

# **HONEYMOON PROJECT**

## **Application**

### **Licence to Mine or Mill Radioactive Ore**

### **Radiation Protection and Control Act 1982**

This information is provided in support of an application for a commercial licence under the Radiation Protection and Control Act 1982 to Mine or Mill Radioactive Ores of the Honeymoon deposit



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# 1 SUMMARY

Southern Cross Resources Pty Ltd currently holds a Licence to Mine or Mill radioactive ore at the Honeymoon site on a non-commercial basis. This licence was initially issued to allow the company to undertake large scale in-situ leaching trials at Honeymoon. It has been maintained by the company since those trials terminated in 2000.

The Honeymoon uranium deposit is a secondary uranium deposit in unconsolidated sands at a depth of approximately 100 metres. The deposit is located approximately 75 km north west of Broken Hill in flat arid pastoral country (Figure 1.1).

The deposit is to be mined by acid in-situ leaching in an operation similar to that of Heathgate Resources' Beverley Uranium Mine. Dilute sulphuric acid containing an oxidant will be pumped into the deposit via a network of injection wells where it will dissolve the uranium. The resulting leach solution will be pumped from the deposit through a series of production wells and the uranium recovered by conventional solvent extraction or ion exchange techniques. A total of approximately 2400 tonnes of yellowcake is to be produced over a period of approximately seven years. The project will employ approximately 50 people, mostly from the local area.

In-situ leaching involves only minor surface disruption. Surface vegetation will be cleared from the area over the deposit but no significant earth moving or excavation will be involved. As a consequence the rehabilitation of the surface at the conclusion of mining will be a relatively simple task. Given time the surface can be returned to a condition similar to that of its surroundings.

The waters in the ore zone are very high in dissolved solids and contain radioactive elements such as radium. Consequently they have no safe agricultural or domestic use or value. The waste liquors from the mining operation are to be returned to the mined out ore zone where, through a process of natural attenuation, they will return to a quality similar to that of the waters which currently occupy the zone.

Any solid low level radioactive wastes which remain on the surface at the end of the mining program will be safely disposed of by burial in appropriately designed pits. All surface facilities will be removed and the mining area returned to pastoral use.

Appropriate monitoring programs will be implemented for the assessment of radiation doses to workers and members of the public. The maximum effective dose equivalent received by a member of the workforce is estimated to be below 5mSv/y and well below the annual occupational dose limit of 20mSv/y. Doses received by members of the public are expected to be unmeasurably low. The estimated dose at the Yarramba Homestead resulting from radon emissions is 7.7  $\mu$ Sv/y or less than 1% of the annual public dose limit while the estimated dose from uranium dust emissions is 4.7 $\mu$ Sv/y. Details of the estimates are provided in the accompanying draft Radioactive Waste Management Plan and draft Radiation Management Plan.

Environmental impacts of the project will be monitored under the scrutiny of the South Australian regulatory authorities.



**Figure 1.1 Honeymoon Project Location**

## 2 PROPONENT DETAILS

Southern Cross Resources Australia Pty Ltd is the Australian subsidiary of SXR Uranium One Inc., a Canadian company engaged in the acquisition, exploration and development of deposits for the production of low-cost uranium. The Company has approximately 112 million issued shares of common stock which are listed on the Toronto and Johannesburg stock exchanges.

The parent company has interests in the Republic of South Africa (RSA), in Canada and in South Australia. The RSA interests include an operating gold mine along with gold and uranium deposits which are under development. Uranium production from the RSA properties is scheduled to begin in 2007. The Canadian interests include uranium exploration properties in the Athabasca region of Saskatchewan.

In South Australia the company holds a 100% in the Honeymoon deposit located on Mining Lease Number 6109 situated on Pastoral Block 1121 and Section 1417 OOH Curnomona. The property is located approximately 75 km north-west of Broken Hill. It also owns a 100% interest in all Tertiary-age uranium on the 452 square kilometre Exploration Licence 2937 and the adjacent 379 square kilometre EL 3017, owns 100% of the 19 square kilometre Goulds Dam property and has a 100% interest in all minerals on the 334 square kilometre Exploration Licence 2956 surrounding Goulds Dam.

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### 3 BACKGROUND TO PROJECT

#### 3.1 Background

In 1971–1972, Carpentaria Exploration Co. Pty Ltd (CEC) explored EL597 which included the area covering the Honeymoon deposit. Drilling intersected minor though encouraging levels of uranium in Tertiary sediments. A Joint Venture was subsequently formed by CEC, Mines Administration Pty Limited (Minad)—a wholly owned subsidiary of AAR Limited, in turn later wholly owned by CSR Limited—and Teton Exploration Drilling Co Pty Ltd (Minad-Teton-CEC JV). Minad was the Operator. Late in 1972, drilling intersected ore-grade uranium at a depth of 100–120 m in Tertiary palaeochannel sediments of the Honeymoon Deposit.

Drilling programs over the next four years established the extent of the deposit, but feasibility studies concluded that it was too small to be mined economically by conventional open-cut or underground mining methods.

Following rapid advances in in-situ leaching (ISL) technology in the USA, a series of in-situ leaching tests was conducted at Honeymoon in 1977 and 1979. These, and additional laboratory tests carried out by the Australian Mineral Development Laboratories (AMDEL) in Adelaide, confirmed the feasibility of uranium recovery at Honeymoon by the ISL method.

In March 1981, Minad submitted a Final Environmental Impact Statement for the Honeymoon Uranium Project. Government approval to proceed to the next phase of development was subsequently granted and in 1982 Minad established an ISL facility at Honeymoon. The facility comprised a pilot leach wellfield of three 5-spot leach patterns, a liquid disposal well, monitor wells, and a processing plant designed to treat pregnant leach solution at a rate of 25 L/s. Supporting infrastructure included an accommodation camp, office complex and workshop.

Minad continued with the process of obtaining the ‘Approval to Mine’ under the *Mining Act 1971* (SA). Approval for an Environmental Monitoring Plan and approval under the *Radiation Protection and Control Act 1989* (SA) were granted. However, before the pilot wellfield and the demonstration plant were commissioned, there was a change of government in South Australia and shortly thereafter, a change in federal government. In March 1983 the final Approval to Mine was deferred and the project was placed under ‘care and maintenance’ in June 1983.

Ownership of the Honeymoon assets subsequently passed to CEC’s parent company, MIM Holdings Limited (MIM). Southern Cross Resources acquired the Honeymoon leases from MIM in May 1997.

Since acquiring the project, Southern Cross Resources has:

- Prepared a Declaration of Environmental Factors (DEF) and obtained the necessary approvals to undertake pilot-scale ISL recovery of uranium (Field Leach Trial).
- Refurbished existing infrastructure including the demonstration plant and pilot wellfield.

- Re-established supporting infrastructure including an office complex, accommodation camp and electricity generation facilities.
- Recommissioned and operated the pilot wellfield and demonstration plant at an initial rate of 6 L/s during the last six months of 1998.
- Augmented the pilot wellfield with new wells and increased the feed to the demonstration plant to the design rate of 25 L/s.
- Undertaken additional technical, environmental, financial and marketing studies.
- Completed and submitted an Environmental Impact Statement.
- Completed and submitted a Response Document for the EIS.
- Completed and reported on additional field work and numerical simulations of ground water movement as requested by the Minister for the Environment and Heritage.
- Received federal and state approval for the project.
- Obtained an Export Licence from the Commonwealth government.
- Been granted Mining Leases by the South Australian government.
- Undertaken extensive drilling programs to provide detailed information on the grade, thickness and structure of the Honeymoon deposit.

### **3.2 Environmental Impact Statement**

On 11 August 1997, the Commonwealth Minister for Resources and Energy (now Industry, Science & Resources), designated Southern Cross Resources as the proponent for the Honeymoon Proposal under the Environmental Protection (Impact of Proposals) Act 1974 (the EPIP Act). The proposal was subject to joint assessment by the relevant Commonwealth and South Australian Government Departments. Planning SA took the lead role in the joint assessment process in close consultation with Environment Australia.

An Environmental Impact Statement was prepared for the Honeymoon Uranium Project and released for public and government department comment on 7 June 2000. The eight-week comment period expired on 2 August 2000. Submissions were received from 1,346 members of the public and 16 government department. The overwhelming majority of the public submissions was based on a pro forma prepared by environmental groups and was dealt with as a block. A total of 27 public submissions required separate response from Southern Cross Resources.

A Response Document, containing the written responses to points raised in submissions was completed by Southern Cross Resources and was released to the public and government agencies on 22 November 2000. Following the submission of this document the South Australian and Commonwealth Government Departments prepared an Assessment Report which detailed conditions to be placed on the project as part of the requirements for the granting of Mining Leases. The preparation of the Assessment Report was required within six weeks under Commonwealth Legislation unless an extension was requested from the Commonwealth Department. A request was made to



Southern Cross Resources for a one-month extension of the deadline because of the holiday season.

On 1 February 2001 the Minister for the Environment and Heritage announced, “further detailed information is required on the hydrology of the Honeymoon aquifers”. He further stated that he had “accepted departmental advice that other environmental issues, such as the method of mining and the production process, were adequately addressed by the environmental impact study process”. Following consultations between commonwealth and state agencies, the Minister released the Terms of Reference for the additional information on 2 March 2001. A program of work was developed by Southern Cross Resources and approved in discussions with government agency representatives on 6<sup>th</sup> April 2001. The additional work program was completed and reported to the government agencies during July 2001. An Addendum to the Assessment report was prepared by the federal and state government agencies. On 20 November 2001 the Minister for the Environment and Heritage announced that “the proposed Honeymoon uranium mine is environmentally acceptable, provided the mine operates under stringent environmental controls and provided that additional measures recommended to the Minister for Industry, Science and Resources, in accordance with the EPIP Act, are implemented”.

The Minister for Industry, Science and Resources announced on 23 November 2001 that he had accepted the recommendation of the Minister for the Environment and Heritage and was issuing an export permission that incorporated conditions based on these recommendations. The export permission authorises exports of uranium from Honeymoon for five years commencing 1 January 2002 subject to compliance with the specified conditions.

These two recommendations formed the basis for Southern Cross Resources receiving Commonwealth environmental approval for the Honeymoon Uranium Project. The South Australian Minister for Minerals and Energy approved a proposal to grant a Mineral Lease over Mineral Claims and Retention Leases held by Southern Cross Resources for a period of twenty-one years thereby authorising operation of the Project subject to Regulations of the Mining Act, 1971 and the special conditions attached. An initial offer for a Mineral Lease was received from Primary Industry and Resources SA (PIRSA) on 6 December 2001. None of the attached conditions was considered by Southern Cross Resources to be unreasonable.

A Native Title Agreement was concluded and signed with the Adnyamathanha people on 1 February 2002. This followed the signing of a similar agreement with the Kuyani people in 1998. With the finalisation and subsequent registration of these agreements, the South Australian Government granted Southern Cross Resources a 21 year Mining Lease for Honeymoon on 8 February 2002.

### **3.3 Permitting**

The nature of the Field Leach Trial required that the necessary permits be obtained from South Australian State and Commonwealth Agencies before the trial could proceed. These permits were limited to the terms and conditions of the Field Leach Trial.

Under the Customs (Prohibited Exports) Regulations (Pursuant to the Customs Act 1901), exports of uranium can be made under the permit granted by the Minister for Industry, Science & Resources. This permit is conditional upon contracts of sale, which must be approved by the Uranium Industry Section of the Energy Minerals Branch, Coal and Minerals Industries Division of the Department of Industry, Science and Resources.

On 19 March 1998, pursuant to the *Nuclear Non-Proliferation (Safeguards) Act 1987* (Commonwealth), the Nuclear Materials Accountant, on behalf of the Director of Safeguards, Australian Safeguards Office, Commonwealth Department of Foreign Affairs and Trade, issued to Southern Cross Resources, a Permit to Possess Nuclear Material. Variation of the permit, which is still in effect, is required for the proposed commercial operation to allow for larger quantities of uranium product to be held on site.

A Licence to Mine or Mill under the Radiation Protection and Control Act, 1982 was granted by the South Australian Health Commission in February 1998 for the Field Leach Trial. This has been renewed on an annual basis and is still in effect.

A Licence to Keep a Dangerous Substance, namely sulphuric acid, hydrochloric acid and caustic soda, was issued for the Field Leach Trial under the Dangerous Substances Act and Occupational Health Safety and Welfare Act, by the Department for Industrial Affairs (now Department for Administrative and Information Services), South Australia, in February 1998. The Licence is renewable on an annual basis and will be required for the life of the project.

Approvals under the Code of Practice on the Management of Radioactive Wastes from the Mining and Milling of Radioactive Ores were granted for the Field Leach Trial by the Chief Inspector of Mines, PIRSA, on 17 March 1998. New approvals will be required for the proposed commercial operation.

On 18 March 1998, conditional approval was granted, under the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores, by the Director of the Radiation Protection Section of the Department of Human Services (formerly the South Australian Health Commission), for commissioning and testing the demonstration plant as part of the Field Leach Trial. A new approval for the proposed commercial operation is required.

## 4 IN-SITU LEACH

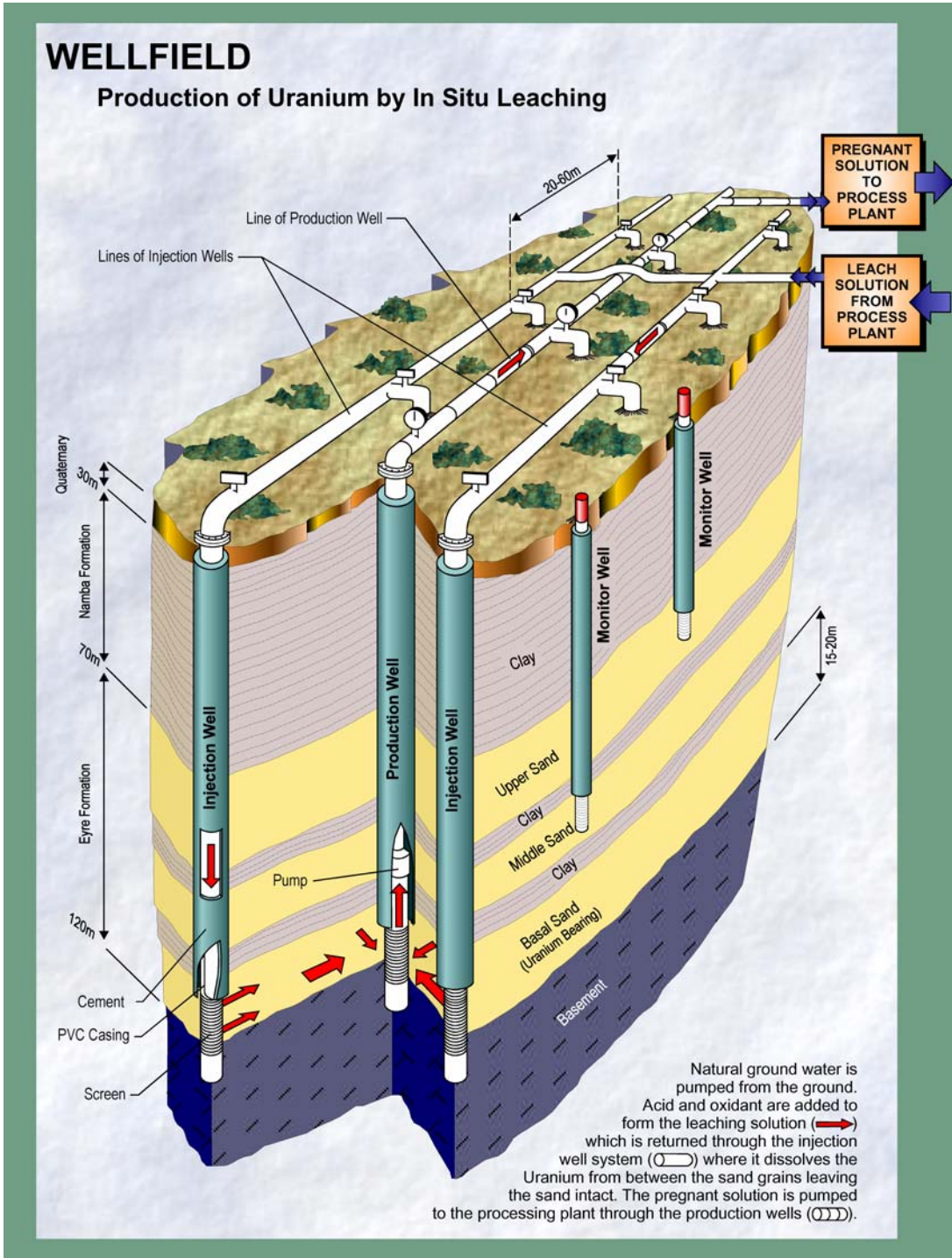
Southern Cross Resources Australia Pty Ltd (SXR) proposes to establish a commercial in-situ leach (ISL) uranium operation, based on the Honeymoon and adjacent deposits. ISL is a closed loop system that involves the extraction of uranium by a circulating solution and processing of the solution to obtain the product at the site. An acidic leach solution containing an oxidant is delivered through injection wells into the uranium-bearing strata. This solution migrates through the sands oxidizing and mobilising the uranium as a soluble complex. The pregnant solution is intercepted by production wells located between the injection wells and pumped to the surface. The solution is passed through a conventional processing plant that extracts the uranium by solvent extraction. After processing, the barren solution is returned to the wellfield to continue the leaching cycle.

The operation of the ISL wellfield is shown schematically in figure 4.1. The operation of the processing plant is illustrated in figure 4.2.

ISL does not involve excavation of open pits or underground mines and all activities requiring operators take place on the surface. On completion of uranium recovery, wells will be filled and capped, process facilities removed, and the land surface rehabilitated leaving little or no evidence of the uranium recovery activities.

Major characteristics of ISL include:

- little disturbance to the land surface;
- no excavation of large volumes of overburden or mine wastes, hence there is smaller expenditure of energy and no extensive, visible, dusty waste dumps;
- a simple processing plant with no crushing or grinding, and with simpler building structures and foundations;
- no large volumes of tailings or tailings dams (although small quantities of other solid waste are produced);
- no exposure of the orebody to the atmosphere, hence less radon, radon daughters and ground radiation;
- no exposure of workers to orebody radiation;
- insignificant dust generation;
- reduced interference with potentially useful water supplies;
- relatively simple rehabilitation requirements after operations are completed.



**Figure 4.1 ISL Wellfield Schematic**

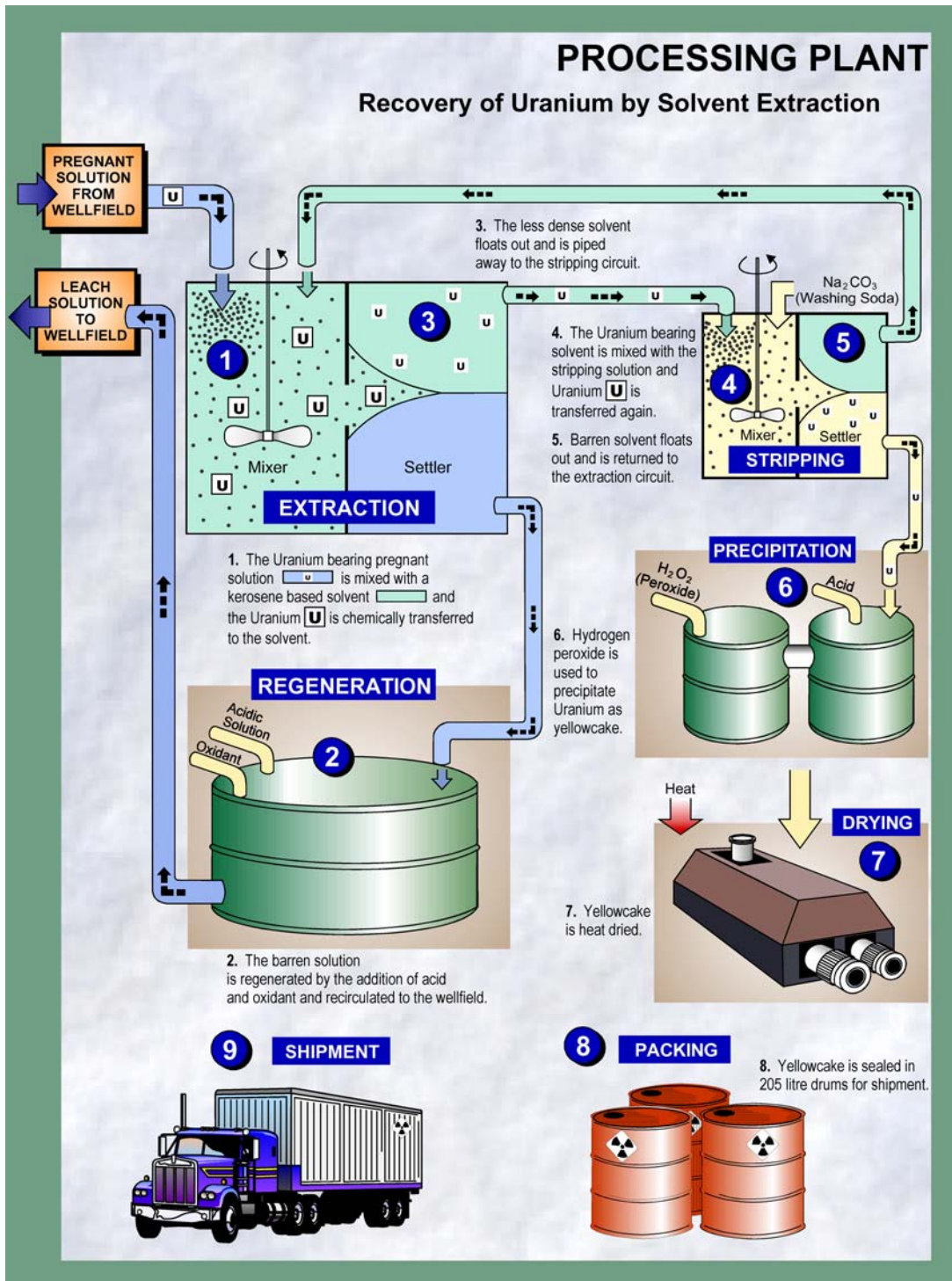


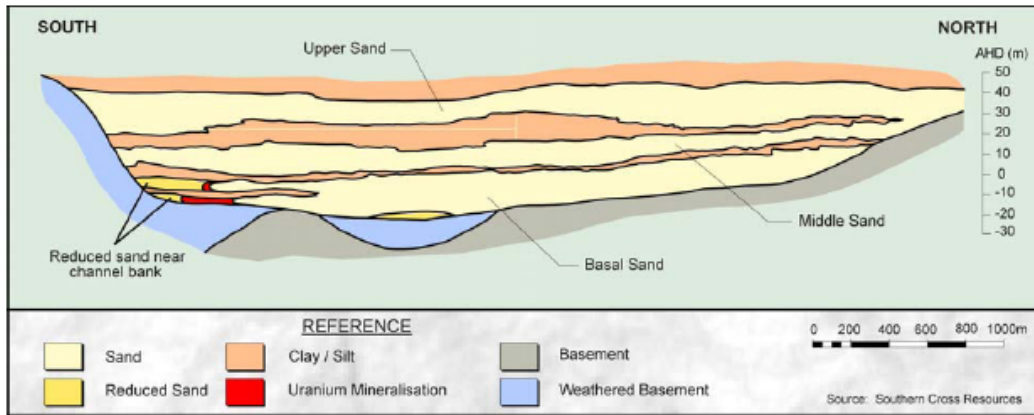
Figure 4.2 Schematic of Process Plant Operation



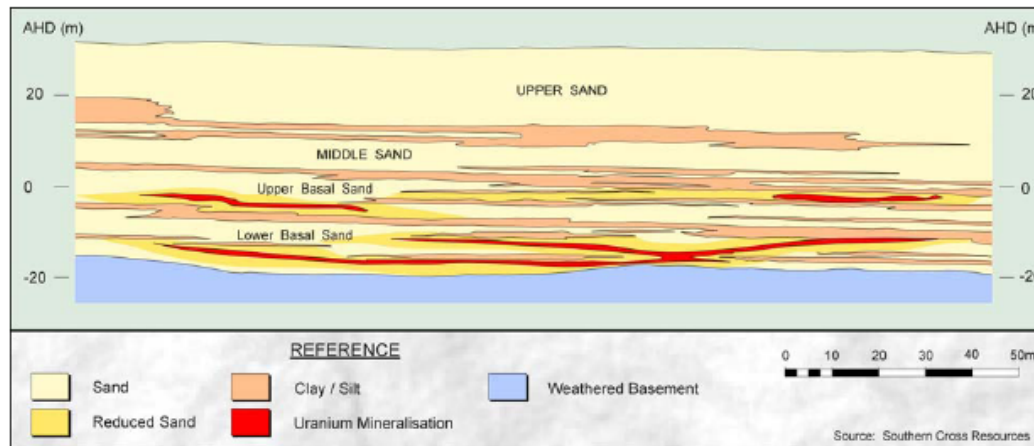
## 5 GEOLOGICAL ENVIRONMENT

The Honeymoon uranium deposits occur in paleochannels incised into underlying Cambrian/Precambrian basement rocks and filled with semi-consolidated, largely uncemented, Tertiary sediments of the Eyre Formation. The late Palaeocene to middle Eocene Eyre Formation is the basal unit of the Tertiary succession in the Callabonna Sub-basin of the Lake Eyre Basin. Schematic sections through the deposit are shown in figures 5.1 and 5.2. A typical drill hole log is shown in figure 5.3.

At Honeymoon, the Eyre Formation includes immature, pyritic, carbonaceous sands and gravels interbedded with lignite and kaolinite-illite-montmorillonite clays. It was



**Figure 5.1 Schematic Section Across Yarramba Paleochannel**



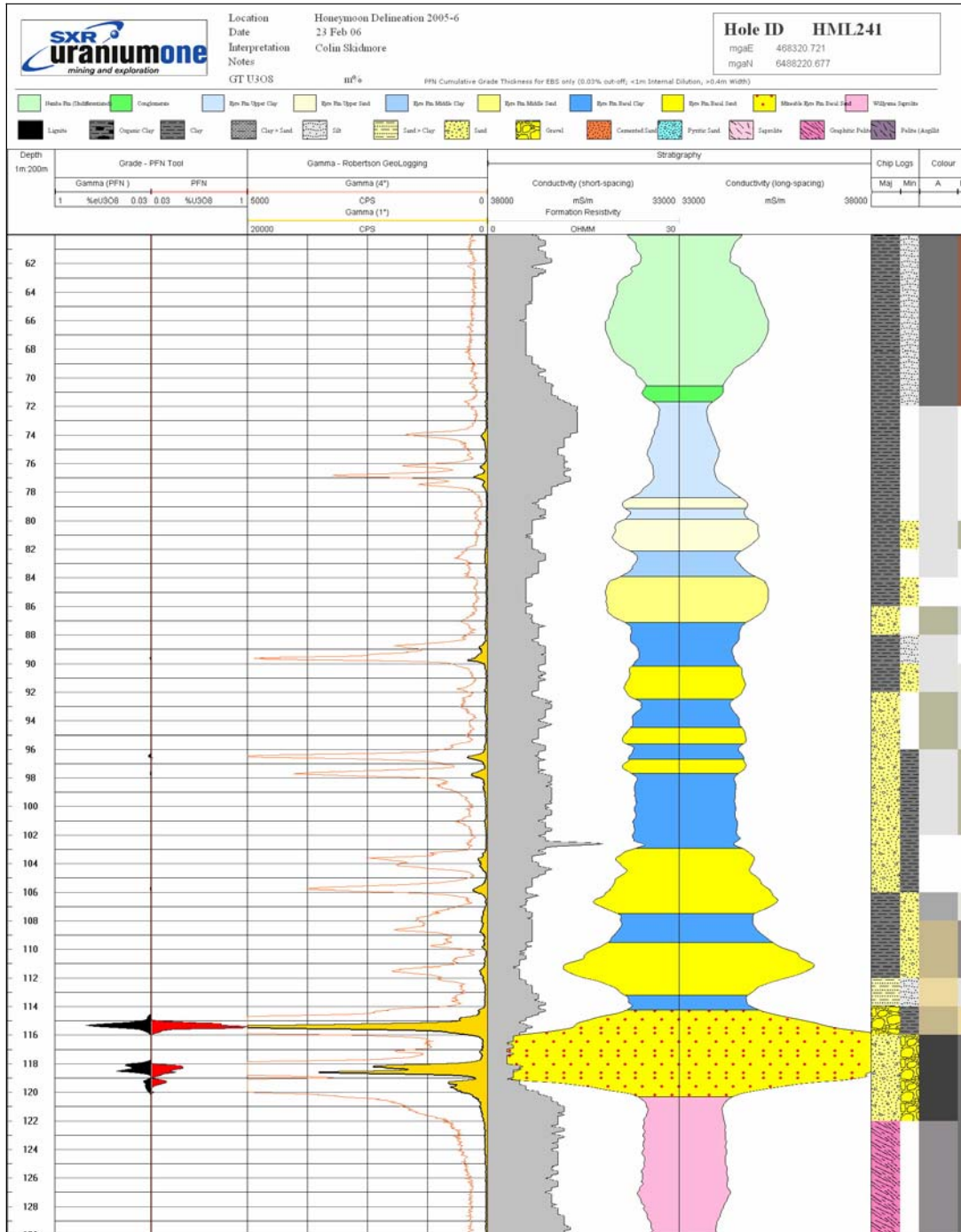
**Figure 5.2 Schematic Section Across the Honeymoon Mineralisation**

deposited by braided streams during epeirogenic uplift of the Olary Ranges, accompanied by subsidence of the Lake Eyre Basin. The Eyre Formation comprises a consistent stratigraphy of interbedded sand and clay units that are continuous over the Honeymoon Deposit but with local variation indicating some hydrological connection between aquifers. The aquifer system is confined by clays of the Namba Formation (above) and the basement rocks (below).

Within the Honeymoon orebody, uranium occurs within coarse-grained pyritic sands where the basal sand pinches out between overlying carbonaceous clay and the southern palaeovalley slope. Its characteristics are typical of the well-developed, planar limb of a roll-front uranium deposit. Zonal changes related to the reduction-oxidation interfaces across the deposit are readily observable. The orebody is flat lying and extends for nearly 1000 m along the valley margin, is 400 m wide at its maximum, averages about 6 m in thickness and extends over an area of 0.21 square kilometres.

The East Kalkaroo orebody also lies within the mineral lease near the southern margin of the Yarramba Palaeovalley. It extends discontinuously for approximately 3.5 km, averages 200 m in width and has an area of 0.12 square kilometers.

Resources have been classified under the JORC Code. The indicated resource in the Honeymoon deposit is 3300 tonnes of U<sub>3</sub>O<sub>8</sub> at an average grade of 0.12% and an average thickness of 7.1 m. The East Kalkaroo deposit contains an indicated resource of 910 tonnes of U<sub>3</sub>O<sub>8</sub> at an average grade of 0.074% and an average thickness of 5.2 m. Intercept definition is at 0.01 per cent U<sub>3</sub>O<sub>8</sub> cut-off with no minimum thickness but a secondary grade-thickness cut-off of 0.20 metre per cent U<sub>3</sub>O<sub>8</sub> is applied.



**Figure 5.3 Typical Drill Hole Log Through the Honeymoon Deposit**



## 6 PREVIOUS MINING ACTIVITIES AT HONEYMOON

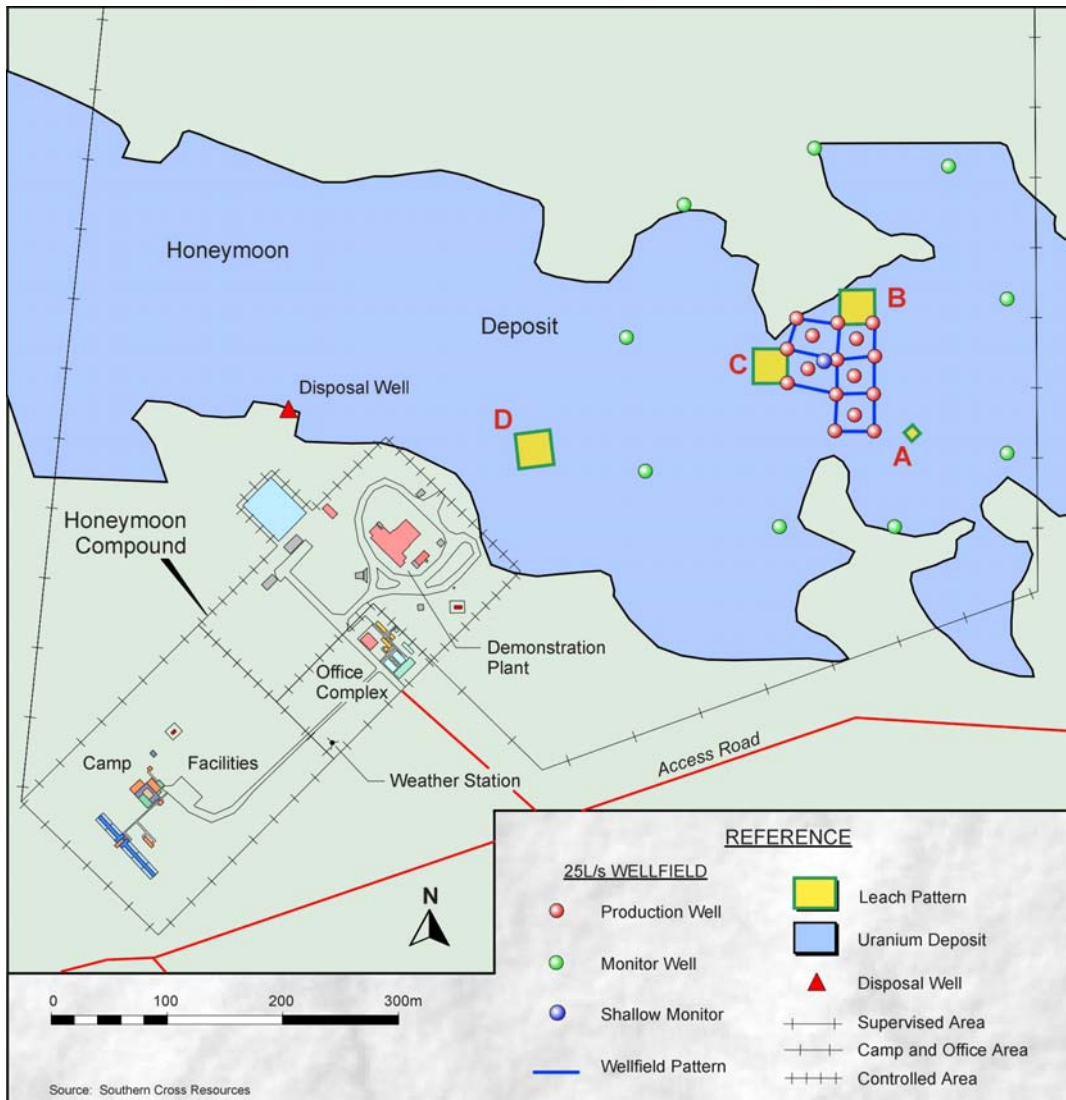
A process plant capable of processing 25 l/s of leach solution, comprising conventional solvent extraction and precipitation circuits, was installed at Honeymoon in 1982. With the exception of some major items—solution surge tanks, sulphuric acid tanks, thickener, and freshwater storage—the wet processing equipment is contained in a simple roofed structure. This structure was built without walls to maximise natural ventilation (figure 6.1). The plant was not put into operation on its completion and lay idle from 1982 until 1998.



**Figure 6.1 The 1982 Honeymoon Process Plant**

During the period November 1998 – February 1999, a wellfield was established to feed the process plant with leach solution at the design rate of 25 l/s. The 25 l/s wellfield comprised 24 wells - five production wells, nine injection wells and ten monitor wells (figure 6.2).

The wells were drilled as 125 mm diameter pilot holes, reamed to 222 mm diameter and cased with 159 mm internal diameter PVC. The annulus between the casing and borehole wall was cemented. After a minimum period of four days to allow the cement to set, the ore zone was under-reamed to a diameter of 279 mm and a 100 mm internal diameter slotted PVC screen was telescoped into the casing. Following well development by circulating drilling fluid and air lifting, the wells were integrity-tested. Production wells were fitted with 15 kW submersible pumps and 90 mm diameter high-density polyethylene (HDPE) production lines.



**Figure 6.2 Layout of the Honeymoon Site for the 1999 – 2000 Leaching Tests**

The wells were connected, via individual 90 mm HDPE pipes, to production and injection manifolds in a purpose-built transportable wellfield control centre. Two production mains and two injection mains, all of 100 mm HDPE, linked the wellfield control centre with the demonstration plant. All pipelines and electrical cables were buried in clearly marked shallow trenches.

The wellfield and plant were used to conduct leaching tests between 1999 and 2000, producing some 30 tonnes of Uranium Ore Concentrates (UOC) before being placed on care and maintenance.

## **7 THE PROPOSED PROJECT**

The main operational components of the Honeymoon project comprise (Fig 7.1):

- The ISL wellfield;
- The wellfield reticulation system;
- The process plant.

### **7.1 ISL Wellfield**

#### *7.1.1 Purpose*

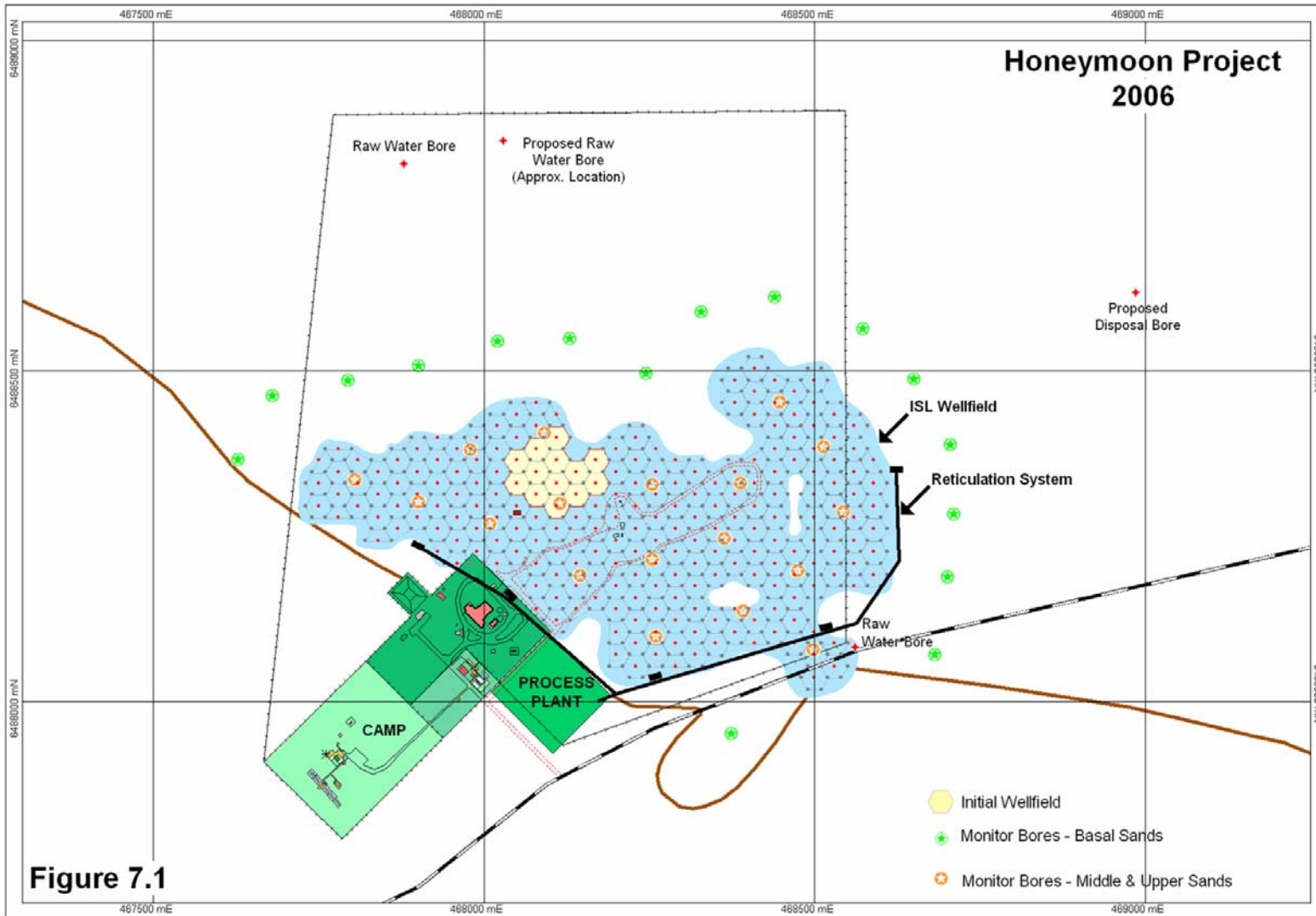
The purpose of the ISL wellfield is to selectively extract uranium from the deposits by leaching. In a continuous process, leach solution is injected into the ore zone via injection wells, and drawn to production wells, dissolving uranium as the solution passes through the host sand between the wells. The uranium-bearing solution is then pumped from the production wells to the process plant where the uranium is recovered. The resulting barren solution is reconditioned and recirculated continuously to the wellfield as leach solution.

#### *7.1.2 Wellfield Design*

The basic wellfield design will be based on '7-spot' pattern comprising six injection wells arranged in a 20–60 m hexagon, with a centrally located production well. Local variations in pattern size and geometry will occur on wellfield margins and where low-permeability ore zones are encountered.

Approximately six litres per second of leach solution will be recovered from each production well resulting in an annual production of approximately 14 tonnes of U<sub>3</sub>O<sub>8</sub> per production well. Consequently for the maximum production of 400 tonnes per annum approximately 30 production wells will be in use in a wellfield approximately 200 metres square. The production wells will be serviced by approximately 100 injection wells. The number of injection wells will depend on the geometric lay out of the wellfield. The layout is determined by wellfield definition drilling carried out at the time the wellfield is developed.

Prior to the commencement of leaching operations, monitor wells will be installed within and around the boundary of the orebody. The boundary wells will be installed at a distance of 125 m from the orebody, at 125 m intervals and will be completed in the Basal Sands. Their purpose will be to obtain pre-leach baseline water quality data, and subsequently to monitor for unintended horizontal excursion of leach solution from the wellfield during and after leaching. Perimeter monitor wells will serve no useful purpose where the Basal Sands are terminated by underlying basement rocks at the margin of the ore zone. Monitor wells will not be installed in these areas. The outermost wells in the wellfield development will also be used as monitor wells for leach solution detection. The installation of these monitor wells will progress across the mineralised area as leaching progresses.



**Figure 7.1 – Plan of Proposed Operation**

Shallow monitor wells will be installed within the wellfield at a density of one well per 1.5 Ha in both the Middle and Upper Sand units. These wells will be completed above the deposit to check for unintended vertical excursion of leach solution from the Basal Sands during and after leaching operations. Excursion parameters will be developed for inclusion in the final Radioactive Waste Management Plan.

Earthen bunds will be created around the operating wellfields to contain run off and spills. These bunds will be progressively removed as areas are mined out.

The proposed layout of the initial wellfield is shown in figure 7.1. This layout may be modified once wellfield definition drilling data is available.

### *7.1.3 Wellfield Installation*

All wells— injection, production and monitor wells—will be installed using conventional rotary drilling rigs and standard well-completion procedures. The program will be conducted in accordance with the South Australian Water Resources Regulations (1997). The selection of well construction materials will be based on the corrosive nature of the ground water and the leach solution.

### *7.1.4 Wellfield Conditioning*

The wellfield will require conditioning prior to commencing leaching operations to achieve optimum uranium production. Conditioning will involve lowering the pH of the ground water in the ore zone, to near the desired operating range from 2.0 to 2.5, by acidification of the circulating ground water. As areas become leached out and the wellfield is extended to unleached areas, Basal Sands ground water from new wellfield areas will be exchanged for leach solution from leached areas. The objective of this procedure will be to restore original ground water conditions in the leached areas and to confine the leach solution to the operating wellfield.

In areas of higher than normal salinity, replacement of the natural ground water in the ore zone area may be necessary. Conditioning may consist of either of the following:

- removal of highly saline Basal Sands ground water from the ore zone via the production wells; the water will be re-injected into the Basal Sands via disposal wells located away from the area to be leached, or in previously leached areas;
- injection of pH adjusted less saline Upper Sand ground water to replace the highly saline ground water removed.

## **7.2 Leaching**

Leach solution will be introduced into the ore zone via injection wells at a rate of up to 6 litres per second per well, depending on the permeability of the Basal Sands surrounding the wells. The leach solution will comprise ground water from the Basal Sands and/or Upper Sand, acidified with sulphuric acid ( $H_2SO_4$ ) to a pH of approximately 2.0 to 2.5 and with one or more oxidants - oxygen, sodium chlorate

(NaClO<sub>3</sub>), hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), or ferric sulphate (Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>). Other oxidants could be tested in operations as experience and on-going development dictates.

The leach solution will cause uranium minerals to be oxidised, and then dissolved as sulphates in the form UO<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub><sup>-4</sup>. The leach solution will also mobilise, to a minor extent, radium-226. Typical analyses of Basal Sands ground water and pregnant solution are shown in Table 7.1.

Unit	Pregnant Solution		Ground Water in Basal Sands	
	Average	Range	Average	Range
U <sub>3</sub> O <sub>8</sub> mg/L	75	20-1,000	1.2	0.02-7.3
Fe mg/L	260	110-370	<1.0	<1.0
SO <sub>4</sub> mg/L	5,300	3,580-6,800	1,770	1,100-2,670
Cl mg/L	8,470	7,650-9640	7,850	4,020-9,740
Ca mg/L	940	810-1,050	870	100-1,480
Mg mg/L	210	90-460	390	200-560
Zn mg/L	110	80-130	0.19	0.03-0.67
Na mg/L	6,170	5,150-7,200	4,310	2,820-5,250
HCO <sub>3</sub> mg/L	<5	<5	145	90-270
Ra-226 Bq/L	830	510-1,300	169	30-450
TDS mg/L	16,430	15,300-20,000	16,100	9,400-20,000
pH	2.2	1.8-2.6	7.1	6.5-8.1

**Table 7.1 Analyses of Pregnant Solution and Basal Sands Ground Water**

The proposed injection and production rates for the wellfield patterns will result in a leach-solution retention time in the ore zone of approximately six days. The shortest path time is expected to be approximately one day. The proposed injection rates will result in only a small increase in hydrostatic head, because of the highly transmissive nature of the ore zone.

### 7.3 Production

Pregnant solution will be pumped from the production wells at a nominal rate of six litres per second. The production well pumping rate will be greater than the injection rate in each pattern. This will ensure the maintenance of a positive hydraulic gradient towards the production wells and thereby prevent excursion of leach solution from the wellfield. However, to avoid unnecessary drawdown of ground water from overlying aquifers and undesirable dilution of the leach solution, the overproduction will be limited to 0.5% to 2% of the injection rate, with an average rate of approximately 1%.

The overproduction will be removed as a 'bleed' stream from the barren solution after removal of the dissolved uranium in the process plant. The bleed stream will be reinjected into the Basal Sands.



As leaching proceeds, uranium production from individual patterns will eventually fall below economic levels. Patterns in leached-out areas will be shut down and new patterns in unleached areas brought on-line, maintaining the design feed to the process plant. This will result in a gradual 'migration' of the wellfield over time, until the deposits are exhausted.

Monitor wells will maintain a continuous check of ground water quality and for unintended horizontal and vertical excursion of leach solution. An excursion is defined as the movement of leach solution outside the area of leach activity. It will be detected by changes in monitoring parameters such as a lowering of the pH of the ground water, increases in the uranium or sulphate concentrations of the ground water or changes in groundwater conductivity. In the case of an excursion, injection of leach solution into the area will cease while production of ground water will be continued. Ground water will be drawn from the affected area until the monitoring parameters are returned to the normal range determined from baseline measurements.

#### **7.4 Wellfield Development Plan**

Development of the Honeymoon ISL wellfield will commence in the area to the north and west of patterns previously leached in field leach trials. The wellfield will gradually migrate to the western limits of the Honeymoon Deposit and then eastward to the eastern limits of the Honeymoon Deposit.

Delineation drilling and geophysical logging to define the physical and economic limits of the deposits will be undertaken before wellfield development. Following down-hole geophysical logging, the drill holes not required for wellfield development or monitoring purposes will be backfilled with cement to prevent inter-aquifer migration of ground water.

#### **7.5 Wellfield Reticulation System**

##### *7.5.1 Purpose*

The purpose of the wellfield reticulation system is to deliver leach solution to the wellfield injection wells and to return pregnant solution from the wellfield production wells to the process plant for uranium extraction.

##### *7.5.2 Wellfield Solution Lines*

The injection and production trunk lines and feeder lines connecting the wellfield control center and the plant will be butt-fused high-density polyethylene (HDPE) pipe. They will be of the appropriate diameter and pressure rating to handle varying flow rates through each portion of the line. The lines to the production and injection wells will also be HDPE and sized to accommodate the individual flows and pressures. All lines will be tested prior to being placed in service, to confirm the integrity of each welded and flanged joint.

Trunk lines, feeder lines, production and injection lines will be, as far as possible, placed on the surface so that surface disruption due to trenching for burial of the pipes will be minimised. Some pipes may have to be buried due to local conditions, access

considerations, or pipe expansion and contraction characteristics. The regulatory authorities will be kept informed on the disposition of surface and buried piping. On completion of the production phase, trunk lines and all surface lines will be removed. Rehabilitation will commence during operations and will be finalised when leaching of an area is completed.

Trunklines will be banded to contain any leakages that might occur from these lines. All other lines will be located within the wellfield bunds.

### *7.5.3 Wellfield Control Centres*

The wellfield reticulation system will be managed by transportable, skid-mounted wellfield control centres. These will act as collection and distribution interfaces between groups of injection and production wells in the wellfield, and the process plant. A typical wellfield control center comprises filters, valves, meters, sensors, oxidant injectors, and booster pumps. Injection and production wells will be connected individually to injection and production manifolds at the control centres, via butt-fused high-density polyethylene (HDPE) pipes. The control centres will be connected to the process plant via HDPE injection and production mains.

The control centres will be provided with a computerized control system which will detect pipe failures and respond by automatically shutting down the affected section of the reticulation system. In these circumstances the control system will also activate alarms in the plant control room which will alert the plant operators, allowing them to begin remedial action.

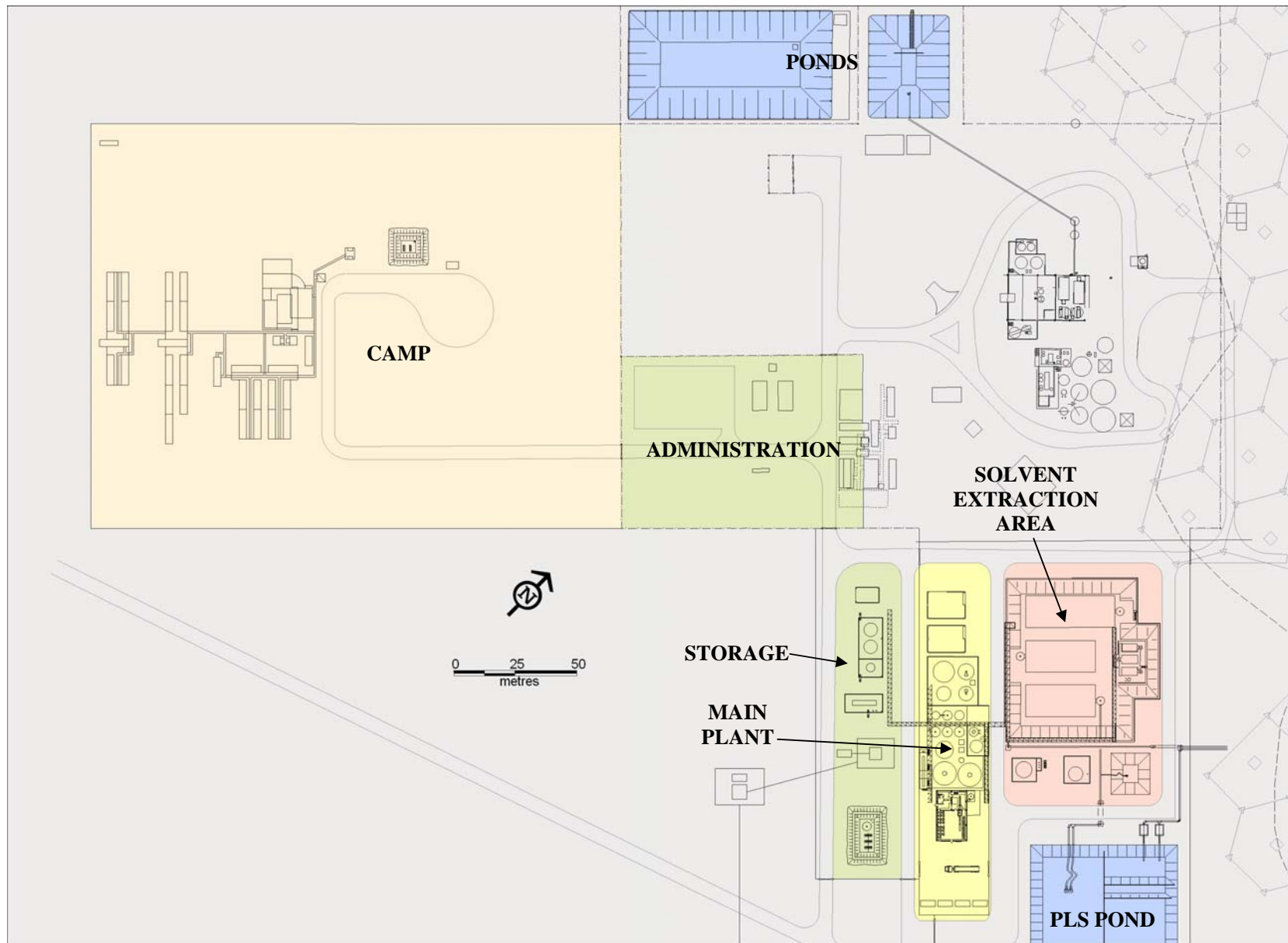
As leaching progresses and the wellfield migrates from leached areas to unleached areas, the control centres may be relocated if appropriate.

Pipes and power lines connecting the control centres to the wells will generally be laid on the surface but will be buried in shallow trenches in those areas where it is necessary to minimise the potential for physical damage.

## **7.6 Processing and Uranium Extraction**

The uranium extraction processes proposed for the Honeymoon Project have been used extensively throughout the mining industry for uranium and copper production for more than 30 years. The main processing steps are described below. The proposed locations for the process plant and facilities are shown in Figure 7.2; a schematic flow sheet is shown in figure 7.3.





**Figure 7.2 – Location of Process Plant and Facilities**

### *7.6.1 Clarification of Pregnant Solution*

Pregnant solution delivered from the wellfield will be clarified by settling or filtering to remove any suspended solids that would contaminate organic solvent or plug equipment in the extraction circuit. Settling is the preferred method of clarifying the solution as filters are prone to plugging by gypsum precipitates. They also present an OH&S problem as they require frequent manual cleaning. The settled solids will be retained in the pond and eventually buried in accordance with an approved Radioactive Waste Management Plan. If filters are used they will require periodic cleaning by backwashing with water. The solids removed by backwashing will be discharged to the retention pond (Fig 7.2).

### *7.6.2 Uranium Extraction*

Uranium will be extracted from the leach solutions by ion exchange. There are two forms of ion exchange used industrially, resin ion exchange and liquid ion exchange (more commonly known as solvent extraction). Resin ion exchange has been adopted at the Beverley Uranium Mine while solvent extraction has been adopted at Olympic Dam. Solvent extraction is preferred for the Honeymoon plant. However, should a suitable ion exchange resin be identified the option of resin ion exchange will be reconsidered. The process described below is for the preferred solvent extraction option. The process for resin ion exchange would be similar.

The clarified pregnant solution will be transferred to the solvent extraction circuit where it will be mixed with kerosene-based solvent. Uranium will be selectively extracted from the pregnant solution and chemically transferred to the solvent. At the same time, the concentration of uranium will be upgraded to a level conducive to obtaining good-quality yellowcake in the subsequent stripping and precipitation stages.

The solvent will include extractants such as DEHPA (di-2-ethyl-hexyl-phosphoric acid), Alamine-336, TBP (tri-butyl-phosphate) and iso-decanol in solution in high flash-point kerosene. The relative proportions of each component will be varied from time to time as process requirements change. The concentration of extractants in the solvent will comprise approximately 10% by volume. The transfer efficiency of uranium from the pregnant solution to the solvent is typically 92-97%.

After mixing, the pregnant solution and uranium-bearing solvent will be transferred to extraction settler tanks where the less-dense solvent will float to the surface. The solvent overflow will be transferred to the stripping circuit

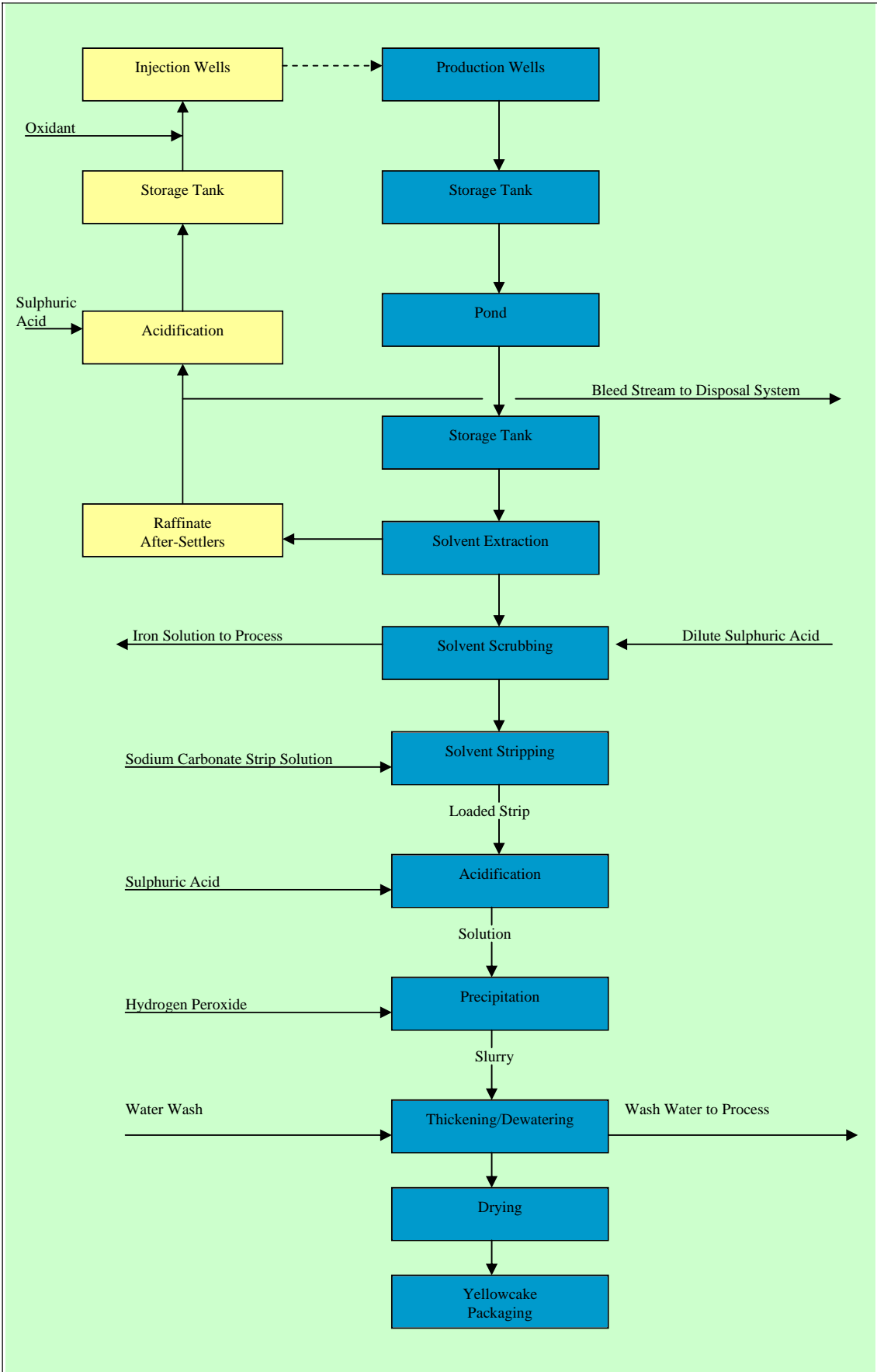


Figure 7.3 Schematic Flowsheet of the Honeymoon Plant Showing Major Process Steps

As outlined above, a bleed averaging 1% of the barren solution will be removed at this stage and directed to the retention pond. Field trials have confirmed that a 1% bleed will provide the appropriate hydraulic head between injection and production wells in the wellfield. The remaining bulk of the barren solution will be reconditioned as leach solution by the addition of acid and oxidant, and recirculated to the wellfield. The pH of the leach solution will be in the range from 2.0 to 2.5.

### *7.6.3 Stripping*

In the stripping circuit the uranium-bearing solvent will be scrubbed with a solution of sulphuric acid containing sodium metabisulphite to remove dissolved iron. The solvent will then be mixed with an aqueous solution of sodium carbonate and the uranium will be chemically transferred to the solution. The pH will be maintained in the range from 9 to 10 during this stage. After mixing, the solvent and uranium-bearing stripping solutions will be transferred to strip settler tanks, where the less-dense barren solvent will be separated from the aqueous phase.

The pregnant strip solution will be transferred to a thickener to allow any iron precipitates which may form during stripping to be separated from the solution before it is pumped to the precipitation circuit.

### *7.6.4 Precipitation*

Precipitation will be undertaken in a two-stage process with a total residence time of approximately 11 hours in a batch system. Precipitation will be carried out in a single large tank. Three such tanks will be provided.

In the precipitation tank, sulphuric acid and air will be added to adjust the strip solution pH to within the range from 2.5 to 3.0. Carbonates will chemically decompose to carbon dioxide and a soluble sodium diuranate complex will be formed. Yellowcake as uranium peroxide ( $\text{UO}_4 \cdot 2\text{H}_2\text{O}$ ) will be precipitated by adding hydrogen peroxide, producing sulphuric acid as a by-product. Caustic soda will be added to a tank to gradually adjust the pH up to the range of 3.1 to 3.3. By the time precipitation is completed the tank will contain a dilute slurry of uranium peroxide (3% to 5% by weight).

The slurry will be pumped to a thickener where gravity settling of the suspended uranium peroxide precipitate will occur. Yellowcake slurry will be drawn off as thickener underflow at about 35% solids by weight and transferred to a dewatering centrifuge. The thickener overflow solution will be recycled for use as makeup solution for the strip and conditioning scrub mixer-settler, so that any valuable contained uranium precipitate will be re-dissolved and collected by the solvent for eventual recovery.

### *7.6.5 Dewatering, Drying and Packaging*

The thickened yellowcake slurry will be reduced to 15% to 20% moisture with a solid bowl centrifuge. The filtrate will return to the uranium thickener and the moist yellowcake will be transferred by chute to a screw-type dryer. Hot oil, in closed circuit, will pass through the vanes of the dryer in a counter-current direction to the

yellowcake, raising the product temperature to a maximum of 200°C. The resultant moisture content will be less than 5% by weight. The yellowcake product will be discharged to a hopper in preparation for packaging.

The yellowcake will be packed for shipment in industry-standard 205 L steel 'Safe Seal' dangerous goods open head drums. Approximately 300 kg of yellowcake will be loaded from the product hopper into a weigh-bin and then discharged into the drum via a sealed outlet operating under vacuum conditions. The drums will be sampled, sealed with airtight steel lids, washed externally, removed from the drying–packing area, and placed in 20 tonne shipping containers. These containers will be stored within a secure product storage compound in preparation for shipment.

The dewatering, drying and packing equipment will be housed in a separate building from the rest of the process plant. Any dust emissions within this building will be contained by a positive ventilation system with a bag filter exhaust system. Appropriate personnel access, safety equipment and procedures will be adopted for the packaging area.

#### *7.6.6 Radon Emissions*

Leach solutions will contain dissolved radon 222 gas. The leach solution from the well field will first be run through tanks which will be agitated by the high velocity of the incoming fluid. It is expected that the major radon release will take place in these tanks. Air sparging will be added to increase the rate of radon emission if this is found to be necessary. The tanks will be located away from the plant site and will be fitted with mechanical ventilators which will exhaust the released radon from a stack some 10 metres above ground level. Smaller radon emissions will be encountered from solution storage ponds which will also be located away from the plant site. A limited amount of the radon will be released as a result of the mixing action in tanks in the process plant. These tanks will be connected to a mechanical ventilation system which will exhaust the radon from a stack 10 metres above ground level.

### **7.7 Solution Control**

Liquid waste streams which arise from routine plant and wellfield operations will be contained and will be directed to the retention ponds from where they will be disposed of by injection into the basal sands of the Eyre Formation. Spills, runoff and other unplanned but anticipated liquid wastes will be contained within the wellfield and/or the process plant by bunding and transferred to the retention ponds as necessary. Unanticipated leaks or spills will be contained by temporary bunding then transferred to the retention ponds as necessary. The retention ponds will be lined with compacted clay and will be fitted with high density polyethylene liners. Disposal of any contained solid wastes will be in accordance with the requirements of the Radioactive Waste Management Plan.

The wellfield reticulation system will be fitted with a sophisticated computer control system (similar to that currently in use at the Beverley Mine) which will ensure that any significant leak within the reticulation system is promptly detected and the appropriate sections of the system automatically shut down. There will be manual shut down options available in case of a computer system failure.

## **8 PLANT LAYOUT**

The design of the Honeymoon process plant has been carried out in sufficient detail to provide the sizing of all process equipment and allow a preliminary plant layout to be produced. Detailed design work which will involve the preparation of construction drawings is yet to be completed. As the detailed design work progresses an extensive Hazops study will be made. It is expected that, as a result of this study, there will be some changes made to the preliminary plant layout. The preliminary plant layout is shown in figure 8.1. More detailed drawings are provided in section 11.

### **8.1 Pregnant Leach Solution (PLS) Area**

In the plant layout shown in figure 8.1 pregnant leach solution from the well field enters the plant area from the right hand side of the figure and passes through two radon release tanks before entering a settling and storage pond. Level controls prevent the radon release tanks and the pond from being over filled. The clarified solution from the pond is pumped to the extraction mixer settlers located to the north of the settling and storage pond.

### **8.2 Barren Leach Solution (BLS) Area**

Barren leach solution from the extraction settlers is sent to the BLS area on the eastern side of the main plant building. This area is provided with a bunded concrete floor which drains to a sump where wash down waters and any spillage are collected and pumped to the retention pond. In the BLS area a 1% bleed solution is taken and pumped to the retention ponds. The remaining solution is reconstituted with sulphuric acid and sodium chlorate before being pumped out to the wellfield through the wellfield return lines which are shown on the right hand side of figure 8.1.

Level controls prevent the tanks in this area from being over filled. Radon releases from the tanks are vented to the plant ventilation system.

### **8.3 Solvent Extraction Area**

The solvent extraction area on the eastern side of the plant site is the only area of the plant within which organic solvent extraction reagents are handled.

The solvent extraction area contains the mixer settler units required for extracting the uranium from the incoming leach solutions and transferring it to an aqueous sodium carbonate strip solution. The incoming leach solutions are expected to average 75 mg/l U<sub>3</sub>O<sub>8</sub> while the strip solution is expected to vary between 10 g/l and 15 g/l U<sub>3</sub>O<sub>8</sub>.

The mixer units where the organic and aqueous phases are contacted have a residence time of approximately one minute. Radon releases are expected to be minor. The large settling tanks are blanketed by the organic phase which will prevent significant radon release.

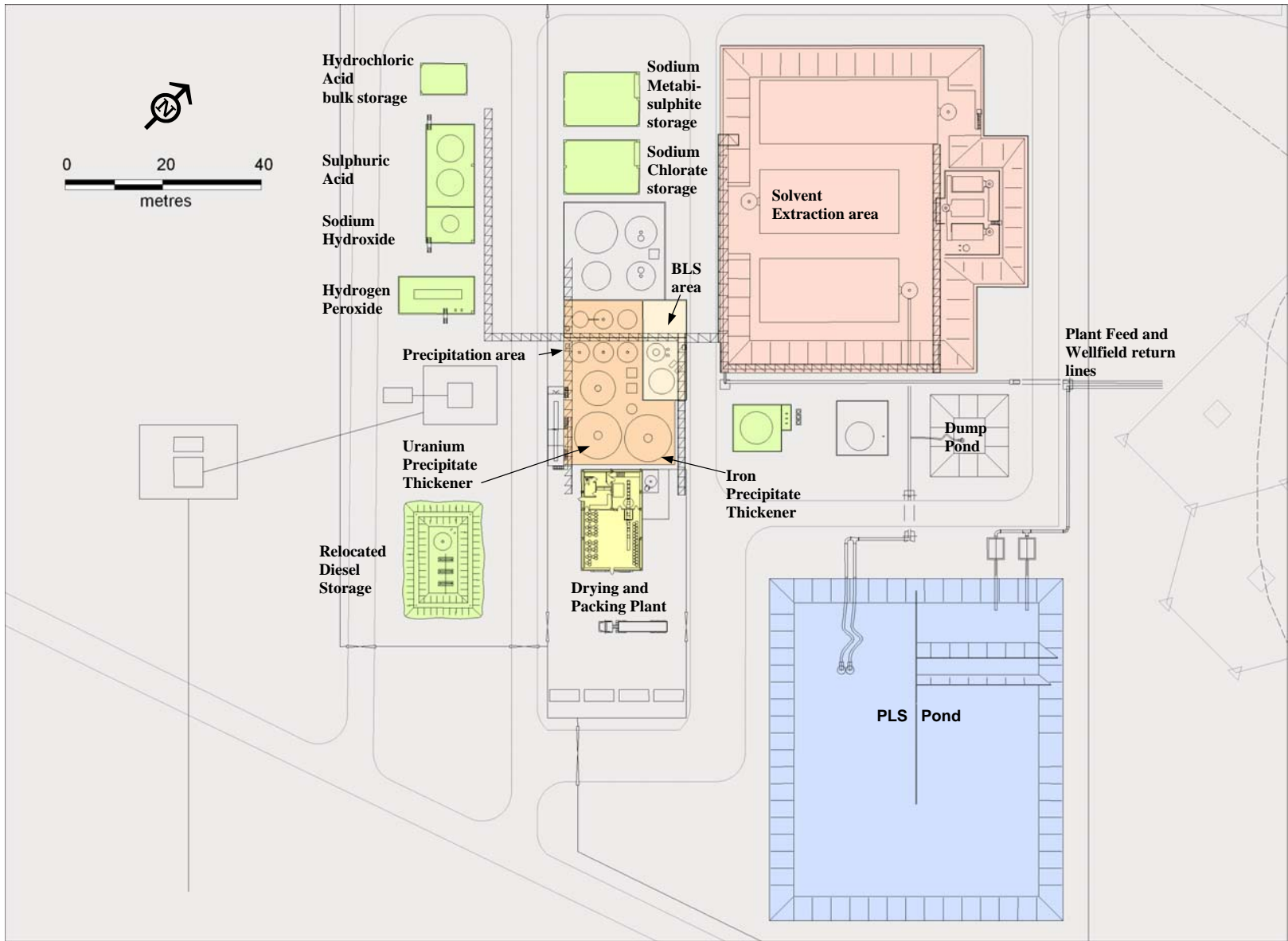


Figure 8.1 – Preliminary Plant Layout

Solvent storage and crud handling equipment is located to the south of the mixer settler units. The equipment will be located on concrete banded floors which drain to sumps from which spills can be recovered for recycle or disposal. A mixer settler dump pond is provided in this area so that in an emergency a mixer settler unit can be drained to the pond.

The solvent extraction units are located out-of-doors and fitted with covers. The area is equipped with appropriate fire prevention and fire fighting equipment. The entire area is surrounded with an earthen bund. Levels within the mixer settler units are controlled by a computerised system.

#### **8.4 Iron Precipitate handling**

A thickener is provided in the south eastern section of the main plant building to collect any iron precipitates which may form in the stripping process. The thickener is located within the concrete bunding of the main plant building. The sodium carbonate strip solution from the solvent extraction area is pumped to the thickener. Any contained iron precipitates sink to the bottom of the thickener and are pumped from there to an iron digestion tank where the iron is re-dissolved in sulphuric acid. The resulting iron solution which contains dissolved uranium is returned to the solvent extraction area for reprocessing.

The clarified strip solution from the thickener is pumped to the precipitation tanks.

#### **8.5 Precipitation Area**

Three batch precipitation tanks are located in the main plant building which is provided with a concrete floor and bunds. The precipitation process, which involves the progressive addition of sulphuric acid, hydrogen peroxide and sodium hydroxide, is computer controlled. Level controls prevent over filling of the tanks. Off gasses are vented to the plant ventilation system. The area is provided with a sump in which wash down water is collected and pumped to the retention ponds.

The precipitation process produces a uranium peroxide slurry (see 7.6.4).

#### **8.6 Yellowcake Dewatering and Drying**

The uranium peroxide slurry produced in the precipitation area is settled in a thickener located in the south western corner of the main process plant building. The supernatant liquor is recycled to the solvent extraction area while the settled precipitate (yellowcake) is pumped to a drying and packing plant.

The uranium drying and packing plant is located to the south of the main plant building. It is housed in a separate secure two story building within the main plant perimeter, with restricted personnel access. The top floor of this building contains the drying plant (centrifuge, dryer and scrubber). The bottom floor contains the drum packing plant (hopper, drum conveyors and bag house filter).



The first stage of dewatering employs a centrifuge, which will reduce the moisture level of the yellowcake to approximately 35%.

The centrifuge solids product discharges into a heated twin screw dryer which reduces the moisture content to 2%. The dryer discharge is stored in a hopper ahead of a drum filling plant.

The operation of the drum filling plant is largely automated. Approximately five drums of yellowcake will be produced each day, with each drum containing approximately 300kg of yellowcake. These drums will be loaded into 20 foot sea-containers. Approximately 63 drums can be loaded into each 20 foot sea-container.

The drying plant and packing plant is considered to pose an increased hazard as there is the potential to generate airborne product dust. Hence, both of these plants are contained in sealed rooms which are maintained under a slight negative pressure to prevent the escape of any airborne dusts. This negative pressure is achieved by a dust extraction fan. The extraction fan exhausts through a bag house filter which collects any entrained dust minimising any release to the environment.

The ventilation system also has ventilation points located where dried yellowcake is transferred from one piece of equipment to another. This allows any dusts produced during transfer to be sent directly to the bag house filter reducing the potential for occupational exposures.

The entire plant is designed so that it can be routinely washed down, preventing any long term dust build up. The areas will be fully bunded to ensure that all wasdown waters are contained and directed to the retention pond.

Access to both plants is via a clean room / dirty room arrangement.

## **8.7 Storage areas**

Bulk liquid reagents and fuels are stored in an area to the west of the plant outside the supervised and controlled areas. Consequently trucks making bulk deliveries can unload without entering supervised or controlled areas.

Solid reagents are stored within the controlled area. The storage areas are adjacent to the western fence of the plant site which enables trucks delivering these reagents to be unloaded through the security fence without entering the controlled area.

Organic solvent extraction reagents, which are delivered in drums, are unloaded outside the controlled area and transferred to the storage area by Southern Cross Resources staff using Southern Cross Resources equipment.

Low level radioactive wastes awaiting burial will be held in a temporary storage area adjacent to the retention pond. This area is designated as the Low Specific Activity (LSA) area. It is bunded and drains to the retention pond.

All storage areas are individually and appropriately bunded.

## 8.8 Ponds and Washdown Areas

There are four ponds (figure 8.2), viz:

*Pregnant Leach Solution Pond.* This pond has two process-related functions. First it allows any solids in the pregnant leach solution to settle, providing a clarified feed for the plant. Second it provides a surge capacity which smooths the flow rate of pregnant leach solution to the plant. The pond will accumulate sediment which may contain radioactive components. The pond is five metres deep, is lined with compacted clay and fitted with a 2mm synthetic liner so that at the end of the project it may be used as a disposal pit for the accumulated sediment, if appropriate, and other lightly contaminated waste materials. The pond has six monitor points located beneath the liner to detect leaks.

*Retention Pond.* The retention pond was constructed for the test program conducted in 1999-2000. It is five metres deep, lined with compacted clay, fitted with a 2mm synthetic liner and provided with monitor bores for leak detection. The pond accepts all of the waste waters from the various plant sumps and wash down areas. The pond acts as a settling pond allowing sediments to settle before the waste waters are disposed of by re-injection into the basal sands. The sediment in this pond will contain minor amounts of radioactive components that may be buried in the pond along with other radioactive wastes at the end of the project as appropriate (see the draft Radioactive Waste Management Plan (RWMP) which accompanies this application).

*Water Disposal Pond.* This pond provides a surge capacity for the bleed stream taken from the barren leach solution area. The bleed stream flow rate varies as the wellfield solution flows are adjusted to contain the leach solutions within the mining area. The water disposal pond provides a surge capacity for the bleed solutions allowing the flow rate to the disposal wells to be regulated. The pond is five metres deep, is lined with compacted clay and fitted with a 2mm synthetic liner so that at the end of the project it can be used as a disposal pit for the accumulated sediment and other radioactive waste materials if this is appropriate (see RWMP). The pond has six monitor points located beneath the liner to detect leaks.

*Dump Pond.* The dump pond provides emergency storage for solvent extraction solutions and reagents should it become necessary to evacuate one of the mixer/settler tanks. It also can be used as a temporary storage for solvent extraction crud which is to be processed.

An area adjacent to the retention pond, designated as the LSA area, has been provided for the wash down of vehicles and equipment. The area has a bunded concrete pad which drains into the retention pond.

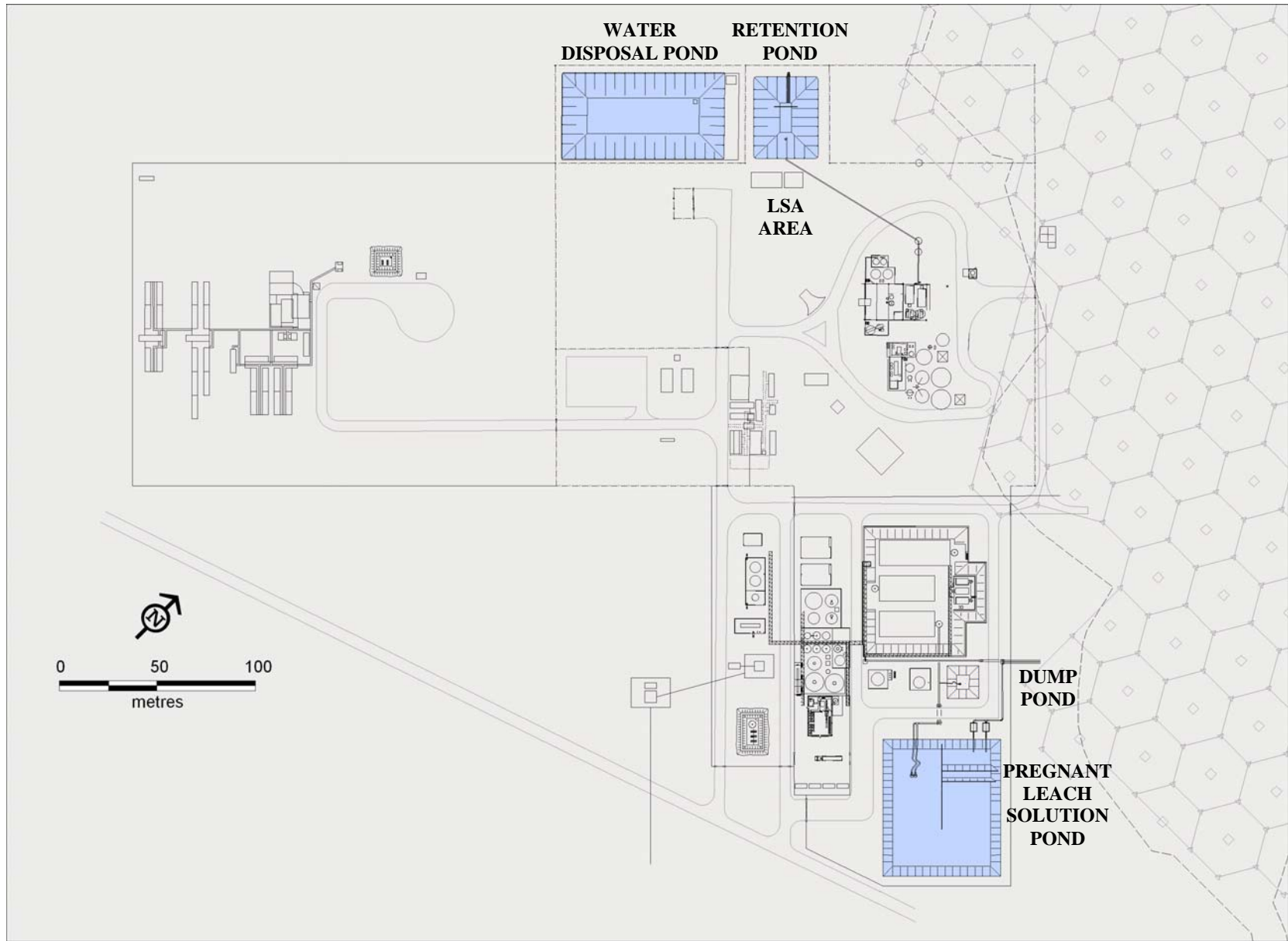


Figure 8.2 – Site Layout Showing Pond Locations

## **8.9 Security and Fencing**

The areas initially designated as Supervised (>1mSv) and Controlled (>5mSv) are shown in figure 8.3. The designations, which are designed to limit occupational exposure, will be reviewed as the project proceeds which may result in some adjustment.

The Supervised areas are provided with low security fencing with access limited by kecard access at all entry points. The Controlled areas are provided with high security (man proof) fencing with access limited by key card locks at all entry points. Access is further limited in the dewatering, drying and packaging area which is equipped with a second segregated man proof fence with controlled personnel access points. The area is continuously monitored by CCTV.



Figure 8.3 – Controlled and Supervised Areas

## 9 RADIONUCLIDE BALANCE

The pregnant leach solutions from the Honeymoon wellfield will contain radon, radium and uranium. Data from the leaching tests run at the site have provided data from which a radionuclide balance can be determined. Uranium analyses on process solutions, which are relatively simple to conduct, were run daily in the on-site laboratory providing a good database. Radium and radon assays, which are more difficult, were run intermittently in specialist laboratories. The database for the concentration of these elements is consequently limited.

A radionuclide balance through the plant is shown diagrammatically in figure 9.1.

*Radon.* The pregnant leach solutions from the well field will contain dissolved radon. As the radon has been dissolved under pressure in the ore zone, some of this radon will be released when the solution is discharged at atmospheric pressure into the PLS storage tanks. These tanks are vented through a 10 metre stack. Smaller amounts of radon will be released from the various plant ponds and some will be released in the plant from the tanks through which the leach solutions pass.

The average radon activity in the pregnant leach solution is estimated as 12.7 kBq/l. If all of the dissolved radon is released from the leach solution the total radon release will be approximately 2.8 MBq/s. Modelling of the dispersion of radon from the plant has shown that radon emissions will not present a hazard to the general public.

The provision of a ventilation system to exhaust radon from process equipment and the provision of adequate ventilation within the process plant will vent radon from occupied areas ensuring that employees are not exposed to excessive radon levels. Radon monitoring and personnel monitoring within the plant site will provide an early warning of any radon related difficulties allowing corrective action to be taken (see the draft Radiation Management Plan (RMP) which accompanies this application).

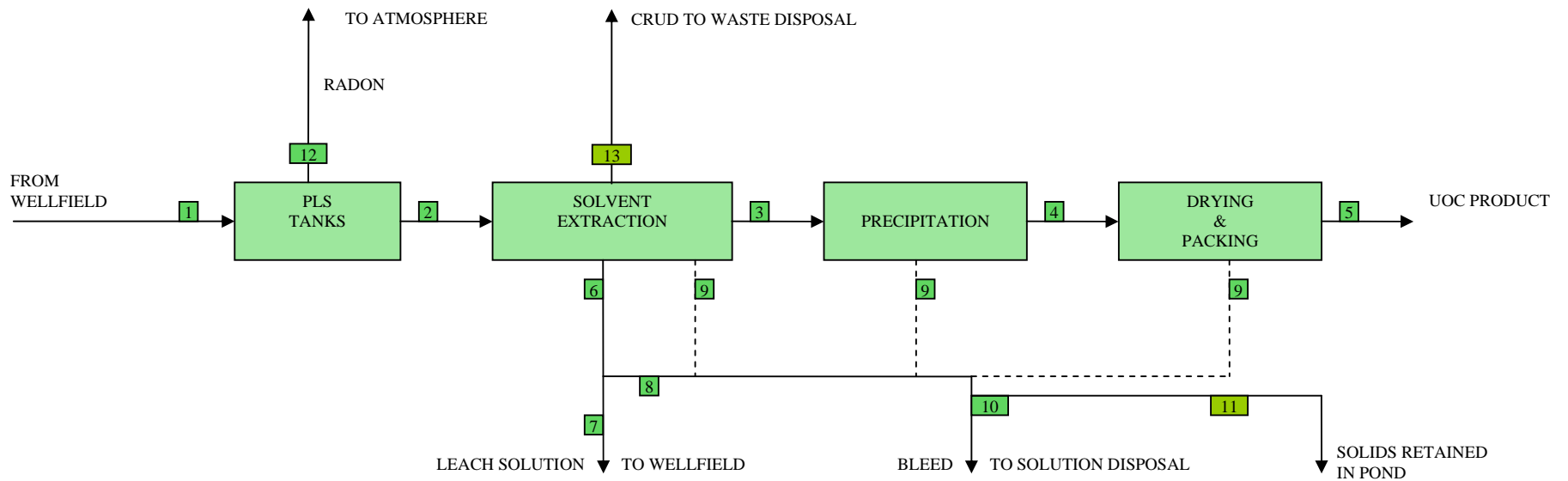
*Radium.* Analyses made during field leach trials show that radium levels in the pregnant leach solutions can be expected to average 830 Bq/l. Radium is not extracted into the yellowcake product. Consequently the majority of the radium will be reinjected into the basal sands with the recycled leach solution; approximately 1% will be injected into the basal sands with the waste waters; and minor amounts will be contained in solid wastes such as precipitates, sediments and cruds.

*Uranium.* The pregnant leach solution is expected to contain an average of 75 mg/l of U<sub>3</sub>O<sub>8</sub>. The plant has been designed to extract 97% of the uranium to produce 400 tpa of U<sub>3</sub>O<sub>8</sub>. Most of the uranium remaining in the barren leach solution - approximately 12 tpa - will be returned to the wellfield with the recycled leach solution. Approximately 0.12 tpa will be injected into the basal sands with the waste waters. Minor amounts will be contained in solid wastes such as precipitates, sediments and cruds.

*Thorium.* Assays on field leach solutions show that thorium (<sup>230</sup>) levels ranged from less than 0.2 Bq/l up to 50 Bq/l. A similar range was found with the barren leach solution and waste water streams.

*Lead.* Assays on field leach solutions show that lead (210) levels ranged from less than 1 Bq/l up to 100 Bq/l. A similar range was found with the barren leach solution and waste water streams.

*Polonium.* Assays on field leach solutions show that polonium (210) levels ranged from less than 0.1 Bq/l up to 22 Bq/l. Assays of the barren leach solution and waste water streams showed polonium (210) levels as high as 8 Bq/l but they were generally below 1 Bq/l.



STREAM	1	2	3	4	5	6	7	8	9	10	11	12	13
Litre per second	183	183	1	1		183	181	1.8	Total 0.5	2.3			
Tonnes per annum					488						38		12
U <sub>3</sub> O <sub>8</sub> mg/l	75	75	13500	13500		2.2	2.2	2.2		1.7			
U <sub>3</sub> O <sub>8</sub> %					82								
Radon Bq/l	12700												
Radon MBq/s												2.8	
Radium Bq/l	830					830	830	830		650			
Radium MBq/T											10		10
Th(230), Pb (210), Po (210) Bq/l	100					100	100	100		78			

Figure 9.1 –Radionuclide Balance



## **10 QUANTITIES OF RADIOACTIVE WASTE PRODUCED**

The major waste stream from the Honeymoon project is the 1% bleed of barren leach solution. At full production this bleed amounts to approximately 60 megalitres per year. The bleed solution will contain up to 2ppm of U<sub>3</sub>O<sub>8</sub> and from 500 to 1300 Bq/l of radium 226. This solution is reinjected into the basal sands of the Eyre formation - the structure from which the uranium and radium were originally extracted - at a depth of approximately 100 metres. The high salinity of the water in the basal sands makes it unsuitable for stock or any other pastoral purpose. It is expected that chemical changes will cause dissolved salts in the reinjected solution to precipitate, gradually returning the waters to their natural condition. This process, known as natural attenuation, has been observed in acid in-situ leach operations in central Asia.

Hydrological modelling of the spread of the reinjected solutions shows that they may over time migrate out of the boundaries of the mining lease. The modelling is detailed in the Honeymoon Environmental Impact Statement.

Solids wastes from the process plant are expected to amount to around 50 tonnes per annum. These wastes will result from the formation of precipitates, scales and cruds in the process equipment. While there is no objective way of determining the composition of these materials they will contain varying concentrations of uranium and radium. A portion of these waste materials – approximately 75% - will be sent to the retention pond along with wash down waters where they will be stored under water until the termination of the project, then buried. The remaining 25% will be separated in the plant, neutralised as necessary, then disposed of in a low level radioactive waste disposal facility. Further details are provided in the Radioactive Waste Management Plan.

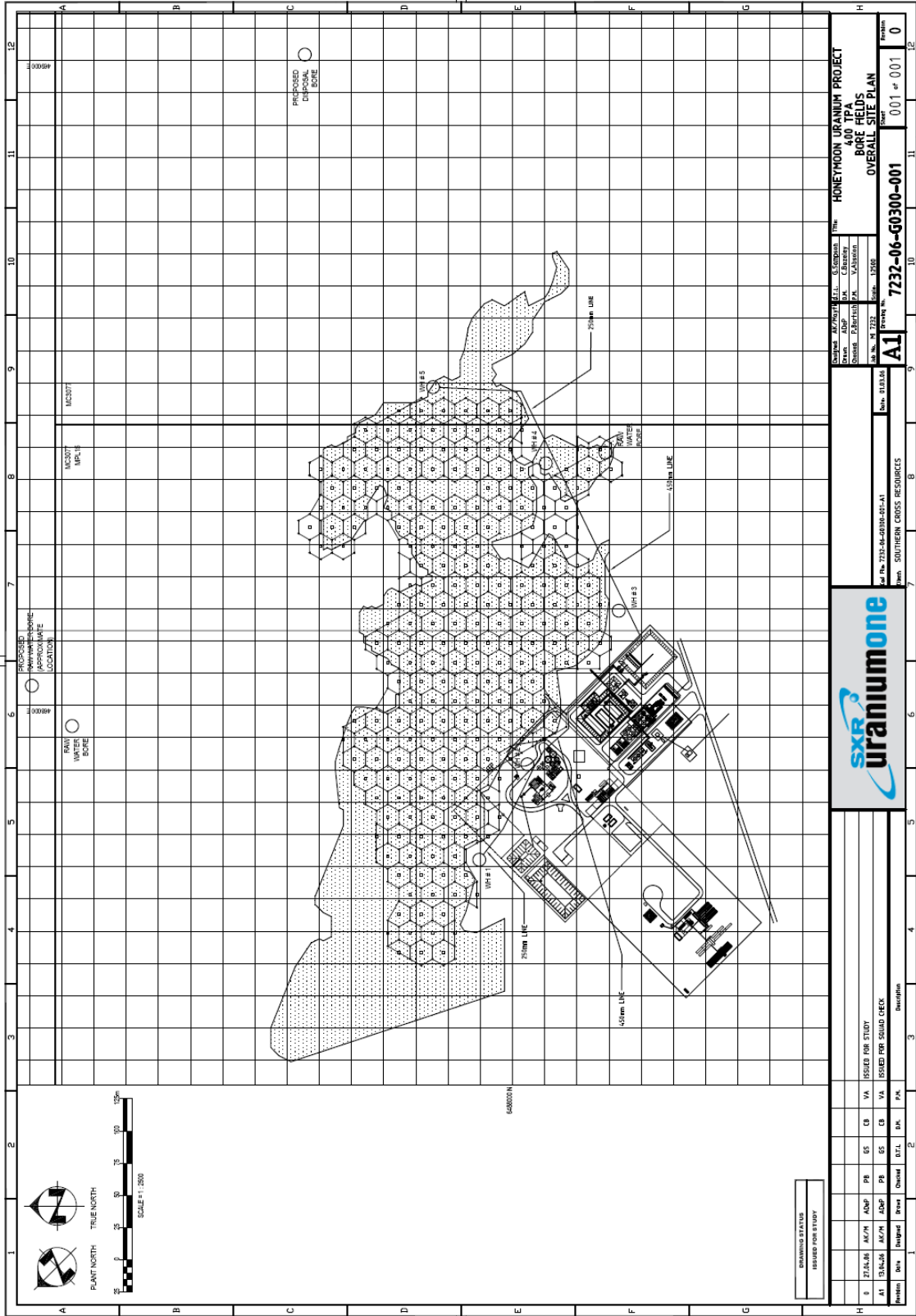
Miscellaneous solid wastes such as contaminated gloves, filter elements and the like will also be disposed of in a low level radioactive waste disposal facility. Drill cuttings from the ore zone will be buried in pits adjacent to the drill holes from which they are taken.

## **11 SUPPORTING DOCUMENTS**

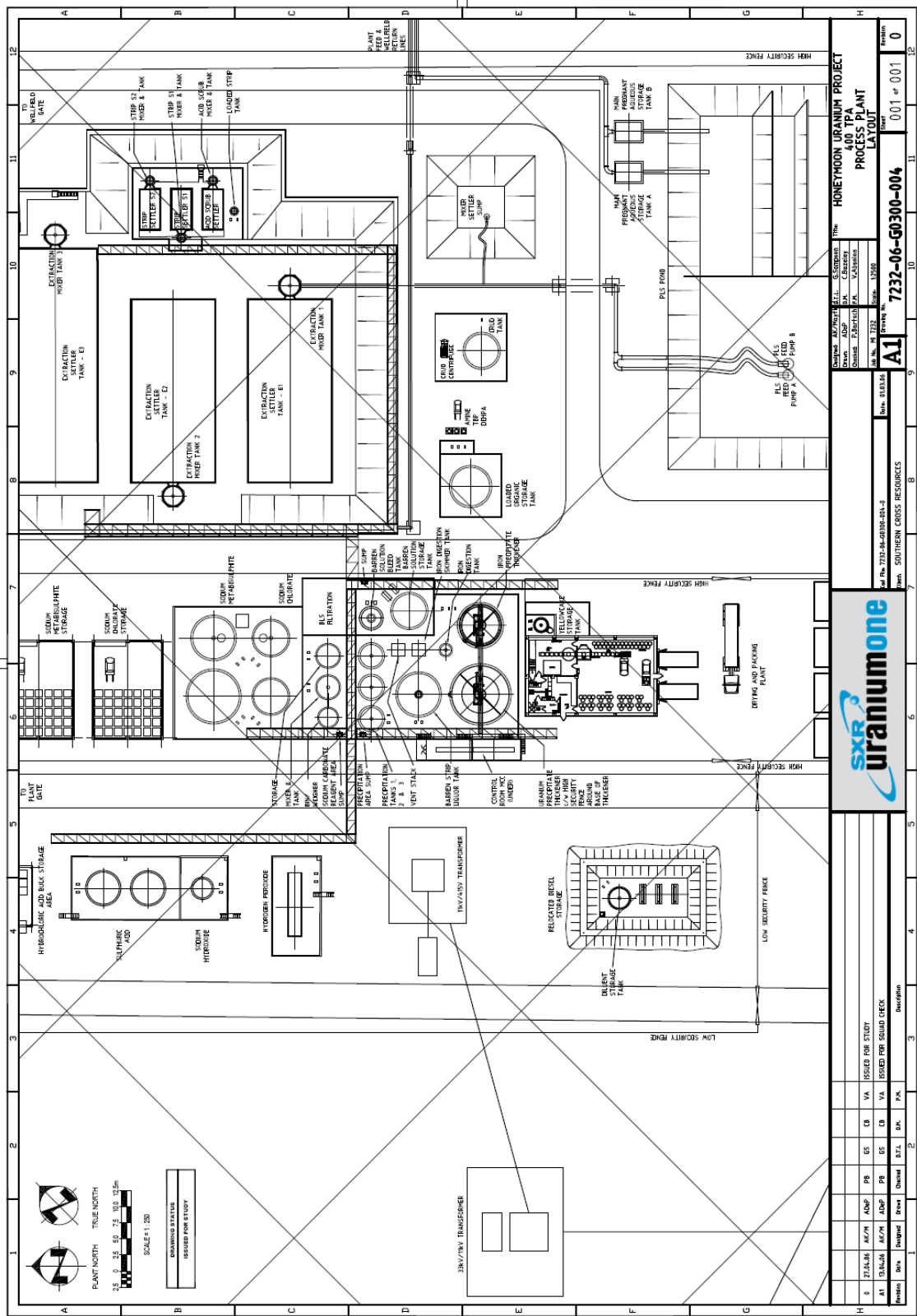
Draft copies of a Radioactive Waste Management Plan and a Radiation Management Plan for the Honeymoon project have been submitted with this application.

A Radiation Safety Manual, Induction Procedures, Safety Manuals and a set of Standard Operating Procedures which were developed for the Honeymoon site at the time of the field leach trials have also been provided. These documents will be updated and modified as required for the commercial operation.

Engineering drawings of the plant site which show more detail than the figures in the text are attached.



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**DRIVING STATUS**  
ISSUED FOR STUDY

SCALE = 1:250

PLANT NORTH  
TRUE NORTH

25 50 75 100 150m

**uraniumone**

**HONEYMOON URANIUM PROJECT**

**PROCESS PLANT LAYOUT**

Sheet No. **7232-06-60300-004** of 001 of 001

Revision: Rev. 001

Rev.	Issued	By	Checked	Date	Description
0	27.06.08	AM/P	PR	05	ISSUED FOR STUDY
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7	13.06.08	AM/P	PR	05	ISSUED FOR STUDY
8	13.06.08	AM/P	PR	05	ISSUED FOR STUDY
9	13.06.08	AM/P	PR	05	ISSUED FOR STUDY
10	13.06.08	AM/P	PR	05	ISSUED FOR STUDY
11	13.06.08	AM/P	PR	05	ISSUED FOR STUDY
12	13.06.08	AM/P	PR	05	ISSUED FOR STUDY

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