THOMPSON & BRETT PTY LTD CONSULTING ENGINEERS

DEPARTMENT OF INDUSTRY & RESOURCES

INDEPENDENT REVIEW OF A PROPOSAL TO RAISE THE FIMISTON 1 TAILINGS DAM AT KALGOORLIE

FINAL REPORT

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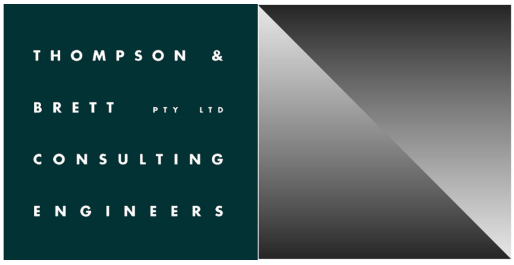

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EXECUTIVE SUMMARY

This report presents the findings of an independent review of the geotechnical and hydrogeological performance of the existing Fimiston 1 Tailings Storage Facility (TSF) operated by Kalgoorlie Consolidated Gold Mines (KCGM) and a proposal to progressively increase the height of the facility from 30 m to 40 m. In summary, the proposed raise is considered to be technically feasible subject to the completion of additional studies of seepage interception and embankment design.

The Fimiston 1 TSF was commissioned in 1988 and since that time there has been seepage of hyper-saline process water into the ground beneath and around the TSF at an estimated rate of 2000 m^3 per day. This seepage raised the groundwater levels around the TSF to within less than 2 metres of the surface during the early 1990's, but levels have subsequently been lowered by pumping.

Seepage from Fimiston 1 TSF has flowed into the ground beneath the structure and formed a “mound” of seepage water, which is spreading laterally into the surrounding areas and merging with similar mounds formed beneath Fimiston 2 and the earlier Oroya TSF. The impact has been most noticeable in the valley between Fimiston 1 and Fimiston 2, including the area occupied by lease P26/1848 held by Optimum Resources, and also into the area of land to the north of Bulong Road. Groundwater levels in the valley floor have risen by at least 10m and in other areas closer to the TSF, by more than 20m.

A groundwater management program (the Eastern Borefield), progressively developed since 1993, has started to control and lower the groundwater levels around the area south of the Fimiston 1 TSF but levels are continuing to rise in areas to the north of Bulong Road. The current groundwater extraction program only intercepts a limited proportion of the contaminated water prior to its escape from the immediate vicinity of the TSF. To date much of the water extracted from the Eastern Borefield is likely to be displaced natural groundwater but there is evidence that contaminated water has travelled at least 1km and that seepage during the life of the TSF has influenced groundwater levels at least 2km from the source.

The most obvious impact of seepage and the rising groundwater levels has been on vegetation. A comparison of aerial photographs and evidence of stumps at the site indicate that there has been an identifiable loss of mature trees in the zone previously affected by elevated water tables but without testing it is not possible at this stage to prove the cause of death. Some existing trees in the area appear noticeably stressed or recovering from previous stress. This impact has now been controlled by reducing high groundwater levels.

Seepage also impacts on water quality by increasing salinity levels by in the order of three times that of the local natural groundwater. In addition relatively low levels of cyanide and some metal contamination is evident in groundwater samples taken several hundreds of metres from the TSF. Claims of potentially higher cyanide

levels cannot be proven from available evidence. The current level of contamination does not appear to affect the Beneficial Use of the groundwater for mining process water but the potential impact on future beneficial uses is one of the important grounds of appeal. The issue of environmental values and appropriate Beneficial Use for groundwater is critical and needs to be addressed to give the proponents a quantified target for compliance and to determine the level of seepage control that is appropriate. The extent of works required to control the impacts could then be engineered by KCGM.

The proposed raise will not markedly increase the rate of seepage from Fimiston 1 TSF but it will prolong the time over which seepage into the environment is occurring from this source and the distance that the contamination will extend unless it is further controlled.

The TSF is considered a “High B” Hazard Category in accordance with ANCOLD guidelines in that failure would lead to potential loss of life, damage to infrastructure including a strategic national transport link, and to environmental impact. This requires a conservative level of design taking into account the possibility of extreme rainfall events and earthquake loadings, in order to meet industry and community expectations. Current design work has covered many of the issues covered by the ANCOLD guidelines but some further work is required. This should include a review of the ability of the TSF surface area to contain more severe rainfall than presently allowed for and assessment of the potential for piping failure at elevated pond levels during flood events. A site-specific earthquake risk assessment should be carried out along with a detailed assessment of the risk of liquefaction during earthquake. This will require further investigation of possible low strength zones within the body of the storage. Slope instability analysis should consider low strength zones, conditions under which high phreatic levels could develop and both drained and undrained conditions as required by ANCOLD and DoIR guidelines. The option of accelerating the placement of selected waste rock on the downstream face for erosion control and wall strengthening should be considered.

It is judged that these additional engineering and hydrogeological studies will demonstrate that the proposed raise is technically feasible but that some design modifications and a more targeted groundwater management plan will be required. If the time frame for extending the storage capacity is critical to mine operation it would be reasonable to approve a limited raise, subject to some relatively straightforward initial stability analysis and with some specific conditions, whilst the additional detailed studies are being carried out.

The long term Management and Closure Plan should be developed further and integrated into the current operating plan to ensure that no aspects of closure could introduce conditions that might affect design. An example of this might be pond levels after extreme flood events. Consideration should be given to limiting any development in the zone immediately below the dam that would be impacted if it were to fail.

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1 INTRODUCTION

This review has been commissioned to provide independent expert advice to the Minister of State Development in relation to the Fimiston 1 Tailings Storage Facility (TSF) and the proposal to progressively raise the height of this facility from 30 m to 40 m. The review will also be used by the Appeals Convenor's Office with respect to appeals against the EPA's level of assessment set for the proposed extension.

The Fimiston 1 TSF is one of two TSF's currently operated by Kalgoorlie Consolidated Gold Mines (KCGM). The proposed raising in height would provide an estimated additional 7 years capacity. The proposal has already been assessed by in-house technical experts at DoIR and has been considered by the EPA which has set its level of assessment at "Not Assessed – Public Advice Given Managed under Part V of the Environmental Protection Act 1986". Appeals have been received against the EPA's consideration and subsequent level of assessment.

The review process has been coordinated through the Office of the Minister for State Development by Mr Chris Fitzhardinge. The review process commenced in early August 2004 with document collection and culminated with a site inspection and interview with proponents and appellants during the week of 9th to 13th August 2004.

2 SCOPE

The scope of the review was outlined in the contract and is presented in Appendix A.

The review is restricted to an overview of technical aspects regarding the performance of the Fimiston 1 TSF in relation to the surrounding area, including the Optimum Resources Lease (P26/1848), with particular attention to determining the hydrogeological setting and geotechnical integrity of both the current structure and the proposed extended structure. This requires consideration of the geology and hydrogeology of the site and surrounds, the nature of materials within the TSF, the construction of the TSF and the resulting performance with regard to water balance and seepage losses, and the stability of the structure. This also involves review of existing technical data and methodology including design consideration of earthquake and blasting forces and potential liquefaction of tailings and review of current risk assessments.

The review is to assess evidence of significant adverse impacts on the environment or nearby landholdings and infrastructure caused by the operation of the existing structure with particular reference to salinity, groundwater contamination and changes to hydrology and to comment on any additional effect by the further raising proposed.

The review is also to assess the adequacy of proposed management and monitoring programs for the extended facility.

No testing or engineering modelling was expected for the purpose of this review.

3 THE REVIEWERS

This review has been carried out by Mr David Brett and Dr Fred Baynes. Their curricular vitae are attached as Appendix B.

Mr Brett is the Principal Director of Thompson & Brett Pty Ltd, a Fellow of the Institution of Engineers Australia and a member of the Australian National Committee on Large Dams (ANCOLD). He has over 30 years experience in dam engineering and water management for government and industry. Mr Brett has specific experience in tailings management and was a co-author of the ANCOLD Guidelines on Tailings Dam Design, Construction and Operation, 1999 (ANCOLD, 1999).

Dr Baynes is a consulting engineering geologist, a Charted Professional Geologist and a Charted Professional Engineer. He has over 25 years experience in major mining and civil projects in Australia and overseas. Dr Baynes was acting as a specialist sub-consultant to Thompson & Brett for the purpose of this review.

4 ACTIVITIES AND REFERENCES

Documentation outlining action by the Appeals Convenors Office is attached as Appendix C

A diary of activities of the reviewers is presented as Appendix D.

A list of references is presented as Appendix E.

5 BACKGROUND

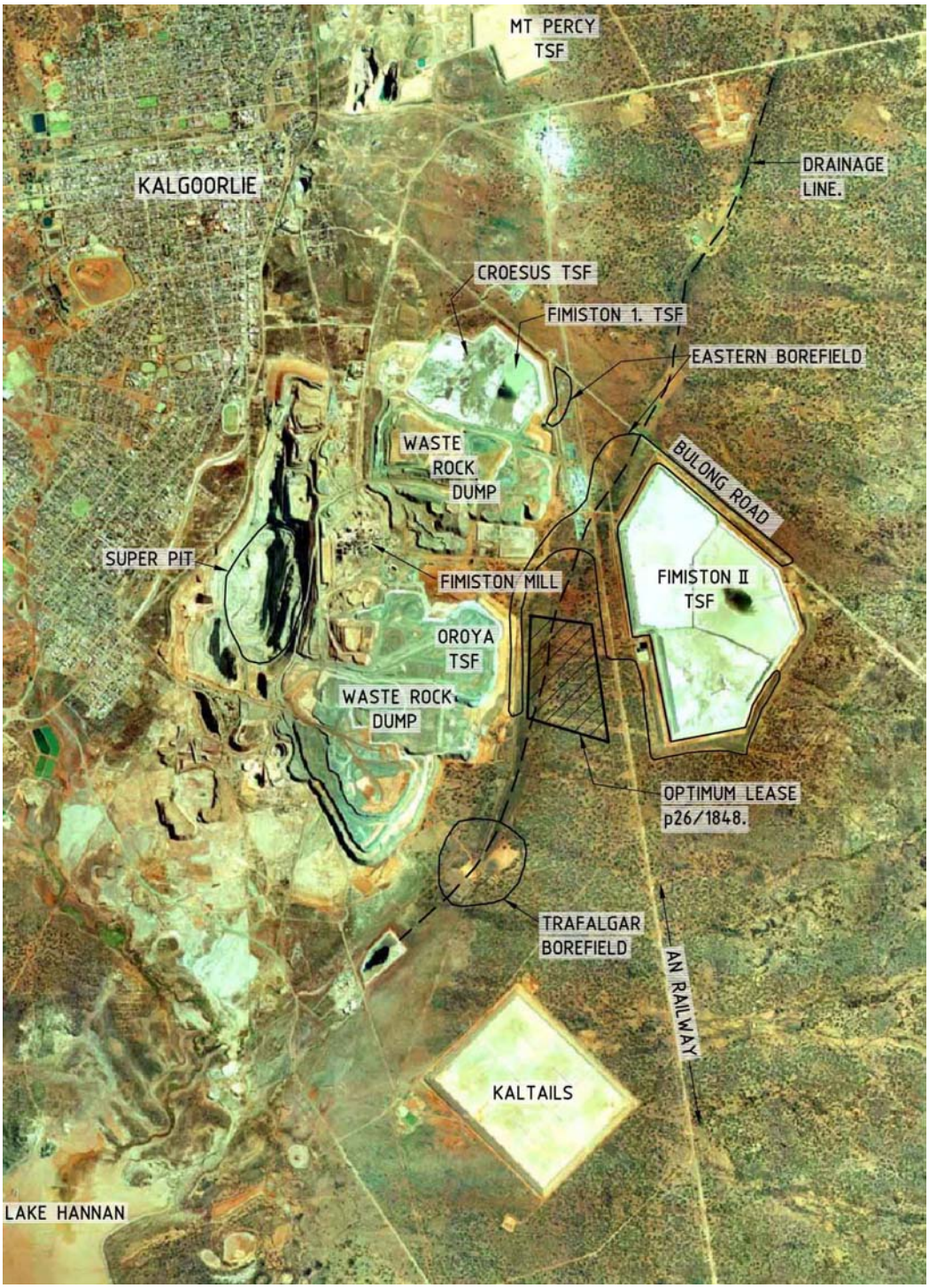
5.1 Location

The Fimiston 1 TSF lies to the east of the mineralised zone of the Golden Mile at Kalgoorlie as shown in Figure 1. It covers an area of approximately 100Ha bounded by earlier tailings and rock dumps to the south and west, Bulong Road to the north and the Australian National Railways main east-west line to the east.

Fimiston 1 TSF is one of two tailings storages currently being used by KCGM, the other being the larger Fimiston 2, located to the southeast. Fimiston 1 and 2 occupy the western and eastern side respectively of a shallow valley, which drains south to Lake Hannan and has a catchment area above the Fimiston TSF sites of approximately 100km^2. An ephemeral drainage channel runs between the two TSF

sites. The Oroya TSF, which closed in 1995, lies to the south of Fimiston 1 and is now covered by waste rock.

Figure 1 Aerial Photograph of the Site Showing Main Features



A groundwater extraction system known as the Eastern Borefield has been developed between Fimiston 1 and 2. This comprises 109 monitoring and production bores. A further borefield, Trafalgar, is located 2 km further south.

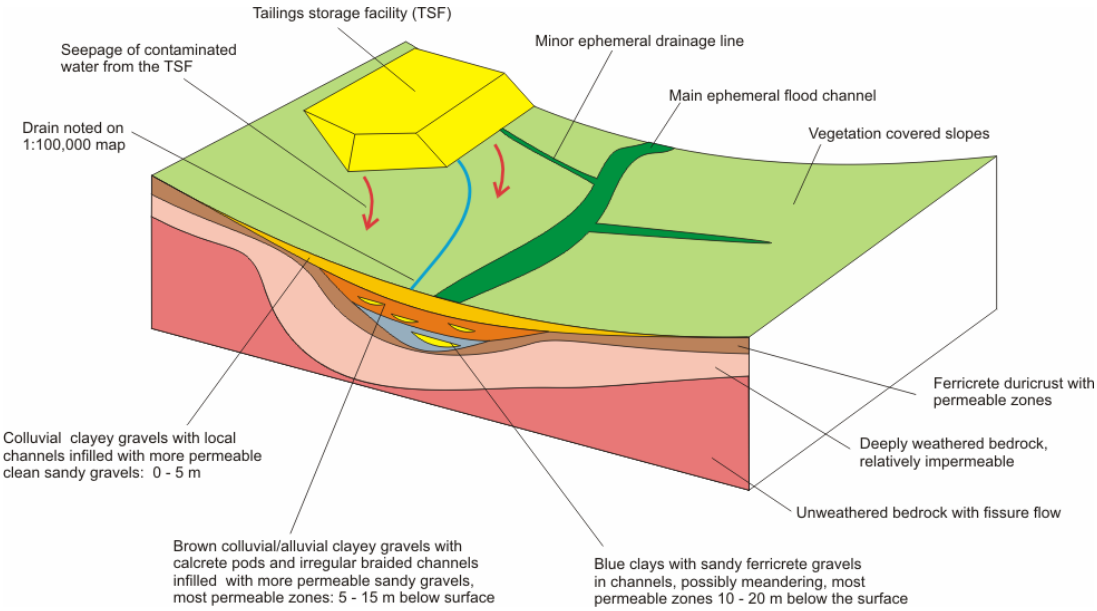
KCGM control mining leases covering much of the area south of Bulong Road but a small lease held by Optimum Resources (P26/1848) lies over the floodway of the valley with Fimiston 1 to the north, Fimiston 2 to the east and Oroya to the west.

5.2 Geological And Geomorphological Setting

This interpretation is based on regional knowledge and an interpretation of various available reports but is intended only as a guide to understanding. Drill logs have not been reviewed in detail given the time available.

The area is underlain by regionally metamorphosed volcanic rocks that form part of an Archaean greenstone belt. These rocks have been deeply weathered and a ferricrete duricrust has developed on the weathering profile in many places. The valley is a broad, shallow palaeodrainage, being the site of a former river system developed under a different higher rainfall climate. The old alluvial deposits within the palaeodrainage system, and some overlying colluvial deposits, are up to 20 m deep within the valley and groundwater flows along the more permeable sands and gravels within these deposits as shown schematically in Figure 2.

Figure 2 Typical section/model



5.3 Groundwater

The groundwater system consists of several relatively low permeability aquifers, which include the fresh jointed bedrock, a ferricrete layer developed in the weathering profile, and lenses of sandy gravels and calcretes within the alluvial deposits. KCGM's test pumping and investigations suggest that the bedrock is of low transmissivity and that the majority of groundwater flow occurs within the ferricrete and the more permeable lenses of sandy gravels, typically at a depth of less than 20 m below surface. Assuming that the groundwater catchment is coincident with the surface water catchment and maximum infiltration is in the order of 1% of annual rainfall (Hundi, 2004) then the groundwater flux through the area is probably less than 300,000 m^3/annum. Natural groundwater in the area is hyper-saline at 20,000 to 50,000 mg/L and has low pH of 2 to 4. The salinity of groundwater in some of the larger palaeochannel systems around Kalgoorlie is understood to range up to 200,000 mg/L. The Beneficial Use of the natural groundwater is currently limited to mine process water, being unsuitable for other recognised Beneficial Uses such as stock watering or irrigation.

5.4 Vegetation

Vegetation comprises open scrub with eucalypts. Past exploitation of timber to feed the boilers of the mines has left the Kalgoorlie area largely devoid of mature trees. Accordingly most trees appear to be relatively young, with trunks typically 100 to 200 mm diameter. The natural vegetation does not depend on the saline groundwater and is supported by rainfall recharge that is held in the clay formations within the root zone (Hundi, 2004). It is commonly found that tree root biomass is concentrated in the upper 1m of the soil profile in semi-arid regions (Breman and Kessler, 1995).

5.5 Tailings and Tailings Storage

The following is a summary of a more complete description of tailings and tailings storage presented in Appendix F.

Tailings are residual finely ground rock particles from which the minerals have been removed after processing. The tailings are transported as slurry with water and discharged into storage dams.

The Fimiston I TSF is an example of "upstream construction" where the tailings themselves are used to construct the storage. This involves excavating dried tailings from the inside edge of the storage and using this material to construct an embankment around the perimeter. This type of TSF is very commonly used in semi-arid areas throughout the world and can be safely constructed with proper design and careful operating procedures aimed at maximising density and controlling water within the storage. The upstream construction method relies on the properties of the tailings material itself for stability. Some tailings materials can

exhibit low strength, poor drainage, potential for liquefaction under earthquake loading and be prone to erosion. Therefore specific design measures are needed to take these properties into account and various standards have been developed in Western Australia and nationally, through ANCOLD to ensure safe standards are met.

A key factor in the stability of an embankment formed by upstream construction is the control of the phreatic surface, or water table, within the structure. An elevated water table has a significant impact on the stability of the outer face due to sliding failure and also the risk of "piping" failure where seepage on the face allows tunnel erosion to develop and lead to a flow failure. To minimise the build up of water within the storage it is important to limit the size of the surface water pond and also to encourage drainage through the base. In the case of Fimiston 1 the base drainage is achieved through the relatively higher permeability materials of the foundation. If the foundation was less permeable or if a membrane liner was used it would be necessary to provide a purpose built drainage system to pick up seepage water percolating through the tailings.

The rate of tailings deposition is also important because if the tailings are deposited too quickly then they do not dry out before they are covered and can remain in a loose, weak, unconsolidated condition. If zones of loose weak unconsolidated tailings are buried within the dam then due to their low permeability they can remain in that condition for many years and can form a zone of low undrained shear strength.

The tailings mass will have a permeability depending on the properties of the tailings and the discharge methods. This will allow some level of seepage through the base of the structure, which will relate to the natural groundwater. The extent of travel and dispersion will depend on the ground conditions below the TSF.

With relatively low ground permeability the seepage will build up as a mound below the TSF as the rate of seepage from the TSF exceeds the rate that it can be dispersed into the surrounding ground. Once tailings discharge ceases the rate of seepage would normally reduce, particularly in an arid climate, and the mound gradually dissipate.

5.6 Dam Design Procedures

The Australian National Committee on Large Dams (ANCOLD) provides advice to Government and private operators on dam design, construction and ownership in Australia. This body comprises a membership of major dam owners and individuals with an interest in dams. ANCOLD develops guidelines on dams which assist developers and regulators to follow best practice dam engineering. A particularly relevant ANCOLD guideline is "Guidelines on Tailings Dam Design, Construction and Operation" (ANCOLD 1999). Other relevant guidelines, which in part supplement sections of the 1999 guideline, are "Guidelines for the Design of Dams

for Earthquake" (ANCOLD 1998), 'Guidelines on the Selection of Acceptable Flood Capacity for Dams' (ANCOLD 2000), 'Guidelines on Assessment of the Consequences of Dam Failure' (ANCOLD 2000) and "Guidelines on Risk Assessment' (ANCOLD 2003).

In broad terms the ANCOLD design philosophy is based on an initial assessment of the "hazard rating" of a dam followed by engineering design at a level of conservatism determined by that hazard rating. The hazard rating is assessed by considering the impact (or consequence) of failure. Dams with potential for loss of life or major impact on the environment or infrastructure are required to be designed for more extreme design loadings.

5.7 Timeline

Table 1 presents a summary of events that are considered important in the context of this review.

TABLE 1 NOTABLE EVENTS

Date	Event
1893	Gold discovered by Paddy Hannan near Kalgoorlie
19 & 20th Century	Mining, modifications to surface forms, groundwater changes, clearing of trees around Kalgoorlie
1950's onwards	Regrowth of vegetation. Development of waste dumps and TSF's on drainage channel to east of Golden Mile ridge
1974	Oroya TSF commissioned and using low salinity water, seepage estimated 5000 m^3/day
1988	Fimiston 1 tailings dam NOI submitted being for new TSF adjacent to Croesus TSF
1988 - 1992	Seepage from Oroya TSF and Fimiston 1 TSF raises groundwater levels in a mound around the facility so that groundwater levels are close to the surface.
1992	Oroya TSF operating to 32 m high, converted to saline process water, up to 1000 m^3/day seepage estimated September, Bores and trenches at Oroya decommissioned October, Optimum complain to WAWA Waterlogging of Optimum Resources lease Dead trees, salt encrusted soil and flowing water on P26 /1848 originating from Balgold lease noted by DME officer
1993	January, KCGM requested to provide management plan and corrective action plan by WAWA February, trenches constructed at Oroya, Seepage from Oroya noted in Golder report July, boreholes recommissioned in vicinity of Oroya Croesus cells and Fimiston cells amalgamated
1995	Four TSF's close to Kalgoorlie, area 330 Ha, production 5mtpa. Oroya closed October
1996	Fimiston 1 operating in some areas with limited freeboard 23 May, Fimiston 2 tailings spill - tailings flowed over southern wall and down across railway land Ground water levels in railway reserve within 1 to 4 m of surface presenting a hazard to the railway and DoIR request KCGM to extend their dewatering programme End of year, major piezometer program initiated
1997	Croesus, Fimiston, Mt Percy and Gidji production at 11.75 Mtpa, Croesus and Mt Percy closed July 1997
1999	11 May, DEP instructs KCGM to reduce groundwater levels in vicinity of P26/1832
2003	NOI for raise of Fimiston 1 submitted, DoIR and DoE decided that informal assessment level applied. Level of assessment was appealed

6 FINDINGS

6.1 Hydrogeology

To understand the significance of the operation of TSF's in the local environment a simple hydrogeological model has been developed by the reviewers, predominantly using information from KCGM reports. The Oroya, Fimiston I and Fimiston 2 TSF's are located within a broad, shallow paleodrainage system that drains to the south towards Lake Hannan. Most of the groundwater flows occur within surficial deposits which are less than 20 m thick and consist of ferricrete layers and lenses of sandy gravels within alluvial and colluvial deposits. The maximum natural groundwater flux past the TSFs has been estimated as 300,000 m^3/yr. In contrast, KCGM estimate current seepage losses from Fimiston I and 2 of 8,000 m^3/day or nearly 3 million m^3/yr (Golder, Dec 2003). This is considered to be a realistic value given the estimated bulk tailings permeability in the order of 10^{-7} to 10^{-8} m/sec (Golder, April 2003) and a total TSF area of 450 Ha. Seepage from the TSF's thus represents approximately 10 times the likely natural groundwater recharge for the catchment. Approximately one quarter of this seepage is from Fimiston 1 in proportion to its footprint area.

The period of operation of Oroya, Fimiston 1 and Fimiston 2 covers over 20 years. During this time mill output has increased significantly and the scale of TSF's has steadily increased. The current estimated seepage is thus greater than the average over the past 20 years, nevertheless it is estimated that in the order of 30 million m^3 of seepage has entered the subsurface over that period. This is sufficient to have saturated up to 150 million m^3 of soil/rock, potentially representing a zone of 10 km^2 by 15 m thick. This appears to be a reasonable estimate of the actual size of the groundwater mound based on groundwater contours reported by KCGM (PCA, 2004). Figure 3 shows groundwater contours as of December 2003 (PCA, 2004) with flow lines drawn perpendicular to contours to indicate the direction of groundwater flow that would now be occurring.

Groundwater flow is clearly leaving Fimiston 1 and flowing out both to the east and north. The easterly flow concentrates in a narrow flow band through the western side of the Optimum Resources Lease. This flow is now clearly influenced by KCGM's extraction borefield in this area. Similar flow lines could be drawn for Fimiston 2 and the area south east of the Fimiston Mill where the Oroya TSF is currently covered with waste rock. The shape of the flow lines and groundwater contours suggest that the seepage mound from Fimiston 1 is influencing groundwater levels at least 2 km from the dam wall and that a similar mound is developing under Fimiston 2. The groundwater contours also suggest that there is still a residual groundwater mound under the decommissioned Oroya TSF.

The flow of seepage water to the north is confirmed by the indicated rise in groundwater level to the north of Fimiston 1 over the period 2002 to 2003 (PCA, 2004).

Figure 3 2003 Groundwater Contours And Flow-lines

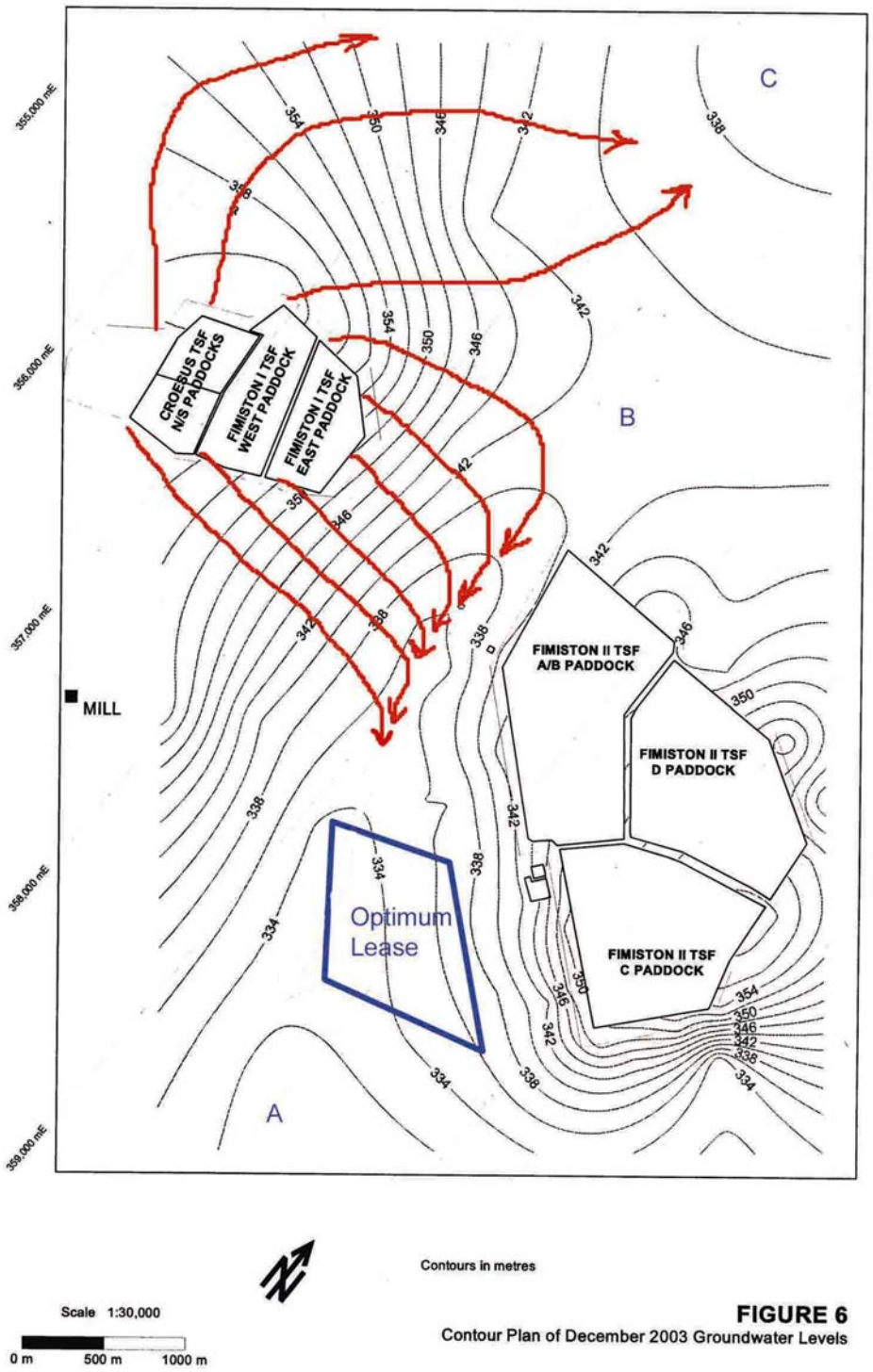
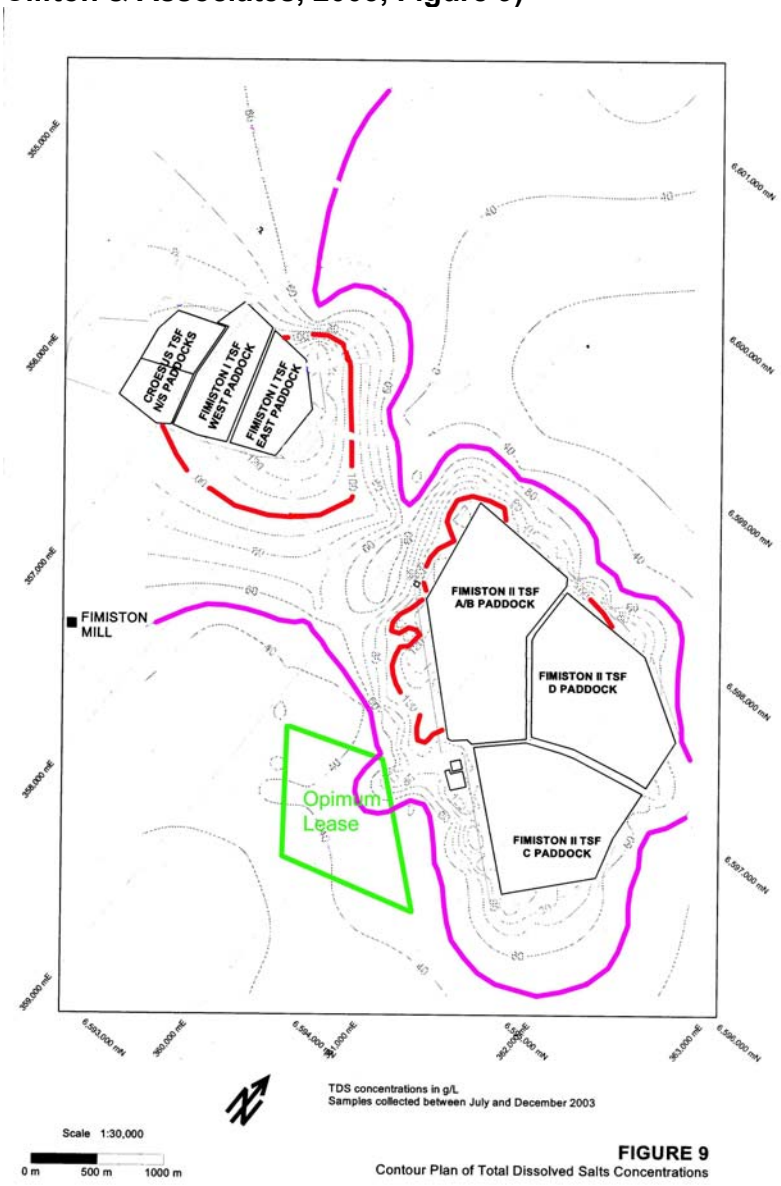


FIGURE 6
Contour Plan of December 2003 Groundwater Levels

Similar indications of seepage impact on groundwater can be seen in the monitoring results for salinity and cyanide as presented by Peter Clifton (PCA, 2004). Contours for these parameters are presented in Figures 4 and 5 (reproduced from PCA 2004) marked up to indicate the location of the Optimum Resources Lease.

Figure 4 2003 Salinity Contours And Flow-lines (modified from Peter Clifton & Associates, 2003, Figure 9)



In Figure 4 the 50,000 mg/L salinity contour, potentially representative of an upper limit for natural salinity in the local region is highlighted purple. The contours clearly show an outward movement of higher salinity water from both Fimiston 1 and

Fimiston 2. Lower salinity in the area of the old Oroya TSF is likely to be due to the use of low salinity water in the process during the majority of the time that Oroya was operating. It is understood that prior to use of hyper-saline water at Oroya the tailings decant water had a salinity of 5,000 mg/L.

Figure 5 2003 Total Cyanide Contours And Flow-lines (modified from Peter Clifton & Associates, 2003, Figure 10)

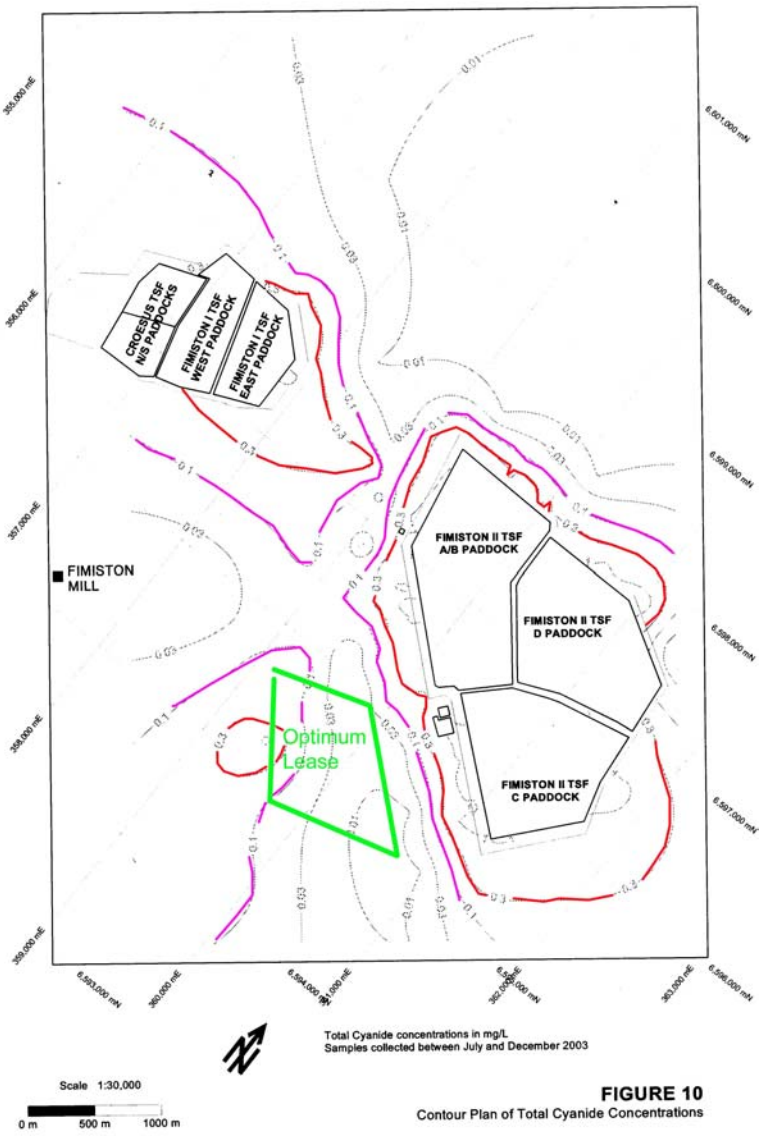


Figure 5 shows similar migration of higher total cyanide levels from Fimiston 1 and Fimiston 2 with 0.3 mg/L highlighted red and 0.1 mg/L highlighted purple. In addition higher levels of total cyanide are also indicated to the west of the Optimum Resources Lease, these are likely to have originated at the Oroya TSF.

Obtaining unambiguous data on pre TSF groundwater levels is difficult as early bores are generally mineral investigation bores not targeting groundwater. Pre-TSF groundwater depths are likely to have been near zero to the south at Lake Hannan, at approximately RL 320 m, and to have increased upstream to the north at a relatively flat gradient. The deepest groundwater level recorded to the north of Bulong Road is from MB 3, 11 km from Lake Hannan. In September 1993 MB 3 had groundwater at RL 335.91. This level has continued to rise since that time, increasing by 7 m by October 2003, so it is likely to have originally been somewhat lower than the 1993 reading. Assuming a constant gradient groundwater table, the upper limit for a natural groundwater level at the northern edge of the Optimum Resources lease, 7 Km from Lake Hannan, would be around RL 330, 12 m below current surface level in the drainage channel. Depths to groundwater away from the drainage line would be greater due to the rise in topography.

Information provided by KCGM (2004) based on data from Morgan (1984) indicates that water bores along the drainage line within and immediately upstream of Optimum Resources lease showed groundwater depths of 9.5, 6.2, 8.05 and 10.45 in 1984 (bores CKE 5, 6, 2 and 3 respectively). At the same time bores on the western boundary of the Optimum Lease, below the Oroya TSF showed depths of only 1.2, 2.15 and 5.6 (bores CKE, 8, 1 and 7 respectively). The variation in these depths and the relatively flat topography suggests that the latter groundwater levels were already impacted by the Oroya TSF operation prior to the creation of the KCGM or Optimum Resources leases and are not indicative of natural groundwater levels.

It is concluded that significant seepage occurs from TSF's on the KCGM lease and that this has led to a rise in groundwater levels within a range of 12 to 20 m depending on location. The seepage mound has extended up to 2km from the source, resulting in a combined mound covering an area of 15 to 20 km^2. The seepage mound has introduced elevated salinity and other contaminants into the natural groundwater.

Since 1993 KCGM have initiated a groundwater recovery program. This has initially targeted problem areas, where elevated groundwater levels have been the cause of complaint but has been extended to include a concentrated ring of bores around Fimiston 2 and several bores supplementing trenches around Fimiston 1. The total water reclaimed at present is nearly 2.4 million m^3/annum, which is approaching the total estimated seepage loss of 3 million m^3/annum.

Considering the general area in which the water table has been lowered by an average of 4m over the period 1999 to 2004 (Peter Clifton, 2004), it is estimated that reclaim in the Eastern Borefield is of the order of 700,000 m^3/yr greater than recharge in that area. However, recharge is continuing to increase groundwater levels in other areas such as to the north of Fimiston 1 and 2.

The Eastern Borefield appears to have been successful in lowering groundwater levels in the area south of Bulong Road and the intersection of flow lines on Figure

3 suggests that the majority of seepage from the eastern side of Fimiston 1 is being intercepted. Figure 3 also suggests that some seepage is flowing past the borefield but that this is predominantly from Fimiston 2. To fully intercept all seepage it would be necessary to develop a broad groundwater 'sump'. This has so far not been achieved. Furthermore, as groundwater levels drop the efficiency of reclaim bores will reduce, and the Eastern Borefield may be unable to maintain current production. This would lead to a slowdown in groundwater level reduction with the possibility that levels could remain above original levels for many years. If that situation were to be allowed to develop the groundwater flowing from the reclaim area would consist of a mixture of natural and TSF seepage water and this could result in contaminated water continuing to spread downstream.

It is difficult to determine the natural groundwater quality as it is likely that all bores could have some level of contamination given their location and the history of mining in the area. Table 2 presents values from Peter Clifton & Associates, 1999. Values for natural groundwater have been derived by review of results least likely to have been impacted. The quality of the TSF seepage is based on analysis of groundwater intercepted in the Fimiston 1 trench.

Table 2 Water Quality

	Natural Groundwater	Tailings Transport Water	TSF Seepage
Salinity mg/L	20,000 to 50,000	130,000	100,000 to 140,000
pH	2-4	8.6	3.7 – 7.4
CN (Total) mg/L	.01	170	0.02 – 2.8
CN (WAD) mg/L	.01	99	0.01 – 0.49
CN (Free) mg/L	.01	<0.05	0.01 – 0.49
Cu mg/L	0.07	2.4	0.5
Fe mg/L	0.2	12	0.5
Zn mg/L	0.2	0.9	0.5
Hg mg/L	0.001	0.042	.0005
As mg/L	0.001	<0.01	.001

These data indicate that the TSF seepage water introduces elevated levels of salinity, CN, Cu, Fe and Zn into the groundwater, but it is important to put the levels of the introduced contaminants into perspective. The current Beneficial Use of the groundwater in the area is as mine processing water and these levels of contamination do not appear have a significant impact. However there are no clear criteria to assess the significance of impacts on the quality of hyper-saline groundwater that is intended for use in mine processing. The establishment of such criteria by the regulators would assist in the monitoring and reporting of the license conditions under which KCGM operate.

The majority of total cyanide levels are within levels recommended in water quality guideline for recreational purposes (ANZECC, 2000). However, some of the measured higher total cyanide levels exceed the levels in those guidelines. The potential for total cyanide levels in groundwater to exceed the recommended levels for recreational use should be taken into account in any activity in the area around the TSF's where contact with groundwater might occur.

6.2 Evidence of Adverse Impacts

There is clear evidence of an increase in salinity of the groundwater within the general area of the KCGM TSF's including Fimiston I, with elevated salinity over a total area in the order of 15km^2. The Oroya seepage incident is reasonably well documented and appears to have been the trigger to commence dewatering operations in 1993. Groundwater clearly reached the surface at this time and was responsible for tree deaths. Groundwater levels have risen to close to the surface in other areas and possibly resulted in vegetation stress and death but on a limited scale. Whilst groundwater levels are now being reduced in some areas there is likely to have been impact on the soil at upper levels. Groundwater levels are still rising in other areas such as to the north of Bulong Road.

A number of trees in the vicinity of the TSFs appear either stressed or recovering from stress, with many showing epicormic sprouting (Figure 6). There are a number of 150 – 200 mm diameter stumps where trees have been sawn off and removed. It is not possible to determine the cause of death but salt stress is a possible cause given the known details of water table rise. From inspection of aerial photographs it is possible to identify a significant reduction in the numbers of trees between the Oroya TSF and Optimum Resources Lease and it is possible to identify isolated tree losses elsewhere in the area. On the other hand, it needs to be accepted that the area was relatively devoid of mature trees following timber harvesting up to mid 1950's, and that KCGM have initiated significant revegetation works during their tenure of the lease. The revegetation does not appear to have been particularly successful in the area immediately south of Bulong Road. However, healthy young trees were noted in a more recent rehabilitation site near Neve's Dam, adjacent to the Optimum Resources tenement P26/1848, which, it is understood, featured an improved planting technique.

Figure 6 Epicormic sprouting – Eucalypt between Bulong Road and Fimiston 1

Other than elevated salinity, groundwater is also contaminated with compounds contained within the seepage water such as metals and cyanide. In general the levels of these contaminants appear low. However, the existence of more permeable flow paths in the shallow aquifer suggest that higher-level "spikes" of contaminants within the groundwater system are possible. Seepage water intercepted in Fimiston 1 trenches shows significant cyanide spikes with one result for WAD cyanide up to 20 mg/L.

Whilst recent dewatering efforts appear to have reduced the elevated water table levels such that vegetation is currently not directly threatened the levels are still believed to be significantly above original levels. The elevated groundwater levels and potentially elevated cyanide levels could impact on the costs of mining or similar operations due to the need to dewater excavations and to take precautions to avoid contact with the water.

6.3 Geotechnical Integrity

6.3.1 General

KCGM have engaged well known and reputable engineering consultants to carry out site investigations, studies and designs to meet industry guidelines for dam design, construction and operation. This includes annual auditing of the TSF operational plans and procedures and independent risk assessments. However the reviewers consider that some additional information needs to be gathered and some areas of design revisited to confirm the overall geotechnical integrity of the current Fimiston 1 TSF and the proposed enlarged structure.

6.3.2 Hazard Rating and Design Parameters

As part of normal modern dam design procedure, KCGM commissioned a dam break study (Golders, 1998). This has shown that if a dam break was to occur

there would be potential for release of tailings with flow covering the AN railway line. Such a failure could also impact on the Parkeston power station, the Liquichem chemical plant and Readymix concrete plant, now located in the vicinity. The study predicted that failure would result in a flow width of up to 900m moving at 10 – 15 m/sec lasting 10 to 30 minutes.

Based on an assessment by the review team, attached as Appendix G. it is proposed that Fimiston 1 should be classed as a Hazard Category of "High B" (ANCOLD, 2000), due to the major cost and loss of credibility to KCGM and the WA Government if failure was to occur and the perceived potential for loss of life by persons passing or working in the area below the dam. This class of hazard requires the use of conservative design parameters. It is suggested that these parameters should include $1:10^6$ Annual Exceedance Probability (AEP) rain events and Maximum Credible Earthquakes (MCE) determined by Risk Assessment methods (ANCOLD, 1998, 2000). Given the risk of loss of life the ANCOLD societal risk criteria would require a probability of failure from earthquake of between 1 in 10,000 and 1 in 1000 although the "As Low as Reasonable Practicable" (ALARP) principle would apply. Indeed the design should be based throughout on conservative assumptions for critical factors that could influence failure. This should include the strength of materials, the location of the phreatic surface within the dam, the potential for liquefaction during earthquake and piping failure during elevated pond levels.

6.3.3 Overtopping

Currently KCGM have adopted a design criteria to accommodate a $1:10^3$ AEP rainfall within the TSF with 0.5 m of additional freeboard. It should be noted that this is more conservative than required by current DoIR guidelines. Nevertheless, even more stringent levels are now proposed by ANCOLD (ANCOLD, 2000), requiring design to cater for $1:10^6$ AEP flood. The new design of Fimiston 1 with central decant and very wide beaches is judged to be able to contain the larger flood but an analysis to confirm this should be performed.

6.3.4 Piping Failure

Piping has been responsible for failure of many TSF structures and always needs to be considered in a conservative design. Piping can develop if water seeping through the tailings intersects the outer face of the TSF. This can lead to seepage flow that can cause erosion of the embankment material. In the case of tailings the material is highly erodible as can be seen on the surfaces currently exposed. As material is washed out a tunnel or "pipe" can develop, potentially extending back to the source of the water. In the case of Fimiston 1 the phreatic surface (or water table) within the TSF has been shown by KCGM consultants to be well away from the surface. However the most likely condition to generate piping would be during a major flood where the water surface would extend towards the perimeter.

Currently no analysis has been carried out to demonstrate that piping will not occur during an extreme event, although the recent conversion of Fimiston 1 to a single cell will significantly reduced the risk of piping due to the increased flood storage capacity and wider beaches. Protection against piping is likely to be based on limiting pond development during extreme events, provision of filters of fine rockfill over the face to prevent wash out of tailings or possibly a management plan involving close monitoring during periods of ponding and provision for rapid remediation of any developing piping.

6.3.5 Embankment Stability

The stability of the dam has so far been assessed in terms of effective stress assuming the piezometric conditions are similar to the results of the levels measured in piezometers, which indicate a relatively low phreatic surface. Analysis has allowed that the dam would be subject to various levels of earthquake shaking. Further analysis with higher phreatic surfaces has determined “key” piezometric levels that initiate action if the phreatic surface rises. The analyses carried out to date do not indicate that there is a stability problem. However it is considered that it would be prudent to carry out further analysis for the following reasons:

a) The piezometer tips used for monitoring are understood (Trevor Tyson pers comm.) to be all located 2 m above the base of the tailings pile, relatively close to the more permeable underlying materials and thus may not be measuring pore pressures that have developed in the middle of the tailings pile ie pore pressures during normal operating conditions could have been underestimated. After a range of piezometric conditions has been measured throughout the tailings pile it may be necessary to revise the piezometric pressures assumed in the stability analysis.

b) The analyses do not include any estimates of the pore pressures that would develop if the dam were to be subject to a major flood. In this condition the pond size would increase to a maximum extent and the phreatic surface would extend towards the outer face and it is possible that higher pore pressures would develop closer to the face. When this condition has been modelled it may be necessary to revise the piezometric pressures assumed in the stability analysis. It may be necessary to consider the post-closure condition with decants blocked as a possible design condition. Even if closure included covering with rockfill it is considered that high phreatic surface could still develop due to the rockfill potentially allowing increased infiltration, particularly in the short term prior to rehabilitation.

c) The current design has not included stability analyses based on undrained strength parameters and yet there are some measurements that indicate that zones of low undrained strength exist within the pile of tailings and the low permeability of some of the tailings may result in these zones consolidating very slowly. The analyses could be based on the existing undrained strength profiles (Golder 2000) and if there were low factors of safety then further measurements

with CPT probes could be carried out to see if any appreciable strength increases had occurred.

d) Analysis to-date has calculated factors of safety for levels of earthquake shaking but the MCE has not been formally assessed. Given the level of hazard for the TSF it is suggested that a site-specific earthquake risk assessment should be carried out. A similar assessment carried out by the reviewers in the Eastern Goldfields suggested a M7.5 for the MCE and peak ground acceleration of between 347 and 605 cm/sec2, significantly higher than values used for Fimiston 1 to-date.

e) Earthquake analysis should also consider undrained strength parameters.

6.3.6 Liquefaction

The potential for liquefaction should be addressed in more detail. Preliminary assessment by the reviewers suggests that there is some potential for tailings to liquefy during earthquake shaking. The tailings within Fimiston 1 fall within the range of gradings known to be subject to liquefaction and the potential for liquefaction will be dependant on the in-situ relative density and degree of saturation of the tailings. Zones have been encountered during probing in the tailings in which low strengths and positive pore pressures were measured. Further field investigation work may be required to provide the relevant data and any analysis should include the effects of a conservatively chosen Maximum Credible Earthquake.

7 ASSESSMENT OF THE PROPOSAL TO RAISE

The technical issues related to the proposal to raise Fimiston 1 are presented in an Addendum to the Notice of Intent (Golder, 2003).

The reviewers agree that the raise is unlikely to change the rate of seepage. However, extending the life of the structure will increase the length of time over which seepage impacts the environment and also the distance that seepage impacts travel, despite the existing groundwater recovery programme. As the seepage could cause significant impacts it is recommended that the regulators should more clearly determine the extent to which these impacts need to be controlled. The extent of works required to control the impacts could then be engineered by KCGM. Possible levels of control are:

i) maintain groundwater levels to prevent vegetation deaths (which seems to be the current approach)
ii) reduce groundwater levels to historic levels
iii) prevent seepage leaving the proponents lease
iv) prevent seepage leaving the perimeter of the TSF structure
v) prevent any seepage entering the groundwater

It is assumed that the regulators would take account of the Water Quality Protection Guidelines (Waters and Rivers Commission, 1999). In particular it is considered that the question of appropriate environmental values and beneficial use of the natural groundwater should be more clearly determined for this particular area as allowed for in Guideline No 1. A clearer determination of the appropriate values and the extent to which impacts need to be controlled is likely to resolve many of the current issues raised by appellants.

In the event that improved groundwater recovery was required by the regulators the reviewers consider that the current hydrogeological model of the area is not sufficiently detailed to understand the mode and location of seepage flows leaving the site and optimise seepage recovery. However KCGM are understood to already be reviewing data that would allow them to prepare a reasonably detailed subsurface model that may assist in significantly improving the understanding of potential groundwater flow paths.

The reviewers consider that the Fimiston 1 TSF structure is currently engineered to a high standard and that the proposed raise is technically feasible. However because a high degree of conservatism is required in the design of such a structure it is recommended that some additional studies of the geotechnical integrity should be carried out before the proposed raise should be approved. The technical experts at the DoIR have also pointed out the need for additional studies.

The further studies are likely to confirm that the raise is technically feasible, although some modification to the detail design might be required. For example if the increased earthquake loading, liquefaction potential or undrained stability analyses suggest that stability under extreme loading was of concern then this could most likely be overcome by buttressing the base of the structure with waste rock. As this work is currently proposed for erosion control as part of final closure the work may need to be brought forward. Similarly, use of suitably graded waste rock as an outer shell may provide filter capability to reduce any risk of piping.

8 PROPOSED MANAGEMENT AND MONITORING

The proposed management procedures are considered to be reasonable and are based on many years of experience. However, the monitoring proposals need to be reconsidered. In particular

i) The groundwater monitoring does not provide a full picture of the development of seepage to the west and south of the TSF and additional bores would be necessary to achieve this, accepting that the bores would be difficult and expensive to install due to the presence of waste rock dumps in the area.

ii) The condition of the natural groundwater system is unclear as even the most northerly current bores appear to have been possibly affected by seepage. Some additional bores are required further to the north to assess groundwater quality in areas that have not been affected by seepage.

iii) The current groundwater quality monitoring program comprises

- Monthly recording of production volumes/bore
- Monthly pH and EC from production bores
- Groundwater levels in monitor bores quarterly
- 6 monthly pH and EC from monitor bores
- Annual water quality testing (pH, EC, TDS and cyanide (total, free and WAD)) from production and monitoring bores
- Major component analysis from a group of 10 bores every 3 years

The level of water quality testing in particular appears low and contrasts with the recommended levels of Guideline No 5 (Water and Rivers, 2000), which recommends a minimum three-monthly cycle. The frequency of monitoring should be reviewed once environmental values are determined and the required level of groundwater control is established. The cost of monitoring will be influenced by the large number of bores involved and this could be rationalised by determining a limited number of designated monitor bores which are monitored more frequently. A recommended realistic program might be based on half a dozen key bores subject to monthly sampling and testing. The choice of parameters to be analysed should be determined from the assessment of environmental values.

iv) Groundwater quality monitoring demonstrates generally low levels of cyanide but some high levels have been noted, particularly in the Fimiston 1 trench. The potential for local spikes of seepage flow and higher contamination levels during discharge of tailings at various locations around the perimeter may not have been appreciated and the current monitoring would not pick this up. Real time monitoring of water levels in several piezometers and perimeter monitoring bores would not be expensive and could give important information on this issue.

v) The low levels of cyanide make indication of the level of contamination and movement of seepage products difficult to determine. Monitoring for cyanide related compounds such as chloramine, cyanogen or thiocyanate may be worthwhile.

vi) The current piezometers potentially give a misleading indication of pore pressures within the TSF due to their location near the base of the tailings. Additional piezometers higher in the tailings would be necessary to give a full picture of performance.

9 RECOMMENDATIONS

The following actions are recommended:

1. The environmental values and beneficial uses of groundwater in the area should be established and the desired target of groundwater control should be determined as policy.
2. Subject to the outcome of item 1, appropriate studies should be carried out to allow improved collection of the seepage from the TSF with the aim of reducing the impacts on the environment as required.
3. A review of the flood capacity of the TSF should be completed
4. A review of the need to provide a level of piping protection should be completed
5. Investigations of the piezometric conditions and the undrained strength of the TSF are required both during normal operating conditions, during extreme events and during operation and closure conditions.
6. Further engineering analysis of the stability should be carried out in terms of effective stress with a range of pore pressures and in terms of total stress taking account of the previously measured undrained strengths. This work should take into account extreme earthquake loading determined from a site-specific study.
7. After completion of the studies it is judged likely that the rise should be approved, possibly subject to new conditions relating to groundwater protection and stabilisation works. However this may take some time to complete. It would be reasonable to carry out an interim raise provided a limited, preliminary study could demonstrate that:
    - The embankment is stable in terms of effective stress under a PMF piezometric condition
    - The embankment is stable in terms of total stress using undrained strength measurements for a range of seismic loadings
    - That existing operating procedures as outlined in the NOI are being complied with.
8. The condition and performance of Fimiston 2 should be subject to a similar review of geotechnical and hydrogeological performance as both structures impact similarly on the environment of the area of interest.

APPENDIX A

SCOPE OF WORK

APPENDIX A

SCOPE OF WORK

REQUEST FOR TENDER: 53DIR0504

PROVISION OF INDEPENDENT REVIEW OF A PROPOSAL TO PROGRESSIVELY RAISE THE FIMISTON 1 TAILINGS STORAGE FACILITY AT KALGOORLIE

Background

The Minister for State Development has a requirement for an independent review of a proposal to progressively raise the Fimiston I Tailings Storage Facility at Kalgoorlie.

The operator of this facility, Kalgoorlie Consolidated Gold Mines (KCGM), has proposed a progressive height increase for Fimiston 1 TSF from the existing approved height of 30 metres to a proposed height of 40 metres. The raise would be carried out in stages over a number of years.

The proposal has already been assessed by in-house technical experts at DoIR and has been considered by the EPA which set its level of assessment at 'Not Assessed – Public Advice Given Managed under Part V of the *Environmental Protection Act 1986*'. Appeals have been received against the EPA's consideration and subsequent level of assessment.

The construction and operation of tailings storage facilities in this area has previously been subject to comment and assessment. The Minister has decided to exercise due diligence to ensure that decisions made, and advice provided, by DoIR are based on competent, expert analysis.

Work Required

The Review will be restricted to the Fimiston 1 Tailings Storage Facility, the surrounding land area and the associated hydrogeological zone and has the following scope of work:

1. Examination and comment on the ***geotechnical integrity*** of the existing Fimiston 1 TSF, including:
   - risk associated with overtopping
   - risk associated with dam breaching
   - performance of the TSF in the context of local ground conditions.

2. Examination and comment on the ***hydrogeological*** setting of the existing Fimiston 1 TSF, including:
   - permeability of subsurface materials
   - natural groundwater levels
     - assumptions of evaporation rates and seepage rates
     - potential for significant impact on groundwater level.

3. Examination and comment on whether there is evidence that existing Fimiston 1 TSF has caused significant adverse impacts on the environment or nearby landholdings and infrastructure from:
   - increased salinity
   - contamination of groundwater
   - changes to hydrology.

4. Assessment of the ***proposal to raise*** the Fimiston 1 TSF in terms of:
   - tailings and water management
   - potential to alter seepage flux in a manner that might cause pollution or significant adverse impact on any party
   - potential for other hydrogeological effects on surrounding land area
   - potential for significant geotechnical impact on the surrounding land area.

5. Review the adequacy of proposed management and monitoring programs for the upgraded tailings facility.

The Review will also comment on:

- the assumptions made by the consultants in preparing the Notice of Intent to raise Fimiston 1 TSF
- the effectiveness of the existing groundwater monitoring program
- potential for liquefaction of tailings
- consideration of earthquake loading
- impacts from blasting in adjoining areas
- the assessment of foundation conditions used in determining that the Fimiston 1 TSF could be safely raised
- any increased risks to persons travelling or working in the vicinity of the

Fimiston 1 TSF
- any increased risks to infrastructure in the vicinity of the Fimiston 1 TSF
- any significant increased risks to the environment
- adequacy of the proposed freeboard in the raised Fimiston 1 TSF.

Surrounding land areas are to be taken to include the Optimum Resources Lease.

The Scope of Work does not require test work or engineering modelling.

Resources:

The Reviewer will be provided with copies of relevant reports, monitoring data, maps and photographs from KCGM and DoIR. Supplementary information may be obtained, subject to normal protocols, from the Department of Environment. Other parties will be requested by the Minister for State Development to provide technical information relevant to the Review.

The Reviewer will be provided with the contact details for representatives from:
- office of the Minister for State Development
- Department of Industry and Resources
- Department of Environment
- Environmental Protection Authority
- KCGM
- other parties

The Reviewer will also meet with appellants and local stakeholders who have raised concerns with respect to the EPA's level of assessment for the proposal as part of the review process. This will be coordinated through the Appeals Convenor's Office and involve site based discussions and review of data and information held by these parties.

It is anticipated that the Reviewer will need at least one site orientation visit and spend at least 5 working days in Kalgoorlie.

Management And Report:

The Reviewer is to be selected by and managed through the Office of the Minister for State Development but will be engaged through the DoIR.

The Report is to be prepared as a document capable of being released to the public.

KCGM and Optimum Resources will need to be encouraged to identify relevant reports and documents at the outset of the Review.

Where KCGM or Optimum Resources consider that any document, extract or report contains information that supports any contention made by either KCGM or Optimum Resources with respect to the subject matter of the scope of work and desire that the Reviewer refer to, recount or rely on the contents of that document, extract or report in preparation of the Reviewer's Report, KCGM or Optimum Resources (as the case may be) must:

- provide a copy of that document, extract or report to the Reviewer;

- consent to any document, extract or report being attached to the Reviewer's Report including any version of the Reviewer's Report which is to be published to the public.

Alternatively if the material is already widely available to the public then that material be fully referenced within the Reviewer's Report including details how to access the material.

If, in respect of any document, extract or report provided to the Reviewer, KCGM or Optimum Resources do not agree to either of the above conditions, the Reviewer will not rely on any such document, extract or report for any purpose (including but not limited to) the preparation of the Reviewer's Report.

The Reviewer is to provide to the Minister for State Development six hard copies of the Report and an electronic copy. The Minister will retain the right to reproduce the Report and provide copies to third parties.

A draft of the report is to be delivered within five (5) weeks of being advised of the awarding of the contract.

APPENDIX B
APPEALS CONVENOR ACTION

Fimiston 1 Review - Appellant consultation

Background

Kalgoorlie Consolidated Gold Mine's (KCGM) proposes to increase the height of its existing Fimiston-1 tailings storage facility from 30 to 40 metres. The Environmental Protection Authority (EPA) set a level of assessment at "Not Assessed – Public Advice Given - Managed Under Part V" as advertised in December 2003.

A total of 13 appeals, under the *Environmental Protection Act (1986)*, were received in response to the EPA's decision for this proposal. The Office of the Appeals Convenor is investigating these appeals.

Appeal Grounds

Appellants are of the view that the current Fimiston 1 Tailings Storage Facility has unacceptably impacted on the surrounding environment. It has been submitted that excessive seepage of water from the facility has resulted in contamination (cyanide, salinity) and an increase in groundwater levels impacting on vegetation, infrastructure (road and rail) and surrounding mining tenements. Appellants also believe that the proposal will unacceptably increase the risk to individuals living, working or travelling through the area (Indian Pacific passenger train, Bulong Road).

To ensure that these impacts and risks are not exacerbated, appellants have requested that the EPA should formally assess KCGM's proposal. Furthermore, appellants consider that KCGM should be required, via its *Environmental Protection Act (1986)* - Part V license, to expand its monitoring and production bore fields, increase the frequency of sampling and reporting, and implement more stringent controls to reduce the artificially high groundwater table and prevent further contamination and groundwater rise.

Fimiston 1 Review

During the appeals investigation by the Office of the Appeals Convenor the Minister for State Development commissioned an independent technical review of the Fimiston 1 Tailings Storage Facility. The aim of the review was to investigate the geotechnical and hydro geological performance of the existing Fimiston 1 Tailings Storage Facility and the proposal to progressively increase the height of the facility from 30 m to 40 m. Mr David Brett (Managing Director of Thompson and Brett) and Dr Fred Baynes (Principal of Baynes Geologic – Geological Engineering Consultants) were appointed to complete the work required for this review.

Given the nature of this review and its relationship with the issues raised in appeals relating to the EPA's level of assessment for the proposal the Minister for Environment advised appellants of her intention to postpone a decision on appeals pending the completion of this review.

Appellant Consultation

During the investigation by Mr Brett and Dr Baynes, the Office of the Appeals Convenor provided appellants with several opportunities to meet with the consultants to discuss issues raised in appeals. Copies of invitations for meetings in Kalgoorlie are attached. The opportunities to meet with the consultants included:

- Kalgoorlie meeting on the evening of Monday 9 August 2004 from 7:30 to 9:30.
- Kalgoorlie site visit proposed to be conducted on the morning of the 10 August 2004.
- Morning meeting in Kalgoorlie to allow appellants an opportunity to submit supplementary information on Wednesday 11 August 2004.
- Appellants were provided with Mr Brett and Dr Baynes' contact details to organise, at their leisure, meeting times in Kalgoorlie between 9 and 13 August 2004 that would be more convenient.
- Appellants were advised that Mr Brett and Dr Baynes would be available at any time to discuss issues over the phone.
- Appellants advised that Dr Baynes would be available in Perth at any other time.

The general response from appellants regarding the proposed meetings with Mr Brett and Dr Baynes was not positive. Appellants expressed concern over the independence of the consultants and their technical ability to carry out the review. Concern was also raised over the terms of reference associated with the consultant's appointment. A number of appellants advised that they would be unable to attend due to prior commitments.

Mr Damien McAlinden, Office of the Appeals Convenor, accompanied Mr Brett and Dr Baynes to Kalgoorlie and attended the Monday night and Tuesday morning meetings. Two appellants attended the meeting held on Monday 9 August, one of which advised that they would attend the site visit the following day. However, on Tuesday 10 August no appellants fronted for the site visit. Consequently, Mr McAlinden and Mr Wayne Astill (Department of Environment) accompanied Mr Brett and Dr Baynes on a site visit in the vicinity of the KCGM lease.

Subsequent to the Kalgoorlie visit, at a Perth based appellant's request, a further meeting with Mr Brett and Dr Baynes was organised in Perth on Monday 16 August 2004.

In accordance with the Office of the Appeals Convenor's protocol to ensure that the anonymity of appellants is maintained throughout appeals investigations, neither the personal details of appellants or any material provided by appellants were made available to Mr Brett or Dr Baynes. However, to ensure that the issues raised by appellants were considered within the bounds of this review the Office of the Appeals Convenor met and discussed the key issues with Mr Brett and Dr Baynes.

Once the report for the Fimiston 1 Review has been finalised it is expected that the Office of the Appeals Convenor will finalise its appeals investigation.

Our Ref: < 00/00>

<ADDRESS>

<SALUTATION>,

10 FIMISTON 1 TAILINGS STORAGE FACILITY M26/383 KALGOORLIE

As you may be aware the Minister for State Development has recently appointed Thompson & Brett Consulting Engineers, based in Tasmania, to carry out the independent review of the proposal to raise the Fimiston 1 Tailings Storage Facility at Kalgoorlie Consolidated Gold Mine's operation. Mr David Brett, Managing Director of Thompson and Brett and Mr Fred Baynes, Principal of Baynes Geologic – Geological Engineering Consultants, will complete the work required for this review.

An important component of this review is the consideration of information within appeals against the Environmental Protection Authority's level of assessment for the Fimiston 1 proposal and providing the opportunity to appellants to discuss the issues raised. As such, Mr Baynes has requested my office to organise and facilitate a series of meetings with appellants in Kalgoorlie.

Mr Brett and Mr Baynes have set aside time in Kalgoorlie to make site inspections and to meet and discuss the Fimiston 1 proposal with appellants, the Department of Industry and Resources, the Department of Environment and Kalgoorlie Consolidated Gold Mines.

Both Mr Brett and Mr Baynes are keen to meet with appellants to discuss the issues raised in appeals and have proposed that an evening meeting be arranged between 7:30 to 9:30 on Monday 9 August, 2004. Following this it is proposed that a site visit be conducted with appellants on the morning of the 10 August 2004. It is then proposed that an opportunity for the further submission of information from appellants be provided on Wednesday 11 August 2004.

Both Mr Brett and Mr Baynes have emphasised that they are eager to meet appellants to discuss their issues and have advised that should the above times be inappropriate that they would be happy to arrange alternative times to meet appellants in Kalgoorlie between 9 and 13 August 2004.

If you are unable to attend the meetings proposed for Kalgoorlie there will be opportunity to discuss, over the phone, your issues with either Mr Brett or Mr Baynes. Furthermore, if you are unable to attend the meetings in Kalgoorlie and wish to meet in Perth Mr Bayne has advised that he would be happy to arrange a time.

This review offers an important opportunity for your concerns to be considered by appropriately qualified and independent parties and for them to be incorporated into advice that will be considered by the Minster for State Development and the Minister for the Environment.

I look forward to your contribution to discussions with Mr Brett and Mr Baynes and request that you please confirm your availability to attend the above meeting times with Mr Damien McAlinden of my Office on 9221 8711 by the 6 August 2004.

Should you wish to make direct contact with Mr Baynes of Mr Brett their contact details are:

Mr David Brett – (03) 6244 6633
Mr Fred Baynes - (08) 9381 9498

Yours sincerely,

Darren Walsh
APPEALS CONVENOR

28 July 2004

Our Ref: «Reference»

«Name__Address»

Dear «Salutation»

11 FIMISTON 1 TAILINGS STORAGE FACILITY M26/383 KALGOORLIE

I refer to Mr Darren Walsh's letter dated 28 July 2004 regarding the evening meeting between appellants of the Environmental Protection Authority's level of assessment for the above proposal and Mr David Brett (Managing Director of Thompson and Brett) and Mr Fred Baynes (Principal of Baynes Geologic).

It has been confirmed that the evening meeting will be held at the upstairs meeting room (turn left at the top of the stairs) at Viskovich House, located at 377 Hannan Street in Kalgoorlie.

As outlined in Mr Walsh's letter a site visit will be conducted with appellants on the morning of the 10 August 2004. Individuals interested in attending the site visit should meet at 9 am at the front of Viskovich House, located at 377 Hannan Street in Kalgoorlie.

An opportunity for the further submission of information from appellants will also be provided on Wednesday 11 August 2004. Mr David and Mr Brett will be available to receive submissions between the hours of 9:30 am and 12:00 pm in the upstairs meeting room at Viskovich House, located at 377 Hannan Street in Kalgoorlie.

Both Mr Brett and Mr Baynes have emphasised that they are eager to meet appellants to discuss their issues and have advised that should the above times be inappropriate that they would be happy to arrange alternative times to meet appellants in Kalgoorlie between 9 and 13 August 2004.

As outlined in Mr Walsh's letter, if you are unable to attend the meetings proposed for Kalgoorlie there will be opportunity to discuss, over the phone, your issues with either Mr Brett or Mr Baynes. Furthermore, if you are unable to attend the meetings in Kalgoorlie and wish to meet in Perth Mr Bayne has advised that he would be happy to arrange a time.

It is requested that you please confirm your availability to attend the above meeting times with myself on 9221 8711 by the 6 August 2004.

Should you wish to make direct contact with Mr Baynes or Mr Brett their contact details are:

Mr David Brett – (03) 6244 6633
Mr Fred Baynes - (08) 9381 9498

Yours sincerely,

Damien McAlinden
APPEALS ASSESSOR

4 August 2004

APPENDIX C
REVIEWERS CV'S

DAVID MAXWELL BRETT

Nationality

Australian

Qualifications

M.E., University of Tasmania, 1987

B.E., University of Tasmania, 1972

Affiliations

Fellow, Institution of Engineers, Australia, registered NPER-3, Civil Category

Fellow, Australian Institute of Company Directors

Member, American Society of Civil Engineers

Member, The Australian Geomechanics Society

Member, American Concrete Institute

Member, Concrete Institute of Australia

Associate Member, Australian National Committee on Large Dams (ANCOLD)

State Chairman— Tasmania , Association of Consulting Engineers, Australia.

David Maxwell Brett is a civil engineer with extensive experience in investigation, design, construction and contract administration. Specific experience in:

water/wastewater	water supply and mine tailings dams, water management systems, hydrology, hydraulics, hydraulic structures, sewerage systems, water and wastewater treatment.
- geotechnical engineering	site investigations, earthworks pavement and foundation design, foundation grouting.
- construction materials	materials testing, soil, rock and concrete technology.
- environmental engineering	mining and industrial water & waste management
- structural engineering	industrial and commercial buildings and civil engineering structures.

Australian Experience

Water Management – David has more than 30 years experience in water engineering with expertise covering the full range of water management from resource assessment, capture, storage, distribution and treatment. David is recognised as a **leading dam engineer** in Australia and has been responsible for design of significant dams for both water supply and waste storage, including Earth and Rock Fill (ERF), Concrete Faced Rockfill (CFR) and Roller Compacted Concrete (RCC). Examples of the EFR and CFR dams include

- Staged raising of the **70 m high Main Creek Tailings Dam at Savage River Mine** on Tasmania's northwest coast to contain an estimated 12 million m^3 of tailings. This work has included interim upstream construction and assessment of the potential for tailings liquefaction under earthquake loading.
- Upgrading of the spillway to **Hobart Water's Knight's Creek CFR Dam** to pass a PMF
- Design and construction management of the **80 m high Princess Creek tailings dam** for Copper Mines of Tasmania allowing major environmental improvement to the King River system which had been used for tailings disposal for the preceding 100 years
- Dam Safety Inspection and Reporting on **Hobart Water's 8 ANCOLD referable dams** including the concrete arch Ridgeway Dam
- ERF **tailings dams for mines** in Tasmania including Henty Gold Mine, Beaconsfield Gold Mine, Renison Tin
- **Closure Plans for waste storage dams** including King Island Scheelite, WMC Resources Kambalda Nickel operation, Renison and the Henty Mine.
- Rehabilitation works to the jarosite and leach residue dumps at Pasminco Hobart Smelter. This $7M project received an **Engineering Excellence Award** from IE Aust in 2001
- Design of innovative **"flow through spillways"** for Savage River Mine that has allowed economical waste rock dumping and extended mine life.
- Project manager for site investigation, design and construction supervision for $40M water **management project at the**

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Recent Publications

Visionary Closure – A Tarn Under The Rainforest, Minerals Council of Australia, Environmental Conference 2003

Interim Raising Of Main Creek Tailings Dam By Upstream Construction, ANCOLD Conference on Dams, 2002

Design and Performance of a Flow-Through Spillway at Broderick Creek Waste Rock Dump, Savage River Mine. 6th Conference on Hydraulics in Civil Engineering, Hobart, 28-30 November 2001

Rehabilitation Of The Loogana And Inshallah By-Product Stockpile Area, Sardinia 2001, International Symposium on Waste Management, Cagliari, Italy, 1-5 October 2001

The Capping Conundrum (With Reference To Savage River Mine) Tasmanian Minerals Council Environment Conference May 2001

The Performance of Roller Compacted Concrete Pavements Cement and Concrete Association of Australia, Seminar on Industrial Floors and Heavy Duty Paving, Adelaide, 20 June 2000

Tailings and Water Management in Wet Climates - From Initial Planning to Final Abandonment, Fourth Mill Operators Conference, Burnie, Tasmania, March 1991

Developments in Australian RCC, 6th International Symposium on Concrete Roads, Madrid, Spain October 1990.

Condensed Silica Fume in Concrete: Tasmanian Experience, Concrete Institute of Australia, CSIRO, Concrete For The Nineties, Leura NSW, September 1990

Worsley Alumina Refinery. Structures include the 32m high, 22m high and 15m high dams, 20 km of channels, PVC lined evaporation ponds and bauxite residue disposal areas. Work included a unique chemical grout curtain to the major dam structure that led to David's **Master of Engineering Degree**. Project awards include:

- o Western Australian Engineering Excellence Award, 1983, I.E. Aust.
- o Engineering Merit Award, 1984, ACEA, W.A.

- Project manager for feasibility study, investigation and design of water management system for **tailings disposal at the Argyle Diamond Mine**, including detailed design of 32m high rock dam, W.A.
- Project design engineer and resident engineer during construction for **Curries River Dam**, a 27m high earth and rockfill dam, concrete spillway and 120 ML/day pump station for Rivers and Water Supply Commission, Tasmania
- Ophthalmia Dam **ground water re-charge** project for Mt. Newman Mining Co, W.A.

David is an **active member of ANCOLD** and contributing author for ANCOLD Guidelines for Tailings Dams.

Roller Compacted Concrete - recognised Australian expertise in the use of roller compacted concrete (RCC) for dam and heavy-duty pavement construction, starting with design and project management of Australia's second RCC dam, **Craigbourne Dam in Tasmania**. This 25m high, 12,000 ML storage dam is used for irrigation of Coal River Valley, S.E. Tasmania. David's involvement included laboratory testing for RCC mix development, structural analysis of dam, hydraulic design and model testing of spillway for flood of 2,300 cumecs detailing to suit RCC placement techniques, supervision of RCC placement and quality control, and monitoring of performance. Dam safety audits have been carried out on two occasions since construction.

Following Craigbourne David became involved with mix design and construction of RCC dam projects including **Toongabbie Retarding Basin** in NSW and **Wrights Retardation Basin** in ACT. David consulted to Water Authority of WA for Australia's highest RCC dam **New Victoria Dam** for mix design, construction detail, technical specification and cost estimating for this 54 m high, 150,000 m3 roller compacted concrete dam near Perth, W.A. and Hydro Tasmania for preliminary investigations for **Langdon Dam** in the Henty-Anthony power scheme.

Currently David is involved with Australia's newest and largest RCC dam, the **Burnett River Dam** in SE Queensland, as Design Manager RCC for the Walter/McMahon/SMEC/HydroTas Alliance team. This **400,000 m3 RCC** dam has a design flood of 100,000 cumecs. Innovative RCC design has led to a lean mix RCC with a composite PVC/precast concrete facing system. David has been involved with mix design, laboratory testing and evaluation, RCC detailing and general dam engineering.

David has also been instrumental in the development of **RCC technology for high strength pavement** design in Australia being responsible for nearly 30 RCC paving projects totalling nearly 300,000 m^2. Works include the Islington Freight Terminal, an RCC pavement for 90 tonne axle fork lift trucks at intermodal yard in Adelaide for

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Design of Dams for Remote Areas, Engineering Conference, Darwin, May 11-15, 1987 I.E. (Aust) Joint Author

RCC Pavements in Tasmania, Australia, Speciality Conference "RCC 88", San Diego, California, Feb. 1988 ASCE

Roller Compacted Concrete Trial Pavement - Tea Tree Road, 14th ARRB Conference, Canberra, 28th August - 2nd September, 1988

Investigation, Design and Construction of Craigbourne Dam, ANCOLD Bulletin, August 1986.

Chemical Grouting for Dams, ANCOLD Bulletin, April 1986

Grouting of Soils in Dam Foundations, thesis for Master of Engineering Degree, University of Tasmania, Jan. 1986.

Chemical Grouting of Dam Foundations in Residual Laterite Soils of the Darling Range, Western Australia, 4th Australian New Zealand Conference on Geomechanics, Perth 1984.

Dams of the Worsley Project, ANCOLD Bulletin, April 1984, Joint Author

Grouting of Low Permeability Soils Using Tube-A-Manchette,
National Waterwell and Drilling Association Conference, Bunbury, Western Australia, October 1982.

Curries River Dam, ANCOLD Bulletin, April 1980, Joint Author.

Australian National Rail. This was the first Australian three-lift pavement construction and one of the first significant uses of retarders in RCC in the world.

Remediation and Closure- David's involvement in water engineering has led to significant work in remediation of waste disposal sites and closure of mine and industrial waste sites such as the Loogana and Inshallah jarosite and leach residue site at Pasminco Hobart Smelter, awarded an Engineering Excellence Award by IEAust. This project involved development and implementation of a rehabilitation plan for the site involving removal of 150,000 t of jarosite and around 600,000 t of leach residue and conversion of the area to a riverside wetland. Technology used included cement - bentonite cut-off walls, low flux soil capping, hdpe liners and an extensive monitoring system including continuous monitoring of soil moisture levels in the secure landfill.

David has recently been responsible for closure planning for WMC's Kambalda Nickel Operation's 20M m^3 tailings storage facility. This significant study is intended to set a benchmark for closure planning for WMC's operations world-wide.

International Experience

1998	Great Yifen Tower - Tiyuan City Xanchi Province China assessment of engineering feasibility of 15 storey international hotel for Tasmanian investor.
1990	Study tour of RCC technology in Europe including Spain, France, Denmark, Norway and Sweden
1973-74	Design Engineer, Singapore, seconded to Monenco Asia for structural design of a 39 Storey hotel complex for Jakarta, Indonesia and parts of Jurong Power station.

Basic knowledge of French, Indonesian

Experience Resume

1997 -	Director, Hobart Regional Water Authority Board of Management, (Hobart Water)
1989 -	Principal Director, Thompson & Brett Pty Ltd
1988 - 1989	Principal, David Brett & Associates
1987 - 1988	Manager/Principal Engineer, ATC Technology Specialist Consultant, Roller Compacted Con crete Pty Ltd
1984 - 1986	Senior Civil/Structural Engineer, Gutteridge Haskins and Davey (GHD) Pty Ltd Hobart, Tas.
1980 - 1984	Manager, GHD, Bunbury, W.A.
1979 - 1980	Senior Engineer, GHD, Perth W.A.
1975 - 1979	Design Engineer, GHD, Hobart, Tas.
1974 - 1975	Design Engineer, Cambridge Designs, Glasgow, U.K.
1973 - 1974	Design Engineer, Stevens and Chin Pty Ltd, Singapore
1972 - 1973	Design Engineer, GHD, Hobart, Tas.

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FRED BAYNES - CURRICULUM VITAE

DATE OF BIRTH: 9 August 1953 **NATIONALITY**: Australian, British

LANGUAGES: English (written and spoken fluently), Spanish (basic)

QUALIFICATIONS:

Bachelor of Science (Honours) Geology, Bristol University, UK 1974.
Master of Science, Engineering Geology, Imperial College, London, UK 1975
Diploma of Imperial College, Engineering Geology, Imperial College, London, UK 1975
Doctor of Philosophy, Newcastle University UK 1978, "Engineering Characterization of Weathered Rock".

PROFESSIONAL AFFILIATIONS:

Australasian Regional Vice President, International Association of Engineering Geologists.
Chartered Professional Geologist and Fellow, Geological Society of London.
Chartered Professional Engineer and MIEAust.
Member, Geological Society of Australia.
Member, Australian Geomechanics Society.
Member, International Association of Engineering Geologists.
Member, Association of Engineering Geologists, USA.

COUNTRIES OF WORK EXPERIENCE:

Algeria, Australia, Georgia, Hong Kong, Indonesia, Laos, Malaysia, Philippines, Tanzania, India, United Kingdom.

AREAS OF SPECIAL EXPERTISE:

Engineering geology, geological mapping, interpretation and geological model generation, site investigation and characterization, geomorphology and air photo studies, structural geology, rockfalls and landslides, karst, slope stability, soil and rock mechanics geotechnical risk studies, dams, hydro power, underground works, quarries, heavy civil and mining projects, expert review, provision of expert opinion.

PROFESSIONAL EXPERIENCE:

1996 to date Consulting Engineering Geologist, Perth, Australia.
Involved in a wide variety of projects throughout the world as an expert engineering geologist, including review of major civil and mining projects, specialist advice on investigation, design and construction, and various research programmes. Projects include: review of a Tanzanian hydro development as part of a panel of experts for the World Bank, offshore oil and gas infrastructure investigations for pipelines and production sites, regional landslide risk assessments, rockfall barrier design, railway investigation design and construction, tailings dam investigations, quarry assessments, underground works etc.

1994 to 1996 Principal Engineering Geologist, Golder Associates, Perth, Australia
Responsible for engineering geological studies of mining and civil projects throughout Australia and overseas, including: open pit stability in Western Australian goldfields, mine feasibility assessments in Sulawesi, rock slope investigation and design in Bali, underground works, dams, foundations, roads, rockfalls, landslides, risk studies, etc.

1990 to 1994 Consulting Engineering Geologist, Hobart, Australia
Provision of advice including: expert review of hydro-power scheme in Tanzania for World Bank, assessment of mine in karstic limestone in World Heritage area, management of a large suburban landslide, investigation of mini-hydro sites in Philippines, studies of coastal geomorphology, geomorphological analysis of road routes, mine shaft location, tailings dam seismicity, assessment of stability and impact of landfills etc.

1986 to 1990 Chief Geologist, Hydro Electric Commission, Hobart, Australia
Responsible for all aspects of the management and technical supervision of eight professional and seven sub-professional staff involved in the design and construction of two hydro-power schemes, the investigation of several hydro-power schemes, the maintenance of an extensive hydro-power system, and the provision of commercial consulting services.

1982 to 1986 Resident Geologist, Hydro Electric Commission, Queenstown, Australia
Responsible on site for six staff involved in site investigation and construction supervision of two hydro-power developments including various major dams, underground works, surface works, roads, quarries, etc.

1980 to 1982 Senior Engineering Geologist, Coffey & Partners, Sydney , Australia
Investigations of slope stability, foundations, groundwater, construction materials, landslides in Tanzania, coastal geomorphology, secondment to Dams Safety Committee for advice on mining beneath stored waters etc.

1977 to 1980 Engineering Geologist, Wimpey Laboratories, London, UK
Investigations of land and marine foundations, landslides affecting road routes in mining areas, rock slope stability etc.

APPENDIX D

DAILY DIARY

APPENDIX D

DAILY DIARY

Wednesday 14 July 2004
Contract awarded to Thompson and Brett with contract period starting on 19 July

Wednesday 21 July
Fred Baynes (FB) meets with Chris Fitzhardinge

Thursday 22 July
FB makes contact with various government departments

Wednesday 28 July
FB meets with DoIR (Patrick Burke, Anil Atri, Bill Biggs, Malcolm Russell, Andy Kempton, Greg Mento, Brenton Walkemeyer
FB perusing DoIR files

Thursday 29 July
FB perusing DoIR files

Friday 30 July
FB perusing DoIR files
FB meets with Tim Gentle of DoE and perusing DoE files

Monday 2 august
FB finalising what needs copying from DoIR files

Sunday 10 August
David Brett (DB) travel to Perth

Monday 9 August
DB and FB meet to discuss Review in Perth, and then meet with Chris Fitzhardinge, Damien McAlinden and Darren Walsh.
DB and FB travel to Kalgoorlie.
DB and FB and Damien McAlinden meet with two appellants in Kalgoorlie

Tuesday 10 August
DB and FB meeting with appellants cancelled. DB and FB view general area with Damien McAlinden and Wayne Astill (DoE)
DB and FB meet with Michelle Birch, Trevor Tyson and Adrian Lally of KCGM to view site and surrounds.

Wednesday 11 August
DB and FB are available at DoE for meeting with appellants but none show up.
DB and FB working on papers

DB and FB inspect Bulong Road
DB and FB have informal discussions with Mr Steve Kean

Thursday 12 August
DB and FB reviewing documentation
Site visit to KCGM in afternoon. Trevor Tyson assists with tour of southern region around Kaltails and Trafalgar borefield.

Friday 13 August
DB and FB reviewing documentation and drafting report
Afternoon presentation of preliminary findings to KCGM, later in evening DB also reports to Steve Kean
Leave Kalgoorlie for Perth

Saturday 14, Sunday 15 August
Preparing Report in Perth

Monday 15 August
Meeting with an appellant in Perth
Briefings to DoIR, Appeals Coordinator and Minister for State Development

Monday 30 August
Complete draft report and submit to Chris Fitzhardinge

Tuesday 14 September
AM meeting with KCGM representatives, Jim Bawden and Trevor Tyson with consultants David Williams, Golder and Peter Clifton (Peter Clifton and Associates) to review draft
PM meeting with DoIR representatives to review draft

APPENDIX E

BACKGROUND TO TAILINGS AND TAILINGS STORAGE

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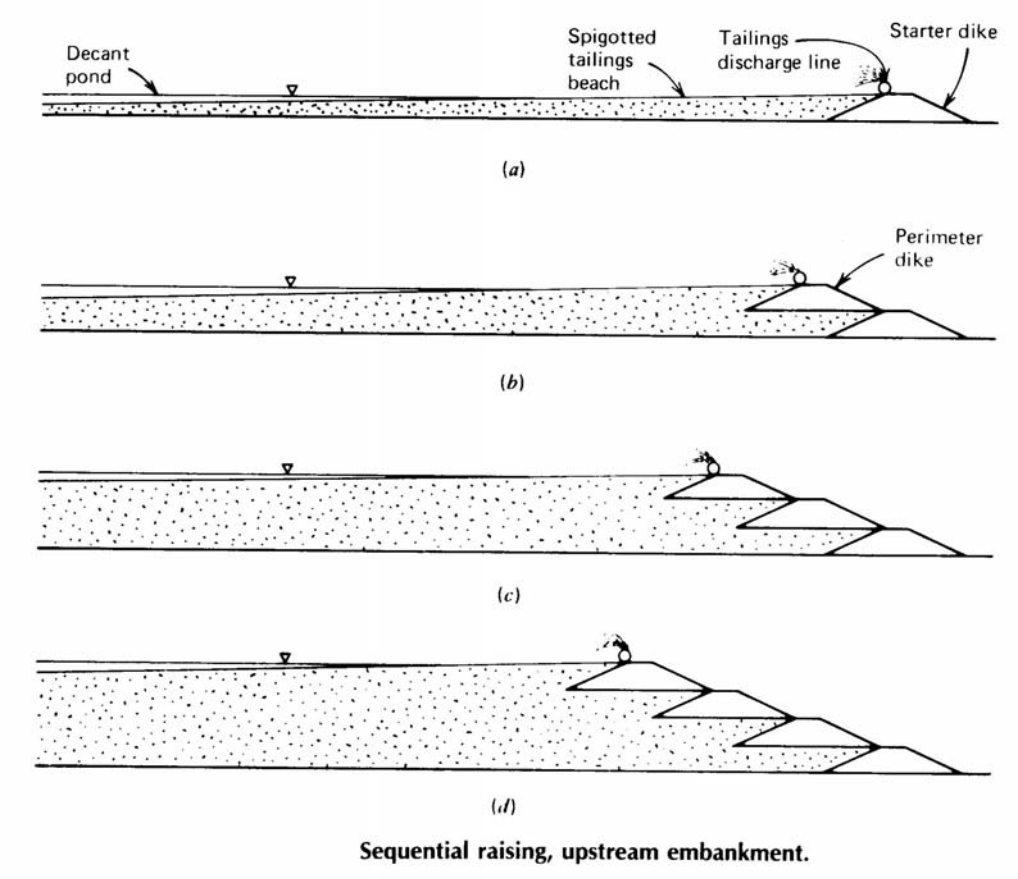
BACKGROUND TO TAILINGS AND TAILINGS STORAGE

Tailings are residual finely ground rock particles from which the minerals have been removed after processing. Essentially tailings comprise fine sandy silt. The tailings are transported as slurry with water and discharged into storage dams. On discharge the tailings solids settle to form “beaches” with the “decant” water being collected and returned to the process. A significant proportion of the transport water is retained in the settled tailings and lost by evaporation. Typically the coarser sand particles separate out closer to the discharge point with finer “slimes” being taken further down the beach. Consequently the beach slope varies, becoming flatter as particles retained in the slurry become finer and settle less effectively. The permeability of the tailings would generally become lower away from the discharge point although the transient nature of tailings flow leads to interlayered zones of coarser and finer particles as the slurry stream meanders over the beach.

The Fimiston I TSF is an example of “upstream construction” where the tailings themselves are used to construct the storage. This involves excavating dried tailings from the inside edge of the storage and using this material to construct an embankment around the perimeter. The discharge pipework is then lifted to the new level. Each lift is progressively moved “upstream” to form a sloping outer face as shown in Figure A1 This method is significantly different from more conventional “downstream” construction where a much greater volume of “engineered fill” would be required to construct an embankment of the same height. The upstream construction method relies on the properties of the tailings material itself for stability and these materials are prone to low strength, poor drainage, potential liquefaction under earthquake loading and are prone to erosion. However embankments can be safely constructed with proper design and careful operating procedures aimed at maximising density and controlling water within the storage.

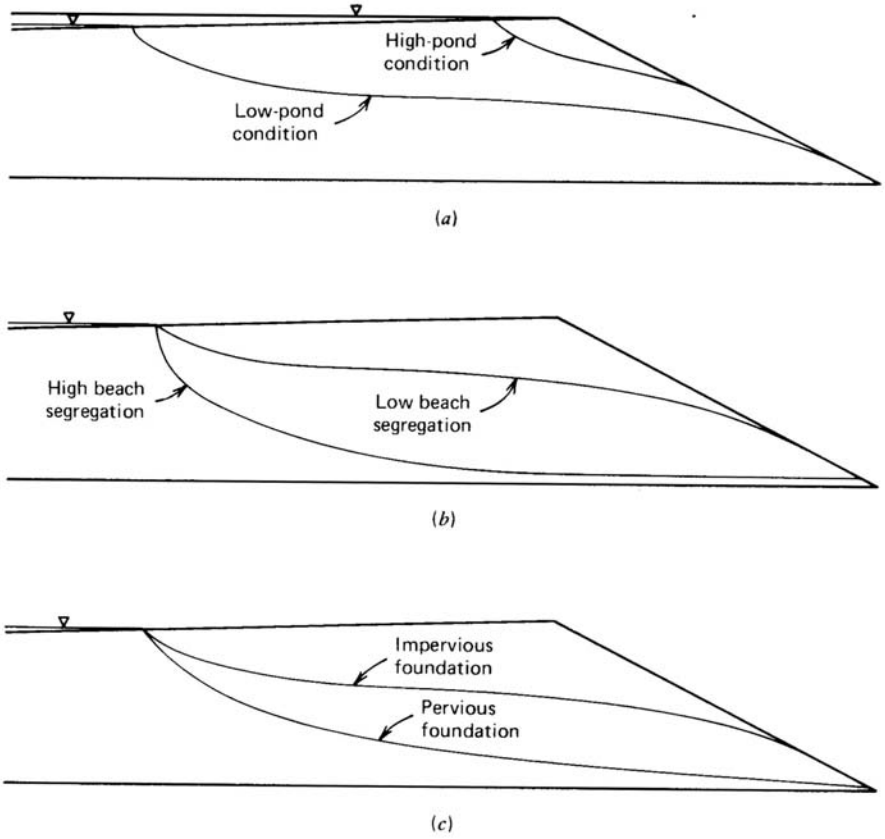
Figure A1 Upstream Construction (after Vick, 1990)



The rate of tailings deposition is important because if the tailings are deposited too quickly then they do not dry out before they are covered and can remain in a loose, weak, unconsolidated condition. If zones of loose weak unconsolidated tailings are buried within the dam then due to their low permeability they can remain in that condition for many years and can form a zone of low undrained shear strength. The presence of zones of low undrained shear strength in tailings dams can be investigated by cone penetrometer testing (CPT) and these results should always be considered in any stability analysis

A key factor in the stability of an embankment formed by upstream construction is the control of the phreatic surface, or water table, within the structure. An elevated water table has a significant impact on the stability of the outer face due to sliding failure and also the risk of “piping” failure where seepage on the face allows tunnel erosion to develop and lead to a flow failure. Figure A2 shows the factors influencing the location of the phreatic surface.

Figure A2 Location of Phreatic Surface (after Vick, 1990)

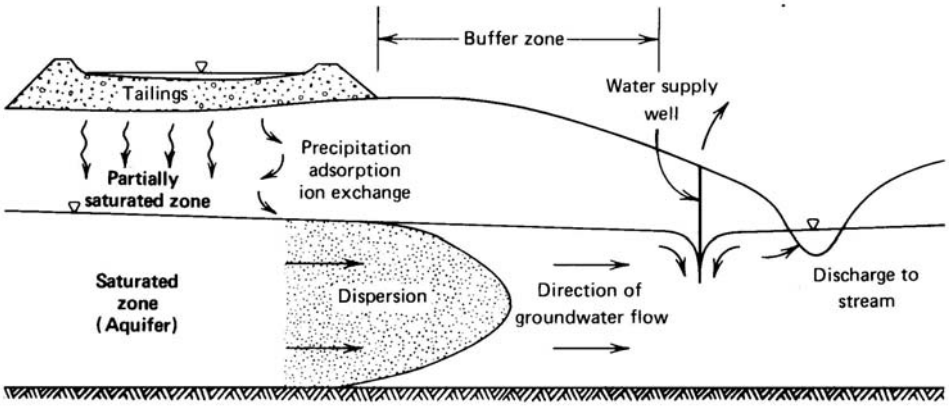


Factors influencing phreatic surface location for upstream embankments. (a) Effect of pond water location. (b) Effect of beach grain-size segregation and lateral permeability variation. (c) Effect of foundation permeability.

To minimise the build up of water within the storage it is important to limit the size of the surface water pond and also to encourage drainage through the base. In the case of Fimiston 1 the base drainage is achieved through the relatively higher permeability materials of the foundation. If the foundation was less permeable or if a membrane liner was used it would be necessary to provide a purpose built drainage system to pick up seepage water percolating through the tailings.

The tailings mass will have a permeability depending on the properties of the tailings and the discharge methods. This will allow some level of seepage through the base of the structure, which will relate to the natural groundwater as shown in Figure A3. The extent of travel and dispersion will depend on the ground conditions below the TSF.

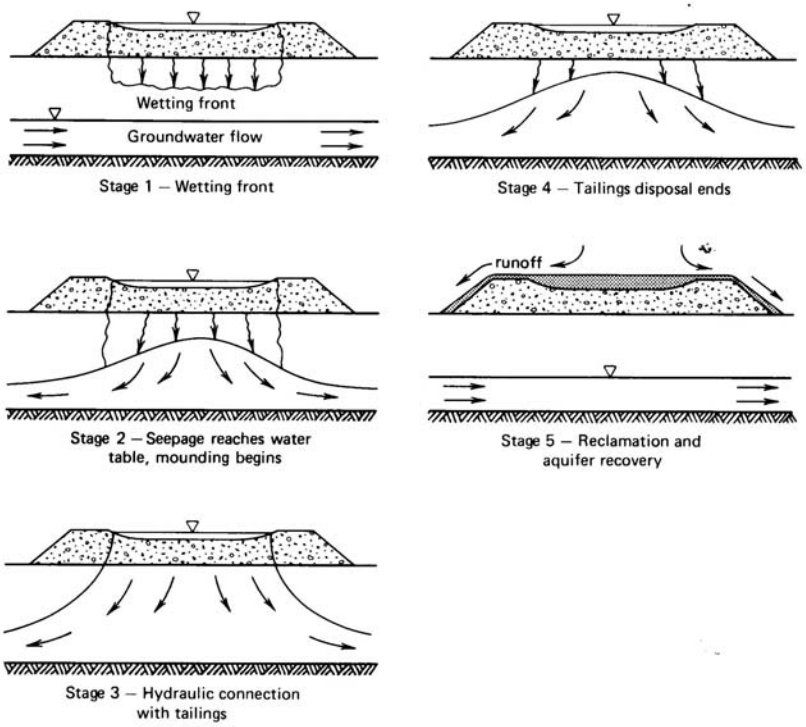
Figure A3 Seepage and Groundwater Interaction (after Vick, 1990)



Groundwater flow and contaminant transport processes.

With relatively low ground permeability the seepage will build up as a mound below the TSF as the rate of seepage from the TSF exceeds the rate that it can be dispersed into the surrounding ground. Once tailings discharge ceases the rate of seepage would normally reduce, particularly in an arid climate, and the mound gradually dissipate as shown in Figure A4

Figure A4 Life Cycle of Seepage (after Vick, 1990)



Stages in seepage development. (From McWhorter and Nelson, 1979.)

APPENDIX F

REFERENCES

APPENDIX F
REFERENCES

The following references are referred to directly in the text:

ANCOLD, Guidelines on Risk Assessment, October 2003

ANCOLD, Guidelines on Tailings Dam Design, Construction and Operation, October 1999

ANCOLD, Guidelines for the Design of Dams for Earthquake, August 1998

ANCOLD, Guidelines on the Selection of Acceptable Flood Capacity for Dams, March 2000

ANCOLD, Guidelines on Assessment of the Consequences of Dam Failure, May 2000

ANCOLD, Guidelines on Risk Assessment, October 2003.

ANZECC, Australia, New Zealand Guidelines for Fresh and Marine Water Quality, 2000

Breman, H and Kessler, J.J., Woody Plants in Agro-Ecosystems of Semi-Arid Regions, Spriger-Verlag, New York, 1995

Brooks, K., ACMER Short Course in Management of Cyanide in Mining - Townsville, Oct. 1999

Coffey, Metago, Fimiston 2 Tailings Dam Risk Assessment & Dam Break Study, December 1996

Davey, S, Site Inspection Report, DoIR, July 2003

Fell et al, Geotechnical Engineering of Embankment Dams, Balkema, 1992

Golder Associates, Report on 2003 Operational Audit of the TSF's at KCGM, December 2003, for KCGM.

Golder Associates, Addendum to Notice of Intent for Increasing the capacity of the Fimiston 1 TSF at KCGM, April 2003, for KCGM

Golder Associates, Report on Risk based dam break study Croesus/Fimiston I Tailings Storage, May 1998

Hundi, N., Memo to Wayne Astill, 22 March 2004, Water Resources Commission

Moran, R., Cyanide Uncertainties, Observations on the Chemistry, Toxicity and Analysis of Cyanide in Mining-Related Water, Mineral Policy Centre, 1998

Peter Clifton & Associates (PCA), Fimiston I and 2 TSF's Annual Review of Groundwater Monitoring Data, February 2004

Seed, H.B. & De Albe, P. (1986), Use of SPT and CPT tests for evaluating the liquefation resistance of sands., In Situ, Conference on the use of In Situ tests in Geotechnical Engineering, S.P. Clements, (Ed) ASCE Geotechnical Special Publication No 6

Vick, Steven, G, Planning, Design and Analysis of Tailings Dams, BiTech Publishers Ltd, 1990

The following references were reviewed:

Date	Document	From	To
18/08/88	Notice of Intent and Works Approval for Fimiston Leases - Expansion Project at North Kalgurli Mine - Fimiston 1	AGC	Dallhold Resources
8/07/91	Mining Tenement Register Search Lease 26/283 & 16/1848	Dept. Ind. & Res.	
1/09/92	History of KCGM Dispute		
20/01/93	Ltr, Reply & File Note re Seepage from Tailings Dams on M26/86	Dept. Min. & Energy	Optimum Res.
3/02/93	Ltr re Oroya Tailings Dam, Hydro Investigations & Man. Plan	Golders	KCGM
19/02/93	Ltr re Saturated Ground on P26/1848	Dept. Min. & Energy	Optimum Res. P/L
1/04/93	Status Rep. Rationalisation Fimiston I & Croesus Tailings Dams	Golders	KCGM
1/10/93	Report on Groundwater Seepage Investigation Oroya Tailings Dam	Golders	KCGM
17/06/94	Technical Review of Tailings Dams for KCGM	Golders	KCGM
1/10/94	Site Investigation, Fimiston 2 TSF	Golders	KCGM
1/07/95	Report on 1995 Annual Review Tailings Storage KCGM Ops. Kal.	Golders	KCGM
8/08/95	Ltr & Attachment A re Addendum to Rationalisation	Golders	KCGM
8/08/95	Ltr re Addendum to Rationalisation Fimiston I & Croesus Tailings Storage	Golders	KCGM
31/08/95	Briefing Notes re Optimum Resources Vs KCGM	G Hewson Ass. Dir, Res. & Tech. Svs	Director General
8/09/95	Memo Addendum to Notice of Intent - Modification of Wall Geometry, Fimiston 2 Tailings Storage Paddocks A &B	E Bouwhuis, Environ & Rehab Officer, Kal	Ass. Dir, Metalliferous Mining Ops. Perth
8/09/95	Letter re above	E. Bouwhuis	Dept. Environ Protection, Kal.
21/09/95	Fax re Strength Parameters KCGM	Golders	Dept. Min. & Energy
21/09/95	Ltr re Strength Parameters Stability Analysis	Golders	KCGM
27/09/95	Memo re Tailings Storage Facilities 1995 Annual Op. Audit	Adrian Lang	KCGM
28/09/95	Fax Addendum to Rationalisation - Fimiston & Croesus	Adrian Lang, Geotech Eng.	KCGM Dir. Mining Ops
28/09/95	Copy Memo of above same date		
1/10/95	Answer 5 from 1995 Annual Review of KCGM TSF	Adrian Lang	Bjorn
1/07/96	Letter	H Jones, Ass. Dir. Research & Tech. Svs	KCGM
1/07/96	Ltr re Rowe to Skidmore Ltrs	H Jones, Ass. Dir. Res. & Tech. Svs	KCGM
1/07/96	Ltr re Tailings spill at Fimiston I	H Jones	KCGM
25/07/96	Safety Issues Letter	Dept. Min. & Energy Kal.	Dept. Min & Energy HQ

26/07/96	Memo re Trans Australia Railway Line possible effects of water seepage from KCGM TSF	Jay Ranasooriya	Ass. Dir. Res & Tech Svs & Principal Mining Engineer
30/08/96	Proceedings: Noise and Groundwater Management Workshop	Hugh Jones	
20/09/96	Ltr re Fimiston Tailings Storage Watershed	Infrastructure Svs	KCGM
1/10/96	Report on 1996 Annual Ops audit KCGM Tailings Storage	Golders	KCGM
1/10/96	Ltr re Freeboard Tailings Storage	Golders	KCGM
1/12/96	Fimiston 2 Tailings Dam Risk Study Assessment & Dam Break Study - Rep. 1 - Appendix Reps.4, -12 for KCGM	Metago/Coffey	KCGM
1/12/96	Fimiston 2 Tailings Dam Risk Assessment & Dam Break Study Rep. 1	Metago/Coffey	KCGM
1/12/96	Executive Summary on Fimiston 2 Tailings Dam Risk Assessment & Dam Break Study	Coffey	
1/12/96	Fimiston 2 Tailings Dam Risk Assessment & Dam Break Study	Metago/Coffey	KCGM
4/12/96	Ltr re 1996 Annual Tailings Storage Review	Ditto	KCGM
1/02/97	Appraisal report on Fimiston 2 Tailings Dam Risk Assessment & Dam Break Study	GHD	KCGM
1/03/97	Addendum report on Fimiston 2 Tailings Dam Risk Assessment & Dam Break Study	Metago/Coffey	KCGM
10/04/97	Summary Report on Dam Break Study	GHD	KCGM
1/11/97	Report on 1997 above	Golders	KCGM
7/04/98	Memo re KCGM Annual Ops. Audit 1997	Jay Ranasooriya	E. Bouwhuis
1/05/98	Report on Risk based dam break study Croesus/Fimiston I Tailings Storage	Golders	KCGM
1/10/98	ditto		
29/10/98	Question on Notice, Legislative Council	Minister for Mines	Hon. Tom Helm
1/11/98	Report on 1998 above	Golders	KCGM
10/11/98	Ltr re Fimiston 2 Tailings Dam groundwater seepage	Waters & Riv. Com.	EPA
10/12/98	Copy emails re Urgent recommended improvements to draft ministerial conditions	Eugene Bouwhuis & Jim Bawden	Bill Biggs & Russel Giles
11/12/98	Fimiston TSF & Surrounds Diagram	KCGM	
11/12/98	Ltr re non-response to previous ltr of 12.9.98	John Baker	Dept. Min. & Energy
15/12/98	Ltr re Fimiston TSF Groundwater Management Plan	KCGM	Dept. Environ. Protection
15/12/98	Memo re KCGM Fimiston Tailings - Dep. Ass. Of possible groundwater impacts	L C Ranford	Hon Minister
5/02/99	Fax re Optimum Res P/L monitoring bores & map etc. (27 pages)	Dept. Min. & Energy Kal	Bill Biggs, DME Perth
10/02/99	Ltr re Briefing DEP & WRC groundwater sampling	L C Ranford, Dir. Gen.	Hon. Minister

24/02/99	Ltr re above	KCGM	J Torlach
5/03/99	Memo & copy ltr from KCGM re above	J Torlach	Acting Dir. Mining Ops. Div.
19/03/99	Ltr re minor adjustment to safety exclusion zone for stores cut KCGM open pit	J Torlach, State Min. Eng.	KCGM
19/03/99	Memo re KCGM Stores cut	J Hones	Dir. Mining Ops.
1/05/99	Guidelines on the safe design & Op. Standards for Tailings Storage	Dept. Min. & Energy	
11/05/99	Ltr re Groundwater recovery program at KCGM	EPA	Dept. Min. & Energy
26/10/99	Memo re KCGM TSF's Ann. Op. Audit 1998	Jay Ranasooriya	Man. Environ. Ops
1/12/99	Report on 1999 Op. Audit of TSF'S at KCGM	Golders	KCGM
18/01/00	Ltr re 199 Op. Audit of Fimiston I & 2 TSF's	Dr Jim Bawden KCGM	Dept. Min. & Energy
1/04/00	Report on Key Piezometric Levels at Fimiston and Croesus TSF's	Golders	KCGM
7/04/00	Memo re KCGM TSF'S Annual Op. Audit 1999	Jay Ranasooriya	GM Environ. Branch
1/05/00	Report on Aquifer Review Jan. 97 to Dec. 99 KCGM E. Borefield	Peter Clifton & Assoc.	KCGM
1/05/00	1999 Annual Environ. Rep extracts	KCGM	
1/05/00	Tailings Storage Data sheet Aug. 99	KCGM	
10/08/00	Copy Ltr re KCGM Borefield Aquifer Review Jan. 97 to Dec. 99	Dept. Min. & Energy	Water & Rivers Com.
29/08/00	Ltr re KCGM Annual Environ. Rep.	EPA	KCGM
1/11/00	Report on 2000 Op. Audit of KCGM TSF's	Golders	KCGM
1/12/00	Piezocone Probe Testing of TSF's at KCGM	Golders	KCGM
10/01/01	Ltr re Inspection of Fimiston Plant & Tailings Disposal	EPA	KCGM
1/05/01	2000 Annual Envron. Rep.	KCGM	
16/10/01	Complaint by Optimum Res. P/L - high water table on tenements	Dept. Min. & Pet Res.	Minister for State Dev.
25/10/01	Ltr as above	Ditto	Ditto
1/12/01	Audit Fig.2 Typical Schematic Detail Current & Proposed positions of Piezometers at Fimiston I TSF	Golders	
28/12/01	Ltr re 2001 Op. Audit Fimiston I & 2 TSF's	KCGM	Dep. Min. & Energy
17/01/02	Memo re Rep. 2001 Op. Audit or TSF at KCGM	Dep. Min. & Pet Res.	P. Burke MPR HQ
1/03/02	Tailings Storage data sheet	KCGM	
1/03/02	Monitoring & Fig. 1 of 2001 Report.	KCGM	
11/03/02	Memo re Annual Op. Audit Rep. 2001 Fimiston TSF	Jay Ranasooriya, Geotech Eng.	G.M. (E.& H) Mining op. Div.
17/06/02	Extract from Mining Regulations 1981	DELS	
22/08/02	Mining Tenement Register Search Lease 26/405	Ditto	
1/09/02	Project visit proforma - Mt Percy Site	KCGM	

1/09/02	Project visit proforma - Mt Charlotte	KCGM	
1/09/02	Project visit proforma - Fimiston super pit	KCGM	
1/10/02	Recommended Further conditions Lics. 24/105, 26/91, 26/172, & Unconditional Performance Bonds & Project visit proforma sheet Mining ops. Kal. Sept. 02	KCGM	
1/10/02	GIDJI Roaster Sep. 02	KCGM	
28/10/02	Ltr re 2001 Annual Environ. Rep & Inspection	Dept. Min. & Pet. Res.	KCGM
1/11/02	Report on Revised Key Piezometric levels for the TSF at KCGM	Golders	KCGM
1/12/02	Report on 2002 Ops Audit of TSF at KCGM	Golders	KCGM
17/12/02	Ltr re 02 Op. Audit of Fimiston I & 2 TSF's	KCGM	Dept. Min & Petrol Res.
1/03/03	Ministerial Conditions and Regulatory Bodies site inspections App. 9.4	KCGM	
1/04/03	Addendum to Notice of Intent for Increasing the capacity of the Fimiston 1 TSF at KCGM	Golders	KCGM
18/06/03	Memo re Mining Lease 26/383	E. Bouwhuis	Jay Ranasooriya
15/07/03	Ltr & Site Inspection re Site visit of water leak from Oroya Waste Dump	Dept. Min & Pet Res.	KCGM
11/08/03	Page 1 of Ltr re Addendum to NOI Fimiston 1 Tailings Dam to increase capacity from 30 to 40 m	B Biggs, EPA?	KCGM
29/08/03	Memo re Comments on Kean's Ltr re pollution leakage	E. Bouwhuis	Xuan Nguyen
8/09/03	Certificate of Compliance Tailings Storage Dam	Golders	
19/09/03	Ltr re Pol leakage above	Hon. Clive Brown	Steve Kean
25/09/03	Email re Fimiston I	Jay Ranasooriya	Trevor Tyson
7/10/03	Email re Fimiston I NOI Amendment	Trevor Tyson	Jay Ranasooriya
7/10/03	Email re Fimiston I NOI Amendment	Trevor Tyson	Jay Ranasooriya
10/10/03	Reply to Email re Fimiston I NOI Amendment		
17/10/03	Email re Email re Fimiston I NOI Amendment	Trevor	Jay
1/11/03	Report on Fimiston I & 2 TSF's Golden Mile	Dept. Industry & Res.	KCGM
1/11/03	Report on Fimiston I & 2 TSF Golden Mile	Jay Ranasooriya	
4/11/03	Memo re Addendum to NOI Fimiston I TSF	Jay Ranasooriya	Bill Biggs
25/11/03	Record of Section 39 referral	DOE	KCGM
1/12/03	Report on 2003 Operational Audit of the TSF's at KCGM	Golders	KCGM
1/12/03	Ltr re Non Assessment Public Advice given & managed Under Part V of EP Act for Fimiston 1 TSF N26/383	Environ. Protection Authority	Dept. Industry & Res.
24/12/03	Inspection of the Fimiston & Gidgi Plants	DOE	KCMG
15/01/04	Final Report, Review of Environmental and Public Safety of Mining in the Kalgoorlie Area	Cooke	
28/01/04	Ltr re Addendum to Notice of Intent for increasing capacity at Fimiston I TSF	Dept. Industry & Res	KCGM

10/02/04	Update for the appeals convenor Fimiston I TSF increase in capacity	KCGM	
1/02/04	Fimiston I and 2 TSF's Annual Review of Groundwater Monitoring Data	Peter Clifton & Associates (PCA)	KCGM
22/03/04	Ltr re Annual Environmental Inspection KCGM Ops. & Photos & further recommendations.	Dept. Industry & Res.	KCGM
22/03/04	Memo re Monitoring Review (2002-3)	Natti Hundi KCGM	Wayne Astill
19/04/04	Memo re Gidji TSF 2003 Ops audit	Jay Ranasooriya	Danielle Risbey
19/05/04	Memo re 2003 audit Rep. KCGM Fimiston TSF's	Jay Ranasooriya	Suellen Davey
19/05/04	Memo re Fimiston TSF 2003 Ops. Audit	Jay Ranasooriya	Suellen Davey
20/05/04	Further Info for the Cooke Report Submission Review	Chris Fitzhardinge	
14/06/04	Email re KCGM Fimiston 1 - Minister's office	Xuan Nguyen	Biggs, Russell & Davey
15/07/04	Memo & topo Map re Cooke Report	Bill Philips	Chris Fitzhardinge
10/02/04	Fimiston I Increase in Capacity - Update for the Appeals Convenor	KCMG	Appeals Convenor

APPENDIX G

HAZARD ASSESSMENT

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HAZARD ASSESSMENT

Damage and Loss	Estimate	Severity Level			
		Negligible	Minor	Medium	Major
ESTIMATED COSTS (The costs are indicative only. For future reference the costs are in 1998 values and should be updated					
Residential	Damage to 1-3 houses	.	YES	.	.
Commercial	$10 000 - $1M	.	YES	.	.
Infrastructure	$1M - $10M	.	.	YES	.
Dam repair or replacement cost	$100 000 - $10M	.	YES	.	.
Provison of temprary services by owner	$1M - $10M	.	.	YES	.
Clean up	$10M +		YES	.	YES
Estimated cost severity level =	**MAJOR**				
SERVICE AND BUSINESS RELATING TO THE DAM					
Importance to the system and need to replace the dam	Restrictions needed during peak days and peak hour	.	.	YES	.
Effect on services provided by owner	Reduced services with reasonable restictions (80% of full suppl	.	.	YES	.
Practicality of replacing the dam	Some impediment	YES		.	.
Community resistance to replacement	Severe widespread reaction	.	.	YES	.
Effect on continuing credibility	Extreme discontent, high media coverage, long term distrust	.	.	.	YES
Political implications	Extreme discontent, high media coverage, long term distrust	.	.	.	YES
Impact on financial viability	Significant with considerable impact in the long term	.	.	YES	.
Value of water in storage (Assessed by the owner in relation	Minor	.	YES	.	.
Service and business damage and loss severity level =	**MAJOR**				
SOCIAL					
Loss of services to the community	None expected	YES	.	.	.
Publichealth adversely affected	No effect	YES	.	.	.
Cost of emergency management	<100 person days	.	YES	.	.
Dislocation of people	<100 person months	.	YES	.	.
Dislocation of business	<20 business months	.	YES	.	.
Employment affected	<10 jobs lost	.	YES	.	.
Production affected	Regional output affected by <10%	.	YES	.	.
Post disaster trauma and stress	<100 person months	.	YES	.	.
Injured and hospilised	10 - 50	.	.	YES	.
Loss of reservoir recreational facility	None expected	YES	.	.	.
Loss of other recreational facilities	None expected	YES	.	.	.
Social damage and loss severity level =	**MEDIUM**				
NATURAL ENVIRONMENT					
Area of impact	1 km2 - 10km2	.	.	YES	.
Vegetation and forest damage	Medium	.	.	YES	.
Duration fo impact	1 month - 1 yr	.	YES	.	.
Significant factors	Forested land may contain environmental factors	.	YES	.	.
Ecological effects	Likely to alter, say fish habitat	.	YES	.	.
Habitat units	Minro effect on weland or forest	.	YES	.	.
Natural environment damage and loss severity level =	**MEDIUM**				
Highest damage and loss severity level =	**MAJOR**				

Population at Risk (PAR) 11-100 **HAZARD CATEGORY =** **High B (note 6)**

PAR includes all those persons who would be directly exposed to flood waters within the dam break affected zone if they took no action to evacuate

Note 1: With a PAR of 5 or more people, it is unlikely that the severity of damage and loss will be "Negligible"

Note 2: "Minor" damage and loss would be unlikely when the PAR exceeds 10

Note 3: "Medium" damage and loss would be unlikely when the PAR exceeds 1000

Note 4: Change to "Significant" where the potential for one life being lost is recognised

Note 5: Change to "High" where there is the potential for one or more lives being lost

Note 6: See section 2.7 and 1.6 of ANCOLD guidelines