MINARA RESOURCES LIMITED OWNS AND OPERATES THE MURRIN MURRIN NICKEL COBALT JOINT VENTURE PROJECT (60% MINARA, 40% GLENCORE INTERNATIONAL AG) NEAR LEONORA IN WESTERN AUSTRALIA’S HISTORIC NORTHERN GOLDFIELDS REGION. MURRIN MURRIN IS A WORLD-CLASS HYDROMETALLURGICAL PROJECT, UTILISING HIGH PRESSURE ACID LEACH (HPAL) TECHNOLOGY TO RECOVER NICKEL AND COBALT FROM LATERITE ORES.

THE COMPANY HAS COMPLETED A SUCCESSFUL FINANCIAL RESTRUCTURE AND IS NOW DEMONSTRATING STRENGTH AND VIABILITY, WITH AN INCREASINGLY EFFICIENT PRODUCTION FACILITY. IT HAS EMERGED A DIFFERENT COMPANY FROM ITS PREDECESSOR, WITH AN ENTIRELY ALTERED FINANCIAL STRUCTURE, A CLEAN BALANCE SHEET AND MINIMAL DEBT.

MINARA IS WESTERN AUSTRALIA’S SECOND LARGEST NICKEL PRODUCER WITH HEADQUARTERS IN PERTH, WESTERN AUSTRALIA.
NICKEL AND COBALT HAVE BECOME ESSENTIAL MATERIALS USED AS PART OF EVERYDAY LIFE.

NICKEL is primarily used in metal alloys, imparting toughness, strength, corrosion resistance and various other electrical, magnetic and heat resistant properties.

At least 3000 nickel alloys have been created, with 65% of primary nickel consumed in the Western world used in the production of stainless steel. Nickel alloys are widely used in the chemical, petrochemical, power, nuclear and aircraft industries.

More everyday uses include construction, cars (in highly stressed areas such as crankshafts and axles), and common household products (kitchen sinks, cooking utensils and washing machines).

Other important markets include nickel-cadmium rechargeable batteries, used to power mobile phones, radios, clocks and calculators, coins which contain between 2% and 25% nickel and electroplate steel or brass articles.

Nickel metal consumption is expected to grow steadily for the foreseeable future, given reasonable levels of world economic growth, and after taking increased stainless steel production into account.

Minara is well positioned to capture a share of this expanding market opportunity.

COBALT is of great strategic importance to the world economy because of its diverse industrial and military applications. Its principal use is in superalloys (25% of demand) and specialty and high-speed steels. Almost 50% of total cobalt consumption is in chemical forms. This includes its uses as a catalyst in chemical production, in paint dryers, radial tyres, adhesives, batteries, animal feed additives, pigments and ceramics. Rechargeable batteries continue to be a strong growth area for cobalt consumption, particularly as an additive in nickel cadmium (NiCd) and nickel metal hydride (NiMH) batteries, and more recently, in the development of lithium ion batteries. Such batteries are widely used in cellular telephones, laptop computers and other high-tech, portable electronic equipment. Batteries account for about 10% of cobalt consumption.

Given its industrial significance, it seems extraordinary that the cobalt market is relatively small when compared with the major base metals markets. Total supply is around 40,000 tonnes per year. Another distinguishing feature of the Western cobalt market is that the metal is derived from a relatively small number of sources - just a few mines and processing plants, the US strategic stockpile, and Russian exports.

Minara is the second largest producer of nickel in Western Australia and has a positive impact on the socio-environment through employment, purchasing materials and services, and taxes and royalties. This also provides significant economic benefit to the local community, with flow-on benefits such as increased spend on infrastructure and services.
CREATING A PATHWAY FOR TOMORROW’S FUTURE

THE FUTURE OF NICKEL IS LATERITES

They may have been the major source of early nickel, laterite ores as the preferred supply were superseded by the discovery of sulphide nickel sources. Now that sulphide nickel sources depleting, laterite ores are making a strong comeback. The prediction of laterites as the future of nickel production, places Minara in an enviable position.

Although about 70% of world land based nickel resources are contained in laterites, they currently account for only 40% of the world nickel production. The advent of high pressure acid leaching technology (HPAL), coupled with insufficient growth of alternative nickel sources, has seen a shift in perception towards lateritic ore and it is anticipated that the two supply source types should be in balance within the next few years.

Nickel laterite mineralisation is a geological term used to describe the concentration of nickel and cobalt in silicate minerals, most often clays, due to extensive weathering of olivine rich ultramafic rocks.

REALISING OUR POTENTIAL

Minara was one of the first nickel producers to invest in laterite nickel and cobalt processing techniques. Poor initial design coupled with the launch of new technology, resulted in delays in achieving name plate capacity. Minara has since invested significant time and resources to eliminate the bottleneck deficiencies and we are now on our way to becoming one of the world’s leading producers of nickel and cobalt.

The journey has also allowed Minara to develop a skill bank of engineering and metallurgical expertise that has an excellent understanding of Australian conditions and ore types.

Quite simply, we are overcoming the challenges that our competitors are yet to face and have established a platform for Minara to reap the benefit from the potential growth in demand for laterite ore production.
A substantial nickel deposit, Minara has 65 million tonnes of proven reserves. It also has 68 million tonnes of probable reserves and 10 million tonnes of stockpile reserves (Source: June 2004 reserve statement).

The Murrin Murrin project has, in 2003/04, mined and processed 2.8 million tpa of laterite ore for the production of around 29,000 tpa of nickel and 2,000 tpa of cobalt briquettes.

Plans are in place to increase the plant capacity and production.

“SAFETY HAS UNCONDITIONAL PRIORITY IN ANY BUSINESS ACTIVITY. THE WORK ENVIRONMENT AND WELL BEING OF OTHERS IS WITHIN OUR CARE.”

THIS IS ONE OF MINARA’S SIX COMMITMENTS DEVELOPED BY OUR EMPLOYEES TO REFLECT SHARED VALUES ACROSS ALL LEVELS OF OUR OPERATIONS.
MINARA IS COMMITTED TO ACHIEVING HIGH STANDARDS IN ALL AREAS OF ENVIRONMENTAL MANAGEMENT. INVESTING SIGNIFICANT TIME AND EXPERTISE TO MANAGE THE REDISCOVERY OF THE PRESUMED EXTINCT PLANT HEMIGENIA EXILIS WAS RECOGNISED EXTERNALLY AS A COMMITMENT TO ENVIRONMENTAL EXCELLENCE.
Minara's aim after mining is to re-establish all pre-existing land uses prior to mining. As part of this approach, extensive environmental surveys are undertaken prior to mining to assess environmentally sensitive areas and minimise impacts. This information is critical to successfully rehabilitating mining areas.

The laterite ore mined by Minara is relatively shallow, averaging 40 to 60 metres in depth and is located usually less than one metre below the soil surface. Due to its soft clay-like nature, the ore is recovered through open cut mining methods. The mining reserves are located at Murrin Murrin North and South and Murrin Murrin East (40 kilometres east of the project site). Combined, they have a proved and probable reserve of 1.57 million tonnes of nickel and 124 thousand tonnes of cobalt, ensuring a project life of at least 30 years (Source: June 2004 reserve statement).

The topsoil and clay overburden is mechanically excavated and used on a newly rehabilitated area or placed in a stockpile.

The geology has been classed into three areas:

- **Ferruginous zone** - the top laterite unit contains mainly iron oxides as waste. A small amount of nickel-cobalt mineralisation appears at the base of this zone.

- **Smectite zone** - the middle laterite unit contains mainly smectite clays and medium to high grade nickel-cobalt mineralisation.

- **Saprolite zone** - the bottom laterite unit contains mainly primary smectite clays and basic minerals referred to as serpentine minerals. The grade of nickel-cobalt mineralisation varies significantly.

Excavators are used to extract the ore and dump trucks are used to transport it and the waste to respective stockpiles.

Since operations commenced, some 283 hectares of land has been rehabilitated with the aim of establishing a self-sustaining cover of native vegetation. Minara aims to attain natural levels of species and plant densities in all restored sites.
THE MURREN MURREN PROJECT INVOLVES CONVENTIONAL OPEN PIT MINING FOLLOWED BY ORE PREPARATION, HIGH PRESSURE ACID LEACH, SOLUTION NEUTRALISATION, MIXED SULPHIDE PRECIPITATION, NICKEL & COBALT REFINING AND NICKEL & COBALT PACKAGING.
THE INTEGRATED HYDROMETALLURGICAL PLANT REQUIRES KEY UTILITIES SUCH AS SULPHURIC ACID, HYDROGEN, OXYGEN, HYDROGEN SULPHIDE, POWER, STEAM AND WATER.

THE PROCESS IS EXPLAINED IN GREATER DETAIL ON PAGES 8 TO 11.
ORE PREPARATION

After mining, the ore is transported to the ROM (Run of Mine) pad where it is sorted according to grade and blended to ensure consistent feed to the leaching circuit. Part of this process involves crushing the ore to less than 150mm using a MMD sizer (a spiked rolls crusher).

Water is added to the SAG mill to produce a mill discharge slurry stream. The slurry is discharged over a primary vibrating screen. The larger particles with lower nickel or cobalt content are removed from the process as rejects. The slurry is then discharged onto secondary screens. Part of the screen underflow is cycloned and thickened whilst the secondary screen reject material is combined with the primary screen reject material and stockpiled.

The slurry is then pumped to holding tanks. The holding tanks allow for minor interruptions to the supply of ore until it is pumped into the acid leach section.

HIGH PRESSURE ACID LEACHING

The high pressure acid leach circuit consists of four large titanium lined autoclaves.

The slurried ore, grading approximately 1.35% nickel and 0.09% cobalt, is preheated prior to entering the autoclaves. Concentrated sulphuric acid is added to the first of six compartments within the autoclave. The 4 autoclaves typically operate at 255°C and 44 bar (or atmospheres) pressure.

As the slurry passes through the autoclaves, the nickel and cobalt is converted to soluble sulphate salts over a period of 90 minutes.

ENERGY IS RECOVERED FROM THE AUTOCLAVE FLASH SYSTEM BY PRE-HEATING FEED SLURRY, ENHANCING THROUGHPUT AND MINIMISING THE OVERALL ENERGY REQUIRED PER TONNE OF ORE.

ENERGY

THE POWER AND STEAM GENERATION PLANT IS MADE UP OF TWO STEAM TURBINES, ONE GAS TURBINE, THREE NATURAL GAS BOILERS, SIX STANDBY DIESEL GENERATORS AND ASSOCIATED MECHANICAL AND ELECTRICAL EQUIPMENT.

MINARA’S ENERGY REQUIREMENTS ASSISTED TO ENSURE THE ECONOMIC VIABILITY OF THE GAS PIPELINE TO THE REGION.

THE SULPHURIC ACID PLANT AT MURRIN MURRIN IS ONE OF THE LARGEST IN THE WORLD. THE PLANT PRODUCES ACID FOR THE HPAL CIRCUIT. ITS SECONDARY FUNCTION IS TO PROVIDE HIGH-PRESSURE STEAM FOR THE PROCESS PLANT AND FOR POWER GENERATION.
SOLID-LIQUID SEPARATION

At this stage, the ore has now been leached and the nickel and cobalt are in a soluble form and must be recovered from residue. To effect this, slurry is pumped to the counter-current decantation (CCD) circuit. The function of this circuit is to wash the pressure leach residues and to recover soluble nickel and cobalt. The CCD circuit consists of seven 50 metre thickeners. The thickeners separate the slurry into two streams by settling the residue solids and decanting the soluble nickel and cobalt sulphate solution.

Each thickener acts as a washing stage which consists of a mixing (washing) operation followed by a solid/liquid separation (thickening) operation.

The washed slurry underflow (which contains all the residue solids) from the last thickener is pumped to the tailings neutralisation circuit prior to disposal into the tailings dam.

The clarified liquor (which contains dissolved nickel and cobalt sulphates) from the first wash thickener is stored prior to solution neutralisation.

SOLUTION NEUTRALISATION

The function of the solution neutralisation circuit is to neutralise the free acid in leach solution. The free acid must be neutralised prior to the hydrogen sulphide precipitation circuit in order to maximise nickel and cobalt recovery.

The first step is to mix hydrogen sulphide with the solution from the first wash thickener to reduce ferric iron to ferrous iron and chromate to chromium.

The solution then flows through a series of four agitated tanks where calcrete slurry is added to react with the free acid to form gypsum (calcium sulphate precipitate).

The pressure leach solution (PLS) is separated from the gypsum precipitate in the neutralisation thickener. The clarified overflow is sent to the sulphide precipitation section for further treatment. The thickener underflow solids are discharged back to the CCD circuit to recover the small amount of contained soluble nickel and cobalt sulphate and allow the gypsum to be discharged with the residue for disposal into the tails dam.

CALCRETE, WHICH IS SIMILAR TO A LOW GRADE LIMESTONE, IS USED TO NEUTRALISE THE ACID IN THE PROCESSING PLANT. CALCRETE IS MINED FROM WITHIN EXISTING TENEMENT HOLDINGS AND HAULED 50KM TO THE PLANT SITE. CALCRETE RESOURCES CURRENTLY TOTAL 95 MILLION TONNES, EQUIVALENT TO 70 YEARS SUPPLY.
MIXED SULPHIDE PRECIPITATION

The purpose of the mixed sulphide precipitation circuit is to separate and recover nickel and cobalt from solution and into a solid form. This is achieved by the chemical process of precipitation.

Hydrogen sulphide gas is injected into high shear reactors with mixed sulphide seed to precipitate metal values as a nickel and cobalt sulphide. Downstream reactors ensure sufficient retention time to effect 98.5% nickel and 96.5% cobalt precipitation efficiency.

The mixed sulphide precipitate is then settled out of the solution in a thickener. The thickened slurry is filtered, washed and stored prior to further treatment in the refinery or it can be sold direct on market.

The barren solution is recycled to the CCD circuit as wash liquor.

TAILINGS NEUTRALISATION

The purpose of the tailings neutralisation circuit is to neutralise the slurry from the CCD circuit prior to disposal in a tailings dam.

This is achieved through the addition of calcrete slurry in agitated tanks. Neutralised tailings are pumped to the tailings dam where the solids settle and decanted liquor gravitates to the evaporation pond.

SULPHUR IS A MAJOR CONSUMABLE USED IN THE PRODUCTION OF ACID AND HYDROGEN SULPHIDE GAS AND IS SUPPLIED UNDER LONG-TERM AGREEMENTS WITH SHELL CANADA AND PETROSUL, AS WELL AS SPOT PURCHASES. ARRANGEMENTS ARE IN PLACE FOR 7 TO 8 PANAMAX (APPROX 65,000MT) SHIPMENTS PER YEAR TOTALLING APPROXIMATELY 500,000 TONNES. THE SULPHUR IS SHIPPED TO KWINANA AND TRANSFERRED BY RAIL TO MALCOLM RAIL SIDING AND THEN BY ROAD TO SITE.

TAILINGS STORAGE

ALL MATERIAL THAT IS SEPARATED DURING THE PRODUCTION PROCESS IS MANAGED AND MONITORED WITHIN OUR TAILINGS STORAGE AREAS. IMMEDIATE AND LONG-TERM MANAGEMENT OF TAILINGS IS AN ENVIRONMENTAL PRIORITY FOR MINARA. WE HAVE WORKED IN COLLABORATION WITH LEADING ENGINEERS TO PROVIDE INNOVATIVE SOLUTIONS TO TAILINGS MANAGEMENT, AIMED AT REDUCING ENVIRONMENTAL IMPACTS. DISPOSAL INTO MINED OUT PITS IS ALSO UNDER REVIEW AS AN OPTION.
OXYGEN RE-LEACH OF NICKEL AND COBALT VALUES

The nickel and cobalt refinery processes mixed sulphide precipitate to produce high purity nickel and cobalt powder and briquettes. A summary of the refining unit processes is described below.

Washed sulphide precipitate is finely ground. The sulphide is re-leached in an autoclave under oxygen overpressure. The leaching time is 90 minutes and achieves >99.5% nickel and cobalt extraction.

The autoclave slurry is discharged to the impurity removal circuit where ammonia and air is added to remove iron. Trace copper is removed from solution using recycled “strip” sulphides. Solid/liquid separation steps removes solids through thickening and filtration.

Precipitate solids are recycled to the HPAL circuit to recover nickel and cobalt.

DURING THE IRON REMOVAL PROCESS, A SMALL AMOUNT OF NICKEL IS CO-PRECIPITATED. PRECIPITATED SOLIDS ARE THICKENED AND RECYCLED BACK INTO THE PROCESS VIA ORE LEACH FEED.

NICKEL AND COBALT SEPARATION

The impurity free liquor is then pumped to the solvent extraction circuit where an organic reagent Cyanex 272 in diluent is used to extract first zinc, which is stripped and sent out to tails, followed by cobalt extraction. Cobalt is preferentially loaded in the organic, ensuring separation of cobalt from nickel. The organic is then stripped and discharged to the cobalt hydrogen reduction circuit whilst the nickel raffinate is discharged to the nickel hydrogen reduction circuit.

NICKEL AND COBALT REFINING

Anhydrous ammonia and ammonium sulphate is added to both the high strength pure cobalt and nickel solutions prior to hydrogen reduction.

The nickel ammonium sulphate liquor is preheated prior to entering the nickel hydrogen reduction autoclaves. Hydrogen gas is introduced under pressure and the nickel is precipitated as a powder. The powder is recovered from the bulk liquor via a flash tank, pan filter and dryer.

AMMONIUM SULPHATE

Ammonium sulphate in barren liquor from the hydrogen reduction autoclaves is recovered for sale in a 3-stage evaporation process.

METAL PACKAGING

Dry nickel ore is briquetted and sintered prior to packaging 99.8% (LME) specification product and is delivered to markets around the world.

Cobalt recovery follows essentially the same process as nickel.
MINARA CONDUCTS BUSINESS WITH RESPECT AND CARE. WE TAKE PRUDENT STEPS TO MINIMISE IMPACTS OUR BUSINESS MAY HAVE ON THE LOCAL AND GLOBAL ENVIRONMENT BY BALANCING SOCIAL, ECONOMIC AND ENVIRONMENTAL NEEDS.
SAFEGUARDING FOR A HEALTHY WORKPLACE

MINARA IS COMMITTED TO IMPROVING SAFETY OUTCOMES FOR ALL INDIVIDUALS ASSOCIATED WITH THE COMPANY, INCLUDING SUPPLIERS, EMPLOYEES, CONTRACTORS AND VISITORS.

We believe that all injuries can be prevented. As part of our preventative safety program, we identify technological solutions, engineering or administrative controls to reduce exposure to chemical and physical hazards. We are also conscientiously improving our health and safety awareness through initiatives such as a behavioural safety system, fitness for work, emergency response, hygiene monitoring and health surveillance.

Whilst we acknowledge that we have come a long way and that our efforts are paying off, we know our safety obligation leaves us with no room for complacency.

PRESERVING THE ENVIRONMENT

In producing nickel and cobalt, our approach is to develop a production cycle that reflects practical and sustainable development. We are committed to engage in best practice environmental management techniques.

We are establishing an Environmental Management System in accordance with ISO 14000 to ensure that environmental impacts are identified, assessed and managed effectively. In addition, Environmental Management Plans are produced for all major projects to ensure we observe and monitor environmental requirements at all stages of our operations.

RESPECTING OUR EMPLOYEES

The Minara workforce is made up of almost 1000 permanent people.

We aim to engender a working environment where cultural and personal differences are valued, where the needs of employees to balance work and personal demands are respected, and where there are equal opportunities for people to progress. Our aim is to build a performance-orientated culture, where employees identify with their role and where their contributions are valued and recognised.

REGIONAL DEVELOPMENTS

Minara’s presence in the region has resulted in regional infrastructure and project infrastructure to support the operation. The regional infrastructure includes upgrades to local roads and improved emergency services. The project infrastructure includes site buildings, an airstrip accommodation village and amenities and plant roads.

Additionally, Minara has continued to support communities near its operations through involvement in local community events, sponsorships and donations. Initiatives primarily focus on promoting health, safety and youth development within local schools and community organisations.

Minara has also developed a strong partnership with emergency service operator The Royal Flying Doctor Service. A five year partnership has produced improvements in emergency service provisions for the greater region.
ONLY 250 YEARS AGO, THIS NATURALLY OCCURRING METAL WAS UNKNOWN TO US AS A UNIQUE ELEMENT. IN THE RELATIVELY SHORT PERIOD OF TIME FOLLOWING ITS ISOLATION AND NAMING, WE HAVE DEVISED SO MANY WAYS TO USE NICKEL THAT WE’VE HAD TO DEVISE EVER INNOVATIVE WAYS TO LOCATE, EXTRACT, AND REFINE IT IN ORDER TO SATISFY OUR GROWING DEMAND.

SOURCE: NICKEL INSTITUTE

www.minara.com.au