

**REMOVAL/RECOVERY OF METALS  
FROM INDUSTRIAL SOLUTIONS AND WASTEWATERS  
BY NEW BIOSORBENT MATERIALS**

**THE COMPANY GROWTH**

**4 STAGES**

***OUTLINE OF THE COMMERCIAL VENTURE***

Original research work by Professor Volesky at McGill University in Montreal has led to significant discoveries involving the use of non-living microbial biomass. Several patents resulted from these efforts which provide a basis for a new family of products called BIOSORBENTS. These biosorbent materials can be used just like ion exchange resins or activated carbon in removal of heavy metals from dilute solutions. At this point it should be stressed that some biosorbents in certain applications outperform commercial ion exchange resins or activated carbons currently used in metal recovery processes and wastewater purification applications. Biosorbents bind and concentrate heavy and precious metals, sometimes very selectively, when contacted with metal-bearing solutions either in mixed tanks, fixed bed or fluidized bed flow-through columns. When saturated with deposited metals, the biosorbent granules are washed, releasing the metal in high concentrations. Following this regeneration they can be used many times over again in repeated operation cycles improving thus significantly the overall economy of the process.

Heavy metallic elements are toxic and discharge of metal containing industrial solutions or wastewaters poses an environmental hazard. The application of cheap biosorbents in detoxification of industrial wastewaters will make their treatment economically feasible. Metals of value can even be recovered this way for reuse or resale. The application potential of the new metal removal/recovery biosorption technology is very broad and the projected low price of the new biosorbents is likely to make them extremely competitive. They are produced from waste microbial biomass rejected by large-scale fermentation operations. Algal biomass for certain types of biosorbents can be collected in large quantities from the oceans.

In order to bring the new biosorbent technology to its full commercial potential, the newly formed company, BV SORBEX, Inc., plans to do so in several venture *development stages* enabling the reassessment of the enterprise after each stage and allowing good control of the growth of the Company. The first two stages of the venture development process cannot be expected to produce any financial return. The third stage should see the beginning of the client-Company interaction and contract-based cash flow. Following the venture consolidation, refinancing and manufacturing plant start-up investments, *Stage 4* should start generating a *positive cash flow*. In the following briefs the summary of individual stages for the development of this commercial venture based on new biosorbent technology are outlined.

Outline of Commercial Venture: EXECUTIVE SUMMARY

## STAGE 1

### FEASIBILITY OF THE BIOSORPTION VENTURE

A considerable amount of research on biosorbent materials has developed a solid basis of knowledge and indicated their enormous potential. The highest priority at this stage is the preliminary and approximate assessment of the commercial potential and feasibility of application of the new technology based on the family of new biosorbent products. Correspondingly, STAGE 1 consists of two basic studies:

#### A) ASSESSMENT OF THE COMPETING TECHNOLOGIES

The current costs and market share of the established conventional processes for metal removal/recovery from dilute solutions or wastewaters have to be summarized and assessed. Similarly for new unconventional and even new biosorbent-based processes which are approaching the stage of application in the field.

#### B) ASSESSMENT OF THE MARKET SIZE

While it is known that the environmentally-based market for metal removal/detoxification of metal-containing (industrial) effluents is enormous, the actual figures to support this generally prevailing perception would be most convincing although not essential for launching the Company enterprise. A quantitative review of the potential clientele is to be carried out for different countries where the Company may consider operating its processes.

Comparison of costs between the conventional and the new technology establish the feasibility of biosorbent applications and their competitiveness in the market place. As the application of biosorbent technology proves cheaper and more competitive it is anticipated that new applications will significantly increase the size of the current market.

***STAGE 1* has been practically completed resulting in 2 thorough *studies* summarized in comprehensive *Reports*. Participation of independent consultants for impartial conclusions was secured.**

**Findings most encouraging for the enterprise are reflected in the Company Business Plan.**

**ASSESSMENT OF NEW BIOSORBENTS COSTS**

At this point it is not known what exactly would be the real production costs of new biosorbent materials processed into suitably applicable granules. Approximate costs of different types of raw biomass need to be ascertained, as well as the costs of processing the biomass into applicable biosorbent materials maintaining their high sorption efficiency.

*STAGE 2 will require:*

Travel and fact finding efforts necessary to reliably establish the exact costs and conditions under which waste industrial biomass can be obtained from the large-size industrial operators.

Similarly for the price of ocean-based biomass of selected marine algae which has to be collected from high seas or offshore areas.

Estimation of the costs of preprocessing and drying the raw biomass to prevent its degradation will have to be carried out for selected representative types of biomass available in large quantities.

Preliminary technical work to be carried out on the processing necessary for biomass formulation into a biosorbent product suitable for process uses. It is anticipated that different raw biomass materials (algae, fungi, bacteria) will require different and specific treatment for their optimal formulation into finished ready-to-use products. This part will entail specifically planned small-scale laboratory work and preliminary optimization of the procedures involved resulting in an efficient biosorbent material.

***THE OVERALL OBJECTIVE:***

Reliable estimate of the biosorbent production costs for selected representative biosorbent materials.

Ideally, **STAGE 2** could be carried out simultaneously with **STAGE 1** as part of a better quantitative venture feasibility assessment.

However, it could also become part of the following scaled-up pilot-plant effort planned as **STAGE 3**.

**The budget for STAGE 2 has been estimated at US\$ 300,000 for approximately a 6 month period**

## **FORMULATION OF BIOSORBENT MATERIALS AND CLIENT-BASED FIELD TESTS**

Positive conclusion on the feasibility of a commercial biosorbent technology venture based on *STAGES 1* and *2* would be ideally a basic "go-ahead" for *STAGE 3*. The spectrum of biosorbent materials for different applications has to be technologically formulated for optimal production and use. This involves:

- establishment of the raw biomass materials supply;
- optimization of the biomass processing technology;
- optimization of the biosorbent granule properties;
- optimization of the biosorbent application mode;
- selection of clients for cooperative tests.

This line of work is expected to be highly technical and laboratory based, requiring skilled manpower. The result:

- selected biosorbents available in (kg) quantities;
- small biosorbent production unit;
- small pilot plant (mobile) application equipment;
- a line of industrial clients identified.

Planning of *STAGE 3* is summarized in a detail proposal which can be modified to suit the circumstances of the agreed-upon Company financing. This stage of work is not considered to be carried out as a Company in-house activity. For a better efficiency at this stage, a suitable arrangement may be negotiated utilizing the existing expertise and equipment at McGill University in Montreal and/or the Company partners.

**STAGE 3 budget is estimated at an approximate total of up to US\$ 3,000,000 over a period of no more than 2 years.**

It is based on a team of probably 4 technical professionals, supporting staff, (pilot) equipment manufacturing and assembly costs, supply materials, travel expenses and an appropriate overhead.

Outline of Commercial Venture:

EXECUTIVE SUMMARY

**STAGE 4****FULLY COMMERCIAL BIOSORBENT ENTERPRISE**

Based on the findings of *STAGE 1* reviews it can be realistically envisioned that the biosorbent technology is well poised for penetrating the market for metal removal and recovery from industrial solutions. The Company development stages have been designed to develop a solid basis for the full-scale commercialization of the new technological venture.

A well organized corporate structure, scaled-up production facilities, and engineering services supporting the application of the new technology are the goal of the totally re-financed and restructured Company in *STAGE 4* which should see:

- securing of raw material supplies
- scaled-up biosorbent processing facility
- marketing strategy for the product lines
- line-up of potential clients (from *STAGE 3*)
- alternative contract schemes for technology application
- further innovative R&D on new products and applications of biosorbents.

Consolidation of the Company and its own production facilities, as well as R&D activities will have to take place early in *STAGE 4*.

Aggressive marketing of the product lines, of the technology, and eventually of the whole service package arrangements including the marketing of or profit sharing on the recovered metals will be essential at this stage. Solid corporate strategies will have to be developed in this respect to back dynamic sales efforts.

This restructuring of the Company and consolidation of its own R&D as well as its scaled-up production facilities will require a certain infusion of capital in another phase of Company restructuring (as yet unspecified at this planning stage). Appropriate negotiations will be initiated in time for developing the most suitable consolidation scheme.

*STAGE 4*, after 2 to 3 years of initial investments in STAGES 1, 2, and 3, should start generating net return on investment with an attractive profit margin based on the innovative nature of the Company business and new market opportunities being gradually opened.

***STAGE 4* represents an open-ended business operation with a steadily increasing cash flow and a healthy operating profit margin. By this time the equity of the original investors in the Company represents an exciting return on the original investment.**

Commercial Venture:

## Where is BV SORBEX ?

### THE SUMMARY OF THE BIOSORPTION VENTURE SITUATION

- 1) The know-how for the metal biosorption technology resides with BV SORBEX, Inc. which is an upstart Montreal (Canada) based privately owned enterprise.
- 2) Most of the R&D advances have been made in McGill University laboratories.
- 3) For very practical reasons it may be advisable to support the pilots from the University or local government laboratories.
- 4) The technology is ready to go “demonstration pilots” with 2-3 well selected industrial sector clients.  
Mining and electroplating industries and/or arsenic water decontamination have been singled out as priority targets.
- 5) The piloting operations will require approximately :  
2 YEARS and the grand total of roughly US\$ 2.5 million.
- 6) This investment could be:
  - supplied in STAGES enabling better progress control;
  - provided by one investor (for better control) or by several parties (an appropriate control sharing has to be agreed upon).
- 7) The initial guaranteed start-up financing should be in the order of **US\$ 400,000**, to be extended based upon satisfactory progress.
- 8) The pilot stage will:
  - demonstrate the feasibility and scale-up of the process;
  - explore the market and line up further clients.
- 9) Following the pilot stage, a **RESTRUCTURING** (Stage 4) of the venture is anticipated to secure operating capital:
  - establishing client consulting activities (providing cash-flow);
  - government participation schemes (grants, tax credits);
  - further guarantees of private and/or corporate placement (?);
  - going public (IPO) to secure operating capital (?).

There are many possible ways of “skinning the cat” – of setting up the partnership(s) in this venture. What remains to be specifically negotiated:

- the ownership and control of the technology venture enterprise;
- the exclusivity of the technology operation and licensing considerations;
- the participation of additional partners,  
(contributing engineering, sales and/or financial component(s) ...)

Technically, the **technology is sound and working**. No major technical obstacles are foreseen, process scale-up is known and NOT considered a problem, driving environmental pressures are steadily mounting. As expected, the “**sales**” are the most sensitive aspects. The art of “**deal-making**” is crucial for formulating a reliable venture enterprise infrastructure.

