RFQ Number	**NOAM-PM-RFQ-0002**
Request for Quotation Date	**2024-01-11**
RFQ Closing Date	**2024-02-02**
RFQ Closing Time	**16:00**
Site Briefing (NOT compulsory)	**N/A**
Contact Person	**Tankiso Modise: Tankiso.modise@necsa.co.za** **012 305 5734** **071 686 1379**
Quotation Validity	**90 Days from the closing date**
Submission Details	**RFQ Response must be sent to:** **Catherine.matima@necsa.co.za**
RFQ Description	**Request for Quotation for Capping of Beva ponds**

Dear Service Provider

1. Introduction

The South African Nuclear Energy Corporation Limited (Necsa) is a state-owned public company (SOC), registered in terms of the Companies Act, (Act No. 61 of 1973), registration number 2000/003735/06.

The Necsa Group engages in commercial business mainly through its wholly-owned commercial subsidiaries: NTP Radioisotopes SOC Ltd (NTP), which is responsible for a range of radiation-based products and services for healthcare, life sciences and industry, and Pelchem SOC Ltd (Pelchem), which supplies fluorine and fluorine-based products. Both subsidiaries, together with their subsidiaries, supply local and global markets, earning valuable foreign exchange for South Africa and are among the best in their field in their respective world markets.

Necsa's safety, health, environment and quality policies provides for top management commitment to compliance with regulatory requirements of ISO 14001, OHSAS 18001 and RD 0034 (Quality and Safety Management Requirements for Nuclear Installations), ISO 9001 and ISO 17025.

Necsa promotes the science, technology and engineering expertise of South Africa and improves the public understanding of these through regular communications at various forums and outreach programmes to the community. We are a proudly South African company continuously striving, and succeeding in many respects, to be at the edge of science, technology and engineering related to the safe use of nuclear knowledge to improve our world.

For more information on Necsa, please visit: www.necsa.co.za

2. Request

Necsa hereby invites interested service providers/suppliers to submit quotation, proposal or bids, as appropriate, for the provision of goods and/or services, as defines in the attached documentation (NLM-SPE-00036) and supporting document as per section 3.

3. Attachments

Ref #	Name	Description
01	NLM-SPE-00036	URS for the closing and sealing of CaF2 pond No. 3
02	NLM-PRO-00173	Capping procedure for the closing and sealing of CaF2 pond No. 3
03	LSA-NLM2016-REP-0001	Safety Assessment for the Capping of Calcium Fluoride Ponds 3 and 4
04	NLM-PLN-00529	WASTE MANAGEMENT PLAN FOR THE CLOSING AND SEALING OF CaF2 POND No. 3
05	SBD4	Supplier Information

4. Pricing

- Use Table 1 to itemize your offer, taking into account the scope of work and associated deliverables as defined in NLM-SPE-00036 and supporting documents. Additional rows can be added if itemized items are more than what is allocated in Table1.
- All price quoted to include all applicable taxes.
- Price must be fixed and firm
- Price should include additional cost elements such as freight, insurance until acceptance, duty where applicable, disbursements etc.
- Quotation must be completed in full, incomplete quote could result in a quote being disqualified.
- Payment will be according to Necsa’s General Conditions of Purchase.

Table 1: Costing

Ref #	Item description	Quantity	Unit Cost	Line Total
01		1		
02				
03				
04				
05				
			Sub Total (Excl.)	
			VAT (15%)	
			TOTAL (Incl.)	

5. Evaluation

- **<u>Phase 1- Functionality Evaluation / Technical Evaluation (N/A)</u>**

<u>NB: The service provider must demonstrate that they are capable of executing the works by issued a method statement they will use in executing the works.</u>

Where functional or technical evaluation criterion is applicable, assessment will be performed in terms of the criterion listed below and the criterion may include Technical, Performance, Quality and Risk. If the Bidder's response to the Technical templates does not indicate that the Bidder can support an acceptable technical solution, the Bidder's response will be rejected and not evaluated further.

Together the Technical, Performance & Quality and Risk criteria make up the functionality criterion and a Bidder's Proposal will be evaluated for functionality out of a possible 100 points. Only RFQ responses achieving an evaluation score of greater than the set threshold points out of the possible 100 points and which score a number of points for functionality that is greater than or equal to the set threshold points of the number of points achieved by the highest scoring Bid for functionality will be selected to progress to the second stage.

IMPORTANT: A bidder/s that scores less than **80 points out of 100** in respect of functionality will be regarded as submitting a non-responsive bid and will be disqualified. Should the relevant bidder/s meet the minimum required percentage or minimum points, they will be evaluated as per Phase 2 evaluation outlined below.

- **<u>Phase 2 - Evaluation In Terms Of Preferential Procurement Policy Framework Act, 2022</u>**

This bid will be evaluated and adjudicated according to the 80/20 point system, in terms of which a maximum of 80 points will be awarded for price and 20 points will be allocated based on the specific goals (B-BBEE status level).

	POINTS
PRICE	80
SPECIFIC GOALS (B-BBEE status level)	20
Total points for Price and SPECIFIC GOALS	100

Preference goal
B-BBEE status level contributor

B-BBEE Status Level of Contributor	Number of points (80/20 system)
1	20

2	18
3	14
4	12
5	8
6	6
7	4
8	2
Non-compliant contributor	0

6. Required Documentation

- Tax Clearance Certificate (Tax pin issued by SARS)
- Declaration of interest (SBD 4)
- BEE Certificate / Applicable Affidavit if classified as EME
- Letter of Good Standing (COID) only if Applicable due to the nature of work required
- Any other document or certification that might have been requested on this RFQ

7. Important

1. Quotation must be submitted on or before the RFQ closing date and time stated above.
2. Orders above R 30 000 will be evaluated according to the PPPFA 80/20-point system and a functionality scorecard where applicable and the ones above R 1 Million will be subjected to the tender process.
3. This RFQ is subjected to the Necsa's General Conditions of Purchase, Preferential Procurement Policy Framework Act 2000 and the Preferential Procurement Regulations, 2022, the General Conditions of Contract (GCC) and, if applicable, any other legislation or special conditions of contract
4. Failure on the part of a bidder to submit proof of B-BBEE Status level of contributor together with the bid, will be interpreted to mean that preference points for specific goals are not claimed.
5. The purchaser reserves the right to require of a bidder, either before a bid is adjudicated or at any time subsequently, to substantiate any claim in regard to specific goals, in any manner required by the purchaser.

6. For a Bidder to obtain clarity on any matter arising from or referred to in this document, please refer queries, in writing, to the contact details provided above. Under no circumstances may any other employee within Necsa be approached for any information. Any such action might result in a disqualification of a response submitted in competition to this RFQ.
7. No goods and/or services should be delivered to Necsa without an official Necsa Purchase order.
8. Necsa reserves the right to; cancel or reject any quote and not to award the RFQ to the lowest Bidder or award parts of the RFQ to different Bidders, or not to award the RFQ at all.
9. The supplier shall under no circumstances offer, promise or make any gift, payment, loan, reward, inducement, benefit or other advantage, which may be construed as being made to solicit any favour, to any Necsa employee or its representatives. Such an act shall constitute a material breach of the Agreement and the Necsa shall be entitled to terminate the Agreement forthwith, without prejudice to any of its rights
10. By responding to this request, it shall be construed that: the bidder, hereby acknowledge to be fully conversant with the details and conditions set out in the Necsa’s General Conditions of Purchase, Preferential Procurement Policy Framework Act 2000 and the Preferential Procurement Regulations, 2022, the General Conditions of Contract (GCC), Technical Information and Specifications attached, and hereby agree to supply, render services or perform works in accordance therewith

BIDDER'S DISCLOSURE

1. PURPOSE OF THE FORM

Any person (natural or juristic) may make an offer or offers in terms of this invitation to bid. In line with the principles of transparency, accountability, impartiality, and ethics as enshrined in the Constitution of the Republic of South Africa and further expressed in various pieces of legislation, it is required for the bidder to make this declaration in respect of the details required hereunder.

Where a person/s are listed in the Register for Tender Defaulters and / or the List of Restricted Suppliers, that person will automatically be disqualified from the bid process.

2. Bidder's declaration

2.1 Is the bidder, or any of its directors / trustees / shareholders / members / partners or any person having a controlling interest[1] in the enterprise, employed by the state? **YES/NO**

2.1.1 If so, furnish particulars of the names, individual identity numbers, and, if applicable, state employee numbers of sole proprietor/ directors / trustees / shareholders / members/ partners or any person having a controlling interest in the enterprise, in table below.

1 the power, by one person or a group of persons holding the majority of the equity of an enterprise, alternatively, the person/s having the deciding vote or power to influence or to direct the course and decisions of the enterprise.

Full Name	Identity Number	Name of State institution

2.2 Do you, or any person connected with the bidder, have a relationship with any person who is employed by the procuring institution? **YES/NO**

2.2.1 If so, furnish particulars:
……………………………………………………………………………………
……………………………………………………………………………………

2.3 Does the bidder or any of its directors / trustees / shareholders / members / partners or any person having a controlling interest in the enterprise have any interest in any other related enterprise whether or not they are bidding for this contract? **YES/NO**

2.3.1 If so, furnish particulars:
…………………………………………………………………………………
…………………………………………………………………………………

3 DECLARATION

I, the undersigned, (name)……………………………………………………………………… in submitting the accompanying bid, do hereby make the following statements that I certify to be true and complete in every respect:

3.1 I have read and I understand the contents of this disclosure;

3.2 I understand that the accompanying bid will be disqualified if this disclosure is found not to be true and complete in every respect;

3.3 The bidder has arrived at the accompanying bid independently from, and without consultation, communication, agreement or arrangement with any competitor. However, communication between partners in a joint venture or consortium2 will not be construed as collusive bidding.

3.4 In addition, there have been no consultations, communications, agreements or arrangements with any competitor regarding the quality, quantity, specifications, prices, including methods, factors or formulas used to calculate prices, market allocation, the intention or decision to submit or not to submit the bid, bidding with the intention not to win the bid and conditions or delivery particulars of the products or services to which this bid invitation relates.

3.4 The terms of the accompanying bid have not been, and will not be, disclosed by the bidder, directly or indirectly, to any competitor, prior to the date and time of the official bid opening or of the awarding of the contract.

3.5 There have been no consultations, communications, agreements or arrangements made by the bidder with any official of the procuring institution in relation to this procurement process prior to and during the bidding process except to provide clarification on the bid submitted where so required by the institution; and the bidder was not involved in the drafting of the specifications or terms of reference for this bid.

3.6 I am aware that, in addition and without prejudice to any other remedy provided to combat any restrictive practices related to bids and contracts, bids that are suspicious will be reported to the Competition Commission for investigation and possible imposition of administrative penalties in terms of section 59 of the Competition Act No 89 of 1998 and or may be reported to the National Prosecuting Authority (NPA) for criminal investigation and or may be restricted from conducting business with the public sector for a period not exceeding ten (10) years in terms of the Prevention and Combating of Corrupt Activities Act No 12 of 2004 or any other applicable legislation.

I CERTIFY THAT THE INFORMATION FURNISHED IN PARAGRAPHS 1, 2 and 3 ABOVE IS CORRECT.
I ACCEPT THAT THE STATE MAY REJECT THE BID OR ACT AGAINST ME IN TERMS OF PARAGRAPH 6 OF PFMA SCM INSTRUCTION 03 OF 2021/22 ON PREVENTING AND COMBATING ABUSE IN THE SUPPLY CHAIN MANAGEMENT SYSTEM SHOULD THIS DECLARATION PROVE TO BE FALSE.

………………………………… ..………………………………………………

Signature Date

---

2 Joint venture or Consortium means an association of persons for the purpose of combining their expertise, property, capital, efforts, skill and knowledge in an activity for the execution of a contract.

………………………………… ………………………………………………

Position Name of bidder

Classification:	OPEN

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South African Nuclear Energy Corporation SOC Limited

Document No.	NLM-PLN-00529
Rev. No.	00
Department/Section:	NLM
Title:	WASTE MANAGEMENT PLAN FOR THE CLOSING AND SEALING OF CaF_2 POND No. 3

Authorization

	NAME	**SIGNED**
PREPARED	RGF ROBBERTS **(Chief Technician: NLM)**	25/07/2023 13:50:25(UTC+02:00) Signed by Richard gerhardus Frederik Robberts, robbie.robberts@necsa.co.za SIGNIFLOW.COM
REVIEWED	M VAN ZYL **(Snr Technician: NLM QA)**	25/07/2023 14:24:37(UTC+02:00) Signed by Maria Maryna van Zyl, marietjie.vanzyl@necsa.co.za SIGNIFLOW.COM
REVIEWED	TE LABUSCHAGNE **(Chief Technician: NLM)**	25/07/2023 14:33:56(UTC+02:00) Signed by Theo Labuschagne, theo.labuschagne@necsa.co.za SIGNIFLOW.COM
REVIEWED	AR DAVIDS **(Chief RPO: PDO)**	25/07/2023 14:39:12(UTC+02:00) Signed by Wally Davids, wally.davids@necsa.co.za SIGNIFLOW.COM
ACCEPTED	E VAN HEERDEN (**Chief Scientist : EMG: SHEQ)**	25/07/2023 14:43:01(UTC+02:00) Signed by Eurika van Heerden, eurika.vanheerden@necsa.co.za SIGNIFLOW.COM
APPROVED	ES THABALALA **(Acting manager: PDO)**	25/07/2023 14:43:58(UTC+02:00) Signed by Eric Tshabalala, eric.tshabalala@necsa.co.za SIGNIFLOW.COM

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5	AR DAVIDS*	10	TE LABUSCHAGNE*	15	

*= Distributed via E-mail

Revisions

This document has been revised according to the following schedule:

Revision	Date Approved	Nature of Revision	Prepared by
00	See title page	First Issue	RGF Robberts

Contents:

1.0 PURPOSE

The purpose of this document is to describe the waste management plan for the waste that will be generated as a result of the capping of CaF_2 Pond No. 3 [1].

2.0 SCOPE

This document will cover the radiological clearance, removal and temporary storage of waste generated during the construction phase of the capping of CaF_2 Pond No. 3.

3.0 REFERENCES

[1].	NLM-PRO-00173:	Capping Procedure for the Closing and Sealing of CaF2 pond No.3
[2].	NLM-PRG-031:	Solid Waste Management Program for Predisposal Operations
[3].	NLM-WAR-004:	Waste Acceptance Requirements for solid radioactive waste.

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

Capping: A process of the closing and sealing a pond to isolate the contents of the pond from the environment.

4.2 Abbreviations

EMG	Environmental Management Group
HDPE	High Density Polyethylene
NLM	Nuclear liability Management
PDO	Pre-disposal Operations a section of NLM
PVC	Polyvinyl Chloride
QA	Quality Assurance
RPO	Radiation Protection Officer
SHEQ	Safety, Health, Environment and Quality
CaF_2	Calcium Fluoride
WAR	Waste Acceptance Requirement
PPE	Personal Protective Equipment

5.0 INTRODUCTION

CaF_2 pond 3 is an open-air evaporation pond that contains chemicals and uranium-contaminated effluent where the aqueous part of the effluent is evaporated by natural processes. However, the degradation of the lining of the pond (mainly due to prolonged exposure to sun and ultraviolet rays, wind and temperature differences) and the sporadic exposure of the top of the sludge during dry seasons has increased the risk of contamination to the environment from this pond.

The project will include the closing and sealing of the HDPE lined pond with sand and new HDPE liners, to isolate the sludge from the environment and rain water.

The activities include:

1. The removal of a steel bridge leading to a concrete sump structure inside the pond
2. The partially dismantling of the sump structure.
3. The covering of the sludge and the HDPE liners inside the pond with sand and soil on different intervals.
4. The instalment of a PVC drain system inside the pond with an associated drain system to the outside of the pond.

The surrounding areas around the pond are classified as a white contamination area and inside the pond a blue contamination area.

6.0 RESPONSIBILITY

1. It is the responsibility of the project leader to ensure that the requirements and instructions as specified in this document are adhered to.
2. Dedicated demarcated area's for all waste associated with rubble and secondary waste generated in the dismantling and construction process will be allocated by the PDO personnel for temporally storage during construction.
3. The facility RPO is responsible for the clearance of waste.
4. PDO personnel shall be responsible for the handling and package of the contaminated solid waste and to ensure compliance to PDO's WAR [3].

7.0 EXPECTED WASTE TO BE GENERATED

Note: All vegetation, dirt and rubble currently in the pond will stay in the pond and covered with the first layer of sand as prescribed in [1] - Paragraph 9.2.

1. Metal waste generated during the dismantling of the steel bridge (e.g. hand rails, support beams, grids and removed bolts and nuts)
2. Concrete rubble generated during the partial dismantling of the concrete sump structure.
3. Possible contaminated soil generated during the installation of the drainage system.
4. Personal Protective Equipment, paper, cloths, plastic that will be generated during the dismantling and construction process.

8.0 STRATEGY AND WASTE MANAGEMENT PLAN

8.1 STRATEGY

- PDO strategy is to minimize radioactive waste by the segregating of contaminated from non-contaminated material/waste and the releasing of the clearable waste thereafter [2].
- The waste will consist mostly of steel, soil and concrete rubble.
- Sign posting shall be in accordance with the requirements specified in [2].
- All waste will be monitored for contamination. Any radiologically contaminated waste will be handled according to the requirements as stipulated in [2].
- All radioactive waste generated shall be controlled in accordance to [3].

8.2 WASTE MANAGEMENT

The below table shows the waste type to be generated, estimated amount and the management approach.

Waste type generated	Estimated amount of waste to be generated	Management approach (disposal, recycling etc.)
Metal waste: (e.g. hand rails, support beams, grids and removed bolts and nuts)	± 1500Kg	1. Contaminated metal will be decontaminated if possible If not possible: 2. Contaminated metal will be handled according to [2]. 3. Uncontaminated metal will be recycled internally at Necsa or disposed of at Necsa's scrap yard.
Concrete rubble	± 3m^2	1. Contaminated concrete debris will be handled according to [2]. 2. Uncontaminated concrete to be used as part of the construction of the water control system to the environment.
Loose soil generated during the digging of the trench for the drain water system inside the pond	± 10m^2	Loose soil generated during the digging of the trench needs to be spread over the first layer of sand inside the pond as prescribed in [1] - Paragraph 9.7.
Compressible waste: PPE, paper, cloths, plastic sheeting etc.	To be determined during construction	Placed inside 160L red drums and handled according to [2]

9.0 RECORDS

The documentation pertaining to the radioactive waste and the results of the tests, checks and inspections carried out shall be retained as quality records at PDO [3].

	LICENSING AND SAFETY ANALYSIS	
BBS BEHAVIOURAL BASED SAFETY REDUCES AT-RISK BEHAVIOURS	*This document is the property of Necsa and shall not be used, reproduced, transmitted or disclosed without prior written permission*	necsa We're in your world NUCLEAR COMPLIANCE AND SERVICES

DOCUMENT NO.	LSA-NLM2016-REP-0001
REVISION NO.	4.0
TITLE	**Safety Assessment for the Capping of Calcium Fluoride Ponds 3 and 4**

	NAME	SIGNATURE & DATE
PREPARED	**D Rasesamola** Nuclear Safety Engineer Licensing Services	17/07/2023 14:03:26(UTC+02:00) Signed by Dumisane Rasesamola, Dumisane.Rasesamola@necsa.co.za
CHECKED	**RGF Robberts** Chief Technician Nuclear Liabilities Management	24/07/2023 08:51:36(UTC+02:00) Signed by Richard gerhardus Frederik Robberts, robbie.robberts@necsa.co.za
CHECKED	**BL Cawood** Nuclear Safety Analyst Licensing Services	24/07/2023 08:52:18(UTC+02:00) Signed by Louise Cawood, louise.cawood@necsa.co.za
ACCEPTED	**ES Tshabalala** Acting Manager PreDisposal Operations	24/07/2023 08:52:50(UTC+02:00) Signed by Eric Tshabalala, eric.tshabalala@necsa.co.za
ACCEPTED	**L Hordijk** Waste Specialist Nuclear Liabilities Management	24/07/2023 09:15:15(UTC+02:00) Signed by Leo Hordijk, leo.hordijk@necsa.co.za
APPROVED	**H Monkoe** Licensing Services Management	24/07/2023 09:17:44(UTC+02:00) Signed by Homeyra Monkoe, Homeyra.Monkoe@necsa.co.za

NO.	NAME	NO.	NAME	NO.	NAME
1	NLM Records	3	PDO Records	5	
2	LSA Records	4		6	

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PART	DESCRIPTION	PAGE

LIST OF FIGURES

LIST OF TABLES

REVISION HISTORY

This document has been revised in accordance with the following schedule:

Rev. No.	Date Approved	Nature of Revision	Prepared by
1.0	17 May 2016	First revision: • The document number was changed from LD-HAZ-2012-ASS-0003 to LSA-NLM2016-REP-0001 for compatibility with Necsa configuration management system • The documents title was changed to *"Safety Assessment for Capping of Ponds 3 and 4"* • The following section numbers were changed for numbering correction: o Section 8.7 has changed to 8.6.1 o Section 8.8 has changed to 8.6.2 o Section 8.9 changed to 9 o Section 9 has changed to 10	OE Montwedi E Raubenheimer
2.0	23 November 2021	The document was revised to address and to accommodate the current status of the pans and the updated capping process design as well as comments in NNR letter NIL04B0162. The safety assessment was revised accordingly.	HS Swart A Tshangela
3.0	11 November 2022	Document revised to address the NNR comments in NIL04B0162	D Rasesamola A Tshangela
4.0	See sign-off page	Document revised to address the NNR comment in NIL04B0198	D Rasesamola

1 EXECUTIVE SUMMARY

For the capping process of the two CaF_2 ponds, the maximum contact dose rate and the maximum alpha contamination levels were used in analysing the accrued dose to the worker. The calculated total worker dose for capping activities in Ponds 3 and 4 are 1.45 mSv and 1.73 mSv without Personal Protective Equipment (PPE) respectively. The calculated total worker dose for capping activities with PPE on Ponds 3 and 4 are 4.5E-01 mSv and 2.45E-01 mSv (Section 8) respectively.

2 PURPOSE

The purpose of this document is to present a description of the capping process to be followed and to quantify the radiological hazards associated with the capping activities in Ponds 3 and 4 by calculating the projected maximum doses that could be accrued by a worker from the existing radiological conditions in these ponds.

3 SCOPE

This document will provide a comprehensive process description of the project to be executed, indicate the already implemented environmental monitoring and safety measures as well as a prospective dose assessment for the foreseen tasks.

The safety assessment is limited to the radiological hazards associated with the identified capping activities in Ponds 3 and 4. The projected doses are only valid for the specified activities and conditions as described in Section 7.3.2.8 and 8.1.

NOTE: The capping of these ponds is a remediation [5] measure before the ponds are to be decommissioned. To decommission the pond content will have to be removed. No existing approved disposal option currently exists for this type of waste. The sludge volumes and chemical and radiological characteristics of the pond contents are indicated in Appendix A to E.

4 REFERENCE DOCUMENTS

[1]	NIL-04	Nuclear Installation License for the Thabana Complex
[2]	NL27/NW-PSA-0017 Rev B	Disposal of CaF_2 slurry waste from the Conversion Plant into sludge ponds.
[3]	NL27/UC-PSA-0001	The U1 Conversion Plant
[4]	SHEQ-INS-8290	Decommissioning of Nuclear and Chemical Facilities
[5]	SHEQ-INS-8280	Management of remediation on the Necsa Site.

[6]	LD-08002012-REP-0014	NLM-Closing and Covering of Calcium Fluoride Pan 3 on Thabana
[7]	DWAF permit: B33/2/121/9/P151	Permit i.t.o. Section 20 of the environment conservation Act 1989 (Act 73 of 1989) for CaF_2 Waste Disposal Site.
[8]	GEA-1065 (Appendix 12)	Motivation Report to accompany the application for a permit in terms of Art 20 of the environment conservation act (73 of 1989) for the CaF2 waste disposal site, Pelindaba: Appendix 12: Rehabilitation of the CaF2 waste disposal site, Pelindaba
[9]	SHEQ-INS-5520	Work Permits
[10]	SHEQ-INS-8120	Safe Work Procedures and Radiation Protection Work Permit System
[11]	SHEQ-INS-8340	Radiological Environmental Surveillance Requirements for the Pelindaba Site and Vicinity
[12]	SHEQ-INS-8030	System for the Classification and Demarcation of Radiological Areas.
[13]	IAEA Safety Series No.111 P-1.1	Application of Exemption Principles to the Recycle and Re-use of Materials from Nuclear Facilities.
[14]	IAEA Safety Series No.115	Safety Standards, IAEA Safety Series No 115, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources.
[15]	SHEQ-INS-8080	Radiation Dose Limitation
[16]	AA5524 to the NNR	AA letter to the NNR on Re-suspension Factor.
[17]	SHEQ-INS-2450	Respiratory Protection Programme
[18]	SHEQ-INS-8070	Radiation Dosimetry Programme.
[19]	SHEQ-INS-8040	Removal of Materials from Radiological Areas
[20]	NLM-NLA-13/001	Liability Re-Assessment Report
[21]	PAL-SAM-2002/01863	laboratory analysis report
[22]	LSA-NLM2016-REP-0001	Pelindaba Groundwater Report for the period October 2014 to September 2015
[23]	NLM-REP-22/063	Report on the calculations done to determine the PVC pipe line sizes inside CaF2 Pond 3 and 4

[24] RD-0024	Requirements on Risk Assessment and Compliance with Principal Safety Criteria for Nuclear Installations
[25] Source Article	IAEA on Depleted Uranium (Available in: https://www.iaea.org/topics/spent-fuel-management/depleted-uranium)

5 DEFINITIONS AND ABBREVIATIONS

5.1 Abbreviations

ALARA:	As Low As Reasonably Achievable
CF:	Continuous Flow
DWA:	Department of Water Affairs
EPD:	Electronic Personal Dosimeter (Direct Reading dosimeter)
HDPE:	High Density Polyethylene
IAEA	International Atomic Energy Agency
LLW	Low Level Waste
L&SA:	Licensing and Safety Analysis
LS:	Licensing Services (Section of L&SA)
NFM:	Nuclear Facility Manager
NIL:	Nuclear Installation Licence
NLM:	Nuclear Liabilities Management Department of Necsa
NNR:	National Nuclear Regulator
PDO:	Predisposal Operations Section of NLM
PPE:	Personal Protective Equipment
RP:	Radiation Protection
RPO:	Radiation Protection Officer
RPS:	Radiation Protection Specialist
SD	Safety Department

SHEQ: Safety, Health, Environment and Quality

U-Plant: Uranium Conversion Plant

5.2 Definitions

Pond/Pan	An open-air dam that contains chemical and Uranium-contaminated effluent where the aqueous part of the effluent was evaporated by natural processes.
Decommissioning	Termination of operation, as described in [4]
Remediation	Any measures that may be carried out to reduce the radiological and non-radiological exposure from existing contamination through actions applied to the contamination itself (the source) or to the exposure pathways to humans; as defined in [5].

6 FACILITY DESCRIPTION AND HISTORY

The CaF_2 Ponds 3 and 4 are two of six Ponds containing Calcium Fluoride (only Ponds 1-4 contains sludge) contaminated with Uranium originating from the previous U-Plant [1]. The Ponds are situated on Thabana. See Figure 6-1 and Figure 6-2.

All six ponds are authorised by the NNR [1] for the storage of the historically deposited Uranium bearing process waste and no new waste is permitted to be placed in the CaF_2 Ponds.

Each pond has a total capacity of about 2587 m^3 but the sludge volumes are only about 1294 m^3 in each of the four sludge containing ponds.

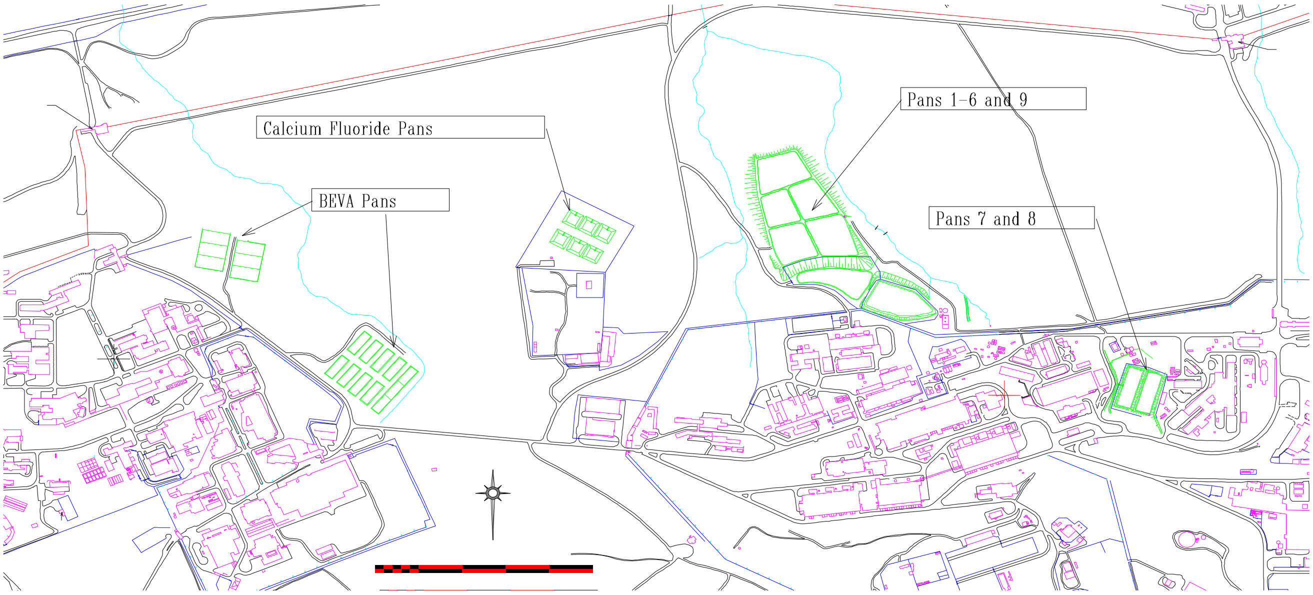


Figure 6-1: Location of the Various Evaporation Ponds on the Necsa Site

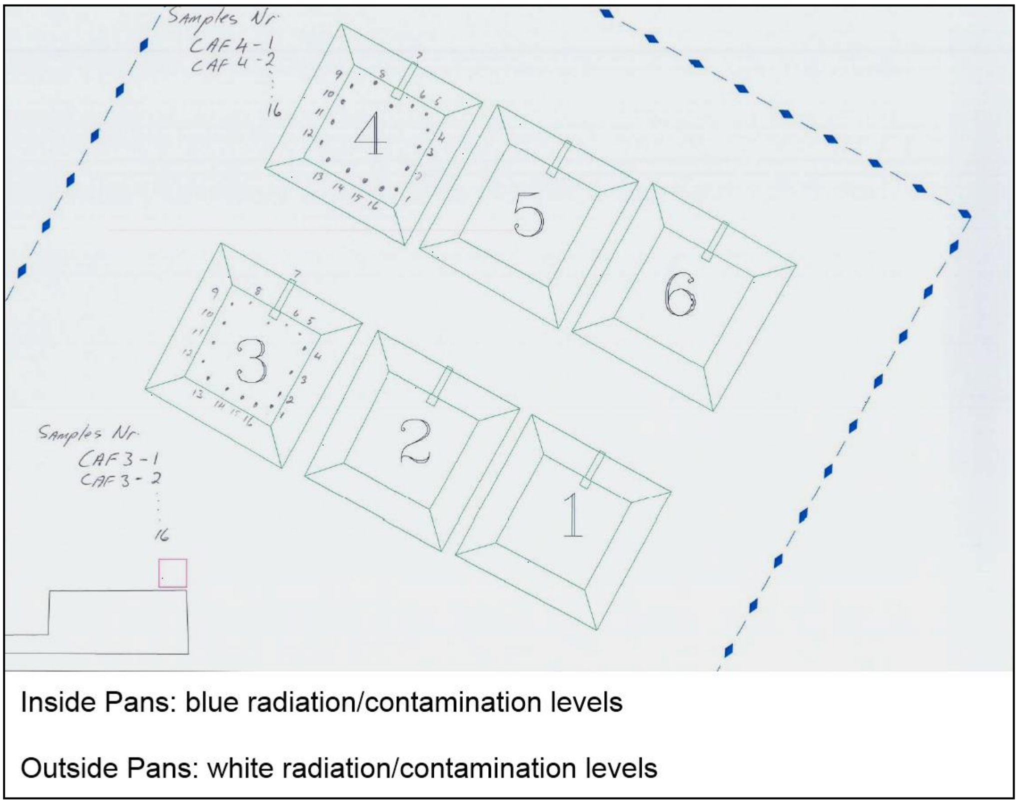


Figure 6-2: The layout of the CaF2 Ponds on Thabana

The measured surface contamination levels and the external dose rates in Ponds 3 and 4 are presented in Appendices A and B. See [12] for the area classification system used.

7 PROCESS DESCRIPTION FOR CAPPING OF PONDS 3 AND 4

This project entails the capping of the Uranium containing sludge in Ponds 3 and 4. The degradation of the exposed liners (mainly due to prolonged exposure to sun and ultraviolet rays, and also wind and temperature differences) and the sporadic exposure of the top of the sludge during dry seasons has increased the risk of contamination to the environment from the ponds. This enhances the potential of leaks and the exposure of the sludge (because of drying) in the winter months increasing the risk of contaminating the surrounding environment. Apart from the existing liquid in the sludge, rainwater will continually add a transport medium for contamination to leak down into the geosphere if there is any damage to the pond liner. When the sludge is dried out in winter, the wind can also transport contaminated dust from the ponds to the surrounding environment.

The aim of the capping and sealing exercise is to isolate the sludge from the environment and prevent further ingress of rain water into the sludge and thus prevent the possible outflow of contaminated effluent down into the unsaturated and saturated geosphere. The intention is to isolate the sludge similarly as what was done with the capping of CaF_2 Ponds 1 and 2 in the 1990's.

An updated INS-0800 process was followed to define the project requirements [8].

7.1 Responsibility

It is the responsibility of the NFM and the appointed Radiation Protection Officer (RPO) to ensure:

- That the regulatory requirements are adhered to;
- That Necsa's SHEQ requirements are met.

The NLM project lead shall coordinate the remediation process in consultation with the NFM, or his delegate.

It is the responsibility of the NFM to ensure that the following training is received by all contractor personnel prior to the start of the construction.

- Necsa induction training
- Facility induction training

7.2 Long term strategy

The long term strategy for the final decommissioning of all the trenches on Thabana was originally scheduled to commence by 2018. This commencement date has been rescheduled in the 2013/2014 NLM Liability Re-assessment Report [20]. The commencement date for the decommissioning is however dependent on the acceptance and funding by the Department of Energy (DoE).

This section is subdivided into two main subjects:

- The process description for the capping project; and
- The reference to and summary of the process description of the operations after capping.

7.3 Process Description for the Capping project

7.3.1 Introduction and Past Performance

The degradation of the linings of CaF_2 Ponds 3 and 4, because of sporadic exposure of the top of the sludge during dry seasons, has increased the risk of contamination of the environment from these two ponds. Apart from the existing water in the sludge, rainwater will continually add a transport medium for contamination to leak down into the geosphere if there is any damage in the pond liner. When the sludge is dried out in winter, the wind can also transport contaminated dust from the ponds.

Pond 3 is being considered the most risky pond in this regard and will therefore be the first pond to be remediated. After consideration of various action plans such as the removal and transportation of the sludge to other ponds it was decided that the most environmental considerate, practical and economical interim solution was to *in situ* surface impound the sludge. A similar process was followed earlier with Calcium Fluoride Ponds 1 and 2. This capping was done in the 1990's according to the Department of Water Affairs (DWA), now referred to as the Department of Water and Sanitation (DWS), approved procedure, included in [7] and [8].

During the routine inspection done since this capping, no evidence of subsidence or preferential pathways for rain water ingress have been observed at Ponds 1 and 2 which indicates that the caps have been performing satisfactorily and that the sludge has been isolated from the environment.

Some vegetation on top of the ponds has been returning naturally on the capping material. Where the sand cover became thin, small sections of the capping liner were exposed and the sand was replaced to cover the lining again. Only minor maintenance of the capping system was therefore required up to the present.

The exercise will include closing and sealing of the HDPE lined ponds with a HDPE liner to isolate the sludge from the environment and rain water. This specialized welding will be done by a contractor. The contractor's involvement will be limited to welding and sealing of the lining. A layer of soil will be added by Necsa on top of the impounded sludge before the cover liner is emplaced, to enable a safer work area and lower possibility of contamination of the workers. This soil cap will be constructed with a slight vertical bulge in the pond centre in order to direct rainwater away from the underlying impounded sludge and avoid ponding of water on top of the covered pond.

7.3.2 Detail Process Description

7.3.2.1 Relevant facilities

CaF_2 Pond 3 and 4 are situated on Thabana and is shown in Figure 6-1 and Figure 6-2**.** CaF_2 Ponds 1 and 2 have already been closed and capped in the early 1990's.

CaF_2 Pond 5 only contains contaminated water which originates from the other CaF_2 Ponds. CaF_2 Pond 6 is not lined, not used and empty, and only accumulates rainwater from time to time.

All six (6) Ponds are currently licensed by the NNR [1] for the storage of the historic CaF_2 and no effluent is allowed to be added. The previous operation is described in [2]. Necsa also has DWS authorisation for these Ponds.

The current condition of the CaF_2 Ponds is as follows:

- Pond 1: Already capped.
- Pond 2: Already capped.
- Pond 3: Partially filled and the contents to be impounded. Equipped with a single lining.
- Pond 4: Partially filled and the contents to be impounded. Equipped with double HDPE liner and double leak detection system (The sampling points at Ponds 3 and 4 and chemical analysis results are indicated in Figure 6-2 and Appendix C).
- Pond 5: Contains drainage water from the other Ponds and some rainwater only. Equipped with a double HDPE lining.
- Pond 6: Was never lined or used. Contains rainwater from time to time.
- All the lined Ponds (Ponds 1-5) have a leak detection system in the form of sumps which are monitored. The higher elevated Ponds (Ponds 1-3) are all connected to a single monitoring sump and Ponds 4 and 5 to another monitoring sump. These two sumps are monitored on a daily basis to detect leakages. No leakage has ever been detected from the monitoring sump that connects to Ponds 4 and 5.

- The monitoring sump connected to Ponds 1-3 has been detecting leaks for many years and an automatic pump has been fitted in the sump to pump the effluent to Pond 5 once a certain effluent level has been reached

7.3.2.2 The materials at risk, Radio-nuclides involved

Laboratory analysis of the recently sampled contents of Ponds 3 and 4 showed only Uranium isotopes to be present and that no significant artificial isotope activity is present. See Page 3 of report RS-2015-0619-02 in APPENDIX A: Page 3 of analysis report RS2015-0619-02.

For example, the activity concentration of Cs-137 is very low compared to the exclusion level of 0.2 Bq/g for artificial nuclides and is only noticeable due to the excellent minimum detection limit of the analysis instrumentation. As such, the result is also associated with large uncertainties and is therefore not considered of any significance.

7.3.2.2.1.1 Uranium enrichment level

The CaF_2 Ponds only contained effluent that originated from the Conversion Plant and therefore contain Uranium of natural level. This was confirmed by a laboratory analysis report PAL-SAM-2002/01863 [21], page 3. An extract, page 3, is attached as Appendix B.

A specific activity for natural Uranium of 2.55E+04 Bq/g [25] is assumed.

7.3.2.2.1.2 Uranium concentration

The contents of Pond 3 and Pond 4 were sampled (a total of 16 different sampling positions in the ponds, see Appendix C) and the analysis results showed the average Uranium concentration of the Ponds as:

- 5 642 mg Uranium per kg of sludge in Pond 3
- 8 474 mg Uranium per kg of sludge in Pond 4

These results are attached as Appendix C to this document. Note that the results reflected in Appendix C are the detail results of those partly reflected in Appendix B.

7.3.2.2.1.3 Radioactivity concentration

The above analysis results (Appendix C) converts to the following activity concentration levels for Pond 3:

- An average of 5 642 mg Uranium per kg of sludge, or 144 Bq/g
- A maximum of 9 239 mg Uranium per kg of sludge, or 236 Bq/g

Note that the gamma spectra analysis Uranium activity results of Appendix A (which are significantly lower than those reported in Appendix B and C) are not included since these represent only single grab samples and the method used is not sensitive for Uranium concentration analysis.

For Pond 4 the results for the activity concentrations are:

- An average of 8 474 mg Uranium per kg of sludge, or 216 Bq/g
- A maximum of 10 979 mg Uranium per kg of sludge, or 280 Bq/g

7.3.2.2.1.4 Total radioactive inventory

In accordance with the Pond volume indicated in Appendix D and the average sludge density in Appendix C, the mass of sludge contained in Pond 3 and 4 at a density of 1.7 g/cm^3, is 2 200 t.

Therefore the radioactive inventory for Pond 3 and 4 which contains both 2 200 t of sludge at an average concentration of 144 Bq/g and 216 Bq/g equates to a total of 3.17E+02 GBq and 4.75E+02 GBq of Uranium in each Pond respectively.

7.3.2.2.2 Chemical compounds involved

According to paragraph 3.1 of [2], the slurry generated by the Conversion Plant, and therefore contained in the sludge, consists of the following compounds and percentages:

CaF_2	14 %
$CaCO_3$ and excess $Ca(OH)_2$	37 %
CaU_2O_7	1 %
H_2O	43 %
KOH	5 %

It is assumed that most of the water has evaporated the sludge will therefore consist of:

CaF_2	25 %
$CaCO_3$ and excess $Ca(OH)_2$	65 %
CaU_2O_7	2 %
KOH	8 %

7.3.2.3 Toxicity of materials at risk

In paragraph 3.4.12.2 of [3], the gas scrubbing and effluent system of the Conversion Plant is described and it is suggested that the effluent contains dust particles coming forward from the various conversion reactions. Since Uranium compounds that represent all the absorption types (F, M and S) occur, the chemical and radiological toxicity of Uranium need to be considered. For soluble Uranium compounds at low U-235 enrichment, the chemical toxicity outweighs the radiological toxicity.

A very high alkalinity, probably pH = 14, can be expected due to the high concentrations of $CaCO_3$ and $Ca(OH)_2$. The high alkalinity of the sludge is regarded as the main chemical hazard to workers that needs to be considered in all operations. The other risk is contamination risk due to the presence of Uranium.

7.3.2.4 Radiological conditions

The current area classification at the CaF_2 Ponds is:

- White contamination levels in areas surrounding the Ponds and Blue contamination levels inside the Ponds.
- White radiation in areas surrounding the Ponds and Blue radiation inside the Ponds.

Radiation and contamination measurements were taken at Ponds 3 and 4. The results of the radiation measurements (Ponds 1-4) and the results of the contamination measurements (Ponds 3 and 4) are shown in Appendix E.

7.3.2.5 The capping process to be followed

The capping is described in licensing document [2], which was included in the previous NIL27 nuclear license and also in DWS permit [7] and Attachment 12 of [8]. This capping procedure is not included in the current Nuclear Installation License [1].

The capping procedure to be followed will be as follows:

- Pond 4 will be capped after Pond 3 has been completed, to ensure that the duration of the Pond not being covered with water be kept to a minimum.
- The excess water in the pond to be covered will be removed in order to dry the sludge as much as possible. It must be hard and dry enough to work on before the next step is taken. This will be done in two ways:
  - The drainage valve in the Pond sump is fully opened to ensure maximum drainage from the pond at all times and allow the water to drain to the applicable monitoring sump. Water accumulated in the monitoring sump will be pumped off to Pond 5.
  - Secondly the excess water will be pumped with a pneumatic driven pump directly from Ponds 3 and 4 to Pond 5 by NLM personnel. The water in Pond 5 will be allowed to evaporate as a normal operation.
- Once the excess water in the pond has been drained and the sludge is suitably dry, a layer of at least 150 mm thick uncontaminated soil is placed on the surface to prevent possible dispersion of contamination and providing a safer and more shielded environment for the workers. The soil will be transported to the pond by vehicle and personnel from NLM and will manually distribute it over the sludge. Before the personnel can enter the pond, it shall be ensured that the sludge top layer is damp to avoid possible dispersion during the soil distribution. If needed, water spray shall be used. Personnel movement directly on the sludge shall be avoided by placing the soil cover starting from the Pond walls, and working towards the middle of the Pond. Where possible the soil shall first be placed by a front end loader from the Pond sides. The front end loader shall not be allowed to enter the Pond.
- The steel bridge leading to the concrete sump inside the pond will be completely removed and the sump backfilled ensuring that the valves are open and the pipeline is not damaged. The removal can be done by a contractor or Necsa personnel. The sump structure shall be dismantled to almost down to the sludge level. A layer of at least 150 mm soil/sand shall cover the dismantled sump structure as well as the sludge. The steel bridge and concrete sump structure will be surveyed first for contamination and then removed down to almost the level of the sludge. Should the steel structure be contaminated it will be transferred to D-Building where it will be cut-up in the licensed cutting facility for steel components. Transfer of these components will follow the applicable procedures as outlined in SHEQ-INS-8040 "*Removal of materials from radiological areas*" [19]. The radiation protection measures will follow the applicable actions as described in [10]. The components will then be drummed as Low Level Waste (LLW). Depending on the geometry of the components it could either be decontaminated in A-Building and cleared, or follow the established waste route of storage at Pelstore. Should the concrete sump structure be contaminated it will be dismantled and the waste will be drummed directly at the Pond, transferred to Pelstore, stored as LLW and eventually disposed at Vaalputs. All waste associated with rubble and secondary waste,

generated in the process of dismantling of the steel bridge and the sump, will be temporary stored in a dedicated area for storage as allocated by Necsa.

- After the sludge has been fully covered by soil/sand and the sump structure partially removed, the pond's own lining will be cut along the four corners on the pond walls and folded back over the sand covered pond contents. Personnel from NLM will fold the lining into position without stepping directly onto the sand/soil layer until the lining is in position to be glued (if possible, welded) together on top of the covered sludge. Additional lining will be used to cover the possible uncovered area.
- Necsa personnel/outside contractor to cover the old lining with a new ±2 mm thick HDPE liner (possible welding together of new cover as needed) and tucked over the folded edges of the old lining to cover the old lining like an "umbrella".
- Necsa personnel/outside contractor to cover the new liner with an initial ±50 mm layer of sand (fine to medium river sand with a grain from about 0,125 mm to 0,5 mm) before a rainwater drainage gutter system can be installed inside the pond.
- The rainwater drainage gutter system will be installed inside the pond with an associated exit point out of the pond. A trench needs to be dug by a contractor to accommodate the piping that needs to be installed and the digging of the trench needs to be carefully done as the piping needs to be roughly on the same level all around the pond with a slight decline (± 10) to the exit point of the drainage system out of the pond. A report in [23] details the design and justification of the rainwater drainage system.
- The contractor installing the piping needs to ensure that the piping is installed in such a way that if the final top liner is installed and after a top final layer of sand (± 50 mm thick) was worked in on the initial ±50 mm layer of sand, the final top liner must be able to enter the lengthwise cut open pipe ± three quarters from the bottom of the pipe.
- On three sides of the Pond, the piping diameter must be about 200 mm and on the side of the exit point out of the pond, the pipe will have a diameter of at least 315 mm. the whole piping system needs to be glued together at all coupling points. A gutter exit point will be dug through the pond wall level by the earthmoving contractor with the sludge content which is roughly 2.5 m deep. The exit point layout and position will be discussed in more detail on site with the responsible Necsa project manager to ensure best practice.
- After the installation of the rainwater drainage gutter system, the final 50 mm thick sand cap will be constructed with a slight vertical bulge in the middle of the pond. The sand will again be moved and placed by a front-end loader and this layer of sand will be on a level of one quarter from the top of the PVC pipe. The contractor that will install the PVC piping shall cut a groove with at least a 40 mm gap into the PVC pipe with the bottom of the groove on the final sand level. This groove needs to be cut on all sides of the piping inside the Pond.
- The earthmoving contractor needs to dig the gutter exit point through the pond wall just below the sand content which is by now roughly 2.5 m deep. The exit point will be lower than entry point for gravitational flow and this will be discussed in more detail with the responsible Project Manager on site to ensure best practice.
- Construction and installation of the top final liner shall be done and the contractor shall install the new 2 mm thick HDPE top liner (possible welding together of the new cover if needed). The top liner shall be installed in such a way that it enters the PVC groove on all four sides.

- After completion of the construction on the PVC water drainage system, an investigation shall be done on the stability of the outside walls on top of the drainage system inside the Pond. Soil must at all cost be prevented from entering and blocking the PVC drain water system. If necessary, a 60% or higher shade netting may be installed by the contractor all around the outside walls, inside the pond, to prevent soil from entering the PVC pipe system. This netting will be secured to the walls to prevent slip and wind damage. If needed, the top edge of the pond wall must also be shaped in such way to prevent outside water from flowing into the pond (possible gutter to be installed etc.).

7.3.2.6 Personnel involved

The following personnel are foreseen to be involved in the physical execution of the project:

NLM personnel for:

- Manual placement of sand and soil covering the sludge.
- Removal of the steel bridge and dismantling of the sump structure.
- Placement of the cover liner.
- Manual placement of the sand/soil cover of the sealed Pond.

Liner contractor for:

- Welding and sealing of pond cover.

Civil contractor for:

- Supply of sand and soil.
- Operate front-end loader from Pond edge.

7.3.2.7 Personnel, area and radiological controls

The following personnel and area control will apply during the different stages of the capping:

Work permits as prescribed in SHEQ-INS-5520 [9] and SHEQ-INS-8120 [10] shall be issued for all the tasks related to this capping operation.

- Placement and distribution of soil over the sludge, dismantling of the sump structure, folding back and placement of the liner, and possible decontamination.
  a. Apart from the general security controls of the whole of the Necsa site, Thabana has also a dedicated security fence and site specific guards who enforces access control to the site and Ponds. All the conventional radiological and security measures also apply to Thabana because it is a classified radiological area.
  b. Radiological access control shall be applied for personnel and equipment entering and leaving the Pond with clearance of equipment done according to SHEQ-INS-8040 [19].
  c. Personnel entering the Pond shall be radiation and chemical workers, wear blue collar one-piece overalls, latex gloves, gumboots and half face respirator.
  d. Personal air samples shall be taken for the duration of the soil placement.
  e. Personnel shall wear their TLDs and be issued with a EPDs.
- Welding and sealing of the Pond

- Radiological access control shall be applied for personnel and equipment entering and leaving the Pond.
  a. Contractors will work under supervision of the facility RPO.
  b. The contractors will undergo the necessary Necsa and Facility specific orientation training.
  c. The contractor workers shall be issued with an EPD.
- Placement of final layer of sand, soil and vegetation.
  a. Personnel shall wear their TLDs and issued with an EPD.
  b. Personnel shall wear protective clothing, leather gloves and safety shoes.

7.3.2.8 Estimated project and task durations

Table 7-1: Estimated project and task durations

Task	No of Personnel	Estimated Duration	Approach
Placement and distribution of sand over the sludge	5 NLM personnel	3 days	Walking on a layer of at least 150 mm sand which covers the sludge
Removal of steel bridge	Contractor/NLM personnel	2 days	Possible walking on a layer of at least 150 mm sand which covers the sludge, bridge ± 3,5 m elevated above sand
Partial dismantling of sump structure	2 NLM personnel	5 days	Walking on a layer of at least 150 mm sand which covers the sludge
Cutting, folding back and placement of the old liner	5 NLM personnel	1 day	Walking on a layer of at least 150 mm sand and folded back liner which covers the sludge
Placement of first new liner on top of old liner, welding pieces of liner together in pond	3 liner contractors	2 days	Kneeling down on new liner and 150 mm sand to operate welding machine
Placement and distribution of ±50 mm sand over first new liner	5 NLM personnel	1 day	Walking on new liner and a layer of at least 150 mm sand which covers the sludge
Instalment of drain water system	4 Contractors	10 days	Walking on a layer of at least 200 mm sand which covers the sludge
Placement and distribution of ±50 mm sand over first ± 50 mm layer of sand	5 NLM personnel	1 day	Walking on a layer of at least 250 mm of sand which covers the sludge.
Cutting of 40 mm groove into the PVC drain lines	2 contractors	1 Day	Walking on a layer of at least 250 mm sand which covers the sludge
Placement of second new liner on top of sand, welding pieces of liner together in pond	3 liner contractors	2 days	Kneeling down on new liner and 250 mm sand which covers the sludge to operate welding machine

7.3.3 Management and control program

Management and control program

The organisational and management arrangements for the project will consist of the following functionaries:

- A NLM project manager.
- A Radiation Protection Specialist from Safety Department (SD)
- The NFM of Thabana (PDO Section)
- A RPO from SD
- An expert contractor for the welding of linings
- Radiation workers from NLM to do the basic labour
- The team will also work in close co-operation with the L&SA Department of Necsa. An INS-0800 meeting with LS was held on 10 May 2012 and the requirements and checklist of activities that will be complied with is indicated in [8]

7.4 Process Description of the Operations after Capping

7.4.1 Introduction

The operational condition of the Ponds after capping is:

- Pond 1: Capped.
- Pond 2: Capped.
- Pond 3: Capped.
- Pond 4: Capped.
- Pond 5: Unchanged; equipped with a double lining.
- Pond 6: Unchanged; never used, uncontaminated.

7.4.2 Operational description

As Ponds 1, 2, 3 and 4 are covered with high integrity materials and capped, no water ingress is expected. However, the drainage systems to detect leakages under Ponds 1, 2, 3 and 4 remain in operation. Any water detected in the drainage sump shall be sampled and analysed and be transferred to Pond 5 as per normal procedure.

7.4.3 Environmental Monitoring

A number of boreholes around the Ponds are currently being used to monitor for any potential environmental effect should any of the Ponds leak. These boreholes are listed in Section 5.9 of [22].

Should any boreholes become unsuitable, an appropriate alternative shall be identified, or a new borehole will be drilled and included in [22]. The SHEQ Department is responsible for the sampling of these boreholes and the reporting requirements as prescribed by the SHEQ-INS set of documents.

The table below provides further detail for the inspection and monitoring actions for the CaF_2 Ponds, see [2].

Table 7-2 Inspection and Monitoring Actions for the CaF_2 Ponds

Action	Frequency	Criteria	Responsibility
Sampling of boreholes	6 monthly	• Samples are analysed and evaluated by SD in accordance with the SHEQ-INS-8340 [11]	SD
General Inspection	Weekly	• Pump Station: When water present sample and pump to Pond 5. • Cap on top of lining: No sagging, flood damage or thinning of soil/sand cover. Repair or add soil when needed. • No big plants, scrubs or trees are allowed to grow on cover: Remove when detected. • Flood channel: No damage/ obstructions. • Fence: Intact. • Surrounding area: Short grass/ vegetation (fire hazard).	NLM
	Monthly	• No rodent damage to liner of Pond 5.	
Monitoring	Daily (5 working days)	• Two sumps, connected to ponds 1-3 and to ponds 4-5, for detection of leakages	

8 HAZARD ASSESSMENT

8.1 Assessment Methodology

The radiological hazards analysed in this document addresses the internal and external exposure pathways associated with the process of capping of the CaF_2 ponds discussed in Section 7.

8.2 Projected Effective Dose

The total projected effective dose is the sum of the doses associated with internal and external pathways for the identified activities as presented in Section 7.3.2.8, and calculated in the succeeding sections.

A conservative approach is taken by assuming that the same critical group will perform all activities as identified below. The capping activities/tasks in Ponds 3 or 4 are fully described in section 7.3.2.8 and are as follows:

1. Placement and distribution of sand over the sludge (3 days).
2. Removal of steel bridge (2 days).
3. Partial dismantling of sump structure (5 days).
4. Cutting, folding back and placement of the old liner (1 day).
5. Placement of first new liner on top of old liner, welding pieces of liner together in pond (2 days).
6. Placement and distribution of ±50 mm sand over first new liner (1 day).
7. Instalment of drain water system (10 days).
8. Placement and distribution of ±50 mm sand over first ± 50 mm layer of sand (1 day).
9. Cutting of 40 mm groove into the PVC drain lines (1 day).
10. Placement of second new liner on top of sand, welding pieces of liner together in pond (2 days).

Tasks 1 to 5 could cause the re-suspension of dried contaminated sludge (as adapted from [16]). Therefore the workers could be exposed to airborne contamination during the performance of these tasks.

During Tasks 6 to 10 workers can be exposed to external radiation only.

The values below are used to project incurred doses to a worker performing activities in dusty conditions;

- Task 1 - 5: t_1 = 13 days x 6 h/day = 78 h
- Task 6 - 10: t_2 = 15 days x 6 h/day = 90 h

The maximum dose rate on contact 0.38 µSv/h was measured for Pond 3 and 0.48 µSv/h for Pond 4 (Appendix E).

The maximum alpha activity of 0.05 kBq/m^2 (Pond 3) and 0.01 kBq/m^2 (Pond 4) for removable surface contamination was measured from swipe sample results in (Appendix F). These alpha values are conservatively chosen to represent the contamination activity.

It is conservatively assumed that the worker will be exposed to these conditions when performing those activities on Pond 3 and 4. Hence these values are used to project incurred doses to a worker.

8.3 Calculation of the Doses Accrued To a Worker (Pond 3)

8.3.1 Task 1 – 5 (Pond 3)

8.3.1.1 *Inhalation and ingestion of airborne contamination*

The placement and distribution of sand over the dried sludge could cause the re-suspension of dried contaminated sludge. Hence the worker could be exposed to airborne contamination during performance of these tasks.

If a worker would be doing these tasks <u>without respiratory protection</u>, the committed effective dose by <u>inhalation</u> would then be

Ds_{1pond3}	=	(Ac)(C)(Ir)(t)(Eh)	Equation II.1, Appendix II in [13], but for respirable dust in air.
	=	1.391 mSv	

Where:

Ac	=	10 mg/m^3	Gravimetric dust load for dusty operation in Pond 3 (from Table 11.2 in [13]).
Cs	=	236 Bq/g	Max radioactivity concentration level for Pond 3, section 7.3.2.2.1.3.
Ir	=	1.2 m^3/h	A gender- average breathing rate [15].
t_1	=	78 h	Time spent doing work , section 8.2
Eh	=	6.30E-06 Sv/Bq	Committed effective dose per unit intake via inhalation [15], U (enr$\leq$2%, Type S compounds).

Also, the committed effective dose for secondary ingestion due to performing the identified activities without prescribed respiratory protection, could be

Dd_{1pond3} = (Ag)(Rg)(t)(Eg) (Equation II.2, Appendix II in [13]).

= 1.794E-05 mSv

Where:

Ag	=	0.05E+03 Bq/m^2	Highest alpha surface activity in Pond3.
Rg	=	1.0E-04 m^2/h	Rate of secondary ingestion for surface contamination [13]
t_1	=	78 h	Time spent doing work, section 8.2.
Eg	=	4.6E-08 Sv/Bq	Committed effective dose per unit intake via ingestion, [14] Table II-III, U-235, Type F (most conservative).

The total internal dose to a worker when working without prescribed respiratory protection is:

$Dw_{1pond3} = Ds_{1pond3} + Dd_{1pond3}$ = (1.391+ 1.794E-05) mSv = 1.391 mSv.

If respirators are used, the average dose to a worker from inhalation and ingestion would then be:

$Dt^*_{1pond3} = Dw_{1pond3}/10$ [17] = (1.391 mSv/10) = 1.391E-01 mSv.

The protection factor 10 [17] is for a half face mask.

8.3.1.2 External radiation Dose to Worker

The maximum dose rate on contact (0.38 µSv/h) was measured at Pond 3 (Appendix E) therefore the dose rate for 78 h spent performing Task 1 - 5 activities could be

De_{1pond3} = (Dose rate) x (Time of exposure)

= (0.38 µSv/h) X (78 h)

= 2.96E-02 mSv

8.3.1.3 Dose Assessment results

The total dose accrued by a worker during Task 1 - 5 activities in Pond 3 <u>without</u> prescribed respiratory protection is:

Inhalation	Ds_{1pond3}	=	1.391 mSv
Ingestion	Dd_{1pond3}	=	1.794E-05 mSv
External radiation	$De_{1\ pond3}$	=	2.96E-02 mSv
Total Dose Task 1 - 5	$Dt_{1pond3\ without\ PPE}$	=	**1.42 mSv**
Without respiratory Protection			

The total dose accrued by a worker during Task 1 - 5 activities in Pond 3 <u>with</u> prescribed respiratory protection is:

Inhalation and ingestion	Dt^*_{1pond3}	=	0.391 mSv
External radiation	De_{1pond3}	=	2.96E-02 mSv
Total Dose Task 1 - 5	$Dt_{1pond3\ with\ PPE}$	=	**4.2E-01 mSv**
With respiratory Protection			

8.3.2 Task 6 - 10 (Pond 3):

8.3.2.1 Inhalation and ingestion of airborne contamination and the external dose

These tasks could not cause the re-suspension of some loose contamination on the surfaces of the sump structure and liner. Hence the worker will only be exposed to external radiation during performance of these tasks.

8.3.2.2 External Radiation Dose to Worker

The maximum dose rate on contact (0.38 µSv/h) was measured at Pond 3 (Appendix E) therefore the dose rate for 90 h spent performing Tasks 6 - 10 activity could be

De_{3pond3} = (Dose rate) x (Time of exposure)

= (0.38 µSv/h) x (90 h)

= 3.42E-02 mSv

The total dose accrued by a Worker during Tasks 1 - 10 activities in Pond 3 with prescribed respiratory protection is:

Inhalation and ingestion	Dt^*_{3pond3}	=	0.391mSv
External radiation	De_{3pond3}	=	6.38E-02 mSv
Total Dose Task 1-10	$\mathbf{Dt_{1pond3\ with\ PPE}}$	=	**0.45 mSv**
With Respiratory Protection			

8.4 Calculation of the Doses Accrued To A Worker (Pond 4)

8.4.1 Task 1 - 5 (Pond 4):

8.4.1.1 Inhalation and ingestion of airborne contamination

These tasks could cause the re-suspension of dried contaminated sludge. Hence the worker could be exposed to airborne contamination during performance of this task.

If a worker would be performing these tasks without respiratory protection, the committed effective dose by inhalation would then be

Ds_{1pond4}	=	(Ac)(C)(Ir)(t)(Eh)	Equation II.1, Appendix II in [13], but for respirable dust in air.
	=	1.651 mSv	

Where:

Ac	=	10 mg/m^3	Gravimetric dust load for dusty operation in Pond 4 (from Table 11.2 in [13]).
Cs	=	280 Bq/g	Max. Radioactivity concentration level for Pond 4, section 7.3.2.2.1.3
Ir	=	1.2 m^3/h	A gender- average breathing rate. [15].
t_{1pond4}	=	78 h	Time spent doing work, section 8.2
Eh	=	6.30E-06 Sv/Bq	Committed effective dose per unit intake via inhalation [15], U (enr$\leq$ 2%, Type S compounds).

Also, the committed effective dose for secondary ingestion due to performing the identified activities without prescribed respiratory protection, could be

Dd_{1pond4}	=	(Ag)(Rg)(t)(Eg)	(Equation II.2, Appendix II in [13].
	=	6.09E-06 mSv	

Where:

Ag	=	17 Bq/m^2	Highest alpha surface activity in Pond 4.
Rg	=	1.0E-04 m^2/h	Rate of secondary ingestion for surface contamination [13]
t	=	78 h	Time spent doing work, section 8.2
Eg	=	4.6E-08 Sv/Bq	Committed effective dose per unit intake via ingestion, [14] Table II-III, U-235, Type F (most conservative).

The total internal dose to a worker when working without prescribed respiratory protection is:

$Dw_{1pond4} = Ds_{1pond4} + Dd_{1pond4}$ = (1.651 + 6.09E-06) mSv = 1.651 mSv.

If respirators are used, the average dose to a worker from inhalation and ingestion would then be

$Dt^*_{1pond4} = Dw_{1pond4}/10$ [17] = (1.651 mSv/10) = 1.651E-01mSv.

The protection factor 10 [17] is for a half face mask.

8.4.1.2 External radiation Dose to Worker

The maximum dose rate on contact (0.48 µSv/h) was measured at Pond 4 (Appendix E) therefore the dose rate for 78 h spent performing capping activity could be

De_{1pond4} = (Dose rate) x(Time of exposure)

= (0.48 µSv/h) X (78 h)

= 3.74E-02 mSv

8.4.1.3 Dose Assessment results

The total dose accrued by a worker during tasks 1 - 5 activity in Pond 4 without prescribed respiratory protection is:

Inhalation	Ds_{1pond4}	=	1.651 mSv
Ingestion	Dd_{1pond4}	=	6.09E-06 mSv
External radiation	De_{1Pond4}	=	3.74E-02 mSv
Total Dose Task 1 - 5 Without Respiratory Protection	$Dt_{1pond4\ without\ PPE}$	=	**1.688 mSv**

The total dose accrued by a worker during Task 1 - 5 activities in Pond 4 with prescribed respiratory protection is:

Inhalation and ingestion	Dt^*_{1pond4}	=	1.651E-01 mSv
External radiation	De_{pond4}	=	3.74E-02 mSv
Total Dose Task 1 - 5 With Respiratory Protection	$\mathbf{Dt}_{1pond4\ with\ PPE}$	=	**2.02E-01 mSv**

8.4.2 Task 6 - 10 (Pond 4):

8.4.2.1 Task 6 - 10 (Pond 4): Dose to a worker from inhalation and ingestion of airborne contamination and the external dose

These tasks could not cause the re-suspension of some loose contamination on the surface of contaminated equipment. Hence the worker could be exposed to external radiation during performance of this task.

The maximum dose rate on contact (0.48 µSv/h) was measured at Pond 4 (Appendix E) therefore the dose rate for 90 h spent performing capping activity could be

De_{1pond4} = (Dose rate) x(Time of exposure)

= (0.48 µSv/h) X (90 h)

= 4.32E-02 mSv

8.5 Dose to a Member of the Public Pond 3 and Pond 4

The members of public are not allowed to visit the pond site during capping activities.

8.6 DOSE ASSESSMENT RESULTS

8.6.1 The Total Dose Accrued By a Worker During Tasks 1 - 10 Activities In Pond 3

The total dose accrued by a worker during Tasks 1 - 10 activities in Pond 3 **without** prescribed respiratory protection is:

Pond 3 Total Dose (Task 1 - 5 without respiratory protection)	Dt_{1pond3} =	1.42 mSv
Pond 3 Total dose (Task 6 - 10 without respiratory protection)	Dt_{2pond3} =	3.42E-02 mSv
Capping Pond 3 Total Dose without PPE	$\mathbf{Dt}_{Total\ Pond3}$=	**1.45 mSv**

The total dose accrued by a worker during tasks 1 - 10 activities in Pond 3 **with** prescribed respiratory protection is:

Pond 3 Total Dose (Task 1 - 5 with respiratory protection)	Dt_{1pond3} =	4.21E-01 mSv
Pond 3 Total dose (Task 6 - 10 with respiratory protection)	Dt_{2pond3} =	3.42E-02 mSv
Capping Pond 3 Total Dose with PPE	**$Dt_{Total\ Pond3}$ =**	**4.5E-01 mSv**

8.6.2 The Total Dose Accrued By a Worker During Tasks 1 - 10 Activities In Pond 4

The total dose accrued by a worker during tasks 1-10 activities in Pond 4 **without** prescribed respiratory protection is:

Pond 4 Total Dose(Task 1 - 5 without respiratory protection)	Dt_{1pond4} =	1.688 mSv
Pond 4 Total dose 6 - 10	Dt_{2pond4} =	4.32E-02 mSv
Capping Pond 4 Total Dose without PPE	**$Dt_{Total\ Pond\ 4}$ =**	**1.73 mSv**

The total dose accrued by a worker during tasks 1 - 10 activities in Pond 4 **with** prescribed respiratory is:

Pond 4 Total Dose (Task 1 – 5 with respiratory protection)	Dt_{1pond4} =	2.02E-01 mSv
Pond 4 Total dose(Task 6 - 10)	Dt_{2pond4} =	4.32E-02 mSv
Capping Pond 4 Total Dose with PPE	**$Dt_{Total\ Pond\ 4}$ =**	**2.45E-01 mSv**

9 CONCLUSION

The total worker dose, assuming the most conservative case i.e. the same worker performing all activities without PPE protection and for all tasks 1 – 10 capping for both Pond 3 and Pond 4 is 3.18 mSv (1.45 mSv added with 1.73 mSv). This is sufficiently below the average annual effective dose to the occupationally exposed workers of 20 mSv NNR limit [24].

The RPO shall prescribe to the workers the use of appropriate PPE prior to the start of the capping activities.

The RP requirements of SHEQ-INS documents shall be complied with regard to registration of workers as occupationally exposed.

10 RECORDS

The following records shall be kept:

DESCRIPTION	PERIOD	BY WHOM
Hazard Assessment	End of facility's life	LS
All borehole analysis reports	Lifetime of facility	L&SA Document Custodian
Inspection Reports	Lifetime of facility	NLM
Radiological monitoring results and dose records including EPD's, smears, air sampling and RPWP's	Lifetime of facility	NLM

APPENDIX A: Page 3 of analysis report RS2015-0619-02

Report number: ***RS2015-0619-02***

APPENDIX 1: ANALYTICAL RESULTS

Activity concentrations of nuclides in pond samples

Unit: Bq/g

Field code	**Pond 3**			**Pond 4**		
Lab code	**RS2015-0619X001**			**RS2015-0619X002**		
Ref date	**23/04/2015**			**23/04/2015**		
Nuclide	**Value**	**Unc.**	**MDA**	**Value**	**Unc.**	**MDA**
^{40}K	<MDA		0.30	0.612	0.075	0.16
^{60}Co	<MDA		0.014	<MDA		0.017
^{134}Cs	<MDA		0.021	<MDA		0.020
^{137}Cs	<MDA		0.020	0.0217	0.0046	0.013
^{235}U	0.837	0.078	0.18	0.908	0.081	0.18
^{238}U	26.1	1.3	1.4	18.4	1.2	1.5

APPENDIX B: Page 3 of analysis report PAL-SAM-2002/01863

NECSA

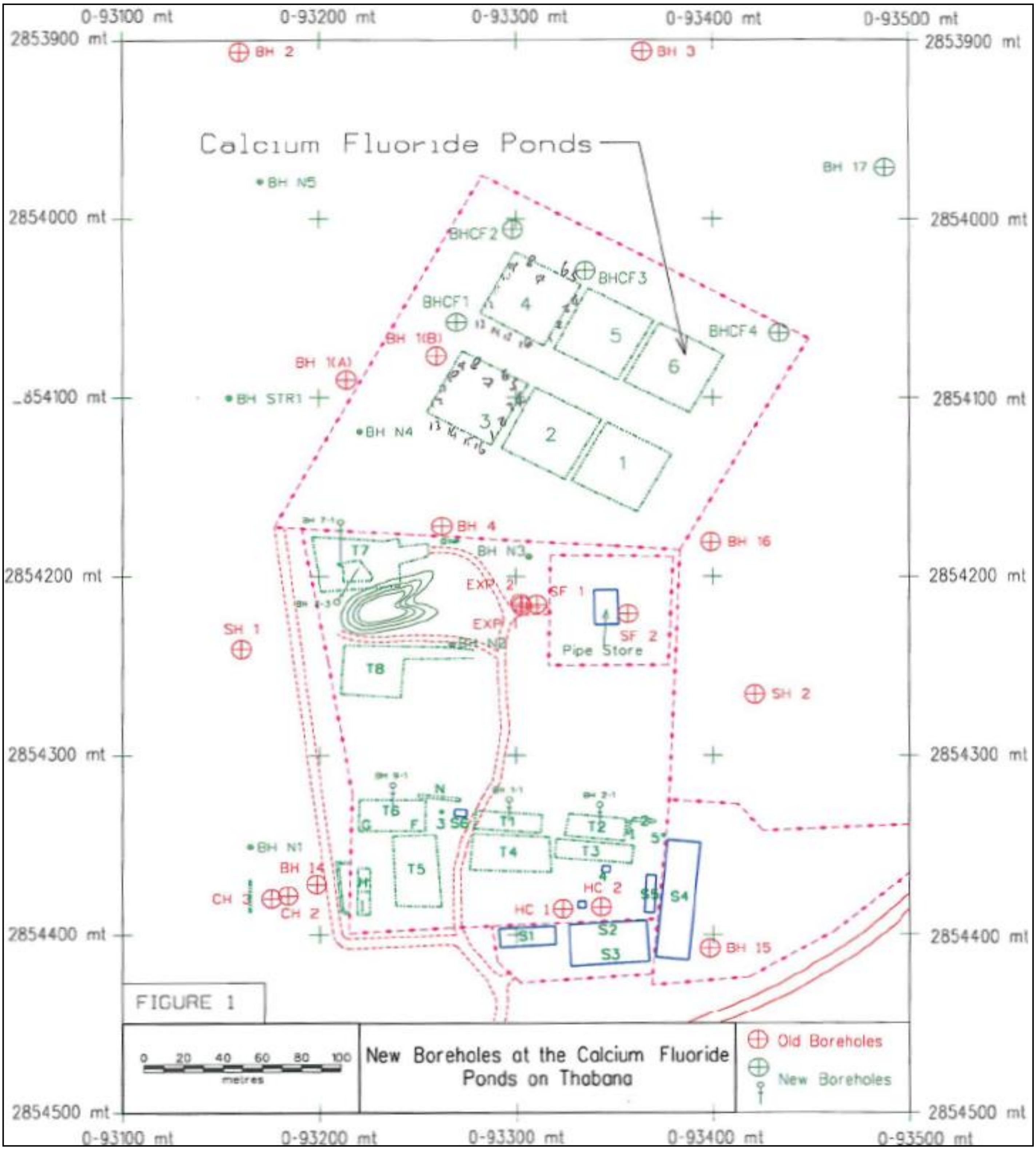
P O Box 582 Pretoria 0001 Republic of South Africa
Telephone: International: 27-12-305-4911
Local: 012-305-4911
Fax: International: 27-12-305-3111
Local: 012-305-3111

NECSA

PAL-SAM-2002/01863 Page No. : 3

Sample	Param.	Result	Units
Pan 3 (3)	Uranium	6.6	g/kg (NV)
Pan 3 (4)	Uranium	9.1	g/kg (NV)
Pan 3 (5)	Uranium	7.4	g/kg (NV)
Pan 3 (6)	U	7.0	g/kg (NV)
	U234	0.005	%mass (NV)
	U235	0.719	%mass (NV)
	U236	<0.001	%mass (NV)
	U238	99.276	%mass (NV)
Pan 3 (7)	Uranium	9.2	g/kg (NV)
Pan 3 (8)	Uranium	7.1	g/kg (NV)
Pan 3 (9)	Uranium	7.4	g/kg (NV)
Pan 3 (10)	Uranium	7.8	g/kg (NV)
Pan 3 (11)	Uranium	5.8	g/kg (NV)
Pan 3 (12)	Uranium	7.5	g/kg (NV)
Pan 3 (13)	Uranium	0.5	g/kg (NV)
Pan 3 (14)	Uranium	0.8	g/kg (NV)
Pan 3 (15)	Uranium	4.5	g/kg (NV)
Pan 3 (16)	Uranium	0.4	g/kg (NV)
Pan 4 (1)	Uranium	3.3	g/kg (NV)
Pan 4 (2)	Uranium	10.0	g/kg (NV)
Pan 4 (3)	Uranium	9.4	g/kg (NV)
Pan 4 (4)	Uranium	7.4	g/kg (NV)
Pan 4 (5)	Uranium	6.5	g/kg (NV)
Pan 4 (6)	U	11.0	g/kg (NV)
	U234	0.006	%mass (NV)
	U235	0.719	%mass (NV)
	U236	<0.001	%mass (NV)
	U238	99.276	%mass (NV)
Pan 4 (7)	Uranium	10.3	g/kg (NV)

APPENDIX C: Sampling of the contents and analysis results of Ponds 3 AND 4



P3	U mg/l	Digtheid	U mg/kg
1	9497	1.5742	6033
2	5203	1.6035	3245
3	10246	1.5421	6644
4	14645	1.6150	9068
5	11715	1.5888	7373
6	10877	1.5641	6954
7	14569	1.5769	9239
8	11157	1.5794	7064
9	11909	1.6057	7417
10	12330	1.5775	7816
11	9323	1.6057	5806
12	12280	1.6354	7509
13	795	1.5969	498
14	1251	1.6299	768
15	6905	1.5450	4469
16	581	1.5748	369
Gemiddeld			5642
Standard afwyking			2934

P4	U mg/l	Digtheid	U mg/kg
1	5699	1.7343	3286
2	16058	1.6076	9989
3	15399	1.6376	9403
4	12149	1.6478	7373
5	10648	1.6395	6495
6	17160	1.5630	10979
7	16302	1.5857	10281
8	10687	1.4969	7139
9	14768	1.6136	9152
10	12700	1.5704	8087
11	16557	1.6076	10299
12	15913	1.6223	9809
13	15098	1.6524	9137
14	16035	1.608	9972
15	14259	1.6822	8476
16	9772	1.7117	5709
Gemiddeld			8474
Std afwyking			2042

APPENDIX D: Estimation of the Uranium volumes in the Ponds

Memorandum

NECSA

2002/06/21

TO: EL UYS
SNR TECHNOLOGIST: NUCLEAR LIABILITIES SYSTEMS

FROM: E RAUBENHEIMER
MANAGER: WASTE MANAGEMENT EVALUATIONS

ESTIMATED VOLUMES OF HIGH URANIUM BEARING MATERIAL/SLUDGE TO BE REMOVED FROM PAN 6 and CaF_2-PANS

a. **PAN 6**

The floor area of the pan is 8 170 m^2 (Lee Ainslee; 21/06/2002). Tests conducted shows a fairly even sludge thickness of 10 cm (0.10 m) throughout the pan. Based on these dimensions, the total sludge/material contained in PAN 6 is: 8 170 x 0.1 = ~ **820 m^3**.

b. **CaF_2-PANS 1 & 2**

These two pans have been closed, capped and contains sludge/material of depth 1.5 m. The pan was originally 2.5 m deep and lower and upper surface areas 604 m^2 and 1 466 m^2 (Lee Ainslee; 21/06/2002). Upper area is therefore taken as [1.5/2.5 x (1 466 - 604)] + 604 = 1 121 m^2. Total amount of sludge/material contained in Pans 1 & 2 is: [(1122 + 604)/2] x 1.5 = ~ **1 294 m^3/pan**.

c. **CaF_2-PANS 3 & 4**

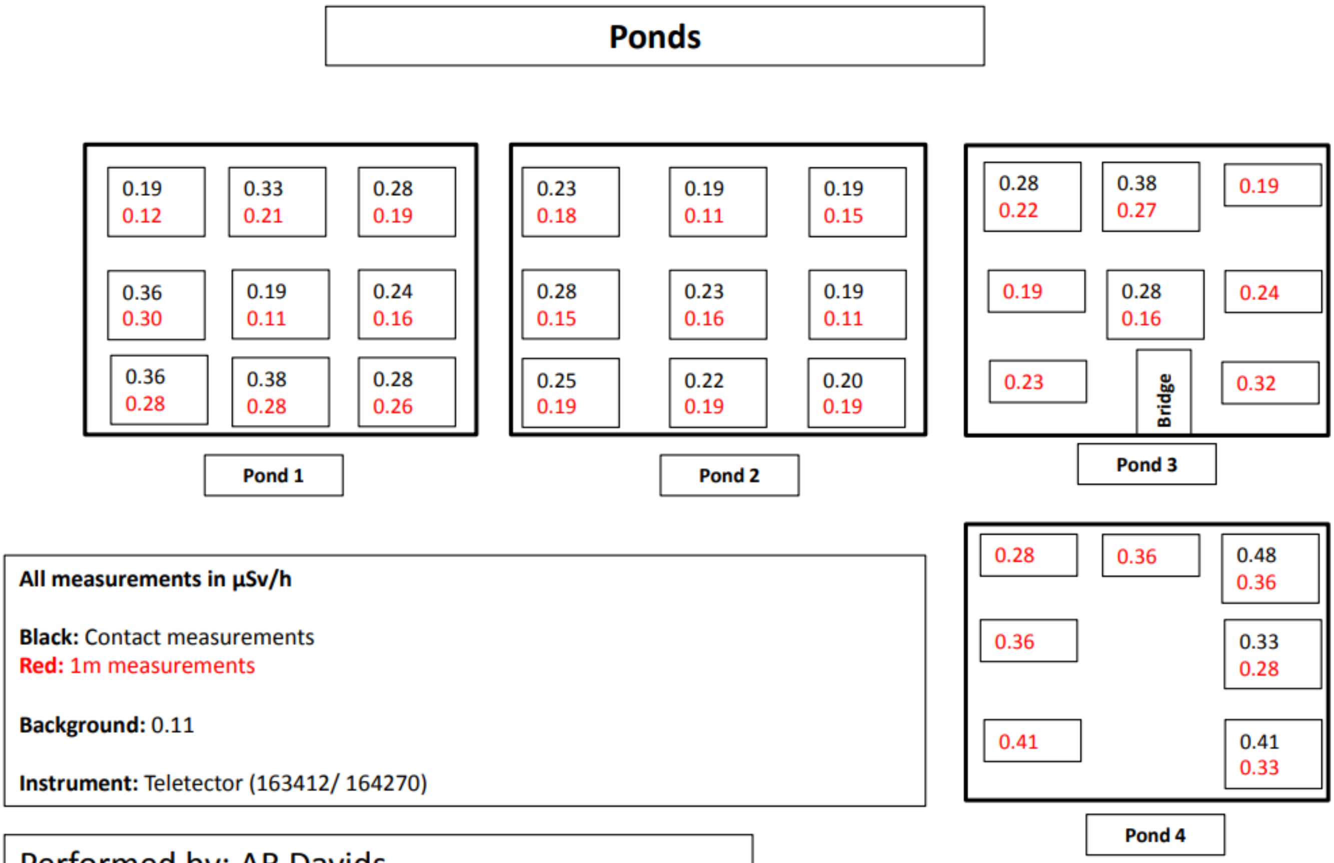
These two pans are still open and contains sludge/material of average depth 1.5 m. These pans are of exact dimensions as Pans 1 & 2 and same approach for calculating volumes is adopted.
Total amount of sludge/material contained in Pans 3 & 4 = ~ **1 294 m^3/pan.**

d. **CaF_2-PANS 5 & 6**

These pans have never been in use therefore no sludge/material is contained in these pans.

Elwin Raubenheimer
Manager: Waste Management Evaluations

APPENDIX E: The results of the radiation and contamination measurements at CaF2 Ponds 1-4.



Performed by: AR Davids

Signature:

APPENDIX F: Survey Results of Ponds 1-4

RadioAnalysis: Monitoring
P1600 Pelindaba West

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NUCLEAR TECHNOLOGY & SERVICES

Test Report: Gross Alpha/Beta Activity on Swipes

Job number: RA- 13035

Client Ref: *CaF2 Pond 3 White 2012/10/03*

Batch ID:	47mm swipes - 5min - 201210051043	Batch Key:	10060		Alpha	Beta
Sampling Date:	2012/10/03	Facility Code:	RA-FS-113	Counting efficiency (%):	26.2	45.5
Receipt Date:	2012/10/03	Voltage:	1350	Spillover (%):	17.0	0.0
Count Date:	Fri, 5 Oct 2012 10:48	Report Template:	Swipes (Rev15) 3.1.2a	Background (cpm):	0.13	1.30
Print Date:	Fri, 5 Oct 2012	Method:	RA-WIN-160(Rev03)	LLD (counts):	1	4

Sample ID	Field Name	Alpha Activity Bq or kBq/m²	Beta Activity Bq or kBq/m²	Classification levels Alpha	Classification levels Beta
20121005104309-D6	no 01	0.0042 ± 0.0128	0.0106 ± 0.0254	WHITE	WHITE
20121005104900-D7	no 02	0.0297 ± 0.0221	-0.0140 ± 0.0221	WHITE	WHITE
20121005105410-D8	no 03	0.0551 ± 0.0285	-0.0311 ± 0.0196	WHITE	WHITE
20121005105920-D9	no 04	0.0169 ± 0.0181	0.0020 ± 0.0244	WHITE	WHITE

The results apply only to the samples received. All detection limits refer to the minimum detectable activity (MDA) at the 95% confidence interval. If the reported activity concentration value is less than the MDA, use the MDA value. The method for gross alpha/beta-activity is intended to merely be a screening technique and gives only a first order estimate of total activities. Because of unavoidable errors that may occur due to differences of particle energies between calibration standards and samples, the reported uncertainties, calculated mainly from counting statistics, may be an underestimation of the true uncertainties.

Analyst: Sindi Jawa

Signed: [signature]

Signitory : *Mrs E Nhlapo*

Page 1 of 1

RadioAnalysis: Monitoring

P1600 Pelindaba West

necsa *We're in your world*

NUCLEAR TECHNOLOGY & SERVICES

Test Report: Gross Alpha/Beta Activity on Swipes

Job number: RA- 13035

Client Ref: ***CaF2 Pond 4 White 2012/10/03***

Batch ID:	**47mm swipes - 5min - 201210051043**	Batch Key:	**10061**
Sampling Date:	2012/10/03	Facility Code:	**RA-FS-113**
Receipt Date:	2012/10/03	Voltage:	**1350**
Count Date:	**Fri, 5 Oct 2012 11:09**	Report Template:	**Swipes (Rev15) 3.1.2a**
Print Date:	**Fri, 5 Oct 2012**	Method:	**RA-WIN-160(Rev03)**

	Alpha	Beta
Counting efficiency (%):	26.2	45.5
Spillover (%):	17.0	0.0
Background (cpm):	0.13	1.30
LLD (counts):	1	4

Sample ID	Field Name	Alpha Activity Bq or kBq/m²	Beta Activity Bq or kBq/m²	Classification levels Alpha	Classification levels Beta
20121005104341-E10	no 01	0.0296 ± 0.0221	0.0080 ± 0.0255	WHITE	WHITE
20121005110951-E11	no 02	0.0043 ± 0.0128	-0.0260 ± 0.0194	WHITE	WHITE
20121005111501-E12	no 03	0.0042 ± 0.0128	-0.0114 ± 0.0220	WHITE	WHITE
20121005112011-E13	no 04	0.0296 ± 0.0221	0.0080 ± 0.0255	WHITE	WHITE

The results apply only to the samples received. All detection limits refer to the minimum detectable activity (MDA) at the 95% confidence interval. If the reported activity concentration value is less than the MDA, use the MDA value. The method for gross alpha/beta-activity is intended to merely be a screening technique and gives only a first order estimate of total activities. Because of unavoidable errors that may occur due to differences of particle energies between calibration standards and samples, the reported uncertainties, calculated mainly from counting statistics, may be an underestimation of the true uncertainties.

Analyst: Sindi Yawa

Signed: [signature]

Signitory : ***Mrs E Nhlapo***

Page 1 of 1

Classification: OPEN

APPROVED

Document No.	**NLM-SPE-00036**
Rev. No.	**00**
Department/Section:	**In-Service & Maintenance Coordination Support**
Title:	**URS FOR THE CLOSING AND SEALING OF CaF2 POND No. 3**

Authorization:

	NAME	SIGNED	DATE
PREPARED	RGF Robberts (Acting Supervisor: IS&MS)		2020/10/14
REVIEWED	L Hordijk (Waste Specialist: NLM)		14/10/2020
REVIEWED	TE Labuschagne (Chief Technician: NLM)		2020/10/14
REVIEWED	E Raubenheimer (Chief Scientist: NLM-Rad Waste)		2020/10/14
ACCEPTED	ES Tshabalala (Acting Facility Manager: PDO)		2020/10/14
ACCEPTED	ZP Dlamini (Manager: Rad Waste)		15/10/2020
APPROVED	SV Dhlomo (Senior Manager: NLM)		15/10/2020

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9	ZP DLAMINI*	23		37	
10	ES TSHABALALA*	24		38	

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Revisions

This document has been revised according to the following schedule:

Revision	Date Approved	Nature of Revision	Prepared by
00	See title page	First Issue	RGF Robberts

Contents:

1.0 PURPOSE

The purpose of this document is to define the user requirement specification (URS) for the capping of CaF2 pond no. 3 to isolate the pan sludge from the environment.

2.0 SCOPE

Although CaF2 pond no. 4 also needs to be capped, this document will only define the URS for the capping of CaF2 pond no. 3. An additional URS will be prepared for CaF2 pond no. 4 after completion of the capping of pond 3.

.

3.0 REFERENCES

The following documents are referenced in this document:

[1] LSA-NLM2016-REP-0001: Safety Assessment for Capping of Ponds 3 and 4

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 DEFINITIONS:

Capping: A process of the closing and sealing of CaF2 pond no. 3 to isolate the contents of the pond from the environment.

4.2 ABBREVIATIONS:

CaF2: Calcium Fluoride

HDPE: High Density Polyethylene

PDO: Pre Disposal Operations

URS: User Requirement Specification

PVC: Polyvinyl Chloride

FM: Function Manager

NLM: Nuclear liability Management

RPO: Radiation Protection Officer

SHEQ: Safety, Health, Environment and Quality

5.0 RESPONSIBILITY

1. It is the responsibility of the FM (PDO) to ensure [1]:
   - That all the regulatory requirements are adhered to.
   - That Necsa's SHEQ requirements are met.

2. The NLM project manager shall coordinate the remediation process in consultation with the FM (PDO), or his delegate.

3. It is the responsibility of the FM (PDO) to ensure that the following training is received by all contractor personnel prior to the start of the construction.
   - Necsa induction training (1 day)
   - Facility (PDO) induction training (0.5 Day)

6.0 FACILITY DESCRIPTION

CaF2 pond no. 3 is an open-air evaporation dam that contains chemicals and uranium-contaminated effluent where the aqueous part of the effluent is evaporated by natural processes. However, the degradation of the lining of the pond (mainly due to prolonged exposure to sun and ultraviolet rays, wind and temperature differences) and the sporadic exposure of the top of the sludge during dry seasons has increased the risk of contamination to the environment from this pond. Apart from the existing liquid in the sludge, rainwater will continually add a transport medium for contamination to leak down into the geosphere if there is any damage to the pond liner. When the sludge is dried out in winter, the wind can also transport contaminated dust from the ponds to the surrounding environment.

Between pond no. 3 and pond no. 4, pond 3 is being considered the most risky pond in this regard and will therefore be the first pond to be remediated.

7.0 BRIEF PROJECT DESCRIPTION

- The exercise will include the closing and sealing of the HDPE lined pond with new HDPE liners to isolate the sludge from the environment and rain water.
- The removal of a steel bridge leading to a concrete sump structure inside the pond and the partially dismantling of the sump structure thereafter.
- The covering of the sludge and HDPE liners with sand and soil on different intervals as prescribe in more detail in Par. 8.
- The installation of a PVC drain system inside the pond with an associated drain system to the outside of the pond.

8.0 USER REQUIREMENT SPECIFICATION

The following of events/steps with associated responsibilities will be as follows and in sequence of order of the activities that must take place.

8.1 PUMPING OF EXCESS WATER

- Necsa personnel will be responsible to ensure that all excess water on top of the sludge inside pond 3 is removed/pumped over to pond 5 as much as possible.
- They will also ensure that the drain valve inside the sump is fully opened to ensure maximum drainage from the pond at all times.

8.2 REMOVAL OF STEEL BRIDGE

- The steel bridge leading to the concrete sump structure inside the pond needs to be fully removed.
- The removal can be done by a contractor or Necsa personal (*note*: possible contamination to equipment used in removal process).
- A dedicated area for all waste associated with rubble and secondary waste generated in the process of dismantling of the steel bridge will be allocated by Necsa for temporally storage.

8.3 DISMANTLING OF THE SUMP STRUCTURE

- The sump structure shall be dismantled to almost down to the surrounding sludge level inside the pond. The inside of the dismantled sump structure shall be covered with a layer of at least 150 mm soil/sand.
- The dismantling can be done by a contractor or Necsa personal (*note*: possible contamination to equipment used in dismantling process).
- A dedicated area for all waste associated with rubble and secondary waste generated in the process of dismantling of the sump will be allocated by Necsa for temporally storage.

8.4 COVERING OF THE SLUDGE INSIDE THE POND WITH SAND.

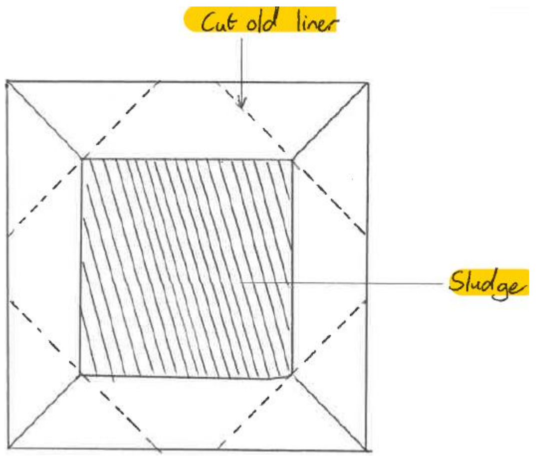
- A layer of sand (± 150mm thick) will have to be worked in by Necsa personal on top of the impounded sludge to enable a safer work area and lower the possibility of contamination to workers.
- This sand will be moved and placed by a front-end loader (only from the pond edge). Typically by equipment similar to a Bobcat 41070 front end loader will be required for this task (supplied and operated by a contractor).
- The centre of the sand stack to be constructed to be slightly the highest point (dome shaped).
- Estimated volume of sand required ~170m^3.
- Contractor to quote for supply and delivery of said volume of sand.

8.5 CUTTING AND BACK FOLDING OF OLD POND LINER

- HDPE lining of pond needs to be cut (see fig. 1) along the edges of pond casting (by Necsa's personal and supervising) and folded back on top of the pond content to mimic an envelope.

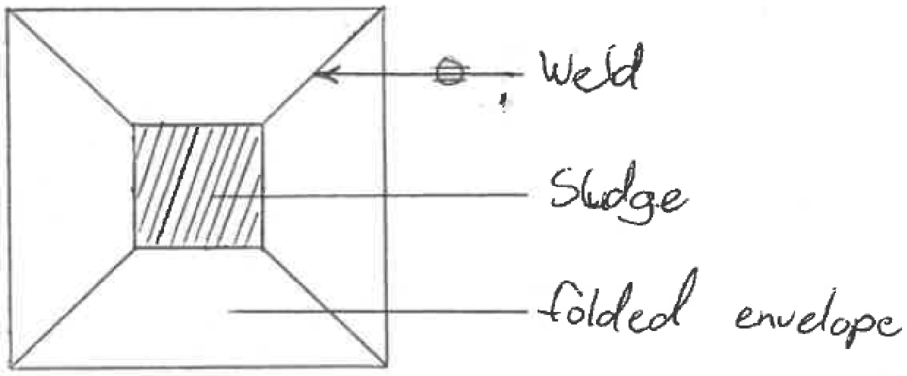
- Personnel from Necsa will fold the lining back over the sand covering the pond contents (without stepping directly onto the sand layer) until the lining is in position to be glued (if possible or to be discussed with supervisor) together on top of the covered sludge.
- Additional lining (if possible - glued to old lining) will be used to cover any uncovered areas.

Fig.1 Cutting of old liner



If possible (see fig. 2), seams needs to be welded (outside contractor) before new lining can be placed on top of the old lining (4x welds, ± 6m each).

Fig.2 Possible welding of old liner



8.6 INSTALLMENT OF NEW BOTTOM LINER.

- Contractor to cover the "folded envelope" with a new ±2 mm thick HDPE liner (possible welding together of new cover as needed) and tucked over the folded edges to cover the old lining like an "umbrella".
- ±1200m^2 of HDPE liner needed to cover the top of envelope.

8.7 *COVERING OF THE NEW LINER WITH A SAND LAYER*

- This sand cap (fine to medium river sand with a grain from about 0,125mm to 0,5mm) will be constructed with a slight vertical bulge in the pond centre in order to direct rainwater away from the underlying impounded sludge and avoid ponding of water on top of the covered pond.
- A first layer of sand (± 50mm thick) will have to be worked in by Necsa personal/outside contractor on top of the new liner before the installation of a drain system. Final top-up layer must be done after instalment of the drain system.
- This sand will again be moved and placed by a front-end loader as previously discussed in Par. 8.4.
- Estimated volume of sand required ~60m^3.
- Contractor to quote for supply and delivery of said volume of sand.

8.8 *INSTALLMENT OF DRAIN WATER SYSTEM*

- A rainwater drainage gutter system needs to be installed inside the pond with an associated exit point out of the pond (see fig. 3 and fig. 4).
- A trench needs to be dug by a contractor to accommodate the piping that needs to be installed.
- The digging of the trench needs to be carefully done as the piping needs to be on the same level all around the pond.
- The contractor installing the piping (in conjunction with the contractor digging the trench if not the same) needs to ensure that the piping is installed in such a way that if the top liner is installed after the top final layer of sand was worked in, the liner must be able to enter the pipe ± three quarter from the bottom of the pipe (see fig. 5).
- On three sides of the pond the piping diameter must be ± 200mm.
- On the side of the exit point out of the pond, the pipe must have a diameter of ± 315mm.
- The earthmoving contractor needs to dig the gutter exit point through the pond wall level with the sludge content which is roughly 2.5m deep.
- In order to have an exit point lower than entry for gravitational flow, the possible location for the exit point for pond 3 is shown in Fig.4.
- The exit point layout and position will be discussed more in detail on site with the responsible Necsa project manager to ensure best practice

Fig. 3 PVC Pipe layout inside pond

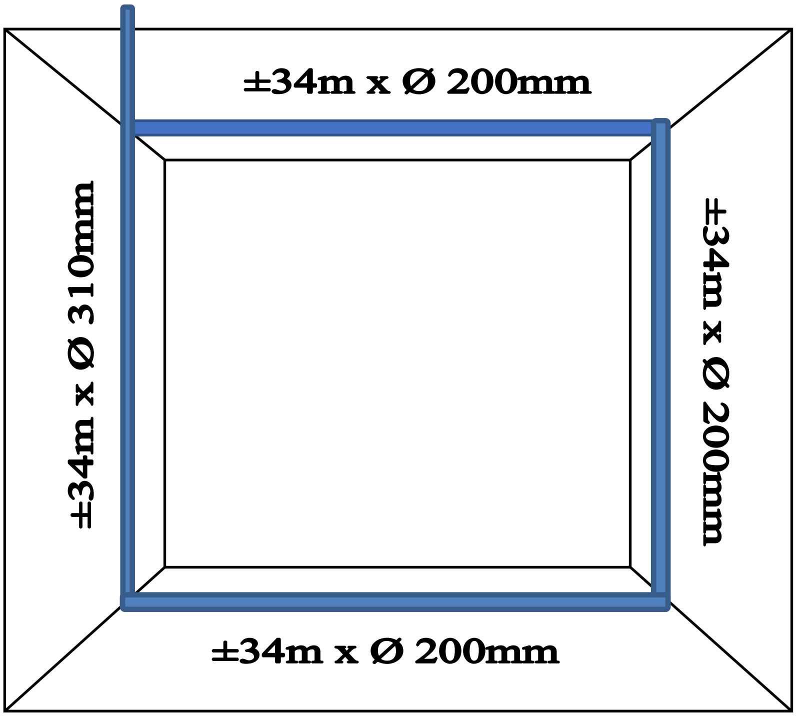
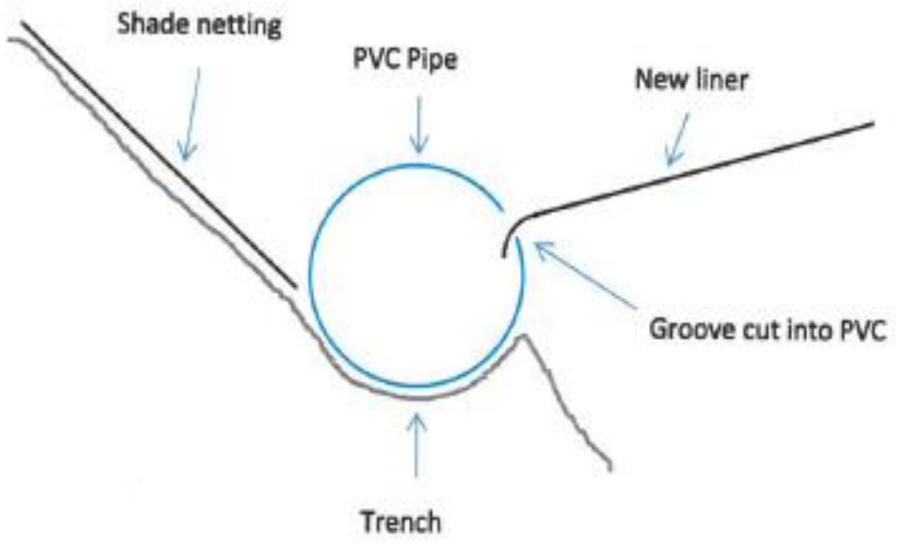


Fig. 4. Possible positions for the gutter exit point

8.9 *FINAL TOP-LAYER OF SAND*

- The *final* sand cap will be constructed with a slight vertical bulge (as previously stated in par. 8.7).
- The final layer of sand (also ± 50mm thick) will have to be worked in by Necsa personal/ contractor on top of the first layer of sand.
- This sand will again be moved and placed by a front-end loader as previously discussed in Par.8.4.
- The final layer of sand must, after the sand was worked in, be on a level ± one quarter from the top of the PVC pipe.
- The contractor that installed the PVC piping needs to cut a groove (with a ± 40mm gap) into the PVC pipe with the bottom of the groove on the final sand level (see fig. 5.)
- This groove needs to be cut on all sides of the piping inside the pond.
- The exit point does not need to be cut.
- Estimated volume of sand required ~60m^3.

Fig. 5. PVC pipe inside trench with groove cut



8.10 INSTALLMENT OF FINAL TOP LINER

- After the final layer of sand was introduce into the pond, construction and installation of the top final liner needs to be done.
- An contractor needs to install the new ±2 mm thick HDPE top liner (possible welding together of new cover as needed).
- ±1200m^2 of HDPE lining needed for final liner.
- The top liner must be installed in such a way that it enters the PVC pipe groove for at least 70mm (on all four sides).
- It must be investigated if wind will be able to blow the top liner out of the pond after installation.
- If the blown-off of the liner is a possibility, discussed on site with the responsible Necsa project manager for a possible preventative solution.

8.11 POSSIBLE INSTALLATION OF SHADE NETTING ON OUTSIDE WALLS OF POND

- After completion of the construction on the PVC water drainage system, an investigation must be done on the stability of the outside walls on top of the drainage system, inside the pond.
- Soil must at all cost be prevented from entering and block the PVC drain water system.
- If necessary, a contractor must installed 60% shade netting all around the outside walls, inside the pond, to prevent soil from entering the PVC pipe system (see fig. 5).
- This netting will have to be secured to the walls to prevent slip and wind damage.
- If needed, the top edge of the pond wall must also be shaped in such way to prevent outside water from flowing into the pond (possible gutter to be installed etc.).

9.0 RECORDS

(No records applicable to this document)

Classification: OPEN

APPROVED

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Document No.	NLM-PRO-00173
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Department/Section:	In-Service & Maintenance Coordination Support
Title:	CAPPING PROCEDURE FOR THE CLOSING AND SEALING OF CaF_2 POND No. 3

Authorization:

	NAME	SIGNED
PREPARED	RGF ROBBERTS **(Chief Technician: NLM)**	22/08/2023 14:56:00(UTC+02:00) Signed by Richard gerhardus Frederik Robberts, robbie.robberts@necsa.co.za SIGNIFLOW.COM
REVIEWED	M VAN ZYL **(Snr Technician: NLM QA)**	22/08/2023 15:37:44(UTC+02:00) Signed by Maria Maryna van Zyl, marietjie.vanzyl@necsa.co.za SIGNIFLOW.COM
REVIEWED	AR DAVIDS **(Chief RPO: PDO)**	23/08/2023 08:16:54(UTC+02:00) Signed by Wally Davids, wally.davids@necsa.co.za SIGNIFLOW.COM
REVIEWED	TE LABUSCHAGNE **(Chief Technician: NLM)**	23/08/2023 08:19:38(UTC+02:00) Signed by Theo Labuschagne, theo.labuschagne@necsa.co.za SIGNIFLOW.COM
ACCEPTED	S MBIZO **(Senior Radiation Protection Specialist: SHEQ)**	23/08/2023 10:02:31(UTC+02:00) Signed by Stanford Mbizo, stanford.mbizo@necsa.co.za SIGNIFLOW.COM
ACCEPTED	E VAN HEERDEN **(Chief Scientist : EMG: SHEQ)**	23/08/2023 10:06:19(UTC+02:00) Signed by Eurika van Heerden, eurika.vanheerden@necsa.co.za SIGNIFLOW.COM
ACCEPTED	ES THABALALA **(Acting manager: PDO)**	23/08/2023 10:07:04(UTC+02:00) Signed by Eric Tshabalala, eric.tshabalala@necsa.co.za SIGNIFLOW.COM
APPROVED	ZP Dlamini **(Manager: Support Services)**	24/08/2023 11:46:36(UTC+02:00) Signed by Patrick Dyasi, patrick.dyasi@necsa.co.za SIGNIFLOW.COM

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Revisions

This document has been revised according to the following schedule:

Revision	Date Approved	Nature of Revision	Prepared by
00	See title page	First Issue	RGF Robberts

Contents:

1.0 PURPOSE

The purpose of this document is to describe the capping procedure for CaF_2 pond no. 3 in order to isolate the pan sludge from the environment.

2.0 SCOPE

Although CaF_2 pond no. 4 also needs to be capped, this document will only describe the capping of CaF_2 pond no. 3. An additional procedure will be prepared for CaF_2 pond no. 4 after completion of the capping of pond 3.

3.0 REFERENCES

The following documents are referenced in this document:

[1]	SHEQ-INS-5300	Written safe work procedures, instruction, orientation and task training.
[2]	SHEQ-INS-8150	Access and Egress Control for Radiological Areas
[3]	SHEQ-INS-8120	Safe Work Procedures and Radiation Protection Work Permit System
[4]	NLM-PLN-00529	Waste Management Plan for the closing and sealing of CaF_2 Pond 3
[5]	NLM-REP-23/019	Radiation Survey Report for CaF_2 Pond 3

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 *DEFINITIONS:*

Capping: A process of the closing and sealing a pond to isolate the contents of the pond from the environment.

4.2 *ABBREVIATIONS:*

CaF_2:	Calcium Fluoride
DM:	Discipline Manager
EPD	Electronic Personal Dosimeter
HDPE:	High Density Polyethylene
Necsa	South African Nuclear Energy Corporation SOC Ltd
NLM:	Nuclear liability Management
PDO:	Predisposal Operations, Group within NLM
PVC:	Polyvinyl Chloride
RPO:	Radiation Protection Officer
SHEQ:	Safety, Health, Environment and Quality
TLD	Thermo Luminescent Dosimeter

5.0 RESPONSIBILITY

1. It is the responsibility of the DM (PDO) to ensure:
   - That all the regulatory requirements are adhered to.
   - That Necsa's SHEQ requirements are met.

2. The responsible project manager shall coordinate the capping process in consultation with the DM (PDO), or his delegate.

3. The NLM project leader and the responsible RPO's are jointly responsible for the insurance of compliance to this work instruction by all personnel involved in the removal and installation process.

4. It is the responsibility of the DM (PDO) to ensure that the following training is received by all contractor personnel prior to the start of the construction [1].
   - Necsa induction training (1 day)
   - Facility (PDO) induction training (0.5 Day)
   - Radiation worker training (1 day)
   - T48 mask training (1 day)

6.0 FACILITY DESCRIPTION

CaF_2 pond no. 3 is an open-air evaporation pond that contains chemicals and uranium-contaminated effluent where the aqueous part of the effluent is evaporated by natural processes. However, the degradation of the lining of the pond (mainly due to prolonged exposure to sun and ultraviolet rays, wind and temperature differences) and the sporadic exposure of the top of the sludge during dry seasons has increased the risk of contamination to the environment from this pond. Apart from the existing liquid in the sludge, rainwater will continually add a transport medium for contamination to leak down into the geosphere if there is any damage to the pond liner. When the sludge is dried out in winter, the wind can also transport contaminated dust from the ponds to the surrounding environment.

Between pond no. 3 and pond no. 4, pond 3 is being considered the most risky pond in this regard and will therefore be the first pond to be remediated.

7.0 BRIEF PROJECT DESCRIPTION

- The project will include the closing and sealing of the HDPE lined pond with new HDPE liners to isolate the sludge from the environment and rain water.
- The removal of a steel bridge leading to a concrete sump structure inside the pond and the partially dismantling of the sump structure thereafter.
- The covering of the sludge and HDPE liners with sand and soil on different intervals is prescribed in more detail in Paragraph 10.2.
- The installation of a PVC drain system inside the pond with an associated drain system to the outside of the pond.

8.0 DOSE RATE MEASUREMENTS

Dose measurements were performed inside and on the outside of pond 3**.**

12 dose rate measurements were performed at the pond. The radiation survey report [5] concluded that if it is assumed that the spreading of the sand will take one week (40h), and taking the highest dose rate measured (0.22 µSv/h) into account, a total dose of 8.8 µSv is estimated for an individual.

It is therefore not envisaged that the personnel will exceed any dose limits.

8.1 RADIOLOGICAL PROTECTION REQUIREMENTS

8.1.1 If not a Necsa employee (outside contractors)

- Personnel involved in the project and working inside the pond shall be registered as Occupational Exposed Workers.
- EPD's to be issued as necessary.
- Urine samples to be taken before and after completion of the project.
- Contractors need to undergo a whole body count before and after the project.
- The RPOs will continuously monitor for contamination and radiation levels.

8.1.2 Necsa employees

- Personnel involved in the project and working inside the pond shall be registered as Occupational Exposed Workers.
- Personnel will wear a TLD at all times.
- The RPOs will continuously monitor for contamination and radiation levels.

8.2 PERSONAL PROTECTIVE CLOTHING

All personnel will wear the following PPE during the project:

8.2.1 Dismantling of sump structure and steel bridge

- Leather Gloves
- Eye protection
- Ear protection (contractors needs to present proof of training)
- Steel cap safety shoes
- Suitable overalls

8.2.2 Covering of sludge inside pond with sand

- Leather Gloves
- Eye protection
- Water boots
- Suitable overalls
- T48 mask

8.2.3 Instalment of drain water system

- Leather Gloves
- Eye protection
- Ear protection (contractors needs to present proof of training)
- Steel cap safety shoes
- Suitable overalls
- Dust mask

8.2.4 Instalment of HDPE liner

- Leather Gloves
- Eye protection (if needed)
- Steel cap safety shoes
- Suitable overalls

8.3 DEMARCATION AND SIGN POSTING

- All entrances leading to the area surrounding pond 3, including temporary classified areas shall be sign-posted at the barrier or entrance.
- At all exits from the area leading to an uncontrolled area a sign indicating that personnel are entering an uncontrolled area shall be displayed.
- Sign posting shall be in accordance with the requirements specified in SHEQ-INS-8150[2].

9.0 CAPPING PROCEDURE

The following of events/steps with associated responsibilities will be as follows and in sequence of order of the activities that must take place (*See figure 9 for the layout of sludge, sand and HDPE liner inside Pond 3 after the completion of the capping process).*

9.1 PUMPING OF EXCESS WATER

1. Necsa personnel will be responsible to ensure that all excess water on top of the sludge inside pond 3 is removed/pumped over to pond 5 as much as possible.
2. A suitable submersible pump will be used for any pump actions that must take place, if practical.
3. Necsa personnel will ensure that the drain valve inside the sump is fully opened to ensure maximum drainage from the pond at all times.

9.2 COVERING OF THE SLUDGE INSIDE THE POND WITH SAND

Note: All vegetation, dirt and rubble currently in the pond will stay in the pond and covered with the first layer of sand.

1. A layer of sand (± 150mm thick) will have to be worked in by Necsa personnel (or contractor) on top of the impounded sludge to enable a safer work area and lower the possibility of contamination to workers.
2. This sand will be moved and placed inside the pond by a front-end loader (only from the pond edge). Typically equipment similar to a Bobcat 41070 front end loader will be required for this task (supplied and operated by an outside contractor).
3. Starting from the side where the sand is loaded into the pond, the sand must be levelled with appropriate spades or similar equipment and spread over the impounded sludge underneath.
4. If wheel barrows are to be used for the transferring of the sand inside the pond, rubber mats or similar material must be used/placed on top off the sand to enable the wheel barrows to be pushed on top off the sand without the risk of getting stuck in the sand.
5. The centre of the sand layer to be constructed to be slightly the highest point (dome shaped) even if it means that the sand thickness in the middle of the pond is ± 50 -100mm higher than the surrounding sand level.

9.3 DISMANTLING OF THE SUMP STRUCTURE AND STEEL BRIDGE (SEE FIGURE 1 FOR LAYOUT OF STEEL BRIDGE AND SUMP STRUCTURE).

9.3.1 Dismantling of the steel bridge inside the pond.

1. The steel bridge leading to the concrete sump structure inside the pond needs to be fully removed.

2. The removal can be done by a contractor or Necsa personal (<u>*note*</u>: possible contamination to equipment used in removal process).
3. <u>*Only SQEP personnel*</u>, trained in the use of power machines (grinders etc.) and hand tools will be authorized in the process of the removal of the bridge.
4. A dedicated area for all waste associated with rubble and secondary waste generated in the process of dismantling of the steel bridge will be allocated by Necsa for temporally storage. See Waste Management Plan NLM-PLN-00529**[4]**.

9.3.2 Dismantling sequence for the steel bridge hand rails and step-on grids:

1. Remove the level indicator device on top of the steel bridge.
2. By starting at the pond-end side of the bridge, remove the steel handrails *(See figure 1 and 2 for handrail layout of steel bridge)* by losing /cutting the fastening bolts of the handrails <u>*and*</u> the loose grids *(See figure 2 and 3 for loos grid layout of steel bridge)* <u>*at the same time*</u>, piece by piece and store in dedicated temporally storage area.

<u>Important</u>: Starting the dismantling process at the pond side of the bridge handrails and step-on grids will ensure that the risk of falling into the pond is minimized.

Figure1: Layout of steel bridge and sump structure

Figure2: Layout of steel bridge handrail structure

Figure 3: Layout of steel bridge loose grids.

9.3.3 Removal of bridge support I-beams (See figure 3 for layout of support beams)

1. Remove all hold-down bolts at the back of the support I-beams *(See figure 4 for layout of bolts at the back of the beams),* with an appropriate spanner/grinder.
2. Standing on the first layer of sand inside the pond, remove all hold-down bolts at the front end of the support I-beams *(See figure 3 for layout of bolts at the front end of the beam),* with an appropriate spanner/grinder. If the heights of the bolts are out of reach by standing on the sand, make use of wooden pallets (covered in plastic sheeting) to stand on.

   Note: The pallet structure needs to be inspected by the dedicated safety officer for the pan project before use.
3. Remove the I-beams from the pond by pulling it from the back off each beam until it is fully removed from the pond.
4. Remove all the debris to the dedicated storage area, See Waste Management Plan NLM-PLN-00529[4] for more detail.

Figure4: Layout of bolts at the back of the support

9.3.4 Dismantling of the concrete sump structure

1. The sump structure shall be dismantled to almost down to the surrounding sand level inside the pond. The inside of the dismantled sump structure shall be covered with a layer of at least 150 mm soil/sand.
2. The dismantling can be done by a contractor or Necsa personal (N*ote*: possible contamination to equipment used in dismantling process).
3. A dedicated area for all waste associated with rubble and secondary waste generated in the process of dismantling of the sump will be allocated by Necsa for temporally storage. See waste management plan NLM-PLN-00529[4].
4. Construct an elevated height with wooden pallets (covered in plastic sheeting) on one side of the sump structure. The height of this structure must be as such that the top of the sump area can easily be reached with an electrical jack hammer impact tool.

   Note: The pallet structure needs to be inspected by the dedicated safety officer for the pan project before use
5. Starting at the top of the side of the sump structure where the elevated height was constructed and by using the electrical jack hammer, dismantle the sump structure as far as possible.
6. Move pallet structure to next part of sump structure to be dismantled and repeat step 5.
7. Repeat step 6 until the whole sump structure is dismantled to the maximum reachable height standing on the pallet structure.
8. Remove pallet structure.
9. Standing on the sand inside the pond and starting from one side of the sump structure, dismantle the remaining bottom of the structure to a level almost down to the surrounding sand inside the pond.
10. Cover the inside of the dismantled sump structure with a layer of at least 150 mm soil/sand.

9.4 CUTTING AND BACK FOLDING OF OLD POND LINER

- HDPE lining of pond needs to be cut along the top edges of the pond (by Necsa personnel/outside contractor), all around the pond.
- The cutting of the lining at the top edges must be ± 300mm from the top of the pond.
- Cut the HDPE liner inside the pond as demonstrated in figure 5, to be folded back on top of the pond content to mimic an envelope.

- Personnel from Necsa/outside contractor will fold the lining back over the sand covering the pond contents until the lining is in position to be glued (if possible or to be discussed with supervisor) together on top of the covered sludge.
- The remaining corner linings inside the pond (if possible - glued to old lining) will be used to cover any uncovered areas.

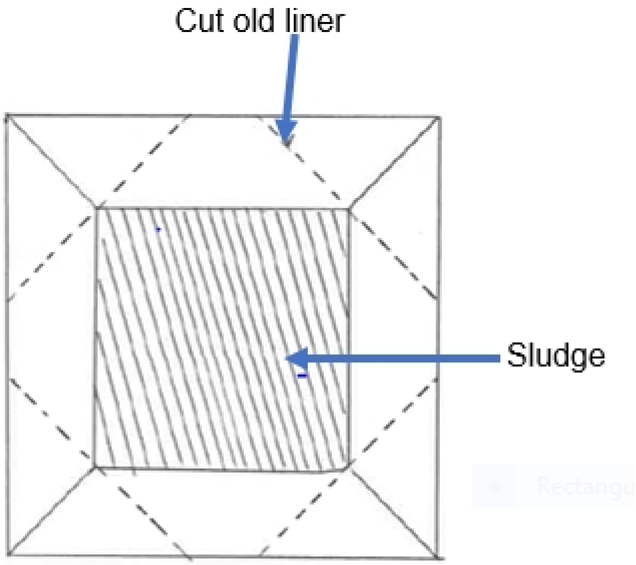

Figure5: Cutting position of old liner

9.5 *INSTALLMENT OF NEW BOTTOM LINER.*

1. Contractor to cover the “folded envelope” with a new ±2 mm thick HDPE liner (possible welding together of new cover as needed) and tucked over the folded edges to cover the old lining like an “umbrella”.
2. ±1200m^2 of HDPE liner needed to cover the top of envelope.

9.6 *COVERING OF THE NEW LINER WITH A FIRST LAYER OF SAND*

1. This sand cap (fine to medium river sand with a grain from about 0,5mm to 2mm) will be constructed with a slight vertical bulge in the pond centre in order to direct rainwater away from the underlying impounded sludge and avoid ponding of water on top of the covered pond.
2. The first layer of sand (± 50mm thick) will have to be worked in by Necsa personnel/outside contractor on top of the new liner before the installation of a water drain system. Final top-up layer must be done after instalment of the drain system.
3. This sand will again be moved and placed by a front-end loader as previously discussed in Paragraph 9.2.
4. Estimated volume of sand required ~60m^3.

9.7 *INSTALLMENT OF DRAIN WATER SYSTEM*

- A rainwater drainage gutter system needs to be installed inside the pond with an associated exit point out of the pond (see figure 6 and figure 7).
- A trench needs to be dug by a contractor to accommodate the piping that needs to be installed.

- The digging of the trench needs to be carefully done as the piping needs to be roughly on the same level all around the pond with a slight decline (± 1^0) to the exit point of the drainage system out of the pond.

  Note: All soil rubble removed during the digging of the trench needs to be spread evenly on top of the first layer of sand inside the pond.
- The contractor installing the piping (in conjunction with the contractor digging the trench if not the same) needs to ensure that the piping is installed in such a way that if the top liner is installed after the top final layer of sand was worked in, the liner must be able to enter the pipe ± three quarter from the bottom of the pipe (see figure 8).
- On three sides of the pond the piping diameter must be ± 200mm.
- On the side of the exit point out of the pond, the pipe must have a diameter of ± 315mm.
- The whole piping system needs to be glued together at all coupling points.
- The earthmoving contractor needs to dig the gutter exit point through the pond wall just below the sand content which is by now roughly 2.5m deep.
- In order to have an exit point lower than entry for gravitational flow, the possible location for the exit point for pond 3 is shown in Figure 7.
- The exit point layout and position will be discussed more in detail on site with the responsible Necsa project manager to ensure best practice

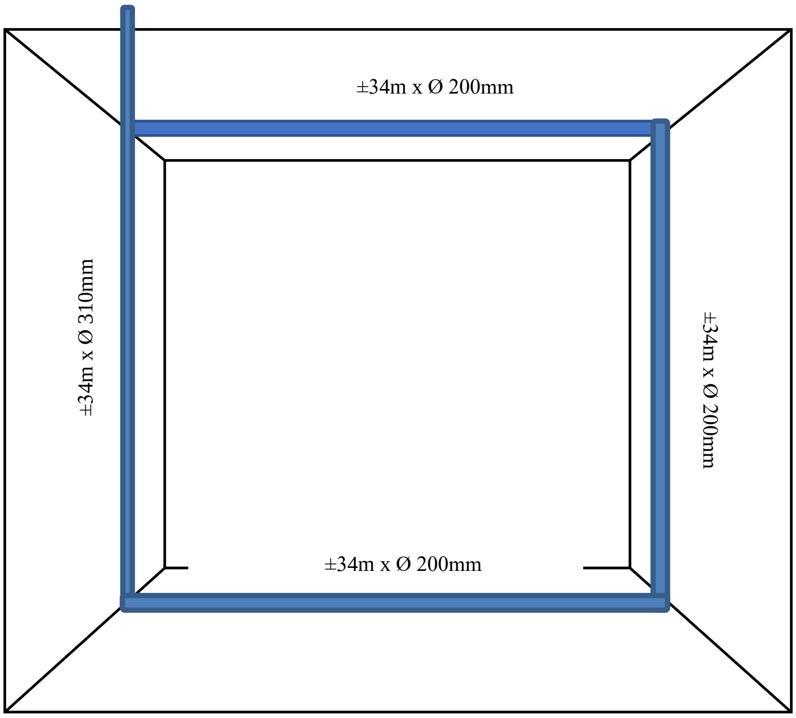

Figure 6: PVC Pipe layout inside pond

Figure 7: Possible positions for the gutter exit point

9.8 *FINAL TOP-LAYER OF SAND*

1. The *final* sand cap will be constructed with a slight vertical bulge (as previously stated in paragraph 9.6).
2. The final layer of sand (also ± 50mm thick) will have to be worked in by Necsa personnel/ contractor on top of the first layer of sand.
3. This sand will again be moved and placed by a front-end loader as previously discussed in Paragraph 9.2.
4. The final layer of sand must, after the sand was worked in, be on a level ± one quarter from the top of the installed PVC drainage pipe system.
5. The contractor that installed the PVC piping needs to cut a groove (with a ± 40mm gap) into the PVC pipe with the bottom of the groove on the final sand level (see figure 8.)
6. This groove needs to be cut on all sides of the piping inside the pond.
7. The exit point does not need to be cut.
8. Estimated volume of sand required ~60m^3.

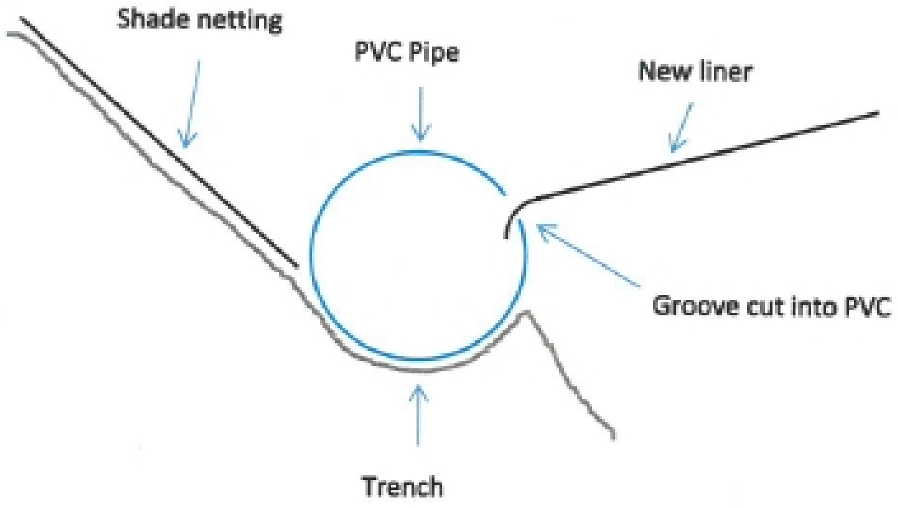

Figure 8: PVC pipe inside trench with groove cut

9.9 *INSTALLMENT OF FINAL TOP LINER*

1. After the final layer of sand has been introduced into the pond, construction and installation of the top final liner needs to be done.
2. A contractor needs to install the new ±2 mm thick HDPE top liner (possible welding together of new cover as needed).
3. ±1200m^2 of HDPE lining needed for final liner.
4. The top liner must be installed in such a way that it enters the PVC pipe groove for at least 70mm (on all four sides).
5. It must be investigated if wind will be able to blow the top liner out of the pond after installation.
6. If the blown-off of the liner is a possibility, discussed on site with the responsible Necsa project manager for a possible preventative solution.

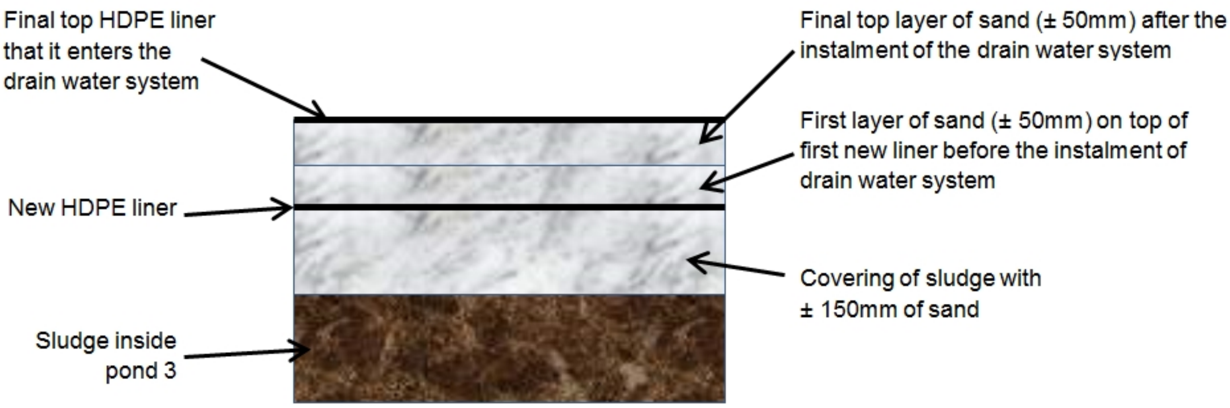

Figure 9: Schematic sludge, sand and HDPE liner layout inside Pond 3

9.10 POSSIBLE INSTALLATION OF SHADE NETTING ON OUTSIDE WALLS OF POND

1. After completion of the construction on the PVC water drainage system, an investigation must be done on the stability of the outside walls on top of the drainage system, inside the pond (*An investigation and final report needs to be compiled and submitted to the NNR*).
2. Soil must at all cost be prevented from entering and block the PVC drain water system.
3. If necessary, a contractor must install 60% shade netting all around the outside walls, inside the pond, to prevent soil from entering the PVC pipe system.
4. This netting will have to be secured to the walls to prevent slip and wind damage.
5. If needed, the top edge of the pond wall must also be shaped in such way to prevent outside water from flowing into the pond (possible gutter to be installed etc.).

10.0 FLOW CONTROLL OF WATER DRAINED FROM POND 3 TO THE SURROUNDING ENVIRONMENT.

After completion of the capping process of pond 3, a water flow control system needs to be implemented to ensure that the flow of water drained from pond 3 (and pond 4 at a later stage), via the PVC drain system, is controlled in such a way that soil erosion, as a result of the water flowing from the drain system, is prevented.

See Figure 10 and Figure11 for possible layouts of water control systems.

Figure 10: Rocks enclosed in wire walls (check dams)

Figure 11: Rocks imbedded in concrete (preferable method

11.0 RADIOLOGICAL MONITORING DOWNSTREAM OF THE WATER OUTLET POINT FROM THE PVC DRAIN SYSTEM.

It is not foreseen that there will be a need for the monitoring of drained water from the pond (mainly rainwater) at the outlet point of the PVC drain system on a continuous basis. As the contaminated contents of the pond are completely enclosed/covered with non-contaminated material, the possibility of contaminated material seeping out of the pond, into the PVC drain system, is extremely low.

It is therefore suggested that:

1. A sample is taken at the outlet of the drain system after the first rain storm (after capping of the pond).
2. Depending on the results of the sample after it was analysed, the way forward for future sampling (frequency etc.) to be determent.

12.0 RECORDS

The documentation pertaining to the radioactive waste and the results of the tests, checks and inspections carried out shall be retained as quality records at PDO[4].