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ERA Ranger Tailings Corridor Review

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Executive summary

This report documents an investigation of the tailings corridor at the ERA Ranger mine undertaken by Sinclair Knight Merz on behalf of the Office of the Supervising Scientist. The purpose of the investigation was to review the adequacy of design, operating and maintenance aspects of the corridor. The key features of the report investigations and findings are as follows:

- The scope of the study was limited to the corridor itself and its associated runoff collection sump and sump contents discharge.
- The study methodology comprised an overview review and assessment by SKM based on current operations documentation and information obtained from investigations on site and discussions with ERA Ranger personnel.
- A summary description of the existing system design and operation is provided along with comment on the current suitability of the original design. The review concluded that, subject to recommendations in respect of widening of the corridor at the tailings dam end to take account of additional pipes added since the original design and checking of corridor impermeability, the original design and design intent was and continues to be appropriate.
- The review found that some maintenance procedures have not, in the latter years of operation, been as effective as those undertaken during earlier operation of the facility. A number of recommendations to generally improve and tighten maintenance planning and implementation procedures are therefore included in the report.
- A review of corridor maintenance roles and responsibilities is recommended to ensure optimal planning and implementation of maintenance requirements for the remaining facility life.
- The possibility of rocks falling from the adjacent waste rock stockpile is seen as a potential threat to the corridor piping and a review of this stockpile in this context is recommended.
- A review of corridor pipework has identified a number of recommendations in respect of ensuring joint integrity.
- A recent ultrasonic survey of corridor line pipe condition by a specialist contractor has not revealed any significant problems. The method used, however, has limitations in respect of tailings pipeline lining condition. Further review is required and recommended to establish whether more sophisticated condition assessment techniques are merited for the linings. The report investigations indicate that suitable technologies, whilst they may be expensive, are available should they be required.
- It is recommended that all redundant piping be identified and removed.

A full listing of recommendations arising out of the review is provided in section 6 (Discussion and recommendations) of this report.

ERA Ranger tailings corridor review

Sinclair Knight Merz

1 Introduction

Sinclair Knight Merz were commissioned by the Office of the Supervising Scientist on 25 May 2000 to undertake a review and complete a report on the tailings corridor at the ERA Ranger Mine.

The objective of the study was to undertake an 'as is', and to some extent historic and look ahead, review of the corridor system sufficient to:

- assess the current suitability of key aspects of the design;
- assess the suitability of current operating, maintenance and system development regimes and responsibilities; and
- record any recommended actions or further investigations arising out of the review;

in order to ensure the adequacy of the design, operation and maintenance.

The scope of the study report was limited to the corridor itself, its associated sump and sump contents discharge and the branch corridors carrying pipelines to Pit 1.

A representative report contents was discussed and agreed with the Office of the Supervising Scientist prior to commencement of the study and this is included as appendix A to this report. The originally agreed content is, with only minor amendment, reflected in this report.

The study methodology comprised a review and assessment by SKM of the design of the existing system and current operations documentation and information obtained from investigations on site and discussions with ERA site personnel. Follow up information and advice as required to complete the study investigations was obtained by fax, phone and e-mail communications with the site.

Concurrent with the investigations for this report, a specialist pipeline inspection firm (Intico) was undertaking a condition assessment of the pipelines in the tailings corridor on behalf of ERA. The findings of the Intico assessment have been obtained from ERA and are included in this report.

2 Overview description of the existing system

2.1 System process and layout description

As part of the mine milling process, tailings produced by milling are carried by process water from the mill to a tailings repository. The process water is then returned to the process for reuse in the process, thereby providing what is essentially a closed process water system.

During the initial operation of the mill, the tailings were pumped to a purpose built tailings dam until mining in Pit 1 was complete. When Pit 1 mining was complete, the pumping of tailings from the process was, in line with ERA authorisation to operate, transferred to Pit 1 after suitable preparation of this pit to receive tailings. As part of the water management system, there is provision to transfer process water from the tailings dam to Pit 1 and vice versa.

Also, as part of the water management system and the ultimate plan to rehabilitate the site, some of the tailings from the tailings dam were transferred to Pit 1 when this pit was brought on line as a tailings repository.

The tailings corridor pipework currently handles the following streams:

- Tailings from the mill to Pit 1 (two lines – A&B)
- Process water return from either the tailings dam or Pit 1
- Process water transfer from Pit 1 to the tailings dam
- Process water/tailings transfer from the tailings dam to Pit 1 although there is currently no transfer of tailings
- Tailings corridor run off water from the tailings corridor sump ultimately to RP2.

An overview water management pictorial drawing no 05-P-8004 which includes these services is included in appendix B. The appendix B schematic also identifies a number of redundant lines from earlier tailings/water management operations at the site. Redundant lines are discussed in section 4.5 of this report.

The tailings corridor system overview layout is shown on water management layout drawing no 1253-05-A0014 and included in appendix C.

2.2 Design and operating philosophy

Accepting the primary objective of carrying the services listed in section 2.1 above, the principal design and operating criteria applied to the tailings corridor is that it forms part of the Restricted Release Zone (RRZ) for the site Water Management System (WMS).

The RRZ has been defined in terms of those areas affected by mining and milling operations where 'material' >0.02 per cent uranium dry weight is exposed. Accordingly the tailings corridor, which carries water and material from affected areas, is included in the RRZ.

Rainfall within the RRZ and resulting runoff must be managed within the RRZ unless the Supervising Authority grants special approval. It is noted that, as of 9 January 2000, water management objectives are being focused toward water quality targets for all waters rather that the previous objectives that sought to primarily manage surface waters in the context of its site origin. This shift in emphasis does not, however, appear to diminish in any way the design and operating criteria which must be applied to the tailings corridor.

The objectives and operation of the WMS are covered in the ERA Ranger 'Water Management System Operation Manual' .

3 Review of design

3.1 Original design

The key features of the original design are briefly described below under the following three headings:

- Corridor design
- Tailings and process water pumping and piping system
- Environmental

3.1.1 Corridor design

The tailings corridor, as constructed, was approximately 16 m wide and ran for approximately 2.5 km from the tailings pumping facility at the mill to the tailings dam, passing to the south side of ore body Pit 1. It comprised 300 mm minimum compacted fill covered with selected earth fill base compacted to 95% relative dry density (modified) with a 300 mm layer of earth-rockfill on top.

Typical cross section details from the original design are shown in drawing no 1253-04-T0039 included in appendix D. In section, from south to north, it comprised an embankment, a 6 m wide vehicle access way, a pipe track, an open drain and a further embankment. The corridor south side embankment formed the southern limit of the RRZ.

The design incorporated a number of culverts passing under the corridor carrying various runoff flows.

The corridor longitudinal profile was such that it had high points at the mill and tailings dam ends and drained by gravity flow to a mid point where a drainage collection sump was located. The sump contents were automatically pumped to RP3.

3.1.2 Tailings and process water pumping and piping system

The original corridor process and tailings water piping system design comprised two tailings lines bringing tailings to the tailings dam and a single process water return line from the dam. Support for these pipelines was provided via concrete supports at 6 m intervals along the corridor pipe track.

The original tailings lines were carbon steel rubber lined with jointing via victualic couplings. Design operating pressure was 1800 kPa.

The original process water line was ERW carbon steel unlined with jointing also via victualic couplings. Design operation pressure was 700 kPa.

Flexibility provision for curved installation (they follow the tailings corridor route) and for thermal expansion and contraction on the tailings and process water lines was provided via the victualic couplings. Another reason for using victualic joints was that leaks do not spray radially from the joints thereby reducing the likelihood of leakage spray reaching outside the corridor. Flange guards need to be fitted to flanged joints to prevent this.

3.1.3 Environmental

As already stated, the tailings corridor and associated pipework and sump were designed as part of the RRZ. Hence, any corridor runoffs or corridor pipe leakages were to be managed under the WMS and not present a risk to the environment.

Clearances provided from the pipe runs to the embankments which formed the boundaries of the corridor ensured a practical minimisation of the risk of any occurring pipe leaks resulting in tailings or return process water being spilt outside of the corridor.

Whilst the full specification of corridor ground preparation has not been sighted during the review, it is assumed for the moment that the grading and permeability specification will have ensured that any seepage of tailings/process water into the environment would be insignificant. Further comment on this is provided later in the report.

3.2 Summary of changes since the original design and construction and additional details

The significant changes which have occurred since the original design and construction are as follows:

1. The rubber lined pipework used in the original tailings lines design and construction provided very poor service life. It initially failed due to a manufacturing fault. The replacement rubber lined pipes failed due to a leakage around the seals and subsequent corrosion of the steel. Replacement polyurethane lined lines failed due to incompatibility with components in the tailings. Ultimately a polyethylene lining was adopted and continues to be successful.
2. The original unlined process water line provided very poor service life. This unlined pipework has been replaced with internal epoxy painted pipework.
3. A number of pipe runs have been either added, removed or changed as required by ongoing mine development operations. The current changes relative to the original design are as follows:
   - The tailings lines now run only as far as Pit 1. Tailings line A leaves the corridor at a point to the south east of Pit 1 and runs towards the pit in a dedicated branch corridor formed by a trench and draining to Pit 1. This line passes through a culvert under the pit perimeter road on route to the pit.

     Tailings line B leaves the corridor at a point on the south side of Pit 1 and runs towards the pit in branch corridor formed by earth bunds either side. The redundant tailings pipework associated with these diversions has been removed because it was needed for the A line branch. The surplus pipe has been stockpiled.
   - A process water return line branch from Pit 1 has been installed and connected into the original process water return line from the tailings dam. This branch runs from the pit to the tailings corridor in the same branch corridor as tailings line B.
   - Two off 500 mm diameter polyethylene lines have been added to transfer tailings dredged from the tailings dam to Pit 1 and return water from Pit 1 to the dam. These two lines run ,between the tailings dam and the Pit 1, in the open drain inside the tailings corridor.
4. An additional culvert underneath the main corridor has been added to carry run off from the south waste rock dump across to the corridor wetland filters. Another has been constructed under the A line branch to drain areas otherwise isolated by this extension.
5. Water collected in the tailings corridor collection sump is now directed via one only sump pump and a 110 mm diameter polyethylene pipe running along the corridor back to the mill and via underground storm water drains to RP2. The pumping system is manually started after storm events. The standing procedure is that the operator inspects the full length of the pipeline corridor for leaks prior to the commencement of pumping to RP2. The sump is provided with a gravity overflow to No. 1 pit
6. In the event of an accidental spillage of tailings from the corridor pipework which contaminates the sump water, the water would be returned to the RP3 process water system subject to a quality check.
7. A 150 mm welded steel line runs part way along the corridor. It transfers ground water from bore MBL to flood irrigation to prevent it entering Pit 1.

8. Regrading of the corridor has taken place on a regular basis as required to maintain the surface and road drainage.

To the north of the corridor, except for the last approximately 0.75 km at the tailings dam end, is a sediment control zone (catchment #11 referenced in the WMS operation manual). For the above mentioned last 0.75 km, the corridor is bordered on the north side by the south waste rock dump/capped area (catchment # 11A referenced in the WMS operation manual).

3.3 Current suitability of key aspects and of the original design

An overview review of the original design has been undertaken and it has been found to be appropriate to the design and operating criteria which prevailed at the time of the original design subject to the following comments. It is also considered to be appropriate for the current design and operating requirements, again subject to the following comments.

1. The 500 mm polyethylene pipes, located as they are in the corridor drain, raise the following concerns:

   - They do not have sufficient clearance between them and the corridor north side embankment to provide reasonably reliable protection against discharge of process water into the catchment areas (11A and part of 11) in the event of a leak in one of these lines. In order to overcome this, consideration should be given to appropriately increasing the width of the corridor on its north side between the Pit 1 branch corridor and the tailings dam.
   - The drainage capacity of the ditch could be impeded by the pipes. This should be reviewed and the adequacy of the drainage confirmed if it is intended to leave the pipes in the drain.
   - Thermal movement of the HDPE lines in the ditch could lead to progressive erosion and degeneration of the trench. General maintenance of the trench is also made more difficult by the presence of these pipes. Again, these aspects should be examined further if it is intended to leave the pipes in the drain.

   The foregoing concerns and their potential solutions are interrelated. They should be studied together to ensure that any alternative widening and HDPE pipe routing/support scheme considered addresses all three issues as appropriate.

2. As noted above, a complete specification for the particle grading and overall impermeability of the corridor cover has not been sighted during this investigation. This specification should be obtained and reviewed to confirm its appropriateness.

3. As for the main corridor, a full particle grading and impermeability specification for the branch corridors should be obtained and reviewed.

4. A recent corridor pipe leakage incident resulted in process water contamination of wetland filters. It is believed that this occurred due to leakage through the corridor floor at the additional culvert installed for the south waste rock run off subsequent to the original design. This suggests that the cover provided above the culvert at this location was suspect. All locations where the original corridor specification has been significantly altered should be reviewed to check whether the cover provided is still adequate. It is understood that remedial action in respect of this suspected leakage path has included the provision of a concrete cover slab in the trench over the location of the culvert. The design of this modification should be reviewed to confirm that it is properly keyed and will not result in an undermining of the slab by storm flow in the drain.

5. Details of the recently installed overflow pipe from the corridor sump to Pit 1 were not sighted during the review. These should be obtained and checked to ensure that adequate overflow capacity is available in the event of the design storm event.

4 Review of existing system and current operating, maintenance and development regimes and responsibilities

4.1 Current inspection, operating, maintenance and development regimes and responsibilities

The overall operating, maintenance and development regime for the tailings corridor is governed by the ERA Ranger general authorisation to operate and the requirements relevant to the tailings corridor are covered, in either specific or general terms, in the WMS operation manual.

The departments within ERA who are directly responsible for aspects of the corridor operation, maintenance and development and their specific responsibilities are as follows:

Department	Responsibilities
Mill (Operations)	• Operation of tailings and return process water supply lines • Inspection of tailings corridor and pipe lines a minimum of 3 and preferably 4 times per shift • Inspection of corridor lines for leaks after storm events prior to pumping of tailings corridor sump contents to RP2 • Management of dams and ponds
Mill (Maintenance)	• Maintenance of tailings pipelines • Maintenance of balance of corridor pipework • General maintenance of tailings corridor
Engineering Services (Mechanical Workshops)	• Maintenance of the process water return line • Maintenance of the Water Management System (WMS)
Engineering Services (Engineering Technical Services)	• Maintenance of drawing records • Provision of engineering support, when requested, for facility upgrades or modifications
Environment Safety & Health	• Overall supervision of tailings corridor operations and development to ensure compliance with the WMS requirements • Conceptual and strategic input for the design of any modifications to the corridor or its associated pipework/ equipment • Liaison with and reporting to the Office of the Supervising Scientist

During the review inspections and discussions, the following general observations were made with respect to the above roles and responsibilities as they apply to the tailings corridor:

1. Corridor maintenance, in terms of cleaning and grading etc, has not in latter years been to the same standards which prevailed during the early stages of mine operations. Recently, however, there has been a recognition of this on the part of ERA and measures are being put in place to rectify the situation. If not already in place, a fully updated formal routine maintenance program and schedule covering these aspects should be drawn up and implemented.

   This program should also include a means of recording maintenance activities carried out.

2. If not already in existence, a means of recording shift etc inspections should be implemented.

3. Whilst significant drawing updates have been undertaken, the process of passing details of all modifications to the Project Technical Services Group for updating of drawings appears to need improvement. If not already in place a formal procedure should be initiated.

4. The above table shows maintenance of the tailings lines to be the responsibility of the Mill Department. However, some discussions on site suggested a desire on the part of the Mill Department to pass this responsibility over to the mechanical maintenance workshops. If this is likely to be considered, it should be cleared up and any role/responsibility changes confirmed as soon as possible to ensure that there is no neglect of the tailings pipelines maintenance.

4.2 Pipe materials and condition/integrity

Table 4.1 summarises the main details of the corridor pipework along with summary comments on current condition/integrity and also some general pertinent observations. The main findings of the review are summarised as follows.

A recently completed ultrasonic inspection of the tailings and process return lines by pipe testing specialists, Intico, has not found any evidence of metal wall thickness reduction in these lines.

Unfortunately the methods employed do not permit the condition of the pipe ends in the region of the victualic couplings to be examined. Neither does it allow the condition of the tailings lines polyethylene lining to be assessed.

The evidence presented during the review suggests that degradation of the lining in the tailings lines is not likely to be an issue at present. This should, however, be confirmed by identification and review of all available evidence in this regard. Should this evidence, or a desire to obtain more conclusive information of the lining condition, indicate a requirement for further examination this can be undertaken.

One available method, based on preliminary discussions with specialist contractors, is the use of an Intelligent Caliper Pig to survey the lining condition. This is a device, capable of recording pipe internal details, which travels down the line either under its own power or the motive power of the fluid in the line. This particular pig technology is not currently available in Australia, however, it is can be made available on a fly in fly out basis from overseas. It tends to be expensive with mobilisation/demobilisation costs being a considerable part of the cost. It would be possible to offset some of the mobilisation/ demobilisation costs if there were other lines at the site which merited similar investigation.

Table 4.1 Description of pipelines in the Tailings Dam Corridor

Stream Description	Line Diameter	Pipe Material	Coupling Type	Condition/ Integrity	Comment
Tailings Line A	250 mm	HDPE lined ERW carbon steel. Some flanged hose included.	Victualic except as noted for flanged hose.	Recent ultrasonic(U/S) testing suggest that the carbon steel pipe is in good condition throughout its main length. The condition of the pipe ends at the couplings is thought to be good but cannot be confirmed by the recently employed U/S testing. The condition of the lining, whilst not currently suspect, is unknown and cannot be tested by the above U/S method. Recent ultrasonic testing of pipes made surplus in the move to Pit 1 revealed no measurable wear.	Methods to non destructively (and if possible, in service) testing the lining condition are available if required.
Tailings Line B	250 mm	HDPE lined ERW carbon steel. MDPE lined in the corridor branch. Some flanged hose included. Also, two rubber lined steel sections in the vicinity of the corridor sump	Victualic jointing in the main corridor and flanged in the corridor branch and as noted for hose.	As above for tailings line A The flange guards are not correctly fitted	As above for tailings line A
Process Water Return	250 mm	Internal epoxy painted carbon steel. Some MDPE lined ERW or spiral welded steel. Some flanged hose where bolts have corroded	Victualic mainly and some flanged.	Condition believed to be generally good based on previous inspections The condition of the pipe ends at the couplings is suspect but cannot be investigated by the recently employed U/S testing. Some recently installed sections have been painted on the outside instead of the inside. Flange guards not correctly fitted and sometimes not fitted in B corridor extension.	Progressive stripping and painting of the coupling joints to prevent deterioration of the pipe ends and reduce the risk of joint failures recommended
Tailings Sump Discharge to RP2	110 mm	MDPE	PP compress'n fittings		This is laid on the ground at each end and draped over the corridor main pipelines over most of the route.
Process Water Pit 1 to Tailings Dam	500 mm	MDPE	Butt Welded Joints with welded flanged joints at intervals and fittings		
Process water Tailings Dam to Pit 1	500 mm	MDPE	Butt Welded Joints with welded flanged joints at intervals and fittings		

Discussions with specialist contractors have suggested other suitable and possibly less expensive internal inspection methods may also be available. However, at the time of writing this report, conclusive information has not yet been received.

The condition of the pipe ends is a concern primarily in the case of the process water return line. A program of progressive stripping and painting of the internal and external pipe ends to prevent further deterioration of the pipe ends and reduce the risk of pipe failures is recommended.

4.3 Pipe support

Pipe support is provided as follows:

Stream Description	Section	Support Type
Tailings line A	• Main tailings corridor	• Concrete pipe supports
	• Branch corridor to Pit 1	• Concrete pipe supports
Tailings line B	• Main tailings corridor	• Concrete pipe supports
	• Branch corridor to Pit 1	• Concrete pipe supports
Discharge line from tailings corridor sump pump to RP2	• Discharge from tailings sump	• Steel pipe supports
	• Main tailings corridor run	• Concrete footings
	• End of tailings corridor on route to RP1 surge sump on west side of tailings pumps	• Sitting on the ground
Tailings – tailings dam to Pit 1	• Branch corridor to Pit 1	• On ground
	• Main tailings corridor	• On ground in drainage trench
Process water - tailings dam to Pit 1	• Branch corridor to Pit 1	• On ground
	• Main tailings corridor	• On ground in drainage trench
Process water return pipe	• Branch corridor to Pit 1	• Concrete pipe supports
	• Main tailings corridor	• Concrete pipe supports

Support designs and spacings appear to be generally in accordance applicable standards, good engineering design practice and, where applicable, vendor recommendations. No specific issues came to light during the review investigations.

4.4 Pipe jointing

Pipe jointing details are provided in table 4.1. The following findings are noted:

1. The most vulnerable aspect of the tailings and process water return lines is the joints. Victualic jointing has been adopted for the reasons given in section 3.1.2 of this report. Risks/problems encountered include the following:

- The sealing surface on the pipe is easily damaged during construction and maintenance by rough handling. Consequently, leakage occurs and corrosion of the surface steel then causes failure of the pipe groove used by the victualic clamp. This allows the joint to fail in tension which it cannot normally do while constrained within the pipeline.
- The couplings are made of SG iron and are therefore more corrosion resistant than the steel. Handling of the pipework carefully when fitting the couplings is important to minimise damage to the pipework. If it is not already the case, the manufacturers instructions for installation of the couplings should be included in a standard maintenance procedure for this activity and monitored accordingly.
- The epoxy lined pipes (process water return) are most likely to fail due to corrosion at the joints as the painting is thinner around the sharp corners because they are more difficult to paint and very easy to damage. Extra care is therefore necessary during construction to prevent handling damage in this area.
- The quality of couplings has been a problem in the past when pirate versions of victualic couplings were purchased and installed from new. Genuine victualic couplings of the correct metric or imperial as appropriate size only should be used.

2. Undersized bolts are suspected of having been a factor in the recent joint failure on the process water return line referred to in section 3.3 (item 4). If not already carried out, a check should be undertaken on bolting in all suspect areas to confirm that correct size and material of bolting has been used.

4.5 Redundant pipework

There is some redundant pipework remaining in the corridor from previous operations. This pipework should be assessed as to any future use for the corridor services and removed at a suitable time if it is not intended to use it. This will result in the corridor being less congested in these areas and will aid future corridor maintenance (refer 4.6 below). Pipework identified as being apparently redundant with known details is as follows:

Diameter	Material	Location	Past Function
250 mm	Polyurethane lined steel	Nearly full length of corridor	Old CD line to tailings dam
150 mm	Steel	Past corridor sump	
150 mm	Steel	Corridor sump manifold to old tailings CD line	Corridor sump water to the tailings dam
150 mm	Steel	Corridor sump pump manifold	Corridor sump water from the sup pumps to the tailings dam

4.6 Maintenance of the corridor

As noted in 4.1 above, general corridor maintenance has been recently recognised by ERA as needing attention and measures are currently in hand to achieve this. Problems which have arisen due to reduced or changed maintenance practices include the following:

1. Grading of the corridor road has resulted in surface material being pushed onto the pipetrack area with the result that, in certain areas, the corridor pipework was either partially or fully buried which is contrary to the design intent. This in turn results in a number of risks/problems as follows:
   - Some external wall corrosion of the pipework and bolts has occurred
   - Thermal expansion of the pipelines could be restricted
   - Early detection of any leaks is less likely
   - The drainage of the corridor road into the corridor drain channel is inhibited with the result that breakthrough channelling and scouring of the corridor surface has occurred particularly in the vicinity of the corridor sump
   - Surface material can be dragged into the corridor drainage channel thereby reducing the design effectiveness of this channel
   - Surface material will have been lost in the clean up removal process and may have to be replaced in order to maintain design levels and contours.

   The regrading process for the tails road should ensure that scraped material is re-compacted (into the road surface) and does not end up being left in the pipetrack so as not to reduce design clearances and not cause the other problems noted above.
2. In the early days of mine operation, the maintenance regime included placing weed killer to prevent the growth of grass and weeds on the corridor particularly along the pipe track in the drainage trench. This practice has, however, subsequently lapsed with the result that extensive growth of grass and weeds occurred. Problems encountered as a result of this include:
   - The corrosion and accidental fire risks are increased. Exposure of pipes to fire is a problem even for steel pipes as here they are usually lined and have rubber seals in the victualic joints and they have linings.
   - Visibility of leaks is reduced
   - There has been a practice of removing the grass using cold burning and, whilst operation should be carefully supervised, there is always the risk of fire damage to pipe internal linings/coatings using this process

   A regular program of poisoning should be re-introduced to the corridor maintenance program to keep grass and weeds at bay.
3. There is some evidence that corridor side embankment heights/integrity might, in a few locations, not be as per the original design. A general survey of these embankments should be undertaken to confirm compliance with original design and remedial action taken if appropriate.

4.7 External threats

External threats were considered as part of the review and the following points are noted:

- The catchment area 11A stockpile is positioned very close on the northern side of the corridor. There may consequently be a risk of damage to the adjacent corridor pipelines due to falling rocks. Consideration should be given to moving the stockpile edge back and/or reshaping the stockpile in this area to reduce the risk of this occurring. This work

would logically be carried out at the same time as any work to increase the width of the corridor in this area as recommended in section 3.3 above.

4.8 Current developments

Ongoing current developments which impact either directly or indirectly on the tailings corridor are as follows:

- New 500 mm Polyethelene sections are being installed in the process water transfer lines between the tailings dam and Pit 1. This is due to the original sections having been damaged by fire apparently caused by the burning of bolts to break a flange connection.

4.9 Environmental

The roles and responsibilities of the ERA Environmental Health and Safety department in respect of the tailings corridor are briefly summarised in section 4.1. There were no specific issues in this regard which came to light during the review investigations

5 Anticipated future developments

There are no currently anticipated future developments which it is envisaged will, either directly or indirectly, impact the tailings corridor during the operating life of the mine.

6 Discussion and recommendations

The significant finding of this report is that, whilst there are a number of matters that need to be checked/addressed, the fundamental design and operation basis for the corridor was appropriate at the time of initial construction and operation, and is still appropriate. It has not been practical, in the time available to undertake and document this review, to follow all of the issues through to obtain full details and make final recommendations. Accordingly, in respect of a number of items, this report includes recommendations for further consideration before deciding on any action.

Whilst a number modifications affecting the corridor are recommended for further consideration, the main findings/ recommendations of the report relate to operating and maintenance practices which should be adopted for the remainder of the mine/mill life.

The review recommendations are summarised as follows primarily under the report headings used in section sections 3.3 and 4 of this report.

6.1 Suitability of key aspects of the original design

- Investigate the widening of the western end section of the corridor where the 500 mm polyethylene pipes run in the drainage trench in order to reduce the risk of a pipe leak resulting in contaminated water falling outside the corridor embankment. Incorporate an examination of the other potential impacts of the polyethylene pipe routing noted in this report as part of the review.
- Obtain and review the particle grade and impermeability etc specifications for all main and branch corridor coverings to confirm their acceptability with respect to prevention of seepage/leakage from the corridor.
- Specifically review all areas where the original corridor base material has been significantly disturbed/altered to ensure that the cover now provided is adequate.

- Review the design of the recently completed corridor concrete cover modification carried out at the retrofit culvert location for the south waste run off.
- Obtain and review the corridor sump overflow details to ensure that the overflow capacity is adequate

6.2 Inspection, operating, maintenance and development regimes and responsibilities

- Prepare a fully updated formal routine maintenance program covering all aspects of corridor maintenance and inspections including recording of maintenance and inspections carried out.
- Review the roles and responsibilities of the various departments within ERA with respect to operation and maintenance of the corridor ensure that all aspects are properly covered and confirm a regime most suited to the foreseeable remaining life of the facility.
- Undertake a review of corridor related drawings to ensure that a fully representative set of updated drawings is available.
- Review and confirm the procedure for advice to Engineering Technical Services Section regarding modifications affecting the currency of corridor drawing information.

6.3 Pipe materials condition/integrity

- Assemble and review all available evidence with respect to tailings lines lining condition. Based on this and specific capability and cost information on internal inspection techniques, review the justification for undertaking an investigation of the tailings lines polyethylene lining condition.
- Progressively strip and paint the pipe ends on the process water return line to prevent deterioration of the pipe ends and reduce the risk of joint failures

6.4 Pipes support

No specific recommendations in respect of pipe supports have arisen out of the review.

6.5 Pipe jointing

- Carry out a survey of flange bolting to ensure that all bolts are adequately sized.
- Carry out a visual inspection for deterioration of bolts etc of all joints which were buried up until recently.
- Check and properly fit guards on all flange joints.
- Emphasise in procedures and to maintenance staff the importance of careful handling of pipes/pipe ends during assembly of victualic coupling joints especially on the non lined process water return line. Provide documentation and training via the maintenance system.
- Ensure that the manufacturers instructions for installation and maintenance of the couplings are included in the standard maintenance procedures for these activities.
- Ensure that manufacture/supply quality continues to be ensured in any future purchases of victualic couplings.

6.6 Redundant pipework

- Identify all pipework not currently being used and establish whether or not it is or should be made permanently redundant.
- Establish a program to remove all redundant pipework as soon as practical

6.7 Maintenance of corridor

- Inspect the embankments which form the corridor enclosure to confirm that they are still as per the original design intent.
- Ensure that the corridor clean up operation recently undertaken has returned all corridor levels, drainage and other features as appropriate to original specifications.
- Document the procedure for future grading operations for the main corridor road and general maintenance of the corridor.
- Safely remove all grass and other growth which has developed along the corridor.
- Initiate and continue a regular supervised poisoning program to prevent further re-growth of grass etc along the corridor.
- As far as possible avoid cold burn-offs of grass etc growth as these place pipe jointing components and pipe linings at risk.

6.8 External threats

- Investigate options to reshape/cut back the waste rock stockpile in the vicinity of the corridor at the tailings dam end in order to reduce the risk of falling rocks damaging the adjacent corridor pipework.

6.9 Current developments

Other than as covered by the foregoing the are no specific recommendations arising out of the review of current developments.

6.10 Environmental

As above for Current Developments.

6.11 General

- Other than the routine 3 times and preferably 4 times per shift inspection of the corridor pipework, there is no automatic means of detecting leaks. Consideration should be given to installing magnetic flow meters to detect major leaks which could have a significant impact if they occurred some time before the next inspection.

Appendix A

Tailings corridor review: proposed report contents

Executive summary

1 Introduction (include definition of scope of report)

2 Overview description of existing system

- 2.1 System process and layout description
- 2.2 Design and operating philosophy

3 Review of original design

- 3.1 Original design
  - Corridor design
  - Tailings and process water pumping and piping system
  - Environmental
- 3.2 Summary of changes since the original design and construction
- 3.3 Current suitability of key aspects of the original design

4 Review of existing system and current operating, maintenance and system development regimes

- 4.1 Current inspection, operating, maintenance and development regimes and responsibilities
- 4.2 Pipe materials and condition/integrity
- 4.3 Pipe support
- 4.4 Pipe jointing
- 4.5 Redundant pipework
- 4.6 Maintenance of corridor (cover aspects such as cleaning, grading, corridor wall, design clearances etc)
- 4.7 External threats (eg stockpile encroachment)
- 4.8 Current developments
- 4.9 Environmental (if not fully covered in earlier item 4 discussions)

5 Anticipated future developments

6 Discussion and recommendations

APPENDICES

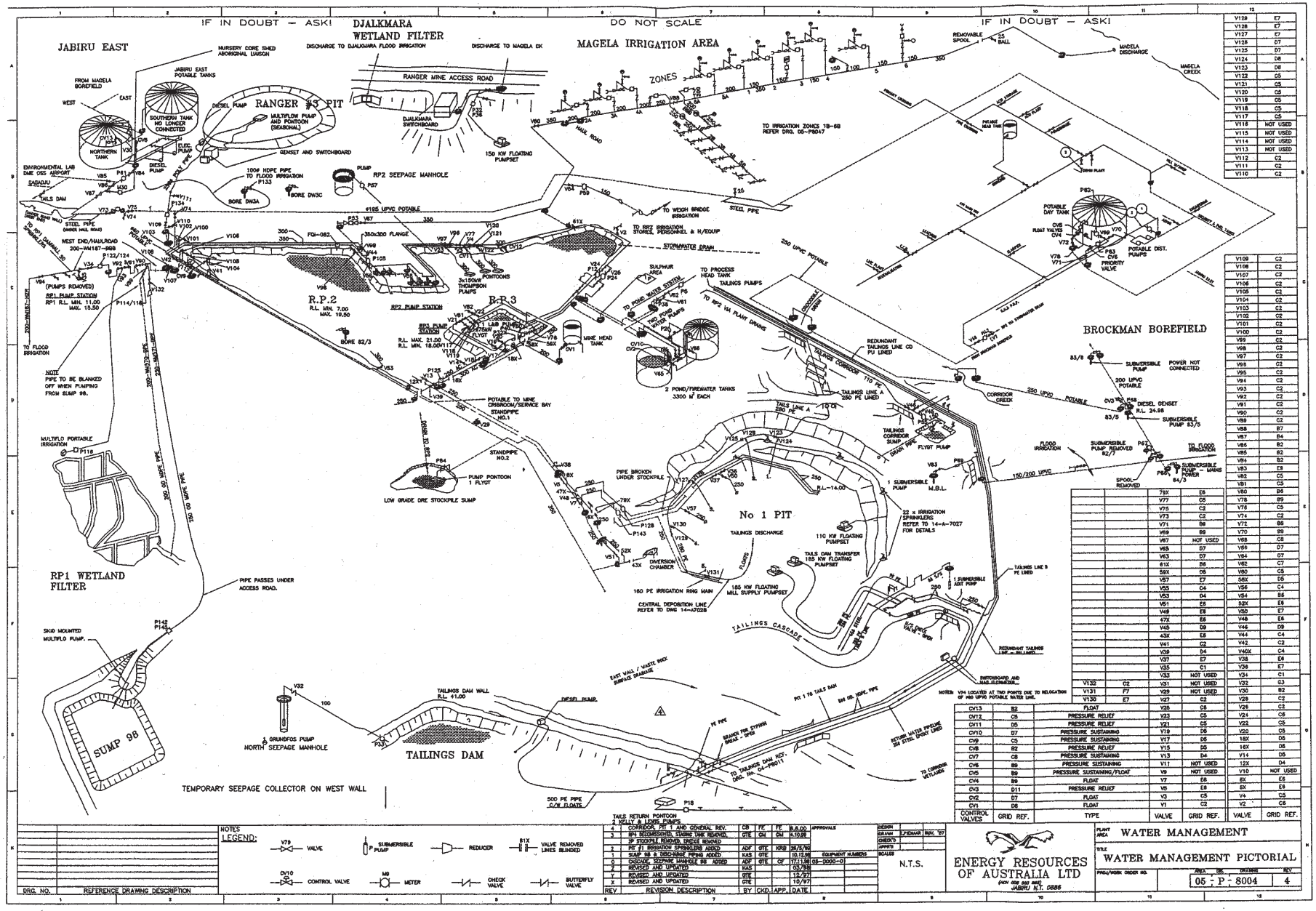
A Process flow diagram

B Schematic system layout

C Photographs

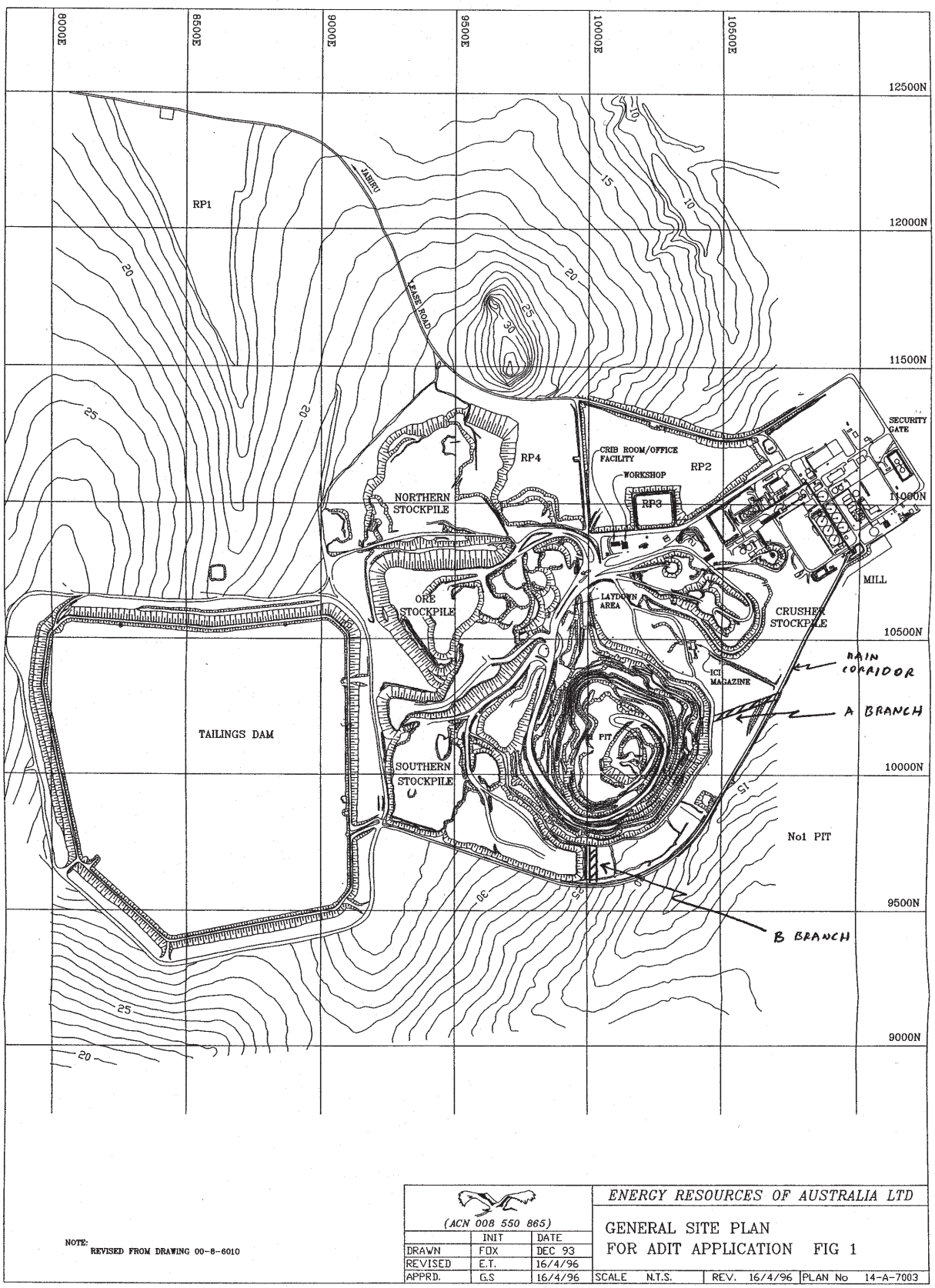
Appendix B

Water management system pictorial

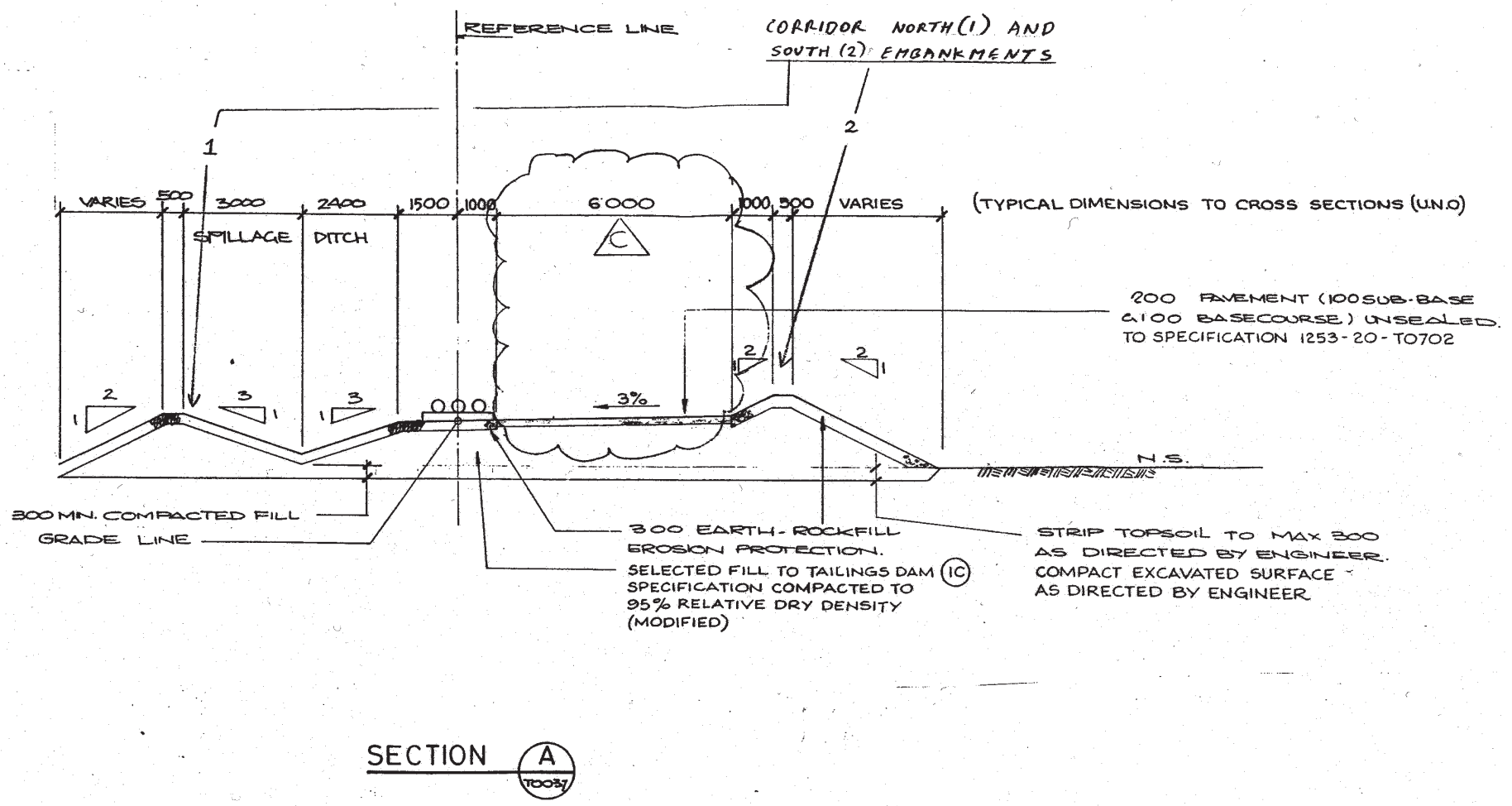

IF IN DOUBT – ASK!
DJALKMARA WETLAND FILTER
DO NOT SCALE
IF IN DOUBT – ASK!
JABIRU EAST
MAGELA IRRIGATION AREA
BROCKMAN BOREFIELD
RANGER #3 PIT
No 1 PIT
R.P.2
R.P.3
RP1 WETLAND FILTER
TAILINGS DAM
SUMP 98
TAILINGS CASCADE
TEMPORARY SEEPAGE COLLECTOR ON WEST WALL
NOTES
LEGEND:
VALVE
SUBMERSIBLE PUMP
REDUCER
VALVE REMOVED LINES BLINDED
CONTROL VALVE
METER
CHECK VALVE
BUTTERFLY VALVE
DRG. NO.
REFERENCE DRAWING DESCRIPTION
REV
REVISION DESCRIPTION
APPROVALS
EQUIPMENT NUMBERS
ENERGY RESOURCES OF AUSTRALIA LTD
(ACN 008 550 865)
JABIRU N.T. 0886
N.T.S.
WATER MANAGEMENT
WATER MANAGEMENT PICTORIAL
05 - P - 8004
4

Appendix C

Corridor Layout



Appendix D Corridor section



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