Water Use Assessment for a remote Indigenous Community.

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Executive Summary.

The effects of renal disease and in particular renal failure are having an increasingly traumatic impact on the culture and life of central Australian Indigenous people. The dramatic rise in the incidence of the disease among these people has been described as an epidemic. It is necessary for those needing dialysis to leave their homes and families and live in Alice Springs to receive treatment. This separation means that vital relationships and connections are being lost and making the life of dialysis patients difficult. It is the desire to be able to undergo dialysis at home, on the community that was the driving force behind this report. The Kintore community raised one million dollars through the sale of paintings in Sydney at the end of 2000 to go towards establishing such a service in their community.

The aim of this report is to determine the technological and environmental aspects of a remote dialysis unit in Kintore. The purpose of the report is to provide useful and appropriate information on water quality to the community of Kintore. In an attempt to present a more comprehensive report issues relating to dust, power and waste are included. This, along with information regarding the quality, management and treatment of the water at Kintore, will enable the community to make an informed decision on future action.

Kintore has three production bores that supply the community. Available water quality data indicates that this water meets Australian Drinking Water Guidelines for most parameters. However in terms of the quality required for dialysis much treatment needs to be carried out. Levels of calcium and magnesium need to be reduced in order to avoid adverse health effects and to prolong the life of the dialysis machines. Treatment options for this water are varied. Further work is recommended to determine the most effective method for the size of the community, cost and maintenance required. Some level of softening is required and then reverse osmosis could bring the water to the required standard. The sustainable use of the resource is another area in which further work needs to be conducted. It has been recommended that close monitoring of water table levels be carried out for all aquifers in the western desert region in order to determine some relationships between recharge and rainfall. This information is vital to establishing water-based infrastructure. A sustainable yield of 235 m$^3$/day was estimated for Kintore and consumption data indicates that this is often exceeded. A dialysis unit has a constant and permanent water requirement and will place a new strain on the supply, which may not be sustainable.

It is necessary to provide a back up power supply to the clinic. It the past the supply of power has been unreliable. The power station has been recently upgraded and now has three diesel powered generators that supply the community with 750 kW of power and outages are not as common as they once were. Options for a back up power supply have been investigated. The alternatives include a solar powered supply or a separate generator for the clinic. This second option could be the easier of the two being cheaper and more familiar to the community.

The presence of dust is evident in all environments around the community. This presents a threat to the health of patients undergoing dialysis and levels need to be kept to a minimum. Further research should be conducted into the actual levels and composition of dust at Kintore,
as no data exists at present. Solutions for controlling the dust include sealing the rooms, air conditioning, landscaping, fencing, building orientation, building design, and cleaning.

Kintore does not have a functioning waste collection program making the disposal of biohazardous waste difficult. Waste generated from dialysis consists of consumables such as bloodlines, swabs, syringes, and fistulas. It also consists of the waste dialysate and wastewater from the reverse osmosis treatment. Complete and satisfactory disposal of this waste is essential and needs to be addressed.

This report provides information on the issues of water, power, dust and waste in relation to kidney dialysis for the community of Kintore. The complexity of the situation demands a holistic approach that should consider the social, cultural, environmental and technical issues involved.
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Acknowledgments.

I would like to thank:

- The Cooperative Research Centre for Water Quality and Treatment for providing me with the opportunity and the funding to carry out this research. The time has been full of amazing experiences, which I would otherwise have not been able to enjoy.

- The staff at CAT for making me feel welcome and for doing everything possible to make my job easy and enjoyable.

- The staff and patients at the Alice Springs Renal Unit for their valuable assistance in pointing out the issues involved with the running of a dialysis unit and details on kidney failure.

- A special thanks to Turkey Tolson Tjupurrula, Amy Nampitjinpa, Parara Napaltjarri and Daniel Tjupurrula for talking with me about their ideas on dialysis and having a unit at Kintore.

- The Power and Water Authority for providing data and essential information on the delivery of services to Kintore.

- The people and staff at Kintore for their assistance and hospitality during the site visit.

- My supervisors: Bruce Walker, Gabriele Bammer and especially Robyn Grey-Gardner.
1. Introduction.

The Indigenous community of central Australia, has in recent years, been forced to deal with the devastating effects of kidney disease on their people and culture. Along with other so-called ‘lifestyle’ diseases, the reality of dealing with renal failure and its treatment has become starkly personal. Catford et al. (1997 p.14) have described the situation as having reached “epidemic proportions”.

Presently, patients from remote communities seeking dialysis must move to Alice Springs, as it is the closest centre with a renal unit. Indigenous people have a spiritual connection with their land and the need to move away from their land causes great distress. The trauma that results from isolation, coupled with illness and homesickness means that renal failure and the ensuing dialysis threatens the well being of the Indigenous community.

In an attempt to address the consequences of dialysis for Indigenous people, this report has investigated primarily the water issues involved with establishing a dialysis unit at the remote Indigenous community of Kintore. A brief overview of renal disease and the social and cultural implications involved has been included to highlight the need for such a report. Specifically this report deals with the availability, quality and sustainable management of water. Power, dust, and waste are included to make the report more useful to the community.

The aim of this report is to determine some of the technological and environmental aspects of a remote dialysis unit in Kintore. The purpose is to provide useful and appropriate information on water quality to the community of Kintore for future reference.

1.1. The Kintore Community.

Kintore is a large community located approximately 500 km west of Alice Springs, 50 km east of the West Australian border (CAT 1990). The community has a population of 450 (CHINS 1999) and has been established since 1980. A group of the Pintubi people decided to move out of the Papunya Native Settlement in response to the Homelands Movement initiated in the 1970s (Wischusen 1995). The installation of a hand pump following the drilling of bores facilitated this move (CAT 1990).

The community is well established with a clinic run by the Pintubi Homelands Health Service, school, store, art gallery (Papunya Tula Artists), community council and the Ngintaka Women’s Centre.
Environmental conditions at Kintore are extreme. It is a dry, dusty and remote community. Travelling to the community involves either a ten hour drive on flood damaged dirt roads or a 4 hour plane flight. Temperature variations are extreme: summer temperatures can exceed 45°C and in winter temperatures below -5°C are common. Situated at the base of Mt Leisler and Mt Strickland, high winds are part of the climate. With these winds come dust storms that often bring the visibility down to a couple of metres (pers. comm Ellis 2 Feb. 2001). Fierce storms also lash the community bringing torrential rain and causing localised flooding (CAT 1990). The community can be isolated due to weather. Both air and road access can be prevented in cases of extreme weather.
At the present time there are 7 members of the Kintore community living in Alice Springs to receive dialysis. People from neighbouring communities are also living in Alice Springs. Four people from Papunya and two from Mt Leibig are living in Alice Springs and would presumably use a renal unit at Kintore should one be built. An exhaustive fundraising effort has been carried out and well over one million dollars has been raised. This was achieved through an auction of paintings by the Papunya Tula artists held at the end of 2000 in Sydney. This indicates the strength of the need the Kintore people have to be back home and have their families near. A portion of that money has been approved to give patients a flight home on several occasions during the year. The first to take advantage of this arrived in Kintore on 28th February 2001.
2. Renal Disease in Indigenous Australians.

2.1. The increase of renal failure in Indigenous Australians.

The following points highlight the degree to which central Australian Indigenous people are affected by renal failure.

- In terms of population, kidney failure in Indigenous people of central Australia is approximately twenty times greater than the non-Indigenous population (Catford et al. 1997). The marked contrast between Indigenous and non-Indigenous people is evident in Figure 3.
- In 1994 the approximate incidence of renal failure in Indigenous people throughout Australia was six times greater than the incidence in the remaining population (Catford et al. 1997).
- The Alice Springs Renal Unit admits twenty-five to thirty new Indigenous patients each year (pers. comm., Kirubakaran 11 Jan. 2001).
- Indigenous people represented 21% of the population of the Northern Territory in 1996, and 95% of the dialysis patients in the State (Hoy 1996 in Catford et al. 1997).
- Current data shows that in 1999 Indigenous patients totaled 86% of the annual intake for the Northern Territory (ANZDATA 2001). Figure 4 shows that the Northern Territory has the highest incidence of all the states. The numbers of new patients is more than double that of the next highest state, Western Australia.
- The average age of Indigenous patients admitted is ten years younger than non-Indigenous patients (Van Buynder et al. 1993) and approximately half of the Indigenous patients at the Alice Springs clinic are under the age of forty (pers. comm. Pilbrow 29 Jan. 2001).

The significance of this data is that renal failure disproportionately affects Indigenous populations and this trend can be expected to continue within the next ten years.

One explanation for this explosion in the numbers of Indigenous people requiring renal dialysis has been attributed to the rapid change from the traditional lifestyle and diet to western lifestyle and diet. Other health issues that have become more concerning are poor nutrition, obesity and diabetes that can all aggravate kidney disease (Van Buynder et al. 1993). It has also been suggested that the Indigenous people may have a predisposition to kidney disease (pers comm. Kirubakaran 11 Jan. 2001). However these arguments do not remove the fact that renal disease is threatening the health and well being of the Indigenous people of central Australia. Preventative measures can be instigated, however, for those already suffering from renal failure, dialysis is necessary.
Figure 3: New acceptances by race 1992-1999 (ANZDATA 2001).

Figure 4: New patients per million for Australian States 1999 (ANZDATA 2001).
2.2. Cultural and social implications of renal disease for Indigenous Australians.

Devitt and McMasters (1998a) carried out a comprehensive study on the cultural and social issues involved with end-stage renal failure in Indigenous communities. The main issues that they raised are breakdown of family connections, relocation and mobility, loss of traditional leaders, adjusting to living in Alice Springs and other traditional disruptions.

As mentioned earlier, patients requiring haemodialysis must relocate to Alice Springs. This causes numerous problems associated with family and homelands. The extended family is of utmost importance to the Indigenous people. The daughter of a dialysis patient made a powerful comment to Devitt and McMasters (1998a): “But when we are alone, we feel sad because we need our families with us”. As is stated in the study, the sadness expressed by the woman is not a passing emotion but one of deep anguish and trauma. The importance of maintaining family connections was a reoccurring theme in the work of Devitt and McMasters (1998a) and they suggest that this could be the most important factor in a patient’s ability to cope and continue with treatment. It is the need to preserve the family connections that causes many patients to forgo treatment to the detriment of their health (Devitt and McMasters 1998a).

As stated by Devitt and McMasters (1998c) mobility is an integral part of Indigenous lifestyle. The need for dialysis three times a week forces patients to remain in Alice Springs. The removal of this freedom and the requirement to receive treatment according to a strict schedule places further strain on the traditional lifestyle of the patient. Going home is very difficult to organise and requires careful planning.

Indigenous communities are experiencing the loss of senior members of their communities as they move away to receive treatment. The difficulties involved with travelling home when important business and ceremonies are being conducted add further strain to the already fragmented society of Indigenous communities (Devitt and McMasters 1998a). In Indigenous communities senior members offer depth, stability and training to other member of their community, without which the community cannot thrive.

Death is dealt with in a special way in Indigenous culture that shows respect to the deceased person and allows for the mourning of their passing. Involved in these processes is the need to distance oneself from the things the dead person was involved with. This makes life difficult for those requiring treatment as they are forced to face death in a way that is not part of their culture.

Another issue raised by Devitt and McMasters (1998a) dealt with the difficulty that Indigenous people from other areas found in having to live and reside in the land of another group of people. The desire to move back to their own lands is partially due to the discomfort at having to live on land that is not traditionally their own. This leads to further feelings of anxiety and depression. Added to these pressures is the need to find suitable accommodation in Alice Springs. This is difficult and some patients and their families may spend time living in
conditions that do not provide essential services such as water and power (Devitt and McMasters 1998).

Social workers at the renal unit in Alice Springs are stretched to their limits as they endeavour to meet the needs of dialysis patients in the town. Basic needs such as housing, food, clothing, and banking are the initial concerns of the social workers and providing this level of care for patients is a demanding task (pers. comm. Pilbrow 29 Jan. 2001). An observation made by a social worker at the renal unit was that those who need to relocate to Alice Springs “never really make the adjustment to town” (pers. comm. Pilbrow 29 Jan. 2001).

A recent study conducted on the health benefits of the Homelands Movement concluded that Indigenous people living on their own land seem to have a higher standard of health with regard to common concerns such as diabetes and hypertension (McDermott et al. 1998). The authors attribute this improvement to a more rigorous physical and social life teamed with a diet that is varied and not solely reliant on store-bought foods (McDermott et al. 1998). Living on their own communities could have a very positive effect on the health of those patients currently living in Alice Springs. In a discussion with patients from Kintore who are receiving treatment in town, one lady said that she was sick of living in Alice Springs and sick of being on dialysis (pers. comm. Napaltjarri 19 Feb. 2001).

As one dialysis patient said in a strong statement made regarding community based dialysis units,

“We [need] to have a dialysis machine out in a community, that way people can be happy in their country and with their family.” (Devitt and McMasters 1998b).

This states very clearly and concisely the needs and issues facing the Indigenous community as they attempt to deal with the effects of renal failure on their lives.
3. Renal Dialysis Units

3.1. Haemodialysis

Living with Kidney Failure (1994) gives the following definition of haemodialysis: “the removal of impurities through an artificial kidney with a machine.”

Haemodialysis involves three treatments per week with each lasting between three and six hours (Living with Kidney Failure 1994). An artificial kidney, the dialyser, is built into the dialysis machine, which removes impurities from the blood through a process of osmosis. Dialysate, the fluid that is used to remove the impurities, is passed through the dialyser and out to the waste. The dialysis machine controls the entire operation. Figure 5 (Harris and Stewart 1995 p. 368) is a schematic of the dialysis procedure.

The process of haemodialysis models periods of high kidney “function” followed by periods of no kidney “function” (Will and Johnson 1994). This means that haemodialysis is a rigorous and taxing treatment as the patient experiences significant health highs and lows.

![Figure 5: Schematic of the dialysis process (Harris and Stewart 1995).](image)

3.2. Peritoneal Dialysis.

Peritoneal dialysis as described in Living with Kidney Failure (1994) is: “the removal of impurities through the peritoneal membrane in the abdominal cavity.”

There are two types of peritoneal dialysis available to patients. The first is continuous ambulatory peritoneal dialysis (CAPD). This involves the patient draining and replacing fluid in the abdominal cavity three to four times a day (Living with Kidney Failure 1994). The second method available is automated peritoneal dialysis. Instead of replacing the fluid throughout the day the patient uses a machine that pumps the fluid in and out during the night. This treatment occurs three times a week. (Living with Kidney Failure 1994).
Peritoneal dialysis is a more continual and gentle treatment than haemodialysis, however great care must be taken to ensure that infection does not occur (Living with Kidney Failure 1994).

### 3.3. Case Study – The Tiwi Islands

Located north of Darwin, the Tiwi Islands are two small islands that have a combined population of approximately 3000 people. The renal unit is located on Nguiu Island and was established in February 1999 as a satellite unit of the Nightcliff Renal Unit in Darwin (80 kms south) and has six dialysis machines (Indigenous Health Matters 2000). Initially the Tiwi Islands had twelve patients undergoing treatment in Darwin and following extensive community consultation the unit was established at a cost of approximately one million dollars with a further $450 000 operating costs for the first year (pers. comm. Gorham 5 Feb 2001).

Several issues arose in the early stages of the unit’s existence. These included the need to provide adequate housing for the returning members of the community, finding staff to run the unit until suitable health workers could be trained, employing cleaners that were reliable and diligent, and ensuring waste was disposed of safely (pers. comm. Gorham 5 Feb 2001).

Positive outcomes from the establishment of this unit cannot be underestimated. A quality of life survey was carried out among the patients receiving treatment at the Tiwi Island clinic it was noted that these patients:

- Were more interactive with their community.
- Lead more active lives.
- Did not live below the poverty line because money was being spent on living rather than travelling home as was the case while living in Darwin.
- Had no problems with domestic violence.
- Maintained a treatment compliance of 100%.

Other bonuses of the situation were the release of pressure from the Nightcliff unit in Darwin (pers. comm. Gorham 5 Feb 2001) and the employment opportunities provided for several members of the community as cleaners and ground staff (Indigenous Health Matters 2000).

Concentrated liaison was needed between the renal unit and the health clinic on the Tiwi Islands. There was a perception that the dialysis patients were going to add extra strain to the clinic staff and resources. This was not the case and after careful negotiations and full communication the health clinic staff accepted the situation (pers. comm. Gorham 5 Feb 2001). This issue will need to be addressed in any remote community wishing to establish a dialysis unit.

The Tiwi Island unit has experienced several technical obstacles during its two years of operation. These involve the breakdown of water and power services. Six small reverse osmosis units were used for the treatment of water, which has proven to be unsatisfactory, and the unit did need to evacuate patients to Darwin during one breakdown of water supply. A truck ran over the water pipes and by the time the situation was rectified the filters in the RO
units had become so clogged up that evacuation was necessary. It has been recommended that a double reverse osmosis treatment system be used in the future (pers. comm. Gorham 5 Feb 2001). The unit has a back-up generator that initially had so many safety mechanisms to prevent it from cutting in unnecessarily that is did not start when it was needed. Numerous power failures were experienced and now the problem with the generator has been fixed. An unreliable computer system also made operation of the unit difficult (pers. comm. Gorham 5 Feb 2001).

Treatment offered at the Tiwi Islands unit deals with all types of renal replacement therapy. Currently there are 3-4 transplant patients, 1-2 peritoneal patients and 7 haemodialysis patients (pers. comm. Gorham 5 Mar. 2001). There are also some patients waiting for housing to be built so they can also go home (pers. comm. Gorham 5 Mar. 2001).

The services and support provided in urban centres will not be readily available in remote locations. The people of Tiwi Islands discovered this and had to learn to cope without the social worker and medical staff support that was available at Nightcliff. Other essential services that need to be arranged are ensuring that the supply of drugs is adequate and safely stored, arranging appropriate disposal of the bio-hazardous waste such as bloodlines and syringes, and that there is suitable housing for community members returning home considering they have a serious illness.

There are currently seven patients from Kintore living in Alice Springs to receive dialysis treatment. At present the Pintubi Homelands Health Service Clinic is located in a building near the centre of the community. Plans have been made for a new clinic which has a room set aside for a dialysis unit.

![Figure 6: Mopping the clinic floor.](image)

There is one doctor, two nurses and five Indigenous health workers. The clinic is open each weekday from 9am to 5pm. It is closed from 12 noon to 2pm each day. During this time there is an almost constant stream of people and dogs in and out of the clinic, the door is opened and closed all the time. The waiting areas fill up very quickly, as whole families come in to support sick family members. For this reason the clinic also empties rather quickly.

Troppo Architects in Darwin have developed a proposal for the new clinic. Negotiations are underway to determine the needs of the community and the health staff. Development of the clinic and the dialysis unit are proceeding independently of each other. There has been room set aside in the clinic plan for the dialysis unit and meaningful communication between parties is necessary.
Figure 7: Inside the clinic at Kintore. The women's room is off to the right and the men’s room is to the left. The staff only door leads to the area where the drugs and records are kept.
5. Ground water.

5.1. Properties of the groundwater at Kintore.

The community of Kintore is situated over the South Arunta aquifer system that produces potable to brackish water which receives very little treatment. A slight amount of aeration occurs as the water is pumped into a storage tank. This causes the removal of a small proportion of the iron in the water. Following this, the only other treatment is ultraviolet disinfection (pers. comm. Hutchins 8 Feb. 2001). This water is not treated for chemical parameters and therefore it is safe to assume that the quality of water coming out of the tap is the same as that leaving the ground in terms of chemical composition. Mean values for water quality parameters are summarised in Table 1.

Table 1: Water Quality Parameters of Kintore Bore Water. The parameters in bold are those that are relevant to kidney dialysis.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>AVERAGE VALUE (MGL⁻¹)</th>
<th>AUSTRALIAN DRINKING WATER GUIDELINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Conductance</td>
<td>1064.8</td>
<td></td>
</tr>
<tr>
<td>Total dissolved solids</td>
<td>667.2</td>
<td>500</td>
</tr>
<tr>
<td>pH</td>
<td>7.6</td>
<td>6.5 – 8.5</td>
</tr>
<tr>
<td>Sodium</td>
<td>84.8</td>
<td>180</td>
</tr>
<tr>
<td>Potassium</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>63.3</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>61.3</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>1.3</td>
<td>0.3 (taste threshold)</td>
</tr>
<tr>
<td>Total Hardness</td>
<td>428.4</td>
<td>200 (increasing scaling problems)</td>
</tr>
<tr>
<td>Total Alkalinity</td>
<td>419.0</td>
<td></td>
</tr>
<tr>
<td>Silica</td>
<td>82.6</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>60.0</td>
<td>250</td>
</tr>
<tr>
<td>Sulphate</td>
<td>50.0</td>
<td>250</td>
</tr>
<tr>
<td>Nitrate</td>
<td>56.5</td>
<td>50</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>511.0</td>
<td></td>
</tr>
<tr>
<td>Fluoride</td>
<td>0.9</td>
<td>1.5</td>
</tr>
<tr>
<td>Sodium Chloride</td>
<td>98.7</td>
<td></td>
</tr>
<tr>
<td>Gross alpha (mBq/L)</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Gross beta (mBq/L)</td>
<td>60</td>
<td>500</td>
</tr>
<tr>
<td>Uranium (µg/L)</td>
<td>1</td>
<td>20</td>
</tr>
</tbody>
</table>
It can be seen from this table that the bore water at Kintore does not meet the levels suggested by the ADWG. The nitrate levels are concerning for health reasons, however the remaining parameters that have been exceeded relate to the aesthetic value of the water. There is a very low health risk in drinking this water. In terms of dialysis, the hardness and the radionuclides will need treatment.

During the course of this project adequate water quality data has been difficult to obtain and there are significant gaps in the existing data. Due to the remote nature of many of these communities extensive and comprehensive monitoring and record keeping has been difficult. In the case of Kintore, the water quality data has been derived from the eight chemical water samples taken over the last twenty years. Other difficulties arise when samples need to be taken. This is due to access being difficult in such a remote community and Pintubi Law and culture. Only men have access to the borefield due to its location on men’s land. For this study, the Essential Services Officer at Kintore took the samples. As mentioned earlier, travel out the Kintore is difficult and when there is cultural business being conducted access is further restricted, for example mourning and initiation.

**Total Dissolved Solids.**

This data is representative of groundwater from central Australia. The high value for the total dissolved solids means that the water is slightly salty to taste and so contains salts that have to be removed before the water is suitable for dialysis. The build up of calcium is evident wherever water is present: shower heads, taps and evaporative air conditioners. The calcification of hardware poses a serious threat to the life of the dialysis machines and the lives of those who depend on them for treatment.

![Figure 8: Evaporative air conditioner showing calcium build up, Kintore.](image)
Aluminium, Silica and Iron.
In order to maintain the in-built systems of the dialysis machines and the membranes of the reverse osmosis treatment the levels of aluminium, silica and iron need to be substantially reduced. These compounds form large hydrated ions, which act to clog up the membranes (pers. comm. Allen 15 Mar. 2001). Silica is an amphoteric compound, meaning it can act as an acid and a base, making it difficult to clean off membranes (pers. comm. Allen 15 Mar. 2001).

Radionuclides.
Preliminary data shows that two of the three production bores (RN13485, RN13804) indicate the presence of radionuclides in the water. The levels present in this water do not exceed the levels suggested by the ADWG however for use in renal dialysis it is preferable that the water be free from this contamination. Further samples have been taken in order to validate these findings. Should they also indicate the presence of these substances more work would need to be carried out on treatment options for the water.

Figure 9: Bore number 13804, Kintore.

Nitrates.
Nitrates (NO$_3^-$) are an issue in drinking water supplies as they remove oxygen from the blood and lead to the so-called ‘blue baby’ syndrome. The ADWG (1996) suggest that 50 mgL$^{-1}$ is the safe limit for nitrate levels. This value is quoted in order to protect bottle-fed babies less than three months old. As can be seen from Table 1, the raw bore water at Kintore exceeds this
level however it is not deemed to be a threat as adults and older children can safely drink water
with a nitrate level of up to 100 mgL$^{-1}$ (ADWG 1996).

5.2. Water quality required for renal dialysis.

Water required for renal dialysis needs to be of a very high quality (Will and Johnson 1994). This is to prevent the build up of toxins in the patient’s blood stream. Toxicity can lead to vomiting, fever, haemolysis and various other conditions (Harris and Stewart 1995). The importance of high water quality was highlighted by an incident involving dialysis patients in Brazil. In February 1996 a cyanobacteria outbreak occurred in a reservoir in Caruaru. Due to a break down in the treatment the water provided to the unit was contaminated and resulted in all 126 patients developing symptoms of toxicity and 60 of those patients dying (Pouria et al. 1998). The presence of cyanobacteria is highly unlikely in a groundwater supply, and Kintore has adequate treatment systems in place for microbiological parameters. This incident serves to highlight the vulnerability of dialysis patients to poor water quality and the necessity of ensuring that the standards are not violated.

In 1982, the Association for Advancement of Medical Instrumentation (AAMI) developed a standard relating to the water quality required in haemodialysis (AAMI 1998). The standard was formally adopted as the standard for Australian dialysis procedures in 1992 (pers. comm. Skipper 5 March 2001). Levels suggested in this standard assume that the water is initially at drinking water quality and that the purification system is capable of removing 90% of the contaminants in the raw water (AAMI 1998). Values recommended by the guidelines have been based on the health effects of these contaminants. Table 2 shows the AAMI guidelines, which determine the water quality required to make dialysate.

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>AAMI Maximum for Dialysis Water (mgL$^{-1}$)</th>
<th>Kintore Water (mgL$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>2</td>
<td>63.3</td>
</tr>
<tr>
<td>Magnesium</td>
<td>4</td>
<td>61.3</td>
</tr>
<tr>
<td>Potassium</td>
<td>8</td>
<td>4.4</td>
</tr>
<tr>
<td>Fluoride</td>
<td>0.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Chlorine</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Chloramine</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Nitrate</td>
<td>2</td>
<td>56.5</td>
</tr>
<tr>
<td>Sulfate</td>
<td>100</td>
<td>50.0</td>
</tr>
<tr>
<td>Copper</td>
<td>0.1</td>
<td>0.003</td>
</tr>
<tr>
<td>Barium</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>0.1</td>
<td>0.022</td>
</tr>
<tr>
<td>Aluminum</td>
<td>0.01</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.005</td>
<td>0.001</td>
</tr>
<tr>
<td>Lead</td>
<td>0.005</td>
<td>0.006</td>
</tr>
<tr>
<td>Silver</td>
<td>0.005</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Table 2: AAMI Standards for Dialysis Water (AAMI 1998).
Other quality requirements relate to the maintenance of the reverse osmosis (RO) unit in the dialysis machine. A level of purity is needed to ensure satisfactory operation of the renal unit. Total dissolved solids, present in high concentrations in most groundwater supplies pose the threat of causing blockages in the dialysis unit. Blockages lead to machine failure and the need for repair and maintenance, which is difficult to obtain in remote areas, along with the inconvenience of having a non-operational unit.

Each dialysis machine has an in built reverse osmosis treatment designed to purify tap water. Reverse osmosis is a very effective method for desalination. It utilises the natural law that water moves from areas of high concentration to areas of low concentration in order to equilibrate the solution. This occurs through a semi-permeable membrane, which allows water through but not salts. Reverse osmosis involves pressure being exerted on the dirty water in order to force the water from this solution into the clean water on the other side of the semi-permeable membrane (Spiegler & El-Sayed 1994).

The membranes used for RO are the component that the entire system relies upon. For the treatment to be efficient the membranes must be clean. So it is necessary to pre-treat raw water before it enters the RO system and to regularly check and clean the membranes (Spiegler & El-Sayed 1994). Fouling of the membrane can come from two sources: suspended solids and dissolved compounds. Both of these groups cause the membranes to become blocked thus affecting the running of the unit.

The solids plug up the membrane thus decreasing efficiency and allowing more ions to escape in the clean water. If the suspended particles settle on the membrane the path for osmosis is blocked and friction losses are increased. This leads to a pressure drop across the system, reducing the speed and efficiency of osmosis (Hydranautics 2001). Included in this group are inorganic particles, colloids, and biological matter such as algae. Filtration is usually sufficient to remove the unwanted solids from the water. Kintore water does not contain a high proportion of silt matter. It is still advisable to filter for any sand or dirt that may be present in the water.

High levels of dissolved compounds are present in the Kintore bore water. The elevated levels of calcium and magnesium would cause RO membranes to become blocked. It can be seen from Table 2 that these levels must be radically reduced to meet the standards required for dialysis. When the concentrations of these salts reach increased levels they can precipitate out and form scales on the osmosis membrane. This reduces the permeability of water through the membrane and the efficiency of the system is compromised (Hydranautics 2001).

<table>
<thead>
<tr>
<th></th>
<th>0.001</th>
<th>0.014</th>
<th>0.09</th>
<th>0.0002</th>
<th>0.001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selenium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td>0.0002</td>
<td>0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
It can be seen when comparing Table 1 and Table 2 that considerable treatment must be applied to the bore water before it can be deemed satisfactory for use in renal dialysis. The levels of calcium, silica and magnesium all must be radically reduced.

5.3. Water Treatment options.
Technology can treat water to the required level; however the issue is whether that technology is sustainable for a remote Indigenous community. Figure 10 (Harris and Stewart 1995 p. 369) shows the standard water purification system used for dialysis. The dialysis machine carries out this treatment and it is based on the water being at drinking water standard to start with, not bore water quality as is the case in Kintore.

Figure 10: Standard water purification system for dialysis (Harris and Stewart 1995).

Pre-treatment of water is necessary in order to prolong the life of the reverse osmosis membranes. The replacement of each of these membranes is expensive and requires a trained technician. Conventional pre-treatment techniques such as softening, coagulation and filtration are used on the raw water prior to treatment in the RO. This extra treatment can account for approximately 30% of the total operating costs for the system (Spiegler & El-Sayed 1994). For treatment of the water at Kintore a rigorous pre-treatment program would be necessary. Spiegler and El-Sayed (1994) report four scale prevention methods used in desalination and reverse osmosis treatment:

1. Design the unit and the process in such a way that removes the supersaturated solution before scale can form.
2. Softening by removing the scale forming salts.
3. Adding chemicals that extend the temperature range where no scale is formed.
4. Adding scale retardant or a chemical that causes the scale to form a soft, easily removed sludge in the time lag between supersaturation and precipitation for a particular salt.

Standard RO systems have numerous pre-filtration measures to reduce the impact on the osmosis membrane. Preventative filtration of the water should be carried out to remove any
suspended solids that could be present in the water. Softening can be achieved through several methods such as ion exchange. This process greatly reduces the levels of calcium and magnesium.

Test results from further samples were not available at the time of writing. Should the results confirm the presence of low levels of radioactive substances serious consideration will need to be given to the treatment of the water. The treatment of radioactive water can be carried out in several different ways. The reverse osmosis treatment would be an effective method. Disposal of waste from the treatment is also of high concern. This is especially important due to the concentration factor that acts on the composition of the wastestream (see Section 6).

It can be seen that extensive treatment needs to take place to deliver water that is at the required level for renal dialysis. In order to ensure the safety of the patients and to prolong the life of the dialysis machines undesirable compounds need to be removed. Further work needs to be carried out to determine the most effective method for achieving this in the context of the Kintore community.

5.4. Sustainable use of groundwater.

Recharge of aquifers in arid environments is often irregular and unpredictable. This means the yield of these aquifers may vary over time (Wischusen 1998). It is therefore necessary to take care when planning developments that will demand the use of water. Lerner et al. (1990 in Wischusen 1998) stated that due to the nature of groundwater supplies in arid regions, developments should be conducted in stages so that the response of the aquifer can be monitored. Across Australia, less than 1% of rainfall is recharged into groundwater supplies (Smith 1999). The vast majority is lost through evaporation, with rates that range from 42% to 99% depending on the region (Smith 1999).

The sustainable yield of a groundwater supply has been defined as the amount extracted that does not exceed the normal flow of the aquifer (Schoeller 1959 in Wischusen 1998). Smith (1999) defines the sustainable yield as being the rate of extraction that is not in excess of the effective recharge rate. This definition accounts for the recharge rate not always equaling the natural discharge rate (Bredehoeft 1997 and Schoeller 1959 in Wischusen 1998). On some occasions the natural discharge may be greater than the recharge due to induced recharge or less due to an imbalance in the aquifer equilibrium.

Kintore extracts its water from the South Arunta aquifer system. This is a hard rock aquifer with indirect and localised recharge mechanisms acting (Wischusen 1998). Figure 12 explains these different recharge mechanisms. Characteristic of these systems is the tendency to produce a yield after drilling that far exceeds the sustainable yield (Wischusen 1998). Smith (1999) shows that the Western Plateau region in which Kintore is situated experiences a groundwater recharge of less than 1% of the rainfall. Figure 11 shows the hydrological balance that exists in this region; evapotranspiration accounts for 99% of the water loss. Wischusen (1998) recommends that any permanent use of this system be carefully monitored as the storage
in the aquifer may be limited. The establishment of water dependent services and infrastructure
should be guided by the results of this monitoring (Wischusen 1998).

Figure 11: Hydrological balance for certain Australian regions (Smith 1999).

There is some evidence that recharge of the aquifer at Kintore occurs in response to rainfall
on the water suggests it to be less than thirty years old showing that the recharge is rapid when
it does occur (Wischusen 1995). However, in the arid environment of Kintore rainfall cannot
be accurately predicted (Wischusen 1995). Australia has the distinction of being the driest
inhabited continent as well as having the highest variability in rainfall (Smith 1999). This
makes the occurrence of recharge highly unpredictable and the sustainable management of the
water supply a critical priority.

The major borefield at Kintore is located at the southern end of the community. Three bores
are being used producing an annual discharge of 74 megalitres (Western Water Study 1998). A
sustainable yield from the aquifer at Kintore was estimated to be 235 m$^3$/day (Wischusen 1995).
This was based on nine years of drought. Water consumption data has been obtained and this
yield is exceeded on numerous occasions, depending on the time of year and the number of
people living in the community. Figure 13 shows how this consumption varies over time. The
zero values are questionable and the gap indicates a week when there was no data. During the
180 weeks of the record, the yield was exceeded in 44. On several occasions the extra usage
was more than double the recommended level. In a number of other weeks the consumption
came very close to breaching the suggested yield. A deep sewerage system, completed in
October 1999, does not seem to have increased the consumption. A summary of the
consumption data is presented in Table 3.
The establishment of the dialysis unit will place extra strain on this water resource. Renal dialysis units require 30 litres of water per hour of dialysis. Based on an average treatment time of five hours, 150 litres of water are needed per patient per session. It is anticipated that approximately thirteen patients from Kintore and neighbouring communities of Papunya and Mt Liebig will use the dialysis unit. This brings the water demand to approximately 6000 litres a week for dialysis alone. An allocation for general duties such as washing and cleaning is added and the total consumption of a dialysis clinic has been estimated to be approximately 30 m$^3$ per week. Consideration must also be given to the amount of water that will be consumed when there are extra people living on the community. The new clinic that is planned for Kintore will have permanent water needs and will bring people from neighbouring communities who will also use water.

The Guidelines for Satellite Dialysis Units (GSDU) suggests that drinking water quality should be the minimum standard. Other water uses such as toilets and washing should not interfere with the delivering of the water at 3L/min at 200kPa (GSDU 1998). This constant pressure must be maintained or the dialysis machine will automatically shut down (pers. comm. Skipper)

| Average weekly consumption (kL) | 1390 |
| Maximum weekly consumption (kL) | 2896 |
| Minimum weekly consumption (kL) | 177  |
| Sustainable weekly yield (kL)   | 1645 |
Water is delivered to the tap at Kintore at a pressure of 24 metres head, or 235kPa. If the RO unit delivers water at a constant rate then there shouldn’t be a problem. However, power fluctuations can cause the pump in the RO unit to reduce its output thus affecting the water supply pressure.

On site water storage is a necessity in a remote, arid location such as Kintore. It is essential that a supply of water sufficient for a week be stored on site allowing dialysis treatment to continue in the event of a supply disruption.

The sustainable use of any groundwater source should be carefully considered when planning a development that requires permanent use of that water. Cautions have been given regarding the over extraction of aquifers and in particular the type that supplies water to Kintore. Recommendations of regular monitoring should be heeded in order to develop a foundation on which to place any development plans. This frequent and regular monitoring has not been carried out in the past and so there is no solid basis on which to guarantee the required supply of water to maintain a dialysis unit and any other infrastructure the community may wish to establish.

The safe and appropriate disposal of waste from any operation is an issue that must be given careful consideration. This is more imperative for a situation such as renal dialysis treatment, which involves biohazardous waste that must be kept from the general public in order to prevent contamination. Kintore does not have a functioning garbage collection program running, which would make effective disposal of waste difficult.

Waste from a renal dialysis unit consists of several components. The process of dialysis involves many consumables such as the dialyser, dialysate, bloodlines, saline, dressings, fistula needles, sterilising equipment, gloves and so on (GSDU 1998). Standard disposal units for this waste are required such as sharps containers and medical grade incinerators (pers. comm Gration 12 Jan. 2001). The Tiwi Island clinic were somewhat surprised at the amount of waste accumulated from the process and had to solve the problem of storing that waste safely until it could be properly disposed of (pers. comm Gorham 5 Feb. 2001). In this case the waste is sent back to Darwin for disposal. This may not be a suitable option for Kintore because it is a greater distance from a major centre, and travel is more difficult.

At present, waste from the clinic at Kintore is burnt in a skip bin outside of the building or taken to the rubbish dump out of the community (pers. comm. Schaeffer 22 Feb. 2001). There is significant risk of contamination because waste is left exposed for sometime before the dump is backfilled.

The other source of waste produced by the dialysis procedure is the dialysate after it has passed through the patient. At the end of treatment the dialysate has the same composition as urine and is simply disposed of in the sewer system (pers. comm Gration 12 Jan. 2001). A sewer system has been installed at Kintore however further study needs to go into the ability of this system to cope with the loads of having extra people living on the community and the amount of waste these patients accumulate from dialysis.

Figure 13: A typical waste dump.
The best method of disposing of the wastewater from the RO treatment requires further consideration. It has been said that a reverse osmosis system should not be viewed as a “‘filtration system’, or a ‘purifier’, but, rather as a ‘waste concentrator’, constantly increasing the contaminant concentrations, producing purified water as a byproduct.” (Comb 1990, p. 1). This concentration factor needs to be considered, as the waste stream from the RO is going to have high concentrations of the compounds that need to be removed to purify the water for dialysis. Radionuclides present in small quantities will reach higher levels in the waste water and will require careful disposal. Figure 14 shows how the concentration factor relates to the amount of clean water extracted.

![Figure 14: Concentration factors with percentage of water removed in reverse osmosis (Comb 1990).](image-url)
Figure 15: Sewage treatment ponds, Kintore.

The disposal of waste with a high salt concentration into the sewerage treatment ponds at Kintore could disrupt the microbial operation of the system. Increased salt levels, depending on the quantity, can interact with the effluent and cause several problems such as increased odours (pers. comm Hutchins 1 Mar. 2001).
7. Dust.

7.1. Problems caused by dust.

The National Pollution Inventory (NPI) defines dust as, particulate matter less than 10.0µm in diameter and thin flakes or fibres of less than 10 µm long (NPI 2001). This is often known as PM$_{10}$. It also states that dust will be present in even pristine environments. Dust accumulation presents a huge challenge to the possibility of a functioning dialysis unit for Kintore, as it must be controlled to provide the clean environment required for renal dialysis. The environmental conditions at Kintore, with its dry and windy climate, make the control of dust immensely difficult because it builds up as seen in Figure 16, and particles are suspended in the air.

Particulate matter can be classified as primary or secondary, depending on its source and formation. Primary particles come from a series of natural and anthropogenic sources such as volcanoes, fires, cars, and waster disposal (Godish 1997). Secondary sources comprise particles that are formed in the atmosphere through reaction processes (Godish 1997).

Particulate matter in the air has several effects:
1. Scattering of light, reducing visibility,
2. threat of inhalation for both humans and animals,
3. climatic changes on regional and global levels,
4. a general nuisance as it settles out of the air.
(Godish 1997).

Particles that penetrate into the lower respiratory tract cause the most serious problems. The degree to which particles penetrate into the respiratory tract depends on the particle size (Davis and Cornwell 1998). Several processes are in place to protect the lungs from the adverse effects of particles. Hairs in the nose help to trap particles greater than 5 -10 µm. Sneezing and coughing also aid in removing foreign particles from the respiratory system (Davis and Cornwell 1998, Godish 1997). Particles of 1 - 2µm avoid removal because of their small size and settle out on the alveoli. Alveoli are found within the lower respiratory tract. The diffusion of oxygen and carbon dioxide occurs at these sites. Coating of the alveoli can lead to emphysema (Godish 1997). However, particles smaller than 0.5µm do not have a large enough terminal velocity to settle out (Davis and Cornwell 1998). Thus lung-damaging dust ranges from 0.5 - 5µm (Davis and Cornwell 1998).

Respiratory illnesses are the most obvious effects of elevated levels of PM10. Pearce (1998) states that the long-term exposure to dust can lead to heart and lung disease, and if carcinogens are present in the dust then cancers may result. It may take weeks or months for the body to expel these dust particles from the aveolar region. This extended contact period with sensitive tissue that makes particulate matter concerning (Godish 1997). Due to the large surface area of these tiny particles, their reactive potential is also greatly increased (Godish 1997).
Elevated dust levels would have less affect healthy individuals than those with already compromised immune systems due to illness. It is necessary to maintain the environment of the renal unit as dust free as possible in order to ensure the satisfactory running of the machines and a suitable environment in which patients can receive treatment.

![Figure 16: Dust being swept up outside the Pintubi Homelands Health Service Administration Office.](image)

### 7.2. Options for dealing with dust.

There are several approaches that can be taken in an attempt to limit the impacts of dust on the proposed renal unit. These are the address the issue through dust suppression, or through dust removal with the use of dust collection systems. A combination of these would provide the optimum solution for the situation at Kintore.

The common technique of watering the area helps to reduce dust levels. However, in the desert this should be carried out considerately and sparingly. Other less resource draining techniques for suppression could include the establishment of vegetation around the clinic to reduce the area of exposed soil, the placement of fences and barriers that can trap particles. The design of the clinic could include features such as sealed windows, rubber strips under doors and an entry foyer that can limit the amount of dust penetrating the rest of the building.
Cyclones and filters are the most appropriate dust removal techniques suited to the situation at Kintore. The cyclones are most efficient in the removal of particles greater than $10\mu m$ in diameter. Centrifugal force is used to remove the particles from the air stream (Davis and Cornwell 1998). There are no moving parts in the assembly, which would be a benefit in Kintore as it reduces the maintenance issues that may arise. Two types of filters are available, the deep bed filter and the bag house filter (Davis and Cornwell 1998). A common deep bed filter is the air conditioner. This is used for relatively clean gases and low volumes. The bag house filter is more suited to dirty industrial wastes with higher volumes (Davis and Cornwell 1998). These control measures are suitable for the efficient removal of particles smaller than $5\mu m$ in diameter (Davis and Cornwell 1998). The filters are more complex and so carry a higher maintenance demand.

The approach recommended here would be to install a dust removal device, either a deep bed filter or a cyclone, in an entrance foyer to the clinic. Coupled with the other control and suppression measures mentioned above, this would provide an adequate solution to the problem with minimal cost. If the other methods, such as sealed doors, were working properly there would be no need for a cyclone to be installed and a simple air conditioner would suffice. Daily cleaning would also keep the accumulation of dust to a minimum.
Data on the specific levels of dust in the Kintore region is not available. Further work in the area of sampling and testing needs to occur. This can be carried out in numerous ways. Static or passive sampling involves sedimentation of heavy particles in a collection vessel, collecting particles on sticky paper or the diffusion of an air stream to a collection medium (Godish 1997). These methods are both simply and cheap, however long collection periods, typically 30 days, limit the usefulness of the technique (Godish 1997). ** I have notes on another useful technique but I don’t have them with me at the moment, will add this soon!!**
8. Power.

8.1. Issues relating to power and renal dialysis units.

The Power and Water Authority provide Kintore with power through the use of diesel generators. The three diesel powered generators provide a total of 750 kW of power. Fuel tanks on site at the power station store 100,000 litres of diesel and the weekly fuel usage is 4500–5000 litres (pers. comm. Hutchins 8 Feb. 2001).

Data from the Community Housing and Infrastructure Needs Survey (CHINS) states that power is connected to all dwellings and the community experienced power break downs 5-9 times in the year leading up to the survey. The outages were due to either equipment failure or maintenance and were not restricted to certain times of the year (CHINS 1999). It was reported that the longest period without power was four hours (CHINS 1999). However discussions with those who have spent time living at Kintore reveal that the outages were both more frequent and for longer periods than reported here (pers. comm Ellis 2 Feb. 2001). This was the case in the past however a recent upgrade to the power station has meant a more reliable supply is now available.

![Figure 18: Generators at the power station, Kintore.](image)
Dialysis units have constant power requirements. Each haemodialysis unit has a thirty minute battery that only allows the patient to be removed from the machine should a power failure occur, no further dialysis can be carried out until power is restored (pers. comm Sharkey and Thompson 12 Jan. 2001). Power failures of longer than a couple of hours will severely disrupt the treatment of the patients who had to have their session abandoned and also those who were due to have their treatment that day. It is therefore essential that a back-up power supply be installed in any remote dialysis unit.

All dialysis units must comply with the Australian Standard 3003 and be wired with body protected electrical system (pers. comm Sharkey 12 Jan. 2001; GSDU 1998). Each dialysis machine requires four 240V power outlets (GSDU 1998). Power needs for lighting, air conditioning, a computer, and other essential equipment also need to be considered.

Due to the small size of the community the delivery of power is affected by other activities within the community that at times cause the supply to fluctuate (pers. comm. Hutchins 8 Feb. 2001). It is important that the power supply is uninterrupted.

8.2. Power options.
In order to provide adequate patient care, an emergency power supply must be considered for those periods when the supply is interrupted. Patient health is threatened when power supply is interrupted. The use of renewable energy to provide a back-up system would be preferable particularly as world focus becomes more and more centred around greenhouse gases and renewable energy. A dialysis unit in Newcastle NSW, The Wansey Dialysis Centre, has installed a solar/grid/battery back-up system in a move towards sustainability.
The Wansey Dialysis Centre caters for hundreds of treatments each week, operating on three shifts each day (McMullan 2001). Work on the emergency power system began in December 1999 and it was decided to compliment the eco-friendly measures already in place with a solar system. Other environmentally friendly aspects of the design include water recycling that has saved six million litres of water since inception and an energy efficient building design (McMullan 2001). A study was conducted into the emergency power needs of the Wansey Dialysis Centre and it was found that power was needed for a three-phase 3.7kW pump, a single phase 3.12kW pump, twenty-six 2.025kW dialysis machines, lighting, the PABX system to keep the unit functioning at a minimum. Back-up power was required for four hours, which is supplied by a 900 amp-hour battery bank (McMullen 2001). The resulting system consists of a solar system that can provide four hours of battery back-up within 20 milliseconds should the mains power fail. When the solar panels are producing energy they can charge the batteries, supply emergency load, power the rest of the clinic and if there is enough power being generated it is sold back to the grid (McMullen 2001).

The solar option is working extremely well in the urban environment of Newcastle but will it be suitable for the social and environmental conditions of Kintore? Ongoing maintenance programs to control dust on the solar panels, repairs and vandalism will need to be established for renewable energy to be sustainable. Houses at Kintore were fitted with solar hot water systems however, now the majority of houses no longer have the solar panels on the roof. Most of them have been vandalised and removed. In order to ensure that the back-up supply will provide adequate service when required daily checks and monitoring is needed. At the Wansey Centre the inverter is checked every day at a certain time. The charge of the batteries and checks on other system components are determined on a regular basis (McMullen 2001).

The cost of purchasing and maintaining a solar system large enough to provide emergency power for the dialysis unit is considerable. This is a major issue with solar power in Kintore.

An alternative back up power supply could be generated from an individual generator connected to the clinic. The cost of this system is reasonable and maintenance can easily be dealt with. One issue that should be addressed for this solution is the risk of fuel shortages that would prevent the generator from running. Kintore is situated such that it can be cut off from both air and road and in the recent past the community was facing a critical shortage of fuel. If this were to occur again, with the clinic relying on diesel generators the situation could be life threatening for patients.
9. Recommendations

Recommendations for the immediate future.
1. A full, independent feasibility study should be completed. Issues to be addressed include:
   - Suitable housing for patients and their families.
   - The recruitment of staff: renal nurses and a renal doctor.
   - Housing for the extra staff.
   - Improvement of the infrastructure of Kintore to cope with increased population.
   - Education and communication with community on the effects of having the dialysis unit.
   - More detail on the power demands of the unit.
   - Options for alternative power sources for the dialysis unit.
   - The transport of supplies such as drugs and dialysate to the community.
   - Emergency procedures and protocols.
   - The most effective method of water treatment in the Kintore conditions.
   - A more detailed look at the impacts and management of dust in the dialysis unit.
   - Further study into the requirements and possibility of establishing a peritoneal dialysis clinic.
   - Other options such as a chartered plane to transport patients to and from Alice Springs for frequent visits.

2. A communication strategy should be developed.
   a) All stakeholders need to be clearly identified and included.
   b) Feasibility study should be widely distributed.

3. The community needs to be better informed of the impact the dialysis unit would have, through participation and education.

Recommendations for ongoing implementation.
4. A regular and diligent monitoring program should be established to record the behaviour of the water table and assess the sustainability of the resource. The community should be informed of the results and adjustments to usage made accordingly.

5. Investigation into prevention programs to combat the increase of renal disease in the community.
10. Conclusion.

This report has concluded that there are many complex issues that need to be addressed regarding the establishment of a dialysis unit in Kintore. The precarious nature of essential services such as water and power mean that extra effort has to go into providing a service that is reliable and satisfactory. A holistic approach is essential.

The water quality at Kintore meets Australian Drinking Water Guidelines and is safe for consumption. However, due to the elevated levels of calcium, magnesium, iron, nitrate, and the presence of radionuclides the water does not meet the standards required for kidney dialysis. Treatment of the water is necessary prior to use in the dialysis machines in order to preserve patient health and machine operation. The degree of pretreatment needed makes it a major risk factor in the establishment of the dialysis unit.

It has been shown that dialysis has a permanent water need. The current rate of consumption in Kintore may not be able to support the needs of the dialysis unit. Considering the possibility of population growth and other water-use infrastructure such as a pool and gardens, the aquifer may not be sustainable. This is of particular concern since regular and frequent water table monitoring is not carried out. An on-site storage should be installed in order to protect against any disruptions in water supply.

Several other issues raised through this study include staffing, ensuring sufficient supplies, education, dust, waste and communication. It is hoped that the work presented here will be useful in the development of a feasibility report, which will provide the remaining necessary information for the community so that informed decisions on future action can be made. These technical, environmental, cultural and social issues all need to be addressed in a region of Australia that is arid, harsh and isolated. The challenge lies in finding the solutions that are going to work the best for the people in the environment where they live.

Figure 20: A man having dialysis at the renal unit in Alice Springs.
Water Use Assessment for a Remote Indigenous Community.

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- Dr Meshak Kirubakaran, Renal Specialist Alice Springs Hospital. Meeting at the renal unit, Flynn Drive Alice Springs, 11th January 2001.
- Debra Gration, Assistant Director of Nursing, Alice Springs Renal Unit, Flynn Drive. Meeting held at the unit on 12th January 2001.
- Steve Sharkey and Andrew Thompson, Medtek Biomedical Engineering, Alice Springs Hospital. Meeting at the Alice Springs Renal Unit, Flynn Drive on 12th January 2001.
Ralph Hutchins, Power and Water Authority, Rural and Remote Services, Alice Springs. Meeting at PAWA Alice Springs, 8\textsuperscript{th} February 2001.

Parara Napaltjarri, dialysis patient from Kintore living in Alice Springs. Meeting held at the Alice Springs Hospital on the 19\textsuperscript{th} February 2001.

Tony Skipper, Renal Technical Services, Austin and Repatriation Medical Centre, Melbourne. Telephone conversation, 20\textsuperscript{th} February 2001.

Peter Schaefer, Pintubi Homelands Health Service Administrator. Meeting held in Kintore 22\textsuperscript{nd} February 2001.

Gillian Gorham, Nightcliff Renal Unit, Top End Renal Services Darwin. Email, 5\textsuperscript{th} March 2001.

Tony Skipper, Renal Technical Services, Austin and Repatriation Medical Centre, Melbourne. Facsimile, 5\textsuperscript{th} March 2001.

Norm Allen, Principle Consultant with Water and Wastewater Quality Specialists. Telephone conversation, 15\textsuperscript{th} March 2001.