

Comments on the Proposed Kayelekera Uranium Project Environmental Impact Assessment Report

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1 Overview Comments

Paladin Resources Ltd ('Paladin'), owners of the **proposed** Kayelekera Uranium Project, have recently released an Environmental Impact Assessment (EIA) Report on the project. The report was prepared by consultants Knight Piésold Ltd based in South Africa. This report will hereafter simply be referred to as the "KEIA Report".

This independent technical review has been prepared at the request of Citizens for Justice Malawi, based on the authors' extensive experience with assessing EIA reports for Australian uranium projects and ongoing role in advising numerous communities on the management of and impacts from uranium mining (especially the Ranger and Jabiluka uranium projects on Mirarr land in northern Australia).

The review is a detailed analysis and critique of the currently proposed Kayelekera Uranium Project by Paladin, and identifies numerous technical issues in the project and flaws in the current KEIA. For example, there is :

- a lack of adequate, high quality environmental and radiological baseline data
- a lack of sufficient technical engineering design detail for critical project components
- a lack of references and discussion of models for numerous critical design issues
- Missing key baseline radiological data, especially pre-mining radon flux
- completely inadequate figures and maps to present and visualise the proposed project
- a lack of appropriate strategic, long-term tailings management plan
- poorly argued project alternatives and inappropriate dismissal of viable project options
- inadequate characterisation and discussion of potential acid mine drainage issues
- a completely minimal and inappropriate rehabilitation plan

The review will focus on the principal issues associated with tailings management, water management, radiological issues, 'conceptual' rehabilitation issues and their respective impacts and assessment. The review will also make extensive reference to how the current proposals for the Kayelekera project vary substantially from expected regulatory and community standards in Australia. The review is structured based on the relevant sections from the KEIA, with a summary of issues for each critical aspect provided at the end of this review.

¹ Note : This review and all comments and criticisms contained herein are the author's personal views only, and not those of any other organisation or entity. The work involved for this review was completed in the author's own time and was not funded by any person or entity.

It must be pointed out that virtually all of these comments on the KEIA would be applicable regardless of the commodity being proposed to be extracted.

Paladin's inexperience as a uranium miner

Paladin has no record as a uranium producer and is therefore inexperienced in this field of mining. To date, no uranium has been produced from any of its projects in Australia or anywhere overseas; although the Langer-Heinrich plant in Namibia may now be producing limited amounts of material during commissioning. Whatever experience they have therefore must relate to exploration only and not mining, milling and processing of uranium. This makes it impossible to assess their environmental performance with respect to production of this mineral and devalues their claims that they have experience in terms of Australian guidelines for Radiation Management (§ 4.3.1.3; p 4-16). Such experience can only be truly gained by successful operation of a uranium mine and processing facility over several years.

The Radiation Management Plan is to be drawn from the Langer-Heinrich plan and incorporate radiation protection experience from several Australian uranium mining operations (§ 10.4.1; p10-66) but does not name those mines. The only uranium mines currently in operation in Australia are at Olympic Dam, Honeymoon and Ranger – none of which are operated by Paladin. This again highlights Paladin's lack of experience as an operator of uranium mines.

It would be prudent for the Government of Malawi to delay approval of this project until Paladin can demonstrate that they can extract uranium from the Langer-Heinrich plant in a safe and environmentally acceptable manner, and thus provide a clear demonstration of their experience in Radiation Management. It would also be of benefit to the Government of Malawi to organise a fact-finding mission to observe Paladin's operations at Langer-Heinrich to obtain a more informed appreciation of whether or not they wish to endorse a similar operation at Kayelekera.

It is also recommended that the Government of Malawi obtain a sizeable security from Paladin to ensure that finance is readily available to rehabilitate the mined areas should significant environmental problems occur or should the company be unable to complete its operations due to early closure.

Transparency

Paladin state that they are transparent and will engage the public as much as possible in the project (§ 5.6, Table 5-2); but have not provided any indication of how this will be achieved as the project progresses. Submission of plans (e.g. Radiation Management Plan §10.4.2;) to the Malawi Government regulatory authority does not meet this ideal unless the plans are also provided to the public for perusal and comment prior to their acceptance by the regulatory authority.

Paladin has also offered no mechanism by which the results of their monitoring programs will be reported to the general public. Experience with indigenous populations affected by mining in Australia indicates that this may be more difficult to achieve than expected, as there is a wide variation in educational standards and cultural practice amongst those concerned. Failure to disseminate information during operations increases the risk of mistrust with serious social consequences.

It is therefore recommended that Paladin reaches an agreement with stakeholders that provides a mechanism where environmental monitoring information is made freely available and where affected people can provide meaningful input to environmental management of the project. Community reference groups and technical committees (such as ARRTC that operates with respect to the Ranger mine) that provide for facilitated discussion between stakeholders are recommended and should be developed by Paladin to provide a greater level of transparency.

Paladin's commitment to on-going management

Paladin has yet to make real commitment to the closure phase of the operations and management of the site once mining has ceased. The plan presented is conceptual only and provides little detail. It is acknowledged that greater detail should become available and the plan will undergo some modification as the project progresses (should it be approved).

It is doubtful that the Malawian authorities alone will have sufficient finances to maintain acceptable levels of monitoring for the lengthy periods of time involved. It is therefore recommended that the Malawian authorities ensure that Paladin remains committed to monitoring of the site for a minimum fifteen years after closure of the mine; and to rehabilitation for a period of at least twenty years after the mine has closed. If Paladin is unwilling to make this commitment, then a sizeable bond or system of funding in perpetuity should be established to ensure that the environment remains protected and repairs to remnant structures (e.g. Tailings Dams) can be completed as and when required.

2 Editorial Comments

- **No Cover / Title page** provided on the internet website for downloading the EIA; meaning no formal publication details are associated with the numerous files. **This professional standard should be improved.**
- **Lack of Numerous and Clear Figures.** **This professional standard should be improved.**
- **Nkhachira Coal Project** – this is referred to as a “mine” (eg. Figure 2-2 on page 2-3) but it is not even operating (it is presently undergoing separate environmental impact assessment). **This could legitimately be perceived to be bias by members of the community.** (This problem, however, is unfortunately common in Australia and globally).

3 Section 2 - Comments

Figure 2-4

- There is **NO “INTERIM”** dam at all, and it is **extremely misleading** to label the proposed Tailings Dam A as “interim”. As currently proposed, this dam will be left there in perpetuity following rehabilitation – any labelling of this dam as “interim” is grossly inadequate and misleading. **All references throughout the KEIA should be corrected accordingly.**
- The surface elevation contours on this figure are too detailed and prevent meaningful interpretation of the proposed project layout. The figure should be presented in a more conceptual fashion with less detail and easier to interpret design. **This is a serious problem with numerous figures throughout the KEIA.** An example of a much more appropriate style of figure is given in Appendix 1 from the Jabiluka EIA.

Section 2.5 Waste Management

- The adoption of a value of 100 ppm (mg/kg) U_3O_8 (or 0,01% U_3O_8) is **commendable**, as this recognises that even at low concentrations uranium can be leached from mine wastes. At the Ranger uranium project in Australia, ‘mineralised’ waste rock is classified as >200 ppm U_3O_8 – despite several instances of known leaching from ‘non-mineralised’ waste rock between 100-200 ppm U_3O_8 .
- It is very disappointing, however, that the expected quantities of each waste type (eg. in millions of tonnes, or ‘Mt’) are not provided in this sub-section. This information is critical to assess the extent of marginal ore, potential for uranium leaching, accounting for environmental management as well as for the potential for this ‘waste’ to be used in processing in the future or as construction material in the two proposed tailings dams. **Paladin should publish the expected amount of waste rock types and their associated grades.**

Section 2.6 Process Plant

- Sub-section 2.6.5 Tailings Handling (page 2-14) – It is stated that the tailings are “acid generating”. Is this confusion between the acid content due to the use of acid leaching or are the tailings mineralogically likely to generate acid of their own accord through acid mine drainage ? This is of course a substantive issue in terms of tailings management. At the Ranger uranium project the tailings are not considered to be susceptible to acid mine drainage, but due to the use of acid leach milling they are strongly acidic and are partially dosed with lime to semi-neutralise the pH of the tailings prior to discharge into tailings management facilities.
- Sub-section 2.6.2 Processing of ores – on page 18 of their annual report (Paladin Resources Ltd, 2006), Paladin indicate that metallurgical test work in South Africa should lead to a ‘more simplified process based on the conventional acid leaching and solvent extraction process and flow sheet’. It is doubtful that this work was completed prior to publication of the EIA report, which was released in September 2006 and no mention has been made of it as an alternative means of processing. The EIA may not accurately reflect the impacts of the true process to be used. Paladin should provide this information, or at least a reasonable assessment of the impact of any changes to the ore processing scheme to the public for consideration, prior to the project being approved.

Section 2.8 Control of Product Sale

- It is stated that the ‘supervision and control’ of any uranium potentially to be produced from Kayelekera would be subject to the international safeguards systems managed by the International Atomic Energy Agency (IAEA). **No guidelines document or reference is provided to substantiate this process.**
- In Australia, uranium can only export uranium to countries with which it has a negotiated safeguards agreement, adapted from typical IAEA safeguards guidelines. Given that there is no history of uranium production in Malawi, it is reasonable to assume they have no similar agreements with any potential customer country. **This should be acknowledged in the KEIA.**

Section 2.9.1 Services - WATER

- **The whole sub-sections on water services is extremely poorly presented and thought through.**
- The basis of the engineering design for the supply of water resources is completely lacking. The process is apparently based on a specially established ‘Water Resources Yield Model’ (WRYM) – **BUT NO BASIS IS GIVEN FOR THIS MODEL (OR TECHNIQUE ADOPTED)**. There is neither hydrologic basis nor standard engineering design method from Malawi or internationally used to substantiate this model as an accurate and effective hydrologic design tool. There are a vast number of water resources models available on the international engineering market to model, assess and design hydrologic systems for purposes such as a proposed mine water system – and it can be reasonably expected that Knight Piésold are extremely familiar with such models and their various technical merits and drawbacks for various situations – yet there is no technical basis presented for the WRYM used for the KEIA. The various design scenarios used in the WRYM to quantify the security of water supply is scattered throughout this sub-section as well as later sections of the KEIA, and is very confusing and poorly argued.
- As such it is impossible to provide an adequate assessment of the water resource requirements of the proposed Kayelekera project and associated impacts.
- Figure 2-6 - It is physically impossible for a reservoir to have a **negative** storage volume. **This figure is therefore highly unprofessional as presented.**
- It is unclear how the WRYM takes account of climatic variability let alone potential future climate change scenarios.

- It is unclear how the WRYM takes account of historic recorded hydrologic data such as gauged stream flow, rainfall, pan evaporation and the like.
- The potential cumulative impacts on drawdown from the River from the Nkhachira Coal Project are mentioned on page 8-11 but are not quantified (despite the EIA for this project being released prior to the Kayelekera EIA). This is important as river drawdown may initially be significant if Nkhachira needs to build large dams; and may be a major concern to the villagers during the drier periods of the year.

Section 2.10.3.3 Services – Coarse and Fine Aggregates

- Figure 2-14 does not show the relation of these sites to the main proposed Kayelekera Project area. Based on a manual comparison of Figures 2-14 and Figure 2-4, it would appear that the area for extraction of aggregates is west of the proposed project and therefore close to the existing Kayelekera village.

Section 2.12 Water Management

- As with the 'Services – Water' sub-section, this section again presents the results of technical analyses and assessments without substantiating the methods used. Although the numerous parameters are presented (which is commendable), if there is no referenced technical basis for the calculations as undertaken, the accuracy of the results presented in the KEIA is of unknown validity.
- ***The lack of a strong commitment to completely prevent discharge of contaminated mine site waters during extreme weather events is of major concern.*** In Australia all recent generation uranium projects (Ranger, Nabarlek, Olympic Dam) operate a water management system which achieves a “no release” outcome. That is, no waters are allowed to directly discharge to the environment. The Ranger project, despite major climate variability and a similar wet-dry climate as Kayelekera, continues to operate on the basis of “no release” water management system.
- The water management system for Ranger also operates on the basis of an engineering design of a 1:10000 year return annual rainfall.
- Figures 2-15 and 2-16 – ***NO UNITS*** included in the figure, making them virtually impossible to accurately interpret. If the single numbers are for water stream accounting, then this should be mentioned and discussed in the KEIA text. ***In any case, both figures are extremely poor in their utility.***

Section 2.13 Waste Characterisation

- ***This section fails to present a sufficiently detailed characterisation and assessment of potential issues such as acid mine drainage.*** This is primarily due to the lack of extensive samples used in characterisation testing.
- ***Firstly, it appears that only 4 waste rock and 3 tailings samples were tested (ie. one of each main type).*** Given the seriousness of the potential impacts from acid mine drainage, and the fact that this issue will commonly manifest itself after the project has been closed, ***such minimal testing is completely inadequate.*** Testing and characterisation should include several samples in order to obtain a more statistically reliable quantification of potential acid generation issues associated with the various issues at Kayelekera (eg. >8 tests per waste type, not just 1).
- Secondly, the wet-dry climate are ideal conditions for an annually fluctuating level of water (or 'saturation') within the waste rock (and tailings post-closure) – creating perfect opportunities to maximise acid generation and therefore highly contaminated leachates emanating from the waste rock piles.

- Thirdly, the presentation of most test results in this entire sub-section is awkward. For example, Tables 2-6, 2-9, 2-14 and 2-16 are presented in terms of 'mg/L' and 'mg/kg'. Further discussion of the twin columns adopted (concentration and salt load) is sorely needed to explain the meaning of the various results.
- Fourthly, the solids:liquids ratio of 1:1 used in the testing would most likely not represent true concentrations in the field. The environment of a waste rock dump is highly dynamic and would clearly be affected by the seasonal climate. The lack of testing to replicate or assess the impacts of these processes on waste leaching is a clear gap in the characterisation work presented.
- Fifthly, environmentally significant results are not given their due weight and consideration. For example, the uranium leachability in Table 2-6 for both mineralised arkose and mudstone waste types gives values of 14,3 and 18,5 mg/L (mg/kg), respectively. For the Ranger uranium project, concentrations of about 0,006 mg/L are considered environmentally sensitive for its surrounding environment². Additionally, many remediation projects around the world treat contaminated groundwater or surface water with uranium concentrations at similar or lower concentrations (sometimes even profitably producing a uranium oxide by-product from the remediation process).
- Sixth, there is no radium (²²⁶Ra) data presented in the numerous tables. Given that radium is the parent radionuclide for radon (²²²Rn) gas, which is of major public health concern due to its long medical association with lung cancer, the lack of radium data is of legitimate environmental and radiological concern.
- Seventh, presenting the minor constituents in bar percentage graphs such as those of Figures 2-19 and 2-21 is misleading. It is not simply the relative proportion of these 'minor' elements which is important – it is their relative toxicity to aquatic ecosystems or for human purposes (potable water, livestock use etc). These graphs are only interesting from a scientific view – **they have no basis in predicting environmental significance**.
- Eighth, there is **NO DATA OR CHARACTERISATION FOR RADON FLUX**. As noted above, radioactive radon gas is critically important from a public and worker health perspective, and has long been associated with elevated lung cancer mortality amongst people with higher radon exposures. **THE KEIA IS EXTREMELY NEGLIGENT IN FAILING TO CHARACTERISE THE RADON FLUX AND RELEASE CHARACTERISTICS FROM WASTE ROCK AND TAILINGS.**

Finally, the cumulative outcome of all of the above issues is that the testing and characterisation of waste types for the proposed Kayelekera project is barely minimal. It points to the potential for major long-term acid drainage issues but the KEIA fails to provide adequate baseline testing and assessment, especially as relevant to potential waste management issues and plans. The lack of any data for radon release is negligent.

Section 2.14 Waste Management – 2.14.6 : Tailings Storage Facilities

- The somewhat *ad-hoc* approach to tailings storage dams and management is exemplified by this sub-section. Predicting tailings behaviour for a full-scale project from laboratory test-work is difficult, and the KEIA does appear to be sufficiently conservative in this extrapolation. A number of issues stand out, however, which point to the need for different options for tailings management to be implemented.
- The waste rock materials used in construction of the dam walls may not be of both sufficient quantity and quality (again highlighting the need for this data earlier in the KEIA). ***This issue must be investigated as a matter of priority, or, if the data exists from feasibility studies, then publicly addressed as part of the response to all comments on the KEIA.***

² For further references to the extensive water quality and ecotoxicology research and regulatory standards for Ranger, see the website of the Office of the Supervising Scientist – www.deh.gov.au/ssd

- Numerous aspects of the tailings dams and tailings management remain omitted or excluded :
 - a. **the design standards for the dam are unspecified.** Will the design follow internationally accepted standards for dam design and construction such as the International Commission on Large Dams (ICOLD) ? Additionally, what Malawi standards for dams may apply ?
 - b. **the type of dam wall is unspecified.** That is, will the conceptual design be based on an upstream, centre-line or downstream construction ? Each approach has its merits and attendant risks, but these need to be considered with respect to site-specific issues.
 - c. **the timing of dam construction is completely unspecified.** Will the entire dam for TSF A and B be built at once or will they be lifted in stages commensurate with tailings storage requirements and the availability of waste rock from the mine ?
 - d. **no cross-sections of the dam walls are presented for either TSF A or B** (despite the labelling of such cross-sections in the respective plan views).
 - e. **no relevant properties of the principal materials to be used in dam wall construction are given**, such as permeability, dry density, Atterberg Limits, and the like.
 - f. **the lack of commitment to a sufficiently low permeability liner** is of major concern, with the overall approach discussed apparently being to wait and see if testing during construction can obviate the need for a critical design aspect such as a low permeability liner. For example, a common regulatory standard for such liners in Australia would be 10^{-7} m/s.
- g. THERE IS NO ANALYSIS NOR DISCUSSION OF RADON EMANATING FROM TAILINGS FACILITIES. This could be described as professional negligence, and would have to be addressed for any proposed uranium project in Australia and Canada (etc) given the public health and environmental significance of radon. Although a minor section later in the KEIA is devoted to radon from tailings (sub-section 7.4.5³), this does not provide measured data for radon flux from tailings – an aspect which should be addressed as part of any discussion of uranium mill tailings management.**
- **Serious alternatives to tailings management appear not to have been given their due consideration** (based on later section 3.1.6). For example, the option of using the mined out pit instead of building TSF B is quickly dismissed due to the perceived cost of lining for the entire pit. In practice, however, at sites where pit backfill has been adopted – in the uranium industry as well as for gold, copper and other mining sectors – complete lining of a pit is extremely rare⁴, with the most common approach being to only line agreed areas of higher permeability and risks to adjacent groundwater resources or aquatic ecosystems connected to those ecosystems. In Australia, the former pit at the now closed Nabarlek uranium project was not lined at all – relying completely on the perceived low permeability of the fractured rock, and for the Ranger project only a small section of the near-surface pit wall was lined prior to tailings deposition reaching this stage of the former pit (the area lined probably accounted for <5% of the total pit wall area)⁵. Additionally, the Nabarlek project re-designed its mining strategy to a 4-month campaign mine to prevent the need to even build an above-ground tailings dam. For the proposed Kayelekera project, an interim dam (the current TSF A or perhaps more appropriate alternative location) could be used for the first 5 years, with an accelerated mining plan implemented to ensure that the pit is available for tailings deposition at this point. The issue of the need for lining of the pit would need to be assessed prior to this point, but it is highly likely that the approach of an interim dam followed by in-pit deposition would be more cost-effective in the long-term as well as being more environmentally appropriate (see next point). This lack of strategic thinking on options does

³ Further comment on radon analyses in the KEIA and this sub-section is given later in this review.

⁴ The author knows of no mine site where complete lining of a former pit for tailings deposition has **ever** been undertaken.

⁵ It must be noted that the indigenous people, the Mirarr, still hold grave concerns about the long-term performance of the pit liner used for the shallow depths of the south-east wall of Pit 1 at Ranger. This is due to the effective permanence of tailings deposition strategies such as in-pit. If tailings could have been assured to go no higher than a maximum level ('RL 0m' in this case), to minimise the potential for tailings seepage to adjacent surficial groundwater and ecosystems, this concern would not be so significant.

not lend confidence to the KEIA's nor Paladin's commitment to manage tailings in a manner which is both cost-effective for Paladin but also minimises potential environmental and radiological concerns for the local community in the long-term.

- In Australia, it has long been considered that the best approach for uranium mill tailings is to return them to the former pit (or possibly underground workings, as proposed for Jabiluka). This position was arrived at convincingly by the public inquiry on the Ranger uranium project⁶ based on three principal arguments : (1) higher seepage rates and solutes released from above ground dams compared to in-pit deposition and long-term containment; (2) effectively permanent guarantee of structural stability for in-pit tailings compared to above-ground dams; and (3) lower radon emanation from tailings in-pit due to the rebound of groundwater levels compared to fluctuating water levels in tailings in above-ground dams. ***The Ranger project in Australia is legally required – and this is now non-negotiable and compulsory – to emplace all tailings into former pits during rehabilitation to achieve both minimal long-term environmental and radiological releases from tailings (Nabarlek has already achieved this outcome).*** Such an approach to tailings management should also be adopted for the proposed Kayelekera project given the similar wet-dry climate and the added proximity of a significant population of local communities.

In general, Paladin's overall management plan seems adequate; however one or two high risk strategies appear to have been used.

- Paladin plans to build two Tailings Dams, both of which will be intersected by known geological faults (§ 2.14.6, p 2-67). Clay material will be utilised to construct liners for the Tailings Storage Facilities (§ 2.10.3.2, p 2-32) but this will serve only as a short-term solution for seepage. Clays ultimately become saturated and therefore porous to water borne contaminants. During the course of operations, Paladin expect that acid seepage from the Tailings Dam represents a risk to groundwater quality (§ 2.13.2.3); posing a long-term threat to the environment.
- Despite their being no recent recorded seismic activity, earthquakes between 3.0 and 4.9 on the Richter Scale have been recorded. Geological faults allow seepage into groundwater, and may cause partial collapse of the Tailings Dams if seismic movement of sufficient intensity occurs. Because Paladin plans to allow these tailings dams to remain indefinitely, the probability of seismic damage to their structure or seepage of contaminated water into aquifers over the long-term will increase and considerable environmental damage over the long-term could occur.
- It is recommended if these structures are permitted to be built, that the Malawian authorities engage an independent engineering expert to assess their structure and suitability as long-term repositories. Special attention would be required to assess their on-going stability in the face of erosion and seismic disturbance.
- Tailings Dam A is to be constructed in the Kantchindu Valley while Tailings Dam B will occupy a basin to the west of the Pit (§ 2.12.2.1, p 2-42). Both Tailings Dams will create a significant hydraulic head that will promote seepage of contaminated water into nearby aquifers. During the life of the project, Paladin proposes to manage seepage by pumping this water back into the Tailings Dam but have not indicated how this will be controlled once mining has finished. Significant infrastructure and costs will be required to maintain seepage prevention contingencies, but Paladin has given no thought to this part of the process and it is presumed that the Malawian Government will need to devote considerable finances to maintaining them.

⁶ This inquiry was known as the "Fox Inquiry", after its chief commissioner (see Fox et al, 1977 in references list).

Finally, the cumulative outcome of all of the above issues is that the proposal for tailings management look ad-hoc, are simply the perceived lowest cost options without clear strategic technical analyses and appear to depend almost entirely on testing and characterisation during actual construction, and later during operation. No strategic planning of timing of dam wall construction, alternative tailings management scenarios (sub-aqueous versus sub-aerial deposition, in-pit, etc), and other engineering design issues have been addressed at a high technical level to warrant confidence in the KEIA's approach to tailings.

4 Section 3 - Comments

- The citing of a reference for the 'Multiple Accounts Matrix' is to be commended (a practice as noted above is missing for numerous key design issues). The reference, Kerr et al., however is only a manuscript – full details should be provided of the as-published reference, especially given its likely source being a conference or journal paper.
- The degree to which the methodology is “reasonably objective” is debateable. If the scores are provided by the project team (Knight Piésold and Paladin), they have a vested interest in arguing against certain alternatives (regardless of how they perceive their ability to assign such scores objectively). For some alternatives, the choices and scores are easily accepted and defensible (such as open pit, underground or in situ leach mining) while for other aspects the choice is not as clear (such as tailings deposition alternatives).
- ***As discussed previously, the authors are of the very strong opinion that in-pit tailings deposition is invariably likely to be the best long-term outcome for all tailings from the proposed Kayelekera uranium project.*** It should not have been summarily dismissed based on economic conditions and seepage concerns – especially as the alternatives analysis presented does not even consider significant seepage concerns from above-ground tailings facilities which will exist in perpetuity, thereby providing likely major seepage sources due to their elevated nature above pre-mining topography.

Although Paladin has ruled out the possibility of backfilling the pit on economic grounds, this may still remain the best practice solution for tailings, marginal ore and waste rock. Storage of potentially acid forming marginal mudstone ores (§13.4.7, p13-8) on the surface maintains a risk of long-term acid mine drainage, where storage under a groundwater filled pit void does not. It is therefore recommended that this material at least should be returned to the pit to ensure that acid mine drainage does not occur.

The spot price of uranium has increased considerably since the EIA Report was issued so the backfill option must now be more economically viable. Paladin should therefore reassess the option of backfilling or partially backfilling the pit at the end of mining.

5 Section 4 – Comments

- Paladin proposes to use the water quality criteria for drinking water purposes in Malawi. They state that these values are similar to other international (Australian and WHO based) standards. However, values quoted as acceptable in Malawi for arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb) and nickel (Ni) are clearly and significantly higher than those recommended elsewhere. It is also alarming that the discharge quality standards for Cd and copper (Cu) are twice as high as the permitted drinking water standard (compare tables 4-6 and 4-5); while all of the others are equivalent or lower. These chemicals can be highly toxic to organisms so their presence in water supplies should be limited to values as low as possible.
- While Paladin is legally able to work to standards set for Malawi, it has the opportunity to use water quality guidelines set to more stringent levels. This is part of the ALARA principle that Paladin says it wishes to apply. It is recommended that, at least for the chemical species identified above, a commitment to using better quality standards is preferred as this will offer an improved level of protection to the environment in both the short and long-term.

6 Section 6 - Comments

This section is heavily reliant on the previous environmental impact assessment prepared by Atkins (1990). It is disappointing that many key aspects have not been further analysed, studied and reported upon by the KEIA, especially climate variability and climate change.

Section 6.2.3.3 Economic Geology - Uranium

- Given that the identified uranium deposit type is a geochemical cell or 'roll-front' type, a significant degree of disequilibrium can be therefore be reasonably expected between the uranium and radium present. What was the basis for the resource calculation and grade ? Has all core material been both radiometrically logged and chemically assayed ? Was disequilibrium then taken into account in estimating the total resource grade and contained uranium ?
- For example, it is common in roll-front deposits for reduced ores to be higher in contained uranium than radiometric logging would suggest, while in oxidised ores it is the reverse. It is stated that some 30% of total ore is oxidised plus 10% mixed, meaning that the extent of disequilibrium will be critical in determining the actual amount of uranium present in the Kayelekera deposit – which in turn affects production capacity and project economics.

Section 6.2.3.3 Economic Geology – Other Minerals (*ie. coal*)

- Have Knight Piésold and Paladin assessed the potentially useful properties of the coal in assessing tailings management, water management or other issues ? For example, using the low quality coal to ensure a reducing environment beneath tailings facilities could improve seepage quality by removing metals and radionuclides from pore waters. This lack of lateral thinking in the KEIA again shows deficiencies in the project conceptualisation.
- ***The proposed Nkhachira coal project is a major issue***, despite its relatively small size as a coal project (especially in comparison to Australia). Given the relative closeness of the projects, there is significant potential for competing interests as well as cumulative environmental and social impacts.

Section 6.2.5 Soils and Sediments

- The generally low metal concentrations of pre-mining soils and sediments should be noted, as this can be used in any assessment of impacts should the Kayelekera project proceed. This section is still overly reliant on Atkins but does present some new testing.

- Given normal uranium concentrations of typical background soils of about 3 mg/kg , the detection limit of “<10 mg/kg” in Table 6-8 is clearly inadequate. Soils should be re-analysed at a lower analytical detection limit (eg. 0,1 mg/kg), presuming some of the sample has been preserved, or alternatively new samples should be obtained prior to any potential development activities.

Section 6.2.6 Climate

- ***It is disappointing to note that, despite Paladin owning the majority rights to the proposed Kayelekera project since February 1998, site-specific climate monitoring was not begun until late 2005.***
- Given that the only “corresponding data” between Chitipa, Karonga and Kayelekera was wind, and that other climatic variables such as temperature, humidity and rainfall are all dependent to a large degree on aspects such as topography, simply arguing that Chipita is more representative than Karonga is unhelpful and could even lead to misleading interpretations regarding these other climatic factors. This is especially pertinent if this alternate data has been used in design calculations for water resource models, tailings dam design and the like.
- Numerous climate aspects presented fail to take into account more recent data since the previous EIA work of Atkins (1990). For example, has the additional 16 years of data since Atkins materially altered design daily and annual rainfall intensity ? Even small changes can make significant differences to the storage volumes required for mine facilities such as water ponds and tailings facilities (this was demonstrated in the EIA for the Jabiluka Project in the late 1990’s).
- The temperature increase of “50 C” noted on page 6-42 is presumably 5 °C.

Section 6.3 Water Resources

- This section finally starts to justify some of the water resource models used and the data upon which they were based. There is some discussion of methodologies and models used but no references provided in the KEIA (eg. Pitman and WRSM2000 models). The references for these models should be cited where used, and not left out. As suspected, the data is less than ideal, although the lack of a continuous data logger on the Sere River even since late 2005 is a major flaw and missed opportunity to improve data availability and quality and therefore all site-specific water resource models.
- Figure 6-34 is very poorly presented and discussed. It can only be assumed that the perpendicular lines to the Sere River are the flood level extents. This suggests that there is significant potential for a 1:100 year flood event to partially engulf the proposed Kayelekera project site – including the pollution control dam, raw water dam, the ‘interim’ TSF A and potentially allow discharge into the open pit mine.

This low potential for flooding of parts of the proposed Kayelekera project site – especially the critical tailings and water pollution control dams – is an extra-ordinarily serious issue yet it is not even discussed in sub-section 6.3.2.

- The surface water quality data for the Sere River, Table 6-27, is very poor with respect to critical environmental aspects such as metal and radionuclide concentrations. This table is poorly presented, with digits missing from several columns (eg. date, Ba), and the use of colour does not facilitate ease of interpretation in printed form from computers as the vast majority of printers use black-and-white laser printers. Further major concerns with the surface water quality include :
 - a. ***Unacceptably High Analytical Detection Limits for Key Parameters*** : The detection limit for uranium was apparently ‘<1,8 mg/L’. This is extra-ordinarily high – even for poorly equipped analytical chemistry laboratories. Uranium is commonly found in natural surface waters at concentrations of the order of 0,001 to 0,005 mg/L, and sometimes even lower (for

the Jabiluka project, typical surface water quality entails uranium concentrations between 0,00001 to 0,00002 mg/L or alternately 0,01 to 0,02 µg/L; see Mudd, 2005a). For the Ranger and Jabiluka projects, an analytical detection limit of 0,000005 mg/L is used in practice, and requires careful sampling and analysis procedures. Without such high quality analytical accuracy and precision in all chemical analyses of water quality samples, it would be impossible to detect the true extent of impacts from the proposed Kayelekera project. This problem of unacceptably high detection limits is manifest across numerous metals presented in Table 6-27 (eg, As, Se⁷, Sn, V), with the earlier data cited from the work of Atkins even using lower detection limits than the most recent analyses for the KEIA. It is most disappointing to note that such high detection limits are used for surface water when uranium analyses for groundwater samples include a much lower analytical detection limit of 0,005 mg/L.

- b. **Unacceptably Low Amount of Monitoring** : The surface water quality presented in Table 6-27 was only sampled on 4 May 2006. There is no other sampling of surface water quality, despite clear seasonal behaviour in the hydrologic system. Such minimal data does not provide confidence that surface water quality has been adequately characterised sufficient to scientifically assess any potential impacts on water quality from the proposed Kayelekera project. This is without doubt one the most critical and fundamental issues in assessing the proposed project – yet without quality scientific baseline data for surface water, a key aspect cannot be judged or assessed. For the Ranger project, surface water quality sampling is undertaken at least every two weeks (and sometimes daily when incidents occur such as accidental water releases within the mine area). Clear seasonal trends are apparent for most chemical species of interest at Ranger, and this could reasonably be expected for the Sere River and associated water resources.
- c. **Radium (²²⁶Ra)** : The radium activity of surface waters is postponed until section 6.4 (Radiological Environment). It should also have been quality presented in Table 6-27 for completeness. Based on extensive research in the Kakadu region, where the Ranger uranium project is situated, radium is strongly accumulated in certain species such as molluscs (or muscles) which are favoured food sources for indigenous people. Due to radium’s relatively high specific radioactivity (ie. radiation intensity), a very small increase in radium activity in water could lead to significant increases in public radiological doses. Further comment is later in the sub-section on 6.4.

Overall the surface water quality data for the proposed proposed Kayelekera project is very poor scientific quality and it is believed that it would not suffice in Australia for statutory monitoring and regulatory assessment purposes.

- Overall, the groundwater sub-section (6.3.5) appears to be an unusual departure from the rest of the KEIA and presents a range of relevant technical details.
- A note of caution should be sounded, however, as the actual groundwater behaviour of the pit and water and tailings storage facilities cannot be so confidently predicted based on the short-term behaviour from 10 hour small-scale pumping tests.
- Additionally, a sufficient number of groundwater monitoring bores are not present in regions of key proposed facilities such as TSF B, water pollution control dam and the stockpiles.
- The field measurement and assessment of seeps/springs is commendable but it was clearly at the wrong time of year – regular monitoring throughout the seasonal cycles is clearly needed.
- The groundwater data clearly shows the potential permeability of faults/fracture zones (Table 6-32), and this should not be ignored or downplayed in all other groundwater aspects of the proposed Kayelekera project.

⁷ Selenium (Se) is labelled as “Sa” in Table 6-27, and has been presumed incorrectly typed.

- Numerous further monitoring bores would need to be established at all key proposed facilities, such as water storages, tailings dam(s), stockpiles, hazardous chemical storages, and the plant itself.

Section 6.4 Radiological Conditions

- The lack of modern baseline radiological data for the proposed Kayelekera project is a major weakness of the KEIA. As with previous aspects, the KEIA is overly reliant on the older EIA by Atkins.
- Additionally, there is strong evidence in Australia that the process of uranium mining, milling and even after rehabilitation leads to elevated gamma radiation over the mine-impacted region (Mudd, 2005a). This is especially true for the former Nabarlek uranium project (north-east of Ranger) – despite what is ascribed as world's best practice rehabilitation undertaken at the site – where field measurements have shown that the gamma radiation has increased by about 50% from about 0,18 $\mu\text{Gy/hr}$ to 0,27 $\mu\text{Gy/hr}$ over an area 20 times larger than the original orebody (see Mudd, 2005a). It is possible that this increase could have been slightly reduced if certain options were adopted during rehabilitation, such as not using waste rock as the final surface layer – but this was not done for economic reasons and the result is elevated gamma radiation (in perpetuity).
- Given the current proposals for the Kayelekera project it is a very reasonable expectation that the opening up and spreading of gamma source wastes such as the open pit, marginal ore and tailings across a larger area than pre-mining will lead to similar outcomes as experienced by Nabarlek. The difference in elevated gamma radiation may not be significant 'numerically' but it is of course critical from a public radiological exposure perspective.

THE LACK OF PRE-MINING RADON FLUX (or emanation) DATA IS A CRITICAL FLAW IN RADIOLOGICAL ASSESSMENT IN THE KEIA.

- The section on radon needs to include not only ambient activities in air but also quantified studies of the source terms. That is, the present radon flux or emanation from the Kayelekera deposit so that a radon load can be estimated.
- There is evidence in Australia that modern rehabilitation practices can lead to an outcome whereby the radon flux is reduced to mining, milling and rehabilitation – the case in point being Nabarlek (see Mudd, 2005b). However, the Nabarlek project involved 4-month campaign mining followed by milling with tailings deposition back into the mined out pit. Given the small volume of ore relative to the volume of the pit, the rich orebody (from ranging 0,1 to 27% U_3O_8) which had outcropped at the surface was effectively buried deeper when deposited as tailings. Rehabilitation saw a thick layer of waste rock and sediments emplaced over the top of the tailings. Overall, the situation at Nabarlek is still relatively uncommon in the global uranium industry. For other uranium project sites in Australia, the available evidence suggests an actual increase in radon releases due to mining and milling of uranium ore (see Mudd, 2005b). This is especially the case for Ranger and Olympic Dam.
- For the proposed Kayelekera project, given the significant local population, it is critical to measure not only the ambient air activity but also radon fluxes and loads attributable to mining and milling. At the present state of data within the KEIA and the proposals for Kayelekera, and by reasonable comparison to Australian projects, it can be expected that radon loads will increase as a result of mining.
- The strong seasonality of water quality is shown by the data in Tables 6-43 and 6-44, and acknowledged in the subsequent discussion – but this understanding is frustratingly absent from the earlier analysis of surface water quality.

- The detection limits for radium (^{226}Ra) are variable and again sometimes high – a regular lower detection limit of <10 mBq/L should be adopted as the basis for all future water quality analyses. For the Ranger project, a difference of just 10 mBq/L between the upstream and downstream water quality monitoring sites is considered of major radiological concern.

The underlying importance of detailed and accurate pre-mining radiological conditions is that it is fundamental to ensure that changes in public radiation dose due to the proposed Kayelekera project are kept to the accepted public standard of 1 mSv/year (as noted in Table 6-63).

7 Section 7 - Comments

Section 7.3.1 Pre-Construction Impacts

- The KEIA clearly mis-understands the issues associated with radon gas (ie. 7.3.1.2). Radon gas itself is relatively chemically inert and would not 'adhere' to dust particles (page 7-4) – its decay products, however, of polonium (^{218}Po , ^{214}Po , ^{210}Po), bismuth (^{214}Bi , ^{210}Bi) and lead (^{214}Pb , ^{210}Pb), are both chemically reactive as well as possessing a high specific radioactivity due to their short half-lives ranging from fractions of a second through minutes to years. This means that it is the radon decay products which are likely to 'adhere' to any dust emanating from the proposed Kayelekera project area – leading to potential radiation exposures of the public to repeated doses of radon decay products. It is the balance of of radon decay products which adhere to particles versus those which remain in suspension in air – known as the "attached / unattached" fractions – which are now understood to be critical in proper radiological dose assessments. Given the lack of detailed long-term climate monitoring (especially wind speed, wind direction, relative humidity, ambient dusts, etc) and detailed waste characterisation for radon flux emanation and loads, the simplistic assumptions and calculations used to estimate the radiation dose are not accepted as a realistic assessment of true potential exposures. ***Further to this, the KEIA proposes no basis for appropriate mitigation measures to minimise dust generation, radon gas and control.***

Section 7.3.2 Construction Impacts

- ***Continuing from the previous point, the KEIA proposes no basis for appropriate mitigation measures to minimise dust generation and control nor does it realistically assess radon decay product exposures.***
- The potential for severe impacts from major storm events and flooding is effectively dismissed by the KEIA. For example, in February 1980 during the construction of the ring-dyke for the above-ground tailings dam⁸ for Ranger, a major cyclonic storm event gave rise to a near catastrophic over-topping failure – this was only avoided by ripping a 5 m deep hole in the northern wall of the dam wall. This led to the discharge of turbid and potentially slightly radioactive runoff waters (due to the use of low-grade ore in dam wall construction, generally about 0,01% U_3O_8) into Djalkmarra Billabong and thence downstream into the Magela Creek. Had the under-construction tailings dam failed it would have led to the collapse of the partially completed dam wall as well the complete destruction of runoff dam Retention Pond 1 (RP1). To simply claim floods will have 'no impact' is an extra-ordinary position to adopt and presents a very high project construction risk.
- As above, the claims of no or minimal impacts on surface hydrology and groundwater are over-optimistic – hydrocarbon spills could occur leading to contamination of surface water and/or groundwater, drawdown impacts on shallow groundwater is acknowledged but simply dismissed.

⁸ Milling and discharge of tailings did not commence until August 1981.

Section 7.3.3 Operational Impacts

- **Continuing from the above points on radon, claims on page 7-56 that “... radon releases ... [were] assessed” are unsubstantiated – no data is presented on the measured radon fluxes from various mine waste streams (ore stockpiles, low grade ore, non-mineralised wastes, tailings, open cut and the processing plant).** Although it appears that this issue is partially addressed later in sub-section 7.4 (see also later comments), it is critical to link these respective sections of the KEIA to ensure that a degree of confidence can be assured in the appropriateness of such an assessment. **The presentation in the KEIA of this most fundamental of aspects for uranium mining projects – radon releases and impacts – is therefore deeply technically flawed.**

The proposition that joining deeply flawed international organisations such as the International Atomic Energy Agency (IAEA) (page 7-97) – which seeks both to promote nuclear weapons disarmament while promoting nuclear power technologies which have been proven time and again to facilitate nuclear weapons production – is HIGHLY CONTENTIOUS. Numerous countries around the world do not mine uranium but are active in opposing nuclear weapons : Malawi does need to mine uranium to promote nuclear disarmament and it is offensive that a foreign company can presume to try and dictate to the Malawian Government policy positions of the utmost critical international significance for the 21st century.

Section 7.3.4 Rehabilitation and Post-Closure Impacts

- The ultimate and long-term water quality of the pit is not as easy to predict as the KEIA seeks to assert (page 7-112). Despite the uranium ore having been ‘mined’ (assuming the project proceeds to completion as hoped by Paladin), there will still be both low grade ore and higher grade economic ore exposed in the pit walls (this is certainly the experience in Australia, Canada, and elsewhere). Given the potential for acid drainage and the fact that evapotranspiration is higher than rainfall, the simplistic assertions of reasonable long-term pit water quality are over-optimistic at best and could be proven to be wrong. Evidence in Australia clearly points to the need to monitor long-term pit water quality, with numerous sites showing significant declines in water quality (eg. the former Mary Kathleen uranium mine).

Section 7.4 Radiological Impacts

- This section is generally overly simplistic, and merely downplays the likely extent of increases in radionuclide releases, radioactivity and associated radiological doses if Kayelekera were to proceed – both to the surrounding community as well as environmental radiation exposures.
- For example, on page 7-129 it is claimed that as the uranium “... large source is in effect removed, [this] may result in a lower radon concentration in some public domain areas when compared to pre-mining radon concentrations”. As analysed in great detail by Mudd (2005b), the experience in Australia is that mining operations are likely to increase the release of radon to the local environment – not decrease it. It would be extremely difficult to ascertain this based on measurement of radon activity in air alone, as daily fluctuations in radon activity in air are significant and monitoring is very rarely undertaken on such a continuous time-scale to allow such estimates to be made (the numerous works cited by Mudd, 2005b, are based on reported studies of radon flux only not radon activity in air).

The lack of field-measured properties for radon fluxes and loads, as well as other components in undertaking and modelling radiological impacts is a major flaw in the KEIA. Based on the author’s detailed knowledge of uranium projects and history in Australia, the KEIA fails to adequately assess the potential scale of radiological impacts from the proposed Kayelekera project, and does not provide sufficient radiological baseline data upon which to judge any future impacts and predictions.

8 Section 8 - Comments

Section 8.5.1.2 Nkhachira Coal Project (NOT Mine)

- **Given the close proximity and geologic relationships between the sedimentary units of the Kayelekera uranium deposit and the Nkhachira coal resource, has the coal been analysed for radionuclide content ?** This could be a major issue but due to the inability to obtain the EIA for the proposed Nkhachira coal project it cannot be considered.

Section 8.5.2.1 Cumulative Impacts

- The claim (page 8-11) that “there is no possibility of [groundwater] in interaction between the two” proposed mining projects is another extra-ordinary claim without long-term field monitoring and studies commensurate with this claim. Given the moderate to large scale of the proposed mining projects and their relative closeness (<5 kilometres), this issue is critical and should not be ignored – at either Kayelekera’s or Nkhachira’s peril. There are numerous examples around the world where pre-development groundwater conditions did not facilitate vertical hydraulic connection and flows between aquifers – but following project development-induced stress, either due to drawdown from pumping and dewatering, hydraulic gradient increases or small movements along faults then provided the pathway for flow – therefore leading to greater impacts on groundwater resources than simply assumed. The development of the water supply borefields for the Olympic Dam project in South Australia in the area of sensitive mound springs is now acknowledged as a classic case study in optimistic predictions about no impacts on groundwater resources being proven wrong in hindsight after development (Mudd, 2000). **This characteristic dismissal of potentially serious impacts is a major flaw of the KEIA.**

9 Section 10 - Comments

- Monthly and quarterly sampling during the pre-construction phase only (table 10-6) does not constitute an adequate monitoring system or an acceptable measure of pre-construction phase baseline data. Quarterly samples will produce a maximum of 4 samples only; which is insufficient to provide statistically valid information – a minimum of ten samples should be collected throughout the year; hence a minimum of monthly sampling for all parameters is recommended. The river monitoring data provided by Paladin (table 6-27 and Appendix 8) is useful as it provides a reasonably comprehensive assessment of the water quality from the catchment area in general, but is limited in its extent as several individual water courses have been sampled only once (in 2006). It is statistically invalid and dangerous to draw conclusions based upon only one data point; so further sampling and characterisation of the catchment should be undertaken prior to construction of the project.
- The application of a simple monitoring scheme based upon selected chemical parameters only is not best practice and provides insufficient evidence that ecosystems are being adequately protected. Ecotoxicology testing, based upon ANZECC guidelines is used at the Ranger Project to provide an integrated system of environmental management aimed at protecting the environment of a World Heritage listed park (i.e. Kakadu National Park). This system is superior to simple monitoring of chemical parameters because it is a truer indication of direct impacts on biological species. By monitoring sentinel species (such as river mussels), appropriate discharge limits have been developed, along with focus and action trigger levels around which appropriate interventions have been devised. It is therefore recommended that, if Paladin is truly committed to protecting Malawi’s water resources, a similar system tailored to the Kayelekera environment should be devised. Any ecotoxicology testing must be performed prior to construction and operation of the plant; to ensure maximum credibility of the findings and accuracy of the results.
- The monitoring programs proposed by Paladin do not include monitoring for ²²⁶Ra; and the drinking water guidelines to be applied provide no values. Should the project proceed, isotopes

of radium must be included in the monitoring program in addition to uranium, and the water management system and contingencies that have been proposed should be monitored where necessary to ensure that loss of ^{226}Ra to the environment is minimised. It is recommended that monitoring should take place according to standard methods and procedures (Hardege, 2005).

10 Section 12 - Comments

- Sub-section 12.9.3 External Communication – the flowchart (presumed to be Table 12-1 as referenced in § 12.9 and provided on page 12-23) indicating lines of communication in the event of a major incident do not provide for adequate stakeholder engagement. This contradicts Paladin's claims of transparency and stakeholder engagement. At Ranger (as in most Australian mining companies) these matters are generally dealt with by a Community Affairs Manager and not the Mine Manager. Failure of Paladin to consider a Community affairs Department speaks volumes for their outlook on stakeholder engagement and transparency.

11 Section 13 - Comments

- The depth of the proposed cover (1.3 metres) for the Tailings Storage Facilities may be insufficient to encourage good vegetative stability. Root penetration from larger plant species into the tailings is anticipated. Should this happen, then increased emanation of Rn and efflorescence of salts at the surface of the structures can be expected; along with increased erosion and carriage of contaminants into the environment.
- It is difficult to perceive how a single field reconnaissance during the first growing season (§ 13.6, p13-11) will enable Paladin and stakeholders to assess revegetation success as this takes several years to demonstrate. Significant effort has been placed into revegetation at Nabarlek over the past 18 years yet a stable vegetation pattern has yet to be developed and this mine still remains a long way from closure being accepted and agreed upon by regulators and community stakeholders.
- While progressive rehabilitation of disturbed areas is commendable, continuation of monitoring programs for a period of only five years after closure (sub-section 13.7, page 13-12) is grossly inadequate. The groundwater contamination pulse from Nabarlek Uranium Mine in Northern Australia has only now begun to diminish to background levels – despite the mine being disused for the past 18 years. The analogous pulse associated with the Ranger Mine is not expected to pass for at least 100 years after mining ceases and this will be entirely dependent upon the modes of engineering used to stabilise the tailings reservoirs – which itself remains uncertain due to the ever-changing scope, nature and size of the mining plan for Ranger.

The closure planning should provide numerous clear commitments with respect to the proposed Kayelekera project : eg. emplace tailings within the mined-out pit; environmental and radiological monitoring for at least 25 years post-mining. Also, it is increasingly being viewed as good practice to facilitate community involvement in decisions regarding rehabilitation and closure. The KEIA provides no proposed mechanism for community participation in this regard – despite difficult lessons still being worked through for the Ranger and Nabarlek projects in this regard.

12 Other Relevant Issues NOT Addressed by the KEIA

Uranium Market

- Although it is apparently not required by Malawi EIA legislation, it is common in Australian impact assessment to include a section of an EIA on economic market conditions. It is entirely remarkable that the KEIA completely avoids the whole question and dynamics of the uranium market – especially given Paladin’s promotion of uranium for numerous years (which has been almost universally unsuccessful until the past two years).
- Two critical factors must be recorded on the public record in this regard (Mudd, 2005a) :
 - a. **Demand** – It seems clear that some basic points are being ignored or at least glossed over on uranium supply-demand. Firstly, most of the nuclear power reactors around the world are in western countries, mostly built between the late 1960’s to mid-1980’s. As such, many of these reactors are facing the end of their useful operating life sometime in the coming one or two decades. There are some reactors which are winning approvals to extend their operating licence (though this is not without major risks), but there are also other reactors which are being closed down earlier due to high operating costs. There are no plans at present to replace these reactors, let alone build new reactors to expand nuclear production. Overall, this will lead to strong and sustained downward pressure on uranium demand over this period (also affecting the spot price and thus many long-term contracts). Secondly, the rate of building reactors elsewhere in the world, such as China and India, in no way replaces the same capacity due to be lost in the western world over this same time period. In the long-term, it is not possible to envisage a realistic scenario where there will be a strong and sustained increase in uranium demand.
 - b. **Weapons-Derived Uranium** – As with the 1990’s, there is the future possibility of additional enriched uranium being made available to the nuclear power industry through the decommissioning of nuclear weapons. Given the large stocks of weapons still menacing the world and the global concerns on proliferation risks, this is clearly an important issue – any new placement of ex-weapons uranium would see an extra-ordinarily rapid collapse in the uranium price (*not to mention Paladin’s share price also*).

Given the low grade of Kayelekera and the historical volatility in the uranium market, there can be no guarantee that the project will indeed be as profitable as Paladin hope. This leads to the local community having to accept all long term radiological, environmental and social risks, uncertain economics (also for government) while Paladin will not be present for the same period.

Proposed Project as in KEIA versus Actual Operation

- A major aspect of uranium operations in Australia is that they are invariably modified during construction and operation when compared to original project proposals assessed through an Environmental Impact Statement (EIS). Although on rare occasions this results in a positive environmental outcome, the changes are invariably for short-term economic reasons driven by the need to contain production costs. This has especially been the case at projects such as Ranger, Olympic Dam and Nabarlek (examples include major changes to tailings management, water management, mine expansion and the like).

Given the ad-hoc nature of the way in which several key design issues are discussed and presented in the KEIA, there can be no trust that even the present project commitments can be maintained into the future (except perhaps under extra-ordinary legal conditions which would more than likely make the project uneconomic). There is simply no guarantee the current uranium price will be maintained – if it does decline it is the low grade, small contained resource projects such as Kayelekera which will not be able to compete with Canada and Australia unless they lower operational costs. That is, unless some of the present (arguably minimal) commitments are altered – historically in Australia this means some of the higher risk environmental options are then sought by operating companies.

13 Conclusions

Overall, the author's are of the strong opinion that :

1 *the KEIA fails to adequately characterise the baseline environmental and radiological conditions of the Kayelekera region and proposed project.*

2 *the KEIA fails to present and justify sound technical approaches to major issues and aspects such as protecting the quantity and quality of water resources, tailings deposition and long-term stewardship, potential radiological releases and associated exposures, etc.*

3 *the KEIA consistently dismisses various potential issues without sufficient baseline data from field studies and subsequent technical assessment (eg. water quality, radon, etc).*

4 *the KEIA fails to make firm commitments and set noble targets for rehabilitation and closure, especially with regards to local community expectations.*

5 References

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6 About the Authors

Dr Mudd has been an active researcher and advocate on the environmental impacts and management of mining for over a decade. He has been involved with many aspects of the mining industry with a particular interest and specialty in uranium mining. His work to date has been published in numerous international journals and conferences. Dr Mudd maintains an independent perspective, and has undertaken research for mining companies, community groups and indigenous organisations. Qualifications include a first-class honours degree in Environmental Engineering from RMIT University and a Doctorate in Geoenvironmental Engineering from Victoria University assessing the environmental impacts and associated management issues of coal ash in the Latrobe Valley region of Victoria, Australia. Gavin has developed a unique understanding of the environmental aspects of uranium mining in Australia and globally.

Howard D Smith has over twenty two years experience in the mining industry as an Industrial and Power Station Chemist and Environmental Scientist. The past 18 months has been spent as a technical advisor to numerous indigenous Australian organisations dealing with impacts of mining, primarily in the uranium sector of Australia's Northern Territory. Qualifications include a B.Sc. in Applied Chemistry with Masters in Tropical Environmental Management and a PhD in Applied Chemistry pending. His work has been published in international journals and conferences. Howard has extensive experience and understanding of the technical, environmental and social aspects of bauxite, base metals, manganese, mineral sands and uranium mining in Australia.

7 Appendices

- 1 Good Example of a Mine Layout Figure : Figure 2-1, Jabiluka EIA
Source : "The Jabiluka Project Draft Environmental Statement", Prepared by Kinhill Engineers Pty Ltd in association with ERA Environmental Services Pty Ltd for Energy Resources of Australia Ltd (ERA), Brisbane, Queensland, Australia, October 1996.

