Voisey's Bay Nickel Project
Hydromet Demonstration Facility
Business Opportunities Study

Prepared by:

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and
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Prepared for:

Government of Newfoundland and Labrador
Department of Natural Resources

under the

Canada/Newfoundland Comprehensive Economic Development Agreement

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GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

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1) Background

Project History

In September 1993, the Voisey's Bay (nickel –copper – cobalt) deposit was discovered on the coast of Labrador, 350 km north of Happy Valley-Goose Bay by Diamond Fields Resources (DFR). In 1996, Inco Ltd. acquired the rights to the Voisey's Bay property from DFR and formed the Voisey's Bay Nickel Company (VBNC), as a wholly-owned subsidiary, to be responsible for development of the project.

Negotiations between VBNC and the Government of Newfoundland and Labrador to commercialize the discovered resources were ongoing from 1996 to 2002. In June 2002, both parties reached an agreement on a $2.9 billion project to develop the deposit. The development plan includes the construction of an integrated mine and concentrator at Voisey's Bay in Labrador, and a demonstration scale hydrometallurgical processing facility in Argentia, Newfoundland.

VBNC committed to the construction and operation of a hydromet demonstration facility at a total cost of $150 million, including approximately $100 million in capital costs and $50 million over a 2 year period to operate the facility. VBNC's overall hydrometallurgical processing program began with basic research, was followed by the operation of a mini pilot plant (both of which occurred at Inco's Sheridan Park research facility) and will culminate with the construction and operation of the hydromet demonstration facility at Argentia.

The Resource Base

The Voisey's Bay mineral deposit, which is a sulphide deposit, containing nickel (Ni), copper (Cu) and cobalt (Co), is classified into two main types: Mineral Reserves and Mineral Resources. These resources are contained in four main deposits.

- Ovoid and related deposits (Mineral Reserve)
- Eastern Deeps (Mineral Resource)
- Reid Brook (Mineral Resource)
- Discovery Hill (Mineral Resource)

The proven reserves at this time are contained in the open pit Ovoid and related deposits, which have a total of 32 million tonnes.

Project Development Plan

The Voisey's Bay project will be developed in phases. During the first phase an open pit mine with a daily ore output of 6,000 to 7,200 tonnes will be operated. The majority of the concentrate produced will be sent to existing smelters in Sudbury, Ontario and Thompson, Manitoba for further processing. However, 1500 tonnes per year will be redirected to the hydromet demonstration plant and used to test the process and determine if a commercial scale plant is technically and economically feasible. A decision on the feasibility of

constructing a commercial scale hydromet facility is to be made by the latter part of 2008. In the event it is determined not to be feasible, a nickel matte facility, or another incorporating proven technology to produce a finished nickel product, is to be built.

2) Physical Facilities

The site selected for the facility is located at Argentia, on the former United States Naval Base, in the area that formerly accommodated an airfield. It is very close to existing docks and roads and is removed from any existing residential developments. For the purpose of this report, the complete site being constructed is referred to as the hydromet demonstration facility. This includes all buildings and site infrastructure. In contrast, the process building refers to the new building containing the infrastructure and equipment required for hydrometallurgical processing.

The major components which make up the demonstration facility include:

- Process building and associated equipment
- Warehouse/storage/laboratory/office building
- Container storage/laydown area
- Residue, treatment, settling and polishing ponds and associated piping
- Sewage collection and treatment system
- Fresh/fire/process water distribution system connected to existing municipal water supply
- Guardhouse
- Site electrical c/w emergency generator and fuel tank
- Site roads and parking areas
- Chain link fencing
- Storm water collection and drainage system
- Telecommunications

Process Building

Of the major components listed, the hydromet process building will be the most complex. The building will be comprised of a combination of stick-built components built directly on site and pre-assembled units (PAU) or skids that will be constructed at fabrication facilities and brought to the site to be installed, hooked up and commissioned.

The building will have a 4,000m^2 footprint and will contain the following process module groups or packages:

- Crushing and grinding
- Atmospheric leaching
- Pressure leaching
- Counter-current decantation (CCD)
- Iron removal
- Solvent extraction
- Utilities
- Neutralization

- Reagent preparation
- Control room
- Electrowinning

Hydrometallurgy Process

In pyromeallurgical processing, the concentrate must go through two stages before finished nickel is obtained: smelting and refining. The hydrometallurgical process essentially entails a single refining process that removes impurities while separating and recovering the metal components. Hydromet has a major environmental advantage over conventional smelting since most of the waste products from the process are not produced as air emissions, but rather as solids which can be easily contained. The process will also yield more of the valuable cobalt which is lost to a great extent in the smelting process.

Process Options

Two processes will be tested in the demonstration plant: an all sulphate process, and a process to which chloride is added. The chloride is added to aid in extraction of the metals and to provide other process benefits, and is recovered in the electrowinning steps as chlorine gas. Each process has various advantages and disadvantages of both a technical and commercial nature, and both must be studied in detail so that the most economical process can be carried forward to the commercial scale.

The demonstration plant will be operated at approximately $1/100^{th}$ of the throughput for the commercial plant. The operation will be on a continuous basis but will go through idle periods when the equipment is inspected and circuit modifications made. The purpose is to develop and advance the technology and test the two flow sheets to assess the viability of constructing the commercial plant.

Labour Requirements

During the construction phase of the project it is anticipated there will be a peak workforce of approximately 60-70 people with an anticipated requirement of 150,000 person hours at site and 100,000 off site. For the operating phase the workforce is projected to be 150.

3) Voisey's Bay Nickel Project Procurement Framework

There are several major agreements governing implementation of the Voisey's Bay project. These include:

- Voisey's Bay Development Agreement
- Industrial and Employment Benefits Agreement (IEBA)

The IEBA forms part of VBNC's Development Agreement with the Government of Newfoundland and Labrador, and commits VBNC to a number of procurement and supplier development principles and initiatives.

Procurement and Contracting Philosophy

VBNC's contracting philosophy is based on adhering to the commitments made in the IEBA with the Government of Newfoundland and Labrador. This agreement contains a commitment to full and fair opportunity and first consideration for qualified NL businesses. VBNC evaluates potential suppliers based on a number of factors such as cost, knowledge and ability.

To assist NL firms acquire business opportunities for the construction phase of the project, VBNC has initiated and will maintain a supplier pre-qualification procedure that will ensure all companies with the required capabilities are identified and known. This process also helps businesses understand the requirements of supplying to a major company such as VBNC. The first step in the pre-qualification procedure is for companies to register on the vendor database through the submission of an Expression of Interest (EOI) to VBNC.

During the infrastructure construction phase of the project thus far NL based companies have obtained the majority of the packages for construction and services that have been awarded by VBNC and have been pre-qualified to bid on all remaining packages.

Contracting Options

It is anticipated VBNC will use one or more of the following options for contracting and procurement during all phases of the project. NL firms are encouraged to study all the opportunities listed on the VBNC website and in this and other documents.

Contract Types
Cost-plus pricing
Fee-for-Service

Procurement Methods
Competitive tenders
Sole source

Inventory Management Options
The management of inventory for the demonstration plant will most likely be incorporated within the original procurement strategy. It is obvious from the contract packages which have already been listed that all new equipment will be ordered with a two year compliment of spare parts. Since the plant will only run on a partial basis for this timeframe, it is not anticipated that a large inventory of parts will be required.

Other Considerations

As this is the first facility of its type in the province, and in Canada, there may be some specialized supplies, services and equipment that are not currently available through existing Newfoundland and Labrador businesses. Since some aspects of this process are experimental and highly specialized, there may be opportunities for local firms to take advantage of "technology transfer". This can be achieved by joining forces, or partnering with firms that have the expertise, and training local workers where necessary so they can gain the

knowledge and skills required to support the operation. In this way local firms will then be well positioned to take advantage of future opportunities that may arise.

4) Construction Phase Opportunities

It is expected the Argentia Hydromet facility will constitute a capital expenditure of approximately $100 million over an 18 to 24 month timeframe. Of this total it is anticipated that $16 million will go towards civil type infrastructure and approximately $85 million being used for process equipment and installation. Applying general information used in the industry, approximately 20% of the total cost is expected to cover wages and salaries (including benefits) This would leave approximately $80 million for supplies, equipment, materials and consumables required for the full construction phase.

Process Construction and Fabrication Opportunities

The philosophy being applied to the process equipment fabrication by VBNC is to utilize pre-assembled unit construction as much as possible with the work split into small packages where feasible. This will result in a significant amount of the work undertaken in fabrication shops with the completed units (skids) then being transported to the site for installation, final hook-up and commissioning. The philosophy is also to standardize components as much as possible in order to reduce the number of spares and maximize the opportunities for interchanging of parts.

The plant consists of a number of circuits which will be grouped into packages for fabrication by contractors. The final phase will be completed by one installation contractor who will also complete all process related architectural, mechanical, electrical and instrumentation circuits required to complete the building interior and make the plant operational. This will also include completion of the plant control and electrical rooms.

Pre-Assembled Unit (PAU) Fabrication

While the equipment requirements for each skid will vary, in general each one will require tanks, pumps, motors, piping, valves, pressure and/or non-pressure vessels etc. The materials of construction for the components will vary from plastic, FRP, steel, carbon steel, stainless steel, titanium and alloy. As well, each skid will be fitted with an array of gauges and instruments to measure all aspects of the process. There is a requirement for specialized equipment and components, some of which will be custom made for this particular application. From a quantity perspective, the major items include a significant number of tanks and pumps. There is also a large quantity of plastic tubing and piping and fiberglass grating required.

Section 4.2 details an extensive listing of the many components and services that are required during the skid fabrication process. It is quite conceivable that skids will be fabricated in several locations thus the potential for a number of businesses contributing to the final product.

Building, Sitework and Service Opportunities

The size and scope of construction of the demonstration facility buildings and sitework incorporates a varied number of contracts for materials, equipment and services. The major expenditure for this portion of the project is associated with the process building envelope and preparation of the site, including provision of water and sewer.

Section 4.4 details a list of the many contracts which must be undertaken in order to render the facility completely operational. All of this work is necessary to provide the following infrastructure:

- Electrical power
- Water (fire, process, potable)
- Communication service
- Sewage treatment
- Office/laboratory/storage
- Residue ponds
- Storm sewer and roads
- Process building

Newfoundland and Labrador Construction Sector Capabilities

In general terms the provincial business community is well equipped and positioned to provide construction and support services to the hydromet facility. The construction of both the Hibernia platform (GBS and some topsides) and Terra Nova with it's variety of both topside and sub sea components and the ongoing activates related to the White Rose oil field have given the business community the opportunity of improving upon and increasing the level of capability related to infrastructure. Equally important are the human skills required for complex applications.

There have been studies undertaken to analyze the province's capabilities related to the manufacture of the various sizes of tanks that must be made using fibre reinforced plastic. It is the understanding of the study team that there have not been any deficiencies identified in this sector. Existing manufacturers of fibreglass products have the capability, or could expand their capabilities, to meet the demands of this project.

In addition a study of local fabrication capabilities was also undertaken. Over the past 20 years there has been a significant upgrading of the physical infrastructure in the area of metal fabrication facilities. As a result no major deficiencies were found. However, there are some highly specialized components which, because of the nature of the items in relation to the process and the associated expertise required, may not be fabricated locally.

In summary, the following business areas represent a substantial portion of the requirements for this project and can be provided locally:

- Reinforced glass fibre fabrication for a large number of tanks
- Steel fabrication facilities which can accommodate the skids and have specialized welding capabilities

- Electrical controls and instrumentation design, fabrication, installation, operation and maintenance
- HVAC equipment installation and servicing

5) Argentia Hydromet Facility Operations Phase Opportunities

The total operating cost for the life of the demonstration plant is projected to be $50 million with the following breakdown:

- 58% Labour
- 21% Consumables
- 18% Contract Services
- 3% Miscellaneous

Operation and Maintenance Opportunities

Supply and service opportunities associated with the operation of the demonstration facility will primarily include maintenance and associated consumables, site services and any equipment that requires replacement. VBNC will likely implement a variety of contracting mechanisms to procure any services, depending upon the importance and frequency of the service. Section 5.2 provides a detailed listing of opportunities that it is expected VBNC will require during the operating period.

Consumables

Section 5.3 provides a listing of consumables which will be required during the operating phase. The study team was not able to obtain any information regarding quantities during the course of the study. However, some information was provided in the Demonstration Plant Project Registration Document which was submitted to the Provincial Department of Environment in November 2002. This information is presented in Table 3 but the reader is cautioned that, due to ongoing changes in the design, these figures may not be accurate in all cases.

Newfoundland and Labrador Supply Sector Capabilities

As with the construction phase of the project, the province's business community is well equipped to provide a range of goods and services to VBNC during the operations phase of the hydromet facility. The range of goods and services required during this phase is compatible with those required in the servicing of traditional industries such as pulp and paper, Come By Chance oil refinery and the province's developing oil and gas sector.

The study team has not been able to identify any gaps in this area. There are, however, a few proprietary products to be supplied and it is felt these may be handled without any involvement by local firms. This is due to the nature of the business and the fact some of the processes are only at the testing stage.

6) Conclusions

The Argentia hydromet demonstration facility will require a variety of goods and services over the two year life of the project. It is anticipated some of these will be specialized and not available locally. However, from a construction and fabrication perspective, the provincial business community is well equipped to provide a majority of the products and services required during the construction and operating phases of the project.

Following are some factors to be considered:

- The implications of the project agreements between VBNC and the Provincial Government
- The commercial evaluation criteria which applies to the project
- The length of time the plant will be operating
- The size of the facility and the fact it will be used for testing purposes
- The implications of any future decision regarding the type of commercial facility to be built

The pursuit, by Newfoundland and Labrador firms, of opportunities listed in this document, or any other opportunities that may arise during the life of the project requires the following steps:

- Register with VBNC's supplier database
- Review the appropriate websites and publications to become familiar with the operational requirements of a hydromet plant
- Review this and other similar reports
- Contact the EPCM contractor's Procurement Manager

1.0 Introduction

The potential commercial business opportunities associated with construction and operation of the demonstration scale hydrometallurgical nickel processing facility being built at Argentia, Newfoundland and Labrador (NL), by Voisey's Bay Nickel Company (VBNC) is of particular interest to the business community of the province. The facility is one component of the VBNC project which is being implemented to develop the nickel resource discovered at Voisey's Bay, NL, in 1993.

This development will utilize a hydrometallurgical (hydromet) process to extract nickel, copper and cobalt from a sulfide ore mined at Voisey's Bay. There has never been a facility of this type in NL and the business opportunities may not be readily apparent. As such, it is anticipated that NL businesses will benefit from a report that captures project specific information related to those opportunities.

The Government of Newfoundland and Labrador and VBNC are committed, through the Voisey's Bay Industrial and Employment Benefits Agreement (IEBA, October 2002), to ensure maximum benefit from this project is available for NL businesses. Therefore, the Industrial Benefits Division of the Provincial Department of Natural Resources issued a Request for Proposals (RFP) in December 2003 for a consultant to assess and report on these opportunities. The study was funded by the Canada/Newfoundland Comprehensive Economic Development Agreement and was overseen by a Steering Committee comprised of officials from the Department of Natural Resources and Atlantic Canada Opportunities Agency (ACOA).

Davis Engineering & Associates Limited (DEAL), in association with Strategic Concepts Inc, was retained in January 2004 to carry out the study. Zeton Inc. of Burlington, Ontario, was retained by DEAL to provide input regarding technical details and equipment requirements for the project. Zeton is a large company specializing in the design and construction of modular pilot, semi-works and small scale commercial plants to support process development. This firm built the mini-pilot hydromet plant that Inco/VBNC is utilizing at it's research centre to define the overall process and equipment that will be tested at the demonstration plant.

1.1 Study Format

The results of the study are presented in five (5) sections. The following is an overview of the report structure and contents.

The balance of Section 1.0, Introduction, summarizes the Terms of Reference for the study including objective, scope of work, methodology and limitations.

Section 2.0, Project Background, provides industry stakeholders with an understanding of the Voisey's Bay Nickel Project as a whole and, more specifically, the hydromet demonstration facility to be constructed at Argentia.

Section 3.0, Voisey's Bay Nickel Project Procurement Framework, focuses on the procurement philosophy for the Voisey's Bay project and its applicability to the Argentia hydromet demonstration facility.

Section 4.0, Argentia Hydromet Facility Construction Phase Opportunities, addresses the opportunities associated with the construction of the hydromet demonstration facility.

Section 5.0, Argentia Hydromet Facility Operations Phase Opportunities, addresses the supply and service opportunities associated with the operations of the hydromet demonstration facility.

The report is supplemented throughout with selected figures and tables, as well as several appendices which provide more detail. Appendix A provides a glossary reference to aid readers in understanding selected terminology related to nickel mining and processing.

1.2 Study Objective and Scope

Based on the Request For Proposal, the objective of this study is *"to identify supply and service requirements for the construction and operation phases of the Argentia hydromet demonstration plant with the underlying objective of providing timely information to allow provincial businesses to enhance their participation in commercial opportunities associated with the project"*.

According to the latest schedule provided by VBNC, the construction phase is expected to continue until the end of 2005. The operations phase will extend for approximately two years beyond this and is expected to conclude late in 2007 or early 2008. Therefore, the scope of this study will detail opportunities associated with these two phases for the demonstration plant only. It is important for the reader to understand that the demonstration facility will be testing processes, materials, equipment and procedures in order to prove out and fine tune the steps involved in hydrometallurgical processing. This means that the facility, while working on a continuous basis, will incur some idle time as circuit modifications and equipment evaluations are undertaken in preparation for additional testing.

The study objective has been achieved by gaining a detailed understanding of the process and the associated construction and operating requirements. From this, and with the assistance of officials at Zeton Inc., a detailed listing of opportunities has been developed in the areas of contracting, construction supply and services and operating supply and services. The scope of work involved in these tasks included:

- review of existing literature on the hydromet demonstration plant
- review of literature on the history of hydromet technology
- review of procurement packages listed on the VBNC website
- conduct original research through direct contact with the Steering Committee
- conduct original research through direct contact with VBNC during a number of meetings along with question and answer sessions
- conduct original research through a visit to VBNC's mini-pilot plant
- determine supply and services requirements for the construction and operating phases

- review existing capabilities within the province to meet these requirements
- identify any other opportunities that may be discovered during the course of the project

1.3 Methodology

To complete the scope of work and fulfill the study objectives, the following workplan was executed:

Review of Existing Literature

Upon contract award, which was followed by a project kick-off meeting between DEAL, Strategic Concepts and the Steering Committee, the study team began a review and assessment of existing information on this development and, in particular, the hydromet process. The activities and documents reviewed included:

- INCO annual presentations to the investment community
- INCO presentation: "VBN Future with Hydrometallurgy"
- R & D Opportunities for Pressure Hydrometallurgy by David Dreisinger
- Status of Pressure Leaching Technology, Journal of Mining, February 1991
- Nickel Smelting and Refining, Pollution Prevention and Abatement Handbook, July 1998
- Manufacturers Association and Construction Association lists of products and capabilities
- Department of Natural Resources, Government of Newfoundland and Labrador, "Analysis of the Supply and Service Capabilities as they relate to the Voisey's Bay Vendor Database", July 2003
- Status reports on progress of testing procedures with the mini-pilot plant
- Presentations given to the study team by VBNC, March 9 & May 6,2004
- VBNC website (www.vbnc.ca)
- VBNC's Demonstration Plant Registration Document submitted to the Government of Newfoundland and Labrador, November 2002
- A Quick Course on Hydromet Technology by Frank Smith, July 2002
- Hydrometallurgy Into the Next Millennium by M.J. Nicol
- Business Outlook, 2004, VBNC, January 2004
- VBNC Project Update, August 18 2004
- Argentia Area Chamber of Commerce publication "Investors Guide and Business Directory" 2003
- "Comparison of Pyrometallurgical and Hydrometallurgical Processing for Ni-Co-Cu Sulphide Concentrates" by Dr. Chris A. Fleming, Executive Vice President, Metallurgical Technology, and Dr. Larry E. Seeley, President and CEO Lakefield Research Limited. presented at CIM Conference, St. John's, Newfoundland, Oct 2001

Site Visits

- VBNC's mini-pilot plant in Mississauga, Ontario
- Sherritt International Corporation's hydrometallurgical processing facility in Fort Saskatchewan, Alberta

Personal Interviews

Personal interviews and ongoing dialogue with VBNC and Steering Committee officials from the Department of Natural Resources and Atlantic Canada Opportunities Agency were a critical component of the study methodology. These individuals provided additional information and clarified and confirmed information contained in the project documents.

Original Research

Following a review of existing information, the Project Team assessed gaps in the information as it pertained to the study objective and identified the key personnel from whom additional information was required. The objective of this task was to further advance specific knowledge of the hydromet demonstration facility's construction and operation phases to facilitate a detailed listing of the supply and services required for the project. Examples of the specific topics considered include: site development, infrastructure requirements, material handling methods, mechanical/electrical/instrumentation systems, transportation requirements, chemical requirements, security, janitorial services, etc.

Key personnel identified for subsequent meetings and research included VBNC officials, Steering Committee members, representatives from Zeton Inc. and industry stakeholders. Documentation identified included background reports detailing the process along with supplies and equipment that may be required.

A session was also held with representatives of the Argentia Area Chamber of Commerce and Opportunities Argentia to review the project scope and discuss capabilities which exist in that local area.

Preparation of Final Report

Upon completion of the Study Team's original research the information collected was evaluated and tabulated separately to identify construction and operation business opportunities. The results were compiled in a draft report for review and comment by the Steering Committee. Comments were integrated into the report and presented in this final version.

1.4 Study Limitations

The study was constrained by the information made available to the Project Team as is often the case with initiatives of this nature which involve private corporations, new and innovative concepts and proprietary information. While information was available from VBNC and third party sources, certain project-specific information, such as the detailed project plans contained in the bankable feasibility study, were not made available due to confidential and commercial reasons. In addition, detailed engineering drawings, which would impact on the accuracy of the construction opportunities presented herein, were not available. The information presented in this report is essentially a "snapshot in time" and subject to change as design plans are finalized. The reader is directed to the VBNC website for the latest information regarding contract packages. Finally, the study could not address specific operational phase contracting strategies as these have not yet been finalized by VBNC.

2.0 Project Background

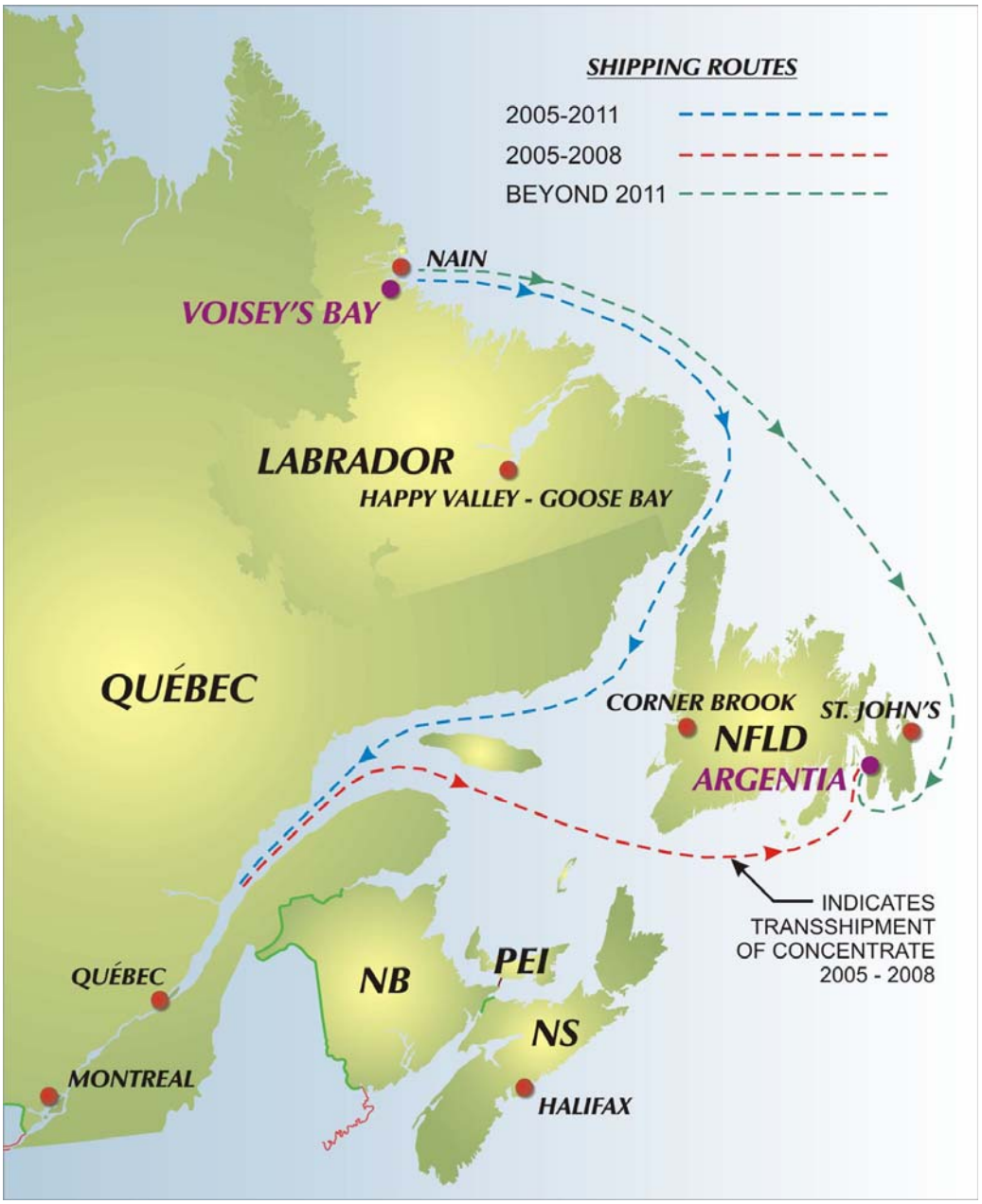
A basic understanding of the Voisey's Bay Nickel Project as a whole, and more specifically, the Argentia Hydromet Demonstration Facility is important when pursuing business opportunities related to the project. This section provides a brief overview of the Voisey's Bay Nickel Project.

2.1 Project History

In September 1993, the Voisey's Bay (nickel –copper – cobalt) deposit was discovered on the coast of Labrador, 350 km north of Happy Valley-Goose Bay by Diamond Fields Resources (DFR). In 1996, Inco Ltd. acquired the rights to the Voisey's Bay property from DFR and formed the Voisey's Bay Nickel Company (VBNC), as a wholly-owned subsidiary, to be responsible for development of the project.

Negotiations between VBNC and the Government of Newfoundland and Labrador to commercialize the discovered resources were ongoing from 1996 to 2002. In June 2002, both parties reached an agreement on a $2.9 billion project to develop the deposit. The development plan includes the construction of an integrated mine and concentrator at Voisey's Bay in Labrador, and a demonstration scale hydrometallurgical processing facility in Argentia, Newfoundland. These locations are depicted in Figure 1. The demonstration facility will then be followed by construction of a full size commercial plant. In the unlikely event that VBNC's proposed hydromet process technology for the concentrate is not technologically or economically feasible, the company will construct a commercial hydromet nickel matte processing facility or other facility incorporating a proven state of the art technology to produce a finished nickel product. This decision is to be made by the end of 2008.

Figure 1
Voisey's Bay Location Map and Shipping Routes



2.2 The Resource Base

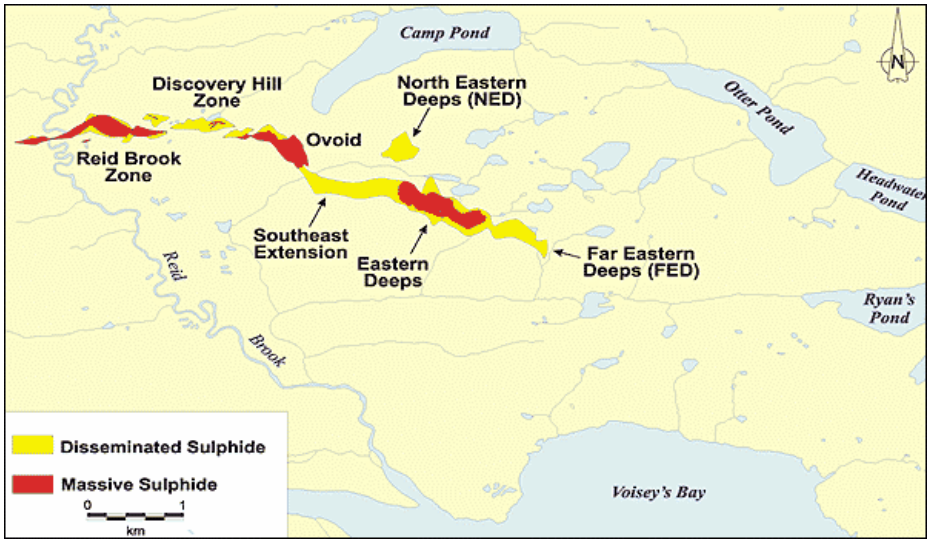
Nickel is produced from two (2) distinct ore types: nickel laterite deposits and nickel sulphide deposits. Nickel laterite deposits are normally found in tropical climates where weathering of the parent nickel bearing rock extracts and deposits the ore in layers at varying depths below the earth's surface. Laterite ores are typically excavated using large earth-moving equipment, screened to remove boulders, and then processed. Nickel sulphide deposits, often found in conjunction with copper-bearing ores which contain sulphides, are formed from magmatic

processes (magma flows) and require conventional open-pit and underground drilling and blasting operations.

The Voisey's Bay mineral deposit, which is a sulphide deposit, containing nickel (Ni), copper (Cu) and cobalt (Co), is classified into two main types: Mineral Reserves and Mineral Resources[1]. These resources are contained in four main deposits as shown in Figure 2:

- Ovoid and related deposits (Mineral Reserve)
- Eastern Deeps (Mineral Resource)
- Reid Brook (Mineral Resource)
- Discovery Hill (Mineral Resource)

Figure 2
Voisey's Bay Project Mineralized Zones



The proven reserves at this time are contained in the open pit Ovoid and related deposits, which have a total of 32 million tonnes and are summarized in Table 1. The remaining deposits, including the Eastern Deeps, are located at much greater depths and would have to be mined using underground methods. The total mineral resources identified in these deposits is 54 million tonnes of indicated resources and 16 million tonnes of inferred mineral resources, giving a total resource potential of approximately 100 million tonnes.

A concentrate, containing the majority of the copper indicated in Table 1, will be produced at the mill and shipped to a separate location for processing.

[1] A "Mineral Reserve" is the economically mineable part of a Measured or Indicated Mineral Resource demonstrated by at least a Preliminary Feasibility Study.
A "Mineral Resource" is a concentration or occurrence of natural, solid, inorganic or fossilized organic material in or on the Earth's crust in such form and quantity and of such a grade or quality that it has reasonable prospects for economic extraction. The location, quantity, grade, geological characteristics and continuity of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge.

Table 1
Mineral Reserve Estimates

Zone	Tonnes	Ni %	Cu %	Co %	Category
Ovoid and Mini-Ovoid Massive[1]	21,280,000	3.72	2.17	0.184	Measured
Ovoid and Mini-Ovoid Disseminated[1]	8,030,000	1.00	0.67	0.055	Measured
Sub-Total	29,310,000	2.97	1.76	0.149	Measured
Southeast Extension[2]	2,600,000	0.81	0.47	0.038	Indicated
Total Measured + Indicated	**31,910,000**	**2.79**	**1.65**	**0.140**	

1 All the blocks in the model are reported as mineral resource, i.e. no cut-off applied.
2 Assuming selective mining of 10 m x 10 m x 5 m blocks based on a 0.5% Ni cut-off grade.

Source: Inco Ltd Technical Report (Pursuant to National Instrument 43-101 of the Canadian Securities Administrators), Aug 31, 2003.

2.3 Project Development Plan

The Voisey's Bay agreement provides for development of a $909 million ($Cdn) mine and mill at Voisey's Bay[2], and a $180 million research and development program in hydrometallurgical processing. The latter includes a $100 million demonstration facility at Argentia which is scheduled to be ready for operation when the mill starts producing nickel and copper concentrates late in 2005.

The project will have a 30-year life, consisting of three (3) phases as follows:

- ***Phase One*** involves the development of an open pit mine and the construction and operation of a concentrator and related infrastructure to produce nickel and copper concentrates at Voisey's Bay. This phase also includes the construction and operation of a hydromet demonstration plant at Argentia to research and develop hydrometallurgical processes to extract nickel, copper and cobalt from concentrates produced at Voisey's Bay.

- ***Phase Two*** incorporates the construction of a commercial plant at Argentia, based on the technology to be developed in Phase One. Should the hydrometallurgical process being tested at the demonstration plant not be successful, a processing facility incorporating a proven, state of the art technology to produce a finished nickel product will be constructed in the Province.

- ***Phase Three*** involves the development of an underground mine and expansion of the concentrator plant at Voisey's Bay to serve the mine operation until exhaustion of the mineral resource. This phase is conditional on a successful underground exploration program.

During the first phase of the Voisey's Bay project, an open pit mine with a daily ore output of 6,000 to 7,200 tonnes will be operated. The majority of the nickel concentrate produced will be sent to existing smelters in Sudbury, Ontario and Thompson, Manitoba for further processing. However, 1,500 tonnes per year will be redirected to the hydromet demonstration

[2] Opportunities related to the mine/mill are the subject of a separate study.

plant and used to test the process and determine if a commercial scale plant is feasible. A decision on the feasibility of constructing a commercial scale hydromet facility is to be made by the latter part of 2008. In the event it is determined not to be feasible, a nickel matte facility, or another incorporating proven technology to produce a finished nickel product, is to be built. **It is important to note that this report only considers the opportunities related to the construction and operation of the hydromet demonstration facility and not the commercial plant.**

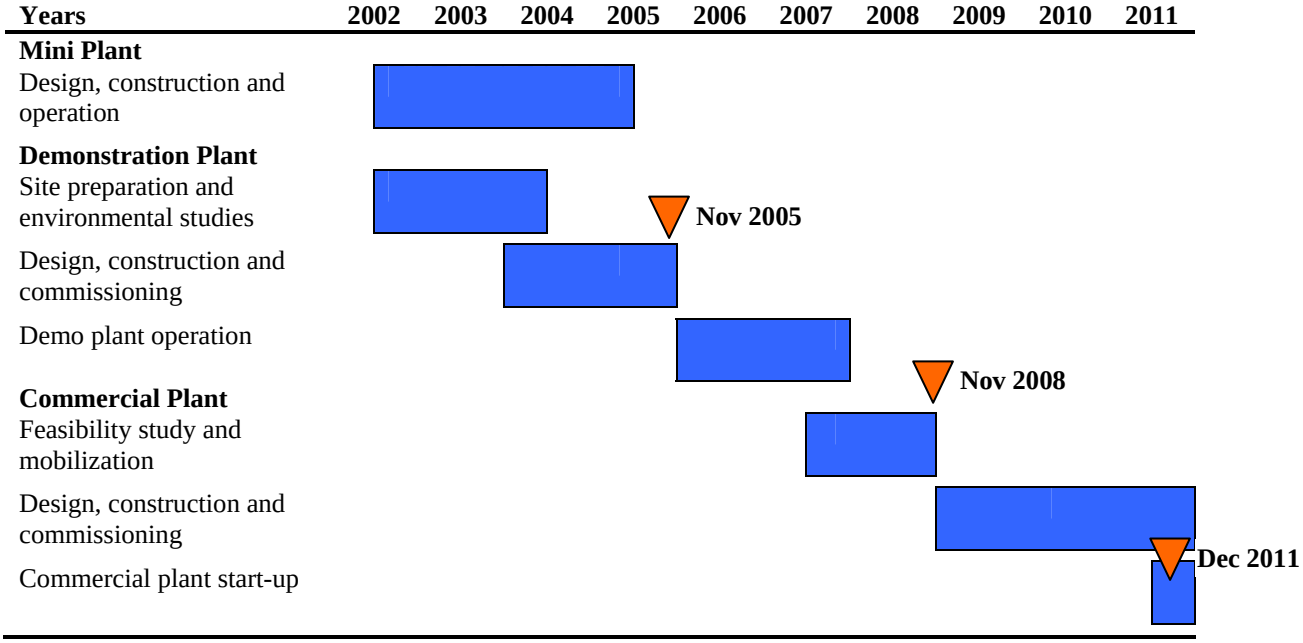
2.4 Hydromet Demonstration Facility

The following sections describe the demonstration scale hydrometallurgical processing facility in more detail with the purpose of providing NL businesses and entrepreneurs with a more comprehensive understanding of the facility and its operation.

2.4.1 Overview

In its agreement with the Government of Newfoundland and Labrador, VBNC committed to the construction and operation of a hydromet demonstration facility in Newfoundland and Labrador at a total cost of $150 million, including $100 million in capital costs and $50 million over a 2 year period to operate the facility. VBNC's overall hydrometallurgical processing program began with basic research, was followed by the operation of a mini pilot plant (both of which occurred at Inco's Sheridan Park research facility) and will culminate with the construction and operation of the hydromet demonstration facility at Argentia. Figure 3 illustrates the project schedule and provides information on key target dates or project milestones beginning with the design of the mini-pilot plant through to the startup of a commercial plant.

Figure 3
Hydromet Project Schedule



2.4.2 Site Location

The site selected for the facility is located at Argentia, on the former United States Naval Base, in the area that formerly accommodated an airfield. It is very close to existing docks and roads and is removed from any existing residential developments. An aerial photo of the peninsula is given in Figure 4.

Figure 4
Argentia Hydromet Demonstration Facility Site

2.4.3 Facility Infrastructure

For the purpose of this report, the complete site being constructed at Argentia is referred to as the hydromet demonstration facility. This includes all buildings and site infrastructure. In contrast, the process building refers to the new building containing the infrastructure and equipment required for hydrometallurgical processing.

The hydromet demonstration facility is being constructed for the purpose of validating a technological process to justify construction of a full-scale commercial operation to process Voisey's Bay concentrate. The process technology has already been tested at a bench-scale level and is currently being tested at a mini-pilot-plant scale at Inco's research facility in Ontario. The results of these testing programs will be incorporated into the design of the demonstration plant which will be operated at approximately $1/100^{th}$ of the throughput for the commercial plant. The processing will not necessarily be on a continuous basis as the purpose is to develop and advance the technology and test two flow sheets: a sulphate/chloride process and an all sulphate process. Because it is a research program, there will be ongoing changes and adjustments as the testing data is analyzed for each flow. Specifically, operation of the demonstration facility will fulfill the following objectives:

- Develop design criteria for a commercial plant
- Test and analyze the two different processes
- Evaluate equipment and materials of construction
- Develop capital and operating costs
- Demonstrate product quality and market acceptability
- Demonstrate environmentally safe residue disposal methods
- Train commercial plant operators and support staff

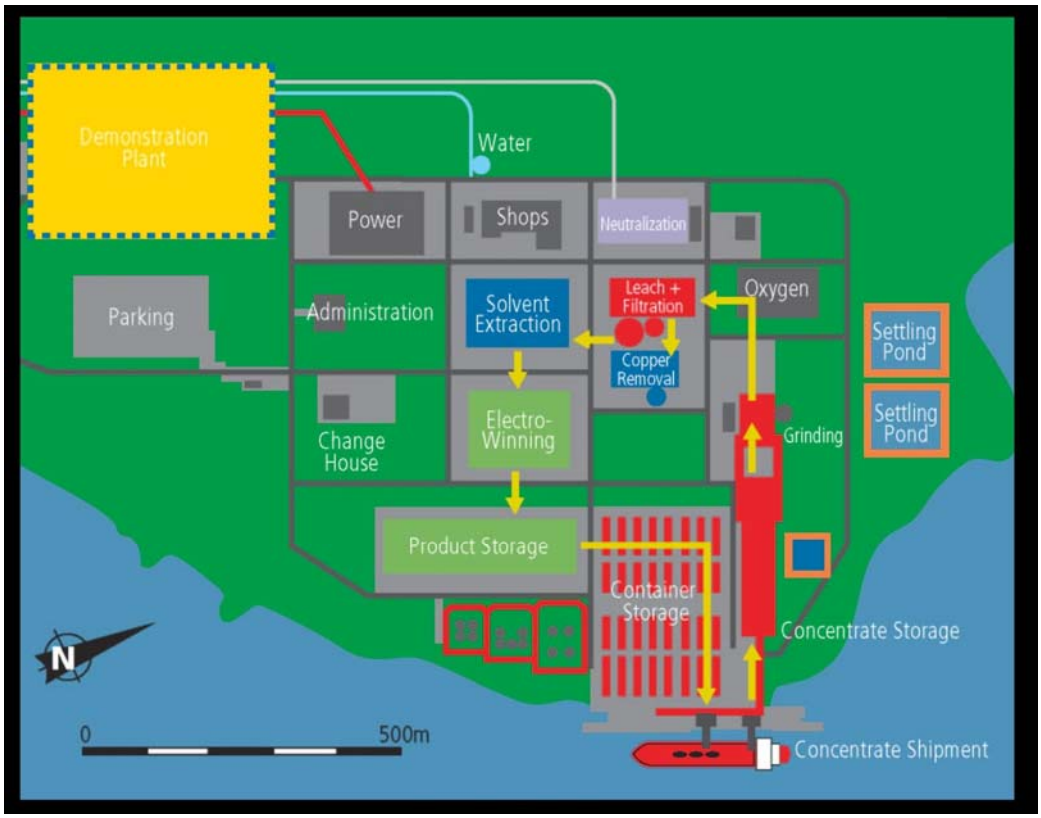
The major components which make up the demonstration facility include:

- Process building and associated equipment
- Warehouse/storage/laboratory/office building
- Container storage/laydown area
- Residue, treatment, settling and polishing ponds and associated piping
- Sewage collection and treatment system
- Fresh/fire/process water distribution system connected to existing municipal water supply system
- Guardhouse
- Electrical distribution system c/w emergency generator and fuel tank
- Site roads and parking areas
- Chain link fencing
- Storm water collection and drainage system
- Telecommunications

A site configuration plan showing the general arrangement for the demonstration facility is provided in Figure 5, whereas Figure 6 provides an illustration of a conceptual layout for a commercial plant, and its relative size as compared to the demonstration scale plant.

Figure 5
Argentia Hydromet Demonstration Facility Site Configuration

Figure 6
Conceptual Layout of A Commercial Hydromet Plant



2.4.4 Process Building and Equipment

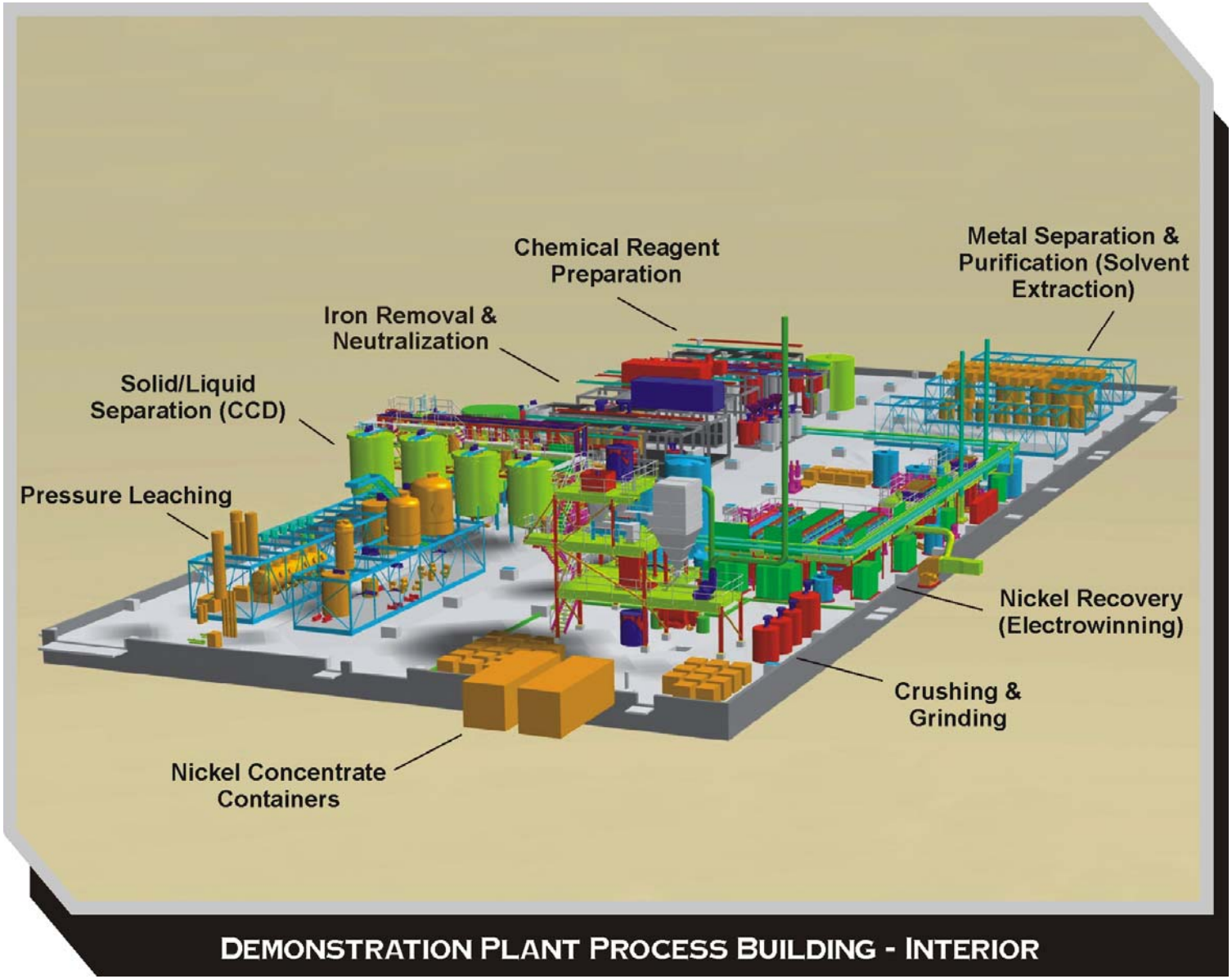
Section 2.2 covered the fact that nickel resources occur in two ore types: sulphide deposits and laterite deposits. Associated with each of these deposit types are several alternative processes that generate a product suitable for nickel processing. Voisey's Bay will produce nickel concentrate, a nickel-rich (approximately 20-25% nickel) finely ground material with a 10% moisture content that will be exported from the mine site via ship. A portion of these shipments will go to the Argentia demonstration facility starting in late 2005.

The hydromet process building will be comprised of a combination of stick-built components built directly on site and pre-assembled skids that will be constructed at fabrication facilities and brought to the site to be installed, hooked up and commissioned.

Figure 7 is presented in order to give an indication of how the inside of the plant will appear. The building will have a 4,000m^2 footprint but the final interior configuration may be somewhat different since changes are being incorporated as results of the mini-pilot plant testing are analyzed. In any event, following is the list of module groups based on process requirements. This is the most complex portion of the entire development.

- Crushing and grinding
- Atmospheric leaching
- Pressure leaching
- Counter-current decantation (CCD)
- Iron removal
- Solvent extraction
- Utilities
- Neutralization
- Reagent preparation
- Control room
- Electrowinning

Figure 7: Process Building Layout



2.4.5 Hydrometallurgy Process

Hydrometallurgy, or "hydromet" for short, is a metal processing technology that uses a chemical process combining water, oxygen or other substances in a pressurized or other vessel to dissolve a metal from its ore, concentrate or an intermediate product (such as matte). Further processing is required to produce high purity metal.

The nickel industry worldwide has traditionally smelted concentrates produced from nickel, copper and cobalt sulphide ores to make an intermediate sulphide product called matte. Hydrometallurgy has been used for refining the matte to produce high purity nickel, copper and cobalt for the market. Thus, traditionally production of these metals has occurred in two steps: smelting and refining.

The new hydrometallurgical process that Inco is developing will be able to process the nickel concentrate directly to metal products without first having to smelt the concentrate. It will be more economical and environmentally friendly since the sulphur dioxide and dust emissions associated with a smelter are eliminated. The process will also yield more of the valuable cobalt which is lost to a great extent in the smelting process.

Hydrometallurgy has a major environmental advantage over conventional smelting since most of the waste products from the process are not produced as air emissions, but rather as solids which can be easily contained. In conventional pyrometallurgical smelting, sulphides are burnt off, creating sulphur dioxide gas, which is released as air emissions. With hydrometallurgy there are no air emissions as the sulphides are transformed into elemental sulphur, which together with iron oxide form solid tailings that can be neutralized to form a stable residue. The Argentia demonstration plant process is detailed in the flowsheet shown in Figure 8.

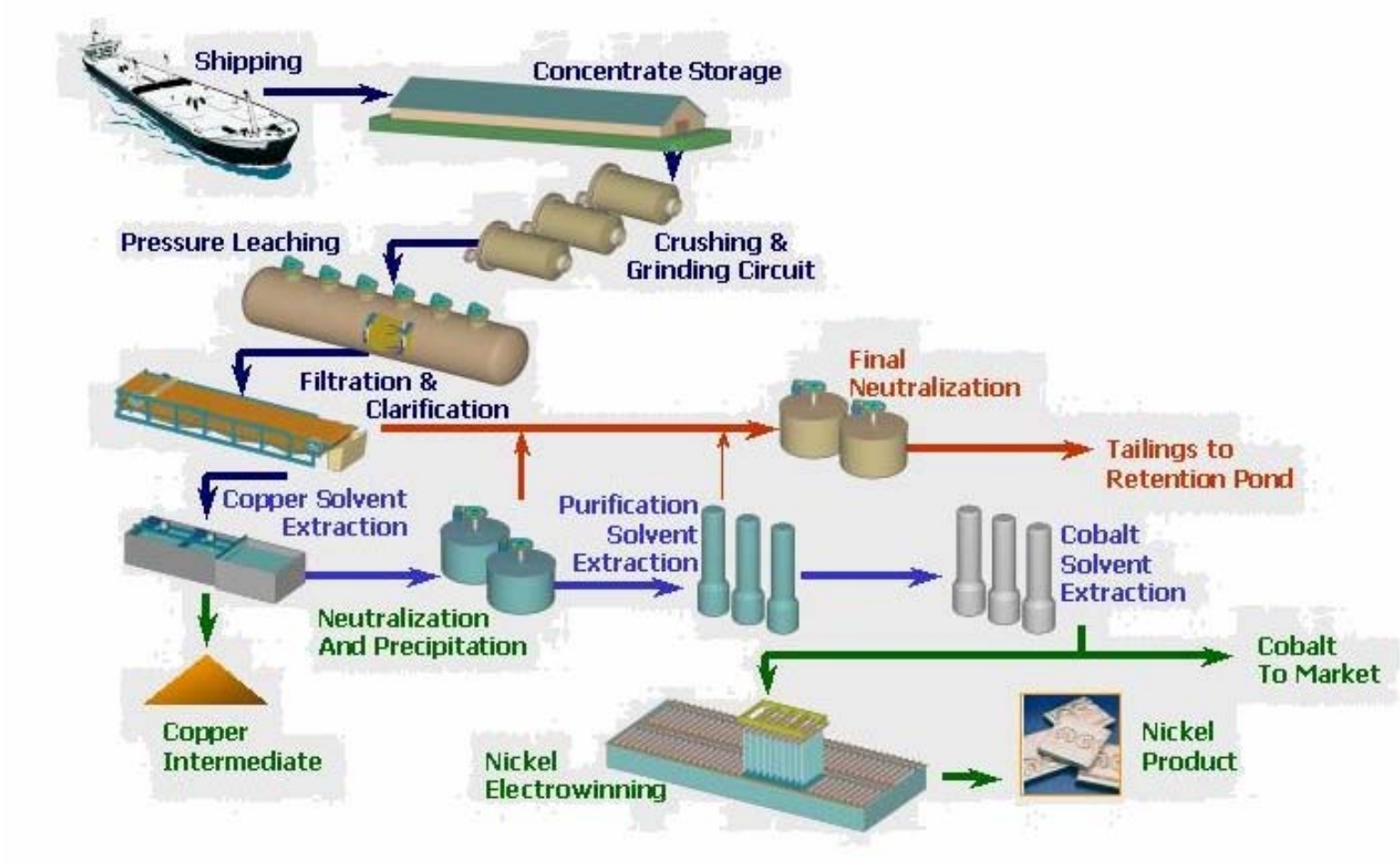
Hydrometallurgy is not a new concept as it has been used for many years in the mineral processing industry, even in the nickel industry. In fact, there is a facility owned by Sherritt International Corporation in Fort Saskatchewan, Alberta, which has been operating since the 1950s. This produces nickel using a concentrate received from a laterite mine in Cuba, and is a significantly different process than that which is being built in this province. VBNC's challenge is to develop a process specifically for the economically viable extraction of nickel from a nickel-cobalt concentrate coming from a sulphide ore body.

Following is a more detailed description of the many steps involved in the process.

Crushing and Grinding

Ore concentrate will be received in 1 m^3 bulk bags at the demonstration plant and will be stored until needed. The concentrate will then be ground in a crushing and grinding circuit which will reduce the material to a fine powder using a roll crusher, ball mill and fine grinding mill. It is then mixed with recycled process solution or water to produce a paste-like slurry. This slurry is the feed for the hydromet process.

Figure 8
Demonstration Facility Process Flowsheet



Pressure Leaching

The concentrate slurry is fed to a pressure vessel called an autoclave which is a specialized device 1.5 meters in diameter and approximately 6 meters long. Here it is mixed with spent process solution, heated and mixed with oxygen under pressure. Pressures of 150 psig and temperatures of 150° C may be required, depending on which process is used. The sulphides in the concentrate slurry react with oxygen to form liquid or solid sulphur and sulphuric acid. Once the sulphides are destroyed in this way, the metals to which they were once bound are free to dissolve into the acidic solution. The product of the autoclave system is a complex mixture of liquid or solid sulphur, an acidic solution of desirable and undesirable metals, and insoluble waste rock. The mixture is brought down to atmospheric pressure in a process known as "flashing", which results in the generation of some steam and the concentration of the metal solution. Since corrosive conditions sufficient to dissolve most metals exist in the autoclave, special metals such as titanium and linings such as acid-resistant brick are required for the process equipment. Once the solution is "flashed", the process takes place at atmospheric pressure in fibreglass and plastic tanks and piping rather than in pressure vessels.

Filtration, Clarification and Neutralization

The waste rock and sulphur are washed in stages with spent process solution and process water in a procedure known as counter current decantation (CCD). This process ensures that the maximum amount of dissolved metals is removed from the waste material so they can become products. The washed waste solids are then mixed with other process waste streams, thickened, filtered and sent to a final neutralization stage where limestone and lime are added for pH adjustment prior to impoundment.

The resulting solution contains all three desirable metals plus a number of undesirable metals (principally iron). Air is added to the solution to oxidize iron, and limestone is added to cause the iron to precipitate. The impure iron oxide/hydroxide byproduct is not useful and is fed to the final neutralization system.

Solvent Extraction and Electrowinning

The iron-free solution is fed to three stages of solvent extraction. In the first stage, a solvent for copper (an "extractant") is dissolved in an oil diluent and contacted in stages with the mixed metal solution. The copper in the process solution dissolves in the extractant oil, leaving behind nickel, cobalt and other metals. The oil extractant solution is stripped with an acidic water solution, resulting in a strong copper solution in acidic water. The copper can then be electroplated in a process known as "electrowinning", resulting in thick copper sheets which can be sold as a product. The electrowinning takes place in a tank in which two conducting surfaces (plates) are inserted and an electric circuit applied such that electricity flows from one plate through the solution to the other. The desired metal will then deposit on one plate to form a solid sheet.

The acidic copper-free leach solution together with a portion of the spent nickel electrolyte solution (produced below) will be reacted with limestone and lime to neutralize the solution and to precipitate gypsum. The gypsum solids will be filtered and sent to final neutralization and disposal.

The neutralized copper-free solution will be sent to a purification solvent extraction circuit to remove impurity metals of various sorts (mainly calcium and zinc) from the solution. The impurities will be stripped as above using an acid solution and sent to final neutralization and disposal.

The remaining purified nickel/cobalt solution will then be sent to a cobalt solvent extraction circuit where another extractant selectively removes cobalt. The cobalt will then be stripped using an acidic solution, producing a concentrated cobalt solution. This is then processed by electrowinning to produce small cobalt discs ("rounds") which are sold as a product.

What remains after these steps is essentially pure nickel in acidic solution. The solution is processed by electrowinning to generate thick nickel electrode sheets which can be sold as a product. The majority of the remaining solution is recycled to the leach circuit.

2.4.6 Process Options

Two processes will be tested in the demonstration plant: a process as described above (referred to as the "all sulphate process"), and a process to which chloride is added. The chloride is added to aid in extraction of the metals and to provide other process benefits, and is recovered in the electro-winning steps as chlorine gas Each process has various advantages and disadvantages of both a technical and commercial nature, and both must be studied in detail so that the most economical process can be carried forward to the commercial scale.

For a detailed description of the demonstration plant components and the associated opportunities relating to their construction, the reader is referred to Section 4 and Appendix 'C'. The operations phase opportunities are described in Section 5.

2.4.7 Labour Requirements

During the construction phase it is anticipated the following classifications and skills will be employed (peak workforce is in the range of 60-70 with an estimated total of 250,000 person hours).

- Project Managers, who will oversee the various contractors
- Design Engineers, who will carry-out the designs required and ensure the work is completed according to the drawings and specifications
- Site Inspectors and surveyors to assist with inspections
- Welders, Electricians, Pipefitters, Plumbers Equipment Operators, Labourers, Electronics Technicians, Sheet Metal Workers, Mechanics and other tradespeople who will undertake construction activities and equipment maintenance
- Support Staff, who will handle activities such as office work, payroll and general administration and re-supply to support construction activities

During the operations phase it is anticipated the following classifications and skills will be required (anticipated workforce will be approximately 150).

- Engineers/Technicians, to monitor the process, adjust equipment and gather data
- Management (Supervisor), to monitor and direct plant operation and maintenance

- Instrumentation Technicians, to operate and maintain the plant control system
- Administrative, to provide office support
- Operators and Labourers, to operate equipment and provide plant and yard support
- Laboratory Chemists and Technicians, to monitor results, analyze data and report on the progress of the testing
- Mechanics/Machinists, to repair and maintain the equipment
- Welders/Pipefitters, to provide maintenance support
- Electricians, to maintain site electrical infrastructure

3.0 Voisey's Bay Nickel Project Procurement Framework

This section focuses on the procurement aspect of the Voisey's Bay project, beginning with an overview of the governing agreements followed by a discussion on the possible contracting and procurement options that may be employed. There is also a discussion of issues and concerns facing Newfoundland and Labrador businesses as they relate to this project.

3.1 Industrial and Employment Benefits Agreement

There are several major agreements governing implementation of the Voisey's Bay project. These include:

- Voisey's Bay Development Agreement
- Industrial and Employment Benefits Agreement (IEBA)
- Impacts and Benefits Agreements (IBA) (one each with Labrador Inuit Association (LIA) and Innu Nation)

The latter of these governs the method in which VBNC procures goods and services required for the mine/mill and is beyond the scope of this study. The first two (2) items are relevant to the demonstration facility.

The IEBA forms part of VBNC's Development Agreement with the Government of Newfoundland and Labrador, and commits VBNC to a number of procurement and supplier development principles and initiatives. Some highlights of the IEBA include commitments to:

- full and fair opportunity for provincial suppliers;
- first consideration for provincial suppliers to participate on a competitive basis;
- timely and ongoing identification of upcoming opportunities and the communication of these opportunities to the provincial supplier community;
- work with government to identify major contracts that have significant long-term potential;
- ensure VBNC's contractors and sub-contractors adhere to VBNC's procurement philosophy and procedures;
- ensure procurement personnel is familiar with the Province's industrial capacity;
- use a pre-qualification process;
- undertake bid packaging and specification development in such a way as to not preclude provincial suppliers from bidding;
- not create artificial barriers to entry by specifying non-provincially produced products when equivalent products are available within the Province;
- include provincial benefits as part of bid requirements;
- utilize provincial construction, fabrication and assembly infrastructure where competitive; and
- make non-provincial bidders aware of the capabilities within the Province.

Suppliers are encouraged to review the complete document, which can be found on the Government of Newfoundland and Labrador's website at www.gov.nl.ca/voiseys/legal.htm.

3.2 Procurement To Date

Procurement for the project during the construction phase is managed in St. John's by SGE Hatch, VBNC's Engineering, Procurement and Construction Manager (EPCM). This firm maintains a database of NL businesses, and vendors can register on VBNC's website at www.vbnc.ca.

During the infrastructure construction phase of the project thus far NL based companies have obtained the majority of the packages for construction and services that have been awarded by VBNC and have been pre-qualified to bid on all remaining packages. In fact, local firms have the qualifications to undertake and complete most if not all infrastructure projects that are required to make the site operational.

With regard to the various packages for equipment (listed in Appendix C), many local firms have pre-qualified as suppliers or manufactures representatives. In fact some items such as tanks and pressure vessels can be fabricated locally. However, some of the equipment is very specialized and thus local opportunities may not be available in all cases. A listing of the various packages is presented in Appendix 'C' and qualified bidders can be found on the VBNC website.

3.3 Procurement and Contracting Philosophy

The components that make up the plant itself will consist of a combination of stick-built (i.e. built in place) and pre-assembled (i.e. constructed off-site and installed as a completed package). VBNC officials have indicated to the study team the plan is to use pre-assembled packages wherever possible. This philosophy should result in the potential for opportunities to accrue to a number of local firms in the assembly and/or fabrication field.

VBNC's contracting philosophy is based on adhering to the commitments made in the IEBA with the Government of Newfoundland and Labrador. This agreement contains a commitment to full and fair opportunity and first consideration for qualified NL businesses. VBNC evaluates potential suppliers based on the following:

- knowledge, appreciation and understanding of the work;
- experience, competence and ability to meet technical specifications;
- cost;
- continuity of supply;
- ability to manage, perform, and complete on schedule;
- safety, security and quality assurance programs;
- level, nature and location of provincial benefits; and
- ability to work with VBNC.

To assist NL firms acquire business opportunities for the construction phase of the project, VBNC has initiated and will maintain a supplier pre-qualification procedure that will ensure all companies with the required capabilities are identified and known. This process also helps businesses understand the requirements of supplying to a major company such as VBNC. The first step in the pre-qualification procedure is for companies to register on the vendor database through the submission of an Expression of Interest (EOI) to VBNC. The company is then evaluated to determine whether or not it meets VBNC's pre-qualification requirements. If so, it is included on the pre-qualified supplier list according to the type of good and/or service offered. This pre-qualified list is then used when a tender is being issued. Companies with the requisite skills and experience are selected from the pre-qualification list and sent bid packages. Out-of-province suppliers can access the database when looking for provincial suppliers for potential joint ventures. In certain cases, pre-qualified companies will be added to a short list before they are chosen for contract work.

3.4 Contracting Options

It is anticipated VBNC will use one or more of the following options for contracting and procurement during all phases of the project. NL firms are encouraged to study all the opportunities listed on the VBNC website and in this and other documents.

Contract Types

Cost-plus pricing is a commonly used pricing method by firms. It is primarily used because it is easy to calculate and requires little information. There are several ways of implementing a cost-plus pricing system, however, the basis for all of them is the calculation of the cost of the product plus an additional mark-up to represent profit.

Fee-for-service is a method whereby a company would contract out a service area (e.g., equipment maintenance). The contractor would hire the personnel required, purchase goods and services, and submit lump-sum invoices to the Owner. The alternative is for the Owner to hire people directly for these service areas, however, this can become more costly from an administrative perspective. Fee-for-service is also beneficial in that it separates out non-core activities and allows the Owner to focus on the activities for which it has the expertise, rather than support services.

Contracting Methods

Competitive tenders are standard contracting arrangements whereby required goods and services are specified in bid documents and sent out to pre-qualified bidders. The benefits is a competitive bidding process which should result in the lowest cost to the project. Despite its appeal of delivering best value for money, there are several potential problems. One potential pitfall is continuity; if the goods or services are required on a regular basis, it becomes inefficient to issue tenders for each order. Another potential problem is the administrative time and cost involved with preparing tender documents and evaluating bids; costs which may negate any savings realized through a competitive process.

Sole source contracts are contracts in which the Owner approaches only one of multiple eligible vendors. The reasons for using sole source contracts vary. One reason may be due to a manufacturer's warranty that requires a specific firm to perform maintenance on a particular piece of equipment. Another may be due to contractual obligations. A variation of sole source contracting is single source contracting. In this method the Owner approaches the only available/eligible vendor.

Inventory Management

The management of inventory for the Argentia hydromet demonstration plant will most likely be incorporated within the original procurement strategy. It is obvious from the contract packages which have already been listed that all new equipment will be ordered with a two year compliment of spare parts. Since the equipment will only run on a partial basis for this timeframe, it is not anticipated that a large inventory of parts will be required. However, a standard selection of fittings, hoses (especially plastic) and other parts will be maintained with additional items purchased locally on an as required basis.

3.5 Other Considerations for Newfoundland and Labrador Suppliers

The pursuit, by Newfoundland and Labrador firms, of opportunities listed in this document, or any other opportunities that may arise during the life of the project requires the following steps:

- Register with VBNC's supplier database;
- Review the appropriate websites and publications to become familiar with the operational requirements of a hydromet plant;
- Review this and other similar reports;
- Contact the EPCM contractor's Procurement Manager.

Since some aspects of this process are experimental and highly specialized, there may be opportunities for local firms to take advantage of "technology transfer". This can be achieved by joining forces or partnering with firms that have the expertise and train local workers where necessary so they can gain the knowledge and skills required to support the operation. In this way local firms will then be well positioned to take advantage of future opportunities that may arise, especially if the decision in 2008 is to proceed with a full scale hydromet plant.

Need For Specialized Products and Services

As this is the first facility of its type in the province, and in Canada, there may be some specialized supplies, services and equipment that are not currently available through existing Newfoundland and Labrador businesses. This will apply to the construction phase as opposed to the operating phase with one exception expected to be in the solvent extraction circuit where specialized and proprietary products are used.

The supplier community should gain a basic understanding of the process and associated infrastructure, along with construction and operational requirements presented in this and

other reports, in order to make informed business decisions. During that process it is important to keep in mind the fact this is a small testing facility with a lifespan of approximately 2 years. As well, while no decision is expected until the end of 2008, there is the possibility a full scale plant will be built and operating by 2011.

Other Information Sources

1. VBNC Office at Argentia

The site office will be located in a portion of the warehouse/multi-purpose building located adjacent to the process building. During the operating phase it is expected all purchasing will be done through this location.

2. VBNC Head Office at St. John's

This is where all management employees will be located and where all planning and decision making will take place for each phase of the project.

3. Argentia Area Chamber of Commerce/Opportunity Argentia

The Chamber is a non-profit, membership driven, organization seeking to improve the economic and social welfare of the area extending from Long Harbour to Admiral's Beach. The Chamber presents the voice of business to all levels of Government and in this case VBNC, provides valuable contacts for business, keeps members informed of local opportunities and provides research assistance to new and existing businesses in the area. As well the Chamber has for several years planned and delivered the Conference titled "Opportunity Argentia" with the support of the Atlantic Canada Opportunities Agency, the Government of Newfoundland and Labrador and others. This conference focuses on future business opportunities at Argentia, especially those that may be generated as a direct or indirect result of the VBNC facility.

4. Argentia Management Authority

This is a non-profit corporation incorporated in 1995 with an investment fund from the Atlantic Canada Opportunities Agency and dedicated to the economic renewal of the area. The Authority was established to help mitigate the adverse economic impacts of the closure of the United States Navy base at Argentia in 1994. Using the numerous assets, and strategic location, the organization is tasked with the responsibility of attracting economic investment to the Placentia area. The AMA has a working relationship with the Avalon West Community Business Development Corporation located in Placentia. The Avalon West CBDC is part of a network of independent not-for-profit corporations which have as their mandate the development of small business throughout rural Newfoundland and Labrador. With the aid of their funding partner ACOA, these groups provide financing and advisory services.

5. Provincial Department of Natural Resources

The Industrial Benefits Division of this Department is responsible to monitor the development and ensure the various agreements which govern it are being followed. As well, a representative of the Department participates on the Steering Committee for this study.

6. Atlantic Canada Opportunities Agency (ACOA)

This Federal Government agency's mandate is to improve the economy of Atlantic Canadian communities through the successful development of business and job opportunities. ACOA provides financial assistance to business and community groups with a role in economic development and works closely with other government departments and agencies to identify opportunities for growth. A representative of this Agency participates on the Steering Committee for this study.

4.0 Argentia Hydromet Facility Construction Phase Opportunities

In Section 1, the objective of this study was noted as the identification of supply and service opportunities associated with construction and operation of the Argentia Hydromet Demonstration Facility. This section of the report contains a detailed list of equipment, materials, services and contracting requirements for the construction phase of the hydromet facility. In particular, the section is further divided into requirements for fabrication and installation of process equipment as one component and construction of buildings and site services as another component. An extensive list of equipment and materials to be purchased during this phase is provided in Appendix 'C'.

4.1 Construction Cost Summary

In summary, it is expected the Argentia Hydromet facility will constitute a capital expenditure of approximately $100 million over an 18 to 24 month timeframe. Of this total it is anticipated that $16 million will be required to install site infrastructure and construct the process building. The balance of the capital budget (approximately $85 million) will be used to acquire and install process equipment. Given that much of the process equipment required for the demonstration plant was being competitively bid at the time of writing this report, a further breakdown of capital costs was not available.

Based on information obtained from VBNC, the construction phase will generate in the range of 250,000 person hours of employment of which about 150,000 will occur on the construction site. Applying general information used in the industry, approximately 20% of the total cost is expected to cover wages and salaries (including benefits) This would leave approximately $80 million for supplies, equipment, materials and consumables required for the full construction phase.

4.2 Process Construction and Fabrication Opportunities

As stated earlier in this report, the philosophy being applied to the process equipment fabrication by VBNC is to utilize pre-assembled construction as much as possible with the work split into small packages where feasible. This will result in a significant amount of the work undertaken in fabrication shops with the completed pre-assembled units then being transported to the site for installation, final hook-up and commissioning. The philosophy is also to standardize components as much as possible in order to reduce the number of spares and maximize the opportunities for interchanging of parts.

The process building consists of a number of circuits which will be grouped into packages for fabrication by contractors. It is expected there will be six or seven tender requests for major process packages, examples of which are listed below.

- Crushing and Grinding
- Leaching
- Countercurrent decantation (CCD)
- Neutralization

- Iron removal
- Solvent extraction
- Electrowinning

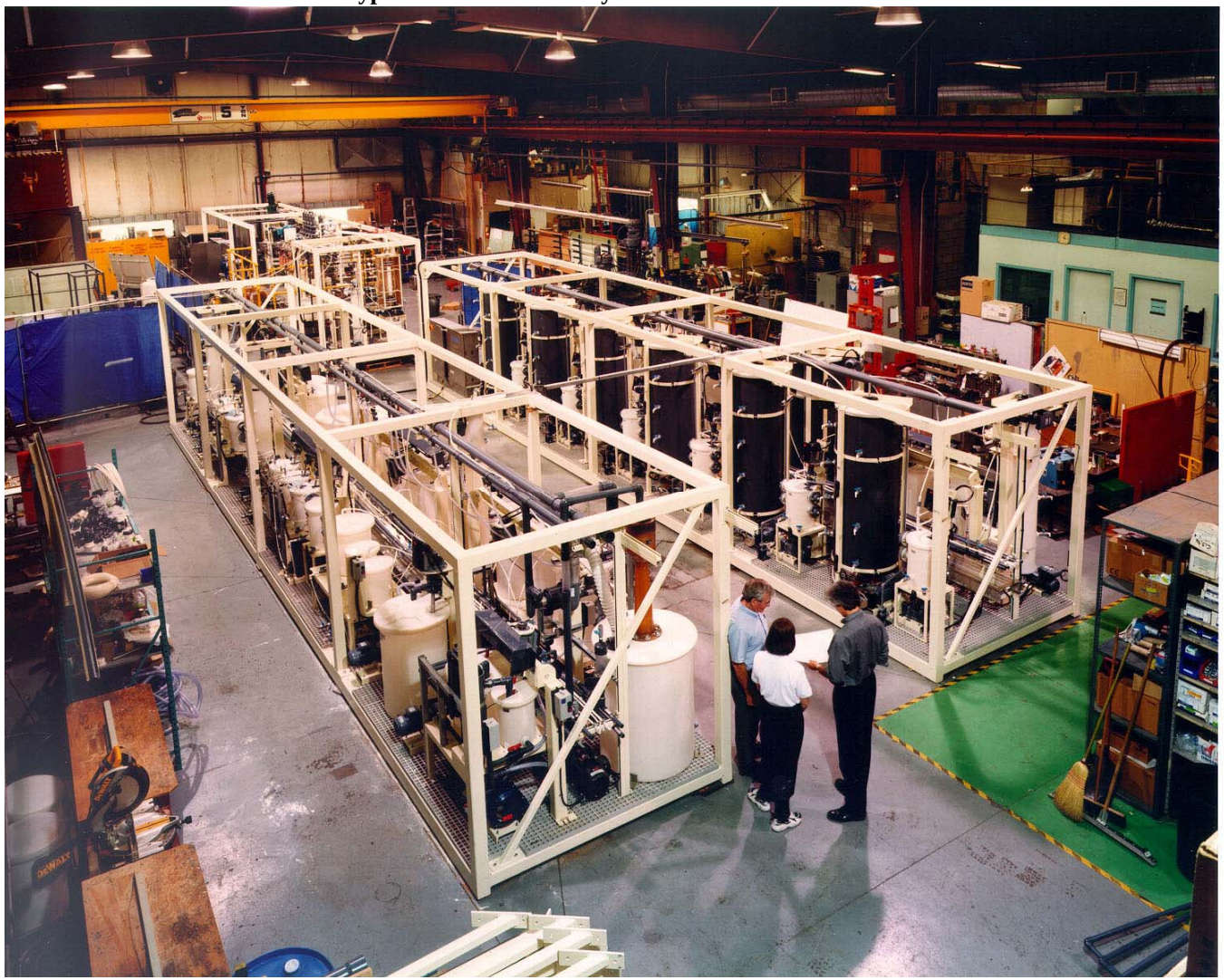
Each package will consist of one or more pre-assembled units (skid) to be transported to site for final positioning and hook-up. In addition to these, there are a number of smaller components listed in Appendix 'C' which will also be assembled on skids prior to delivery. The final hook-up will be completed by one installation contractor who will also complete all process related architectural, mechanical, electrical and instrumentation circuits required to complete the building interior and make the plant operational. This will also include completion of the plant control and electrical rooms.

Pre-Assembled Unit (PAU) Fabrication

All units must be sized such that, if required, they can be safely transported over the local highways and positioned properly within the building. In total it is expected there will be approximately 25 skids ranging in size from 4.2m wide, 3.8m high, up to 15m in length and weighing a maximum of 9 tonnes. While the equipment requirements for each skid will vary, in general each one will require tanks, pumps, motors, piping, valves, pressure and/or non-pressure vessels etc. A more detailed list of components follows and a detailed list of all packages posted to date on the VBNC website can be found in Appendix 'C'. The materials of construction for the components will vary from plastic, FRP, steel, carbon steel, stainless steel, titanium and alloy. As well, each skid will be fitted with an array of gauges and instruments to measure all aspects of the process. The photograph in Figure 9 illustrates the size and arrangement of typical skids fabricated for a similar hydromet demonstration facility at another location. While it is not an exact replica of the Voisey's Bay facility, it does serve to illustrate how the PAU would look.

VBNC has planned the sequence of purchasing to ensure that long lead items, such as the autoclave and chlorine compressor, are available in time to meet the critical path schedule.

Figure 9
Typical Skids Used for Hydromet Demonstration Plant



The process skids require a wide variety of specialized equipment and components, some of which will be custom made for this particular application. From a quantity perspective, the major items include tanks and pumps. There is also a large quantity of plastic tubing and piping and fiberglass grating required. Where possible common components will be used to allow for interchangeability and thus minimize spares. A detailed listing of the various components, along with materials of construction, follows.

- Structural steel framework fabrication, sandblasting and painting
- Tanks- steel, stainless steel/alloy, plastic and fiberglass for storage and mixing
- Pressure vessels- steel, stainless steel, titanium and fiberglass
- Pumps- (centrifugal sealless, centrifugal ANSI, peristaltic hose, air diaphragm metering etc.) in CPVC , FRP, stainless steel, rubber lined and titanium
- Agitators- may include complete designed mixer assemblies, or parts thereof (impellers, gearboxes, motors, variable frequency drives, sheaves/belts, bearings, shafts from carbon steel and titanium,)
- Valves- (ball, globe and diaphragm in CPVC, PP, PVDF and ball/plug/gate/needle/check valves in stainless steel, titanium and carbon steel)
- Steam regulators and steam traps
- Instrumentation- flow, level, temperature, pressure, density, ph/redox
- Pressure piping
- Cable trays and variety of electrical wiring and conduit
- Fiberglass subway grating (major item)
- Autoclave (specialized item)
- Electrowinning cells
- Pressure piping fabrication (pipe spools in carbon steel, stainless/alloys, and titanium)

In addition to these major items, there are a number of sub-components and services required including:

- Hardware, common and stainless steel
- Pipe and fittings, (carbon steel, stainless steel, titanium, CPVC, PP, PVDF)
- Compression fittings and tubing (PP, PVDF, stainless steel and alloys, titanium)
- Pipe and vessel insulation
- UniStrut channel and hardware
- Epoxy powder coating
- Epoxy painting
- Electrical cabinet, switchgear and control wiring
- Electrical cabinet supplies (terminal strips, fuse blocks, relays, DC power supplies, switches etc.)
- Gaskets and seals
- Power and cutting tools (rental or supply) c/w consumables
- Welding equipment and consumables
- Forklift and crane equipment
- Plastic sheet and rod (HDPE, polypropylene, PVC, CPVC)
- Plastic thermal welding services (custom tank and tray fabrication)
- Hose and fittings (plastic hoses and tubing will be a major item)
- Steel plate including cut to order
- Steel, stainless steel and titanium cutting by CNC microplasma, CNC water-jet
- General machining services (lathe, milling machine, brake press etc.)

- Lifting and rigging supplies/services and scaffolding/stair towers
- Safety supplies
- Scissors-lift equipment
- Non-destructive weld examination services
- Shelving/industrial racking

4.3 Infrastructure

1. Electrical power is available from Newfoundland Power using the existing power line to the north side of Argentia. A substation complete with distribution panel and transformer is required at site along with a back-up diesel generator.
2. Raw, process and potable water will be supplied via the existing municipal water system to the peninsula. A distribution system will be installed at the site and existing underground tanks will be utilized for process water storage. A hot water tank and cooling tower is included as part of the equipment packages.
3. Telephone services will be provided via the existing service lines in the area.
4. Sewage treatment will be provided by means of an above-ground packaged facility of sufficient size for the anticipated workforce. The treatment plant will discharge effluent in compliance with regulatory requirements.
5. Propane storage tank will be supplied as part of a fuel supply contract.
6. Office, laboratory and warehouse will be incorporated within the existing building built in 2003.
7. Electrical room will be included within the process building.
8. Control room will be included within the process building.
9. Solid waste (non-hazardous) will be trucked by certified waste haulers to approved landfill sites.
10. Three residue storage ponds and associated piping will be constructed to accommodate residue produced over the life of the demonstration plant. They will be sized and operated to contain precipitation and will be constructed adjacent to the facility complete with a liner system, leakage detection and collection system. Outflow will be directed to polishing ponds which will discharge treated effluent into Argentia harbour. Clean site run-off will be collected and directed to Placentia Bay through the existing site storm sewer.

Preliminary estimates of plant waste streams include leach residue 1,800 t/yr., gypsum 1,500 t/yr. and liquid effluent 70,000 m^3/yr.

4.4 Building, Sitework and Service Opportunities

The size and scope of construction of the demonstration facility buildings and sitework incorporates a varied number of contracts for materials, equipment and services. The major expenditure for this portion of the project is associated with the process building envelope and preparation of the site, including provision of water and sewer.

While detailed drawings were not available to the study team, the following breakdown is compiled based on the information that was provided and a general knowledge of similar

projects. As well, the divisions of the National Master Specification Index are listed in Appendix 'B' and provide additional details of the types of products, materials and services that may be required.

It should also be noted that some of these services have already been or are currently being procured and the reader is directed to the VBNC website for the most current status. In the case of contracts that are awarded or are still open for bidding, the website will provide the name of the successful bidder or the list of bidders respectively.

The opportunities associated with construction of the demonstration facility are listed in the following section.

Construction Contracts

- Demonstration plant building - structure and enveloped 4000 sq. m (presently under construction)
- Demonstration plant building – interior architectural, mechanical and electrical (non-process)
- Security building (presently under construction)
- Telecommunications
- Site security services
- Sewage treatment plant (packaged above ground type)
- Refurbishment of two underground water storage tanks
- Change house, laboratory and office (renovation of portion of warehouse previously constructed)
- Fresh/fire/process water pumphouse
- Storage for supplies, concentrate and reagents (This will be a combination of modifications to existing warehouse, storage area within the process building and container/yard storage outside the process building)
- Power distribution/site electrical (substation c/w distribution panel for a demand of 4 to 5 megawatts, diesel generator c/w fuel tank)
- Site infrastructure, roads, water (connected to existing municipal system) and sewer/storm water system, base asphalt
- Asphalt ,surface course
- Residue ponds (lined) c/w leakage detection and collection system
- Steel & concrete equipment foundations & floors including sumps
- Corrosion resistant floor and sump coatings
- Concrete work associated with the process building and other infrastructure

4.5 Newfoundland and Labrador Construction Sector Capabilities

The intent of this section is to provide comments on the supply, service and construction capabilities of Newfoundland and Labrador business to support and respond to opportunities in both the construction and operation phases of the Voisey's Bay demonstration scale hydrometallurgical processing facility, which is being built at Argentia.

It is important to note that this facility will be in operation for a period of approximately two years wherein VBNC will commence engineering and evaluation of a full-scale commercial facility. As noted previously, the proposed facility at Argentia is a demonstration facility being built to test the hydrometallurgical process using ore from the concentrator at Voisey's Bay.

However, it is also worth noting that experience (albeit at a much smaller scale) gained during the construction and operation phase of the facility may be of benefit to the business community in the event the full-scale commercial plant is constructed and operated.

In general terms the provincial business community is well equipped and positioned to provide construction and support services to the hydromet facility. The construction of both the Hibernia platform (GBS and some topsides) and Terra Nova with it's variety of both topside and sub sea components and the ongoing activates related to the White Rose oil field have given the business community the opportunity of improving upon and increasing the level of capability related to infrastructure. Equally important are the human skills required for complex applications.

Over the past 25 years we have seen local companies successfully participate in these developments not only during the construction phase but significantly so at the operations phase.

Construction Phase

As mentioned in the preamble above the business community, and in particular the fabrication sector of the business community, is well prepared for the construction phase of the Voisey's Bay hydromet facility having upgraded the capability over the past number of years. With a starting point of the required infrastructure to the provision of specialized welding Newfoundland and Labrador businesses can indeed participate.

There have been studies undertaken to analyze the province's capabilities related to the manufacture of the various sizes of tanks that must be made using fibre reinforced plastic. It is the understanding of the study team that there have not been any deficiencies identified in this sector. Existing manufacturers of fibreglass products have the capability, or could expand their capabilities, to meet the demands of this project.

In addition to the fabrication requirements imposed by the full Voisey's Bay project, the Province has witnessed a major improvement in the skill levels in the associated trades. We now see more and more highly qualified local trades people particularly in the area of welding. These people have advanced the skills level so much so that welding with exotic metals at local fabricating shops is now quite common.

Coincidental with the advancement of physical infrastructure and skill levels Newfoundland and Labrador businesses now have high appreciation for quality assurance and quality control procedures. The large number of ISO certified shops that are now present in the Province is evidence of this.

The construction of the Voisey's Bay facility for Argentia will also require a work force that has a high degree of familiarization in the areas of electrical, instrumentation and controls. As with welding expertise Newfoundland and Labrador has a number of firms which, through their oil and gas experience, have undertaken large projects that require an intimate knowledge of the full range of electrical and instrumentation needs for a project of this type. Because it is a test facility, instrumentation will be an important factor in this case.

In addition to the review of local glass fibre facilities mentioned above, a study of local fabrication capabilities was also undertaken. Over the past 20 years there has been a significant upgrading of the physical infrastructure in the area of metal fabrication facilities. As a result no major deficiencies were found. However, there are some highly specialized components which, because of the nature of the items in relation to the process and the associated expertise required, may not be fabricated locally.

The previous section identifies the major construction and fabrication contracts that will be forthcoming. As was mentioned earlier in this report, a review of these contracts and the corresponding local capabilities reveals that there are a number of firms capable of undertaking and completing the work.
In summary, the following business areas represent a substantial portion of the requirements for this project and can be provided locally:

- Reinforced glass fibre fabrication for a large number of tanks
- Steel fabrication facilities which can accommodate the skids and have specialized welding capabilities
- Electrical controls and instrumentation design, fabrication, installation, operation and maintenance
- HVAC equipment installation and servicing

5.0 Argentia Hydromet Facility Operations Phase Opportunities

This section contains a detailed list of supplies and services required for the operating phase of the project, a timeframe of two years during which several processes and various pieces of equipment will be tested and evaluated. The operation will require a reliable supply of materials and services keeping in mind the fact the plant will contain all new equipment at start-up. Businesses electing to invest in new supply and service opportunities should consider the potential for short term plant operation and how it may affect demand.

The following sections provide information on the cost of this phase as well as a listing of contracts, materials and service requirements that are expected.

5.1 Operating Cost Summary

The total operating cost for the life of the demonstration plant is projected to be approximately $50 million. This amount consists of:

- 58% Labour
- 21% Consumables
- 18% Contract Services
- 3% Miscellaneous

5.2 Operation and Maintenance Opportunities

Supply and service opportunities associated with the operation of the demonstration facility will primarily include maintenance and associated consumables, site services and any equipment that requires replacement. VBNC will likely implement a variety of contracting mechanisms to procure any services, depending upon the importance and frequency of the service. Table 2 provides a listing of services that the study team anticipates will be required during the life of the facility.

Table 2
Services Required for Hydromet Operations

Service	Description	In House	Out Sourced
Security			X
Snow Clearing			X
Waste Removal	Office and Industrial (non toxic)		X
Residue Pond Maintenance			X
General Equipment and Services Maintenance	e.g. Tanks, pumps, piping, electrical, mechanical, and instrumentation	X	X (primary)
Preventative Maintenance	e.g. Tanks, pumps, piping, electrical, mechanical and instrumentation	X	X (Primary)
Cleaning	Office, Laboratory, Locker Rooms, Change Rooms		X
Corrosion Monitoring		X	
Safety Training	Plantwide	X	X (Primary)
Transportation of Concentrate			X
Transportation of Finished Products			X

Service	Description	In House	Out Sourced
Transportation (General)	Movement of supplies		X
Courier			X
Specialized Welding	Maintenance and Process Adjustments		X
Non-destructuve Weld Examination			X
Insulation (piping)	Maintenance		X
Instrument Calibration and Repair	Instrumentation		X
Weigh Scale Calibration	Maintenance		X
Hazardous Waste Disposal			X
Gamma Ray Equip. Maintenance	Maintenance		X
Plant Control System Support	Instrumentation	X	X
Modification Services	Modify Process Equipment and Circuits		X

5.3 Consumables

Table 3 provides a listing of consumables that will be required during the operating phase. The study team was not able to obtain any information regarding quantities during the course of the study. However, some information was provided in the Demonstration Plant Project Registration Document which was submitted to Provincial Department of Environment in November 2002. This information is presented in Table 3 but the reader is cautioned that, due to ongoing changes in the design, these figures may not be accurate in all cases.

As pointed out earlier, the plant equipment will be supplied with a compliment of spare parts. However, there will be requirements for replacement hoses, fittings, valves etc. In addition, should there be a need to modify or change areas of the process, the result will be requirements for more substantial items such as tanks, pumps, motors etc.

Table 3
Consumables Required for Hydromet Operations

Consumable Type	Description	Estimated Usage	Function
Oxygen	Major Process Consumable	800 tonnes/year	Hydromet Process
Analytical Lab Supplies			Testing
Metallurgical Lab Supplies			Testing
Gasoline		100 m^3/year	
Diesel fuel		200 m^3/year	
Sulphuric Acid	Major Process Consumable	800 tonnes/year	Hydromet Process
Hydrated Lime	Major Process Consumable	400 tonnes/year	Hydromet Process
Hydrochloric Acid	Major Process Consumable	150 tonnes/year	Hydromet Process
Limestone	Major Process Consumable	400 tonnes/year	Hydromet Process
Ball Mill Grinding Media			Reduce size of feed particles
Office Supplies and Equipment	Computers, Stationary, Furniture		
Cleaning Supplies			
Caustic Soda		10 tonnes/year	Hydromet Process
Soda Ash		70 tonnes/year	Hydromet Process
Flocculants			Hydromet Process
Kerosene	Medium for Extractants	2 m^3/year	Hydromet Process
Solvent Extractant Organics	Proprietary	1 m^3/year	Hydromet Process
Safety Supplies and Equipment			Sitewide Requirements
Bulk Bags			Transport Concentrate to Argentia
Lubricants			Equipment Maintenance
Water Boiler Chemicals			Water Treatment

Consumable Type	Description	Estimated Usage	Function
Tools			
Propane			
Electricity		4.2 Megawatts	
Fresh water		20,000 m^3/year	
Miscellaneous supplies	Bolts, nuts, fittings, plastic tubing, hoses, etc.		

5.4 Newfoundland and Labrador Supply Sector Capabilities

As with the construction phase of the project, the province's business community is well equipped to provide a range of goods and services to VBNC during the operations phase of the hydromet facility. The range of goods and services required during this phase is compatible with those required in the servicing of traditional industries such as pulp and paper, Come By Chance oil refinery and the province's developing oil and gas sector.

In addition, the supply of well trained personnel appears to be adequate. Again, as with the construction phase, the province has available a comprehensive and well trained workforce. As identified in other sections of this report, the demands on the labor force can be met.

The supply community in Newfoundland and Labrador has been innovative in the servicing of oil and gas projects and as such has established many good supply houses which represent a wide variety of manufactures. The study team has not been able to identify any gaps in this area. There are, however, a few proprietary products to be supplied and it is felt these may be handled without any involvement by local firms. This is due to the nature of the business and the fact some of the processes are only at the testing stage.

As well, the industry is seeing the concept of life cycle service evolve as a result of conventional activities around the pulp and paper and oil and gas industries. Some of these activities are as follows:

- Hose monitoring and maintenance
- Valve maintenance
- Motor rebuilding
- Electrical system upgrading
- Instrumentation and Controls operation and maintenance

In general terms, Newfoundland and Labrador has some of the most competent electrical, mechanical and instrumentation contractors and fabrication facilities in Eastern Canada. In the area of QA/QC, the majority, if not all the large and medium size firms have achieved the appropriate level of ISO certification. The skills and capabilities of employees with these firms has also been enhanced in recent years as a result of the strict requirements utilized in other areas, especially the oil and gas industry.

From a review of the Investors Guide and Business Directory published by the Argentia Area Chamber of Commerce, the following supply and service capabilities, which may be applicable to this project, exist in the immediate area of the development:

- Catering

- Computer training, service and consulting
- Concrete forming
- Courier services
- Contractors - general and electrical
- Crane rental
- Equipment rental – commercial
- Foundry
- Fuel distributors
- Handling and storage - hazardous
- Industrial supplies
- Industrial waste transport
- Janitorial services
- Metal fabrication shop
- Moving supplies and equipment
- Ready – mix concrete
- Safety supplies and services
- Security services
- Steel erection
- Trucking/transport services
- Waste management services
- Welding services

For more information on these and other businesses in the Argentia area the reader is directed to the Argentia Area Chamber of Commerce or the Business Directory can be accessed at http://www.argentiachamber.org/guide/index.htm.

Appendices

Appendix A – Glossary of Terms
Appendix B – Classification of Construction Related Goods and Services
Appendix C – Hydromet Demonstration Plant Equipment List

Appendix A
Glossary of Terms

The following terms are defined as to their specific use in the mining and metallurgical industry.

Absorption
The penetration of one substance into the inner structure of another, such as liquid into a solid or gas into a liquid.

Alloy
A substance with metallic properties, composed of two or more chemical elements of which at least one is a metal. For example, aluminum plus one or more other elements, produced to have certain specific, desirable characteristics.

Anode
A rectangular plate of metal cast in a shape suitable for use in metal refining by the electrolytic process.

Aqueous
Containing water; a water solution.

Assay
The testing of a sample of ore to determine the content of valuable minerals.

Autoclave
An airtight vessel for heating and sometimes agitating its contents under high steam pressure; used for industrial processing, sterilization and cooking with moist or dry heat at high temperatures.

Ball Mill
A horizontal rotating steel cylinder which grinds ore to fine particles. The grinding is carried out by the pounding and rolling of a charge of steel balls carried within the cylinder.

Base Metal
Any non-precious metal (e.g., copper, lead, zinc, nickel, etc.).

Catalysts
Catalysts are substances which through their presence influence (increase) the process rates of chemical reactions and after completion of the reaction are still in an unchanged form. In theory, a catalyst is not consumed.

Cathode
A rectangular plate of metal, produced by electrolytic refining, which is sold to market for various uses such as melting into commercial shapes such as wirebars, billets, ingots, etc.

Caustic Soda
Corrosive chemical substance comprised of sodium hydroxide.

Coagulation
Process by which a finely divided substance or individual particles come together to form a coherent mass.

Coke
A porous solid composed mainly of carbon and ash.

Complex Ore
Ore named for two or more valuable metals, such as lead-zinc or nickel-copper ores.

Concentrate
Product containing the valuable minerals from which most of the waste rock has been separated. This is the raw material for smelting or hydrometallurgical pressure leaching.

Concentrator
A mill or plant, in which minerals are separated from waste rock, usually containing grinding mills where the ore is ground and flotation cells where the mineral concentrate is extracted.

Crusher
Apparatus in which ore is broken into progressively smaller pieces. Used for reducing coal, ore or rock. It may be used for preparing the feed to grinding mills.

Crushing
Reducing ore by stamps, crushers or rolls.

Cut-Off Grade
Percentage grade of contained mineral at which recovery from an orebody is deemed economic.

Deposit
Mineral deposit or ore deposit is used to designate a natural occurrence of a useful mineral, or an ore, in sufficient extent and degree of concentration to invite exploitation.

Dissolving
One substance becoming an integral part of another substance.

Electrolysis
An electric current is passed through a solution containing dissolved metals, causing the metals to be deposited on to a cathode.

Electrolytic Refining
The process of purifying metal ingots that are suspended as anodes in and electrolytic bath, alternated with refined sheets of the same metal which acts as starters or cathodes.

Feed
The crude ore introduced to a treatment plant or grinding mill

Flotation
A concentrating process by which some mineral particles are induced to become attached to bubbles and float, and others to sink. In this way the valuable minerals are concentrated and separated by skimming from the top away from the worthless gangue.

Flowsheet
An illustration showing the sequence of operations, step by step, by which ore is treated in a milling, concentration, extraction or refining process.

Gangue
The worthless minerals in an ore deposit.

Grade
The percentage of valuable metal or mineral in ore.

Grinding
Size reduction into relatively fine particles.

Hydrometallurgical
Pertaining to metallurgical operations that involves processing in which the principal phase is water; can be at temperatures and pressure substantially above ambient conditions when autoclaves are used; generally involves chemical reactions.

Impurities
Undesired or unintentional elements or substances containing pure or nearly pure products.

Ingot
A cast form suitable for re-melting or fabricating.

Laterite
A residual soil developed in tropical countries, out of which the silica has been leached. May form orebodies of iron, nickel, bauxite and manganese.

Leaching
Extracting a soluble material compound from an ore or concentrate by selectively dissolving it in a suitable solvent, such as water, sulphuric acid, or hydrochloric acid. Also a natural process by which ground waters dissolve minerals, thus leaving the rock with a smaller proportion of some of the minerals that it originally contained.

Matte
A metallic sulphide mixture made by melting the roasted product in smelting sulphide ores of copper, lead and nickel.

Matte Smelting
The treatment of a sulphide ore or sulphide concentrate with sufficient heat to cause melting of the sulphide mineral(s) in the ore or concentrate such that a molten metal sulphide phase is formed.

Metallurgy
The production of metals from raw materials such as ore concentrates, residues and recycling materials. There are two principal routes; pyrometallurgy (where high temperatures are used to extract metals) and hydrometallurgy (where chemical reactions in water are used to extract metals).

Milling
The grinding or crushing of ore to fine particles.

Mineral
Natural inorganic substance with varying degrees of purity, which often has to be refined to be used.

Mineralization
The concentration of metals and their chemical compounds within a body of rock.

Ore
A mixture of natural occurring minerals and gangue from which at least one of the metals can be extracted at a profit.

Ore Reserves
The calculated tonnage and grade of mineralization which can be extracted profitably; classified according to the level of confidence that can be placed in the data.

Ore Zone (Orebody)
A continuous, well-defined mass of material of sufficient ore content to make extraction economically feasible.

Orebody
A natural concentration of valuable material that can be extracted and sold at a profit.

Oxidation
A chemical reaction caused by exposure to oxygen that results in a change in the chemical composition of a mineral.

pH
A relative measure of the acidity of a solution using a scale of 1-14. It is used to indicate whether a solution is acidic (below 7), neutral (7) or alkaline (above7).

Pilot Plant
A trial assembly of small-scale reaction and processing equipment which is the intermediate stage between laboratory experiment and full-scale operation in the development of a new product.

Precious Metals
Metals such as gold and silver which are valued for other than ordinary industrial uses.

Precipitation
Solid particles forming by chemical reaction of dissolved components in a liquid.

Pyrometallurgical
Pertaining to metallurgical operations that involve processing at temperatures substantially above ambient condition, generally involving chemical reactions: as distinct from metal casting which involves only a physical transformation , i.e., solidification.

Reagent
A chemical or solution used to produce a desired chemical reaction; a substance used in assaying or in flotation.

Recovery
The percentage of valuable metal in the ore that is recovered by metallurgical treatment.

Refinery
Purifying concentrates or matte to produce one or more marketable metals.

Refining
Extracting and purifying metals and minerals.

Resource
The concentration of naturally occurring minerals, based on limited drill information, in such a form that economic extraction is currently or potentially feasible.

Sample
A small portion of rock or a mineral deposit, taken so that the metal content can be determined by assaying.

Slurry
A suspension of finely dispersed particles which usually has to be agitated to retain its consistency.

Smelter
A pyrometallurgical plant where concentrates are processed into an upgraded product.

Smelting
A pyrometallurgical operation in which metal is separated by fusion from those impurities with which it may be chemically combined or physically mixed.

Solvent Extraction
Use of organic solvents to selectively extract and thereby separate metals from dilute solutions.

Sulphide Ore
Material containing economically extractable concentrations of valuable metal in sulphide form.

Sulphides
A compound of sulphur with more than one element.

Thickener
A large conical tank used in metallurgical processing operations to separate solids from liquids; clear fluid overflows from the tank and rock particles sink to the bottom.

Appendix B

Classification of Construction Related Goods and Services.

The following listing of equipment and materials is based on the National Master Specification Index.

Sitework

Description – Material used to provide all infrastructure and services required to render a site ready for development.

- Geogrid, Geotextiles, and Geomembranes
- Water Mains
- Foundation and Under-slab Drainage Piping
- Storm Sewer Piping
- Manholes and Catch Basins
- Pipe Culverts
- Aggregates
- Hot Mix Asphalt Paving
- Painted Traffic Lines and Markings
- Concrete Walks, Curbs, and Gutters
- Chain Link Fences and Gates
- Guide Posts
- Roadway Signs
- Trees, Shrubs and Ground Covers
- Topsoil
- Seeding/Sodding

Concrete

Description – Ready-mix concrete and accessories for building and sitework structural requirements.

- Concrete Forms and Accessories
- Concrete Reinforcement
- Cast-in-Place Concrete
- Concrete Floor Hardeners/Sealers
- Precast Concrete Parking Curbs

Masonry

Description – Masonry units and accessories for use where required in site buildings.

- Mortar and Masonry Grout
- Masonry Reinforcement and Connectors
- Brick Unit Masonry
- Concrete Masonry Units

Metals

Description – Fabricated steel and aluminum components for buildings and process modules.

- Structural Steel for Buildings
- Steel Joists
- Steel Deck
- Steel Stud Systems
- Metal Fabrications
- Metal Stairs and Ladders
- Grating (fiberglass)

Wood and Plastics

Description – Items used for building construction and renovations.

- Rough Carpentry
- Treated Wood
- Prefabricated Wood Trusses
- Finish Carpentry
- Architectural Woodwork
- Plastic Laminates

Thermal & Moisture Protection

Description – Items used for building insulating, water and fire proofing.

- Bituminous Dampproofing
- Sheet Vapour Retarders
- Traffic Coatings
- Loose Fill Insulation
- Board Insulation
- Batt Insulation
- Air Barriers
- Asphalt Shingles
- Metal Building Panels
- Wood Siding
- Rigid Vinyl Siding
- Preformed Metal Cladding/Siding
- Double Skin Metal Cladding
- Sheet Metal Roofing
- Sheet Metal Flashing and Trim
- Roof Hatches
- Applied Fireproofing
- Fire Stopping
- Joint Sealers and Caulking

Doors and Windows

Description – Building construction and renovation items used for access control (mainly in the process building)

- Steel Doors and Frames
- Aluminum Doors and Frames
- Wood Doors
- Overhead Coiling Doors and Grilles
- Coiling Counter Doors
- Sliding Metal Fire Doors
- Safety Glass Doors
- Sectional Metal Overhead Doors
- Vertical Lift Metal Doors
- Windows
- Door Hardware
- Cabinet and Miscellaneous Hardware
- Glazing

Finishers

Description – Items required for building architectural finishes.

- Acoustical Suspension
- Gypsum Board
- Ceramic Tile
- Quarry and Paver Tile
- Acoustical Ceilings
- Resilient Tile Flooring
- Resilient Sheet Flooring
- Interior Paint
- Exterior Paint

Specialties

Description – Items used for interior mechanical finishes.

- Tackboards
- Toilet Partitions
- Shower and Dressing Compartments
- Wall and Corner Guards
- Access Flooring
- Flagpoles
- Building Signs
- Lockers
- Portable Fire Extinguishers and Safety Blankets
- Wire Mesh Partitions
- Metal Storage Shelving
- Toilet and Accessories

Equipment

Description – Items and accessories used for movement of concentrate and supplies.
- Dock Levelers
- Dock Bumpers
- Dock Seals and Shelters
- Safety Supplies
- Forklifts
- Overhead Cranes
- Safety Equipment
- Container Hauler

Furnishings

Description – Items used for office finishes.
- Laboratory Casework
- Louvre Blinds
- Furniture

Special Construction

Description – Interior specialty items for building systems.
- Prefabricated Buildings
- Security Door
- Building Entrance Control System
- Lighting Control Equipment
- Fire Alarm System
- Fire Pump
- Fire Suppression Sprinklers

Mechanical

Description – Building and process mechanical requirements.
- Access Doors for Mechanical Systems
- Motors, Drives and Guards for Mechanical Systems
- Bases, Hangers and Supports
- Thermal Insulation for Piping
- Thermal Insulation for Ducting
- Thermal Insulation for Equipment
- Acoustic Duct Lining
- Valves
- Thermometers and Pressure Gauges - Piping Systems
- Flexible Connections, Expansion Joints, Anchors and Guides
- Domestic Waste and Vent Piping
- Standpipe and Hose Systems
- Plumbing Fixtures and Trim
- Domestic Water Heaters

- Packaged Air Handling Units
- Computer Room Air Conditioning System
- Packaged Rooftop HVAC Units
- Humidifiers
- Unit Heaters
- Unit Ventilators
- Flexible Ductwork
- Duct Accessories
- Dampers
- Commercial Fans
- Packaged Roof and Wall Exhausters
- Louvre, Intake and Vents
- Grilles, Registers and Diffusers
- Filter and Filter Gauges
- Electric Heating and Cooling Controls
- Steel, Stainless Steel, Titanium, Plastic & Fiberglass Tanks, Pressure Vessels & Piping
- Flow, Level, Temperature, Pressure, Density & Analysis Process Instrumentation

Electrical

Description – Items to be used for building and process electrical systems.

- Metering and Switchboard Instruments
- Grounding
- Fastenings and Supports
- Underfloor Distribution System
- Power Cable and Overhead Conductors
- Wires and Cables
- Communications Conductors - Outside Plant
- Communications Cables - Inside Buildings
- Splitters, Junction, Pull Boxes and Cabinets
- Outlets Boxes, Conduit Boxes and Fittings
- Conduits, Conduit Fastenings and Conduit Fittings
- Surface and Lighting Fixture Raceways
- Cabletroughs
- Wiring Devices
- Wire and Box Connectors
- Cable Splice and Junction Boxes
- Outdoor Equipment Enclosures
- Motors
- Motor Starters
- Motor Controllers
- Motor Control Centre
- Diesel Electric Generating Units
- Storage Batteries and Racks
- Battery Chargers
- Pad Mounted Transformers

- Transformer Vault Equipment
- Outdoor Substation
- Service Equipment
- Service Entrance
- Circuit Breakers
- Load Break Switches
- Disconnect Switches
- Contactors
- Fire Pump Control
- Control Devices
- Panelboards
- Busways
- Ground Fault - Equipment Protection
- Lighting Equipment
- Floodlighting - Exterior
- Exit Lights
- Unit Equipment for Emergency Lighting
- Street Lighting Poles and Luminaries
- Lighting Control Equipment
- Terminals and Connectors for Building Communication Conductors
- Telecommunications Raceway System
- Incoming Telephone Service
- Intercom, Interphone System
- Public Address System

Appendix C
Hydromet Demonstration Plant Equipment List

Equipment & Components	Qty	Description	Function
Pump	18	Vertical cantilever sump pump	Pump slurries at flowrate of 7 Cu. M/hr. with 10 M head
Pump	56	Air operated double diaphragm pump	Pump slurries at flowrate of 0.1 to 2 Cu. M/hr. with 40 M head
Pump	11	Centrifugal slurry pump	Pump acidic slurries at flowrate of 4 to 15 Cu. M/hr. with 70 M head
Pump	1	Mechanically actuated diaphragm pump	Metering pump for solutions at flowrate of 0.01 Cu. M/hr. with 30M head
Pump	11	Electronic chemical metering pump	Pump acidic solutions and slurries at flowrate of 0.01 to 0.25 Cu. M/hr.
Pump	11	Gear pump	Pump flocculants with flowrate of 0.1 Cu. M/hr. Magnetic coupling drive.
Pump	4	Barrel pump	Flowrate of 3 to 9 Cu. M/hr.
Pump	97	Horizontal centrifugal end suction pump (Mag Drive)	Pump acidic solution at flowrate of 2 to 20 Cu. M/hr. at 10 to 40 M head
Pump	49	Hose pump (Variable speed drive)	Pump acidic slurries at flowrate of 0.1 to 1.7 Cu. M/hr. at 60 M head
Forklift	1	3 Tonne capacity	
Overhead crane	3	5 tonne capacity	Plant operation and maintenance
Truck	1	Service truck c/w boom	
Pick-up truck	2	Super Cab 4x4	
Van	2	Passenger vehicle	
Skid steer loader	2	Bobcat or equivalent	1 clean-up 1 floor sweeper
Analytical lab equipment			Testing
Metallurgical lab equipment			Testing

Equipment & Components	Qty	Description	Function
FRP tank	127	Tanks to have 8 different sizes from 400 mm to 4000 mm diameter. 61 to have full span drive support for mixer drive unit.	Freeboard of 500 mm.
HDPE tank	51	Tanks to have 6 different sizes from 500 mm to 3000 mm diameter. 27 to have full span drive support for mixer drive unit.	Freeboard of 500 mm.
Carbon steel tank	10	Tanks to have 3 different sizes from 1800 mm to 3700 mm diameter. 9 to have full span drive support for mixer drive unit.	Freeboard of 500 mm.
Stainless steel tank	4	Tanks to have 3 different sizes from 1200 mm to 3000 mm diameter. 1 to have full span drive support for mixer drive unit.	Freeboard of 500 mm.
Autoclave	1	Horizontal carbon steel vessel 1.5 M inside diameter, 6.095 M long	Principal component of hydromet process
Dust control baghouse	2	Pulse-jet type fabric filter operating under negative pressure.	1 concentrate crushing and grinding area 1 reagent handling area
Autoclave agitators	7	Drive units c/w impellers, upper shaft, lower main shaft, gear drive assembly, gearbox lubricant drain valves, tapered roller bearings, supports, cover plates and all guards.	
Crushed concentrate tote bins	2	Minimum capacity of 2.25 Cu. M. Maximum process material weight will be 3,000 kg.	
Flowmeters	260	Magnetic flowmeters, coriolis flow/density meters, vortex flowmeters. Size range from 15mm to approximately 20mm.	
Pressure and temperature transmitters	410	Approximately 25 pressure differential transmitters, 100 pressure transmitters, 140 temperature transmitters, 140 temperature elements (RTD and TC) and 5 orifice plates. 3 valve, 2 valve manifolds and diaphragm seals included. Wetted material include 316LSS and titanium.	

Equipment & Components	Qty	Description	Function
Nuclear instruments	16	Continuous level, level switches and density instruments using nuclear technology. Transmitters shall have HART communication capability.	
Safety shower Eyewash station	12	Units to be skid mounted and include a heated water storage tank.	
Reactor (spaghetti) cooling coils		Installed in FRP or HDPE tanks and may be constructed of TEFLON.	Used to cool process solution.
Liquid analyzer	100	Includes pH, ORP, conductivity and turbidity analyzers.	
Pressure and temperature gauges	80	Includes pressure, differential pressure and temperature gauges including thermowells as applicable. Some gauges will use diaphragm seals of various materials including 316 SS, TI Gr 1, 2 and Alloy 2205.	
Pressure and temperature switches	69	Includes 8 temperature, 3 pressure, 45 solenoid valves and 13 level gauge glasses.	
Process fan	10	Centrifugal fans c/w electric motors.	Supply and exhaust for push-pull tank ventilation system.
Vent scrubber		Skid mounted c/w mist eliminators, recycle pumps and interconnecting recycle piping. Flow rate in the range of 2,500 to 5,000 Am3/h.	
Thickeners and clarifier	11	Supply rakes, rake drive, rake lifting mechanism and rake support bridge for 10 thickeners and 1 clarifier. Size range from 1.6m diameter to 4.2m diameter	
Plate and frame heat exchanger		Design capabilities range from 10kW up to 405kW. Materials of construction may include 316 stainless steel, titanium grade 1 or titanium wetted parts.	
Cooling / heating coils		May be constructed of titanium gr.2 or gr. 16.	To be installed in FRP tanks.
Air compressor/ drier/ receiver		System required to deliver approximately 1700 cu. m. per hr. @ 690 kPa.	
General purpose agitators	75	Material of construction to include carbon steel rubber lined (natural & chlorobutyl), carbon steel FRP coated, titanium gr. 2, SAF 2205, FRP structural composite, 316 stainless steel, alloy 2507/ti gr. 7.	Suitable for installation in flat-bottom tanks ranging from 0.5m to 5.3m diameter.

Equipment & Components	Qty	Description	Function
Cartridge filter		Material of construction may include 304 or 316 stainless steel or PP/CPVC for filter housing.	
Anolyte gas compressor	1	Cl2/02 compressor c/w seal water heat exchanger, compressor separator and seal water recirc pump. Unit to be constructed of MOC and have design capacity of approx. 34 Nm3/h.	Suitable for handling wet chlorine gas.
Cooling tower	1	Galvanized steel structure – PE basin. Approximate dimension 3.07 m W x 2.57 m L x 2.71 m H	
Polymer concrete electrowinning cells	5	Cells including 1 tank constructed of polymer concrete. Following dimensions apply: 3@ 7.5m x 1.2m x 1.5m 1@ 2.6m x 1.2m x 1.5m 1@ 1.5m x 1.2m x 1.5m Tank 1.5m x 1.2m x 1.2m	
Dip tubes and inserts			
Vacuum belt filter	1	1 belt filter and 1 beltwash water tank c/w filtrate pumps, cakewash pumps, entrainment separator, filtrate and cakewash receivers and vacuum pump.	Countercurrent washing is required.
Miscellaneous pressure vessel	1	Anolyte vacuum pot may be constructed of polypropylene lined FRP.	
Oxygen vaporizer / pump / storage tank	1	c/w 2 liquid oxygen pumps and oxygen storage tank.	
Alloy pressure vessel			
TEMA heat exchangers package		High pressure shell and tube heat exchangers with effective areas of 2.2 m2 and 5.0 m2.	
Packaged vacuum system	1	Includes 2 liquid ring vacuum pumps c/w moisture separators, intercoolers and motors.	
HP & LP steam boiler	1	Boiler package c/w all necessary multistage pumps.	
Level instrument	230	Includes ultrasonic level transmitters and limit switches, guided radar level transmitters, vibrating fork level limit switches.	
Polishing filter		Capacity of approximately 1 to 2 m3/h volumetric flow.	

Equipment & Components	Qty	Description	Function
Nickel hydroxide filter	1	Plate and frame filter press. Approximate feed rate 0.69-1.3m3/h, 0.2-0.4 t/h solids.	Dewater nickel hydroxide/gypsum cake produced by using lime and limestone.
Rectifiers, buss work and cell top furniture		Rectifiers, electrical buss between rectifiers and cells.	
Gas analyzer	9	Includes 8 ambient air monitors and 1 process gas oxygen analyzer c/w sample preparation system.	Monitors for chlorine and hydrogen sulphide gas.
Flow instrument	63	Metal tube rotometers, positive displacement meters (process water) and low flow switches.	
Copper anode	18	Rolled lead alloy anodes.	Installed in copper electrowinning circuit.
Roll crusher	1	Handle concentrate delivered in 2.3 tonne capacity bulk bags.	Reduce lump size from 100mm to 12.5mm.
Fine grinding mill	1	Located downstream of a wet ball mill. Unit mounted on self supporting steel frame.	Grind nickel concentrate slurry
Motor starters, adjustable speed drive, MCC		600 V enclosed NEMA 4/12 starters which require communication ability to the plant control system.	
Ni and Cu blanks	40	Dimension approx. 1.1m x 0.9m x 4mm thick constructed of 304 SS or similar.	Installed in nickel and copper electrowinning circuits.
Multistage centrifugal pump		High pressure pumps in stainless steel, Hastelloy and titanium construction with single mechanical cartridge seals.	0.7 – 2.1 m3/hr
High pressure piston diaphragm pump		Duplex, double acting.	0.3 – 0.6 m3/hr
Control valve	125	Range from 15mm to approx. 80mm. Includes modulating control valves, self-actuated pressure reducing/back pressure valves, pressure relief valves, Globe, V-Notch ball and rotary plug valves. Equipped with spring/diaphragm actuators and positioners.	
On/Off valve	25	Range from 15mm to 50mm remotely controlled valves. Majority are ball and rotary plug c/w quarter turn/rack – pinion pneumatic actuators.	

Equipment & Components	Qty	Description	Function
Ball mill	1	Repulping overflow discharge ball mill mounted on steel frame c/w motor, speed reducer, gear train and/or v – belts.	Reduce concentrate from 12.5mm to 150 micron.
Chlorine vacuum stripping	1	Consists of a chlorine stripping tower, heat exchanger, gas/liquid separator and vacuum pump.	Remove chlorine gas from electrowinning anolyte.
Weigh scale	2	1. Minimum capacity 4000kg. with approx. dimensions 1800mm x 1800mm 2. Minimum capacity 250kg with approx. dimensions 1200mm x 1200mm	Weigh concentrate and finished product.
Belt feeder	3	Belt weigh feeders for crusher, repulping mill and impurity filter press.	
Refractory lining		Supply and install acid resistant refractory linings and impermeable membranes.	
Bulk bag	2000	Capacity of 1 m3 c/w poly liner.	Transport concentrate
Switchgear: 600 V		Double ended service entrance with tie breaker, draw out vacuum circuit breakers, metering and breaker distribution boards incorporating moulded case breakers.	
Uninterruptible power supply	1	Battery charger, battery bank and inverter c/w automatic transfer switch and manual bypass transfer switch.	Provide power for plant control system and critical loads for minimum 30 minutes.
SX fire suppression system	1	System will be a total flooding application type using “High Expansion Foam”. System will be c/w UV detectors and IR detectors including a handheld IR thermometer.	Fire suppression for the solvent extraction area of the plant.
Autoclave internals		Design, supply, fabricate, NDE, clean, pickle and passivation of miscellaneous autoclave vessel internal components including compartment walls, agitator baffles and anchor brackets. Materials of construction to be titanium.	
Reagent preparation skids	4	Design, fabrication, assembly and testing of skids for processing limestone, lime, soda ash and flocculant.	
Chutes, hoppers, bag breakers, grizzly		Design, supply and test lined carbon steel chutes, shrouds, hoppers, launders, bag breaker and feed grizzly	

Equipment & Components	Qty	Description	Function
Seal water reservoirs	6	Design and supply seal water fluid buffer reservoirs suitable for use with API plan 53. All components shall be supplied assembled and mounted on a stand or modular skid package.	
Vent gas cyclone	1	Design, supply fabrication, NDE, clean, pickle and passivation of a vent gas cyclone constructed of 316 stainless steel.	
Autoclave hydraulic bolt tensioning system	1	Multiple hydraulic bolt tensioners or torque heads, c/w hydraulic pump and power pack, hoses and fittings.	Used to provide an even and accurate load to bolted connections on large reactor vessel nozzles and piping components.
Vent gas cyclone	1	Cylindrical vessel constructed of 316 stainless steel.	
Seal water reservoirs	6	Skid mounted seal water fluid buffer reservoirs suitable for use with API plan 53.Materials of construction shall be 304 or 316 stainless steel.	