

P.O. Box 2403, Palmerston, N.T., 0831.  
1305, (lot 2382), Leonino Road, Darwin River, N.T.  
08-89886229, <kylegj@arafura.net.au>

August 6<sup>th</sup>, 2002.

The Secretary,  
Senate ECITA References Committee,  
Parliament House,  
Canberra, A.C.T., 2600.

To Whom It May Concern:

I should like to make a submission to the Environmental Regulation of Uranium Mining Inquiry.

The submission consists of a written complaint that I submitted to the relevant federal and territory government departments in April of this year, and this covering letter.

The content of the former document relates to the period of time between September, 1993 and December, 1998, during which I was employed as Technical Officer and Senior Technical Officer at the Ranger Mine Environmental Laboratory in Jabiru, N.T.

The document was written some years after the events which it describes occurred. At a meeting between OSS personnel and myself, review of the document revealed an apparent error of fact, and a perceived mis-statement of the relevant data.

The error of fact related to my complaint reporting a significant conversation with my supervisor as having occurred on a particular date. It has been shown that the conversation could not have taken place on that date. Clearly, the Committee will decide for itself, but I make the point that it scarcely matters on what date my supervisor made the statements that I reported. The environmental issue to which they related had been in existence before I worked there, and continued to exist after my resignation and departure.

That which one or two of the OSS personnel who investigated my complaint saw as mis-stated evidence can be seen from different perspectives. Rather than defend my original presentation, I would prefer that the Committee inspect for itself the primary data that I have quoted in my original complaint. These are numerical downloads from Ranger's own database and, therefore, are not vulnerable to semantic exercises.

These two issues, and the manner in which they were dealt with by the various government departments and that part of the OSS inquiry to which I was privy, serve to illustrate a general perception that I formed as events unfolded after my original complaint was submitted.

The complaint was dated April 5<sup>th</sup>, 2002. On April 8<sup>th</sup>, OSS acknowledged receipt and indicated that an investigation would ensue. On April 23<sup>rd</sup>, OSS wrote to me confirming that an investigation was underway, and that I would be required to attend an interview in May. The interview took place on May 13<sup>th</sup>, and was, at my request, minuted.

Throughout the interview numerous attempts were made to put words into my mouth in respect of assessments of the likely environmental damage caused by the events that I described. I was obliged to point out on several occasions that I believed that some members of the committee were attempting to obscure the pertinent detail of my complaint by obtaining my assent to statements suggested by themselves. These were categorical statements to the effect that no environmental damage had been caused by the incidents I described in my complaint.

The actual incidents and technical issues, and breaches of Ranger's licence to operate the mine that they indicated, were the focus of my complaint. Of these, only the two incidents relating to RRZ infringements were discussed in any detail. Moreover, as an analytical chemist, my view of the potential environmental damage was not expert, whereas my statements about the operation of the environmental monitoring programme and the laboratory were of an expert and informed nature.

Some members of the OSS review committee seemed intent on discrediting the data on the basis of the way in which they were presented, rather than their scientific validity. Resolution of that seems unlikely as my complaint is supported by contemporary print dumps of selected data, and Ranger has apparently lost the original data during its translation from one database platform to another.

When I received the draft minutes, I was astounded to read that none of my reservations were recorded. Neither were my protests about attributing to me statements that were really postulates suggested by the OSS committee members. There were also blatant errors of fact, where what I had said during the review was completely misrepresented in the minutes. I was profoundly disappointed by the clumsy attempt by OSS to manipulate facts, and was obliged to insist that the minutes be rewritten.

In respect of the Northern Territory Government, my disappointment was even more pronounced. Shortly after receiving three separate acknowledgements from Minister Henderson, (on April 8<sup>th</sup>, 15<sup>th</sup>, and 17<sup>th</sup>), I heard the minister on ABC radio saying that he had not received my complaint and did not know

anything about my allegations. The next day, when questioned further by ABC radio, the minister was able to tell listeners that an investigation into my complaint by his department was almost complete, and that he was not convinced that actual environmental damage had occurred as a result of the incidents described. He promised that the result of his investigation would be available a few days thence.

The minister also found an opportunity to speculate – without supporting evidence and contrary to the facts – on an earlier media report that I was a disgruntled former employee who had been dismissed, and implied that my complaint might be compromised by the fact that my wife had been employed by the Gagadju and Gundjehmi aboriginal organisations. Notwithstanding that he had never met or spoken with me, the minister attributed my motivation to an ideological opposition to mining.

Aside from proforma acknowledgements signed by ministerial assistants, I have not been contacted by Minister Hendersen or been involved in the investigation conducted by his department.

In general, the response from the authorities did nothing to ameliorate my fears that no useful result would issue from this entire exercise. As a consequence of my first-hand experience, I do not have a lot of confidence in environmental self-regulation and the commitment of major corporations to environmental protection. Moreover, after my recent dealings with the various authorities, I find that I am unable to trust the impartiality of the regulators.

For those reasons, my submission to the inquiry at hand remains unaltered from its original expression as a complaint to the regulatory authorities.

My intention in that exercise was to show that, having demonstrated its incompetence, insouciance, and unwillingness to employ best practice in the management of mining a dangerous substance in a sensitive area, Ranger had breached its licence conditions, and behaved as an unsuitable operator and an irresponsible corporate citizen.

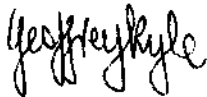
Irrespective of what might be done to tighten up the various aspects of ERA's operation of the Ranger Mine, my experience with ERA culture, and the very loose regime of self-regulation to which it has been subjected, does not fill me with confidence that the situation will improve unless ERA is required to:

- recommission its on-site environmental laboratory,
- employ sufficient competent technical staff who have the resources and support to investigate problems,
- augment set frequency sampling with a comprehensive event-based programme, and

- accept direct regulation from government officials who regularly inspect the operational sites, independently acquire and test environmental samples, and review extant data.

Furthermore, I believe that OSS should be supplied with appropriate resources and freed from political direction, such that it is capable of performing the full extent of its role in monitoring the operation of the Ranger Mine.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'Geoffrey Kyle'. The script is cursive and fluid, with the first name 'Geoffrey' written in a larger, more prominent hand than the last name 'Kyle'.

Geoffrey Kyle.

P.O. Box 2403, Palmerston, N.T., 0831.  
1305, (lot 2382), Leonino Road, Darwin River, N.T.  
08-89886229, <kylegj@bigpond.com>

---

5 April 21, 2002.

Mr Paul Henderson  
Minister for Resource Development NT  
Parliament House  
State Square,  
DARWIN NT 0800

Dear Sir,

I am a former employee of the Ranger Uranium Mine Environmental Laboratory at Jabiru. From 1993 to 1998, I was a Technical Officer with responsibility to collect and analyse samples for the purposes of statutory reporting.

In recent times, the press has featured articles alleging that Ranger has a poor record in respect of spills both inside and outside its RRZ, has been less than transparent in its reporting, and is generally not up to standard with its environmental monitoring.

The publicity convinced me that I should make another effort to draw some matters to the attention of the authorities. I say "another", because, throughout the tenure of my employment with Ranger, I tried to alert its management to various matters, and to take remedial or preventative action. My efforts were not met with success.

Among its stories on the subject, the press has not canvassed the fact that Ranger no longer maintains a functional laboratory and contracts out its statutory analyses. That practice has increased my level of concern.

Accordingly, I have attached a statement and supporting documents for your consideration. In the statement, I provide details of three issues which I believe expose Ranger to charges of failing to honour the conditions of its authorisation to operate the mine. Those issues are:

1. Under-reporting and mis-reporting in respect of an RRZ infringement on the Corridor Road in December, 1997;
2. Failure to clean up a substantial amount of spilled tails material that occupied the Corridor Road Sump and its feeder drains as a result of the incident in 1 above;

3. Employment of *ad hoc* water management strategies that resulted in over 300 kg. of uranium being lost into RP2, from which pond water is released into the Magela system;
4. The routine discharge from the RRZ of water containing up to 10,000 ppb uranium from the toe loading of the tailings dam, via the South Road Culvert, (TDSRC), into the headwaters of Gulungul Creek.
5. When an indication was recorded that an effect from the discharge in 4, above, had been found downstream at Gulungul Creek, Ranger refused permission for field staff to investigate the matter, attempted to suppress the datum, and described it as "spurious" in a statement to shareholders. The offending result came from two separate samples, each tested in triplicate by the same experienced analyst who acquired the samples.
6. Laboratory management consistently refused to address technical issues that compromised the performance of the laboratory. This failure led to an inability to honour the conditions of its licence to operate the mine, especially in terms of the NATA registration of certain critical test procedures and equipment. Even when it was demonstrated that the points raised were valid, Ranger did not rectify the problems.

As a citizen, I find myself deeply concerned over this deepening issue. To me, it seems unlikely that the current commercial environment will allow mining at Jabiluka in the foreseeable future. And Pit 3 is pretty-much played out. It seems to me that Ranger might be applying the cap and re-vegetation sooner than originally envisaged.

For that reason, I believe it is critical that Ranger's ability and will to de-commission the mine and rehabilitate the surrounding area in a "best practice" exercise that will leave the park safe in future times, must be examined in terms of past performance.

I send this material to you with a formal request that you investigate the matters raised in my statement.

Please acknowledge receipt of this letter and statement within fourteen, (14), days, and indicate whether or not an investigation is to be mounted. In the event that these issues are investigated, please inform me of progress on a regular basis.

Yours sincerely,

Geoffrey Kyle.  
ADAC, MRACI, Chartered Chemist.

cc: Dr Arthur Johnston  
Office of Supervising Scientist

Mr Alex Zapantis  
Office of Supervising Scientist

Senator Hill  
Minister for Environment

Mr Peter Blake  
Department of Business, Industry & Resource Development

Mr Steve Tatzenko  
Department of Business, Industry & Resource Development

**STATEMENT ON THREE ISSUES PERTAINING TO  
ENVIRONMENTAL MONITORING AT THE ERA RANGER  
URANIUM MINE, JABIRU, N.T.**

***by Geoffrey Kyle, ADAC, MRACI, Chartered Chemist***

***(Technical Officer and Senior Technical Officer at ERA Environmental Services and  
RUM Environmental Laboratory, 1993 – 1998.)***

**1. Gulungul Creek and Tailings Dam South Road Culvert**

***1.1 Geography, Site Designations and Monitoring Programme Design Features***

Refer to the general plan view of the RUM mine site, given as Figure 1.1, and the sketch of the tailings dam wall at the point of interest, given as Figure 1.2.

Around the southern side of the dam is a perimeter drain that collects surface water running off the toe, or base, of the outside of the dam and from its surrounds during wet season rain events. Water builds up in the drain and overflows, through a pipe under the road, into a small pond. The pond was then approximately four metres across and up to one metre deep. The pond is designated as Tailings Dam South Road Culvert, TDSRC.

When the pond is full, it overflows down-grade in a southerly direction, passing under the perimeter fence and feeding an ephemeral creek that is tributary to Gulungul Creek. The effluent flow between the pond and the catchment area of the Gulungul Creek tributary is designated as TDSRCX, where X is given in metres as the distance below the pond at which the sample was taken.

The tributary conflues with Gulungul Creek south west of the mine side and the latter flows in a northerly direction until it intersects the Arnhem Highway about one kilometre west of the Jabiru Airport. The intersection is designated as Gulungul Creek Highway, GCH. Gulungul Creek continues northward and conflues with Magela Creek below the downstream monitoring point known as MG009.

MG009 is intended to provide information on any changes in water quality in the Magela system that might occur as the Magela flows past the mine site area and is augmented by wet season run-off, seepage, effluent and planned water releases. To do so, its results are compared with results from Magela Creek Upstream, MCUS, a site on the Magela that is well upstream of the mine site area.

Similarly, GCH provides information about any changes to the water quality in the Magela that might result from water quality changes in Gulungul Creek and its tributaries that rise in, or flow past, the mine site operation areas.



The statutory environmental monitoring regime imposed by RUM's mining licence required that these, and other sample points be monitored at a specified frequency and for specified chemical species. MG009, MCUS and GCH are designated as "monthly" sites and were analysed for uranium on that basis throughout the history of the mine.

TDSRC is not a statutory point whose testing is required by the licence. Like many other sample points, it was created as a part of Ranger's own monitoring programme. It was routinely sampled on a weekly basis.

In the cases of MG009 and GCH, which are "exit" sites sampled from pristine locations, the measured levels of chemical species related to uranium mining should be no higher than those at the corresponding "entry" sites. The only exception to this is when controlled water releases are in progress. These approved wet season releases from retention ponds are monitored in terms of the contribution to the total load in Magela Creek made by the released water. Thus, MG009 is compared with MCUS, but there is no corresponding entry point for GCH. It is important to note that Gulungal Creek has two tributaries that confluence upstream of GCH and downstream of the mine. These are not routinely monitored. The main arm of Gulungal Creek rises in pristine country to the south of the mine site and the smaller, wet season creek that conflues with the TDSRC tributary before the confluence with the main arm, rises in the feet of Mount Brockman, to the south east of the mine site. All three creeks are dry for much of the year.

As both unmonitored tributaries rise in pristine country, it was apparently assumed by those who designed both the Ranger internal and government statutory monitoring programmes that no deleterious contribution to the water quality of Magela Creek was to be expected from those ephemeral water courses other than the one that rises at TDSRC.

### ***1.2 Water Quality Measurement, Standards and Background Levels.***

Instruments used to measure the concentration of chemical species in water all have a minimum level below which they are incapable of measuring with confidence. This is known as the detection limit. Because the detection limit can therefore never be zero, very low results are conventionally recorded as "less than" the relevant detection limit. In the case of uranium, the measurement technique employed at the time was known as "kinetic phosphorescence". Its limit of detection was quoted as 0.1 microgrammes per litre, ( $\mu\text{g/L}$ , or, in chemists' shorthand, "parts per billion", ppb).

The accepted level of uranium at MCUS, MG009 and GCH was  $<0.1$  ppb. Due to the then current limitations of computers, (they were unable to mix alpha and numeric characters in the same data string), the less than sign was never reported. Such results often appear as zero.

The area around the mine site is characterised by uranium mineralisation in the host rock, so some detectable level of uranium is to be expected in the natural course of events. In respect of surface water, in a climate where massive rainfall flushes and leaches the land

annually, background levels are expected to be at or below detection limits. With respect to groundwater, the Jabiru town drinking water, drawn from the town bore, was monitored and frequently reported up to 2 ppb uranium. The drinking water at the mine site could be sourced from either of two bores. One of those, on the Brockman bore field, reported up to 5 ppb uranium. The other, some distance away to the north west, and drawing from a different aquifer again, reported much less. Thus, the accumulation of uranium in groundwaters is variable up to, say, 5 ppb, in the immediate region.

At the time, the recommended maximum level of uranium in potable water was 40 ppb. That was revised to 20 ppb a year or so later, and at least one of the reviewers has expressed the view that a more appropriate maximum level would be 10 ppb.

### ***1.3 An Account of Relevant Events***

In January, 1997, I performed the monthly sample collection and uranium analysis for statutory monitoring purposes. As was routine procedure, I acquired duplicate samples from all of the sites. Later, when analysing the samples, I was alerted to a possible problem when GCH reported 7 ppb uranium. I re-tested the sample several times, and then tested the duplicate sample several times. All the tests confirmed the initial value of 7 ppb.

As this was overwhelmingly the highest result I had personally seen for that site, I checked the data base for history and found that, of the previous 25 tests, 10 had reported results greater than zero. Of those, seven reported 1 ppb, and the remaining three reported 2, 7 and 11 ppb.

I reported the occurrence to the then Chief Chemist, Allan Ryan. I explained that I suspected the source of the higher than expected uranium levels, both now and in the history, might be the elevated uranium readings that were routinely recorded at TDSRC during the first flush rain events each wet season. I requested permission to sample the two unmonitored arms of the creek system feeding Gulungal at GCH to eliminate any other potentially contributing factors, and to venture further down-grade from TDSRC to sample the creek at various locations with the aim of monitoring the dilution suffered due to rainwater and confluences.

Permission was refused on the grounds that GCH was a monthly site and that we did not need to check it again until February. TDSRC was not statutory and would continue to be monitored on a weekly basis. Allan Ryan suggested that the result was most likely to reflect contamination in the sample or the analysis. He suggested that the result not be recorded on the database. I did not agree, and entered the result.

Neither did I obey his instruction fully. It was not possible to sample further from the lower Gulungal system, but, on my other routine sample acquisition runs I was able to acquire samples from various points on the TDSRC system. I did that on two occasions. The first was later on the same day as the 7 ppb GCH sample was acquired and the other was nineteen days later on 21/01/97. The results indicated that significant dilution was

suffered during the overflow events. For example, 669 ppb U recorded at TDSRC was diluted by run-off to 7 ppb two kilometres down-stream in the upper Gulungal.

These results clearly established that a contribution to uranium concentration in Gulungal Creek was being made by the run-off from TDSRC. It was not possible to state the magnitude of the contribution because of the episodic operation of the system and the limited extant data.

It was accepted wisdom among the laboratory and hydrology field staff that there existed under the tailings dam wall, adjacent to TDSRC, a small spring. Assisted by the hydraulic pressure in the dam, the spring expressed "seepage" onto the toe of the dam wall. The toe consisted of crushed "waste rock" compacted around the foot of the wall. Essentially, waste rock is very low grade uranium ore. It is used as fill, in earthworks, or is stockpiled. It contains uranium, but is not rich enough to warrant processing.

The seepage of water and dissolved salts from the dam continues for the entire year, but is not visible at the surface during the dry season. This is because the large surface area of crushed waste rock, heated by the sun, evaporates the water rather quickly. That leaves the solute salts accumulating just below the surface of the toe. When the rains come, the first good flush dissolves and mobilises the salts and carries them into the perimeter drain, thence into TDSRC, off the mine site, and into the creek system as described above.

The seepage and spring theory was not without precedent or support. At the time, I was aware that the Northern Territory Department of Mines and Energy, (DME), had been concerned about the seepage at that point in the dam wall, and had required Ranger to shore it up with an increased "toe loading".

This was done with further quantities of fresh waste rock. It did not allay the seepage, but, being fresh, unleached rock, it provided a new reservoir of oxidised mineral salts for the next season's run-off to transport out into the environment via TDSRC. From the graph of TDSRC uranium values, (given as Figure 1.3), the effect might be seen in the difference between the peak readings in February 1997 and February 1998.

If one wanted to accurately establish the progress of this mechanism, one would need to be present to catch the peak of the first flush rain event of the season at TDSRC. Sampling should then continue at short time intervals at TDSRC1000, TDSRC2000, GCH, and at the confluences between them, in order to catch the diluted peak of the first flush event as it progressed through the creek system to the Magela. The initial rain event would produce the biggest slug of effluent as it would represent the accumulated dry season load. Subsequent rain events would encounter less salt load and the peaks would therefore be lower.

It is noticeable from the graph that each event features a major peak, but is accompanied by subsidiary peaks. This suggested that several slugs of contaminated effluent were mobilised in discrete rain events. All of this went into the creek system.

My chief concern was that, because of the monthly or weekly nature of the water quality snapshots we were acquiring, we had no measure of the magnitude of the problem at the entry end. Moreover, we were certainly not seeing the full extent of what was occurring downstream, and were therefore failing to appreciate the ultimate consequences for the surrounding environment.

At that time, (February 1997), the highest level recorded at TDSRC during routine monitoring was around 5000 ppb, of which, it seemed from the limited data available, only around 10 ppb remained at TDSRC2000. The main slug might be a great deal bigger than that. Its apprehension depended upon a sample being acquired at the right moment. Its magnitude depended on the amount of solute load and the volume of run-off available for dilution. Getting to the bottom of it was clearly going to require a good deal of time and effort to acquire and analyse closely-spaced sample sets. The design of the monitoring programme, and the availability of staff and resources, did not allow for the synchronisation of sample acquisition with the first TDSRC overflow event, much less the proper investigation required of both entry and exit sites.

Subsequently, in the wet season of 1997-8, a peak of nearly 10,000 ppb was recorded at TDSRC. To me, that result confirmed that the monitoring programme had a significant gap in it. Further alarmed, I summarised the problem, and made a personal representation to Mick Nolan, then the Senior Technical Officer in the Environmental Laboratory, and my direct supervisor. Mick Nolan undertook to look into the matter.

Mick Nolan wrote to me on 11/02/98, (Figure 1.5), saying that he had looked into the history data and stated that he believed that the peak concentrations were showing a decreasing trend over the previous wet seasons and that the increase noted in that year was due to a combination of the new toe loading and earthworks on the southern side of the dam. He instructed that the monitoring of TDSRC would remain at weekly intervals, and proposed that the situation should be assessed again towards the end of the next dry season.

A copy was sent to Peter Woods, then 2IC of the RUM Environmental Department, and a former NT DME manager. PW replied with a copy to me, (Figure 1.6). PW agreed with MN and acknowledged that any effect would be seen at GCH by noting that measurements are taken at that site, and requesting that data for GCH be plotted against TDSRC and sent to him. Strangely, he goes on to say that he, "... assumes levels there [at GCH] have always been low."

PW and MN do not address the likelihood that a toe loading seepage of tailings water is contributing to water quality changes in the downstream environment. Neither do they acknowledge that there is a problem with routinely releasing water containing up to 10,000 ppb uranium into pristine creeks.

From the extant data, TDSRC reported 738 ppb at the pond and 392 ppb when it flowed under the fence to join the creek, (02/01/97). On another occasion, (21/01/97), the respective

figures were 669 and 621. The solutes in the seepage and run-off suffer variable though significant dilution, but, irrespective of that dilution, an absolute amount of uranium is released. Put another way, I had no way of knowing the volume of water passing me as I took the sample. Neither did I know the volume of diluent water that was being added by rain, run-off and other creeks. What my test showed was that every litre of water leaving the site at the TDSRC fence contained 392 µg of uranium, (020197), and 621 µg of uranium, (210197).

In a monitored part of the external environment, such numbers would have threatened the operation of the mine.

PW should have known the history of GCH. The graph he requested never reached me, but I have produced a similar depiction in Figure 1.4. The data are clearly incomplete, but they are also clearly indicative that further investigation was warranted.

Within a report to shareholders in 1997-98, in a paragraph addressing environmental monitoring and compliance, the performance of the company is lauded. A sentence notes that only one reading above background was recorded, and that was regarded as “spurious”.

### ***1.5 Conclusions from the Perspective of an Analyst***

RUM knowingly and routinely allowed heavily contaminated water to flow out of the mine site at TDSRC and into the surrounding environment in the catchment of Gulungul and Magela Creeks.

RUM did not report the instances where an indication of this was observed at GCH.

RUM discouraged investigation into the elevated level found at GCH in December, 1997.

Senior RUM Environmental Department personnel were alerted to the problem but did not regard it as serious and would not allocate resources to further investigation.

## **2. Tailings Spill in Corridor Road**

### ***2.1. Geography and Mine Hardware***

Refer to Figure 2.1. Tailings slurry is pumped from the neutralisation plant to the tailings dam through pipes that are laid on the surface, at the verge of Corridor Road. On the outside of the road is a 25-odd metre wide strip of creek flats with native vegetation forming the east bank of Georgetown Creek. That ephemeral waterway feeds a major billabong in the wet season. Georgetown billabong in turn flows into Magela Creek.

Inside the road is the restricted release zone, (RRZ), from which the release of contaminants into the surrounding environment constitutes a reportable breach of RUM's

licence to operate the mine. Those operations, although heavily regulated by statute, are largely self-regulated in every-day practice.

Running parallel to the road, on the inside, is a perimeter drain that is intended to collect run-off water from the surrounding mine site area and divert it to a turkey nest sump adjacent to the road. From that sump, the water is pumped to other retention ponds for storage, or disposed of via evaporation or authorised wet season releases. Depending upon its degree of contamination, the sump water could be pumped to the then disused Pit J or the tailings dam.

## ***2.2 An Account of Some of the Relevant Events***

On a Sunday evening in early December, 1997, my neighbour told me of a big spill of tailings from a ruptured pipe on the Corridor Road.

The neighbour was then a shift supervisor at the RUM plant. He had come on-shift at 0700 on the Saturday and found that a tailings line had ruptured and sprayed tailings slurry across the RRZ at Corridor Road, into all the perimeter drains along that section of the road, and up the outer bank of the turkey nest sump.

From the tailings system pump and lineout log, and from the amount of material spilled, he found that the line had ruptured during a routine line change, and that the ruptured flange had probably been discharging for around four hours before it was discovered.

As soon as I arrived for work on the next day, I went to the site. It had been raining most of the weekend, but was reasonably fine at the time. I saw the site much as my neighbour had described it. Any material that had been sprayed over the road onto the creek banks, outside the RRZ, had, by then, been removed. There was evidence of machinery having been used to excavate an area approximately 25 metres square and 250 mm deep, on average. The excavation extended from the foot of the road batter to the creek bank and had removed all vegetation. I estimated that approximately 156 cubic metres of material had been removed. Not all of that would have been spilled tailings slurry, but there must have been a substantial amount to have extended at whatever depth over the area excavated.

I was later told by Heather Baines-Thompson that several large tipper truck loads of material had been excavated and carted off to the contaminated waste dump.

HBT was operating a water cart that was being used to hose the heavy slurry back across the road and into the perimeter drains. Those drains were full of slurry and were carrying the overflow into the turkey nest sump. No attempt was being made to remove the slurry that had been sprayed up to half a metre up the sides of the motor control station operating the sump.

I returned to the environment laboratory and reported the spill to the Chief Chemist. I made clear my fears that an incomplete cleanup would become a health hazard for staff in

the dry season. AR agreed, and said he would raise the matter with the Mine Department. An investigation was mounted in the laboratory to sample the creek at several locations, and to look for any effect downstream in Georgetown Billabong.

A couple of days later, I saw a statutory infringement letter from RUM to the DME and other stakeholders reporting the incident, and describing it. In that letter, PW stated that the amount of material that had been spilled outside the RRZ was one cubic metre, and that a full cleaned up had been performed immediately. As a result there was no environmental damage.

The material that had been sprayed or hosed into the perimeter drains and turkey nest remained where it was for the remainder of the wet season and most of the following dry. During the dry months, the sump was allowed to dry out and the fine tailings blew around in the wind. I was concerned for the health of my people who visited that site on a daily basis as a part of their monitoring roles, and again approached AR about the OH&S aspects of the failure to clean up the residue of tailings spills. He agreed, but again, no action was forthcoming to rectify the situation. I also raised the matter at meetings where were present the most senior management and environment staff on the site. The cleanup did not occur.

The following September, after another similar, though much smaller, spill occurred on the inside verge of the Corridor Road, I became concerned enough to write a duty of care letter to the new Chief Chemist, David Toohey, (Figure 2.1). In that document, I summarise the history of the problem and my efforts to get something done about it.

Among other fears, I wondered about the quality of water from that system that was usually sent to RP2 and subsequently released into the Magela during planned release events. If its quality was prejudiced by the contaminated material from the spill that was still laying in the drains and sump, it might not be suitable for release at all. That eventuality would raise enormous water management and storage problems.

My duty of care letter was written on 090998. On the morning I wrote the letter, I had seen the result of machines scraping the sump out. A large amount of tailings material remained in the dry sump and in the drains feeding it. I realised that, if the job was not done soon, the coming wet season rains would distribute the contamination further into the managed water inventory.

On 281098, only six weeks-odd after I wrote my duty of care letter, Ranger learned that it had problems with RP2. Ranger began investigating an alarming water balance calculation that indicated there were 340 kilogrammes of uranium in RP2 that were not supposed to be there. (Figure 2.2). That is, according to the records of the water management programme, that amount of uranium could not be accounted for. Chemical tests shortly after that showed 7000 ppb uranium in the pond. This means that every litre of water in the pond contained 7 milligrammes of uranium. It is a large water body. The level had reached 3000 ppb in the dry season that year but was usually well under the 1000 ppb level, and frequently less than 250 ppb, (Figure 2.3).

Subsequently, I saw a letter, (Figure 2.4), written on 021198, in which PW notifies the stakeholders of a small spill on the Corridor Road. PW notes that, although only a small quantity of material had been involved, and none had left the RRZ, he has concerns about small quantities that might have persisted and entered the sump, and which might later pose a water quality problem in respect of disposal into RP2 and thence into the Magela system.

## ***2.3 Conclusions***

RUM significantly understated the magnitude and extent of the tailings spill in December, 1997. The statutory report to the stakeholders stated that only one cubic metre had been spilled. For that to have been the case, the spilled material would have to have been spread over the 25 square metre area to a depth of only 1.6 millimetres. Given the nature of the spray from ruptured flanges, and that the leak was undetected for several hours, the scenario reported by Ranger is not possible.

Although the area outside the RRZ was cleaned up quickly, the affected area inside the road was left for nine months before a serious effort was made to remove the tailings material. Even that effort was not completed. This exposed staff and the environment to ongoing exposure to toxic materials.

In view of what was occurring concurrently in Retention Pond 2, the failure to clean up promptly probably did cause or contribute to subsequent water management problems.

## **3. Technical Matters Affecting the Function of the RUM Environment Laboratory**

### ***3.1 Introduction***

The nature of this issue is highly technical. And it is riddled with jargon and convention. Some of the concepts and most of the argument will be foreign to persons who do not have a working acquaintance with analytical chemistry.

Rather than attempt to explain and justify each step in the logic behind the five technical issues, I shall confine myself to providing information on the potential environmental and statutory consequences of the failure to adhere to established best practice, and the terms of RUM's licence to operate the mine.

To support the validity of my points, I quote Ranger's own investigation into the matter. Ranger preferred to characterise my disagreements with the Chief Chemist as personal, rather than professional, and referred the matter to a "conflict resolution" process. That process engaged a senior scientific consultant to review the issues and adjudicate. Whilst I do not have a copy of his report, a letter to me from Ranger's Environment Superintendent, (given as Figure 3.3), clearly demonstrates that Ranger accepted the validity of the points I had made.



The issue reduces to Ranger's failure to operate within the provision of its licence which states, *inter alia*, and paraphrased, that Ranger shall maintain on the site a laboratory that is capable of being NATA registered. NATA is the national laboratory accreditation body. Among other things, it requires for registration that laboratories retain sufficient qualified and experienced staff who are fully conversant with the tests being performed, observe Australian Standards for the presentation and operation of methods used in chemical analysis, and maintain all of its equipment according to performance standards set out in the NATA regulations. The latter are, in turn, expressions of relevant Australian and international Standards.

That Ranger did not comply with the terms of its NATA registration did not necessarily cause inaccurate reporting. But in some instances, it definitely did, and in many more there is no way of knowing whether or not results were prejudiced. In the case of Alkalinity, the error was small and not frequently encountered. In that of Zinc, errors six times greater than the reporting limit were being propagated and reported. And in the case of TDS and the Balance, a result was reported that the test was not capable of measuring.

My contention here is that Ranger did not comply with the analytical best practice required by the regulatory authorities. That much can be demonstrated. It remains my opinion that there existed at Ranger the capability to adopt and operate best practice. During the tenure of my employment, there were sufficient competent analysts and appropriate instruments for the core Ranger tasks at hand. What was missing was the will to look more deeply into problems.

### ***3.2 The Technical Issues***

The text of the individual points, as presented to RUM management, is given as Figure 3.1. As stated above, this text can be somewhat obscure in places.

#### ***3.2.1 The Balance***

Refer to Figure 3.1.1.

The balance is a critical and mandatory item of equipment. Most of the operations in a laboratory depend, at some point, on the traceability of accurately weighed amounts of various standard and other materials. All volumetric apparatus, for example, is calibrated against the mass of water it contains or expels at a certain temperature. The calibrations employed require four decimal places in the data.

At the time, a laboratory balance capable of that performance could have been purchased for around three thousand dollars, and be freighted to the site in a couple of days. That the then Chief Chemist did not replace the existing balance when it was condemned by a NATA-certified calibration engineer is inexplicable.

The accuracy of a balance is critical in the case of low level analyses, where the results are close to the limit of detection. In one case at Ranger, the fourth decimal place in the mass of the sample becomes the result. That is, every tenth of a milligram, (0.0001 g.), in the sample represents a whole milligram in the result. If the balance cannot see the fourth place, it is not possible to produce results that are less than 10 mg/L for that test. Ranger continued to report such results for some months after they had been made aware of the problem.

### **3.2.2 Radium**

In this point, the failure to replace the failed balance propagated serious errors into the procedure for analysing radium. The scheme of the analysis is complicated, but essentially, the sample is inoculated with a very accurately weighed amount of a radioactive “tracer”. The tracer is analysed as well as the radium, and its recovery is used to correct the empirical value obtained for radium. If the tracer cannot be weighed accurately, the remainder of the analysis cannot proceed with accuracy.

When the balance was condemned, it was not withdrawn from service for two months. When it was finally accepted that its performance was compromised, the balance was not replaced. Rather, a “pea and thimble” shuffle was employed to create the extra decimal place and thus include an order of magnitude in the result that was not predicated by the original data.

To do this, the Chief Chemist instructed that a three-place balance be used to weigh out approximately 2.000 grammes of the tracer, but to record it on the worksheet as 0.2000 grammes. The shuffle was completed by diluting the tracer by a factor of ten.

I was asked to do this and append my signature to the worksheet, and declined. I was then rotated off the radium bench and replaced with a very junior trainee.

To put the problem another way, If I weigh out 1.234 grammes of something and analyse it, I may not report a result which has more decimal places in it than the least accurate original base measurement. I may report, say, 5.6 ppb, 5.67 ppb or 5.678 ppb, but not 5.6789 ppb. Such a difference is small in absolute terms, but it is finite, and when introduced at the beginning of a calculation it can be multiplied manyfold and produce an erroneous result.

Initially, the strategy failed to produce the expected results. Months of work were found to be invalid. As it turned out, there had been an error in diluting the tracer. Because nothing was documented, the error was not trapped and eliminated. And because no test work was performed to validate the changes, the error was not detected until it had been propagated through Ranger statutory monitoring results and some of the baseline work for the Jabiluka EIS. When it was discovered, there was insufficient time to repeat the test work, so the results were mathematically corrected to remove the supposed tenfold error.

Other changes were made to the method in order to speed up the analysis. Refer to the text in Figure 3.1.3 for details. Deadlines were approaching for the Jabiluka EIS and there was a great deal of pressure on senior staff to get the results out.

None of the changes made were in accordance with NATA registration. Indeed, the text of the method itself must be approved by NATA before it can be used under the registration. The changes were not incorporated into the manual of methods.

### ***3.2.3 Alkalinity***

This point is entirely technical. The discussion given as Figure 3.1.3 amounts to the following:

The original method was correct and functional. It was re-written to reflect changes to reporting units and remained correct. It was further re-written to accommodate the use of a new model instrument and continued to remain correct.

The method was reviewed by a new staff chemist and altered to reflect a NATA requirement that intermediate calculations be shown on the worksheet as an aid to traceability. After that review the method was checked and went into service.

Unfortunately, an error had been introduced by the new chemist and not trapped in the checking process. This should not be possible if the NATA requirement for documented method validation had been followed, and the checking process had been complete and thorough.

When problems became apparent with a particular type of sample, I investigated and noticed the error. I followed it back to its source and wrote a report explaining the problem to the Chief Chemist. He could not see the validity of the stoichiometric argument, and declined my request for the method to be re-validated.

### ***3.2.4 ICP Performance and Detection Limits***

This point pertains to the well-accepted fact that machines do not always perform to the level stated in their advertised specifications. It is especially true for highly complex instrumentation where the set values of a large number of variable operating parameters, the skill levels of the operators, and the environmental conditions obtaining at the time of analysis can have a significant bearing on the ability of the instrument to perform satisfactorily.

NATA, and other quality control/assurance systems, require that the performance levels and detection limits be determined empirically on a regular basis. By continuous verification at set intervals, this ensures that changes in the analytical environment cannot adversely affect the results produced by the instrument.

Prior to the matter being raised by me, Ranger had not performed those checks. The results it was then producing for itself, and on a commercial basis for other mines in the NT, were published over performance and detection figures that were not documented, and indeed, seemed on inspection by a practiced eye, to be derived from literature values.

I performed a set of validation tests and reported to the Chief Chemist. The results were mixed. Some of the results we were producing were technically valid, but some were not. He was unwilling to acknowledge the validity of the theory, could not see that we were breaching the terms of our NATA registration, and would not agree to changes in the procedure that would rectify the situation and involve very little extra work for the analysts. He pointed out that our credibility would be greatly reduced if we suddenly produced a set of ICP performance numbers that were substantially different from those quoted over the previous years.

A major impetus for Ranger to ignore the very well-accepted standards and practices in respect of validation, must have been the pressure of commercial work that was not related to Ranger itself. At the time, laboratory management were contracting out analytical services to most of the mines in the Top End, and a few in other states. The laboratory also performed corporate environmental work for its parent company, North Ltd.

All of that was done in addition to the statutory work required for Ranger itself, and with no increase in human or instrumental resources provided by the company. Instruments were set to "one size fits all" operating conditions, calibration standards became cocktails containing numerous exotic minerals that were not relevant to the Ranger operation, and some staff members were working six and seven days a week to keep pace with the volume of work arriving from the surrounding mines, and to cope with their core functions at Ranger.

### ***3.2.5 Zinc and Deionised Water, (DIW).***

This point illustrates the reluctance of Ranger management to investigate and rectify problems and confront the consequences of error.

Essentially, I encountered a problem with the ICP analysis of zinc. Zinc is reported above a detection limit of 2 ppb, but some results required a correction, (for background in the DIW blanks), of up to 12 ppb. There were two possibilities, one in the water and another in the conditions obtaining in the instrument at the time.

As chemical analysis is dependent on comparisons with blanks, I investigated the DIW system and found brass fittings that were probably contributing zinc to the water. I was also aware of the matrix problems being experienced by the ICP itself, (refer to Section 3.2.4), and needed to perform further test work to isolate and rectify the ultimate cause of the problem. For the interim, I recommended that the DIW system be serviced and the brass replaced with plastic.

A number of previous investigations had produced a mixture of results, but the problem had persisted. It was an accepted fact in the Ranger laboratory – but not elsewhere – that zinc must be blank-corrected. That the situation could and should be addressed and resolved seemed to have a low priority.

Ultimately, the problem was addressed by installing a final polishing, or clean-up stage to the DIW system. This unit mopped up any zinc, and other species, in the product DIW, but did not eliminate its source. The inter-twined issue of the ICP background continuum that is capable of distorting zinc measurements was not addressed directly, although the cocktails were rationalised. Blank corrections continued to be applied to Ranger statutory work.

### ***3.3 Discussion of Events***

As previously indicated, Ranger chose to interpret technical disagreements as personal conflicts. The disagreement that I encountered in the Chief Chemist was referred to a mediation process.

A respected expert in environmental chemistry, Dr. David Jones, from Earth, Water and Life Sciences Pty. Ltd., (formerly ERA Environmental Services), adjudicated the issues raised and agreed that each had merit.

Andrew Jackson, Ranger's Environment Department Superintendent, acknowledged the merit of the issues but would not allow me to obtain a copy of Dr. Jones' report. (Refer to Figures 3.2 and 3.3). In a communication to me, Mr. Jackson ventured the view that, notwithstanding the merit, "... pragmatic decisions are required ... [and] ... the system may not be perfect at all times."

I would have thought that best practice at all times should be the yardstick in all industry, but especially in a uranium industry that is located in the middle of Kakadu National Park. The very low level presence of chemical species at which baseline analysis is directed will not be accurately quantified by other than best practice technique. That reality, in turn, has enormous ramifications for our understanding of the effect that industry has on the environment.

### **4. Post Script**

The conflict resolution process ended in February, 1998. I continued to work in the environmental laboratory until December of 1998. At that time, an opportunity arose to work for another organisation outside the mining industry. I resigned from my position at Ranger of my own accord.

Where laboratory results have been quoted as real numbers in this statement, I have retained extracts from the laboratory data base to verify those numbers and correlate them with a sample site and a unique sequential sample number. In most cases, the date of the

sample is also recorded. Those documents amount to columns of numbers and acronyms, however they can be made available for inspection and verification against the primary records, which latter should be on record at the Ranger environmental laboratory.

Geoffrey Kyle.  
March 21<sup>st</sup>, 2002.

Figure 1-1 Plan View of Part of the RUM  
Minesite and Surrounding Country.

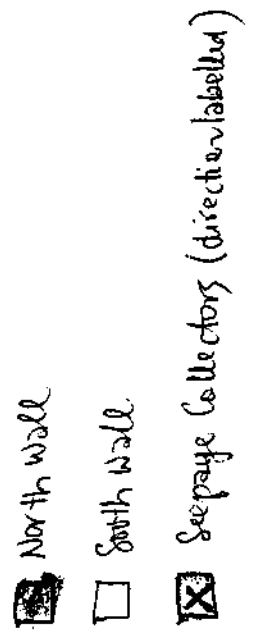


Figure 1.2 - Detail of TDSRC

Figure 1.2

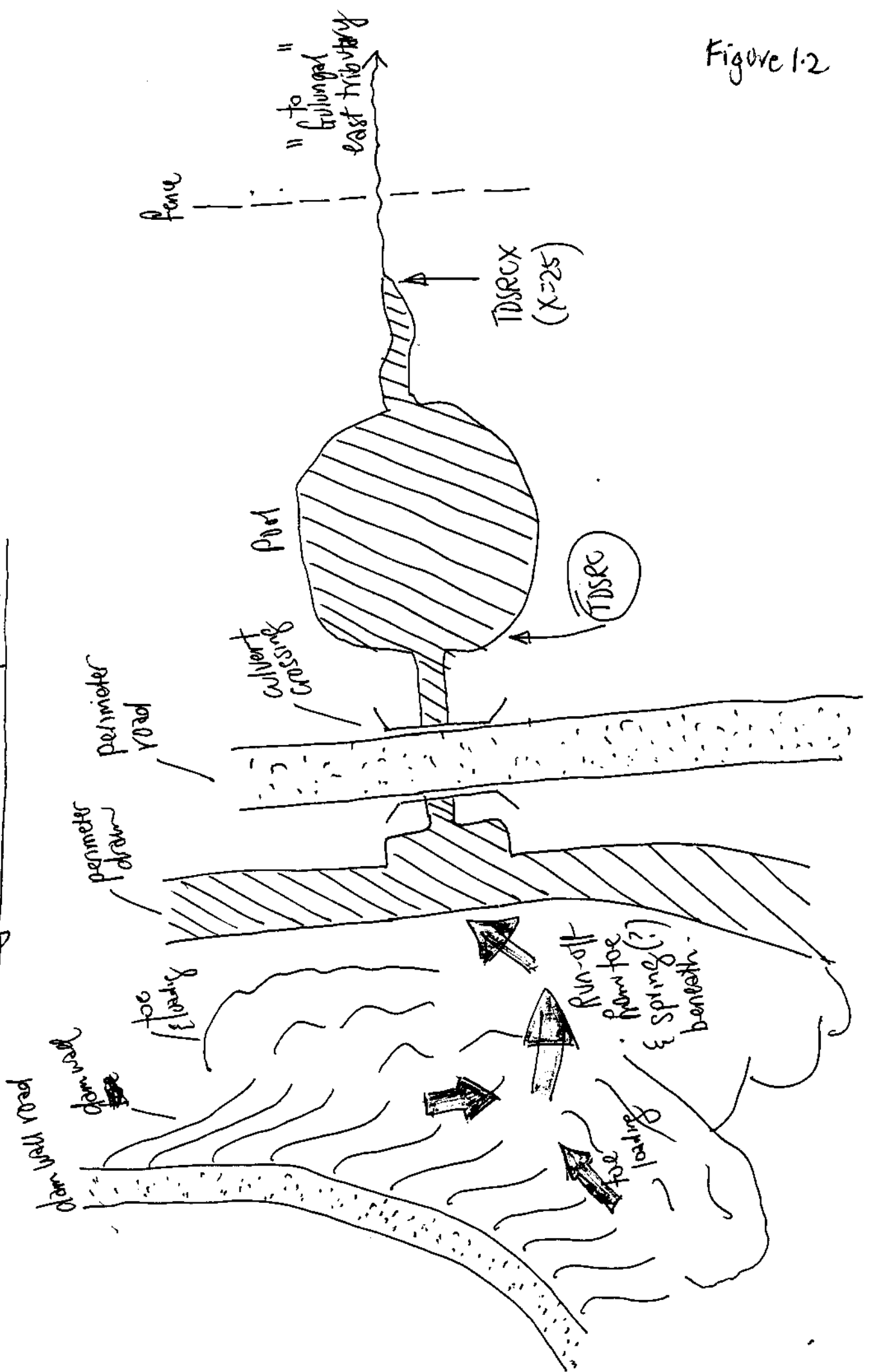
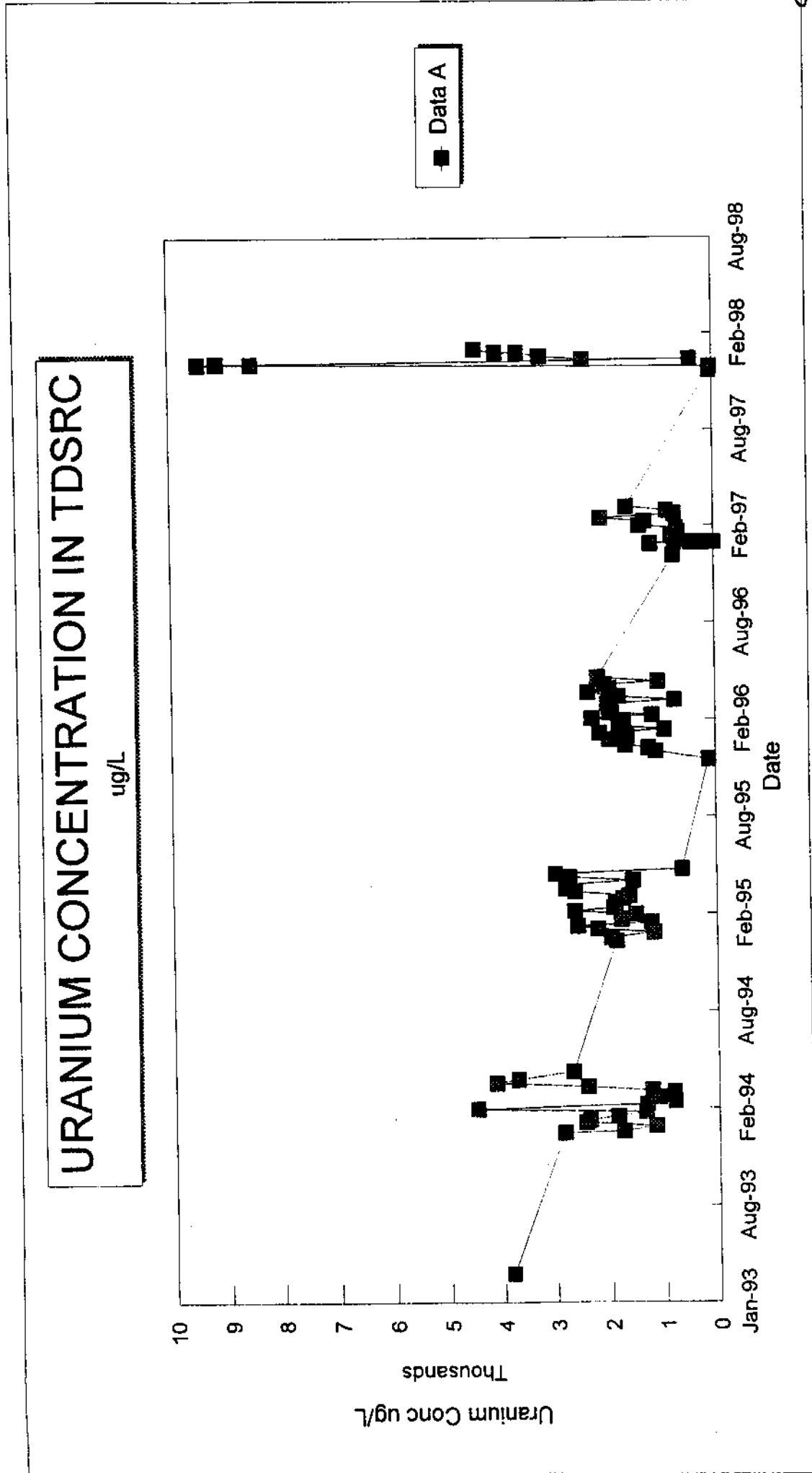




Figure 1.3



# U in TDSRC

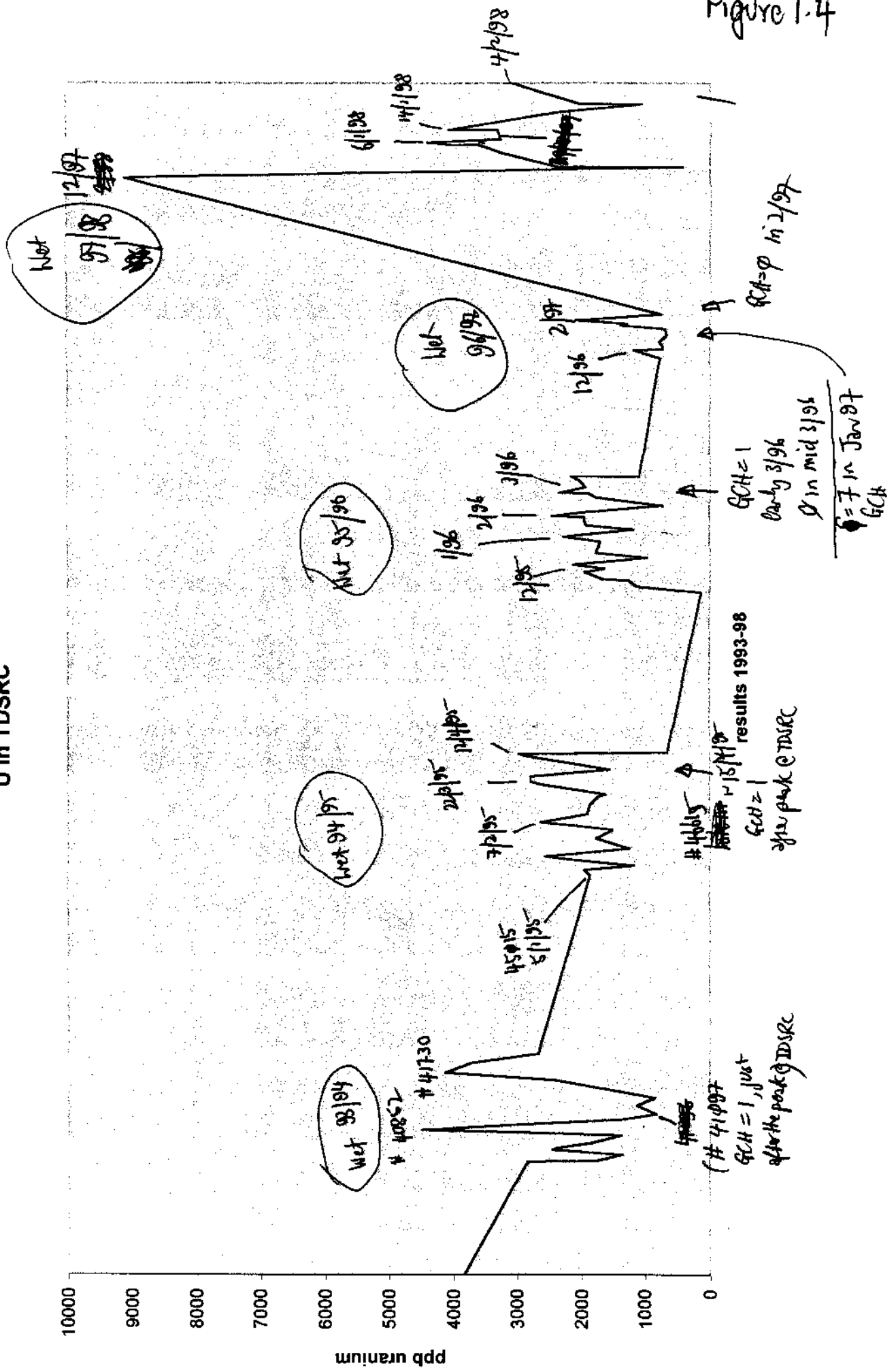


Figure 1.4



Figure 1.5

**ERA**

**Energy Resources of Australia Ltd - Ranger Mine**

ACN 008 550 865

## MEMORANDUM

TO : Geoff Kyle  
FROM : Mick Nolan  
CC : P Woods, A Ryan  
SUBJECT : TDSRC Uranium History  
DATE : 11 February 1998  
REF :

---

Geoff,

I have looked up the history of TDSRC uranium concentrations and found that the uranium concentrations were decreasing each year up to the 1997-1998 wet season. This year the increased uranium concentrations were most likely due to the toe loading of waste rock and earth works on the southern side of the tailings dam, and the general area of TDSRC last dry season.

I propose that the uranium monitoring continues at one sample per week and that towards the end of next dry season the situation should be assessed again.

Mick Nolan  
Senior Technical Officer.

Figure 1-6

Peter H Woods 23/02/98 01:17 PM

To: Mick Nolan/ERA/North/AU, Geoffrey Kyle/ERA/North/AU, Allan Ryan/ERA/North/AU  
cc:  
Subject: U in TDSRC

Thanks for the update on U in TDSRC. The graph at the end seems to tell the story well, and I also consider the recently placed waste rock to be the most likely source. Some of the toe loading was crushed and screened so has a relatively high surface area for initial leaching of constituents. I know we measure U at the road crossing of Gulungul Creek, and presume the U has always been low there. Could one of you please extract the data and put it on the same graph with TDSRC (maybe using a log scale), then circulate to the same list (MN, GK, PW, AR). I agree it is a 'watching brief', so we can confirm that the same trailing off of U values over the next few years. This info. is of use for final rehab. planning as we will have a lot of fairly fresh waste rock draining to the local creeks, mostly via wetlands such as the two bunds we have on Corridor Creek (MBL and Brockman).

Regards

Peter Woods  
23/2/98

Never done!

Fig 2-1



Geoffrey Kyle on 09/09/98 01:33:47 PM

Sent by: Geoffrey Kyle

To: David Toohey/ERA/North/AU,  
cc:  
Subject: TAILING SPILL CLEAN-UP

David,

In December of last year there was a spill of tailings slurry on Corridor Road, adjacent to what we call the Corridor Road Sump, CRS, and production people refer to as the Turkeys' Nest. The spill occurred when a tailings line flange burst.

Tailings material filled both north and south drains feeding the sump, covered part of the road and extended east almost to the creek. On the Monday after the incident, I saw wet tailings material half a metre high against the MC station which controls the pontoon pump. The mess was dealt with by hosing the material into the drains and thence into the sump. It was intended to drain the sump and dig out the offending material in order that water filling the sump in the following wet season would be of suitable quality to store in RP2.

This plan was not carried out in full. The sump was allowed to dry out, allowing the tailings material to blow around all over the place. Nothing was done about the drains. Although the material was not very mobile in the wet season conditions then prevailing, I felt that a health hazard would be present for people in the vicinity in the dry season when the wind stirs up this very finely divided and toxic material, I brought the matter to the attention of Allan Ryan. That person agreed that the potential for a hazard existed, and undertook to raise the matter with the Mine Department. When no action was forthcoming, I again referred the matter to AJR. I have also mentioned the matter to Peter Woods, Andrew Jackson, and, most recently, to Ken Lonie. All of those persons promised to look into the matter and get back to me. None has.

Today I noticed that the floor of the sump has been scraped by a machine of some sort, but most of the tailings material is still there. Again, nothing has been done to clean the drains. It is hot and windy today, and a considerable amount of material is becoming airborne each time a vehicle passes the drains and with each gust of natural wind.

David, I wish to report this once again, and ask that action be taken to remove the hazard. I think you will agree that nine months should be adequate time for action in respect of something like this, especially when such senior people are aware of it. I am concerned that, if nothing is done soon, the problem will be conveniently obscured by the coming rains, only to raise its head in the next dry. During the wet, some of the material could be mobilised by the mechanical processes of water flows, and individual chemical species could be mobilised by dissolution. This could cause problems in other environmental contexts, as well as constituting a hazard for our staff.

Geoffrey Kyle.



Fig 2.2

**ERA**

**Energy Resources of Australia Ltd – Ranger Mine**

ACN 008 550 865

**MEMORANDUM**

TO : Peter Woods  
COPIES : Allan Wade, Holger Topp, David Toohey  
FROM : Paul Bryers  
SUBJECT : RP2 Water Quality  
DATE : 09 November 1998  
REF :

Gentlemen,

Following is a summary of all the information I have to date on the increase in uranium in RP2.

On the 28 October it was noted that the U level in RP2 had increased substantially and a sample was taken and analysed on the 29<sup>th</sup> to confirm the high value. This was confirmed and subsequently the samples were assayed by a different technique for further confirmation which did further qualify the results.

Water resources were then contacted and conducted a water balance on RP2 and calculated a 340 Kg load of U which could not be accounted for.

A meeting was conducted with Allan Wade, Geoff McKenzie, Paul Bryers, Steve Abbott, Jacqui McGill and Ray Anderson. This outcome of this meeting was that it was unlikely that any uranium had been added from the mill area.

After inspecting the RP2 area samples were taken from sites 1, 3 and 4. It was decided that after a 30mm rainfall event that more samples would be taken. This occurred on 30<sup>th</sup> and only two samples were taken due to safety considerations.

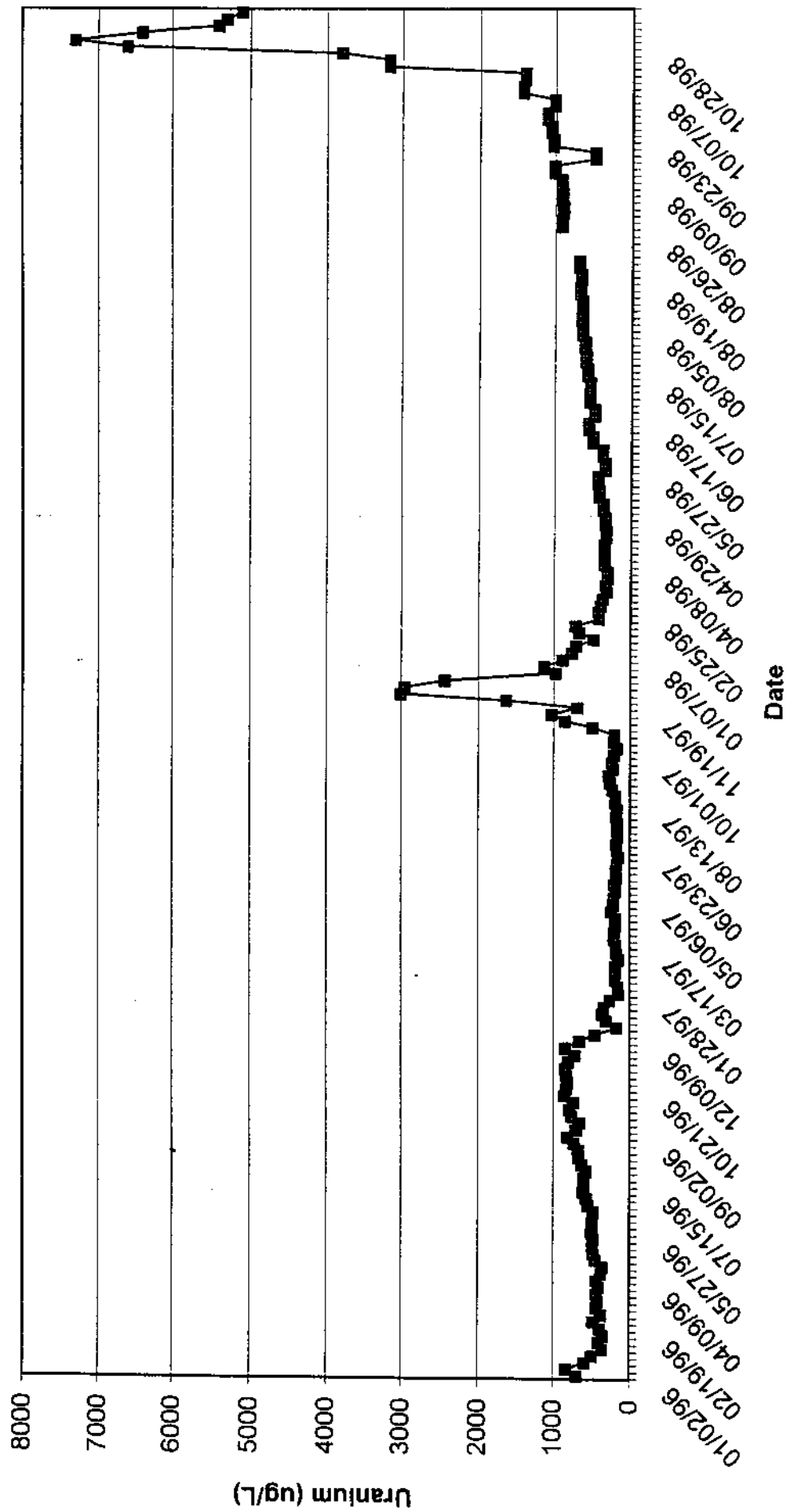
Other trace element concentrations have not yet been analysed and should be available by 16 November.

It has been suggested that uranium solubility in the presence of bicarbonate may be responsible for the increased uranium concentration. To measure the maximum available uranium, acid digestion on RP2, Pit 3, and the ore stockpile sump sites from before and after the uranium increase are underway and should be available 10<sup>th</sup> November. This will also detect an increase in the percentage of dissolved uranium.

The diagram on the following page shows sample sites and corresponding U concentrations.

Fig 2.3

## Retention Pond 2 Water Quality



**ERA****Energy Resources of Australia Ltd – Ranger Mine**

ACN 008 550 865

Fig 2-4

**FACSIMILE TRANSMISSION**

**TO :** Mr Tony McGill ( Director Of Mines ) **FAX NO :** 8999 6527  
 Mr Peter Waggitt (SSG Darwin) 8981 4316  
 Mr Stewart Needham (SSG Canberra) 02 6217 2060  
 Mr Steve Roeger (NLC Darwin) 8920 5177  
 Director, Uranium Industry Section, (DPIE 02 6272 4309  
 Canberra)

**COPIES :** K Lonie, A Jackson, A Wade, P Bryers, H Topp, S Walker, P McNally

**FROM :** Peter Woods (Acting Manager -TEL. NO : (08) 8938 1228  
 Environment, Safety And Health)

**REF :** I25-0001 **FAX NO :** (08) 8938 1203

**SUBJECT :** Notification (Non-Infringement)

**DATE :** 02 November 1998 **NUMBER OF PAGES:** 3 (including this page)

All pages of this document are intended for the named addressee, are confidential and may contain legally privileged information. The copying or distribution of these pages or any information they contain, by anyone other than the addressee, is prohibited. If you receive this document in error, please advise us by telephone, then destroy the document.

I write to inform you of a small quantity of tailings material that reported to the tailings corridor drain on Saturday 31 October.

This occurred at two locations (see attached figure) during clearing of the tailings lines which had become bogged. Neither tailings nor process water left the drain, which is RRZ and present for such events. Nevertheless, ERA committed in 1996 to advise the main stakeholders should tailings enter the tailings corridor catchment, given its preference to transfer water to RP2 rather than the tailings dam as was the earlier practice. The ESH and mill departments have held initial discussions as to possible improvements to the protocol for clearing blocked lines with a view to reduce the likelihood of adverse effects on water quality in the tailings corridor sump.

Whilst most tailings material can be cleaned quickly, it is possible that some has entered the tailings corridor sump, and a small quantity of process water has been washed into the sump. As a result water in the sump will be allowed to overflow into Pit #1 for the time being. Routine and additional monitoring of water in the sump will continue until it is established if there is an effect on water quality. Water quality data will be provided to the Minesite Technical Committee, and if water quality is suitable endorsement sought from DME to recommence pumping to RP2.

Due to the locations of the tailings both east and west of the sump it is not possible to construct a temporary sump as was done last year.

Sydney Office Level 18, Gateway, 1 Macquarie Place, Sydney NSW 2000 Australia Tel: (02) 9256 8900 Fax: (02) 9251 1817  
 Ranger Mine Locked Bag 1, Jabiru NT 0886 Australia Tel: (08) 8938 1211 Fax: (08) 8938 1203  
 Web Site [www.enamvres.com.au](http://www.enamvres.com.au)

A Member of the MORTM Group

Date Printed: 2 November 1998

\\ERAJAB\_F05L\\Tails\_2\_11\_98.doc

this not  
 cleared  
 Dec 97 No  
 improvement  
 since then  
 (gt)

MTC  
 due  
 24/11  
 please call  
 & discuss  
 Peter

2 sump is  
 try fill!

It took 3 months to clear the sump and the  
 drain was never fully cleared after Dec 97 (gt)





Fig 3.1

**ERA**

**Energy Resources of Australia Ltd - Ranger Mine**

ACN 008 550 865

**Jabiru Environmental Laboratory:**

ph: (08)89381331

**Chemistry Laboratory:**

fax: (08)89381302

ph: (08)89381325

email: geoffrey.kyle@north.com.au

## **M E M O R A N D U M**

**TO** : Andrew Jackson  
**FROM** : Geoffrey Kyle  
**SUBJECT** : TECHNICAL MATTERS  
**DATE** : 16/2/98  
**REF** : gjk:gjk:16feb98a.lwp

---

Andrew,

Please find attached a statement detailing some of the technical matters which were identified during the course of my discussion with Ian Shakespeare.

As suggested by Ian, I have restricted the exercise to a presentation of the verifiable facts.

Regards,

Geoffrey Kyle.

- Balance

The analytical balance was declined a NATA certificate for four-place operation on 16/8/96. On 26/10/96 the balance was labelled as suitable only for unrounded three-place readings. For two months until then, all analyses requiring the balance continued to record and use the fourth place.

The balance failed a required in-house calibration check on 24/9/96, and was later internally tested against three place criteria on 22/10/96 and 25/3/97 and passed.

Up until the balance was replaced in 10/97, the fourth place continued to be employed for routine and statutory work, and some early work on the Jabiluka project, (excluding radium).

Other volumetric instruments whose Australian Standard calibrations depend on the four place accuracy of the balance failed required in-house performance checks but were deemed to pass when compared with three place criteria, (eg. Gilson Dilutor, 29/1/97).

A fully-functional analytical balance is a critical item of equipment. Its performance is either specified or implied in most of the methods employed at this laboratory, including those with NATA registration. The production of all primary, intermediate and working standards must be traceable through an appropriately certified analytical balance.

Failure to replace the balance immediately had the potential to compromise results, (see Radium below), and in some methods represented non-compliance with the requirements of NATA registration, (preparation of standards, calibration compliance checking, and quantitative dilution of samples). In the case of Total Suspended Solids, where a three place balance is not capable of reporting less than 10 mg/L, such results were reported and passed through the quality system.

- Radium

After QTC reported that the balance would not support four place measurements, statutory radium analyses continued to utilise the fourth place for more than two months until 10/96 when the balance was labelled as described above. Thereafter, the barium tracer material was diluted by a factor of ten, and ten times the original mass was weighed out and recorded on the local work sheet to three decimal places.

No test work was performed to determine the effect of dilution and validate the change of procedure. The written method and electronic calculation were not altered, and data were entered into the electronic calculation after moving the decimal place in the recorded mass one place to the left such that the report hard copy recorded the mass of  $\sim 0.2000$  g. instead of the actual mass weighed, which was  $\sim 2.000$  g.

The revised process encountered difficulties when a large number of sequential results were observed to vary consistently from historical trends. The discrepancies were attributed to a putative tenfold dilution error in the preparation of the diluted barium standard. The results were corrected by dividing the mass of the erroneously diluted standard by a factor of ten and then recalculating.

Radium analyses were also compromised by reducing the gamma count time from 600 to 300 seconds. Even though the majority of the samples submitted for radium analysis will report at very low levels, no test work was done to determine the effect of halving the statistical population of the recorded count data. The analyses proceeded for some time using standards which had been prepared and verified at the specified 600 seconds. The standard counts were scaled to approximate the sample count time. More appropriate standards are now in use, but the 300 second count time is routine.

Radium analysis is a skilled task. Experience with gravimetric techniques is required for the classical wet end, and reliable instrumentation which is supported by adequate statistical data is necessary for the alpha and gamma counting procedures which yield the quantitative data.

This very important statutory and EIS parameter is currently analysed by an inexperienced person using a semi-quantitative, three place top pan balance, whose certified limit of performance is  $\pm 0.021$  g. This top pan unit is used without its shroud and lid, accessories which are necessary to achieve the limit of performance quoted. This level of accuracy in the determined mass of the tracer material is transposed into the electronic calculation in the form of 0.2 g. to four decimal places. These changes have not been tested except by reference to the internal "recovery" calculation, which is itself dependent on the same data.

- Alkalinity

The method for alkalinity, P/N 1106, was originally written and registered for use with a particular model auto-titrator and reported in units of calcium carbonate. It was reviewed and rewritten by its author to reflect the 1992 change of reporting units to carbonate and bicarbonate. The resultant changes were documented and accounted for in the new machine factors. The method was subsequently modified to suit a new model titrator. This involved no factor or programme change.

The method was subsequently modified again to address a requirement to document intermediate calculations for each determination, and to clarify a change to the data entry procedure for the LIMS system which received the results electronically.

As part of a method review, which followed the NATA review delegation finding that some laboratory documentation was not up to standard, many of the RUM methods were rewritten to the relevant Australian Standard, including Alkalinity. The revision was checked and approved and went into service. The method was later included in a general NATA review and passed.

The method was later further reviewed and a resultant rewrite was checked and approved. It went into service around 9/97.

This latest version of the method appears to contain errors in respect of the internal quality control standard and the calculation units of results produced from Methods 3 and 4. The errors apply only to the internal quality control standard, and to rare samples having a pH in excess of 8.3.

The routine external quality control standard reports within the range specified for low level alkalinities, according to Method 5, and Methods 1 and 2, which account for the vast majority of samples, were not involved, being unchanged from the earliest version.

The text of the method dealing with the preparation of an internal reference material standard, (4.4.8), contains an apparent error, (hydrolysis and speciation of primary salt not accounted for), which predicts an incorrect value for the quality control standard as it is to be determined empirically according to Sections 6.1 and 6.2.

0.164 g. sodium carbonate = 175 mg. calcium carbonate (4.4.8) ( ~ 189 mg. bicarbonate)

For example: actual print-out data from an analysis of an aliquot of that standard, whose pH was around 10.4, was: R = 83.317 mg/L and R2 = 111.53 mg/L. According to the method, both are expressed as calcium carbonate. From the method,

$P = R / 2 = 41.66 \text{ mg/L}$  and  $M = R2 = 111.53 \text{ mg/L}$ . Thus  $T = P + M = 153.19 \text{ mg/L}$  as calcium carbonate, (6.2).

Since  $P < T / 2$ , "carbonate alkalinity" will be reported as  $2P$  or 83.32 mg/L, and "bicarbonate alkalinity" as  $(T - 2P)$  or 69.87 mg/L, both as calcium carbonate. (App. 4). Since the unit of reporting is no longer calcium carbonate, these must then be converted to 49.95 mg/L as carbonate and 85.17 mg/L as bicarbonate for the "carbonate" and "bicarbonate" alkalinities respectively.

If the same data are used to calculate a result based on the machine-resident constants in the auto-titrator, and the theory of speciation, the following is obtained:

$R = 83.317$  mg/L as carbonate, and  $R2 = 111.53$  mg/L as bicarbonate. From theory;

$P = R / 2 = 41.66$  mg/L as carbonate, (69.49 as calcium carbonate), and

$M = R2 = 111.53$  mg/L as bicarbonate, (91.49 as calcium carbonate). Thus

$T = P + M = 160.98$  mg/L as calcium carbonate, (6.2).

Since  $P < T / 2$ , "carbonate alkalinity" will be reported as  $2P$  or **83.32** mg/L as carbonate, and "bicarbonate alkalinity" as  $(T - 2P)$ , (22.01 mg/L as calcium carbonate), or **26.83** mg/L as bicarbonate.

The same data calculated by the formula provided in the text of the original method yields "carbonate alkalinity" of **83.32** mg/L as carbonate, and "bicarbonate alkalinity" as **28.21** mg/L as bicarbonate. (The text of that method acknowledges rounding constants to integers for calculation of "bicarbonate" alkalinity directly as  $(R2 - R)$  as bicarbonate.)

If another method is used to determine the total stoichiometric alkalinity to pH 4.5 of that standard, say, using Method 2, reported as bicarbonate, the results agree with the theoretical prediction.

The original machine-resident constants remained active throughout the several reviews of the written method and all sample results reported by Methods 1,2 and 5 of this procedure are sound. Nevertheless, an internal quality control error was instituted, approved and perpetuated for some time without being exposed by the quality system.

- ICP Performance and Detection Limits

No documentation seems to exist which supports QC and performance criteria quoted in respect of ICPOES analyses. Beyond a statement of limits for some analytes given in the text of the 12/92 edition of the laboratory method, (see below), and a page in the maintenance log from 11/90 which consists of a computer print-out software summary of background equivalent concentration and detection limits for 14 analytes at 21 wavelengths, (obtained from the analysis of blank and synthetic solutions under unspecified conditions, and calculated by an unknown software algorithm.), no data which address the verification of performance are extant.

There should be two sets of data, one for each of the matrix types analysed. (That is, filtrate and residue. Acid-extractables were not analysed until around 1994.) According to the relevant authorities, the sets should have been appended to the registered method and verified empirically as a regular, documented QC exercise. A minimum regime would have produced data sets on commissioning and NATA registration, and thereafter annually, and after major component changes.

The instrument concerned generates a great deal of baseline and low-level data whose credibility is predicated, at least in part, on the presumption of documented performance characteristics, including detection limits. For most of its service life it has not been subject to a programme of routine performance checking against established standards.

During a period of exception to that, and when the instrument was performing well, several sets of empirical data were produced according to the recommendations of the testing authority and reported through the laboratory quality system. Some of those data supported the values routinely quoted and some did not.

For the currently relevant suites; for filtrates, K, Fe, Cu and particularly Al were detected above the quoted limits, and Na, Mg, Ca, SO<sub>4</sub>, Mn and Zn either met or bettered their respective quoted limits. For residues, only Mn met its quoted limit. (See table below.)

The detection limits currently quoted are the originals, used since the ICP method first addressed them in 1992, and possibly since the instrument was commissioned in 1989. During its life, the ICP has occasionally suffered serious maintenance problems and had several major components either changed out or repaired. It operates in an environment of somewhat variable conditions and is driven by persons of varying technique. It has never been the subject of regular professional service. Quoted performance characteristics therefore must depend to a significant extent on consistent application of consistent conditions to an appropriate standard method.

At various times, significant and undocumented changes have been made to some or all of those factors in the course of routine operation. Modifications to instrumental operating conditions have been made without subsequent verification of performance criteria and detection limits, and without reference to the quality system.

All ICP analyses described in P/N 1119, are performed by the same parent method. Single calibrations are used to quantify samples whose undiluted concentrations vary from below detection limits to the calibration maxima of 20 ppm for "cations" and 1000 ppb for

metals. Process samples whose concentrations can be 2 orders of magnitude outside the calibration maximum are analysed, after appropriate dilution, by the same method as statutory samples of baseline level.

Identical parameter values apply for all instrument functions and plasma conditions. The software capabilities for individual background correction and spectral compensation are not utilised. Internal quality control standards of a concentration 20 to 50 percent of the calibration curves, are run within batches. An external standard, whose concentration is 10 percent of the curve, is checked in singlicate on a monthly basis. All tolerances are set at the nominal plus or minus 5 percent. Empirical verification of the stated analyte concentrations of successive batches of both internal and external standards applies a plus or minus 5 percent nominal tolerance to a single data set of five elements which is acquired in a single run. In recent times, a quarterly calibration interval has been observed.

#### DETECTION LIMITS

ANALYTE		INITIAL (stated in 10.2, method, rev.1)	CURRENT (routine use since 1992)	EMPIRICAL CHECK (November, 1996) ( F ) ( R ) (AExt)		
Na	ppb	5	100	100	n/a	n/a
K	ppb	50	100	200	n/a	n/a
Mg	ppb	1	100	100	n/a	n/a
Ca	ppb	1	100	100	n/a	n/a
SO4	ppb	100	100	100	n/a	n/a
Mn	ppb	1	1	1	1	1
Cu	ppb	2	2	3	4	3
Zn	ppb	2	2	1	4	2
Fe	ppb	n/g	2	3	3	2
Al	ppb	n/g	10	20	15	18
Pb	ppb	20	n/u	20	20	20
U	ppb	70	n/u	130	110	100
PO4	ppb	100	n/u	n/t	n/a	n/a

n/a = not applicable, n/g = not given, n/t = not tested, n/u = not used

At various times the instrument and method have seen extensive duty analysing commercial environmental and geochemical samples from a diverse range of sites. Elements analysed included: Ni, Co, Cr, Cd, As, Se, Sb, Si, V, Mo and Tl. These analytes were calibrated from cocktail solutions in concentrations of up to 10,000 ppb each, and which included the routine Ranger suite of analytes at up to 1,000 ppb each, (for metals.) No test work is available to document the performance of the instrument and its single method under those conditions. Those elements are no longer quantified. The calibration solutions were rationalised when the method was rewritten to Australian Standard in 11/96, and have since contained only those analytes relevant to the current operational requirements of the method. That is, those tested in 11/96 less Pb and U.

Fig. 3.1.5

- Zn/DIW Investigation

There is a history of puzzling inconsistencies in zinc results. The incidence is recurrent and apparently episodic. It has variously been attributed to contaminated acid dispensettes, contamination of samples during filtration in the clean room, and contamination emanating from commercial acids which had not been screened.

One investigation examined a great deal of historical digestion and filtrate data and indicated a possible contamination problem in the DIW system. Further sampling and testing of DIW from various sources confirmed that a contamination was likely and narrowed it to a brass tap fitting in the digestion fume hood. Other fittings on the DIW ring main, including several of the taps, were found to be brass.

A report in 7/96 detailed the results and recommended that the DIW system be refitted with plastic components. To that was added a recommendation that method development work would be required to eliminate the possibility that measurement errors close to detection limit were contributing to, or masking, the apparent problem. The measurement of zinc was at that time compromised by the use of multi-elemental cocktails for bulk calibrations. (Refer to comments on methodology in the discussion of performance and method detection limits for the ICPOES instrumentation.)

A work request was raised and brochures describing appropriate fittings for the DIW system were sent to a contractor. That work requested has not been performed. The calibration matrix has been rationalised to a suite appropriate to the current statutory requirements. The ICP method continues to rely on a single set of conditions. Only ultra-pure acids are now used, and DIW is not drawn from the suspected outlet.

Another investigation of the zinc/DIW problem was later instigated after further problems with the low level analysis of zinc. The results of that investigation are apparently undocumented and no test data or notes are extant.

Recently another investigation of the problem was requested. No action has been taken on the recommendations of previous investigations. Zinc analyses are subject to blank correction at the discretion of the analyst. Such corrections vary between 2 and 9 ppb and have been as high as 12 ppb. Results are reported subject to a detection limit of 2 ug/L.



Fig 3.2

P.O. Box 561.  
Jabiru, N.T., 0886.

November 11 th., 1998.

The Manager,  
Department of Environment, Safety and Health.  
Ranger Uranium Mine.  
Locked Bag 1.  
Jabiru, N.T., 0886.

Andrew,

As you will be aware, I have resigned from my position as a Technical Officer in the Chemistry Section of the RUM Environment Laboratory. Separation will be effective from December 11 th., 1998.

I would like to take this opportunity to remind you of your commitment to provide me with a document which states the results of David Jones' adjudication of the five technical matters which I raised during the course of my "conflict resolution" sessions with Allan Ryan.

Notwithstanding my intended departure, the "further clarification" of those technical matters, as it is described in the mediation report, remains an important professional issue with me.

Yours sincerely,

Geoffrey Kyle.  
MRACI CChem.



Fig. 3.3

**ERA**

**Energy Resources of Australia Ltd – Ranger Mine**

ACN 008 550 865

**MEMORANDUM**

**TO** : Geoffrey Kyle  
**FROM** : Andrew Jackson  
**SUBJECT** : Technical Matters  
**DATE** : 03 December 1998  
**REF** :

Dear Geoff,

My apologies for the delay in my response to your e-mail of 11 November 1998, but I have been diverted onto other matters entirely for the last few weeks.

Having discussed these issues at the feedback meeting held with Ian Shakespeare, I understood that it had been agreed that these matters were in the past, and further I have no record of ( nor believe there was ) a commitment to provide " a document which states the results of David Jones adjudication of the five technical matters ".

Despite that, I provide the following advice in relation to the issues you raised viz;

- analytical balance
- radium
- alkalinity
- ICP performance and detection limits
- Zn/DIW investigation

David Jones agreed that each of your points has technical merit. Sometimes, however, pragmatic decisions are required and, as a result, the system may not be perfect at all times. This does not mean, however, that the overall performance is, or was, compromised.

You will note however, that over the past 8 months the capital acquisition process has been followed in a prioritised manner and the issues you raised have been substantially addressed – in particular the issues of the balance and water supply. In other cases procedures have been reviewed.

I am satisfied that ERA's laboratory strives to operate to a very high standard and am proud of the work done by everyone associated with it.

Good luck in your future endeavors.

Yours sincerely

Andrew Jackson  
Manager, Environment, Safety & Health