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APPLIED SUSTAINABILITY LLC: MAKING A BUSINESS CASE FOR BY-PRODUCT SYNERGY

The time is right. I'm convinced that it's going to happen. It makes so much sense and it's very simple. You can see in the future, as these pressing issues that are defining the sustainable development movement continue to grow, that the market is going to move in this direction.
—Andrew Mangan[1]

On November 14, 2001 Andrew Mangan received a long-awaited letter. The New Jersey Corporation for Advanced Technology, an independent group certifying the scientific and economic soundness of technological processes, verified that Mangan's by-product synergy (BPS) program was both environmentally beneficial and energy efficient. The approval was a milestone for Mangan, and signaled the possibility of wider acceptance of BPS. Sitting in his office in Austin, Texas, Mangan reflected on his uphill battle that began almost ten years ago when he founded a regional business council to help companies implement and profit from sustainable development practices. One of the council's most successful ventures was by-product synergy, a process that helped companies discover new ways to convert their wastes into saleable commodities. Compelled by the business and environmental opportunity of by-product synergy, Mangan left the council in 1999 to commercialize the process by starting a new business, Applied Sustainability LLC. Despite initial progress, the company soon faced both business and regulatory challenges, and eventually depleted its funding in May 2001.

Despite this setback, Mangan continued to pursue his mission. He fervently believed that by-product synergy was a practical and effective means to achieve sustainable development. Yet, while the U.S. Environmental Protection Agency (EPA) was broadly supportive of by-product synergy, the organization was entrenched in a "command-and-control" structure that inhibited innovative business solutions to environmental problems. Mangan was eager to tear down these regulatory barriers, and found such an opportunity with the New Jersey Department of Environmental Protection, whose commissioner was actively seeking new ways to promote corporate environmental responsibility and innovation. The department had contacted Mangan in February 2001 to design and implement a BPS project in New Jersey. The November 2001

[1] All quotes from Mangan are from the author's interview, unless otherwise noted.

Susan Mackenzie prepared this case under the supervision of Professor Terry Anderson as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

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certification letter allowed Mangan to go forward with this potentially groundbreaking project with the state of New Jersey; however, there was still much work to be done. Could Mangan recruit enough companies to commit to a BPS project in New Jersey, especially in an uncertain economic environment? Was there enough support in Washington from the Bush administration? Would Mangan be able to restart Applied Sustainability as an independent enterprise, and if so, what was the appropriate pricing model? Was the time right?

BY-PRODUCT SYNERGY

Defined by the National Academy of Engineering, sustainable development "represents the quest for an economy that exists in equilibrium with the earth's resources and its natural ecosystems. Sustainable development brings environmental quality and economic growth into harmony, not conflict."[2] One concrete approach to sustainable development was by-product synergy. BPS programs could effectively transform corporate liabilities into assets by converting wastes into saleable commodities, either as raw materials for another company's product or as the foundation for an entirely new product. The EPA defined by-product synergy as "the synergy among diverse industries, agriculture, and communities resulting in profitable conversion of by-products and wastes to resources promoting sustainability." Such synergy was not limited to manufacturing companies. For example, a fleet of trucks inactive between hauls could be considered a "waste" that could be better used by another company.

BPS programs were an improvement over simple waste exchanges. A simple waste exchange was a directory wherein firms could list their marketable wastes. It restricted potential synergies because firms perusing the list had to know exactly what materials they needed and even then could not be guaranteed a steady supply of quality materials. By-product synergy, by contrast, was like a dynamic waste exchange. It utilized a forum of business, regulatory, and community leaders from which ongoing, synergistic business arrangements could be established.

However, while by-product synergy was not a new concept, it had often proven difficult to implement due to a variety of factors, including technical, geographic, regulatory, legal, time, and informational barriers (Exhibit 1). One significant barrier was that most synergies occurred across, rather than among, industries. As companies focused on their own markets, competitors, and business models, executives had little time to evaluate the raw material requirements of companies in unrelated industries. Thus there was a role for impartial third parties to facilitate information flow and inter-company processes.

Chaparral Steel and Texas Industries

One of the first companies to adopt the by-product synergy concept was Chaparral Steel Company, a steel product manufacturer based in Midlothian, Texas. Its parent company, Texas Industries (TXI), manufactured Portland cement. In the early 1990s, Gordon Forward, then vice chairman of TXI, pursued a "zero waste, 100 percent product" approach to steel making. By bringing together managers of both companies, Forward was able to explore synergies that previously were unknown. In their most successful effort, the managers discovered that steel slag (a residual of the steel making process) could be converted to a raw material in Portland

[2] Deanna J. Richards et al., "Overview and Perspective," *The Greening of Industrial Ecosystems*, National Academy of Engineering (Washington, D.C.: National Academy Press, 1994), p. 5.

cement. They developed a patented process that converted the slag into a raw material for the cement. Management described the benefits of the CemStar process:

> CemStar allows cement manufacturers to skip two energy-intensive steps. The CemStar process uses steel slag that has already been subjected to the high temperatures of the steel furnace, which supplied the heat of formation of its principal compound, dicalcium silicate, the building block for Portland cement. This saves energy in the cement process, since the step doesn't have to be repeated. In addition, by using lime that has already been calcined, cement manufacturers are able to skip a step that would have expended considerable energy and generated CO2.[3]

In addition to increasing profits for both companies, Cemstar reduced energy requirements by 10 to 15 percent, reduced carbon dioxide emissions per ton of cement produced by over 10 percent, and greatly increased the value of the slag over its worth under previous use.

The Business Council for Sustainable Development—Gulf of Mexico

Forward's work inspired Andrew Mangan, executive director of The Business Council for Sustainable Development—Gulf of Mexico (BCSD–GM). In 1993, Mangan, along with a group of regional businessmen, founded BCSD–GM to "forge regional cross-border public-private partnerships that promote and implement sustainable development."[4] BCSD–GM, one of the seventeen regional councils of the World Business Council for Sustainable Development, was a non-profit organization of American and Mexican companies trying to implement the ambitious goal of sustainable development. In 1997, through the group's most successful project, Mangan brought together twenty-one major companies, primarily chemical and petrochemical firms, in the gulf port of Tampico, Mexico. With Mangan's guidance, and crucial leadership from Tampico businessman Eduardo Prieto, the companies identified sixty-eight potential synergies, of which twenty-nine had immediate commercial potential. Ultimately, they pursued thirteen demonstration projects. In one, a company's unusable butadiene (a hydrocarbon used in making synthetic rubber) was used as a lower-cost combustion gas at another firm. In another project, PVC residuals (a polymer resin) were converted into sole shoes.

APPLIED SUSTAINABILITY LLC

Excited by the success of the Tampico project and the promise of by-product synergy, Mangan and his colleagues decided to commercialize the BPS process by establishing a new company. In September 1998, he founded Applied Sustainability, LLC in Austin, Texas, funded by four companies: TXI and Conoco of the United States, Hatch Associates of Canada, and Grupo IMSA of Mexico. As president, Mangan quickly recruited technical and marketing expertise while securing the support of Gordon Forward, who joined as chairman. By the summer of 1999 prospects looked bright, and Mangan resigned from BCSD–GM to devote his full attention to Applied Sustainability.

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[3] This material first appeared in *The Bridge* 29 (1): 12–15, published by the National Academy of Engineering.

[4] The Business Council for Sustainable Development–Gulf of Mexico, "Mangan Moves On," *Gulf Council News*, summer 1999, p. 1.

Andrew Mangan

Mangan's deep affinity for the natural environment was rooted in Alaska, where he spent his summers during college as a commercial salmon fisherman. While there, he began writing for a local fishing magazine, which led to a journalism career that took him from China to Washington, D.C. As a congressional correspondent for the Associated Press in the early 1980s, Mangan soon learned how federal agencies worked, and did not work. However, after his third State of the Union address, he began to tire of the role and felt that there were other things he was interested in pursuing.

His entrepreneurial drive brought him back to Austin, his college town, where he became the deputy commissioner of the Texas General Land Office, responsible for the state's natural resource portfolio. Despite bureaucratic hurdles, Mangan was able to effect change through determination and consensus building. Given the challenge to implement a coastal management program in the late 1980s, he faced steep opposition from oil companies cautious of federal regulatory ties, as well as thirty different constituencies with diverse interests, all wary of one another. Yet Mangan brought them together to collaborate and eventually agree on a consensus bill that subsequently passed through the House and Senate and was signed into law.

Applied Sustainability LLC Business Description

Mangan founded Applied Sustainability in an effort to achieve one of BCSD–GM's core goals: "the replication of its sustainable development projects by groups of companies around the world."[5] Through its BPS program, Applied Sustainability served as consultant and facilitator to client companies throughout the process, from providing introductions to helping evaluate potential synergies. The company believed it brought significant value to clients, and highlighted key benefits in its marketing material:[6]

- ***Diversity***: The group of companies we bring together represent a wide variety of industries. This increases the potential for finding synergies, broadening the industries in which our participants find business opportunities.
- ***Uniformity and Confidentiality***: To identify synergies, participants' materials balance data are compared. Our data collection consultant visits all participants to assist them in reporting data in a consistent manner. All data provided to Applied Sustainability is confidential, and participants control what data they choose to report.
- ***Communication***: The confidentiality of our data collection process fosters trust between the participants, opening the door to sharing synergy ideas. Throughout the project, Applied Sustainability conducts facilitated brainstorming sessions with the group to help participants uncover all potential synergies.
- ***Partnerships***: We bring in technical consultants to help identify possible synergies. We also tap into the experience of our previous BPS projects in looking for synergies. Applied Sustainability leverages our relationships with technical consultants and regulatory agencies to assist participants in overcoming any barriers to implementing the synergies they identify.

[5] Ibid.
[6] Applied Sustainability LLC Web site (http://www.as-llc.com).

BPS Projects

Applied Sustainability began each project with the recruitment of fifteen to twenty diverse companies in an industrial region. In forming the initial cross-industry team, Applied Sustainability sought key companies to champion the project and cover initial project costs. Once the teams were formed, a process which lasted roughly three-to-four months, the project team began a formal process of identifying and evaluating synergies. After the initial valuation, the companies worked closely with Applied Sustainability to design and implement a customized BPS program. While there were some industry-specific steps and considerations, the process was structured in five major phases (Exhibit 2).

Alberta, Canada

Applied Sustainability initiated its first commercial BPS project in Alberta, Canada in February 1999. Participants included ten corporations and fourteen research, academic, and governmental organizations. The group selected twenty-five potential synergy opportunities to pursue as demonstration projects. For example, a Weyerhaeuser Kraft mill and a Husky refinery discovered that the refinery's spent caustic (contaminated NaOH) could be used to compensate for Na losses at the Kraft mill. The idea was tested, negotiated, and implemented in January 2000. The venture proved profitable for the companies and the environment: the companies saved approximately $300,000 annually, and the caustic could be reused rather than deep-well injected.

North Texas, United States

The North Texas group completed the synergy identification phase of the BPS program in April 2000. The participants met quarterly to provide support for existing implementation projects and to search for new synergy opportunities. One of the projects, implemented in November 2000, involved by-product water from a manufacturer of copper-impregnated graphite rods. The graphite company had previously disposed of the water as a "waste." In contrast, as part of the program it sold the water to another company, which extracted the copper for sale in the market. The synergy brought new revenues to the metal recovery company while providing cost savings of several thousand dollars annually to the graphite rod manufacturer.

Montreal, Canada

The Montreal project began in July 2000. The participants met quarterly to provide support for existing implementation projects and to search for new synergy opportunities. One synergy explored was the opportunity to use one company's by-product of relatively pure hydrogen gas as a fuel for several other companies, provided it could be transported economically.

BUSINESS MODEL CHALLENGES

Despite initial progress, Applied Sustainability encountered both business and regulatory barriers. In addition to coaching executives on how to think differently about products and wastes, Mangan also needed to price his services to reflect the value his company provided. Mangan commented:

> What we are selling is not only a new service, which we have to convince the companies is valuable, but also one that does not have a guaranteed end result.

> For example, we cannot say 'You pay us $10,000, and we guarantee you will get three synergies.'

Mangan also needed to convince executives that government regulatory organizations would support their efforts. Federal regulatory support was critical to the success of the program; yet historically, active regulatory relief had not consistently followed verbal support.

Business Barriers

New Perspective

Helping companies think differently about products and wastes was the first major hurdle for Mangan. Approaching the production process with a "100 percent product" objective was new for many companies. Mangan encouraged companies to view the process in terms of feedstocks, products, and by-products, emphasizing that by-products were not necessarily wastes. He also encountered organizational and operational barriers. For example, said Mangan:

> Some people at the operational level know the synergy connections that are out there, but they either do not have the incentive to make it happen, or there is a barrier in the way that they do not know how to overcome. That was the job of Applied Sustainability—to help them overcome the barriers and actually implement it.

On the corporate level, some CEOs were too focused on short-term performance and investor sentiment. From the company's inception, Mangan sought out like-minded CEOs who were already thinking about sustainable development and would be able to champion a project in their geographic region. In fact, Applied Sustainability's most successful projects were those in which Mangan had an existing relationship with the CEO project leaders. However, even when the CEOs were fully behind a project, many found it difficult to switch from a "competitive to a collaborative mindset," according to Mangan. This barrier became easier to overcome as executives began to work together on a personal level through regular meetings, building a sense of trust. Mangan believed that these personal relationships drove the success of the program: "through the BPS program, CEOs can make a very informed business decision based not only on the materials, but also on the relationships they have with the different companies involved."

Pricing Model

In its first BPS project in Alberta, Canada, Applied Sustainability charged a flat fee per company for its services. However, because the end result was long-term and uncertain, investing in the program was difficult for executives to justify in purely financial terms: there was no estimated return-on-investment (ROI). Additionally, companies wanted Applied Sustainability to work with them beyond the first year to provide a catalyst and ensure continuity.

These issues prompted Mangan to reevaluate the company's pricing model, and he developed a graduated formula that combined a flat fee with revenue sharing. Clients could choose from five options, from a small up-front fee with less revenue sharing (i.e., Applied Sustainability kept more of the revenues) to a large up-front fee with 100 percent share of the revenues. However, while this addressed the issue of a lack of demonstrable ROI, it created new obstacles. First, clients' lawyers were concerned that the percent of shared revenue could become millions of dollars and were reluctant to commit to such an amount. Second, determining a baseline to

measure performance was subjective. Third, the negotiation process was costly for both parties. Finally, the long-term nature of the pay-off strained Applied Sustainability's resources. Mangan commented: "That proved to be too long-term a commitment for us. We didn't have the staying power to be able to be there." In the end, Applied Sustainability reverted to a flat-fee charge that scaled based on the size of the client's revenues.

Regulatory Barriers

Federal Support

The EPA had been broadly supportive of by-product synergy and of Mangan's efforts in particular. However, the support had been largely verbal, as existing laws frequently prevented companies from taking imaginative steps toward achieving the mutually supported goal of sustainable development. According to Mangan:

> Federal inaction was due in part to the command and control structure of the EPA and the federal government, which commands that you deal with materials a certain way under the law. This effectively eliminates innovation because companies have no motivation or incentive to move in that direction.

The EPA recognized these obstacles, but it was hindered by legal and operational barriers. For instance, the EPA's Project XL[7] foundered in Minnesota in 1996 due to legality concerns and ambiguous definitions of environmental terms. 3M ultimately dropped out of the program rather than guarantee "superior environmental performance," a measure neither defined nor quantified by the EPA. The legality of granting modifications or waivers from environmental regulations (such waivers were fundamental to the success of the program) was also an issue, as companies feared lawsuits without explicit legal protection. Moreover, Andy Ronschak, the Minnesota Project XL coordinator at the time, believed that national legislation was critical to the success of the program. The Minnesota Center for Environmental Advocacy also believed that "legislation that authorizes EPA to waive federal environmental statutes for experimental programs would help overcome barriers."[8]

Defining 'Waste'

The EPA's definition of 'waste' was also a major hurdle. Rebekah Young, an Applied Sustainability employee, commented:

> Once something is defined as a waste, it is subject to a unique set of regulations governing its transportation and disposal. The concept excludes the consideration of re-use, thus it is a cumbersome process for an industry to gain permission to adopt approaches other than those outlined in the regulations.[9]

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[7] Project XL, one of President Clinton's key environmental reinvention initiatives, is a "national pilot program that allows state and local governments, businesses, and federal facilities to develop with the EPA innovative strategies to test better or more cost-effective ways of achieving environmental and public health protection. In exchange, the EPA will issue regulatory, program, policy, or procedural flexibilities to conduct the experiment." EPA Web site (http://www.epa.gov).

[8] Janet Pelley, "Project XL Founders in Minnesota; Critics Call for National Legislation," *Environmental Science & Technology*, October 1996 (http://pubs.acs.org/hotartcl/est/96/oct/oct.html).

[9] The Business Council for Sustainable Development–Gulf of Mexico, *By-Product Synergy: A Demonstration Project, Tampico, Mexico*, August 1999, p. 12.

Moreover, the Resource Conservation and Recovery Act (RCRA) imposed a "cradle-to-grave" responsibility on generators of hazardous waste. The originator of the hazardous waste remained liable for any resulting environmental damages regardless of whether they still owned and controlled the materials. Thus, despite worthy intentions, RCRA presented companies with a very strong disincentive to explore innovative approaches to materials reuse.

NEW BEGINNINGS

Facing these obstacles and dwindling funds, Applied Sustainability as a legal entity dissolved in May 2001. Despite this setback, however, the by-product synergy movement had not died. Hatch Associates, a Toronto, Canada-based engineering consultancy, continued to pursue BPS projects as part of its sustainable development business. Gordon Forward, a member of the National Academy of Engineering, had championed the benefits of by-product synergy to that organization. Mangan pursued his mission, working with CH2M Hill, a Colorado-based engineering consultancy that had expressed both a financial and business interest in Applied Sustainability. BCSD–GM also expressed interest in working with Mangan again to restart its by-product synergy efforts that had languished after the organization spun off Applied Sustainability.

Mangan began working with a multinational corporation that was enthusiastic about pursuing by-product synergy initiatives to achieve its sustainable development goals. The company asked Mangan to help them evaluate a pilot BPS project to implement internally. One major barrier was already overcome: the company had the resources to cover the time and expense necessary to identify and implement the synergies. If successful, the company might incorporate Mangan's expertise into a new, internally funded business unit that would reach across the parent corporation's global organization.

Mangan was further encouraged by enquiries from international agencies. The World Bank and the Inter-American Development Bank had both expressed interest in implementing BPS projects to help developing countries build out their infrastructure. Yet Mangan's most promising opportunity was a domestic one, championed by Robert C. Shinn, Jr., the forward-thinking commissioner of environmental protection for the state of New Jersey.

The New Jersey Department of Environmental Protection

The New Jersey Department of Environmental Protection (NJDEP) was created on April 22, 1970, the first official "Earth Day," to manage the state's natural resources and to tackle pollution problems. Under Commissioner Shinn's leadership, the department focused on "integrating environmental, health, and economic considerations to reach sustainable developmental goals based on sound scientific data and a comprehensive indicator monitoring system to measure progress."[10] New policies and regulations instituted under Shinn emphasized compliance assistance and cooperation combined with strict governmental oversight and enforcement.

Robert C. Shinn, Jr.

Shinn, a nationally recognized leader in performance-based and market-oriented regulation, became commissioner of the NJDEP on February 7, 1994, under the appointment of then-

[10] NJDEP Web site (http://www.state.nj.us/dep).

Governor Christine Whitman. As DEP commissioner, Shinn implemented the first facility-wide permit program in the country, established an Office of Innovative Technology and Market Development, and created a National Environmental Performance Partnership System with the EPA.

Prior to his position as Commissioner, Shinn served for twenty-six years as an elected official at the local, county, and state levels, focusing on environmental protection issues. From 1985 to 1994, he served as a New Jersey State assemblyman. Shinn's legislative accomplishments included authoring New Jersey's Water Supply Critical Area Law, guiding passage of the state's mandatory recycling act, and authoring a law regulating the handling and disposal of medical waste in New Jersey. Shinn had also served as president of the Environmental Council of the States, a national association of state environmental commissioners, and as a board member of the Center for Clean Air Policy, an international air policy organization.

The Silver and Gold Track Program for Environmental Performance

The NJDEP recognized that the traditional command and control approach to environmental regulation inhibited both business and environmental innovation. In 1999, in an effort to implement a "regulatory structure that requires accountability, measures environmental performance, provides operational flexibility, and produces environmental results," the NJDEP introduced the Silver and Gold Track program.[11] The program offered different degrees of regulatory flexibility and oversight depending on corporate environmental performance (Exhibit 3).

Many businesses expressed strong interest in the program and the environmental regulatory flexibility it offered. However, the requirements to participate were strict, severely limiting the number of companies able to qualify. Shinn was eager to expand participation in the program, but did not want to compromise the department's high environmental standards. Shinn, who first met Mangan when they served together on the board of the Center for Clean Air Policy, believed that incorporating a BPS project into the Silver and Gold Track program would be an effective way to grow the program while promoting corporate environmental innovation and responsibility. In February 2001, Shinn invited Mangan to present a proposal to the NJDEP to implement and manage a BPS project in New Jersey. However, while Shinn and his department were enthusiastic about the prospect of a BPS project, the NJDEP could not directly support the effort with CH2M Hill, a private enterprise, without independent verification of the technological and economic soundness of Mangan's BPS program. Thus, talks slowed while Mangan's BPS process was evaluated by the New Jersey Corporation for Advanced Technology (NJCAT), an independent certifying group.

MOVING FORWARD

In November 2001, the NJDEP notified Mangan that it had certified the NJCAT's report. Mangan hoped the endorsement would help him gain ground in recruiting companies for the New Jersey project and elsewhere. Mangan smiled as he read the letter from the NJDEP:

> NJCAT's verification documents that the BPS process is based on sound scientific and technical principles, and that the overall BPS process can result in

[11] Ibid.

> the reduction of energy usage and significant amount of greenhouse gas emissions…and [that it] will result in a significant net environmental benefit.[12]

Once again, the future looked bright for Mangan. The project in New Jersey was moving forward, and Mangan was making progress with the EPA. The EPA was considering implementing a BPS project in its Performance Track program, which was modeled on New Jersey's Silver and Gold Track program. Using the New Jersey experiment as a pilot, the agency's goal was to implement such a program nationally. In addition, plans for implementing a BPS program with the multinational corporation client were proceeding well. An initial five-day intensive evaluation of the BPS process led to a proposed six-month pilot project. With these successes, Mangan had an opportunity to revive Applied Sustainability. Yet he had to decide if this progress was sufficient to support a fresh start with his company. As he boarded yet another plane, Mangan reflected on his decade-long struggle and the options facing him. Was the time right?

[12] NJDEP letter to Andrew Mangan, November 14, 2001.

Exhibit 1
Barriers to By-Product Synergy

Barrier Type	Question	Recommended Principles
Technical	• Is conversion of the by-product to the resource technically feasible?	• Process technical experts should participate in project planning/implementation. • All technical options should be evaluated (including patented processes). • Innovation should be encouraged to develop new conversion processes.
Economic	• Is conversion of the by-product to the resource economically feasible?	• *True* project economics should be evaluated using life cycle cost analysis and full-cost accounting tools.
Geographic	• Can the by-product be safely and economically transported from its generator to its consumer?	• Transportation options and economics should be evaluated.
Regulatory	• Is transportation or use of the by-product regulated? • Will the use of the by-product as a resource lead to additional regulation of the process (for example, by adding trace contaminants to the process)?	• Potentially applicable regulations should be evaluated to identify issues. • Regulatory experts should participate in project evaluation. • There should be communication and collaboration with legislators and government agencies to achieve regulatory relief if necessary. • Innovation is needed to create strategies for dealing with regulatory issues.
Legal	• Could the use of a "waste" in the process lead to increased liability? • Is transportation or use of the by-product prohibited?	• Potentially applicable laws should be evaluated to identify issues. • Legal experts should participate in project evaluation. • There should be collaboration with partners to share or reduce liability risks.

Source: The Business Council for Sustainable Development–Gulf of Mexico, *By-Product Synergy: A Strategy for Sustainable Development—A Primer,* April 1997, pp. 16–17.

Exhibit 1 (Cont'd.)
Barriers to By-Product Synergy

Barrier Type	Question	Recommended Principles
Business	• Could the project lead to a loss of competitive advantage? • Are partners willing to make a long-range commitment to the project? • Is project funding available? • Are reliable markets available for products produced via by-product synergy?	• The competitive situation and market potential should be evaluated. • Partners should collaborate to (1) protect intellectual property through patents, trade secrets, and other methods; (2) make long-range commitments through negotiated contracts; and (3) secure funding. • Innovation is needed to identify new markets, alternative sources of funding, create unique business alliances, etc.
Social	• Does the public mistrust the motives of the organizations involved in the project? • Does the public have "Not in my back yard" syndrome? • Will the public resist the purchase of products produced from "waste"?	• There should be communication with community leaders and citizens about the project, emphasizing its environmental and social benefits. • Where feasible, business, government, and communities should collaborate on projects.
Time	• Is by-product synergy a low priority in the organization?	• Employees/citizens should be motivated by senior organizational leadership to make by-product synergy a priority using performance goals and measures, and other incentive programs.
Informational	• Is information about candidate by-product and resource streams available? • Is information about potential partners available? • Is information about conversion technology available?	• Employees/citizens should be motivated by senior organizational leadership to increase availability of information using performance goals and measures, and other incentive programs. • Potential partners and other stakeholders should communicate and collaborate to increase availability of information.

Exhibit 2
Steps in the By-Product Synergy Process

Phase 1 **Planning/Organization**	Step 1	Obtain organizational leadership commitment to by-product synergy
	Step 2	Set organizational goals for by-product synergy
	Step 3	Define individual incentives for supporting by-product synergy
	Step 4	Raise awareness about by-product synergy
	Step 5	Form teams for participating in by-product synergy projects
Phase 2 **Assessment/Prioritization**	Step 1	Identify candidate waste, by-product, and resource streams
	Step 2	Characterize candidate streams
	Step 3	Identify and contact potential collaboration partners
	Step 4	Form joint teams with selected collaboration partners
	Step 5	Identify technical, economic, geographic, regulatory, legal, business, social, time, informational, and other factors impacting project feasibility and estimate probability of overcoming them
	Step 6	Do preliminary feasibility studies
	Step 7	Review results and prioritize potential projects for further evaluation
Phase 3 **Evaluation/Decision-Making**	Step 1	Perform detailed feasibility studies addressing technical economic, geographic, regulatory, legal, business, social, time, informational, and other factors
	Step 2	Define performance metrics by which project success will be measured
	Step 3	Determine whether project is viable
Phase 4 **Implementation**	Step 1	Obtain project funding
	Step 2	Develop implementation plan
	Step 3	Implement project
Phase 5 **Monitoring and Improvement**	Step 1	Monitor performance metrics
	Step 2	Evaluate project performance
	Step 3	Take corrective action to improve project performance as necessary

Source: The Business Council for Sustainable Development–Gulf of Mexico, *By-Product Synergy: A Strategy for Sustainable Development—A Primer*, April 1997, p. 20.

Exhibit 3
Silver and Gold Track Program Summary

Level	Requirements	Benefits
Silver Track	• Have no significant violations as defined in EPA and New Jersey regulations for past five years • Have no criminal violations • Maintain up-to-date facility or institutional environmental plans • Develop and implement an Operations and Environmental Compliance plan • Develop and implement a Community Outreach plan	• Corporate recognition • Single point of contact within NJDEP • Expedited permit processing • Consolidated and simplified reporting of operations • Consultation by NJDEP on application for new permits and permit modifications
Silver II Track	• Silver Track requirements • Achieve verifiable reduction of greenhouse gas emissions over time	• Silver Track benefits • Waiver of requirement to obtain certain air pollution control pre-construction approvals
Gold Track	• Silver II Track requirements • Achieve hazardous air pollutant emission reductions over time • Commit to enhanced handling, storage and treatment of hazardous waste • Implement ways to reduce potable or surface and ground water use through conservation and/or effluent reuse • Incorporate enhanced pollution prevention and/or source reduction in day-to-day operations	• Silver II Track benefits. • Expansion of the de minimus concept to establish facility-wide emission caps • Exemption from definition of solid waste materials (that would otherwise be listed as hazardous waste) destined for recycling • Reductions in monitoring frequency for water discharges

Source: NJDEP Web site (http://www.state.nj.us/dep).