Assessing the past and the present role of the National Nuclear Regulator as a public protector against potential health injuries: The West and Far West Rand as case study

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Abstract

Recent national and international news media articles and television programmes, official public domain Government and peer reviewed academic reports drew the international and national public's attention to the health risks and hazards and impacts pertaining to uraniferous waste from the gold mining industry within the Witwatersrand goldfields and the role of the National Nuclear Regulator (NNR) in this regard. The Dutch research organizations' Wise and Somo's recent report, entitled "Uranium from Africa – mitigation of uranium impacts on society and environment by industry and governments" found that that the lack of knowledge within institutions and lack of proper environmental management systems, both in industry and in the government, "render South Africa a poor example of environmental and human health protection….The government is failing." It is especially the poor, the disempowered and the vulnerable members of mining communities that bear the highest risks and impacts. These communities have low adaptive capacity because of chronic and acute malnutrition and high HIV/Aids percentages. The World Health Organization (WHO) recently estimated that 34% of all childhood illness in the world (compared to 24% of all age illness) and 36% of deaths in children under age 14 are due to modifiable environmental factors. As with many illnesses, genes may create a loaded gun, but environment pulls the trigger. However, determining how impacts from gold mining waste within the West and Far West Rand as part of the Witwatersrand goldfields influence or determine human health is a challenge. This is due to the social, cultural and economic conditions (thus their broader well-being status) which influence the vulnerability of communities, and subsequently their resilience. The focus of the discussion will relate to this area and the NNR's role – past and present – as public health protector in this area per se.

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Keywords: National Nuclear Regulator; Far West Rand; Witwatersrand; Gold mining; Environmental pollution; Environmental health; Human health.

Introduction

The recent Greenpeace Report, entitled "*True cost of nuclear power in South Africa*", dated August, 2011 highlighted the inability and unwillingness of the National Nuclear Regulator to regulate mining waste outside mine property and to conduct epidemiological studies in order to quantify the health risks and impacts upon mining communities.[2] The National Nuclear Regulator is the organ of state mandated by the South African Government, in terms of the National Nuclear Regulator Act (47 of 1999) to protect the public from nuclear damage.[3]

The National Nuclear Regulator (NNR) is not strictly a government body and obtains 80% of its funding from operators (e.g. the mining industry, Nuclear Energy Corporation of South Africa, Eskom, etc.) and 20% of its funding from the South African Treasury. It is an advisory board to the Ministry of Energy. The NNR provides the Certificates of Registration (CoR) to the mining companies, in which issues such as safety for workforce, materials, transport, and environment, are described. The NNR, being responsible for radiation protection, is obliged to carry out monitoring programmes at all the mines who deal with radioactive materials.[4]

The NNR was called upon, in terms of the Water Research Commission Report, entitled "An Assessment of Sources, Pathways, Mechanisms and Risks of Current and Potential Future Pollution of Water and Sediments in Gold-Mining Areas of the Wonderfonteinspruit Catchment,"[5] dated 2006, in terms of the NNR Report, entitled "Radiological Impacts of the Mining Activities to the Public in the Wonderfonteinspruit Catchment Area", dated the 12th of

2 Greenpeace, Report, R Teule (Ed.), "The true cost of nuclear power in South Africa", 2011, p. 23.

3 "Nuclear damage" means "any injury to or the death or any sickness or disease of a person or other damage, including any damage to or any loss of use of property or damage to the environment, which arises out of, or results from or is attributable to, the ionizing radiation associated with a nuclear installation, nuclear vessel or action." National Nuclear Regulator Act, 1999. No 47 of 1999, Section 5.

4 Somo & Wise. A joined report by Wise and Somo, "Uranium from Africa. Mitigation of uranium mining impacts on society and environment by industry and governments", ISBN: 978-90-71284-82-3, Report number, June 2011, p. 89.

5 H Coetzee et al, Council for Geoscience, WCA, Report no. 1214/1/06, 2004.

July 2007[6] and in terms of the Department of Mineral Resources' Regional Mine Closure Strategies for the Witwatersrand Goldfields (2008), respectively, to take regulatory decisions regarding the radiological contamination and risk within the Witwatersrand Goldfields, particularly the Wonderfonteinspruit Catchment Area (WCA).

Past anecdotal concerns exist about human and environmental health risks in the gold mining, as well as concerns about health risks in gold mining areas raised by individual (professional) observations.[7] Recent government reports also highlighted the health risks pertaining to mine residue deposits within the Witwatersrand goldfields[8] and "a history of extreme secrecy and confidentiality on all nuclear issues".[9] Health effects may manifest not merely as cancers but it may extend to non-cancer illnesses, eye lens destruction, neurological illnesses, diabetes, immunologies and several other radiogenic illnesses and will specifically include a risk factor for heart disease.[10]

This article assesses the past and present role of the National Nuclear Regulator (NNR) as a public protector against potential health injuries and discusses the possible health risks grounded upon anecdotal and documentary evidence that mining communities are exposed to within the Wonderfonteinspruit Catchment Area within the West and Far West Rand Goldfields, Informal Settlement and the Tweelopiespruit within the West Rand Goldfield, and the role of the National Nuclear Regulator in this regard.

6 National Nuclear Regulator (NNR), Report – TR-RRD-07-0006, 12 July 2007.

7 The first document that raised the possibility of radioactivity having an impact on the environment in the Oberholzer/Welverdiend area was written by Dr Gerry Retief and Prof Leslie Stoch and presented to the Deputy Minister of Water Affairs, Herman Martins on the 3rd November, 1967; ES van Eeden, "Whose environment? whose nature? – a trans-disciplinary discussion on some inhumane actions in the destruction and construction in nature – case study, the Merafong municipal region", *The Journal for Transdisciplinary research in Southern Africa* , 2, November 2006, pp. 409-430.

8 See for example Department of Mineral Resources' Draft Regional Mine Closure Strategies for the Witwatersrand Goldfield (2008); The Gauteng Department of Agriculture and Rural Development, "Feasibility study on reclamation of mine residue areas for development purposes: Phase II strategy and implementation plan" (July 2011); F Winde, "Uranium pollution of water resources in mined-out and active goldfields of South Africa – a case study in the Wonderfonteinspruit catchment on extent and sources of U-contamination and associated health risks", 2009.

9 DM van Tonder, "South Africa's challenges pertaining to mine closure - The concept of regional mining and closure strategies", AB Fourie, M Tibbett, IM Weiersbye, PJ Dye (Eds), *Mine closure* (Australian Centre for Geomechanics, Perth, 2008), p. 95.

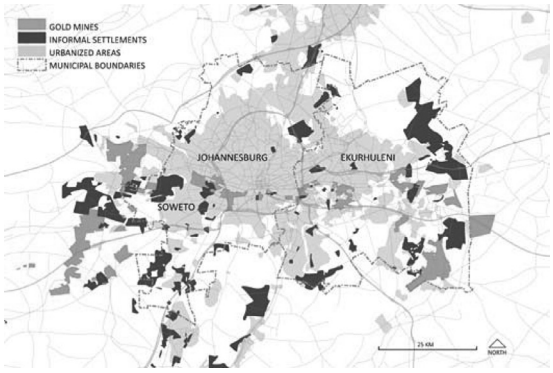
10 C Busby, "Uranium, and health: The health effects of exposure to uranium and uranium weapons fallout". Documents of the European Committee on Radiation Risks (ECRR), No 2. 2010. ECRR, 2010; C Busby (Ed.), "Recommendations of the European Committee on Radiation Risk. The health effects of exposure to low doses of ionizing radiation", Brussels, 2010, p. 7.

A historical reflection on the location and role players

The Far West and West Rand Goldfields and health risk factors

An airborne radiometric survey of the West and Far West Rand goldfields was done in 2008 for the Department of Water Affairs by the Council of Geoscience. Interpretation of the data shows many of the residential areas (e.g. Carletonville, Westonaria, Khutsong) fall within areas of high risk of radioactivity contamination.[11] Informal and formal residential settlements are established on or adjacent to uraniferous tailings dams.[12] It may expose the residents to direct external gamma radiation, inhalation and ingestion of radionuclides, radon and radon gas, and chemotoxic metals. To limit the risk due to external gamma radiation, the Chamber of Mines uses a guideline that each tailings deposit should have a 500 m buffer zone surrounding it, where no human settlement is allowed. In many cases, however, this guideline has not been adhered to in the development of new settlements (See map Image 1):[13]

Image 1: 1.6 Million people live in informal settlements close to mine residue deposits.



Source: A Turton, Powerpoint presentation during the Minewater Management Conference, 28th September 2011 (Midrand Convention Centre, Midrand).

11 Department of Minerals and Energy. Draft Regional Mine Closure Strategies for the West and Far West Rand Goldfield. 2008.

12 DM van Tonder, "South Africa's challenges pertaining to mine closure - The concept of regional mining and closure strategies", AB Fourie, M Tibbett, IM Weiersbye, PJ Dye (Eds), *Mine closure*, pp. 87 – 97, 363; H Coetzee, "Radiometric surveying in the vicinity of Witwatersrand gold mines", AB Fourie, M Tibbett, IM Weiersbye, PJ Dye (Eds), *Mine closure*, pp. 617- 626; MW Sutton, IM Weiersbye, "Land use after mine closure - risk assessment of gold and uranium mine residue deposits on the eastern Witwatersrand, South Africa", GDARD, Final report, 788/06/02/2011, Umvoto Africa (Chris Hartnady, Andiswa Mlisa) in association with TouchStone resources "Feasibility study on reclamation of mine residue areas for development purposes: Phase II strategy and implementation plan", July 2011.

13 H Coetzee, "Radiometric surveying in the vicinity of Witwatersrand Gold Mines, Mine closure", AB Fourie, M Tibbett, IM Weiersbye, PJ Dye (Eds), *Mine closure*, pp. 1- 625.

In South Africa, most tailings dams and unrehabilitated footprints of re-mined tailings dams are unfenced and even used for recreation (e.g. quad-bikers), as informal playgrounds by children, and for livestock grazing. In addition to increasing erosion and dust emissions, the increased hand to mouth activity (and ingestion of particles) exhibited by young children is known to place this population group at particularly high risk of metal toxicity.[14] Crops are planted in wetlands within the West and Far West Rand and broader Witwatersrand goldfields, containing elevated levels of toxic and radioactive heavy metals and on uraniferous tailings.[15] It is well established that some plant species can accumulate metals to potentially toxic levels and that plants on tailings and AMD have elevated metal contents. Heavy metals are found to be present in a range of herbal medicines.[16]

Risks associated with the ingestion of riverbank material by young children and pregnant mothers (the practice of geophagy[17] – also known as 'pica'[18]– are widespread in rural African communities) are not quantified. It is worth noticing that uraniferous salt crusts, preferably forming on low-lying floodplain sediments and river banks, were found to contain extremely high concentrations of uranium (up to 1 100 mg/kg).[19] The author observed, on frequent occasions, young mothers and children eating uraniferous salt crusts. It is common knowledge that uraniferous mud cakes are sold at taxi ranks and on the streets. Uraniferous tailings are also used as an acne cure by residents of informal settlements.

In the engagement with mining communities, the author of this article has found that there exists a significant body of anecdotal evidence of cancers, mental retardation and impairment of cognitive functions amongst humans and documentary evidence of congenital malformations amongst mammals. There has, however, been no epidemiological or toxicological studies conducted in order to quantify the health impacts and to assess the chronic

14 MW Sutton, "South African legislation pertinent to gold mine closure and residual risk", A Fourie, M Tibbett and J Wiertz (Eds), *Mine closure* (Australian Centre for Geomechanics, Perth, 2007), p. 95.

15 Personal observation and H Coetzee, J Venter and G Ntsume, Council of Geoscience, Report No 2005-0106. "Contamination of wetlands by Witwatersrand gold mines – processes and the economic potential of gold in wetlands", 2005.

16 MW Sutton, "South African legislation pertinent to gold mine closure and residual risk", A Fourie, M Tibbett and J Wiertz (Eds), *Mine closure* (Australian Centre for Geomechanics, Perth, 2007), p. 95.

17 Compare JM Hunter, "Geography in Africa and in the United States: A culture-nutrition hypothesis", *Geographical Review*, April 1973, p. 192.

18 RK Gupta & R Gupta, Clinical profile of pica in childhood", *JK Science*, 7(2), April-June 2005, pp. 61-63.

19 Council for Geosience, H Coetzee, "An assessment of sources, pathways, mechanisms and risks of current and potential future pollution of water and sediments in gold-mining areas of the Wonderfonteinspruit Catchment", Report No 1214/1/06, WRC, 2004.

effects such as mutagenicity, teratogenicity and estrogenicity on mammals and humans. The Cancer Registry furthermore has failed to publish its booklet on cancer incidences since 1999.[20] An urgent need is identified to establish whether or not there is a causal link between mining waste and increased percentages of cancers, mental retardation, impairment of cognitive functions and congenital malformations in order to be more sensitive towards preventative measurements and be more proactive in remediation processes.

National Nuclear Regulator and the Far West and West Rand health risk issues

The National Nuclear Regulator is a juristic person, comprising a board, a chief executive officer and staff, and its objects are to regulate nuclear safety, and monitor the nuclear industries and their waste production. It is funded by government grants and on the licensing of nuclear facilities. It is required to protect the public from exposure to radioactivity from sources like mining, nuclear research, nuclear electricity production and other industries.[21] Before 1988, licensing was conducted by the Atomic Energy Board (later to become the Atomic Energy Corporation). From 1988, these activities were converted into a Council for Nuclear Safety, and only in 1999 did it become the National Nuclear Regulator (NNR). For the first time the institution had its own distinct founding legislation separate from the legislation promoting the nuclear industry. The NNR is answerable to the Minister of Energy. The NNR is governed by the National Nuclear Regulator Act (47 of 1999) (NNRA).

There exists uncertainty regarding the regulation of radioactive waste outside licensed sites and the regulation of historical mine residue deposits[22], and the mandate of the NNR in this regard. The NNR is of the opinion that

20 Personal communication between Dr Carl Albrecht, Head Researcher of the Cancer Association of South Africa and the author, 14th December, 2011. Personal Communication between Dr Caradee Wright, Senior Researcher , Climate Studies, Modeling and Environmental Health CSIR and the author, 12th August 2011.

21 Republic of South Africa, NNR Act (47 of 1999) Sections 3 and 5; Greenpeace, Report, R Teule (Ed.), "The true cost of nuclear power in South Africa", 2011.

22 Mine residue deposits refer generally to the following entities: Tailings disposal facilities (TDFs), whether hydraulically placed (dams) or mechanically placed (dumps); waste rock dumps; open cast excavations and quarries; water storage facilities and return water dams; tailings spillage sites, generally near TDF dams; footprints left after the re-mining of TDFs, in some cases eroded and reduced to a "badland" condition; and mixtures of building material, mine waste, urban waste, spillage, industrial waste, etc, within the boundaries of former mine properties. There are approximately 380 mine residue deposits in Gauteng Province, most of which are the residues of gold-mining, GDARD, Final report, 788/06/02/2011, Umvoto Africa (Chris Hartnady, Andiswa Mlisa) in association with TouchStone resources "Feasibility study on reclamation of mine residue areas for development purposes: Phase II strategy and implementation plan", July 2011.

it is not responsible for the regulating of radioactive mining waste outside licensed sites and historical mining waste.[23] This has resulted in radioactive mining waste outside mining properties not being regulated, which presents a significant hazard and risk to communities living in these areas.

The NNR and scientific research findings and activities

In a scientific research report by the Water Research Commission (WRC) in March 2006 (Report 1214/1/04)[24] the WRC found that the measured uranium content of many of the fluvial sediments in the Wonderfonteinspruit, including those off mine properties and therefore outside the boundaries of licensed sites, exceeds the exclusion limit for regulation by the National Nuclear Regulator. A decision was therefore necessary by the NNR, regarding a regulatory response to this problem. The NNR disclaimed the findings and recommendations of the WRC Report and stated that the NNR makes use of an internationally recognized methodology as well as international norms and standards in its radiological risk assessment of uranium levels in water. The methodology used by the WRC in this report was regarded by the NNR as inconsistent with these norms and standards. The NNR therefore felt that it is not in a position to concur with the methodology[25] and conclusion of the WRC-report and that the NNR will undertake its own investigation and will make the findings available to the public.[26]

The NNR conducted its own investigation in 2007 by commissioning research on the radiological impact of mine water discharges to members of the public living around the Wonderfonteinspruit Catchment Area (WCA). Potential radiation exposures caused by emissions of radon and contaminated dust from mining legacies were outside the scope of the investigation. A report was made public in April 2007[27] that served as a guideline for responding to issues such as the removal of residents in the Tudor Settlement. Several recommendations surfaced from the 2007 report that were commendable

23 Republic of South Africa, NNR Act, 47 of 1999. Section 6.

24 WRC Report No 1214/1/06, P Wade, F Winde, H Coetzee (compiler), "An assessment of sources, pathways, mechanisms and risks of current and potential future pollution of water and sediments in gold-mining areas of the Wonderfonteinspruit catchment," 2004, pp. 119-165.

25 The disclaimer was issued by the senior manager of the NNR, Mr. Orion Phillips, on behalf of the NNR.

26 Council for Geosience, H Coetzee, "An assessment of sources, pathways, mechanisms and risks of current and potential future pollution of water and sediments in gold-mining areas of the Wonderfonteinspruit Catchment", Report No 1214/1/06, WRC, 2004 (See disclaimer).

27 NNR, Report BSA-Project-No. 0607-03, "Assessment of the radiological impact of the mine water discharges to members of the public living around Wonderfonteinspruit Catchment Area", April 2007.

and raised expectations of proactive measurements through a governing body such as the NNR. They were, amongst others:

- Slimes dams located in the immediate vicinity of surface water bodies should be equipped with an appropriate water-retention system for run-off waters to prevent further dissemination of slimes in the surroundings (short-term).
- A remediation concept for the Tudor Dam should be elaborated (short-term) and implemented (intermediate-term).
- The former wetland downstream of the Lancaster Dam should be included in the remediation project regarding the Lancaster Dam (short-term).
- The mines should install effective systems for the treatment of mine- and production waters to be discharged into the environment (intermediate-term).
- Remediation concepts aiming at a sufficient reduction of diffuse radioactive emissions (especially seepage, run-off water) in the long-term should be developed for slimes dams located in the WCA.
- A rehabilitation concept should be elaborated for the existing system of wetlands in the WCA. It should be envisaged to combine these measures with the remediation of slimes dams, e.g. relocation of contaminated sediments to slimes dams prior to their remediation.
- Restriction of public usage of contaminated environmental media.
- Farmers/herdsmen in the WCA should be informed about the risks of the usage of surface water bodies containing radioactively contaminated sediments for cattle watering and about alternatives for cattle watering bearing lower radiological risks (immediate).
- Cattle watering facilities, which largely exclude the uptake of resuspended radioactively contaminated sediments during cattle watering , should be erected in the WCA (short term).
- In the interim time, suitable warning signs should be installed at surface water bodies polluted with contaminated sediments and used for cattle watering (immediate).
- It would be beneficial to intensify the scientific investigations concerning this matter and extend this research on to all relevant slimes dams in the WCA (short-term).
- Operating water retention ponds at slimes dams should be fenced and their usage for cattle watering should be prevented (immediate).

- The owners of properties contaminated by slimes should be informed immediately about the existing radiological risks regarding the agricultural usage of these areas.
- The mining companies responsible for the contamination should be committed to the removal of the soil contamination in the near-term.
- Farmers supplied with radioactive contaminated mine water for irrigation of agriculturally used land should be informed immediately about the associated radiological risks.
- Simple methods for the reduction of the interception of radionuclides by leafs of pasture and crop plants should be tested and – if successful – propagated to the concerned farmers (short-term).
- A concept for the provision of radiologically innoxious water for the irrigation of agriculturally used land in the WCA should be developed (intermediate-term).
- Improvement of the information base concerning the real usage, occupancy and consumption parameters at sites for which relatively high incremental doses were estimated on the basis of generic assumptions (short-term).
- Execution of radiological measurements of slime dams and radiological impacts in the surroundings (specific activities, radon, wind and water erosion etc.) to establish a comprehensive data base (slime dam register / environmental cadastre) (intermediate term).
- Measurement of environmental impacts of radioactive dust (especially dust deposition on agriculturally used land) caused by wind erosion from slimes dams, and completion of the radiological impact assessments with respect to air-pathways (short- to intermediate-term).
- Completion of the radiological measurements with respect to potentially contaminated objects not yet covered by the already performed investigations (short-term).
- Comprehensive investigation of mine and groundwater used by farmers for irrigation with respect to radioactivity concentrations (especially U-238 and Ra-226), and radiological assessment of the use of these waters based on medium- and long-term considerations (short-term).
- Measurement of activities of the relevant long-lived radionuclides in agriculturally used land plots that were irrigated since 10 to 30 years (or more) ago with radioactively polluted water, and assessment of actual radiological

impacts as well as of potential long-term effects caused by the decay-ingrowth processes (short-term).

- Execution of experimental and field investigations concerning adsorption of radionuclides from irrigation water in soils, and of potential removal processes in the root zone with respect to regional conditions (intermediate-term).
- Measurement of transfer factors for the long-lived natural radionuclides with respect to all relevant exposure pathways, especially soil-pasture, soil-crops, pasture-milk, pasture-meat and water-fish with respect to regional conditions (short- to intermediate-term).

Based on their joint responsibility, the NNR and the Department of Water Affairs (DWA) embarked on a co-operative venture to evaluate the extent of impairment in the Wonderfonteinspruit Catchment Area (WCA) and if impairment exists to determine what remediation is to be implemented. In order to address these issues a team of specialists was appointed to advise the authorities on prioritisation of the Areas of Intervention for which remediation is required. A remediation methodology was adopted during March and April 2008[28] and also the order of priority in which these "Areas of Intervention" should be dealt with. The Specialists Task Team went through a process of identifying 36 Areas of Intervention ('radiologicial hotspots') that could be impacted on by water-borne radioactive material within the WCA and could potentially be a public health risk. The WCA Remediation Action Plan was prepared by Iliso Consulting (Pty) Ltd. on behalf of the NNR and the DWA in September 2008. A public participation process followed between August 2009 and November 2009. An Implementation Task Team (ITT) was furthermore appointed and the first ITT meeting took place on the 14th of May 2010, the second ITT meeting took place on the 15th of October 2010. The third ITT meeting took place on the 24th of March 2011 and at the meeting the ITT was transformed into a Remediation Steering Committee (RSC). The Specialist Task Team (STT)/ITT initiative was abandoned without any explanation. Three Steering Committee meetings were held since.[29]

The Status Report on the actions arising from the Study of Radiological Contamination of the WCA was published by the NNR on the 29th of October, 2009 but was not made available to the general public. The study confirmed

28 Wonderfonteinspruit Catchment Area (WCA), Radioactive contamination specialist task team, Report on site visits and recommended actions. Remediation plan prepared for DWA and NNR by Iliso Consulting (Pty) Ltd., Final draft report, 30 April 2009, p. 81.

29 Remediation Steering Committee (RCS), Minutes, 24 March, 2011;14th June, 2011; 5th August, 2011; E-mail communication, December 2011, EJ Stoch.

the presence of radioactive contamination in the WCA. Preliminary results of analyses on produce grown in the area have indicated that the dose levels are of radiological concern to the NNR. The study has also highlighted the need for all the regulators to work closely together since the contamination includes non radiological contaminants such as heavy metals and salts. There has been no further reporting on the recommendations and findings of the above-mentioned Status Report.

On the 5th of August, 2011[30] the NNR announced that it will no longer coordinate and lead the steering committee to provide a comprehensive strategy for the rehabilitation of the WCA and that the DWA will in future take over the chairing and organizing of upcoming remediation steering committee meetings,[31] notwithstanding the statement in the NNR's Annual Report, which was presented to the Parliamentary Portfolio Committee on Energy, on the 18th of October, 2011 that the "...NNR will coordinate and lead the steering committee…to provide a comprehensive strategy for the rehabilitation of the Wonderfonteinspruit."[32] However, on the 29th of November, 2011, the NNR entered into an agreement with the Federation for a Sustainable Environment (FSE) in order to – in collaboration with the FSE – conduct awareness creation campaigns amongst mining communities at risk within the Witwatersrand Goldfield.[33]

A critical assessment on the:

NNR and Acid Mine Drainage

The history of acid mine drainage (AMD) in the West Rand Basin via mine water decant on the Randfontein Operations property of Rand Uranium is well documented. Decant first manifested in 2002. The ramifications of decant for the sub-region are enormous. The greatest focus in this regard is the Cradle of Humankind World Heritage Site, which includes the home of "Mrs Ples" and "Little Foot" in the Sterkfontein Cave system. Of no lesser concern, however, are the 11 491 downstream landowners and agricultural activities that are largely or wholly dependent on groundwater for potable

30 E-Mail, Mr. Phillips (CEO Gold Fields)/M Liefferink, 28 September 2011.
31 WCA, Remediation Steering Committee, Minutes, 5 August 2011.
32 The CEO of the NNR's presentation of the NNR's Annual report to the Parliamentary Portfolio Committee (PPC) on Energy, 18 October 2011, pertaining to the Wonderfonteinspruit.
33 Personal communication, Mr. Gino Moonsamy (Manager: Stakeholder Relations and Corporate Communications) of the NNR and Mrs M Liefferink, 29 November 2011.

and business use.[34]

With regard to the question of acid mine drainage (AMD), which involves the seepage of waste water from abandoned mines into the environment, the NNR has up to 2011 played a very ineffectual role[35], given that the waste water is radioactive and toxic due to the presence of radionuclides. The NNR has essentially ceded the problem to other government departments and state institutions like the Department of Water Affairs.[36] It is therefore not surprising that in conducting surveys to test its public profile, the NNR has discovered that public confidence in its activities is rated extremely low.[37] The NNR has, neither historically, nor currently, acknowledged or recognised its responsibility in addressing AMD and is of the firm opinion that the responsibility falls within the jurisdiction of the DWA. The NNR justifies its position in this regard by arguing that the principal pollution risk is chemical and not radiological. At the time of writing, the author has no knowledge that a co-operative agreement between the DWA and the NNR exists in this regard.

NNR and dust pollution

During a sampling tour[38] in 2007 the authors of the NNR report (the same year) observed strong dust emissions from slimes dams during wind events. Due to the small particle size of the slimes, particulate matter can be transported over relatively long distances to agricultural land in the

34 CSIR, Report no. CSIR/NRE/WR/ER/2007/0097/C, PJ Hobbs and JE Cobbing, "A hydrogeological assessment of acid mine drainage impacts in the West Rand Basin, Gauteng Province (CSIR/THRIP, Pretoria, 2007), p. 1.

35 R Teule (Ed.), The true cost of nuclear power in South Africa, *The Greenpeace*, Report, 2011.

36 Republic of South Africa (RSA), National Assembly Question 2756 , Mrs H Lamoela (DA)/The Minister of Energy (2011) and the Minister of Energy's Response, 14th October, 2011. The honourable Minister responded: "In respect of this matter, NNR is obligated to observe the mandate of the Department of Water Affairs but would however need to engage in cooperative governance regarding acid mine drainage".

37 Unpublished market research done for the NNR has been said to reveal public confidence levels at 25%. The NNR has avoided revealing these poor results and in its Strategy Plan and budget for 2009-12 is only prepared to admit that the organisation "will need to elevate itself to a position where it is recognised as a credible custodian of public health and safety", p. 13, implying it is not there yet. See Greenpeace, Report, R Teule (Ed.), "The true cost of nuclear power in South Africa", 2011, p. 34.

38 Sampling of water, sediment and soils to investigate the radiological impact of former and actual mine water discharges as well as of diffuse seepage/runoff water from the many slimes dams to members of the public living in the Wonderfonteinspruit Catchment Area. "Report to Contract No. RRD/RP01/2006, Assessment of the radiological impact of the mine water discharges to members of the public living around Wonderfonteinspruit Catchment Area", BSA-Project-No. 0607-03, prepared on behalf of National Nuclear Regulator (NNR), 2007, p. 10.

surroundings. It was found that the so-called 'air-pathways' (inhalation of Rn-22 daughter nuclides from radon emissions of desiccated water storage dams and slimes dams and the inhalation of contaminated dust generated by wind erosion from these objects) can cause significant radiation exposure in the surroundings of mining legacies. The deposition of dust on leaves of vegetable and forage plants, and the agricultural use of the contaminated crop can cause significant radiation exposures exceeding those from the "inhalation of contaminated dust" substantially being in the same order of dose contributions of the so-called "water-pathways". [39]

Motivated by the findings of the NNR Report, entitled "Radiological Impacts of the Mining Activities to the Public in the Wonderfonteinspruit Catchment Area", dated the 12th of July 2007, the NNR[40] appointed a team of specialists called the Specialists Task Team (STT)[41] to investigate the logical process to start the clean up action for the Wonderfonteinspruit Catchment and to advise the authorities on the prioritization of the Areas of Intervention for which remediation is required.[42] The initial approach was that all radioactive material not properly disposed of on a licensed disposal area, or that has been dispersed from such an area, must be cleaned up due to its potential to pose a health hazard to members of the public. The STT[43] went through a process of identifying 36 "Areas of Intervention" by focusing on sites that could be impacted on by water-borne radioactive material within the Wonderfonteinspruit catchment and could potentially be a public health hazard.[44] The overriding intention of the STT was to start with the clean up action as soon as possible, and not to wait until everything is too widely known. Grounded upon physical (real) evidence, there has been no clean-up or remediation of the WCA, except for a few isolated spots.

39 RSA, NNR report, TR-RRD-07-0006, "Radiological impacts of the mining activities to the public in the Wonderfonteinspruit Catchment Area", 12 July 2007.

40 According to Prof EJ Stoch "the NNR never appointed the STT, the STT was appointed by the Wonderfonteinspruit Catchment Area Technical Project Working Group (WCATPWG)". Electronic communication between EJ Stoch and the author, 16 December 2011.

41 See historical outline earlier.

42 WCA, Radioactive contamination specialist task team, Remediation plan radioactive contamination Specialist Task Team, Report on site visits and recommended actions", Iliso Consulting (Pty) Ltd., 24 October 2008.

43 Specialist Task Team comprising of M van Veelen, G de Beer, F Winde, D Lush, R Cohen, G Mlangeni, K Pema. EJ Stoch was originally on the Task Team but resigned and R Cohen requested that a disclaimer regarding the findings of the Report be included in the final report. This was not adhered to.

44 RSA, Department of Water Affairs (DWA), Wonderfonteinspruit Catchment Area, Radioactive Contamination Specialist Task Team , Report on site visits and recommended actions, Final Draft Report**,** 2009-04-30, Iliso Consulting (Pty) Ltd; RSA, NNR, Remediation plan and the NNR, 30 April, 2009.

A few findings were made during the research process towards active intervention. With reference to the Tudor Dam, located in the south eastern portion of the headwaters of the WCA, it was found that the area behind the dam is currently dry and being mined by a company called Mintails to recover gold from the sediments that have accumulated as a result of past mining practices considered inefficient by today's standards. It was furthermore found that Mintails is currently [in 2011] in violation of its water use license at the Lancaster Dam. It was recommended by the STT that the Tudor Dam with its high uranium and radium activity concentrations (8000-10000 Bq/kg for uranium and with radium at 1700-2800 Bq/kg) and wetlands downstream of the Tudor Dam (2 000 Bq/kg for uranium and 1200 Bq/kg for radium) be immediately remediated.[45]

Grounded upon physical (real) evidence and institutional developments within the NNR, the implementation of remediation initiatives within the Wonderfonteinspruit Catchment Area (WCA) had, after the effluxion of five years, not been implemented.[46] The communities continue to be at risk.

NNR and epidemiological studies

When the Minister of Energy, Ms Dipuo Peters in 14th October, 2011 was asked by Mrs H Lamoela (National Assembly Question 2756) whether the National Nuclear Regulator (NNR) has:

- cleaned up radioactive contamination emanating from the 120 years of poor disposal of mining wastes;
- conducted epidemiological studies to quantify the health impacts of radioactive waste on communities in the Witwatersrand Goldfields; if not, why not; if so, what action did the NNR take in each case,

the Minister responded as follows: [47]

> In ensuring the correct application of the "polluter pays" principle, the NNR cannot be held responsible for the cleanup of radioactive contamination[48] due

45 RSA, DWA, "Wonderfonteinspruit Catchment Area, Remediation plan radioactive contamination, Specialist Task Team Report on site visits and recommended actions", Iliso Consulting (Pty) Ltd.; RSA, NNR, NNR Final draft report, April 2009, pp. 28-30.

46 Electronic correspondence, Mr O Phillips/Steering Committee members, 28 September 2011; WCA, Minutes Steering Committee, Minute, 5 August 2011.

47 RSA, National Assembly Meeting, Question 2756, 14 October, 2011.

48 The author's underlining.

> to poor disposal from mining activities. This is a matter for the operators who were responsible for generating mining waste and if these are not traceable, the Department of Mineral Resources bears the responsibility in this regard;
>
> It is not within the scope of the NNR mandate to conduct epidemiological studies for affected communities.[49] The Department of Health is the appropriate authority in this regard.

While it is acknowledged that the NNR cannot be held responsible for the clean-up of historical radioactive contamination, in terms of its mandate, it is responsible for the regulatory decisions regarding the protection of people, the environment (non human species) and property against historical radioactive contamination. Regulatory decisions in this regard may involve the issuing of directives against the responsible parties. The polluter pays principle, including the historical application of the polluter pays principle ought to apply.[50] There are no ownerless mines within the West and Far West Rand goldfields.[51]

In terms of Section 6 of the National Nuclear Regulator Act (47 of 1999) in order to give effect to the principles of co-operative government and intergovernmental relations contemplated in Chapter 3 of the Constitution of the Republic of South Africa. 1996 (Act No. 108 of 1996), all organs of state, as defined in section 239 of the Constitution on which functions in respect of the monitoring and control of radioactive material or exposure to ionizing radiation are conferred by this Act or other legislation, must co-operate with one another in order to:

a. ensure the effective monitoring and control of the nuclear hazard;

b. co-ordinate the exercise of such functions;

c. minimise the duplication of such functions and procedures regarding the exercise of such functions; and

d. promote consistency in the exercise of such functions.

The NNR must furthermore conclude co-operative agreements with relevant organs of state to give effect to the co-operation contemplated in the abovementioned section and the Minister of Energy must make regulations

49 The author's underlining.

50 Compare RSA, National Environmental Management Act, Section 28, no. 107 of 1998.

51 RSA, Department of Mineral resources, "Mine Dumps around Gauteng. As per site verification. Randfontein/ Krugersdorp Area, 2011. Written document supplied by Ms Munyadziwa E Sinthumule, Directorate: Mine Environmental Research & Sustainable Development, Department of Mineral Resources to the author on the 27 June 2011.

regarding matters that must be provided for in co-operative agreements.

The author has no knowledge that a co-operative agreement has been entered into between the NNR and the Department of Health or any other relevant organ of state in order to assess and quantify the health risks. This urgent matter therefore remains unattended and unaddressed.

NNR and public interests

As mentioned earlier a recent Greenpeace Report[52] found that the NNR is a weak protector of the public interest, because it often interprets its mandate so narrowly. For example, instead of taking the lead on questions of radioactive contamination, it waits for other government agencies to be active. It rejects its broad responsibility and argues that it is only accountable for overseeing licensed nuclear facilities. Therefore it cannot function effectively to reduce radioactive contamination outside of these facilities, which in the case of South Africa is quite extensive. A few examples are discussed to accentuate the concerns of Greenpeace and others with the NNR approach to environmental risks:

Environmental risks and NNR responses on public anecdotal evidence and concerns

Perhaps from the start of this discussion it is necessary to state that the NNR does not acknowledge past and present anecdotal evidence. To exemplify: In an interview with the *Carletonville Herald*, Mr. Orion Phillips of the NNR expressed the opinion that:[53]

> … the radiation risk in Carletonville area is so low that inhabitants have nothing to fear.

Also, in a May, 2011 interview with well-known TV presenter Johann Botha, the CEO of the NNR, Adv. Boyce Mkhize, made a noble statement:[54]

> One soul lost is one too many… Anything that ought to be done should be done.

52 Greenpeace, Report, R Teule (Ed.), "The true cost of nuclear power in South Africa", 2011.
53 A Louw, *Carletonville Herald*, 16 July, 2010.
54 J Botha, Summit TV, Series 3, Episode 34, Kyknet, Projek Aardwolf, May 2011.

However, in reality these noble or soothing remarks provide room for concern when reflecting the NNR's record on its activities from its founding to the present. So for example has the NNR's engagement with members of the communities been limited to two Imbizo's[55] organized by the Executive Mayor, Cllr Andrew Maphetle of the Tlokwe Local Municipality during December 2009 and January 2011.[56] The NNR record of engagement to environmental risks that concerns the public reflects four meetings with the public pertaining to the WCA remediation action plan during September and November, 2009 and the once-off distribution of 600 pamphlets amongst residents of the Tudor Shaft Informal Settlement during 2011. Two other areas, namely the Tweelopiespruit and the Tudor Shaft Informal Settlement also are worth discussing:

Tweelopie Spruit

The decant of acid mine drainage water into the Tweelopiespruit and the Krugersdorp Game Reserve resulted in the Tweelopiespruit East becoming a Class V River (Very high acute hazard) in 2002. It has resulted in the poisoning of the surface water by sulphates, metals and radioactive elements. The water has decanted since 2002 and the water in the underground located dolomitic aquifer is at significant risk or has already become poisoned and unfit to be used in any manner. Water leaving the aquifer has already contaminated and increased the contaminant load in the Rietspruit and Blaauwbankspruit.[57] Several deaths, claimed to have been directly related to the drinking of mine void water from the Tweelopiespruit have occurred among the animal population in the Krugersdorp Game Reserve. Where mortality can be ascribed to a toxin, it is possible to isolate the causal agent, a process simplified where the possibilities can be identified.[58]

It was found that the mine void water is toxic and could lead to severe health effects or death in humans should it be used for drinking purposes

55 *Imbizo* is a forum for enhancing dialogue and interaction between government and the people.

56 Personal communication, M Liefferink/EJ Stoch, December 2011.

57 Harmony Gold Mining Company. "Impact of the discharge of Treated Mine Water, via the Tweelopiespruit, on the receiving water body Crocodile River System, Mogale City, Gauteng Province", DWAF 16/2/7/C221/C/24. Johan Fourie & Associates, Final Document – 3 December 2006, p. 89.

58 L Stoch, "Memorandum, Krugersdorp Game reserve: Animal Mortality, V2", 13 May 2005. ES van Eeden, "Whose environment? whose nature? – a trans-disciplinary discussion on some inhumane actions in the destruction and construction in nature – case study, the Merafong municipal region", *The Journal for Transdisciplinary research in Southern Africa*, (2), November 2006, pp. 409-430.

in its undiluted form.[59] High concentrations of heavy metals, including uranium, cadmium, cobalt, nickel, manganese, iron and aluminium can cause impairment of cognitive functions, skin lesions, cancers and affect the neural development of the foetus, which may result in mental retardation.[60]

Some of the observations and findings of a resident (and researcher) in the area, Mr Stephan du Toit are: [61]

> Heavy metals... we discovered in my son (Hannes) when we [were] still staying in the Krugersdorp Game Reserve when he was diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) at the age of 5 years. He also had elevated levels of mercury, cadmium, aluminium and lead. It was later determined by the Council for Geosciences (for both my daughter Christi-Ann and Hannes) that the lead accumulated in their systems were originating from Uranium (based on the lead isotope ratios). We intensely assessed the various pollution sources (point & diffuse) that they were confronted with and the various pollution pathways...highlighting again the need for a high confidence population health study."

Other residents, Mr. Mitchell Krog and his wife, Elise (who live downstream from the Tweelopiespruit) also submitted some anecdotal evidence:[62]

> We spoke with Carin [Smit][63] on Friday evening regarding Elise's blood results which have revealed high levels of mercury in her system, a known cause of Multiple Sclerosis (MS). What is concerning though is that Carin says the tests show that some of her mercury is current, perhaps something in our environment…Our farm in Magaliesburg sits between two prevailing winds, one from the West Rand / Carletonville area, the other from Rustenburg, both areas have lots of mines and industries that could be emitting mercury.

59 Harmony Gold Mining Company. Environmental Impact Document, "Impact of the discharge of Treated Mine Water, via the Tweelopies Spruit, on the receiving water body Crocodile River System, Mogale City, Gauteng Province", DWAF 16/2/7/C221/C/24. Johan Fourie & Associates, Final Document – 03 December 2006. pp. 89-90.

60 SHH Oelofse, PJ Hobbs, JRasher and JE Cobbing. "The pollution and destruction threat of gold mining waste on the Witwatersrand - A West Rand case study", Publication no: CSIR/NRE/PW/EXP/2007/0161/. Natural Resources and the Environment CSIR. Natural Resources and the Environment; CSIR. Proceedings of the Sixteenth International Symposium on Mine Planning and Equipment Selection (MPES 2007) and the Tenth International Symposium on Environmental Issues and Waste Management in Energy and Mineral Production (SWEMP 2007). Held jointly in Bangkok, Thailand, 11-13 December 2007, p. 6 of 11.

61 Electronic communication, Mr Stephan Du Toit, the author and third parties, 6 November 2011.

62 Electronic communication, Mr Mitchell Krog (photographer)/M Liefferink, 1 November 2011.

63 In terms of the website http://carinsmit.co.za/ Carin Smit, is listed as the founder of the Synapse Africa Neuro-Nutritional Clinic is a C/Clinical Metal Toxicologist (www.IBCMT.com / www.IAOMT.org) and an autism practitioner. One of her main focal points being the optimization of health through the metabolic recovery from dread diseases. Carin Smit is also a qualified AIT (Auditory Integration Training) – Practitioner and Internationally approved Instructor for new AIT practitioners. She aids in the recovery of individuals, especially children who may suffer from a variety of neuro-integrational disorders.

The concerns of the abovementioned residents as well as many other affected residents were not acknowledged, investigated or acted upon, neither by the NNR nor by any other relevant organ of state. However, the gold mining company, Goldfields has initiated an epidemiological research project, which will commence in January, 2012.[64] This is conceived as a noble and progressive paradigm shift within the gold mining industry.

Tudor Shaft Informal Settlement

Tudor Shaft Informal Settlement was established in approximately 1997 by Mogale City Local Municipality as a temporary settlement upon uraniferous mine residue. Thousands of residents have subsequently located to Tudor Shaft Informal Settlement. Informal housing are erected adjacent or directly upon radioactive and toxic waste material from historical gold mining. The houses do not have concrete foundations. This renders these areas a potential hot spot for radon exposure.

Image 2: Barefoot child standing on uraniferous tailings in the Tudor Shaft Informal Settlement

Source: The *Durango Herald*, Jenny Gross Associated Press, 2011.

64 Personal communication, Mr Phillip Jacobs, Head of Sustainable Development of Goldfields (South Africa) and the author, 12 December 2011.

Image 3: Tudor Shaft Informal Settlement which was established by Mogale City Local Municipality, 14 years ago, on uraniferous tailings

Source: The *Durango Herald*, Jenny Gross Associated Press, 2011.

Tudor Shaft Informal Settlement, within the WCA, is one of many informal and formal settlements in the goldfields of the Far West Rand, which was established upon and adjacent to uraniferous tailings waste. The Federation for a Sustainable Environment (FSE)[65] called upon the NNR for intervention. After eight years of whistle blowing, advocacy and lobbying, the NNR decided, motivated undoubtedly by the international and national news media coverage and advocacy of the FSE, to conduct, at cost to the NNR, a surveillance exercise on the 21st and 22nd of July, 2010 and published a surveillance report. The exercise entailed collecting samples of water, soil, vegetable, other media and taking measurements of external radiation in order to independently assess if there were any adverse radiological impacts to members of the public. The NNR team visited 10 sites over a two day period.[66] In its formal testimony the NNR reported that it could find no evidence of a threat to the public and that there were no internal signs of radioactivity present in the bodies of two residents of the Tudor Shaft Informal Settlement

65 The author of this article is an Executive Member of the FSE that approached the NNR.

66 The names of the team are not disclosed in the Report. The Report was prepared by Mr Orion Phillips (Senior Manager) and reviewed by Mr A Joubert (Principle Specialist Radiation), J Pule (Senior Specialist Radiation) and N Mohlala (Radio-Chemist) of the NNR. The Report was recommended for approval by Mr O Phllips (Senior Manager).

that were tested for radioactivity.[67]

The Greenpeace report afterwards stated that the scientific reporting of the NNR pertaining to Tudor Shaft Informal Settlement was inadequate and unreliable.[68] Dr. Rianne Teule of Greenpeace found that the main issues were: [69]

- The report lacks references regarding chosen methodology, risk factors, etc. It refers to the 'Brenk report' but without reference to where that report can be obtained. Without references it is hard to evaluate or criticise the chosen methods and calculations.
- The report does not explain how doses from airborne/re-suspended particles are determined. No volumetric activities are given in the analysis results or how it was determined. If measurements were done during the two day site visit, this would have been insufficient to evaluate a useful value for the volumetric activity, as it will vary significantly depending on season and weather conditions.
- The omission of the dose due to radon exposure especially in Tudor Shaft Informal Settlement is a serious flaw. These doses can be very significant, and would add to the 3.89 mSv currently estimated for the most affected group.
- The emphasis the report puts on the Whole Body Count results for two people is highly unjustified and unprofessional. Not only can the most relevant radionuclides not be detected with this technology, also the relevance of a two-person (random?) selection is debatable. These two people should be retested using other methods (as they might now falsely assume to not be exposed).

However, the FSE encouraged the intervention of independent scientists[70] who verified that the contamination was a serious threat to human health. Also, the FSE in co-operation with national and international experts, identified worrying mistakes in the NNR report, for example on the mis-calculation of dose impacts. The NNR claimed that it was "not a research body", and undertook to revise its findings.[71] The revised report was published on the 14th

67 RSA, NNR Report No TR-NNR-10-001, "Surveillance Report of the Upper Wonderfonteinspruit Catchment Area", 25 August 2010.

68 Greenpeace, Report, R Teule (Ed.), "The true cost of nuclear power in South Africa", 2011.

69 Electronic communication, R Teule/NNR and M Liefferink, 7 January 2011.

70 Dr R Teule (Greenpeace); Mr P Diehl (World Information Service on Energy) and Dr E Blaurock-Busch of Germany critically reviewed the NNR report. Dr Busch, 29 November 2010, also participated as a speaker at the North West University's (NWU) 1st Forum on Ecohealth research in Pretoria, South Africa, titled: Toxic Bodies – Toxic Environments- Some multidisciplinary research perspectives; Also see the findings of F Winde of the NWU in several articles and that of C Busby on "Radioactivity in the Upper Wonderfonteinspruit Catchment Area. Review of National Nuclear Regulator Surveillance Report TR-NNR-10-001". December 2010.

71 Greenpeace, Report, R Teule (Ed.), "The true cost of nuclear power in South Africa", 2011, p. 24.

of March, 2011.

It is the author's opinion that the NNR has financial, technical and human resource constraints which impedes its ability to fulfil its mandate effectively. The author is furthermore of the opinion that the NNR's engagement with the public and civil society is ineffective and there is an historical unwillingness to collaborate with affected communities in addressing radioactivity; to address issues transparently and a tardiness to make pertinent information available to interested and affected parties.

Subsequently, the NNR recommended to Mogale City Local Municipality that the residents of Tudor Shaft Informal Settlement be relocated.[72] This recommendation was undoubtedly motivated by the subsequent negative news media reports pertaining to the NNR's Surveillance Report and alleged errors in its mathematical calculations, although the NNR publicly objected to the fact that the peer review of its Surveillance Report was unsolicited.

In the NNR's Annual Report presented by the CEO of the NNR, Adv. Boyce Mkhize to the Parliamentary Portfolio Committee on Energy, on the 18th of October, 2011, it was submitted that as a result of the recommendation of the NNR that: "…the Tudor Shaft Informal Settlement …resulting in the entire settlement being relocated to another site."[73]

From the above-mentioned response it is evident that the NNR conducted no further follow-up inspections or visitations to the area in order to verify whether the entire settlement has been relocated. The statement by the CEO of the NNR was not informed by the current situation within the Tudor Shaft Informal Settlement. The pre-directive which was issued by the Department of Environmental Affairs to Mogale City Local Municipality furthermore substantiates this statement.[74]

72 The recommendation was issued in July, 2011. See Notice of intention to issue a directive in terms of section 28(4) of the National Environmental Management Act (107 of 1998) and / or a directive in terms of section 31 A of the Environmental Conservation Act (73 of 1989) in respect of the radioactive mine tailing within the Tudor Shaft Informal Settlement, Mogale City by the Deputy Director General of the Department of Environmental Affairs, Ishaam Abader to the City Manager of Mogale City Local Municipality, 5 September 2011.

73 S Bega, "Residents use radioactive mud as an acne cure", *Saturday Star*, 12 November 2011.

74 The recommendation was issued in July 2011. See Notice of intention to issue a directive in terms of section 28(4) of the National Environmental Management Act (107 of 1998) and / or a directive in terms of section 31 A of the Environmental Conservation Act (73 of 1989) in respect of the radioactive mine tailing within the Tudor Shaft Informal Settlement, Mogale City by the Deputy Director General of the Department of Environmental Affairs, Ishaam Abader to the City Manager of Mogale City Local Municipality, 5 September 2011.

Tudor Shaft Informal Settlement residents like Jeffrey Ramorute stated that all of them were not removed. He recently stated:[75]

> These people are lying if they say they've moved everybody. We're still here, living in poor conditions.

Grounded upon physical evidence, only 13 shacks were relocated adjacent to an uraniferous tailings dam which is currently being re-mined. There are hundreds of residents within Tudor Shaft Informal Settlement who continue to live upon uraniferous tailings. The area, from which the 13 families were removed, remains unrehabilitated and has become an attractive nuisance for barefoot children to play.[76]

Thousands of residents continue to live on radioactive contaminated soil. The situation in Tudor Shaft Informal Settlement is mirrored in the entire Witwatersrand goldfields.[77] It is to be concluded that the intervention by the NNR, while laudable, was a cosmetic and wholly inadequate address of the situation but inspires hope that it will establish a positive legal precedent.

The Socio-Economic Rights Institute of South Africa,[78] in conjunction with members of the FSE, conducted interviews with residents of Tudor Shaft Informal Settlement. A qualitative questionnaire was used to interview the members on any problems they had with their environment; the level of knowledge of these environmental problems and the health risks posed. Approximately half of the respondents in Tudor Shaft Informal Settlement mentioned issues to do with the environment as a key concern facing them and their communities without being prompted. In a recent government

75 Notice of intention to issue a directive in terms of section 28(4) of the National Environmental Management Act (107 of 1998) and / or a directive in terms of section 31 A of the Environmental Conservation Act (73 of 1989) in respect of the radioactive mine tailing within the Tudor Shaft Informal Settlement, Mogale City by the Deputy Director General of the Department of Environmental Affairs, Ishaam Abader to the City Manager of Mogale City Local Municipality, 5 September 2011.

76 Grounded upon anecdotal evidence and news media reports. See for example S Bega, *Saturday Star*, 12, C Matthews *Financial Mail, 26* August 2011.

77 Notice of intention to issue a directive in terms of section 28(4) of the National Environmental Management Act (107 of 1998) and / or a directive in terms of section 31 A of the Environmental Conservation Act (73 of 1989) in respect of the radioactive mine tailing within the Tudor Shaft Informal Settlement, Mogale City by the Deputy Director General, Ishaam Abader to the City Manager of Mogale City Local Municipality, 5 September 2011.

78 J Dugard, J MacLeod and A Alcaro. Abstract for "Human Rights and the Global Economy", Conference, *Rights Mobilisation in South Africa in the context of acute environmental harm,* New School, NYC, 9-10 November 2011. Jackie Dugard is executive director of the Socio-Economic Rights Institute of South Africa (SERI).

report[79] it is believed that the NNR ruling is "likely …to be relevant for a number of other sites" and high risk informal settlements will need to be moved to minimize human health risks.

It is the author's opinion that the implementation of changes and relocation will be a slow and arduous process. It is furthermore the NNR's firm opinion that it is not the relevant organ of state to address these issues; that the health risks are low and does not warrant action. Grounded upon the historical address of radioactive contaminated sites by the NNR, it is concluded that the actions by the NNR are reactive and not proactive and a piecemeal approach to these issues is followed.

In the final draft of another report titled; *"Feasibility study on Reclamation of Mine Residue Areas for Development Purposes. Phase II Strategy and Implementation Plan"* commissioned in 2011 by the Gauteng Department of Agriculture and Rural Development, the institution sound:

> The unfortunate case involving the NNR-enforced relocation of the Tudor Shaft Informal Settlement illustrates that there are powerful scientific arguments for preventing human settlement in or close to these mine residue areas until toxic and radiogenic materials have been completely removed, the area radiometrically surveyed and monitored until cleared for safety by the NNR.

Notwithstanding the powerful scientific arguments to prevent staying on contaminated land, it remains the NNR's firm and deliberate opinion that it is not responsible for the regulation of uraniferous mining waste and spillages on public and private properties and for the assessment of impacts of radioactive mining waste upon human health. In the absence of co-operative agreements - on a vertical and/or horizontal level – between the NNR and relevant organs of state, uraniferous mining waste remains largely unregulated and the impacts upon communities unaddressed.

Working towards a positive legacy in the Far West Rand and broader goldfield areas

The above-mentioned concerns have been acknowledged by organizations and institutions such as the Council for Scientific and Industrial Research, the

79 GDARD, Final report, 788/06/02/2011, Umvoto Africa (Chris Hartnady, Andiswa Mlisa) in association with TouchStone resources "Feasibility study on reclamation of mine residue areas for development purposes: Phase II strategy and implementation plan", July 2011.

North-West University, University of the Witwatersrand, Harvard Law School (Human Rights Program), the Social and Environmental Rights Institute, the Pretoria University (Onderstepoort), the Legal Resources Centre, Oxfam, the Ford Foundation, the Centre of Environmental Rights, Greenpeace International, Stichting Onderzoek Multinationale Ondernemingen, World Information Service on Energy, the Department of Mineral Resources, etc. These organizations and institutions are currently assisting or co-operating with the author in research projects pertaining to the said concerns and gaps in information.

The South African Human Rights Commission, a national human rights institution established in terms of section 184 of the Constitution of the Republic of South Africa, (Act 108 of 1996) has, inter alia in support of the author's concerns, established a section 5 Expert Advisory Committee in order to find workable methods of promoting responsible mining practices and monitoring thereof in an effort to address historical and current impacts of mining.[80] With the Commission's focus on the right to a safe and clean environment and the designation of a dedicated Commissioner to deal specifically with natural resource management and human rights, the Commission is well placed to carry out a number of activities in promoting and protecting this right.

In a recent decision the Constitutional Court provided guidance on the meaning of "ecologically sustainable development", thereby informing on the nature of the state's obligations in terms of the right. The court stated that sustainable development requires recognition of the inexorable links between socio-economic development and the environment: Development cannot subsist on a deteriorating environmental base – unlimited development is detrimental to the environment and the destruction of the environment is to development. All decision and law-making processes therefore need to integrate economics and ecology – not just to protect the environment, but to protect and promote future development as well.[81]

The 125 years of gold mining within the Witwatersrand goldfields may in future leave a legacy of abandoned ghost towns, excavated areas, pits,

80 Minutes of the Section Five Committee Meeting On Acid Mine Drainage, 22 March 2011.

81 Fuel Retailers Association of Southern Africa v Director-General: Environmental Management, Department of Agriculture, Conservation and Environment, Mpumalanga Province & Others 2007 (6) SA 4 (CC) (Fuel Retailers case) and MEC: Department of Agriculture, Conservation and Environment & other v HTF Developers (Pty) Ltd., 2007.

overburden rock dumps, tailings dumps, reseptor dams, abandoned machinery and infrastructure, sinkholes and degraded ecosystems and soil with accompanying health risks and hazards, and impacts. Realizing that the Witwatersrand mining legacy cannot be addressed at the highest level of rehabilitation standard, i.e. re-creating pre-mining conditions in all disturbed areas, and that available finance will invariably influence rehabilitation standards, the following practicable environmental options are proposed for the attention of the NNR:

- The NNR should exercise its mandate to protect people, the environment and property against radiological damage.
- Co-operative agreements by the NNR with relevant organs of state, on vertical and horizontal levels, should be entered into in order to address the health risks and hazards within the Witwatersrand goldfields.
- As far as possible, all pollution, including pits filled with radioactive and toxic sludge, uraniferous tailings spillages and receptor dams containing elevated levels of radioactive and toxic heavy metals, must be cleaned up, all infrastructure for which there is no future use must be demolished, and all mine waste must be disposed according to legal standards, and where, feasible, international best practice, while taking the close proximity of the mine waste to residential developments, into account.
- If existing tailings dumps or dams are re-mined for the recovery of gold and/or uranium, remediation of the footprints must take place concurrently with the re-mining of the dumps or dams. If tailings dumps or dams are not re-mined the surface of any dump should be as small as practicable and domed, rather than flat, and vegetated and encapsulated (e.g. capping the top and slide slopes with one meter of soil, planting grasses, and paving the top with asphalt) in order to ameliorate toxic and radioactive dust fallout, erosion and water pollution.
- Mine tailings dams and dumps must be fenced off, with clear warning signs at prominent places and with no housing within a 1 000 m buffer zone of a tailings dam or dump.
- Resident relocations (formal and informal settlements) may be required.
- Rehabilitation standards are largely determined by end land use. Since they are the ultimate recipients of potential ongoing and historical pollution and the potential future land users, the requirement of the Mineral and Petroleum Resources Development (MPRD) Regulation 62 entails that interested and affected parties must be involved in the agreements regarding future land

use of affected areas and thus in the decisions regarding the establishment of objectives for such future land use, as well as in discussing the alternatives for engineering interventions, where decisions regarding such options will affect the future land use.

- Based on current information, residential townships, edible crop production and livestock grazing are considered to be high risk land-uses for tailings storage facilities, footprints and areas within the aqueous or aerial zone of influence of tailings storage facilities and metallurgical plants in the Witwatersrand goldfields. Failure by the regulators and industry to agree on suitable "soft" end land-uses and buffer zones could exacerbate liabilities for closing mines by resulting in subsequent land-uses that are subeconomic or risky.[82]

Conclusion

It is the considered opinion of certain academics that "the implications of the NNR's ruling on Tudor Shaft Informal Settlement" is that "Government is in panic because of the NNR Tudor Shaft Informal Settlement ruling, with 36 known radioactive hotspots across Gauteng, and that "buffer zones are being mooted at 2,000 metres from tailings facilities."[83]

It was found by the authors of the GDARD document, titled "Feasibility study on reclamation of mine residue areas for development purposes: Phase II strategy and implementation plan" that the level of interaction between national government departments that administer environmental legislation is lacking, especially between DWA, Department of Environmental Affairs (DEA), Department of Mineral Resources (DMR) and NNR. There is thus a lack of responsibility and will to act from government departments and an attempt to place the onus on other departments or directorates. Directorates and departments are thus not working together. There are cases where mandates between various departments or directorates overlap, where no work is being undertaken due to each department thinking that the other is doing it. In addition, there are issues of limited capacity: government staff are under-trained and overstretched, and high staff turnover is also common. In institutions such as the NNR and Council of Geoscience (CGS), capacity and

82 MW Sutton, "South African legislation pertinent to gold mine closure and residual risk", A Fourie, M Tibbett and J Wiertz (Eds), *Mine closure* (Australian Centre for Geomechanics, Perth, 2007), p. 89-102.

83 A Turton, Powerpoint presentation during the Minewater Management Conference, 28 September 2011. Midrand Convention Centre, Midrand. (Author's note: Prof F Winde indentified 99 radioactive hotspots in the WCA alone. RSA, DWA, "Wonderfonteinspruit Catchment Area, Remediation plan radioactive contamination, Iliso Consulting (Pty) Ltd.; RSA, NNR, NNR Final draft report, April 2009, Annexure C.)

skills are dying out.[84]

It can be concluded that the historical regulatory decisions by the NNR pertaining to uraniferous mining waste were insufficient and significant challenges remain. The NNR is of the opinion that it is not responsible for the regulation of historical uraniferous mining waste and its impacts upon communities. As a result it remains largely unregulated. Since South Africa is of the intention to expand its nuclear power, it is imperative that the NNR demonstrates its willingness and commitment to regulate uraniferous mining waste in order to build trust and confidence in the public that it will successfully regulate and manage highly radioactive nuclear waste.

Not all risks can be addressed by the gold mining industry. Future land-uses must be addressed by the regulator to ensure that current rehabilitation practices are not short-sighted or incompatible with end land-uses, and that municipal development plans are risk-averse. Examples of the latter include residential and agricultural developments well within the zone of influence of tailings storage facilities, and the use of contaminated water for crop irrigation. The presence of contaminated mine water and soils in the Witwatersrand goldfields has long been recognized, and the World Health Organization has identified hand-to-mouth activity in young children worldwide as a significant risk factor in the consumption of contaminated soil. The close proximity of poorer and high density residential areas, together with household food gardens, to tailings storage facilities and acid mine drainage in the West Rand could expose to risk the sector of the population that is least equipped to deal with it.

There is also a lack of regulatory guidance regarding what land-uses tailings storage facilities and footprints can potentially be converted to during and post-closure, and this has resulted in gold mining companies allocating resources to short-term measures for dust control and aesthetics. Guidelines for sustainable closure options which minimize future risks to the industry and the Municipality should encompass the conversion of gold mine tailings and mine water to resources, and mainstream the objectives of the Kyoto Protocol, to which South Africa is a signatory, and the Marrakesh Accord of

84 GDARD, Final report, 788/06/02/2011, Umvoto Africa (Chris Hartnady, Andiswa Mlisa) in association with TouchStone resources, "Feasibility study on reclamation of mine residue areas for development purposes: Phase II strategy and implementation plan", July 2011, p. 11.

2001 which supports the use of new land forms as carbon sinks.[85] Examples include the treatment of mine water to standards suitable for industrial purposes, with concomitant recovery of useful chemical compounds, and the conversion of tailings storage facilities and footprints to restricted "soft" land-uses that combine rehabilitation with economic returns – at least on a break-even basis. Restricted end land-use that are potentially suitable for mine closure outcomes include industrial sites, line landfills, graveyards, sewage sludge disposal and land-farming, and carbon sinks facilitated by the growth of low-water demand and high root-biomass crops, such as certain fibre, pharmaceutical and biofuel species.

85 MW Sutton, "South African legislation pertinent to gold mine closure and residual risk", A Fourie, M Tibbett and J Wiertz (Eds), *Mine closure* (Australian Centre for Geomechanics, Perth, 2007), pp. 89-102.