PROCEEDINGS OF THE NCASI MEETING
ON BY-PRODUCTS SYNERGY

SPECIAL REPORT NO. 01-06
DECEMBER 2001
Acknowledgments

NCASI appreciates the interest and contributions of those individuals who participated in the By-Products Synergy Meeting. The meeting was organized by Dr. William Thacker, NCASI Senior Research Engineer. This report was assembled by Anna Aviza.

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PRESIDENT’S NOTE

Different industries have common interests in the management and regulation of non-hazardous industrial by-products. In an effort to promote these interests, NCASI organized a meeting on “by-product synergy,” which is a systematic approach to beneficial use. The meeting was intended to (a) initiate a dialog between different industries on the subject of beneficial use; (b) share information on the quantities and characteristics of major industrial by-products; (c) review barriers and aids to beneficial use; and (d) discuss current and potential beneficial use options. Participants represented or were otherwise knowledgeable about the following industries: cement manufacture, power generation, food processing, agriculture, pulp and paper, iron and steel, metal casting, environmental consulting, and waste processing/brokerage. This report contains presentation material from the meeting and summarizes some of the discussion that occurred among the participants.

Ronald A. Yeske

December 2001
ABSTRACT
Industries generate enormous quantities of various non-hazardous wastes that must be managed effectively. Increasingly these wastes or by-products are viewed as a resource, as potential raw material. Cooperation between industries can be valuable with respect to identifying beneficial use opportunities and to improving the regulatory climate surrounding industrial by-products.

This report contains presentation materials from a meeting NCASI held with individuals representing or otherwise familiar with several industries. The purpose of the meeting was to initiate a dialogue on “by-product synergy” (i.e., multi-industry beneficial use). Ample time was allocated at the meeting to informal discussions regarding barriers and aids to beneficial use. These discussions are summarized in the lead article that provides an introduction and overview of the meeting.

KEYWORDS
alternative management, beneficial use, boiler ash, by-product synergy, cement, fly ash, industrial by-products, integrated waste management, pollution prevention, reuse, sludge, solid waste, steel, wastewater residuals

RELATED NCASI PUBLICATIONS


NCASI BY-PRODUCTS SYNERGY MEETING

FINAL AGENDA
DAY ONE

Tuesday, March 27, 2001

9:00 – 9:10  Welcome and Opening Remarks

9:10 – 9:30  Individual Introductions

9:30 – 10:15  Beneficial Use of Industrial Byproducts – A Perspective
Elizabeth Olenbush, EO Associates

10:15 – 10:45  A By-Products Synergy Case Study: The Alberta Project
Stuart McCormick, Weyerhaeuser Company

10:45 – 11:00  BREAK

11:00 – 11:30  Utilizing Industrial By-Products in the Cement Industry (Anything Goes?)
Dr. Alex Mishulovich, Construction Technology Laboratories

11:30 – 12:00  Open Discussion: Regulations, Liabilities/Risks, Public Acceptance, and Related Barriers Surrounding the Beneficial Use of Industrial By-Products

12:00 – 1:00  LUNCH

1:00 – 1:30  Drake’s Rule for a Sale and a Case Study: Alum Process Residue as a Primary Feedstock in Cement Manufacture
Andy Bettman and David Shively, Marvic Minerals

1:30 – 2:00  The Production & Use of Coal Combustion By-Products from Electric Utilities
Dean Golden, Electric Power Research Institute (EPRI)

2:00 – 2:30  Pulp and Paper Industry – Overview of Raw Materials and Waste Products
Dr. William Thacker, NCASI

2:30 – 3:00  Screening Process for a Waste Blending Program
Doug Hermann, STS Consultants

3:00 – 3:15  BREAK

3:15 – 4:00  Open Discussion: Specifications/Performance Standards, By-Product Blending/Enhancement, Technology Development, and Other “Technical” Issues Surrounding the Beneficial Use of Industrial By-Products
NCASI BY-PRODUCTS SYNERGY MEETING

FINAL AGENDA
DAY TWO

Wednesday, March 28, 2001

9:00 – 9:30  Beneficial Use of Short Paper Fiber® (Paper Mill Sludge) For Pollution Prevention in the Mining Industry
Joe Laubenstein, BFI

9:30 – 10:15  Open Discussion:  Internal Advocates, Brokers/Processors, and Marketing Issues Surrounding the Beneficial Use of Industrial By-Products

10:15 – 10:45  Sustainable:  Attainable?
Ron Vriesman, Environmental Resources Management (ERM)

10:45 – 11:00  BREAK

11:00 – 11:45  Open Discussion:  Transportation, Competing Outlets, Total Cost Accounting, and Other Economic Issues Surrounding the Beneficial Use of Industrial By-Products

11:45 – 12:45  LUNCH

12:45 – 1:15  Integrated Organic Byproducts Processing in Wisconsin’s Fox River Valley
Leslie Cooperband, University of Wisconsin

1:15 – 1:45  Food Byproducts Utilization - Challenge and...Opportunity
Mike Malecha, Kraft Foods

1:45 – 2:15  Steel Industry Wastes:  Types, Synergies and Other Issues
Kim Lenti, Heritage Environmental Services

2:15 – 2:30  BREAK

2:30 – 3:30  Open Discussion:  Communication, Collaboration, and Innovation - Any important waste trades untried?  Problems and successes with current beneficial uses?  What can we do better?  Where do we go from here?
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INTRODUCTION AND OVERVIEW

“By-product synergy” (BPS) has been defined by the Business Council for Sustainable Development - Gulf of Mexico and the USEPA as “the synergy among diverse industries, agriculture and communities resulting in profitable conversion of by-products and wastes to resources promoting sustainability.” In one sense, BPS is the application of the “eco-industrial park” concept to existing facilities. More broadly, it might be viewed as an active and systematic approach to waste exchange.

A two-day BPS meeting was organized by NCASI and held in Chicago in late March 2001. The meeting was intended to (a) initiate a dialog between different industries on the subject of beneficial use; (b) share information on the quantities and characteristics of major industrial by-products; (c) discuss current and potential beneficial use options; and (d) review barriers and aids to beneficial use. Although initially dozens of businesses and other organizations were contacted to gauge interest, there was an objective to limit attendance in the hope of facilitating a comfortable, dynamic atmosphere. Participants represented or were otherwise knowledgeable about the following industries: cement manufacture, power generation, food processing, agriculture, pulp and paper, iron and steel, metal casting, environmental consulting, and waste processing/brokerage. A list of participants is displayed in Table 1.

Table 1. Participants at the By-Products Synergy Meeting

<table>
<thead>
<tr>
<th>PARTICIPANT</th>
<th>AFFILIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joseph Laubenstein</td>
<td>Allied Waste - BFI Pulp &amp; Paper Group</td>
</tr>
<tr>
<td>Alex Mishulovich</td>
<td>Construction Technology Laboratories (CTL)</td>
</tr>
<tr>
<td>Dean Golden</td>
<td>Electric Power Research Institute (EPRI)</td>
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<tr>
<td>Ronald Vriesman</td>
<td>Environmental Resources Management (ERM)</td>
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<td>Elizabeth Olenbush</td>
<td>EO Associates</td>
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<tr>
<td>Saul Furstein</td>
<td>Georgia-Pacific Corporation</td>
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<tr>
<td>Kim Lenti</td>
<td>Heritage Environmental Services</td>
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<tr>
<td>Michael Malecha</td>
<td>Kraft Foods</td>
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<td>Andy Bettman</td>
<td>Marvic Minerals</td>
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<td>Reid Miner</td>
<td>NCASI</td>
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<tr>
<td>William Thacker</td>
<td>NCASI</td>
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<tr>
<td>Ann Dougherty</td>
<td>Portland Cement Association</td>
</tr>
<tr>
<td>Douglas Hermann</td>
<td>STS Consultants</td>
</tr>
<tr>
<td>Marion Bradford</td>
<td>Tate &amp; Lyle - A.E. Staley Manufacturing Co.</td>
</tr>
<tr>
<td>Paul Ruesch</td>
<td>USEPA Region 5</td>
</tr>
<tr>
<td>Leslie Cooperband</td>
<td>University of Wisconsin, Department of Soil Science</td>
</tr>
<tr>
<td>Stuart McCormick</td>
<td>Weyerhaeuser Company</td>
</tr>
</tbody>
</table>

Formal Presentations

Twelve formal presentations were scheduled over the two-day period. The first speaker, Elizabeth Olenbush, reviewed the beneficial use of industrial by-products from a market development perspective, and raised themes that included barriers and opportunities within five “E” categories – environmental, engineering, economics, end users, and education. These themes set the stage for the presentations and discussions that followed.
A specific example of a BPS project, in this case within the Canadian province of Alberta, was described by Stuart McCormick. The facilitated project involved 15 sponsoring organizations and 18 other interested parties and consisted of four phases: raising awareness and recruitment of participants; collection and analysis of data on by-products and their characteristics; implementation in terms of the identification of possible beneficial uses, including top prospects; and evaluation of the project, including an analysis of barriers to beneficial use.

Two presentations addressed the use of by-product materials in cement manufacture. Alex Mishulovich shared information on the U.S. cement industry, the cement manufacturing process, and the use of various by-products (e.g., fly ash, blast furnace slag) as fuels, raw mix ingredients, and cement product additives. The chemical characteristics of cement and of possible by-product ingredients were also reviewed. Andy Bettman introduced a case study on the development of alum processing residue, which is a variable mixture of silica, alumina and titanium dioxide, into a valuable feedstock for cement manufacture. On a more general note, the importance of supply (material characteristics), transportation, and market conditions to the feasibility of a beneficial use project was explained.

Dean Golden described the research and practice on the beneficial use of coal combustion by-products such as fly ash and flue gas desulfurization sludge. About one-third of the fly ash generated in the U.S. is beneficially used, principally in the areas of land application and cement/concrete products. One interesting research area involves the development of aluminum-fly ash composites for the manufacture of automobile parts and similar applications. No paper on this presentation was available for the proceedings.

In his review of raw materials and by-products associated with the pulp and paper industry, William Thacker explained the current management of, and potential alternatives for, the industry’s by-products. Particular emphasis was placed on management options for boiler ash, wastewater treatment solids, and causticizing wastes. Causticizing wastes, for instance, are employed as agricultural lime substitutes and as cement kiln feedstocks.

Considerations in the evaluation of beneficial use options were delineated by Douglas Hermann, with a focus on the blending of by-products to produce an improved material. A case study involving the matching of a high-carbon pulp residue with a high-nitrogen pharmaceutical residue for land application was described in detail.

Joseph Laubenstein explained his company’s program that employs an engineered soil to cover enormous mine refuse piles, thereby preventing the generation of contaminated water. The soil includes short paper fiber (wastewater treatment solids from the paper industry) as one of its ingredients.

Sustainable business practices were defined and illustrated by Ronald Vriesman. The West Michigan Sustainable Business Forum was offered as an example of an association of businesses promoting recycling and other pollution prevention activities.

Leslie Cooperband described a project in northeast Wisconsin that is investigating the feasibility of combining organic residuals from farms, food processors and possibly other sources at a centralized processing facility and generating one or more products. The initiation of this project was covered in the December 2000 issue of BioCycle.

Michael Malecha reported on the types, characteristics, and management of the variety of by-products created by facilities of a major food processing company. The company is focusing efforts on finding uses for by-products that are not land-based. No paper on this presentation was available for the proceedings.
Finally, characteristics of the raw materials, manufacturing processes, and by-products of the iron and steel industry were presented by Kim Lenti. Current beneficial applications for the major by-products were reviewed, with the use of steelmaking slag in asphalt mix recounted in some detail.

**Informal Discussion Periods**

Discussion periods were scheduled as part of the meeting to allow ample time for informal dialogue regarding various issues surrounding the beneficial use of industrial by-products. These periods were structured along the following interrelated topics: environmental/liability, technical, economic, and markets/advocacy. Much of the discussion centered on barriers to beneficial use.

Significant attention was given to environmental and liability issues. The following were among the observations.

- Classification as a waste creates stigma and regulatory hurdles that virgin materials do not face.
- The traditional command-and-control approach to environmental regulation hinders flexibility and innovation; regulations may not have been designed to promote beneficial use.
- Markets cross state borders, but solid waste regulations, which differ among the states, do not.
- Regulators and generators often are uneasy with the idea of commingling wastes, a step that may greatly enhance a beneficial use option; for generators, there is a concern with establishing a shared liability.
- Regulators and the public can have an excessive fear of trace chemicals.
- Liability/risk concerns may thwart a project, yet liabilities may be more perceived than real.
- Well-designed regulations can reduce uncertainty and concerns with liabilities/risks.

Technical issues that can have a bearing on the feasibility of beneficial use were reviewed as well. The discussion included the comments below.

- Variability in characteristics can eliminate a by-product from consideration; control of by-product quality may need tightening to broaden beneficial use possibilities.
- End-use specifications or performance standards are sometimes unclear or undeveloped.
- Reluctance of potential end users to consider materials of “different” composition can be a hindrance.
- Tech transfer is often haphazard; success stories frequently are not communicated, or not widely communicated.
- Lack of understanding of technical aspects of other industries results in unrecognized opportunities.
- Blending or other processing can improve the utility of residuals.

As with any business enterprise, a beneficial use opportunity must make economic sense. Discussion of economic considerations raised comments that included the ones below.

- A successful project generally requires reduced generator costs, at a minimum.
- Transportation distance is critical to the cost of most projects and is a possible deal breaker.
- Generators are too often unaware of the true cost for their current waste management method.
- Many companies lack capital to make process changes or add a new process that could enhance a beneficial use.
• State taxation and incentive policies can aid the beneficial use of industrial residuals.

Issues related to markets and advocacy, not only reaching possible customers but also gaining support within an organization, were also contemplated. Among the points raised were the following.

• By-product quantity and processor/market demand mismatch (way too little material or way too much) can eliminate potential markets.
• A pessimistic “been there, done that” attitude among generators, from exposure to a number of beneficial use programs that never developed or were short-lived, results in reduced motivation to pursue opportunities.
• Generators and end users are focused typically on normal business activities, and there may be a lack of time to thoroughly investigate potential beneficial uses.
• Waste brokers/facilitators have beneficial use as an area of focus and can be critical to the success of a project.
• State market development agencies can help promote beneficial uses of industrial residuals.

The Future

At the end of the meeting, participants were asked to express any interest and ideas for future activities to promote multi-industry interaction and beneficial use. There was interest by a number of participants in seeing the issue carried forward. It was suggested that state market development officials, state environmental regulators, and additional industries be engaged in future discussions. These “discussions” might take several forms, including publicizing the meeting though the publication of articles. Another route would be to attend or speak at meetings sponsored by certain industries or organizations, such as those related to agriculture, chemical production, and mining.

Subsequent to this BPS meeting, representatives of NCASI and EO Associates attended USEPA’s Jobs through Recycling Roundtable where the beneficial use of industrial by-products was discussed with state officials having responsibility for development of recycling markets. NCASI is considering the development of meetings with a regional focus, a by-product-specific emphasis, or with the specific purpose of reviewing by-product characteristics and beneficial use experiences with state regulators. NCASI expects to receive a USEPA grant on beneficial use coordination, and tasks include hosting one or more meetings with state regulators to advance the productive use of industrial by-products.
BENEFICIAL USE OF INDUSTRIAL BY-PRODUCTS - A PERSPECTIVE

Elizabeth Olenbush, EO Associates

Following are copies of the slides used for this presentation.

Beneficial Reuse of Industrial Byproducts - A Perspective

Elizabeth Olenbush
EO Associates

OVERVIEW

- Similar to other market development opportunities
- Goal: Create demand for recycled content products
- Are industrial byproducts really different?
  - Manufacturing process wastes
  - Treated differently than MSW
  - Limited acceptance in market development
  - Most larger waste streams are non-hazardous under RCRA
- Do states have a responsibility to help industry?
  - Multi-economic development strategy
  - Experience not cost to rec

Public Policy Impacts

Byproduct Generation

- pulp & paper mill sludges
- recycled content mills generate higher proportions of sludges
- coal ashes
- Other renewable resources requiring air & waste control
- Co-generation means non-spec ash
- foundries, steel mills, smelters
- Most producers have highest recycling rate of any industry
- Impacted by market development activities for plastics
- Biofuels
  - Results from Clean Water technologies

Market Development Issues

- Creating demand for recycled content products
- Developing reliable, quality-controlled sources of supply
- Overcoming barriers: 5 E's
  - Environmental
  - Engineering
  - Economics
  - End Users
  - Education

Environmental Barriers

- Playing field is not level
  - Naturally occurring background levels need to be considered
  - Comparable virgin materials need to be considered
  - Why different regs for different materials?
  - Confront Resources background and applications of pulp & paper mill sludge: cornstarch uses for soft & fluffy sand
- Markets cross state & local borders
- Different state standards apply for multi-state end users or marketers
  - Innovators need to be involved
- Case by case permitting especially costly
  - Often one pre-test for smaller producers
  - Compliance costs for end users can be deal breakers

Engineering Barriers & Opportunities

- Acceptance of "new" materials tied to technical specifications
  - Performance standards
- Specifications needed for many approved end uses
- Specifications don't accommodate multiple materials
- No customized technical recommendations exist
  - Lots of success stories out there
- Technology transfer mechanism needed
- Transportation agencies set construction standards
- UNR Recycled Material Resource Center
  - Website: http://www unr.ash.edu
- Little coordination of agricultural/amendment research

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Economic Barriers & Opportunities

- Transportation is the highest cost factor
- Companies want to do the right thing, but often don’t have the technical and financial resources
- Lack of capital for technical process changes & processing
- Smaller generators don’t have enough material for markets
- Cost of permitting real economic barrier
- Sustainable economies require efficient material management systems, apply principals of industrial ecology
- For smaller quantity generators, commingling and co-processing will be only viable economic model
  > PA’s Process Recovery Corp handles byproduct streams from 40 foundries
  > Centralized processing can provide better environmental accountability

Educational Barriers & Opportunities

- Definition as “waste” concerns end users
- Need dialogue involving both generators & end users
- Educational efforts typically focus on DOE’s
  > Most construction isn’t DOT controlled
  > Contractors will ultimately determine materials usage in free market
- “Technical Conference on Beneficial Use of By-Product Materials in Construction Applications”
  > November 1996 in Albany, NY
  > Technical proceedings available
- Tech transfer should focus on markets, not materials

End User Barriers & Opportunities

- Lack of knowledge, inertia
- Cost savings/performance benefits
- Perception of Liability due to designation as “waste”
  > Most difficult barrier to overcome
- End users don’t want waste haulers/MRF regulation
- Most end user industries organized through regional chapters with educational venues
- Other state agencies communicate with end users
- Procurement programs could have large impact

Other Perspectives on Beneficial Reuse

- US Department of Energy Report to Congress on barriers to coal ash utilization
  > Institutional Barriers:
    > Insufficient Information
    > Inefficient Technology/Information Transfer
    > Lack of Coordination/Leadership
    > Inadequacies of State Programs to Promote Beneficial Reuse
    > Non-existent or Inadequate Specifications for Byproduct Use
    > Existence of Antidotal Barriers
- New York Pulp/Paper Mill Sludge Report
- Massachusetts Foundry Study

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A BY-PRODUCTS SYNERGY CASE STUDY: THE ALBERTA PROJECT

Stuart McCormick, Weyerhaeuser Company

Following are copies of the slides used for this presentation.

A By-Products Synergy Case Study: The Alberta Project
NCASI By-Products Synergy Meeting
Westin O'Hare Hotel
Rosemont, Illinois
March 27-28, 2001
By Stuart McCormick, P. Eng.
Weyerhaeuser Company

Warning: This was a Canadian project eh?

Geographical Approach: Who is my neighbour?

Alberta: An Exciting Place to Explore By-Product Synergies

- 3 million people and two of Canada's largest and most vibrant cities
- more than 60 percent of Canada's proven reserves of conventional crude oil
- 85 percent of Canada's natural gas
- 83 percent of Canada's coal
- 1/5th of Canada's electricity requirements
- one of the world's most productive agricultural economies
- Alberta's forestry cover 58% of the province and generate over $4 billion dollars of forest products annually, making it the Province's third largest industry

Project Organization

Applied Sustainability LLC, a private company based in Austin, Texas, supported by the International Institute for Sustainable Development and Match Associates, facilitated the process by bringing 13 sponsoring companies and organizations, as well as 18 interested parties, together to identify ways in which the "waste" from one company can be converted into a valuable product for another. Regulatory and technological barriers that stand in the way of successful synergies were also identified and addressed.

Sponsoring Companies and Organizations

The project was funded through a partnership of public and private sector sponsors, including the following organizations:

- Commission for Environmental Cooperation
- Alberta Science and Research Authority
- Alberta Research Council

And the following Alberta-based corporations:

- Frono-Canada
- Air Liquide
- Alberta's Industrial Hydraulics Association
- Sasjen Energy Inc.
- Alberta Research Council
- Syncrude Canada Ltd.
- Alberta Science and Research Authority
- TransAlta Corporation
- Bear
- Trans-Alta
- Waskesiu Energy Inc.
- Mansfield

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Other Participants
Alberta Agriculture
CNR/AD
Alberta Beverage Container Recycling Corporation
Dalhousie University
Alberta Chamber of Resources
Environinc
Alberta Energy
Environment Canada
Alberta Environmental Protection
Inland Cement
Alberta Forest Products Association
PL Earth Systems Inc.
AVAC Ltd.
Nelau Castle
CIFAC-WEST
Olds College
City of Calgary
Tyndall Technologies

Project Stages

Data Collection and Analysis

The "My Company" View

Implementation

Implementation - Top Prospects

Subgroups Created to Better Explore Opportunities

Energy
Sulphur and High Sulphur Coke
Inorganics (e.g. Fly Ash, Spent Catalysts)
Eco Industrial Parks
Industrial Gases

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Implementation Support Structure

Support Structure for Sub-Group Activities

Preliminary Technological Assessment

Critical Path Development

Project

Subgroup Output Example - Energy

Key Opportunities

Heavy Hitter

Biogas to Energy

Co-firing of biomass

Regional electricity and co-generation facilities

Biomass and/or oil waste as fuel for cement kilns

Sewage sludge technology

Biofuels from biomass

Bio-Oil and its derivatives from biomass

Energy By-Products

Biomass (agricultural and forestry residues)

Uranium, Oils, Gas, Coal to Liquid

Heavy Fuel Oil

Hydrogen, Propylene, and other derivatives

Fuels (gasoline, diesel, jet fuels)

Coal to liquid

Barrier Assessment

Barriers to By-Product Synergy

<table>
<thead>
<tr>
<th>Category</th>
<th>Barrier Description</th>
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<tr>
<td>1</td>
<td>Fuel availability</td>
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<td>2</td>
<td>Distribution risks</td>
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<td>3</td>
<td>Cost of fuel transportation</td>
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<tr>
<td>4</td>
<td>Technology</td>
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<tr>
<td>5</td>
<td>Environmental impacts</td>
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Caustic By-Product Synergy: A Success Story

Kraft Process

Weyerhaeuser

Naphtha Cycle

Heavy Oil

“Fresh” Caustic

“Spent” Caustic

Sodium Lenses

Products and Environment

Dow Chemical

Comments on the Process

The truth is not in the numbers.

Regulator participation was an investment.

Facilitation is gold ... magic doesn't just happen.

Details are best left to proprietary interests.

Project Legacy

By-Product Synergy community was established.

Proprietary investigations stimulated.

Players identified.

Report is a milestone event.

Priorities indicated.

Money is “in the bank”.

National Council for Air and Stream Improvement
UTILIZING INDUSTRIAL BY-PRODUCTS IN THE CEMENT INDUSTRY
(Anything Goes?)

Dr. Alex Mishulovich, Construction Technology Laboratories

Following are copies of the materials used for this presentation.

CEMENT INDUSTRY DATA SHEET (1999)

- Annual output, thousand metric tons: 86,000
- Number of cement plants: 116
- Average plant capacity, thousand ton/year: 754
- Number of rotary kilns: 199
- Average kiln capacity, ton/day: 1,240
- Number of cement-producing states: 39
- Top 10 cement-producing states: CA, TX, MI, PA, MO, FL, AL, SC, NY, IL
1. Stone is first reduced to 5-in. size, then to 1/4 in., and stored.

2. Raw materials are ground to powder and blended.

3. Burning changes raw mix chemically into cement clinker.

4. Clinker with gypsum is ground into Portland cement and shipped.
BY-PRODUCTS IN CEMENT MANUFACTURING

1. WASTE-DERIVED FUELS

2. RAW MIX INGREDIENTS

3. SUPPLEMENTARY CEMENTITIOUS MATERIALS

USE OF BY-PRODUCTS IN CEMENT KILN FEED

<table>
<thead>
<tr>
<th>Material</th>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>Fe₂O₃</th>
<th>CaO</th>
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<tr>
<td>Deinking sludge</td>
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<td>25</td>
<td></td>
<td></td>
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<td>Shredder fines</td>
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<td>6</td>
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<td>Spent pot liner</td>
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<td>10</td>
<td>60</td>
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<td>Oily residue</td>
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<td>9</td>
<td>28</td>
<td></td>
<td>86 (as is)</td>
<td></td>
</tr>
<tr>
<td>Food containers</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td>52</td>
<td>7,300</td>
<td></td>
</tr>
<tr>
<td>Pigment byproduct</td>
<td></td>
<td>55</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

National Council for Air and Stream Improvement
DRAKE’S RULE FOR A SALE AND A CASE STUDY: ALUM PROCESS RESIDUE AS A PRIMARY FEEDSTOCK IN CEMENT MANUFACTURE

Andy Bettman and David Shively, Marvic Minerals

History

Tri-State Minerals began doing business as a mining company in 1990. During the next 10 years, Tri-State merged or bought several smaller operations throughout the Midwest and near South.

By 1920, they were mining fluorspar, zinc, lead barite, clay, and coal. Consolidations, low recovery rates, and downward business cycles led to Tri-State’s eventual transition into industrial minerals with emphasis on construction and cement raw materials.

By 1980, 50% of Tri-State’s business has either secondary recovery of spent minerals or byproducts recycling and beneficiation. Recruitment of byproducts was based on the ability to combine these materials with existing product lines in order to achieve lower unit price raw material supplies to customers and as a low cost booster to low grade mined ores.

In 1988, some of the officers and vendors of Tri-State Minerals purchased some of the mineral rights and all the byproduct business of the company and formed Marvic Minerals, Inc., with its primary goal to develop a better strategy and higher end users for its byproducts and waste materials business. By now, there was a burgeoning demand by generators for services that would process and develop beneficial reuse technologies and waste products. Today, 75% of Marvic’s market is in beneficial reuse technology.

What is Marvic?

Marvic is a facilitator for waste materials and byproduct market development. This consists of:

Product analysis

- Site analysis
- Logistical analysis
- Market analysis
- Facility analysis—existing facilities processing options
- Like material comparison
- Analysis of shipping options

Processing phase

- Product staging and dewatering
- Material processing, including comminution, washing, drying, or calcination and agglomeration.
- Transporting—hauling and loading on any form of transport
- Shipping and transloading
- Unloading

Marketing/Sales phase

- Off-loading
- Contracting for reuse
- Customer billing
- Collections
- Penalties and carrying charges

**Who does Marvic serve?**

**Consumer—net revenue user**
- Makes an end product
- Needs one or more of the constituent minerals contained in raw material
- Can facilitate erratic streams of waste material
- Is and remains in environmental compliance

**Generator**
- Negative revenue stream—must lower cost of disposal or strive toward a zero or positive revenue stream for byproducts
- Desires to change wastes to useable products through incentive, joint ventures or manufacturing changes

**Where does Marvic work?**
- Operates on generator’s site or nearby
- Utilizes, when possible, fugitive heat sources or additional facilities available to generator
- Operates at port facilities or rail loadout
- Operates on user site

**How does Marvic operate?**
- Analyzes needs of consumers that could be served by generator’s product or combination of products which would include generator’s products
- Confirm economic viability of project
- Reclaims and processes generator’s wastes to comply with end users needs
- Contracts transportation of wastes or byproduct to end users to assure consistent, timely deliveries
- Can, if necessary, facilitate separate stockpiles and blending at points of origin or discharge to assure product quality and quantity
Anatomy of a Sale

Drake’s Rule

3 Phases of a sale
1. Supply
2. Transportation
3. Market

No sale will ever become a reliable commitment without control of 2 phases of the 3 possible by the seller
Aspects of application for Drakes Rule

Supply

- Quantity
- Quality (consistency)
- Price
- Ease of handling
- Possible value added features
- Customer service

Transportation

- Mode
- Customers’ accessibility to multiple modes of transport i.e. barge, rail, truck
- Competitiveness of available modes
- Possible freight combinations i.e. barge to dock, blend—reload rail
- Ownership of vehicles i.e. barge, rail cars
- Contractual relationship with hauler

Market

- Analysis of raw material stream quality and quantities
- Analysis of accessible markets for raw material
- Analysis of available competing raw materials currently serving potential end user and price structure
- Analysis of potential customer long term viability (cyclicality)
- Analysis of costs of beneficiation if necessary for end user including ROIC and analysis of optional disposal costs
- Sale of material to each user


**Comparisons of Marketing Entities**

<table>
<thead>
<tr>
<th>Producers</th>
<th>Facilitators</th>
<th>Brokers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Produces one or more products for sale either by themselves or broker</td>
<td>Can produce some primary raw material for use as blending stock with byproducts</td>
<td>Produces no product Represents producer or facilitator</td>
</tr>
<tr>
<td>Maintain possession of raw material until point of sale</td>
<td>Can maintain possession of raw material until point of sale or recycle fee from generator</td>
<td>Takes no possession Makes representation according to producer</td>
</tr>
<tr>
<td>Assume all risks</td>
<td>Assumes all risks except residual liabilities inherent in product</td>
<td>Assumes no risk</td>
</tr>
<tr>
<td>Can sell direct to end user</td>
<td>Can sell direct to end user</td>
<td>Can only represent former or latter as sales agent</td>
</tr>
<tr>
<td>Owns and operates Facility to process</td>
<td>Can own and operate facility Almost always maintains rolling stock for staging material</td>
<td>Office staff only Sometimes owns transportation vessels and storage</td>
</tr>
<tr>
<td>Insures for all risks, environmental and liability</td>
<td>Insures for all risks</td>
<td>Limited liability only</td>
</tr>
<tr>
<td>N/A</td>
<td>General knowledge of several industries and processes Inclined to find maximum uses of waste material and has capacity to combine his material with others in order to dilute or enhance one or more of the product’s constituents</td>
<td>Generally a veteran of a specific industry Specializes in specific needs and acquaintances within that industry</td>
</tr>
</tbody>
</table>

The following is a case history of an actual product we have developed using the aforementioned profile.
Alternative Raw Materials for Use in the Manufacture Of Portland Cement

Alum Process Residue

A Case Study

Background:

Marvic Minerals experience has been about a 50/50 proposition that it finds the “pile” or the “pile” finds Marvic.

In the case of alum process residue (a.k.a. APR), the industrial producer, the one with the “pile”, came to Marvic for assistance in developing a viable marketing program. Heretofore, the producer (an expert in aluminum sulfate marketing) had attempted to create a need vis-a-vis internal assessment of where the APR should work, however with limited success they sought expert assistance.

Enter Marvic—byproduct review—targeting a reuse option—testing—contracting -The rest is history.

What is APR:

Essentially the insoluble fraction from the action of sulfuric acid on a ground and calcined bauxite to produce alum or aluminum sulfate.

Spot Analysis:

<table>
<thead>
<tr>
<th>Oxide</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIO2</td>
<td>~67.00%</td>
</tr>
<tr>
<td>AL203</td>
<td>12.50</td>
</tr>
<tr>
<td>FE203</td>
<td>0.70</td>
</tr>
<tr>
<td>CAO</td>
<td>1.50</td>
</tr>
<tr>
<td>MGO</td>
<td>0.25</td>
</tr>
<tr>
<td>NA20</td>
<td>0.03</td>
</tr>
<tr>
<td>K20</td>
<td>0.75</td>
</tr>
<tr>
<td>TI02</td>
<td>2.40</td>
</tr>
<tr>
<td>SO3</td>
<td>0.06</td>
</tr>
<tr>
<td>LOI</td>
<td>11.00</td>
</tr>
<tr>
<td>Moisture</td>
<td>23.00</td>
</tr>
<tr>
<td>Sieve</td>
<td>90.00 plus 80 mesh</td>
</tr>
</tbody>
</table>

Listed oxides are of major interest to a cement operation and potential positive or negative (based on percentages) impact on clinker quality.
Protocol to Characterize the APR and Potential Reuse Options

Review: What is it? Where is it? How much? How to reuse? What are economics? What are options?

Step 1. What is it?
…A variable mixture of silica/aluminum/titanium dioxide…with the silica being predominately non-crystalline in form.

Step 2. Where is it?
…East St. Louis, IL with rail & river access.

Step 3. How much?
…About 1.5 million tons

Step 4. How to reuse?
…study reveals that some cement operation using a roller mill to crush quartz sand (MOHS 7) can benefit form the softer high silica APR (MOHS 3.5-5.0) i.e. higher thru put and less grinding energy. Also, there is improved in-kiln burnability. Easier grinding & better burning

Step 5. What are economics?
(how to move)…survey determined need for barge movement to optimize freight.
(where to move)…identified plants with processing issues and accessible by barge.
(why to use)…Discuss features and benefits of APR as a silica substitute with key cement managers, with one agreeing to take the lead in testing and champion the project and track:
A. Front end benefits
B. In-kiln advantages
C. Production impact
D. Cost/benefits

(what makes it work)…Explore/negotiate with generator our needs to implement the program:
A. Site access
B. Lab availability
C. Environmental issues
D. Subsidies
E. Multiyear contract

Step 6. What are the options?
…with the establishment of the cement plant as the primary consumer of the byproduct it is still necessary (if one is smart) to develop some alternative uses…i.e. a food chain. Find ways to reuse the waste in other industries as secondary, tertiary outlets.
…Marvic allocates some applied research dollars to fully characterize its contract waste streams…e.g. Is it inert, reactive, absorbent, etc? With an understanding of what it is (as-generated) and our broad knowledge of other markets, it may be possible to beneficiate (physical/chemical) the waste… “sow’s ear can become the silk purse”?

Thank you for your attention………….Comments?
Pit from hole 60-64
Samples taken Sept 24
7 samples
take up face of pit

Revised 10/5/00

Mar. 4, 2000
Darken Points have been explored.
Outlined Points have been staked only.

A - Samples
Comp taken
Pile 10-2-00
8 samples taken
with Bob Beste

National Council for Air and Stream Improvement
## Holes Samples at General Chemical

<table>
<thead>
<tr>
<th>Ft.</th>
<th>Hole 1</th>
<th>Hole 2</th>
<th>Hole 3</th>
<th>Hole 4</th>
<th>Hole 5</th>
<th>Hole 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Topsoil</td>
<td>Topsoil</td>
<td>Black Topsoil</td>
<td>Topsoil</td>
<td>Topsoil</td>
<td>Topsoil</td>
</tr>
<tr>
<td>1</td>
<td>Buff APR w/ some</td>
<td>Gray APR (1Jwa)</td>
<td>Gr. Clay (1Jwc)</td>
<td>Gray APR</td>
<td>Buff APR</td>
<td>Pink &amp; Gray APR</td>
</tr>
<tr>
<td>2</td>
<td>Bricks &amp; Rocks</td>
<td>Buff APR (1Jwa)</td>
<td>Light to Dark Brown Soil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Gray Clay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Buff APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Gray Clay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Pink &amp; Buff APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Ft. | Hole 7 | Hole 8 | Hole 9 | Hole 10 | Hole 11 | Hole 12  |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Black Topsoil</td>
<td>Topsoil</td>
<td>Gray APR (1Kea)</td>
<td>Waste</td>
<td>Buff APR</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Gray APR (1Kea)</td>
<td>Buff APR</td>
<td></td>
<td>Gray Clay</td>
<td>Rainbow Clay in APR</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Buff APR (1Keb)</td>
<td></td>
<td></td>
<td></td>
<td>Grey Clay with Waste</td>
<td>Waste</td>
</tr>
<tr>
<td>4</td>
<td>Pink APR (1Keb)</td>
<td></td>
<td></td>
<td></td>
<td>Yellow &amp; Grey Clay</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Gray Clay (1Ke)</td>
<td></td>
<td></td>
<td></td>
<td>Grey Clay with Waste &amp; Clay</td>
<td>Waste</td>
</tr>
<tr>
<td>6</td>
<td>Buff and Pink APR</td>
<td>(Brown Clay increasing to bottom)</td>
<td>Yellow &amp; Pink Clay</td>
<td>Buff APR</td>
<td>Grey Clay Waste &amp; APR</td>
<td>APR Clay &amp; Waste</td>
</tr>
<tr>
<td>7</td>
<td>Buff Colored APR</td>
<td>Brown Clay &amp; APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Buff &amp; Yellow Clay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Buff Clay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>APR</td>
<td>Soil</td>
<td>APR</td>
<td>APR</td>
<td>APR</td>
<td>APR</td>
</tr>
</tbody>
</table>
September 26, 2000

Denver Div. # MM777-5
Sample ID: Hole 52 Side & Bottom 9/21/00

CHEMICAL ANALYSIS
WT%, DRY BASIS

Silicon Dioxide, SiO2 69.74
Aluminum Oxide, AL2O3 14.26
Iron Oxide, Fe2O3 0.62
Calcium Oxide, CaO 0.13
Magnesium Oxide, MgO 0.17
Sodium Oxide, Na2O 0.15
Potassium Oxide, K2O 1.00
  Total Alkalies as Na2O 0.81
Titanium Dioxide, TiO2 2.82
Manganese Dioxide, MnO2 0.01
Phosphorus Pentoxide, P2O5 0.05
Strontium Oxide, SrO 0.09
Barium Oxide, BaO 0.05
Sulfur Trioxide, SO3 1.28
Loss on Ignition 9.62

Moisture, as Received 17.14

Analysis performed by Wyoming Analytical Laboratories, Inc.
PULP AND PAPER INDUSTRY - OVERVIEW OF RAW MATERIALS AND WASTE PRODUCTS

William E. Thacker, NCASI

Following are copies of the slides used for this presentation.

**PULP AND PAPER INDUSTRY**

Overview of Raw Materials and Waste Products

William E. Thacker
NCASI

Outline

- Quick introduction to the pulp and paper industry (PPI)
- Quick review of PPI raw materials in terms of fiber, fuel, and chemicals
- Quick review of PPI waste materials with an emphasis on wastewater treatment residuals, boiler ash, and kraft causticizing wastes

**U.S. Pulp and Paper Industry**

- Approximately 600 mills
- Mostly in: southeast, west coast, northeast, and eastern midwest
- Variety of manufacturing processes, production capacities, raw materials and products

**Raw Material Categories**

- Fiber
- Fuel
- Chemicals

**Fiber**

- Standard - wood and recovered paper (wastepaper)
- Specialty - cotton, hemp, kenaf, synthetics
- Ag residues? - straw, bagasse, corn stalks, cotton stalks, sorghum

**Fuels**

- Standard - coal, bark/wood, fuel oil, and natural gas
- Other - wastewater treatment residuals (WTR), OCC rejects, non-recyclable paper, tire-derived fuel, used oil, etc.
### Pulping & Bleaching Chemicals
- Sodium sulfate
- Calcium carbonate
- Sodium carbonate
- Sodium hydroxide
- Sodium silicate
- Soaps
- Fatty Acids
- Sulfuric acid
- Sodium chloride
- Sodium hydrosulfite
- Oxygen
- Chlorine
- Sodium hypochlorite
- Hydrogen peroxide
- Ozone
- FAS

### Papermaking & Coating Chemicals
- Kaolin clay
- Talc
- Titanium dioxide
- Calcium carbonate
- Soy protein
- Poly vinyl alcohol
- Polyethylene
- Sizing agents
- Retention Aids
- Dyes & pigments
- Starches
- Latexes
- Paraffin

### Mill Cleaning Chemicals
- Hydroxides (sodium, potassium)
- Acids (sulfuric, hydrochloric, citric)
- Ethoxylates (nonylphenol and alcohol)
- Glycol ethers
- Naptha, other organic solvents
- EDTA

### Waste Material Types
- **Wastewater treatment residuals** (WTR) (sludge)
- Bark & wood residues
- Boiler ash
- Causticizing wastes
- Pulping rejects (virgin and secondary)
- Wood yard wastes
- Paper mill rejects
- Broke not recycled in-mill

### Wastewater Treatment Residuals
#### General Characteristics
- 20 - 60% solids content after mechanical dewatering
- Not RCRA hazardous waste
- Low in metals, low to medium in nutrients
- Low in trace organics

### Wastewater Treatment Residuals
#### Amount and Type (proportion) in 1995
- ~5.8 million dry tons generated in 1995
- Primary WTR (40% of total)
- Secondary WTR (1%)
- Combined (primary & secondary) WTR (54%)
- Dredged WTR (5%)

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**WTR Management**
Technique (proportion in 1995)
- Landfill or lagoon (51%)
- Combustion (26%)
- Land application (12%)
- Reuse in-mill (5.5%)
- Other beneficial use (5.5%)

**Primary WTR**
General Characteristics
- Ash (inorganic fract.) <10 - 70% dry wt.
- Inorganic fraction - clay, CaCO₃, TiO₂, boiler ash, causticizing wastes
- Organic fraction - wood fiber

**Primary WTR**
Other Beneficial Uses - Actual
- Artificial soils
- Compost feedstock
- Landfill cover
- Landfill cap
- Animal bedding/litter
- Cement kiln ingredient
- Glass aggregate prod
- Concrete or brick additive

- Industrial absorbent
- Ag chemical carrier
- Fuel pellet ingredient
- Building board
- Roofing felt/tar paper
- Papermaking fiber

**Primary WTR**
Other Beneficial Uses - Potential
- Plastics additive
- Animal feed
- Ethanol production
- Levulinic acid prod.
- Other chemical prod.
- Lightweight aggregate
- Molded pulp products
- Cellulose insulation
- Minerals recovery
- Fuels from pyrolysis

**Power Boiler Ashes**
Amount and Type (proportion) in 1995
- ~2.8 million dry tons generated
- Coal + wood ash (23% of total)
- Wood ash (22%)
- Coal ash (15%)
- WTR + coal &/or wood, etc. (23%)
- Other + coal &/or wood, etc. (17%)

**Boiler Ash Management**
Technique (proportion in 1995)
- Landfill or lagoon (72%)
- Construction* (12%)
- Land application (11%)
- Other beneficial use (5%)

* Earthen construction such as road beds and berms, not cement or concrete
Wood Ash
General Characteristics
- Function of wood type (e.g., species, bark v. stem wood) & combustion conditions
- Unburned carbon (LOI) <10 - 50%
- Alkaline (high pH) and source of Ca, Mg, K, & P
- Heavy metals generally not a concern

Boiler Ash Management
Other Beneficial Use - Actual or Potential
- Compost feedstock
- Artificial soils
- Landfill daily cover
- Cement Manufacture
- Concrete Additive
- Cattle bedding
- Activated carbon manufacture
- Soil stabilization
- Flowable fill

Kraft Causticizing Wastes
General Characteristics
- Alkaline and high in calcium
- Generally not RCRA hazardous waste
- Low in metals

Kraft Causticizing Wastes
Amount and Type (proportion) in 1995
- ~1.7 million dry tons generated in 1995
- Excess lime mud (59% of total)
- Green liquor dregs (28%)
- Slaker Grit (14%)

Causticizing Waste Management
Technique and proportion (%), 1995
<table>
<thead>
<tr>
<th></th>
<th>LM</th>
<th>GLD</th>
<th>SG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill or lagoon</td>
<td>70</td>
<td>95</td>
<td>91</td>
</tr>
<tr>
<td>Land application</td>
<td>9</td>
<td>3</td>
<td>5.5</td>
</tr>
<tr>
<td>Reuse in-mill</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Other beneficial use</td>
<td>21</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Causticizing Waste Management
Other Beneficial Use - Actual or Potential
- Compost feedstock
- Artificial soils
- Landfill daily cover
- Road dust control
- Soil stabilization
- Cement manufacture
- Clay brick additive
- Asphalt additive
- WW neutralization
- WTR settling aid
- WTR dewatering aid
- WTR stabilization

National Council for Air and Stream Improvement
SCREENING PROCESS FOR A WASTE BLENDING PROGRAM

Doug Hermann, STS Consultants

Following are copies of the slides used for this presentation.

Screening Process for a Waste Blending Program
by Doug Hermann P.E.
STS Consultants Ltd.
By-Products Synergy Meeting
Rosemont, IL
March 27 and 28, 2001

Wastestream Characterization Process
- Assess Waste Types
- Assess Waste Volumes
- Assess Current Disposal Costs
- Assess Internal Waste Reduction/Recycling/Reuse Opportunities

Characterization Parameters
- Moisture Content
- Bulk Density
- Viscosity
- BTU/Ash Content
- Transport Characteristics
- Chemical and Mineral Content
- Nutrient Content and Nutrient Balance C:N:P
- Indoor and Outdoor Storage Issues

Characterize Transportation Infrastructure and Logistics
- Marine
- Railroad
- Truck
- Logistics / Costs ($/ton-mile)
- Backhaul Opportunities
- Staging Storage Needs

Evaluate Synergistic and Compatible Waste Industries
- Use Waste Exchanges
- Use Yellow Pages
- Use GIS SIC Code Databases
- Commonly Combined Wastes
  - Mineral, Nutrient and Carbon Wastes to AG
  - Mineral Waste Exchanges between Utility, Cement, Steel/Foundry, and Construction Materials

Evaluate Synergistic and Compatible Waste Industries (Continued)
- High Carbon Wastes with High Nutrient Wastes
- Food Processing Wastes to Other Food Processors
- Ash/Silica Wastes to Mineral-Filled Products
- Dry, High BTU Wastes to Fuel Users

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Waste Product Development & Liability
- Produce Reliably Consistent Waste Product
- Match Waste Volume to Opportunity
- Evaluate Transportation Costs
- Evaluate Market Potential
- Evaluate Processing Requirements

Case Examples
- High Carbon Pulp Residue Matched with High Nutrient Pharmaceutical Residue
- High Carbon Pulp Residue Matched with High Nutrient Animal Manures
- Scrap Tires Matched to Chemically-Durable Aggregate Applications
- High Nutrient and Carbon Wastes Matched to Low Productivity Soils

Case Examples (Continued)
- High Carbon Wastes Formulated for Chemical Carrier/Delivery in Granulated Products
- Cullery Wastes to Fuel Users

SLIDE 10 - Dinking wastewater sludge cake (high C:N ratio) on left, pharmaceutical fermentation sludge cake (low C:N ratio) on right

SLIDE 11 - Day-old pharmaceutical sludge (to right of loader) slumps badly and attracts insects.

SLIDE 12 - High nutrient pharmaceutical sludge alone was insect breeding substrate.

National Council for Air and Stream Improvement
SLIDE 13 Both sludges were combined and blended with twin auger in spreader box at 1:1 ratio.

SLIDE 14 Note the pharmaceutical sludge adhesion to the spreader box wall. This was eliminated after blending.

SLIDE 16 - Two minutes of auger blending (about the time to pick up a new load and return to the field) was needed to thoroughly blend the sludges.

SLIDE 17 - Combined sludges were applied with a side discharge spreader. This was never possible with the wet pharmaceutical sludge.

SLIDE 18 - Note uniform application on the ground.
SLIDE 20 - Crop production was well above average and fertilizer application was reduced.

SUCCESS WILL COME with

- Waste Characterization
- Understanding Transportation
- Finding Compatible Waste
- Maintain Waste Quality Characteristics
- Collaboratively Market and Sale By-Product
BENEFICIAL USE OF SHORT PAPER FIBER® (PAPER MILL SLUDGE) FOR POLLUTION PREVENTION IN THE MINING INDUSTRY

Joseph Laubenstein, RFI

Browning-Ferris Industries (BFI), Inc. has been a service provider to the Pulp & Paper Industry for the past 12 years. Over these past 12 years, BFI has focused on developing beneficial use programs for residuals generated from the papermaking process. The most successful of these programs is the BioMix® Technology. The technology utilizes Short Paper Fiber® (SPF®) which is commonly referred to as paper mill sludge. The program utilizes the SPF® as its raw material to manufacture BioMix® soils which are then sold to the mining and landfill industry to be used as capping materials. Over years of monitoring and performance reviews, this technology has gained acceptance as a means of stopping contamination of rain water flowing through mining refuse piles and landfills alike.

This presentation will focus on the success of working with two industries to fulfill the economical and environmental needs of both industries. By using Short Paper Fiber®, BFI has proven to the mining industry that this product possesses inherent properties that are beneficial to mining operations. Today, BioMix® soils are the preferred product for capping mine refuse piles where water quality issues are of concern.

Following are copies of the slides and text used for this presentation.

NCASI BY-PRODUCTS SYNERGY MEETING

Beneficial Use of Short Paper Fiber® for Pollution Prevention in the Mining Industry

Wednesday, March 28, 2001

TOPICS OF PRESENTATION

- Overview Pulp & Paper Industry
- BioMix® Technology Review
- Martinka Mine Site / West Virginia
- Alcoa Reclamation / Arkansas
- What the Future Holds

BIOMIX® PROGRAM

A manufacturing process for producing engineered and agronomic soils having value-added benefits based on the intrinsic properties of the P&P residuals used as raw materials in the process.

National Council for Air and Stream Improvement
SLIDE 5 - BioMix® soils have been used in many different applications. This is a listing of some of those applications. The most prominent of these are in the mining and landfill industry where water treatment costs are of major concern.

SLIDE 6 - After investing $5 million of Research and Development funds this is the unit that BFI engineered for the manufacturing of BioMix® soils. This plant has the capacity to manufacture 200 tons of product per hour under a very stringent QA/QC program resulting in a product that can meet any product specifications required. The blending recipes are laboratory-trailed, making certain of the proper mixing ratios, before the manufacturing process is started on a large scale. During production of the product many samples are taken, typically every 5,000 tons of product, assuring the BioMix® meets and many times exceeds the QA/QC program.

SLIDE 7 - One of the most important parts on the manufacturing plant is the preprocessing unit. Shown above is the rototiller assembly which can also be switched out with a hammer mill unit for more difficult SPF® materials. This unit preprocesses the SPF® down to particle size of 3/8 of an inch or less. This is very important in the manufacturing process. Many product specifications require a large surface area so microorganisms can readily get to the carbon source that is available in the SPF®. Allowing the SPF® to stay in a “slug” form, which is the way it is mostly received from the paper mills, results in soil matrixes that do not perform satisfactorily in the field. Another important attribute of the preprocessor is it transforms the SPF® into a raw material resulting in a very homogeneous BioMix® soil.

SLIDE 8 - This is the unit that feeds our proprietary fertilizers and pH adjusting compounds into the mixes. This is especially critical when we are manufacturing agronomic soils. Agronomic soils are manufactured based on their moisture holding capacities and their abilities to grow vegetative plants having the highest evapotranspiration properties achievable. This is the most beneficial property of these soils for in many instances the hydraulic barrier layer can be eliminated from the closure process.

SLIDE 9 - You are looking down the throat of the pug mill mixing component. This is where all the ingredients are mixed together resulting in the proper BioMix® soil. The mixing chamber has a retention time of only a few seconds up to 20 seconds depending on the mixing requirements to obtain a soil matrix needed to meet the QA/QC requirements of the project. The paddles are made of ¾-inch tempered steel able to withstand the most difficult materials (granite, shale, and other hardened materials) which are used sometimes to manufacture BioMix® soils.

SLIDE 10 - The hand on the right holds Short Paper Fiber® or SPF® as it is commonly received from a paper mill. The hand on the left holds SPF® after it has gone through the preprocessing unit. Notice how the particle size is much smaller, resulting in larger surface areas for the microorganisms.
UTILIZATION SITES OF BIOMIX® SOILS

- Golf Courses
- City Parks
- Mine Reclamation - coal, bauxite & phosphate
- Landfill Closures - Over 100
- Operating Landfills - daily cover, intermediate cover, grading material, and base of service roads.

National Council for Air and Stream Improvement
SLIDE 11 - The hand on the right is holding SPF® after being processed through the preprocessing unit. The hand on the left is holding a BioMix® soil matrix. Notice the BioMix® soil has a dark brown color as compared to the SPF® on its own. This is a very important feature of our soils for we try to mask the presence of the SPF® material in our soils. This is accomplished through mixing the SPF® with on-site native soils that may contain humus material or at times we even spray the BioMix® soils with environmentally friendly color enhancers that turn the soils a deeper earthen brown color. Not only are the soils more accepted by the end users but it also results in soils that germinate plants quicker and in the Northern climates longer into the fall months due to their solar absorption properties.

SLIDE 12 - Here you are looking at a stockpile of BioMix® soil. It is hard to see from this picture but the tip of the pen is pointing to an aqua colored fertilizer particle. The fertilizer particles that we purchase are actually sprayed this color so we can visually see the distribution of the fertilizer throughout the product. Also, when we go back to projects that have had our soils in place for a period of time we are able to easily locate the fertilizer particles to evaluate their breakdown and remaining nutrient values. This practice is only done today on those projects requiring close scrutiny.

SLIDE 13 - These are two different mining operations where we have successfully employed the BioMix® Technology. The Martinka Mine site is a 135-acre coal refuse pile over 300 feet high in Tygart River, West Virginia.

The Alcoa mining site is located in Bauxite, Arkansas. This site encompasses 7,000 acres; all of the rainwater falling on this site is treated through a water treatment process to remove acid mine drainage commonly referred to as AMD.

SLIDE 14 - This is what streams look like that receive Acid Mine Drainage (AMD) from many of the inactive mine sites throughout the Appalachian Mountains. The water coming from the small stream in the middle of this picture contains the AMD from an abandoned mining site. The pH of this water is in the range of 2.3 to 2.5. As it flows into the larger receiving stream the pH is quickly raised by the dilution of the larger receiving stream resulting in the precipitation of the iron and manganese. One can see the settling of the red precipitate around the rocks in the stream. Hundreds of miles of streams are void of life due to the effects of AMD.

SLIDE 15 - This is an aerial photo of the Martinka Mine site located in Tygart River, West Virginia. Active mining of coal stopped at this site in 1993. You are looking down on the coal refuse piles that were constructed over the past 50 years while the mine was in operation. The combined area of the two refuse piles is 135 acres. The piles rise to a height of 300 feet from toe to top, having slopes of 2:1. Reclamation on the refuse pile on the left side of this slide was started in 1995 and completed in 1999. The refuse pile to the right is in the process of receiving BioMix® soils and is scheduled for completion in summer of 2001. Upon completion, over 700,000 tons of Short Paper Fiber® will be used on this site to cure the AMD problem.

One can see all the collection ponds around the site that collect all the rain water that percolates through the pile. In the center of the slide, or the area between the two refuse piles, is where the water is treated before being discharged into the Tygart River.

SLIDE 16 - This is one of the treatment ponds that the AMD is pumped up to. Notice the dark red color of the water which is characteristic of AMD water.
MINE RECLAMATION

- Martinka Mine Site - Coal Mine
- Alcoa Corporation - Bauxite Mine
SLIDE 17 - This is one of our permitted blending areas in the state of West Virginia. The Short Paper Fiber® is trucked from the mill to this site where it is blended with native soils, fertilizers, and pH adjustments in the manufacturing of BioMix® soils. This is a 5-acre site that is permitted to handle 60,000 tons of product at any one time. From here the BioMix® soil is trucked to the mining site where it is placed on the refuse piles.

SLIDE 18 - This is a 5,000 square foot test pad to get the proper permeability to get the right placement methodology which is required for developing our QA/QC program. Shelby tubes are extracted from the test pad area and sent to a laboratory to determine the permeability of the material. Once the proper methodology is determined, number and depths of lifts plus number of passes needed to be made by the compacting piece of equipment, the specifications are implemented into the field placement and become the major part of the QA/QC program. When placed in the field Shelby tubes are taken every acre to confirm the proper permeability for the project is met.

SLIDE 19 - These are the permeability results from the 5,000 square foot test pad used at the Martinka project. One can see from this table that this SPF® has great permeability properties resulting in a barrier layer that will stop both water and oxygen from entering into the coal refuse piles. Without the presence of water and oxygen together, Acid Mine Drainage (AMD) cannot be generated.

SLIDE 20 - This is placement of the SPF® for barrier layer on the slide slopes of the coal refuse pile. Notice the steepness of the slopes.

SLIDE 21 - The placement equipment must be able to move both up and down the slopes to properly and economically place material. For this project a wide track D-6 low ground pressure dozer is used.

Notice in the background the refuse pile on the other side of the valley which was capped from 1999 through 2001.

SLIDE 22 - Notice the Acid Mine Drainage (AMD) which is seeping out from the refuse pile where the bench is constructed for support of the height of the pile. This did cause problems during placement of SPF® and BioMix® on the slopes of the refuse piles. Each bench was graded so that all the AMD would flow by gravity to the collection ponds.
PERMEABILITY TEST

*Client project: Martinka Capping Test Pad - April 1997*

<table>
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<th>Sample</th>
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<tr>
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<tr>
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<tr>
<td>ST - 6</td>
<td>5.50E-08</td>
</tr>
</tbody>
</table>
SLIDE 23 - Once the final vegetative layer is placed on the refuse piles the areas are seeded. The preferred method of seeding BioMix® is drill seeding. On slopes too steep for this method, seeding is accomplished by standard hydroteering methods.

SLIDE 24 - One truly gets the feeling of the steepness of the slopes from this slide. One major advantage of BioMix® soils is its ability to stick on steep slopes with little to no erosion. This ability is achieved from the interlocking mechanism of the fibers in the product. Each fiber interlocks with an adjoining fiber resulting in a matted effect which resists erosion. It takes tremendous energy from a violent downpour to overcome this interlocking phenomenon; thus the product is virtually non-erodible.

SLIDE 25 - Once the turf plants become established, usually within 6 months, the entire slide slopes become secured and chances of slope failures are nonexistent.

SLIDE 26 - From this slide, one can notice the uniformity of the grass cover. The cover is the most important part of the closure; each grass plant acts as a pump in removing water from the refuse pile. The grass varieties are chosen based on their evapotranspiration rates. Another characteristic of the grass species chosen is winter hardiness along with tolerance to heat stress.

It is extremely important that these capping systems are functional for the majority of the calendar year. Winter and summer dormancy of the plants is kept to a minimum by the selection process. In some climatic regions dormancy cannot be overcome. In these areas the capping layers are increased in depth allowing for a larger reservoir capacity for water in the soils. Once the turf plants come out of dormancy the excess moisture held in the BioMix® soils is extracted and vacated out of the soil. Once again the systems are restored to 100% of their holding capacity.

SLIDE 27 - This close-up of the grass cover shows some of the plants going to maturity and starting to form seed heads. Upon maturity these seeds will fall to the ground where many of them will germinate, resulting in young new plants. This is also important to the cap performance for younger grass plants have a higher evapotranspiration rate than older more mature plants.

SLIDE 28 - This is an area where acid mine drainage (AMD) is seeping from the refuse pile even after the BioMix® cap has been placed over it. This is due to the fact that there are extremely large quantities of water in these piles for they have been open to the environment for years. This area is one where the water pressure within the pile is being relieved both by hydraulic pressure within the pile and gravitational forces. Since the pile has been capped off, water no longer is able to penetrate the refuse pile; over time the flow will become less and less until it stops altogether.
SLIDE 29 - Historically, the normal practice of the reclamation industry was to install seep drains into these refuse piles to release the water to collection areas for treatment. The soils used to cap the piles were very porous, allowing rainwater to move freely into the piles. It’s not uncommon to see seep drains every 20 to 50 feet around the entire toe area. These drains also were important to relieve the internal water pressure at the toe of the pile that resulted in many slope failures on these enormous piles. With the use of BioMix® soils rainwater is held in the top 24” where it is used by the grass and not allowed into the refuse pile. With the use of this technology not only is water treatment eliminated but also the need to install and maintain these seep drains. Also, the engineered integrity of the refuse pile stays intact eliminating the danger of slope failures.

SLIDE 30 - This is the same area that was shown two slides back. This was taken two years after the BioMix® cover was placed on the refuse pile. Notice that the flow has been reduced to a trickle and the grass is creeping in. Once the seep slows the grasses grow in due to their tilling and reseeding properties. Today this entire area is completely grassed and this seep is non-existent.

SLIDE 31 - This picture was taken half-way up the refuse pile showing one of the collection ditches located on every bench. There is still some flow of AMD as the BioMix® has only been in place on this area just under one year.

SLIDE 32 - This is one of collection ponds for the AMD being generated from the refuse pile. Notice the dark red coloring of the water which is characteristic of AMD. More importantly, notice how the level of water in this pond has been reduced some 18 to 20 feet. At one time the water level was up to the lower bench area of this pile. From this slide one can also see that the grass cover has not matured yet so the full performance of the BioMix® cap has not even been achieved at this time.

SLIDE 33 - This picture was taken later of the same collection pond as the previous slide. Notice once again that the level of AMD water has dropped another 10 to 12 feet and the grass is maturing with the dark green color which is characteristic of plants growing on BioMix® soils. This dark green coloring is due to the beneficial inherent properties from the Short Paper Fibers® used in the manufacturing process of BioMix®.

The right side of this slide was not reclaimed with BioMix® soils but with native soils that came from the site. The BioMix® side, the left side of the slide, was seeded approximately a year prior to this picture.

SLIDE 34 - This is where one really begins to appreciate the impact BioMix® soils have on reducing the generation of AMD. Notice from this slide that the water level has been lowered some 20+ feet in the collection pond. More importantly this slide was taken in mid-January when the evapotranspiration rate of the cap is at its lowest and still very small volumes of water are coming from the refuse pile. This truly shows how well these caps work even during the most demanding times of the year.

Also notice the green color of the grass on the slope of the refuse pile to the right of the slide. This shows the importance of the selection process of the proper varieties of grasses based on their winter hardness characteristics.
SLIDE 35 - This is a different view of the same holding pond from the previous slide. Once again notice the depth that the water level has been reduced to and also what little flow is contributing to the pond during this most critical time of the year.

SLIDE 36 - Looking down into the holding pond, one notices the characteristic dark red color of the AMD is gone. This water is clear, as can be seen along the edge of the pond, and the water quality is excellent. The pH of this water is 7.2 while the iron and manganese levels are in the range of 2 to 5 ppm. This is additional validation of the beneficial effects BioMix® soils have on curing and eliminating the generation of AMD from coal refuse piles.

SLIDE 37 - This slide shows the difference in water quality after reclaiming the coal refuse pile using BioMix® soils.

SLIDE 38 - Looking at the refuse pile on the left side, one will notice that the backside of the pile has no turf cover. This area was reclaimed with a mixture of coal fly ash, soils, and fertilizer.

SLIDE 39 - A close-up of this area reclaimed with the fly ash product reveals severe erosion and a turf cover that is not uniform.

SLIDE 40 - A closer view of these washout gullies reveals that the topsoil layers have been completely eroded and the refuse coal is exposed to the elements. This results in rainwater infiltrating into the pile resulting in additional AMD generation.
SLIDE 41 - This is a slide showing the coal refuse pile that has been under reclamation for the past three years. This picture was taken in 1997, a year prior to reclaiming this pile.

One can get a sense of the magnitude of the pile by looking at the Euclid truck in the middle of the picture. This truck is large enough to hold 60 tons of coal.

SLIDE 42 - This aerial photo was taken in 2000 showing the amount of the refuse pile that has been reclaimed. All of the steep slopes are completed on the front face of the pile. The arrow is pointed to where the turf cover is starting to establish on the right hand side of the pile.

SLIDE 43 - The Alcoa site encompasses some 7,000 acres located in Bauxite, Arkansas just 15 miles south of Little Rock. This is a closed site where bauxite ore at one time was mined for manufacturing aluminum products. All rainwater falling on this site is treated due to the generation of acid mine drainage (AMD) also.

SLIDE 44 - This is a massive site. As far as the eye can see the land has been disturbed to mine the bauxite.

SLIDE 45 - This slide shows a ten-acre area that was reclaimed using BioMix® soils. The entire area to the left of the arrow and the area in the middle of this picture received BioMix® soils. The light area to the right of the arrow was reclaimed under the normal operating procedures for reclamation.

Immediately after this area was seeded the site received 5.2 inches of rain in a 6-hour period. One can actually see the water flowing in the tracks left from the tractor seeding.

SLIDE 46 - The arrows show the line of demarcation delineating between the BioMix® soils above the arrows and the native soils below the arrows. What is so noticeable in this picture is all the erosion of the native soils and no erosion whatsoever of the BioMix® soils. Even where the tracks from the tractor ran straight up and down the slope there was no movement of the BioMix® soil.
ALCOA RECLAMATION PROJECT

BAUXITE, ARKANSAS

National Council for Air and Stream Improvement
SLIDE 47 - This is a later picture taken of the same area as the previous slide. Notice to the left of the arrow the uniform dense crop of turf established. The native soils have patches of turf while erosion continues to move soils off of the site into the retention ditches below.

SLIDE 48 - Moisture-Point® Technology was deployed for all the reasons mentioned above.

SLIDE 49 - These listed companies along with Texas A&M are instrumental in the development of this technology.

SLIDE 50 - Moisture-Point® Technology is a methodology for monitoring and calculating moisture-holding capacities of soils on a real time basis. In the past, evapotranspiration rates could only be projected by using theoretical models and one could only project based on the assumptions used in the model. This is not the case with Moisture-Point® Technology which gives one live data from the site based on the actual live time performance of the turf cover and soil.

Probes are placed in the soil profile at predetermined depths. Through the process of electric diodes within the probe one is able to get readings of soil moisture at each diode depth. If one wanted to, the soil profile could be dissected into 1-inch slaps, monitoring the performance of the soil based on the readings for every one-inch layer of soil. The system has the capabilities of taking readings every three (3) minutes. By knowing the moisture holding capacity of the soil from a simple laboratory test, one can calculate the moisture holding capacity of the soil at anytime by subtracting the current moisture in the soil from the available capacity of the soil.

SLIDE 51 - This shows a technician installing a probe in the field at the Alcoa site in Bauxite, Arkansas. The probe is driven into the ground with a special tool resulting in 100% soil to probe contact which is necessary to get readings of the moisture in the soil.

SLIDE 52 - Once the probes are installed at the proper depth in the soil they are hardwired back to a data logger. The data logger not only sends out the electrical impulse to the probe but records the data as to the moisture content in the soil at that given depth.
**MOISTURE-POINT® TECHNOLOGY**

- Substantiate BFI's claims of the superiority properties relating to BioMix® soils
- Development of Landfill Closure Caps for the next millennium
- Further differentiate BFI from competitors "Market Protection"
- Booster BFI's position for patent rights
- Online monitoring of sites for cap performance

**ENTITIES INVOLVED IN PROJECT**

- BFI Developer/Owner
- Environmental Sensors, Inc.
  - Moisture-Point® Technology
- Surron Corporation
  - Weather Stations, Water Quality Monitoring
- Oncom Corporation
  - Satellite Transmission of Field Data
- Texas A&M
  - Proprietary Research Studies
SLIDE 53 - At the Alcoa site a complete weather station was installed to record all the local weather conditions right at the site. All these data were collected into the data logger. From the data logger the data were retrieved via satellite transmission to a receiving station in Virginia then back to BFI offices via the Internet in Houston. We set up the system to take readings every hour, with 58 different data points monitored.

SLIDE 54 - This is a picture of the 10-acre reclamation area one (1) year after planting. The Moisture-Point® equipment with weather station is at the tip of the arrow. The area behind the equipment is the area reclaimed with native soils that also has been monitored with probes to compare the performance of the BioMix® soils to native soils.

SLIDE 55 - These last six (6) slides are an artistic rendering of how the BioMix® soils actually work as compared to native soils. We will only concern ourselves with the final topsoil layer which is the most important layer for landfill closures and mine reclamation.

On typical closure and reclamation projects the topsoils used are very coarse in structure and usually void of any organic matter, resulting in a growing medium that has little moisture holding capacity. The void spaces between soil particles are very large and mostly filled with sand particles or just air.

In BioMix® soils the organic matter content is very high resulting from the Short Paper Fibers® filling the voids between the soil particles. The proper ratio of soil to SPF® is critical for the proper performance of the soil. Each fiber must be in contact with a neighboring fiber which allows for a wicking process which is why these soils are superior growing mediums over native soils used on these projects.

SLIDE 56 - As a rain event occurs water moves quickly into the native soils and many times on sloped areas the water moves over the surface of native soils which is the cause of erosion. The water entering the soil matrix on native soils moves quickly down through the soil due to the large void spaces and little if any is captured since there is little to no organic matter to absorb the water.

The BioMix® soils act just in reverse of native soils. First, due to the high organic matter and lush vegetative covers achieved, minimal water moves across the surface even on the steepest slopes 2:1. Water is pulled into the soil matrix based on the inherent properties of the fibers making the medium act as a sponge. Once the water is in the matrix it moves slowly downwards from fiber to fiber resulting in uniform wetting across the entire soil profile. The upper soil layers achieve maximum moisture holding capacity before the lower soil areas start to take on water. In the native soils just the opposite takes place. Water moves quickly down to lower soil strata by short-circuiting through the voids which are present throughout the soil matrix. This can result in areas within the soil completely dry just hours after a major rain event occurs.

SLIDE 57 - Once the rain event stops, water moves very quickly out of the growing zone into layers below on native soils. Once water leaves the top six (6) inches of the growing medium it can not be used by the growing plants. This water moves down into the refuse pile where it becomes acid mine drainage (AMD) which needs to be treated as contaminated water when it exits the refuse pile.

BioMix® soils have moisture-holding capacities exceeding 200 to 300 % compared to native soils. This impressive moisture holding capacity is due to the properties of the fiber. Once the rainwater comes into contact with the fiber it is immediately drawn into the fiber. As the water enters, the fiber swells giving it the ability to hold 10 to 20 times its weight in water. It has been shown that a 12-inch layer of a properly blended matrix of BioMix® soil can hold 16 inches of water before releasing water to the layer below.

SLIDE 58 - Since the native soils have a very low moisture-holding capacity the turf covers become stressed and go into dormancy for survival. This further adds to the deterioration of the cap for once the turf begins to die back and thin it further exposes the native topsoil layer to erosion.

The BioMix® soils sustain a rich vibrant vegetative cover for the grass plants have a reservoir of water available. All of the water that is held in the topsoil layer is available to the turf plants for growth.
SLIDE 59 - This is the most **important** property of BioMix® soils. When blended properly, these soils develop wicking properties allowing water molecules that are below the root depth layer, typically 6" or less, to move back up into the rooting zone by traveling from fiber to fiber. This unique characteristic allows the grass plants access to water during drought conditions. By doing this, the available moisture holding capacity of the soil is restored as the plants utilize the water from the reservoir.

On native soils there is no water reservoir for the turf. Under summer stress conditions the turf covers typically go dormant and in many cases dormancy leads to death of the cover.

SLIDE 60 - By keeping a dense cover of turf on these steep refuse pile slopes erosion becomes non-existent. Erosion not only leads to water getting into the refuse pile resulting in AMD, but also increases maintenance costs for many of the surface ditches need to be excavated of the soils that have moved off the slopes into these ditches.

Not only are the water treatment costs reduced dramatically on sites using BioMix® soils, but also their post-closure maintenance costs are substantially reduced.

National Council for Air and Stream Improvement
SUSTAINABLE: ATTAINABLE?
Ron Vriesman, Environmental Resources Management (ERM)

Following are copies of the slides used for this presentation.

Sustainable: Attainable?
By: Ron Vriesman - ERM, Inc.
NCASI

West Michigan Sustainable Business Forum

- MISSION - To promote sound business practices that sustain the environment.
- GOAL - Encourage use of sustainable business practices that encompass environment, economy and social responsibility while enhancing the long term health of the environment.

WMEAC Member Companies

Sustainability:

- Moves an organization beyond regulatory compliance
- Represents a proactive approach to environmental management throughout the organization
- Results in reduced costs and liabilities and improved profitability, production and environmental performance
- Utilizes an EMS as a tool for pursuing integration within the organization
- Success is dependent upon internal processes as well as supply chain performance

What is Sustainable Business?

- Adapting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining, and enhancing the human and natural resources that will be needed in the future.
- Doing business in such a way that it does not harm the ability of future generations to continue to produce their products.

National Council for Air and Stream Improvement
What is Sustainable Business? -continued

* A profitable company!
* A company focused on reducing their labor costs.
* A company focused on reducing material costs.
* A company focused on reducing wastes.
* A company which recognizes that the environment needs to be protected to protect future profits.

Environment Management Hierarchy

- Restoration
- Economic Performance
- Risk Management
- Environmental Performance
- Sustained Development
- Lowest
- Highest

Business Performance as a Function of Sustainability

Project Objectives

- Utilize Secondary Resources to Manufacture Counterweight Components
- Reduce Environmental impact from Products and Operations
- Demonstrate Commitment to Environmental Sustainability
- Simplify Counterweight Design and Reduce Assembly Effort
- Develop Returnable Counterweights Remanufactured into New Product
- Minimize Types, Sizes and Fastening Methods of Existing Counterweights
- Easily Emerging Customer Needs for Environmentally Friendly Products
- Become Less Reliant on Secondary Markets for Resources

Secondary Resource Materials

- Various metal products
  - Painted, non-painted
  - Punch-outs
- NCM assemblies
- 0 barrels of powder paint
- Bale of various plastics

National Council for Air and Stream Improvement
Conclusions (Incoming Materials)

- Current secondary resources include powder paint, plastic in various forms, metal in various forms.
- Plastic received contained non-plastic materials (i.e. cardboard, tape, paper).
- Removing foam wrap and bubble wrap improved pressing performance.
- Metal can be successfully shredded.

Conclusions (Pressing Procedure)

- Paint bonds to shredded metal and metal dies easily.
- 6” x 6” coupons can be pressed consistently to a density of ~3.1g/cc.
- Impact testing of 6” x 6” coupons shows better response than ½” plywood.
- Concrete counterweight style prototypes can be pressed to at least 3.0g/cc.

Process Flow Sheet

- Metals -> Shredder
  - Powder Paint
  - Hot Pressing
  - Counterweights
- Plastics -> Formulate & Reduce

Preliminary Layout

Unresolved Issues

- Metal Processing
  - Feeding metal to shredder.
  - Shredder configuration - cascading multiple shredders, size, staging requirements, sorting/recycling phase design.
  - Discharge of shredded metal from storage bin.
  - Live bin bottom + narrow dial could work - needs testing.
- Dry Paint Handling
  - Delivery system needs testing.
  - Dust collection for delivery system.

Unresolved Issues

- Thin Film Processing
  - Bale shredder size.
  - Capital expense.
  - Large throughput required for economic viability.
  - Outside processing may be necessary.
  - Technical feasibility has not been demonstrated.
- Presses
  - Size of press.
  - Quantity of counterweights pressed vs. cycle time.
  - Mold release practices.
Sample Supply Chain

Drivers
- Supplier performance needed to meet corporate business goals
  - costs
  - cycle time
  - quality
  - reliability
- External perception
  - accountability for supplier performance
  - GRI guidelines, socially responsible investors, etc.

Opportunities and Benefits
- Environmental improvements
- Cost reductions
- Quality assurance
- Risk management
- Product improvements

Business Case: uninterrupted, dependable, cost-effective supply chain

Opportunities to Affect Supplier Environmental Performance
- Purchasing
  - Training and awareness on selecting suppliers
  - Cost vs. price
- On-site assessments
  - Company or 3rd party
  - Integrated into existing quality audits
- Motivating performance
  - Awards and recognition
- Product innovation
  - Design for environment, problem-solving, etc.

Sustainable Purchasing:
- Represents an area of business operations which can positively influence an organization future sustainability and success
- Handbook has been developed by the West Michigan Sustainable Business Forum: This Handbook:
  - is a tool to improve corporate profitability while enhancing environmental health
  - must be communicated internally to achieve successful sustainable purchasing practices
  - identifies a means to monitor and measure success
  - provides access to numerous other resources including case studies from other leadership companies
- Is a step toward “greening” of the organization and ensuring continued access to existing customers and markets

National Council for Air and Stream Improvement
Sustainable Purchasing
Goals/ Objectives
• Educate Organizations on Environmental Sustainability Purchasing Elements
• Promote Adoption and Implementation of Environmental Sustainability Purchasing Practices
• Utilize Supplier Development Activities to Promote Sustainable Purchasing Opportunities
• Monitor and Measure Sustainable Purchasing Efforts

Establishment of Purchasing Requirements
Process Assessment
a) Does Environmental Policy Statement support pollution prevention and sustainability throughout the organization?
b) Do purchasing procedures incorporate sustainability aspects and support the Environmental Policy Statement?
c) Has a green material checklist been developed?
d) Have recycled content/sustainability specifications been established?

Identification of Material Needs
Process Assessment
a) Have environmental aspects of product manufacturing/service delivery been considered?
b) Are employees within all business operations knowledgeable on sustainability?
c) Have product sharing or short-term rentals been considered?
d) Do material specifications incorporate sustainability opportunities?

Alternate Material Drivers:
• Consumer Environmental Consciousness
• End-of-Life Reuse/Recycling
• Durability
• Brand Personality

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INTEGRATED ORGANIC BYPRODUCTS PROCESSING IN WISCONSIN'S FOX RIVER VALLEY

Leslie Cooperband, University of Wisconsin, Madison

(Reprinted with permission from the December 2000 BioCycle, Journal of Composting and Organics Recycling, Emmaus, PA; www.biocycle.net.)

MANAGING FAST GROWTH AND RESIDUALS IN FOX VALLEY

New project will help waste generators in Northeast Wisconsin find alternatives to direct land spreading and landfilling of organic residuals.

Northeast Wisconsin - particularly the Fox River Valley - is faced with increasing obstacles to land spreading or landfilling organic residuals. The region is home to food processors (canneries, cheese manufacturers), municipal wastewater treatment and solid waste facilities (biosolids and yard trimmings), paper mills, wood product manufacturers and livestock producers. Dairy herd expansion is progressing at one of the highest rates in NE Wisconsin. In addition, the region represents one of the fastest growing urbanizing populations in the state. Because of increasing competition for land available for land spreading, rising landfill costs, increasingly restrictive regulations on spreading of organics and loss of agricultural land to urban/suburban development, farmers and industries in the Fox Valley are looking for alternatives to direct land spreading and/or landfilling of raw wastes.

The University of Wisconsin's "University-Industry Relations" Program has given a one-year grant to the Department of Soil Science to conduct a feasibility study of organic waste management in the Fox River Valley. The main objective of the project is to evaluate the economic, technical, organizational and regulatory feasibility of combining organic residuals in a centralized processing facility. The facility would collect the organics, process them into soil amendments using appropriate technologies (anaerobic digestion, composting, dehydration) and market the finished

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products (fertilizers, composts, soil blends) to landscapers, horticultural enterprises, state departments of transportation, golf courses, land reclamation projects, etc.

Specifically, a feasibility study of a pilot scale processing facility in the Fox River Valley is being conducted. This study includes 1) Demographics of “waste generators” (geographic location, company size, volumes and timing of wastes generated); 2) Chemical and physical characteristics of each waste stream as well as combinations of wastes; 3) Economics of transporting wastes to a centralized processing facility; 4) Suitability of processing technologies for production of soil amendments; e.g., fertilizers and or compost; 5) Costs of building a processing facility and managing it; 6) Market opportunities for finished products; 7) Business structure of processing facility, e.g., a cooperative structure vs. other types of structures; 8) Existing regulatory and political climate for such a project and changes that might be needed to provide incentives for this type of project and 9) Potential location of centralized processing facility and sources of financing.

**GENERATORS AND INTEGRATORS**

We have identified several “waste generators” (industries, livestock farmers, municipalities) and a waste “integrator” (public sector agency or private sector company or entrepreneur, responsible for waste collection, processing and marketing/distribution) who might participate in a pilot-scale centralized waste processing project. We anticipate that at least one food processor, several large dairies, Appleton Wastewater and Department of Public Works (yard trimmings), a paper mill and a wood products processor (pallet company, lumber mill) will be the major generators. We also expect Agriliance (formerly Cenex Land O’Lakes) to play a major role as either waste processor/integrator or product marketer and distributor. These key players will participate in the feasibility study by providing information about the demographics of their waste streams (amounts, timing, current fates) and chemical, physical and biological characteristics. Cenex Land O’Lakes will provide knowledge and expertise in product marketing and distribution. All key players will participate in discussions about the structure of their business partnership. We will explore the feasibility of a cooperative structure for bringing industries, farmers and municipal agencies together. The University of Wisconsin's Center for Cooperatives and Cooperative Development Services (a consulting agency) are assisting with this part of the feasibility study. We will also identify and evaluate appropriate processing technologies and potential markets. We will also develop a plan for securing private investments and grants for the construction and operation of the pilot processing facility.

A number of operational projects will be studied by the steering committee members to assemble feasibility data. These project include: A-1 Organics, Inc. in Colorado which composts diverse feedstocks into marketable soil amendment blends; Chamness Technologies in Iowa which also composts varied organic residuals; and Pheasant Run near Kenosha, Wisconsin that blends and composts duck manure, cranberry processing residuals, wood shavings and other feedstocks. Regulatory agency policies will also be reviewed carefully. Two specific public agencies and their positive incentives for creative management projects include the California Integrated Waste Management Board and the Iowa Department of Natural Resources Solid Waste Management Initiative.

**FROM STUDY TO FACILITY**

As industry representatives, farmers and municipal government officials will be involved continuously and actively in the feasibility study, they will receive information about the economic and technical feasibility of a pilot-scale processing plant as it unfolds. We have formed a steering committee of several key players and an advisory group consisting of by-product generators,
extension agents and state agency personnel. The steering committee will provide advice and
guidance on technical, organizational and financial issues. The advisory group will provide feedback
on the study as it progresses. We will test and demonstrate appropriate processing technologies on-
farm and at the Appleton Waste water Division waste treatment facility. We anticipate development
of clear guidelines for use of optimal waste streams, processing technologies, business structures, and
marketing/distribution opportunities for the soil amendments generated at a centralized processing
facility. The feasibility study will be completed in 12 months, and it will serve as document for
securing funds for a pilot-scale waste processing facility in the Fox River Valley. We will hold
public and private presentations for potential financiers of the pilot-scale processing plant, including
state and federal agency personnel, private investors and private foundation representatives.

If successful, this project could have a significant short- to long-term economic impact in Northeast
Wisconsin. It should reduce waste handling costs for most of the industries, farms and municipal
agencies participating in the project. It should also generate revenue from the sale of the soil
amendment products. It may also alleviate regulatory oversight and lower liability costs associated
with waste handling and disposal. It should facilitate industry compliance with ISO 14,000
environmental management standards. Overall, the project should have a beneficial economic and
environmental impact in the region by converting wastes to resources, reducing over application of
nutrients (nitrogen and phosphorus) on agricultural lands and redistributing organic matter to soils
where it is most needed.

STEEL INDUSTRY WASTES: TYPES, SYNERGIES, AND OTHER ISSUES

Kim Lenti, Heritage Environmental Services

Following are copies of the slides used for this presentation.

Steel Industry Wastes

Types, Synergies & Other Issues

for NCASI By-Products Synergy Meeting
3/28/01

Kim Lenti
HERITAGE

Outline

- 1 Minute Steelmaking Course
- Wastes Generated
- Raw Materials Used
- Current Synergies
- Other Heritage Synergy Work

National Council for Air and Stream Improvement
Steel Slag

- Heritage has been evaluating steel slag as an aggregate in hot mix asphalt since 1993

Steel Slag in Asphalt Pavements

Steel Slag Research

- Studies conducted in the 1990's found that Steel Slag Asphalt Mixtures are much stronger than conventional asphalt pavements

Superpave Shear Tester

Used to determine Rut Resistance of Pavements

INDOT Research

- INDOT found Steel Slag Asphalt Surfaces have excellent long term friction
- INDOT Specifications include Steel Slag as an option for its highest traveled pavement surfaces where long term friction is critical

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Steel Slag on I-74 (1999)

Steel Slag on I-74 (2001)

U.S. Aggregates - Gary Operations

Steel Slag Aggregate Production

Steel Slag Production
- Involves Crushing
- Destruction of Deleterious
- Removal of Metal
- Screening to Size

Steel Slag Finished Product

Steel Slag Advantages
- Better Rut resistance in pavements
- Better and longer lasting wet friction
- Better Durability
- Produces a Quieter Pavement
- Completely Recyclable

National Council for Air and Stream Improvement
Steel Slag is not a waste!

- Steel Slag is a valuable resource for Indiana Roads
- Steel Slag is currently being used to make Indiana Highways safer and longer lasting
- Steel Slag is a premium product and is expected to be in short supply within 5 years

Other Heritage Successes

MICRONUTRIENTS.

Printed Circuit Board

Animal Micronutrient

Micronutrients produces TriBasic Copper Chloride (TBCC)

from Acid and Base Spent Etchants from Printed Circuit Board Industry which are converted into TBCC and Recycled Etch (no waste products)

TBCC Production
ISO 9002

TBCC QC Laboratory

An improved and proven source of copper for animal feed

National Council for Air and Stream Improvement
TriBasic Copper Chloride

-produced from zinc rich co-products such as EAF dust

Biomass in Coal

Heritage is working with CQ, Inc. to make Biomass Syngas from paper sludge and plastic by-products for Stoker Coal

Paper Sludge (60% Water)

Nearing Full-Scale Production