Florida Polytechnic University
Florida Industrial and Phosphate Research Institute

2011 - 2016

Strategic Plan

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Florida Polytechnic University
Florida Industrial and Phosphate Research Institute
(FIPR Institute)

Overview

Introduction

The Florida Legislature created the Florida Institute of Phosphate Research (FIPR) in 1978 to initiate, conduct or sponsor studies on the environmental and health effects of phosphate mining and processing and to determine better methods to improve the economy, environment and welfare of Florida's citizens, including their health and safety. In 2010, FIPR became part of the University of South Florida Polytechnic (USFP) and its name was changed to the Florida Industrial and Phosphate Research Institute (FIPR Institute). In 2012, the Institute was re-established within Florida Polytechnic University.

The Institute's functions are to

- Establish methods for better and more efficient practices for phosphate mining and beneficiation
- Conduct or contract for studies on the environmental and health effects of phosphate mining and reclamation
- Conduct or contract for studies of reclamation, including wetlands, reclamation, and technologies for phosphate mining and processing.
- Conduct or contract for studies of phosphatic clay and phosphogypsum disposal and utilization as a part of phosphate mining and processing
- Provide the public with access to the results of its activities and maintain a public library related to the Institute's activities, which may contain special collections

In addition, the Institute may

- Research and develop methods for better and more efficient processes and practices for non-phosphate commercial and industrial activities, including, but not limited to, mitigating the health and environmental effects of each of these such activities as well as developing and evaluating alternatives and technologies
- Secure funding from grants and other available sources

- Enter into contracts with any firm, institute, or corporation or federal, state, local or foreign governmental agency in order to carry out its activities

- Promote the issuance of patents for, and commercialization of, the Institute's technologies, knowledge and intellectual property

- Educate the public about the science related to topics and issues that are within the Institute's scope of expertise

- Hold public hearings

- Establish public-private partnerships

- Provide consulting activities

The 2010 legislation established a five-member Phosphate Research and Activities Board to monitor expenditures from the Phosphate Research Trust Fund. The Governor appoints two members to the Board from the phosphate industry and one member from a major environmental or conservation group in the State. The Secretary of Environmental Protection or his or her designee and the President of Florida Polytechnic University are also Board members. The Board determines which research projects to fund from the Phosphate Research Trust Fund with the assistance of outside experts, standing technical advisory committees, Institute staff, and the public.

Research

The FIPR Institute categorizes its research into several work areas:

- Chemical processing and technology development

- Mining and rock processing

- Environment and reclamation

- Public and environmental health

Research projects, however, often pertain to more than one of the Institute's research areas because they have components that fit under more than one heading. For example, research on phosphogypsum, a by-product of phosphate fertilizer production, may include chemical processing of the phosphate, production and treatment of the process water, use of the by-product, and reclamation of a closed phosphogypsum stack.

Public Information

The FIPR Institute conducts seminars, conferences, and workshops on subjects pertaining to its research program. Research projects result in peer-reviewed documents

which are available in hard copy and in electronic format. Scientists and engineers working for the Institute are encouraged to present their findings in peer-reviewed journals and at scientific conferences.

The FIPR Institute works with the media to ensure the accuracy of stories about the industry and its impacts. The Institute's library is considered to have the finest collection in the world on phosphate resources, mining, and associated industries such as fertilizer production. The library is open to the public and has the ability to access technical references through extensive online resources and where necessary, through interlibrary loan. A description of the library's services and its collection can be found on the FIPR home page at http://www.fipr.state.fl.us.

Education

The FIPR Institute has an education program to assist teachers in achieving the Florida Next-Generation Sunshine State and Common Core Standards using information concerning phosphate industry operations and issues. To achieve this objective, the Institute uses its scientific, environmental and technical expertise in teacher training workshops, in-class presentations, and in the development of lesson plans, curricula and materials for use by teachers.

Staff

The FIPR Institute has a dedicated staff of professionals, including chemists, biologists, engineers, librarians, education coordinator and staff, research assistants, and administrative personnel. In addition, about 70 to 80 volunteers representing the Institute's various stakeholder groups serve on Technical Advisory Committees (TACs) that assist the Institute in developing and overseeing its research and other programs.

Facilities

The Institute is located on the western edge of Bartow, Florida, the county seat of Polk County, in the heart of the phosphate mining district. It occupies eight acres of land that once was mined and has been reclaimed. The campus contains four buildings, which house administrative offices, the library, a biological laboratory and greenhouse, metallurgical and analytical chemistry laboratories, and an education center.

Mission Statement

The mission of the FIPR Institute is to maintain a leadership role in identifying, conducting, funding, disseminating and assuring the scientific validity of research that:

- Results in the assessment and resolution of significant phosphate industry issues
- Benefits the phosphate industry and the citizens of Florida by developing and commercializing new technology

- Applies its scientific and engineering knowledge and techniques to assess and resolve issues related to other industries, including those outside of Florida

- Applies its scientific and engineering knowledge and techniques to research, develop and commercialize new technology for other industries, including those outside of Florida

- Assists Florida Polytechnic University in achieving its education, training and research goals

- Informs the citizens of Florida and other interested parties to provide perspective on phosphate and related issues

The Institute accomplishes this mission by:

1. Conducting in-house research and funding research by others.

2. Facilitating the application of research results and commercialization of technology.

3. Coordinating Institute activities with local, regional, state, national and international governmental agencies, and research organizations.

4. Disseminating research results to industry, government, the research community, and the public.

5. Maintaining an information center on the Institute's research mission areas of mining, chemistry, environment, technology and education.

6. Maintaining technical contacts worldwide and participating in international programs, research and education.

7. Keeping Institute staff up to date on phosphate and related issues and keeping open lines of communication between them and interested parties.

8. Conducting public information, education and technology transfer programs.

9. Conducting conferences and workshops for all interested and affected parties about the research results and priorities of the Institute.

10. Acting as a liaison among educational institutions, associations, industrial, governmental, and environmental entities.

11. Facilitating achievement of Florida Polytechnic University goals.

Relationship to Florida Polytechnic University Strategic Goals

The Strategic Plan Goals of Florida Polytechnic University are:

1. Gain regional accreditation.

2. Recruit faculty for a 21st century university.

3. Achieve student enrollment projections.

4. Create capacity for learning.

5. Foster industry partnerships for increased student opportunities.

The Institute will contribute to these goals by:

1. Hiring and retaining outstanding researchers.

2. Providing students with opportunities to contribute to applied research at the Institute.

3. Contributing to academic programs throughout the University.

4. Contributing to development of infrastructure to support polytechnic learning and research and development of a stable economic base for campus and program development.

5. Continuing to develop public and private partnerships and seeking state and federal funding for the Institute's research and public information programs.

Values Statement

We, the Board and Staff of the Florida Industrial and Phosphate Research Institute, pledge that we will:

- Act without bias or favoritism in the performance of our duties
- Operate with openness and integrity, and with respect for all laws and regulations
- Perform high-quality, professional work, and insist upon the same from our contractors
- Respect each other and those we serve
- Be receptive to thoughts, ideas, and criticism from the public, the environmental community, industry, the education community, the Legislature, and regulatory and governmental agencies

FIPR INSTITUTE'S 2011 - 2016 STRATEGIC PRIORITIES

Technology

Chemical Processing and Technology Development
Mining and Rock Processing

Environment

Environment and Reclamation
Public and Environmental Health

Programmatic Work Areas

Technology Transfer
Information Services and Library
Education

This strategic plan is the first for the Florida Industrial and Phosphate Research Institute. It covers the period 2011 to 2016 and was presented to the Institute's Advisory Board and the public in January 2011. After revision, its adoption was recommended by the Board at the January 2011 meeting and adopted on February 17, 2011.

This strategic plan discusses goals in each of the Institute's research and programmatic areas. For each area, goals are presented. Each goal is accompanied by a discussion of the rationale for pursuing the goal as well as approaches to achieving it. In many cases, the goals and approaches related to phosphate are continuations of goals and approaches that the Florida Institute of Phosphate Research (FIPR), the Institute's predecessor, followed in the past. Although substantial progress has been made towards achieving these goals, more work is still needed. In addition, the plan contains new goals and approaches applicable to non-phosphate work.

The order in which work areas are discussed and the order in which goals are numbered and discussed is for clarity and convenience. The order of discussion and the order of numbering should not be interpreted as an order of importance or priority.

FUNDING FOR INSTITUTE PROGRAMS AND OPERATIONS

The FIPR Institute gets most of its revenue for phosphate research from the severance tax paid by the phosphate industry. The Institute's allocation from the phosphate severance tax is placed in the Phosphate Research Trust Fund. The Institute draws on the Trust Fund to pay for its phosphate programs and operations. Other sources of revenue such as contracts, grants and training activities will be used to fund non-phosphate programs.

The Institute has developed several proprietary technologies and computer-based instructional programs. Commercialization of these proprietary technologies and programs could significantly supplement the Institute's revenue. Revenue may also be obtained from contractors who sell commercial products whose development was fostered by the Institute's assistance and funding and from joint ventures and partnerships with the private sector.

The Institute pays a substantial fee from its severance tax allocation to the Department of Revenue. This fee usually represents approximately 9% of the Institute's allocation and significantly reduces the funding available for FIPR Institute research and programs. The fee has been rising steadily over the years and is expected to continue to rise. When the Non-Mandatory Land Reclamation Trust Fund, which also pays the fee, no longer receives an allocation from the severance tax, the Institute will be solely responsible for its payment. By that time, the fee could easily exceed more than 20% of the Institute's allocation.

The fee that the Institute pays can be reduced or eliminated only by action of the State Legislature. We will be working with legislators through Florida Polytechnic University's government relations staff to reduce the fee to a more reasonable level.

DEVELOPMENT OF TRUST FUND PROJECTS

The Institute's projects that are funded by the Phosphate Research Trust Fund are directed at solving real-world problems identified with the mining and processing of phosphate rock in Florida in which the public has a substantial interest. Projects originate from one or more of the following sources:

- Unsolicited proposals from the technical community and researchers.
- Proposals formally solicited by FIPR Institute staff from the technical community through requests for proposals.
- Proposals originating from FIPR Institute staff and/or its Technical Advisory Committees.
- Project requests from other governmental agencies, including the Florida Department of Environmental Protection.

This document is intended to provide guidance for proposal topics of interest for all of the above sources.

First and foremost, the Institute and its reviewers attempt to answer the following three questions when evaluating whether proposals should be funded:

- Is the project technically feasible?
- Is the project beneficial, or at least neutral, to the environment and public health?
- Is the project economically practical?

RESEARCH PRIORITIES

CHEMICAL PROCESSING AND TECHNOLOGY DEVELOPMENT

Goal 1. Develop procedures for reducing the magnitude of the process water problem.

Discussion: Process water is essential to the operation of phosphoric acid plants. It is used as make-up water for phosphoric acid manufacture, to convey the phosphogypsum to the stack, to remove the heat generated during phosphoric acid manufacture, and to scrub all the exhaust gases within the chemical complex to prevent the discharge of undesirable gases to the atmosphere. In the course of serving all these functions, the process water becomes acidic and reaches an equilibrium concentration of all of the materials found in both the phosphate rock and the sulfuric acid. While the plants are designed to operate with a negative water balance, periods of excessive rainfall may make it necessary to treat and discharge surplus water. Treatment involves a two-stage neutralization with lime to remove fluoride and phosphate, followed by aeration to remove ammonia, then the addition of sulfuric acid to reduce the pH to 6-7. Even after treatment, the conductivity of the treated water is higher than allowed and fresh water must be added before it can be discharged to the surface waters of the state. Finding or developing a technology that would significantly remove any or all of the soluble salts, or raise the pH of the process water economically, would be desirable.

Approaches:

A. Develop effective economical treatment methods for process water.

B. Reduce the volume of process water.

C. Improve the quality of process water by reducing the concentration of various soluble salts such as fluoride and phosphate.

D. Utilize process water to generate soluble fluorite and phosphate products.

E. Develop technology to raise the pH of the process water to 2 or greater.

F. Develop acceptable uses for partially treated process water, e.g., irrigation, or reduce the TDS (Total Dissolved Solids).

G. Convert TDS to salable product.

Goal 2. Reduce the accumulation of phosphogypsum in the stacks.

Discussion: Phosphogypsum has the potential to become a major asset to the state of Florida. Phosphogypsum is a by-product of phosphoric acid manufacture. For every ton of phosphoric acid produced, approximately 5 tons of phosphogypsum are produced. Therefore, if acceptable uses can be found for phosphogypsum, it will have the benefit of

improving the environment, economy, and welfare of the citizens of the state. Research has demonstrated that using phosphogypsum in both road-building and agriculture offers substantial economic benefits without creating excessive risks. Other uses that are environmentally and/or economically desirable are also possible. The major effort in this area must be to obtain permission from the EPA and/or FDEP to use the phosphogypsum to obtain these potential benefits. Since it is highly unlikely that methods can be developed which would use all phosphogypsum production, it is desirable to find methods which will reduce its rate of production.

Approaches:

A. Develop and promote environmentally acceptable uses of phosphogypsum.

B. Develop factual information on actual risks and economic benefits of various uses of phosphogypsum.

C. Develop economically alternative phosphoric acid manufacturing technologies to reduce or eliminate phosphogypsum production.

D. Utilize phosphogypsum to fix/sequester-CO_2, thereby removing this greenhouse gas from the atmosphere.

Goal 3. Investigate methodology to provide maximum stability for phosphogypsum dams.

Discussion: Failure of the dams used to contain the process water utilized in the production of phosphoric acid would result in serious adverse environmental consequences. Technological developments that could provide improved dam stability will be investigated.

Goal 4. Generation of energy from sulfur combustion.

Discussion: Burning sulfur produces significant energy somewhat in excess of the amount presently recovered in the production of sulfuric acid. Recovering this energy offers obvious benefits in addition to providing energy without the generation of greenhouse gases.

Approaches:

A. Investigate the use of a combined-cycle energy generation system for sulfuric acid production.

B. Investigate sulfur combustion for standalone power generation.

Goal 5. Recovery of uranium during the processing of phosphate rock.

Discussion: Central Florida phosphate contains enough uranium to make its recovery possible during the production of phosphoric acid. Uranium recovery was practiced during the 1980s and 1990s until the price of uranium fell so low that it made recovery processing uneconomical. Due to concern about global warming, it has been predicted that with the expected increased power production from nuclear energy there will be a worldwide shortage of uranium fuel for these plants. Since Florida was the only place in the world where uranium recovery from phosphoric acid was widely practiced, there are a significant number of local people with firsthand knowledge of the details of uranium recovery plant design and operating practices.

Approaches:

A. Become a center of knowledge for uranium recovery technology.

B. Develop uranium recovery plant design capability.

C. Develop a training capability for uranium recovery technology plant operators.

D. Develop technologies for uranium extraction.

MINING AND ROCK PROCESSING

Goal 1. Develop methods for reducing water consumption.

Discussion: The Florida phosphate matrix (ore) is composed of roughly one-third each of phosphate, clay and sand. The clay must be removed before phosphate can be upgraded using flotation. Therefore, approximately one ton of clay waste (phosphatic clay) is generated for each ton of phosphate rock product. This translates to nearly 100,000 tons/day of waste clay in Florida. Under current practice, phosphate clay slurry with an average solids content of about 3% is pumped through pipelines to clay storage ponds where the clay slowly settles.

Although impounding is the most economical method of waste clay disposal, it has several major disadvantages. Clay settling ponds occupying up to 800 acres each cover about 40% of mined lands and generally have limited use after reclamation, causing adverse economic impacts. The waste clay not only ties up a large amount of water, but a significant amount is also lost through evaporation over the clay settling areas.

Other major operations that use large volumes of water include phosphate matrix transportation, the flotation process, and pumping of tailings.

Approaches:

A. Develop and test technologies for reducing or eliminating clay settling ponds.

B. Increase solids content in waste clay slurry pumped to settling area.

C. Develop and evaluate alternative mining and beneficiation methods that do not generate waste clay slurry.

D. Reduce the water mined with matrix.

E. Develop dry beneficiation methods and leaching techniques that require less water.

Goal 2. Find environmentally acceptable uses for clay settling ponds.

Discussion: Although many new disposal/reclamation approaches for phosphatic clays have been proposed and investigated, the conventional impounding method will be the primary method of disposal for the foreseeable future because many of the alternatives are significantly more expensive than current practice. The most practical approach is to continue the efforts of finding productive uses for the clay ponds while trying to reduce the total acreage of clay settling areas.

Approaches:

A. Develop methods for accelerating the dewatering of clay settling ponds.

B. Develop alternative uses for clay settling ponds, e.g., to produce water for domestic, commercial or industrial use.

C. Develop techniques to utilize the phosphate and clay mineral values in consolidated phosphatic clays.

D. Develop techniques to improve dam safety for clay settling areas.

Goal 3. Develop technologies for solving the problem of contaminants in phosphate rock.

Discussion: Among the deleterious materials (Fe_2O_3, Al_2O_3, CaO, MgO, F) in phosphate rock feed for phosphoric acid production, MgO is the most common and the one which causes the most problems. Generally, the phosphate rock acidulation process requires a feed of less than 1% MgO. Phosphate rock which does not meet the requirement consumes too much sulfuric acid per ton of P_2O_5 produced in the wet phosphoric acid process. In addition, MgO in the wet acid reduces the filtering capacity and ties up an equivalent amount of P_2O_5 when acidulated. MgO also causes problems in the production of diammonium phosphate fertilizer (DAP), which has a strict requirement for the minor element ratio (MER), of which it is a constituent.

With the depletion of the higher-grade, easy-to-process Bone Valley deposits, the Central Florida phosphate industry has moved into the lower-grade, more contaminated ore bodies in the Southern Extension. The phosphate deposits in the Southern Extension may be divided into two zones: an upper and a lower. Rock in the upper zone can be processed readily using the current technology; however, the lower zone is highly contaminated by dolomite. Geological and mineralogical statistics show that nearly 50% of the phosphate resource would be wasted if the high-dolomite deposits were bypassed in mining. FIPR recently developed a feasible technology, designated as the CLDRI fine flotation process, for high-dolomite pebbles. Pilot testing has demonstrated both the technical and economic feasibility of the CLDRI process. The CLDRI process may be commercialized in the near future; however, improvements in the CLDRI process and developments of other technically feasible and practical technologies are desirable.

Iron oxides and aluminum are also becoming serious problems. These contaminants reduce phosphate recovery in the flotation process and make it difficult to produce phosphate rock suitable for the manufacture of high-grade DAP.

Approaches:

A. Foster use and improvement of the FIPR fine flotation (CLDRI) process and other promising techniques.

B. Develop techniques to float relatively coarse dolomite.

C. Develop technologies to remove iron oxides and aluminum from phosphate rock.

D. Develop analytical tools for the instantaneous analysis of the mine face.

Goal 4. Improve mining and transportation efficiency.

Discussion: For over half a century, surface mining using draglines has been the predominant method for phosphate mining in Florida. The dragline scoops out the top 15 to 30 feet of overburden and places it in spoil piles to the side of the mine pit. The dragline then digs out the phosphate matrix (ore). The overburden averages 25 feet in thickness in the Bone Valley deposit and 30 feet in the Southern Extension, while the matrix thickness is about 17 feet in the Bone Valley and 39 feet in the Southern Extension.

The matrix is slurried using high-pressure water guns, and then pumped via pipeline to a processing plant, which can be up to 10 miles away. At the beneficiation plant, the first operation is separation of clay from the phosphate and sand. The waste clay, with an average solids content of about 3%, is pumped through pipelines to clay settling areas where the clay slowly settles.

This practice is energy-intensive for three major reasons. First, the thirty-foot overburden has to be dug out and later put back for reclamation. Pumping the matrix consumes a lot of energy because of the long-distance pumping at low solids concentrations (less than 40%). Finally, the clay fraction is pumped twice, first with the matrix and then as a dilute slurry.

Approaches:

A. Evaluate alternative mining methods.

B. Develop and test low-cost transportation methods for matrix and tailings.

C. Develop low-cost transportation techniques for phosphate rock.

Goal 5. Improve flotation efficiency.

Discussion: In the conventional flotation (the Crago "double float") process, about 30-40% by weight of the sands in the feed are floated twice, first by fatty acid, and then by amine. The Crago process is, therefore, inefficient in terms of collector utilization. Another major drawback of this process is the de-oiling step. De-oiling consumes a significant amount of sulfuric acid. Insufficient de-oiling often causes loss of phosphate and poor concentrate grade. Yet another problem with the Crago process occurs in the amine flotation step. Not only are amines more expensive than fatty acids, they are also very sensitive to water quality, particularly the clay content in water. Numerous

experiments have indicated that phosphate flotation could be improved to reduce chemicals use by up to 50% (10 million gallons/year) and increase P_2O_5 recovery by 5-10% (1.2 million tons/year).

Another possible approach to achieving a significant improvement is real-time control of each of the unit operations. Process control systems are routinely used in mineral processing. It is expected that control systems of the future will continue to develop towards user-friendly computer-based systems that use powerful software analysis and control techniques.

Approaches:

A. Develop alternatives to the Crago "double float" process and new flotation reagents.

B. Develop more efficient technologies for washing/cleaning flotation feed.

Goal 6. Develop mining and beneficiation technologies to reduce the carbon footprint.

Discussion: Although the phosphate industry co-generates electricity to provide electrical power for its fertilizer producing facilities, it still consumes a few billion kWh of electricity at its mines and beneficiation plants that comes from power plants burning either coal or natural gas. Some of the flotation reagents, primarily amines and fatty acids, used in the flotation process eventually decompose into carbon dioxide and water by biological degradation in the environment.

Reduction in the carbon footprint is closely related to sustainable development. The definition and interpretation of sustainable development may vary from region to region, background to background, industry to industry, but can be summarized in two words: minimizing and maximizing. The former involves minimizing movement of masses (earth, wastes, water, etc.), use of resources (primarily energy and water), and effluents (solids, liquids and gases). The latter is maximizing social satisfaction, which includes improvement of community life, creation of new jobs, and education of the general public. Sustainable development takes both stewardship and new technologies.

Approaches:

A. Find more energy-efficient transportation methods.

B. Reduce use of flotation reagents.

C. Investigate environmentally friendly energy sources.

D. Investigate bioprocessing of phosphate matrix, phosphate rock, and phosphatic clays.

Goal 7. Establish a vibrant mineral processing program.

Discussion: The Florida mining industry is not small by any measure. It includes over 200 mining operations, and ranks somewhere between fifth and seventh in total tonnage nationally; it ranked fourth in 2004 in total value of nonfuel mineral production. Principal minerals (in order of total value) mined in Florida include phosphate rock, stone (crushed), cement (Portland), sand and gravel, zirconium concentrates, and ilmenite and rutile. However, there has been no mining program of national recognition within the Florida University System since the Materials Engineering Department of the University of Florida switched its research focus from minerals processing to particle science and technology ten years ago. Since its inception, the beneficiation program of the Florida Institute of Phosphate Research has processed 182 proposals and funded more than 110 projects covering every aspect of mineral processing, including crushing, grinding, and sizing; flotation, gravity separation, and electrostatic separation; reagent testing of fatty acids, amines, and polymers; waste disposal and utilization; modeling and analysis; and process control. Throughout this time, the Institute's staff has kept abreast of the latest developments in mineral processing and has built a sound foundation for expanding the program.

Approaches:

A. Renovate and equip the FIPR Institute metallurgical laboratory for lab-scale testing of mineral processing unit operations.

B. Staff the metallurgical laboratory with three full-time research scientists, two of whom would specialize in physical separations and the third would have expertise in hydrometallurgy.

C. Establish and maintain a research team consisting of a half-dozen graduate students/visiting scholars, in addition to the full-time research staff.

D. Develop an internationally recognized research center for nutrient and industrial minerals mining and processing.

Goal 8. Develop economic waste tailings disposal techniques.

Discussion: The Florida Institute of Phosphate Research has funded many projects on rapid dewatering and disposal of phosphatic clays, and has accumulated substantial information on the treatment of fine tailings in general. This experience, along with the expertise that the new FIPR Institute can tap, would allow the Institute to expand its research in this field to include tailings from the oil sands, clay and metal industries. In the oil sands industry in Alberta, Canada, huge amounts of oil sands tailings are generated. These tailings contain water, fine sands, silt, clay, and residual bitumen, with very poor consolidation characteristics. Oil sands tailings are also disposed of in tailings ponds, which already cover more than 50 square miles of land in Alberta. Tailings ponds pose a significant challenge to oil sands mining operations, and the industry is under mounting

pressure to reduce the footprint of tailings ponds. On June 17, 2010, the Alberta government approved Suncor Energy's plan to spend more than $1 billion to cut the size of its existing tailings ponds by about 30%. In copper mining, large amounts of fine tailings are generated. These copper tailings are also difficult to dewater and are generally impounded as well. Copper tailings pose a potential environmental threat due to various heavy metal contaminants. The cost for building a tailings dam in the copper industry is very high, with one company in Chile (Antofagasta Minerals) having spent $600 million to do so at its Los Pelambres copper mine.

Approaches:

A. Develop fine tailings disposal/treatment systems based on deep cone thickening technology for the oil sands industry.

B. Develop fine tailings disposal/treatment systems based on deep cone thickening technology for the non-ferrous metal industry.

C. Develop fine tailings disposal/treatment systems based on deep cone thickening technology for red mud.

D. Develop a polymer mixture for treating oil sands tailings.

E. Develop a polymer mixture for treating red mud.

F. Develop a polymer mixture for treating non-ferrous metal tailings.

Goal 9. Recover rare earth elements from phosphates.

Discussion: Rare earth elements (REE) are a group of 17 elements, including those of the lanthanum series, as well as the non-lanthanides yttrium and scandium. These elements have very specific critical uses in a multitude of markets. REE are vital to national security because of their key roles in the defense industry for communication, satellite and laser equipment, and precision munitions. These elements are critical to clean energy and greenhouse-gas-reducing technologies. For example, as many as seven REE are used in batteries and motors for electric and hybrid cars; wind turbines require REE; and some REE are the most effective catalysts for biofuels production. They are critical in high-tech applications such as computers and network equipment, cell phones, fiber optics, and medical nanotechnology for cancer treatment. Many of these applications have no substitute materials. In the United States, REE deposits are scarce and of low grade. Currently, China supplies about 95% of the world's REE market, while the U.S. has zero production and is totally dependent upon China for REE. The recent international outcries about China limiting REE export have served to reinforce the need for the U.S. to develop a strategy for domestic production of REE. Published analyses, decades old, of trace elements in Florida phosphate rock have shown that many of these vital elements are present in the rock. Though only present in trace amounts, because of the tonnage of phosphate produced these elements are still significant in aggregate mass but have not been

recovered. Preliminary data showed approximately 40% of the REE ends up in the waste clay, 37.5% in phosphogypsum, 12.5% in fertilizer, and 10% in sand tailings after the rock is mined and processed.

Approaches:

A. Conduct detailed characterization of REE in different phosphate mining/processing streams.

B. Develop techniques for removing clay and sand from waste clays.

C. Find economic methods for separating undissolved phosphate from calcium sulfate in phosphogypsum to enable concentrating of REE in a small amount of material.

D. Develop technologies for extracting REE from low-grade materials.

ENVIRONMENT AND RECLAMATION

Goal 1. Evaluate the effects of mining, processing and reclamation on the environment and develop methods for minimizing and ameliorating impacts.

Discussion: In the legislation that created FIPR (the predecessor of the FIPR Institute), the Institute's mission included study of the environmental effects of phosphate mining and reclamation as well as the disposal and utilization of phosphatic clay, together with the related environmental and land use issues.

Historically, clay settling areas (CSAs) have occupied about 40% of the area disturbed by mining. Because the clay is much less permeable than the native sandy soils, there is concern about the impact these CSAs may have on surface and groundwater. There is also concern that CSAs may have less ecological or economic value or usefulness than unmined lands or other types of reclaimed land.

Phosphogypsum may be used in a variety of beneficial ways. Chemical plant process water, following treatment to various degrees, can be recycled for industrial uses or used in other ways that have positive or neutral environmental impacts.

The public has expressed concerns about the impacts of mining on wildlife and their habitats. More recently, the possible ecological, hydrologic and economic impacts of lakes and reservoirs on reclaimed lands have come under increased scrutiny.

Approaches:

A. Evaluate the impacts of settling areas and other mining landforms on surface and groundwater hydrology.

B. Develop ways to maintain off-site water levels and wetland health during periods of active site dewatering and mining.

C. Evaluate the impacts of reclaimed lakes and reservoirs on the hydrology of surface and groundwater systems.

D. Find environmentally acceptable uses of chemical plant process water and phosphogypsum stack pond water treated to various degrees, along with disposal or use of water treatment sludge.

E. Evaluate methods to achieve a broad spectrum of wildlife utilization of habitats on reclaimed lands.

Goal 2. Develop mined land reclamation and management technology.

Discussion: In the legislation that created FIPR (the predecessor of the FIPR Institute), the Institute's mission included the study of reclamation alternatives and

technologies, including wetlands reclamation. Reclamation may be defined as the process of returning mined land to a useful condition. The process includes reshaping the land and establishing vegetation. For natural systems, native plants must be established and exotic plants or weeds must be controlled. Cogongrass, considered one of the world's worst invasive weeds, has infested thousands of acres of mined lands and other disturbed lands in Florida and needs particular attention.

Since 1975, reclamation has been required by Florida state law, and several of the counties also have mining and reclamation ordinances.

The public has expressed concerns about the value and potential/possible uses (both economic and ecological) of mined lands, the quantity and quality of surface and groundwaters, and the restoration of natural ecological and hydrologic systems. The mining industry is concerned about obtaining mining permits (which require a reclamation plan) and achieving the reclamation and environmental requirements in a cost-effective manner.

Approaches:

A. Develop methods to enhance the functioning of ecological systems and reduce the time between construction and compliance with regulatory success ("release") criteria.

B. Develop more cost-effective and environmentally sound methods to reclaim areas disturbed by mining.

C. Develop methods to minimize impacts of phosphogypsum stacks and develop cost-effective, environmentally sound methods for their closure.

D. Develop ecological, hydrologic, and economic uses for clay settling areas, including wetlands, forests, wildlife habitat, water treatment, carbon sequestration, biofuels and agriculture.

E. Develop improved, more cost-effective methods to control exotic plants and weeds.

F. Develop improved, more cost-effective methods to establish native plant communities in reclaimed wetlands and uplands.

G. Improve understanding of ecosystem functioning on disturbed and reclaimed lands.

H. Develop methods to improve and accelerate the establishment of wildlife habitat on reclaimed mined lands and facilitate wildlife recolonization.

Goal 3. Increase knowledge of the functioning of hydrologic systems in mining areas and develop methods for enhancing them.

Discussion: With increasing population pressure, Florida's water supply (both in terms of quantity and quality) is of utmost importance. Proper water flow is necessary both to supply human needs and to maintain the ecological health of the Peace River, its tributaries, and the Charlotte Harbor estuary. Research on ways to improve water supply, stream flow, aquifer recharge, and water treatment is important. Mined lands present opportunities for water treatment and storage, and this potential should be investigated further.

Approaches:

A. Evaluate and improve the hydrologic functioning of clay settling areas.

B. Evaluate the impact of phosphate mining and reclamation on the hydrology of streams, rivers and other surface and groundwater systems.

C. Evaluate use of mined lands for water harvesting, treatment and storage.

D. Evaluate the contribution and relative importance of first- and second-order (headwater) streams to hydrologic and ecologic functioning within the landscape.

E. Develop methods for enhancing the functioning of streams (and their associated riparian wetlands) and other hydrologic systems in mined and reclaimed areas.

F. Evaluate the hydrologic and ecologic functioning of reclaimed lakes and reservoirs.

Goal 4. Develop reclamation and management technology to cost-effectively ameliorate the environmental impacts of various industries and other human activities.

Discussion: In addition to the Institute's historic emphasis on Florida phosphate, funded by the severance tax on phosphate, our mission has now been broadened to include work on environmental issues and problems related to other industries and other human activities in Florida, the nation, and the world.

Many of the types of environmental issues and challenges faced by the phosphate industry are also faced by other industries. Institute staff and cooperators have prior experience with environmental issues and reclamation of disturbances from mining and processing of oil shale, coal, uranium, sand and gravel. In addition, their phosphate experience is likely applicable, in many cases, to other mining or industrial disturbances. This expertise will be applied through consulting, training and research activities. Staff will also increase involvement in national and international professional organizations.

Approaches:

A. Apply the lessons of phosphate mine reclamation to other environmental disturbances through consulting, training and research.

B. Develop more cost-effective and environmentally sound methods to reclaim areas disturbed by mining, other industries, or even natural disasters.

C. Develop methods to minimize impacts of waste piles, settling ponds, etc., and develop cost-effective, environmentally sound methods for their closure.

D. Develop ecological, hydrologic, and economic uses for waste piles, settling ponds, etc., including wetlands, forests, wildlife habitat, water treatment, carbon sequestration, biofuels and agriculture.

E. Develop improved, more cost-effective methods to control exotic plants and weeds.

F. Develop improved, more cost-effective methods to establish native plant communities for reclamation and restoration of disturbed lands.

G. Improve understanding of ecosystem functioning on disturbed and reclaimed lands.

H. Develop methods to improve and accelerate the establishment of wildlife habitat on disturbed lands and facilitate wildlife recolonization.

I. Evaluate use of mined lands and other disturbed lands for water harvesting, treatment and storage.

J. Develop methods for enhancing the functioning of streams (and their associated riparian wetlands) and other hydrologic systems in disturbed areas.

Goal 5. Develop and evaluate cost-effective methods and systems for energy crop production; carbon dioxide sequestration or recycling; and conversion of energy crops to usable biofuels or other chemicals.

Discussion: Production of energy through renewable resources, that is, biofuels, plus the accompanying sequestration and/or recycling of carbon dioxide, is of national and international interest. With its long growing season, Florida is an ideal place for energy crop production. In addition, the phosphate industry has produced thousands of acres of clay settling areas that contain highly fertile soils with high water-holding capacities. Earlier studies have indicated a potential for high productivity of various energy crops and for carbon sequestration. The need now is for demonstration of the economic as well as technical feasibility of energy crop production in conjunction with processing and transportation. There are other lands throughout the state and nation, such as roadsides and

medians, or industrially disturbed lands, which possibly could be used for biofuels production. In addition to suitable conditions for energy crop production, efficient means for converting the energy crops to biofuels are needed. Short-term sources of bioenergy feedstocks could even include exotic plants (e.g. cogongrass and Brazilian pepper) as part of eradication programs. Additional CO_2 could be supplied to algal ponds by power plants or other industrial sources.

Approaches:

A. Develop and evaluate terrestrial and aquatic energy crop production demonstration and research projects.

B. Develop and evaluate techniques and systems for converting energy crops to biofuels or higher-value chemicals and other products.

PUBLIC AND ENVIRONMENTAL HEALTH

Goal 1. Evaluate the occupational, public, and environmental health aspects of phosphate industry emissions and by-products.

Discussion: There are chemical hazards associated with the phosphate industry. The emissions include sulfur dioxide, ammonia, sulfuric acid, and silicon tetrafluoride. Other potential emissions are radon gas; fugitive dusts from product storage and phosphogypsum stacks; and leachate from phosphogypsum stacks.

A major concern is the accidental release of acidic pond water from phosphogypsum stacks, or wash water from clay settling areas. Among other problems, a release can cause acute changes in pH and dissolved oxygen to which aquatic and marine organisms and ecosystems are generally sensitive. Over time, accumulation of nitrates and phosphates can also pollute water bodies.

Approaches:

A. Conduct and sponsor studies of the chemical composition of emissions from processing plants to determine the mechanisms and plant conditions that cause the emissions and further evaluate their health impacts on the phosphate regions.

B. Monitor Florida health statistics, such as adjusted incidence and mortality rates for cancers, and conduct or sponsor a regional epidemiology study for residential health impacts if indicated.

C. Continue studies to evaluate occupational-related risks to the health and safety of persons employed within the phosphate industry due to exposure to inhaled or absorbed chemicals.

D. In collaboration with the Institute's Information and Education Programs, conduct educational programs to inform the public about environmental issues related to health concerns, with emphasis on relative risks.

E. Conduct studies to evaluate the impacts on groundwater from the collapse of phosphogypsum stacks and the normal migration of leachate materials from phosphogypsum stacks into the groundwater.

Goal 2. Evaluate the occupational, public, and environmental health aspects of exposure to technologically enhanced naturally occurring radioactive materials (TENORM).

Discussion: The magnitude and consequences of radioactivity and radiation in the phosphate industry have been studied since the Institute's inception. There will always be new technologies and unforeseen situations that alter the accumulation, concentration and exposure to radioactive materials. The science of radiation protection also grows and

adapts as empirical data are obtained. The various scientific bodies mold the science into recommendations that are adopted in whole or in part by governing bodies that set regulatory limits. As the situations, recommendations and limits change, studies must be conducted to address them.

The uranium content of phosphate rock is becoming more valuable as nuclear energy demand increases and the uranium supply is not expected to meet that demand. In order to help alleviate this problem, uranium can be extracted from phosphoric acid. Recent advances in solvent extraction technologies and membrane extraction techniques may lead to new safety and health challenges for the industry.

Approaches:

A. Conduct and sponsor studies of radiological contaminants in air, water, and soil in the phosphate regions to further evaluate their impacts on public and environmental health.

B. Evaluate occupational-related radiation risks to the health and/or safety of persons employed within the phosphate industry.

C. Conduct educational programs to inform the public about natural radioactivity and radiation in the phosphate industry and environment, with emphasis on relative risks.

D. Collaborate with international organizations, such as the International Atomic Energy Agency (IAEA) and the International Commission on Radiological Protection (ICRP) to determine appropriate uses for phosphogypsum and guidelines for safe use.

E. Conduct demonstration projects both nationally and internationally to develop the evidence base for safe, beneficial uses of phosphogypsum.

Goal 3. Evaluate the occupational, public, and environmental health aspects of technologies, procedures, and practices developed by the FIPR Institute through the Mining and Beneficiation, Chemical Processing, Reclamation, and Public and Environmental Health research programs.

Discussion: The Institute's research projects are evaluated in terms of improvements in cost, phosphate recovery, water use, waste reduction, habitat restoration, etc., and must be at least environmentally neutral and preferably beneficial. Some projects or Technical Advisory Committee recommendations may have environmental or public health impacts that are largely unknown.

Approaches:

A. Evaluate environmental and public health consequences of treatment processes developed for process water.

B. Evaluate exposure pathways from removal to ultimate disposal for technologies that reduce the concentrations of potentially hazardous constituents in process water.

C. Evaluate environmental and public health consequences of proposed uses of phosphogypsum.

D. Evaluate environmental and public health consequences of proposed uses of clay settling ponds.

E. Evaluate environmental and public health consequences of commercial uses for phosphatic clays.

F. Evaluate existing data or gather new data for radionuclide, metal, and metalloid (e.g., arsenic) concentrations in soil, water, flora and fauna for pre- and post-mining comparisons.

G. Statistically evaluate and interpret the existing DOH pre- and post-mining radiological data.

Goal 4. Respond to new environmental health concerns raised by the public, the phosphate industry, and governmental agencies.

Discussion: There is always the potential for unforeseen hazards, and reassessment of known hazards. Regulatory standards can change such that administrative and mechanical controls are no longer adequate, and the industry requires new practical solutions to reduce worker exposures to potentially harmful substances. Education of the public in these matters is an ongoing process. Educational materials must be continually updated for content, such as new limits or risk estimates, and new media avenues, such as Web-based training, should be explored.

Approaches:

A. In conjunction with the Institute's Library and Information Services staff, establish collections of information related to common queries from the public on potential contaminants of concern.

B. Conduct evaluations and studies to define the current state of knowledge, gather industry-specific data, and determine the degree of hazard of each item of concern.

C. Continue to develop multimedia products, such as computer programs, to educate the press, government, and members of the public, and for use by teachers.

D. Raise the level of public awareness of health issues through the Technology Transfer Program, the Teacher Education Program, Information Services, workshops, and lectures.

Goal 5. Evaluate the occupational, public, and environmental health aspects of industrial emissions and by-products.

Discussion: The environmental and public health impacts of the phosphate industry have been investigated in depth over many years. In contrast, other industries in Florida have not been scrutinized in such detail. In some cases, simple scoping evaluations may indicate insufficient hazards to warrant the effort and expense of further evaluation. However, some of these industries mine and relocate deep deposits to the surface in proximity to humans, alter hydrological conditions, and otherwise disturb the natural condition and potential for human exposure to metals and radionuclides. In addition, there are chemical hazards associated with mining, processing, energy, and other industries. These emissions are monitored by the companies as well as the Florida DEP and the USEPA, and data are readily available. Industries that are still in production can be evaluated in this way, but others such as mineral sands operations (titanium dioxide production) have ceased and closed their facilities, leaving mine tailings and other legacy issues.

Industrial hygiene concerns fall under the following categories:

- Common throughout all industries (such as fall protection, fire/explosion hazards, respiratory protection and electrical hazards)
- Industry-specific (such as uranium recovery from phosphoric acid)
- Site-specific (such as a chemical produced or used at only one site)

Approaches:

A. Identify industries of potential concern, such as aggregates or oil and gas, and evaluate the need for public and environmental health studies.

B. Conduct and sponsor studies of the emissions from industrial operations.

C. Conduct studies to evaluate the impacts on groundwater from industrial sites.

D. Monitor Florida health statistics, such as adjusted incidence and mortality rates for cancers, and conduct or sponsor a regional epidemiology study for residential health impacts if indicated.

E. Evaluate occupational-related risks to the health and safety of persons employed within each industry due to exposure to inhaled or absorbed chemicals.

F. Seek grants and other funds to facilitate research.

G. In collaboration with the Institute's Information and Education Programs, conduct educational programs to inform the public about environmental issues related to health concerns, with emphasis on relative risks.

Goal 6. Evaluate the occupational, public, and environmental health aspects of exposure to technologically enhanced naturally occurring radioactive materials (TENORM) in non-phosphate industrial operations.

Discussion: The magnitude and consequences of radioactivity and radiation in the phosphate industry have been studied since FIPR's inception, but other industrial operations are also NORM-impacted. Uranium is strongly correlated with phosphate, but other industries and locations in Florida are associated to a greater extent with thorium. Furthermore, there will always be new technologies and unforeseen situations that alter the accumulation, concentration and exposure to radioactive materials. Such was the case with the mineral sands industry, in which thorium temporarily reached "source" concentrations during processing, which greatly increased the level of regulatory control and economic requirements. As the situations, recommendations and limits change, studies must be conducted to address them.

Approaches:

A. Conduct and sponsor studies of radiological contaminants in air, water, and soil in the industrial regions where NORM impacts are identified to further evaluate their impacts on public and environmental health.

B. Conduct and sponsor studies of radiological contaminants in air, water, and soil in the industrial regions where radionuclides are possessed and used under state or federal licenses to further evaluate their impacts on public and environmental health.

C. Evaluate occupational-related radiation risks to the health and/or safety of persons employed within the impacted industry.

D. Conduct educational programs to inform the public about radioactivity and radiation, with emphasis on relative risks.

E. Foster and form international relationships for the exchange of information, development of joint research projects, and formulation of solutions to global industrial problems.

Goal 7. Evaluate the occupational, public, and environmental health aspects of technologies, procedures, and practices developed by the FIPR Institute for non-phosphate industrial operations through its research programs.

Discussion: The Institute's research projects are evaluated in terms of improvements in cost, product recovery, water use, waste reduction, habitat restoration, etc., and must be at least environmentally neutral and preferably beneficial. Some projects or Technical Advisory Committee recommendations may have environmental or public health impacts that are largely unknown.

Approaches:

A. Evaluate environmental and public health consequences of processes developed for industrial use.

B. Evaluate exposure pathways from generation to ultimate disposal for technologies that produce residuals containing potentially hazardous constituents.

C. Evaluate environmental and public health consequences of commercial uses of residuals.

D. Evaluate existing data or gather new data for radionuclide, metal, and metalloid (e.g., arsenic) concentrations in soil, water, flora and fauna for pre- and post-industrial activity comparisons.

Goal 8. Respond to new occupational, public, and environmental health concerns raised by the public, industry, and governmental agencies in non-phosphate industrial operations.

Discussion: There is always the potential for unforeseen hazards, and reassessment of known hazards. Regulatory standards can change such that administrative and mechanical controls are no longer adequate, and the industry requires new, practical solutions to reduce worker exposures to potentially harmful substances. Education of the public in these matters is an ongoing process. Educational materials must be continually updated for content, such as new limits or risk estimates, and new media avenues, such as Web-based training, should be explored.

Approaches:

A. In conjunction with the Institute's Library and Information Services staff, establish collections of information related to common queries from the public on potential contaminants of concern.

B. Conduct evaluations and studies to define the current state of knowledge, gather industry-specific data, and determine the degree of hazard of each item of concern.

C. Raise the level of public awareness of health issues through the Technology Transfer Program, the Teacher Education Program, Information Services, workshops, and lectures.

Goal 9. Develop and commercialize technologies, devices or educational materials related to the Public and Environmental Health research mission.

Discussion: Collaborative, applied research is the cornerstone of the polytechnic approach and leads to development of practical technologies, devices and/or teaching materials that may be commercialized to establish new funding sources for the Institute. The mechanism of such funding could take the form of royalties, equity stakes, and the like.

Approaches:

A. Identify knowledge and technology gaps as candidates for applied research.

B. Develop practical solutions through Institute research, public-private partnerships, and/or industry cooperation.

C. Commercialize technologies, devices, and/or educational materials.

D. Continue to develop multimedia products to educate the press, government, and members of the public.

E. Continue to develop MiLoRad and its derivative products to address competency-based training requirements for industries such as oil and gas, medicine, nuclear power, metal recycling, and food irradiation.

F. Develop specific educational materials in coordination with Florida Polytechnic University.

G. Develop professional education and certification courses in coordination with Florida Polytechnic University.

PROGRAMMATIC WORK AREAS

TECHNOLOGY TRANSFER

Goal 1. Further develop and enhance technology transfer to ensure that interested parties are aware of the Institute's latest research and have ready access to the results of this research in a form that facilitates its use.

Discussion: The Technology Transfer Program at the FIPR Institute has two principal components: the gathering of resources and information generated and housed within the Institute, and the development of a program to disseminate this information to interested parties. The information-gathering effort is well established through the Institute's Research and Information Programs. Electronic copies of the Institute's publications are made available to the public through a website designed and maintained by the Institute's staff. While this makes research results readily available to all, they may not be seen by professionals in a position to implement new technologies, and may not be understood by a wider audience. Professionals who would be interested in a given topic need to be identified and notified of new publications. Members of the public who are interested in the Institute's research, but may not be technically oriented, need results presented in a manner that can be understood by the layperson.

Approaches:

A. Provide, through the use of internet technology, FIPR Institute and industry-related information for release, access and future decision-making.

B. Provide information on FIPR Institute research through the Library, Information Services and Education Programs.

C. Develop procedures to deliver targeted information and research results to appropriate professionals.

D. Conduct demonstrations to show the feasibility and practicality of FIPR Institute research.

E. Provide technical support, through FIPR Institute Staff and the Institute's contractors, to users of its research and technologies.

F. Conduct and sponsor workshops and conferences.

Goal 2. Promote the commercial use of technology developed through the Institute's research programs.

Discussion: Potentially viable commercial technologies are developed through FIPR Institute research, particularly in the Mining and Beneficiation, and Chemical

Processing areas. Some of these technologies are placed into service while others are not, for a variety of reasons including economics and lack of awareness. The Institute strives to assure that the economics of these technologies are well known. In some cases, new technology may not be practical for Florida operations, but could be ideal for a new facility elsewhere in the world. The Institute must raise awareness of its research. As a funding source, the Institute has patent rights and is encouraged to seek a return on its investment when appropriate. Effective relationships between the Institute, phosphate companies, the regulatory agencies, and the industrial and commercial business sector must be fostered to develop and commercialize technologies that can and will be used.

Approaches:

A. Pursue patents or other intellectual property protection agreements for innovative technologies.

B. Identify and establish a dialogue with senior corporate officers, senior level regulatory officials, legislators and others who have the ability to implement and foster new technologies.

C. Conduct seminars and field demonstrations on a periodic basis, according to the accumulation rate of new technologies, for the individuals identified in Approach B.

INFORMATION SERVICES AND LIBRARY

Public Information

The FIPR Institute, as a whole, produces a large volume of technical information resulting from its dedicated research programs. It is the mission of the Information Program to distribute this information in an efficient and clear manner, across a wide spectrum of levels. The Institute conducts seminars, conferences, and workshops on subjects pertaining to its research program. Research projects result in peer-reviewed documents that are available in hard copy and in electronic format. Scientists and engineers working for the FIPR Institute are encouraged to present their findings in peer-reviewed journals and at scientific conferences.

The FIPR Institute works with the media to ensure the accuracy of stories about the phosphate industry and its impacts. The Institute's Library holds what is considered to be the world's finest collection of information about the phosphate industry. The Library is open to the public and has the ability to access technical references through extensive online resources and through interlibrary loan.

Goal 1. Integrate the Information Program work areas with Florida Polytechnic University.

All Information and Communication work areas support the same mission at the FIPR Institute: to circulate and explain the information the Institute generates and collects to its broad variety of constituents. To do this well, the information should be developed and distributed in a consistent manner, clearly identifying the information as coming from the Institute. This material must also be consistent with the guidelines for materials produced and distributed by Florida Polytechnic University.

Approaches:

A. With Florida Polytechnic University's guidance, develop and implement a consistent look and feel to information and communication materials produced by and/or for the FIPR Institute Library, website, Education Program, research areas and public information.

B. Continue to facilitate communication between the FIPR Institute's information generating departments—Public Information, Library, Education, and Technology Transfer—to ensure that information is accurate, current, and is distributed appropriately.

C. Utilize Florida Polytechnic University's facilities and resources wherever appropriate to expand the reach of the Institute's Information Programs.

Goal 2. Support the interdisciplinary core values of Florida Polytechnic University by continuing to facilitate the exchange of information and ideas between research and information areas with the Institute and throughout Florida Polytechnic University.

Improving the process used to keep the technical community and the public aware of FIPR Institute research findings, both past and present, is necessary to make the scope, depth and usefulness of the Institute's research and knowledge more evident and to define who needs more information about the research.

Approaches:

A. Develop and implement a process for FIPR Institute research directors to share significant progress on ongoing projects, and to update research and information staff members on the outcomes of completed projects and how this information may be used.

B. Publish regular features on FIPR research on the Institute's website.

C. Update newly approved, continuing and completed research on the Institute's website and in printed materials as needed.

Goal 3. Develop an integrated information resource system to include the Library and Public Information and integrate with resources of Florida Polytechnic University.

Continued development of information resources is critical to the FIPR Institute's ability to inform its constituents about its mission and accomplishments. In order to do this effectively, the various research and programmatic areas must be part of an overall integrated information system that includes the FIPR Institute Library, Technology Transfer, and K-12 Education Program. The Institute has entered into a Memorandum of Understanding with Aleff Group to develop and market information resources using the MiLo product platform, which will assemble topic-specific information for various target audiences.

Approaches:

A. Continue development and maintenance of MiLo, including:

- Refining the process for reviewing and adding lesson plans and units to MiLoEdu.
- Supporting the development, publicity and use of MiLo*rad*.
- Support Aleff Group efforts to maintain and market MiLo products.

B. Update the FIPR Institute website to reflect the Institute's expanded mission and relationship with Florida Polytechnic University by:

- Posting the Institute's latest research highlights and news.
- Incorporating new research areas as they are added.
- Posting grants awarded.
- Compiling and presenting pertinent Florida phosphate data, statistics and information.
- Including video with streaming capabilities.
- Expanding the K-12 Education section of the FIPR Institute website.
- Updating news and features at least quarterly.
- Developing online learning delivery capabilities.

C. Provide strategic leadership in the continued development of the information component of the FIPR Institute's K-12 Education Program by:

- Creating and expanding tools that use FIPR Institute information and educational resources to teach teachers about phosphate and ways in which the topic can be used to meet the Florida Next-Generation Sunshine State and Common Core Standards in science, social studies, language arts and math, and that assist the public's understanding of the Institute's education efforts. Such an effort includes, but is not limited to:
  - Continuing to develop content for MiLoEdu.
  - Expanding the Education Program section of the FIPR Institute website.
  - Developing teaching units, activities and publications.
  - Generating publicity materials for the Education Program.

D. Continue to assist the Education Program in building, organizing and implementing procedures for a Media Center collection that will include materials related to education and the Education Program in a variety of formats.

E. Add to existing internal Library databases and bibliographies and create others as needed to allow easy access to Library information and provide improved searchability for Staff.

F. Identify publicly available electronic phosphate-related resources including, but not limited to, the Web.

G. Continue to improve Library resources by weeding the collection, identifying and addressing informational gaps, and organizing the map collection to make it more useful.

H. Add resources for new research areas to reflect the Institute's expanded mission.

I. Improve communications with Florida Polytechnic University's Library, especially on matters of staff training.

J. Continue to develop a graphics library to catalog pictures, slides, maps, videos and other graphic materials in support of FIPR Institute presentations and publications.

K. Address space and storage issues for the Library.

L. Create a more user-friendly environment in the Library.

M. Aim to reduce paper and perform more tasks electronically.

N. Offer staff training on Web and database searching.

O. Broaden the collection to include expanded subject areas.

P. Promote library services to all potential users.

Q. Separate out special collections.

Goal 4. Publicize the FIPR Institute's role as a key component of economic development in Florida and its relationship with Florida Polytechnic University and expanded mission.

Discussion: The research programs of the Institute have had a significant economic impact. Several of its projects have had impacts ranging from tens of millions to hundreds of millions of dollars.

Approaches:

A. Define the information for stakeholder needs to better understand phosphate and related issues and the mission of the FIPR Institute, and implement methods for providing this information.

B. Develop ways to increase exposure to, and understanding of, the Institute's Education Program as a way to improve science and math teaching in schools.

C. Create brochures, annual reports, newsletters, one-page issue briefings, research updates and other public information resources by first putting the information

on the Institute's website and then using that information as a basis for developing other publications.

D. Revamp the overall look of the website and improve its functionality; integrate it with Florida Polytechnic University and include information about the Institute's expanded mission.

E. Continue to provide public access in the FIPR Institute Library to Florida Polytechnic University virtual library databases.

F. Support distribution of FIPR Institute information at workshops, conferences and training sessions, and at other events.

G. Post annual reports and FIPR Institute publications on the Web and make them available on electronic media in order to minimize printing costs and release them more rapidly.

H. Support Technology Transfer efforts at the FIPR Institute by:

- Assisting in efforts to release MiLo products.
- Supporting the Institute's involvement in technical conferences.
- Supporting the planning and execution of the Annual Regional Phosphate Conference.

I. Make targeted FIPR Institute presentations to appropriate persons at institutions of higher learning and consulting firms in order to broaden the base of future research proposals.

J. Continue developing relationships and meeting with key interested parties, such as legislators; phosphate county school district members; educational and environmental groups; and the media, to keep current with them and to provide background, perspective and technical information on FIPR Institute research and programs.

K. Increase the Institute's visibility in local communities.

L. Liaison with Florida Polytechnic University personnel involved in community affairs.

M. Partner with related organizations.

N. Update all display and presentation materials.

O. Become an integrated component of the Florida Polytechnic University system.

K-12 EDUCATION PROGRAM

Education

The Institute has an education program to assist teachers in achieving the Florida Next-Generation Sunshine State and Common Core Standards using information concerning phosphate industry operations and issues. To achieve this objective, the FIPR Institute uses its scientific, environmental, and technical expertise in teacher training workshops and in the development of lesson plans, curricula, and material for use by teachers and their students. During the past two years, the Education Program has made a concerted effort to bring phosphate-based activities into the schools directly, by presenting to students in the classroom. This has proved to be a successful and popular venture, and it is expected to expand.

Goal 1. Provide resources of the Education Program to a broad audience.

Training formats, lesson plans, and materials have been developed. The goal is to continue to develop resources and deliver or make them available to a wider audience.

Approaches:

A. Develop working relationships with subject coordinators in Florida counties and with Department of Education personnel.

B. Contract with experienced curriculum developers to further develop curricula.

C. Solicit grants for curriculum development and delivery.

D. Train facilitators to deliver curricula to both teachers and students.

Goal 2. Develop additional training workshops with specific content instruction to meet the needs of teachers.

There is a shortage of qualified science and math teachers all over the state. The shortage has caused universities to reduce the course load to graduate students, but this only increases the problem by producing teachers with limited content knowledge. In addition, many teachers are forced to teach courses out of their field. Veteran teachers who have attended the Institute's workshops and who understand how to teach this content as it relates to local issues are reaching retirement age and the educational community is now in danger of losing their expertise. Many teachers do not have the depth of knowledge needed to engage students in scientific inquiry and critical thinking about issues.

Approaches:

A. Build relationships with other education and science-related organizations.

B. Create separate one-week sessions that are grade-level-specific and content-oriented to teach local science content as it relates to the Florida Next-Generation Sunshine State and Common Core Standards, with help from local scientists and with former workshop participants serving as the trainers for the teachers.

C. Conduct in-service workshops concerning basic content for curriculum units at various grade levels.

D. Work with research directors to develop projects for high school students.

E. Conduct seminars providing more detail on specific topics that need clarification for former participants and the general public.

F. Partner with Florida Polytechnic University to provide college-credit courses to validate the content and experience offered to teachers by the summer session.

G. Integrate the K-12 Education Program with Florida Polytechnic University K-12 Education initiatives.

Goal 3. Define content basics and best practices for integrating phosphate material with standards.

Approaches:

A. Develop a curriculum framework for what should be taught and in what order.

B. Align topics of the curriculum framework to Florida educational standards.

C. Determine what information is appropriate for each grade level.

D. Determine the training needs of each county's school system.

E. Identify best practices for teaching phosphate information.

F. Publish the curriculum framework and make it electronically accessible.

G. Coordinate with other K-12 education programs with similar goals.

Goal 4. Expand existing resources and develop new resources that support the curriculum.

Currently, there are five key concepts of phosphate-related information for which materials have been created. However, the information is not available for every grade level. The materials need to be modified or created, where appropriate, to meet the Sunshine State Standards at each grade level so each level has information that builds upon

what was taught the previous year. Whatever the FIPR Institute develops must originate with teachers so that they have ownership of the curriculum and materials that will be used.

Approaches:

A. Publish thematic units for each grade-level group and solicit similar units at other grade levels.

B. Develop additional traveling libraries for each grade level that correlate to the key content ideas.

C. Continue to populate the database of lesson plans created at the workshops to be housed in MiLoEdu.

D. Develop content-specific units to be delivered in the classroom.

E. Create self-directed, interactive learning modules that can be centered around topics of special interest as needed.

F. Foster relationships between the FIPR Institute's Education Program and college education programs to improve teacher training for math and science.

G. Provide opportunities for project-based instruction at secondary school levels.

H. Create a virtual workshop in an online environment.

Goal 5. Distribute materials to interested teachers and programs.

All of the educational resources and materials that the FIPR Institute creates are correlated to the Florida Next-Generation Sunshine State and Common Core Standards, which are a reflection of national education standards. These standards drive the curriculum choices that are made by every school board across the nation. Therefore, FIPR Institute resources will be useful to teachers in every state and will serve to unify some of the curricula that are taught throughout the country. They will also offer models that can be applied to other subjects of local interest to help teachers meet educational standards and close the achievement gap among communities.

Approaches:

A. Work with Aleff Group to provide access to the lesson plan database through MiLoEdu.

B. Provide training sessions on MiLoEdu to teachers.

C. Present the Institute's program and its curricula at state and national education conferences.

Goal 6. Develop a formal program to have research directors and other experts review and clarify content and materials created for the Education Program.

It is critical that whatever information the FIPR Institute gives to the public and teachers through the Education Program be scientifically and factually accurate. Materials and content developed by the Education Program should undergo a review process similar to that used in the Institute's research programs. This will assure that materials maintain a high level of quality and are used consistently across all FIPR Institute programs.

Approaches:

A. Revise and develop new activities that illustrate difficult scientific concepts that are applied in various processes of the phosphate story.

B. Expand to other science areas.

Goal 7. Develop a sufficient number of well-trained staff capable of conducting the expanded Education Program.

With the new Education Media Center and the Program's expansion into other counties, the staff of the K-12 Education Program will need some restructuring, and additional staff will be needed. There will be much more collaboration with the research directors and new materials will be developed that will require expertise the staff does not currently possess.

Approaches:

A. Define staffing needs according to program priorities and goals.

B. Evaluate the skills and abilities of existing staff to meet goals, and identify areas that need to be addressed.

C. Train existing staff in new skills and hire additional staff when necessary.

D. Where appropriate, hire teachers who have participated in the FIPR Education Program as independent contractors to work as curriculum consultants.

Goal 8: Develop the Education Building into a valuable resource center for the FIPR Institute and the public.

The Education Building was designed with some unique features to facilitate training seminars, meetings and professional discussions. In addition, all FIPR Institute staff members will use the rooms and materials in the building as needed. Many Institute events and functions that are currently held elsewhere could be accommodated in the Education Building. For example, the County School Board's curriculum coordinators and

teachers need resources that explain how phosphate, as an important subject of local interest, can be used to meet educational standards. In addition, other state and local agencies could also request use of the facilities for their needs. The public is also welcome to use the Media Center as a place to study and learn about phosphate as it affects their daily lives.

Approaches:

A. Build, organize and implement procedures for a Media Center collection that is consistent with, and fully integrated into, the main FIPR Institute Library collection.

B. Develop a plan to determine the best use of the facility, including classroom use by Florida Polytechnic University faculty.

LEGISLATION ESTABLISHING THE FLORIDA INDUSTRIAL AND PHOSPHATE RESEARCH INSTITUTE

Title XLVIII
K-20 EDUCATION CODE Chapter 1004
PUBLIC POSTSECONDARY EDUCATION

1004.346 Florida Industrial and Phosphate Research Institute.—

(1) INSTITUTE CREATION.—The Florida Industrial and Phosphate Research Institute is established within the University of South Florida Polytechnic.

(2) PHOSPHATE RESEARCH AND ACTIVITIES BOARD.—The Phosphate Research and Activities Board is created to monitor the expenditure of funds appropriated to the university from the phosphate Research Trust Fund.

(a) The board shall approve an annual report, prepared by the institute executive director, which outlines the expenditure of the funds appropriated to the university from the phosphate Research Trust Fund and describes the various phosphate-related projects and institute operations funded by those moneys.

(b) The board shall consist of five members. The Governor shall appoint two persons representing the phosphate mining or processing industry and one member representing a major environmental conservation group in the state. The Secretary of Environmental Protection or his or her designee and the Campus Executive Officer of the University of South Florida Polytechnic shall also serve as board members.

(c) Members of the board appointed by the Governor shall be appointed to 3-year terms. A board member may continue to serve until a successor is appointed, but not more than 180 days after the expiration of his or her term. A board member is eligible for reappointment to subsequent terms.

(d) Board members shall annually elect a chair from among the membership.

(e) Board members shall serve without compensation, but are entitled to reimbursement for per diem and travel expenses as provided in s. 112.061.

(3) INSTITUTE EXECUTIVE DIRECTOR.—An executive director shall be designated by and serve at the pleasure of the Campus Executive Officer of the University of South Florida Polytechnic or his or her designee. The executive director shall be responsible for the daily administration of the institute, including the expenditure of funds from all sources. The executive director shall consult with the Phosphate Research and Activities Board on

the projects that the institute expects to undertake using moneys appropriated from the Phosphate Research Trust Fund.

(4) INSTITUTE DUTIES AND AUTHORIZED ACTIVITIES.—

(a) The institute shall:

1. Establish methods for better and more efficient practices for phosphate mining and processing.

2. Conduct or contract for studies on the environmental and health effects of phosphate mining and reclamation.

3. Conduct or contract for studies of reclamation alternatives and technologies in phosphate mining and processing and wetlands reclamation.

4. Conduct or contract for studies of phosphatic clay and phosphogypsum disposal and utilization as a part of phosphate mining and processing.

5. Provide the public with access to the results of its activities and maintain a public library related to the institute's activities, which may contain special collections.

(b) The institute may:

1. Research and develop methods for better and more efficient processes and practices for commercial and industrial activities, including, but not limited to, mitigating the health and environmental effects of such activities as well as developing and evaluating alternatives and technologies.

2. Secure funding from grants and other available sources for carrying out the activities authorized or required under this section.

3. Enter into contracts with any firm, institution, or corporation, or federal, state, local, or foreign governmental agency, to carry out the activities authorized or required under this section.

4. Promote the application, patenting, and commercialization of the institute's technologies, knowledge, and intellectual property in accordance with university policies and procedures.

5. Educate the public about the science related to topics and issues that are within the institute's scope of expertise.

6. Hold public hearings.

7. Establish public-private partnerships.

8. Provide consulting services.

History.—s. 6, ch. 78-136; s. 1, ch. 83-41; s. 16, ch. 83-339; s. 1, ch. 85-23; s. 3, ch. 86-294; s. 12, ch. 89-117; s. 114, ch. 90-360; s. 638, ch. 95-148; s. 181, ch. 96-406; s. 62, ch. 97-100; s. 1, ch. 2010-206.

[1]Note.—Section 3, ch. 2010-206, provides that "[a]ll powers, duties, functions, records, personnel, property, and unexpended balances of appropriations, allocations, and other funds of the Florida Institute of Phosphate Research are transferred by a type two transfer pursuant to s. 20.06(2), Florida Statutes, to the Florida Industrial and Phosphate Research Institute within the University of South Florida Polytechnic."

Note.—Former s. 378.101.

2012 Legislation

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(e) Board members shall serve without compensation, but are entitled to reimbursement for per diem and travel expenses as provided in s. 112.061.

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1. Establish methods for better and more efficient practices for phosphate mining and processing.

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History.—s. 6, ch. 78-136; s. 1, ch. 83-41; s. 16, ch. 83-339; s. 1, ch. 85-23; s. 3, ch. 86-294; s. 12, ch. 89-117; s. 114, ch. 90-360; s. 638, ch. 95-148; s. 181, ch. 96-406; s. 62, ch. 97-100; s. 1, ch. 2010-206; s. 10, ch. 2012-129.
[1]Note.—Section 2, ch. 2012-129, provides that:

"The following transfers shall be made:

"(1) All real and personal property, licenses and associated revenues, existing contracts, unexpended balances, appropriations, allocations, funds, and mutually agreed-upon obligations, responsibilities, and liabilities of the University of South Florida which relate to the University of South Florida Polytechnic campus, as determined by the Board of Trustees of the University of South Florida and the Board of Trustees of the Florida Polytechnic University, shall be transferred to the Florida Polytechnic University.

"(2) All Florida Industrial and Phosphate Research Institute programs, functions, offices, records, faculty positions, and staff positions of the University of South Florida Polytechnic shall be transferred to the Florida Polytechnic University.

"(3) After the transfers required in subsections (1) and (2) are complete, all programs, functions, offices, records, faculty positions, and staff positions of the University of South Florida Polytechnic shall be transferred to the University of South Florida."

Note.—Former s. 378.101.