Tropicana Gold Project

Operational Area Groundwater Assessment

Tropicana Joint Venture

Anglogold Ashanti Australia Ltd &
Independance Group NL

penningtonscott
securing your water future

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EXECUTIVE SUMMARY

The Tropicana Joint Venture has prepared a Public Environmental Review (PER) for its proposed Tropicana Gold Project (TGP) located on the western edge of the Great Victoria Desert in Western Australia. This document outlines analysis of the Operational Area groundwater issues associated with dewatering of the proposed open cut and associated infrastructure.

The proposed mining area could cover up to 400ha to maximum depth of about 420m. Dewatering will consist of pumping from several advance dewatering bores, in-pit sumps and horizontal seep wells. The pits will be constructed in gneissic rocks in the foreland of the Albany-Fraser Orogen. The basement rocks are overlain with discontinuous fluvial-glacial-lacustrine Permian Paterson Fm, which is in turn buried beneath about 30m of Cenozoic alluvium and clayey colluvium, and a veneer of Quaternary aeolian sheet sand and sand ridges.

Gravelly glacial tillite lenses at the base of the Paterson Formation appear to offer reasonable aquifer characteristics, but this unit tends to be unsaturated in the Operational Area due to its elevated position in the landscape. The Cenozoic alluvial/colluvial deposits also have relatively high permeability and storage, but these too are only ephemerally saturated during seasonal rainfall accessions. Groundwater within the Operational Area thus occurs mainly in fractures and joints in the deeper basement rock, with most porosity and permeability occurring in the lower saprolite (the zone of joint oxidation) and the underlying saprock (the zone of broken fresh rock). The lower saprolite is about 10 to 20m thick and occurs from 30 to 60 m below ground, whilst the saprock extends up to 90m below ground. Groundwater levels fluctuate between 20 and 30m below ground and tend to be saline to hypersaline. The groundwater gradient and flows are toward the Rason palaeodrainage several kilometres north of the mine.

A numerical groundwater model of the Operational Area has been constructed using the FEFLOW finite element code to simulate abstraction rates and changes to groundwater levels and flowpaths associated with the mine dewatering activities and tailings storage facility (TSF) management. Typical parameter values were used for each of the units, and the model was calibrated to measured water levels. Key findings of the numerical groundwater modelling relevant to mine dewatering are:

- The peak baseline groundwater influx will occur during excavation of the saturated lower saprolite and is anticipated to be between 3,000 and 5,000 kL/day over the first year or two of mining. Once the excavation enters the underlying saprock and fresh rock, the baseline groundwater influx will steadily decline to less than 1,000 kL/day over several years, much of which is likely to evaporate on the pit wall before it reaches the pit sumps;
- Worst case nuisance influx from unforeseen water bearing shears is unlikely to add more than 125kL/day to the baseline groundwater influx;
- The largest nuisance flow is likely to be direct rainfall influx over the mine pit from a cyclonic rain event. Adopting the 100 year ARI 72 hour storm as the worst case scenario, the direct rainfall influx could flood the lower benches of the pit with up to 600,000 kL of water. This volume of water may take up to six weeks to consume through the mill circuit at the maximum production rate of 14ML/day;

- Seasonal rainfall can also recharge the local groundwater system; temporarily increasing the baseline groundwater influx to the mine. Modelling of a high recharge event suggests that such events could temporary increase the baseline groundwater influx by up to 6,000 kL/day, recessing back to the baseline over about 4 weeks. Each such event could produce an additional 80,000 kL of mine influx above the baseline.

All dewatering discharge from the mine will be consumed in construction and mineral processing. At no stage will the TGP need to discharge surplus water to the environment.

At the end of mining, drawdowns of 1m would not extend more than 4km from the mining area, equating to a total impacted area of 25 km^2. The area impacted by more than 10m of drawdown would be confined to less than a 1.5km radius from the mining area. Much of this area lies beneath the proposed waste dumps and other disturbed mine areas. The greatest drawdowns, of up to 50m would occur within about 1km of the eastern wall of the pit.

Being located in a remote region of the Great Victoria Desert, there are no dwellings or stock and domestic bores within 200 kilometres of the Operational Area, and therefore the TGP drawdown will not adversely impact other water users. The drawdowns are also not predicted to have an impact on vegetation as there is unlikely to be any groundwater dependence in the region. A stygofauna sampling and investigation program has been undertaken by *ecologia* Environment; results suggest that no stygofauna occur within the mining area.

At the completion of the project, access to the mining area will be blocked off, waste stockpiles and TSF will be reshaped into stable landforms and surface water runoff from the waste landforms and TSF will be directed to the mining area via a series of drains. All pit dewatering will cease and water levels in both voids will gradually rebound and stabilise within 50 to 100 years at a depth of 170m above the base of the pit at Havana (or about 250 m below surface) and 110m above the base of the pit at Tropicana (or about 150 m below surface).

The salinity in each void steadily increases in a linear manner over time, with the rate of salinisation in the Havana void being slightly faster than in Tropicana. Given the high salinity of groundwater influx to the pit, the water in each void will be too saline to support native or feral fauna from the onset. The void salinities will steadily increase through evaporative concentration to become hypersaline within about 50 years.

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1. INTRODUCTION

The Tropicana Joint Venture (JV), comprising AngloGold Ashanti Australia Limited (70%) and Independence Group NL (30%), has interests in the Tropicana / Havana deposits located on the western edge of the Great Victoria Desert in Western Australia (**Figure 1.1**). In 2007 the joint venture commenced a Prefeasibility Study investigating the potential establishment of the Tropicana Gold Project and in 2008 the JV commenced the Western Australian and Federal Government assessment processes.

The Tropicana Gold Project (TGP) is comprised of:

- an Operational Area - This area contains the mine, processing plant, aerodrome, village and other associated infrastructure;
- a Water Supply Area - Two basins have been investigated, the Minigwal Trough and Officer Basin; and
- an Infrastructure Corridor - Two options are under consideration, including the Cable Haul and Pinjin Road alignments.

The proposed Operational Area includes the development of open cut pit/s of up to 420m deep; waste landforms, a carbon in pulp (CIP) processing facility; and a tailings storage facility (TSF). The TGP will extract and process up to 7 mtpa of gold bearing ore for approximately 15 years.

Pennington Scott (water consultants) was appointed to manage several groundwater components of the TGP, including mine water supply and pit dewatering. Water supply is dealt with in a separate document.

This document outlines modelling and analysis of the Operational Area groundwater issues associated with pit dewatering, potential TSF leakage and final void management, and is an input to the approval processes.

1.1 Basis of this Review

This report refers to the following available hydrogeological documents and data:

- Knight Piesold (2008) TSF report;
- URS (2007) dewatering report;
- Tropicana Gold Project exploration drilling database;
- Tropicana Gold Project Environmental monitoring database;
- Tropicana Gold Project Arcview infrastructure diagrams of the TSF and pit shell dated Sept 2008;
- Tropicana Gold Project 1m contour data for the mine area; and
- Tropicana Gold Project aerial photography, Landsat and ALOS satellite imagery;

All site works associated with the Operational Area groundwater management have been developed in accordance with design standards and guidelines contained in the following documents:

- Department of Water (2000) Water Quality Protection Guidelines No. 11 protection Guideline No. 11, Mining and Mineral Processing, Mine Dewatering;
- ARMCANZ 1997: Minimum Construction Requirements for Water Bores in Australia; and
- AS1726 – 1993: Australian Standard Geotechnical Site Investigations.

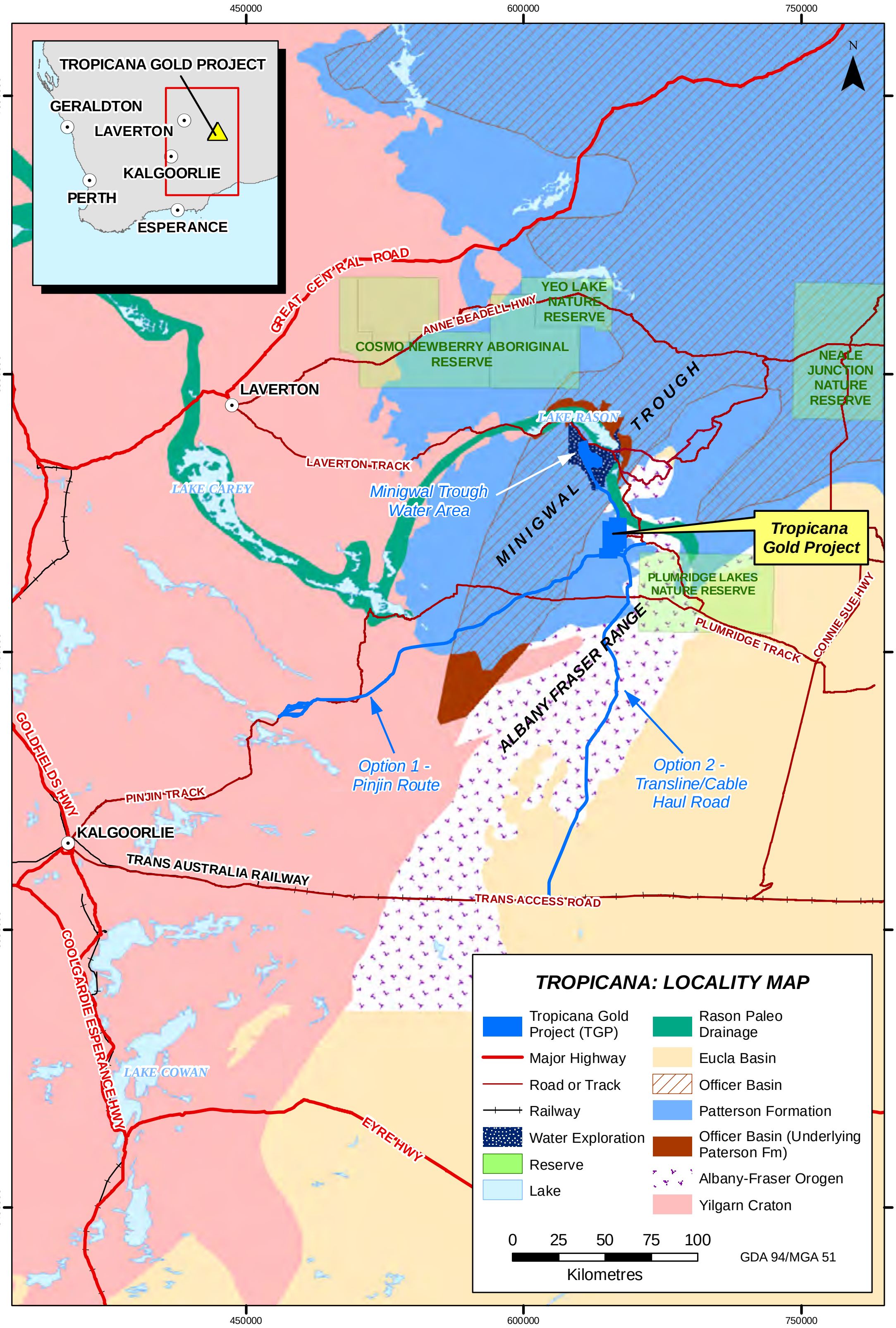


Figure 1.1: Tropicana Gold Project Locality plan

1.2 Operational Area Description

The proposed Operational Area is shown in **Figure 1.2**. The pit/s are located on a ridge line trending to the northeast with natural ground elevation of about 330 to 370 mAHD. Two main pits are proposed to be mined: the Tropicana pit to the north and the Havana pit to the south. The two pits are separated by distance of 200m with four associated satellite pits: one between the two large pits and three directly to the south of the Havana Pit.

The Tropicana pit is approximately 650m by 1400m with a total area of about 70 ha. The base level is about 50m AHD on the southwest. The larger Havana pit is 1000m x 1500m with area of about 110 ha. The Havana pit is also the deepest with a base level of about -70m AHD giving a depth of about 420m. Grades are similar to the Tropicana pit. The smaller satellite pits total about 35 ha, with depths of up to 150m. It is possible that under certain economic conditions all pits may be joined into a single mining area that is approximately 5km long and up to 2km wide in areas, covering 400ha.

The tailings storage facility (TSF) will be located directly to the northwest of the proposed mining area (see **Figure 1.2**) in the topographic low lying area, over Cenozoic alluvial/colluvial sediments. The TSF designs presented in Knight Piesold (2008) show that the TSF will be a downstream raise construction with two paddock tailings cells. The TSF will be approximately 1330m wide by 1850m long with walls to a maximum height of 24m, and will be lined with a compacted clay liner. A tailings underdrainage system will direct water to a sump where it will then be pumped to the supernatant pond, then central decant, before being returned to the plant. Maximum leakage potential from the TSF has been modelled at 180 kL/day (Knight Piesold, 2008).

Surface water management for the Operational Area has been investigated by GHD and will be managed on-site by AGAA. Rainfall at the TGP will be managed locally through cut-off drains and channels. Flows generated off-site from the up-gradient catchment will be intercepted, impounded and disposed of via evaporation and infiltration.

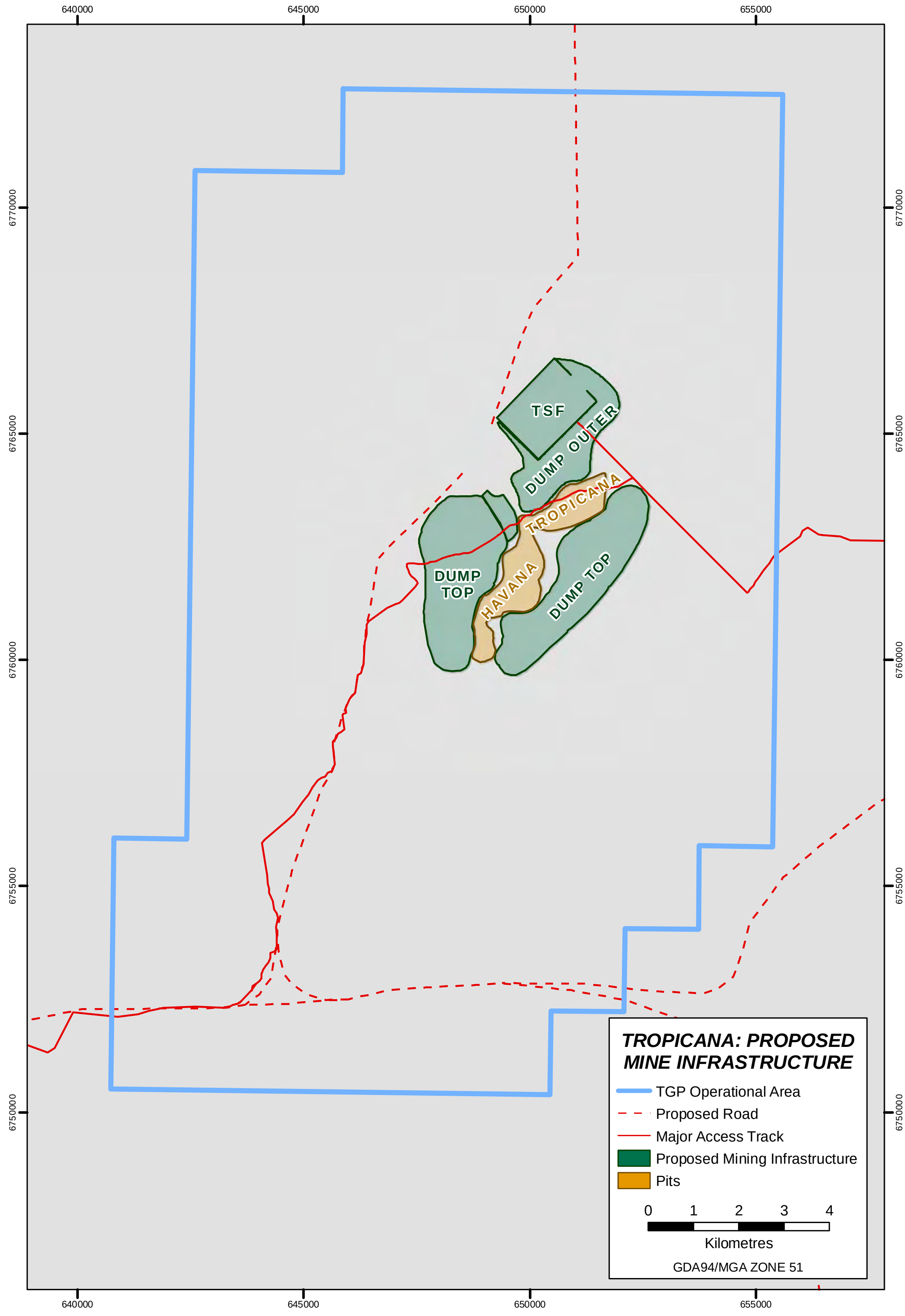


Figure 1.2: Operational Area infrastructure layout

2. HYDROGEOLOGICAL SETTING

2.1 Climate

The Great Victoria Desert is characterised by an arid climate, with hot summers and cool winters. Summer maximum temperatures average about 35 ^{o}C, while winter minima are around 5 ^{o}C. Annual rainfall around the Tropicana Gold Project is 200-230mm. Rainfall is related both to locally generated thunderstorms and to dissipating tropical cyclones tracking southeast. Thunderstorm activity tends to be greatest between September and December when cool airflows from the south wedges beneath humid north-westerly winds. Cyclonic activity is greatest between December and May reflecting the tropical wet season in the north of the state. Between April and September the weather in the region is influenced by cold fronts originating from the south-west or the Great Australian Bight.

These two mechanisms of rainfall generation in opposing seasons lead to a more evenly distributed annual rainfall distribution than in most of the state. Rainfall is highest in the cyclone season but only about 50% higher than in the winter (**Figure 2.1**). While relatively evenly distributed, rainfall is very infrequent with only about 30 rain days per year. Most of the annual rainfall is often received in one or two significant events, and many years have close to zero rainfall.

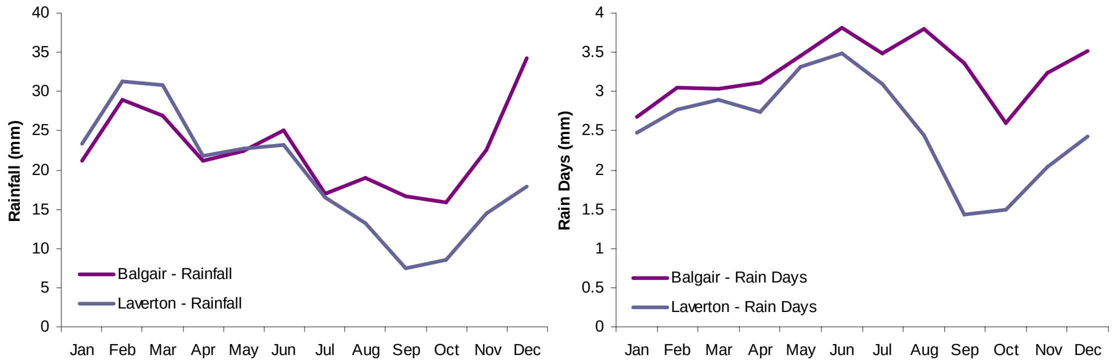


Figure 2.1: Monthly rainfall distribution at Balgair (1983-2008) and Laverton (1910-2008) about 300km to the south and west of the Operational Area respectively

2.2 Geology

Figure 2.2 shows the interpreted surface geology around the Operational Area based on interpretation of thematic mapping, bore logs, and digital elevation modelling. **Figure 2.3** shows an interpreted schematic block diagram of the Operational Area. The stratigraphy consists of at least five distinct lithological groups, namely:

- Achaean basement
- Permian Paterson Fm;
- Cenozoic alluvial/colluvial deposits,
- Cenozoic laterite weathering profile; and
- Quaternary aeolian sand dunes, alluvium and lake deposits

The predominantly gneissic Achaean basement was once incised by ancient NNE draining streams, which are now buried beneath 30 metres or more of Cenozoic alluvium and clayey colluvium deposits. The basement and Cenozoic deposits have in turn been subjected to millions of years of continuous lateritic weathering, which has created a gently undulating semi arid terrain with generally low relief. Ferruginous hard cap duricrust provides the few elevated landmarks in the form of buttes and breakaways. This terrain is in turn covered by a veneer of extensive Quaternary aeolian sheet sand and sand ridges.

2.2.1 Achaean Basement

The basement rocks belong to the Achaean-Proterozoic Albany-Frazer Province, which extends along the southern and south eastern margins of the Yilgarn Craton. The eastern part of the Albany-Frazer province, which includes the Tropicana-Havana deposits, initially formed from widespread granite emplacement around 2620 Ma.

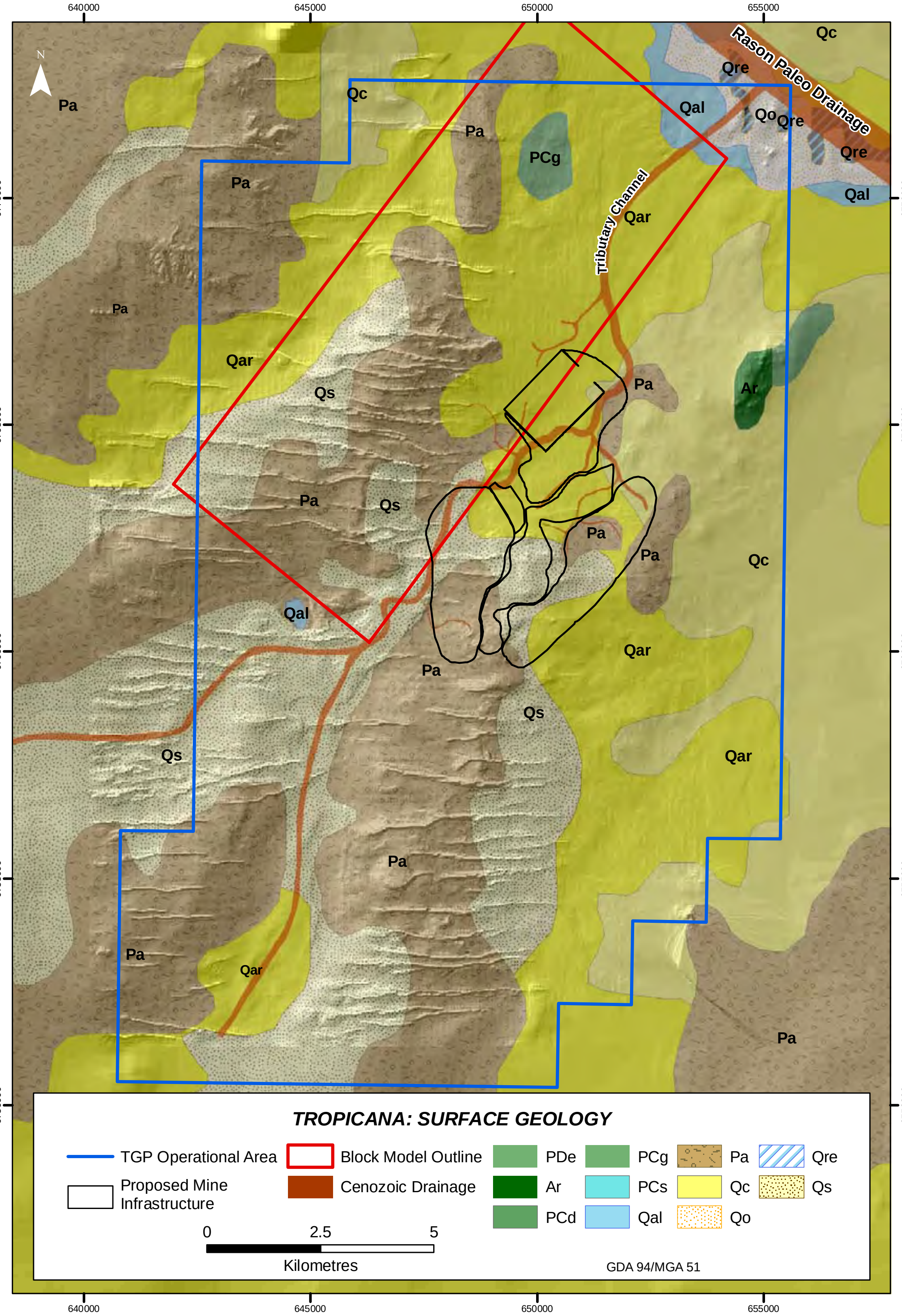
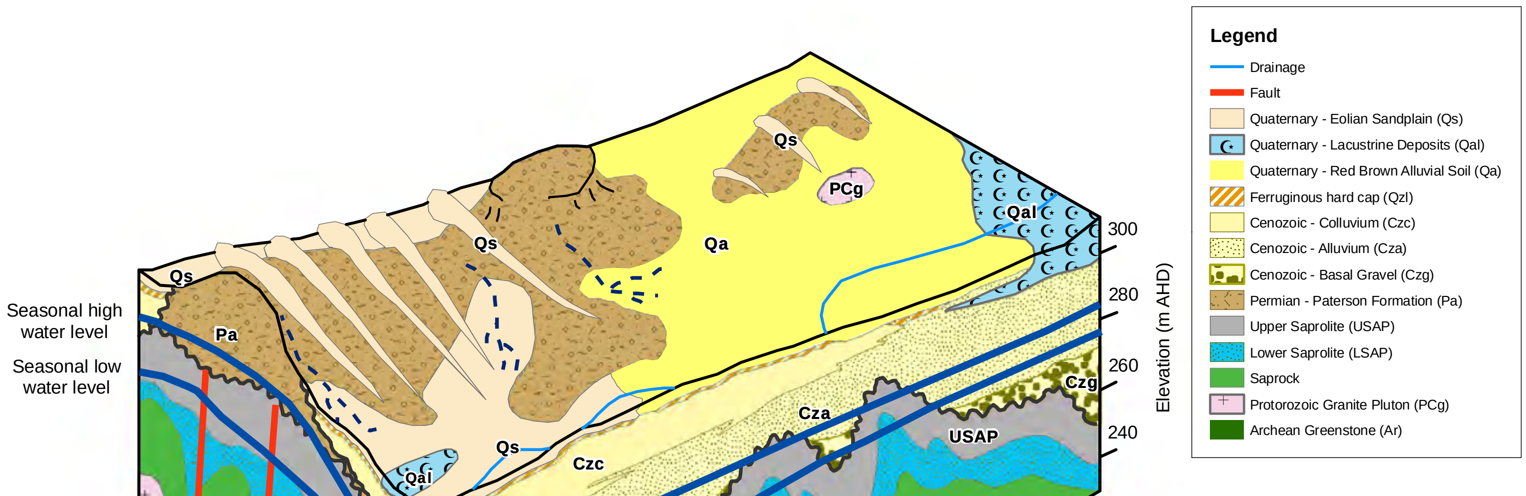


Figure 2.2: Local surface geology interpreted from thematic mapping



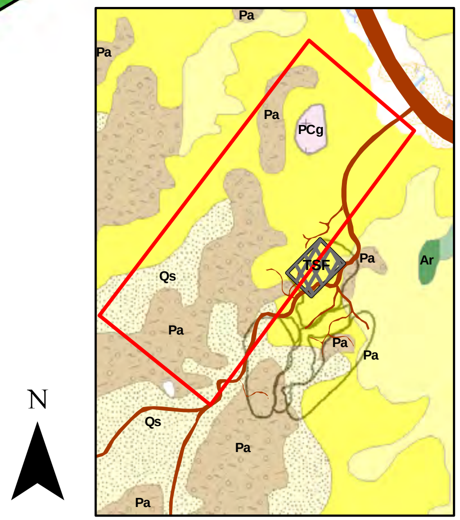


Figure 2.3: Schematic block diagram of geology and hydrogeology

2.2.2 Permian Paterson Formation

The Paterson Formation is a mixed glacial, fluvial-glacial, and glacial-lacustrine sequence with a maximum thickness of about 100 m deposited during several advances and retreats of the Gondwana continental ice sheet during the Late Carboniferous to Early Permian ice age (~300 – 250 Ma) (Lowry et al., 1972). It is overlain by Cretaceous deposits of the Eucla Basin in the south, and often outcrops at breakaways. The formation unconformably overlies both the Officer Basin and older formations, or crystalline rocks where it on-laps the Yilgarn Craton and Albany-Fraser Orogen.

Within the Operational Area, the Paterson Formation appears as a cover of weathered and lateritised white porcilinised clay and gravels, stranded on the elevated ground.

2.2.3 Cenozoic Deposits

Until recently the Cenozoic era was divided into the Tertiary (65 to 1.5 Ma) and Quaternary periods (1.5 Ma to present). The Tertiary was in turn subdivided into the Palaeogene and Neogene sub-periods. Following international convention, Geoscience Australia has promoted the two sub-periods into Periods and the term “Tertiary Period” is no longer to be used. Due to a lack of reliable field age dating information, sedimentary deposits that were previously assigned to the Tertiary Period are herein assigned to the Cenozoic era.

Cenozoic deposits (65 Ma to present) form an extensive but relatively thin cover over the majority of the region, but most notably within in the Rason palaeodrainage. The Rason palaeodrainage is best developed in the Minigwal Trough and Eucla Basin where it can be over 100 metres thick and several kilometres wide, but where it crosses the elevated Albany-Fraser Range the drainage narrows to less than 300 metres wide and becomes an incised meander valley with less than 40 metres of alluvial/colluvial deposits.

Apart from the main Rason palaeodrainage valley, there are several subregional surface catchments that feed into the drainage over the Fraser Range which also contain Cenozoic sediments. One such shallow tributary drains NNE through the middle of the Operational Area and joins the Rason drainage several kilometres to the north (see **Figure 2.2**).

Resource and sterilisation drilling of the Operational Area shows that the Cenozoic deposits comprise several metres of fluvial infill, thickening to about 30 metres in the central tributary area. The Cenozoic deposits are mostly a mixture of fine grained interbedded silty and clayey fluvial and lacustrine deposits; however, several drill holes intersect 3 to 5 m of gravel at the base of the tributary, which comprises medium to coarse quartz sand with occasional clayey rounded quartz pebble gravel.

The contact between the Cenozoic and Paterson Formation is difficult to distinguish since one is the reworked product of the other and therefore both appear compositionally the same. Furthermore, subtle sedimentary textures are now obscured by Cenozoic lateritisation. Much of the Paterson Formation may have previously been mapped or logged as Tertiary (Cenozoic).

2.2.4 Cenozoic Laterite Weathering Profile

The surface formations have undergone significant weathering and digenetic alteration throughout the Cenozoic Era, developing a deep lateritic soil profile that extends up to 90m depth. Typical characteristics of a laterite profile are shown in **Figure 2.4** and are discussed below.

The top few metres of the soil profile is an aggressive leaching zone in which tannic and carbonic acids from plant activity leach away relatively immobile haematite, goethite and silica minerals leaving behind friable red brown loam and hard pan soils (Qr) and red brown alluvial loam (Qar). The iron and silica, however, doesn't move far; tending to re-precipitate immediately below the root zone as either concretionary oolitic and pisolithic gravels around organic nuclei, or as a box work of joint coatings and liesegang. As the softer clay materials are eroded, the box works and pisolite horizons collapse upon themselves, concentrating the iron into pediments of coffee rock or gossanous duricrust, referred to the **ferruginous hard cap**. At the catchment boundaries the ferruginous hard cap is often exposed on the breakaway ridges, mesas and buttes.

The **upper saprolite** (also known as the pallid zone; the smectite zone; or the zone of strong oxidation) refers to the zone immediately beneath the hard cap where the regolith has undergone complete chemical decomposition into heavy textured clay minerals, which may display remnant rock textures. This clay can range in colour through red brown, yellow, tan or ochre staining and in extreme cases may be totally bleached white or light grey.

The transition into **lower saprolite** (the zone of joint oxidation) is characterised by a change from heavy textured clay into 10 to 20 metres of soft decomposed friable rock. In mafic and ultramafic rocks, the transition is also commonly marked by a distinctive colour change from redbrown or grey clay into greenish rock due to the Fe^{2+} oxidation state, which gives rise to the term "greenstone". However, the most obvious change commonly observed during air drilling is a sudden and significant sub artesian water strike, particularly in greenstone and banded iron formation rocks. The lower saprolite zone is the most reliable water target in a fractured rock environment.

The lower saprolite overlies hard fresh rock which can also contain open water bearing defects, particularly faults, shears and joints. The defects tend to close with depth and the prospects of obtaining significant water bearing fractures diminishes beyond 90 metres depth. This zone of broken fresh rock is referred to as **saprock**.

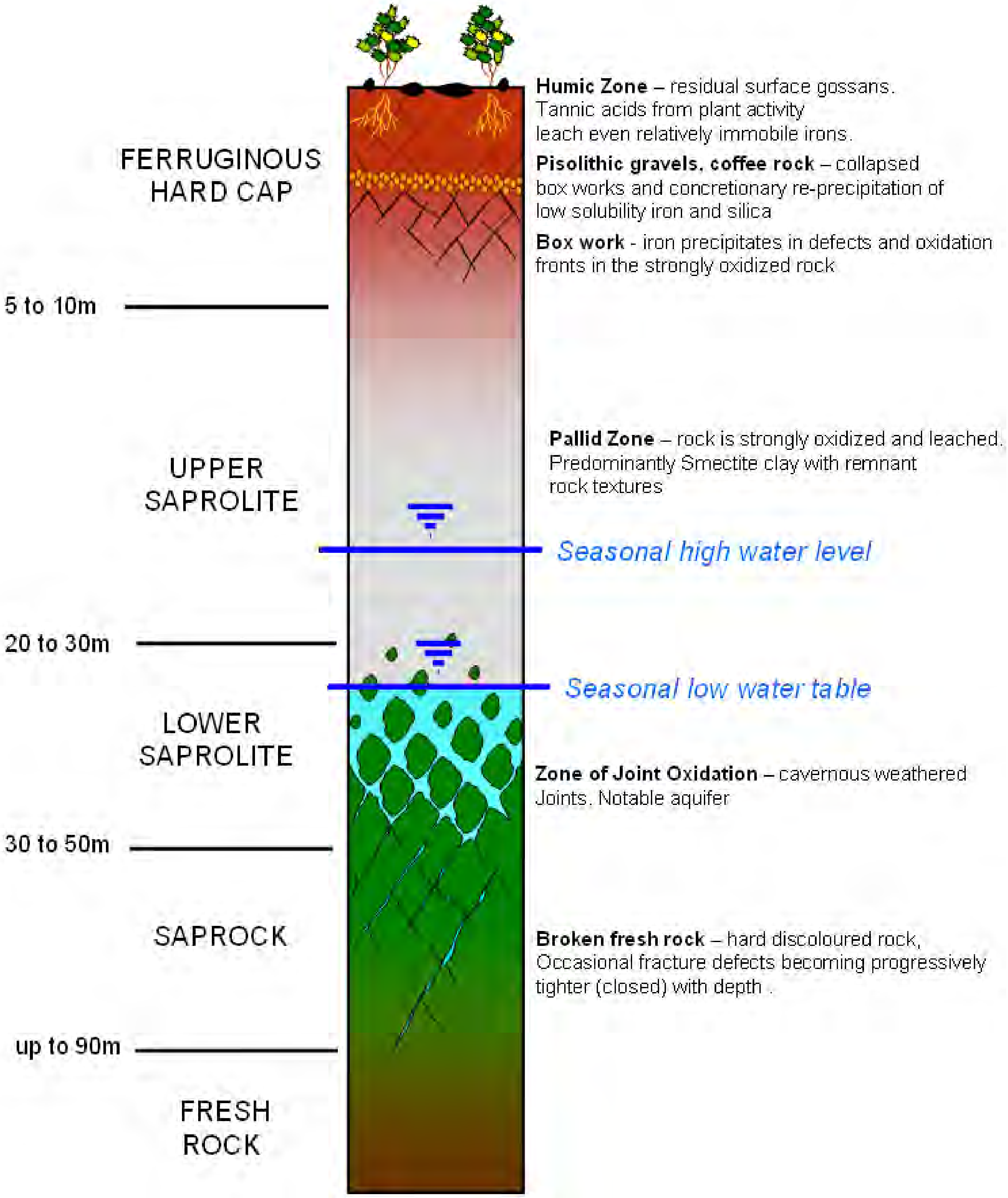


Figure 2.4: Typical laterite weathering profile

2.2.5 Quaternary Dune sand

Much of the higher hills around the Operational Area are topped by a veneer of unconsolidated sand plain and with regular W to NNW sand ridges up to several kilometres in length and between 5 to 20 metres high and about approximately 200 metres wide. **Figure 2.5** shows a typical stratigraphic profile at the crest of a hill in the Operational Area.

Sand ridges are mostly comprised of orange poorly sorted fine aeolian quartz sand with some clay. The upper 0.2m to 0.4m of the dunes tend to be relatively loose and readily excavated by shovel. However, below this depth the sand can often turn to a hard cake, presumably due to appreciable dry clay content. Of the few road cuttings and excavations through the dunes, there is evidence of macro pores in the upper few metres; remnants of shallow root systems and burrowing activities of various dunal flora and fauna.

The interdunal areas are often a veneer of one or two metres of sand sheet, but equally as often the interdunal zones are wind swept, exposing the underlying redbrown earth, colluvium or the ferruginous hard cap.

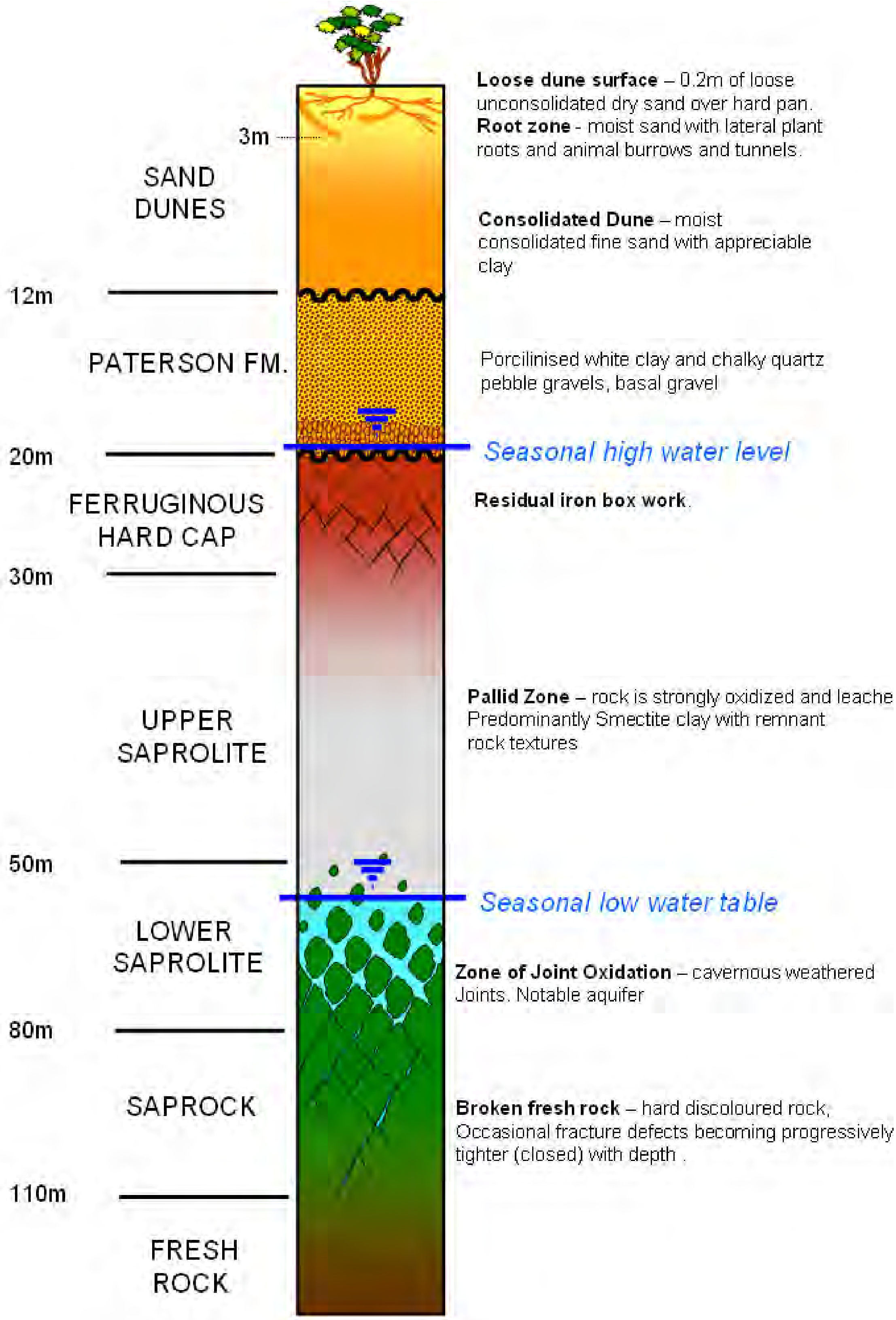


Figure 2.5: Typical hill crest stratigraphic profile

2.3 Groundwater Occurrence

Groundwater in over the Albany-Fraser Range occurs mainly in fractures and joints in the crystallised basement and in the primary interstitial porosity of unconsolidated Cenozoic alluvial/colluvial sediments.

2.3.1 Basement Aquifers

The greenstone and granitic basement rocks in the region offer low permeability and virtually no primary porosity. Water occurs in secondary porosity developed in the saprolite and in faults, shears and joints in the underlying saprock.

The upper saprolite is mostly unsaturated, but where water is struck, it normally occurs as a slow seepage zone. Being mostly massive heavy textured clays, the upper saprolite is expected to have very low vertical and horizontal permeability in the order of 0.001 m/day and virtually non existent specific yield, less than 0.1%. By contrast, lower saprolite permeabilities in the Yilgarn tend to vary between 0.2 and 10 m/day, with 1 m/day being a generally accepted average. Specific yield is problematic to determine accurately in an anisotropic aquifer such as saprolite, but a bulk value of 1% is considered a conservative estimate. While the underlying saprock can also contain open water bearing defects, it tends to be an unreliable and unpredictable water target.

Attachment A shows interpreted cross-sections of the saprolite profile every 200m through the pit and TSF based on interpretation of almost two thousand resource drill holes. The saprolite profile is recognisable in most resource holes, however reference to these figures shows that the elevation and thickness of the units is highly irregular, apparently being disrupted by local land features, local faulting and geological changes.

The yield from bores drilled into the fractured rocks is highly variable, ranging from 5 to 150 kL/day. Although occasional high yields of 500 kL/day can occur, these yields tend not to be sustainable due to the limited aquifer extents of fault and shear systems. .

Gravelly glacial tillite lenses at the base of the Paterson Formation offer significant aquifer storage and permeability characteristics, however, the unit tends to be invariably unsaturated in the Operational Area due to its elevated position.

2.3.2 Cenozoic Sedimentary Aquifers

The Cenozoic Rason palaeodrainage forms the low point in the Albany-Fraser Range. The fluvial channel infill deposits are derived mostly from reworking of the Paterson Formation and mostly comprise red brown, khaki to white clayey fine sand to sandy clay with low to medium plasticity. Several resource holes intersected a coarser grained basal unit which varies from a poorly graded silty smoky quartz gravel with well rounded river stones within a chalky white matrix, through to poorly graded orange medium silty quartz sand.

An extensive network of monitoring piezometers and several bores have been developed to support the exploration camp. Following storm events water levels in these bores rises and can partially saturate the deeper Cenozoic deposits. During these periods the higher permeability Cenozoic deposits may temporarily enhance bore yields, however for the most part of the year, bore yields are dictated by the poorer aquifer characteristics of underlying saprolite and saprock aquifers.

Although no pump tests have yet been undertaken in the Cenozoic; Knight Piesold (2008) conducted several *in situ* dual ring soil infiltration tests in unsaturated Cenozoic deposits beneath the proposed TSF. Their work suggested that the soils can have relatively high bulk permeabilities ranging from 1 to 12 m/day. It is likely that these permeabilities reflect near surface lateral macro pores. The vertical permeability, however, is more likely to be similar to that hard pan clay, being in the order of 10^{-3} m/day.

2.4 Groundwater Flow

The continuous monitoring of water levels in 40 saprolite piezometers in the resource area has been undertaken monthly for a period of nearly two years. This data suggests that groundwater levels in the upland Cenozoic deposits can fluctuate several metres over the course of the year, but for the most part gravel lenses at the base of the buried tributary channels act as effective drains, keeping the water table mostly below the base of the Cenozoic. **Figure 2.6** shows the interpreted dry season water table in the Operational Area based on measured piezometer water levels and assuming the water table in the Rason palaeodrainage is about 5 m below surface. Reference to this figure suggests that regional groundwater flows through the Operational Area generally follow the topography, draining from the southwest towards the Rason drainage to the north-northeast. The water table within the Rason palaeodrainage appears to be almost flat, suggesting that there is negligible flow along the Rason Drainage over the Albany-Fraser Range and virtually all water is evaporated in the chain of lakes in the central drainage area

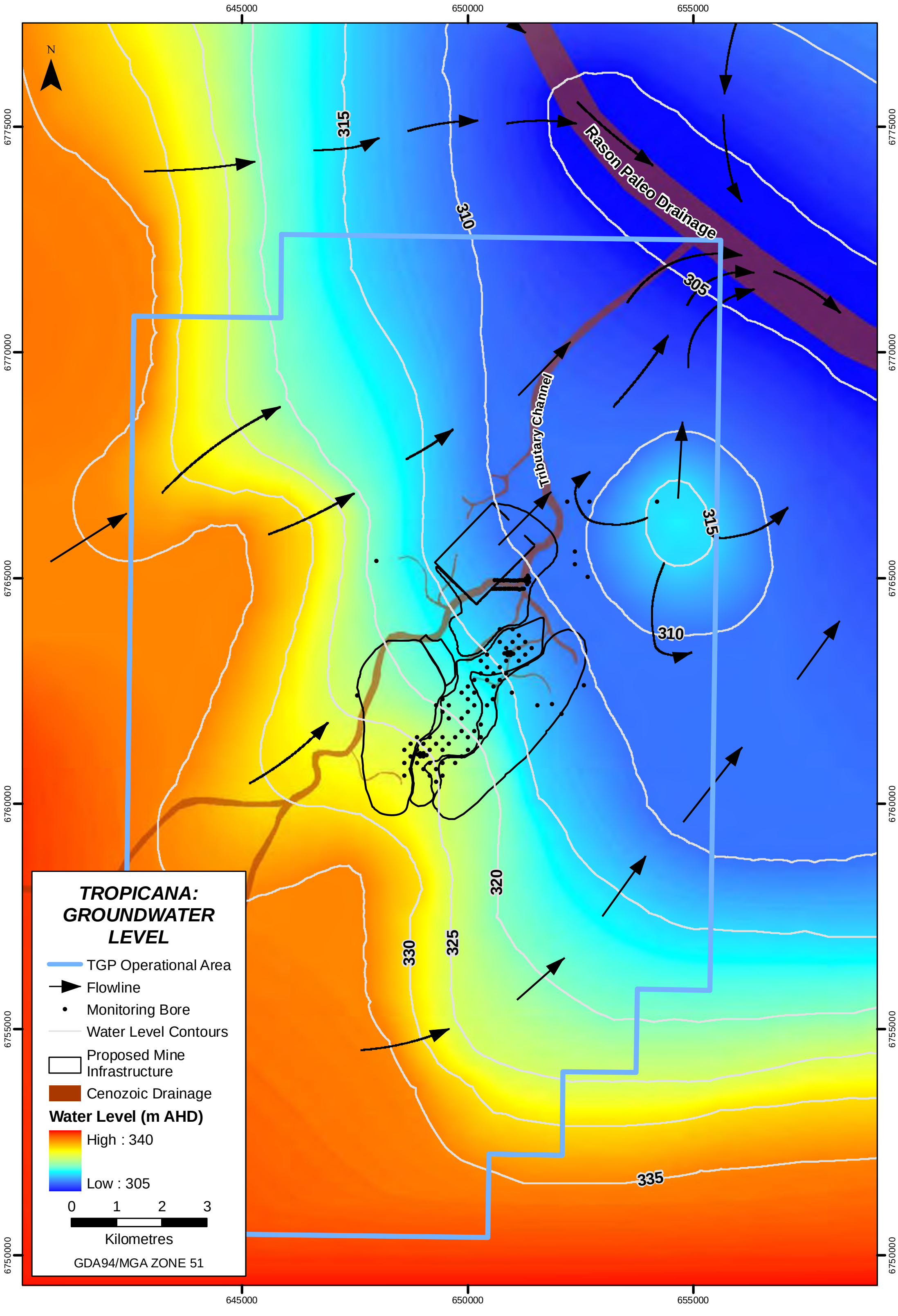


Figure 2.6: Interpreted regional water table

2.5 Groundwater Recharge and Discharge

Groundwater recharge over the Albany-Fraser Range is likely to be extremely low due to the low rainfall rates over the Great Victoria Desert. Recharge, when it occurs, follows rare extreme rainfall and flood events associated with tropical depressions (usually ex-cyclones) that pass over the region.

Accurate estimation of recharge rates is always problematic, but a commonly used approach is the chlorinity method. The approach is based on the assumptions that: chloride is a non-reactive element in the environment; the main source of chloride is marine salt contained in rainfall; and any elevated chloride levels (above rainfall levels) are due to evaporative concentration in the soil prior to recharge. Chloride concentrations are dependent mainly on distance from the coast in the direction of prevailing winds. Studies by CSIRO of typical chloride levels contained in rainfall through Western Australia have shown rainfall in the western Yilgarn to contain between 8 and 12 mg/L (Hingston and Gailitis 1976). The freshest quality groundwater in the Operational Area has chloride levels around 5,000 mg/L, equivalent to recharge rates of about 0.2% of annual rainfall or about 0.5 mm/year.

During storm events, rainfall percolates into the dune sands replenishing soil moisture lost through plant transpiration. The excess water then percolates downward through the sand dunes and underlying permeable Paterson Formation, and recharges the water table contained in the fractured Achaean basement, causing it to rise. After each recharge event the water table recedes as the mounded groundwater dissipates through permeable lower saprolite and Cenozoic sand aquifer units towards the Rason palaeodrainage north of the Operational Area. This recharge/recession causes the water table to fluctuate up to 40m seasonally at the catchment boundaries and up to 10m within the tributary valley.

During very high rainfall events, excessive rainfall infiltration can in places run along the basal contact of the Paterson formation and wash out into the valley areas causing local sheet wash scours and local ponding. The ponded water evaporates or infiltrates in the days and weeks following the rainfall. **Figure 2.7** shows an example of a sheet wash area beneath Paterson Formation outcrop immediately south of the Operational Area.

2.6 Groundwater Quality

Field salinities have been measured in 13 fractured rock bores and piezometers within a 50km radius of the proposed mine and comprehensive lab analyses have been obtained for 8 of these. Interpreted groundwater salinities are illustrated in **Figure 2.8**. Groundwater salinity ranges from brackish (lowest measurement of 12,300 mg/L) to hypersaline, with salinity grading to the Rason palaeodrainage where evaporative concentration results in the highest levels of over 200,000 mg/L. The Operational Area is located part-way along this gradient with measured salinities in bores in the proposed mining area of 20,000 to 50,000 mg/L, with an average of around 30,000 mg/L.

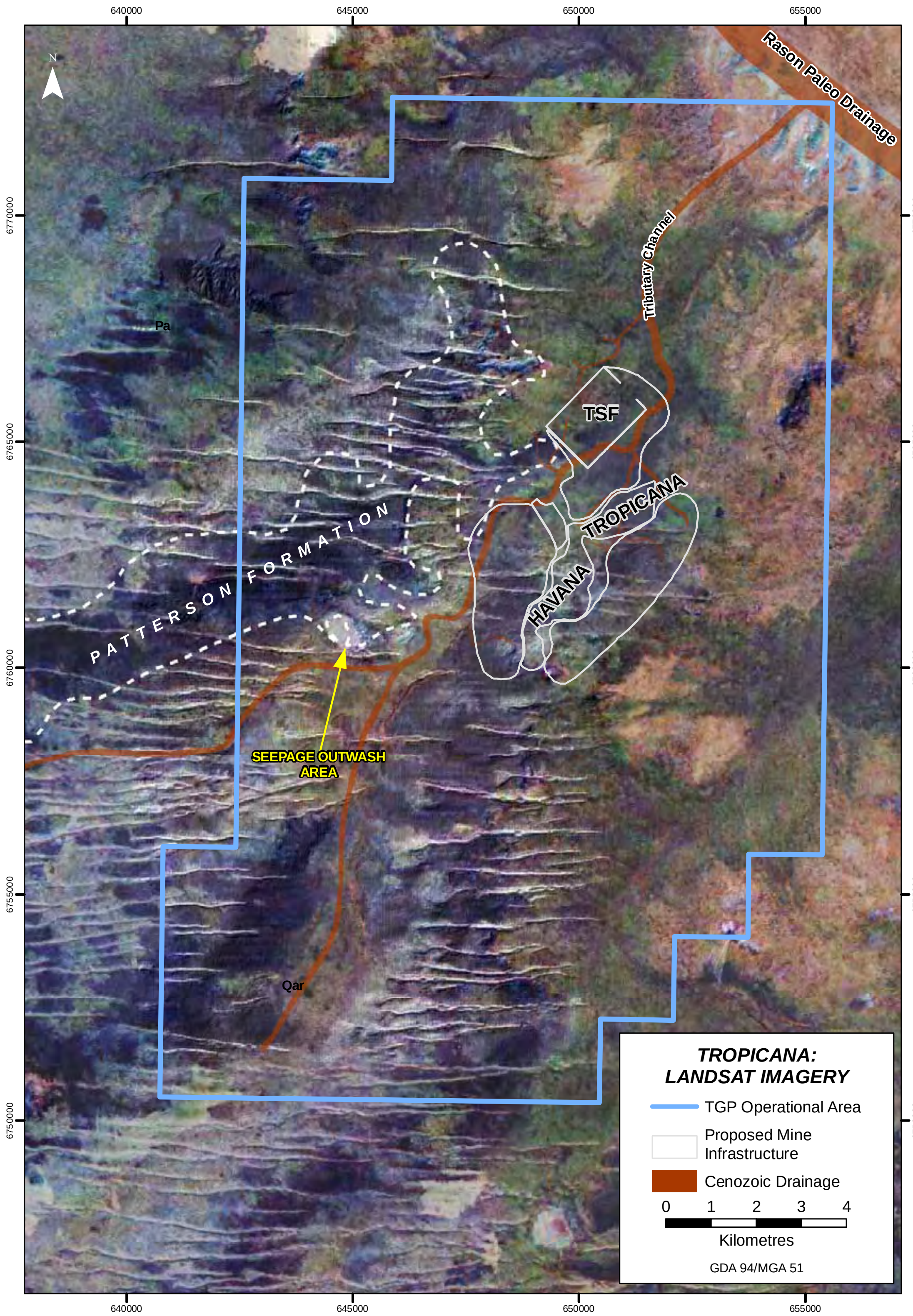


Figure 2.7 Landsat image of the project area showing sheetwash scour beneath the Paterson Fm caused by winter spring discharge

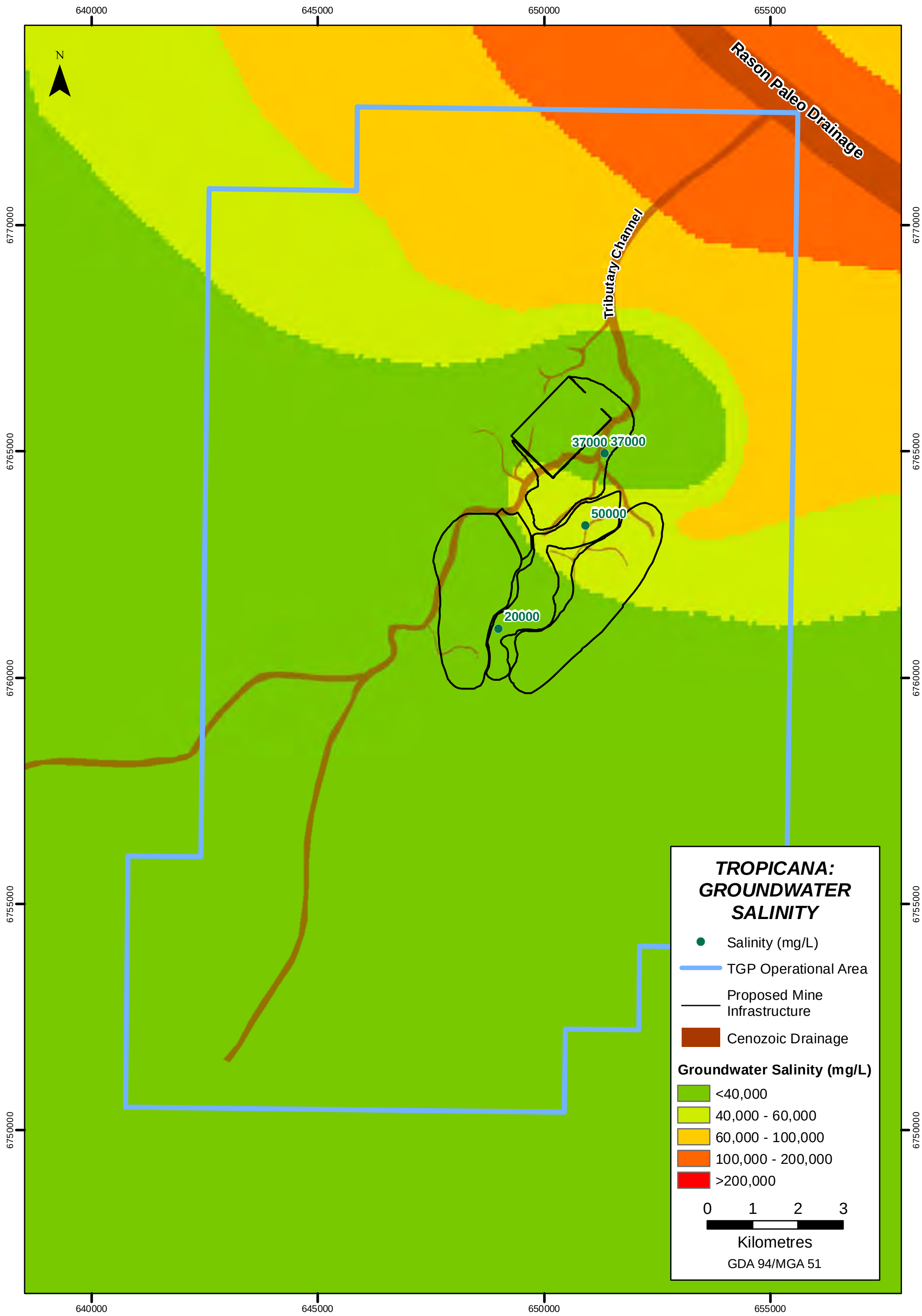


Figure 2.8: Interpreted groundwater salinity

3. OPERATIONAL AREA GROUNDWATER MODEL

A numerical groundwater model of the Operational Area has been developed to simulate abstraction rates and changes to groundwater levels and flowpaths associated with the mine dewatering and TSF management.

The use of computer-based numerical models as an aid to problem solving in groundwater investigations provides a powerful tool for the rationalisation of spatial and temporal variability of field conditions. The development of a numerical model also facilitates sensitivity analyses that assist in understanding the dominant parameters and mechanisms within an aquifer system. The modelling process is a method of simulating groundwater regimes by a system of mathematical equations based on Darcy's Law for groundwater flow. The process requires definition of the following characteristics of an aquifer system:

- The aquifer geometry, including lateral and depth extent;
- The aquifer hydraulic properties - permeability, specific yield etc.; and
- The regional head distributions or fluxes - rainfall recharge, throughflows, outflows and borefield abstraction.

Aquifer modelling in this investigation was undertaken using the FEFLOW finite element model code (Diersch 2006). The finite element method employed by FEFLOW requires discretisation of the modelled area into a mesh of triangular elements defined by a series of nodes. Solutions are obtained for potentiometric head at each node point within the model domain and linear interpolation is then employed between nodes.

3.1 Model Geometry

A three layered confined modelling approach was adopted using the FEFLOW finite element modelling code. This two dimensional model mesh covers an area of 129 km^2 and consists of 115,524 nodal points defining 171,561 triangular elements (**Figure 3.1**).

The model has four model slices defining three model layers, as shown in **Figure 3.2**:

- Layer 1 represents the Lower Saprolite, being the main aquifer interval. The upper surface of layer 1 (Slice 1) is set with a free and movable condition to allow for simulated changes in water levels. The base of layer 1 (Slice 2) was interpreted from TGP resource drilling.
- Layer 2 represents the lower permeability saprock aquifer. The base of Layer 2 (Slice 3) is set to the top of fresh rock interpreted from TGP resource drilling.
- Layer 3, the bottom layer, represents the effectively impermeable fresh rock with its base given as a nominal flat surface at -200 mAHD.

The Cenozoic deposits are not included in the model because they have poor connection to the Lower Saprolite and are not intersected by the mine pits and are therefore not considered significant for dewatering. Seasonal through flow in the Cenozoic deposits is, however, significant for interception of any potential leakage from the TSF, and is considered further in Section 3.6.

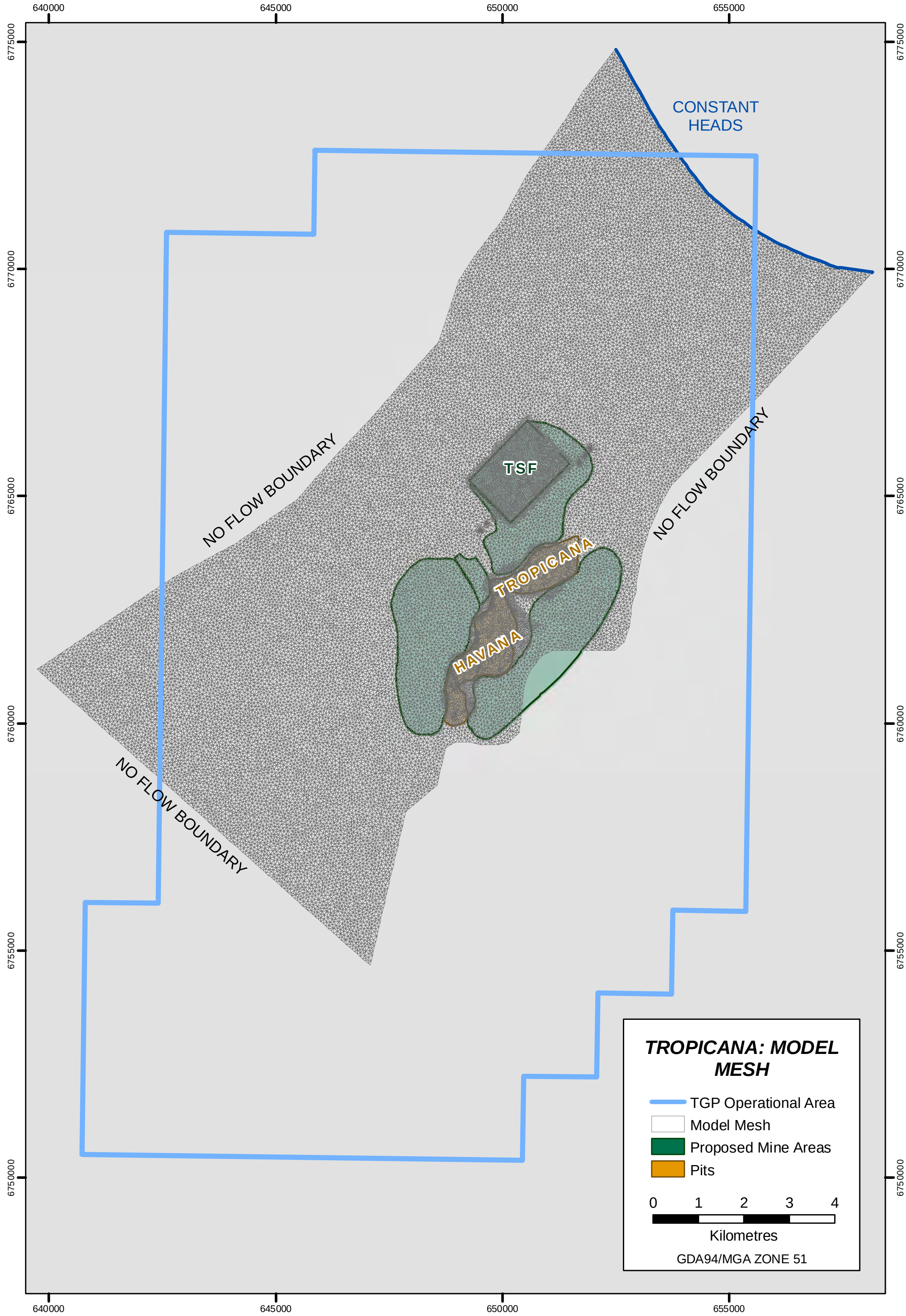


Figure 3.1: The model mesh

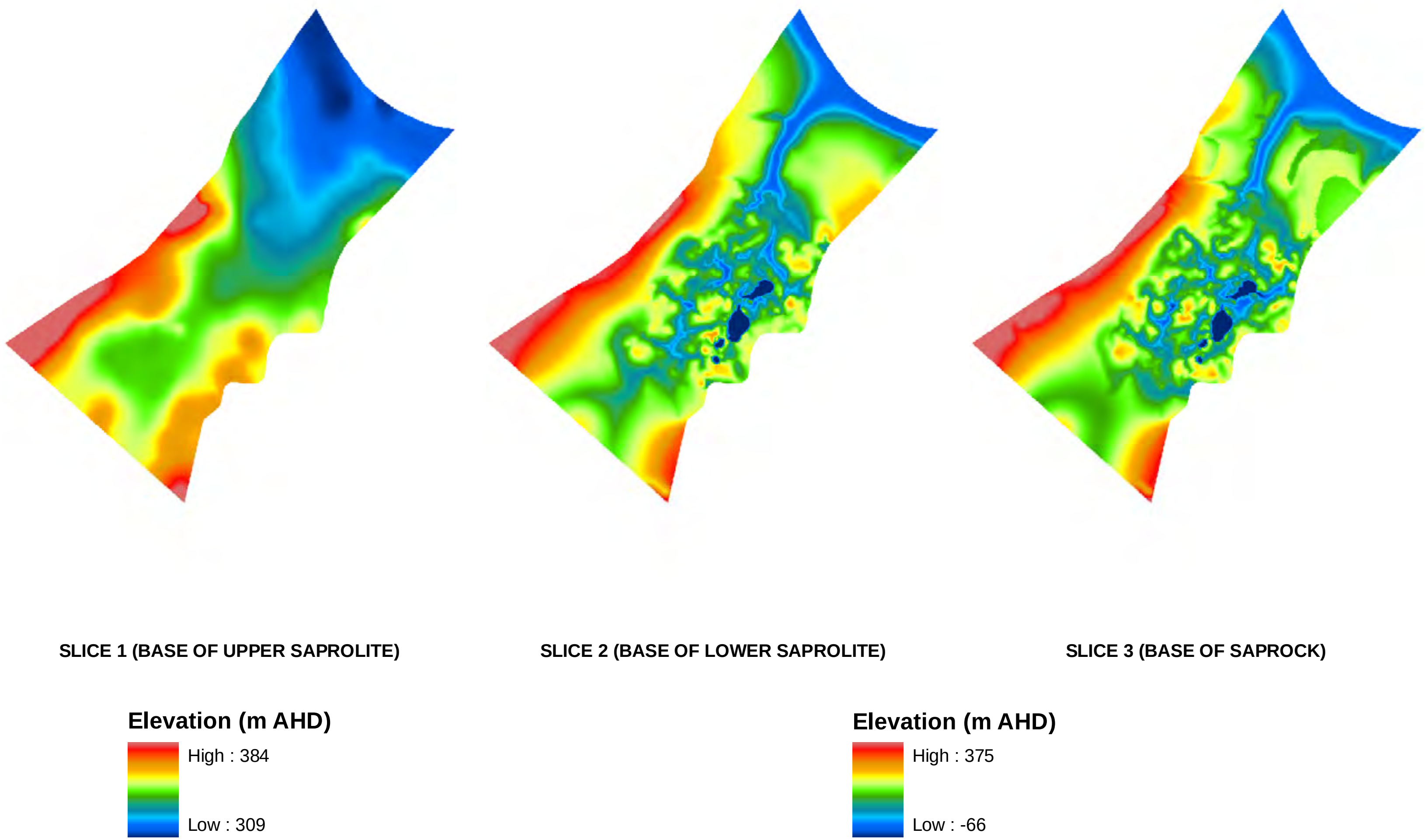


Figure 3.2: Slice elevations

3.2 Model Boundaries

Boundaries were set several kilometres from the pit and TSF to minimise boundary effects. The use of constant heads has been minimised and only applied to the northeast boundary to avoid over-constraining the model.

The northeast boundary coincides with the base of the Rason Drainage Valley at the base of the catchment and has been assigned as one-way constant heads, which allow water to drain from the model, but does not allow water to enter the model.

The northwest and southeast boundaries are treated as no flow boundaries, being along regional flow divides which also correspond to the sub-catchment boundaries, where shallow fresh rock is evident from resource drilling. The southwest boundary has also been assigned as a no flow boundary, broadly coinciding with an equipotential line 5.5 km upstream from the mine.

3.3 Model Parameters

A summary of the adopted horizontal and vertical permeability parameters is provided in Table 3-1. As pump testing has not yet been completed for the saprolite aquifer, conservative estimates of parameters have been adopted in the model. Values for the upper saprolite are based on typical shale permeability and storage parameters. Permeability values for the lower saprolite are based on tests recorded at other mines in the Yilgarn, particularly by WMC at Norseman and Agnew in the late 1990's.

The compressibility of the saprock and fresh rock is considered to be virtually non-existent and therefore each of these units has been assigned a compressible storage parameter close to the theoretical minimum of 10^{-8} (i.e. the compressibility of water). The fresh rock is considered to act as a hydraulic basement and therefore has been assigned a very low permeability value equivalent to that of shale.

Table 3-1 Summary of model parameters for dewatering model

Unit	Bulk Permeability (m/day)	Vertical Permeability (m/day)	Specific Yield	Specific Compressible storage
Lower Saprolite	1.0	0.1	0.01	0.0001
Saprock	0.1	0.01	0.001	0.000001
Fresh rock	0.0001	0.00001	0.0001	0.000001

3.4 Model Fluxes

A spatially distributed rainfall recharge rate of 0.2% of annual rainfall has been evenly distributed over the entire model area based on the chlorinity analysis in Section 2.5. The resultant steady state water levels for the recharge rate and permeability distribution are shown in **Figure 3.3**.

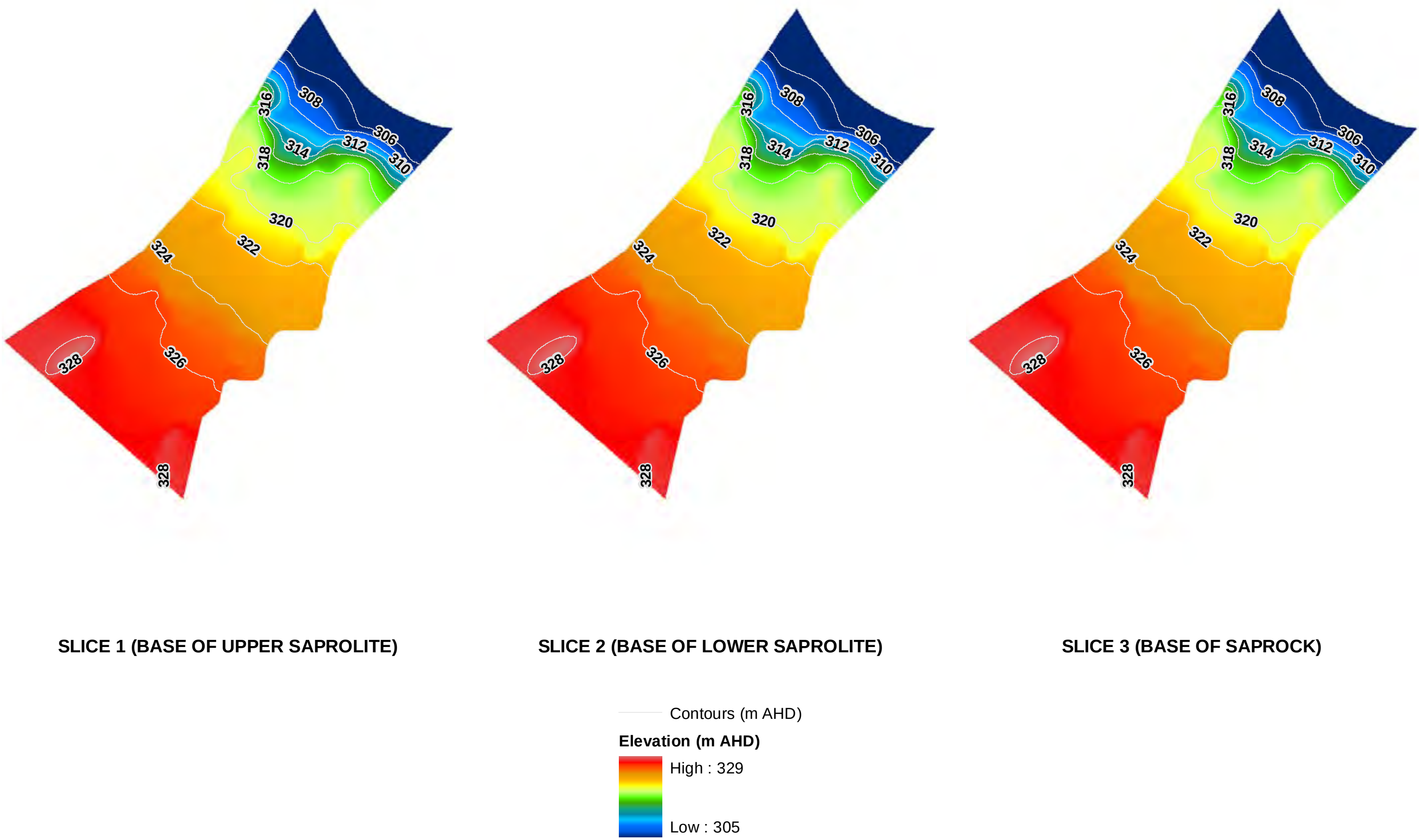


Figure 3.3: Steady state water levels

A potential worst case leakage rate from the TSF of 0.77 kL/ha/day was modeled using SEEPW, which is equivalent to 180 kL/day over the entire TSF area (Knight Piesold, 2008). This leakage value has been adopted and applied in the model as a spatial elemental flux over the TSF area over the life of the TGP.

3.5 Model Limitations

While the model geometry is robust due to the extensive database of exploration drill hole data, aquifer parameter information for the saprock and saprolite is sparse due to a lack of local pump tests. This data gap will be addressed through a dewatering pump test program as the next stage of this investigation in 2009 to 2010, and as part of detailed design.

The model also assumes that the aquifer is homogenous and isotropic when in fact there is evidence of faulting in the area which can results in preferential flowpaths. Discussion of this issue is presented in the following section in relation to connection between groundwater flow paths between the TSF and the mining area.

In the arid climate, with infrequent rainfall, recharge is episodic rather than evenly distributed over time and space as represented in the model. This limitation is addressed in the following section in scenarios testing the impact on dewatering flows of short-term intense recharge during storm events.

3.6 Flows in the Cenozoic Sediments

While the proposed mining area does not intersect saturated Cenozoic sediments, the TSF is to be constructed across a valley with a thin cover of the Cenozoic deposits that are ephemerally saturated during episodic recharge events. From Attachment A, the Cenozoic sediments appear to be up to about 500m wide, with up to 30m of alluvial/colluvial deposits. Piezometric measurements indicate that the bottom 20m can be saturated following a recharge event but the sediments are rapidly drained with the water table below their base for much of the year.

The Darcy Equation was used to estimate the range of likely peak flow rates through the Cenozoic deposits. Given their mainly silty, clayey lithology, the permeability of the sediments is likely to be less than 5 m/day. However as a basal gravel layer is sometimes present, the Cenozoic deposits have conservatively been assumed to have a hydraulic conductivity of 20 m/day (based on a typical clean unconsolidated sand). During the wet season, the cross sectional area of saturated Cenozoic deposits in the Operational Area is calculated to be 7,500 m^2. Given a measured regional ground surface slope of 1 in 500, the upper limit of the wet season peak flow through the saturated Cenozoic is calculated to be 300 kL/day.

4. DEWATERING ANALYSIS

The groundwater model of the Operational Area has been used to assess the likely magnitudes of influx to the dewatering system and the impacts of dewatering on water levels and groundwater flow paths. The issues associated with dewatering are discussed in the following sections of this report.

4.1 Dewatering Approach

Dewatering will occur in two stages. In the first stage, advanced dewatering will take place through construction of four 100m deep out-of-pit dewatering production bores. The bores will be located to intersect deep structures around the proposed mining area, with pumping commencing prior to pit excavation and during excavation above the water table. These out-of-pit bores will serve the dual purpose of reducing pressure heads around the pit, while providing water for the construction phase.

Once excavation intersects the water table, the second stage of dewatering will use in-pit sumps to capture the majority of flows. As the pit progresses to the base of the upper saprolite, the pore pressure on the pit walls increases and horizontal seep wells may be required to assist the depressurising the walls, which will add to the volume of pit influx.

Management of groundwater influx during these two dewatering stages is a continuous balance between water demands for dust suppression against the water produced from dewatering bores and in-pit sumps to achieve a zero net water production/loss. Hence the timing of advance dewatering would coincide with the start of the pre-stripping for the pit. In the second phase of dewatering, as the demand for dust suppression water drops significantly in the hard rock, there is a chance that water make may exceed dust suppression demand. In this case, any surplus water would be used for other site activities such as processing water or non-mining area dust suppression.

4.2 Dewatering Influx

Figure 4.1 is a schematic block diagram of the mine showing likely types of groundwater influx to the mine area. Influx to mining area are normally classified into three main categories:

- Baseline pit influx;
- Nuisance influx; and
- Catastrophic influx.

Baseline groundwater influx refers to the predictable groundwater inflow calculated from bulk hydraulic parameters and mine development assumptions.

Nuisance influx results from quantifiable variations on the baseline inflow resulting from foreseeable events such as 1 in 100yr 72hr rainfall over the mining area or seasonal peak groundwater influx from cyclonic aquifer recharge.

Catastrophic influx describes the risk of large scale inflow events such as a dam wall collapse, or intersecting flooded mine workings. There are no large water bodies or historic mine workings likely to be intersected by the mine and therefore the potential for catastrophic influx is not considered to be a risk.

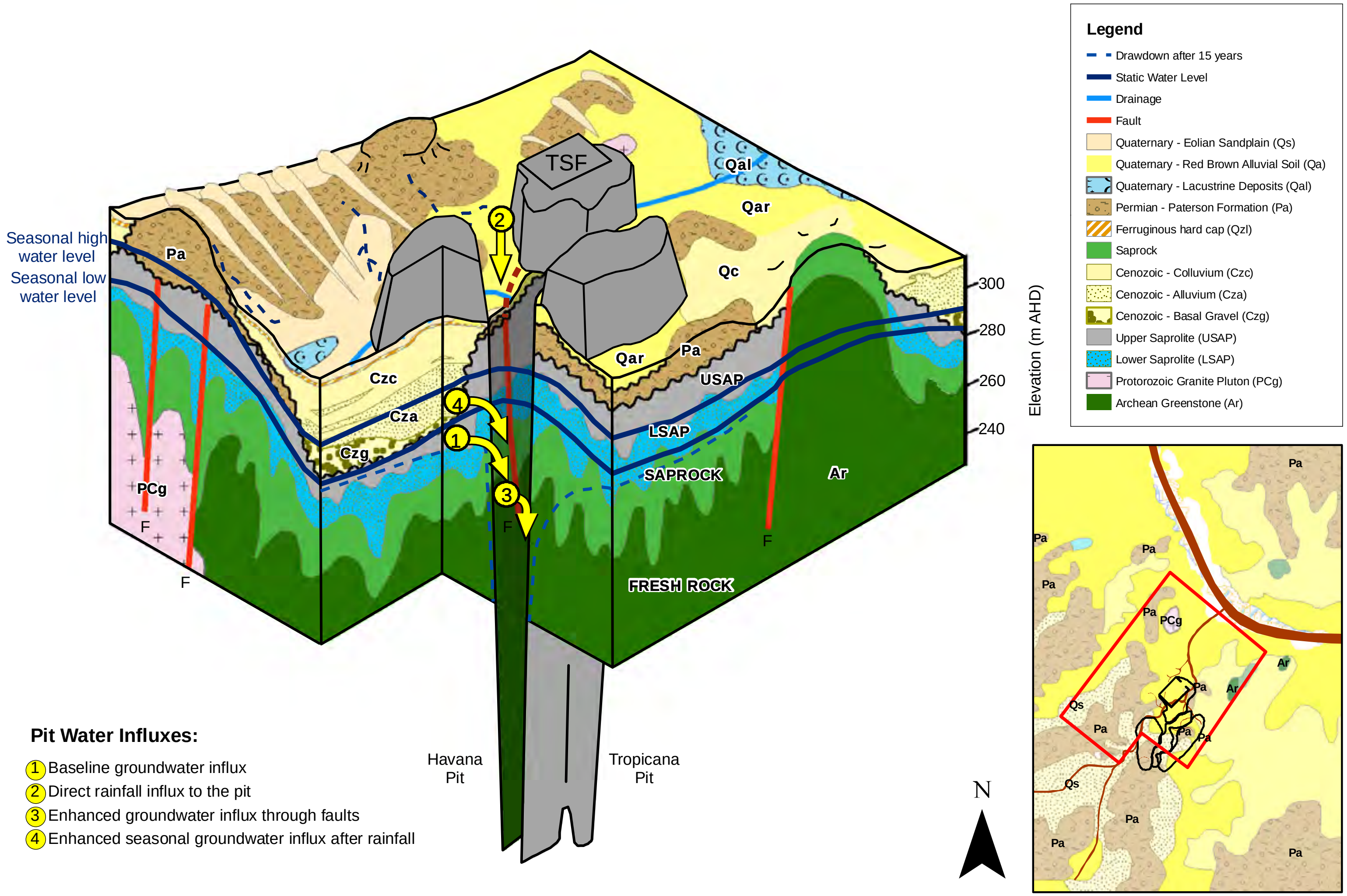


Figure 4.1 Schematic block model of the mine area showing the types of pit influx

Likely volumes of each form of pit influx are summarised in Table 4-1, and the derivation of these values is discussed in the following sections.

Table 4-1: Potential pit influx

Type Inflow	Indicative Volume	Timing
1. Baseline Groundwater influx	3,000 to 5,000 kL/day	Baseline influx in first year of mining, whilst excavating the saprolite
	< 1,000 kL/day	Long term baseline influx during excavation of the saprock and fresh rock
Nuisance Influx		
2. Direct 100yr rainfall influx	Up to 600,000 kL total	Following a 1 in 100yr 72hr rainfall event
3. Enhanced fault influx	Up to 125 kL/day	Continuous over life of project
4. Enhanced seasonal groundwater influx	Up to 6000 kL/day	Receding rapidly over about one month following a peak recharge event (e.g. cyclone)

4.2.1 Baseline Groundwater Influx

To estimate baseline influx to the mine, the groundwater model was run for 15 years. Excavation of the mine area to full depth was assumed to occur at the start of the model run. Actual mining excavations will be created over a period of 10 to 15 years. The model therefore does not fully capture the gradual ramp-up in flow rates with increasing depth of excavation but does accurately reflect the quasi-steady state impacts of the mine on flows and water levels when the mine is at full depth and has its maximum impact. The majority of influx will occur once excavation extends below the base of the lower saprolite.

For simplicity, the model assumes that the entire pit is instantaneously mined to full depth on the first day and therefore does not accurately capture the steady ramp-up in dewatering requirements during the first years of mining. The model also does not account for significant evaporative losses of the influx as it drains over the exposed pit faces. Notwithstanding these model limitations. **Figure 4.2** shows the modelled pit influx from year 2 onwards. Reference to this figure suggests that dewatering requirements would be highest during the excavation of the oxidised saprolite zone during the first years of mining. Although the model suggests a peak demand of 5,000 kL/day, in practice, advance pumping for construction water will significantly reduce the peak dewatering requirement during initial mining. Once the oxidised ore has been mined, groundwater influx through the low permeability hard rock will drop off significantly to less than 1,000 kL/day, most of which is likely to be evaporated within the pit during the summer months if left within the mining area.

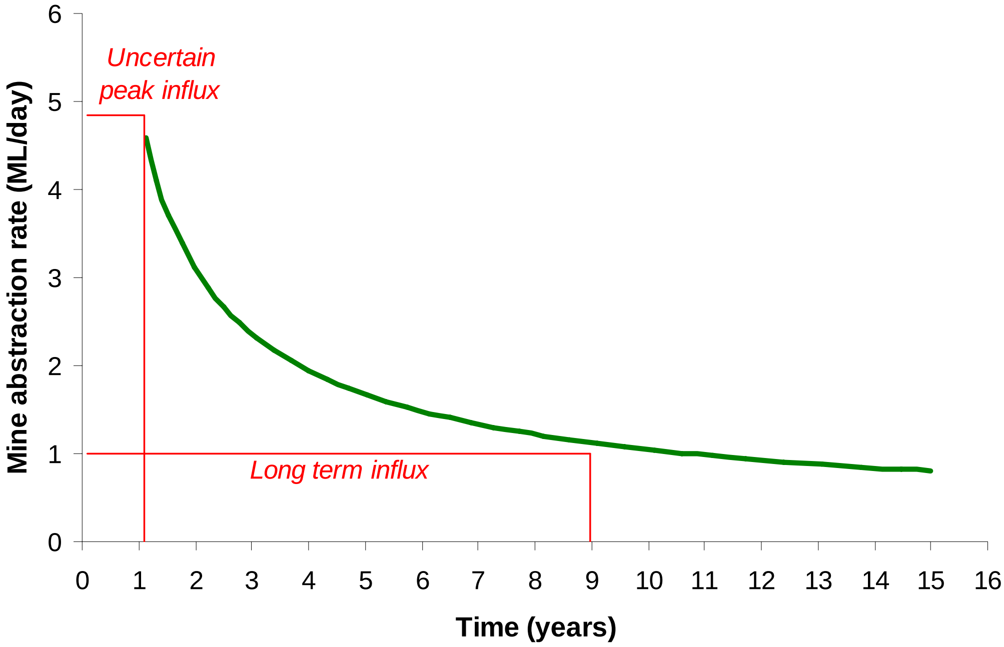


Figure 4.2: Modelled mine dewatering requirements over time

4.2.2 Nuisance Influx

4.2.2.1 Direct rainfall influx

Stormwater management for the mine is being undertaken by GHD and storm influx to the mining area will be dealt with in detail in GHD's analysis. However storm influx is touched on here for completeness as it is a significant component of the pit water balance.

Cut-off drains and exclusion bunds will used to limit much external runoff from entering the mining are, however, the mining area catchment still includes side slopes from the waste dumps and other surface areas, bringing the total pit catchment area up to 400 ha. Based on rainfall intensity-frequency-duration curves from the Bureau of Meteorology, a 100 year ARI recurrence 72 hour event would contribute 152 mm of rainfall, which is equivalent to 600,000 kL of runoff over the catchment area. This runoff would flood the lower benches of the mining area and would be recovered for use either in the processing plant or dust suppressing activities. On the processing of 7 mtpa at 1kL/tonne this volume would take about four to six weeks to consume in the process. The mining design and ore stockpile management will take these flows into account to ensure that adequate storage volume is provided in the pit to allow operations to continue during the period required for pumping out the excess water.

4.2.2.2 Enhanced groundwater influx through faults

The exploration activities have indicated the presence of faults and shear zones in the resource area. While the groundwater model has assumed a homogenous aquifer, these structural features can provide a preferential groundwater flow path. While there are no significant water bodies or aquifers in the vicinity that could contribute extra flow to the pit through fault-driven short-circuiting of the aquifer, there is the potential for stored water in a fault or shear zone to be rapidly mobilised to the mining area along these preferential flow paths.

A typical maximum dimension of a shear zone, the worst case structural feature for dewatering flows, would be 1km long by 50m wide. Assuming a conservative specific yield of 1%, and a mining rate of about 1m excavation per 4 days, this shear zone would yield an extra 125 kL/day of flows to the mining area for the duration of excavation, or a 12% augmentation of the long-term baseline flows.

4.2.2.3 Enhanced influx after seasonal groundwater recharge

The episodic nature of recharge in the area causes significant fluctuations in water level of up to 40m seasonally in the Quaternary Sand and Paterson Formation. While this fluctuation is substantially attenuated in the underlying saprolite aquifer, there is still likely to be a seasonal pattern in water levels and flows in this aquifer as mounded groundwater dissipates towards the Rason palaeodrainage north of the Operational Area. The fluctuation is also likely to affect influx to the mining area.

To assess this seasonal effect on influx, a second model simulation was run starting from water levels at the end of the 15 year quasi-steady state scenario. The entire 0.5 mm/year annual recharge was added to the model over 3 days, representing a typical cyclonic-driven recharge event, and the model was run for 180 days to determine the peak flow to the pit and recession curve associated with such an event.

The resulting fluviograph of flows to the pit is show in **Figure 4.3.** Immediately following a storm, enhanced influx to the pit could peak at up to 7,000 kL/day above the baseline influx. The influx would recess back to baseline over four to six weeks following the recharge pulse. Enhanced groundwater discharge following a cyclonic rainfall events could thus contribute in the order of 85,000 kL to the baseline influx over several weeks following the recharge event.

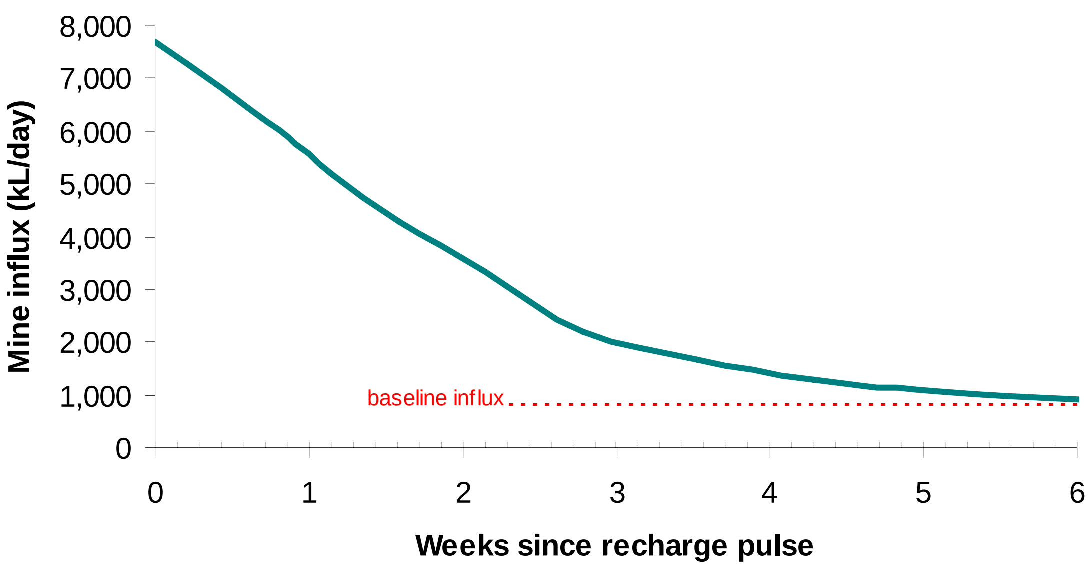


Figure 4.3: Modelled influx to the pit following a rainfall recharge pulse

4.3 Dewatering Impacts

Modelled impacts of pit dewatering on groundwater levels and resulting flow lines are shown in **Figure 4.6** and **Figure 4.5**. These figures show the maximum impact at the end of the 15 year model scenario representing the cessation of mining. The flow lines shown in **Figure 4.6** indicate that groundwater migration to the mining area is sourced from all directions, with flow paths impacted over the same area as the drawdown impacts.

Reference to these figures suggests that drawdown impacts are constrained by the relatively low permeability in the mined materials, particularly in the fresh rock which has virtually non existent permeability and storage. The apparent asymmetric geometry of drawdown impacts between the east and west sides of the mining area are a function of the access to relatively higher bulk permeability, aquifer storage and recharge in the saprolite on the western side of the mining area.

Given that the water table fluctuates 10m or more on a seasonal basis, drawdowns of less than 1m are considered an indicative cut-off for measurable impacts. After 15 years of mining, drawdowns of 1m would not extend more than 4km from the mining area, equating to a total impacted area of 25 km^2. Average recharge over this impacted area would equate to 12 ML/year, being less than 2% of the pit influx, indicating that the bulk of groundwater influx is derived from aquifer storage.

The area impacted by more than 10m of drawdown would be confined to less than a 1.5 km radius from the mining area. Much of this area lies beneath the proposed waste landforms and other mining infrastructure such as the ROM, processing plant. The greatest drawdowns, of up to 50m, would occur within about 1km of the eastern wall of the mining area.

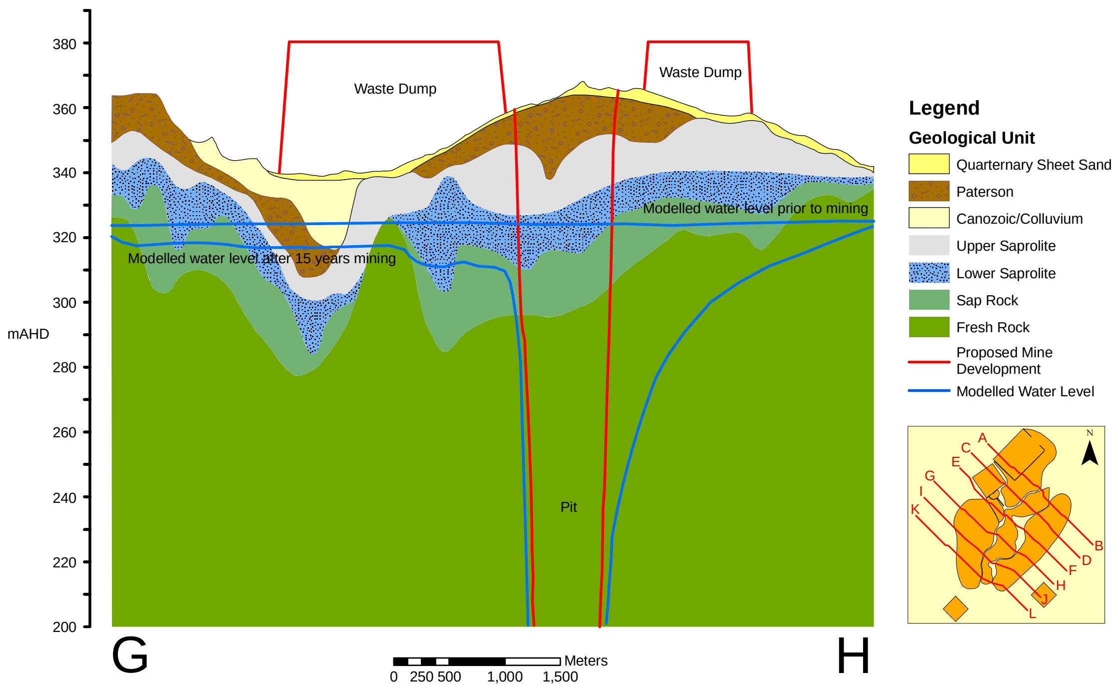


Figure 4.4 Modelled drawdown through the pit

4.3.1 Groundwater Dependent Ecosystems

The relatively deep water table in the Operational Area (20 to 30m below ground) is beyond the root depth of many arid zone vegetation. While there are some vegetation species that are known to have tap roots that could conceivably reach the water table, the saline to hypersaline groundwater quality precludes most plant usage apart from halophytes. No deep rooted halophytic vegetation has been identified in the Operational Area. .

As part of the PER process, the JV has undertaken stygofauna sampling programs of both the water supply area and mining area and other historic bores in and around the Minigwal Trough area. Thus far this program has identified no stygofauna.

4.3.2 Other Water Users

Being located in a remote region of the Great Victoria Desert on vacant crown land, there are only a few third party projects, dwellings or stock and domestic bores within 200 km of the Operational Area. There are no other existing or foreseeable water users within the 1m drawdown radius caused by mine dewatering. The discernible depressurisation impacts over the life of the TGP will not extend more than 4 km from the mining area, and will not extend significantly outside the boundaries of the lower saprolite aquifer. There is therefore no potential for the TGP to adversely impact other water users

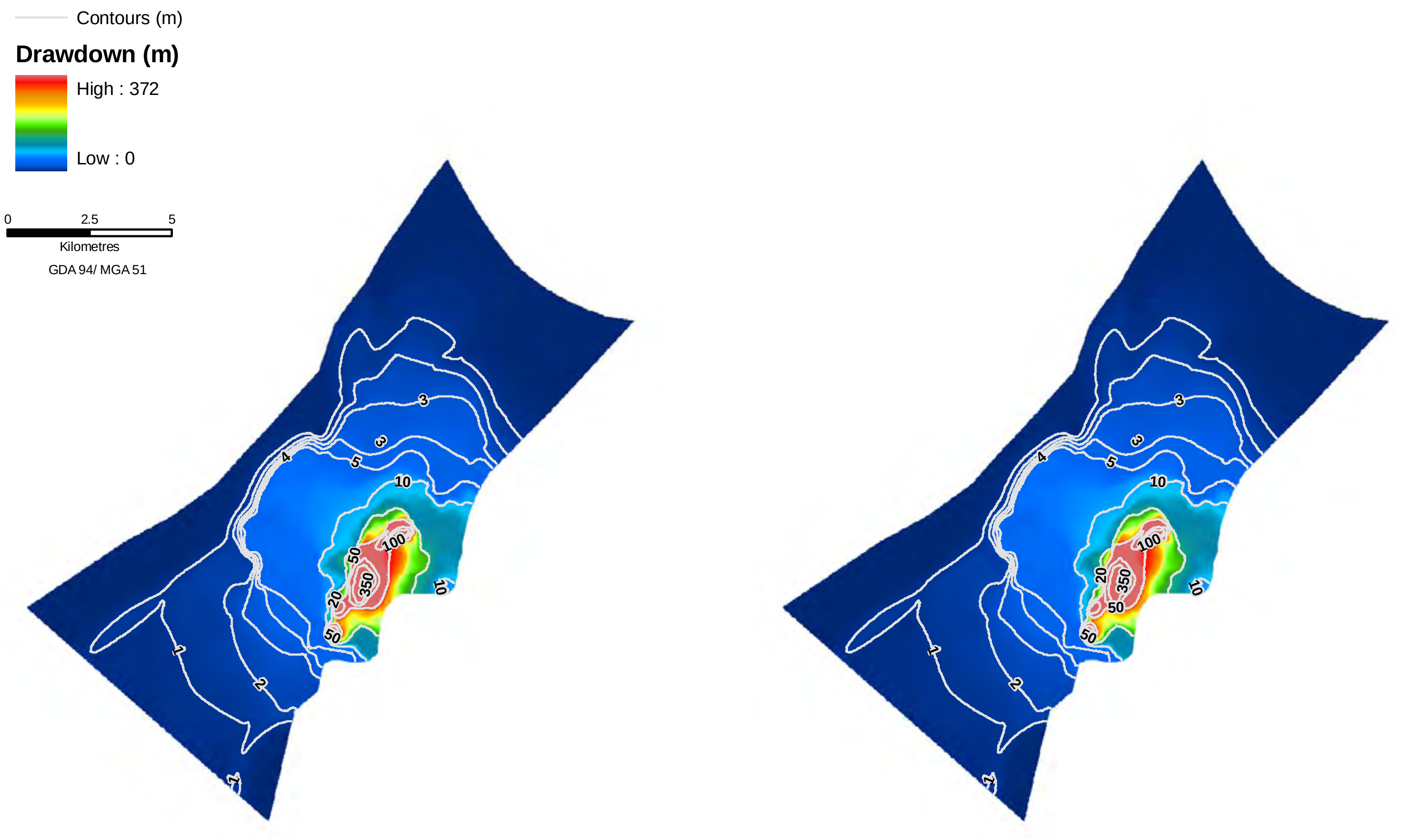
4.3.3 Groundwater Quality

The existing groundwater in the Operational Area is saline and falls into the lowest beneficial use category, suitable only for limited industrial uses with no potential agricultural or domestic uses. Any minor changes in salinity distribution as a result of the TGP will therefore not change the groundwater's beneficial use category.

Reference to **Figure 4.5**, suggests that the TGP enhances groundwater migration of lower salinity (10,000 to 20,000 mg/L) water from the south western part of the Operational Area into the mining area. Water levels on the northern side of the mining area are locally reversed causing higher salinity (30,000 to 50,000 mg/L) groundwater to migrate back towards the mining area.

Leakage from the TSF is expected to have a salinity of between 80,000 to 100,000 mg/L TDS and will cause local mounding. It is predicted that around two thirds of this TSF leakage will be captured within the pit groundwater capture zone and migrates into the mining area. The remaining third of the leakage is predicted to diffuses slowly through the saprolite aquifer in a northerly direction towards the Rason palaeodrainage and mixes with the naturally hypersaline groundwater, with salinity up to 200,000 mg/L.

Groundwater influx to the mining area is expected to have salinities ranging from 10,000 to 50,000 mg/L TDS, with a likely weighted average estimated to be close to 30,000 mg/L.



SLICE 2 (BASE OF LOWER SAPROLITE) SLICE 3 (BASE OF SAPROCK)

Figure 4.5: Regional drawdown impact at end of mining

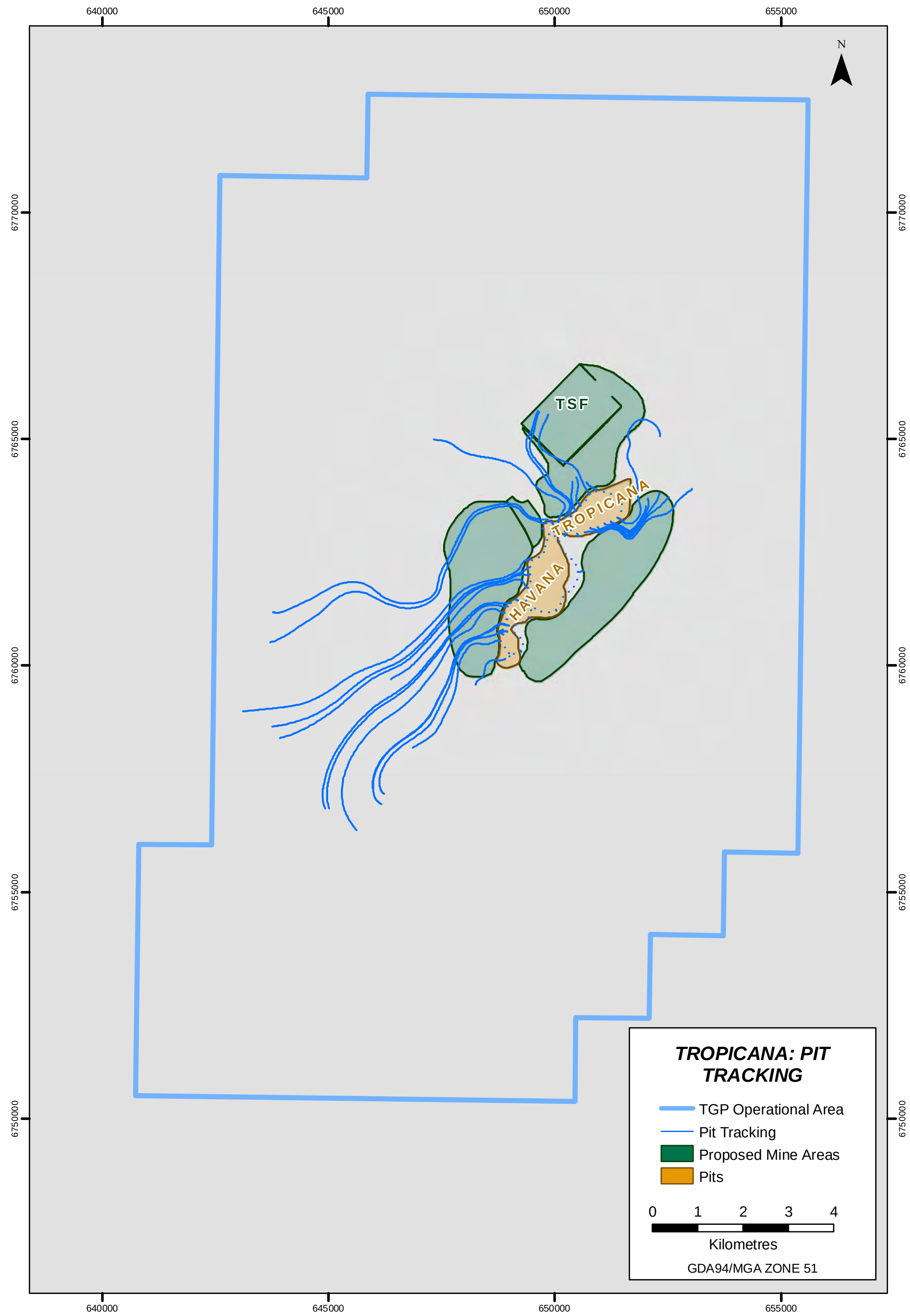


Figure 4.6: Modelled flow lines associated with drawdowns due to pit dewatering

4.4 TSF Water Discharge Analysis

Potential leakage from the TSF has been estimated at 177 kL/day (Knight Piesold, 2008). This section examines the migration of this leakage through the Cenozoic deposits and the saprolite aquifer systems.

Figure 4.6 shows numerical model results of particle tracking of water from the TSF after 15 years. Reference to this figure indicates that about two thirds of the TSF leakage flows in the direction of the mining area, with some flow just beginning to reach the pit at 15 years. Any flows migrated to the mining area would be recirculated back through the mine dewatering systems to the processing circuit and back to the TSF. The remaining third of groundwater flows from beneath the TSF has moved only about 100 m over the 15 years in a north-westerly direction, the slow flow rate the result of the regional hydraulic gradients toward the pit induced by pit dewatering. At this rate, it would take thousands of years for flows to reach the Rason palaeodrainage.

While Cenozoic alluvial/colluvial deposits in the TSF area are normally unsaturated, they can become wetted during an episodic recharge pulse and act as drain. Seasonal groundwater recharge to the normally unsaturated Cenozoic deposits can produce northerly throughflows around 300 kL/day (refer to Section 3.6).

If necessary, these flows could be intercepted by bores screened through the Cenozoic materials and underlying saprolite. Based on results from existing water bores, such interception bores would likely yield between 100 to 400 kL/day, and thus two or more bores should be sufficient to capture any seasonal groundwater flows from beneath the TSF.

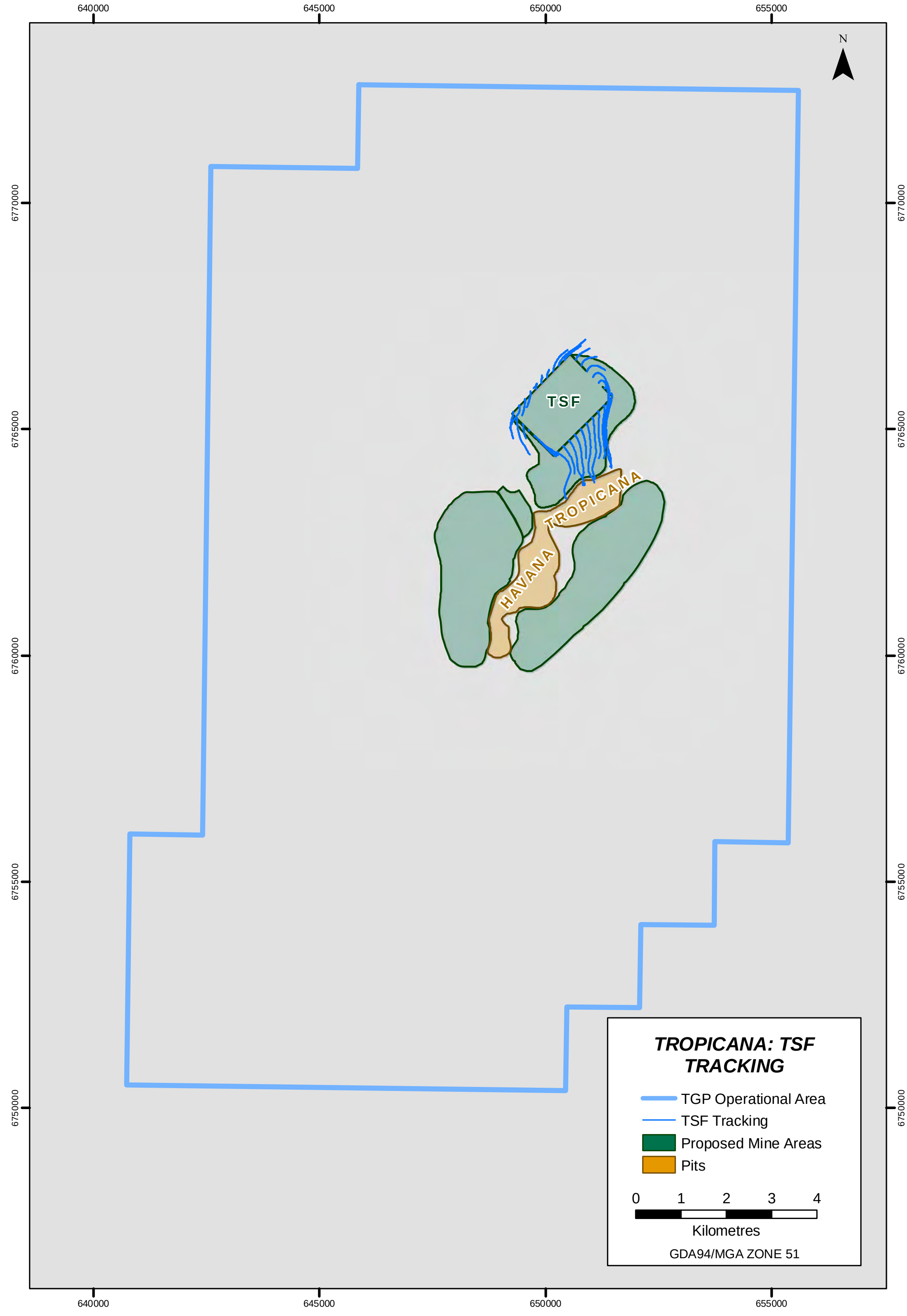


Figure 4.7: Modelled particle tracking from the TSF through the Saprolite aquifer after 15 years

5. CLOSURE ANALYSIS

At the completion of the project, access to the mining area will be blocked off, waste stockpiles and TSF will be reshaped into stable landforms and surface water run-off from the waste landforms and TSF will be directed to the mining area via a series of drains. All pit dewatering will cease and water levels in the pits will gradually recover. The water level in the mining area is expected to rise due to the influx of direct rainfall recharge and groundwater seepage, until it comes to an equilibrium point where this influx is balanced by evaporation from the void. Salts derived from rainfall and groundwater influx will steadily accumulate and be concentrated in the void water through continuous evaporation, turning the pits hypersaline over time. This section of the report assesses the changes in water levels and water quality in both the Havana and Tropicana mine voids following mine closure.

5.1 Void Water Level Recovery

Water level recovery was estimated by preparing a daily water balance model for the operation. The analysis used an average annual rainfall rate of 230mm; a total groundwater influx rate of 1000 kL/day (based on the model results in Section 4.2); a pan evaporation rate of 2,649 mm (Laverton airport); and a Webb open water pan coefficient of 0.75. The void water volumes and surface areas were calculated by GIS analysis of pit design contours.

Water levels in the mining area, shown in **Figure 5.1,** are expected to gradually rebound and stabilise about 50 to 100 years after the cessation of mining at a depth of 170m above the base of the pit at Havana (or about 250 m below surface) and 110m above the base of the pit at Tropicana (or about 150 m below surface).

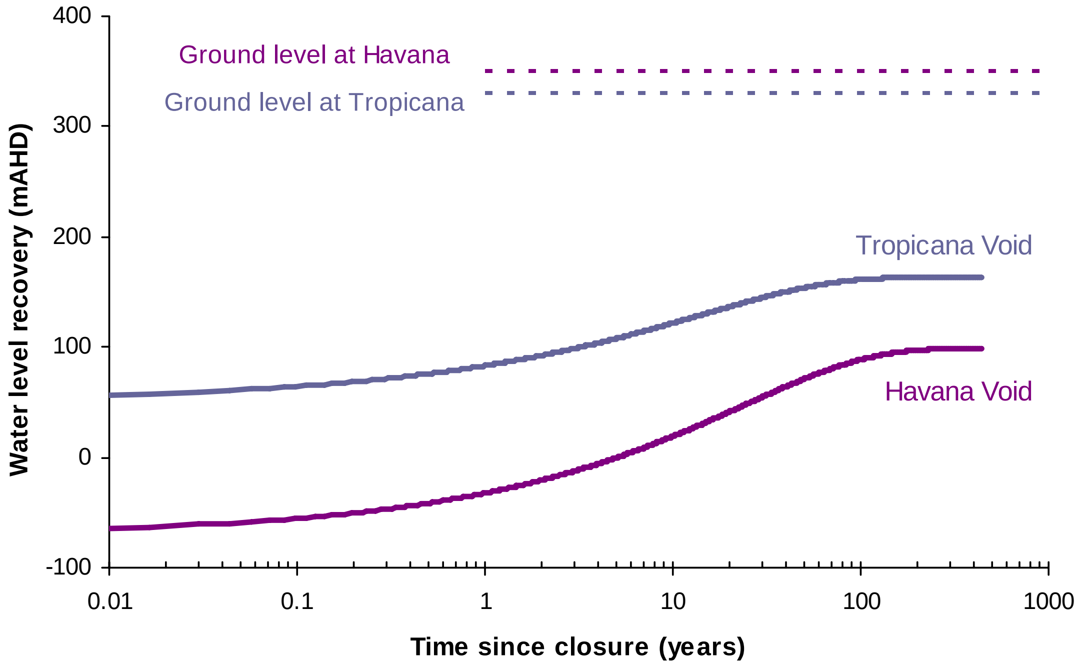


Figure 5.1 Water level recovery in the final void after closure

5.2 Void Water Quality

Water filled voids after closure are a concern for attracting and supporting elevate animal populations. Many voids in the arid interior turn hypersaline over time due to the relatively high evaporation rates and poor throughflows. The fresh rock in the mining area will exhibit the same pattern; having virtually non existent permeability and throughflow, these voids will effectively be closed water systems. Any salt contained in incident rainfall and/or groundwater influx will be trapped in the void and will steadily become concentrated due to continuous open water evaporation at the base of the voids.

Figure 5.2 shows the calculated rate of salt accumulation in the mining area after mine closure assuming a rainfall salinity of 25 mg/L and a salinity of groundwater influx into the void of 30,000 mg/L TDS. Reference to this figure shows that the salinity in each void steadily increases in a linear manner over time, with the rate of salinisation in the Havana void being slightly faster than in Tropicana due to different void to catchment geometries.

Given the high salinity of groundwater influx to the pit, the water in the void will be too saline to support native or feral fauna from the onset. The void salinity will steadily increase through evaporative concentration to become hypersaline within about 50 years.

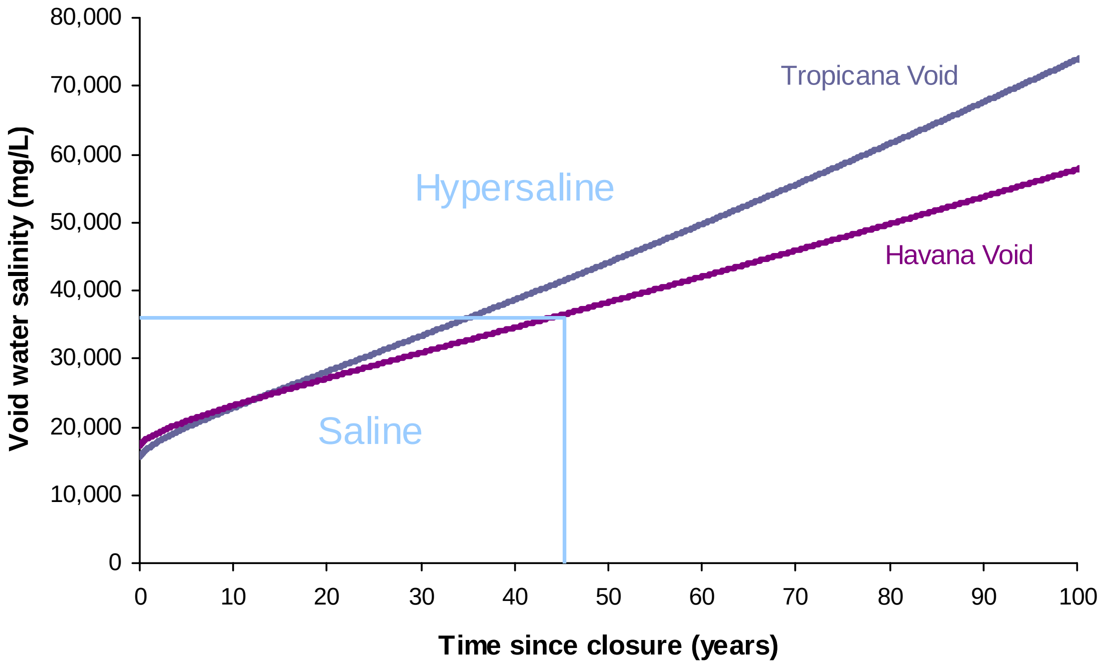


Figure 5.2 Salinity in the final void after closure

5.3 Cessation of tailings deposition after closure

When the proposed mine is ultimately decommissioned, dewatering of from the void will cease and the TSF will be rehabilitated. As the tailings material dries out, leakage from the TSF will cease.

The proposed TSF rehabilitation strategy will be to cap the facility with a layer of waste material and growth medium and then rehabilitate with suitable native plant species in order to prevent dispersion of tailings dust by wind erosion and to minimise the potential leaching of the tailings material by rainfall infiltration. To optimise the volume of earthworks required for the rehabilitation process, the final surface of the tailings facility will be contoured to reflect the final tailings surface. As a result the final surface will be concave towards the centre of each cell. During heavy rainfalls surface runoff may temporarily pool in the centre of each cell and then be evaporated over the following months.

6. GROUNDWATER OPERATING STRATEGY

Development of the Operational Area will require drafting of a detailed monitoring program and operation strategy according to the Department of Water guidelines. Key elements of this program are described below.

6.1 Dewatering and Monitoring Bore Construction

Development of the Operational Area will comprise development of the following borefield:

- four (4) advanced dewatering bores;
- abstraction from in-pit sumps;
- at least eight (8) TSF monitoring bores; and
- six regional monitoring bores

All bores will be installed by a licensed groundwater drilling contractor to the ANZECC (2003) standard, in accordance with the conditions of the well construction licence issued by the Department of Water (DoW). All bores will be screened through the lower saprolite and saprock aquifers to depths of between 70 and 100 metres depth.

Monitor bores will be a nominal 100mm diameter slotted PVC with gravel pack, while dewatering bores will be 205mm slotted PVC. In pit sumps will be installed as required at the base of the pit(s).

Upon completion of the drilling program, each dewatering bore will be equipped with an electric submersible pump. Pit sumps will be fitted with pontoon mounted surface pumps. All dewatering water will be piped to a raw water turkey's nest dam. Water from the turkey's nest will be used primarily for mine construction, with any surplus used in mineral processing.

All dewatering discharge will be used by JV for construction, mineral processing or other mining related activities. At no stage will the TGP need to discharge surplus water to the environment.

6.2 Monitoring Program

The JV approach to sustainable water abstraction will be achieved through the establishment of a detailed groundwater monitoring program. Monitoring will consist as a minimum of:

- The volume of water drawn from all dewatering bores, metered and recorded monthly.
- The volume pumped from pit sumps metered and recorded monthly;
- Water levels and groundwater electrical conductivity (salinity) in all Operational Area bores monitored on a monthly basis;
- Water quality analysis of TSF monitoring bores including major components together with total CN and WAD CN on a quarterly basis.

6.3 Borefield Performance Review

Reporting of borefield performance and aquifer response to groundwater abstraction will be undertaken annually starting from the time the borefield is commissioned. Reporting will include both individual bore performance including hydrographs, pumping rates and variation in water quality. Reporting will also include water level and water quality data from monitoring bores.

7. REFERENCES

DIERSCH, H.J.G., 2006. *FEFLOW Finite Element Subsurface Flow and Transport Simulation System Reference Manual*. WASY GmbH Institute for Water Resources Planning and Systems Research.

HINGSTON, F.J. AND GAILITIS, V. (1976). The Geographic Variation of Salt Precipitated over Western Australia. Aust. J. Soil Res. 14:319-35.

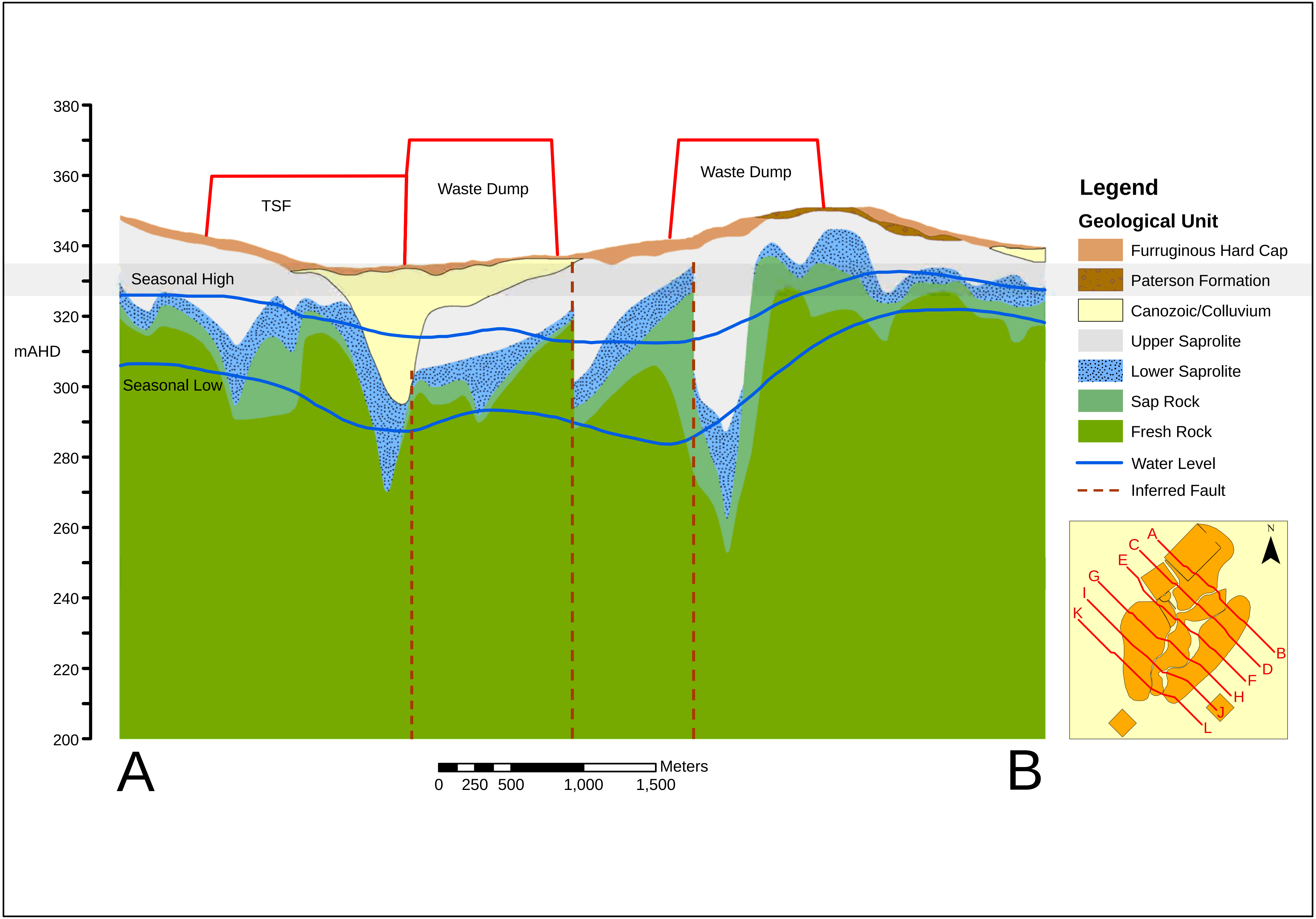
KNIGHT PIESOLD. 2008. Tropicana Gold Project Tailings Storage Facility Prefeasibility Design Summary. Prepared for AngloGold Ashanti Australia Pty Ltd. September 2008. Unpublished Report. Ref PE801-00083/3.

LOWRY, D.C. , JACKSON, M.J. , van de GRAAFF, W.J.E. , KENNEWELL, P.J. 1972 Preliminary results of geological mapping in the Officer Basin, Western Australia 1971. Western Australia. Department of Mines. Report 1971 p94-100

URS. 2007. Tropicana Project Hydrogeological Scoping Study. Prepared for AngloGold Ashanti Australia Pty Ltd. 6 December 2007. Unpublished Report. Ref 42906543/605-F8542.1

Attachment A

Interpreted geological cross sections through the proposed Tropicana/Havana Pits



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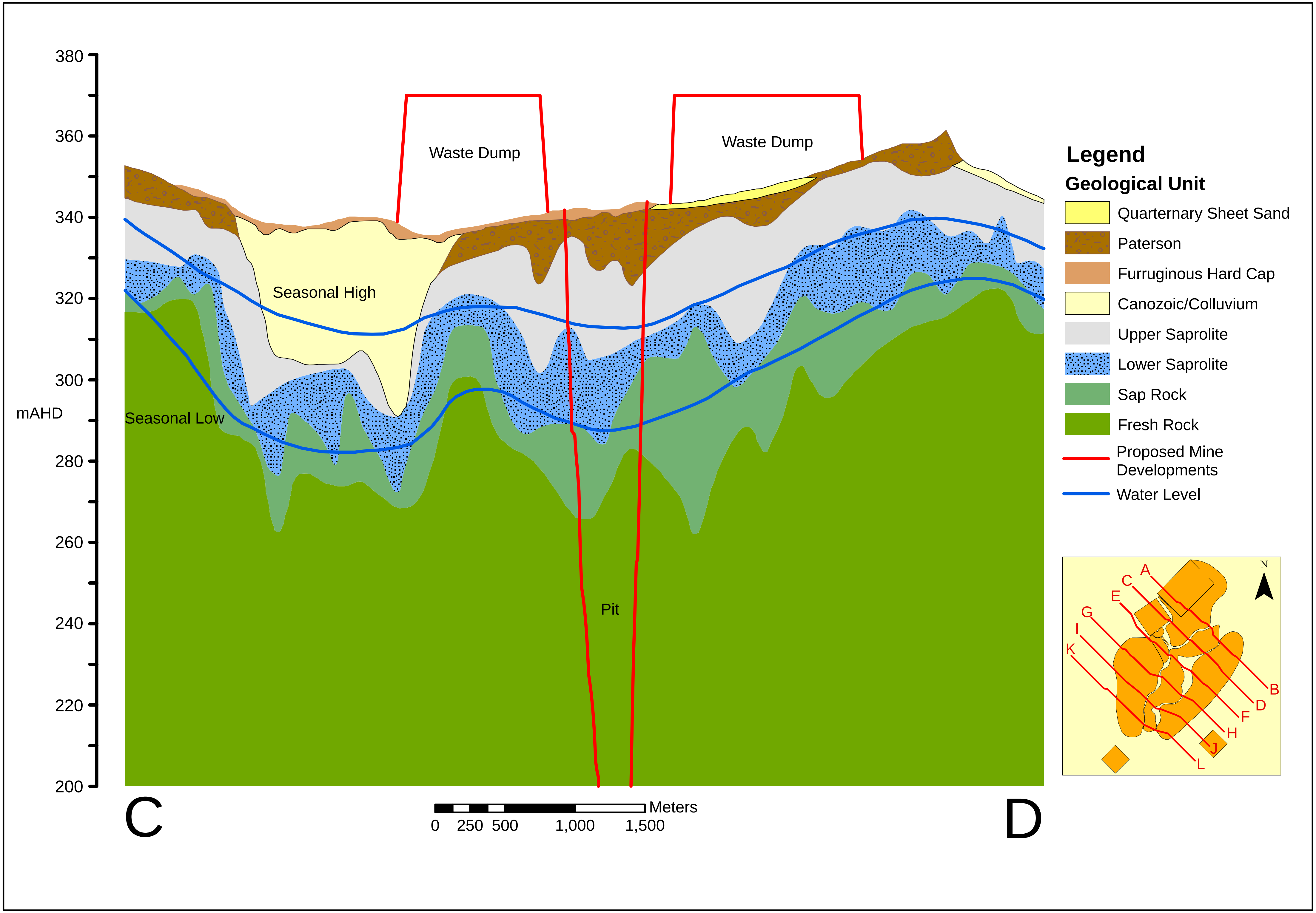

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Upper Saprolite
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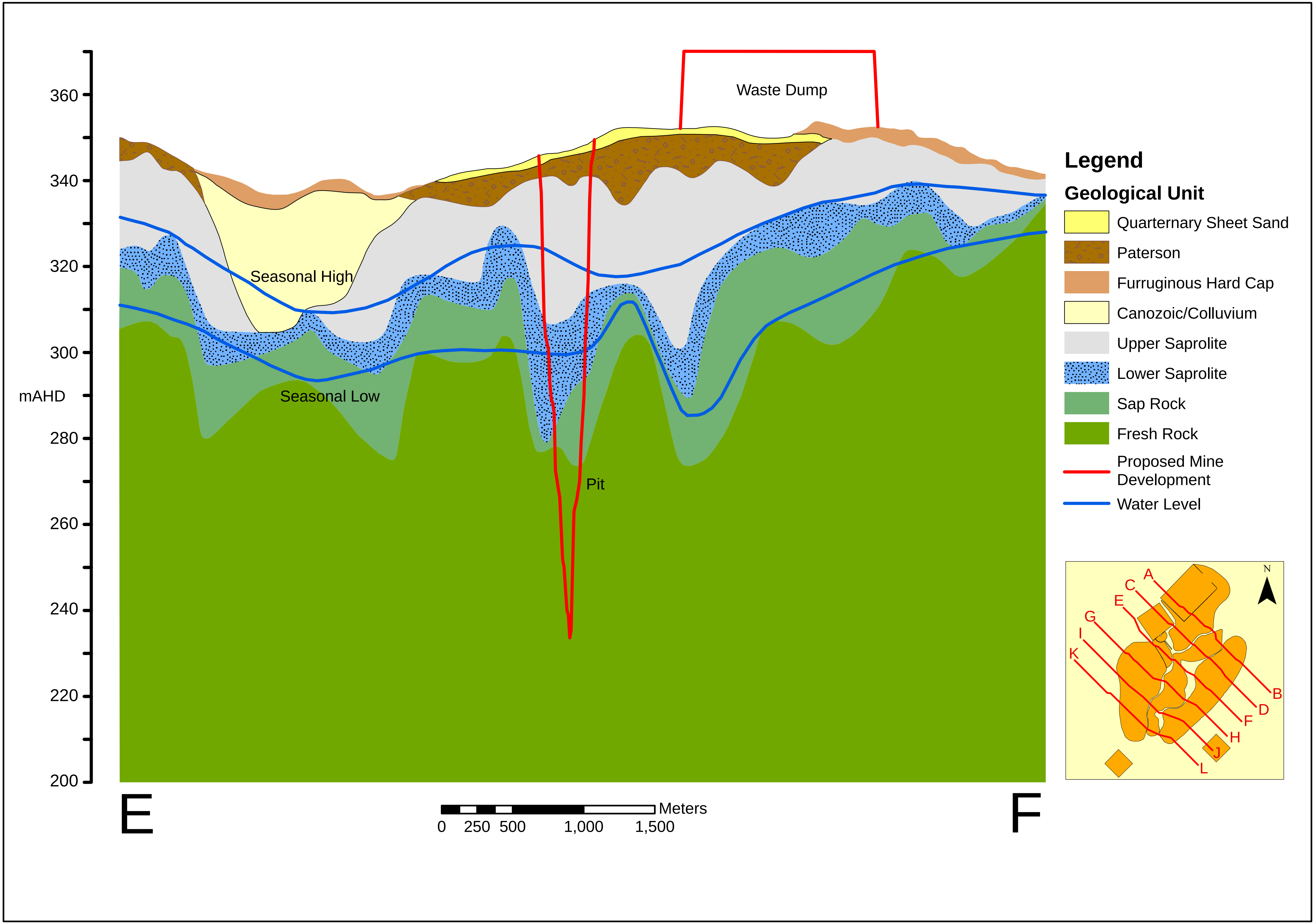
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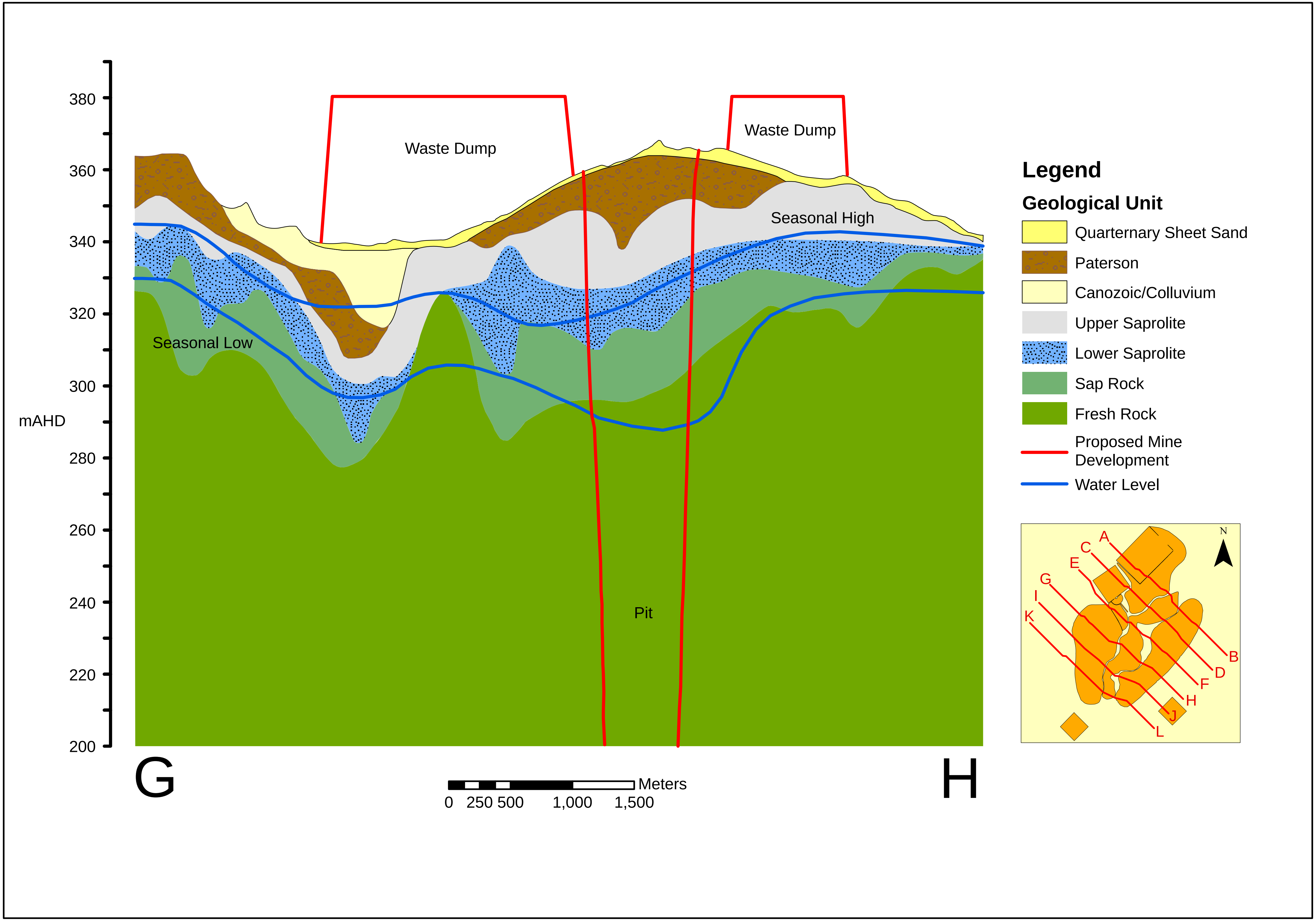
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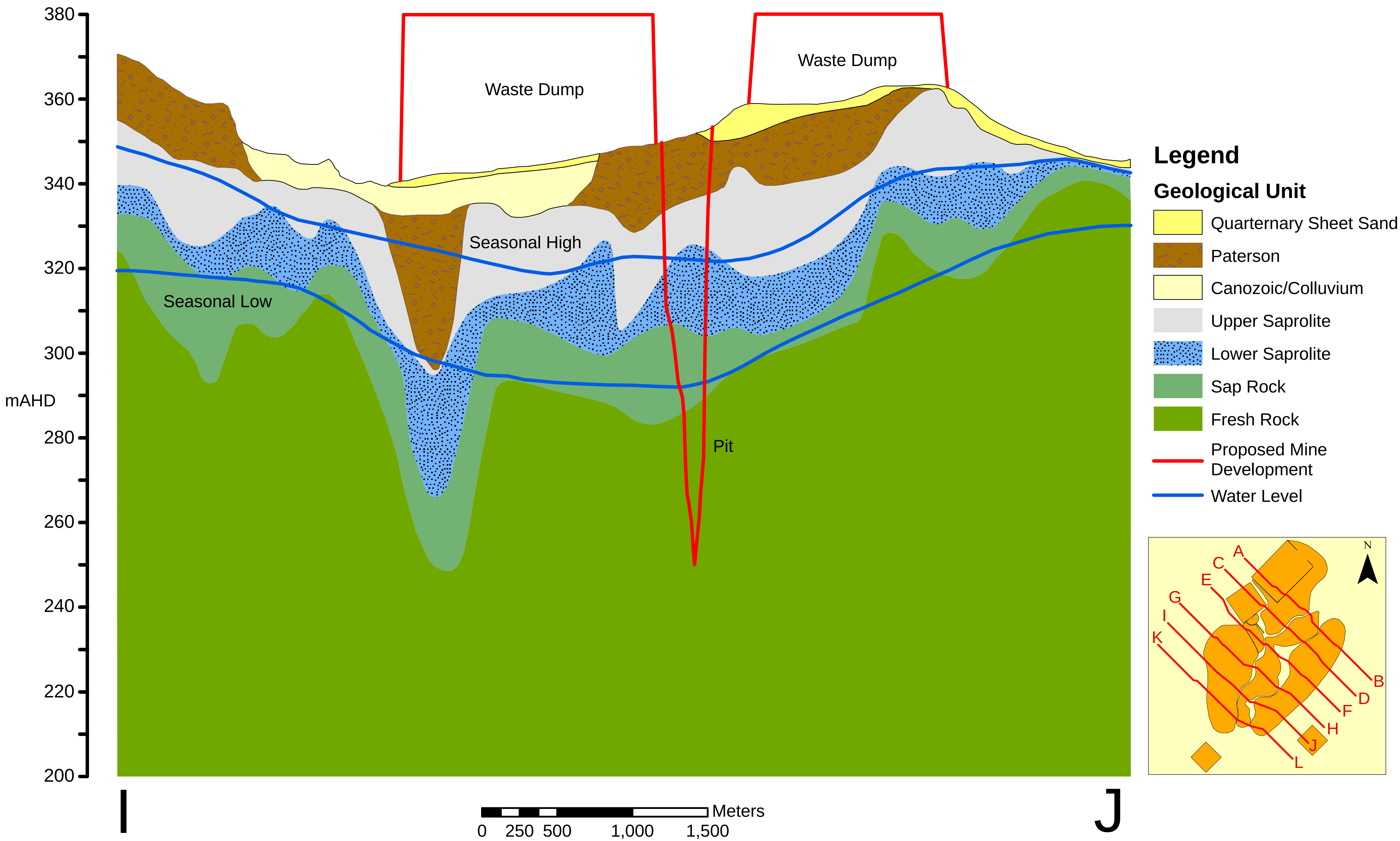
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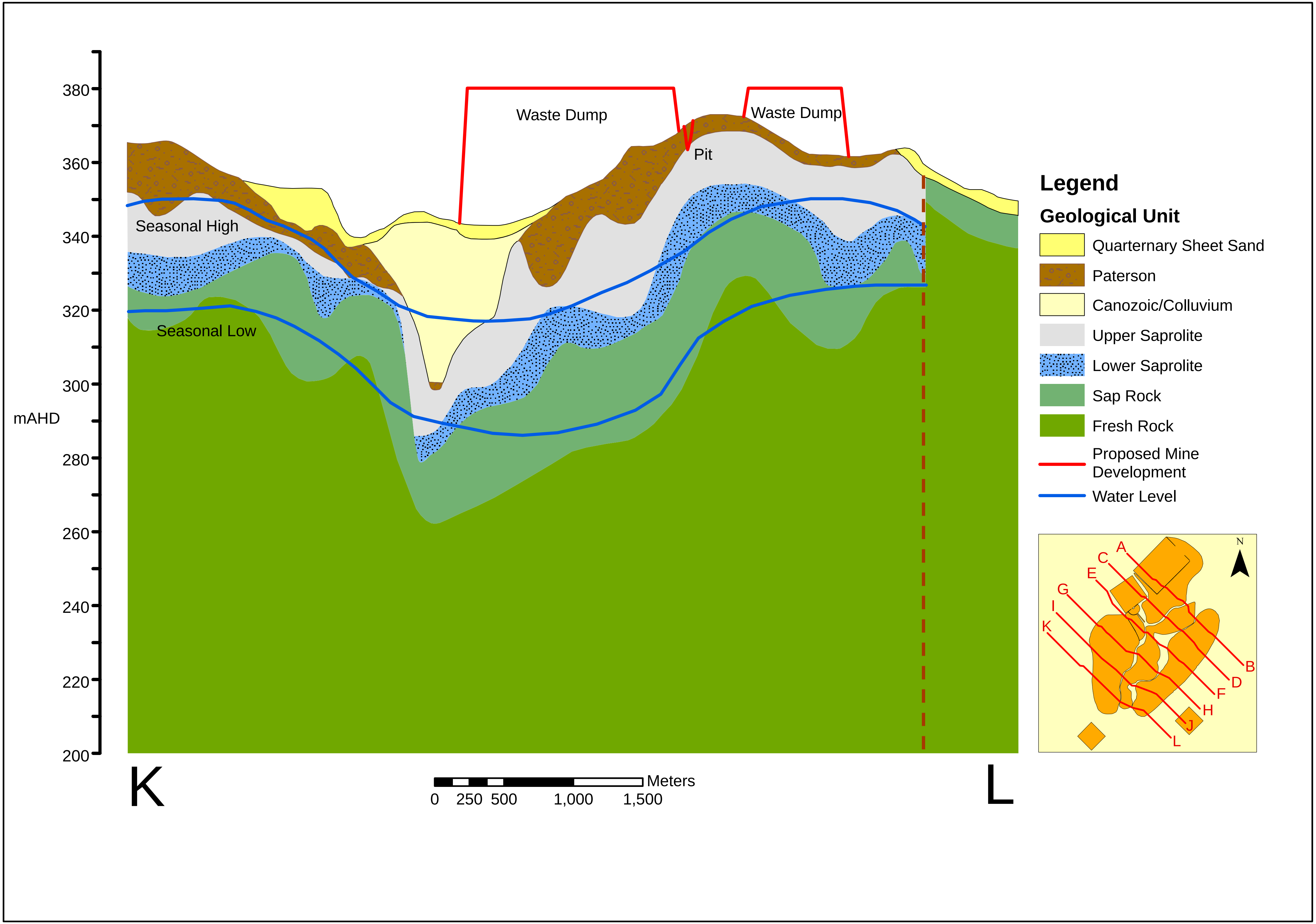

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