Response to The Citizen
Prof. Anthony Turton

The core allegation from the FSE is that Mintails is largely responsible for the increased ingress of water into the Western Basin void and is thus also responsible for the current flow of decanting water from 18 Winze Shaft. In order to answer this complex question we are informed by the following scientifically verifiable facts:

Fact No 1: **Rainfall** sources over the Western Basin. **Figure 1** shows the spatial distribution of rainfall across the Western Basin. Attention is drawn to the fact that there are localized areas of higher rainfall, all associated with elevated terrain (mountains, ridges, koppies etc). This is known technically as "orographic rain" and it falls mostly along the Witwatersrand Ridge. Note the location of Randfontein on the map, and then note the localized rainfall. Then compare that with the rainfall levels around Krugersdorp, where the latter appears to be higher. Krugersdorp gets more rainfall than Randfontein, but this is only part of the story.

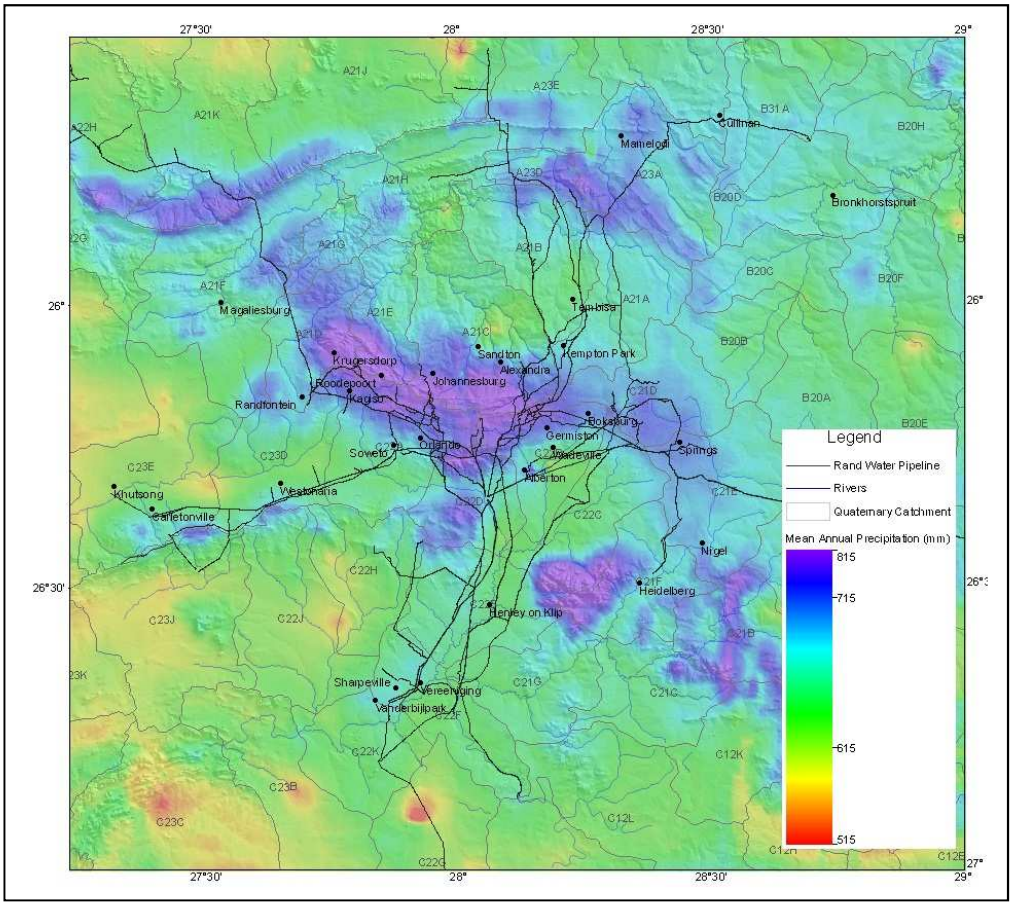

Figure 1. Mean annual precipitation (MAP) model for the Witwatersrand Goldfields on SRTM topographic base (Hartnady *et al*., 2012).

Figure 1 shows the mean annual precipitation, which means it is an annual average. However, during the months of January – March 2014, there was an abnormally high amount of rainfall. In fact the rain falling in those three months alone equalled the annual average for

the area. This means that we are dealing with a hydrological anomaly in the current decant, driven by abnormally high levels of rainfall.

The next question to answer is what happens to this rainfall? More importantly, how does it inter the Western Basin mine void? Or does is simply run off as surface flow without entering the void?

Fact No 2: Groundwater recharge over the Western Basin is a function of the localized geology as well as the prevailing slope of land. The data shown in **Figure 2** indicates the presence of a very high level of groundwater recharge west of Krugersdorp, and thus west of the Mintails mining right. When compared to the data on **Figure 1**, it becomes clear that there is not a direct correlation between local rainfall and groundwater recharge. The reason for this is the presence of geological conditions that either enhance the ingress of water, or else repel it by converting it to surface flow instead. Therefore to answer the assertion that Mintails is largely responsible for the increased ingress of water into the Western Basin void, we need to better understand the geology at localized levels of scale. Scale matters!

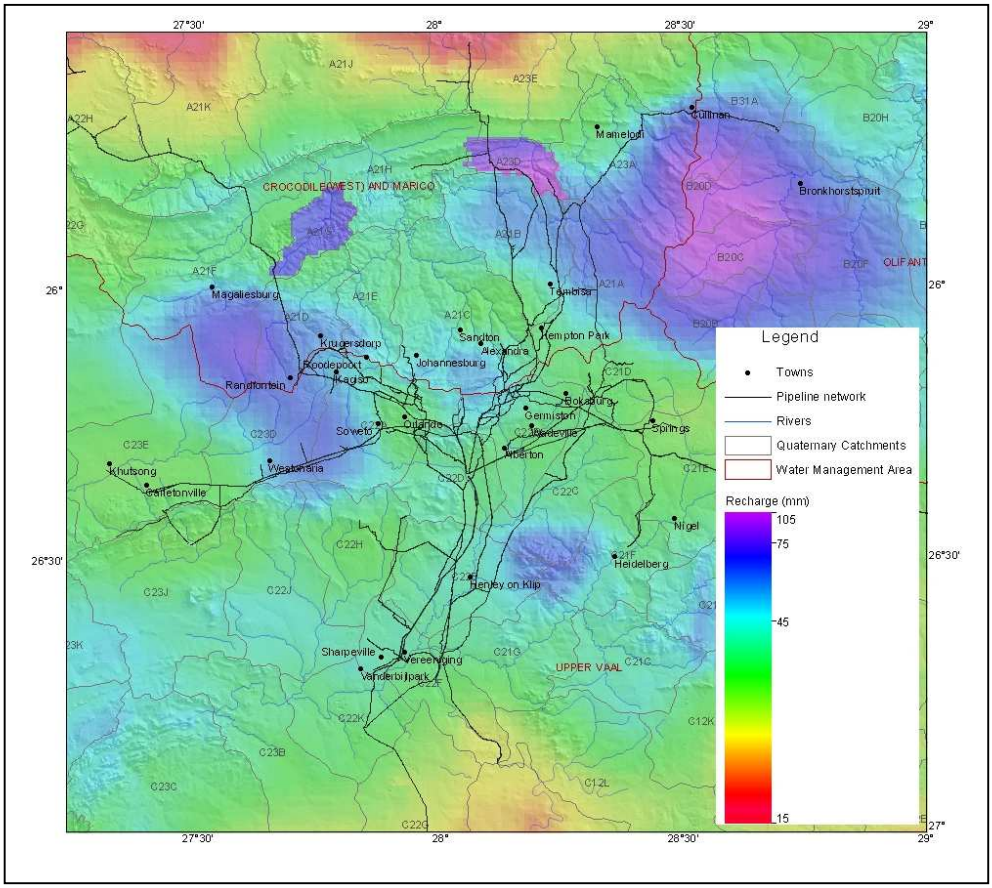

Figure 2. Groundwater recharge model for the Witwatersrand Goldfields (Hartnady *et al.*, 2012).

Fact No 3: Geological conditions in the Western Basin are shown in **Figure 3**. The decant point at 18 Winze is shown in this map as a black triangle to assist in orientation. Attention of the reader is drawn to two distinct features that are relevant to the answer. The first is the presence of dolomite to the south and the west of the Mintails mining right. It is here that the main recharge takes place into the Western Basin void. The second is the presence of basement granites south and east of the Mintails mining right. There is no recharge possible in this area because the geology simply does not allow it to happen. The conclusion when interpreting **Facts 1 – 3** is that surface ingress into the Western Basin void from rainfall is not possible on the Mintails mining right, with the only exception being the West Wits Pit. In this regard two things must be understood by the reader. (1) This is not the only open pit in the Western Basin. (2) The WWP was in existence before Mintails acquired the mining right. Stated simplistically therefore, the contribution made by the <u>current</u> Mintails surface mining operations to the current decant, when expressed in terms of <u>volume</u> only, is negligible. The issue of water quality is a different matter, and will be dealt with separately.

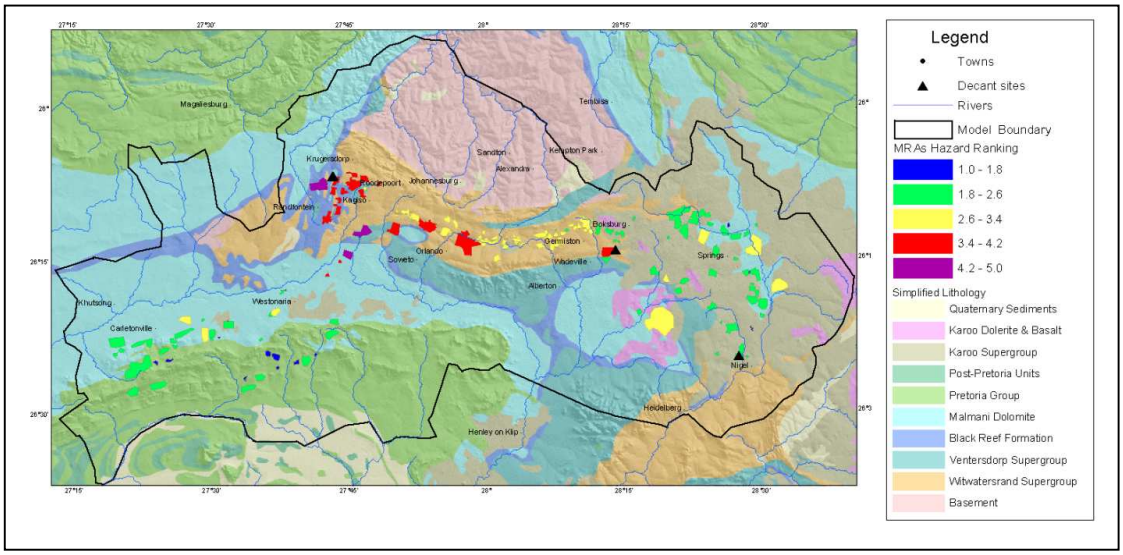

Figure 3. Model domain for the Western Basin showing hazard rating of all tailings dams and the presence of dolomite (Hartnady *et al.*, 2012).

Fact No 4: Near sub-surface flow of AMD in the Western Basin is a major contributor to water quality on the aquifer system associated mostly with the dolomite structures to the west and south of the Mintails mining right. This was mathematically modelled in such a way that the movement of pollution plumes could be predicted up to 100 years into the future. The result of that modelling, most notably for the 100 year future, is shown in **Figure 4**, where it is clearly apparent that two plumes of acidic water containing metals are relevant to the Western Basin. The first plume is associated with the dolomitic outlier in which 18 Winze is located. This is shown as a plume moving in a northerly direction from the decant point, roughly following the Tweelopies Spruit, which is the surface manifestation. The West Wits Pit is one of the major sources of this plume, which is why the <u>concurrent rehabilitation</u> is centred on the closure of the WWP permanently. The second plume, which is also much larger in extent, is located west of what is known as MRA 172. This major source of pollution is beyond the control of Mintails as it occurs off their mining right area.

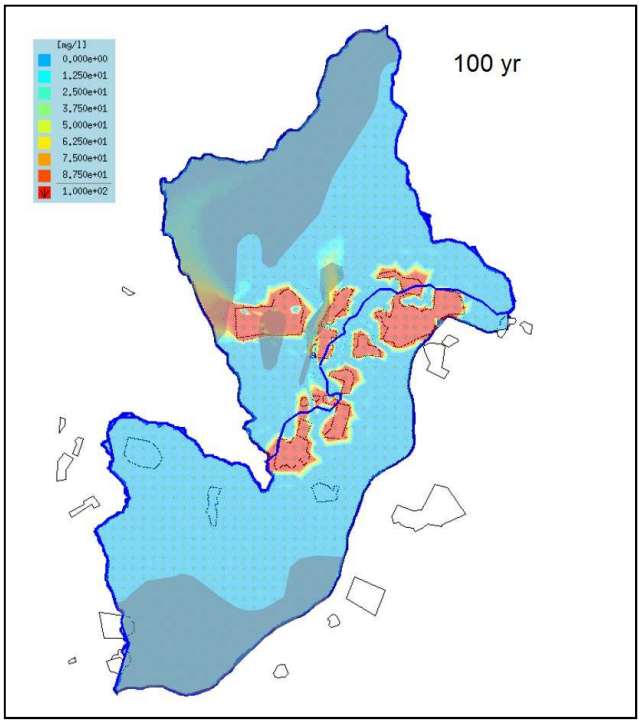

Figure 4. Results of horizontal dispersion in the near-surface zone at 100 years after the start of the model simulation (GDARD, 2011).

Fact No 5: Water quality in the Western Basin is impacted by a combination of localized sources of concentrated pollution when understood in relation to preferential flow pathways defined by geological conditions, most notably the presence of dolomite.

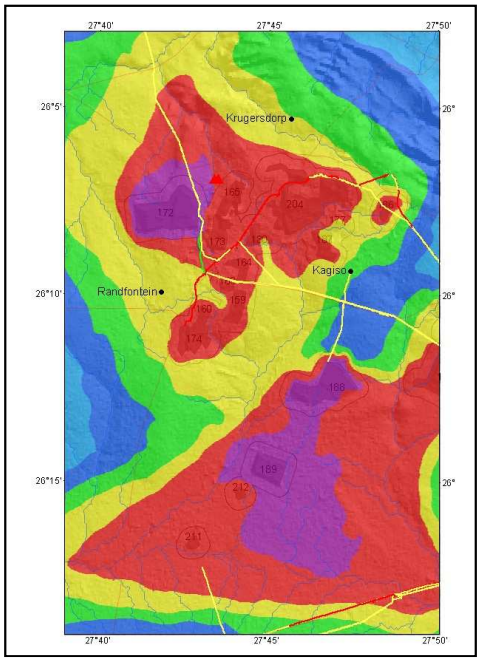

Figure 5. Plumes from AMD in the Western Basin are associated with specific surface tailings dams (Hartnady *et al.*, 2012).

The data presented in **Figure 5** shows the presence of two major pollution plumes, one moving into the Tweelopies Spruit northwards and the other moving into the Wonderfontein Spruit southwards, but also being drawn to a big pumping station for the city of Johannesburg that is now being closely monitored by the authorities. The major source of pollution in each case is the presence of a large surface tailings dam that is not on the Mintails mining right.

To deal with the allegations, specifically as it relates to the current decant at 18 Winze and the heavy flow of surface water in the Tweelopies Spruit, the following can be concluded from the above peer-reviewed scientific data:

1) While the flow of water is high, the quality is in fact not too bad when compared to the past. The pH of the water at decant is currently around 6 and claims that it has been sampled at a pH of 7 are unlikely. The significance of the pH value 6 is that it is above the threshold value for the solubility of uranium (pH 5) only because of the deposition of alkaline tailings into the West Wits Pit by Mintails. Therefore, based on empirical peer-reviewed scientific data, while the current decant is unfortunate, the impact is mitigated by the higher pH (tending to neutral) arising from the Mintails operation. i.e. The impact that Mintails has had is, in fact, positive by virtue of the fact that it has ensured the solubility threshold of uranium has not been reached. Having stated this, the chemistry of decant is important to understand, because while it emerges from the shaft at a pH of 6, it rapidly acidifies as it gains oxygen from the atmosphere, so downstream of the decant point the pH will steadily drop. This again makes the case for the permanent closure of the mine void as encapsulated within the concept of Closure Mining.

2) The contribution to ingress and thus void water level is a direct function of higher than normal rainfall over an entire summer, falling on areas of dolomite that are not on the Mintails mining right area. Where ingress is happening on the Mintails right, is well known and documented – the West Wits Pit – making a robust case for closure of that pit as is currently being done. Mintails is therefore acting in a responsible manner based on defendable science.

3) The presence of surface tailings dams will remain a persistent source of pollution well into the future. Three major tailings dams have been documented in the Western Basin (MRA's 172, 188 & 189), none of which are on the Mintails mining right. Mintails therefore has no control over this aspect. However, this reinforces the logic that the best interest of all parties will be serviced by adopting a Closure Mining approach in partnership with the state. More significantly, these three MRA's are in fact the most hazardous in the entire Witwatersrand Goldfields (see **Table 1** below), yet they seem to escape external scrutiny.

MRA ID	Basin	MRA Vol. Score	Geology Score	%TDF Score	Age Score	Recharge Score	Severity	Probability	Hazard (S+P)
189	Western	3	5	5	2	4	4.3	5	4.7
172	Western	5	4	4	5	5	4.3	5	4.7
188	Western	4	2	5	3	4	3.6	5	4.3
204	Western	5	3	2	5	5	3.3	5	4.2
190	Central West	5	5	3	4	4	4.2	4	4.1
173	Western	4	3	1	5	3	2.7	5	3.8
174	Western	4	3	1	5	3	2.7	5	3.8
192	Central West	5	3	3	5	5	3.7	4	3.8
165	Western	4	3	1	4	3	2.6	5	3.8
211	Western	2	5	1	1	2	2.6	5	3.8
212	Western	2	5	1	1	1	2.5	5	3.8
160	Western	2	3	1	5	2	2.3	5	3.6
164	Western	2	3	1	5	2	2.3	5	3.6
186	Western	2	3	1	5	2	2.3	5	3.6
159	Western	3	3	1	1	3	2.2	5	3.6
187	Western	3	2	1	4	3	2.1	5	3.5
196	Central West	5	3	1	5	5	3.0	4	3.5
130	Western	3	2	1	4	2	2.0	5	3.5
163	Western	1	3	1	4	2	2.0	5	3.5
293	Central East	5	3	4	5	4	3.9	3	3.5

Table 1. Hazard rating of all Mine Residue Areas in the Witwatersrand Goldfields ranked in descending order to risk (Hartnady *et al*., 2012).

4) Allegations of failure to do concurrent rehabilitation are based on a perception of what is possible under the current circumstances. Mintails is doing concurrent rehabilitation as manifest by the deposition of alkaline barren tailings into the WWP, which has had the effect of pushing the void water pH above the threshold of solubility for uranium (pH 5) while slowly closing out the pit forever. This takes time and will only be finished more than a decade from now. The removal of IL8 is also an example of concurrent rehabilitation, in the sense that before the footprint can be fully restored to ecological functionality, the tailings have to first be removed. This takes place over long time scales, but is happening. The rehabilitation of PSG 4, immediately adjacent to the Tweelopies Spruit and shown to journalists, is an example of concurrent rehabilitation taking place in a shorter time frame. In conclusion then, Mintails is doing concurrent rehabilitation, but it is not physically possible to fully rehabilitate an ecosystem in a short period of time, particularly where we are dealing with the cumulative legacy of 120 years of impact.

5) This raises the issue of pipelines. Unfortunately pipelines are needed to move the process water to the tailings dams and the slurry back to the treatment plant. Sadly they fail on occasion. However these failures are being managed. It is unfortunate that the servitude for the pipelines was granted through a wetland. This is an artefact of history and is not ideal, but again it is being managed in the best way possible. Much effort is being invested into developing procedures and processes that minimize the impact of pipeline failures in wetlands.

6) Clearly Mintails is aware of the complexity it is dealing with, as evidenced by the quality of the science underpinning its decision-making process. Scientific data

informs all decision-making which is not always appreciated by activists. The challenge for Mintails is therefore how to communicate this complexity with the public in a way they can understand. This is inherent to the concept of Closure Mining where partnerships are central to any prognosis for success.

Anthony Turton