FINAL REPORT
INNOVATIVE RECYCLING GRANT
CITY OF JACKSONVILLE, FLORIDA

Final Report
Innovative Recycling Grant
City Of Jacksonville, Florida

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Section 1.0
Background

1.1 Background

Polystyrene, by volume, is one of the major components of solid waste produced by many public schools in the United States. In Duval County, more than 18 million meals are served per year to public school students on polystyrene dinnerware. This results in a large quantity of spent food service polystyrene. In an effort to reduce costs, promote recycling and alleviate landfill costs, the Duval County Public Schools (DCPS) began a polystyrene recycling program in the mid 1990's. This recycling effort faced several problems, however. One significant problem was the cost of collecting and transporting the polystyrene to market. Another problem was the continuing reduction in marketability of food service polystyrene. This is due in part to lowered market costs for 'virgin' materials. Therefore, the Duval County public schools chose to investigate a more feasible method for recycling their food service polystyrene.

Awarded by the Florida Department of Environmental Protection (FDEP), this Innovative Recycling Grant allowed for the examination of the various stages involved in polystyrene recycling, including the collection, processing, and marketing of polystyrene dinnerware from Duval County Public Schools. The grant primarily investigated the use of ground polystyrene as a substitute for perlite, which is a common compost amendment for horticultural applications. It was hypothesized that size reducing the polystyrene dinnerware would create a form that could be utilized as a soil amendment. Using a portable-grinding machine, the polystyrene trays would be shredded or ground and then blended with composted yard debris. The polystyrene and compost mixture would be lighter than traditional compost, and the polystyrene would provide aeration of the soil. The enhanced

compost would then be shipped back to the public schools and to other sites for landscaping and campus beautification projects. The grant project also sought to develop alternate uses and markets for the ground product.

The Department of Environmental Engineering Sciences (DEES) at the University of Florida and TIA Solid Waste Management Consultants, Inc. of Tampa, Florida, were contracted by the Duval County Department of Solid Waste and Resource Management to provide technical assistance in regard to the Innovative Grant.
The DEES conducted a general market analysis for size reduced polystyrene, evaluated the polystyrene grinding equipment and conducted various analytical tests regarding the use of the ground polystyrene product. TIA conducted an extensive waste audit and market development analysis for the Duval County Public Schools' food service polystyrene.

Aggressive efforts have been taken to develop markets for ground food service polystyrene. Four primary potential markets for the ground product were identified and evaluated.

1. *Potting Soil Amendment:*

   The ground polystyrene was blended at up to a one to five ratio with composted yard waste to produce an organically rich, well-aerated potting soil. Enviro-Comp Services, the City of Jacksonville's contracted yard waste recycler, provided the compost and blending services for the grant. The potting soil was delivered to six selected public schools in the Jacksonville area for specific minigrant projects. The schools were provided with gardening supplies, plants and the amended soil. The projects included butterfly gardens, vegetable gardens, an outdoor classroom and an indoor atrium designed and installed by school volunteers, teachers, students, and in one instance, by Boy Scouts as part of an Eagle Scout Service Project. The amended soil was delivered to eighteen additional public schools for their gardening and

campus beautification efforts. Response from the schools regarding these efforts has been very positive.

The potting soil was delivered to the Jacksonville Electric Authority's (JEA) tree farm for use in the potting of trees. The JEA reports that the polystyrene amended potting soil is lighter in weight than the soil normally used to pot trees, thus, it is easier to handle.

The ground product was also used as part of the organic component of several REBOUND projects. REBOUND is a mixture of ground recycled scrap tires and an organic component, which is tilled into the subsurface of athletic fields (Attachment 1). The material provides a bouncy feel to the field and helps promote athlete safety. Improvements to field drainage and other horticultural improvements are common. The ground product was added to composted yard debris with favorable results for these projects.

2. *Insulated Concrete Forms (ICFs):*

RASTRA is a company that uses a mixture of ground styrofoam beads, Portland cement powder, and water to manufacture ICFs. A RASTRA ICF panel is a honeycomb-like styrofoam and Portland form that is filled with poured concrete which hardens, much like a standard ICF, providing structural integrity to a building. This particular type of panel is widely used in Europe and the western United States, but is relatively unknown in the Southeast. Attachment 2 depicts the RASTRA product and provides additional information about the RASTRA Company.

RASTRA ICFs display good insulating properties, are fire retardant, and are resistant to insects and vermin. The product was originally designed and marketed in Europe for its' user-friendly properties in do-it-yourself construction.

The RASTRA Company incorporated the ground food service

polystyrene product as a substitute for one-third of the styrofoam beads in the ICF mixture. The company had favorable results with this mixture. The altered panels are composed of one-third Portland cement powder, one-third recycled styrofoam beads and one-third recycled ground food service polystyrene. RASTRA offered to manufacture and provide wall panels using the ground product for a structure or structures on Duval County Public School property. The RASTRA Company also offered to provide technicians to 'dry in' the building(s).

The Jacksonville branch of Habitat for Humanities, HabiJax, plans to continue constructing hundreds of homes in the Jacksonville area. HabiJax is interested in using new types of building materials to help lower construction costs. The RASTRA Company contacted HabiJax concerning the feasibility of using the altered ICF panels in future construction. RASTRA indicates that a HabiJax home constructed using the RASTRA ICFs will be competitive in price to one built using standard construction methods. Further the RASTRA structure will provide similar benefits to concrete block construction. Because the RASTRA panels can be assembled by carpenters (a less expensive alternative to concrete masons) and because the product is user friendly, construction costs are cut. These properties have the potential to make the product a desirable building material for HabiJax. Meetings between HabiJax and RASTRA officials are ongoing.

The RASTRA Company and Moriah Industries of Rome, Georgia, have partnered to create EnviroWall of Florida, Inc. to further develop and market the food service polystyrene amended ICFs. Plans are to market the product under an exclusive agreement with Florida Rock Industries, Jacksonville, Florida (see Section 3.3)

3. *Concrete Additive:*

Florida Rock Industries is a major concrete and concrete product manufacturer in the Eastern United States. The company has shown an interest in using the ground polystyrene product as an additive to its' poured concrete.

Florida Rock performed extensive preliminary tests on the polystyrene altered concrete. Results indicate that replacing the aggregate in concrete with up to a 5% volume of ground polystyrene does not alter the structural integrity of the concrete. Further, the thermal properties of the altered concrete are slightly improved.

As a pilot program, Florida Rock provided the altered concrete for poured dumpster pads at two Duval County public schools, Ortega Elementary and Cedar Hills Elementary. The company also plans to provide the altered poured concrete for a sidewalk at Lake Forest Elementary school. Provision of the concrete for a slab foundation and for concrete building blocks (manufactured from ground polystyrene altered concrete) for the Englewood High School sports complex is also planned. These products will be at no charge to the school district. They will be monitored and evaluated by the School District.

Several concrete statuary manufacturers were provided samples of the ground product for testing. The ground polystyrene was substituted for the sand aggregate in concrete to create a finished product that is lighter in weight than one made of traditional concrete. Reduced shipping costs are possible. Strength is not a major issue in statuary manufacture. Therefore, a greater proportion of aggregate can be substituted with the ground polystyrene product with negligible effect. However, due to the limited total volume of ground polystyrene required for this potential market, this recycling alternative was not pursued.

4. *Soil additive for growing sod:*

Florida Carter is a Jacksonville firm specializing in sod development and installation as well as custom laser grading. The firm expressed an interest in testing the polystyrene/compost mixture as well as a mixture containing ground recycled waste tires as a medium for growing sod. The company indicates that a large volume of the ground polystyrene is required for an adequate test. Unfortunately, due to timing and the limited availability of the ground product, this test was not performed.

1.2 Project Objectives

The main objective of the project was to demonstrate a more economically and environmentally feasible alternative for spent food service polystyrene recycling in the public school system. The project addressed this objective as well as 'closing the loop' for a recyclable material. Another objective was to identify and troubleshoot problems associated with food service polystyrene recycling.

The project serves as a prototype for other communities to follow. The polystyrene grinding equipment developed by Moriah Industries for use in this project is on a trailer and can easily be pulled to various sites for operation/demonstration. Therefore, an additional project objective, transportability throughout Florida, is achieved. The potential for regional impact, portability of the project and end products, are obvious.

1.3 Formal Presentation of Project Results

The Innovative Recycling Grant was presented to the public in several venues.

- Jack Saye, Environmental Specialist for the Duval County

School Board, presented the project at the 1999 Recycle Florida Today (RFT) Conference in Stuart, Florida, May 16-18. The project also received an award from RFT for 'Best Innovative Recycling Grant 1998-1999'.

- Dr. Timothy Townsend, Department of Environmental Engineering Sciences, University of Florida, plans the project results for publication in an article for *Resource Recycling* magazine.

- Jack Saye, Duval County Public Schools and Jackie Eldridge, Recycling Coordinator for the City of Jacksonville, appeared on the government access cable talk show *Jacksonville on the Move* to discuss the polystyrene-recycling project. This show was aired on Thursday, August 27, 1999.

- A board display and handouts describing the Innovative Grant were presented at the City's Earth Day and America Recycles Day events (Attachment 3) and at the City's Neighborhood Summit conference. The display was also presented at the Mayor's Environmental Luncheon and at numerous school-based activities.

- Articles concerning the project were published in *Waste News Magazine* and *Harriman Chemsult Limited* magazine. Copies of these articles may be seen in Attachment 4 and 5 respectively.

- Information about the grant was presented in the Duval County Public Schools publication, *Acclaim* and in the Duval County Council of PTAs newsletter. Articles about the project were also published in the City of Jacksonville news publication *The Consolidator*.

Section 2.0
Project Implementation

2.1 Equipment and Services Acquisition

In order to meet the objectives of the project, a portable polystyrene grinder was necessary. Moriah Industries of Rome, Georgia, was contracted to develop such a machine. See Attachment 6 for a picture of the grinding equipment. Attachment 7 provides a sample of the ground polystyrene product. Initially, the City of Jacksonville Solid Waste and Resource Management Department was to purchase the machine with Innovative Grant funds. The machine would be housed and operated by BFI staff at their Jacksonville Materials Recovery Facility (MRF). These plans changed so that Moriah retained ownership of the equipment, being reimbursed for research and development only. The City had a contractual agreement with Moriah to process or grind the recycled polystyrene with the equipment. A more detailed discussion of this change is presented in Section 2.4.1 Operation/Production. Expenses relating to processing included labor, rental of a facility to house the grinder, industrial bags for transport and storage of the ground product, and transportation.

Ground polystyrene was blended with composted recycled yard waste by Enviro-Comp Services, the City of Jacksonville's contracted yard waste recycler. These services were paid by grant funds. Payments were made to three trucking companies for hauling, including shipping polystyrene to Rome, Georgia for machine testing purposes and transporting the blended material to schools and other Jacksonville sites. Several small signs were purchased. These signs described the polystyrene and compost mixture and that it was available free of charge to the public at specific sites.

A unique feature of the grant effort was the selection of six Duval County Public Schools as recipients of minigrants to develop

garden and campus beautification projects. Each of these projects utilized the polystyrene and compost mixture as a growing medium for plants. These projects included butterfly, native plant, flower and vegetable gardens and an indoor atrium planting area. Grant funds were used to purchase plants and planting supplies for implementation of these projects.

A part time employee was hired to assist in educating students on proper polystyrene recycling techniques. This staff person was also responsible for reporting and other duties relating to the grant. As part of the education process, workbooks featuring recycling and composting were purchased and distributed to students as well as incentive items.

The University of Florida Department of Environmental Engineering Sciences (DEES) was contracted to conduct research and a market development analysis for the ground polystyrene product. DEES performed a variety of analytic tests on polystyrene mixtures and applications. TIA Solid Waste Management Consultants was contracted to produce a waste audit and market analysis for the spent food service polystyrene generated by the Duval County Public Schools. The TIA analysis includes a survey of current and potential markets for the school districts' polystyrene; material specifications, prices, locations of markets within Florida and both traditional and non-traditional market uses for polystyrene. Final reports of these studies are available for review from the Solid Waste and Resource Management Department, City of Jacksonville.

The Innovative Grant Project was presented at a Recycle Florida Today conference. Grant funds were utilized for travel and conference registration.

Attachment 8, *Expenditures*, depicts all project expenditures in detail.

2.2 Implementation of Cooperative Recycling Effort

Duval County and the Duval County School Board partnered to make the Innovative Grant project a success. The Duval County Public Schools serve more than 18 million meals per year to students on polystyrene dinnerware. This project addresses a common problem for many school districts and other users of polystyrene dinnerware. By implementing a program targeting one of their largest waste fractions this project serves as a model for other counties to follow as they investigate viable methods to recycle spent food service polystyrene.

2.3 Project Tasks and Timeline

The project was composed of several major tasks. The first task was to develop a piece of machinery capable of size reducing spent food service polystyrene. The next task was to collect the polystyrene from school sites and transport it to the grinder. When the grinding was completed, the shredded polystyrene was transported to a site for blending with recycled composted yard debris. The blended polystyrene and compost was transported to schools and other locations for gardens and beautification projects. Educating teachers, students, school custodial and food services and others about the Innovative Grant Project and proper recycling techniques was an important part of this effort. An additional task, which included the development and marketing of alternative uses for the ground polystyrene, evolved as the grant proceeded. Substantial effort was given to these activities.

A detailed description of major project elements follows. The project timeline is presented in Attachment 9, *Project Timeline*.

2.3.1 Composting and Distributing Ground Food Service Polystyrene

The major elements of this project provided a local recycling alternative for the school district. Prior to the proposal, polystyrene was baled by the school districts' waste hauler and trucked to Chicago for recycling.

The public schools were visited and instructed on proper recycling techniques. On site assistance was provided to schools to encourage student polystyrene recycling. Custodial training sessions were provided and recycling information was included in paycheck envelopes of these employees to ensure proper procedures were being used when handling polystyrene. Meetings with cafeteria supervisors and managers concerning polystyrene handling were also held.

Students were instructed to source separate polystyrene by placing their used polystyrene dinnerware into receptacles located in school cafeterias. Specifically, students were to dispose of food wastes and stack their partitioned lunch plates for bagging in clear plastic bags. The bagged material was deposited in specially designated recycling dumpsters by school custodial staff for pick up by BFI, the school systems' contracted waste hauler. BFI trucks transported the polystyrene to the Jacksonville BFI Materials Recovery Facility (MRF) for sorting. The still bagged polystyrene was placed in roll offs and trucked by BFI to Moriah Industries' Jacksonville location for processing (grinding). A piece of grinding equipment, developed by Moriah Industries of Rome, Georgia, was used for processing the polystyrene. This procedure continued for approximately five months until the August 31, 1999, expiration of BFI's service contract with the Duval County School District. Prior to arrival of the grinder in Jacksonville BFI had baled and stored much of the bagged polystyrene at their Jacksonville MRF. A portion of this spent school food service polystyrene was transported to Moriah's Rome, Georgia, location for early testing of the grinding

machine.

During the five month period that the grinder was in operation, two forty cubic yard roll off containers filled with spent bagged polystyrene dinnerware from the Duval County Public Schools were delivered to the grinder on a weekly basis. As space allowed, several bales of polystyrene that had been stockpiled at the BFI facility were incorporated into the roll-off for processing. A number of bales of polystyrene had been stockpiled by BFI since it's last delivery of the material to a Chicago recycler. During the school summer break period, BFI delivered the remainder of these bales to Moriah for grinding.

Moriah workers placed the ground product into heavy-duty industrial bags. A contracted hauler delivered a portion of the bags to Enviro-Comp Services for blending with composted yard waste. A front end loader was used to mix the ground material with the compost (Attachment 10). Mixtures ranging from eight parts compost to one part polystyrene up to five parts compost to one part polystyrene were used. The blended material, which resembles commercially prepared potting soil, was trucked to 24 schools for gardens and landscaping (Attachment 11) as well as the JEA (Jacksonville Electric Authority) Tree Farm, Tree Hill Nature Preservation Center and to Jacksonville's Westside Regional Park, where it was available for gardens and beautification projects. Aproximately 700 cubic yards of the polystyrene and compost blend, mixed to a higher proportion of polystyrene to compost, were used for three REBOUND projects, baseball fields and a football field. Attachment 12 depicts the football field REBOUND project at Raines High School.

Ground bagged polystyrene that was not used for projects during the grant process became the property of Moriah Industries. The company plans to use the material for continued testing of concrete applications.

It is important to note that Moriah workers processed a total weight of 107 tons of material (including contamination) during

the project, producing approximately 39 tons of shredded or ground food service polystyrene.

2.3.2 Education and Information Dissemination

Sample bags of the potting soil product and flyers describing the Innovative Grant project were made available to approximately 1,500 Duval County public school teachers at three openings of the school district's Teacher Supply Depot. The Depot serves as a warehouse of recycled or reusable materials from donations made by area businesses and community leaders. Since its' inception in 1996, materials valued at more than eight and one-half million dollars have been donated. Hundreds of teachers visit the Depot during each scheduled opening.

Activity booklets were distributed to more than 6,000 students. The booklets feature recycling, composting and gardening techniques. A handbook for use by the schools was written by staff members to describe proper recycling and solid waste procedures. Descriptions of the school district's environmental activities and several locations for environmentally focused student field trips are also offered.

The Duval County Public School District consists of 157 elementary, middle and high schools with more than 125,000 students. Handouts describing the Innovative Grant project and other informational material about recycling in general were presented during formal presentations at many of these schools. Board displays and handouts were prepared for the city's Earth Day celebration, America Recycles Day, the City of Jacksonville's Neighborhood Conference and the Mayor's Environmental Luncheon. The project was also described on the local government access cable talk show *Jacksonville on the Move.*

Information about the project was published in the City of Jacksonville employee news magazine *The Consolidator* . The

project was also presented in the Duval County Council of PTA's monthly newsletter as well as the school districts' employee magazine *Acclaim*. These publications have wide distribution within Duval County.

The project serves as a model for other cities and counties to follow. Many educational programs and information were presented about this program thus educating the public, from students and parents to government employees and the public at large, about the potential benefits of recycling polystyrene. Educational materials and study results, which were produced as part of the project, are readily available to the public for review.

2.4 Problems Encountered and Solutions Developed

No serious problems were encountered in this project. However, several changes were made in the project elements and budget. These changes became necessary as work on the project progressed. Specifically, it was determined to be in the best financial interest of the public for Moriah Industries, the company contracted to construct the polystyrene-grinding machine, to retain ownership of the grinder. An agreement was made to reimburse Moriah for its' research and development of the grinder and for the company to retain ownership. Moriah was then contracted to provide grinding services for the county. This very significant change placed the future development of ground food service polystyrene as a recyclable material into the private sector. A discussion of the problems associated with the project follows.

2.4.1 Operation/Production

As a test of the grinding machine, a large quantity of spent food service polystyrene in bale and loose forms was transported to Rome, Georgia for processing. According to the University of Florida study, concerns regarding the grinders' production and

operation including engine speed, capacity and operator safety were identified. In addition, the grinders' feeding and conveyance systems (manually operated) were determined to be inadequate for high volume operation. Most of these issues were addressed and resolved by Moriah Industries. However, automated methods for breaking down trays prior to entrance into the conveyance system and the ability to handle large batch feedings of polystyrene should be determined by the manufacturer. The company, with further evaluation and testing, can resolve these issues.

Following initial testing the machine was transported to Jacksonville. Plans were to house and operate the grinder at the Jacksonville BFI Materials Recovery Facility (MRF) utilizing BFI employees to operate the equipment. Due to the aforementioned operational and design issues, BFI refused to allow placement of the machine at their site. A determination was made to pay Moriah a one-third payment for the machine (for research and development) and for Moriah to retain ownership of the equipment. Moriah was requested to secure a Jacksonville location for the machine at the expense of the grant.

Employees to operate the machine were obtained by Moriah as part of a 'Learn To Work' program sponsored by Jacksonville's City Rescue Mission. This program provides employment-training skills for previously homeless workers. Operational expenses for the grinding process, including labor, were paid by Moriah and reimbursed through the grant.

No major problems related to the operation of the grinding machine, with the exception of several odor complaints from neighbors were further reported. These complaints were made near the end of the grinding process and no changes were necessary. In the future, the processor should address odors. It is possible that the addition of a 'washing phase' to processing could resolve any odor concerns.

The hauling contract for solid waste and recycled material

between BFI and the Duval school district expired on August 31, 1999. As food contaminated polystyrene is considered a non-profitable recyclable by most recycling companies, only one vendor bid to handle the school polystyrene. Based on bid costs, polystyrene was excluded as a recyclable material in the school districts' new contract. The school district no longer has a hauler for its' food service polystyrene and the flow of spent food service polystyrene has stopped. However, students are still instructed to 'recycle' their dinnerware; the bagged product is placed in the solid waste, not recycling, dumpsters by school custodial staff.

The school district has expressed hopes that a viable market for recycled polystyrene will be established by the private sector and that the material can be recycled once again. By encouraging students to continue source separating their polystyrene dinnerware from the waste stream the established pattern of behavior continues. A detailed discussion of these efforts is presented in the Introduction of this report, Section 1.1.

Two additional changes to the initial Innovative Grant application include:

1. An amendment to the Innovative Recycling Grant contract to extend the length of the Innovative Grant period to February 13, 2000.
2. An amendment to allow a waste audit of spent food service polystyrene and analysis of potential market development for the Duval County Public Schools' polystyrene.

Section 3.0
Project Results

3.1 How Project Objectives Were Met

This project was developed by Duval County (Jacksonville) to demonstrate the feasibility of recycling school food service polystyrene as an amendment to composted yard waste. The objectives set forth in the grant project were met beyond expectation. The participants achieved the objectives by identifying and fostering the development of a potentially self-sustainable method for recycling spent food service polystyrene and identifying other potential markets for the ground polystyrene product.

With respect to the Duval County Public Schools, all participants were very pleased with the results of their individual projects. Students learned about recycling and composting, and benefited from receiving the polystyrene/compost mixtures. The REBOUND projects for the athletic fields have received praise and schools have benefited from the completed concrete based projects as well.

Polystyrene recycling containers were placed at school sites as part of the project. Students and staff at the schools were instructed on proper recycling techniques. Recycling incentives and educational materials were provided. Schools received activity books for 6,000 students. Other incentive items and materials featuring gardening and composting methods were widely distributed.

Amended soil was delivered to eighteen schools for use in school projects. The schools have been very pleased with the results of their gardening and beautification efforts. Projects were developed at six selected public schools that were the recipients of minigrants for plants and gardening materials. These schools planted various types of gardens (Attachment 11), and one

school incorporated the garden into the math and science curriculum. The amended soil was delivered to the Jacksonville Electric Authority's Tree Farm for use in tree potting. The soil was also delivered to Tree Hill Nature Preserve for distribution to the public. The Duval County Public Schools' Teacher Supply Depot was the recipient of the soil as well. It was made available to public school teachers at three regularly scheduled openings of the Depot. Positive reports have been received from each of these activities.

A geomaterial product called REBOUND was incorporated into the grant projects. A ground polystyrene and compost mix was used as the organic supplement to recycled ground shredded tires for several REBOUND projects on athletic fields at public schools (Attachment 12) and a city park. Test results from the University of Florida indicated that the presence of the polystyrene in the organic blend for REBOUND could have a positive effect on impact values (shock absorbency). The REBOUND projects have proven to be successful and recipients are very pleased with the result.

The ground polystyrene product was utilized as an additive for concrete in various applications. These include: insulated concrete forms for building construction panels; as an additive to poured concrete in sidewalks and dumpster pads; and in concrete blocks and statuary.

Each of these methods for recycling the ground product was explored with favorable results. However, in terms of economics and 'value added' it was determined that using the product as part of insulated concrete wall forms holds the most promise to become a viable method for recycling spent food service polystyrene. Without the financial support of the grant, the soil-based use of the product is cost prohibitive. In addition to the fee for transporting polystyrene from schools for processing, processing and blending fees, as well as costs associated with returning the blended product to various sites, make this an expensive option. The product was delivered to sites during the

grant ‘free of charge’. It is unlikely that recipients would pay a charge that adequately covers costs for this method.

Continuing use of the product as an additive to poured concrete is also unlikely. Based upon tests by Florida Rock, only a small amount of the ground product can be added to poured concrete and still maintain the structural integrity of the concrete. This limits the amount of material that can be recycled in this manner. Other factors to consider include the need to manually add the ground product to the concrete for mixing. Equipment to handle this task must be developed at the expense of the vendor. Florida Rock indicates that due to the highly competitive nature of the concrete industry, even a slight mark up in price to cover the associated costs, estimated at five cents per cubic yard, is unacceptable. Further, the ‘value added’ to the consumer will not off set the added costs.

It was determined that using the product for ICFs does have a degree of market potential. Standard ICFs are composed of styrofoam beads and Portland cement powder. The RASTRA Company reports that they currently purchase and grind non-food service styrofoam for this use. By substituting the recycled ground product for the ground styrofoam, the structural integrity of the ICF is slightly improved. The environmentally friendly aspect of the product is planned as a selling point and in fact the product will be marketed under the product name EnviroWall.

This Innovative Grant Project serves to ‘pave’ the way for the development of additional markets by businesses. The project also serves as a prototype for other communities to follow in resolving their polystyrene recycling issues. It is anticipated that public education and awareness of polystyrene recycling will continue as planned polystyrene altered concrete projects are completed. Demand for these products should grow. The equipment and procedures for handling and processing spent food service polystyrene will continue to be evaluated and developed by the private sector. Necessary modifications to the process will be made in order to make the program operate as

efficiently as possible and be financially viable.

3.2 Using Advanced Technologies or Processes

Prior to this proposal, spent food service polystyrene generated by the Duval County Public Schools was trucked to a facility in Chicago for recycling. This project provided a local recycling alternative. The portable grinder is uniquely designed to handle spent food service polystyrene. It was discovered that grinders currently in existence would not process food service polystyrene for this application. The material will not properly feed into the equipment and is not adequately ground. The machinery developed by Moriah for the grant adequately processed the material.

Blending ground food service polystyrene with composted yard waste has not been done according to project research. The benefits of adding polystyrene to the compost for horticultural applications was explored by the University of Florida in their study *Market Evaluation of Size-Reduced Polystyrene from Food Cafeteria Trays*, produced as part of the grant. It was determined that ground food service polystyrene has many of the same characteristics as perlite, a common soil additive. Ground polystyrene also has particular drainage and compaction advantages when used on golf greens. As golfing is a year-round activity in Florida this is of potential importance.

Using the ground product as a geomaterial for REBOUND applications provides a new and innovative method for recycling spent food service polystyrene. According to the contracted University of Florida study, polystyrene as a geomaterial has seen wide use in Europe. The polystyrene is most often found in block or sheet form and only a fraction is post consumer. Polystyrene has the ability to insulate and absorb energy and is therefore beneficial for use on athletic fields. The University of Florida study indicates that use of the ground product in

REBOUND does not negatively effect the recognized impact or cushioning value of REBOUND and may have positive effects.

The addition of ground food service polystyrene to concrete for various applications is not unique to the project. However, the development of insulated concrete forms made from the ground product is unique. The RASTRA Company had experimented with post consumer food service styrofoam in its' ICFs in the past. According to the company, use of ground polystyrene in lieu of one-third of the non-food service styrofoam in the ICFs produces a wall form which is not only environmentally sensitive but is stronger than the original product.

3.3 Increasing the Amount of Recovered Materials

According to TIA and University of Florida research, the cost for 'virgin' materials for polystyrene product manufacturing has helped to depress the market for recycled food service polystyrene. As the development of new products containing the ground polystyrene product continues, spent food service polystyrene has the potential to independently become an economically viable recyclable material. Specifically, use of the product in concrete wall form applications holds the greatest promise for the development of a sustainable market for the recycled material. According to Moriah Industries, a partnership between RASTRA, Florida Rock Industries and Moriah is planned. A new company, EnviroWall has been formed to manufacture ICFs using the ground product. Construction of an EnviroWall manufacturing plant is planned. Attachment 13 depicts an ICF manufacturing plant of similar size and design as the planned facility. Examples of ICF construction are presented as well. A very large volume of polystyrene material is required to supply such a facility. The manufacturer estimates that their plant tentatively planned for northeast Florida will require between 250 to 275 tons of food service polystyrene per year. This is far greater than the polystyrene available from the Duval County Public Schools. Company officials state that tentative

agreement has been reached with Publix Super Markets to accept its' polystyrene and negotiations are underway with several school districts to supply the necessary volume of polystyrene. The intangible environmental benefit to the consumer of using a recycled product remains a significant marketing tool for the manufacturer.

The Duval County Public Schools are committed to a comprehensive recycling program. Although polystyrene is no longer a part of this program, the framework for food service polystyrene recycling remains in place.

3.4 Transferability of Technology and Processes

This project serves as a prototype for other counties and cities to follow. The equipment and procedures, which were developed, are readily transportable to other counties. The polystyrene grinding machine is relatively small and on a trailer. It is easily pulled by a pickup truck to sites for operation/demonstration purposes. Blending of the product is satisfactorily accomplished using a front end loader to handle bags of the ground product. This equipment is commonly available.

A wide spectrum of the community, from students and parents to government employees, was educated on the benefits of recycling polystyrene. Instructions for proper food service polystyrene recycling methods were developed. Other school districts or similar entities throughout Florida may easily implement these techniques.

3.5 Analysis of Cost Effectiveness

Placing a dollar value on the environmental benefits of recycling specific materials is a difficult task. Intangibles such as quality of life and 'doing the right thing' are impossible to quantify. However, it is possible to determine the actual expense of recycling a particular material.

Actual costs incurred for recycling Duval County Public School food service polystyrene during the five-month period ending August 31, 1999 (approximately one-half of a school calendar year) are used as a basis of comparison for this analysis. These costs are compared to the most recent actual costs incurred by BFI (the District's contracted waste hauler) for recycling Duval County public school polystyrene by shipping the material to a reclaimer facility in Chicago. This shipment was made by BFI to the National Polystyrene Recycling Company in Chicago on November 21, 1997. It is important to note that this company continues to charge a similar fee to accept food service polystyrene. Freight costs and costs to the MRF operator for handling the material and baling it for shipping may vary. The estimated cost for placing a similar amount of the material in Duval County's Trail Ridge Landfill is presented for comparison purposes.

The pick up fee from school sites and transportaion to the MRF for handling must be included in the total cost. This cost is assumed to be the same for each recycling alternative. A fee for transportation of the material to a grinding facility from the MRF should be considered as well. Due to the cooperative effort of the innovative recycling project, BFI did not charge for this service.

During the project, according to the BFI/school contract, solid waste hauling charges were slightly more than double that of recyclable material charges per cubic yard at $2.69 vs $1.33. According to the TIA study, polystyrene by volume accounted for approximately 5% of the total school waste stream. Considering

the material as solid waste may result in a greater cost for the initial pick up at school sites. However, it interesting to note that since polystyrene has been added to the solid waste stream by the school district, an increase in the frequency of solid waste 'pulls' at each school has not been necessary. Conversely, the number of recyclable material 'pulls' has not been reduced. Therefore, the school district has not seen an increase in its' solid waste charge due to increased 'pulls'.

The following table displays the actual relative costs for the various recycling methods. An assumption has been made that the ground material becomes the property of and is marketed by the operator of the grinding equipment. If the market for the polystyrene altered concrete develops, this would occur. It is impossible to establish a firm cost for preparing and delivering the polystyrene amended soil product. Due to the artificial financial support given by the project's partners to this recycling effort, reliable cost figures for this activity are not available.

COMPARISON OF DISPOSAL COSTS*
DUVAL COUNTY PUBLIC SCHOOLS
SPENT FOOD SERVICE POLYSTYRENE
FIVE MONTH VOLUME (Approximately 14 TONS)

RECYCLE BY SHIPPING TO NATIONAL POLYSTYRENE RECYCLING COMPANY	
Sorting And Baling Polystyrene At MRF	$9,604.00
Freight Charge To Chicago	$870.00
National Polystyrene Recycling Company Fee For Processing @ $.15 Per Lb.	$4,116.00
TOTAL COST	$14,590.00
RECYCLE BY GRINDING FOR PROJECTS	
Delivery Of Loose Polystyrene From MRF To Grinder-19 roll offs(N/C for this project but valued @ $80.00 per roll off)	$1,520.00
Processing and Bagging Of Ground Polystyrene ($475 per roll off: 19 roll offs processed)	$9,025.00
TOTAL COST	$10,545.00
LANDFILL AT TRAIL RIDGE LANDFILL	
Average Tipping Fee At Trail Ridge Landfill 14 tons/19roll offs ($35.00 Per Ton)	$490.00
Intangible Cost for Landfill Space	$0.0
TOTAL COST	$490.00

*There is a fee for pick up, handling and delivery of polystyrene from school sites to the MRF. This fee should be similar for each alternative. A fee is charged for hauling material from schools to the landfill (see text Section 3.5).

As stated, nearly 14 tons of polystyrene was generated by the public schools during the five-month grinding period and processed by Moriah Industries. In addition to this amount, approximately 75 tons of baled polystyrene was processed. This later amount consisted of highly contaminated baled school polystyrene material that had been stored by BFI. Moriah Industries estimated that they processed a total of 96 tons of material (loose and baled), with a contamination rate for the baled material of 56%. This amount includes material used for machine testing purposes. The total amount of ground polystyrene produced was 39 tons. By utilizing a portion of this material for the soil-based projects, for concrete applications and for testing, disposal costs were avoided. Moriah Industries retained ownership of the balance of the ground product for start

up of the ICF facility and other market development purposes. Disposal costs for this material was also avoided. The avoided costs to landfill the processed polystyrene would have been $1,365.00 (fees for transportation from school sites to the landfill must be added to this amount). The project saved 39 tons of virgin polystyrene material. Avoided costs for the waste tires and composted recycled yard debris used for the REBOUND projects are a consideration as well. However, these projects were planned regardless of the Innovative Grant. Avoided costs for these two materials have not been calculated.

Calculation of recycling costs per ton and cost per capita is shown below. In a real market situation, since research and development is complete, the cost per ton for recycling the material for ICF construction is substantially lowered. Currently, the RASTRA Company purchases styrofoam for use in ICF manufacturing. The company pays an estimated $80.00 per ton for the material. The company must also pay for shipping the material to its' facility for processing or grinding. The most cost prohibitive aspect of recycling food service polystyrene is grinding. Use of the new grinding technology developed as part of this grant, in lieu of the grinding necessary for standard RASTRA production substantially reduces recycling costs. The newly formed EnviroWall Company plans to construct a grinding machine capable of pre-washing the polystyrene, accepting batch loads, and handling the greatly increased volume of material necessary.

COST PER TON OF GROUND RECYCLED MATERIAL PRODUCED

Actual Cost To Process/Grind 96 Tons of Food Service Polystyrene From Duval County Public Schools	$ 64,510
Number of Tons Of Ground Product Produced	39
Cost Per Ton	$1,654

COST PER CAPITA TO PROCESS AND GRIND
FOOD SERVICE POLYSTYRENE

1998 Population of Duval County	753,823
Actual Cost To Process/Grind 96 Tons Of Food Service Polystyrene	$64,510
Cost Per Capita To Process 96 Tons	$.085

3.6 Enhancing the Marketability of Non-Traditional Materials

Typically, polystyrene is not a part of most county/city recycling programs. This is due to the limited number of recycling options for the material. Avenues for recycling food service polystyrene in particular are extremely limited and include substantial collection/transportation costs.

Grinding food service polystyrene creates a new and potentially marketable product. Several options for use of this product, beyond soil based applications, were evaluated. Aggressive efforts to foster private sector development of these options were undertaken. The most promising of these included several pilot projects for concrete based applications.

The future development of this particular recycling method lies within the private sector. The RASTRA Company and Moriah Industries have partnered to form EnviroWall. This company plans to construct insulated concrete wall forms using the new technology at a plant to be located in northeast Florida (Attachment 13 depicts a similar size manufacturing facility). Discussions with venture capitalists in the Jacksonville area are ongoing concerning this project. According to a company official the company could be in operation by 2001.