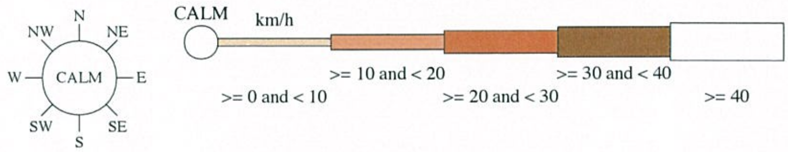
istorm times selected, refer to attached note for details

## EARCE RAAF

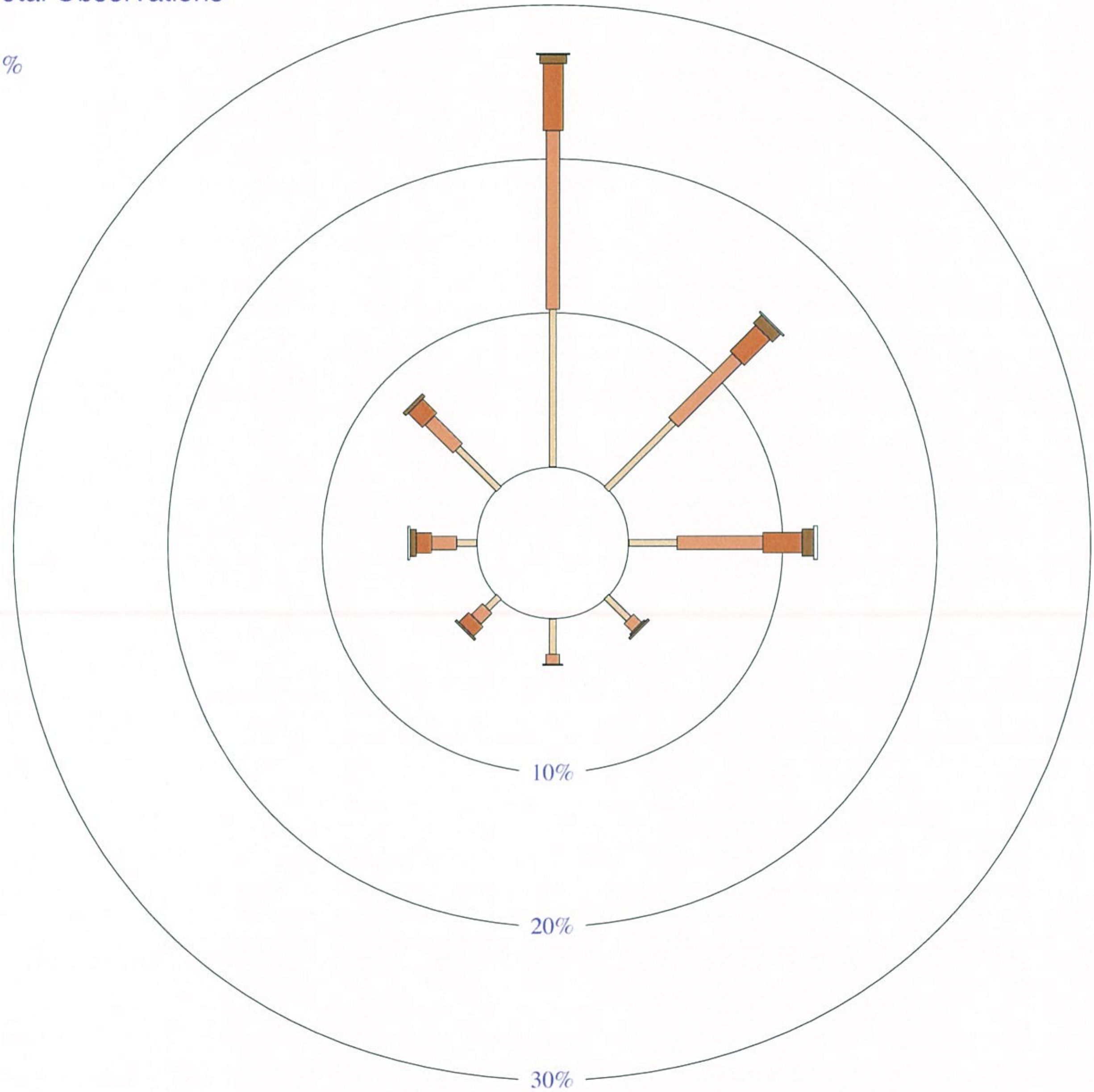
e No: 009053 • Opened Jan 1937 • Still Open • Latitude: -31.6669° • Longitude: 116.0189° • Elevation 40m

n asterisk (*) indicates that calm is less than 0.5%.
ther important info about this analysis is available in the accompanying notes.




9 am Jul
1428 Total Observations

Calm 25%



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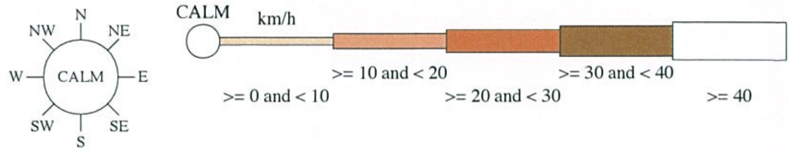
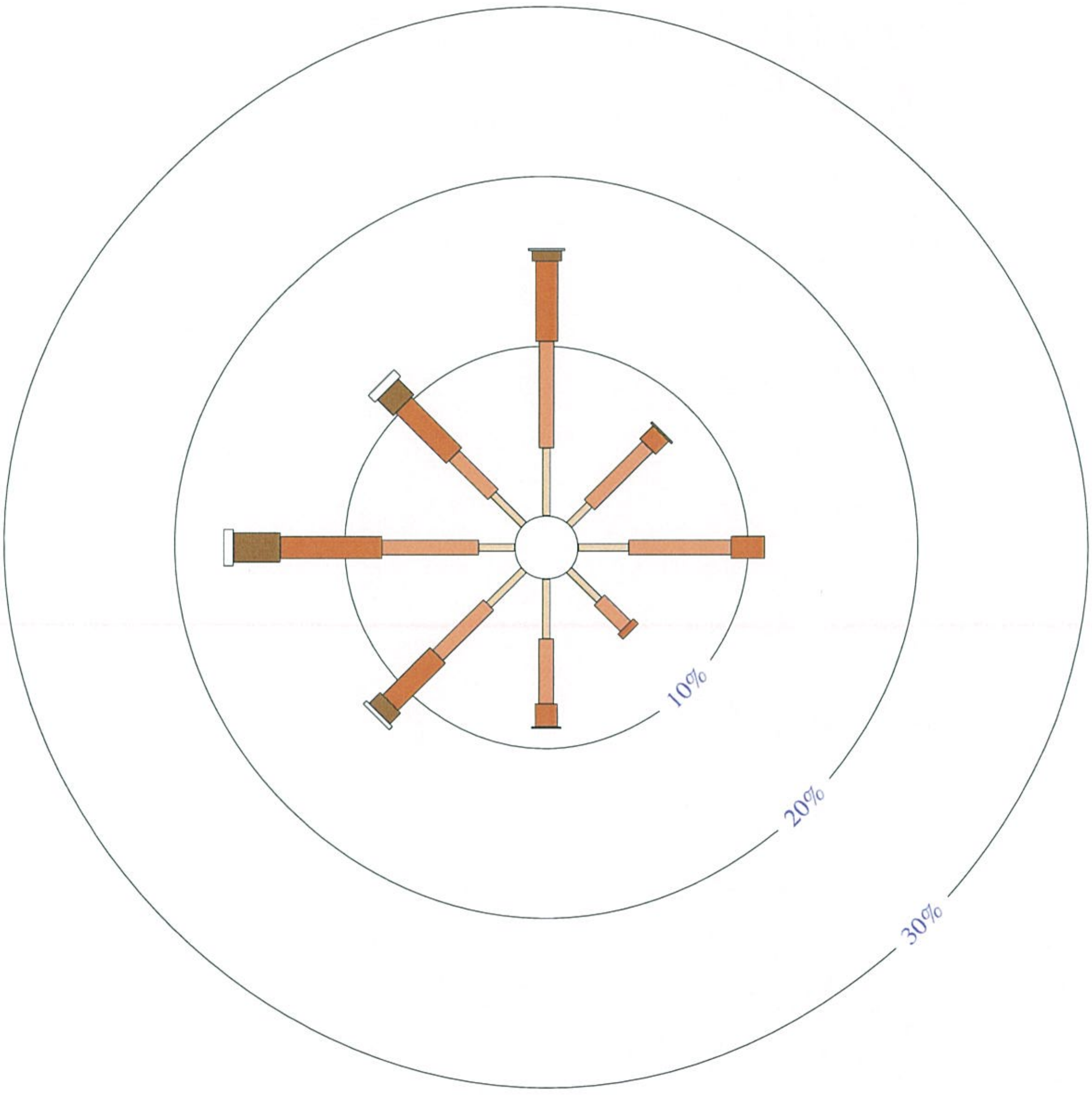



3 pm Jul
1325 Total Observations

Calm 9%



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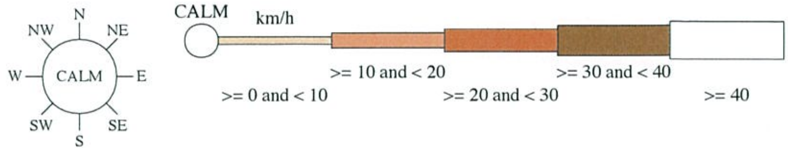
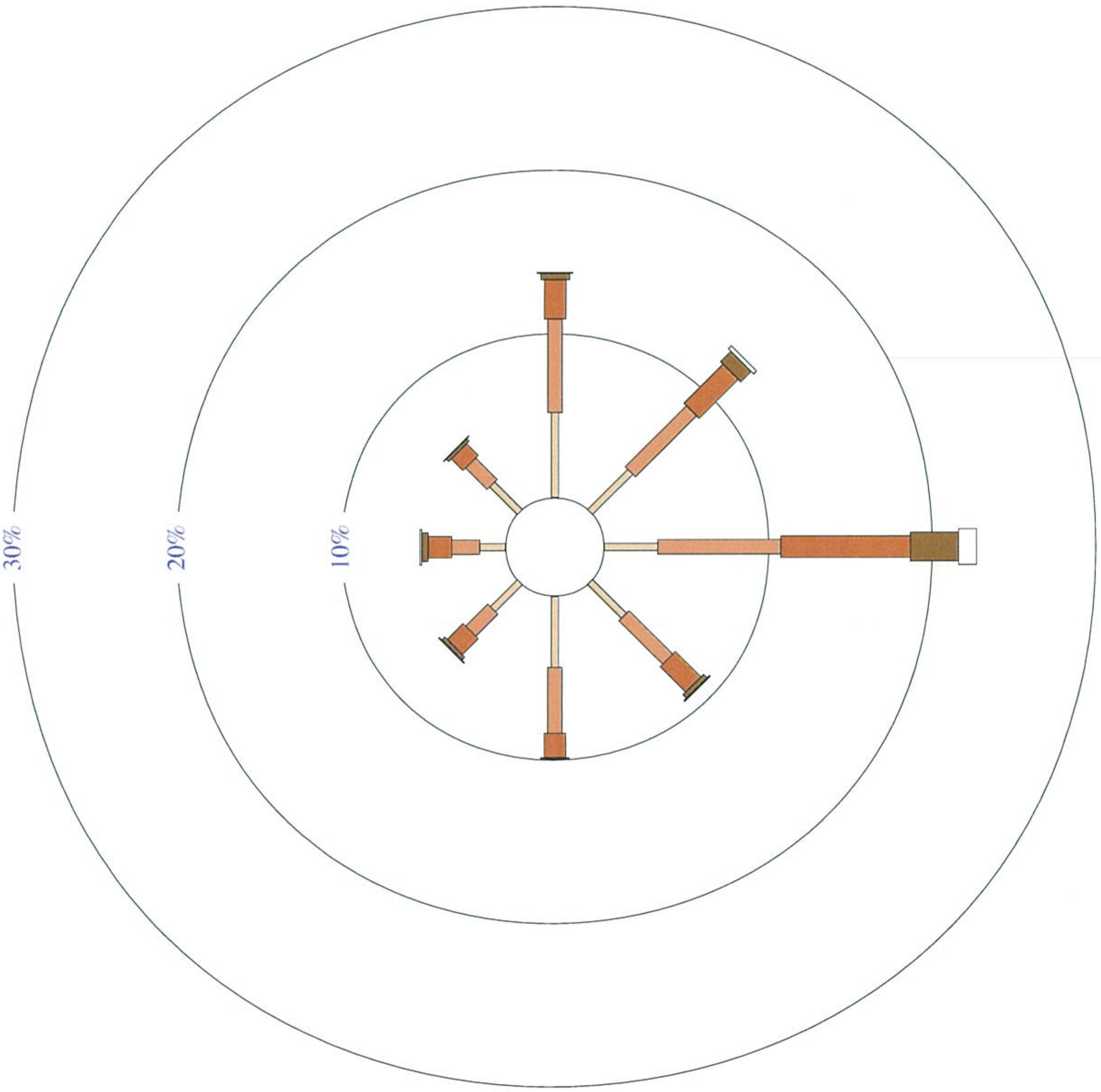



9 am
15689 Total Observations

Calm 15%



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## EARCE RAAF

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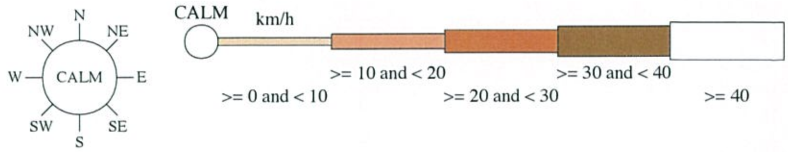


3 pm
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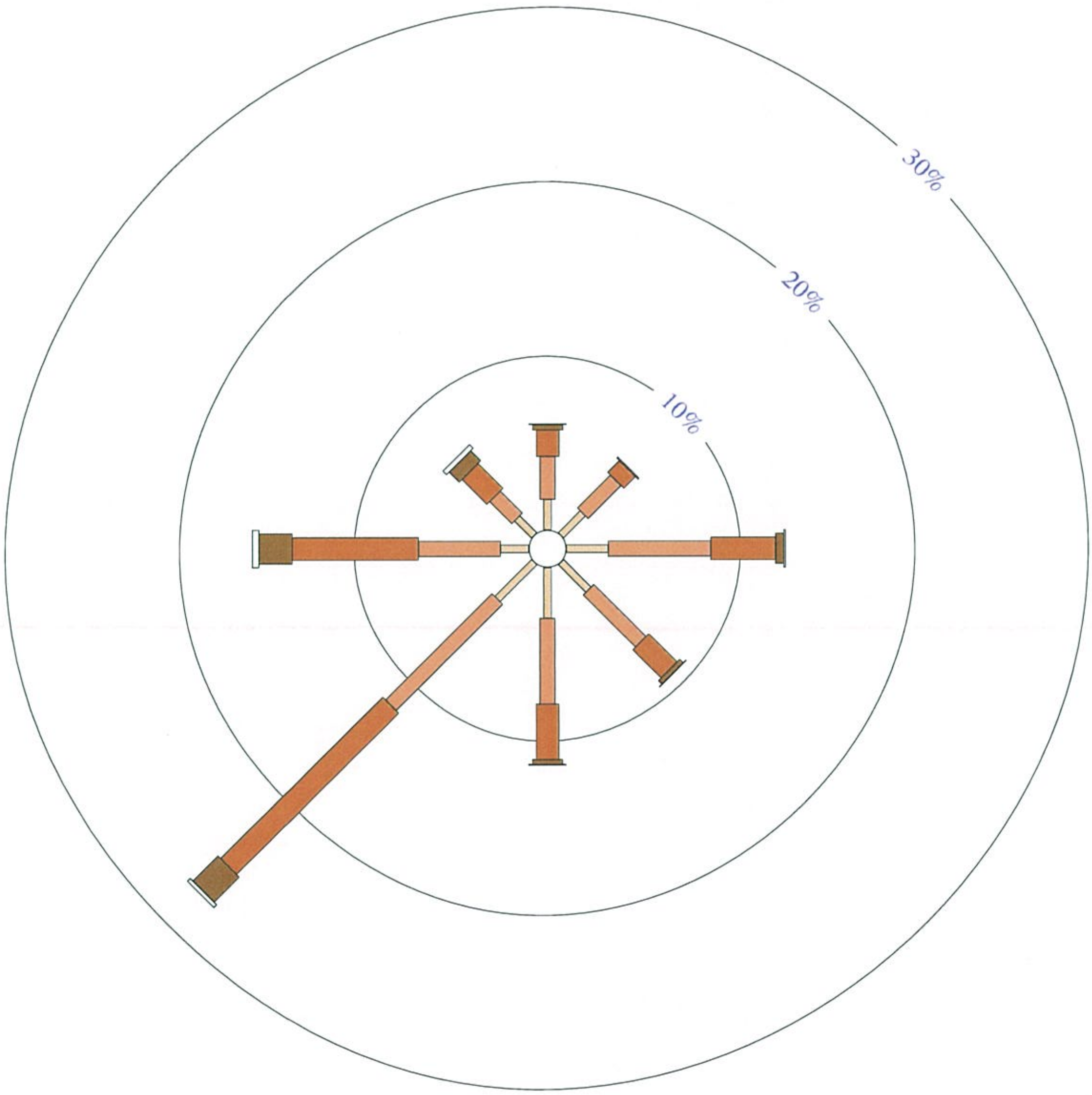
Calm 5%



# Appendix 2

# Water Management Plan
# Clay Excavation

# Lot 7, Toy Road, Bindoon

BRIKMAKERS

Brikmakers Pty Ltd

August 2015

Operations Manager

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## EXECUTIVE SUMMARY

The findings of the water management assessment and management procedures are summarised below and on the attached Figures 9A and 9B, of the Excavation and Management Plan and Figures 1W to 5W of this document.

### Summary

- The Brockman River is brackish.
- The flow in most years is confined to the main channel.
- The main channel was trained straightened and deepened many years ago to improve the pasture.
- In winter there is some water flowing from the hills to the north that form wet pasture and surface water north of the bend in the Brockman River.
- The main body of water during floods is located 500 – 1.2 km downstream from the crossing on Lot 7, but temporarily spreading upstream during high floods.
- On Lot 7, a water body forms across pasture most winters, downstream of the access and excavation. This water body has been given the name Lake Ginniby by some local people. The status of the name is unclear.
- The river crossing lies in an area of free flowing water.
- The proposed clay excavation and stockpile area is located 200 metres from where the water body pools, at an elevation approximately 14 metres higher than the water body.

### Management - Commitments

In addition to the findings above there are a number of mitigation measures to be used.

- All water from the pit and stockpiles is to be directed to the sediment settlement/storage dams.
- No water from disturbed areas can leave site without passing through the dams with the exception of the access road where runoff will be to pasture which is the normal way rural roads are treated.
- Stormwater cutoff drains are proposed upslope of the proposed pit and disturbance areas to reduce the flows to the disturbance areas. That stormwater is directed to the water storage/settlement dams.
- The bridge is to relace an existing crossing to a standard suitable for use by large farm vehicles and road transport of clay.
- The crossing and bridge have been designed to not change the water flows of the Brockman River during normal and flood flows.
- The stormwater management, bridge and earthworks are designed to have no impact on the flood water body referred to as “Lake Ginniby” by some near neighbours, the flood frequency or extent of flooding of the Brockman River.
- Quarrying is a clean industry permitted in Priority 1 public drinking water catchments.
- Extensive management of fuels, lubricants and other materials is provided.

- There will be no fuel stored on site.
- Tree belts, stormwater channels and bunds will be used to manage water, views, dust and noise.
- There will be no alteration to water flows in the Brockman River through increased sediment, changed water flows or flood regimes.

**CONTENTS**

**HYDROGEOLOGY – WATER MANAGEMENT PLAN**



FIGURES

# HYDROGEOLOGY - WATER MANAGEMENT PLAN

## 1.0 Background

A 9 hectare clay pit plus an associated stockpile area is proposed to be located on the western part of Lot 7 Toy Road, Bindoon.

Lot 7 is a large rural property that lies within the catchment of the Brockman River.
See Figure 1W.

## 2.0 Location

Lot 7 is located 5 km north from Bindoon townsite on the northern side of the Brockman River.

## 3.0 Guidance Documents

The protection of water whether groundwater or surface water is an important part of the management of quarries. Different types of quarries have different potential impacts which are listed below in general terms. Not all potential impacts will apply to this quarry and the main impacts affecting this site are also listed.

Guidance on the quality of water can be found in;

- Western Australian Water Quality Guidelines for Fresh and Marine Waters, EPA Bulletin 711, 1993.
- ANZECC, 1992, Australian Water Quality Guidelines for Fresh and Marine Waters.

A number of documents provide guidance on the management and disposal of surface water that can lead to waterways, wetlands and underground water systems. These mainly apply to urban development but the methods are also applicable to the quarrying industry.

- Engineers Australia 2003, Australian Runoff Quality, National Committee on Water Engineering.
- Stormwater Management Manual for Western Australia, Department of Environment WA, 2004.
- Guidelines for Groundwater Protection in Australia, ARMCANZ, ANZECC, September 1995.

Documents specific to the mining and quarrying operations are the DOW – DMP Water Quality Protection Guidelines for Mining and Mineral Processing.

- Overview
- Minesite water quality monitoring
- Minesite stormwater
- WQPN 28 Mechanical servicing and workshop (2006)
- Mine dewatering
- WQPN Landuse Compatibility in Public Drinking Water Source Areas (2004)

- WQPN 15 Extractive Industries near sensitive water resources.

The clay excavation complies with all the documents above. The most relevant document is WQPN 15 *Extractive Industries near sensitive water resources.* The location of the clay and its proposed excavation complies with all Advice and recommendations, of the policy (Numbers 1 – 62).

## 4.0 Geology and Geomorphology

The site lies east of the Darling Fault within the Chittering Metamorphic Zone. The Chittering Metamorphic Belt is characterised by schists and granite basement that are intruded by several ages of dolerite dykes of which the older ones have been subjected to regional pressures and are changed to amphibolite.

The resource sits on a south facing valley slope of the dissected edge of remnant of a lateritic Tertiary erosion surface at an elevation that ranges from 190 metres AHD in the north east, down to 155 metres AHD in the south west.

The land drops away towards the Brockman River in the south.

The schists and amphibolite are part of the Chittering Metamorphic Belt that underlies the whole locality. The schists strike north to north west dipping at a steep angle.

The schists are deeply weathered in part forming brown to red brown loam soils.

Additional geological information is presented in the hydrogeological report prepared by Meyer Water and Environmental Solutions that is attached. The report shows a contour plan and wider resources of which only the southern portion of the identified areas is proposed to be excavated.

South of the site the land drops to the Brockman River at an elevation of 135 metres AHD. A small floodplain formed from alluvial silts and clays occupies the base of the Brockman River Valley.

A drilling program outlined clay resources in the central north west of Lot 7 with depths ranging up to 10 to 12 metres, shallowing towards the edges.

The clay resource consists of a series of weathered dipping beds of schist and sheared dolerite - diorite that form a number of clay types.

Based on the drilling the clay resource occurs at elevations ranging from 155 – 190 metres AHD See Figures 6,7 and 8 of the Excavation and Management Plan.

## 5.0 Regolith and Soils

The soil profile is a relatively thin red brown loam that is stony in places and carries a small amount of gravel pisolites shed from upslope.

The subsoils become more clay rich grading to weathered schists and saprock at depths of 1 – 2 metres, variably extending to depths of 20 metres with an average of 10 – 12 metres.

The soil system on the extraction area is classified as Coolakin (Cek) in Smolinski, 1998, Soils of the Chittering Area, South West Forest Region, Western Australia, Department of Agriculture WA. On the valley floor of the Brockman River the soils are incorrectly classified as Norinne (No) a plateau soil. The valley floor is better classified as Murray 4 (My4) or Helena (2H3).

Coolakin – Valleys with narrow valley floors and some rock outcrop. Sandy duplex and gravels are common. This only generally describes the soils on site which are loam and clay based soils.

The reconstructed soils, at the completion of excavation, will be replacement of the red brown topsoils on overburden from the existing subsoil profile on deep ripped schist basement.

## 6.0 Climate

The climate of the area is classified as Mediterranean, with dry hot summers and cool wet winters.

Climatic data is recorded at Bullsbrook, (Pearce RAAF), 37 km to the south. Precipitation is 688 mm per annum, of which 89% falls in the months April to October inclusive. At Swan Research Station evaporation exceeds rainfall in all but the four wettest months, and the situation at Bullsbrook can be expected to be similar.

Average maximum temperatures at Bullsbrook reach 33.3 degrees Celsius for the hottest months, January and February, but fall to 17.6 degrees Celsius in July. Average minima for the coldest month August, is 8.2 degrees Celsius.

Further data on climate is attached and provided in Section 2.1 of the Excavation and Management Plan.

## 7.0 Water Source

Water for the proposed operations is to be sourced from dams to be constructed as part of the operation that will remain in place at the end of excavation and be used to supplement farm supplies. Figures 1W and 2W.

The water collecting in the base of the pit will be directed to the water storage dams and used for dust suppression.

Water in clay pits in similar geological situations, such as near Toodyay, is fresh because the water runs quickly across the clay and excavated surface to a dam.

Calculations on this water supply recharge and the management of the supply are considered in Section 8.5 Recharge and Water Supply.

A number of bores are present on Lot 7 that are used for stock purposes and will not be required for dust suppression.

Potable water is to be brought to the site as needed.

## 8.0 Hydrogeology

### 8.1 Background

The site lies to the north of the Brockman River within the Brockman River Catchment.

A number of studies have been conducted on the Brockman River such as;

- Ali et al, 2010, *Regional Drainage Evolution for the Avon Basin*, WA, CSIRO.
- Beatty, S J, D L Morgan, M Klunzinger and A J Lymbery, 2010, *Aquatic Macrofauna of Ellen Brook and the Brockman River: Fresh Water Refuges in a salinized Catchment*, Murdoch University.
- Chittering Landcare, Brockman Snapshot Years 2010 to 2014.
- Department of Water 2010, *Setting allocation limits for Brockman River and Marbling Broo*k, Report 44.
- Hindmarsh R 2003, *Natural Resource Management Plan for the Brockman River Catchment,* Water and Rivers Commission.
- Smith M G, 2002, *Groundwater Information and Management Options for the Brockman River Catchment*, Water and Rivers Commission.

The studies aim to provide data and management actions to protect the Brockman River Catchment and the future water quality.

The Chittering Landcare Group is active in monitoring and overseeing management of the Brockman River Catchment.

### 8.2 Surface Water

The Brockman catchment at times is brackish to saline in summer reducing in winter to brackish water. Trends towards increased salinity are due to land clearing within the catchment and changed rainfall regimes. Most of the catchment remains uncleared. There have been some changes to nutrient levels in the river in recent years but in 2014 these did not increase.

Much of the local catchment remains uncleared. Refer to Figure 1W.

There are minor watercourses near the site, running south along the western side of the proposed clay pit and stockpile area. This watercourse and tributaries will be protected with setbacks and diversion of all water from disturbance areas to detention basins and a large dam. A small drainage line will be intersected by activity on site. The upper portion of this drainage line will be diverted along contour to join a drainage line in the south that drains to the Brockman River.

Most drainage runs as surface runoff from the clay based hill and a small amount of recharge will infiltrate the loam and clay soils.

In storm events, when surface water exceeds infiltration, there are diffuse flows to the watercourse. A small portion of this will be diverted by the pit to the water storage dam.

At the end of excavation the site will be rehabilitated, with the water storage dams remaining as farm dams to enhance the agricultural capability of the land.

Trends towards increased salinity are due to land clearing within the catchment and changed rainfall regimes. As the land is already cleared the proposal will not impact on salinity.

See also Section 8.5 Recharge and Water Supply.

## 8.3 Groundwater

The hydrogeology and groundwater is considered in the report of Meyer Water and Environmental Solutions, attached as Appendix 1. For water quality, see Section 8.6 Salinity (below).

Additional information is provided in *Smith, 2002, Groundwater Information and Management Options for the Brockman River Catchment,* Water and Rivers Commission.

A costean was excavated at hole DW047 shown on the figure attached in The Meyer Report. That costean was located where the proposed water storage dam is to be located and represents a perched aquifer. The water quality intersected on 23 February 2005 was 612 mg/L salinity. Clay testing by Brikmakers shows low salt content, averaging 200 ppm, which is normal for sloping loam soils in a moderate to high rainfall zones and lower than other soils in the Chittering area.

Drilling by Brikmakers to depths of several, to over 10 metres, did not intersect the water table in the drill holes. The base of the holes were at a lowest elevation of 235 metres AHD. Some drill holes struck granite basement at higher elevations.

Drilling on the floodplain by Brikmakers intersected a superficial sandy aquifer located below 1 – 2 metres of loamy clay. The water was abundant and brackish in quality and will not be used.

The base of the proposed excavation is well above the water table.

*Smith, 2002, Groundwater Information and Management Options for the Brockman River Catchment,* noted that groundwater levels were rising in the Brockman River Catchment. This does not impact on the proposed excavation because the water source is to be harvested surface water.

## 8.4 Dewatering

Dewatering of the pit is not proposed and is not normally used at other clay pits operated by Brikmakers. All surface water collecting in the pit will drain to a sump near the stockpile area. From there it will drain to the water storage dams.

Maps are attached showing concept design pits during excavation of clay. See Figures 4 – 8 of the Excavation and Management Plan and Figure 2W (attached).

At the end of excavation the pits will be prepared to a landform to ensure that all stormwater will be retained within the water storage dams as a future water source for the farm.

## 8.5 Recharge and Water Supply

When the farm was first cleared and the vegetation removed the recharge will have increased.

As the pasture is to be returned at the end of excavation, and additional trees are required to be planted as part of the excavation, there will be no changes to the current level of recharge on site as a result of excavation.

The proposed dams are to be located off the main creek line, which will not be impacted, and maintain its environmental flows. Refer to Figure 2W.

The behaviour of the dams during, and at the end of, excavation is considered below.

Both proposed dams have an open area of 1 hectare each. With an anticipated depth grading from 0 metres at the edges to 8 plus metres in the center, the total volume of water available in each dam is about 25 000 cubic metres or kL based on an average depth of 5 metres. That is 50 000 kL water holding capacity for the two dams. Making the dams deeper reduces the percentage of evaporation from the surface as a percentage of water volume and is desirable. The dams will be deepened to perhaps 8 metres in the deepest points, but for the sake of calculations a 5 metre centre depth is used. Figure 2W.

The cut off drains will be located on the upslope side of the pit and stockpile areas to capture and direct water to the storage dam. That catchment has an area of 31.5 ha. The total pits have an area of 9 ha, the stockpile areas about 4 ha and the dams themselves have an area of 2 ha.

Rainfall is 688 mm at Pearce. Considering Lot 7 is further north, but hilly, the rainfall is likely to be similar. However a figure of 600 mm rainfall is chosen to be conservative. For example the annual total at Bindoon in 2014 was 663 mm.

Using data from *Coles and Moore, 1998, Runoff and Water Erosion, Soil Guide, Department of Agriculture and Food, WA*, runoff from Type A Landscape forms is 20% of rainfall for 600 mm. That is equivalent to 120 mm per year for the upslope pasture. For the pit runoff is anticipated to be 40 % or 240 mm per year and for the dams 80 % of rainfall or 480 mm per year will add to the dams.

The following water availability is therefore;

35 ha pasture catchment x 10 000 $m^2$ x 120/1000 = 42 000 kL per year surface water

9 ha pit and 4 ha hardstand x 10 000 $m^2$ x 240/1000 = 31 200 kL per year surface water

2 ha water body x 10 000 $m^2$ x 480/1000 = 9 600 kL per year surface water

The catchment is therefore likely to generate 82 800 kL per year. As the two dams will be designed to hold 50 000 kL the design of the system is such that the water will be captured during excavation and operations and on closure, when the recharge from the pit will reduce back to pasture, there should still be sufficient water to fill the dams.

Evaporation is likely to reduce the dams by 40% however there will be around 50 000 kL water available for dust suppression through summer following a relatively dry year. See the note above relating to deepening the dams to 8 metres at the deepest point to reduce the influence of evaporation. Conservative estimates are used.

Brikmakers estimates that 80 tonnes or kL per day water will be required to suppress dust during the summer months. If water is required for five months of the year (120 working days) the water requirement would be 9 600 kL.

The proposed water collection will therefore produce and retain sufficient water for dust suppression.

During excavation and in wetter years the dams should overflow to assist in maintaining the environmental flows in the Brockman River. At such times the stormwater will be diverted around the dams to direct clean stormwater to the watercourses and ensure that water from the disturbed areas are retained on site. See Figures 2W (attached) and Figures 7 and 8 of the Excavation and Management Plan.

The amount of change to recharge is therefore small and unlikely to lead to any change in the regional water table or water flows in the Brockman River.

The proposed operation complies with all Government Policies and Guidelines.

There will be no alteration to drainage lines, and neither surface water nor ground water will be affected.

## 8.6 Salinity

Salinity is the main concern of the protection of the Brockman Catchment. The Brockman catchment is brackish, becoming more salty in summer and reducing in winter. Stock are able to drink the water in winter but not in summer.

There are no watercourses on the excavation area, although surface water can flow down a depression/drainage line.

There are no salt or seepages on the resource area and the clay has low salinity.

Meyer Water and Environmental Solutions assessed the water quality and showed the presence of two small seepages. The main seepage lies in the creek line west of the disturbance area. This flows all year round and was found to have a salinity of 490 mg/L in February 2005.

Other testing of water encountered during drilling was less than 470 mg/L. See attached report from Meyer Water and Environmental Solutions.

Clay testing by Brikmakers shows low salt content, averaging 200 ppm, which is normal or lower than other soils in the Chittering area.

A costean was excavated at hole DW047 shown on the figure attached in the Meyer report (attached). That costean was located where the proposed water storage dam is to be located and represents a perched aquifer. The water quality intersected on 23 February 2005 was 612 mg/L salinity. See Meyer Water and Environmental Solutions.

The dam was tested by Meyer Water and Environmental Solutions on 23 February 2005 and found to have water concentrated by evaporation with a salinity of 2157 mg/L. See attached report from Meyer Water and Environmental Solutions.

All water is suitable for stock.

### 8.7 Acid Sulfate Risk

Acid sulfate only becomes a potential risk when a number of circumstances are present.

- There is rock, soil or regolith present that is carrying sulfides.
- Sulfide carrying materials from below the water table are to be exposed to the atmosphere.
- Excavation below the water table is to be carried out exposing the sulfide carrying materials to oxygen in the atmosphere.
- Dewatering of the sulfide carrying materials is proposed, exposing them to oxygen.

None of these conditions occur on site based on geological mapping of the site during the site inspection, examination of the drill data, examination of the pit and from published information, and none would be expected from this type of geology. The potential acid sulfate within the Muchea area relates to sedimentary shales of Mesozoic age which do not occur in this geological environment or nearby.

On this site the geology of the weathered metamorphic schist and amphibolite does not contain disseminated sulfides. Any sulfide minerals that may occur in the unweathered basement rocks has geologically been weathered and dissolved within the Tertiary weathering regime. In addition the clay to be extracted is well above the water table in oxidised conditions.

Brikmakers has conducted an extensive drill based exploration program. Samples are collected from each metre of depth and all samples are analysed for a number of parameters including total Carbon, Sulfur and soluble Salts

The clay examined on site does not carry any sulfide, or the weathering products of sulfides, from site geological examination of the clays by Brikmakers' geologist and from site examination by Landform Research.

Brikmakers have parameters for sulfur in clay which would burn to sulfur dioxide during brickmaking. They therefore regularly test the clay for sulfur as part of their quality control for firing bricks and the resulting gaseous emissions. Clays which contain any significant sulfur are not used.

Brikmakers have standard management practices in place at all their clay pits if any acid sulfur conditions are detected, because acidic conditions can impact on clay processing and brick making.

On this site the basal geology of the hard rock and regolith are under well oxygenated terrestrial conditions, located high in the landscape, and have no known potential to contain disseminated sulfides. The geological and regolith environment is not conducive to sulfides.

Therefore there is no potential for acid conditions to develop in this ecological or geomorphological situation.

## 9.0 Protection – Brockman Catchment

### 9.1 Background

A summary of the Brockman River Catchment can be found in the documents listed in Section 8.0 Hydrogeology, under Background.

### 9.2 Protection of ground and surface water and the Brockman Catchment

Contour plans at 0.5 metre interval have been generated by Brikmakers for the area upstream and downstream of the access road.

The 0.5 metre contours were produced around the river crossing and operation to enable the design of the access road and crossing. In other areas 5 metre contours are available and are used. The one metre contours enable flood planning and assessment.

- As noted above the project will use water harvested from the on site dams. The water is fresh and will have no impact on salinity through its use for dust suppression.

- The key to protecting the catchment is to ensure that operations, in particular fuel and maintenance, are effectively managed. This is covered below.

- Recharge is calculated to not change significantly.

- The other key management issue is the access road crossing the Brockman River. The proposed crossing is located in the same point as the existing access road.

- The disturbance footprint is designed to be isolated from surface water flows.

- Cut off drains are proposed up slope to direct water away from the disturbance areas to the storage/settlement dams.

- All water from the disturbed areas is directed to the water storage dams. These dams are sized to fill in average winters and to overflow in wet winters through protected overflow outlets. The dams will provide the time for sediment to settle prior to overflow. Refer to Figure 2W.

- There are extensive management procedures proposed for operations that are detailed in the individual sections of this Water Management Plan and are listed in the summary.

As discussed below there will be no alteration to water flows in the Brockman River through increased sediment, changed water flows or flood regimes.

### 9.3 Access Road

The current access road has a bridge that has deteriorated and is no longer safe. It must be replaced. The bridge and access needs to be capable of taking farm traffic and heavy farming machinery in the long term and quarry road trucks during the life of the excavations. It will therefore have to be designed and constructed to a suitable standard. Refer to Figures 9A and 9B attached from the Excavation and Management Plan.

The access road will be subject of engineering drawings, submitted prior to construction. Geotechnical assessments of the ground receiving the footings will be completed to inform the design of the bridge.

The current flow paths are cut off by the existing road on the southern side of the channel and the same is proposed for the upgraded access road.

The access road is to be formed from Toy Road as a causeway to the channel of the Brockman River where the existing bridge will be replaced. From there a causeway will cross the flood plain to the rising ground where the access road will continue.

The causeway is anticipated to be the minimum elevation to provide a road access. Based on the type of soils of the floodplain that is anticipated to be 300 - 500 mm in elevation above the natural soil. Figures 9A and 9B of the Excavation and Management Plan.

The engineering advice received by Brikmakers and their pre-cast concrete division is that the bridge can be designed with precast concrete spans and abutments and a single centre support. The bridge is designed not to impede the flow of the river during normal winter rainfall, storms or flood events.

The causeway on the northern side of the channel will be 300 – 500 mm lower in elevation

The floodplain south of the main channel is slightly higher than the northern side by around 500 mm. The causeway will consequently be lower.

The main reason for this is to minimise disruption to the natural flows of the Brockman River.

South of the channel the access road is proposed to be 133.5 m AHD. The bridge crossing is anticipated to be a similar elevation.

The main channel is some 15 metres wide at the crossing point. The replacement bridge is proposed to have a cross sectional area of 6 $m^2$ to allow for normal winter flows with the road surface being 133.0 m AHD.

North of the channel the elevation will reduce to 132.5 to 132.7 m AHD.

## 9.4 Brockman River Flows and Flooding

Normal winter flows will continue in the main channel flowing under the replaced bridge crossing.

The Brockman River only floods in response to significantly heavy storm events at any time of the year.

The previous owners of Lot 7 "trained" the Brockman River by cutting, deepening and straightening the river channel along Lot 7. This had the effect of allowing the smaller flows to move relatively quickly along the watercourse whilst retaining the existing flood paths of the floods. Figures 9A and 9B of the Excavation and Management Plan.

When the river rises in a small flood the additional water will flow across the access road north of the channel as it does now.

In this location the river runs through pasture covered floodplain wholely on Lot 7 from 150 metres upstream of the crossing to 1.2 km downstream. There are low and narrow alluvial terraces to the south and north although these are mostly narrow and not significant. There are minor natural levee banks particularly on the northern side of the main channel which rise to about 0.5 metres above the existing floodplain.

They affect the minor flood flows downstream of the crossing by directing water to the edges of the flood plain which is typical of river systems such as this. The effect is that during floods the water temporarily flows out of the watercourse particularly to the north and in higher flood south of the main channel, and slows down.

Downstream of Lot 7, over 1.2 km from the crossing, there are more densely vegetated areas typified by *Melaleuca* that slow the flow of the floods raising the water elevation so that it pools on the eastern side of Lot 7. Refer to Figure 5W.

There is no detailed flood data calculations available for this section for the Brockman River, some flood data is available in some other locations from Department of Water Gauging Stations and published data. A Gauging station is located upstream to the north west. Even so there is good field and observational evidence for the location and elevations of the water and flood flows.

The current flow paths and flood paths are based on photographs of the floods, recollections of the landholders, examination of the geomorphological patterns of the river, patterns of pasture and winter water patterns and the location of the Flooded Gums which typically germinate near or at the edge of floods.

It is noted that in a submission to the Shire of Chittering there is mention of a “Ginniby Lake”. A photograph provided in that submission (Appendix 5 of the Excavation and Management Plan)) is attached and is labelled as “Lake Ginniby” in the submission, stating that it forms in winter. The “lake” apparently is located almost totally on Lot 7.

The current owner has lived on Lot 7 for a number of years and has been associated with the property for many years and is unaware of the name “Lake Ginniby”.

As noted above, the area in the east of Lot 7 does pond with water in flood flows and in winter and appears to be what the local people are referring to as “Lake Ginniby”. The water body only forms in time of higher flows and may form as a variable sized body of water that lasts for some days with remnants remaining for a longer time.

In some years the water body will form, dry up and then reform depending on the rainfall pattern. The large bodies of water that form are related to flood events within the Brockman River floods that occur every few years.

In winter surface water flows from the hills to the north form areas of wet pasture and surface water on the northern side of the bend in the Brockman River.

The flooded area on Lot 7 is wholely located on pasture, but does occupy some *Melaleuca* thickets downstream. Apart from the photograph provided by the local residents in their submission (Appendix 5 of the main report) the only aerial photograph showing the water body is from Landgate dated 1981 which is attached as Figure 5W.

The assessments of flood flows are drawn together by Lindsay Stephens of Landform Research who has extensive experience in landform and regolith morphology, backed by field assessments and the 0.5 metre contours. Refer to Figures 9A, 9B of the Excavation and Management Plan and Figures 3W, 4W and 5W of this Water Management Plan.

The use of geomorphology is a highly valid means of determining historical and likely future flood paths and flows.

The size of the flood is determined by providing an historical surface area to the cross section of the flood flow and then using that cross section to determine the likely impact of the construction of the bridge and causeway. This was completed using the geomorphology, ground observations of the flood plain and terracing, aerial photography, lines of *Eucalyptus rudis*, and 0.5 metre contours. The flood levels were then determined. Refer to Figure 4W.

It was not till after the interpretation was made that the site photograph provided in the submission (Appendix 5 of the Excavation and Management Plan) was provided to Brikmakers. The photograph was matched by the trees and the elevation of the water plotted on the plans and photos.

The Landgate aerial photograph dated 1981 also shows the flood extent and from the photo it would appear to have been when the flood was receding. The previous extent of the water body can be interpreted from the aerial photograph. Refer to Figure 4W.

All these lines of evidence are independent and they all provide a very similar footprint for the flood paths. Therefore the data can be viewed with a some level of confidence. Refer to Figures 3W to 5W.

The proposed bridge will not impact on flood flows or the water that pools on the alluvial soils of Lot 7 in winter and during floods.

## 10.0 Waste Management

### 10.1 Waste Rock and Tailings Management

There will be no washing of products. Subgrade materials and overburden will be placed around the perimeter to form the screening bunds.

At the end of excavation the bunds will be spread back across the excavated surface for subsoil restoration and landform restoration.

There will be no waste rock or tailings. All materials are natural clays, soils and weathered rock. Subgrade material will be used to backfill the pit batter slopes and for soil restoration.

Al subgrade materials will be stored within the disturbance footprint.

### 10.2 Unauthorised Access and Illegal Dumping

The potential for rubbish to be dumped relates to unauthorised access to the site. Access is restricted by current farm fencing and locked gates. This is unlikely to be an issue at the pit which is not located near the boundary of Lot 7, but may occur at Toy Road. Fences will be maintained and upgraded as required.

Wastes generated from on site operational activities will be recycled wherever possible and periodically disposed of at an approved landfill site.

Any illegally dumped materials are to be removed promptly to an approved landfill or other suitable site, depending on the nature of the material.

### 10.3 Solid Domestic and Light Industrial Wastes

All solid domestic and light industrial wastes will be stored in commercial waste storage containers and/or removed to an approved landfill facility.

There will be no waste disposal on site. Waste storage containers will be sealed so that rainfall cannot enter, therefore preventing the formation of leachates.

### 10.4 Wastewater Disposal

As the operations are small scale and intermittent it is proposed to use the on site approved serviced portable toilet facilities when the site is manned.

This complies with *WQPN 15 Extractive Industries near sensitive water resources.*

## 10.5 Refuelling

The protection of water from fuels and other chemicals is an important part of the management of quarries. Different types of quarries have different potential impacts which are listed below in general terms. Not all potential impacts will apply to this quarry and the main impacts affecting this site are also listed

Extraction of clay is a clean operation similar to sand excavation in the nature of the risk to groundwater. No chemicals are used apart from normal lubricants, which is similar to sand excavation, and sand excavation is one of the few industries that are permitted to operate in a Priority 1 Public Drinking Water Source Area, indicating the clean nature of the activity. See Department of Water *Land Use Compatibility in Public Drinking Water Source Areas.*

All spills are to be cleaned up in accordance with the summarised procedures following.

> *Documents specific to the fuel and maintenance are the DOW – DMP Water Quality Protection Guidelines for Mining and Mineral Processing*
>
> - *Mechanical servicing and workshop facilities*
> - *Above-ground fuel and chemical storage*
> - *WQPN 28 Mechanical servicing and workshop (2006)*
> - *WQPN 15 Extractive Industries near sensitive water resources.*

A list of the management actions for maintenance is provided. The actions will be used where applicable and as the opportunity presents to maintain water quality on this site.

Brikmakers have in place safety and pollution management procedures for all their operations. They also use self contained service and recovery vehicles to undertake minor servicing in the field.

- **Refuelling - Fuel Spill Management Plan**

The protection of water from fuels and other chemicals is an important part of the management of quarries. Different types of quarries have different potential impacts, which are listed below in general terms. Not all potential impacts will apply to this quarry and the main impacts affecting this site are also listed.

The operational procedures proposed comply with *WQPN 15 Extractive Industries near sensitive water resources.*

Refuelling will use mobile tankers. There will be no onsite fuel storage. This method is undertaken on most mine and construction sites as well as many farming properties and is the method used on all other Brikmakers pits. Refuelling will occur in the active pit or stockpile area to allow for containment if any spill did occur.

Clays such as this are normally impermeable. Clays usually have permeabilities of $10^{-11}$ - $10^{-5}$ cm/sec, (Hirschberg 1993) depending on their nature.

The main risk of contamination is the minor drips that occur during the removal of hoses etc. Minor spills are quickly degraded by soil microbial matter. Any drips or minor fluid spills will be scooped up with the clay resource and sent to the Hazelmere works site, where they will be burnt with the clay during the firing process.

The only other risk is from a tank rupture, but tanks are designed to manage this eventuality. Soil contaminated by large spills will be removed from the site to an approved disposal area.

- Refuelling will be carried out in accordance with the DOW – DMP Water Quality Protection Guidelines for Mining and Mineral Processing, *Mechanical servicing and workshop facilities, Above-ground fuel and chemical storage* and *WQPN 15 Extractive Industries near sensitive water resources.*

- Soils and hardstand such as those on this site are partially adsorptive. The main risk of contamination is the minor drips that occur during the removal of hoses etc. Minor spills are quickly degraded by soil microbial matter.

- The operators of the mobile refuelling facilities (SWP) are trained in re-fuelling duties including the management of any spills.

- Refuelling and lubricating activities are to occur in the base of the pit, and equipment for the containment and cleanup of spills is to be provided. The mobile facilities are equipped with adsorbent mats and products (eg attapulgite) to be used in the event of spills.

- Spillage will be contained in plant and working areas by shutting down plant or equipment if the plant or equipment is the source of the spill (provided it is safe to do so).

- Transport chemicals in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code).

- All significant adverse incidents (such as a fuel spill of >5 litres) in one dump, are to be recorded, investigated and remediated. A record is to be kept of incidents, and DER, DOW and Shire of Chittering notified within 24 hours of an incident.

- In the event of a spill or adverse incident, activities will be stopped in that area until the incident is resolved.

- Any spills will be contained by the excavation. Soil and resource will quickly be placed around the spill to contain it in as small an area as possible. When contained, the contaminated clay will be scooped up and removed to an approved landfill or other approved site.

## 10.6 Dangerous Goods and Hazardous Substances

There is no transport, storage or handling of hazardous materials involved in clay extraction.

## 10.7 Servicing and Maintenance

- All major servicing of vehicles will be conducted off site, and maintenance using dedicated trucks with oil and waste recovery systems will be used. This is consistent with *WQPN 15 Extractive Industries near sensitive water resources*.

- Waste oil and other fluids derived from the routine maintenance of mobile machinery, will be transported off site and disposed of at an approved landfill site. Grease canisters, fuel filters, oil filters and top-up oils will be stored in appropriate containers in a shed or brought to the site as required.

- Vehicle washdown is not proposed.

- Regular inspections and maintenance of fuel, oil and hydraulic fluids in storages and lines will be carried out for wear or faults.

- Servicing plant and equipment will be in accordance with a maintenance schedule.

- Accidental spill containment and cleanup protocol will be implemented as necessary.

- Rubbish generated is to be recycled wherever possible and periodically disposed of at an approved landfill site.

- The site will be maintained in a tidy manner by removing all rubbish regularly offsite.

## 11.0 Monitoring

Monitoring will concentrate in two areas;

- Supervision and management of the operations.

- Monitoring of surface water in the dams.

Monitoring of groundwater is not considered necessary because all surface water is to be collected and directed to the dams. Any fuel or other spills should show up in that monitoring. See Figures 2W showing the concept operational diagram of the pit operation.

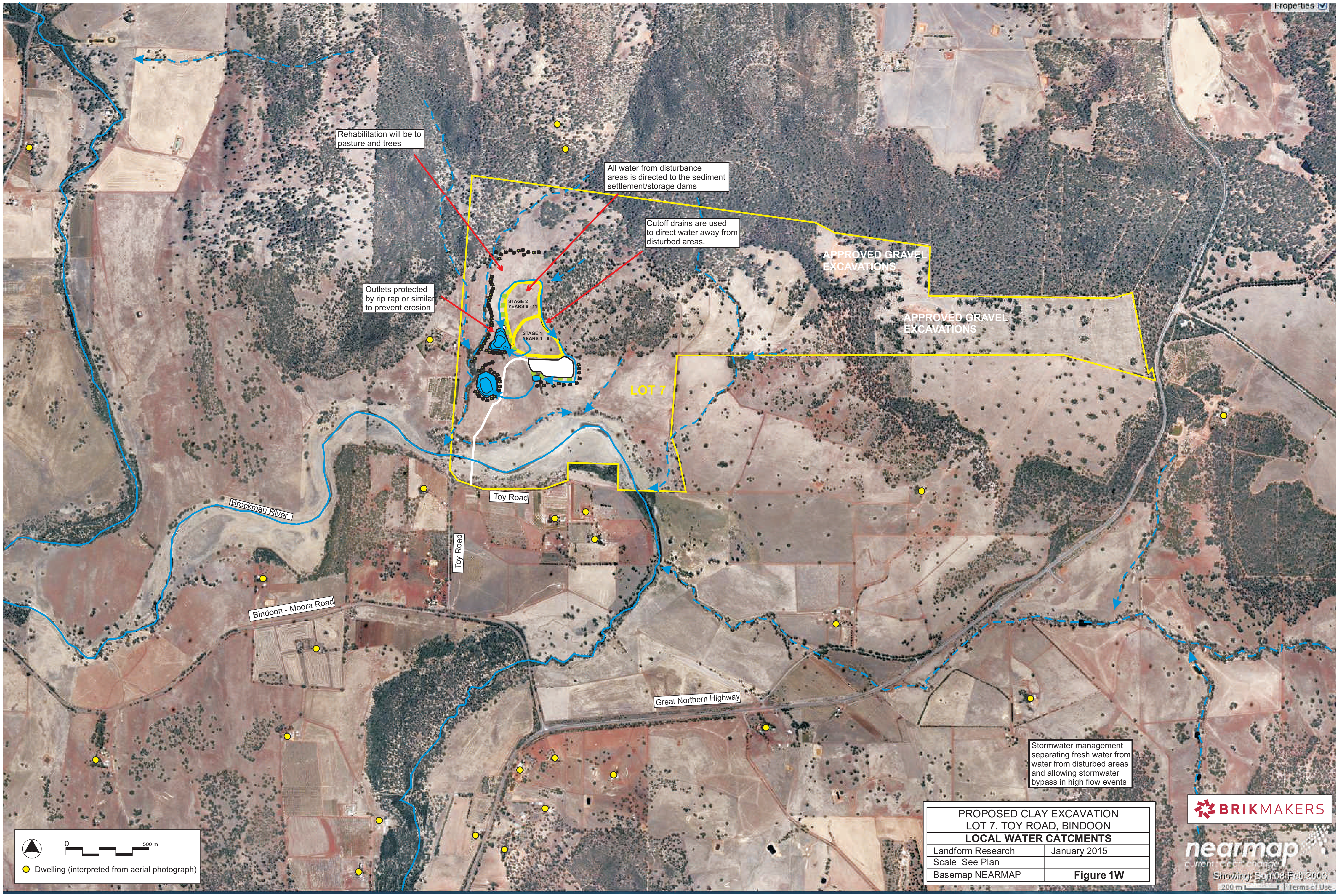
The resource is clay with very low permeabilities and therefore any fuel or other spills may not show up for some years in the groundwater.

The management is therefore essentially the management of surface water.

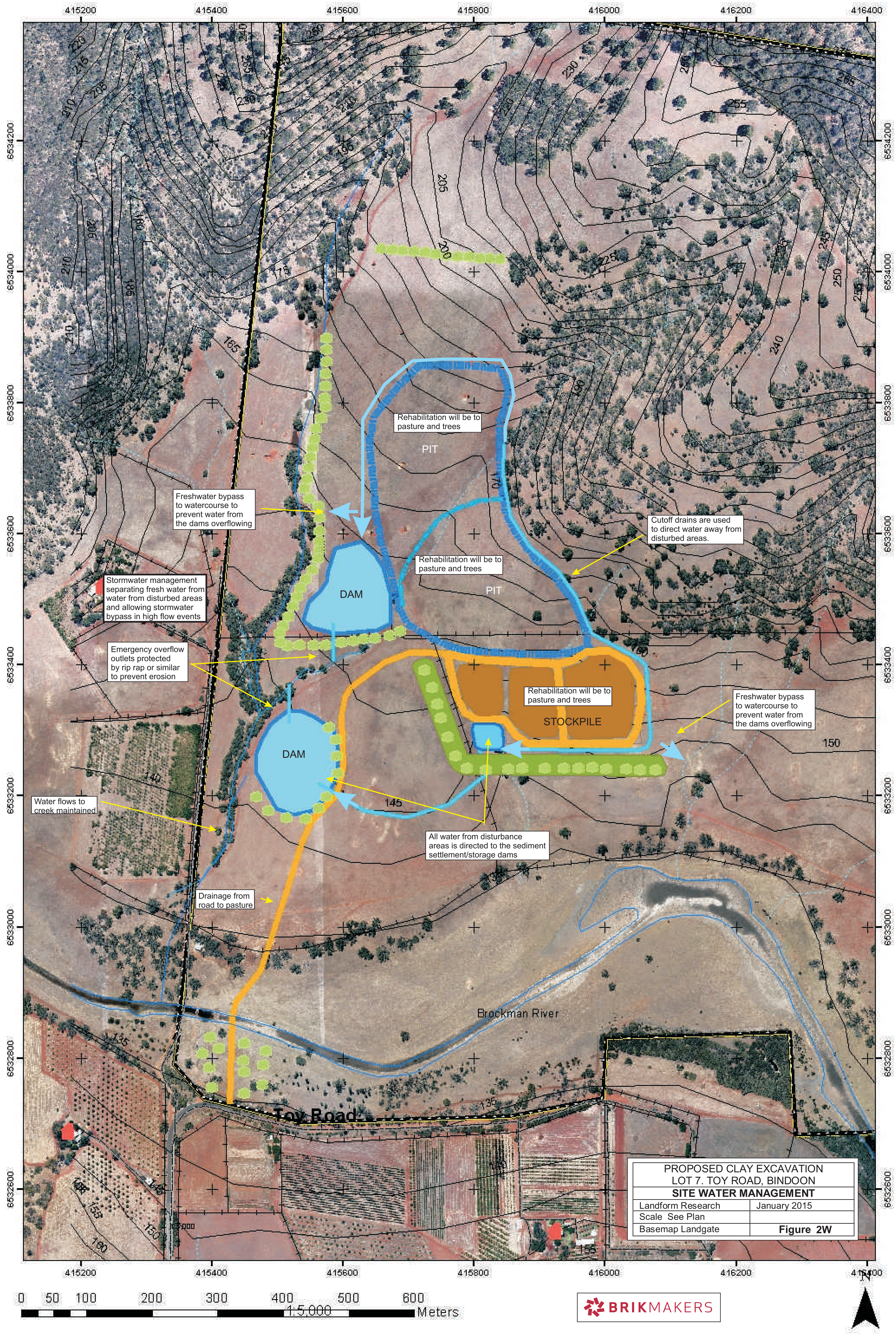
The dams will form water storage and act as detention basins located outside the excavation area and at the downstream end of the stockpile area as shown in Figure 2W.

The dams will retain all stormwater landing in the pit within the excavation area and allow time for any sediments to settle. There may be limited excess water directed to the dams at the end of winter that will overflow to the creekline. Refer to Figures 1W and 2W.

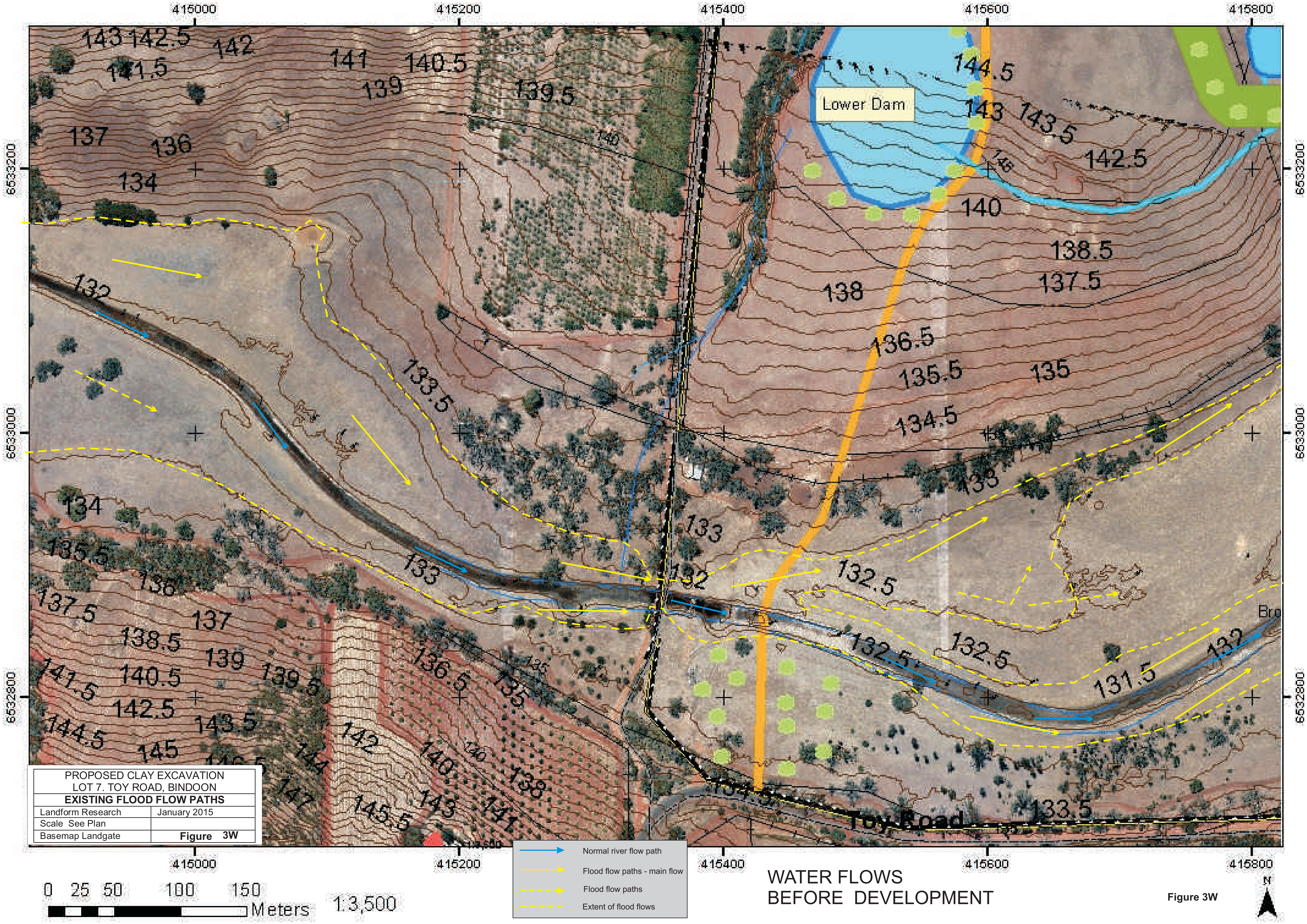
As this water will be used for dust suppression it will be monitored twice yearly (in spring and autumn) for salinity and hydrocarbons.




| PROPOSED CLAY EXCAVATION LOT 7. TOY ROAD, BINDOON | |
|---|---|
| **LOCAL WATER CATCMENTS** | |
| Landform Research | January 2015 |
| Scale See Plan | |
| Basemap NEARMAP | **Figure 1W** |

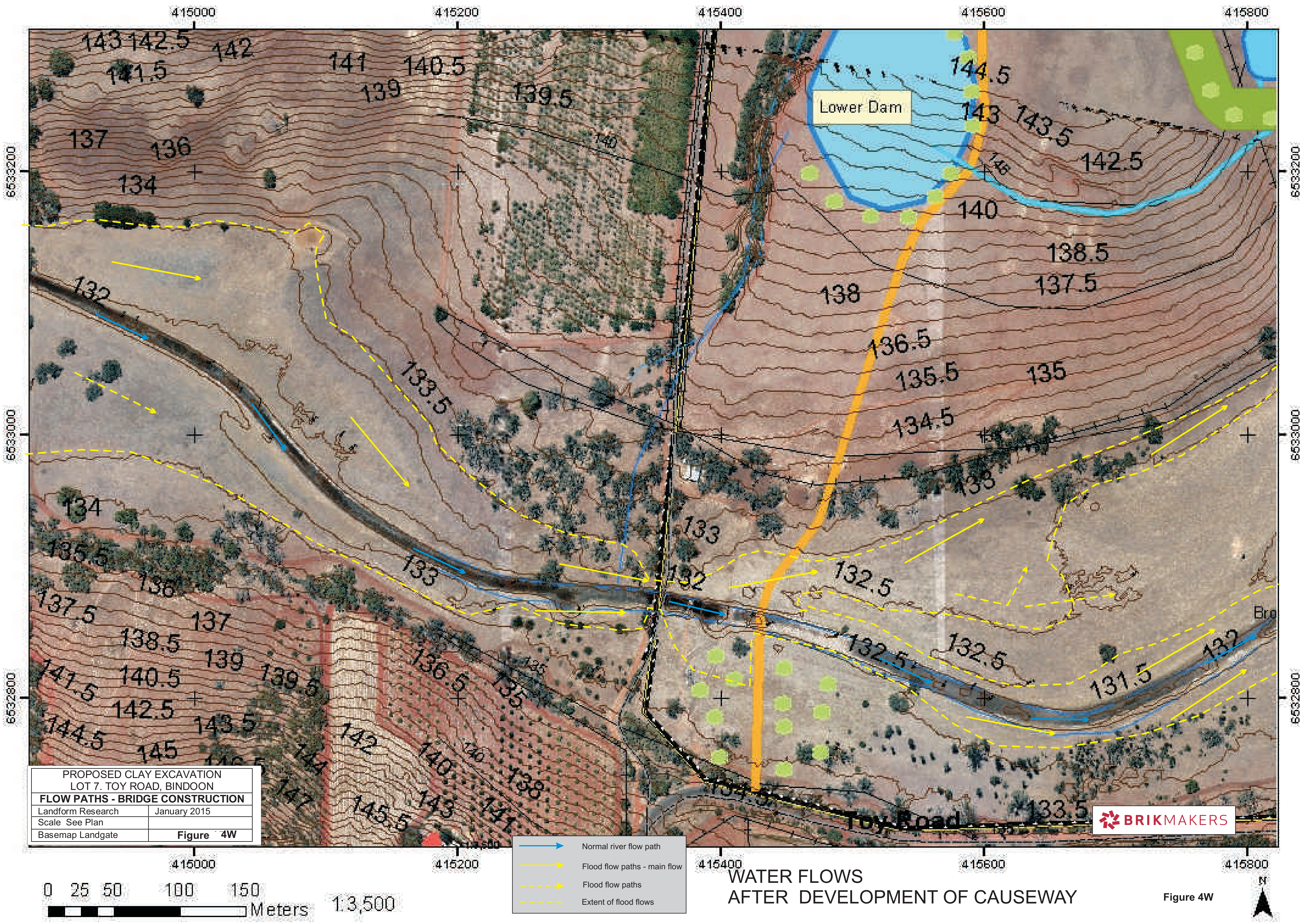


Rehabilitation will be to pasture and trees
PIT
Freshwater bypass to watercourse to prevent water from the dams overflowing
Cutoff drains are used to direct water away from disturbed areas.
Rehabilitation will be to pasture and trees
PIT
Stormwater management separating fresh water from water from disturbed areas and allowing stormwater bypass in high flow events
DAM
Emergency overflow outlets protected by rip rap or similar to prevent erosion
Rehabilitation will be to pasture and trees
STOCKPILE
Freshwater bypass to watercourse to prevent water from the dams overflowing
DAM
Water flows to creek maintained
All water from disturbance areas is directed to the sediment settlement/storage dams
Drainage from road to pasture
Brockman River
Toy Road
PROPOSED CLAY EXCAVATION
LOT 7. TOY ROAD, BINDOON
SITE WATER MANAGEMENT
Landform Research
January 2015
Scale See Plan
Basemap Landgate
Figure 2W
0 50 100 200 300 400 500 600
1:5,000
Meters
BRIKMAKERS



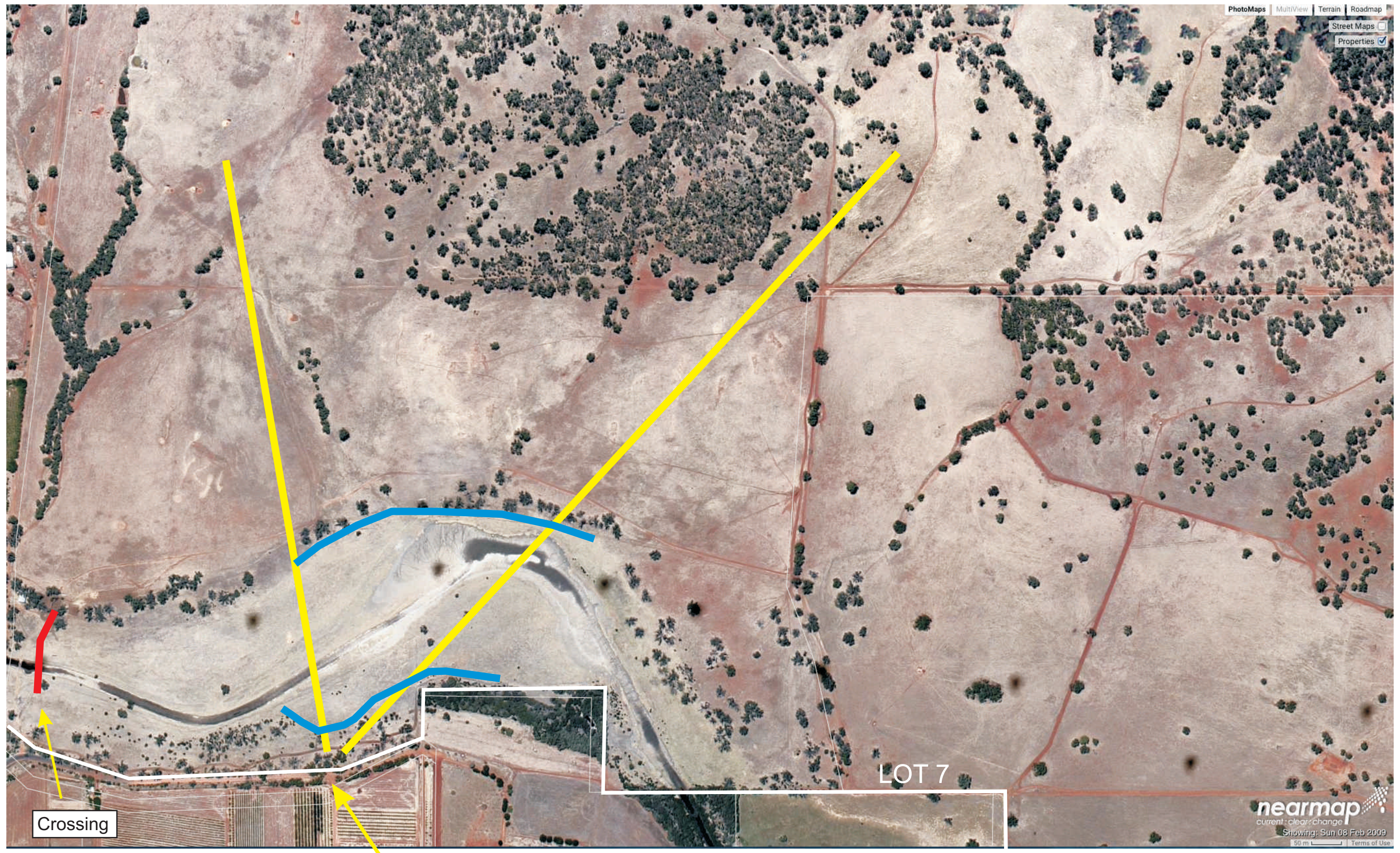

WATER FLOWS
BEFORE DEVELOPMENT

Figure 3W

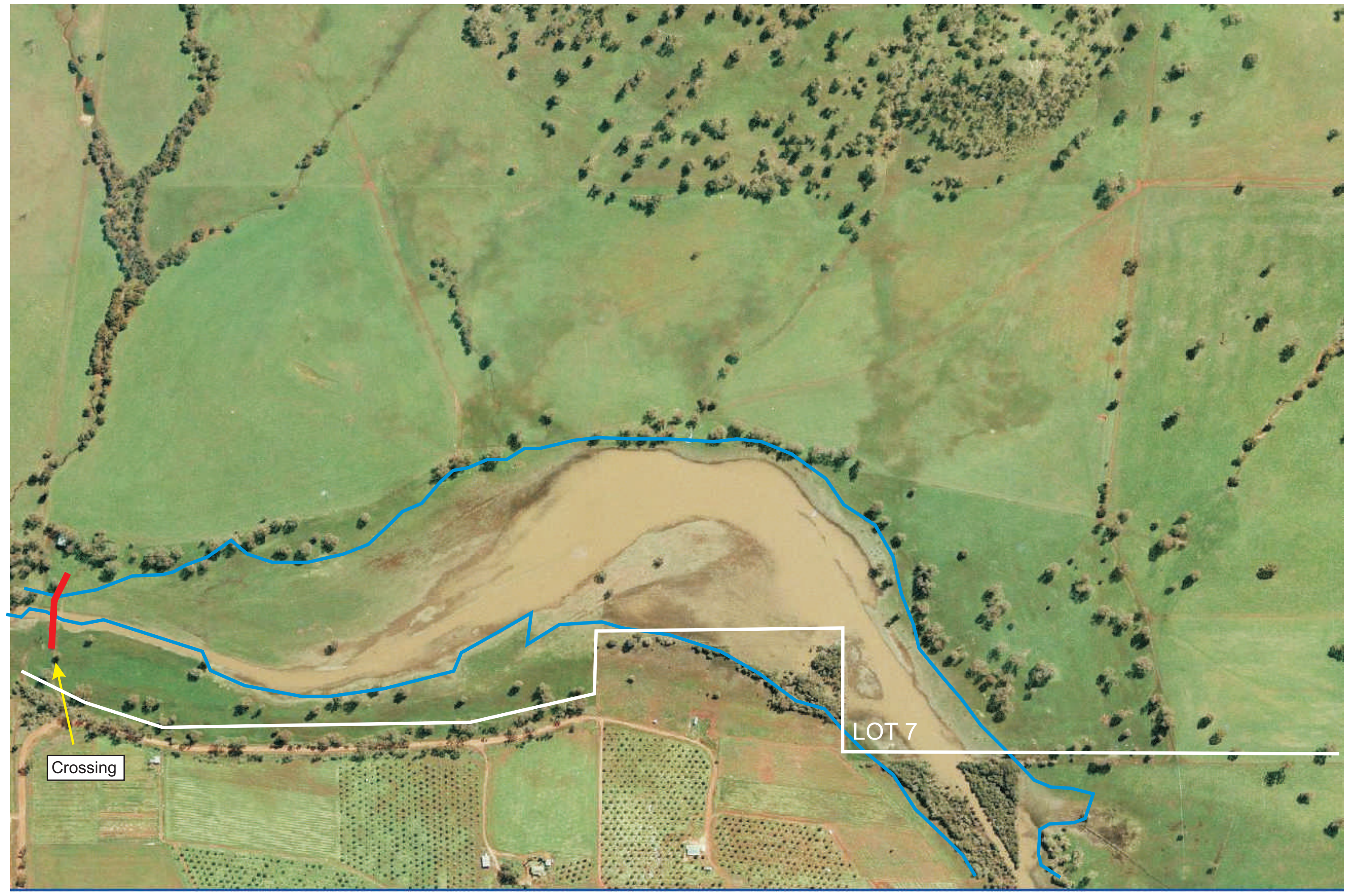



WATER FLOWS
AFTER DEVELOPMENT OF CAUSEWAY

Figure 4W




Interpreted match for flood photo




Interpreted extent of flood (Landgate 1981)


Interpreted extent of wet winter surface water

| PROPOSED CLAY EXCAVATION<br>LOT 7. TOY ROAD, BINDOON | |
|---|---|
| **INTERPRETED FLOOD EXTENT** | |
| Landform Research | January 2015 |
| Scale See Plan | |
| Basemap Landgate | **Figure 5W** |

BRIKMAKERS

Otto-Markham Holdings Pty Ltd (ACN 098 910 019) trading as

MEYER WATER & ENVIRONMENTAL SOLUTIONS

1st March 2005

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Dear Nathan,

Re: Review of Groundwater Occurrences, Toy Road Clay Deposit

## 1. Introduction

The Toy Road Clay Deposit is located in the Brockman Valley on the Darling Plateau north of Bindoon. The hydrogeology of the area was investigated during a field visit on the 23rd February 2005. Groundwater was known to occur near the clay deposit due to the presence of two springs in the low topographic areas south of the proposed pit (Attached Plan). This investigation was conducted to determine:

- If there were significant groundwater resources in the proposed clay pit area.
- If the proposed pit could impact groundwater resources or the known springs in the area.
- If there were any other issues associated with the presence of groundwater in the area.

## 2. Hydrogeological Description

The Toy Road Clay Deposit is located in the Western Fractured Rock Zone of the Brockman River catchment. Groundwater resources are generally limited but are usually good quality.

The clay deposit is located in the weathered zone above a north-south trending Diorite Dyke. Groundwater occurs in the contact zone on either side of the dyke. On the west margin, the contact is coincident with a valley and at the base of the valley there is a permanent spring where groundwater discharges to the surface and is used for stock watering. The aquifers along the contact zone are referred to as Saprolite or Fractured Rock Aquifers depending on their position in the weathered rock profile.

On the east margin of the dyke, groundwater was found during this survey. This eastern aquifer is not defined by a valley like the western aquifer but can be seen partly by outcropping micaceous rocks and granites and possibly by a groundwater soak located some 330m south of the proposed pit and at about 7m lower elevation than the West Spring. The soak is referred to as the East Spring but is generally never more than a patch of wet ground with no observable run-off.. The relationship between this spring and the eastern aquifer is only inferred for several reasons:

- The contact zone of the dyke has not been mapped by drilling south of the pit.
- There is no well defined topographic feature along the contact zone.

- There is some evidence for potential north-easterly orientated structures crossing the contact zone. The soak could be fed from groundwater travelling along one of these cross cutting structures.

Minor groundwater was also observed from below the soil zone and on top of the weathered bedrock. This aquifer is referred to as the Perched Aquifer and the groundwater is essentially recent seasonal rainfall recharge. It will have a lower salinity than groundwater in the two main aquifers.

Land salinisation issues are not known in this area as the soils are generally less saline than those further east.

## 3. Results from Field Investigations

The field survey was divided into two parts in line with the expected occurrence of the two known aquifers.

**West Aquifer**

Groundwater was observed in two locations along the western aquifer.

- A natural spring, referred to as the West Spring occurs in a low topographic elevation near the SW corner of the proposed pit. The spring flows all year but flows are generally low near the end of summer. The salinity of the spring water was measured using an electrical conductivity (EC) meter. The value recorded was 720 to 750µS/cm @25°C (470 to 490mg/L TDS[1]) and is therefore fresh and potentially suitable for irrigation. Water in a collector dam downstream from the spring had concentrated by evaporation. The measured EC was 1410µS/cm@25°C. The landholder had observed spring flow rates of about 20L/min.

- A costean had been dug to 6m depth over hole DW47 at a location some 210m south from the spring. The costean had been pumped by the landholder at a rate of approximately 350L/min for 2 hours. Water levels recovered to near, but a lower water level than prior to pumping. This indicates that the costean is fed from groundwater. The water depth on the 23rd February 2005 was 2.4mbgl[2] and the EC measured from a bailed sample was 400µS/cm@25°C (260mg/L TDS). Some surface run-off or preferential inflow from the Perched Aquifer has probably contributed to the lower salinity observed in the costean compared to local spring water. Also some evaporation may have increased the salinity of the spring water sample.

Groundwater was not found in three clay exploration holes that were opened up and dipped. These were:

- JD18. Originally drilled to 6.5m but now blocked at 4.9m.
- JD64. Originally drilled to 7.5m and still open to full depth.
- JD72. Originally drilled to 16.5m but now blocked at 10m.

Groundwater levels are expected below these depths.

[1] Total Dissolved Salts calculated by multiplying EC by a conversion factor of 0.65.
[2] Metres below ground level.

**East Aquifer**

Groundwater was found in two clay exploration holes opened up for this survey.

- JD49 is located near the north east corner of the proposed pit. Groundwater with EC of 720µS/cm@25°C (470mg/L TDS) was found at 11.6m depth. The hole was open to 13.2m depth and had been originally drilled to 14.5m. The water was inferred to be groundwater as this section of the hole had intersected fractured, weathered Diorite.

- JD76 is located 150m south from JD49. Groundwater with EC of 270µS/cm@25°C (175mg/L TDS) was found at 10.95m depth. The hole was open to 12.1m depth and had been originally drilled to 13.0m. The lower salinity groundwater was inferred to be from the shallow Perched Aquifer and not the main, deeper aquifer.

Hole JD21 is located near the south eastern corner of the proposed pit but no groundwater was present to a depth of 10.6m.

The eastern aquifer is fractured diorite and is located in the saprolite zone just above fresh un-weathered bedrock. The depth of the fresh bedrock was mapped as the point where the drilling rate reduced significantly (drilling refusal).

## 4. Impact of Proposed Pit on Groundwater

**West Aquifer**

The water levels in the West Aquifer are below the depths measured in the clay exploration holes. They will also be below the adjacent stream level. The base of the pit at this location is above the expected level of the groundwater and therefore there will be no direct impact of mining on this aquifer. There could however be an indirect impact if surface runoff ponded above the top of the aquifer and infiltrated into the aquifer. This will particularly be a concern if pond water was allowed to deteriorate in quality through evaporation or through geochemical processes such as acidification.

There will be no impact of clay mining on the West Aquifer and associated spring flows provided water is not allowed to pond along the western side of the pit.

**East Aquifer**

The East Aquifer is located along the eastern edge of the proposed pit. Mining will intersect and drain the East Aquifer if mining is taken to full depth along the eastern edge. The pit can however be redesigned to avoid the aquifer and therefore not have any direct impact on the groundwater. It is however difficult to imagine the pit not intersecting some minor fractures extending into the pit from the main aquifer. Even if the fractures are minor, groundwater will still seep into the pit and cause this aquifer to slowly drain. Grouting of a fractured rock aquifer to prevent this occurring is generally difficult and costly.

If mining intersects the aquifer it will have the following impacts:

- A portion of the groundwater resource will be depleted. The amount of depletion will depend on how deep the fractures within the aquifer are intersected. The amount of depleted groundwater will be less than 100kL/hectare of aquifer for each metre of drop in the groundwater levels (drawdown). The maximum drawdown is expected to be only 3metres. The area of the aquifer is expected to be less than 5 hectares so the loss of resource is in the order of 1000 to 1500kL.

- The Western Spring may dry up if it is located in the same aquifer. This soak is not significant as it does not support any ecological habitats or economic entities.
- The aquifer will be exposed and there will be a potential for contamination to enter the aquifer if surface runoff is allowed to pond over the fractures. The base of the pit should be designed to not allow ponding along the eastern wall.

## 5. Conclusions and Recommendations

In summary it is expected that there will be a small loss of groundwater resource along the eastern side of the pit. This groundwater resource is small and would only have benefit to the local landholder. An alternate surface water resource can be made available to the landholder. I understand a collection dam along the western creek is proposed for this purpose.

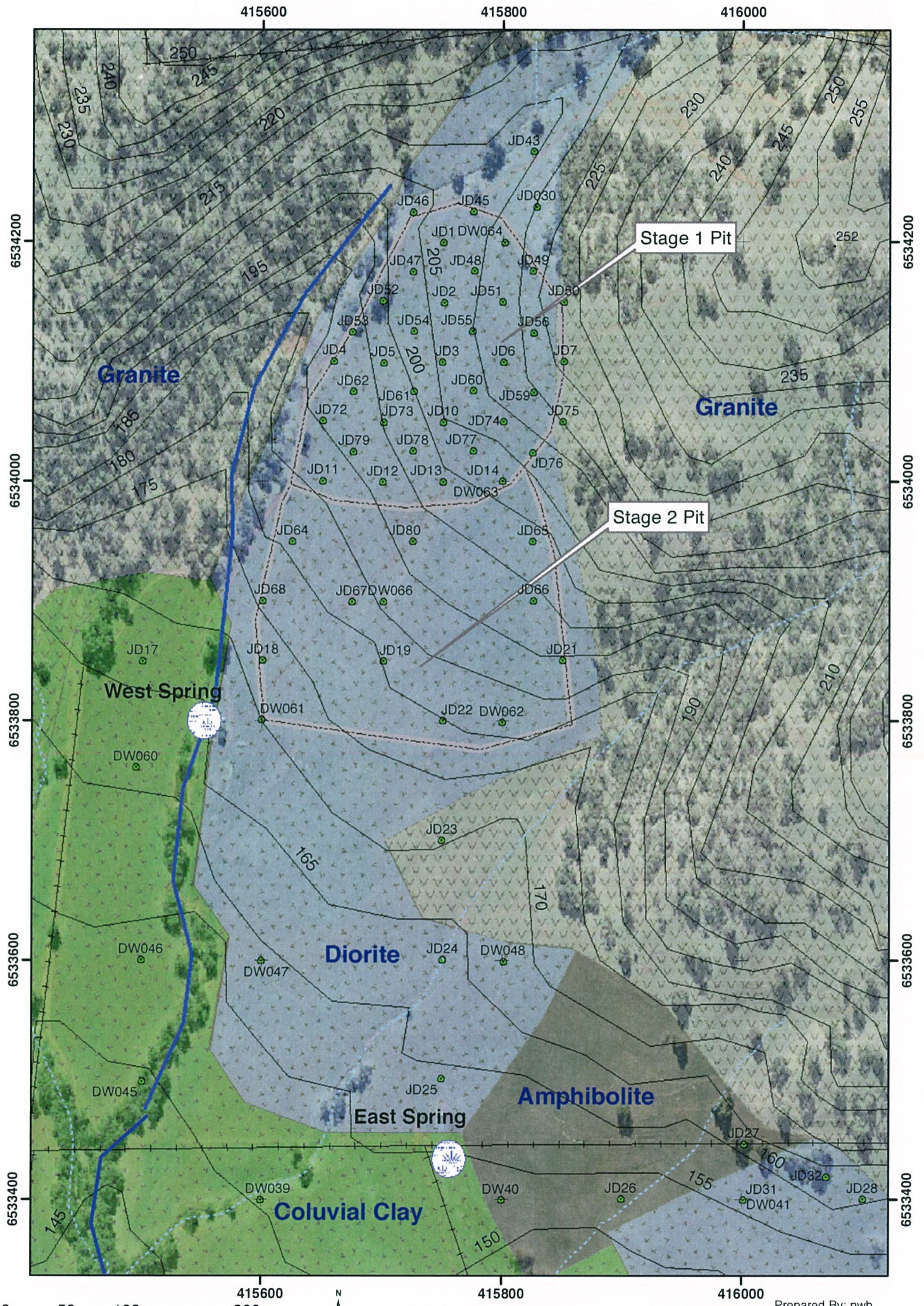
With proper design of the pit floor and control of surface water ponding there are not expected to be any issues associated with contamination of groundwater in the aquifer. It is recommend that surface water not be allowed to pond along the western and eastern margins of the pit where it can infiltrate into the aquifers.

To monitor the impact of mining on the two main aquifers it is recommended that a monitoring bore be drilled into each aquifer near the southern limit of the pit. Groundwater levels and quality can be measured during the course of mining to confirm the predicted impacts.

The lowering of groundwater levels in the eastern aquifer will have a positive impact on the potential for salinisation in this area.

Yours sincerely

Gary Meyer




0 50 100 200 Meters

1:4,000

# Preliminary Plan
# Pit, Lot 7 Toy Road Bindoon

BGC

Prepared By: nwb
Printing Date: March 2, 2005
File: Bindoon hydro .mxd
BGC Clay Products