and local governments to:

(i) Define source reduction;

(ii) Determine at what extent, if any, source reduction and reuse are currently included in reporting to the State;
(iii) Research source reduction and reuse activities currently occurring throughout the State. This information will be gathered by examining the existing body of literature and practices; around the nation/world and speaking with local governments and reuse facility operators.
(iv) We will gather data from operations such as Goodwill Industries that track materials received, reuse and recycled.

Task 2. Identify Missing Materials Categories.

Additional waste categories that should be integrated into the new model will be determined by:
(i) Examining recent waste composition studies;
(ii) Researching product and materials trends;
(iii) Reviewing the scientific literature;
(iv) Speaking with waste management professionals.

At a minimum, the potential for include electronic devices and new packaging products will be investigated.

Task 3. Develop Missing Impact Factors.

The FY 18/19 project focuses heavily on developing conversion factors to estimate the social, environmental, and economic impact associated with a material and its waste management practice. If impact factors do not exist for the source reduction and reuse activities identified in Task 1 or the new waste categories in Task 2, we will identify and develop these factors based on existing science and literature.

Task 4. Refine the Model.

The research team will use the data from Task 1-3 to expand the more recently updated WasteCalc model to include the additional waste categories, the new life cycle categories, and the new source reduction/reuse features. We envision that the model may be renamed at some point to better reflect its refined purpose and approach, but to help illustrate how WasteCalc is currently structured and how changes will be integrated, please see Figure 6. We anticipate that this tool will result in decisions that are more informed and will allow decision makers to begin to shift from solid waste management to a materials management regime.

Task 5. Training.

Training materials for the refined model will be developed. The researchers will work with FDEP, local governments and the working group to test these training materials. A series of case studies for several counties will be integrated into this exercise. The research will them work with FDEP to provide training statewide through a webinar or conference presentations. Following each training event we expect to receive feedback or comments that will be used in potential model refinement.

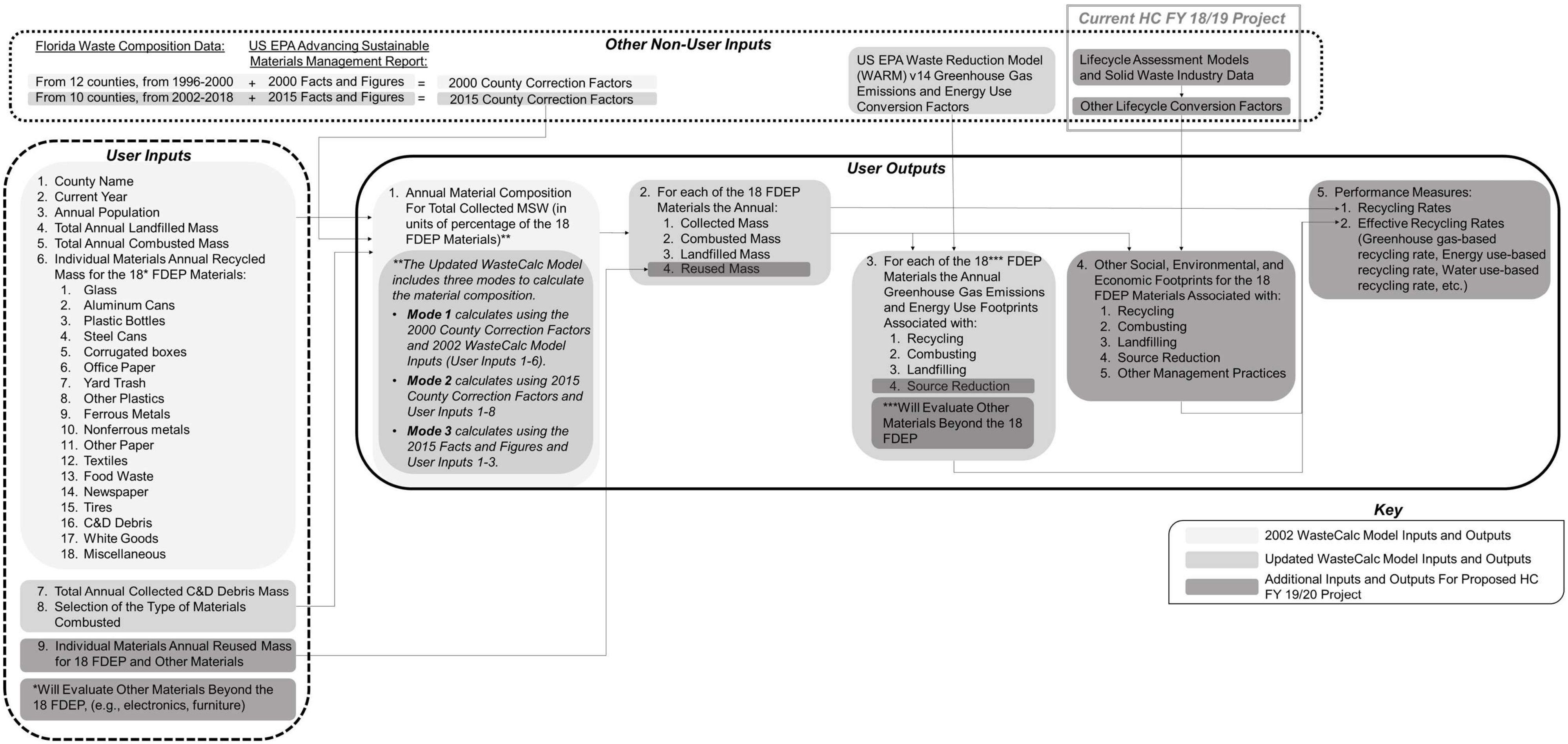

Figure 6: Schematic that shows the original 2002 WasteCalc model, updated WasteCalc model, and proposed FY 19/20 Project's tool inputs and outputs. The key presents that each shaded region is associated with either the 2002 WasteCalc model, updated WasteCalc model, or the FY 19/20 Project's tool. *Note: the proposed FY 19/20 Project's tool will incorporate all of the shaded regions into a single tool.*

TIMELINE

A 12-month project is proposed with the following timeline:

Task/Milestone	1	2	3	4	5	6	7	8	9	10	11	12
Task 1. Research on Source Reduction and Materials Reuse	X	X	X	X								
Task 2. Identify Missing Materials Categories			X	X	X	X	X					
Task 3. Develop Missing Impact Factors.					X	X	X	X				
Task 4. Refine the Model								X	X	X	X	X
Task 5. Training and Refinement										X	X	X
TAG Meeting			X			X					X	
Milestone 1: Defining, Determining, and Collecting Data on Source Reduction Activities				**X**								
Milestone 2: Investigating Potential Missing Material Categories to Include in the Tool							**X**					
Milestone 3: Developing Missing Impact Factors								**X**				
Milestone 4: Providing Training Materials and Webinars/Workshops to Model Users												**X**

COMMUNICATION PLAN

We will communicate the study's objectives and progress at planned stakeholder working group meetings, training events, and any conferences. We expect to satisfactorily meet each milestone by receiving and incorporating comprehensive feedback from federal and state regulatory agencies, local government, non-governmental organizations, solid waste consultants, and the waste management and recycling industry.

DELIVERABLES

Deliverables for the proposed work include progress reports to the Center, the compiled data on materials source reduced and methodology for incorporating the data, the WasteCalc model, and the LCA tool into a single tool, and any manuscripts or thesis chapters completed by students working on this project as part of their degree requirements. All other deliverables required by the Center will be met. A project website will be maintained, an information dissemination plan will be developed, and other necessary deliverables will be completed.

BENEFITS

The solid waste community in Florida will benefit from having a tool that allows the solid waste community to track the composition and disposition of their waste management system and to track the progress of their system beyond simply tons. The tool will incorporate the functions promised in the FY18/19 study and the updated WasteCalc model into a single tool that also considers source reduction and an expanded suite of waste categories.

REFERENCES

1) ICF International. (2016) Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM): Management Practices Chapters. U.S. Environmental Protection Agency

2) Anshassi, M., Laux, Steven, Townsend, T. (2018) "Replacing Recycling Rates with Life-Cycle Metrics as Government Materials Management Targets." Environmental Science & Technology 52 (11), 6544-6554

doi: 10.1021/acs.est.7b06007

3) Borthakur, A., Govind, M. (2017). "Emerging Trends in Consumers' E-Waste Disposal Behaviour And Awareness: A Worldwide Overview with Special Focus on India." Resources, Conservation and Recycling 117, 102–113. https://doi.org/10.1016/j.resconrec.2016.11.0114

4) Ikhlayel, M. (2017). "Environmental Impacts and Benefits of State-Of-The-Art Technologies for E-Waste Management." Waste Management 68, 458–474. https://doi.org/10.1016/j.wasman.2017.06.038

5) Lehman-Wilzig, S., Cohen-Avigdor, N. (2004). "The Natural Life Cycle of New Media Evolution: Inter-Media Struggle for Survival in The Internet Age." New Media & Society 6, 707–730. https://doi.org/10.1177/146144804042524

6) N.P., Nambiar, A.N. (2010). "Trends in Food Packaging and Manufacturing Systems and Technology." Trends in Food Science & Technology, Advances in Food Processing and Packaging Automation 21, 117–128. https://doi.org/10.1016/j.tifs.2009.12.006