Appendix H – Hydrogeological Assessment

HYDROGEOLOGICAL ASSESSMENT OF PROPOSED NEWNES JUNCTION KAOLIN PIT

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TABLE OF CONTENTS

1 BACKGROUND

1.1 General

Newnes Kaolin Pty Ltd is proposing to mine both sand and kaolin from a proposed pit at Newnes Junction, east of Lithgow. The proposed pit will be excavated over a 20-year period to RL of 993m. The kaolin material will be separated out from the crushed friable sandstone strata.

The proposed pit site area (Figures 1-1 and 2-1) lies within hilly topography just north of the existing Rocla Quarry, which has been mining similar material since the late 70's.

This report outlines the hydrogeology of the site and makes an assessment of the potential hydraulic and water quality impacts of the proposed pit on the surrounding groundwater system.

1.2 Report Objectives

The specific objectives of this report are to:

1 Review the regional hydrogeology of the site, existing bore and water quality data and hydrogeological conditions in the adjacent Rocla Quarry.

2 Determine the potential hydraulic impacts using simplified but rigorous numerical modelling techniques.

3 Indicate possible post mining conditions and mitigation measures, if any, that could be implemented at the site to reduce impacts to a minimum.

2 HYDROGEOLOGY

2.1 Rainfall

Daily rainfall analysis from Lithgow records since 1890 to 2000 indicates an average annual rainfall of 816mm. The mean rainfall from the Newnes Forest Centre is 1072mm, no doubt higher due to orographic effects.

At Lithgow average monthly rainfall is highest during the months June to August inclusive, and lowest during February. Average monthly rainfall for the two stations is given in Table 2-1 and 2-2 below.

Table 2-1

Average Monthly Rainfall - Lithgow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
58.7	40.4	59.5	60.3	72.3	84.7	85.9	85.7	73.2	79.3	60.0	55.9

Table 2-2

Average Monthly Rainfall – Lithgow (Newnes Forest Centre)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
121.	114.	103.	79.	80.7	83.0	68.3	83.5	67.9	91.5	89.0	90.9

2.2 Topography, Drainage and Groundwater Flow System

The topography in the area is hilly. The proposed site lies inside of and along the western boundary of the Wollangambie River catchment. Within the proposed mining area the drainage is towards the east to north-east. Further west, beyond the Old Bells Line road that lies on the surface water divide, the drainage direction is to the south within the Dargans Creek catchment with elevations from about 1040m RL to 1000m RL south west of the proposed pit.

The drainage gullies in the upper part of the Wollangambie River catchment across the site are largely ephemeral with some seepages evident at lower elevations.

The proposed site area has an elevation at its centre of about 1030m RL. Along the eastern boundary the eastern corner of the site area has an elevation of about 1000m RL within a minor drainage gully that crosses the north-eastern corner of the block. The topography rises further south to about 1040m RL, and then falls away again to about 1020m RL within an easterly drainage gully. Average elevation along the western boundary is more uniform at about 1040m RL.

2.3 Geology

The mining area lies within the Triassic Narrabeen Group sandstone, shale, which is in turn underlain by the Permian Illawarra Coal Measures, comprised of coal, sandstone, shale and tuff. A representative lithological section of the entire geological layered sequence is given in the bore log of the Newnes Junction coal investigation bore sunk in the late 19 century (Figure 2-1a,b). The surface elevation of this bore, based on topographic map interpolation is at about 950m RL. The upper part of the Triassic sequence at the proposed mining site (based on exposures in the adjacent Rocla quarry) and interpolated from the bore log comprises largely a coarse grained friable sandstone with some ironstone bands. The matrix of the sandstone consists mainly of kaolin and it is this material that will be separated into product as part of the mining process.

2.4 Groundwater Distribution and Flow System

Groundwater occurs in both primary and secondary structures in the Triassic sandstone and is supplied entirely by infiltration and recharge to a shallow groundwater system in the upper sandstone. This aquifer system is distinct from additional much deeper aquifer zones beyond 100 metres and 200m or more within the coal measure strata.

At Clarence Village some kilometres to the south-west (Figure 1-1) from the proposed pit standing water levels in shallow aquifer system are in the range 12m to 64m from ground surface. Topographic surface elevations in this area are in the range 1080m to 1140m RL.

Depth to the potentiometric surface over the site area could be expected to be at a depth from ground surface in the range less than 2m to 25m. The adjacent Rocla Quarry has no doubt influenced the water table depths to some extent in the southern part of the proposed pit site area due to drawdown effects over time. The depths to water table given above however are consistent with the emergence of seepages in the lower lying sections of the drainage gullies that cross the western boundary.

The current pre-mining inferred regional groundwater flow directions, which will be largely controlled by topography across the area, and the existing Rocla quarry in accordance with well-known hydrogeological principles, are shown in Figure 2-1. In summary, the predominate groundwater flow occurs in an easterly to north-easterly direction with some groundwater flow being re-directed towards the Rocla Sand Quarry. Beyond the main western railway line groundwater would flow in a general south-westerly direction towards Dargans Creek.

2.5 Groundwater Quality

Generally the groundwater quality from the shallow groundwater system in the area is known to have low to moderate salinity. The groundwater currently being extracted from the Clarence Village bores and the Rocla Quarry would be similar to that which could be expected from groundwater inflow in the new pit. This is so since all sites lie at a depth that is within the sandstone shallow groundwater flow system in the area.

No detailed analyses are at hand from bores in the Clarence Village although water quality is reported in the bore records to be "good" in one case and in the range 0 to 500mg/L in another (i.e. low salinity). Available groundwater results are shown below in Table 2-3 as supplied by International Environmental Consultants. The analysis shows ponded groundwater with low salinity and a salinity of 1350mg/L from sampled fresh groundwater seepage.

Table 2 - 3
Groundwater Analysis Report 19/6/00

Sample Details	Ponded Groundwater - 6/6/00	Ponded Groundwater - 6/6/00	Fresh Groundwate6/6/00
to pH 3.7 (as CaCO3) mg/l	<1	<1	<1
to pH 8.3 (as CaCO3) mg/l	<1	4	20
ALKALINITY			
CO3 (as CaCO3) mg/l	4	<1	<1
HCO3 (as CaCO3) mg/l	17	6	6
OH (as CaCO3) mg/l	<1	<1	<1
Calcium mg/l	5.0	1.9	1.9
Chloride mg/l	11.0	11.0	10.0
Specific Conductance uS/cm	60	30	35
Iron (filterable) mg/l	<0.05	<0.05	<0.05
Potassium mg/l	1.5	1.4	0.9
Langelier Saturation	-0.4	-5.3	-6.0
Magnesium mg/l	0.7	0.4	1.1
Manganese mg/l	0.11	0.09	0.06
Sodium mg/l	9.0	3.7	5.4
pH	9.2	5.3	4.6
Total Sulfur as SO4 mg/l	3.6	1.8	8.7
Total Dissolved Solids mg/l	40	20	20
Total Hardness (as CaCO3) mg/l	15.5	6.6	9.2
Total Suspended Solids mg/l	10	27	1350

Data supplied by International Environmental Consultants Pty Ltd.

3 ASSESSMENT OF HYDROGEOLOGICAL IMPACTS

3.1 Proposed Pit Development

The mining operation at the new pit is currently planned over a 20-year period. At the end of this period the pit floor would be at an elevation of 993m RL[1]. During excavation the local watertable within the sandstone will be intersected, and as the pit is deepened groundwater will flow towards the mined out voids. Based on existing data the total drawdown in the pit from the initial watertable level is likely to be in the range 15m to 25m. As groundwater flows into the pit the watertable will be lowered progressively around the periphery of the pit. The drawdown will migrate outwards from the pit until it reaches an equilibrium (i.e. steady state). This will occur when rainfall recharge into the sandstone strata, within the created cone of drawdown depression, balances the inflow to the pit. Once equilibrium conditions are established further migration of the watertable drawdown will not occur once the final pit depth has been achieved.

The creation of a drawdown zone of influence will cause groundwater flow directions to be directed towards the pit. Outside of this zone of influence the groundwater flow directions will remain unaffected and unchanged from the pre-mining flow directions.

3.2 Model Simulated Impact

Drawdown Influence

A numerical groundwater model was set up to determine the extent of the hydraulic influence of the proposed pit on the local groundwater system and to long term inflow to the pit. The details and results of the analysis are given in Appendix A.

In summary, simulations were conducted to determine maximum drawdown effects by running the model to steady state conditions using a range of parameters determined from the bore data at the Clarence Village and based on experience in similar hydrogeological environments. The simulation included the combined impact of both the proposed pit and the adjacent Rocla Quarry.

The drawdown results shown in Appendix A will lead to changing groundwater flow directions as shown in Figure 3-1. The results indicate also that the pit will not have any hydraulic effect on the groundwater system within the Clarence Village because it would lie outside the pit drawdown zone of influence.

Any significant drawdown influence will be restricted to within about 500m or so from the pit under maximum development. Ultimate steady state conditions will be reached within a year or so once the 20-year pit floor depth has been achieved. Note however that the drawdowns shown in the simulations are the maximum and will develop slowly to such levels over time as the mining progresses.

Drawdowns around the periphery of the pit will not affect vegetation since these species rely largely on soil moisture conditions. This is verified by the sound condition of tree species evident in the areas surrounding the existing Rocla Quarry where drawdown conditions occur.

The drawdown influence on the tributary streamflow will also be small. Some baseflow and surface water seepage will be lost to the easterly drainage gullies, but the volume would not be measurable in the lower reaches of the main draining tributaries. Any change would be well within the variations created by climatic variations.

Pit Inflow

Final pit inflow will average at about 0.2Ml/day, but the major proportion of this will be lost in evaporation from the high walls of the pit and storages

[1] Data supplied by IEC May 2001

within the floor of the pit. Note that no groundwater would exit from the pit during active mining operations since the watertable gradient will be directed toward the pit.

3.3 Post Mining

Once mining ceases the mined out pits will fill with both ground and rainfall and rainfall runoff. Filling will occur until a new equilibrium is established between the ponded water depth, evaporation and natural groundwater seepage. It would be expected that a new lake system would be finally established as regrowth occurs and natural seepage of good quality water re-enters the catchment area.

4 CONCLUSIONS

1. The proposed pit will be excavated within the upper sandstone formation. The 20-year pit floor is likely to be some 15m to 20m below the current water table. For the purposes of the assessment a conservative 30m drawdown at the pit has been assumed.

2. Numerical model analysis based on the most likely aquifer parameters and conservative steady-state drawdown simulation indicate a long-term drawdown which will not extend more than 500m or so from the high wall. Long-term pit groundwater inflows should be about 0.2 ML/day. However a major proportion of this inflow will evaporate from the high walls and within the pit floor and storages. During the latter stages of mining it is possible that water collected within the pit, should it become excessive, could be transferred to decommissioned storages within the Rocla Quarry.

3. The current Rocla quarry to the south established in the 70's indicates that watertable drawdown around the pit has not influenced vegetation species surrounding the pit as these plants rely mainly on soil moisture conditions. The drawdown has also not caused any demonstrated measurable influence in the surrounding area.

4. The pit construction will not measurably influence surface runoff and baseflow in the Wollangambie River system because of the relatively small area of the total catchment affected. Seepage from the area will in time be re-established to the catchment.

5. Water quality in any storages within the pit will be controlled largely by the incident rainfall and should be of good quality as evidenced by the water quality of the current Rocla quarry storages.

6. Post mining water storages within the proposed pit should fill to become artificial lakes with good quality water and will, in time, re-establish equilibrium conditions with the surrounding groundwater system.

5 CONSIDERATIONS

At least three monitoring boreholes should be sunk in a westerly direction at increasing distances from the western boundary of the proposed pit. It would be advisable to establish these holes prior to commencement of mining at the proposed pit area. The holes could be placed at suitable locations at say 50m, 150m and 300m to 400m from the edge of the proposed western high wall. The holes should be sunk to a minimum depth of 50m and airlift tested conducted during construction. Water level recovery measurements should be obtained during the airlift tests. The holes should be completed with 50mm slotted PVC and gravel filter and be completed as permanent observation holes with a surface concrete block and cap fitted in the usual manner.

Water samples collected during airlift operations should be analysed for the major ionic constituents to establish baseline conditions for the active and post mining period.

Water level measurements should also be conducted initially on a monthly basis in each hole over time to establish seasonal trends and then perhaps ever 3 monthly periods. This consideration is suggested not necessarily because the drawdown predicted in this report is uncertain but to have at hand the necessary data should there be any dispute about the extent of drawdown effects in the future. The result will also allow the drawdown estimates provided in this report to be verified.

6 FIGURES

APPENDIX A FIGURES

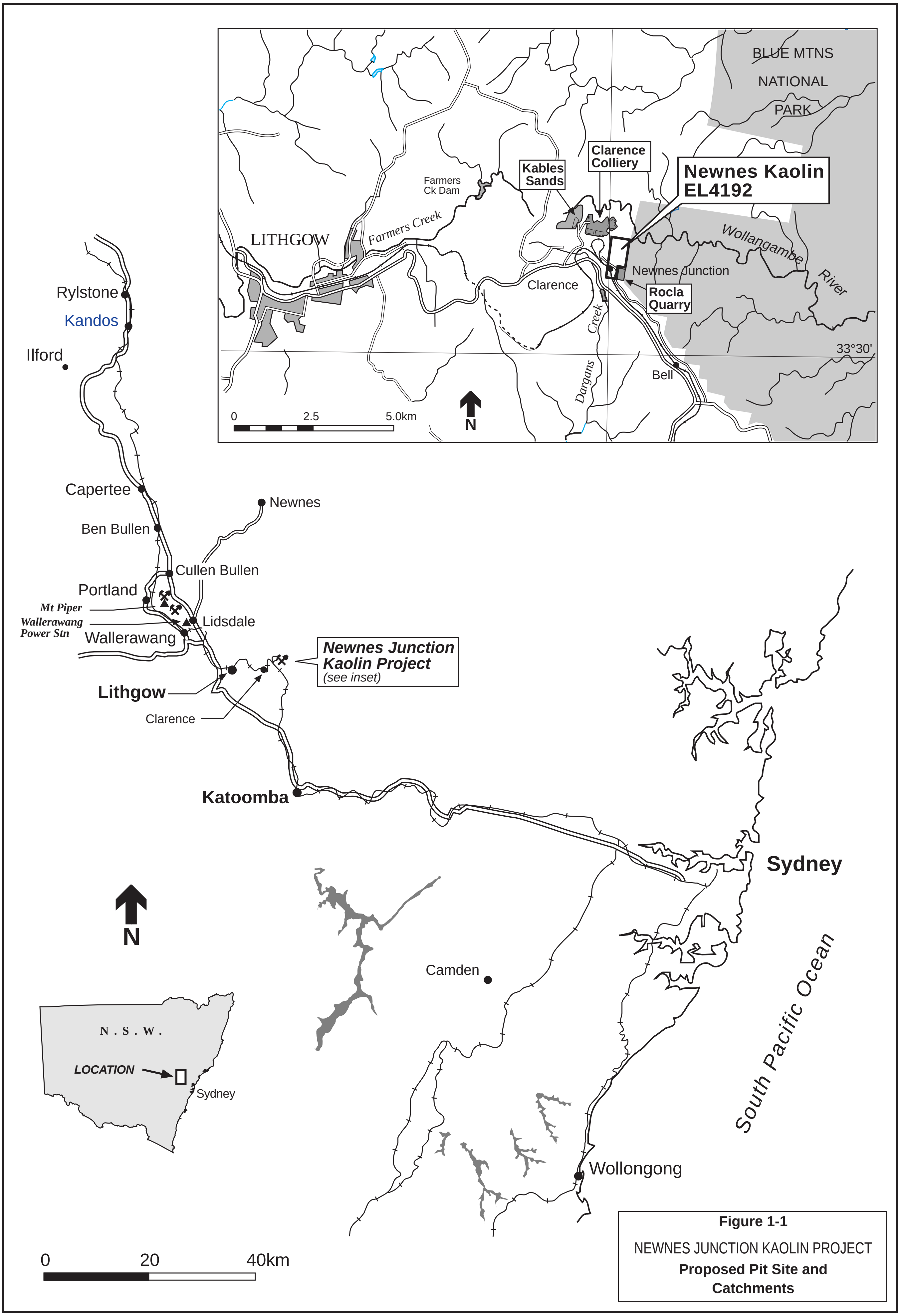
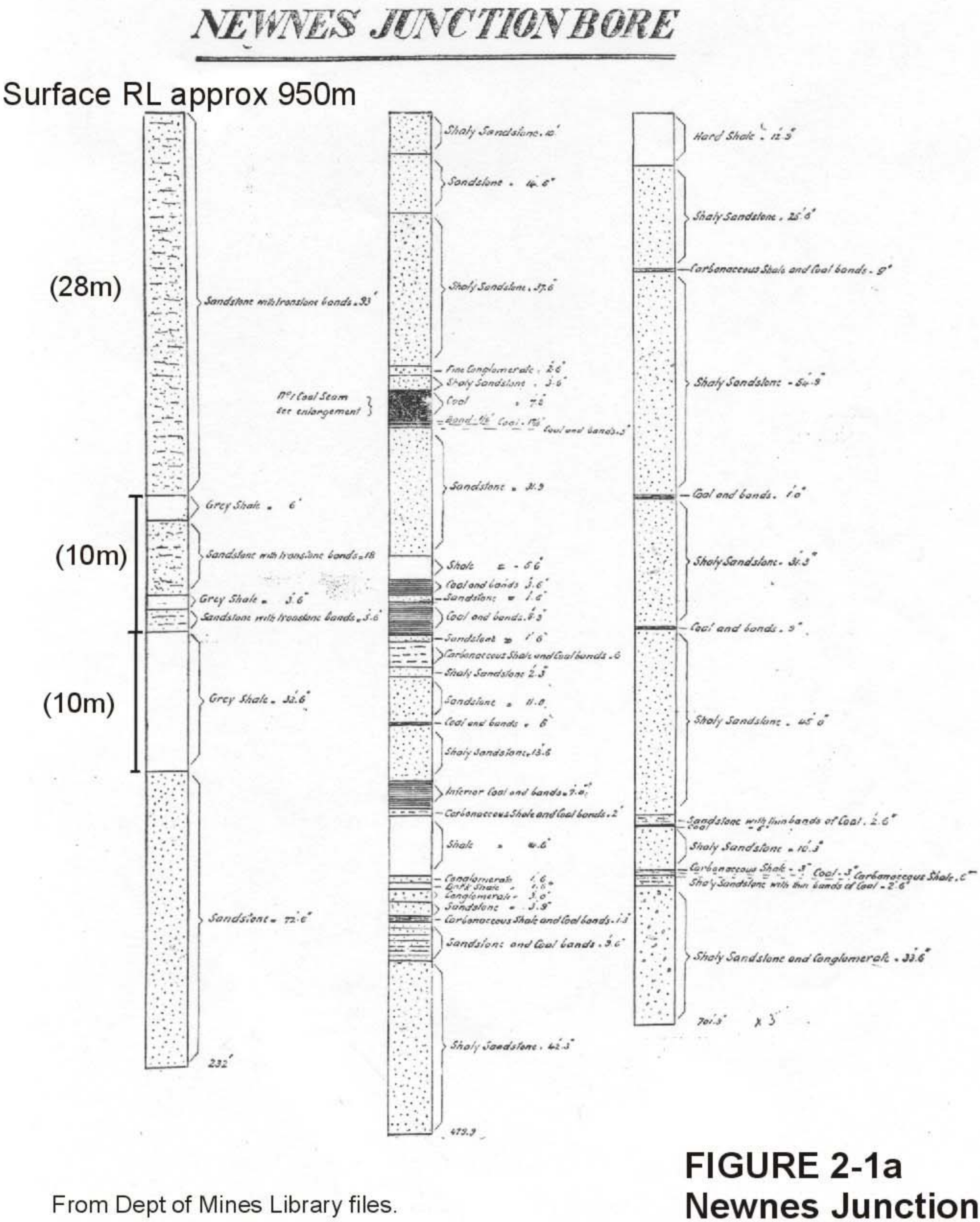


Figure 1-1

NEWNES JUNCTION KAOLIN PROJECT

Proposed Pit Site and Catchments



From Dept of Mines Library files.

FIGURE 2-1a
Newnes Junction
Bore Log

NEWNES JUNCTION BORE.

No. 1 Coal Seam.

No. 1 Analysis								
[illegible]	[illegible]	Specific Gravity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Ash
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

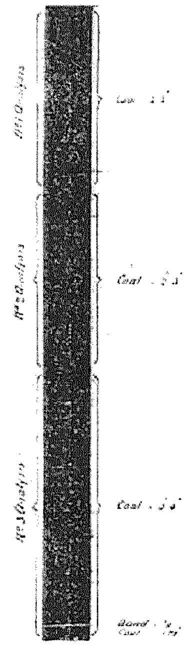
Coke — slightly swollen [illegible]
Ash — [illegible]

No. 2 Analysis								
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Coke — [illegible]
Ash — Light grey, semi-granular

No. 3 Analysis								
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Coke — [illegible]
Ash — Light grey, semi-granular



PLAN SHOWING POSITION OF NEWNES JUNCTION BORE, PARISH OF CLWYDD, COUNTY OF COOK.

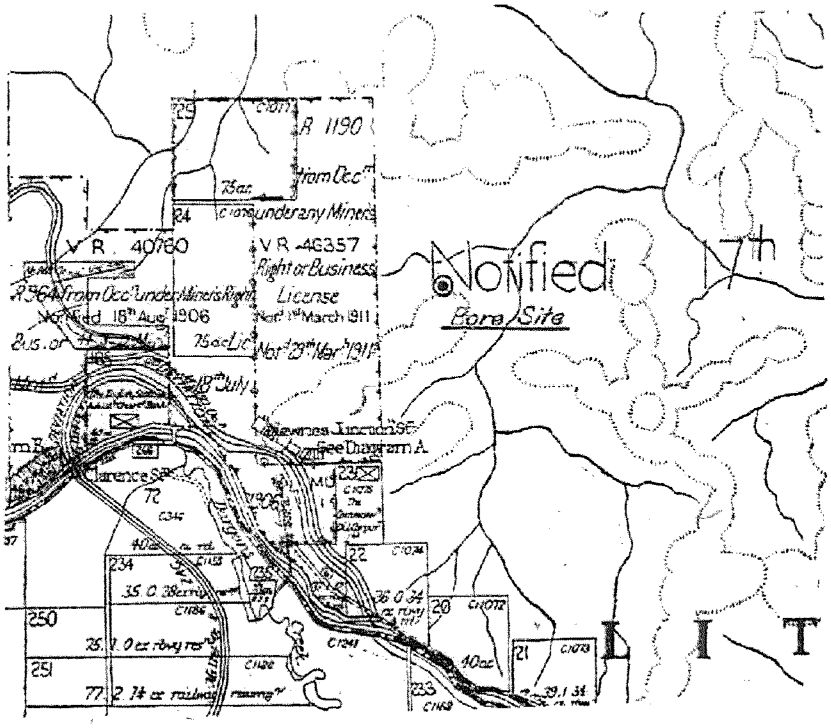


FIGURE 2-1b
Newnes Junction Bore Site

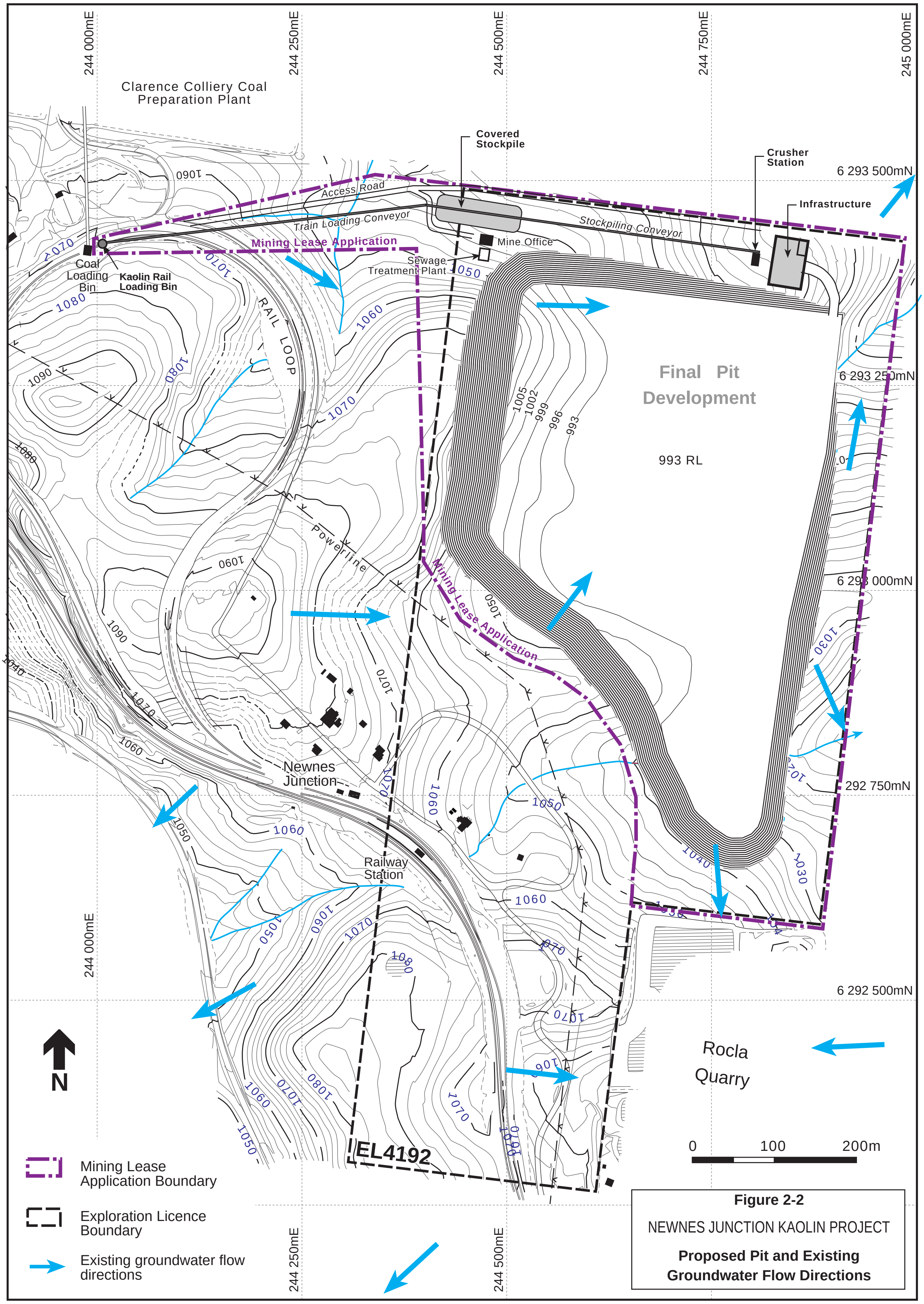


Figure 2-2
NEWNES JUNCTION KAOLIN PROJECT
Proposed Pit and Existing Groundwater Flow Directions

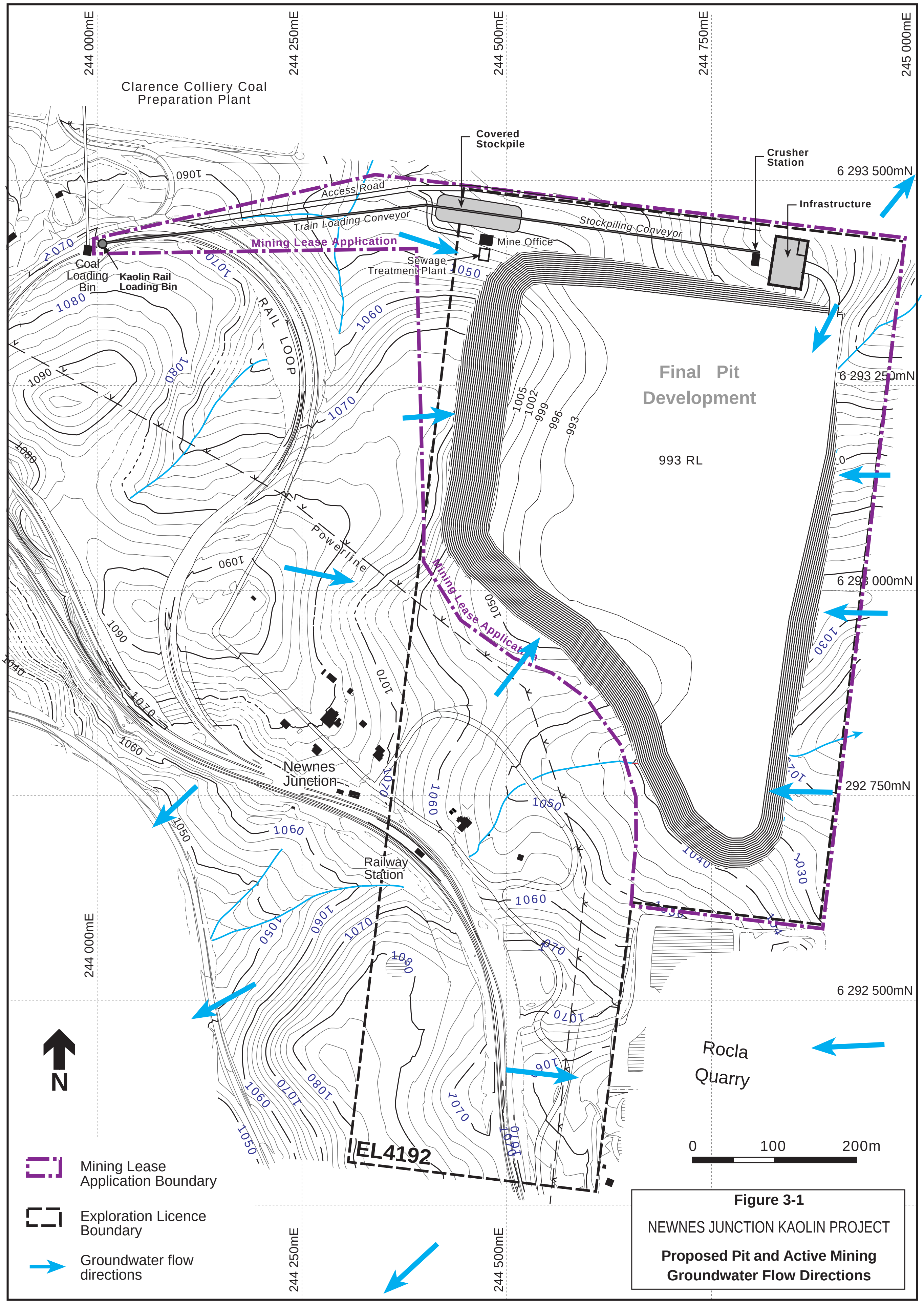


Figure 3-1

NEWNES JUNCTION KAOLIN PROJECT

Proposed Pit and Active Mining Groundwater Flow Directions

APPENDIX A

Numerical Model Assessment of Hydraulic Effects of the Proposed Pit

Appendix A

A-1 Modelling Methodology

A simplified although rigorous numerical model was set up to determine the hydraulic influence of the proposed pit on the local groundwater system and also to determine the long term inflow to the pit. The computer code used was the internationally recognised MODFLOW-SURFACT (MS) program.

The model was set up using 100 x 100 50m square cells with no flow boundaries around the edges. Transmissivities were determined from the bore data at the Clarence village using approximate one drawdown estimates. These calculations yielded transmissivities in the range 0.5 to 3.2m^2/day.

Because simulations were conducted under steady state conditions no storativity values were required. Steady state conditions are conservative because they ignore aquifer storage characteristics.

The model was run for permeabilities of 0.01m/day and 0.04m/day for an assumed saturated thickness of 80m. Average recharge for each case was assumed to be 5% and 10% of the average annual rainfall of 1000mm expressed in metres/day. The most likely situation was considered chosen to be one with a permeability of 0.02m/day and a recharge of 8%.

The surface “ponding” option was used in the MS model to prevent artificial model build up of recharge under the “no-flow” boundary condition. Under this option a flat pre-mining equilibrium watertable condition suitable for this type of simulation were set up as an initial condition.

The maximum (conservative) constant drawdown of 30m was then applied to the model pits and the model run to steady state conditions. Note that the combined effect of both the current pit and the existing Rocla quarry were included together in the simulation.

A-2 Results

The results of all simulations are shown in Figures A-1 to A-5. Note that the effect of the existing Rocla quarry south of the proposed pit has also been included in these figures.

The figures show the steady-state drawdown contours around the pit in metres. The actual water table heads created would be approximately equal to the simulated drawdown shown, superimposed on the existing long-term pre-mine watertable/potentiometric surface for the area.

Figure A-1 shows the most likely situation whilst the other figures A-2 to A-5 show the sensitivity of changing both permeability and recharge percentage. An outer 0.5m drawdown limit is shown on all diagrams, which is considered to lie within the expected accuracy of the simulation.

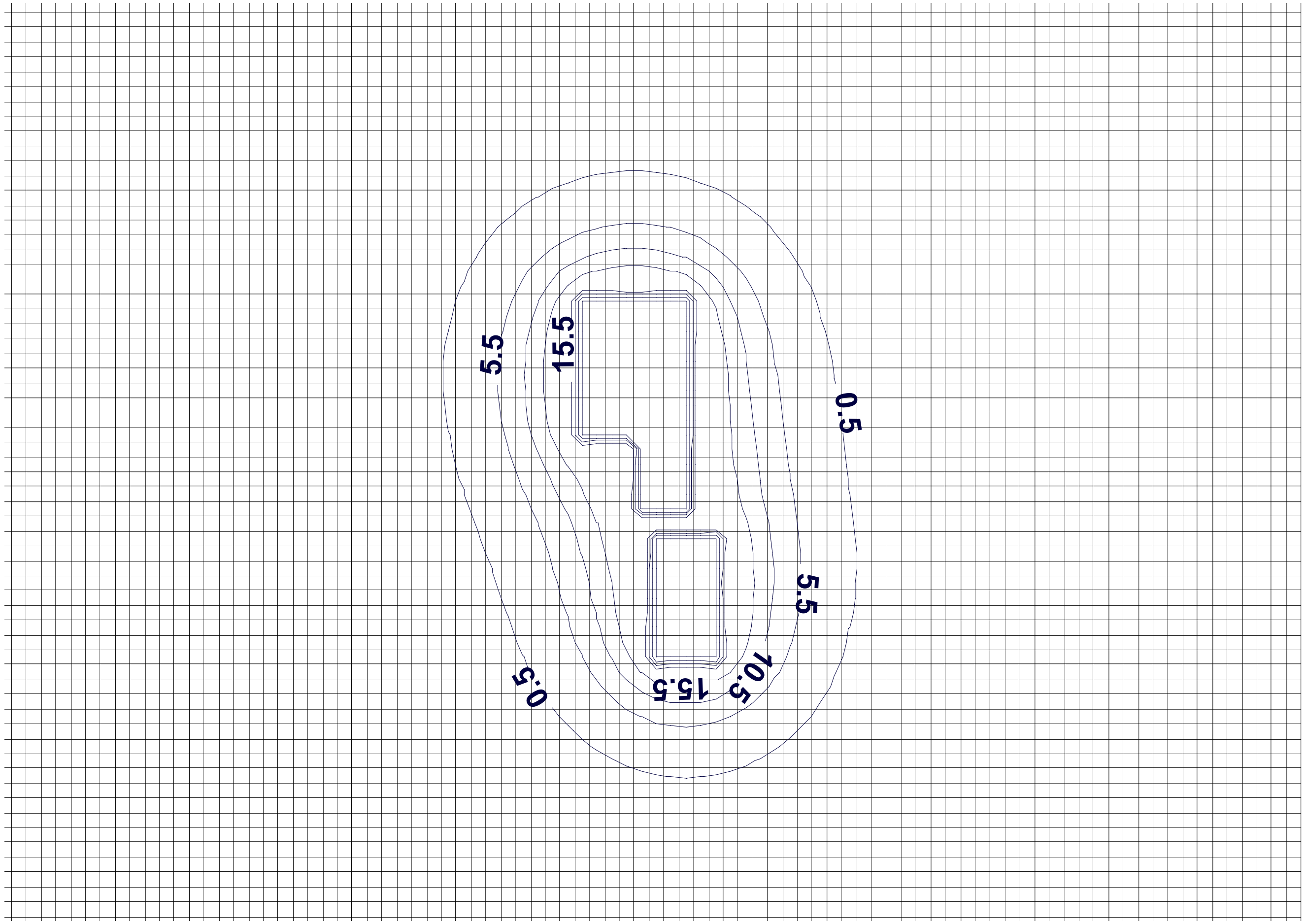


Figure A-1 Proposed Pit – Combined Maximum Steady State Drawdown Contours (m). Most Likely Situation. K=0.02 m/d. Recharge 8% of 1000mm annual.

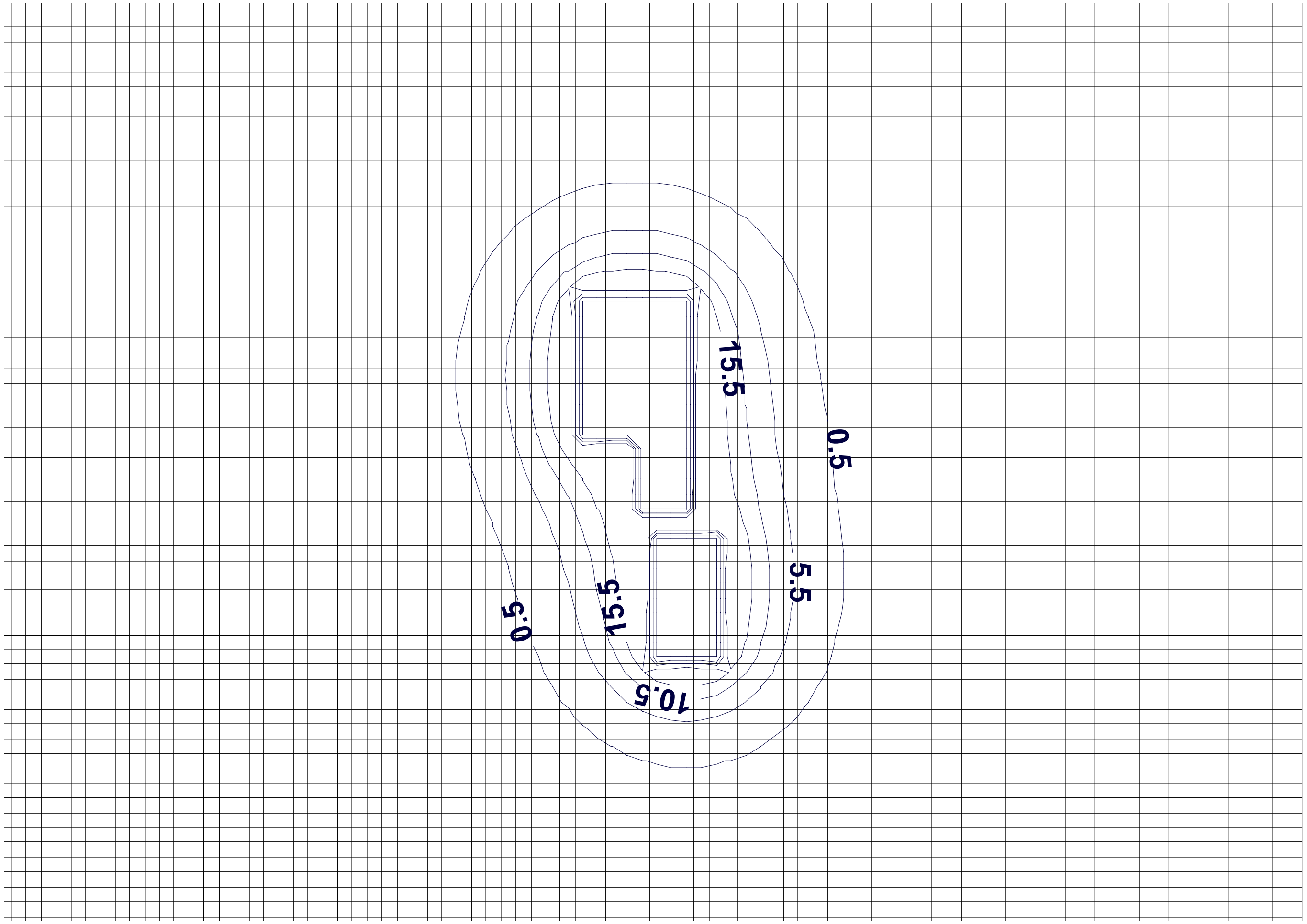


Figure A-2 Proposed Pit – Combined Maximum Steady State Drawdown Contours (m). K=0.01 m/d. Recharge 5% of 1000mm annual.

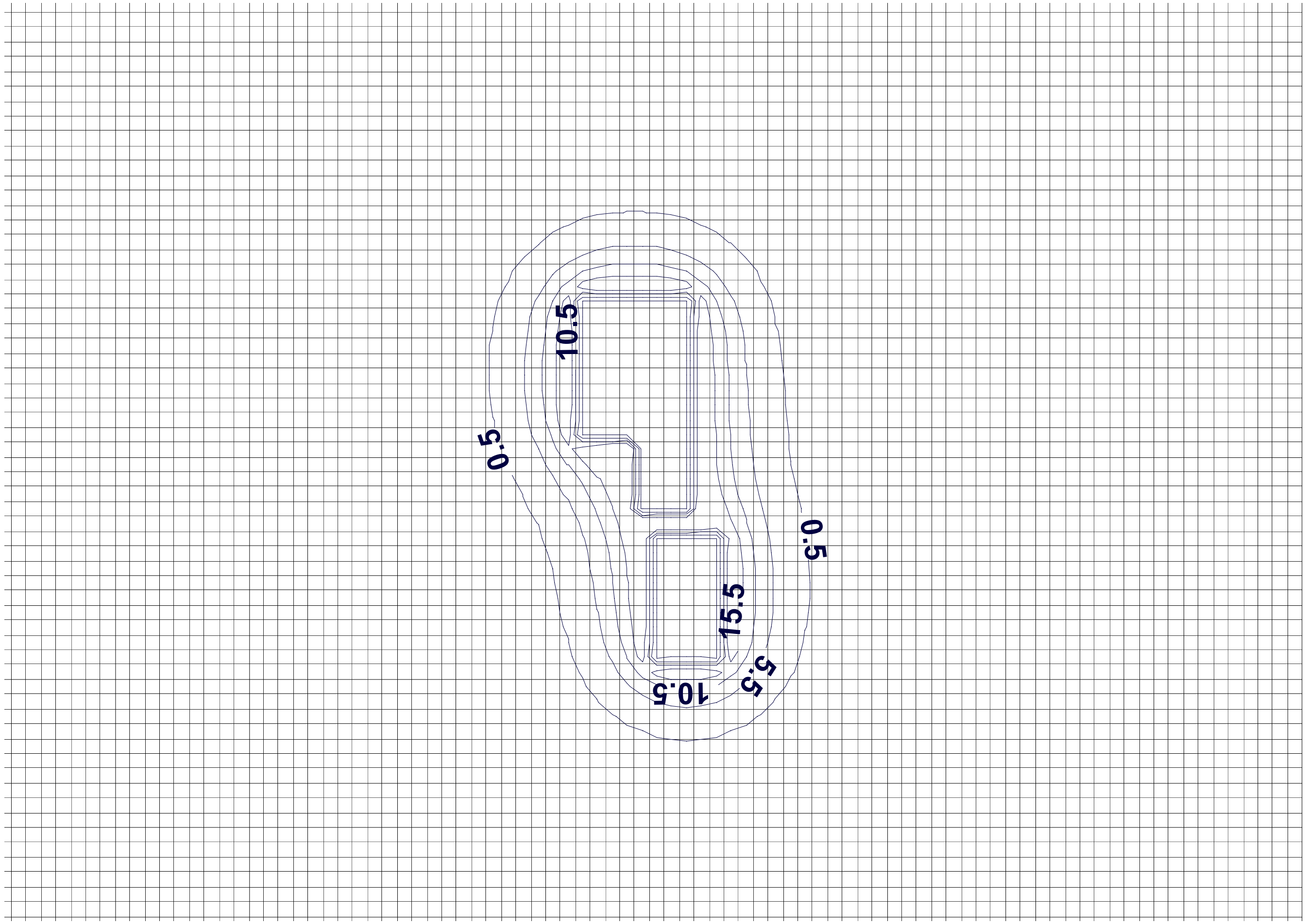


Figure A-3 Proposed Pit – Combined Maximum Steady State Drawdown Contours (m). K=0.01 m/d. Recharge 10% of 1000mm annual.

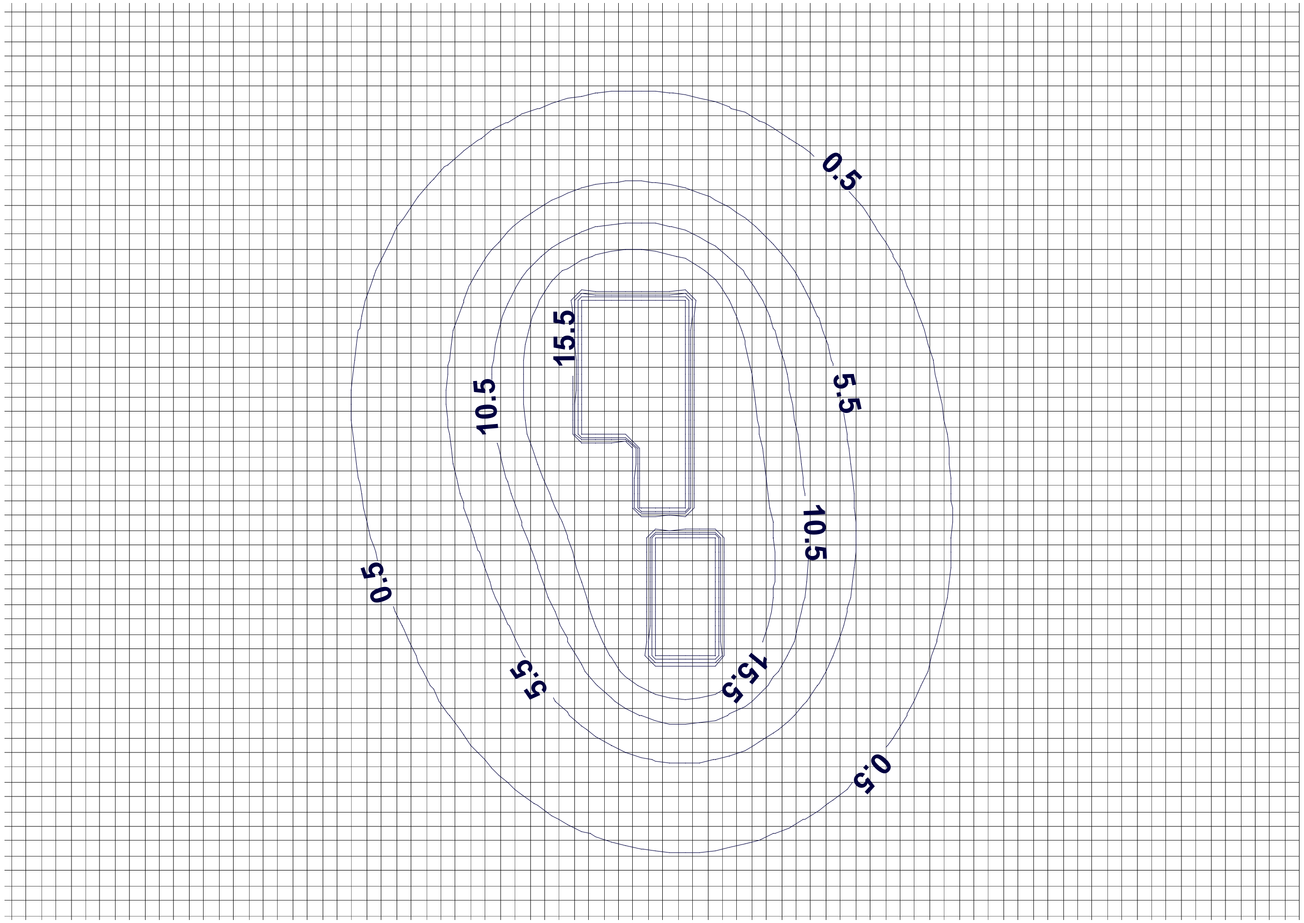


Figure A-4 Proposed Pit – Combined Maximum Steady State Drawdown Contours (m). K=0.04 m/d. Recharge 5% of 1000mm annual.

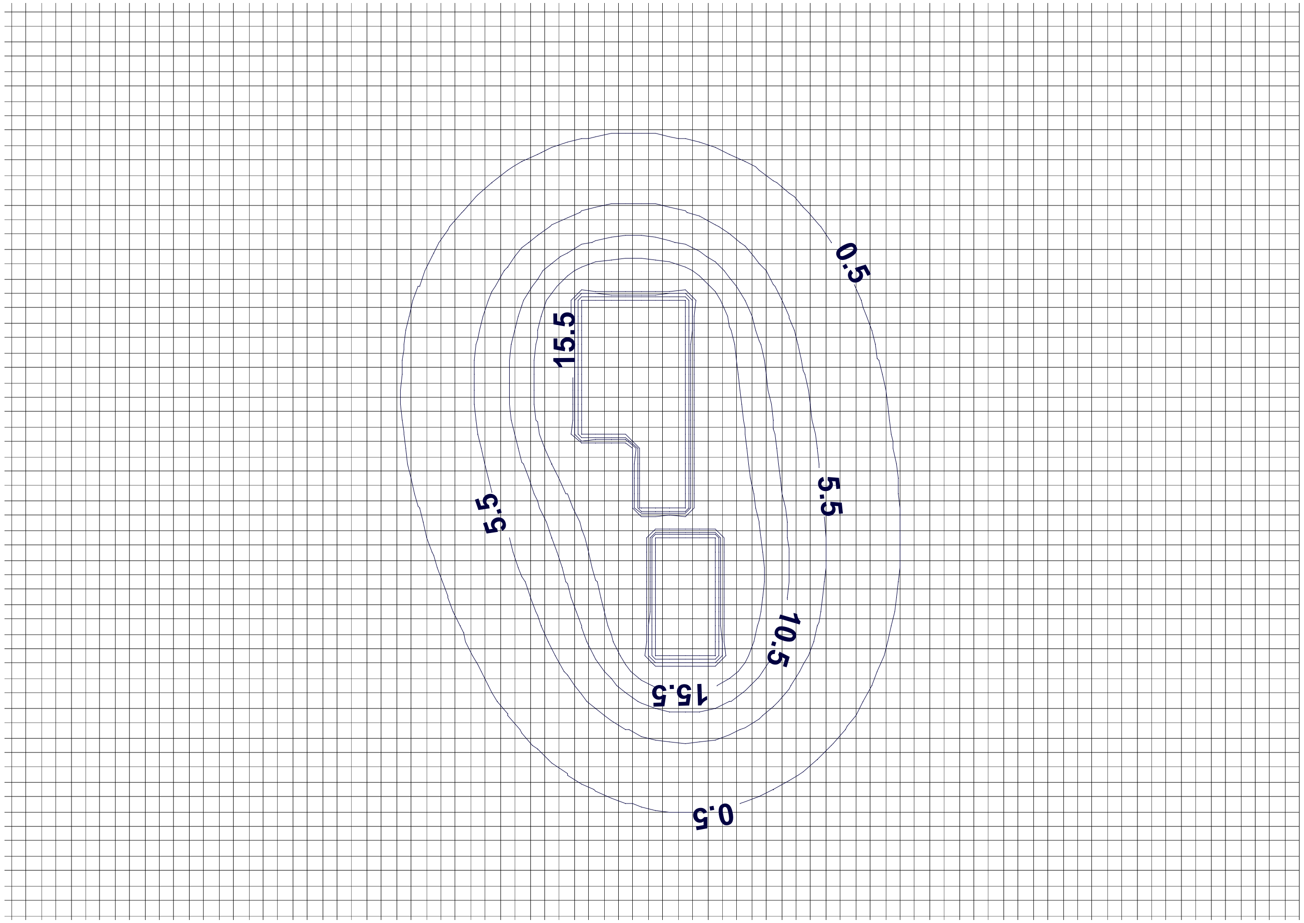


Figure A-5 Proposed Pit – Combined Maximum Steady State Drawdown Contours (m).
K=0.04 m/d. Recharge 10% of 1000mm annual.